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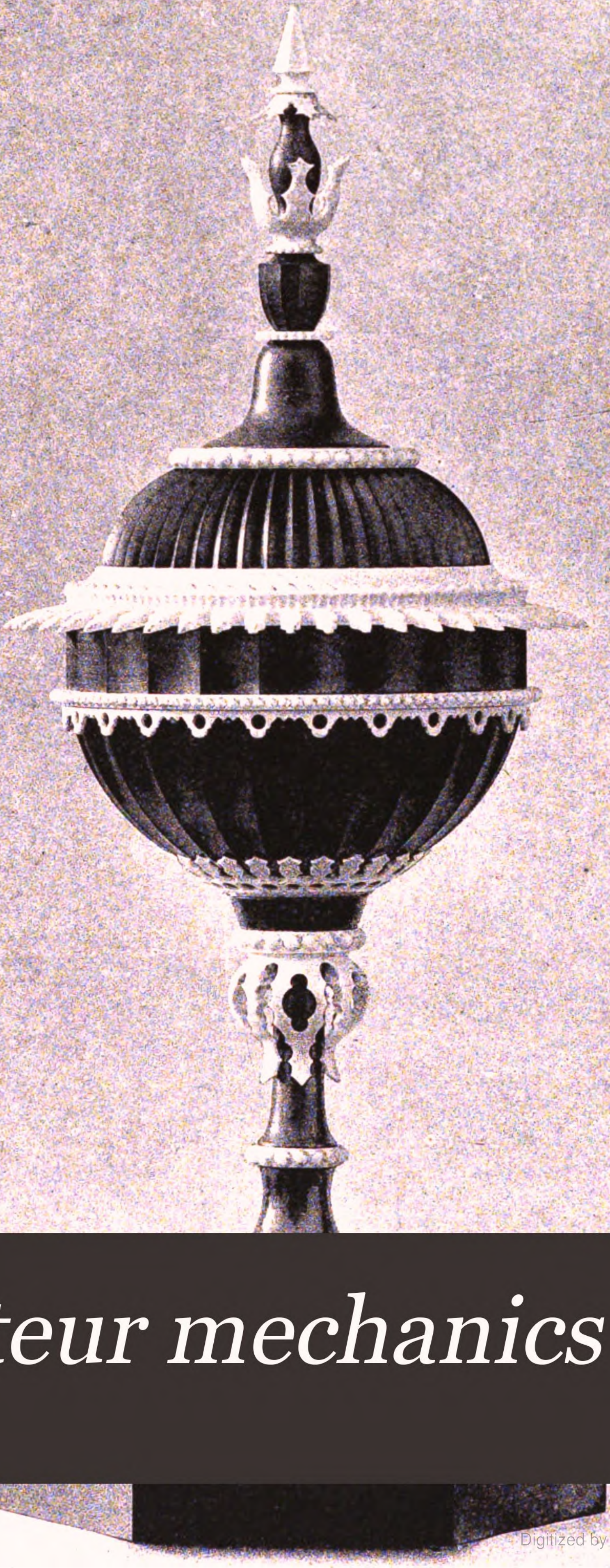

Amateur mechanics

AMATEUR MECHANICS:

ILLUSTRATED MONTHLY MAGAZINE,

Conducted by PAUL N. HASLUCK.

AUTHOR OF "LATHE-WORK," &c., &c.

VOLUME I.

ILLUSTRATED WITH 46 FULL-PAGE SUPPLEMENTARY PLATES, AND OVER 300 CUTS IN THE TEXT.

LONDON:
TRÜBNER & CO., LUDGATE HILL.

LIST OF FULL-PAGE ILLUSTRATIONS.

**** The Supplements issued with the Monthly Parts should be bound at the end of the Volume, in the order shown.*

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AMATEUR MECHANICS

AN

Illustrated Monthly Magazine,

CONDUCTED BY PAUL N. HASLUCK.

No. 1.—Vol. 1.] JANUARY, 1883. [Price Sixpence.

INTRODUCTORY PROSPECTUS!

THE first issue of a periodical publication is usually prefaced with some particulars of the intended scheme of the nascent literary venture. How closely the original design is adhered to only time discloses. As a matter of fact, it appears that the original schemes of periodical publications are subject to extreme mutability. Our own experience has shown us that as time advances new features are disclosed, and hence the scheme of a periodical should be progressive in order to keep pace with advancing time. To define a precise course for this magazine to pursue is, at the present time, inconsistent. We shall endeavour to meet the wishes of those who support our venture. When we have had the privilege of hearing the views of our constituency, our efforts will be directed to carry out such of them as appear consistent.

This magazine is not engendered of any to which a similarity may be supposed to exist. The basis of the scheme of this venture was conceived many years ago, and ever since then the details have been maturing. The want of a journal treating on the topics of which we purpose treating has been recognised; and several diverse attempts have been made to supply it. How far the attempts have proved successful it is not within our province to discuss. We need not particularise any of the journals, weekly, monthly, and quarterly, that have successively appealed to amateur mechanics for support. Our personal knowledge of the origination and subsequent career of most of those which have been brought into existence during the past ten years, affords experience of which we intend to make the fullest use.

In placing our first issue into the hands of a large number of subscribers, we are constrained to express a hope that it will be found to equal premature expectations. In many ways disappointment may be caused, but so long as it is only in matters of trivial detail, it will probably be but slight. Only those who have experienced them can understand the embarrassments that attend the production of a first issue. The multiplicity of extraneous subjects that have to be considered are appalling. Happily, when once determined upon, a particular subject requires no further consideration, thus lightening the duties connected with subsequent issues. The time expended on the entire magazine has been limited, and did not allow of the full development of some of the features intended. With number one before him, the reader may infer an idea of the style and scope of the magazine. Original subject matter to fill the columns was not to be procured without notice, and, consequently, we have ventured to reproduce some articles that have already appeared.

A photograph, illustrating some specimen of ornamental turnery was intended as an extra supplement to the first issue of this magazine. We are fully sensible of the great amount of interest that would be centred on such an object, and regretfully have to acknowledge that, owing to the failure of the artist to produce a good photograph, we must postpone the publication of the intended extra supplement. By the kind courtesy of General G. C. Clarke, we have an excellent specimen of his skilled handiwork to copy. The object is a cup and cover, in blackwood and ivory; enriched with chaste flutings, beadings, and ornamental drilling. Nothing but artistic photography can do justice to the workmanship. The picture which we now have has all the outline, but there is a want of clearness in the whole which mars the effect, and renders the details obscure. We intend to publish, as occasion offers, photographs of specimens of turnery, and in so doing we shall only respond to a widespread desire for authentic illustrations of ornamental lathe work. The inherent characteristics of such work are frequently lost in translation to a woodcut, be this ever so well done, but a photograph from the object itself bears the impress of unquestionable authenticity. To an extent we are dependent on our friends to supply originals of suitable objects, and shall be glad to hear from any readers disposed to assist. Our next issue will contain a photograph of the cup above mentioned.

The lithographic illustrations are a novel feature which readers will appreciate. We shall be able to give, from time to time, absolute working drawings of various mechanical work. Tools, appliances and instruments used in the mechanical arts will be carefully illustrated and described. It is a fact, which amateurs have fully recognised, that real working drawings are seldom published. We have already several drawings in progress for illustrating the various details of a fine amateur's lathe, fitted with screw-cutting motion, overhead gear, duplicate headstocks, and a large assortment of chucks and apparatus. This lathe shows a type possessing many peculiarities, and, by fully illustrating it, we shall place before our readers correct scale drawings of many good modern tools that have cost hundreds of pounds. Simple machines and appliances, such as chucks, drilling instruments, and the innumerable kindred tools, will be shown in a way to make their construction clearly apparent.

The subjects embraced in the scope of the magazine are limited only to those that are comprehended by the title. Any subject appertaining to the practice of mechanical work by amateurs has a claim upon our space, but we intend to rigorously exclude all other matter. In the next issue will be commenced articles on the following subjects: Clockwork, cabinet work, geometric chuck construction; all illustrated with lithograph plates. Knowing the inconvenience and disappointment attending the want of punctuality on the part of contributors, we have determined to secure the whole of the subject matter for a series of articles before the first is commenced. Several other serial articles are under consideration, and we doubt not that our second issue will surpass the first.

The commercial success of this magazine, which is to us the main object of its existence, can only be insured by the assistance of individual readers. Each can do something towards promoting its welfare; perhaps each one may have a different special facility for assisting us. Any help will be appreciated. Members of the community that are included in our title exist in such diverse places that they are somewhat difficult to reach. Every amateur mechanic usually knows some other following similar pursuits, and we ask each individual reader of our first issue to bring the magazine to the notice of any friends to whom it will be likely to prove interesting. By this course the magazine will be introduced to a large circle, to which it would be very difficult to gain access in any other way. Any contributions we shall be glad of, and suggestions will receive careful consideration.

A practical acquaintanceship with the subject matter of the magazine will enable us to exercise due control over the contents. That our previous efforts to afford information to those practising the useful arts have been successful, we have been agreeably convinced. The distribution of a few thousand circulars has brought us shoals of letters from old and new friends in all parts of the kingdom. We cordially thank all who have kindly assisted to promote the success of this magazine, and hope to increase an ever widening circle of friends with each successive issue.

SLIDE-REST TOOLS FOR METAL TURNING.

(For Illustrations see Lithograph Supplement.)

SLIDE-REST tools have been the subject of innumerable essays. The subject of the cutting edges and their modification for application to different materials is one which has been discussed again and again. The object of this article is simply to illustrate some of the simple forms of slide-rest tools commonly used in engineering workshops, and to explain their action when in use. The cuttings taken off good metal by a suitable tool properly applied would probably somewhat astonish amateurs who are used to light lathe work only. Some of the very large self-acting lathes throw a shaving that is quite a bulky strip of metal. A cut two inches deep and fed at the rate of an eighth of an inch per revolution, is spoken of as being common practice in some of the American workshops.

Referring to the illustration, fig. 1 shows a tool having its cutting edge applied to the work on the line of centres, which is the correct position. Fig. 2 shows a tool incorrectly applied at a point above the centre. Fig. 3 shows a tool also incorrectly applied much below the centre. Considering the obvious erroneousness of the two latter methods of applying the tool it is curious to find many so-called skilled artisans adopt either the one or the other; the advocate of the high tool having supreme contempt for the ignorance of the advocate of the low tool, and *vice versâ*. It would be very interesting to hear a discussion between advocates of the two methods. Perhaps the consideration of the effect of each successive cut on the relative position of the tool to the work will suffice to show the error of applying tools either above or below the line of centre.

Suppose we take it that in fig. 2 the work is one inch in diameter, and that the point of the tool is one eighth of an inch above the centre. As soon as the work becomes reduced to one quarter inch diameter it will be absolutely impossible to make the tool act, because the whole of the work will be below the cutting edge. In fig. 3 suppose the tool to be one eighth of an inch below centres, and as soon as the work is reduced to one quarter inch diameter the tool cannot be made to cut it further, because the work will be entirely above the cutting edge. As a matter of fact, the tool would in both cases cease to act effectively long before the work was so much reduced. The above results are supposed in order to prove the fallacy of the method. It will be seen that during the passage of the tool from the periphery towards the centre, the angle that the cutting edge makes with the work is continuously changing. As has been pointed out many times, the face of the tool should form a tangent to the work on which it operates, and this position can only be maintained at all diameters when the cutting edge is applied on the line of centres.

The position of the tool at fig. 1 is better explained by reference to fig. 7. This latter illustration is copied from *Lathe-Work*, where the following particulars concerning it are given:—

"The angles best suited for the particular material to be operated upon are most desirable in slide-rest tools, and after having had some experience with hand tools, more especially as applied to soft wood turning, anent which some information is given in another chapter, the advantage of various angles will be appreciated. It will be understood that the cutting edge will penetrate best when it is thinnest; other considerations, however, prevent the adoption of this rule unreservedly; and for metal work tools are found to act best when the faces form the cutting edge at an angle of from 60° to 90°. The face of the tool coming next to the work requires to be ground at a slight angle, leaving the point prominent to prevent the whole face touching the work, and so by the friction greatly increasing the labour of turning. When this requirement is satisfied, the face should be as upright as possible, and 3° from the perpendicular suffices. This applies equally to tools with acute edges used on wood, though when we come to knife edges the face of the tool itself usually rests against the work it has to cut and there is no angle of clearance.

"The fig. shows tools correctly applied for cutting both wood and steel. By this it is seen that the slide-rest tool, with a strong cutting edge suited to dividing cohesive metal, and the acute wood-turning chisel, each have the lower face-angle placed in the same position with regard to the work. Therefore it is only the upper face which wedges back and curls or breaks off the shaving that is altered agreeable to the different nature of the materials. The line of centres is shown at *a b*, and at precisely the height of this line should be the point of the tool fixed in the rest. Here it may be advisable to point out that tools must be packed up with parallel strips, otherwise the relative position of the angles is interfered with. The edge of the metal turning tool is formed by the meeting of the faces *a x* and *d x*; *a x* being parallel with *a b*, and *d x* 3° from the perpendicular gives the angle of the point as 87°. This is the most obtuse angle usually employed, though for some purposes where a scraping action is required the top face is bevelled off downwards to make the edge even more blunt. The edge of the soft wood chisel is formed by the meeting of the faces *c x* and *d x*, enclosing 25°, still keeping the lower face situated precisely alike. The tools might be applied at any part of the circle even vertically above it, so long as the same relative position is maintained; but the slide-rest as ordinarily constructed necessitates the application of the tool on a level with the centres."

When hand tools are used, the position of the cutting edge relative to the work may be altered by simply raising or depressing the handle. The tool may be applied at any point on the periphery of the work, and so long as the cutting edge forms a tangent to the circle, the principles before advocated will not be violated. This fact so often puzzles the majority of young beginners that it cannot be too strongly insisted upon. When a wood-turner is seen to work with the turning tool applied somewhere about the top of the work, the theory of "apply the tool at the line of centres" appears to be practically contradicted, but this is not so. The tool still forms a tangent to the circle, and as the work becomes smaller in diameter the position ot the tool is altered by raising or lowering the handle within certain limits, and then the T rest is shifted. It is only when the tool is moved perfectly horizontally, as it is with an ordinary slide-rest, that the point must be applied at precisely the same height as the lathe centres.

Side-rest tools for metal turning, as sold at most tool shops, in London at any rate, are made on an absurdly wrong principle. Fig. 6 gives an idea of the usual style in which the tools are forged. The cutting edge is considerably above the top of the shank of the tool, and, as a rule, the tool cannot be used on an ordinary lathe. The top of the metal turning slide-rest, for a foot lathe, about five inch centre, is usually half an inch below the line of centres. It is very rare that the top of the rest is three-quarters of an inch below the centres even in a six-inch lathe. Yet the tool shop slide-rest tools are made of five-eighth and three-quarter steel, and have the cutting edges above the top of the shank even then. Consequently the tools cannot be used unless tilted up from the back, so as to bring the point down to the work, and at the same time destroy all the relative angles of the cutting edges. Steel half-an-inch square is quite large enough for most slide-rest tools for foot lathes of the sizes mentioned above, and it would be a boon to amateur mechanics if useful slide-rest tools could be purchased at the tool shops. Cutter-bars are, perhaps, all things considered, more suited for work, and these will be treated upon in a subsequent article. A sheet of illustrations, showing useful slide-rest tools, will no doubt be interesting, and will be given at an early date.

At fig. 8 a tool is shown having the point depressed considerably, and having but slight side rake. In use this tool would be forced away from the work by the action of cutting. The slight side rake would tend to help the feed of the tool along the work. The cuttings made by this tool would roll over slightly towards the right. If the tool had no side rake the cuttings would roll over on itself, forming a ball, or breaking off as soon as it touched the work if the metal be not very tenacious. The action of this tool is more scraping than cutting—the side rake gives a certain amount of cutting action, but the front rake gives none.

At fig. 4 a tool is shown having no front rake, but a considerable amount on the leading side. With this tool the shaving would curl off in the direction shown by fig. 9. This tool would have no tendency to dig into the work from the front, but would be drawn into cut by the side rake. If the slide-rest moved freely in a direction parallel to the cut, the tool would probably be broken by the self-feeding action just alluded to.

For the rapid removal of a large quantity of material, a tool having both front rake and side rake is best. A tool of this kind is shown at fig. 7; the form of shaving that it would make is shown at fig. 10. In this tool the action of cutting would tend to draw the tool into the work. When the tool was brought up to its work, and commenced to cut, it would be drawn into the work as far as any back-lash if the slide-rest screws would allow. Such a tool requires care in manipulation, as, if the slide-rest fitting was very slack, the tool would probably be broken as soon as it was brought into cut. Frequently the lathe would be stopped before any actual breakage occurred. At an early date we shall return to the subject of slide-rest tools.

FITTING UP A WORKSHOP.

By Rev. James Lukin, B.A.

AMATEUR Mechanics are often puzzled how to buy economically and arrange conveniently the tools required for putting their mechanical proclivities into practice. We often meet with the question, variously expressed: "What tools ought an amateur to begin with?" To answer this satisfactorily, it is necessary to ask another: "What sort of work do you propose? Are you going in for a little carpentery and joinery; or is your pet hobby engine making, and other work in metal; or do you aspire to emulate the carved and turned works in wood and ivory displayed in shops and private cabinets?" Let us begin with a bit of sound, practical advice. Do not aim at too much; make up your mind which branch of the mechanical arts is likely to give you the greatest satisfaction, and stick to it. As to the rest, leave them alone. The professional carpenter does not attempt shoeing horses and working in metal; nor does the clock-maker endeavour to rival the engine builder. Each has his own special trade, which he carries out, therefore, efficiently, and he is content with the tools of that trade, which are expensive enough to prevent his wishing for others. As a rule, amateurs aim at too many trades, and, consequently, do nothing well. I think, however, we may give him this much freedom. He may work in wood or in metal. Carpentry and wood turning are closely allied—and metal working may embrace more or less of two or three different trades. These main divisions of the mechanical arts are almost a matter of necessity for the purpose of the present paper.

Beginning with woodwork, however, it is rather the lighter kind, known as joinery, that an amateur is wont to undertake; and boxes, cupboards, shelves, cabinets, and small chests of drawers, with tables and plain deal furniture, will be the articles on which he will be likely to exercise his ingenuity. Not a very costly outfit is needed for work of this kind, but the tools must be really good, and ought, therefore, to come from a toolshop rather than from an ironmonger's. The commoner tools, however, may be bought very often, even in the country, of excellent quality, and obtained from the best makers, only there is the second profit to be reckoned, and, therefore, the price is for the most part higher. Beginning with a very small set, we must, of necessity, procure—hand saw, smoothing plane, brace and bits, mallet, tenon saw, three firmer chisels, six gimlets, three bradawls, jack plane, one square (6in.), two-foot rule, pincers, one light and one heavy hammer, two screw-drivers, compasses, one gauge, glue-pot.

With these alone you can make a good box or cupboard, dovetailed at the corners or plain, and mortised and tenoned works of various kinds, if not heavy. For the latter, the firmer chisels are not sufficiently strong Begin, therefore, with these, and specially aim at sawing exactly to line and planing truly, and thus fairly win a title to the following, as your next purchase:—one trying plane, one mortise gouge, one bevel, keyhole saw, four mortise chisels (1in., ½in., ¼in., ⅛in.), skew rebate (½in. iron), two gouges (¾in and ⅜in.), one plough with eight irons.

The plough, and another called the fillister, are expensive planes, but you so often need them in joinery—the one for grooving, and the other for rebating—that both should be added to the tool chest as soon as may be. With these additions, the amateur may considerably enlarge his sphere of work, because he will be able to execute panelling, and to join boards neatly side by side with tongue and groove, so that, if they shrink, no daylight will appear between. The trying plane will enable him to shoot the edge of a tolerably long board quite true, so that really close joints may be made. The jack plane will then be kept for roughing down surfaces, which the trying and smoothing planes will finish. Advancing yet another step, we may add—one mitre saw, set of augers (1in. downwards), one sweep or turn saw, two paring chisels (1in. and ½in.), one beading plane, three moulding planes. I do not think that an amateur needs more than two or three moulding planes, just to enable him to fill up angles in rebated and panelled work, or for an occasional frame, such as that of a small sash, or picture frame. The set of augers will be handy for out-door work, such as will occasionally be required, and a beading plane or two, to put a finish on the edges of boards joined side by side, and other similar purposes. A full set of planes for moulding are costly affairs, and the irons are very difficult to sharpen and keep true to the outline of the moulding. Moreover, mouldings are now made by machinery and sold very cheaply, so that a couple of such planes will amply suffice for an amateur's wants. The sweep saw is a very handy tool for all curved work. A compass saw, or a keyhole saw, may be pressed into service for such work, but the latter generally gets broken, and the first is too stiff for any but tolerably large curves.

The above will form a very complete outfit for an amateur, unless he goes in for sashwork, etc., which he had far better leave alone.

But he will require one or two appliances under the generic name of bench fittings, to wit, mitring and shooting boards, which any carpenter will make for him at 2s. or 3s. each; and if he aims at really good work, he will be wise to lay out 25s. or 30s. in a good bench, with vice and planing stops complete. He may make a rough and ready substitute for a beginning, but a good bench, with a really level top, and a vice that will hold as it ought to do, will, sooner or later, be found essential.

The next consideration is where to keep the tools. I confess to a dislike to a tool chest as ordinarily made, and incline to a cupboard with a drawer below for planes, and with tool racks attached to the back (inside), and hooks and studs on the sides and door for hanging up saws, squares, compasses, and all that needs suspension. With a cupboard, you see at a glance the whole stock. The gouges and chisels are in rows in front of you; the jack, trying, and smoothing planes lie on the shelf above the drawer forming the inside bottom of the cupboard; and the plough, fillister, and less used planes, are in safety in the drawer. A row of small drawers can also be fitted at the top of the cupboard, but so as to be shut in by the door, for nails and screws, sandpaper, and odds and ends.

Every evening the tools used can be wiped, and returned to their places in five minutes, and the whole secured by lock and key from the various marauders, who use chisels for screw-drivers, compass points for bradawls, and planes in experimental researches upon the metals When such cupboard is open, it is just as easy to hang up a saw inside, as to hang it on a nail in the shop; and if tools are always put in the same place, any absentee is missed directly, which gives decidedly the best hope of its recovery; if not missed till wanted, it will generally prove to have reached the mysterious region of *nowhere.* Of the workshop itself it is next to impossible to speak, except to advise plenty of light and dryness, with a stove of some sort for heating the gluepot. There is often no choice, and any outbuilding at all suitable has to be pressed into service. The accessories of the workshop, apart from the bench, will be a pair of sawing trestles, sawing stool, heavy stool for mortising work upon, and screw cramps (or clamps) for holding glued work while drying. Among tools I see that I left out the axe—a hand axe—which will, of course, be needed, and must be kept in good condition, and not suffered to go upon the perilous expedition to the housemaid; or worse still, to the odd boy, who will split wood for fires on a stone or brick floor, unless he can find an anvil.

There now remains only the lathe, and I do not propose in the joiner's department any other than a plain one, without slide-rest, and preferably with a wooden bed, that can be home made if desired, because there need be no nice limit to its length; and iron beds, if long enough for turning table-legs, become costly. If, however, an iron bed is for any reason a necessity or preferred, the lathe should be so placed that a wooden bed can be arranged at the end of the iron one, so as to lengthen it. It may be secured to the iron one by a couple of screw bolts, while the other end may reach to the wall, or be supported by a leg underneath. There will be no need to lengthen the treadle or crank axle if not more than about two feet be added. But there is no doubt that for joiners' work alone the best plan is to buy a good set of headstocks and mount them on a wooden bed, with standards also of wood. Most lathe makers will supply independent heads, and also the fly wheel and axle without insisting upon supplying also the bed. It is, however, a mistake to go back to the old wooden headstocks—an entirely home-made affair—as it is almost useless for real work when made, and as sure to bring about trouble and disappointment. It is far wiser to spend £2 or £3 in iron heads, properly made (of 5in. or 6in. centre), and then to confine the home work to the lathe and standards, with, perhaps, also the treadle.

We will now suppose an amateur prone to work in metal, including turned and soldered, or sheet metal work. A large number aspire to this, which has its special charms.

The list will still comprise one or two tools of the carpenter, but these may now be confined to hand-axe, hand-saw, and hammer, with a gimlet or two, and a screw-driver—tools used alike by nearly all mechanics. The special set for metal work will be: Files—various in size and shape, hack-saw, chisels for metal, centre-punch, straight-edge (a good steel rule), square, spring compasses with set-screw, light tongs for holding hot metal—such as drills—while hardening and tempering; pliers, large and small; drillstock, of which more anon; screwing tackle. The bench will be of 3in. plank, securely fitted, with a good leg vice attached. A hand vice should be had, but the small table vices can be well omitted if a leg vice is obtained. A pair of callipers with set-screws will be also needed. This is a small set, that will have to be supplemented with soldering iron and its attendants, viz., resin, and Baker's soldering fluid, with a pair of tinman's shears; and, if much sheet metal-work is proposed, a few "stakes" (as they are called), hatchet, bottoming, and taper mandrel for tubes will become necessary. Observe, I do not think casting and forging to be amateur's work, and the tools needed are therefore omitted.

With respect to the drillstock, a good deal of drilling will be done in the lathe, which is now fitted with chucks to hold both small and large drills; but it often happens that need arises for a hand tool to drill work not easily capable of being mounted on a lathe bed. For work needing drills of ¼in. to an inch the hand brace, with some kind of lever or screw pressure, still holds its own. No metal worker would willingly be without it, although it is seldom to be classed among tools of precision. It is, however, strong, cheap, and durable, and is recommended accordingly. For small handwork I do not care for the Archimedean drillstocks. They get loose in the head very quickly, and are only fit for the lightest work in brass. Much to be preferred are the bevel-wheel drillstocks, obtainable, at no great cost, at any of the tool shops. For these the small twist drills are the best, and if taken care of as they deserve, will last a long time without re-grinding—this operation being considered somewhat difficult. It *ought* to be, but apparently is not, undertaken at the tool shops. Compared with what are needed by the carpenter and joiner, the tools of the amateur in metal work are, it will be seen, few in number, and—apart from the lathe—are very inexpensive. Files may or may not become costly, according to the amount of care bestowed on them, and the same may be said of drills. Of the former a dozen will do for a start—one 12in. bastard-cut for rough work, with one flat and one rounded face, called a half-round file, which it certainly is not; one 3in. and one 6in. round or rat-tail file, two taper middle cut flat 6in. or 8in. files, two ditto parallel fine cut with safe edges, and half-a-dozen assorted small files—flat, triangular, and knife-edge, for more delicate work and for key wards. Following the previous plan, we shall call the above list a small set, and proceed to add thereto the following reamers and broaches—the first half-round or triangular to fit the brace, intended to follow the larger drills. One or two will suffice. The latter are five-sided, and used in clock and watch work, and also in model making. A set of six, in neat hard-wood handles from ¼ downwards, will be found very useful; but even a set of three may suffice. Small metal saw with brass back, for nicking screw heads, for which the hack-saw will often prove too coarse. Hand hammer, about 2lbs. weight, for general work and chipping. Boxwood tinman's mallet, with one flat and one round end; small screw-driver; blow-pipe, borax, silver solder and spelter, for brazing, to be kept in a separate box duly labelled, or at most housed in a box with the soldering iron, etc., already set down in our list. It is always the best plan to keep soldering apparatus separate, with resin (powdered) in a box with a spout, and the borax (also powdered) in a box labelled. A lump of sal-ammoniac will also be useful for tinman's work. The chisels may consist of one ½in. and one 1in. flat, and one ½in. and one ¼in. cross-cutting or grooving. These are chiefly for chipping cast and wrought iron, and will not be largely used; but when needed it is a nuisance to be without them, and in some advanced details of metal work they are absolutely necessary.

We may now pass to the metal worker's lathe, but as the lathe will be very fully treated in other articles, only a few notes will be placed here. The best lathe in the present case is *not* one with a wooden bed; this and the standards should be of cast iron. For general work, such as would be termed in the trade "jobbing," a very plain lathe with hand-rest, and for hand tools alone will suffice. But it should be firm and strong, capable of standing real work. The width, a 3ft. or 3ft. 6in. bed, and 4in. to 5in. centre, will probably answer well, and at any time when necessary a slide-rest can be added. A set of hand tools handled sensibly in ash or beech, nicely stained, can be had for 7s. 6d. or thereabouts, and need not here be further detailed. These will not include chasers for screw cutting, which indeed need not be added till the want of them is found. Emery cloth (from coarse to the finest made), crocus for fine polishing, powdered emery, oilstone powder, rottenstone, and such like, are scarcely tools, but demand place in the workshop, as do also lacquers for brass, stains, varnishes, and French polish for wood. The item classed as screwing tackle must have a little more detailed explanation.

Apart from screws cut in the lathe, the metal worker will often find the necessity for making them by the hand tools contrived for the purpose. These are screw-plates and die-stocks, taps being as a matter of course supplied with each of these. Screw-plates, whether large or small, are plates of steel fitted with one or two handles, and drilled with holes which are then tapped with screw threads. They are chiefly suited to the manufacture of small screws with shallow threads which are cut partly or burred up by screwing the plate upon the pin which is required to have a thread cut upon it. It will be better only to purchase a small one, either clock size or intermediate between this and that for watch screws. The latter are so minute as seldom to be needed outside the watch trade. The die-stock is *par excellence* the screwing-tool for all sizes above ⅛in. until we come to those which are more economically made by machinery, or which by the amateur will certainly be made in the lathe. These die-stocks are rather expensive, varying from about 12/6 for the smaller ones of continental manufacture, to large ones costing £5, and upwards. I extract from one catalogue in which prices are low :—

	£	s.	d.
Stocks and Dies, with three sizes, warranted best quality, and standard pitch to screw $\frac{1}{4}$ $\frac{3}{16}$ $\frac{3}{8}$ with 6 Taps ...	1	0	0
" " $\frac{7}{16}$ $\frac{1}{2}$ $\frac{5}{8}$	1	7	6
" " $\frac{7}{8}$ $\frac{3}{4}$ 1in.	2	5	0

This will serve as a sample of cost. The intermediate one will be very handy.

Another maker fits four pairs of dies in one stock instead of three, and charges £1 15s. for $\frac{1}{2}$in., $\frac{3}{16}$in., $\frac{1}{4}$in., $\frac{5}{16}$in. Also for $\frac{1}{4}$in., $\frac{5}{16}$in., $\frac{3}{8}$in., $\frac{1}{2}$in., £3 3s. 6d., which seems a good deal, but the tool is of best make, and the selected sizes are well chosen. The "American Lightning Screw Stock" at about £2 2s. has solid dies, but is a good tool and finishes a deep well-cut thread, by once passing the tool down the flank.

The only absolutely necessary tools left out of our list are callipers for the lathe, preferably outside and inside as separate tools, a depthening gauge for inside measurement of hollow work, spanners, and a screw-hammer. There are other tools which will be treated of in other articles, which need not be added to the list at present, and may indeed never be required. Nothing seems, besides, to call for notice except a supply of nails, screws, and copper rivets, which last are often needed ; they are sold by the pound as nails are, and an assorted lot should be had. Nails for immediate use are best carried in a nail box with a handle across it, and this should be divided into three or four compartments, besides having a tray fixed for small brads and tacks.

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Welding Cast Steel.—A method, which is probably new to many, is given below as communicated by an old friend :—Some years ago, when I was engaged manufacturing rock drilling machines and air compressors, and had a good deal to do with cast steel for the drills, I came across a method of using up the short ends of the drills when they were no longer useful for our boring machines. It was in the Buxton district, where I had gone to start some new rock drills, and while looking round me I came upon the drill smith repairing the "jumpers." These are iron bars about 6ft. long, 1$\frac{1}{4}$in. diameter, and have a length of cast steel welded on at each end and sharpened. I got into conversation with the smith about welding, and in due course asked him if he could weld cast steel to cast steel. He said he could, and straight away took two of our short lengths, scarfed and welded them so that one could scarcely see the joint, and by the ring they were one piece. By the judicious application of a special oil to the palm of this horny-handed son of toil, I had the secret imparted to me, and a good sackful of the compound used sent to our works. I must say I was somewhat horrified at the prescription—which was, six quarts of powdered limestone to one of sulphur—thinking the latter ingredients would be sure to make the metal short, but later trials have dispelled this idea. It is now three or four years since I saw any steel welded with this mixture, but I remember that it is necessary to heat very carefully with frequent turnings, taking from the fire and brushing with a short besom; then dipping into the mixture, and again returning to the fire. I should think this was done four or five times before the heat was on. Both pieces were heated on the same hearth, one at each side, and as soon as ready brought to the anvil and well brushed, laid on, and closed quickly, but not very heavily. Many times I had occasion to use this, and always had success.

ON FILES AND FILING.

By "MERELY DEXTER."

FILING is an operation that amateur mechanics frequently require to practice. Whenever the use of the file can be avoided, by the use of the lathe, the milling machine, or the planer, it is certainly desirable. Considerable skill is required to "get up" surfaces of large area by means of files alone, more especially when these surfaces are required to be accurately flat. The method of preparing surface plates, as detailed by Sir Joseph Whitworth, is most valuable information to any one desirous of excelling in this particular branch of practical handicraft. Those interested should get Whitworth's pamphlet, entitled, "Plane Metallic Surfaces, and the Proper Mode of Preparing Them ;" the price is only 4d. In large engineering works, filing is superseded by the planing and shaping machines for almost all work of large size. The speed and accuracy of the planing machine cannot be approached by the file when there is a great quantity of material to be removed. Files are then only used for the purpose of "fitting," and to smooth up those parts which are inaccessible to the planing tool. A planing machine is one of those expensive and heavy pieces of machinery frequently beyond the reach of amateurs, and it therefore becomes necessary to learn how to dispense with its valuable aid.

Cast iron usually forms the bulk of the material used by engineers, and on this is the metal we will proceed, metaphorically, to operate. The hard, outside skin on cast iron, and the sand adhering to its surface, make it somewhat formidable to attack. If a new file is used for the purpose, it will be assuredly spoiled, and to no purpose. One which has been very nearly worn out will be nearly as effective, and will not be much deteriorated by the use to which it is put. There are several ways of removing the "bark." One is to "pickle" the casting, that is, immerse it in a bath of sulphuric acid and water for a couple of days. This will dissolve the outer crust of the casting, and liberate the sand adhering to the surface. Another plan is to remove a stratum of the casting from that part which has to be filed, by means of a chipping chisel. This is a very good plan where much material has to be removed from some particular part of a large, unwieldy piece of machinery, though some practice will be required with the hammer and chisel before they can be used satisfactorily.

The art of filing a flat surface is not to be learned without considerable practice, and it will be in the workshop that the reader will have to do his best to follow written instructions. Long and attentive practice will be necessary ere the novice will be able to creditably accomplish one of the most difficult operations which fall to everyday engineering work, and one which even the professionally taught workman does not always succeed in. The file must be used with long, slow, and steady strokes, taken right from point to tang, moderate pressure being brought to bear during the forward stroke. The file must be relieved of all pressure during the return stroke, otherwise the teeth will be liable to be broken off ; just in the same manner that the point of a turning tool would be broken if the lathe were turned the wrong way. It is not necessary to lift the file altogether off the work, but it should only have its bare weight pressing during the back stroke. One of the chief difficulties in filing flat is that the arms have a tendency to move in arcs from the joints, but this will be conquered by practice. Work which has been filed up properly will present a flat, even surface, with the file marks running in straight parallel lines. Each stroke of the file will have been made to obtain a like end; whereas work which has been turned out by a careless or inexperienced workman will often bear evidence that each stroke of the file was made without any regard to all others, and the surface will be made up of an unlimited number of facets, varying in size, shape, and position. Amateurs who have never received any practical instruction in the use of files generally have a bad habit of pressing heavily on the tool continuously, during both forward and backward stroke, and, at the same time, work far too quickly. These habits, combined, will almost invariably spoil whatever is operated on, producing surfaces more or less rounding, but never flat.

The position of the vice at which we are to operate is a most important point to be decided before commencing our filing proper. The vice should be fixed at the correct height, and so that the work held in the jaws will lie level. As to what is really the correct height, some slight difference of opinion exists. This is, probably, owing to the fact that the height of people varies. The right height is such, that the "chops" or jaws of the vice come just below the elbow of the workman when he is at his place in front of the vice. Having the vice fixed properly, the correct position to assume, when filing, is the next consideration. To describe the position: the left foot should be about 6in. to left and 6in. to "front" of the vice leg; the right foot being about 30in. to front—that is to say, 30in. away from the board in a straight line with the vice post. This position gives command over the work, or, rather, over the tool, and is at once characteristic of a good vice-man. The file must be grasped firmly in the right hand, by the handle. It is as well here to make a few parenthetical remarks on handles; they should always be proportionate to the files to which they are fitted. The hole in the handle should be properly squared out, to fit the "tang," by means of a small "float," made from a small bar of steel, similar to those used by plane-makers and cabinet-makers. The handles should always have good, strong ferrules on them, and the files should be driven home quite straight and firm, so that there is no chance of the tool coming out. Each tool should have its handle permanently fixed; it is very false economy to be continually changing, considering the low price of handles. The left hand must just hold the point of the file lightly, so as to guide it, and, when taking the forward cut, a fairly heavy pressure must be applied, proportionate to the size of the tool in use and the work being done.

Suppose we have a casting home from the foundry, the operation of filing would be preceded by thoroughly brushing the casting with a hard brush, so as to remove all the loose sand. Then take an old file, and file away steadily at the skin till you come to a surface of pure metal. Having by then removed those parts which spoil files, the "old file," with which but slow progress is made, can be changed for a better one. The best, as well as the most economical, will be one which has been used for filing brass till it has become too much worn for that material. Such a file is in first-class condition for working on cast iron after its sandy skin has been removed, and when worn out on that it will serve first-rate for steel.

When it is necessary to file up a small surface—say, 2in. or 3in. square—the file must be applied in continually changing directions, not always at right angles to chops of the vice. In that case, though the work might be made perfectly straight in that direction, yet there would not be any means of assuring a like result on the part lying parallel to the jaws. When the surface is fairly flat, the file should be applied diagonally both ways; thus any hollow or high places, otherwise unobservable, will be at once seen, without the aid of straight edges. This method of crossing the file cuts from corner to corner is recommended in all cases. The file should invariably travel right across the work, using the whole length of the file, not just an inch or so at some particular part, as is too often the case. When in use the file must be held quite firmly, yet not too rigid, so that the operator cannot feel the work as it progresses. The sense of touch is brought into use to a far greater extent than the inexperienced would imagine, and a firm grasp of the tool, at the same time preserving a light touch to feel the work, is an essential qualification for a good filer.

In filing out mouldings and grooves which have sections resembling, more or less, parts of a circle, a special mode of handling the file becomes requisite. The files used are generally rats'-tails or half-rounds. These are not used with the straightforward stroke so necessary in using the ordinary hand files, but a partial rotary motion—a sort of twist axially—is given to the file at each stroke. This screwlike motion, given alternately from right to left, and *vice versâ*, serves to cross the file cuts and regulates the truth of the hollow.

With regard to cleaning tools which have become clogged with minute particles of metal, dirt, and grease. Files which are in that state are not fit to use, and the following directions will enable anyone to keep them in proper order. The most generally used tool for cleaning files is the scratch brush; but this is not very efficient in removing those little pieces which get firmly embedded and play havoc with the work. File cards are also used; they are made by fixing a quantity of cards—such as a pack of playing cards—together by rivetting, or by screwing to a piece of wood. These file cards are used in the same way as the scratch brushes—transversely across the file in the direction of its "cuts"—and though neither tool produces much effect, yet they are both often used.

When files have become clogged with oil and grease, the best plan is to boil them for a few minutes in some strong soda water; this will dissolve the grease and, as a rule, set most of the dirt and filings free. A little scrubbing with an old tooth brush will be beneficial before rinsing the files in boiling water and drying them before the fire. These methods will prove effective in removing the ordinary accumulation of dirt, but those "pins," which are so much to be dreaded when finishing work, can only be removed by picking them out with a scriber point, or, what is better, a piece of thin, very hard, sheet brass, by means of which they can be pushed out very easily. These "pins" may be to a certain extent avoided by using chalk on the file, if it is used dry, or a drop or two of oil will sometimes help matters.

With regard to finishing filed work, such as has to be made particularly presentable to the eye, there are many ways of polishing and burnishing, but, properly speaking, these are not filing. Nothing can exceed the beauty of well-finished work perfectly square and smooth, as left by the file, untouched by any polishing materials. In such work the filing must be got gradually smoother by using alternately files of finer cut. When the work is deemed sufficiently finely finished for the purpose, the lines should be carefully equalised by "draw-filing." For this the file is held in both hands, in a manner similar to a spoke-shave, and drawn over the work in the same way, producing a series of fine parallel lines, the beauty of which it would be difficult to exceed for the purpose of high-class engineering work.

A PORTABLE BOOK-CASE.

(For Illustrations see Lithograph Supplement.)

THE book-case shown in the illustration is so simple in construction that a mere tyro at cabinet work may fairly be expected to succeed in an attempt to make this useful piece of furniture. The principal characteristic of this book-case is the ease with which it may be folded up for carrying. Those who have occasion to remove frequently will be able to appreciate the convenience of a portable book-case. The design, together with particulars of the method of construction, were originally contributed by a correspondent to a weekly contemporary. From its peculiar merits we now give an amended article, knowing that many will be interested.

The front of the complete book-case is shown at fig. 1. The details are made very plain purposely, but there is scope for plenty of ornamental work, should it be wished. An end view is shown at fig. 2 on the right, the left-hand portion showing the two uprights, which form the front ends of the book-case, close together as they would be when the book-case is folded for removal. A section of the entire book-case, with the back partially folded, is shown at fig. 3; the top and bottom and the two shelves are shown lying against the ends. When folded close the section is as shown at fig. 4, the blank space there seen being for the reception of the small balustrade shown at the top of fig. 1. One end of a shelf showing the tenons, which fit into corresponding holes in the ends, is shown at fig. 5. This completes a brief description of the entire illustration.

The following description of its construction was given by the maker, and will render further comment unnecessary:—

The two ends are 4ft. long over all and 12in. broad. They may be a plain board or panelled as shown in fig. 2; they have a piece of wood fixed on the front of each, 3½in. broad and 1in. thick, and also a piece on the back of each, 2¼in. broad and ¾in. thick. Crosspieces are dovetailed into the bottom of these uprights, back and front, of the same breadth as front pieces, less the thickness of ends. Corresponding crosspieces are mortised into the uprights at top, and these uprights and crosspieces convert the ends into two shallow boxes or trays. The top board of the book-case is hinged at one end underneath one crosspiece, and folds down parallel to that endpiece, allowing sufficient space behind it to contain one of the shelves. The bottom board forming the lowest shelf is hinged to the crosspiece at the bottom of the other endpiece in the same manner, with sufficient space to allow the other shelf to lie behind it. Thus the two shelves and the top and bottom are arranged to lie close against the inside of each endpiece. There is still 2½in. space left between the top and the bottom; this is to contain the back. Assuming the book-case to be 3ft. 6in. broad, the back will consist of four divisions, each a little more than 9in. broad, and these are hinged together in the manner shown in fig. 3. The four pieces composing the back are hinged to each other, and the outer ones hinged to the back haffits attached to the gables. When fig. 3 is entirely closed up, it assumes the appearance shown at fig. 4. As the back pieces are about 2½in. narrower than the shelves, a space is left as shown, to contain the baluster railing. This railing is held in its place, as shown in fig. 1, by the two rails being let into the edge of the uprights by shallow mortises. The two shelves are supported in place by short tenons, as seen in fig. 5, corresponding holes being made in the ends to receive them. This book-case may be packed or unpacked in a very few minutes. When folded up, as in fig. 4, it is held together by hooks and eyes, top and bottom, and the manner of getting it opened for use is this: Lay the parcel with the back on the floor, undo the hooks, pull the ends apart till the back is fully extended; then the bottom is opened over to the opposite side, and the top also to its opposite side. They are then fastened by passing a 1½in. screw through the crosspiece into each of them, but this must not be done till after the two shelves have been fitted into their holes in the end-pieces, and the baluster rail fitted in the same manner. The two screws being in, two other screws are passed through the back near the centre joint into each shelf, and this completes the job. The back is made of ⅜in. wood, the ends and shelves ¾in. wood. The uprights of the front are chamfered and channelled down the centre. The shelves have ornamental leather—common to book-cases without doors. The closed book-case, as may be seen by fig. 4, is a parcel of wood 4ft. by 12in. by 7in., and may be carried easily. For a larger book-case of this description, having more shelves to stow away, an increased recess in the ends would have to be allowed.

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Lantern Pinions for Clocks.—The lantern pinions used in American clocks are made, like all other parts, by machinery, which supersedes hand labour, both for accuracy and price. Those unaccustomed to the use of mechanism in the production of work would marvel at the ease and rapidity with which machinery acts. The machine used for drilling the holes in the brass collets for the wire leaves to go in is constructed thus:—An iron bed has a peculiarly arranged pair of headstocks, one being constructed so that the revolving spindle can be moved laterally by means of a lever; the end of this spindle is fashioned to receive a drill, which bores the holes in the pinions; the other headstock has its spindle fitted with an index plate, and a pointer fixed to a strong spring attached to the headstock casting serves to hold the plate as in a wheel-cutting engine. The spindle of this headstock has a small carrier chuck fitted to the end facing the drill, and the pinion which has to be bored is fitted into this carrier, so that there is no shake between it and the index spindle; this head has a motion at right angles to the line of centres, so that the diametrical line of the pinion trundles may be adjusted. An accurately cut screw, with a micrometer head, is used to adjust the transverse movement of the head which may be done to the thousandth part of an inch; a flat pointed drill is used to bore the holes; it has a shoulder on its stem that forms a stop, preventing the drill going to a greater depth than has been predetermined, one side of the pinion head being drilled through, and the other only partially. In use, the pinion head, after being bored and turned, is put in the chuck, and the diametrical line adjusted; the drill, which is revolving at a high speed, is brought up by the action of the lever to the end of the pinion head, and the hole bored. In releasing the lever, the drill is brought back by a spring, the index plate is moved on a division, another hole bored, and so on till all are drilled. The wires for the trundles are cut off to the proper length in large quantities, and are put in the pinion by hand. They are prevented from falling out by having the holes slightly rivetted; this may be seen by examining an American clock pinion; 1,500 can be turned out daily by one man.

FRENCH CLOCKS: HOW TO ADJUST AND CLEAN THEM.

PROBABLY no class of clocks used for ordinary purposes of life are capable of giving better satisfaction to the public, or less trouble to the dealer and repairer, than those known as French clocks. Their comparative moderate cost, when real worth is taken into consideration, and the beautifully artistic design of the cases, has been the means of creating a demand for them in refined communities, all over the globe. Works of art in this line, which were at one time only to be found in the palaces and castles of kings and noblemen, have found their way into the dwellings of those possessed of less affluence, and they are gradually being introduced into the homes of all possessed of a cultivated taste and a moderate income.

The cleaning and management of these clocks is simple, and requires care and a little experience, more than any other qualification, but it is seldom done in a manner that gives full justice to the clock. It is our object, in the present paper, to impart a few hints to those who may not have had the necessary experience; and we will begin by making a few remarks on new, or newly imported clocks.

It occasionally occurs in newly imported French clocks, that a movement has been fitted to a case that is not high enough to allow the pendulum to swing free when the clock is regulated to the proper time. Sometimes filing a little off the bevelled edge of the ball will allow the pendulum to clear the bottom of the case or stand of the clock, and allow it to be brought to time. Should more than a little be required taken off the edge of the ball, there is no use troubling with it further. Either get a new movement, or alter the train, or make a new pendulum ball of a peculiar shape. The train is easiest altered by putting in a new escape-wheel pinion containing one leaf less than the old one. In all cases, where pinion wire can be had, putting in a new pinion is not much trouble; but if this cannot be done, and a new movement cannot be had, a new pendulum ball of an oblong shape may be used.

When French clocks are unpacked, whether they appear in good condition or not, it is always well to take the movements to pieces, and to examine every action in the clock. Begin by taking off the hands and the dial, first trying if the hands move freely, then examine the drops of the escapement to see if they are equal, and if they are not exactly equal, they can easily be corrected by moving the front bush of the pallet arbor with the screw-driver, making a light mark across the bush with a sharp point, which will show how much the bush has been moved. The fly pitching may next be examined, and adjusted by the movable bush in the same way. The object of this bush being left movable is to admit of the depth to be adjusted, so that the fly will make the least noise possible, and also to regulate the speed of the striking train. The dial work and the repeating work, if any, may now be removed, and the *springs let down*, the end and side shakes of the pivots in their holes carefully tried, and all the depths examined; as a general rule they will be found to be correct. The pivots will, in some instances, be a little rough, and it will not be much trouble to smooth them. After examining the main-springs, and noticing that the arbors are free in the barrels, the clock may be cleaned and put together. This will be most conveniently done by placing all the wheels first on the back plate, and putting the front plate on the top. Get all the long pivots into their holes first, and as soon as possible put a pin into one of the bottom pillars. The locking of the striking work of these clocks are very simple, and all the pieces are marked that are necessary to be marked. All the workman has to do is to follow the marks, and he cannot go wrong; but should he begin to bend or twist anything, he will soon find himself in serious trouble.

There are a few items that special attention should be directed to. Be sure that the arbors in the barrels are oiled, and that the main springs are hooked before you put them in the frame. Be sure there is oil on the pivots below the winding ratchets before they are put on, and that the wheel that carries the minute hand moves round the centre pinion with the proper tension, before you put on the dial. This cannot be remedied after the dial is put on, without taking it off again, and if the hands are loose, results fatal to the character of the clock are sure to follow.

In regulating one of these clocks, it is always safest to turn the case round, examine the regulator, and, if it is a Breguet, put a slight mark with a sharp point across the regulator. When the regulating square is turned you will see exactly how much the regulator is altered; because there is sometimes a want of truth in the screw that moves the sliding piece, which deceives people as to the distance they may have moved the regulator. There are various kinds of regulators, but probably the Breguet one is the most common of those of modern construction. Those who have silken thread regulators should always be regulated with caution, and when small alterations have to be made, it is well to use an eye-glass and notice how much the pendulum is moved up or down. When a clock with such a regulator has to be moved or carried about, when it is out of the case, it is always best to mark the place where the pendulum worked in the back fork when it was regulated to time; for should the thread be disarranged, it can be adjusted so as to bring the mark on the pendulum to its proper place, and the regulation of the clock will not be lost thereby.

On fastening one of these clocks in its case they are generally put in beat by moving the dial round a little till the beats become equal; but it sometimes occurs that when the clock is in beat, the dial is not square in the case. When this happens, it is always best to take the clock out of the case and bend the back fork *at its neck* till it moves exactly as far past the centre wheel pivot on the one side as on the other, when the pallets allow the escape wheel to escape. If this is done, the dial will be square when the clock is in beat. Some French clocks have their back forks loose, or rather spring tight, on their arbors. This is sometimes done in movements that have plain as well as jewelled pallets. If the pallets are exposed in front of the dial, you can at once detect by the eye if the clock be out of beat; but if they are inside, you cannot tell without close listening. One of the objects of the loose crutch spoken of is that the clock can be put in beat by giving it a shake; but it is evident that if a shake puts it in beat, another shake will put it out of beat again. Great annoyances arise from these loose crutches, and long journeys have been made to examine clocks, when nothing was the matter with them more than they were out of beat, caused by the housemaids moving them in their dusting operations. The crutches ought always to be rigidly tight, except, perhaps, when the pallets are jewelled, or when the clock is not liable to be moved.

As to cleaning these clocks, there is but little to say; they seldom, if ever, require any repair, except perhaps the pallets get cut, but they are generally made so as to admit of the action being shifted, which is easily done. Cleaning the brass, of course, is done in the usual way. Buffs should be used for the large pieces, when very dirty; but if they are only slightly tarnished, a little cyanide of potassium dissolved in alcohol will be found very suitable.

The ornamental cases require to be handled with care, and special care should always be taken to prevent finger marks. In the very highest priced clocks this precaution is perhaps not quite so necessary, because then the cases are either real bronze, or gilt and burnished; but in the cheaper qualities, and also in some expensive patterns of cases, the gilding is easily damaged. A little cyanide of potassium and ammonia, dissolved in water, will often clean and restore it, if the gilding is not rubbed. There is a preparation sold in the form of a paste that renews the lustre of black marble cases if they have become dim. If the preparation cannot be got conveniently, a little beeswax on a piece of flannel is a good substitute.

Although in some instances there is much trouble and little satisfaction in the going of newly imported French clocks, in almost every instance the trouble could be traced to the mismanagement of those persons who were entrusted to put them in order and adjust them. A little care, and the exercise of sound judgment on the part of an amateur mechanic, would prevent many annoyances that sometimes happen with pendulum French clocks.

IRON AND STEEL.

TO the mechanic no metals are so valuable as these, and a few words on their origin and production will be read with interest by all mechanicians who desire to learn the operations involved in the manufacture of the materials which they are constantly using, not only for the construction of every description of mechanism, but also in the form of tools and appliances by which the rough metal is wrought to shape with a celerity, certainty, and precision, far surpassing hand labour.

Pure metallic iron has comparatively no commercial use, and in this state is but little known; it is, when combined with carbon, sometimes modified by other elements, that pure iron becomes the iron of commerce, and is known as malleable iron, steel, and cast iron, as the proportion of carbon is increased. For the purpose of chemical experiments pure iron may be obtained by placing a mixture of magnetic oxide of iron and fragments of commercial iron, such as filings, in a crucible, and heating to a white heat—the crucible being meanwhile covered. The pure iron thus obtained is softer than ordinary soft malleable iron; it is very tenacious and ductile, and its malleability is not affected by heating and suddenly cooling. Though it does not retain magnetism, its magnetic power is very high. The more free from impurities the higher will be the electrical conductivity of the metal, and the greater the heat required for its fusion—admixture of carbon reducing the point at which pure iron melts, which is but little below the melting point of platinum. Though unaffected by dry air at ordinary temperatures, iron, when in a state of very fine division, is liable to spontaneous combustion.

Heated in contact with the atmosphere, as at the ordinary smith's forge, layers of scale form on the exposed surface, which easily detach themselves if the bulk is hammered; the outer scale is fusible only at a very high temperature; it is very brittle, and highly magnetic. Malleable iron and steel have a curious property imparted to them when united with sulphur, to which it has great affinity; a very small percentage has the effect of rendering the metal unworkable at a red heat, termed "red short;" whilst it may be wrought with every facility when cold. The addition of copper has a similar effect. Precisely the reverse effect results from the presence of phosphorus, an infinitesimal proportion causing marked alteration in the working qualities of the metal; the tenacity is very sensibly impaired by even a half per cent., and the metal shows decided signs of being, in smith's parlance, "cold short"—that is to say, unworkable in a cold state, but when heated it may be worked easily.

The few combinations above noted will guide the reader as to the effect some of the principal metals have on iron; but it is chiefly by carburisation—the admixture of carbon—that iron becomes the useful well-known iron and steel with which we become familiar in workshop practice. Carbon and iron do not combine at ordinary temperatures, but when raised to redness and above that heat combination is effected with more or less rapidity. In cast iron the proportion of carbon may be something like five per cent., the quantity gradually decreasing in cast steel, shear steel, and iron, in which the presence of carbon may be but barely traceable; the addition of sulphur, phosphorus, silicon, and manganese to carbonised iron is usually practised in the course of manufacture with the object of obtaining the results which have previously been pointed out.

The treatment of iron ore in furnaces has generally for its object the production of pig-iron, which is a material yet unfit for tangible purpose. It cannot be welded, and, in fact, cannot be wrought with the hammer at all. This pig-iron has always a slight admixture of some of the metals above noted, and is charged with carbon to a large percentage. When carbon exists in but the smallest proportion, the metal is malleable or wrought-iron—that is, the iron of commerce—varying in quality and physical structure according to the constituents and the treatment they have received. When melted and allowed to cool, the fracture is crystalline or granular, assuming a fibrous structure, after having been rolled or hammered; this process giving at the same time a great increase in tenacity. The melting point of malleable iron is governed by the amount of carbon it contains; a large percentage of carbon rendering it more easily fused. Before this point is reached the metal assumes a soft condition, and when in that state, if two clean surfaces are brought in contact, and adhesion enforced, they will unite and form one solid piece. This process is termed "welding," and may be effected with ease by hammering when sufficiently hot any good malleable iron, though the presence of even minute proportions of foreign matters will sometimes prevent all efforts to weld metal which is "red short;" it will of course be practically unweldable. Hardness and brittleness are the effects of continued hammering on cold iron, and if heated to whiteness, exposed to air, the iron burns, and is rendered unfit for welding. In that state it is called "burnt iron." All malleable iron is strongly affected by magnetism, but will not retain any magnetic power.

Bar iron is supplied in various grades, the commonest being that which has been but once passed through the rolling mills; the next quality is that produced by taking lengths of No. 1 and welding them together to form a solid bar made up of several; this process is repeated to produce better and so on. The continued repetition of the processes of welding and rolling renders the metal more ductile and in every way better fitted for engineering purposes. This system is most completely developed in the process called "faggoting," which consists of binding a large number of small bars together in the form of a faggot and heating the whole to welding heat, and consolidating the mass by welding. Carriage axles are so made, and for the production of gun barrels and the best class of iron lathe mandrels the plan is still further developed.

Steel, which is so abundantly used by the mechanic for the manufacture of the tools he uses for all purposes, is, with regard to its physical structure, midway between malleable iron and pig iron. Malleable iron has a percentage of from the merest trace to ·3 of carbon, though this latter combination will be metal of decidedly steely characteristics, and whether to be classed as iron or steel will be dependent on the presence of other elements which influence the main one. A proportion of 2·0 per cent. of carbon will produce pig iron, the intermediate proportions in combinations resulting in steel proper, which partakes, more or less, of the characteristics of pig or malleable iron, as the presence of carbon decreases. The precise point at which metal ceases to be steel and becomes pig iron or malleable, as the case may be, is perhaps hard to determine, but a generally-accepted distinction is, that when heated to a full blood-red heat, and plunged into cold water, *steel* becomes hardened, whereas the same process has not that effect on iron. This fact of steel being rendered so extremely hard by such a simple process is a most important one, and at once places this metal foremost amongst those used for cutting tools and implements of every description.

By heating to redness, and allowing steel to cool gradually, it resumes its normal hardness, and any degree of "temper" may be produced by judicious reheating after the metal has been made perfectly hard—an operation rendered necessary from the fact that in its hardest condition steel is too brittle for most purposes. The effect of hardening is produced in the most marked degree by the most rapid cooling, and it has been found that mercury, being the best conductor of heat available, is best suited for cooling the red-hot metal when extreme hardness is required; water and oil effect the purpose equally well for all practical purposes, though in point of fact the result is not so intense. If the liquid is warmed the hardness will be proportionately less, and we have been given to understand that boiling water is used for quenching red-hot spiral springs in, which do not then require any subsequent tempering, they being in a condition similar to that which would result from being thoroughly hardened and then tempered to a blue colour, whilst it is obvious that the risks attending the usual operation of hardening are very materially lessened, as the steel never is made "flint hard," and consequently is not so liable to fracture.

The surface of a piece of hardened steel will, if previously polished, show most palpably the effect of the heat applied to it for the purpose of "tempering;" access of air being freely allowed an oxide forms on the bright surface, and assumes a regular gradation of tint according to the temperature; the first colour perceivable is yellow, very light at first and deepening into brown, then purple and blue, the darkest shade of blue fades away, and the steel approaches a red heat—in fact, it is as soft as it was previous to the hardening.

Steel articles which require to be hardened are wrought to their proper form and filed to shape when the metal is in its softest state, and the finished article is then hardened, as above described, and can be rendered bright and polished by the application of emery in some form. This peculiar quality of hardening is dependent on the amount of carburisation of the steel, and the mechanician has availed himself of this knowledge to produce on iron a surface of steel which is capable of being hardened by the same process as though the article were of solid steel, though in this case the hard part is only skin deep. As may be gathered from what we have said previously, it is the absence of a necessary proportion of carbon in wrought iron that renders it unsusceptible of hardening, and the deficiency of carbon is supplied to the surface of the iron by heating it to redness in close contact with leather, bones, or other animal refuse rich in the required element. Chemicals have been employed to produce the same effect, and prussiate of potash or ferrocyanide of potassium plentifully applied to the red hot iron will answer equally well. These latter materials are those most commonly used for small articles which may be wanted in a hurry, and the process of case hardening simply consists in heating the iron to redness, sprinkling its surface plentifully with one of the above chemicals, then returning it to the fire to allow the carburisation to take effect and to get the now steel to a hardening heat, and on being suddenly cooled the article will be hard as steel.

Case-hardening, when carried out on a more extensive scale, is effected by enclosing the articles to be case-hardened in wrought-iron boxes, together with animal refuse, such as above enumerated, and subjecting the whole to a continuous red heat for a period of from twelve hours, extending in some cases to several days. At the end of that time—the carburisation having been effected—the articles are hardened by making red hot and suddenly cooling. An operation, having for its object an exactly opposite effect, is carried out in producing malleable cast iron, so termed from its being rendered somewhat malleable. The object of this process is to remove from the cast iron the excess of carbon, and so render it similar to soft steel or malleable iron; and the object is effected by placing a decarburising material in contact with the casting, for which powdered peroxides of iron are generally used, and the heat kept up for from three to six days. Such so-called malleable iron cannot be worked when heated, though it may be hammered to a certain extent when cold.

Having made our readers acquainted with some of the peculiarities of iron and steel, and the processes by which they are worked, we shall endeavour to give them some further information, more interesting to the practical reader, on the manipulation of these materials at the forge and in the lathe. Those interested and desirous of information should not hesitate to apply.

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Wax Polishing.—This is not considered a good method, as it is not durable, and is easily spoiled by water splashes. Mix white wax and turpentine to the consistency of paste; with this anoint a rag and rub well into the pores of the wood. Clean off the superfluous wax with a wooden scraper, and smooth the surface by rubbing with a pad of rag, and finish by polishing with a little French polish. For large surfaces it is advisable to get the wax more deeply imbedded in the wood, and when a layer has been rubbed on, a hot iron passed over the surface will melt the wax and drive it in. This gives more body to polish on than by the method first described. The work is afterwards treated with more wax on a rubber, and finally polished.

To Take out Bruises in Furniture.—Wet the part with warm water; double a piece of brown paper five or six times, soak it, and lay it on the place; apply on that a hot flat-iron till the moisture is evaporated. If the bruise be not gone, repeat the process. After two or three applications, the dent or bruise will be raised level with the surface. If the bruise be small, merely soak it with warm water, and apply a red-hot poker very near the surface; keep it continually wet, and in a few minutes the bruise will disappear.

SHARPENING PLANE IRONS FOR CABINET WORK.

By A. Cabe.

BEFORE we begin practical operations at the bench, a few observations have to be made regarding putting the tools, particularly the planes, in order for wood planing. The bench planes —namely, the jack, the half-long, and the hand plane have to be properly sharpened, or "set," on an oilstone, and this first operation, the young beginner must bear in mind, requires some experience.

About the first job that must be undertaken is to put a case or cover on the set-stone. The stone is bought in the tool-shops without a cover; but it should not remain long without one, as the stone must be kept free from dust, and besides, in the event of falling off the bench, the cover protects the stone from breaking. So we will finish this article with a description of how to case the set-stone. Supposing the stone to be 9in. long, 2in. broad, and 1in. thick, get two pieces of mahogany or other clean, straight, hard wood, each an inch longer and an inch wider than the stone, and each ⅞in. thick. Plane one side of each piece flat, so that they will lie closely together. Take one of the pieces, place the set-stone upon it, keeping the side of the stone which you mean to use uppermost. With a draw-point draw a line all round the wood close to the stone, when you will have a margin outside the line of ½in. With the brace and a centre bit (⅜in. or ¾in.) bore all over the portion within the line ½in. deep, then with a shap chisel (⅞in. or 1in.) cut down to the draw-point line all round, clearing out all within to ½in. deep, and making the bottom of this hollow box level throughout. If it is pared square down at the edges, the stone will slip into it, taking care to put it in the same way as when you previously drew it. When the stone is bottomed, ½in. will project above the wood, and this part is to receive the top or cover. The stone is placed upon the second piece of wood, which is to make the cover, and drawn in the same way; and this piece has to be bored and cleared out in the same way to fully ½in. deep. It must have a smoother finish inside than the under piece; and, moreover, it must be pared a little without the draw-point line, so that the cover will slip on to the stone easily, but without shaking. The stone being within, the case is to be planed on the edges and ends; this is best effected by catching it in the bench vice. The four corners may be rounded as well as the edge all round of the cover, and a ⅛in. bead may be run round of the cover where it joins the under part. If the plane irons are new, they are very probably thick on the edge and require to be ground. This is done on a grindstone; and it would be well for a beginner to get a practical hand to do this for a time or two; but if the young cabinet maker has access to a grindstone, the sooner he begins to try for himself the better. After grinding, the irons have to be set on the oilstone, or, as we call it, the "set" stone. In grinding the jack-plane iron the cutting edge should be somewhat round, so that the shaving taken off is thicker in the centre than the edges. The half-long iron is also slightly round, but so slight that it is hardly noticeable. The hand-plane iron should be a straight line on the cutting edge, with the corners very slightly rounded —but on no account should the edge be curved, though ever so little, as it would only make ridgy work. These irons are all ground on the back only —that is, the under side—and the bevel or ground part is about half an inch long. It is not good to have the bevel too long, as the iron when working is apt to jump.

With a new set-stone the irons will probably keep straight on the edge for some time, but by usage the set-stone gets hollow in the breadth as well as the length, and consequently the irons set upon it become round on the edge. This is no detriment so far as the jack is concerned, but unless the hand-plane iron is straight you can never make a good smooth and even surface to a piece of wood.

To make a hollow set-stone flat various methods are employed, such as rubbing on a flat sandstone, with plenty of water, or on the side of a grindstone. The method I have found to be about the best is to plane up two or three pieces of pine, 9in. or 10in. long, 2½in. broad, to coat them well with glue, and pour the emery all over it, letting all remain on that will stick. After being laid aside for about a day, they will be ready for use. The oil is cleaned off the stone, and it is rubbed with the emery stick, which will soon take the high parts down and make a level surface, the hollow in the centre being the last to disappear.

With your iron ground and your set-stone in good condition, pour a little *sperm* oil along the centre of it, and holding the back part of the iron in your right hand, with the fingers of the left lying along the top side near the front and the thumb underneath, apply the bevel or ground side of the iron to the stone, and begin rubbing backwards and forwards nearly the whole length of the stone. During this operation the iron is to be held slightly more upright than it was when at the grindstone, so that the extreme cutting edge only may come in contact with the set-stone. After five or six rubs on the bevel, as directed, the iron is to be turned over and receive one or two light rubs when lying quite flat on the stone. This operation is to be repeated, five or six rubs on the back, and one or two on the front, until a keen sharp edge is obtained. If the irons are freshly ground, very little setting is required, but as they are very soon dulled or "blunted" when working, a fresh edge has to be brought up on the set-stone, and this sharpening may go on for twenty or thirty times before the irons require re-grinding. A blunt iron is very easily detected by looking at it on the bevel side. It presents a whitish rounded or worn appearance, and the sharpening has to be continued until this white worn edge disappears. A practical man ascertains this not by looking at, but by touching the edge lightly with his thumb. Another thing to observe is that when an iron is sharpened or set, a very fine wire edge remains all along the edge. This is removed by a dexterous slapping backwards and forwards on the palm of the hand, and is the same in effect as finishing the setting of a razor by stropping on a piece of leather. The three irons above referred to, after being sharpened, are put together as follows: Take the break iron and drop the head of the screw through the hole in the cutting iron, and slide it forward to within 1/16in. of the cutting edge, for the jack plane. Seeing that the break-iron is even with the cutting edge, screw head uppermost, and screw it somewhat tightly with a screw driver. Then, taking the stock of the plane, rest the back end on the bench and the fore end towards your face, so that your eye travels along the sole. While in this position, and holding the plane with the left hand, slip it forward until the cutting appears through, then place your left thumb on the screw head, holding the iron firmly till you insert the wedge, which push in as far as it will go, then give it two or three taps with a hammer. Remove your thumb from the screw, and regulate the iron by tapping the stock lightly on the back end with the hammer, when you want to give *more* iron, and tapping it on the top side, about an inch from the front when you want to give less iron. Two or three smart taps on this part wil loosen the wedge and iron for re-sharpening. While doing this the plane is held by the middle of the stock. Many have a habit of turning the plane over and striking the front of it smartly on the bench, when the iron and wedge drop out into the left hand. The half-long plane is fitted exactly as the jack, only the break-iron is fixed a little nearer the cutting edge, being about 1/20in. for working pine and other soft free woods. The hand-plane is also set in the same way, but with the break-iron a little nearer, the cutting edge being about 1/32in. The break-iron should fit quite closely all along the breadth of the cutting iron; otherwise shavings will get in and choke the plane. The margin between the break-iron and the cutting edge should in all cases be of the same width across the whole breadth of the iron; otherwise the iron will not fit the stock properly, but will show one corner projecting further than the other.

If the half-long and jack were set for hard wood, the margin between the break-iron and the edge would in both cases be only about half that given above. The hand-plane for hard wood which is smaller in size, and has a higher pitch, would have the break-iron very close to the cutting edge, within about the thickness of a thin card, and for cleaning veneers it would be so near the cutting edge that the margin would be scarcely visible, being little more than the thickness of common writing paper. In grinding and setting square and skew planes the irons should always appear an equal amount through the sole throughout their whole breadth. The cutting edge should be perfectly straight, and the corners square and sharp. The bevel of these irons should not be too long, as when working they will make a series of unpleasant jumps, leaving the work ridged in the direction of the face of the iron.

Bead planes are generally set ready for use when bought, but when they require setting, this is done with a stone called a slip. Several of these are necessary for the various bead and other moulding planes. These slips, which resemble gouge-slips, are usually about 6in. long and 2in. broad, and from ⅜in. to ½in. thick. They have the edges rounded to fit the irons to be set. The cutting part of a bead-plane iron is something like a semi-circle, and is a little smaller than the corresponding curve in the stock of the plane, the difference being the thickness of the shaving taken off. When the iron has been set a number of times with the slip, the curve has a tendency to get wider, and consequently is soon as wide as the curve in the stock. The iron will not then take off a shaving of equal thickness throughout the whole curve, but thickest in the middle, so the iron must be reground and set anew by the plane-maker, who has very thin round-edged grindstones for the purpose. The same thing occurs with most of the other moulding planes—an ogee, for instance, which consists of a curve called a "hollow-and-round." In setting it with the slip, the hollow part is continually getting wider, and the round part which is set on the ordinary set-stone is getting smaller. From these causes the moulding gets out of proportion and unshapely; besides, the iron does not fit the stock with a cutting edge even throughout its whole breadth, and will not turn a good shaving as before. The tool-maker must take it in hand and regrind the iron when in this condition.

To Polish Marble.—Make a thick paste with rotten stone and olive oil, and vigorously rub the marble with it on a cloth.

MAKING SMALL DRILLS.

WATCHMAKERS' pivot drills can be made from good sewing needles, which are of convenient form to be readily converted into a drill. Firstly, the needle must be made sufficiently soft for working by heating it till it assumes a deep blue colour. The extreme end may be made quite soft, and filed, slightly tapering to a trifle less than the size of the hole to be drilled. The point is now spread out by a sharp blow of a hammer—not by a series of gentle taps, which would cause the metal to crack—and filed up to shape, the point being made more blunt than would be used for drilling ordinary metal. For drilling tempered steel the cutting angles must also be much less than usual. The thickness of the drill across the flattened part should be about half the diametrical measurement. Finish up the end on a strip of Arkansas stone, a file being too coarse for such small work.

It is the great difficulty of getting such a very small piece of steel to an exact predetermined degree of temperature—*i.e.*, hot enough to harden, but not so hot that it is burned—which makes the manufacture of these small tools uncertain, and this is abundantly proved by the fact that of half-a-dozen drills made from the same piece of wire, thereby assuring uniformity of quality in the material, it often happens that some are exceedingly good and others of no use whatever, the difference being caused by the manipulation during hardening. This does not apply to drills or other steel things which are of sufficient size to show by the colour of their surface how hot they are; but it is the tiny pieces which are rendered white hot by the contact with the flame.

By heating the drill and plunging it into the body of a tallow candle the hardening will be effected, but the steel will not be rendered so hard but that it crumbles away under pressure in use. Thus, in one operation, the drill will be hardened and tempered. Instead of tallow, white wax, sealing wax, and such like materials are adapted to the purpose. There is another method which finds favour with some: it is to envelope the thin point of the drill in a metal casing, and so get a bulk of metal which can be heated to a nicety, the drill inside being, of course, raised to the same temperature as the surrounding metal; the whole is then plunged into oil or water. Still, there is the difficulty of tempering to overcome, though the danger of burning is avoided; burnt steel is no use for tools. The best plan is to exercise the greatest possible care not to overheat the drill, and harden and temper in one operation by plunging into tallow.

The following method dispenses with the hardening process altogether:—Select a round Swiss pivot brooch; as sold, they will be found to be tempered to the correct degree of hardness. By means of the split gauge, measure the part of the brooch which is the exact diameter required for the intended hole, and break off the steel at that point; the small piece is used; it must be broken off if too long, and cemented into a drillstock by shellac; an ordinary drillstock will do, or a piece of brass joint wire serves the purpose. Soft solder may be used instead of shellac, and, if carefully heated, the temper will not be drawn. The piece of tapering steel is now formed into a drill by grinding down the sides with a piece of Arkansas stone, and the end shaped up to a cutting angle. The thick end of the brooch is, of course, the point, and the ordinary taper of a brooch will be quite sufficient to give clearance to the drill, which may be ground off until the whole is used.

THE ART OF TURNING.*

By Paul N. Hasluck.

(*For Illustrations, see Lithograph Supplement.*)

A DEFINITE idea of the subject matter or this paper is desirable before an attempt is made to enlarge upon it. Speaking broadly, the art of turning consists of shaping articles on a lathe. Lathes are machines used for shaping material by causing it to revolve while acted upon by a cutting tool. To define the art more closely, we understand it to mean the fashioning of articles that are themselves revolved on the lathe, and which are acted upon by a cutting tool held by the hand, or in a slide-rest. The derivation of the word "lathe" has been attributed to the pole used for working the earliest turning machines. The pole, in order to render it fit for use, was pared down to a taper form, and thus made to resemble a lathe. The English word lathe is one that has been specially bestowed by us. "Turn" is the word applied, in other languages, to the machine. We yet call the smallest form of lathe, in common use amongst watchmakers, "turns."

It will be useful to classify the variety of lathes in common use. Hand lathes are those driven by hand power; the ordinary drill bow being the means most frequently employed. Some hand lathes are driven by means of a wheel, turned by the left hand, whilst the turner manipulates his turning tool with his right hand. The turns used by watchmakers is an example of the former; the throw used by clockmakers is an example of the latter. A lathe, driven by the other hand power, which has no slide-rest, is sometimes called a hand lathe, but the term is in such cases wrongly applied. Probably the fact of the machine being adapted for the use of hand tools only has suggested the erroneous term. Foot lathes are those driven by foot power, generally applied to a treadle, which is attached to a cranked axis carrying a fly wheel. Any method of applying foot power for driving the lathe would render foot lathe a correct designation for the machine. Steam lathes are those driven by steam power.

The process of shaping materials by means of rapidly rotating cutters, often practised on the lathe, should not be considered as turning. I refer especially to the work produced on machines conventionally called "lathes for turning irregular forms," and used for making boot lasts, gun stocks, and many other articles. Within the last few years these machines have been greatly improved, and have, in fact, completely revolutionised certain branches of the wood working trades. In plain turning, the work rotates on the line of centre, and the contour formed by the cutting tool must necessarily be circular. By means of elaborate chucks, the work may be made to travel in various directions simultaneously, and in this way geometrical figures are placed by a fixed tool. Ovals are turned by simply moving the work to and fro, at right angles to its axis of rotation, by a synchronous motion. An inclined plate on the mandrel, working against a fixed roller, and giving the mandrel a motion lengthwise whilst it is rotating, affords the means of producing oblique mouldings, well-known as "swash-plate" turning.

For turning very large diameters, especially when the objects are heavy, lathes are frequently vertical; that is, the mandrel is upright, and the face plate, always fixed to it, revolves horizontally. It is much easier to chuck work on the face-plate in that position. A lathe, having the mandrel in the usual horizontal position, that I know of, is capable of turning a disc twenty-five feet in diameter. It weighs about sixty tons. At Whitworth's works in Manchester, I have seen a lathe, similar in design to the ordinary type of machine, which has five feet centres, so as to admit work ten feet in diameter. It will take fifty feet between the centres, and the entire machine weighs one hundred and ten tons.

In the Arsenal at Woolwich, a larger lathe, very similar in construction, is in use. It is called a circular planing machine, but I should like to know for what reason? It appears that a lathe may have its line of centres either horizontal or vertical, or at any inclination. With the machine at Woolwich, the work is itself revolved; a tool is held in a slide-rest—in fact there are two distinct tool holders at diametrically opposite points. Why is the machine not called a lathe, and the work upon it turnery? So far as our original definition of the art serves us, that machine is a lathe, though some may cavil at the designation. The lathes erected at Woolwich for turning the large guns are amongst the largest and heaviest constructed; they weigh over 84 tons each.

Having now some definite ideas of what the art of turning really is, the subject may be profitably studied in its various branches. Turning indisputably holds a forward place in the useful arts, and it is one of the oldest. The lathe has been aptly called the "father of mechanism," so much is mechanism indebted to it for its very existence. The date of the origin of the art is lost in antiquity. It was probably known before historians began to write. The potter's wheel is believed to have been the earliest form of lathe. This primitive lathe is now commonly used by the potters of the present day; it is, technically, "a throw." The work that a potter produces on his lathe, using his hands to shape it, is technically termed "thrown;" the turning of pottery ware is a subsequent process. The oldest Egyptian monuments had representations of the potter at work with his lathe. The first illustration shows this early record of turning, similar representations are drawn on many ancient stones. This takes us back two thousand years before the Christian era. Ptah, a god worshipped as the leader of mundane artisans by the Memphites, who flourished about two thousand years before Christ, is represented in the act of moulding man upon a potter's throw. Thus we find in the earliest records a special tribute to the art of turning, which, in that remote period, was evidently deemed the art by which man was fashioned. In scripture history we have in Jeremiah a distinct allusion to the potter and his wheel. This date is about 500 years B.C.

The processes employed by the Hebrews were probably similar to the Egyptians, from whom they had learned the art. The wheel used consisted of a wooden disc placed on another large one, and turned by hand by an attendant, or worked by foot by the potter himself. The illustration shows a potter standing in a pit and kneading the work with his hands. The vertical spindle, with the flat disc on the top, is revolved by the feet of the workman.

Sir Gardner Wilkinson, in his book, "The Manners and Customs of the Ancient Egyptians," published in 1836, says:—"Potters are represented in the tombs of Thebes and Beni Hassen. They frequently kneaded the clay with their feet, and after it had been properly worked up, they formed it into a mass of convenient size with the hand, and placed it on the wheel—which, to judge from that represented in the paintings, was of very simple construction, and turned with the hand." The

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*A paper read before the Society of Arts, with illustrations and additions by the author.

author, in continuation, says:—"It is impossible to fix the period of the invention of the potter's wheel, but it was known at the earliest epoch of Egyptian history, of which the sculptures have been preserved. The notion that the gods imparted to men the arts of civilisation was common to the Egyptians as to the Greeks, and Neph is represented showing them the potters' art." The invention of the potters' wheel has been claimed by Athens for Carœbus; by Corinth for Hyperbius; and for Dædalus or Talus by the Cretans.

The Rev. W. M. Thomson, who was for 25 years a missionary in Syria and Palestine, gives an excellent illustration of a modern potter at work. The figure is a reproduction of this; the original will be found in his work, entitled "The Land and the Book," published in 1859. The description is given thus:—"I have visited the potteries, and was delighted to find the whole Biblical apparatus complete and in full operation. There was the potter sitting at his frame, and turning the wheel with his foot. He had a heap of the prepared clay near him, and a pan of water by his side. Taking a lump of clay in his hand, he placed it on the top of the wheel (which revolves horizontally) and smoothed it into a low cone, like the upper end of a sugar-loaf; then thrusting his thumb into the top of it, he opened a hole down through the centre, and this he constantly widened by pressing the edges of the revolving cone between his hands. As it enlarged and became thinner, he gave it whatever shape he pleased, with the utmost ease and expedition. From some defect in the clay, or because he had taken too little, the potter suddenly changed his mind, crushed his growing jar instantly into a shapeless mass of mud, and beginning anew, fashioned it into a totally different vessel.

Long before the fly wheel, worked by a crank, was invented or used, lathes were driven with the aid of a spring pole, and also by bows; not used in the manner of the modern drill bow. The pole lathe is still in use in some trades—amongst which that of the watch case maker occurs to me—but the alternating motion has been almost entirely superseded by the continuous fly wheel. Pole lathes are driven by the foot; an elastic springy pole is fixed by one end—usually to the ceiling—so that the free end is in a direct line with the mandrel pulley. A cord from the free end of the pole is passed around the pulley, and attached to the treadle. When the foot is applied, the mandrel is made to revolve in the direction necessary for cutting; on relieving the treadle of pressure, the elastic force of the spring pole draws the cord back, at the same time causing the work to revolve backwards. In this way the treadle is brought to its original position, ready for another effective stroke.

It is evident that this alternating motion is by no means economical. Every effective movement of the work is only the precedent of an equal amount of non-effective motion. To take the matter at its best, and allow that the speed is in both instances equal, half the time employed in turning is wasted in waiting for the backward motion. Despite this obvious and serious drawback, the pole lathe has been used ever since the invention of the centre lathe. In its earliest form this lathe consisted of two fixed centre points; between these the work was mounted. The cord was placed around the work itself, and no mandrel was used. Bergeron, in his book on turning, published in 1792, illustrates and describes lathes of this description as being machines of the period. At the present time watch case makers use them, the alternating motion being convenient. When the watch case is partially finished, and has the knuckle or the pendant soldered on, it may be mounted on the old-fashioned pole lathe, and, by dexterously regulating the amount of the motion given to the treadle, the work is revolved barely a complete turn, and thus the whole edge of the case, excepting the one projecting piece, may be operated upon by the tool. In the modern lathe this operation would be impossible; when the circular motion is continuous, the projections cannot be left intact. This explanation accounts for the apparent inconsistency of using a pole lathe in the present perfected state of the art of turning, in a country where its development is perhaps the most complete.

Geologists have discovered pottery ware in some of the oldest formations which contain human remains, but this pottery was, it is evident, made by hand-moulding, and not by being thrown or turned upon a wheel.

The ancient Peruvians are said to have used the lathe, and specimens of their supposed turnery are to be seen in the British Museum. Quite recently some pottery has been exhumed from tombs in Peru, together with relics said to ante-date the reign of the Incas, but it is recorded as a remarkable circumstance that the potter's wheel has not been used on these articles, and the manner in which they were moulded is unknown.

The turning lathe of modern form was apparently not known in those early times. Though many trades and occupations are vividly represented upon the sculptured records of ancient Egyptians, the turner—other than he working at the potter's wheel—is unrepresented. This fact leads to the conclusion that the turning lathe proper was unknown in Egypt.

Turning was evidently one of the arts practised by the Greeks and Romans. Their writers mention lathes and turners frequently some five hundred years before the Christian era.

Diodorus Siculus says the inventor of the art of turning was a nephew of Dædalus, named Talus. The reputation he acquired by this invention excited the jealousy of Dædalus, who put Talus to death secretly. If this account is true, we have the name of an early martyr to the art. Pliny ascribes the invention to Theodorus of Samos, and also mentions one Thericles, who rendered himself very famous by his dexterity in managing the lathe. Socrates mentions the works produced in the lathe as productive of pure pleasures. Plato also speaks of the art of turning in similar terms. It was a proverb amongst the ancients to say a thing was formed on the lathe to express its delicacy and accuracy. Amongst the polite French people a precisely similar expression is used to-day to convey a high compliment.

The early practice of turnery was almost confined to fashioning wood. We read of bowls, also of flutes, and musical instruments that have been produced by the skilful turner. The application of the art to fashioning metal is of comparatively recent origin.

An attempt to trace the progress of the art of turning through successive generations would probably become wearying. The subject is a very speculative one. There are few indisputable data on which a connected history could be wrought. No treatise on the subject exists, and hence the difficulty in dealing with it.

(To be continued.)

Cement for Turners.—Melt together beeswax one ounce, resin half an ounce, and pitch half an ounce; stir in the mixture some very fine brickdust to give it a body. If too soft, add more resin; if too hard, more wax. When nearly cold, make it up into cakes or rolls, which keep for use.

MY FIRST CLOCK.

(A REMINISCENCE OF AN APPRENTICE.)

I HAD learnt to handle the tools, and could use the lathes and the turning tools tolerably well, and at last "our maister" decided that I should make something, so he gave me some castings and other materials to make a plain eight-day clock, when my time was not occupied with the other duties that usually and very properly fall to be done by the youngest apprentice.

I had to clean the shop and the shop windows, and run the errands; and I also cleaned all the clocks, although I was not allowed to put them together, and every morning it was my duty to clean all cases of the watches that had been repaired the day previous. But the worst thing of all, I had to go to the well to bring water not only for the use of the shop, but also for the use of "our maister's" wife. I did not mind doing dirty work inside the shop, where but few saw me, but I was of the decided opinion that carrying water on the public street was altogether below the dignity of a watchmaker's apprentice. Still I did not grumble openly, except when at home I sometimes relieved myself, but consoled myself with the hope that the day would come when I would get square with "our maister's" wife for the imposition I then imagined was being practised on me by making me carry water for household purposes.

Although the position of a young apprentice had menial duties connected with it, there were also times of pleasant relaxation. When "our maister" went to the houses of the neighbouring gentry of farmers to clean or correct their clocks, I had always to go with him, and generally these were days or enjoyment; but I liked the farmers' houses best, for to me all restraint was thrown off, and unaffected joy everywhere abounded. The farmer or some of his family attended on us all the time, and told us stories while our work was being done; and after the clocks were set going we would wait a little while, on the pretext that some of them might stop. The farmer and "our maister" usually went into a private room containing nothing particular except an old cupboard in which stood some fine cut crystal ware. I was sent outside to enjoy myself with the members of the family of my own age, with full liberty of access to the milk-houses, barns, and stables, and sometimes equestrian feats were executed by us on patriarchal horses, who appeared to enjoy the fun as much as we did ourselves. I do not know what kind of business "our maister" and the farmer transacted in private, but sometimes their deliberations were somewhat protracted, and I noticed that usually when the interviews were over they were perfectly pleased and satisfied with themselves in particular, and felt well disposed towards mankind generally.

At one time, if a marriage was projected in our town, a brand new eight-day clock was considered to be indispensable to the respectable appearance of the home of the young couple, and when the house was being prepared for their reception, an eight-day clock that would reach from the floor to the ceiling was sometimes given as a present from the bride's father. On these occasions universal joy abounded, and the joy was often temporarily increased by the ceremony of drinking the health of the young people. The "old folks" were happy over the projected marriage of the "young folks," which reminded them of their own earlier years, and which promised to enlarge their own happiness in the future. "Our maister" was happy because he had sold a clock and a wedding ring, and perhaps a watch or a piece of jewellery besides, while I was happiest of all, for I generally got my pockets stuffed full of cakes or confectionery, or one of the old people would "play a trick upon me" by slipping several coins into one of my pockets while I was putting up the clock.

It was a long time before I got my new clock completed, because there were many interruptions, but at last I got it finished, and I did not experience much difficulty in doing it, because I had at first been taught the use of the tools, and "our maister" gave me careful directions at every stage in its construction. The rules he insisted on me following were exactly the same as those laid down in Ried's Treatise, which need not be mentioned here, because many readers must either own a copy of the work or are familiar with its contents. But those not in possession of a copy, or who are unacquainted with the contents of the book, will find considerable extracts from it in such of our trade papers as in their judgment of Ried consider imitation to be the most sincere flattery.

Although I was a boy, my imagination led me to think that I had learned all that was to be learned, and at the very least I was as good a man as "our maister" was, although he had taught me everything. I showed the clock to all my friends as being the very best that ever was made, and nothing could exceed the care I exercised over that clock to keep it from harm. But one day it was sold to go to a distant part of the country. I would much rather it had remained at home, but I dared not interfere; and when the clock was being packed up and the head slided on for the last time, I felt as if I saw a dear friend put in his coffin.

Since that time I have designed and constructed many pieces of complex mechanism both for horological, astronomical, and philosophical purposes, and although I now look upon making my first clock as but learning the first letters of the alphabet, the successful completion of no undertaking ever gave me such genuine pleasure as the finishing of my first clock.

Young men are too apt to jump at conclusions, and to imagine that when they have been taught the preliminary elements of their business they know everything, and in their blindness consider every little thing that they accomplish to be a great achievement. A little experience in the world will show them their mistake, if friendly advice prove impotent, and instead of their having accomplished all that can be done, they will, like the sage philosopher, discover that they have only found a grain of sand on the sea shore, while all beneath the ocean is hid from their view.

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To Cut Good Steel Scrapers.—Part of the blade of a broken saw makes the best of scrapers; but, as it is hard, it is very difficult to cut it into the required form. The best and most expeditious way is to mark it out to the size wanted, and then to place the blade or steel plate in a vice whose chaps shut very close, placing the mark even with the face of the vice, and the part to be cut to waste above the vice. Then with a cold chisel, or a common steel-firmer that has its basil broken off, holding it close to the vice and rather inclined upwards, begin at one end of the steel-plate, and with a sharp blow of the hammer it will cut it. Keep going on by degrees, and you will with ease cut it to the shape required; then grind the edges of your scraper level, and finish by rubbing it on your Turkey-stone.

To Harden Wood Pulleys.—Soft maple is often used in the construction of friction pulleys. If it is boiled in olive oil it will prove beneficial in a number of ways. It will harden the timber and render it less liable to split, but at the same time the gear will slip more after such treatment.

ORNAMENTAL LATHE SCREWS.

THE obsolete and inconvenient character of the screws that still survive in our costly ornamental lathe apparatus has recently been brought before the public by Dr. Edmunds, an eminent physician, himself much attached to ornamental turning, microscopy, and other scientific pursuits. Twenty-six letters upon these screws have appeared in the columns of the *English Mechanic* (Jan. 20th to May 5th, 1881)—the writers being Dr. Edmunds, Mr. John Jacob Holtzapffel, Mr. J. H. Evans, members of the Amateur Mechanical Society, and others. In the course of this very able and valuable correspondence, Dr. Edmunds elicited from Mr. Holtzapffel all the *data* which had remained unpublished of the "Holtzapffel," or "ornamental lathe screws," and, in closing the correspondence, Dr. Edmunds gave a carefully prepared table, showing all the definable *data* of the "Holtzapffel" screws, and comparing them with other standards. Starting from the numerical denotements by which Charles Holtzapffel strung these comb screw-tools together, Dr. Edmunds shows how these numbers correspond to the screw-mandrel guides, to the alphabet denotements used for the Holtzapffel taps and dies, and to the mandrel noses. He then appends other columns, showing for comparison on each line the nearest element of the English and American standard threads, and also such aliquot pitches as might be substituted in the event of the English standard screws not being adopted for scientific purposes.

Now that these screws are thus exhibited, they are seen to be a mere relic of rule-of-thumb mechanics which have been kept alive for trade purposes, as if the screw-cutting lathe had never been invented. No one will be fatuous enough knowingly to prefer a screw 39·83 threads to the inch when he can have one of 40; 36·10 in place of 36; 19·89 in place of 20; 13·09 in place of 12 or 14; or a mandrel nose of 9·45 to the inch when he can have one of 10. Even the ornamental slide-rest screws used to be cut 13·09 to the inch, but, as amateurs would not stand this, they have long been made 10 threads to the inch. The back poppet cylinder, however, is still screwed 13·09 to the inch, and, therefore, in boring with the D bit by screwing up the back centre, one has to stop and divide an inch by 13·09, and then multiply the result by the number of revolutions that have been given to the back poppet screw in order to get at the depth which the drill has entered. Otherwise the lathe must be stopped, and the hole itself actually measured. In the beautiful ornamental lathes, made by Kennan, of Dublin, the English standard screws were long since adopted, with a back poppet screw of ten threads to the inch, so that with a Kennan lathe one has only to write down the number of turns of the back poppet, and the depth bored is expressed in decimals of an inch. Again, in order to screw chucks for the mandrel nose, Holtzapffel actually sells an extra brass wheel of 53 teeth, so as to get a screw of 9·43 to the inch, which then is the nearest his client can get to the 9·44 of his mandrel nose. Now, why should an amateur be burdened with the cost and complication of this otherwise useless 53-teeth wheel, when the simple screwing of the mandrel nose ten to the inch would be so much easier and better? It is clear that if the back poppet screw, the mandrel nose, and the slide-rest screw were all ten threads to the inch much botheration would be saved, and everything would be simplified.

Dr. Edmunds advises also that the ornamental mandrel should be tubular, with the screw at its left end, either bored through or made in the shape of a nut, so as to carry in from the back a ·25 inch wire or slender rod of ivory, without disturbing anything; that it should have a ⅞ inch (·8750) nose screwed with a Whitworth thread of ten to the inch; that, instead of being a traversing mandrel, it should be a double collar mandrel of the best construction, and carry a spiral arm behind the lathe head. Six change wheels would then cut all the aliquot pitches which Dr. Edmunds recommends, and many more, including the 36 thread universal microscope screw. This arrangement would be more enduring, more effective, and much cheaper than the troublesome traversing mandrel, with its screw guides and spiral apparatus to the right of the lathe head, as is still made by Holtzapffel and Co.

At the conversazione of the Amateur Mechanical Society, held at the Suffolk Street Galleries, on December 6th, we noticed that Holtzapffel & Co.'s exhibit still had the mandrel nose screwed 9.45 threads to the inch, and the poppet cyclinder screwed 13·09 to the inch. Mr. Evans, however, exhibited prominent notices to the effect that he had adopted a mandrel nose and back poppet screw of ten threads to the inch, and that henceforth all his pitches would be aliquot parts of the inch, capable of being originated accurately and easily by means of the spiral apparatus or screw lathe. We may therefore congratulate Mr. Evans's clients upon the advance and simplification that is promised them without further delay. At a general meeting of the Amateur Mechanical Society, in May, 1881, the whole question of ornamental lathe threads was referred to the Council of the Society for consideration and report. The Council have already unanimously adopted the principle of aliquot pitches, and are about to come to a conclusion on the question of angle and cross section of thread. We understand that they are pretty well agreed that the thread of the mandrel nose should be suitable for a cast-iron chuck, and this principle may possibly lead to the adoption of the Whitworth thread, which has an angle of 55°, and is rounded off one-sixth at top and one-sixth at bottom. The multiplication of standards is to be deprecated, and the Whitworth thread, when finely executed, has much to recommend it besides the fact of its universal currency amongst scientific mechanical engineers. Dr. Edmunds, however, points out that a thread of 50°, flattened or rounded down at top and bottom, so as to make its altitude exactly equal to the length of its base, would make but a slight departure from one of the present ornamental screw threads, and that this thread—while an admirable sharp thread for fine purposes—would have the unique advantage that its depth would in all cases be exactly equal to its pitch. Thus Dr. Edmunds's thread, when cut ten to the inch, would be one-tenth of an inch deep, and would leave its shaft diminished by two-tenths of an inch in diameter at bottom of thread. So his thread, if cut thirty to the inch, would be one-thirtieth of an inch deep, and would take two-thirtieths off the diameter of the shaft on which it was cut. This would be a great simplification. The mere form of the thread, however, is of much less importance than the principle of *aliquot pitches*, which can always be originated exactly by means of change wheels without the least difficulty. There is no imaginable purpose for which Holtzapffel's incommensurable pitches could be preferable to the aliquot pitches. Aliquot pitches are easily originated, accurately producible, and lend themselves admirably to calculation. Holtzapffel's incommensurable pitches can only be copied mechanically from the old hobs cut by the present Mr. Holtzapffel's grandfather. There is great variation in the screw tools actually sent out under this name by the ornamental lathe makers, and, in case of accidental breakdown of the apparatus, the greatest inconvenience is experienced unless the owner have in store a complete set of the Holtzapftel screw tools. It must be obvious that scientific amateurs will no longer invest hundreds of pounds in lathe apparatus constructed with obsolete screws, and we trust that makers of ornamental lathes will, on reflection, cordially co-operate with the Council of the Amateur Mechanical Society, so as to settle this question upon a satisfactory basis.

As there are thousands of ornamental lathes in circulation amongst gentlemen amateurs, we take occasion to reproduce in a permanent form for reference Dr. Edmunds' tables of the Holtzapffel screw data, which we take from the *English Mechanic* (No. 892, page 173):—

TABLE OF SCREW THREADS.

Holtzapffel Screw Threads, as now used for Ornamental Lathe Work.						Whitworth Screw Threads (English Standards).			Sellers' Screw Threads (United States Standards).			Aliquot Pitches, suggested for Ornamental Lathe Work.			
			Taps and Dies.												
Comb Screw Tools Numbered.	Mandrel Guides. Numbered.	Threads per inch. Angle 50° or 60°.	Alphabetical Denotements.	Diameters outside Thread.	Diameters at bottom of Thread.	Diameters outside Thread.	Threads per inch. Angle 55°.	Diameters at bottom of Thread.	Threads per inch. Angle 60°.	Diameters at bottom of Thread.	Width of Flat.	Diameters outside Thread.	Threads per inch.	Mandrel-Guides.	Denotation.
1		6·58	A	1in. = 1·0000	Undefined.	1in. = 1·0000	8	.8399	8	·837	·0156	1in.	8		The comb screw-tools and mandrel-guides to be denoted solely by a number, indicating the number of threads per inch. Taps and dies to be denoted by their number and outside diameter of their screw-thread.
2		8·25	B	$\frac{7}{8}$in. = ·8750		$\frac{15}{16}$in. = ·9375	9	·7952	9			$\frac{15}{16}$in.	9		
2		8·25	7in. nose	$\frac{9}{8}$in. = 1·1250		$\frac{14}{16}$in. = ·8750	9	·7327	9	·731	·0138	$\frac{14}{16}$in.	9		
3	1	9·45	6in. nose	$\frac{15}{16}$in. = ·9375											
3	1	9·45	5in. nose	$\frac{13}{16}$in. = ·8125		$\frac{13}{16}$in. = ·8125	10	·6844	10			$\frac{13}{16}$in.	10	10	
3	1	9·45	C	$\frac{3}{4}$in. = ·7500		$\frac{12}{16}$in. = ·7500	10	·6219	10	·620	·0125	$\frac{12}{16}$in.	10		
4	2	13·09	4in. nose	$\frac{3}{4}$in. = ·7500		$\frac{11}{16}$in. = ·6875	11	·5710	11			$\frac{11}{16}$in.	11		
4	2	13·09	DD	$\frac{5}{8}$in. = ·6250		$\frac{10}{16}$in. = ·6250	11	·5085	11	·507	·0113	$\frac{10}{16}$in.	11		
4	2	13·09	D	·5600		$\frac{9}{16}$in. = ·5625	12	·4557	12	·454	·0104	$\frac{9}{16}$in.	12	12	
4	2	13·09	E	$\frac{1}{2}$in. = ·5000		$\frac{8}{16}$in. = ·5000	12*	·3932	13*	·400	·0096	$\frac{8}{16}$in.	12		
5	3	16·5	F	·4500		$\frac{7}{16}$in. = ·4375	14	·3460	14	·344	·0089	$\frac{7}{16}$in.	14		
6	4	19·89	G	·4100											
6	4	19·89	H	·3600		$\frac{6}{16}$in. = ·3750	16	·2949	16	·294	·0078	$\frac{6}{16}$in.	16	16	
7		22·12													
8	5	25·71	I	·3300		$\frac{5}{16}$in. = ·3125	18	·2413	18	·240	·0074	$\frac{5}{16}$in.	18		
8	5	25·71	J	·2900											
8	5	25·71	K	$\frac{1}{4}$in. = ·2500		$\frac{4}{16}$in. = ·2500	20	·1859	20	·185	·0062	$\frac{4}{16}$in.	20	20	
9		28·88	M	·2100								$\frac{4}{16}$in.	24	24	
10	6	36·10	L	·2400											
10	6	36·10	N	$\frac{1}{5}$in. = ·2000								$\frac{1}{8}$in.	30		
10	6	36·10	P	·1800								$\frac{1}{8}$in.	36	36	
11		39·83	O	·1900								$\frac{3}{16}$in.	40		
11		39·83	Q	·1625											
12		55·11	R	·1500											
12		55·11	S	·1350											
12		55·11	T	·1200								$\frac{2}{16}$in.	50		
12		55·11	U	$\frac{1}{10}$in. = ·1000								$\frac{1}{10}$in.	60		

* In the half-inch screw Whitworth uses twelve threads, as with his 9-16. Sellers uses thirteen threads in the half-inch and twelve n the 9-16. In all other pitches the English and American standards are alike.

AN INEXPENSIVE LATHE.

(For Illustrations, see Lithograph Supplement.)

AN inexpensive lathe is the one great desire of every amateur mechanic whose spare cash is limited. Some time ago a small bench lathe was illustrated in *The Scientific American Supplement*, and this is shown at figs. 1 and 2. The description given explains the construction. A lathe that will do admirably, says the writer, for amateurs, and which may be easily made, is shown in perspective complete at fig. 1, and the headstocks are shown in section enlarged, at fig. 2. We have added figs. 3 and 4, which show more clearly the construction of the mandrel headstock and of the small standards that form a leg and headstock in one piece. Fig. 3 shows the form of the standard, one pattern only being required from which the various castings can be moulded. Two castings are wanted for the mandrel head, one for the poppet which has its lower part removed, and one for the right-hand standard, which is low, as shown in fig. 2.

The lower part of the poppet is made in two pieces, so that they may be clamped tightly together on the bed by means of the bolt that passes through both pieces, and is provided with a nut having a lever handle. The rest support is also made in two parts, clamped together on the head in a similar way.

The patterns may be easily sawed from 1¼in. pine. The holes that receive the round bars may be chambered to receive Babbitt metal, used in making the fit around the bars forming the bed, around the head and tail spindles, and around the shank of the tool rest. The smallest diameter of the holes that receive the round bars should be a little less than that of the bars, so that the several pieces that are placed on the bars may be fitted to hold them in place while the Babbitt metal is poured in.

The dimensions of the lathe are as follows:— Length of roundbars forming bed, 24in.; diameter of bars, 1in.; distance from the upper side of upper bar to the centre of mandrel, 3in.; between bars, ¾in.; between standards that support the mandrel, 3½in.; size of standard above shears, ¾in. x 1¼in.; diameter of spindles, ¾in.; diameter of pulleys, 5in., 3½in., and 2in.; width of base of standards, 5in.; height of standards, 7in.

The mandrel should be enlarged at the nose end, and tapered at both ends, as indicated in the engraving. It will be easy to see the details of construction by carefully examining the drawings.

The pulleys, which are of hard wood, are made of three pieces glued together, bored, and driven on the mandrel, secured by a pin passing through both it and the mandrel, and turned true. The bars forming the bed may be either cold rolled iron or round machinery steel; they will require no labour, except perhaps squaring up at the ends. The castings having been fitted to the bars, and provided with set screws for clamping them, the two standards that support the mandrel and the support for the opposite ends of the bars are put in position. When the bars are placed truly parallel, a little clay is placed around each bar and over the annular cavity that surrounds it, and is formed into a spout or lip at the upper side to facilitate the pouring of Babbitt metal. The metal must be quite hot when poured, so that it will run sharp and fill the cavity. To guard against a possible difficulty in removing the castings from the bars, it might be well to cover the side of the bar next the screw with a thin piece of paper. The pieces of the tail stock and T rest support are fitted to the bars by means of Babbitt metal, the metal being poured first in one half and then in the other. The bolt which clamps the two parts of the rest support together are provided with lever handles. After fitting the parts to the two bars by means of Babbitt metal, the tail spindle, which is threaded for half its length, is placed in the tail stock parallel with the bars and Babbitted. A binding screw is provided for clamping the tail spindle, and the spindle is drilled at one end to receive the centre, and has at the other end a crank for operating it.

A steel button is placed in the hole in the standard that supports the smaller end of the mandrel, and the spindle is supported in its working position and Babbitted. The thread on the spindle should be rather coarse, so that wooden or type metal face plates and chucks may be used.

The table shown in fig. 1 is simple and inexpensive. It consists of two pairs of cross legs halved together and secured to a plank top. A small rod passes through the rear legs near the lower ends, and also through a piece of gas pipe placed between the legs. A diagonal brace is secured to the top near one end, and is fastened to the lower end of the rear leg at the other end of the table.

A block is secured to each pair of legs for supporting a pair of ordinary grindstone rollers, which form a bearing for the fly-wheel shaft. This shaft has formed in it two cranks, and it carries an ordinary fly wheel, to the side of which is secured, by means of hook bolts, a grooved wooden rim for receiving the driving belt. The cranks are connected by means of hooks of ordinary round iron, with a treadle that is pivoted on the gas pipe at the rear of the table. The shaft will work sufficiently well, even if it is not turned. The cranks must have half-round grooves filed in them to receive the treadle hooks. The size of the different diameters of the drive wheel may be found by turning the larger one first and the smaller ones afterwards, using the belt to determine when the proper size is reached. The wooden rim may be turned true in position by means of a turning tool.

The lathe above described, although very easily made and inexpensive, will be found to serve an excellent purpose for hand work, and if the holes, instead of being Babbitted, are bored, and if the bars forming the shears are turned, the lathe may be converted into a kind of engine lathe by placing a feeding screw between the bars, and putting a small tool post in the rest support.

To the above lathe we have added the illustrations shown at figs. 3 and 4, some particulars of which will be necessary. The first shows the shape of the standard; and further particulars are not required. In fig. 4 the bars used for the bed are shown as gas barrel. The standard at the right hand end of the mandrel is secured in position by pins put transversely through it and the barrel. Tubes are then slipped over the barrel to keep the back standard at a proper distance from the front, and nuts are screwed on to the thread at the extreme left, so as to firmly clamp the two standards. The tail-pin supporting the back end of the mandrel is also shown, made more in conformity with our English form of lathe heads. Particulars of the method of manufacturing this lathe will form the subject of another article.

HOW TO COMMENCE ENGINEERING.

By Edward Hines.

A NATURAL mechanical talent, or genius for tinkering, as some of their less gifted friends facetiously allude to this proclivity, seems an instinctive gift from the wondrous Divine Mechanician to a large body of mankind in general. This inventive and constructive faculty or power of adapting means to ends is not confined to any class, or simply to the reputed lords of creation. Many of the gentler sex also practise some of the most agreeable, fascinating, and enjoyable of indoor recreations included under the head of mechanical manipulation—I include turning in gold, silver, and metals generally, ivory and hard and soft woods—mechanical engineering, or machine construction and the construction of scientific apparatus; carving, engraving, modelling, and fretcutting; cabinet and Buhl work, and other kindred occupations.

An old friend of mine, living something under 500 miles away, has a desire to obtain a practical insight into the mysteries of the art of a mechanical engineer without going back to his early days and signing his name to a wonderful hieroglyphic on parchment before a profound-looking gentleman in wig and spectacles, has asked me to furnish him with a little information from month to month, commencing at *a b c*, so that he can, without intrenching on other than his leisure time, cultivate a really practical acquaintance with mechanics. I have consented to afford him the much-desired information, and write a series of articles on "How to commence engineering."

It is with the desire to afford to those who have not enjoyed the immense advantages of a combined theoretical and practical education in mechanical designing and construction an opportunity of availing themselves of the lifelong study and experience of a practical workman that these pandects are undertaken. Knowing also something of the unscrupulous decoys which have often induced in untutored minds the innocent belief that inexperienced amateurs can readily and efficiently construct a perfect-working model engine, or complete some far more intricate and wonderful piece of mechanism entirely without a turning lathe or other machine tool, and of other similar inducements to purchase unhandy, most imperfect, and useless articles, termed amateurs' tools, offered at most tempting prices, and which consist in the main of vile imitations of the carefully designed and accurately constructed tools of substantial and well-known manufacturers, I shall endeavour to point out the most convenient, economical, and suitable tools and appliances with which to furnish an amateur workshop.

It is quite true that great and noble intelligences have plodded step by step through apparently insurmountable difficulties, overcoming obstacles which would have baffled—it may be defeated, but certainly disheartened—ordinary minds, having but the most primitive kinds of tools and apparatus with which to obtain results that have fairly startled the world. But in these days of manipulative skill, when tools and instruments of the greatest precision and most perfect mathematical accuracy are employed by adepts and experts in every department of scientific investigation and mechanical experiment, it is highly necessary that those who would either win renown or enjoy real pleasure in pursuing the mechanical arts as a profession or a recreation, should obtain the most modern, as well as the most perfect, appliances for their purpose which skill and ingenuity can suggest or devise.

The use in the present day by manufacturers of antiquated mechanism, with which to compete in producing either quality or quantity, will in the end surely lead to bankruptcy and ruin, and it may not be out of place to quote an instance in support of this statement. Some years since the writer was instructed by a manufacturer of note to proceed to another industrial town and purchase an entire plant of machinery for a certain purpose, provided it did not sell by auction above certain prices, which were intimated, and accordingly I thought it prudent to go thither one day previous to the sale, that I might thoroughly inspect the machinery I was commissioned to buy; for, having authority to spend a thousand pounds, I was anxious to use discretion in the matter. To my utter dismay, as I examined machine after machine, I found that, although excellently constructed, and capable of doing their work in a superior manner, the power required to drive them was at least double that used in driving a similar plant producing at least twice as much per diem—consequently I was led to believe this must have something to do with the failure of the firm in question, the outlay for coals and attendance being certainly double what it should be for an equal output of goods; and, in consequence of this knowledge, I returned without purchasing, although the machinery fetched far below my commission, and, although at first I was severely taken to task for allowing the plant to be sold away from me at prices below my limit, I had afterwards the best thanks of the would-be purchaser for my conduct.

* * *

Cement for Stopping Flaws in Wood.—Put any quantity of fine sawdust of the same wood your work is made with into an earthen pan, and pour boiling water on it, stir it well, and let it remain for a week or ten days, occasionally stirring it; then boil it for some time, and it will be of the consistence of pulp or paste; put it into a coarse cloth, and squeeze all the moisture from it. Keep for use, and, when wanted, mix a sufficient quantity of thin glue to make it into a paste; rub it well into the cracks, or fill up the holes in your work with it. When quite hard and dry, clean your work off, and, if carefully done, you will scarcely discern the imperfection.

Soft Files.—Small single-cut files or "floats" of various shapes not hardened, may be met with at some of the dealers in watchmakers' tools, which are useful in finishing small articles in hard wood, ivory, and also gold and silver; they are used sometimes by jewellers for finishing, on account of their leaving a smooth surface behind them instead of a rough one, as a cross-cut file does.

WOODWORKING ATTACHMENT FOR LATHE.

(For Illustrations, see Lithograph Supplement.)

IT is not the intention of the writer to enter largely into the subject of wood-working, but simply to suggest a few handy attachments to the foot lathe which will greatly facilitate the operations of the amateur wood worker, and will be found very useful by almost any one working in wood. It is not an easy matter to cut even thin battens into strips of uniform width by means of a handsaw, but by using the circular saw attachment, shown in fig. 1, the operation becomes rapid and easy, and the stuff may be sawed or slit at any desired angle or bevel. The attachment consists of a saw spindle of the usual form, and a wooden table supported by a right angled piece of round iron, fitted to the toolpost and clamped by a wooden cleat, which is secured to the under side of the table, split from the aperture to one end, and provided with a thumbscrew for drawing the parts together. By means of this arrangement the table may be inclined to a limited angle in either direction, the slot through which the saw projects being enlarged below to admit of this adjustment.

The back of the table is steadied by a screw which rests upon the back end of the tool rest support, and enters a block attached to the under side of the table. The gauge at the top of the table is used in slitting and for other purposes which will be presently mentioned, and it is adjusted by aid of lines made across the table parallel with the saw.

For the purpose of cross-cutting or cutting on a bevel a thin sliding table is fitted to slide upon the main table, and is provided with a gauge which is capable of being adjusted at any desired angle. For cutting slots for panels, etc., thick saws may be used, or the saw may be made to wobble by placing it between two beveled washers, as shown in fig. 7. Saws mounted in this manner are known technically as drunken.

The saw table has an inserted portion, held in place by two screws which may be removed when it is desired to use the saw spindle for carrying a sticker head for planing small strips of moulding or fluting. The head for holding the moulding knives is best made of good tough brass. The knives can be made of good saw steel about one-eighth inch thick. They may be filed into shape, and afterwards tempered. They are slotted and held to their places on the head by means of quarter-inch machine screws. It is not absolutely necessary to use two knives, but when only one is employed a counterbalance should be fastened to the head in place of the other. All kinds of moulding, beading, tonguing, and grooving may be done with this attachment, the gauge being used to guide the edge of the wood. If the boards are too thin to support themselves against the action of the knives they must be backed up by a thick strip of wood planed true. The speed for this cutter head should be very great, it is scarcely possible to drive it too fast by means of a foot lathe.

Fig. 6 shows an attachment to be used in connection with the cutter head and saw table for cutting straight, spiral, or irregular flutes on turned work. It consists of a bar carrying a central fixed arm, and at either end an adjustable arm, the purpose of the latter being to adapt the device to work of different lengths. The arm projecting from the centre of the bar supports an arbor, having at one end a socket for receiving the twisted iron bar, and at the other end a centre and a short finger or pin. A metal disc having three spurs, a central aperture, and a series of holes equally distant from the centre and from each other, is attached by its spurs to the end of the cylinder to be fluted, and the centre of the arbor in the arm enters the central hole in the disc while its fingers enter one of the other holes. The opposite end of the cylinder is supported by a centre screw. A fork attached to the back of the table embraces the twisted iron, so that as the wooden cylinder is moved diagonally over the cutter it is slowly rotated, making a spiral cut. After the first cut is made the finger of the arbor is removed from the disk and placed in an adjoining hole, when the second cut is made, and so on.

Figs. 2 and 5 show a convenient and easily made attachment for moulding the edges of irregular work, such as brackets, frames, parts of patterns, etc. It consists of a frame, supporting a small mandrel turning at the top in a conical bearing in the frame, and at the bottom upon a conical screw, as shown at fig. 5. A very small grooved pulley is fastened to the mandrel and provided with a rubber ring which bears against the face plate of the lathe, as shown in the upper engraving. The frame is let into a wooden table supported by an iron rod which is received by the tool rest holder of the lathe. The cutter is made by turning a piece of steel the reverse pattern of the required moulding, and slotting it transversely to form cutting edges. The shank of the cutter is fitted to a hole in the mandrel and secured in place by a small set screw, shown in fig. 5. The edge of the work may bear against the shank of the cutter, which then forms a guide for the depth of cut. Should the face plate of the lathe be too small to give the required speed, a wooden disc may be attached to it by means of screws, and turned true.

Figs. 3 and 4 represent a cheaply and easily made scroll saw attachment for the foot lathe. It is made entirely of wood, and is practically noiseless. The board supports two uprights, between which is pivoted the arm, whose under side is parallel with the edge of the board. A block is placed between the uprights, to limit the downward movement of the arm, and the arm is clamped by a bolt which passes through it and through the two uprights, and is provided with a wing nut.

A wooden table, secured to the upper edge of the board, is perforated to allow the saw to pass through, and is provided with an inserted hardwood strip which supports the back of the saw, and which may be moved forward from time to time and cut off as it becomes worn. The upper guide of the saw consists of a round piece of hard wood inserted in a hole bored in the end of the arm. The upper end of the saw is secured in a small steel clamp pivoted in a slot in the end of a wooden spring secured to the top of the arm, and the lower end of the saw is secured in a similar clamp pivoted to the end of the wooden spring. At fig. 7 is an enlarged view showing the construction of clamp.

The relation of the spring, *k*, to the board, *h*, and to the other part is shown in fig. 9. It is attached to the side of the board, and is pressed upward by an adjusting screw near its fixed end.

The saw is driven by a wooden eccentric placed on the saw shown in figs. 1 and 6, and the spring spindle always pressed upward against the eccentric by its own elasticity, and it is also drawn in an upward direction by the upper spring. This arrangement insures a continuous contact between the spring and the eccentric, and consequently avoids noise. The friction surfaces of the eccentric and spring may be lubricated with tallow and plumbago. The eccentric may, with advantage, be made of metal.

The tension of the upper spring may be varied by putting under it blocks of different heights, or the screw which holds the back end may be used for this purpose. The saw attachment is fixed to the lathe by means of an iron bent twice at right angles, attached to the board, *t*, and fitted to the rest support. The rear end of the sawing apparatus may be supported by a brace running to the lower part of the lathe or to the floor.

The group of objects around fig. 7 comprise two saws mounted slantways on the spindle, an end and perspective view of the cutter head and a moulded frame, as made by the apparatus shown in fig. 2.

The simple attachments above described will enable the possessor to make many small articles of furniture which he would not undertake without them, and for making models of small patterns they are almost invaluable.

FINISHING SMALL SCREWS.

THE excellence of the finish usually seen on the steel-work of high-class watchwork, and especially the polish of the screws is frequently admired. From a trade journal we gather the following particulars of the process of finishing the screws used in watchwork. In the first place it must be understood that watchmakers almost invariably use a special tool, called a screw-head tool, for manipulating the screws whilst shaping and polishing the heads. Comparatively rarely is the lathe employed, for, as a matter of fact, this machine is but little used by watch jobbers. The screw-head tools usually have three sliding holders for different sized screws, and also holders for other purposes. Watchmakers who use lathes generally have chucks to replace the various sliding holders used in the screw-head tool. Either a screw-head tool or a lathe is indispensable for finishing screw heads.

The first operation is to file down the head of the screw to the required thickness. For this operation the screw may be chucked on the lathes, or on the screw-head tool. The work is revolved continuously in the usual way if on the lathe, or with an alternating motion by hand if on the screw-head tool. Then remove the file marks by using an oil-stone slip; always be careful in filing and stoning to carry your hand perfectly at right angles to the axis of the work, for the purpose of making a flat head. It is much easier to make a round, or oval, or pointed head, than a flat one; it requires considerable practice to make a flat head. When your file marks have been removed, the next thing is to harden the screw, because soft steel will not receive a satisfactory polish, and in order to resist the action of screw-drivers, it is necessary that the head should possess a certain degree of hardness. A great many make a mistake in getting their screws too hard, not only rendering them brittle, but making the process of removing the tap difficult in case of breakage. Water can be used for hardening, but olive oil is preferable. Keep it in a small porcelain cup, enclosed in a round wooden box which shuts tight, so as to exclude all dust when not in use. Charcoal for holding the screw while heating is objectionable on account of its liability to soil everything with which it comes in contact. A piece of pumice stone is to be preferred. A favourite way is to take a piece of very fine binding wire and give a turn or two around the screw, being careful to get the end turned back so as to leave the screw on the extreme end of the wire. Then hold it in an alcohol flame, carefully watching till it is heated to a cherry red colour, then instantly plunge the screw in the oil. If you allow a higher degree of heat, you burn your steel. Many allow their steel to acquire even a white heat, which is a great mistake. The cherry red is produced very quickly in a small screw, even when holding in that part of the flame where there is the least heat; but the instant it is obtained plunge with all speed into your oil cup. By this process the steel screw will be rendered quite hard.

If it is desired to leave the screw simply polished, without colouring, remove superfluous oil, leaving a small globule covering the screw; then pass it again backward and forward through the flame of the lamp until the oil becomes sufficiently heated to ignite. As soon as the oil ignites remove it from the lamp and let it burn out. Allow it to cool, and the screw is of the proper temper. Now replace it in the holder or chuck, apply the oil-stone, and if you find on revolving the screw that it is not the same flat as when removed, loosen the grip of the holder, and with a screw-driver turn the screw round a little. Adjust it in this way until it is as nearly in the original as you can get it. Then with your oil-stone, which should be a very fine grained Arkansas stone, remove every trace of fire and file scratch, and with a piece of pith and pegwood clean the head carefully. Next take a flat steel block known as a polishing block, covered tight with a lid to carefully exclude dust and dirt. On this put a piece of crocus about the size of a small pea, and with a clean flat burnisher crush it to an impalpable powder, being careful to leave no lumps or large grains. Then take a strip of bell metal from ⅜ inch to ½ inch wide; file one face of it perfectly flat with a smooth cut file; wipe it off clean, and smear the surface of the polishing block with sufficient watch oil to mix the crocus into a paste. Rub the burnisher on the polishing block until thoroughly coated, then apply your bell metal polisher to the screw head in the same manner as you did the oil-stone, and continue the rubbing until you have a fine looking-glass polish. When you desire to leave the screw without colouring, rub until the crocus becomes dry and bright; but when it is desired to colour the screw, instead of tempering by burning off the oil as just described, put it as soon as hardened into the screw holder and polish as described, always being careful to leave the crocus quite moist when you finish. Then with peg and pith carefully remove all oil, and wipe off the polished head with a chamois. Use tweezers in handling; never allow a finger to mark the polished screw. Place the screw on a thin strip of brass or copper plate, having made a hole for the thread, so it will lie down flat. An old watch dial, with the enamel removed, is just the thing. Holding the strip with a pair of pliers, pass it carefully over the flame of an alcohol lamp, and carefully watch the change of colour, bringing it to match the colour of the other screws in the watch. The best colour, where there is no matching to be done, is a deep blue. All of this requires some practice, but there is no reason, if these directions are followed, why any one should not produce as good a screw as can be found in the finest movements, although those are generally finished on a lap. A little diamantine mixed as directed for the crocus, and applied with a piece of pegwood, gives a brilliant finish, and expedites the process.

MACHINE DESIGNING.

There is nothing sooner attracts the eye of the mechanic, when visiting different manufacturing establishments, than the varieties in form of machines or tools for producing the same results or doing the same work made by different manufacturers. The variety is not confined to unimportant parts of the machine, the exact form and weight of which are demanded and designated by the duty required, but extends to those portions directly engaged in the work. The cross section of the bed of a lathe of a certain size, and for a certain purpose, could be calculated and laid out on absolutely mathematical data so as not to vary in dimensions one-sixteenth of an inch, the web and slides being of exactly the same proportions, and thousands of these lathes could be made at twenty different shops, and each bear its own family likeness. In this case the size and proportion of the lathe would be almost identical, even though draughted by a dozen different draughtsmen, as the design would be based on immutable laws. Yet lathe manufacturers insist in showing each a different proportioned as well as different patterned lathe, although cast iron is *cast iron*, though run in any county of the country. If the tensile and crushing resistance of cast iron, or the tensile and torsional resistance of wrought iron are constants, calculations may be made for their use in tools and machines which will be correct, and any considerable departure from them will be erroneous—an error of waste of material, on one hand, or of insufficient strength, on the other hand. If these premises are correct, manufacturers of machinery and tools are foolishly sacrificing either material or strength for the sake of sustaining a useless appearance of originality, which could be as readily effected by affixing a name to the pattern of one of the castings.

There are minor differences in tools and machines by different makers that are entirely legitimate and proper, and they suit different buyers. Take the ordinary geared engine lathe as an instance. Some makers build the head-stocks low, so that the lathe will not swing so large a diameter as the width between the beds would seem to suggest. But this gives wonderful stiffness to the spindles and firmness to the tool post, that is never moved beyond the width of the bed, even for the largest object the lathe can swing. Another lathe, of the same width of bed, has an elevation of one and a half inch for the spindles greater than the first, and permits swing of more than two inches larger. This fact would recommend the lathe to some. Then the method of throwing in and out the back gears, changing the feed, securing the dead spindle, changing gears for cutting screws, differ in different makes of lathes. These variations and distinctions are seen in all sorts of tools as made by different manufacturers. They are valuable and important only as they serve a purpose to the user, and add to the orders of the producer. But it is quite evident that much of this diversity is the result of personal whim only.

This is especially seen in the fanciful and sometimes absurd devices for those parts of a machine that may be considered adjuncts rather than active parts. Here all rules of proportion and all dictates of taste are frequently violated. A machine bed, in one solid rectangular piece, weighing from 250 to 400 pounds, is mounted on four curved Louis Quatorze legs that seem about to break, as they have already bent, beneath the superincumbent weight. The legs are not braced nor strengthened in any way, but stand, in all their slender sprawliness, supporting a mass that ought to rest on apparent solidity, if only to relieve the strain of the anxious mechanical eye. There is as much offence in error on the other side. It is puerile to mount a tasty, elegant, and light mechanism, which a man could carry away under his arm, on a square pedestal or circular column large enough to serve as the base of a life-size equestrian statue. It does not detract from the disgust to know that the pedestal is a sham, and, being furnished with a door and shelves, is used as a tool closet.

Architects are generally agreed as to the proper employment and proper forms for their materials—stone, brick, iron, wood—and, although there have been some feeble attempts at imitation, yet generally architects do not attempt to mount stone on wood, nor use lattice for brick work. It would seem that a similar agreement among mechanical designers would conduce to a better style, and, possibly, a better sort of machinery and tools. It is time that cast and wrought iron should have their own classes of forms and rules of styles as well as other materials.

FORMATION OF PINION CUTTERS.

(From "The Horological Review.")

VARIOUS methods have been proposed and employed to form the curves on small wheels and pinions with mathematical accuracy; but the whole question resolves itself into the subject of making the finishing cutters so that the desired curve will be produced. For although we have met with workmen who had the natural gifts and the necessary practice to be able to file pinion leaves and the teeth of wheels with great accuracy, the operation is so difficult, and especially so slow, that it becomes desirable, and in this age of cheapness it becomes imperative, that a quick and certain method of forming these curves with accuracy should be practised. Although filing the teeth with files is a primitive means of gaining the desired end, the work done in some instances in this manner will stand favourable comparison with many engine-rounded teeth of greater pretensions to accuracy. Even in some of those that pass for our best time-keepers, the curves of the wheels and leaves of the pinions will be found, on being put to the test, to vary more or less from the mathematical curves that ought to be followed. Hence the necessity ot having the cutters made so as to produce the desired curve with certainty.

That talented horologist, the late Richard F. Bond, of Boston, was the originator of a very simple and effective method of forming the curves on cutters with certainty. A piece of steel, suitable to make a cutter, is selected and prepared, and turned in the lathe to the proper diameter, and to nearly the proper shape. A turning tool having its point of the same shape, and of the same curve, that is desired to be given to the leaves of the pinion, is now fastened in the slide-rest exactly square, or at right-angles to the centres of the lathe, and the screws of the slide-rest are moved till the cutter is brought to a proper position to turn the groove or curve on one edge of the circular cutter that is under construction. The work is then taken out of the lathe to allow the tool in the slide-rest to be moved along to a proper position to turn the other side of the new cutter, and the work replaced in the lathe, and the groove or curve is formed on the other side the same as on the first, and the new cutter brought to the proper thickness. At first Mr. Bond fastened a stop on the slide-rest, so that in the working of it the turning tool would only be allowed to move a certain distance towards the centre; but this plan he afterwards abandoned, because it was found that if the tool was moved out or in from the centre at all, even with the aid of the stop, it never could be got so exactly to the position that would make both sides of the new cutter perfectly equal; and afterwards he only used the parallel motion in working the slide-rest, and never disturbed the other, after it had been first set, during the entire operation of forming the curves on the cutter.

On reflection, the reader will perceive that if the turning tool that is fastened in the slide-rest be made with the same curves that the leaves of the desired pinion are required to have, and that if the tool be set square in the slide-rest, and the parallel motion of the slide-rest be true with the centres of the lathe, the curve formed in both sides of the new cutter will be exactly the same on both sides, and the reverse of those of the fixed cutter; and when the new cutter has got teeth cut in it, it will produce a leaf in the pinion exactly the duplicate of the shape of the fixed cutter that was in the slide-rest of the lathe in the first instance. By this means the process of forming the curves in cutters, and also of making them of the proper thickness, is reduced to a simple operation, which any one possessed of a good lathe can practice. The mathematical part of the operation lies in forming the cutter fastened in the slide-rest, and in this part some knowledge of drawing cycloidal curves is necessary.

The proper curves being formed, and the cutter brought to the desired thickness, the next question to be considered is the formation of suitable cutting edges; for at this stage the cutter is simply a steel disc with no teeth. And here we will make a few remarks on the subject of cutting edges. We all have observed that cutting edges vary according to the material the cutting tool is designed to cut.

We do not grind a graver that is to cut steel in the same manner that we grind one to be exclusively on brass; neither do we grind a chisel that is to be used on wood in the same manner as we grind one to be used on a harder material. It is generally acknowledged by machinists that the cutting angle of a lathe turning tool operates best, is most effective, and has the greatest strength, when ground to an angle of about 60°, and which in tools of this kind may be called the angle of strength, and can be used to advantage in all tools which are used to cut iron or steel. The teeth of cutters operate as a series of revolving chisels, and in order that the cutters should work to advantage the cutting edges must be formed according to the same rules that govern cutting edges in general. A cutter to cut a steel pinion, should have the teeth formed at about an angle of 60°; and one to cut brass, from about 45° to 50°, according to the hardness of the metal.

The teeth of cutters are easiest formed by cutting them on a cutting engine with cutters kept for that special purpose. The faces of the teeth of the cutter ought to be in a line with its centre; and in order to give the necessary clearance, and produce a proper cutting edge, the tops or points of the cutter teeth must be formed so that they will make an angle of from 45° to 60°, according to the kind of metal the cutter is designed to cut. This is easily and accurately accomplished by fastening the cutter on an eccentric arbor, placing in a lathe, and working the spindle backward and forward by hand till the necessary clearance be given by the action of a cutting tool fastened in the slide-rest. We believe that Messrs. Brown and Sharp, of Providence, R. I., own or control a patent for making cutters after this system. We have practised the method ourselves for many years, and we know it is a favourite plan used by certain clockmakers both in the United States and in Europe. Mr. Bond had a novel method of giving clearance to single tooth cutters.

Instead of turning the cutter on an eccentric arbor he simply bored a new hole a little out of the centre, which answers the same purpose when only a single tooth cutter is required. Cutters with only one tooth are very convenient to use for some purposes, because of the simplicity of making and hardening them; but they possess no other advantage, as is generally supposed, over cutters having a number of teeth. When used on steel a single point cutter soon wears out, and they are principally used for small brass wheels, for which purpose they are admirably adapted when a sufficient speed can be given to the cutter spindle, because it is plain that a cutter having only one tooth must move ten times faster than one that has ten.

WOODS FOR WOOD CARVING.

SPEAKING generally, oak is the best wood for large surfaces, and ebony or boxwood for small, minute work; but walnut, lime, chestnut (both horse and Spanish), mahogany and plane, are all suited to the purpose, while sandal-wood, apple, pear, holly, cypress, fig, and lemon tree, being hard and fine-grained, may all be used with good effect, according to the style and size of the carving, and other circumstances. Foreign oak is much to be preferred to home-grown wood, which is of a hard, tough nature, and liable to knots, which are a great impediment to the carver, and from which the American and Norwegian forest-grown oak is comparatively free. These oaks may be known by the close and smooth grain, and somewhat grey tinge, the English wood being closer grained and of a yellower colour. Oak is especially useful for decorative work in library or large hall, and, above all, for ecclesiastical purposes. Spanish chestnut and mahogany may be classed next after oak for carvings, which, though large, require a great amount of finish. Of mahogany there are two very distinct kinds. That suited for carving must not be confounded with the common soft wood known as cedar mahogany, used for ordinary furniture. The kind we mean is hard and dark, and known as Spanish. Many of the works of the great Gibbons are carved in this wood, which is also well suited for basso relievo, as is also the Spanish chestnut, the two woods, when polished, being much alike, though the mahogany is of a somewhat richer colouring. The best walnut also comes from abroad, and is much in use amongst Continental carvers, especially the Austrian, but we cannot recommend it very highly, for though it is pleasant and easy to work, it has a dull and dingy appearance; so that in every instance in which I have seen it used, the carving, to our taste, would have looked better and been more effective had it been done in any of the other woods mentioned, though no doubt the labour would have been far greater. Sycamore, lime, holly, and woods of a like nature, being white or cream-coloured, are only suited to that especial style of carving, the beauty of which depends on great purity of colouring—such, for instance, as the minute basso relievo after a picture, models of figures in imitation of ivory, groups of birds or delicate foliage, such as we sometimes see exhibited in proof of the artist's skill; but all these woods, unless protected by glass, soon lose their extreme whiteness, and with it their chief beauty. Therefore, these woods are little used, excepting for the trifling purposes we have just mentioned. The wood of the apple and pear tree are, from the hard texture and fine grain, exceedingly pleasant to work, but their value as productive trees renders them rare, and the occasional deep-coloured veinings sometimes interferes with the design. Boxwood is equally hard and fine-grained, and is far superior in uniformity of colour, which is a rich yellow. Fig-tree wood is also much prized for small carvings, being of a very beautiful warm red colour; but even in Italy it is rare, owing to the value of the living tree, and extremely difficult to procure in England, being so completely a fancy wood. The great bar to the free use of all these hard woods is the difficulty of procuring them in pieces of any sizes, for as their texture indicates, they are mostly bushes of slow growth, rarely attaining to more than 10in. to 12in. in diameter, added to which, as regards boxwood especially, it is largely used for other purposes besides carving, which necessarily increases the demand, and makes it more expensive. Ebony or black wood is above all woods the most suitable for small carvings of every description, whether for use or ornament, the deep black colour and the hardness and fine texture of grain giving it, when polished, the appearance of black marble. This wood is also somewhat difficult to procure in large blocks—not, however, on account of the growth of the tree, which is very large, but, either from the carelessness of those who are employed in felling it, or the extreme heat to which it is exposed (for it comes from the topics), it rarely arrives here in logs of any size that are not more or less riven and spoilt by cracks and flaws—"shakes," as they are termed in timber merchants' *parlance*. There are two kinds of ebony—the green and black; of these the former is for some reason the more highly prized, and consequently is the more expensive; but for carving purposes there is little or nothing to choose between them; they are both equally pleasant to use, but the blackest, being the harder of the two, is capable of taking a higher polish, its only drawback being an occasional white or red streak, but these are rare, and can be obliterated by applying a little ink to the spot after the carving is done. Black, or iron wood, as it is sometimes called, is a species of ebony, but has little to recommend it but its extreme hardness and weight; indeed, on the former account it should rather be shunned by the carver, as it will turn the edge of the tools. Sandal-wood, from the texture, beautiful colour (a rich yellow brown), and the delicious scent, which is familiar to everybody, is especially suited to small carvings. The superabundance of oil, which emits so delightful a fragrance, causes it also to take a beautiful polish merely by rubbing it slightly with the hand. The best sandal-wood is brought from Italy and Ceylon. It also, like ebony, is difficult to procure in sound pieces. It is sold, as are the most valuable woods, by weight, the price varying from 6d. to 1s. per lb., according to the size and soundness of the logs. Small pieces are cheaper than large ones in proportion, unless they are prepared and squared to any even size, and then they are far more expensive, as in the course of preparation two or three logs may perhaps be cut up and spoiled before one can be found without flaw, and of course this waste is taken into account, and charged for by the wood merchant. Ebony and boxwood are sold in the same manner, and cost from 3d. to 6d. per lb., or even less, according to the quality; but sandal-wood, though the actual price is more than double, yet, from being considerably lighter in weight, and less liable to flaws than ebony, does not cost much more in the end. Each little piece is valued for the smell, even the chips and sawdust being treasured by some people to burn on the hearth to scent the room.

Oiling Tools.—When a set of bench-planes is French-polished, they certainly look very well on the bench for a short time, but the French-polish does not add to their durability or usefulness, and, I think, gives them anything but a workmanlike appearance. My plan is to knock the irons out, weigh them, and then drop them into the linseed oil barrel, and let them stay there a week; I then take and weigh them again to ascertain how much oil they have absorbed. The oil goes right to the heart of the planes, and as it sets it makes them hard, and they may be depended upon for keeping their shape. Rubbing them over every dinner-hour for a week or two will give them a beautiful surface, and they will not show scratches or dints as they would if they were French-polished.

THE "MECHANICAL ENGINEER" ON AMATEURS.

OUR American contemporary, an excellent fortnightly, which affects to be the only journal owned and edited by practical engineers, recently wrote: A correspondent reminds us that to his knowledge many amateur mechanics read the "Mechanical Engineer" regularly, and are more or less edified by its contents, and he suggests that the class is so large and numbers so many men eminent in letters and in private life, that we should devote some attention to their especial wants, and not mind the first-class workmen who laugh at elementary instruction. There is much more in our correspondent's communication, but this is the gist of it.

We would be glad to devote some space to the special wants of amateurs, for our sympathy and appreciation of their efforts to excel is active, but we fear that the support we receive from them, as a class, is not so great as that from men in regular trades, so we would not be warranted in devoting a department of our paper to amateur mechanics.

When he says in his letter that regular workmen are jealous of and try to belittle the work of amateurs, we think he makes a mistake. There cannot be any jealousy, for there is nothing to be apprehended, and surely no one would belittle the effort of an amateur who tried to do the best he could with his facilities and his knowledge!

There is a wide difference, however, between the amateur and the journeyman mechanic. The first has nothing at stake, and it matters little to him whether he spoils his job or not. He can easily get more material, and begin anew, for his time is of no value. When a mechanic spoils a job, however, there is a great difference. He suffers a loss in prestige and sometimes a loss in purse, for some employers deduct the value of spoiled material. This is a trifle to him compared to what he suffers in personal feeling, when he falls below the standard.

Amateurs sometimes fail to excel, for the reason that they are in too great a hurry to see the results of their design. They want to plan, build and occupy at one sitting. They are too anxious to complete to consider details and finish them thoroughly. They miss perfection and hit mediocrity because they are not content to begin at the bottom and work up as a mechanic does. They wish to leap at once into first-class workmen. Moreover they labour under the disadvantage of being without any stimulus or incentive to exertion, beyond a personal pride in their handiwork, also they have no example set before them. A mechanic finishing a piece of work sees that his idea of finish is not so good as that of another man alongside of him, and he gains something by the example.

An amateur is not willing to produce effects in workmanship legitimately, or in the only way that they can be produced, but he strives to imitate them with less labour. He uses shellac where the mechanic makes a French polish, or he finishes a piece of steel with files and emery paper, where a mechanic uses a file and oil, and glazes the whole with old emery cloth. The amateur burnishes over scratches instead of removing the scratch, because that would take time and delay the completion of his work. He jumps at the quick and easy method in preference to the slow and laborious, and for these reasons the results obtained are inferior. Exceptions to these remarks of course abound. There are amateurs who are excellent workmen, and who delight to take pains with their work, but the amateur in general is a superficial workman because he jumps the track, so to speak, and wants to go across lots.

WATCHWORK FOR AMATEURS.

By "Watchman," from "Design and Work."

IN writing these papers, it is not my intention to dwell on those abstruse questions concerning horology which, though of great importance to those in the trade, are for the most part unintelligible, and—even if understood—uninteresting to those to whom this series is addressed. The chronology of the art is, therefore, of little moment, suffice it to say that the earliest timekeeping machine is the Clepsydra of the Greeks and Romans, which, in its simplest form, consisted of a graduated vessel, having a hole in the bottom. Water placed in the vessel, running through the hole, recorded, by the height, the lapse of time.

The invention of clocks of mechanical construction dates back to an undefined period, about the ninth or tenth century, though the earliest description of a mechanical clock which has been yet traced is of one sent by the Sultan of Egypt in 1232. The early history of watches—then called pocket clocks—is equally obscure. The invention of the coiled spring as a motive power, in place of a weight, was, undoubtedly, the first step towards making the timekeepers portable, but we are not able to fix this date, though it may with tolerable exactness be said that watches were first made towards the end of the fifteenth century.

The writer had in his possession a very antique watch, probably one of the first ever made, bearing on it the name of a Papist who flourished in the year 1477. This watch was oval in shape, and popularly called a Nuremberg egg, that town being famous for watches, and where were produced a large proportion of the early pocket clocks. This specimen is in a very fine state of preservation, having escaped any serious process of renovation. It has no hair-spring, the escapement being very similar to that of the ordinary kitchen "bottle-jack." The power of the spring was conveyed through a fusee, a catgut serving in place of a chain. There is but one hand, which travels round the dial in twelve hours, and a little pin at each of the twelve figures enables one to feel the time, the hand being protected by a metal cover when the watch is carried. The pinions are all evidently filed out by hand, and the wheels still bear slight scratches, showing that the teeth were all divided with compasses by hand.

The next great improvement in watches was made in 1658 by Dr. Hooke, who invented the hair-spring, and shortly afterwards watches had minute hands put to them. Previous to the use of a hair-spring the timekeeping was too inaccurate to allow of this. Successive inventions were the horizontal or cylinder escapement, now used exclusively by continental makers; the lever escapement, which is the best adapted for pocket wear; the chronometer escapement being best suited for ships' use, where the instrument is protected from violent concussion by being gimballed in its case. When worn in the pocket the motion of the body is liable to cause the chronometer escapement to stop, and it has not, like others, the qualities necessary to set itself going again.

I will now proceed to notice the chief characteristics of the watches most likely to come into the hands of a beginner, a knowledge of which will enable him to distinguish various kinds at a glance. Technically, watches are usually described as gold or silver, English or foreign; open face, crystal glass, hunter, half-hunter, or pair-cased; verge, cylinder, lever, or duplex, &c. It is not difficult to see whether the cases of a watch are of gold or silver when the hall mark is visible and can be understood, but as the greater portion of the watches in England are of foreign manufacture, and consequently their cases bear no hall mark, some further guide is necessary. To an experienced eye a bare inspection is sufficient, and the application of nitric acid or *aqua fortis* will incontestibly show the base metal. However, this subject can scarcely be considered as part of watchwork, as we have only to deal with the mechanism.

To decide the nationality of a watch is far from easy. The superiority of English watches, which was at one time proverbial, has been the cause of most persistent and ingenious imitation on the part of foreigners, though their productions could well afford to rely on their own merits in comparison with our own at corresponding prices, and it is only to overcome popular prejudice that the imitation is made. In foreign watches the cases usually open at the back or dome, whilst in English the movement itself is jointed to the belly of the case, and its inspection is effected by opening the bezel, and then the movement may be lifted out at right angles to the case by pressing the bolt with the thumb nail. These peculiarities are, however, by no means certain criteria. Watches with cylinder escapements are invariably foreign. Only a very few, and those very old-fashioned, have ever been made in this country. A brass cap covering the movement is peculiar to the English construction, though a few foreign watches are made with spring caps, which fly up on pressing a spring catch, the English always having a locking spring on the cap. The skeleton, or cock movement, is essentially foreign. English makers only make full-plate or three-quarter-plate—that is to say, the top plate of the movement is in the one case circular, having the balance cock screwed to its surface, whilst in the other a portion of the plate is cut away, and the balance cock fixed to the pillar plate, this arrangement allowing the movement to be made much thinner.

A verge watch is known by its having the escape wheel axis at right angles to the axes of the other wheels, &c., the direction of motion being altered by means of a crown wheel on the fourth pinion. A crown wheel is one in which the teeth are perpendicular to the plane of motion of the wheel, and by watchmakers it is usually termed a contrate wheel. The verge proper is the axis of the balance, a steel shaft having two pallets which alternately engage the teeth of the escape wheel. That this latter runs with its face in a vertical plane to the plates of the watch is probably the reason why this escapement is so named. Verge watches are always full-plate, but none are made now, so that any which may come into our hands for repair will probably need it badly, and an old verge is perhaps the most difficult movement for a beginner to tackle successfully, though their low value makes them the most accessible for experimenting upon.

The cylinder or horizontal watch is recognised by having a cylinder as the axis of the balance. The escape wheel is usually of steel, with teeth of a triangular form. Cylinder watches are made principally in Switzerland and France. They are characterised by their flatness, and are the most inexpensive to produce. Owing to the small compass into which cylinder movements can be packed they are invariably used for the smallest specimens of horological skill. The small flat watches for ladies' wear are all cylinders, and they will require very delicate handling by the inexperienced to guard against breakage. To a certain extent the danger of breaking pivots is lessened by each axis having a cock peculiar to itself, and entirely independent of all the other axes; cylinder movements of small caliper are always made with cocks throughout.

The lever escapement is used in all English watches of modern make. The majority of American watches are levers, and Continental makers manufacture them very largely. This escapement is the best for all ordinary purposes for which a watch is required, and it is only to suit peculiarities that others sometimes take its place. The lever is readily seen in watches—one end connected with the axis of the balance, and the pallets embracing the escape wheel. Thus the lever forms an intermediary, between the balance axis and the escape wheel, which is dispensed with in the verge and the cylinder escapement. The axis on which the lever oscillates finds no corresponding part in the other escapements, and it will be at once apparent that the lever and all its accessories, including its bearings, are items which have to be provided over and above the component parts of a cylinder watch.

It will be unnecessary to further mention the duplex, chronometer, and some other escapements not in general use, as they are not likely to fall into the hands of a beginner for adjustment. I intend to minutely describe the operation of taking a common verge watch to pieces and putting them together again properly, at the same time describing the tools used, as I may have to name them in connection with the work in hand, giving instructions for the manufacture of those which may be made by the beginner, and then to go on through various kinds of watches, and give instructions for effecting repairs of an ordinary nature which will come within the scope of a beginner.

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Softening Horn.—The bony core of the horn is first removed; the next process is to cut off with a saw the tip of the horn—that is, the whole of its solid part, which is used by the cutlers for knife handles, and sundry other purposes. The remainder of the horn is left entire, or is sawn across into lengths, according to the use to which it is destined. Next it is immersed in boiling water for half-an-hour, by which it is softened, and while hot is held in the flame of a coal or wood fire, taking care to bring the inside as well as the outside of the horn, if from an old animal, in contact with the blaze. It is kept here till it acquires the temperature of molten lead or thereabouts, and in consequence becomes very soft. In this state it is slit lengthwise by a strong-pointed knife like a pruning knife, and by means of two pairs of pincers, applied one to each edge of the slit, the cylinder is opened nearly flat. The degree of compression is regulated by the use to which the horn is afterwards to be put. When it is intended for leaves of lanterns, the pressure is to be sufficiently strong (in the language of the workmen) to break the grain, by which is meant separating in a slight degree the laminæ of which it is composed, so as to allow the round-pointed knife to be introduced between them, in order to effect a complete separation. For combs the plates of horn should be pressed as little as possible, so that the teeth may not split at the points. They are shaped chiefly by means of rasps and scrapers of various forms, after having been roughed out by a hatchet or saw; the teeth are cut by a double saw fixed in a back, the two plates being set to different depths, so that the first cuts the teeth only half way down, and is followed by the other which cuts the whole length; the teeth are then finished and pointed by triangular rasps. Horn for knife handles is sawn into blanks, slit, pared, and partially shaped; then heated in water and pressed between dies. It is afterwards scraped, buffed, and polished.

SHOP WRINKLES.

By G. B. FOOTE, in *American Machinist.*

A FEW years ago I broke a screw on one of my instruments. This necessitated sending the instrument, or part of it, to get a new one fitted—which would involve the loss of at least six or eight weeks' time and heavy expense.

I had hunted in all of the jewellery, gun and blacksmith shops for a screw plate with the right number of threads, but, of course, I failed to find one. There was no screw-cutting lathe in the vicinity on which I could cut a screw, or make a hob with which to cut a chaser. Under these circumstances it became necessary to originate a screw; and for the benefit of others who may some time be similarly situated, I will tell how I managed.

I found a jeweller who offered me the use of a small hand lathe with a slide-rest, the feed screw of which was, I believe, 14 threads to 1in. The screw I desired to cut was an odd number—47, I think. The problem I had to solve was how to produce a screw of 47 pitch from one of 14 pitch, without gears, and this is how I did it: I first turned and filed up a milling cutter about ½in. diameter, the edge of which I made of the same shape as the thread on the broken screw. I then took a strip of thin brass, drew a straight line through the centre, took a pair of sharp-pointed dividers, setting the points about ⅓in. apart, and marked off 47 points along the line on the brass strip, prick-punching small holes at each point. I cut off each end of the strip a little over ⅛in. beyond the end holes, bent the strip in the form of a hoop, and fitted the ends squarely together until the two end holes were brought the same distance apart as the others. I then wired the ends together, and soldered them with silver solder. I next fitted a wooden wheel on a flange in place of the feed handle of the slide-rest, placed this wheel in the lathe, and turned it down until the hoop fitted snugly. I now had an index divided by 47 true enough for the purpose. I then forged a blank chaser, fastened it in the tool post of the slide-rest, placed my cutter in the lathe, and commenced by milling a groove in the end of the blank chaser to the depth of one thread, screwing the cross-feed up to the cutter, and marking the position of the handle. I then backed up the cross-feed, and advanced the feed-screw 14 holes on the index, and milled another groove by screwing up the cross-feed to the same point as in the first cut, bringing the handle to the position marked when milling the first groove, and so on till I grooved the end of the blank across its whole face. I then filed up the chaser, so as to give the proper rake or slant to the teeth, hardened it, and did the job, making the required screws with my improvised chaser a perfect fit.

Any required chaser can be easily made in this manner, the rule being to make an index, having same number of holes as the required screw has threads to one inch, and advance it the same number of holes as the lead screw has threads to one inch; or, when both numbers are divisable by same number, make a fraction, the numerator being the number of threads in the lead screw, and the denominator the number of threads in the required screw; then reduce to its smallest denominator. For instance, the lead screw has 12 threads, and it is required to cut 48; then as $\frac{12}{48}=\frac{1}{4}$, you can make an index of four holes, and advance the screw one hole on the index.

I believe the way to groove taps is to make spiral-flutes like a twist drill, only giving less twist, making the flutes with circular section. Small taps up to say ½in. diameter, I file up in the vice with 3 flutes. I use for this purpose a drill file, or a round file. By this method of fluting you can give full stroke to the file, and finish quicker than you can rig up to plane or mill them with the ordinary straight flutes. Any one using this form of tap for the first time will be surprised at the ease with which it cuts, if otherwise properly made.

I have found by experience that there are only a few machinists who can harden and temper such tools as taps, fluted-reamers, &c., and do it properly. They sometimes burn the steel, spring the tool, or crack it in hardening, or temper it so unevenly that it will come out with all the colours of Jacob's coat. I will tell how I do it, and if any think it better than their method they are welcome. There is no patent on it, neither do I claim it as original. I expect a great many mechanics will say, "Who don't know all that," &c. Some may have even a better method. If I have many tools to temper at one time, I use a lead bath. I heat the tools only sufficient to harden, and if heated in an open fire, I use hard soap to prevent oxidation. With some steels which require a high heat to harden, I have found the use of a paste made of prussiate of potash and salt, dissolved in stale beer and thickened with flour, of advantage. The tool should be heated perfectly even, not too quickly, and still it should not soak in heat too long. Experience must be the only guide on this point. After it is properly heated, I quench it in a bath of salt brine containing prussiate of potash and corrosive sublimate, acidulated with sulphuric acid. This solution should have the chill taken off so that the temperature is about 50° to 60° F. I don't say that I know this solution is better than pure water, but I have always had better luck (if that is the right word) with it than with pure water. I keep the tool perfectly straight, without motion sideways, and after dipping quickly to a point above where I desire to harden it, then dip very slowly, and raise and lower it slowly for a distance of an inch or two. After the shank has cooled down below a red heat, I cool off by dipping its whole length. After this I polish so as to give a bright clean surface, then wipe it all over with an oily rag or waste, to give a very thin film of oil all over the surface (lard or sperm oil—not mineral). I then heat to a red heat an iron ring or tube of sufficient weight to retain heat, and of sufficient length to take in about half or two-thirds of the length of the hardened portion of the tool. The hole should be of a size so that the tool, when placed in the centre, will be an inch or so from the hot ring or tube. Insert the tool in the hole, moving it slowly back and forth, and turning it around until it takes on the desired colour.

For a ½in. tap or reamer, a piece of 2in. or 2½in. gas-pipe, about 3in. long, answers a good purpose. Other tempering sleeves can be made of old pulley hubs, or other pieces that can be found in the scrap heap. Draw the temper slowly, and let the tool cool off without quenching in water, and I believe you will have a satisfactory job. These tempering sleeves are excellent for drawing the temper on many other tools when an even temper is desired.

Lacquering Metals.—The process of lacquering is only to preserve the bright surface of the metal by coating it with a layer of varnish. The colour of this varnish may be modified to suit the work to which it has to be applied. Lacquer contains either seed-lac or shell-lac, hence its name. Seed-lac is the gum in its original form, and when it has been purified and prepared by moulding into thin sheets it is called shell-lac. This material may be bleached so as to become almost colourless, but in that condition it is not so strong or effective for lacquering purposes. With regard to applying the lacquer it should be understood that much depends on the condition of the work. Perfect cleanliness and a tolerable polish are necessary to insure a successful application of the lacquer. The work must be heated to about the temperature of boiling water before lacquering, and this must be laid on evenly with a camel-hair brush. With regard to the lacquer itself—yellow is made by mixing turmeric with lac varnish; gold is made with dragon's blood and lac varnish; red contains a larger proportion of dragon's blood. Lacquers suffer a chemical change through heat and light, and for this reason must be kept in a cool place, and away from the light. The brushes used should always be carefully washed out in methylated spirits, and be kept scrupulously clean. There are innumerable receipts for lacquers. A good pale gold lacquer is made by dissolving 5oz. of seed-lac in half a gallon of methylated spirits, and then adding a small quantity —less than half an ounce—of red sanders. Allow the whole to thoroughly incorporate, then strain for use. To this lacquer may be added dragon's blood or gamboge, or annatto, to suit the colour required.

JAPANNING ON METAL.

By P. N. Hasluck.

THIS is simply the process of laying a coat of varnish, and afterwards drying by artificial heat. This second operation, the baking, is the essential part in japanning. The art was originated in Japan, whence we have derived the name. Many examples of japanning on *papier maché* may be seen at fancy repositories where various ornamental nicknacks imported from Japan are on sale. In making this ware the Japanese employ a lacquer which exudes from an indigenous tree. Successive coats are laid on, each one being thoroughly dried in the sun before the application of another. Thus a thick hard coating is made, which may be smoothed and polished by abrasive materials, though the natural lustre suffices for general requirements. Gilding and other ornamentation is then made to adhere by means of boiled oil. The whole is finally finished by a coat of clear varnish. The above is a rough sketch of the art as practised by the originators, but we have to deal with modern japanning, and confine our observations to its application to metal.

The japanner's oven is a receptacle in which the work is placed when being heated. Usually the heat is applied by means of external flues in which hot air or steam is circulated. By this system the temperature may be regulated to great nicety, the supply of heat being controlled by dampers or stopcocks. A sheet iron box, encased by another of the same shape, but somewhat larger in size, so that an interspace of an inch or two exists between them, is the most simple form of oven. Heat is applied to the interspace, and thus an even temperature is maintained. A flue must be provided to carry off the vapours which arise from the japan. A doorway, by which to introduce the articles, provided with a tolerably well-fitting door, is, of course, essential. Hooks or wire shelves are provided, by which the work is supported, so that the heat may take effect equally all round. Moisture, dust, and all other extraneous matter must be carefully excluded, so that the japanning may be kept perfectly clean and free from foreign substances. Thermometers are hung in the oven to indicate the precise degree of heat, which is regulated as explained above, to suit the requirements of particular work.

Metals require no special preparation before laying on the japan. After being wrought to the desired shape, and smoothed as much as may be considered advisable, the article has only to be made thoroughly clean to prepare it for japanning. The surface must be quite dry, or the japan will not adhere properly. Wood requires to be primed and otherwise prepared for japanning.

Japan, that is the paint-like material to be laid on the metal, is made of shellac varnish, with which may be incorporated any pigment necessary to produce a desired colour. Shellac varnish is made by dissolving shellac in alcohol. A better varnish for japanning is made by adding resin and shellac, 2oz. of each, to a pint of methylated spirit. Any pigment may be added to such varnish to form japan of the colour required. A few formulæ may be useful. Black: Mix lampblack or ivory-black—this latter preferably—with the above varnish. Another black: Melt 1lb. of asphaltum, and mix with the same quantity of balsam of capivi, thin the mixture to a workable consistency with hot oil of turpentine. Another black: Mix lampblack with oil of turpentine, and grind smooth on a muller, thin the mixture with copal varnish. White: Flake white, or white lead, ground up with a sixth of its weight of starch; this must be thoroughly dried and mixed with mastic varnish. Yellow: King's yellow is used as the pigment, but the effect is considerably improved by dissolving turmeric in the alcohol before adding the shellac to form the varnish. Various colours are made simply by the incorporation of a suitable pigment in the varnish made as described above.

Tortoiseshell japan is extremely pretty, and comparatively easy to manipulate. The work is first coated with a japan made by boiling two pints of linseed oil, to which ¼lb. of umber has been added, till it becomes thickened; the mixture is then strained and further boiled till it becomes of a pitchy consistency. This is mixed with turpentine to a workable consistency, and then applied. On a thoroughly dry coating of this japan lay a quantity of vermilion spots to represent the clear portions of the shell. The vermilion japan is made by adding vermilion to shellac varnish; it should be laid on thinly and dried. The whole surface is then finally coated with a thin layer of the above described brown japan, still further diluted with turpentine. A long course of stoving will be necessary to thoroughly harden the japanning.

The operation of japanning consists of driving off the solvents of the japan at a high temperature. When the article, covered with a coating of japan, is placed in the oven and submitted to a temperature of about 300° Fahrenheit, and even more, the solvents quickly evaporate. The residue, a gummy substance with which is incorporated the colouring matter, is kept liquid by the heat, and in the semi-liquid state forms a smooth coating filling any small inequalities of the surface. The baking process secures a very firm adhesion of the japan to the metal, far superior to that of ordinary varnish or paint. The japan is also made hard, and consequently better able to resist wear. When one coat is dried another is applied and submitted to the action of heat. These operations are repeated, as may be deemed necessary, from one to six times. Each succeeding coat of japan will present a more uniform and glassy surface. The natural flow of the japan generally suffices to produce a good smooth surface, but in some cases a process of polishing is resorted to before the application of the final coat.

The temperature for light coloured japans must not be sufficiently high to scorch, or the surface will, of course, be discoloured. Dark japans are usually dried at a very high temperature, if the article is not likely to be injured by heat. The final coating of japan is generally a layer of clear varnish, which will add to the lustre of the surface. Practical experience is the best, and, indeed, the only guide by which proficiency in the art of japanning can be attained.

WHAT BOOKS SHALL AN ENGINEER READ?

I AM frequently asked by young beginners in this business to indicate a course of study and the books best adapted to give a clear and not too tedious explanation of the principles upon which mechanical engineering rests. I usually recommend first, and above all as a ground-work, the study of mathematics, physics, and the natural laws; then take Bourne's "Catechism," or Templeton's, following these with Thurston's "History of the Growth of the Steam-engine" and any other books which may be accessible. I have gleaned very much valuable information from "Goodeve's Text-books of Science," which are the most modern works with which I am acquainted, also Rigg's Treatise on the Steam-engine."

Some of the works mentioned I have found rather abstruse, and I have often wondered whether some one had not discovered a more systematic course of study than the one I have pursued. A large number of students in this branch of engineering are men who (like myself) have never had an opportunity of studying a regular course in the higher mathematics, and some of the equations to be found in the books are positively appalling. Sometimes when I have consulted two authors on some particular point, I have found the results obtained from their formulæ to differ so much and so widely that I am left in greater doubt than before I consulted them. It occurs to me that an article upon this subject would be eminently practical, and of service inestimable to hundreds who are now groping in the dark and are earnestly desirous of obtaining light, but need very much a guide or director to show them how to study in a systematic way, so that they may take up the different books in the order which is most conducive to enlightenment. I know I could derive considerable benefit from the perusal of such an article, and I shall be glad to see one.

Thus writes a correspondent to our American contemporary, "The Mechanical Engineer," and the Editor's reply :—

Formulas are the one snare to the feet and stumbling block that trip every young engineer. He thinks there must be rules for everything and every detail of a steam engine. Of necessity there cannot be any that are reliable in all cases. It is easy to construct one, or several, based upon current practice and certain conditions; but when it is applied to other than those it was constructed for it fails. Witness these from the latest work on modern marine engines. They are from the practice of a consulting engineer, who is said, by the author of the work in question, to be "one of the most talented engineers of the day."

Crank-pin = diam. of shaft; thickness of main brass on bottom, $\frac{1}{15}$th diam. of shaft; total length of all bearings = 6 times diam. of shaft; area of steam port, $\frac{1}{18}$th area of cylinder; diam. of valve stem = $\frac{1}{3}$d diam. of piston rod; piston rod = about $\frac{1}{10}$th diam. of cylinder.

These figures are for marine engines, and the value of them will be apparent when tested at random. For instance, a 60in. cylinder has a 6in. piston rod, but a 30in. cylinder has only a 3in. rod. The valve stem for the 60in. cylinder engine is only 2in., while the 30in. engine has a 1in. valve stem! It seems hardly necessary to follow this matter further.

Probably every one who has ever attempted, unaided and alone, to master unfamiliar subjects experiences the same difficulty as that alluded to by our correspondent. He does not know what books will give him a solution of the phenomena presented in his every-day work, or set forth in the tersest and clearest way the laws of the universe. In answering his question, which has been discussed so often that it is almost a stock subject, we can only say that many works on mathematics and physics are more useful than a single one, for the reason that the language or style of authors is often the main stumbling-block. Sometimes writers who are thoroughly grounded in their subjects signally fail in attempting to convey their information. It is there and can be obtained ; but to get it the reader must wade through interminable sentences and unravel involved paragraphs. Interpolations trip him up and metaphors befog him, so that before he finishes one chapter he loses sight of the original text altogether. Another hindrance is that persons trying to master subjects unfamiliar to them try to cover too much ground. They have but little time and wish to improve it, so they skim the contents of works without acquiring any benefit thereby. Mere desultory reading of scientific works is a delusion. It only flavours the reader with impressions instead of grounding him in the principles which underlie all laws. A habit of study is as essential to mental acquisition as the food itself, for without the first there can be no assimilation and no benefit. A young man sits down, for example, with a natural philosophy, and he opens it at acoustics by chance. He reads here and there a paragraph, but not finding it very entertaining or instructive turns to some other subject, which he "studies" in the same way. After he has gone through the work by fits and starts, when he endeavours to apply his reading he finds he cannot recall it. The reason is that he has gone the wrong way to work. He should begin at the first chapter and master that before looking any further. He should not read too much at once, but should be satisfied with moderate progress. In following this course he will, by successive steps, train his mind so that it will take and record the impressions given it. Any other course is certain to result in disappointment, the working student, not being accustomed to memorising, finding his reading slips away, and it discourages him. He gives the course up and charges the loss to his own incapacity.

It is a great mistake. Any man intelligent enough to be a good engineer—a good working engineer—has just the experience and just the training requisite for recording natural phenomena and making correct deductions therefrom. If he will apply the same intelligence and the same thoroughness to his study that he must necessarily do to his engine, he may become as thorough a student as he is an engineer. It is not a lack of capacity which discourages many so much as erroneous methods.

We will make a distinction only in favour of mathematics. In this branch all are not favoured alike. Many are devoid of the faculty; that is to say, while science and physics generally are easily mastered, the science of numbers confuses. It is not necessary to go into the causes of this weakness in some. It is, we think, indisputable and a fact. We can recall in our experience through life among working men several accomplished mathematicians. They absorbed even the "Mécanique Celeste" as one would a common arithmetic. One of them was a shop labourer; he could scarcely make intelligible figures, but his results were never at fault. History abounds with mathematical prodigies, and there are many unrecorded who, though not prodigies, master figures readily. If any mechanic student labours under the disadvantage of being slow at figures, confused by unusual signs and formulas—if algebra is a terror, and the integral calculus mere gibberish, so to speak—he need not waste time in endeavouring to learn them. The arithmetic still remains, and all there is to be learned, every calculation and stress he has to compute, lies within its pages. He need not feel humiliated or ashamed if he cannot read signs that others repeat glibly. If he only *knows* what he knows, it is a possession quite as absolute as if it had been acquired through, what we will call, ornamental mathematics.

These, then, are the disadvantages working students labour under in trying to overcome a want of opportunity in early years, and we think it will be of use to such as wish to mount up higher to follow the hints we have given. As to the specific books a working student should read, we cannot give in the limits of an article a compendious list. We cannot give even a synopsis. We should say the most essential item would be to take up a common school natural philosophy, where the simplest and most elementary information is given. When "the reasons why" are known, more abstruse works on scientific subjects can be read. For example, "Williams on Heat and Steam" contains a good deal of useful information on those subjects, but "atoms of carbon and atoms of hydrogen" are alluded to in treating of combustion in a way that presupposes the reader knows all about them. Unless the student-engineer has read an elementary chemistry he fails to see the connection, or indeed to follow at all the author's explanation. Or, again, take up a work on mathematics. The reader has this proposition stated:

> **"All the radii and diameters of a circle are equal. If a line passes through the centre of a circle it also bisects the chord at right angles. A radius that bisects the chord also bisects the arc. In a circle equal chords are equally distant from the centre," etc., etc.**

This is all very simple and very plain, and though it may not perhaps have anything direct and immediately applying to the horse-power of an engine, it is good mental exercise, which prepares the way for a better understanding of other propositions.

From these citations we think it is plain that what the student-engineer wants is first and foremost a habit of study. He does not so much want specific books. No printed text can supply information; it is the faculty, the habit of study, which gives that. The dead letter becomes the living fact only when the student knows how to hold on to it.

MECHANICS A PROGRESSIVE ART.

By "Cold Chisel."

MECHANICS is a progressive art, though the popular idea of the mechanic's art, or of the mechanical arts, is that the rules of management of materials, the manipulation of substances, and the means of arriving at results are unvarying, so that all manufacturers and all workers are on the same level as to present production or future possibilities.

This notion is shared, also, by some mechanics who look upon their chosen work as a mere mechanical treadmill, offering no inducements to extra exertion, and calling only for a certain amount of mechanical service in a certain number of specified hours. When the worker in the useful arts conceives this as his only mission, there is little to be gained for the industrial world, and little to be predicated for personal advancement, so far as he is concerned.

The popular idea is wrong, and the mechanic's idea is incomplete. It is not true that mechanical laws, as now understood and generally followed, comprehend all that is practically and usefully known and practised; nor is it true, as assumed by some mechanics, that the best practice has been reached. The real fact in both these projections is that the law of mechanics and the practice of mechanics are susceptible of variations on the one hand and exceptions on the other. The true resultant is in mechanical practice. This is far beyond theories or assumptions. The practical mechanic readily chooses between the "talk" of a specialist and the "sense" of a worker, and his work is the best answer to the theorist and to the professed improver.

There is no stage in mechanical manipulation of every kind that does not suggest further possibilities. The worker on wrought or cast iron, on brass or other alloys, who does not learn something from his work-a-day task that does not inform him about the material he works and the methods he uses, is a dolt. No true mechanic can have the opportunities of work offered in even the most mechanical and half automatic job, but he will gain a knowledge of material, its nature, its conduct under force applied as power, and its resultant state.

Men who are mechanics should look as they work, use their brains as they employ their hands, and in such cases the industrial world and the individual worker is progressed and advanced. The worker engaged on some large, cumbersome, unwieldy job puts into his work no small amount of the patience, hand skill, and finish of labour that belong specially to the producer of fine work. He may do this without intention and without present object, but the result is a superior job.

A notable instance of the value of mechanical practice in the improvement of the workman may be mentioned as an illustration of the progressive tendency of mechanics. One of the most exact and painstaking engravers on metals the writer has ever known is a man who served his apprenticeship as a machinist in an establishment that built engines and other heavy machinery. This apprentice showed an inclination to do fine or nice work, and to his lot fell, occasionally, the more exact and higher finished work. From this establishment he went to one where tools of precision were built, and here he became valuable as a workman on small exact jobs. From this class of work he passed to his present employment, and as engraver has become very successful.

Now, it would be folly to assert that his progress is an example that follows as a sequence to his fidelity to his bent of doing his work in the best possible way, or that the practice of machine building or tool making leads to engraving. Much in this instance of change—of improvement—in work and skill is attributable to natural inclination and taste; but much in his progress is to be found in his careful manipulation and his aiming at perfection. Perhaps his change from the shop to the engineer's bench has not been the best change he could have made. Perhaps he would have achieved greater success as a tool builder. But the illustration is given to show the tendency of careful mechanical work that leads on to more perfect results, a tendency that does not depend on defined methods, on textual directions, but is encouraged by opportunity and perfected by practice.

WHY LATHES CHATTER.

(From "The Mechanical Engineer.")

IF the spindle of the lathe was as large as the ordinary face plate upon it, any work done in such a lathe would—all other things being equal—undoubtedly be free from inequalities or chattering. Particularly would this be the case where castings are faced off, such as cylinder heads, etc.

The reverse of this statement is true. If a lathe of, say, twenty inches swing had a spindle only one inch diameter, it would spring and chatter greatly. Now, where lies the mean between the two?

A large spindle is undoubtedly of great advantage, for it obviously brings the point of support further from the centre, but how large should it be for a lathe of a given swing?

As now constructed, these details vary with the views of builders, but it seems to us there is or should be a fixed size. The only objection we see to a lathe with a very large spindle, is that in case it is not perfectly adjusted, it will require more power to drive it; but this is no argument against a large spindle, for we might say, similarly, if the boxes were screwed down too tight on the spindle, the lathe would run hard. One statement is just as correct as the other.

Many writers lay great stress on the centres of lathes, as important details, which greatly affect the nature of the work done on them. We have ourselves written on this subject, and pointed it out, but the spindle also has much to do with the nature of lathe-work, for the centres might be all that any one could expect and the lathe fail if the spindle was too weak and badly fitted.

A reason why many lathes fail to do satisfactory work, even when well proportioned, is that they are not half fitted up. They look so when they are not. The spindle looks round, and feels "smooth," but it does not bear properly in the front bearing if the lathe chatters, unless the spindle is very light.

An argument for the importance of a solid bearing at the front end of spindle, is shown by the practice of all lathe men of experience, who when they have a flanged casting to face off put a brace between it and the dead centre, slacking off the end screw first, so that the spindle collar bears on the box; the work runs steadily then, when without the brace it would have chattered.

The cause of chattering, so chronic in many lathes, is, in our view, owing to small spindles badly fitted, and it is so easily remedied, as regards the fitting at any rate, that there is no occasion for it.

There are comparatively few engine lathes in the country which, when driven at their utmost capacity of cut, do not tremble and jar to a greater or less extent, and this where the cut is continuous and even in depth all around the work. This shows that the gearing or belt power of the tool is in excess of the capacity of the structure to withstand the strain; for if this was not correct the jar spoken of would not exist. The beds spring more or less, and so do the carriages, these evils arising not only from the lack of metal, but the shape of the sections. In some lathes this springing is invited by the form of the bed itself, which sometimes approaches an ogee, curving in and out at top and bottom, with possibly the idea of obtaining stiffness thereby, but actually perching the carriage and all belonging to it on top of an S. The carriages themselves are lacking in stiffness from want of metal and from the shape of the section. Sometimes they are curved downward to admit of swinging work over them as large as can be swung over the shears. There is no particular objection to this if the radius is small and metal enough be added on the lower side of the carriage. Neither is there any special advantage in it, for the reason that it is very rare in the ordinary work of the machine shop that it is necessary to swing large pieces over the carriage. Sometimes a pulley may have to be turned, and it would be handy if it would go over the carriage, but, as a rule, pulleys can be turned readily without this. To our thinking, carriages are not so stiff and rigid as they should be, for it takes very little pressure to spring a large body of iron suspended on two points some distance apart. It is true that the work of the tool is not always in the middle of the carriage, or when it is the strains are the lightest because the smallest work is then done; but it is also true that the body of the carriage has to resist all the work done by it, or rather to distribute the work from one side of it to the other.

Where lathes are made for special work it would be easy to construct a carriage to answer a specific purpose, but where lathes are used for jobbing, which is the hardest kind of work a lathe can be put to, one form has to answer for all purposes. In a jobbing lathe all the work is done on the left hand side of the carriage, for the feed is from right to left; the strain, therefore, is greatest on the left hand side of the carriage. If the tool was always at work in the centre of the tool-post and the centre of the carriage, then the strains would be equal; but this is rarely the case, oftener than otherwise the tool is offset at a greater or less angle, and in the case of boring chucked work, the strain is altogether on one side. It would seem that from this view the carriage would be stiffer and the tool held firmer if the right hand side of the carriage was made heavier or larger in wearing area than the other. Just how this is to be done we leave to the consideration of others. Also when any work held in the chuck is to be faced off, such as a cylinder head, there is no means of locking the carriage fast, so it cannot back off of the cut. The only way to keep the tool up to its work is to throw the feed gear out of connection with the main spindle, put on the feed, and run the carriage up by hand. A simple clamp screw or "jam" of an obvious nature would hold the carriage firmly down to the bed, and not be in the way for other work.

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

Dear Sir,—I hope that your new monthly venture will be adequately supported, and as far as my multifarious engagements allow me, I shall hope to co-operate with you by penning you an occasional paper upon some point connected with amateur mechanics. It seems to me, in my practice as a physician, that our young people are much damaged by the present methods of education and teaching. Their immature brains are worried with *words* for which they have no real ideas, when what they need is *to see*, *to handle*, and *to work* *with things*. The things appeal to them through the channels of the senses, which, in young people, are wonderfully acute and wonderfully voracious. Thus children are worried at school about abstract definitions of the circle, the radius, &c., when five minutes' proper teaching at a lathe would put into a whole roomful of children perfectly clear notions of the fundamental geometrical lines—notions which they would acquire with pleasure and retain without effort. Again, doctrines and definitions about lineal measure, square measure, and cubic measure, with all their correlatives, are hammered into children until all the edge is taken off their brains. Now a competent teacher, having before him, say half a block of salt, by sawing this up into slices, prisms, and subordinate cubes, and then packing the cubes together into various forms, might teach a roomful of children such fundamental relationships and *facts* without any kind of effort to himself or to his hearers. When will people come to understand that young folks learn with ease and pleasure, and profit by means of objects presented to their senses, when by means of words and ideas hammered into their brains nothing but the systematic manufacture of stupidity comes to pass? It is from these standpoints that I am chiefly interested in mechanical pursuits, although to me, personally, they are also a source of much pleasure, and a vast relief when wearied with unadulterated work with pen, and tongue, and brain. But to get mechanical pursuits—of which the lathe is the basis—into its proper place in our schools and homes, we must either appeal to Birmingham or America. The present price of such tools, by good London makers, is prohibitory, except to men who can spend hundreds of pounds over what is named an "ornamental lathe," as if to intimate that these lathes are not intended to be useful. Certainly, the present models of amateur lathe apparatus are wanting in that scientific character and simplicity, which we need to look for if they are to come into general use as teaching instruments for our people—young and old. A lathe-head for such a purpose ought to be a model of artistic beauty—I mean of mechanical proportion and utility for its purpose. Now, from such a standpoint, what are we to say when "our leading ornamental lathe maker" persists in putting into his mandrel nose a screw 9.45 threads to the inch, and turns out his mandrel nose at its base, so as to destroy all sense of proportion, and of mechanical fitness for its purpose; when he sells his customers screw tools cutting all sorts of absurd threads which defy calculation and reproduction, except by the same process as that by which you copy an old seal?

Were this gentleman a Chinese, he might say that he persisted in the manufacture of these screws because they were made by his grandfather, and that filial piety was a greater virtue than any possible adoption of the inventions of barbarians from England. But one might as well attempt to teach arithmetic by means of the old Greek or Roman numerals as attempt to introduce, for educational purposes, lathes constructed upon such principles as these.

Pray let me say that I do not in the least impute any conscious intention to victimise unwitting clients by selling lathe apparatus put together and worked by means of such screws. But as you now have an important class in practical lathe work at the Polytechnic Institution, I know that you will do all you can to help on such objects, and I am glad to hear that you will have a paper in your first number on the lathe screw question.

No doubt many of your engineering and mechanical readers will rub their eyes and think they have before them a page from a journal of the last century if you tell them of the screws which still stop scientific progress in our costly and beautiful geometric lathes, and which, if "ornamental," are but sparingly useful.

Faithfully yours,
JAMES EDMUNDS.

[We are favoured with Dr. Edmunds' consent to our request for the publication of this letter, and hope to have occasional communications from his pen.—ED.]

Dear Sir,—I am looking forward with much pleasure and no little interest for the first number of "Amateur Mechanics"—a magazine which, to my mind, both in title and intended subject matter, will exactly fill the present need of literature on mechanical subjects suitable to us amateurs.

The majority of amateurs of the present day are self-taught. The books they obtain on technical subjects are mainly beyond them. The terms used, well known to the professional, are often without meaning to them; and it being difficult to write on mechanical matters without now and again using a word more or less purely technical, I think it might be very well to devote a chapter in each number to a kind of glossary or index of terms used in the mechanical arts. Another point on which amateurs as a rule require special teaching, is lining. In carpentry and woodwork construction, lining is carried out as a matter of course, yet in magazines and papers intended for the instruction of amateurs I have seen little or no information given on this very important branch of mechanics. Amateurs in this matter—and also in several others—are more inclined to follow out a kind of common sense arrangement, and arrive at the end they wish to attain more by luck than good guidance.

Another matter I hope to see opened out in the new magazine is "Unorthodox Tools and Appliances," that is, descriptions of tools and appliances used as makeshifts by those who do not possess, or are not within reach of, the more complete apparatus. Much invention—and often of a high order, too—is shown by amateurs in making use of what they have in the way of tools, rather than go to the expense of obtaining the tool fitted for some special object. Tools of improved construction are all very well for engineering shops, where time means money; but to buy a new tool just because it is an improved one, and to be used, perhaps, but once in a way, is foolish in the extreme for an amateur.

Very truly yours,
GRAHAM.

Dear Sir,—Having received a prospectus of your new magazine, "Amateur Mechanics," I hasten to send you a few words of congratulation and encouragement.

It is not egotism on my part to say that there are few who know better than I do how many per cent. of the population are taken up with amateur mechanical work. I can conscientiously assure you that there are not fifty towns in the kingdom from which, or to which, I have not had some communication upon my special department in Amateur Mechanics, and I am sure your new venture will not only be a success, but will be hailed with delight by many thousands of British amateurs.

Some years ago I did my utmost to impress upon the minds of the proprietors of a contemporary that it was absolutely necessary to provide as much for the amateur as for the professional mechanic. You will probably remember, sir, how strongly I wrote upon this subject to the Editor, but my letters were never inserted. I am very glad indeed to see that you, a well known and favourite author, have now started in this direction, and I promise you I shall do my best for you and your readers. You know you have only to express your wishes, and I am at once at your service.

I am,
SAXOPHONE.

* * *

To Prevent Belts Slipping.—A piece of rubber belting fastened around the belt pulley of an engine will keep the belt from slipping.

Varnish Finish.—For cheap work.—One coat of filler or stain, followed by one coat of cheap turpentine varnish, without rubbing. In this class of work the brilliancy of the gloss and covering qualities of the varnish are principally considered. The cheaper turpentine varnishes have a brilliant gloss, and dry very hard, but the gloss is not permanent, and after drying, the gum is very brittle and easily cracked and broken. The gum used is principally common resin.

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THE ART OF TURNING.

By Paul N. Hasluck.

(For Illustrations, see Lithograph Supplement.)

PART II.

NATIVE turners of Africa and India still practise their art with the primitive pole lathe. A somewhat similar tool, worked with drill-bow, is used by the Arabs and Persians. The tools employed and methods of working practised by these people will be understood by reference to subsequent illustrations.

A picture published in a German book printed in 1568 shows a turner working a sphere on a lathe. In the original picture there are numerous objects of turnery lying on the bench and about the workshop. Balusters, vases, trenchers, a spinning top, and other articles are shown. The turner is standing, but he rests against a back rail, probably to support his body and give him greater power over the tools he uses. For spinning metal a back rail is used at the present day. The pole by which this lathe is driven is shown with its end inserted in the wall at the back. A beam running across the workshop serves to support the pole, which merely rests upon it, and may be shifted to bring the cord directly over any part of the work. This lathe is probably a centre lathe, but in the engraving the position of the back centre, if there is one, is not shown clearly. The rest on which the tool is supported *appears* to be on the near side of the line of centres, a position that could scarcely be correct. The tool used is a long one, the handle projects beyond the elbow. Both hands are used to grasp the tool. The illustration makes the construction of the machine tolerably clear. From the pole the cord is passed around the work itself. This shows that the mandrel was not then employed. Different kinds of lathes are mentioned in works of about the same period, but the centre lathe appears to have been the only one known. The introduction of the mandrel, itself running in bearings, is not defined. All the work lying around the turner of 1568 is of wood; and, in fact, the extensive working of metals on the lathe is comparatively only a recent introduction.

A French mathematician and inventor, named Jaques Besson, who flourished about the third quarter of the sixteenth century, illustrated, in a book published in 1579, three different forms of lathes, in which the pole, an ordinary bow, and weights were respectively employed to produce the return motion of the cord when the pressure was taken from the treadle, after an effective stroke had been made with the foot. One of the lathes invented by Besson was capable of cutting screws of any pitch, by the employment of pulleys and band gearing. Right or left-handed threads could be cut at will, by crossing or uncrossing the band, and the pitch was regulated by means of pulleys of different diameters. This is the earliest screw-cutting lathe known.

A curious machine for turning oblique mouldings is illustrated in Besson's book. The work is shown mounted between uprights, the axis is continued at both ends. A disc at each end is fitted so that it can be set obliquely to any extent. The end motion of the work was controlled by rubbers acting against the flat side of the oblique discs, and thus cause the work to move to and fro endways, as it was rotated by the cord fixed to a pole overhead.

In Birch's "History of the Royal Society," it is recorded that in 1668 Captain Salter gave to the Royal Society "a specimen of the Queen's face turned with a turning lathe by a medal." It is further stated that "Dr. Fairfax wrote of this gentleman as being the greatest turner of the age, and that he turned the King's picture embossed as on the five pieces." It is a very interesting fact that this kind of work could be done on the lathe in its then primitive form.

Joseph Moxon, an Englishman, hydrographer to King Charles II., gives the first known intelligible description of a metal turning lathe, in a small book entitled "Mechanick Exercises," which was brought out in monthly parts, commencing in 1677. In this, the art of turning occupies a large proportion of the space. It will be interesting to quote the quaint language used in this book. The description accompanies an illustration of a turn-bench held in a bench-vice. The work is rotated by means of a drill-bow, and a sphere is shown being turned. The chapter reads as follows:—

> "OF TURNING SMALL WORK OF BRASS OR OTHER METTLE.
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> "Small work in mettal is turned in an Iron lathe called a turn bench. When they use it they screw it in the Chops of a Vice, and having fitted their work upon a small Iron Axis, with a Drill-barrel fitted upon a square shank at the end of the axis next the Left Hand, they with a Drill-bow and Drill-string, carry it about as was shown in smithing, with this difference that when a Hole is drill'd in a piece of Mettal they hold the Drill-bow in their Right Hand; but when they Turn small Work they hold the Drill-bow in their Left Hand, and with their Right Hand use the Tool, which is commonly a Graver, or sometimes a Sculpter, fit to such Moldings as are to be made on the Mettal. They begin to work first with a sharp point of a Graver, laying the Blade of it firm upon the Rest, and directing the point to the Work, and lay Circles upon it close to one another, till they have wrought it pretty true. Then with one of the broad Edges of the Graver, they smoothen down what the Point left, and afterwards with Sculpters, Round or Flat, or great or small, they work their intended Mouldings. The Circumstances and Considerations in the choice of a Drill-bow and

Drill-string for Turnery are the same with what you find in Smithing and Drilling."

That the art comprehended the fashioning of metal at a remote period, evidence exists. Metal vessels, exhumed from the ruins of Thebes, bear unmistakable marks of the tool applied when the object was rotating. The machinery then in use, probably lacked the stability necessary for turning metal successfully.

Various forms of fly-wheels are shown in books published about the beginning of the nineteenth century, proving that the continuous rotary motion was then used. The pole was, however, evidently preferred, and now soft wood turners use it. The alternating motion allows them some advantages, which we need not here discuss. Some of the turning practised in the present day, by people amongst whom mechanism is comparatively little known may illustrate our own primitive methods.

The Kabyles or Berbers, a native tribe of Northern Africa, employ a lathe with a reciprocating motion, a sketch of a native turner at work is given. As the turner presses with his foot in the bight of the cord, the work is rotated towards him, and he then applies the cutting tool. It is not easy to understand what is used as a rest for the tool as nothing of the kind is shown in the drawing, When his foot has nearly reached the ground the turner releases the pressure, and the elasticity of the spring bar, which has been bent over, rotates the work backwards, and lifts the bight of the cord into position for another effective stroke.

Turners who live in the vicinity of the Carpathian Mountains appear to adopt the natural productions of their country to the requirements of their art. The work is mounted for turning, as shown in the sketch, between two growing trees. The pole used is any cane that may happen to grow in a convenient position. At the Vienna Exhibition of 1873, turnery produced by this method was shown. A couple of nails to form centres and a piece of rope with which to drive the work, apparently include all the requirements of those people so far as a lathe is concerned. The treadle and the bar, fixed across as a rest, may be found in the forest, where the trees for the headstocks, the cane for the pole, and the materials to be turned all grow.

A fly-wheel, driven by hand, is often used by turners where labour is cheap. The small motors which are now made, and which are rapidly increasing in public favour, will probably supersede manual power within a short space of time. The hand-driven fly-wheel offers the advantage of leaving the turner unfettered by any work, except that of manipulating his tools. The fatigue of working the lathe is spared him, and he can give his undivided attention to the work on which he is engaged. More power can be got from a man whose energy is confined to turning a winch-handle than from he who works a treadle with one foot; hence the hand-wheel gives the turner greater power.

Steam-power is now generally used in our manufactories, and it has become the means of driving by far the largest portion of lathes used in various industries. The cheapness of the power is its chief recommendation, and the one that at once commends it to the manufacturers. For many operations the foot lathe is still more advantageous; the complete control that the turner possesses over the machine that he drives with his own muscles is a boon that is essential when treating delicate work. The various speeds requisite for various operations are regulated intuitively by the man who works his own lathe. On the other hand, steam-power, applied to a lathe for doing work of one particular calibre, and which is also fitted with automatic gearing, does all the work. When the machine has been set to work, it will continue to work till the automatic arrangements stop it at the end. An occasional overlook from the mechanic is all that is needed, till the work in the lathe is changed for some other.

The automatic lathes now in use for producing large numbers of objects, each of which are counterparts, are attended by mere lads, who have only to turn a handle or shift a lever, as occasion requires, in order to keep the machine at constant work. Every object made by these automatic lathes is precisely alike. The machinery makes no error of judgment; everything is turned to gauge, as predetermined; and when an accurate machine is used, the work produced by it is accurate.

The relative value of machine-work, as compared to hand-work, is readily appreciated by every mechanic. A plain cylindrical rod—say, for instance, a bar of shafting—may be mounted on a self-acting lathe, and turned up, perfectly true, parallel, and smooth. Suppose the same operation had to be done with hand tools. Compare the truth, the parallelism, and the smoothness of the two bars. In each case the comparison would be favourable to the machine-work. Then consider the time taken for each operation, and thus arrive at the comparative cost. The labour—that is to say, the skilled labour—in the first case is an unnecessary quantity; whereas, in the second case, only a turner of exemplary skill could do the work. Compare the relative wages of the artificers, and the amount of work that each produces, then you can appreciate the value of machine-work.

Having made a digression from my attempt to trace the history of lathes, I will now briefly resume that subject.

Independent mandrels were used about three hundred years ago; one is figured in a book dated 1568. The idea of employing a mandrel on which the work could be fixed, probably suggested itself from the use of a contrivance precisely analogous to our modern collar plate. A contrivance of this kind was used long ago, as we use it now, for boring objects rotated in the lathe. Centre lathes—that is, those with fixed centres, which we now call dead centres—were used by the past generation of wood-turners. Mandrels were known and described by the French writers about two hundred years ago, but they do not appear to have been much used. The machinery for making a good headstock did not exist at that time, and the requirements of the age did not exact the high-class turnery of the present time. The perfection of turnery was gradual, as in other arts. So long as bed-posts and common furniture were all that was wanted from the turner; we may well understand that he was content to use the lathe as I have described it.

The state of the mechanical arts in the early days of the eighteenth century is shown by Plumier's instructions how to cut screws on the mandrel which shall be tolerably true. As a superior method, he recommends that an angular slip of paper is to be coiled around, and then cemented upon the mandrel. The margin of the paper forming a spiral line, is to be carefully followed with a knife, which would cut through the paper, and mark a thread upon the mandrel beneath. This line served as a guide for filing a groove, which was enlarged to form a screw thread. This method of originating screws was employed even so recently as the beginning of the present century. If all this process was necessary in order to cut a screw thread, we may easily understand why mandrels were, to an extent, forbidden.

Wood was used to construct lathe heads, and the wood was fastened together by wedging. Besson's idea of cutting screws by band-gearing was apparently not acted upon. Mandrels had guide screws cut upon them, and were traversing mandrels, which had a longitudinal motion, equivalent to the pitch of the guide screw which was in use. The wooden headstocks were all more or less subject to distortion from atmospheric changes, and from this cause uniform accuracy was not to be depended upon.

The employment of cast-iron as a constructive material for lathes at once gave a great impetus to the art of turning. Iron headstocks, giving greater steadiness, were quickly used to produce better work. Iron beds followed, then slide-rests were invented. The requirements of the age created a market for mechanism, and to supply this, the lathe and its appliances were perfected to produce the work in demand.

Slide-rests were but rude contrivances till the planing machine was applied to shaping metal. Wood planing machines had been in use some years before the same principle was applied to metal working. In the "Philosophical Transactions" for 1747, the art of casting articles of iron is spoken of as a curiosity. The middle of the eighteenth century gives the date of the introduction of the steam engine. In the production of this new engine the most advanced mechanical arts were requisitioned. The early mechanism was very imperfect; good substantial metal turning lathes were not then constructed; the planing machine for metal was not invented. The mechanic of the present day may appreciate the difficulties that his ancestors experienced only a generation ago.

It is now just fifty years since Joseph Clement communicated to the Society of Arts a description of his metal planing machine. This is probably the first machine of the kind. Bramah, who was the employer of Clement, used a kind of milling machine for shaping metal, and Clement made a planing machine specially for planing the triangular bars then used as lathe beds. Clement's planer is described and illustrated in the "Transactions of the Society of Arts" for 1832 (vol. 49). As a special tribute to the art of turning, the words of the inventor are particularly appropriate. He said he aimed to do with his planing machine for straight surfaces all that the lathe was made to do for round surfaces. That planing machine is, in its essential particulars, the same as the one now used. That Clement accomplished his aim is, therefore, a thing not to be disputed.

Planed metal beds and accurate slides were a great feature in the improvement of turning machinery. Sliding lathes, made before the planing machine was used, were necessarily not only imperfect, but very costly. The utility of slide lathes was not, however, appreciated in their early days, and years passed before they were generally adopted. The necessities of the manufacture of modern wrought iron and steel ordnance, and the revolution they have caused in the construction of vessels of war, have called into requisition many new machines. New lathes, constructed on new principles, and adaptations to the older machines, have created quite new branches in the art of turning.

(To be continued.)

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Cleaning Brass.—Make a mixture of one part common nitric acid and one part sulphuric acid in a stone jar; then place ready a pail of fresh water and a box of sawdust. Dip the articles to be cleaned in the acid, then remove them into the water, after which rub them with sawdust. This immediately changes them to a brilliant colour. If the brass is greasy it must be first dipped in a strong solution of potash and soda in warm water. This cuts the grease so that the acid has the power to act. This is a government recipe used in the arsenals.

WATCHWORK FOR AMATEURS.

By "Watchman."

(From "Design and Work.")

AS promised in my last article (concluded on page 26), I now proceed to the process of taking to pieces, cleaning, and reputting together a verge watch movement.

The tools required for this job are neither numerous nor costly; a small screwdriver is, perhaps, the only tool which is absolutely indispensable; a pocket knife having a small blade will be useful; and a pair of watchmaker's tweezers are also desirable. The movement has to be supported by its circumference whilst being taken apart, and for this purpose the watchmaker's eye-glass is generally used, though hard wood rings are made specially, and sold by most dealers in watchmaker's materials. In the absence of these, however, a good substitute may be improvised by using the ring of a table napkin. To clean out the pivot holes pegwood is used. This material is sold in bundles, of sticks about 6 inches long and $\frac{3}{16}$ inch diameter, at twopence a fagot. It is a small underwood known as wild cornel or dogwood, and is used for the purpose I name, in preference to other woods, owing to its being remarkably free from silex and pith. The plates, wheels, and other parts of the movement are cleaned by brushing with a soft brush. Such brushes may be had from dealers in materials, and cost from about eightpence upwards. A piece of dry bread, or better, a lump of French chalk, is used to rub the brush on, and so free it from grease and dirt. Tissue paper is used to hold the parts of the movement in whilst being brushed, and an inverted wine glass, one having the foot broken off being preferable, is used to cover over the parts which are cleaned. The articles I have enumerated are all that are really required for the operation of simply cleaning a watch, but to these must be added a bottle of watch oil with which to lubricate the bearings before setting the machine in motion.

Screwdrivers can be bought for eightpence or a shilling; but one may be easily made by those having any skill in mechanical manipulation. The main shaft of the turnscrew may be made from pinion wire or any cylindrical rod of about $\frac{3}{16}$ of an inch in diameter, having its surface faceted or grooved so as to afford a good grip for the fingers. The total length of the screwdriver, from the blade to the button, should be three and a half to four inches. The button is about the size of a fourpenny piece, and revolves freely on a pivot at the end of the shaft, the pivot being riveted over to prevent the button falling off. The blade is similar to a bradawl in shape, and may be about one half to three-quarters of an inch long. It is, of course, hardened and tempered. The screwdriver is used by the watchmaker in a very different fashion to that practised by other tradesmen. The watchmaker uses only his right hand, and placing the index finger on the button, he rolls the cylindrical shaft of the screwdriver between the thumb and the middle finger. The beginner should practise this mode of handling the tool, and cultivate a sensitive touch, so that he can *feel* exactly what he is doing. If the screwdriver slips from the slit of a screw an ugly scratch is sure to follow the path of the tool across the plate. When the shaft is made of steel the blade is usually filed down from the solid metal; but brass shafts fitted with steel blades are equally good. A constant practitioner at watchwork should provide himself with three or more screwdrivers—one for general use, a small one for removing jewel screws, the heads of which are sometimes less than a sixty-fourth of an inch in diameter, and a large one, with a blade say one-eighth of an inch wide, to remove large pillar screws, &c. The screwdriver for general use may be just over one-sixteenth in width, and this is the tool I shall assume to be provided.

Tweezers for watchwork are best bought. They should be quite plain, made tapering, from about half an inch wide at the closed end to the points. Do not have those which are fancifully shaped. A good pair, made of steel, will cost about a shilling. The points should be hardened and tempered, and care must be exercised in clipping pieces of brass in them, as the steel will scratch. Brass tweezers are used in order to prevent such a mishap, but for the general run of work steel ones are preferable. The insides of the jaws are left quite smooth, and the serrated tweezers, such as are usually found in dressing-cases, are not adapted for watchwork.

An eyeglass is usually considered indispensable to the watch adjuster, though I entirely disagree with such a theory. It requires considerable practice to enable one to hold the glass properly by the skin around the eye without further assistance, and when the feat is accomplished but questionable benefit results. I would strongly recommend the amateur watchmaker to work without an eyeglass if his eyesight is sufficiently good to enable him to see. With regard to the difficulty which beginners have in holding an eyeglass, I have only to say that, so far as my experience goes, it is equally easy to hold a glass of one or two inches in diameter, or any intermediate size. To grip the glass press the upper edge under a slight fold of skin just by the eyebrow, and raise it upwards about a quarter of an inch; then let the lower edge of the glass fall upon the skin of the cheek under the eye, and the glass will be found to be firmly fixed. Time alone will render the beginner accustomed to wearing an eyeglass; and in my opinion it is by no means a desirable accomplishment.

The brush used for cleaning should be itself kept clean by brushing a piece of French chalk, such as is used for chalking billiard cues, or, failing that, a piece of very dry bread will serve the same purpose. When very dirty the brush should be washed with soap and warm water, and it must be thoroughly dried before being again used on the parts of a watch. For cleaning some parts alder pith is used. This is sold in bundles by material dealers, but it is not to be recommended.

For cleaning out the holes the previously described pegwood is used. A stick is pointed at one end like a pencil, except that less pains are taken to make the cone smooth and regular. Three cuts are made, commencing at about half an inch from the end, so as to form a triangular pyramid. The apex is inserted in the hole to be cleaned, and the peg of wood twirled in alternate directions by the fingers and thumb, used precisely as described for actuating the screwdriver, except that the index finger assists the middle and third fingers instead of resting on the top of the stick. The other end is cut off in three facets, and the obtuse pyramid thus formed is used to clean out the countersunk oil-holes. The wood is continually cut at each end, and thus new and clean points are made till only an inch or so of the stick is left, and it becomes too short for further use. Even the simple process of cutting the wood to a sharp point is not to be done without practice, as the reader will notice that the extreme point of the pyramid must be very fine, and still perfectly firm, so that it can be got in the fine pivot holes. By the way, a freshly-sharpened peg is generally used first in the finest pivot hole and then through the larger, till finally the fusee hole is cleaned, before it is re-sharpened; and the process is repeated till the clean peg fails to show discoloration when twirled in the holes.

The bench on which we are to make our first essay in watchwork may be the drawing-room table, for all the harm that will be done to it. Any firm table will do; and to prepare it for our use it is only necessary to spread a double sheet of white note paper on it near one side, and place a seat in a convenient position. With the tools and materials that I have enumerated as essential lying within easy reach, and the watch to be operated on in the centre of the sheet of paper, I now suppose the novice seated at the bench ready to commence operations on a verge watch. The first thing to be done is to get the movement out of the case. This is done differently in different makes of watches, but verge movements are invariably fixed in their cases by "a joint and bolt." At a point just under the figure VI. will be found a small steel projection, forming a spring catch-bolt. Press this in (towards the centre), and the movement will be opened outwards, there being a joint at the figure XII.

The joint-pin should be pushed out before opening the movement, and tyros should remember that the pin is always put in the joint with its smallest end towards the knuckle of the bezzle, and must therefore always be pushed out in the direction of from the XI. to the III. The pin is generally pushed out with the points of the tweezers, though a tool called a joint-pusher is made specially by inserting a steel pin in a handle. The majority of watch-jobbers, however, use the tweezers. After removing the joint-pin open the movement, and it will drop out of the case. Put the joint-pin loose inside the case, close it up, and lay on one side till the movement has to be put back.

Removing the hands is the next process. This is sometimes done before the movement is taken from the case, and this is perhaps the better plan for general adoption, as when the movement is laid on its back the balance-cock forms the most prominent point, and if any pressure is inadvertently brought to bear on the movement the verge stands a chance of being bent or broken. A pair of nippers, with their cutting jaw at an angle of about 45° with the handles, is the tool for removing the hands, but not being yet provided with such a tool we must use those that are at hand, and a penknife will serve the purpose almost as well as the nippers, and skilful hands use the one or other with indifference. Take off the minute hand first by pressing the point of the knife blade under the hand at the cannon pinion and by a gentle twist prize the hand off; the screwdriver may be used in place of the knife, or the two may be used simultaneously, one on each side of the cannon pinion. The seconds hand and hour hand are taken off precisely similarly, extra caution being exercised with respect to the seconds hand, as the pivot on which it is fixed is very fragile.

When the hands are off remove the dial thus:—Take off the cap and lay the movement, dial downwards, on the eyeglass, or on some annular stand which will support the dial near its edge, and allow the projecting square of the cannon pinion to go free; then, penknife in hand, search for the feet, which come through the lower or pillar plate, holding the dial on. There are three of them, each having a pin hole diametrically across it; the pins are drawn out by pressing the knife blade slightly into them quite close to the feet, and by a twist prizing the pins out. The three pins thus removed should be put aside, and the movement and dial will come apart.

Under the dial, running quite loose on a small stud, will be found the minute wheel, which communicates the motion of the cannon pinion to the hour wheel. This minute wheel must be looked after, or it will probably be lost, being quite free to drop off when the dial is removed. Running loose on the cannon pinion is the hour wheel, to which the hour hand is fixed, the cannon pinion itself being fitted on the projecting arbour of the centre wheel, quite tight, yet free to revolve. The cannon pinion is taken off by gripping the square firmly, and then turning it backwards and forwards, all the while drawing the cannon off as much as possible. It will soon be quite free of its arbour, and should be put with the hour and minute wheels. This series of wheels and pinion forms collectively the "motion work," which is but very rarely out of order, and the only defect likely to come under the notice of a beginner will be that of the cannon pinion not fitting sufficiently tight on the centre arbour. This is remedied by inserting a hair from the cleaning brush inside the cannon pinion, and so jambing it on the arbour. A more workmanlike way of effecting the same purpose is to file, with a round file, a notch on each side of the cannon about midway between the ends, and the burrs resulting will make the fit sufficiently tight.

The dial off, and motion work removed, next lay the movement face side downwards to unscrew the balance-cock. When the movement is in this position take care that the projecting seconds pivot, which carries the seconds hand, does not touch anything and so get broken. Unscrew the cockscrew by turning it quite clear of the thread, and leave it lying in its place, then, with the tweezers, remove the cock. That is done by inserting one of the points between the plate and the foot of the cock, this latter having a small slot filed in it for the purpose. Lift the cock bodily away from the plate and place it aside. The lifting should be done vertically, so as to avoid bending the verge pivot, and this will leave the balance exposed, showing the hair-spring and regulator. At this point we may find one of two kinds of regulator, one fitted to the hole in the top plate, through which the verge passes, the other fitted to a circular groove cut in a piece of brass, usually of a highly-ornamental character, fixed by screws to the upper plate. Irrespective of the form of regulator, the first thing necessary is to mark the position of the end of the hair-spring which passes through the hair-spring stud, and is fixed in it by a brass pin. Make a slight scratch on the watch plate at the end of the spring, so that when the watch is put together again you can be sure of repinning the spring in the same position. Considerable care will be necessary to avoid any mishap in removing the pin which holds the hair-spring in the stud; press the pin out by the aid of the tweezers, and by gently turning the balance get the spring clear of the stud. If the watch is not completely run down the train of wheels will commence to revolve as soon as the verge is disengaged from the escape-wheel, which by the way is always called scape-wheel by watchmakers. So be careful in lifting out the balance, holding it with the tweezers by one of its arms near the centre, that the teeth of the scape-wheel do not get damaged. By keeping a finger against the edge of the crown wheel whilst taking out the balance all danger will be avoided.

When the balance is out, let the watch run down to the full extent of the main-spring, and then proceed to "let down the spring." On one end of the barrel arbour will be found a steel ratchet-wheel held by a click—this is generally on the side where the dial comes; with the screw-driver slack back the click-screw half a turn, and note the tooth of the ratchet-wheel which it engages; with a good key on the projecting end of the barrel arbour give a slight turn towards winding the spring up, and after disengaging the click let the spring uncoil itself, at the same time notice how much it does so, which may be from one quarter to nearly a whole turn. This done, the chain will lie loose on the barrel, and this latter may be taken out by removing the "name bar" held to the top plate by two screws, and forming the bearing of the barrel arbour; it is called the barrel bar, or more frequently the name bar, as on it is usually engraved the name of the ostensible maker. This bar off, the barrel is taken out after the chain has been unhooked from it; the chain is then unhooked from the fusee and taken out. It will be advisable for the beginner to take especial notice of the hooks on the ends of the chain, and remember which belongs to the fusee and barrel ends respectively. The two hooks have quite a different form, one having a peculiar long tail, and belongs to the barrel. If there is any ornamental work fixed to the top plate by screws, remove it, leaving all the screws resting in the holes from which they came, to save any confusion when putting together again.

The top plate may now be taken off by taking the pins from the four pillars, using the blade of the penknife, as previously explained, or the points of the tweezers, if found to be more serviceable. When the pins are out and put on one side—each one having its special place, and, as a rule, not being interchangeable—care should be taken to so arrange all the pins that their respective places will be easily known when the watch has to be got together again. Lift the top plate gently from the pillar plate, keeping the two as parallel as possible, so that no pivots will be broken, and taking especial care of the crown wheel, which will probably be caught by the potence-cock—that one which forms the bearing for the lower verge pivot, and also of the wheel end of the escape pinion. It is sometimes necessary to take the crown wheel from between the plates before these can be got asunder. Carefully notice the position of each wheel of the train, so that you may have a good general idea of how they go back; then with the tweezers take out each separately, first the crown wheel, if not already out, through the circumstances named above, then the fusee, next the centre wheel, and finally the third wheel. It will be found that the wheels lie one over the other in the order I have named, and thus they must be taken out in that rotation. The pillar plate will now be left bare, and the beginner will be well employed in putting the train—train is the technical name for all the wheelwork in a watch, from the fusee to the scape-wheel—back in its place, each wheel independent of the others, and thus familiarise himself with the positions of each and all.

Turning over the top plate we find the scape-wheel still fixed to it; and the endshake should be tried, so that it may be the same when the watch is put together again. Near the edge of the plate will be found a stud having a plug fitted through it, and forming a bearing for the pivot after the scape-pinion. This plug is called the follower, and must be drawn out to release the scape-wheel. It need not be removed entirely, but sufficiently far to let the pivot fall out of its bearing. The potence-cock, previously alluded to, is removed by taking out the single screw which holds it, and then on the same plate will remain only the stopwork catch which prevents the watch from being over-wound. This is often not removed for cleaning, but the way to do so is to take out the pin on which the stop-finger is pivoted. It will, however, be advisable for beginners to leave all unnecessary work undone.

Parts which appear to be removable, but which are not or need not be disturbed, are the hair-spring stud on the face of the top plate; the stopwork, including stopwork stud, stopfinger and spring, on the underside of the same plate; the third and fourth wheels bar on the dial side of the pillar plate, forming the bearings of the wheels named, and held by two screws; the stud on which the minute wheel revolves; the locking bolt, which holds the movement in the case, and its spring; the corresponding joint, and, of course, the pillars, which must on no account be loosened. I give the names of these pieces, so that the student at watchwork may make himself familiar with them; and having now taken our watch thoroughly apart, we must figuratively cover the pieces with bell glasses or inverted wine glasses till my next chapter on Cleaning, and then we will put the watch together again.

(To be continued.)

HOW SCREW GAUGES ARE MADE.

A TAP, or screw-gauge, is an exact *fac simile* of a screw-bolt in hardened steel, and is used for a standard measurement in making all working taps and dies sold in tool stores or made for workshops. Necessarily this is a very delicate operation, making a hardened gauge with a thread on it, that shall be as absolutely correct as human intelligence can make it, and the processes are extremely interesting. We find the following particulars of the method adopted by the Pratt and Whitney Company of Hartford, U.S.A.

"The first step in making a tap or screw-gauge is to turn a bar of steel to the exact diameter of the outside of the screw. Then, each end of the portion on which the thread is to be cut is turned down to the diameter of the screw at the root of the thread.

"On the exactness of this first operation the precision of the ultimate size of the gauge or tap will depend. It is therefore essential to be able to measure exactly these two diameters. The next step is to cut the thread. To do this a tool must be ground which will cut a thread whose sides will have an angle of exactly 60° to each other. An amount equal to one-eighth of the pitch must be taken off the point of the tool, the flat portion being true to the sides of the thread. To make a true thread the tool must then be set so that its centre line will be square with the axis of the screw. In order to be able to do this the sides of the tool are ground so as to be true parallel planes, and the parts which cut the sides of the thread are ground so as to be true with the sides of the tool and at an angle of 60° to each other. It can then be set true in a lathe with a square bearing against its sides, and against the blank top or head-stock of the lathe. What adds to the difficulty, though, is the fact that a cutting tool of this kind does not stand vertically, but at an angle of 20° to a perpendicular line. The top surface is horizontal. Now if the portions of the tool which conform to the sides of the thread were ground with an angle of 60° to each other, the edges of a plane which intersects these sides at an angle of more or less than 90° would not be inclined at an angle of 60° to each other. For this reason the tool must be ground at an angle somewhat less than 60°, so that the cutting edges formed by the intersection of the flat top surface and the inclined edges of the tool will be exactly 60°.

"It would be impossible, without elaborate illustrations, to give a description of the delicate instrument which is used to measure the exact amount which should be taken off the point of the tool for cutting threads of various sizes. It must be sufficient to say that this too is done with the highest degree of precision.

"These processes and appliances are required to make a turning tool of the exact shape and size to cut the threads of screw-gauges. With such a tool, then, and a blank for a gauge, such as has been described, it would seem that by cutting the thread so that the point of the tool would just touch that part of the blank which has been turned down to the size of the screw at the root of the thread, the screw must be of exactly the right size. If, as has been said, all the work described has been done with absolute precision, such will be the case; but in order to verify it, the same tool used for cutting the thread is put into a planer or shaping machine, and a template is cut with it out of a thin piece of steel. The space cut of the steel plate will, of course, be an exact duplicate of the space between the threads. As the spaces at the root of the threads should be exact counterparts of the point of the threads themselves, the latter can be measured by the template, and if they are exactly alike it will indicate that all the operations have been performed with the required precision. If so, the screw thus made supplies a true gauge to work to. It should be kept in mind that the sides of the threads of a screw are, or should be, the actual bearing surfaces, and that in making taps and dies, the threads should be measured over the sides. With such a gauge as will be supplied by the screw described, it is an easy matter to set an ordinary pair of callipers over the sides of the threads, and then reproduce that size in any number of other screws and taps.

"A skilful tool-maker will measure with ordinary callipers to within $\frac{1}{2000}$ of an inch, provided he has a correct gauge to set his callipers by. Experience has shown that with a gauge of the kind described to work from, a very high degree of precision can be attained, but it was also found that it was always necessary to make an allowance for the wear of the cutting-tool which occurred when it was first used, and therefore to make it somewhat larger than the actual size of the thread.

"But there is still another difficulty with screw-gauges. If they are made as described, the steel must of course be soft, and a very little use would soon destroy their accuracy. It is, therefore, requisite that working gauges should be hardened. The process of doing so, however, changes their form and dimensions slightly, so as to destroy their accuracy. To get over this difficulty hardened gauges are made somewhat larger than the standard size. The Pratt and Whitney Company have devised a plan to grind these gauges, after they are hardened, to the exact size, form and pitch. To do this the gauges are put into a lathe and a rapidly revolving steel disc or wheel is attached to the tool-holder, which is moved by the lead-screw, whose pitch is exactly that of the screw of the gauge. Diamond dust is used on this disc for grinding the hardened threads, and the exact size is reproduced from a soft gauge, whose dimensions have not been changed by hardening.

"For the most exact standards of reference, the Pratt and Whitney Company recommend the unhardened gauges. For standards of reference which must be used oftener, and where a high degree of precision is also required, they recommend the hardened and ground gauges.

"They will also furnish another kind which are hardened but not ground, to be used in the shop as reference gauges, and which are correct enough for practical purposes. Specimens of all these kinds were submitted with the report.

"It should be clearly understood that none of these gauges are intended for shop use, and that if subjected to much wear their accuracy will soon be destroyed. The size of new taps may be tested by them, and if of the correct size a few nuts may be cut with the new taps, and these be used as shop gauges by the workmen. As these wear they can be replaced with new nuts cut with other new taps.

"The external gauges, it will be seen, are made adjustable. The internal gauge is the real guide to work from, and the former can always be set from the latter. The committee find that there is some difference of opinion among those having most knowledge of the subject with reference to the need of the external gauges. Some hold that a correct internal screw gauge is sufficient to test the size of a tap from, and that then the nuts, already referred to, will answer for working gauges to maintain sizes in the shop.

"Complete sets of gauges like the samples exhibited can be furnished by the Pratt and Whitney Company in a few weeks or months, and the Committee think that the master car-builders, and all who have occasion to use screws, may be congratulated that standard screw-gauges can now be procured made with a degree of precision which has never been attained heretofore, and that this has largely been due to the agitation of the subject by this Association. It is worthy of note that a remedy for the evil complained of by master car-builders, that nuts made by some firms or at some shops would not screw on bolts made at others, at first baffled the ability of the most prominent manufacturing companies of tools of precision in the country, and that to provide an adequate remedy it was necessary to secure the assistance of the highest scientific ability in the country, which was supplied through the co-operation of the professor of astronomy of the oldest and most noted institution of learning in the land. The man of science turned his attention from the planets and the measurement of distances counted by millions of miles to listen to the imprecation, perhaps, of the humble car-repairer lying on his back and swearing because a $\frac{5}{8}$ nut—'leetle small'—will not screw on a bolt a 'trifle large.' It is a striking example of the assistance which science can give in conducting the 'practical' affairs of life."

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Oilstone Powder.—The Turkey oilstone can hardly be considered as a hone slate, having nothing of a lamellar or schistose appearance. As a whetstone it surpasses every other known substance, and possesses, in an eminent degree, the property of abrading the hardest steel, and is, at the same time, of so compact and close a nature as to resist the pressure necessary for sharpening a graver or other small instrument of that description. Little more is known of its natural history than that it is found in the interior of Asia Minor, and brought down to Smyrna for sale. The white and black varieties of Turkey oilstone differ but little in their general characters; the black is, however, somewhat harder, and is imported in larger pieces than the white. Fragments of oilstone, when pulverized, sifted and washed, are much in request by mechanicians. This abrasive is generally preferred for grinding together those fittings of mathematical instruments and machinery, which are made wholly or in part of brass or gun-metal, for oilstone being softer and more pulverulent than emery, is less liable to become embedded in the metal than emery, which latter is then apt continually to grind, and ultimately damage the accuracy of the fittings of brass works. In modern practice it is usual, however, as far as possible, to discard the grinding together of surfaces, with the view of producing accuracy of form, or precision of contact. Oilstone powder is preferred to pumice-stone powder for polishing superior brass works, and it is also used by the watchmaker on rubbers of pewter in polishing steel.

"BURNING" IRON CASTINGS TOGETHER.

(From "The Art of Founding."

By C. Wylie.

WHEN any part of a casting has been broken off, such as a flange, or should a blown hole have appeared, the moulder considers whether he can mend this without injuring the casting. Mending, so as to insure success, will depend wholly upon what part of the casting requires it. The formation of the casting has also to be considered, as well as the kind of metal that has been used; and herein lies the danger of burning or mending. It is not every casting that will stand a portion of it being brought to a melting heat without splitting in some adjacent part; it depends almost wholly upon the formation of the casting. Mending at the extremities of a casting of almost any shape is generally safe, but at the middle part seldom a success. In our opinion, mending a casting by burning a piece on should never be resorted to unless it cannot be mended otherwise, as it is often a forlorn hope. When the casting is a bad one, owing to a fracture, blown part, etc., it cannot be made worse by burning, which may as well be resorted to. Burning or mending a casting can only be done once on the same place; hence the necessity of taking every precaution before beginning.

When a casting has been broken, and mending the part resolved on, it is best to use the piece broken off when it can be had, and if it cannot, then one exactly the same pattern should be cast. The broken piece being laid to the casting in its place, pieces of dried loam (called cakes) are then fitted about the part, leaving about half an inch of space all along the fracture exposed; these cakes to be two or three inches higher than the broken part, so that all the dirt and scum may float to the top, and clear of the fracture. Cakes of loam are also made to cover the bottom part, to prevent the metal from running right through during the mending. The broken part should then be surrounded with a fire until it becomes red hot, the dried loam cakes being removed before the fire is applied. The portion of the casting to be mended, as well as the piece to be burned on, being now red hot—good hot metal in readiness—the fire smartly taken away—the loam cakes and the broken part put back in their proper places—pieces of iron ready at hand to secure them there—the metal is then run along the fracture until the casting and broken pieces are thoroughly fused together. This will be easily known by travelling the point of a quarter or three-eighths iron rod between the two. When the point of the rod touches the bottom cake of dried loam, and nothing is felt but liquid iron, the mend is complete.

Many castings stand the fire, but give way during the time the metal is being poured on the fracture. After the mend has quite set, it should be covered over with hot metal, and not again touched until the whole is quite cold. The hot metal used to cover it is generally that which was used in the mending, broken into suitable pieces. Again, some castings rend in the cooling. The softest of iron No. 1 should be used for a fracture, as it does not produce the greasy scum which comes from No. 2, and it also penetrates quicker into the fracture, and is much easier chipped. The importance of mending a broken casting when red hot is obvious, as it requires less metal to be poured on the break than if the parts were black. Moreover, when the parts are black, the metal when poured seems to glide off, as if the broken part had been oiled or greased. The oil and tar from the coal cause this to be the case; and when the fire is made with gas coke, the sulphur from it also produces the same effect. The metal for burning should be all in one ladle, it does not answer when a second has to be used, as the mend is sure to be dirty; the refuse or "slag" as it is commonly termed, from the last of the first ladle being liable to lodge in some part of the half mended fracture. When a large casting has to be mended, it is best to put it the night previous into the stove, which should be cold when it is first put in, then fire well up till the next day. When it is taken out of the stove, put the fire at once on the place to be mended, and when that is done lose no time in returning it back again to the hot stove.

When a casting has been imperfectly mended, and has been done again, it will be liable to crack two or three inches from the fracture, the reason of this being, that the metal two inches back from the fracture has lost all its elasticity; in short, it is calcined—it has become like the top, or rather middle part, of a furnace bar that has long been in use. The two inches of casting next the fracture are dead, and even should the second mend by a complete weld, if that part be struck lightly with a hammer, it will be very liable to break two or three inches from the original fracture; hence, if a mend is not properly done on the first trial, you cannot go back to it again with success. The best thing to be done, on a second burn being resolved on, is to cut three inches off, next the fracture, and in this way you come to good metal again.

It may be fairly questioned: Is a burn as good as if the casting had never been burnt? We at once answer (assuming the mend has been properly done and there are no symptoms of a crack on any part of the casting), it is equally as good as if no burn had taken place. For example, we have known the tooth of a spur-wheel burned on to stand, while some of the others gave way. Again, we have burned a large piece on propeller-blades which have come back to us again, broken on the same blade, but never near the burn. Therefore, from carefully watching the results of mending castings, our impression is, that the mend, when properly done, is equal in strength to the rest of the casting.

It may again be asked: Would the burning have an evil tendency on any other part of the casting, even a considerable distance from the mend, and thus, when the working strain is put upon the casting, cause that part to give way? In answer, we would say that it may and even does take place in castings of a certain structure, such as bed-plates, condensers, cylinders, grinders, &c., where it is difficult to determine on what part of the casting an undue strain may take place, owing to a portion of it being made to a melting heat, cast iron being of such a nature that it may be on the point of flying and no one be aware of it; but in plain castings (and especially when the mend is at extremities), we scarcely think that burning has any vital effect upon the other part.

When a mould has been cast, and an eruption takes place, however slight, if the moulder is sure that metal has been vomited out, it is well to take the top part of the mould off to see the casting. The hollow-blown places can then be quickly and safely burned, the casting being in a bright red state. Sometimes a mould will blow and vomit metal out for a considerable time, and then after it has relieved itself of the gases, it will take back quietly all the required metal, in which case the casting is seldom blown. In other cases, a mould will blow violently for some time, and as far as can be seen, not take any metal back, and, on the top part being taken off, will show no symptoms of requiring to be burned, but when this does occur the soft parts of the casting are found out when it is too late to burn it, and most likely on parts where it would be foolish and impracticable to try it.

Blisters or shells on a casting are easily mended, when they appear after being recently cast. They are generally to be found on green sand castings, and are caused through hard ramming of the top part, and the want of the free use of the vent wire. They are seldom above a quarter-of-an-inch deep, two or three inches in length, and an inch broad, and very often castings are condemned on account of their presence.

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Cutting a Worm Wheel.—To do this work properly, it will be necessary to have a lathe fitted with a divided headstock and wheel-cutting gear; such as overhead motion, a cutter spindle running vertically, &c. The method is this:—Mount the blank wheel to the cut very firmly, and arrange the dividing apparatus for the number of teeth required. Select a cutter which will cut a notch fitting the thread of the screw, and this cutter must be the same diameter as the screw, which will ultimately be used to drive the wheel. It is obvious that the notches to be cut in the periphery of the wheel must not be straight across its face, but at an angle, corresponding with the rake of the tangent screw, and to place the cutter spindle at this angle the shank which goes in the tool-box of the slide rest may be packed up on one side, so as to tilt it over and incline the spindle from its normal vertical position, and in this position it must be firmly fixed. The band from overhead pulleys has now to be adjusted to drive the cutter, and, by setting the lathe in motion, the first notch may be cut. The depth must be carefully watched, and a stop fixed to the slide-rest to prevent the cutter from being advanced any further at subsequent notches. The slide must, of course, always be driven right against this stop, or some of the cuts will not be so deep as others. When all the teeth are cut in, as just described, they must be made to fit the screw more exactly than could be done by the aid of the circular cutter, and this is done by means of a hub, similar to those used for cutting dies in a die-stock, which is made to revolve against the periphery of the wheel, which is itself free to rotate, and cuts away the metal till a perfect fit is produced. This is oftentimes a long job, and how to mount the hub is generally a source of great difficulty. In fact, as a rule, it is necessary to make a hub specially for the job; this hub is then made to fit the vertical cutting frame, and has a pulley to it, just like the cutter spindle. The part used for shaping the teeth of the worm-wheel consists of some half-dozen turns of the thread, carefully cut to match the tangent screw for which the wheel is intended, and having three or four longitudinal grooves cut right to the bottom of the thread, so as to form cutting points. This spindle tap has to be hardened and tempered, and is then brought into action against the periphery of the wheel, already correctly spaced out by means of the single cutter, as above described. The mandrel must, of course, be quite free to revolve, and the hub-cutter must be kept well up to its work; that is to say, it must be pressed as deeply as possible into the notches by means of the slide-rest. Plenty of oil will assist in cutting a smooth worm, and as soon as the hub has cut out a perfect thread, the worm-wheel is finished. It is impossible to cut a worm-wheel of any predetermined number of teeth by the aid of a hub cutter without first dividing off the spaces.

MAKESHIFT MACHINISTS.

THE following, contributed to our contemporary, the *American Machinist*, throws some light on American engineers' work. Though written in a style which scarcely commends it to careful consideration and reflection, the letter contains much worthy of such, and the results of automatic machine work and subdivision of labour are made apparent:—

I really believe that a machinist who likes to see things can find more solid enjoyment in some of the rough-and-tumble jobbing shops located in the woods than he can in some high-toned manufacturing establishment, gotten up without regard to cost. The workmen turned out by such concerns are invariably of more value than those raised in nice shops. A new man comes along and says he worked ten years in H——'s shop. Now H—— has the reputation of selling the nicest shafting known in the market. You want a man to turn shafting, and of course you ask this new comer if he worked on shafting any in H——'s shop. He answers truly that he never did much else. You consider yourself lucky, and set the man to work. You soon find that he turns the worst shafting in the world, and gets out about twelve feet a day. You go for the gentleman and ask him why he can't do some decent work, and some reasonable quantity of it. He explains, in a very condescending manner, that if you want good work you must furnish good facilities. He explains that, when at H——'s, he used a special lathe with a wonderful carriage arrangement, carrying numerous tools, and with a centring and straightening attachment, and a burring rest for finishing to size. With this rig he turned a hundred and fifty feet of nice shafting in ten hours, and says he can do it every day in the week, if you will bring him the apparatus. Now you know all about this kind of thing. You have been in H——'s shop, and know this man speaks truly. But you aint in the shafting business, and don't propose to go into the business. You have shafting jobs now and then, and want to do the work fair in quality and reasonable in price. You don't expect to do it as cheap as H—— does, who makes a speciality of it. You see, at once, that this man, who was all right in H——'s shop, don't know anything about turning shafting at all.

You hunt up a boy in the other end of the shop—a long-legged, long-headed youth, who has spent two years with you learning the *machinist's* trade. He knows how to turn shafting, and you know it. You put him on the long lathe and he gives you 40 ft. of shafting in ten hours, and it's forty times as good as the machinist (?) from H——'s shop could turn. If your long-legged boy ever gets a job in H——'s shop, H—— will have a rough diamond capable of high polish. You give the new man another lathe and set him to boring pulleys. He bores about three miserable holes in a day. He finds no pulley-boring machine, no good chuck drills, no reamers, no nothing. He ridicules the idea of doing work without tools. He never looks at his own deficiencies, but looks at the deficiencies of the shop. He is a nice fellow, but is not smart enough to admire the men all around him, who, every hour in the day, are doing things he can't do at all. You tell the new man he is a failure on a lathe. You set him to key-seating some big pulleys. They must be chipped and filed. Does he go and get good solid side chisels dressed, and does he lay a wide straight edge in the hole and draw one mark to chip his key-seat to, and does he sit down on a block and send three heavy, nice, clean, straight, flat cuts through the pulley, and does he file five minutes and show you a nice clean key-seat, out of wind and free from chisel marks, all done in forty minutes? No; he does not. He never cut a key-seat, and never saw one cut this way. He was brought up alongside a slotting machine, and he is now five hundred miles from the nearest slotting machine. He knows he can't do this job, and is smart enough to tell you so. This man is no machinist at all. He served a five years' apprenticeship, and worked on eight years in one of the best shops in the United States, but he is actually of less value than your youngest cub.

You put the case to him fairly; tell him you need men and like his looks, and that if he can point out any work in the shop which he can do properly, you will be glad to keep him. He feels badly, and, after looking around, decides that he can't do what the poorest men in the shop are doing. He will do one of two things: If he is a coward, without any coarse grit in him, he will abandon the "machinist" trade and tramp back to H—— and beg for a job on that shafting lathe. If he has the right stuff in him, he will start in and learn the trade. He has sense and experience, and don't need to commence just like a boy. He can start anywhere he chooses, at such wages as his work shows he earns, and increase his wages as he increases his value. You go into one of these rough-and-tumble shops and watch a man at a lathe. He whistles and sings and sky-larks and smokes, maybe, and does a hundred other things which the high and mighty think ought to send a man to the penitentiary. But don't that chap do the work though? Don't he earn and get good wages, and don't the proprietor make more off of him every day than the high and mighty do off of three men who were brought up to use every modern facility, and who are stumped if one of the aforesaid facilities happens to get broken. Watch this *outré* machinist as he works. He runs an eighteen inch lathe, perhaps, and the work brought to him might well be, and, in a better fixed shop, would be, distributed among big lathes, little lathes, Fox lathes, planers, slotters, milling machines, cutting machines, drilling machines, screw machines, bolt cutters, gear cutters, &c. But this chap does everything which is laid by his lathe. Some he does tip-top, some he leaves slouchy, but all of it is done as well as is required. He does this all the time. He lives on it. Every job he does is something he, nor anybody else, never did before, but he does it all the same. This man is no mere machine wound up and set to running a shafting turning machine. This shop aint a manufacturing concern with a system adapted to a special product. This is one of my Simon Pure machine shops, doing job work, new and old, and this fellow we see is a lordly lathesman, a real machinist. You may set him down in any shop in the world where there's a lathe, and a job to do, and he can do it. He will jump at new and better ways, but is not helpless in the meantime. He's no baby. He's a machinist, and he's worth money every day.

Oh, ye puny chaps that claim to be lathesmen! You only know one way of doing things, and that's the way you were *taught* to do it. You only know how to do one job, and that's the job you worked on while you were being taught, and you can't do that job when you get in another shop away from home. Aint you ashamed to ridicule a poor one-horse machine shop when every man in it is immeasurably your superior? Aint you ashamed to claim fellowship and equal wages with these sharp fellows, full of mechanical wit, who do work every day which you don't even dare to undertake? You say they can't do it well. You can't do it at all. You don't know how to tackle it. Look at the job this lathesman gets. He is sitting on a casting and handling a connecting rod strap. It's a rough forging for a strap to hold square boxes. You can't see a bit of lathe-work about it anywhere, or a chance for any. Pretty soon he gets his present job done. Now he puts a miserable-looking angle-plate against his face-plate, and sets this strap in some shape. He fishes a dirty piece of paper out of his tool box. This paper contains a memorandum of sizes which he took down verbatim as the foreman gave them. He goes to work, and in two hours lays two hours of planing on the floor. He has surfaced that strap nicely and squarely all over the outside. There's one job of lathework done. There is but one planer in the shop, and that is too much crowded to be doing anything that can be done in any other machine. The same planer will stand still six months in the year, so it would be folly to get another, and thus be ready for a rush which never comes when you are ready.

Here goes for the next job. Twelve studs about two feet long, one-and-three-quarters diameter, to have thread cut eight inches on one end. No turning, simply a thread to be cut. They belong to a bridge-bolt job, and the bolt cutter has no dies for this size. Soon this job is done. It aint nice lathe work. Nothing to be proud of, but it is o. k. in every way. What next? He puts on a chuck and proceeds to chase out twelve hot-pressed nuts for these bridge bolts. Ough! how your teeth grit to see a lathesman having to do such a job. It's a nasty job, but there's no tap that size, and soon it's done and off this chap's mind. Next comes some nice lathe work; a couple of lathe mandrels. They are finished to the size given and nicely polished. He gets them done, and feels proud of them. Bless him, any lathesman can do such work. Here's a brass casting for a 2in. stop-cock, and by it lies the old one. It's a repair job. The old one is bursted wide open. The plug is swelled, but not broken. Does a foreman come around and instruct this man how to do this job? No. His orders were to " rig up that cock." He takes the casting, chucks it, and in half an hour has a 2in. pipe thread chased in each end. Now he chucks crosswise, and you suddenly notice that this cock must be bored tapering. How is this fellow going to bore this hole? Will he go and get a nice taper reamer? I guess not in this shop. Will he fit up some kind of a reamer? Not he. He is fitting up an old water-cock, not making new reamers. He'll set the head of the lathe over, won't he? No, he won't. The head of the lathe can't be swivelled. Will he set the Slate taper attachment over? Guess not, seeing as he never heard of Slate; and don't know what a taper attachment is. Will he use the compound rest? He may, some day, when such a thing gets into the shop. Will he stick a wedge under the back wing of the carriage? No. He never heard of it, and is not so deep an inventor as to think of it just when he wants it. Will he wrap a cord around his cross-feed screw-handle and tie it to his tail-stock, and thus get the taper? No, he has no time to invent this ingenious plan. Will he find a fancy little sliding-head boring bar somewhere? Not a bar. Has he a mandrel which he can screw his chuck on, and thus do the job on the steady test? No. He won't do any of these smart things, and he won't tell you that the shop ought to have a Fox lathe for such work, and he wont't tell you how the Metropolitan Cock Company bore them out, for he don't know, and, I am sorry to add, he don't care. All he cares about is to lay that cock down on the floor and call it done, and done as well as is needed.

He whistles a very peculiar air in a very soft manner, and turns his cross-crank slowly to keep time. The result is a hole which is tapering, if it's nothing else. It would have taken him just about as long to bore it straight. He takes the job out, puts on a face-plate, and puts the old cock plug in the lathe. He chalks it and hammers the swells out, or in, rather. Then he sets his lathe over and takes a light cut over it. Then he makes a close fit in the cock, but keeps the plug large. Now he goes to a vice and *files the hole.* It was tapering all right, but the sides were not straight. He files carefully, but boldly, watching the tool-marks in the hole, and trying the plug. Soon he is done with the filing, and returning to his lathe completes the fit of the plug. Now he guides it in, and soon there aint a a file-mark or a tool-mark in the hole or on the plug. It is simply a first-class water-tight taper job, quickly done in a third-class manner. He screws the thing together, and bounces the next job. Time on old cock three hours and a quarter. Could you or I do it as well or as quick with all the cock-making appliances in existence? This man never fitted up a water-cock before. He is a machinist, and will hustle out any job you will bring him, and will do it as good as you want it done, and no better.

Bigotry Amongst Mechanics.—Students find so many contradictory assertions put forth by those who should be competent authorities upon mechanical matters, that they become confused and led astray in the pursuit of correct knowledge. In most cases these erratic assertions are circulated to gratify a spirit of intolerance directed against some fortunate competitor. Experts frequently delight in laying pitfalls for each other. Instead of uniting to advance mechanical discovery they too often diverge to hinder it. Such exhibitions of intolerance re-act upon their authors, by creating public distrust in every mechanical decision made by the parties. If one engineer goes somewhat in advance of generally accepted mechanical knowledge, and makes an important discovery, he is obliged, in many cases, to defeat the jealous obstinacy of a whole category of self-styled experts, before he can open a clear road for its application. When an engineer gets in the way of decrying original results obtained by any of his contemporaries it is best to give him a free field and let him go alone unaided. This course will soon bring him to a better and more liberal understanding of the principles of mutual dependence. Intolerance always represses, never helps, the evolvement of mechanical truths. The science of mechanics is progressive. Certain facts in it are established beyond any reasonable doubt, but many things are yet subjects of experiment and controversy, not having been clearly proved or disproved so as to make their settlement conclusive. The open discussion of these questions often develops a degree of intolerance among certain leading engineers that works serious disadvantage to the profession. Intolerance is the worst distemper that seizes upon the master spirits of mechanical progress. Often when an engineer holds views at variance with most of his contemporaries he is so positive as to brook no opposition. He hotly decries the merits and ability of all those who combat his position upon the question at issue. He tries to persuade every casual visitor to his office that certain of his contemporaries are donkeys because they do not agree with his views. Again, we often see an engineer trying to build up a peculiar theory or system of his own, and endeavouring to overthrow everything that will not conform to it. Sometimes his zeal leads him to write a book, assailing the published works of other engineers which have proved of great practical value, a course which usually gives him notoriety, if not popularity, and affords a relief to his combativeness.

TECHNICAL JOURNALS.

[From the "Boston Journal of Commerce."]

THE influence of the ordinary newspaper is an enigma to the newspaper man himself. It almost seems that the employment of type to convey ideas had some magical power. A statement made in the newspaper columns seems to have a popular importance not to be accredited to the vocal utterances of the newspaper writer. Much of this difference may, however, be accounted for in the fact that it is assumed that the newspaper manager, or editor, or reporter, has superior means of information, which information he gives, not verbally and in chance conversation, but reserves for the columns of his paper. Some of this difference of influence between the verbal expression of individual opinion and its publication in the newspaper is also to be attributed to the fact that the newspaper office is the receptacle into which is poured driblets of information, the accretions of facts, and the deductions of individual experience and results of personal investigation. There is still another reason for the power of influence of the newspaper, and that is to be found in the opportunities the newspaper man has for receiving and comparing the results of other newspaper work in the extended custom of newspaper interchange, a custom that has become a necessity. One additional reason may be cited, and that is the habit of newspaper men of keeping themselves out of the hurry and swirl, and personal influence of the stirring community, and sitting in judgment or listening in consideration, as the judge in a court case or the jury in a trial. All these combined give sufficient reason why the utterances of the newspaper columns have a larger and stronger influence than the verbal, individual statements of any one, or two or three men.

If these deductions from existing facts are applicable to the general newspaper, they apply with greater force to the technical newspapers. Those which are devoted to the record of current discoveries in chemistry, to their application to the productive arts, and those which keep abreast with the progress in mechanics, are means of communication that no verbal or personal efforts can reach, and text books become less reliable as the progress of the arts, as shown in the current technical publications, is given from week to week and month to month.

It is acknowledged that our technical books on mechanics and chemistry need frequent additions and corrections, as their data are based largely on theories, and even where founded on experiments, are shown from time to time, to be untenable in the light of additional experiments. Even the tables and recipes that are so handy in our manuals are subject to alteration and radical change in the light of progressive science. They are only approximately true, and the workman, manufacturer, or student who cares to keep up with the progress of the arts must avail himself of the results of experiments and tests that are continually being made and tried, if he does not wish to be left behind in this progress.

The practice of mechanics, as an instance, differs not only in different countries, but in different establishments in one country. The multiplication of special tools, the variety in methods, the difference in appliances employed are all elements of the general progress; but they cannot be available for general information except through the medium of periodical publications. Through these the working world is informed of what is being done by the workers. Frequent visits of competent agents of special and technical newspapers, to the sources of production and the seats of manufacture, result in reports of facts, and details of processes, and amounts of results that furnish a large fund of valuable information. Added to this is the custom of publishing the communications of bright workmen, practical mechanics, and experimental students, who give an immense amount of valuable information, that in time may find its way into text books, but through the medium of the technical newspaper is available immediately, serving as guide to success in experiment, aid to manipulation, and warning to useless trial. The custom, also, of some of our technical newspapers of producing pictorial illustrations, sections, plans, diagrams of improvements in the mechanic art, or of processes in chemistry, adds greatly to the value of this means of periodical information. The hints, suggestions, descriptions, advice, and caution contained in the editorial columns of these periodicals are very valuable. They are, in most cases, drawn either from personal observation or individual experience, and are, so far, reliable and trustworthy. Indeed these papers do not often admit to their columns mere theories and analogical assumption, but demand the why and wherefore for statements intended as guides to practice.

A newspaper conducted on a sound independent plan, is a valuable adjunct to the means of the manufacturer, and an aid to the enterprising and wide-awake mechanic.

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Unbalanced Handles.—One of the most aggravating things in the experience of a lathe hand—working a slide-lathe—is, after starting a fine cut and running a short distance, to suddenly discover that the cutting tool has moved, owing to the turning of the unbalanced handle upon the end of the screw for operating the tool. Under these circumstances, the workman has to fix it with a wrench, or hang on a bit of old iron to keep the handle from moving. Some very fine lathes have this small, but very serious fault of unbalanced handles. Some of these small features, although of very great importance, do not seem to be at all appreciated by some machine tool-builders. It costs no more to accurately balance the wheels and handles for operating slide rests and lathe carriages than it does to leave them several ounces out of balance. Upon boring mills and other machinery, work is, in some instances, spoilt, by reason of unbalanced wheels and handles suddenly moving while a finishing cut is being taken. Another serious fault in some lathes is the fact that so much weight is placed upon the front end of the rest that the back end is lifted from the ways. A lathe having this defect upon which the workman endeavours to take a finishing cut would allow the tool to cut very nicely for a few inches, when it would suddenly dig into the work, making terrible havoc with the finished surface. A few moments' consideration would show what was the matter, and suggest that a block of iron be placed upon the back end of the carriage. This done, after which the finishing cut may be completed without further difficulty. The trouble in this case is, that the weight of the front of the rest with its appurtenances, is enough, greater than the carriage to overbalance it so that the back end is lifted as far as the small space between the gib and the underside of the ways permit; this will allow the tool to dig. After sufficient weight is applied to hold it down, the tool necessarily works smooth. In the endeavour to accomplish some great improvement in machine tools, the small, but very essential details are often overlooked.

BOY MECHANICS.

(From the "Boston Journal of Commerce.")

BOYS precede men and apprentices precede journeymen. The boy is the father of the man. It is an old saying and a true one. Almost all boys are naturally mechanics. The constructive and imitative faculties are developed, in part, at a very early age. All boys are not capable of being developed into good, practical, working mechanics, but most of them show their bent that way. There are a few cases in which the boy has no competent idea of the production of a fabricated result from inorganic material, but such cases are rare. Given the proper encouragement and the means, and many boys whose mechanical aptness is allowed to run to waste, or is diverted from its natural course, would become good workmen, useful, producing members of the industrial community. Boys are always planning, contriving, and fabricating. Give a boy a good pocket knife, and, unless the trader is uppermost in his nature, he will use it instead of swapping it, and with its aid he will begin construction, the making of something useful, ornamental or attractive out of handy material. With this comprehensive tool he will do, in his crude way, what the experienced mechanic does with his planes, chisels, gouges, augurs, bits, &c., and be a shipwright, cabinet worker, joiner, carpenter and toymaker in one, and sometimes he will turn out specimens of work that the accomplished mechanic need not blush to own.

There are sold, all over the country miniature chests of wood-working tools ostensibly adapted to the hands of the boy mechanic. But in most cases these are play tools in another sense than that they are of diminutive size. The old notion that "anything is good enough for a boy," or "any worn-out tool, is good enough for the apprentice" has not lost its force, and these beginners in art and neophytes in work are furnished with miserable apologies for tools that could not keep a place, after a single trial, on the bench of a workman. Such nonsense is reprehensible in theory and wicked in practice. Give your boy and your apprentice good tools and good materials. It is enough for the workman that he can do better work with his years of experience and his ripened judgment, without imposing upon the boy and apprentice with inefficient tools and improper material.

The mechanical boy ought to have a shop of his own. Let it be the attic, or an unused room, or a place in the barn or the woodshed. Give him a place and tools. Let him have a good pocket-knife, gimlets, chisels, gouges, planes, cutting nippers, saws, a foot rule, and material to work. Let the boy have a chance. If he is a mechanic it will come out, and he will do himself credit. If he fails he is to follow some calling that does not demand mechanical skill.

With a foot rule in his pocket the boy will be continually measuring. Before he is aware of it his eye has been educated to judge of dimensions and proportions. It is a good substratum on which to erect the knowledge of practical mechanics. Acquired as an amusement, this knowledge will become practically useful as the boy developes into the man. The employments suggested by the pocket-knife and rule will occupy many an otherwise idle hour, and afford a pleasant relief to the routine of school study and the weariness of oft-played games. The boy will become acquainted practically with substances and be interested in the mechanical operations he witnesses, and this will pave the way for his easy entrance on the vast field of useful endeavour before him. He will become an intelligent and willing apprentice, and a judicious and skilful workman.

ORNAMENTAL TURNERY.

(CUP AND COVER IN BLACKWOOD AND IVORY.)

(For Illustration see Lithograph Supplement.)

THE illustration accompanying this issue shows the object mentioned in our first issue. The photograph shows the form of the cup as a whole, and the details may be examined critically. We are indebted to General Clarke for the subjoined explanation of the details and process of manufacture; but for the benefit of those desiring even more minute particulars we give a few dimensions, taken from the object itself.

The total height from base to finial is 10¾ inches, the photograph therefore is as nearly as possible two-thirds of the actual size. The base is ¾ inch thick and 3⅝ inches across the hexagon. The ivory disc lying on the hexagonal base is nearly 3¼ inches in diameter, and barely ¼ inch thick. The black-wood piece with its rounded edge fluted is 2¼ inches in diameter and ⅓ inch thick; it has fifty flutes. The ivory ring with the beaded edge is 1⅝ inch diameter and 3/16 inch thick. The stem to the next ivory ring is ¾ inch long, the ring is ⅛ inch thick, and from it to the blackwood ring just below the cup is 1½ inch. The perforated ivory piece is 1 inch in diameter at the largest part; the perforations have six leaves. The ivory ornament supporting the cup has twenty-four leaves, produced by drilling out the interstices; the extreme diameter at the points of the leaves is 1⅞ inch. The cup part is 3¼ inches diameter; it has twenty-four flutes. The ivory ring around it is 3½ inches diameter. The largest part—that is, the ivory-leaved ring—is 4¼ inches diameter; it has forty-eight leaves; from the tips of these leaves to the base is 6¼ inches.

The cover itself is 3⅜ inches diameter at the base, which is an ivory ring shown just above the large-leaved ring. The fluted round-edged black-wood piece above it is ⅝ inch high; it has forty-eight flutes. The beaded ivory ring above is 1¾ inch diameter. To the ivory washer with a serrated edge is ¾ inch. The ivory ornament above has six leaves, formed by drilling, and the interstices from the washer to the tops of the leaves is 1¼ inch. The serrated washer is 9/16 inch in diameter. The various pieces that compose the article are fitted together and fixed with screws cut in the material itself. The following particulars will enable even the merest tyro to set about making a similar object to that illustrated:—

I have been requested by the Editor to give some explanation of the details of the cup represented in the photograph, for the benefit of such readers as may not be acquainted with the use of the various instruments employed in ornamental turning.

To begin with the base or foot of the cup, which is hexagonal:—A disc of wood, slightly exceeding in diameter the distance from one point to the opposite one of the hexagon, being reduced to the thickness of the intended base—made true and flat on both sides, and polished on what was to be the upper surface—had a hollow screw formed on that side to receive a corresponding portion of the ivory disc, with beaded edge, which lies upon it. The wooden disc was then attached by that screw to a chuck of less diameter than the distance from one flat side of the hexagon to the opposite side, and the six flat sides were cut, in succession, by means of the eccentric cutting-frame carrying a round-ended tool, set to such a degree of eccentricity as would cause the circle it described in revolving to be somewhat larger in diameter than the length of one of the sides of the intended hexagon. The mandrel, with the chuck carrying the disc of wood, being held by the index in the division plate, the revolving eccentric cutter was drawn—by a handle on the slide-rest screw—past the edge of the disc, carrying away a small portion of its material, and thus planing, as it were, a flat surface. This operation was repeated, taking off a little more of the wood each time, until the flat surface was supposed to be nearly at the proper depth; then, shifting the mandrel round one-sixth of the circle for each of the remaining sides, they were cut in the same manner, and each side was cut a little deeper until they met one another. To avoid tool marks, it is as well to finish each side with a light cut, after sharpening the tool afresh. To save wear and tear of the tool, a portion of each side may be removed by the saw before beginning the work with the cutter.

The ivory disc, with its edge cut into beads, requires no explanation. It screws into the wooden base, and has a hollow screw in it to receive the next portion of blackwood, which has its rounded edge cut into flutes. These were produced by means of the dome chuck and eccentric chuck combined. The dome chuck was so placed on the eccentric chuck that its length lay at right angles to the slide of the latter, and then such an amount of eccentricity was given the slide as caused the edge of the wood, mounted on a chuck and placed on the dome chuck, to describe a portion of a small circle when the mandrel was moved round by hand. The flutes were cut with a **Λ** shaped tool in the universal cutting-frame, set to cut vertically upwards.

The perforated piece of ivory, showing a portion of the blackwood stem through its openings, having been chucked by a screw at its large end, was shaped externally and polished, and bored throughout its length with a hole large enough to admit the stem. A tool, filed up out of a piece of flat steel, being inserted into the hole, was worked about until the interior of the orifice was about parallel with the exterior, and the ivory was reduced to a thin shell, coming to a sharp edge at the bottom. The perforations were made with drills of various diameters.

The lower portion of the cup itself was fluted on the dome chuck with broad flutes, produced by a round-ended tool in the universal cutter, cutting horizontally, while the mandrel, carrying the dome chuck, was moved slowly round by hand for each flute. The next piece of blackwood, with parallel sides, has a corresponding number of flutes, executed with the same cutter, set to cut vertically, and drawn past the edge of the wood by the handle on the slide-rest screw, the wood being in the usual position on the mandrel, without employing the dome chuck.

The ivory ring, with projecting pointed leaves, which forms the top of the cup, was shaped, partly by the eccentric cutting frame, and partly by the drill. The tool in the eccentric cutter cut the edge of the ivory, which had been reduced almost to a knife-edge, into scollops, just meeting one another to form the points of the leaves. Then, with the same divisions of the division plate, a drill cutting at the sides, was carried horizontally towards the centre of the work for about a quarter of an inch, and then a larger drill at the inner end of the opening finished the cut.

The cover of the cup has at the bottom a flat ivory ring, which just fits into a circular recess in the upper rim of the cup. Into this is screwed the dome-shaped piece of blackwood, fluted on the dome chuck by a **Λ** shaped tool in the universal cutter, set to cut vertically upwards. The next piece of wood is simply turned and polished, and the one next above it, with a little ivory washer between them, with beaded edge, might as well be also simple turned to shape and polished, though in the original it has fluted sides, cut, if I recollect rightly, with the assistance of what is called the "curvilinear apparatus," in which a template, filed to the required form of outline, serves as a guide to the path of the cutter.

The small cone of ivory with flat sides, which forms the summit of the cover, after being roughly turned to conical shape, had its sides cut with a flat-ended drill, cutting on its left side, drawn while revolving, by a handle on the slide-rest screw, from the point towards the base of the cone, the slide-rest being set at the necessary angle.

The various parts of this cup and of the cover are, of course, attached to one another by screws, and, the stem being somewhat slender, it is as well to strengthen it by a rod of steel wire throughout its length, with a small brass nut at each end, which can be sunk in recesses in the wood.—G. C. C.

We have only to again express our thanks to G. C. C. for his kindness in lending the object and furnishing the above description. We also are pleased to say that the loan of several other specimens of ornamental turnery, executed by the same facile hand, has been offered and gladly accepted, so that our readers may anticipate a specimen of ornamental turnery to accompany our forthcoming issues. Should any other possessors of interesting specimens be disposed to allow of their being photographed, we shall be glad to have an early intimation.

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Home Made Emery Wheels.—The manufacturers of solid emery wheels fill a large gap in the demands of the manipulations of metals. But there are cases where certain forms of abrading surfaces must be maintained in order to give proper results. In these cases there is no outside help for the manufacturer, but he must construct his own wheels. If this is not really exacted, yet it is believed to be cheaper to form and dress wheels for certain purposes than to depend upon manufacturers of solid wheels. In some instances it is required that the wheel shall be of some determinate diameter, impossible to be preserved in a wheel that wears gradually away and gradually is reduced in diameter. Ordinary glue is the matrix generally employed to hold the particles of the cutting emery in place; but sometimes this is not tenacious enough, or rather it fixes the particles to the periphery without holding them. Where **V** scores or **U** scores are required on the face of a wheel, it is found that when glue alone is employed it retains the partcles of the coarser grades of emery only by a portion of their surfaces, and that these particles fly off before they have performed any large amount of work. A means of imbedding these particles firmly is found in the mixture of a certain portion of hydrate of lime—plaster of Paris—with the melted glue. The mixture should be not only plastic, but almost fluid, and plaster should be added just before using the glue on the wheel, and the glue and plaster should be hot and the surface of the wheel wet. When rolled in the emery the wheel should be pressed down with as much force as can be applied by the hands on the rod through the wheel centre, and the rolling should be continued as long as the emery will adhere. The proportion of plaster is just sufficient to reduce the liquid glue to a viscid or semi-fluid state; its only use is to give body to the glue and assist in holding the emery in place.

PLASTER CASTING.

By H. C. Standage.

(From " Design and Work.")

PLASTER-casting, of which I propose to treat, not only affords amusement, but may also be turned to a useful account; for there is many a little thing in a man's home which, if left unadorned, is at least plain if not positively ugly, but which may be beautified by plaster castings of leaves, ornamental carvings, etc. In this article I shall treat on the casting of medallions. I have frequently amused myself with this art, therefore my instructions should be reliable, as having been derived from experience; in fact, when dealing with a delicate subject, I shall beforehand practically work it out, that I may not miss any little technicality. In the first place, then, like all first lessons, we can do no work before we get the tools ready. The tools required will be plaster of Paris, coarse and fine, at 5d. and 1s. per bag respectively, a modelling tool, having a spatula at one end and teeth at the other—this is obtained at the artists' colourman's for a few pence; a pound or two of sulphur or "roll brimstone," at a few pence per pound; half a pound of paraffin wax, for a shilling and threepence, from an electric apparatus maker's; a little sweet oil; and a few soft hair pencils. These are the essential things, others can be requisitioned from the household utensils. As instructions are more easily comprehended when practically carried out, we will at once furnish an example.

Get a smooth board, about a couple of feet long and one wide: this will serve to work on, and prevent spoiling the table. Take a coin, say a very little worn pennypiece, cut a strip of writing-paper half an inch wide, and long enough to go round the coin and over-lap. Fit this to the coin and gum the over-lapping edges, or else glue the paper round the edges of the penny with a cement of thin glue, having a little vinegar in it. Next take a small brush and brush over the surface of the coin, of which an impression is desired, with a little oil, not too much, or else there will be holes in the cast, but simply sufficient to damp the surface, making sure that every interstice on the face of the coin is covered. Failing this, we shall have the cast broken at these points. Should the surface, however, be flooded with oil, mop it up with a brush, and then tilt the coin on its edge to allow the paper to absorb the remainder. Having oiled the surface properly, some paraffin wax should be melted in an evaporating basin or a saucer, and while hot it should be poured quickly into the mould formed by the coin and paper, commencing at one side and allowing the melted wax to run quickly over the remainder of the surface by tilting the board on which it rests. It should be left to cool undisturbed, and when cold and set, the paper should be stripped off round the coin by applying the thumb-nail gently at one edge between it and the wax, when the two will separate. A mould is thus obtained, from which a cast similar to the coin may be taken. A strip of paper should now be fastened round the wax mould, as directed to be done with the coin, and some fine plaster of Paris mixed in a saucer to the consistency of cream, by sprinkling the plaster into the water and stirring with a spoon (not an iron one), and when sufficiently thick it should be poured into the mould and allowed to set. When perfectly hard the paper should be taken away, and the plaster separated as before. The plaster will be a *fac simile* of the surface of the coin, though probably in this first essay it will be full of small holes—a result which renders the cast perfectly useless. In this case, lay the cast aside, and make another one, being careful in mixing the plaster this time to break all the air-bubbles seen in it, and likewise to make it assume a proper fluid condition—*i.e.*, consistency of cream, not setting too rapidly nor too slowly, and flowing easily out of the basin. I mention this probable result that the experimenter be not disgusted at the first attempt, and by following the minute directions given above failure a second time is scarcely likely to ensue.

A few words concerning the plaster will not be amiss. If very old it will not set at all, whereas if it be a little bit stale it will set very rapidly, and hence be unmanageable. In such a case put into the water with which you mix it a little thin glue or milled size. The best condition for the plaster is when it is new, as it then requires only two or three minutes before setting. Sometimes, however, although new, it sets too slowly for the purpose in hand, in which case it should be mixed with warm instead of cold water. Another thing to be guarded against is that of injuring the cast whilst separating it from the mould. In the case of a plaster cast this is easily overcome by holding it in water a few seconds, plaster downwards, when a film of water insinuating itself between the cast and mould. the two easily separate. Supposing a difficulty should be experienced in obtaining the finer kind of plaster, pound some of the coarser sort in a mortar, sift it through muslin or a very fine sieve, and put it in an iron ladle over the fire, stirring with a stick until it bubbles like water beginning to boil; in a little time it will become thick and difficult to stir, when it must be allowed to cool. Should a number of imperfect casts be obtained, the plaster need not be wasted, but returned as thus described, when it will once more become usable.

We will take for our next experiment a cast from a head, such as those sold at a shilling each for "bumpology" purposes, whereon we have nicely mapped out for our enquiring minds those mysterious bumps of our good and bad qualities.

Having obtained our head, some silver sand, and some soft clay, pile up some sand into a heap, or put it in a box sufficiently large to hold the head. Next lay the head upon the sand, and press it well into the bed; the head should be laid on its side, and pressed down to leave half its surface exposed. Having rolled out a thin layer of clay, cut some slips about a ¼in. wide, and stick these, by lightly wetting them, round the model, so that they divide the head into two halves—*i.e.*, pass them under the chin, across the lips, along the bridge of the nose, between the eyes, and so on across the top of the head to the back of it. In laying this strip on be careful to keep the unburied portion—the upper part, the one you are going to take a cast from—very slightly more than half the head; otherwise if we let the slackness of the clay strip intervene between the two halves they will, when cemented together, allow no width for the nose, and the eyes will probably be closed together—a figure entirely unnatural.

Next oil the part we are going to cast from, following the directions in our last on this point. Melt a sufficient quantity of paraffin wax, and pour it quickly over all the exposed part, so as to form a thin layer. If the layer thus formed be too thin to manipulate with, having let it "set," pour on a second quantity of wax, which, however, should only be sufficiently warm to flow, otherwise it will melt the first, and in so doing cause some parts to be thin. The whole having set, lift out the head, with wax and clay attached; strip off the clay, and apply the thumb-nail as before to separate the plaster. Should, however, there be any deep recesses, such as the eyes sunken in, that would not allow the two to separate in this way, fill them up previously with plaster. The wax mould being good, lay on the clay strips as before, being careful to keep the top face of them level with where the top face was before; lay the head down again in the sand-bed, and take a cast from the reverse side in a similar manner.

The two moulds having been obtained, we have next to proceed to obtain a cast from them. Slightly oil them in every part, imbed in sand, mix some fine plaster of Paris, pour it in, and force into every cavity by blowing hard. This plaster should line the wax mould, and be about ¼in. thick, the body of the cast being composed of the coarser plaster. Should it be desired to have the cast a solid one, obtain a plaster cast from each mould, let set, and separate. Any difficulty experienced in so doing—which there should not be—is overcome by melting of the wax and sacrificing the mould. Now we have a cast of the model in two halves; to join them together, mix a little fine plaster with a very little thin glue, damp the two flat sides of the heads—here let me say that in pouring the plaster into the wax mould it should be only just "flush"—*i.e.*, level with edge of the moulds—with a wet sponge, smear a little of this plaster and glue on each half, and press them together, holding them so for a moment or two. In joining them together, see that they coincide and do not have one eye or one-half of the lips higher up than the other. The whole having set, with the blade part of the spatula dipped in water, scrape down the seam that appears where the joint is made. Should any deep recesses have been filled up in the original, carve them out of the cast with the spatula, as near like the original as possible. The whole cast is now complete. In a similar manner casts can be taken from feet, hands, &c., of a living person. To take a cast from a foot, the clay strips should be carried down the ankle, and along each side of the foot, so as to take a cast from the top and bottom of it, these afterwards being joined as in the last example. Besides the examples named, there will be many more that will suggest themselves to the mind of the modeller, such as a symmetrical wooden bracket as an ornament: should, however, a carved one be selected, and the carving be complex—*i.e.*, will not admit of the halves being separated from the model—the casts should be obtained from the carved parts, and these fastened into a plain model of the original. In casting a bracket two bits of strong wire bent in a half-hoop should be inserted in the plaster while soft, to allow the bracket being hung against the wall.

(To be continued.)

Welding Cast-Iron in China.—The Chinese process of welding cracked iron wares by cementing them with molten iron is thus described:—In the case, for example, of a cast-iron pan requiring such treatment, the operator commences by breaking the edges of the fracture slightly with a hammer, so as to enlarge the fissures, after which the fractured parts are placed and held in their natural positions by means of wooden braces; the pan being ready, crucibles made of clay are laid in charcoal and ignited in a small portable sheet-iron furnace, with bellows working horizontally. As soon as the pieces of cast-iron with which the crucibles were charged are fused, it is poured on a layer of partly-charred husk of rough rice, previously spread on a thickly-doubled cloth, the object of this being to prevent the sudden cooling and hardening of the liquid metal. While in the liquid state, it is quickly conveyed to the fractured part under the vessel, and forced with a jerk into the enlarged fissures, while a paper rubber is passed over the obtruding liquid inside of the vessel, making a neat, strong, substantial, and in every respect thorough operation.

USES OF A SMALL CIRCULAR SAW.

IT may be that textual directions, without diagrams, appear confused, but if read carefully, there will probably be found no difficulty in making them ocular and palpable verities. This article, which is one of several written for the *Boston Journal*, is in no sense a fancy sketch, but the result of actual use by a practical mechanic, who has "been through the mill." It is his desire that his experience and observation may save his brother mechanics bother and trouble, and help them to help themselves. If others know "a more excellent way," their suggestions will be gladly received.

Many of the tools used in the machine shop suggest their own uses at sight, but there are some, particularly lathe appliances, which are capable of a much larger range of work than their primal use indicates. One of these is the nicking saw, or miniature circular saw for cutting metals. It is well to have two or three of these saws, of differing diameters and thicknesses. One of one-sixteenth of an inch, one of three-thirty seconds, and one of one-eighth of an inch are all handy in the shop ;. and the thinner the saw the smaller its diameter to get good work out of them. Four inches diameter is plenty large enough for the thickest of the three mentioned above.

Some of their uses may be suggested here, but the intelligent mechanic will readily see where such uses may be extended, to a great saving of time and a great facilitation of work. Although machine-produced screws are plentiful in the market, there are occasions where a peculiar form, length, proportion of shoulder, thickness and form of head, and grade of thread differing from standard sizes, are required. Reference is made here to screws for metal work—"machine screws" as they are called. The workman sometimes is compelled, by the exigencies of the case, to make the screws for a certain job. Nicking the heads for the screw-driver is rarely satisfactorily performed by means of the hand or "hack" saw. The circular saw is not only more convenient, but it produces more perfect work. The handiest appliance that can be made, that is at once simple and effective, is a modification of a pair of blacksmith tongs. Take a pair of tongs with somewhat broad jaws, and in place of the ordinary rivet that secures the jaws, make one that projects from one side half an inch, the projecting portion being cylindrical—in fact forming a stud or pivot. Any decent shaped pair of tongs will answer. Remove the ordinary rivet, and insert in place of it a shouldered stud confining the jaws, if you choose, by a nut, instead of rivetting the stud. The projecting portion of from half an inch to one inch in length, is to fit a hole drilled in a block secured in the tool post of the lathe in the place of the turning tool. It is evident that the tongs, as an entirety, may be instantly placed or removed, and that the jaws of the tongs may be opened and closed as usual. File one or more V scores in the jaws, from the open end back, to receive the shank of a screw. Now, with the saw and its arbour on the lathe centres, you have an efficient means of holding a screw of any size, from No. 8 wire, and even smaller, to three-eighths of an inch. Of course the height of the screw should be that of the lathe centres; in other words, the pivot of the tongs and the centre of the saw arbour should be on the same horizontal plane. In operation the screw, being secured in the jaws of the tongs, is held by the handles of the tongs in either hand of the operator, while the other hand advances the tool carriage towards the saw. When the requisite depth of nick, or score, is obtained on one edge of the screw head, elevate or depress the handle end of the tongs so that the cut will be made gradually clear across. Opening the tongs drops the screw. It is not necessary to advance or draw back the feeding screw of the lathe carriage for the next screw, if the previous one has been nicked to the proper depth. Move the carriage on the lathe slides out of range of the saw, put another screw in the jaws, elevate the handles of the tongs, bring the carriage back to place, and gradually depress the handle end as the saw does its work. Once started the work is very rapidly performed.

There is another device for holding screws for nicking in the lathe that is somewhat more elaborate, but has additional advantages. It is to make an attachment to the lathe carriage. In this case the nicking is done on the under side of the saw, instead of on the front towards the workman, and the cutting across is done by screwing in the lathe carriage. It is seldom any screws are required which are not more than one quarter of an inch in length under the head, generally more. Take a piece of flat iron one-quarter by one inch; bend it to a right angle with one arm three inches, and the other two inches. The three-inch arm is to be secured to the upper or moveable portion of the lathe carriage on the side by a screw, or it may be slotted and two screws used. The top arm is to be drilled on the portion furthest from the workman, near the other edge, to receive a rivet. The edge, or face, of the upper bend is to be cut into a V score. Now make a lever of two strips of the same kind of iron, long enough to project out to the workman's hand, where they may be connected to a handle, the distance between them to be that of the knee on the lathe carriage—one quarter of an inch. Make a rivet-hole in the further end, and connect this handle with the angle iron by a rivet, pin, or screw. Form a V slot or cut in both straps of this handle to correspond with the V cut in the edge of the angled iron. When the lever is brought towards the carriage its double surface will embrace the angle iron and the Vs will form a vice for holding a screw shank, wire rod, or small pipe. In operation the workman holds the double strap lever towards the carriage with one hand, and advances the lathe carriage transversely across the ways with the other, the screw being held securely by the fixed angled iron and the moveable double iron lever, as in a vice. This arrangement will admit of the reception of rods as long as the height of the tool carriage above the floor. The V in the fixed piece on the tool carriage may be ½in. wide at the opening and extend inward 1in. This will leave plenty of room for the rivet of the lever, which may be placed ½in. from the end of the angled iron on that side of the V furthest from the operator. The angle in the moveable piece or lever may be ½in. wide at its opening and ⅜in. deep. This will give a hold for rods or shanks from ⅜in. diameter down to $\frac{1}{16}$in., or smaller. The lever may be removed when the work is done, and the angled iron left attached to the tool carriage for future use. It will not interfere with the general uses of the lathe.

The nicking saw can also be used for cutting off rods, wire, small tubes, or pipe. Take a piece of iron of a size to fit the tool post, slot and drill a hole the size of the tube or rod to be cut, through it near the end. Insert the tube or rod, put a common lathe dog on the projecting end of the tube or rod to steady it, and advance the tool carriage to the saw. Or, if differing sizes of tubes or rods are to be cut make the hole in the block of a V shape towards the bottom, and fit a set screw from the top. This will hold the tube or rod, of whatever size, securely. If the tube is thin, a block of wood inserted under the set-screw will prevent injury to the tube. This is a very rapid way of cutting up tubes or rods into lengths, much better than clamping in a vice and using the "hack" saw. It is a handy method to cut ferrules from iron or brass pipe. Of course, in cutting iron oil should be used, and the rotation of the saw must be less rapid than in cutting brass or other softer metals.

Colour for Black Boards.—These are not stained, but are painted with ordinary black paint, care being taken not to have too much oil in the paint. An excess of oil makes the surface of paint shiny; less oil and more turpentine gives a dead or flat surface. When little oil is used, the paint requires some patent driers; otherwise sufficiency of boiled oil causes it to dry.

Mending a Watch Chain.—Rest the broken chain upon a piece of hard wood, and with the edge of a sharp penknife slightly raise one end of the outside (double) link nearest the end of the chain, keeping the thumbnail of the left hand upon it in such a manner that only one rivet is loosened in the link. Turn the chain over and loosen the corresponding end of the opposite link in the same manner. Take the chain in one hand and hold the short broken link with a pair of plyers in the other and give a sharp pull, when the piece will easily come out, leaving the free ends of the links ready to receive the inside link of the other part of the chain. Temper a sewing needle to a blue colour, and file with a smooth file until it passes easily through the holes in the links. Place the chain in position upon a piece of soft wood and join up with the needle. Press it in quite tight, then with the nippers cut off as close as possible and file off with a very smooth file until nearly level with the chain. A few taps with a small round-faced hammer will complete the job.

Putting in a Verge.—This will be found rather a delicate job by one not accustomed to turning small work. The first thing is to select a suitable verge. It should be of such a length that, when the wheel is kept up close against the brass, the bottom pallet reaches beyond the wheel just sufficient to allow of perfect freedom of the brass when pivotted in, without fear of the bottom pallet rubbing the potence, or the seat of the balance being too high. Having found a suitable verge, secure a light screw-ferrule upon it near the brass, so that the top pallet is within the ferrule, mount it in the turns, and see that the verge itself runs perfectly true. If bent it must either be straightened or replaced by another. With a pinion gauge take the size that the brass must be for the balance-spring collet to fit on tight, and proceed to turn down the brass till the gauge passes it. Re-set the pinion gauge to the size of the hole in the balance, and turn off as much as may be necessary for the seat of the balance, taking care to fit it on very tight and not too low. Remove the brass that comes through the balance with the graver, leaving only just sufficient to make a firm rivet when the balance is finally put on in its proper place. Turn the bottom pivot perfectly true with the shoulder close up to the bottom pallet, slightly run it, that is reduce the size of the turned pivot with a smooth pivot file, and fit it in its hole, burnish and round up the pivot. It is advisable now to put the balance on its seat, and stand the verge in its place, to see if the balance is the correct height, as it may be easily let on a little further if necessary before turning the top pivot. If the height is correct, turn the top pivot true, then run it slightly and burnish till it goes in its hole; finally, shorten till the endshake is correct, and round up the end quite smooth. Rivet on the balance so that the bankings are correct, and reduce the pallets to the necessary width and polish the faces.

Vs AND FLAT LATHE BEDS.

A CORRESPONDENT, writing to an American contemporary, remarks that the proof of the fact that the raised way system on engine lathes has not yet been fully developed, is shown in the many different styles, shapes, and proportions of lathe carriage guides found on our machine tools. The round-top way, the acute angled V, and the obtuse angled V, with various length and breadth of carriage bearing, are seen, and there are still not wanting reformers who would discard raised ways altogether, and substitute flat ways, and let the outside of the lathe bed form the lateral guide for the carriage.

The advantages claimed for the flat way over the V way system may be briefly summed up as follows: First, greater stiffness of carriage, consequent upon its inability to lift from its bearing on the lathe bed; second, greater wearing surface, and consequently a more durable alignment; third, an advantage of diminished deviation from alignment, due to the same amount of surface wear upon the flat way as compared to the V way.

Granting that it is not practicable to make and maintain a perfect bearing, both on the V and beneath it, for the gib, I will assert that a well-fitting carriage cannot be maintained on the flat gibbed ways, because of less wearing surface for the gibs, as compared to the surface on top of the flat ways, and because of the lever action of the feed, consequent upon the lateral guides for the carriage being so far apart. The advantage of greater wearing surface attainable with flat ways, cannot be claimed if we enlarge our obtuse angled Vs to sensible dimensions.

The most hair-splitting of all the advantages claimed for flat ways is the third one. The writer, a few years ago, was engaged in Leeds, England, and was running an imported "Yankee" lathe, when one day he was visited by an English engineer, who, after examining the lathe carefully, began to talk of the superiority of English lathes, especially in regard to their flat carriage guides. He argued in favour of English tools and flat ways, and proceeded to demonstrate that, with a V of 90 deg., for instance, the wear of a certain amount of surface dropped the carriage more than the same surface wear on a flat way, or, representing the depth of surface wear by 1, the deviation from alignment of the carriage moving on the V ways would be represented by v_2, while the other, of course, would be represented by 1. The writer claims no credit for powers of argument, but rather claims the credit due to the excellency of the tool, when he says that the same engineer afterwards ordered a similar lathe, and was much pleased with it.

Let me say right here, to anyone that is inclined to believe in the heresy of English superiority in the line of machine tools, that he is likely to find himself mistaken when he has practical experience with them. But this is a digression.

Having committed myself in favour of Vs, I will state my ideas as to the best practice in proportioning and making them.

I contend that the *front* V should be the only guide for the lathe carriage, and that it should be at least twice the size of those found on the standard lathes at present. The second V, on the front of the lathe, may be left off entirely, that the chips and grit may be frequently and easily brushed off. The back side of the lathe should have one smaller than the front one, for the alignment of the head and tail stocks, and the back side of the carriage may slide on a flat surface, and be gibbed or weighted at the back. I am in favour of making the carriage bearings extra long, and letting the carriage be heavy enough to need no weighting.

The advantages of this style of ways may be briefly stated as follows: The large front V, forming at once the top and lateral guide for the carriage, and near the point of feed propulsion, causes the carriage to move easily and strongly, and the V being raised so much will not get covered with chips and grit to so great a degree. The advantage of having the second way flat has already been spoken of, and if one V is sufficient for the carriage, it is sufficient for the head and tail stocks.

The lead screw should be on the front side of the lathe, and should be splined and used for the feed-rod also, as is the practice with our best tool makers at present.

There are many little points about the engine lathe that are not apparent to the casual observer, but which would fill volumes if fully discussed.

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To Re-tin an Iron Stew-pan.—First get it perfectly clean, and if any parts of it have entirely lost the coating of tin, these places will have to be scraped so as to get an untarnished metallic surface, otherwise the tin will not adhere. The entire part to be tinned must now be coated with flux, and either powdered salammoniac, mixed with enough water to make it adhere, or the ordinary soldering fluid—*i.e.*, muriatic acid killed with zinc—may be used. Rub the flux well over every part, and make the stew-pan hot enough to melt the tin; fuse inside the pan as much metal as is wanted to properly cover it, and distribute it over the surface by means of a little bunch of tow; let the pan cool and never re-heat it sufficiently to melt the tin again.

Cements for Engineers.—The subjoined recipes may be found useful upon occasion:—*Cement for objects which have to be heated.*—Iron filings, 100 parts; clay, 50; common salt, 10; quartz sand, 20. *Cement for fastening Iron to Stone.*—Fine iron filings, 10 parts; plaster-of-paris, 30; sal-ammoniac, half. These are mixed to a fluid paste with weak vinegar and used at once. *Cement for Iron Cisterns.*—Finest iron filings are mixed with vinegar into a paste, which is left to stand until it becomes brown; the mass is then pressed into the joints. *Fireproof Cement for Iron Pipes.*—Wrought-iron filings, 45 parts; clay, 20; china-clay, 15; common salt solution, 8. If china-clay cannot be found, fire-clay will serve the purpose instead. *Ammonia Iron Cement.*—Iron filings, 100 parts; sal-ammoniac, 2; water, 10. This cement begins to rust after some days, and becomes very strong, and is proof against water and steam. *Rust Cement for Iron.*—Wrought-iron filings, 65 parts; sal-ammoniac, 2½; sulphur (flowers), 1½; sulphuric acid, 1. The solid ingredients are mixed dry, sulphuric acid diluted with sufficient water being then added. This cement dries after two or three days, and unites with the iron, making a very resisting and solid. mass. *Cement for Filling Faults in Castings.*—Iron filings, free from rust, 10 parts; sulphur, ½; sal-ammoniac, 0.8. These are mixed with water to a thick paste, which is rammed into the "faults." This becomes strong when the iron filings are rusted. The parts which have to be cemented are treated before the operation with liquid ammonia, so as to be perfectly free from grease. *Fireproof Cement.*—(1) Iron filings, 140 parts; hydraulic lime, 20; quartz sand, 25; sal-ammoniac, 3. These are formed into a paste with vinegar, and then applied. This cement is left to dry slowly before heating. (2) Iron filings, 180 parts; lime, 45; common salt, 8. These are worked into a paste with strong vinegar. The cement must be perfectly dry before being heated. By heating it becomes stone hard.

THE USE OF GLUE FOR JOINTS.

HOW common is it for the young artisan or apprentice to fall into the error of thinking that glue is King Cure-all, regardless of the manner in which it should be applied ! This being so, some hints as to the proper use of glue will not be out of place. In the first place, the article used should by all means be a good one, and of the quality of glue every mechanic ought to be a judge. After the glue has been dissolved and brought to the proper consistency or body, according to the work to which the application is to be made, we come to the part of the work in which failures are so frequent.

The cause for this lies, not so much in the glue or the application thereof, as in having everything suitably prepared beforehand. In other words, be sure that you are ready, by having tried the work together, before you take the glue-brush in hand. If the work be mortising and tenoning, guard against their being too large for the other. Presuming that this point has been attended to, see that the temperature of the room is warm; if in cool weather, use artificial heat to bring the thermometer to 70° or 80°, if you can conveniently do so. But this depends entirely on the nature of the work. But little time should be allowed to elapse between the first spread or application and the final set—not to be moved any more at the joints until the work is dry.

The great inconvenience of chilled glue should be avoided by getting the wood to be glued first warmed up and by having the glue boiling hot. Here it will be proper to add that every factory where much glueing has to be done should have a room set apart for the special purpose, so that the temperature in cold weather may be easily brought to a high point. In finishing fine work that is mortised and tenoned together the face the work has should not be dressed off for several days after being put together, for this reason: dissolved glue contains a large percentage of water, and the glue joint dries by the wood absorbing the water from the glue ; this must of necessity expand the fibre of the wood, and if dressed off in this expanded condition, unevenness in the surface will result. This same rule is applicable to joints in the edge of boards that are glued together ; the tongue and the groove joint becomes more expanded than the square joint, and hence takes longer to dry from the simple fact that it takes in more glue.

There is a difference of opinion in regard to making edge joints in boards. Some advocate the rub joint, both pieces of which are made perfectly straight and set on without clamps. But others rightly advocate the sprung and clamped joint, holding that glue is not intended to fill holes larger than the pores of the wood ; it is, moreover, generally held that it is an impossibility to make a perfect joint without the aid of pressure. Now, what is the advantage of the clamp ? Simply this: to remove all protruding parts, and make an even, smooth surface. The clamp should therefore be liberally used for mortise and tenon as well as for edge joints.

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To remove a Screw rusted in the Wood.—Heat a poker in the fire red-hot, and put it on the screw for a minute or two ; then take the screw-driver, and you will easily get it out if you do it whilst it is warm.—J. SAVAGE.

MAKING A FISHING ROD.

I WOULD suggest, in the first place, that a ferrule joint anywhere except near the butt of the fly-rod is a great disadvantage. Every ferrule joint on a rod adds to its weight, and takes away from its throwing and killing powers by diminishing its pliability. It is no particular advantage that the rod should consist of very short pieces. Did I require a double-handed rod I should make it in two pieces, with a spliced joint to be bound up with string when required for use. The wood for such a rod should be greenheart throughout, and it would kill a 20lb. fish with the greatest ease. The only disadvantage would be that it would not throw a long line against a wind. But in ordinary weather these spliced rods (such as the "Castleconnell" rods, for example) are simply perfection. But if 7ft. joints be considered too long, the rod should be made in three equal lengths; certainly not more, if a really good article is required. In that case the bottom joint might be made with a ferrule, but the upper joint should certainly be the splice. The butt I should make of straight-grained red deal, as being lighter than ash, the middle joint of hickory, and the top one of greenheart. Some fishermen prefer about 10in. of spliced bamboo at the very tip of the rod, but I do not think you can improve upon the greenheart. The diameter of the ferrules it is impossible to give—the rod must be made first, and worked down nearly to the required pliability, and then the ferrules fitted on to the wood. The top ring should be about 3in. from the loop at the top of the rod; the second ring, 4in. from the first; the third, 5in from the second, and so on. But take care so to arrange that the rings shall not come inconveniently near the joints. Bind on the strips of brass that hold the rings with silk which has been rubbed with resin softened in turpentine. Solder your own ferrules : it is almost the only way of getting a good fit. Silver solder will do very well, and is easy to manipulate. Solder also the winch rings and butt ferrules yourself, and turn them up on a mandrel afterwards. To stain the rod a jet black boil some logwood in a pipkin, and give the joints two or three coatings of a strong solution, waiting till one is dry before the next is applied, and rubbing down *lightly* with fine glass paper or a handful of shavings after each coat. When the wood is thoroughly dry apply two coats of ordinary black ink — shellac spirit varnish is the best for finishing. Mark out your wood before sawing with a chalk line, not with a gauge. Reject such pieces of hickory or greenheart as go much out of straight when sawn out. You can, of course, straighten them by the fire, but they will be very liable to warp again when the rod is finished. Plane up the joints square till you have nearly got them down to the size you require; then octagon, and lastly with a hollow plane. While the planing down is being done, the rod should be very frequently tried. The easiest way of doing this, is to borrow from a friend a rod of the exact length and pliability that you wish to make yours. Then lay the pieces you are planing up end to end, as they will be in the finished rod, and secure the joints with short strips of wood bound firmly on with stout string. Then lay the borrowed rod by the side of your own, thus roughly put together. With the tips exactly even, pick up the two rods, and raise the points side by side to the ceiling of your room, and press them upwards. If you have not taken too much off, the borrowed rod will bend more than the one you are making, and you will see at once where you must plane away your wood to make the two equally pliable. Be careful to begin to do this at the point of the rod, and work downwards towards the butt. When you have got your wood down so that the rod is a little stiffer than you wish it to be when completed, the joints must be made and finished. Then put the rod together, and try it again with the borrowed one, and go on reducing until the two bend exactly to the same amount, through their entire lengths, when the points are pressed against the ceiling.

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Machanics are in Demand.—An American contemporary gives some interesting experiences of the death of intelligent mechanics across the herring pond. The same state of affairs is to be found at home; when will the dignity of labour assert itself over the so-called genteel pursuits? A large shoe manufacturer of the State, advertised in Boston and New York for 25 shoe-fitters to work in his factory, offering full current rates and steady work. The advertisement brought one application. About the same time a Boston firm advertised for a book-keeper, and the next day's mail brought 347 answers. During the same month on advertisement for a clerk, in a Detroit paper, brought 130 applications the first day, and a greater number of letters and personal applications the next day. An advertisement for a week in the same city, calling for a good carpenter, brought only four replies. It is altogether probable that in any considerable city in the land an advertisement for a book-keeper or retail clerk will bring 50 times as many replies as an advertisement for a fair workman in any trade. Further, it is fairly certain that, with equal capacity, industry, and thrift, the man who learns any trade will achieve a reasonable competence sooner than the man who sticks to clerking; while the chances for materially improving one's condition are more numerous in the trades than behind the counter or at the desk. Why is it then, that boys all want to be clerks? Why is it that intelligent parents encourage them in looking for a chance to "get into business," and in looking down on mechanical employment—as though there could be any calling more wretchedly mechanical than average clerking? Why is it that teachers almost invariably train their pupils to "look above" mechanical pursuits? What the country wants now is workmen—intelligent, industrious, thrifty workmen—men who can do skilfully the work that waits for the doing—who can invent new means and better processes for developing the crude resources of the land, and for converting brute matter into life-sustaining and life-enriching wealth. Mere clerks and record-keepers are at a discount: there are too many of them. And the professions, so called, are almost equally crowded with men who have nothing to do. There never was a time when ability to do something real and practical was worth so much as now. Yet our young men swarm after clerkships. Why is it, when the mechanical world offers such superior inducements to energy and intelligence?

Duplicating Fret-saw Patterns.—Those who wish to duplicate the above-named patterns find the use of impression paper sometimes tedious and inaccurate. A correspondent recommends the following method:—Take two pieces of wood of proper size, cut any number of sheets of common writing paper to the same size as the wood, place the sheets on one piece, and tack the other piece of wood to it, with the paper between. Paste your design on one side, and saw through paper and all. Saw the holes first, and then the outlines accurately; and when done you will have as many beautiful designs as you wish, with the least possible labour.

ORNAMENTAL LATHE SCREWS.

THE Council of the Amateur Mechanical Society having—as we stated to our readers in our January number—unanimously resolved that the fractional and unmanageable screw pitches at present in use should be superseded by *aliquot pitches*, proceeded on the 10th ult. to consider a report by Dr. Edmunds upon the question of screw-threads, *i.e.*, the form and cross section of the *thread* of the screw—a question which stands apart altogether from that of the *pitch* or the inclination of the thread, which, in new screws, is to be an aliquot fraction of the English inch. The report brought up by Dr. Edmunds also dealt with the ornamental lathe-mandrel in reference to the form of its face and nose, the pitch of its screw thread, and the question of its bore. After a protracted consideration of the question, the Council resolved unanimously to adopt the suggestions contained in Dr. Edmunds' report, and they recommend as follows:—

1. That all new screws for ornamental lathe-work should he pitched at an aliquot position of the English inch.

2. That the cross-section of thread should be an isosceles triangle of 50°—the apex of the triangle being flattened down or rounded off 7¼ per cent. of the pitch (more exactly 7·23 °/₀), *i.e.*, 14½ thousandths of the inch upon a finished cylinder screwed ·1 inch pitch or ten threads to the inch.

It will be seen by our mathematical readers that the thread thus defined has its altitude exactly equal to the length of its base, and therefore that, in a homogeneous material—such as steel or other metal—it will have its substance distributed in the best possible manner, in order, on the one hand, to resist deformation or stripping, and, on the other, to endure the wear and tear of frequent fixing and unfixing. Dr. Edmunds's thread will also have the unique advantage that its pitch is equal to its depth, and therefore that, without reference to a complicated table or a trigonometrical calculation, the extent to which the shaft of the screw is incised by the groove of the thread is seen at once by its pitch. The altitude of this truncated triangular thread being exactly equal to the length of its base; the length of the base of the thread expresses also its pitch and its depth. Therefore, upon a shaft screwed (say) ten threads to the inch, the pitch—*i.e.*, one-tenth of an inch—giving the length of the base of the thread, gives also the depth of the groove by which the radius of the shaft is shortened. The tensile strength, the resistance to torsion, and the resistance to deflection which remains in the shaft after the screw thread has been cut upon it, are thus easily seen. In callipering a bolt for this screw-thread, twice the radial shortening has to be allowed for diametrical diminution, while the truncation of the tops of the threads leaves the very bottom of the groove unoccupied and permits of a slight rounding-off of the tool-point—a fact which will further recommend this thread to skilled mechanicians for scientific purposes.

To give a practical example, we take the new mandrel-nose hereafter further described, which is ·9in. long over all, ·9in. in diameter outside its finished screw thread, with a cylindrical base of ·15in., finished ·95in. in diameter—one-fortieth of an inch in radius beyond the tops of the screw thread, and ten threads to the inch. Having turned up a cylinder 1· inch in diameter, and bored this out ·375 inch as accurate in bore and finish as a rifle—the cylinder for the nose being left, say 1·5 inch long—we finish off the first ·15 inch at the base of the mandrel-nose to a true cylinder, exactly ·95 inch in diameter.

The next ·75 inch we finish off to a true cylinder of exactly ·9 inch in diameter. The next ·2 inch we finish off to ·9145 inch in diameter. The next ·2 inch we cut down and finish off to ·7145 inch in diameter, and the last ·2 inch to ·7 inch in diameter. The first short cylinder, at the base ·15 inch in length, is left ·95 inch in diameter in place of the groove which has hitherto been turned out at the base of the nose, and which has had the same effect in weakening the mandrel-nose that cutting a corresponding groove round the base of a tree would have upon the strength of its trunk. This short cylinder will in future give vastly increased strength to the base of the mandrel-nose, and, at the same time, will serve as a true cylinder upon which chucks may be centred so accurately that, as Dr. Edmunds thinks, mandrels may hereafter be made interchangeable with regard to important and valuable chucks which have been fitted with proper accuracy, just as modern high-power objectives are now interchangeable with regard to the screwed noses of microscopes.

Now an accurately drawn diagram of the screw thread and mandrel-nose, already defined, will show that we have to obtain a finished nose, which, when its thread is accurately truncated, is exactly ·9 inch in diameter outside the thread. Therefore, the second cylinder, ·9 inch in diameter and ·75 inch in length, represents the screwed portion of the nose; if the thread, instead of being cut up to a sharp edge and subsequently truncated 7½ per cent., be left with original surface of the finished cylinder to form the truncated tops of the threads, and in this way a finer surface and more accurate callipering of the diameter outside the thread can probably be secured. The third cylinder, ·2 inch in length and ·9145 in diameter, represents the cylinder on which the thread should cut up absolutely sharp, and this is to be a gauge by which the thread is cut on the second cylinder. The fourth cylinder, ·2 in length and ·7145 inch in diameter, represents the solid stem of the screw shaft, ·7 inch in diameter, *plus* the ·0145 inch, which, having been truncated from the tops of the threads, will not require to be incised upon the shafts, and therefore is to be used as a working margin for gauging the bottom of the thread. The fifth cylinder, ·2 inch in length and ·7 inch in diameter, represents the stem which must be left absolutely intact in cutting the thread. In these four cylinders we therefore have the top and the bottom of the thread in original plan, and as left finished, shown side by side, and serving to gauge each other within the last limits of mechanical accuracy.

Upon the base thus prepared for screwing the nose, a set of accurately-made cutters is to be used, for cutting the thread of the mandrel-nose—the last cutter having only a single tooth, finished accurately to 50°, and rounded off at the point 7 per cent. of the pitch, which, for a one-tenth inch pitch, amounts to ·007 inch. The first two or three cutters must also have been ground with approximate accuracy to 50° angle, but they must not have cut the thread up quite sharp upon the ·9145 cylinder, nor must they have trenched at all upon the ·7145 cylinder. The final single toothed cutter, in perfect order, must then be adjusted upon the slide-rest, so that in revolving, it just makes a barely perceptible trace with its rounded point upon the ·7145 cylinder; and then being traversed accurately and slowly upon the edge of the first cylinder, by means of the spiral apparatus or screw-lathe, the thread will be finished. On examination, the ·7 inch cylinder must appear intact, the ·7145 inch cylinder just perceptibly grooved by the point of the tool, the ·9145 inch cylinder cut up to an absolutely sharp edge, the ·9 inch cylinder cut up with a beautiful plane-top just sufficing to prevent its easily bruising. The end of the ·95 cylinder must not be broken in upon. The cutter leaves no trailing-off thread to weaken the base uselessly, but enables the groove to be cut out fully to the last fraction. The chuck-screw thread must correspond, and begin with a blunt-full end inside the ·95 hollow cylinder, which is to engage with the short solid cylinder at the base of the mandrel-nose, and the entry of which will be facilitated by a slight rounding-off of the sharp edge inside the base of the chuck.

From this interesting example of an exercise in scientific screw-cutting, it will be seen that, with Dr. Edmunds' thread of exactly 50° flattened down 7½ per cent. of its pitch, the ten-thread screw encroaches upon the radius of the shaft by one-tenth of an inch, and lessens its diametrical measurement by two-tenths of an inch. In the same way it will at once be seen that a screw of 30 threads encroaches upon the radius of the shaft by one-thirtieth of an inch, and lessens its diametrical measurement by one-fifteenth of an inch. Similarly with every screw, the mere number of threads per inch gives all the data both of screw thread and of shaft. This simplification will be of great importance in scientific and amateur work. This thread is easily and accurately cut by a point 50°, and fixed on a level with the centre of the shaft to be screwed.

3. That the ornamental mandrel-nose and back-poppet cylinder screw be pitched at ten threads to the inch.

4. That the base of the nose of the mandrel, instead of being grooved out as at present in the Holtzapffel lathe, be a cylinder larger in diameter than the screwed portion of the mandrel-nose.

The only reason, we believe, why the ornamental lathe mandrel is still turned out into a groove at its base, is, that it was so done by Mr. Holtzapffel's grandfather. Probably at that time, when the nose had to be screwed by hand, this was an unavoidable defect, but by the method of Dr. Edmunds, which we have described above, and with the aid of the spiral or screw-lathe wheels to guide the tool, there is no necessity whatever to maintain this defective construction. Two cases were mentioned to the Council of the Amateur Mechanical Society, in which finely executed lathe-mandrels, constructed on this plan by Holtzapffel, have had their noses broken off, and when we consider that the ornamental lathe mandrel-nose is virtually the basis upon which hundreds of pounds' worth of costly ornamental chucks and other apparatus is gradually built up, it is clear that no pains ought to be spared to make the mandrel a model of mechanical proportion, and of artistic skill.

Several models of mandrel-noses, executed by Dr. Edmunds, upon the method we have already described, were placed before the Council for examination, and we append dimensions of the mandrel-nose and face, which Dr. Edmunds recommends for the ornamental lathe. The face is much larger than at present, being 1·75 inch in diameter, and giving a clear face bearing of ·4 inch outside the ·95 inch. base of the mandrel-nose, which we have already described. The end of the nose is coned out at 15° from its axis to a base of ·5 inch wide. Into this hollow cone conical-cylindrical chucks will be held by a tubular steel-screw passing in from behind as is at present done in the watch-lathe. For many delicate purposes such chucks will be very useful, and can easily be made in great variety. The centre point also will fit into this cone for all work not of extraordinary weight. Dr. Edmunds pointed out that for wooden chucks the extended face-bearing would be of great value, while for metal chucks it might be more or less fully occupied according to the weight of the chuck, and the accuracy of fit required. Dr. Edmunds urged that it was inexcusable folly to shirk the expenditure of one or even two days' extra labour in finishing a mandrel-nose and face up to the level of a Withworth guage; and, arguing that, as long as things that were equal to each other were each equal to a third, there was no reason why duplicate and interchangeable mandrel-noses and chucks should not be made with as much certainity as Whitworth cylinder guages or surface plates. Finally, Dr. Edmunds showed that for the sake of durability, all wearing surfaces that could be hardened without lessening the strength of the mandrel-nose should be left hard, and he thought that by the skilful use of emery wheels, the face and cylinder-base of the nose could easily be finished off so as to be left quite hard up on the surface. The same could certainly be done with the extreme end of the mandrel-nose which, he advised, should have its thread ground off at an angle of 45° with the axis of the mandrel, but so as to leave intact the end of the stem cylinder ·7 inch in diameter. As to the tips of the thread upon the cylinder of the mandrel nose, he thought there would also be no insuperable difficulty in tipping them down by the emery wheel, after cutting them up to a sharp edge upon a .9145 cylinder, and so managing as to have these fairly hard upon their outsides. But on this point we had not yet had time to make practical experiments.

We are indebted to Dr. Edmunds' private notes for the substance of the above, and shall give the interesting subject further consideration, with diagrams, at an early date.

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Lacquering Brass.—When properly lacquered, brass work will retain its colour, and resist the action of the atmosphere for a long time; hence the necessity of always lacquering work which should retain a good appearance. The process is rather difficult to execute properly, especially on large surfaces, where the tyro will find the lacquer continually getting a smeary look. Before applying the lacquer the brass must be heated to a certain degree, and the difficulty is to know the exact degree best suited to the particular lacquers and materials used, and the effect to be produced; this kind of knowledge cannot be attained but by experience. If you do not feel disposed to prepare the surfaces of your work by means of filing, &c., another plan, far easier and equally effective, though not producing such a workmanlike job, is the following:—Put the brass work, having previously taken it to pieces as much as possible, into pickle, made of nitric acid and water; this will eat away the outer coat, all the corrosion, and all lacquer, leaving a surface of pure brass. The time required to effect this and the strength of the pickle can be soon ascertained by trial. The work must be carried on in the open air, as the fumes given off are very baneful to health. Thoroughly wash the articles to remove all traces of acid, and then dry them in hot sawdust; they will then be ready for lacquering. Use a camel's-hair brush to lay on the lacquer with, heat the articles as hot as may be held in the hand; be careful not to touch the bright surface with anything that will stain it, and lay on the lacquer as thinly as possible to prevent smears. If the work is too hot it will burn the lacquer, and if too cold this will not set hard. Small thin articles part with a large proportion of their heat in laying on the lacquer, but bulky work is comparatively unaffected; so small articles must be made somewhat hotter than large before lacquering. Only experience will enable you to judge correctly.

CABINET WORK.

NOTES ON MATERIAL AND TOOLS.

WE hear a good bit about amateur carpentry and the amateur carpenter, but, as a matter of fact, amateurs seldom do any carpenters' work, which consists of designing and making roofs and staircases, fixing rafters and laying floors. The joiner's work consists of making doors and sashes, window shutters and panelling. The cabinet-maker deals with hard and fancy woods, and it is in this direction that the amateur usually finds delight—in making boxes, desks, cabinets, and other useful articles. The charm the working of wood possesses for the human mind is wonderful. Almost all boys, as soon as they can walk, want knives to hack wood with, and it is as imperative that a boy should have his tool chest as that a girl should have a work-box. But in after-life leisure is but too often wanting to continue the art, though it is still pursued, in some cases, under extraordinary difficulties. One dear old bachelor is in our remembrance, who, having spent many summer evenings in making a work-box out of a remarkably handsome piece of wood, finally covered it with glazed note paper to hide all defects.

The fascination of cabinet-making is not limited to any class, but extends to all. Many sovereigns at different times have practised it. Peter the Great of Russia is an example; the present Sultan of Turkey is another. A most distinguished Englishman may be added to the list. The present Lord Derby, when Lord Stanley, cut his hand severely in cabinet-making, an occupation which he now so successfully carries on in a slightly different manner.

With such a demand for information, one would suppose there would be a corresponding supply; such, however, is not the case. Numerous books exist on the subject, but none seem to have hit the mark. The men that know their subject cannot write of it; perhaps, if they can, they do not think it to their advantage—if they do teach, practical lessons pay the best.

Under these circumstances a few hints of a thoroughly practical nature, in which to describe the different woods and their properties, for what work best suited; the tools, how to use and how to keep them in order; minute directions for making certain small articles, in which all processes are gone through, as in larger pieces of furniture, and a few designs and general directions for these will be acceptable; but a man will not become a cabinet-maker unless he is able to make his own designs.

Of all wood in use in cabinet-making mahogany stands at the head. It is suitable for almost all descriptions of work; free from knots; less liable to warp than any other woods. It is kept in stock at most wood-yards, and one peculiar thing recommends it—it can be obtained in pieces very long and wide. Some excellent examples of these latter desiderata may be seen in the dado of the reception room at Grosvenor House. The doors there also are fine examples of work in mahogany, especially the *old* doors. This leads us to the remark that there is mahogany *and* mahogany. The two principal divisions of mahogany are Cuban and Honduras mahogany.

The price of Honduras is from 6d. to 10d. per ft. 1in. thick; Spanish commences at 1s. 4d., and advances, according to the beauty of the grain, to 16s. per ft., the more expensive kinds being usually cut for veneers. To attain success in cabinet-making, well-seasoned wood *must* be obtained. For pianos for hot countries the wood is frequently kept from fifteen to twenty years before being used.

Mahogany, which now seems so necessary, has only been in use about 150 years. Before that oak was used instead, but its use now seems to be declining. Twenty or thirty years ago bed-room furniture was generally mahogany ; now bedsteads are iron, and deal and birch are more used for the other articles, while for drawing-room furniture walnut is used as frequently as mahogany, and there is a tendency to return to oak for hall, dining-room, and library furniture. Mahogany, on the other hand, is more used in ship building, many boats and launches being built of that wood.

It would be difficult to enumerate the uses to which mahogany may be applied, but one or two instances may be given of what it is unsuitable for. Picture frames should not be made of mahogany. Any fine carving should not be attempted in the wood, though it answers admirably for scrolls, &c., in ordinary furniture. Where weight is an inconvenience, as for travelling boxes, it had better not be used.

We will now proceed with the tools. It will be a convenient method to do so in alphabetical order.

The axe consists of an iron head fixed on a handle of wood; the head consists of a socket, to receive the handle, and a flat piece of iron with a steel edge, of a somewhat triangular shape; there is a basil on one or both sides, the edge being convex. The basil is a term used to express the abrupt slanting off of a metallic surface, by which an edge is formed, and at the same time strength gained; a knife may be brought to an edge without a basil, the blade becoming thinner from back to edge, but the edge so formed, though sharp, is not strong ; the shorter the basil the greater strength the edge has. The handle of the axe is made usually of ash ; it is not straight, but curves upward at the part where it is held by the hand.

This tool is not much used in cabinet-making, but it serves to roughly shape a mass of wood. If a piece of wood is to be turned the axe is used to cut off the angles, and it may also be used to reduce to a certain form a block of wood that is to be carved. Axes are sold by weight, at about 1s. per lb.; a small one only is required, and, indeed, this may be dispensed with ; all that the axe is used for may be accomplished with a large chisel and mallet.

The auger is a tool used to bore holes in wood, such holes requiring to be of some considerable depth and size. It consists of a rod of steel, having a round eye one end, through which a round handle fits at right angles ; at the other end is a spiral twist of larger diameter, terminating in a conical screw with a sharp point; the edge of the spiral is sharp, and cuts the wood. When using this tool, most power is obtained by standing over the work and boring downwards; a little grease should be used with it. Augers are not much used in cabinet-making; a small auger is sometimes fitted to the stock or brace, and this is sufficient for most purposes in cabinet-making. Augers are made from ⅜in. to 2in. in diameter; the most useful sizes for general use are the ⅜in. and the ⅝in.; the price of the ⅜in. is about 1s. 8d., of the ⅝in. 2s.

The awl, or bradawl, is a round piece of steel, having at one end a shoulder and a tang, that is fastened into a handle of wood; at the other end a double basil brought to a short edge. The bradawl varies in diameter from the size of a needle to ¼in., or more. The bradawl makes a round hole in wood; it does not remove the wood, but the wood around the opening is compressed, which is an advantage when a nail is to be driven in. Bradawls should be kept sharp; when being used they should be pressed against the work, and worked to and fro circularly at the same time ; the holes are used for brads, small nails, and screws. Bradawls are sold, all sizes at 9d. per dozen, without handles, the handles being about 1d. each.

The brace is a tool made of iron or iron and wood, or of wood only, with brass where greater strength is required. The use of the brace is to rotate certain small tools, called bits, that fit in one end. The cabinet-maker's brace should be made of wood; it consists of a semicircular crank of wood, octagonal in section, having a round portion in the centre to act as a handle; at either end of the crank is a short piece at right angles with the crank, but in a line with one another, so as to form an axis. One end has a brass plate on it, and a steel rod terminated by a ball in the axis of the tool. This rod, with the ball at the end, is inserted into the centre of a round flat nob of wood faced with brass, called the cap, turning freely on the steel rod, and being prevented from coming off by the ball, the two surfaces of brass being separated by a disc of iron that turns freely. At the other end of the brace there is a square steel socket in the axis of the tool, this end being called the nose. A spring catch is on one side that fits into a notch filed in the bits.

The brace is one of the most useful tools, and from the variety of bits that can be adopted to it, it serves many purposes. It serves to bore holes for nails, screws, or pegs. It cuts circular holes, such as the circles for coins in coin cabinets, or for bottles in chemical cabinets, or for test-tube stands ; circles may also be used as ornaments, a cut being occasionally made in them, Wood may be also cut away in roughing out carving, frequently more quickly and certainly, by the aid of a brace and bits, than by any other means. Mortises are often better cut in thin wood by first boring away the centre ; such a proceeding prevents splitting. Braces are sold separately, or with 12, 18, 24, 36, or 48 bits ; the bits being either bright, black, or straw-coloured, the last being the most expensive, but no better for use than the black, except that in bright bits you can at once see if they are free from flaws. It is better to buy the bits with the brace, as they are more truly centred than those bought separate, and the centreing of the bits is essential to their proper action. To see if centred, fix the brace, with the bit in, in a vice by the head or cap ; then rotate the brace, and observe if the bit turns concentric. The brace can be used in an upright position or horizontally. The greatest force is obtained in the latter position, holding the cap with the left hand, and pressing with the stomach, leaning the weight against the tool. For the upright position the work should be low, so that the operator may lean a little over the top of the brace, and, holding the cap in the palm of the right hand, press on the back of the hand with the right shoulder and turn with the left hand. It is quite possible to break a brace by pressing on it too strongly. If of iron, the iron may bend, and this is one of the disadvantages of iron braces, for if bent the tool is made eccentric immediately. The bits for the brace are shell bits, straight pieces with a crescentic action, like a gouge, but semi-circular. Sometimes the end is brought to a point, forming what is called a spoon shell. If the bit has a sharp-cutting tooth at the end it is called a nose bit, and a parallel nose bit, the same thickness to the shank, the edges being quite parallel, is a sash borer. The centre bit is one of the most useful bits; it is made to bore from ⅛ to 3in. or more. It has a centre pin on which it revolves, and a cutting tooth or nicker one side, and a lip that cuts away the wood on the other. The pin is not quite in the centre; the circle cut is of larger diameter than the width of the tool, so if any hole is to be cut of a certain size, measure the distance between the nicker and centre pin of the centre bit, but not from the extreme point of the centre pin, because that is longer than the other, and so you will get an oblique measurement. The surest way to be exact is to bore a hole in a piece of waste wood similar to the kind you are at work on, and then you will be right. The large centre bits have two or even three nicker teeth on the one side, about ⅛in. apart; these bits are expensive. If it is required to cut circles out of thin wood, such as for a cabinet for bottles of greater diameter than 3in., they may be cut by a tool like the knife of a cutting gauge, fixed to an arm that rotates on a pivot fixed on a block of wood acting like beam compasses. In boring with centre bits see that the chips rise out of the hole; if not, remove the tool and shake out the pieces, for the chips may wedge against the tool, when the hole will run all on one side or the bit be broken. In boring with fine bits use a little grease pull out the bit and remove the core occasionally; if it gets fixed take off the brace and pull out with pincers. All boring tools may be heated, to spoil their temper when in use. Countersinkers are of two kinds, one with the point like a drill, the other a cone, cut with converging furrows and called a rose head; this is used for wood, the other, like a drill for metal, on iron or brass only; they are useful to the cabinet-maker to sink the holes for screws in locks, and other brass work, so that the heads of the screws fit them accurately. A new form of countersink for wood only has lately been introduced. It consists of a brass cone with a projecting knife; at the side, fixed to the shaft, is a stop adjustable by a small screw, that regulates the depth it goes. Screwdriver bits are useful, and one, at least, should always be included in a set; the leverage of the brace is great; for turning long screws, the fatigue is much less. Old screws may easily be taken out that seem immovable with an ordinary screwdriver. A forked screwdriver bit, with a notch in the middle, for use with nuts, in which the screw projects, as in saw handles, is contained in a complete set, but it is not often required. Drills: One or two drills are necessary. They may often be used on wood, where other borers, as awls or gimlets, would split the wood. The American twist drills are excellent for this, but cannot be held in the ordinary brace. In the American chuck brace they may be used. Rimer bit, a tool for enlarging holes that, for wood, consists of a hollow tapering semicircular piece of steel coming to a sharp point. For iron or brass, a tapering steel rod, usually square in section, is used. Auger bits consist of a shank, then a piece twisted into a spiral and a tapering screw point; the end of the spiral is filed on either side of the screw to a sharp cutting edge, a small piece at the extreme outside being left to form a tooth on either side, which cut a clean circle. They bore well in the direction of the grain of the wood, which centre bits in most woods will not, unless they have a screw in place of the pin. The most useful bits are the ⅜ and ⅝, the price of which is about 1s. 6d. and 2s. 6d. One or two special bits will be mentioned to complete the list. Dowelling bit, used by table-makers to make the holes for the pegs in the leaves of tables; also by coopers to join the heads of casks. It is similar to a spoon bit, but shorter, and with a round point. Clarke expanding bit is useful when a number of various sized holes have to be bored. It is about 10in. long, and works as a centre bit, the wings shifting, and being fixed by screws, and having a divided scale to show the size. They are expensive, costing about 11s., and require to be used with great care. Taps are occasionally fitted to the brace, but there is little advantage in this, though it is perhaps convenient to have small taps for wood so fitted. A good selection of 24 bits would be 14 centre bits from 3/16in. to ¾in. by 16ths. ⅞in., 1¼in., 1½in.; 2 sash bits with collars, 2 rimers, 1 screwdriver, 1 rose head countersink, 3 pin bits.

The American chuck brace demands a few words. It is an iron brace with a hard wood cap and handle; the chief difference is in the nose, which, instead of being solid with the rest, is connected by an axis, and is turned by a ratchet, of which there are two, so that it can be turned in either direction. If this brace is to be used in a corner where the ordinary brace will not turn, this ratchet is a decided advantage. The chuck which holds the tools consists of two flat jaws joined at the back by a wire spring, and forming a portion of a cone on their edges, over which a hollow cone cap screws, and as this is turned the jaws open or close and centre the tool accurately. But sometimes it requires a long time to accomplish this; however, it holds the Morse drills fairly well. It is a useful tool to have in addition to the ordinary stocks; the price is about 10s. The ordinary wood stock costs about 9s.; if plated with brass and a hard wood, about 15s.; all bits 4½d. each; centre bits above 1in. increase rapidly in price, a 3in. costs about 3s.; the rose head is 8d.; large ones more; the sash bits are 8d. also. Bits as a rule do not require sharpening; if slightly notched they may be repaired with a sharp file. The pin of centre bits may be repointed if the point is blunt—observe the section is triangular. Sharpen the nicker if necessary from the inner side.

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Gilding Ivory.—Ivory is not so easy to gild as articles made of wood: wood, being porous, retains a portion of the gold size; yet, on the other hand, bone or ivory may be so gilt that it shall resemble gold. Free the ivory from dirt or grease; when quite dry, give the article a thin coat of gold size laid on evenly with a fine hair brush; lay aside until set, which may be known by feeling whether tacky to the finger. The gold size should be just the least warm; the article may, with advantage, be warmed before applying the gold size; great care must be used to keep the dust from the article until gilt and quite dry. Cut the gold leaf in suitable-sized pieces, and apply with the tip; the gold leaf may then be pressed into shape with a piece of white wool. Should any part appear not gilt, apply a dab of gold size, then a piece of gold leaf. When quite dry, it may be burnished with an ivory paper knife, or even a glass penholder, always inserting a piece of tissue paper between the burnisher and the article to be gilt. When finished off, the appearance will be much improved by giving the article a coat of gold lacquer.

Dipping Brass Work.—The best method of cleaning old brass work is by "dipping." The pickle consists of nitric acid, diluted with water. The brass work is dipped in the acid, which quickly dissolves the metal, leaving a bright untarnished surface. After dipping, the brass is swilled in clean water to arrest the action of the acid. The operation of dipping in acid and swilling is repeated till the surface of the metal is considered to be thoroughly clean and bright; after the last swilling the brass work is dried in hot sawdust, after which it is finally lacquered with gold lacquer. The surface as left from the action of the acid, will, when lacquered, present the dull polished surface; the bright parts are got up so by the aid of a steel burnisher, applied before the lacquer of course. The brass work will have to be warmed for lacquering, as usual, and the process is just the same.

LATHE OVERHEADS.

By Rev. J. Lukin, B.A.

(For Illustrations see Lithograph Supplements.)

NO lathe can be considered complete until it has been fitted with an "overhead," the uses of which are many and various. A complete overhead converts an ordinary lathe into a self-acting or screw-cutting one; but apart from this there are much simpler contrivances which enable the workman to drive revolving cutters, drills, and saws for the purpose of grooving slotting mouldings and ornamenting work held in a chuck or between centres. The capabilities of a lathe are therefore vastly extended by this addition, and it becomes easy by its aid to shape accurately many-sided work, as well as that which is circular. The simplest overhead consists of a set of adjustable pulleys, generally two pairs, of which one is placed over the mandrel pulley, while the second pair is adjustable and can be fixed over any part of the lathe bed, and shifted at pleasure. It will not answer merely to screw the pulleys into the ceiling or into a beam over the lathe bed, because means must be found for keeping up the tension of the cord, the length of which varies according to the position of the slide-rest and size of the pulleys attached to the revolving spindle of the apparatus. For any one special job, however, such fixed pulleys may be made serviceable. It will probably occur at once to the mind of the reader that the easiest way to secure tension will be to suspend the pulleys by elastic cords, and such will answer fairly well; but for reasons to be stated presently they will not prove in all cases the most satisfactory method. At the same time, in writing specially for amateurs, I would suggest the propriety of pressing into service all and every kind of material that may be at hand, and to learn to adapt to a special purpose when necessary odds and ends of various materials which gradually accumulate in the workshop or in the house. To be brought up "all standing," as a sailor would say, because some requisite is not at hand, is the mark of an amateur destitute of resource and ingenuity, and to be able to meet an accidental emergency with skill and prompitude bespeaks a true workman. To begin with the simplest device of the kind, let a horizontal bar of iron, fig. 1, A, be fixed securely at a convenient height above the lathe bed; let it be a flat bar set on edge, and let the upper edge have a number of notches filed along it about half an inch apart and a quarter of an inch deep. Tie at the two ends of an india-rubber door-spring a pulley, such as can be bought of any ironmonger for 2d. or 3d. Do the same with a second door-spring, and hang them across the bar in such of the notches as will bring them into the desired position over mandrel and lathe bed. If the bottom of the notches are rounded off, the india-rubber will not be cut, and will last a long time. Another plan is to use four springs instead of two, tying pulleys to one end of each, and tying the other ends together with cord or wire, or linking them by a stout ring passed through the brass eyes of the springs. The sole object in this kind of overhead is to arrange fair-leaders or guide-pulleys to direct the cord from the fly-wheel of the lathe to the rotating cutter held in the slide-rest. The strain upon this cord requires to be considerable for driving such a tool as a milling cutter, for metal, while for ornamental work it may be much less, and these door-springs, some of which are very strong, will suffice. The pulleys will take up a position regulated by the direction of the tension, but will more or less draw towards each other, and will not in any case hang perpendicularly from the iron bar. Hence the necessity for the notches to prevent the cords or rubbers from sliding along the bar. Pulleys held thus by cords or lengths of elastic adjust themselves better than when they are made to run in orthodox brass bearings, and the lathe cord is, therefore, less liable to be fretted and worn out. I have, in place of the above, in an emergency screwed four pulleys, B, into an overhead beam just where needed, but there is here great difficulty in the management of tension. I generally have a 3in. plank overhead resting in a couple of supports to take anything requiring to be thus fixed. It often proves handy. Fig. 2 shows another ot these unorthodox expedients, not, I think, in reality better, a little more troublesome to make, but just one degree more *en regle*. In this case the support is a round bar, preferably with nuts and screws, or at any rate shouldered by the reduction of the metal where it passes through a pair of brackets which attach it to the ceiling joist, or to such a plank as I have just spoken of. A pair of slides of wood or metal, B, with clamping screw at the top, enable the pulleys to be placed in position. These are as before slung by india-rubber door-springs. The best way to do this is to saw and chisel out a pair of recesses or notches to receive the brass eyes of the springs, and to run a bit of steel rod through from side to side. Another way is to bore holes, as shown at C; knot two bits of stout cord or gut into them, and to these attach the india-rubbers. All this may and ought to be neatly done, for though we may be often driven to inferior expedients, we should use them in a workmanlike manner, and when we have so fitted them, we shall often find ourselves sticking to what we at first meant to replace by some so-called superior contrivance. I have known an amateur, who may be labelled A1, using these pulleys screwed, not into the ceiling, but into a carpenter's bench brought up to the back of the lathe and adjusted to keep the cord tight, and with this simple appliance he has grooved large taps with a revolving cutter or mill in far better style than many of the bought ones. I mention it to show what a first-rate workman will use in the way of unorthodox appliances. The iron wire pins of these pulleys should always be driven out and replaced by steel ones of larger size, the holes being broached out to receive them. In speaking, however, of makeshifts, and home-made appliances, of which I may in all probability write frequently, I wish at once to explain that I am not disparaging or crying down orthodox lathe fittings and tools. These are in many cases far superior to any that can be rigged up at home (just as I would not myself counsel anyone to fit up the lathe illustrated in our last number, if one of ordinary design is to be had—I doubt if it would be even cheaper to make). But very often home appliances are matters of necessity, and if they will answer the intended purpose as well as more costly apparatus, it is not easy to see why they must be rejected; and they certainly are *not* rejected by practical mechanics.

We will now approach a step nearer to the orthodox. In fig. 3 the overhead bar is no longer a fixture, but is pivotted near one end to the upright A. This upright is of stout iron, ⅞ to 1 inch, and is fixed to the standard of the lathe, or from floor to ceiling, so as to be capable of revolution on its own axis to a certain extent. It may pass through a pair of eye-bolts, for instance, B, fixed to the lathe standards. This permits the whole gallows to swing round over the lathe bed or at any angle to it to assist in its adjustment. If, too, owing to the low ceiling, the overhead is not much above the lathe bed, this movement allows the whole to be swung out of the way of the workman's head when not in use. I have sometimes found this very handy. The upper part of this upright rod should be made into a fork, in which the horizontal arm can be pivotted, and if a flat bar is used there may be a row of holes for the pivot, either of which may be used at pleasure to increase or diminish the leverage. If orthodox sliding double pulleys are used, as is the case in bought apparatus, the swinging bar is usually round, and turned up bright, and the pulleys are of gun metal. But the suspended ones, made as before, but with gut instead of india rubber, will answer just as well; and as in their case the actual pulleys can turn about in all directions, and are self-adjusting, they have a decided advantage of their own. Nevertheless here is room for choice, and if cords offend the eye, I have no doubt that the pulleys and their sliding blocks can be had finished or in the rough from some one or more of our accommodating lathe makers. Many of these makers have, of late, adopted the custom of selling castings of apparatus for amateurs to work up themselves, and will send working drawings too. This has sensibly broken through established custom, helped amateurs, and no doubt also pays the manufacturer—at any rate I hope it does so—as I do not see why he should be good-natured for nothing, I think, therefore, I may say that the pulleys, or any part of this overhead, are procurable separately, or the whole concern in a complete state by those who prefer to pay for it. It will be self-evident that an overhead of the above kind will be of limited application, and it is indeed solely used for driving rotary cutters. Tension is maintained by a weight suspended from the short end of the lever, and it will surprise the amateur to find what a heavy weight is needed to keep all taut. For this reason it should be suspended so as to hang but a little off the floor, in case of a mishap. The length of cord required for the overhead is somewhat of a drawback, and so is practically the lever arm itself, with its counterpoise; but when it is once arranged for work with plenty of tension on, and the pulleys oiled and nicely adjusted, the whole apparatus will work admirably, and it is on the whole about the best where expense is an object, and where no more is needed than means to drive at a great rate revolving cutters and ornamental drills. I have also used it to drive an emery wheel mounted on the lathe centrés as on two dead centres, instead of using the mandrel in the usual way. Greatest speed is obtained, which is of importance in emery wheel grinding. We now pass to overheads, in which at least two cords are used, and which are capable of far wider application than those with a mere swinging arm and pulleys. In this arrangement, when in its simplest form, there are two upright standards attached to the lathe-bed, with bearings at the top for brasses, in which runs an axle parallel to the lathe-bed, carrying either variously-sized pulleys or sometimes one pulley like that on the mandrel, and a mahogany roller in place of any others. The standards require to be braced by a tie-bar, or by two, if they are high and slender. Mr. Hines uses cast iron ones of a light and elegant kind, with bearings of white metal. The Britannia Co., in the advertisement sheet of this paper, illustrate an overhead with round bar standards. Sometimes none are used, but a pair of cast iron hanging brackets affixed to the ceiling or overhead beam carry the axle of the pulleys, and this is in reality the better plan where it can be so arranged. I think I remember seeing in a catalogue of Churchill's that such brackets are sold there with the bar for axle turned and fitted, with or without the pulley and roller. Fig. 4 will sufficiently illustrate this apparatus. The pulleys must be bushed with brass tube and slide along the axle, to which they can be fixed by hollow keys, which saves the nuisance of having to file a flat all along it, or still worse, to make a slot, or fix a feather. The hollow back key is simply an ordinary one filed out lengthwise on the back with a rat-tail file, to make it fit nicely the convex surface of the bar. For a light shaft this answers well, but it would slip under a heavy strain.

In using this overhead we at once obtain a vastly extended range of speeds; and we can now drive with a cord to the pulley of the upper shaft from the fly-wheel, or from the mandrel; and we can take a second cord from the top roller or second pulley to one fitted to the screw of the slide-rest, which then becomes self-acting; the rate varying according to the sizes of the pulleys on the shafts. At first sight such an overhead appears to provide all that can be needed in the way of driving apparatus, but the real limit of its use is soon made evident in practice, and the addition of a second shaft parallel to the first is sure to be called for. By this second shaft much can be done which a single shaft renders impossible. For instance, one shaft driven from the fly-wheel may be geared by its second pulley to a revolving cutter, acting upon a cylinder turned and mounted between centres, or otherwise chucked. The second cord may pass from the mandrel to the supplementary shaft, and thence down to a pulley on the slide-rest screw, causing the cutter to traverse longitudinally along the work while it slowly revolves. In this way are cut variously shaped spirals in ivory and hardwood, and as the cutter is a revolving one, worked at a tremendous pace, soft wood may be manipulated as well as hard. If the respective speeds are right and a small disc is driven with a V shaped edge cut into teeth, a very perfect screw of any desired pitch can be thus cut in soft wood, which is difficult to manage at slow speed except with a keenly sharpened V tool and with special apparatus to guide it. The V tool can also be used here Details of screwing, however, I am not now speaking about. The range of speeds attainable by two shafts is very much increased in comparison with that which can be managed with a single one, and there is very little shifting of cords, or rather change of cords, required. The second shaft is carried in a frame pivotted on the screws or bearings of the first, so that the two remain equi-distant as this frame swings round to bring the rollers and pulleys into position, consequently if the pulleys which gear with one another are stopped alike but put on in opposite directions, the small end of one opposite the large end of the other, the same cords can be used from step to step with both pairs and yet a good range of speeds compassed. Fig. 5 represents this overhead in front and profile. It is not difficult to make, and well worth the trouble; the cost will depend upon the way in which the work is carried out. Suppose a roller to be used instead of a pulley, it should be of mahogany capped with brass, the latter enabling it to be fitted on with keys as if wholly of metal. Wood pulleys bushed are more satisfactory than metal ones, as there is less liability of the cords slipping: they will probably also prove easier to make. Mahogany or beech will do; but the former looks better, and is so. It is a pity wholly to sacrifice appearance to save a shilling or two, and I think, generally speaking, an amateur or professional who takes a pride in the appearance of his workshop will do better work than he who gets into the habit of putting up with apparatus of inferior appearance; otherwise beech will answer well enough for this kind of work, and may be stained and polished to imitate mahogany or left white, but in this case it soon gets dirty and has a disreputable aspect. In the case of the overhead of one shaft, in order to keep up tension, it is necessary to use a sliding bar carrying a tension pulley at one end, the other being weighted. This bar is pivotted upon the top tie-bar between the standards when these are used. It is a matter of necessity to use something of the kind, as the cord could not otherwise be kept tight, but it absorbs power and makes the leg work harder. In the double-spindle overhead, the fixed axle may generally be used without this if care is taken to adjust the cord to the right length, and it is only the swinging axle in the frame that needs vertical motion to keep the cord strained; this is done by attaching a weight or weights to the opposite side of the swinging frame. For all ordinary lathe work of an ornamental character, and also for tap grooving, wheel cutting, and such like, the two overhead shafts are generally deemed sufficient, owing to the ease with which they are geared to produce the required rates of speed, and because they are capable of independent or united action. Most lathe makers supply them with their first-class lathes, and use the single shaft for the cheaper ones; but in spite of this, one of our leading amateurs has devised an overhead in which he uses in addition an intermediate or supplementary shaft, carrying its own separate speed pulleys. This shaft is, however, much shorter than the other two. I shall have to speak of this, however, in a future number.

DRILL-BOW AND FLY-WHEEL.

IN technical language the drill-bow produces an alternating circular movement, and the fly-wheel a continuous circular movement. From this it results that the drill-bow makes as great backward movement without effect as it does forward in producing it. Whilst the fly-wheel goes forward without loss of time, so that in reality it performs twice the work of the drill-bow during the same period. But this law has some exceptions, and we shall see by the examination of the different operations that sometimes the drill-bow performs as much work as the fly-wheel.

The drill-bow is the primitive process, not only for small work like that of watchmakers, but also for those of wood and metal turners. The latter did not use a drill-bow moved by the hand, but a flexible lath, more or less long and thick, according to requirement. This lath was firmly fixed, parallel to the ceiling, by its stiffest end; to the other end was attached the cord, which, after going round the pulley of the lathe, was attached to the footboard. Thus, both hands remained free, the force being communicated to the treadle by the pressure of the foot, assisted by the weight of the body; so that objects could be operated on of larger dimensions than when driven with the drill-bow held in the hand. Sometimes, instead of a lath, a bow was used, also fixed to the ceiling by its centre, and directly over the lathe; to the cord of this bow was attached another cord, which, passing round the pulley, joined the footboard, and the result was the same. Later on came the fly-wheel—that is to say, a wheel turning freely on its axis, and put in motion by means of a crank attached to the footboard. The periphery of this wheel was of wood, and it was little employed except for turning large objects; it replaced the pole and the bow mentioned above. Its weight was often insufficient, and had to be increased by attaching pieces of iron or lead. In addition, these fly-wheels were difficult to make properly; they were dear, and almost always warped out of shape. It is very probable this latter defect was the chief cause of their being little used, until the progress made in the manufacture of iron favoured the production of cheap wheels of all sizes, not liable to get out of shape, and realising the best mechanical conditions.

Before entering further into details, let us examine a little the subject of true turning. What is the necessary conditions for turning an object true?

From an examination of these it appears, theoretically, that the fly-wheel turns truer than the drill-bow. But conscientious watchmakers have noted a contrary effect in practice; and this is a question which must be examined more closely, either to dispel an erroneous opinion, or to draw attention to whatever facts may present themselves. In turning with the drill-bow, the graver must cut while the oject turns one way, and be withdrawn while the drill-bow makes a reverse movement; the hand must therefore become accustomed to produce an alternative movement corresponding to that of the drill-bow. Where is the watchmaker who recalls with pleasure this period of his apprenticeship? In any case, he remembers the difficulty he had to turn true. After having succeeded and practised this method of turning for several years, what happens when the fly-wheel is tried? The alternating movement of the foot on the treadle replaces that of the hand working the drill-bow; thus the movement is transformed into a continuous one. The hand holding the graver, acting under the influence of habitude, continues its reciprocating motion until the necessary firmness has been acquired, According to the nature of the individual this change of movement is more or less rapidly achieved, during which time the turning is badly done. This is still further aggravated by the fact of the movement of the foot rendering the hand somewhat unsteady; for the foot having also an apprenticeship to make, works irregularly on the treadle, and destroys the regular inertia of the wheel, especially if this latter be light. Many watchmakers are deprived of the useful aid of the lathe from want of sufficient study of it.

Let us now see in what cases the use of the drill-bow is to be preferred to that of the fly-wheel, and *vice versâ*. Their operations may be divided into three categories—first, those in which either movement may be used indifferently; second, those which require an alternating movement; third, those necessitating a continuous one. The principal operations for watchmakers are—turning, drilling, polishing, and countersinking.

Turning is most frequently done with the drill-bow, but is very well executed with the fly-wheel, this latter being the most expeditious method. However, when it is requisite to give a rapid touch with the graver, as for instance in finishing, the drill-bow is preferable: when the operation is more prolonged the fly-wheel is best.

Drilling, as well as making small counter-sinks, is usually done as rapidly by one process as the other, provided that the cutting angles are properly shaped. For the drill-bow they should be in the centre of the thickness of the boring-bit, that is to say form two equal edges; the drill then cuts equally both ways, there is no time lost. The to-and-fro movement of the drill-dow has even the advantage of clearing away any particles having a tendency to adhere, especially when brass is drilled. With the fly-wheel the cutting parts of the drill should be formed of single bevels at the side opposed to the movement; half-round drills act better with the foot-lathe, because the two cutting angles are of necessity in reverse directions. When one cuts, the other moves the reverse way, and is easily splintered; care must also be taken to grind away the non-acting side, so that it does not touch the metal.

Polishing is done both with the drill-bow and the fly-wheel; but unless certain conditions be complied with the operation does not succeed, or it is performed badly. Steel objects are polished with the polisher or the emery wheel. Arbors are best polished with the drill-bow and file, because the to-and-fro movement of the file always responds in an inverse sense to the movement of the drill-bow, there being no time lost. Further, the file working from right to left, as well as to and fro, draws the material employed in polishing to the proper place, and the polishing thus obtained is perfectly clean. It is not the same with the shoulders of the pivots, which, as they are polished by the friction of the side of the file, are very difficult to get smooth. Some axes of balances also present part turned in shoulders, which it is hardly possible to polish by hand correctly.

These difficulties originated the idea of polishing the shoulders with the emery wheel, which was afterwards employed for flat bearings, the result being completely satisfactory. This method of polishing with the emery wheel was first employed with the aid of the drill-bow; the object to be polished as well as the emery wheel are placed on a depthing tool; each is moved by a drill-bow, and these, which must both work the same way, are held in one hand. Moving thus together, the two objects cross each other at their opposed points, resulting in a regular grinding. Besides, their diameters being different, their speed is also different; consequently the lines are crossed, and the polishing succeeds better. With the fly-wheel the conditions are the same; only the objects have a continuous movement in lieu of an alternating one.

Ordinarily, however, the polishing of an arbor and that of a bearing is effected at the same time. To attain this, the emery wheel should have its circumference turned in a way corresponding to the arbor; then it should be traversed over the entire length of this latter to polish it. With this depthing tool process, the spindles which receive the emery wheel must be left free, but pressed together, either by the hand or a special appliance, in order to give the arbor to be polished the necessary longitudinal movement. This motion of the emery wheel right and left is communicated to the drill-bow, and causes the cords to overrun. With the foot-lathe this friction is obviated, the greater lentgth of the cords annulling the effect of the lateral movement of the emery wheel. Only the hand working this is in use, leaving the other free; the general conditions are better, and the conclusion is that the fly-wheel is preferable for polishing with the emery wheel.

Jewels require a great rapidity of rotation for their polishing—three or four thousand turns a minute. Here the drill-bow is as powerless as the fly-wheel is indispensable. The important operation of pivoting is performed, or rather may be performed in two ways. The first, the oldest, consists in making the pivot by the graver, on an ordinary lathe, then polishing it with the burnisher on a special lathe furnished with a spindle having a succession of slits graduated according to the thicknesses adopted for the pivots, and in which these latter revolve whilst undergoing the operation of polishing. For a long time the drill-bow alone was employed for this work; but since the foot-lathe has come into general use it has been successfully employed for pivoting, using the same tools as before. For this it has sufficed to adapt, either to the spindle of the turning lathe or that of the pivoting lathe, a small pulley or screw ferrule, the face of which has a catch pin long enough to reach the arms of the wheel being pivoted. This latter has, therefore, no need of any apparatus to put it in motion; placed directly on the lathe, it is driven by the pin on the screw ferrule, which turns it without its having any strain arising from the tension of the cord or the inequalities of its movement, when it is required to make a certain number of pinions, time is gained by this process that would be lost in taking off and replacing screw ferrule and drill-bow.

Many years ago a method of pivoting was tried, based on the use of the fly-wheel and the suppression of the pivoting lathe. This process consisted of fixing the pivoting wheel on the extremity of an arbor; the pivot was turned with the graver and polished with the emery wheel; this being carried by a small apparatus which took the place of the back centre, Satisfactory results were thus obtained, but certain difficulties were encountered which required a skilful hand; then the use of the fly-wheel being very limited, led to this process being abandoned. Here, however, was the idea, which, though relinquished at the time, was not lost. The *Journal Suisse d'Horlogerie*, to which we are indebted for this article, recently published a description of this procedure, in which the emery wheel is replaced by the polishing file. The great difficulty of this method of pivoting is to get the pinions perfectly true. The aim of this article being simply to examine the various uses of the drill-bow and fly-wheel, we confine ourselves to remarking that the fly-wheel may be advantageously employed for pivoting, especially in quantities.

It remains to say a few words on counter-sinking. This tool replaces more and more the file in many of the operations of the watchmaker, taking the most varied forms; it has been used for a number of other things. If, for some special work, the countersink may still be used with the drill-bow, it has a special advantage with the continuous movement of the fly-wheel, and for the generality of the operation of counter-sinking the fly-wheel is indispensable; for with this latter alone could the extension of the class of work be possible which has taken place at the present day. In conclusion, we repeat that the drill-bow and the fly-wheel, far from excluding each other, tend to completion, and that it is desirable to study in which case one is preferable to the other to achieve the best results.

Varnish for Violins.—The varnish most used for violins is what is called a "fat" or oil varnish, made with amber; this is the most insoluble of gum resins, and, in its natural state, soluble only in chloroform. It contains an essential oil (oil of amber), and, until deprived of this by the process of melting, cannot be mixed or dissolved in spirits of turpentine. To prepare the amber for varnish melt it carefully in a sand bath; a small iron saucepan half filled with sand, in which a small thin cup is imbedded to contain the amber, which should be coarsely powdered, will answer the purpose. The right heat for melting must be found by trial, and will be indicated by a light-coloured or white vapour rising; if black smoke comes from the melting amber the heat is too great; the vapour has a very powerful, penetrating smell. About 1 dr. of amber will make enough varnish for two or three violins; when sufficiently melted, and allowed to cool, the amber will be found in small, brittle flakes of a dark brown colour. Amber in this state may be dissolved in "camphine" (the best spirit of turpentine procurable), which should be put, with the amber, in the proportion of about four to one in bulk, into a small bottle; allow the mixture to stand for a day or two, occasionally shaking it, then add about one-fourth to one-sixth of the quantity of best linseed drying oil. Size the violin, and get the grain of the wood thoroughly smooth, then apply the varnish with the finger, rubbing well; the violin should be slightly warmed during the process. Several coats will be required, but the first must be allowed to dry thoroughly before applying a second. Colouring matter, according to taste, may be mixed with a little of the varnish by the aid of a palette knife, and rubbed on, but there is great difficulty in laying the colour smoothly and evenly.

EMBELLISHING METALLIC SURFACES.

(From "The Boston Journal of Commerce.")

NONE of the metals while in their natural state present themselves, either in colour or form, to the eye in a noticeably attractive guise; for the most part they are dull as to colour and amorphous as to form. To be attractive as well as to be useful they must be submitted to human manipulation. Even the gems are rude and coarse in appearance as they come from their gangues, matrices, the mine or the stream. The popular idea of glistening gems gleaming out from common earth, or lighting up dark mines and gloomy caverns, finds expression in poetry and Arabian Nights tales, but gets no support from the truth of science.

The polishing of finished metallic surfaces is the simplest method of embellishment, and in many cases it is the most effective; but in this style of beautifying it is the colour and texture (material) of the metal that gives the beauty, qualities which have simply been brought out by human labour; there is nothing in this surface finish that can properly be called embellishment by manipulation.

Gold and silver articles receive almost all their ornamentation by variation in height of surface produced by various means; sometimes the figure being raised, and sometimes the figure being depressed, but the effect being dependent on the inequality of surfaces and not at all owing to colour or difference of tint. There are exceptions in which acids and heat are employed to tint the surface of the finished metal; but most of the surface embellishment of jewellery and plate is produced by engraving, chasing, *repoussé*, milling and similar means, disturbing the even surface, and producing relative heights on it.

Probably engraving is the oldest method of embellishing the surfaces of the precious metals, and, so far as we know, there has been no radical or even important change in the tools used or the methods employed, for hundreds of years. Its success depends entirely on the taste and skill of the workman, as the tools are simply hand chisels of various forms, held, guided, and controlled entirely by the hand, and the details of the pattern are frequently left to the judgment of the engraver, who, of course possesses some artistic taste. Indeed, the work of some engravers justly ranks with the products of fine art. Sometimes hand ornamentation of surfaces of gold and silver articles is produced by means of hammer and punches, which indent the material outside the figure and between its various parts, depressing the immediate surrounding surface and leaving the figure in apparent relief. There is a method, also, that in reality brings up the figure in quite bold relief that is very effective in some instances. This is called *repoussé*, a term from the French verb *repousser*, "to drive back," and is usually produced by blows from the inside of the article to be embellished through the medium of steel prongs, one end of which is struck, the other producing the impression. This pronged instrument is called a "snarling iron," and the hammer used is hardly heavier than a small tack hammer, which, striking one horn of the iron, induces a sharp blow on the other against the inner surface of the metal, raising it into protuberances. The skill required for this work and the resultant effect is wonderful. Delicate tracery of stem and tendril, the veining of leaves and shading of flower petals are brought out with exquisite delicacy and distinctness of outline. In large manufactories of gold and silver and of plated articles much of the surface embellishment is produced by means of rotary mills and by stamps. In either case the mill and the stamp have the pattern formed on them either in relief or intaglio, producing the pattern on the article in a reverse position. For instance, the raised ornamentation on silver spoons and forks is produced by passing the blanks through hardened steel rollers, one of which has the pattern sunk beneath its surface. Our coins are instances of stamping, both the die and the punch having an intaglio device corresponding respectively with the obverse and reverse of the coin. Much of our silver plate shows a contrast between burnished surface and a dead or unglossed surface. This dead surface is frequently produced by the abrasion of swiftly revolving brushes of rigid wire that roughens the surface, producing what is known as the "satin finish."

Chemical science also lends its aid to the embellishment of metallic surfaces by the employment of acids. These are adapted to the nature of the material and are used to bite into the surface, leaving it in a minutely honeycombed state, giving it an elegant appearance contrasted with the burnished portion. Sometimes also acids are used to colour a portion of the surface of gold and silver. In brass and bronze articles the use of acids produce some very elegant effects. In all these instances the acids corrode, giving a result similar to the oxidation of the atmosphere on long exposed bronze, as on statues. But by the employment of acids immediate effects are produced, varied as to colour by the quality and nature of the acid.

In all these methods of embellishment the metal itself receives no additional substance, nor does it undergo any material change. But in many other ways metallic substances are ornamented by the addition of other materials. Inlaying is one method in which the original metal is removed to form a device or figure, and another metal or a flux of silicious material introduced. Where another metal is added it is forced into place by hammer blows, and then abraded to the surface of the material to be ornamented. Where fluxes are used they are placed in the recess in a plastic or semi-fluid state, and "fixed" by heating in muffles which evaporates the water used to make the paste and fuses them. This is known as enameling. But there is a style of embellishment called inlaying, which is a merely surface application. Such is the ornamentation of tables of sewing machines, and similar articles of iron. In these cases the mother-of-pearl is merely cemented to the surface of the iron and a fusible varnish, or "japan," spread around it, filling up to the surfaces of the pieces of shell, and then baked to harden it. Some fine effects are produced by this simple process, but it ranks rather with painting and varnishing than with engraving, chasing, or *repoussé* work.

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Sizes of Geneva Watches.—It is very doubtful how small or how large watches have been made, but in general use the small size lady's watch is about a 10 size, and the large gent's watch a 22 size. These represent the limits of size in common use, but watches both smaller or larger are made. All Geneva watches are sized by *lines*, a French measure equivalent to ·0888 of an inch; a watch size 10, that is 10 lines in diameter, is, therefore, ·888in. in diameter, say ⅞ of an inch; one 22 size is 1954, say 2in. in diameter. The movements are sized in even numbers of lines, and the measurement is the diameter of the watch plate. The case may be extended on the edge to make a movement appear bigger, but the size would be determined by the diameter of the pillar-plate, in the same way that English watches are sized. The thickness of a watch does not affect its size. A number showing the "lines" is generally punched on watch movements under the dial.

WIRE SPIRAL SPRINGS.

(From the "Boston Journal of Commerce.")

IMPROPERLY treated, wire is a very obstinate material. If at all "springy" or possessing temper, either from condensation by drawing, or by hardening, it will not occupy the space or shape in which it is formed, and calculation or experiment is necessary to guide the workman to a satisfactory result. All wire of any stiffness, when coiled, will open or expand, making the coil larger in diameter and longer in stretch. In ignorance or neglect of this quality a workman once tried to form a spiral spring of wire to play upon a flat rod 1in. wide by ⅜in. thick. He wound the wire on the flat rod, and when released the spiral was a sight to make his shop companions laugh. The coil was elegant, but scarcely useful; its short diameter and its long diameter alternated in a beautiful geometric spiral, instead of preserving a straight line. Sometimes it is necessary to make a spiral, or rather a coiled spring, of a certain diameter, to fit a hole, or to fit a rod acting as its core or support. It is impossible to give rules to determine the amount of expansion of the coil in diameter, as the nature of the material is so varying. This variation comes from the stiffness of the wire, the size of the wire, and the material—whether brass, iron, or steel.

In the case of desiring to produce a coiled spring of a certain diameter it is best to try a simple experiment with the specimen of wire to be employed. Wind one or two turns on a rod of the proper size for the core, and then, releasing it, measure the interior of the ring or spiral, and compare with the diameter of the core or rod. Reduce the size of the core or rod to an amount a little more than the difference between the size of the hole in which the spring is to work, and the rod on which it was formed. If the wire is of a gauge that when wound on a ½in. rod it will fill loosely a hole ¾in. in diameter, but when allowed to expand the coil requires a hole ⅞in., wind the coil on a rod $\frac{3}{16}$in. smaller than the ½in. rod. A trial should be made, as before mentioned, by coiling the wire around a core of the estimated diameter, and thus determine the amount of opening or spring of the coil. It may be feasible, in some cases, to anneal the wire before forming it into springs. In this case the wire can be wound to the finish size at once. But with brass or iron wire, the springiness of which depends upon the condensation of the particles by the drawing dies, this plan is not practicable, as hardening and tempering by heat and water will not restore the stiffness of the wire. But with steel wire it is better to use the wire in an annealed form, making the spring just as it is to be in its finished state, and then tempering it, a process which is described further on.

It is a comparatively easy matter to make a close or expanding coiled wire spring in the lathe. The size of the core rod having been determined, all that is necessary is to keep the winding wire close to the previous coil, and this can be done by hand-feeding and guiding. The rod on which the spring is wound is placed on the lathe centres, and one end of the wire secured in the dog end, when the lathe may be started on a slow speed, the wire being led to it by hand. This is a handy way also to form rings, the coil being cut apart either with a file or cold chisel.

But in forming open or compressing springs, there must be greater care employed. The stiffest open spring from a certain size of wire is that which has the interstices of the same space as the wire's diameter; so, such a spring—or, rather, two of them—may be formed by winding two wires at the same time, making a close spring, doubled. When completed, one is unscrewed from the other. A more open spring may be guided by means of a thin piece of iron with a hole large enough to receive the core on which the spring is wound, the hole being in one end of the piece, and the other having a handle attached. A small hole should be made through the piece close to the large hole, to receive the wire. In operation the guide is slipped on the core spindle up to the dog end, the wire passed through the small hole, and secured by the dog. Then start the lathe, holding the guide close against the rotating core, pulling towards the operator, and the wire, passing through the small hole in the guide from one side, winds against the guide on the other. It is evident that the thickness of the guide will determine the width between the coils. A still better way of forming an open spring is to use an engine lathe with screw-cutting feed. With this the grade of the spring may be determined with great accuracy.

Sometimes it is necessary to close the ends of close coiled springs so as to make a central pull by means of hooks or loops. There is machinery to do this with rapidity, but for ordinary jobs handwork is sufficient. The closing is effected by a gradual reduction of the diameter of the coils at the ends of the spring. Unless the wire is very rigid and obstinate, repeated blows with a mallet, a lead hammer, or a copper hammer will do the work satisfactorily. The open end of the spring should be held at an angle on the bench block, and the hammer wielded, striking backward towards the held end of the spring, the spring being turned in the hand in the direction of the coiling. Before the end is closed, a looped piece of wire should be introduced to form a holder for the end of the spring, the projecting end of the looped wire to be formed into a hook or ring.

Large springs of large wire, which from its size and rigidity cannot be managed during winding by the hand, should be made on a contrivance similar in principle, build, and operation to the tyre tenders in the blacksmith's shop, or the pipe-formers in a tin-shop. These consist of two rolls to give a forward motion to the material, and another to give the curvature. In spring forming the modifications consist in substituting narrow wheels with a V or segmental groove on their peripheries for the two rolls which receive the wire, and a guide instead of the back roll to produce curvature. The two grooved wheels should be geared together, so as to turn in opposite directions, and the guide should be a curved piece, standing at an angle to the axial rotation of the rolls or wheels. And this guide should be capable of being set up to the rolls or moved back from them, to determine the diameter of the coil, and should also be capable of being inclined from a vertical position, more or less, to make a close or open spring. The guide should have a lip on its working edge to guide the wire. With such a contrivance, coiled springs of steel rod, a quarter of an inch and more in diameter, may be readily formed.

Sometimes a weak spring is required where a flat forged spring would be costly. In this case a piece of stiff wire of hard brass or unannealed iron may do the work when coiled two or three times around a core, the coiled portion forming the spring, leaving ends to be formed into loops or secured by a screw, or left to act on the moveable attachment it is to actuate, as a pawl. The principle of such a spring is seen in the extreme form in the U, or main spring, of a gun lock. In this spring the two long arms have little to do with its action, the spring of life being wholly in the curve between the two arms. The wire spring has its curve in one or more complete circles.

Coiled springs of steel wire are tempered by heating them in a box, or piece of gas pipe, in which they are packed with bone dust or animal charcoal, precisely as though they were to be heated for case hardening. If a piece of gas pipe is used, which is very handy in such work, one end should be closed by a screw plug or cap, and the open end luted with clay. When sufficiently heated—the box or pipe deep red—remove the spring, or plunge spring and its receptacle together into a bath of animal oil. Do not attempt water hardening or the use of crude petroleum. If common whale oil is not handy, melt lard and use it while it is liquid. The wire will be sufficiently hard to require drawing. This should be done by putting the spring in a shallow pan, with tallow or animal oil, over the forge fire, and agitate the pan and its contents until the oil takes fire. Take the springs out, and when the oil is burned off cool them in water.

Do Work Well.—The observant mechanical visitor to manufacturing establishments cannot but notice the difference in the manner of doing work and the quality of work done by different and differing workmen. One makes a great show and bluster, and sweats and torments himself, and then turns off his job with an air of "it will pass." Another works with a steadiness and quiet earnestness that shows his intent and intenseness, and when his job is done it is well done, even if he loses a little time in earning claim to the adjective, "Well done." Some workmen seem to think that the amount of work is the only criterion by which their effort is to be judged; quality is a consideration to be ignored. Some think that effort, show, and fuss pass current with fellow workmen and employers, if not for absolute excellence, at least for fair rating. Yet the experienced inspector knows each man's handiwork by its style, even though it does not receive any distinctive mark, and cumulative evidence, at last, has its effect, and the careless workman is reprimanded or discharged. If all the verbal instruction to apprentices to mechanical occupations, or to those starting in any branch of useful endeavour, must necessarily be crammed into a single sentence, that sentence should be: "Whatever you attempt to do, do it as well as you can." If a young man, aspiring to be anything when his youth has gone, will literally follow this advice, his course will be creditable, and ultimately beneficial to him and others. There is no sense in slighting a job. It is not satisfactory to the workman himself, it is not satisfactory to his employer or overseer, and is not satisfactory to the purchaser or user. The "shirk" who is content to make a job "pass" is unfit to be classed amongst honourable mechanics. He has no proper place in this working world. He is incompetent for any mechanical work, and cannot even wheel and dump coal ashes properly. The manager of a mechanical establishment has more trouble from these careless "shirkers" than from any other source of annoyance. They must be continually watched, and checked, and corrected, and finally their finished work must be more carefully inspected than that of men who are known to do their work well. Of course it would be folly to expect an apprentice, or an untaught worker, to do work equal in quality or even in amount to one who had the advantage of experience and the help of practice. But there is no reason why the workman, inexperienced or mature, should not do his best. The habit of doing well what is to be done is a grand one. It recommends the practiser to all who have contact with him; it inspires confidence; it invites trust; it needs no endorser, it is the mint stamp on uncoined gold, making it current; it keeps a man in paying occupation, and opens the door of promotion that leads to the goal of success, when "shirks" are sent adrift.

ON WORKING STEEL AND IRON AT THE FORGE.

THE process of working iron and steel at the forge, as practised by blacksmiths, is designated forging—an art which consists in giving to iron every possible shape, either by beating out the article to be fashioned from a bar of metal, or by uniting various pieces of different shapes and sizes, to form a composite mass of the required dimensions; the parts being joined together by "welding" at a heat very nearly approaching the melting point of the metals operated on, thus forming a join equal in homogeneity to the solid metal. A few general principles of the art of forging will be of great service to amateur mechanics, as—though probably not, as a rule, equipped with a regular smithy, furnished with forge, anvil, and so forth—they are continually obliged to perform the process with more or less appropriate tools, and generally under disadvantageous circumstances; the kitchen fire serving for a forge, and not unfrequently a flat-iron has to do duty as an anvil.

The iron chosen for the work in hand should be proportionate in size and quality to the exigencies to which it has to be applied. If the object to be wrought can be made from a piece of plain bar-iron, it will only be necessary to raise it to a white heat in the fire, then lay it on the anvil, and beat into shape with a hammer till the iron becomes a dull red colour. The hammering may be continued till the metal becomes almost black, and by thus prolonging the operation the metal is made more homogeneous, the cracks are welded together, and the metal made stronger and more close in texture. The method of making the article being forged will, of course, mainly depend on its shape; but, suppose we wish to make a bolt, of the shape usually denominated coach bolts, the following details will be interesting. The head of the bolt can be made by two methods—by "upsetting" and by welding. The first plan of doing the job is to heat the extreme end of the rod to a good white heat, and then spread it by striking it on the end with a hammer, or, as is more frequently done, by holding the bar of iron itself in the hands and striking it, end on, on the anvil. This spreads the metal diameterwise, and will thus produce sufficient protuberance to make a head. If the end appears inclined to crack at all, the extreme point or end of the rod should be slightly cooled by immersing the end in cold water, or resting it for a short time against the face of the anvil; this proceeding will make the end harder and less susceptible of cracking—in fact, the end itself will not be materially altered in shape, but will be driven bodily into the rod, which must of course expand sideways in a proportionate degree to the quantity of metal so driven in. In some cases it is requisite to form a swelling on a bar of iron at some distance from its end, as, for instance, when making a spindle for a grindstone to run between staples; this swelling is made by heating the bar to nearly a white heat just at that part where the swelling should come, the metal on both sides being kept comparatively at a low heat, and then by striking the bar on the end the hot metal will yield and expand, forming a swelling. To return to the bolt head. It will be, of course, necessary to further shape the head to get a good square shoulder. For this purpose the bolt blank has to be driven into a correspondingly shaped hole made in a piece of flat iron. The end of the rod must be heated and the plain part of the bolt put through; by blows on the head the blank is driven in till the head is flat against the hole in which the shank is. The hot metal is readily compressed to the form desired by using swages of any particular formation. Should a mushroom-topped bolt—*i.e.*, one with a dome-shaped head—be wanted, a swage with a corresponding hollow is placed against the red-hot bolt-head, and all the superfluous metal is driven through the plate, leaving only sufficient to completely fill the hollow in the swage. The hole in the plate would, of course, be square, so as to produce the square shoulder requisite with mushroom-headed bolts, so as to prevent the bolt turning round when the nut is being screwed on and off.

The other plan of making a head or other protuberance is by welding on to the bar a separate piece of metal, which has first to be made into the form of a ferrule, the diameter of which must not, however, be so large as that of the iron bar to which it has to be welded. The sectional shape of the metal from which the ferrule has to be made is perfectly immaterial, though it should be as near as may be of the form intended for the finished article; square, round, flat, oblong, semi-circular, &c., may be used for making the ferrules to be welded on; the substance of the added metal should be considerably more than the finished size of the bolt-head, as, though it may be reduced to almost any extent by hammering, it will be very difficult, if not impossible, to make the welded protuberance larger. When the ferrule is turned roughly into the shape required before being welded on to the main part of the bolt, it should not join as a perfect ring, but the two ends should gape slightly, and the ring being then put on to the rod, and the whole raised to a welding heat, on hammering the metal the ring will be expanded and so close the crack mentioned.

To effect a proper weld, the iron, when heated to very nearly the required heat, must have sprinkled over it, at the points of contact, a ltttle silver sand. The metal is then put back into the forge fire, and the heat raised to welding point, the sand melting and forming a vitreous covering which preserves the iron from the effects of the sulphurous fumes escaping from the coal, and also prevents the ashes of the fire from adhering to the metal, in which case, on the application of the hammer, they would become embedded in the iron, and so spoil its texture. The glassy covering also prevents the oxidising and scaling action of the fire.

Iron is always subject to fractures lengthways of the metal. These are caused by the non-adhesion of the particles through the intervention of some foreign matter, usually in the early stages of manufacture. By constant forging these flaws may be very greatly reduced in magnitude, and "faggotted iron" is the best which is to be obtained for tenacity. Lathe mandrels are made of fagots of iron, with steel collars welded on for the bearings. The method of making these fagots is to take a quantity of small pieces of iron wire of good quality, and generally square section, and gradually to weld these into a thick cylindrical piece. Suppose three pieces of ¼in. sq. iron were welded together into a solid bar, twisting each piece separately, and the whole together, so that the molecular formation of the complete bar will be as equal as possible, it will be understood that such a bar will be far more trustworthy as a whole than would be either of its component pieces taken at a proportionate value. If three such compound bars were then welded together, still twisting each as before, the homogeneousness of the bar would be still further improved, and by again repeating the process and thus welding twenty-seven distinct bars into a solid mass the texture of this will be far more uniform and good than could be obtained in iron produced in the usual way of making rolled bars. The method I have here given is, as I have above stated, largely adopted for making lathe mandrels, and the iron mandrels so produced are better than those made of cast steel for standing the knocking about to which a lathe is generally subjected in an engineer's shop.

In joining together bars of iron end to end, as is necessary, supposing a piece cannot be found sufficiently long for the purpose required, these particulars should be borne in mind:—The ends to be joined together by welding should in the first place be slightly "upset," which is the technical way of expressing the operation of smelting the iron diameterwise, by heating the end and striking the bar in the direction of its length, much in the same way as a cold chisel is struck when in use; this will cause the ends to be somewhat larger than the original diameter of the rod; the faces of the ends are then beat off by the hammer to form a scarph joint, and the two pieces are made hot in the forge fire. On their attaining a welding heat, the two pieces are laid together and a weld effected by light blows with the hammer, and as soon as the two are found to be really joined, that part is put in the fire and reheated to white heat, the join being completed by hammering. If the operation has been carried out properly, the welded joint may be so neatly done that it is only by very critical examination that it can be detected at all.

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Subscriptions: Twelve Months, 6s.; Six Months, 3s.; Three Months, 1s. 6d., postage free.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse, the opinions expressed.

MUSICAL WORK!

Dear Sir,—When I penned the concluding words of my letter to you—which you have courteously inserted in No. 1 of "Amateur Mechanics"—I was not so vain as to suppose I should receive such a hearty welcome to your pages as you have given me. That my past work has been kindly appreciated by you, as well as by a large circle of readers and correspondents is, indeed, a source of gratification, and in repeating that I am happy to be at your service I thank you for your invitation to resume what has always been to me a labour of love.

Before, however, commencing what may be a lengthy series of articles, I should like to ascertain the feeling of a—presumably—new class of readers upon "Musical Work," therefore if I explain what I think of offering them, and if you request musically interested readers to communicate to you their opinions and offer any suggestions, I think it probable that such a mutual interchange of ideas will have a result at once beneficial and satisfactory.

For some time I have been preparing for publication, in book form, two rather bulky works; one, a treatise on "Amateur Organ Building," the other, a "Glossary of Organ, Reed Organ, and Harmonium Work." I now propose to publish the combined information of both works in a series of articles in the pages of this magazine, offering such information as will guide and instruct for the erection of pipe organs, from the small cottage or sitting-room organ up to any reasonable size, describing, and, as far as may be necessary, illustrating with reliable diagram, all the parts and arrangements, their action and use. How to make all that can be made by the amateur, and how to purchase what should be purchased. I do *not* propose to convert (by writing and drawing) any one into a "Willis" or "Speechly," but to give the results of many years' study and experience as a successful amateur.

Harmoniums and reed organs will have their full share of attention. These instruments, from their compactness and portability, are always more favoured than their big brothers, the pipe organs. I shall endeavour to show how easily and cheaply every industrious and patient workman may have in his home a good instrument. I intend to give my readers several successful inventions, some of which are adopted and practised by existing professional builders.

I shall be happy to give any special information that may be asked for through the editor of this magazine, but the teachings of past experience in this department render it necessary for me to say that I will not pretend to teach any royal road to music or musical work. What my readers must do, to attain success, is what I have had to do, patiently and cheerfully plod, plod, plod, and their success will follow.

Yours faithfully,
"SAXOPHONE."

[We place the suggestion before our readers without expressing a scintilla of our own views. How far the subjects proposed are interesting to our readers is for them to say. This magazine is intended for amateur mechanics, and if a sufficent number write us approving the suggestion we will carry it out. It would be superfluous to comment on the competency of our old collaborator whose pseudonym is well-known amongst amateur organ builders. We are anxious to know whether the subject will interest our present readers, and perhaps secure others.—Ed.]

MANDREL NOSE THREADS.

Sir,—Until the advent of No. 1 of your publication there *has* been a want of some serial to take up a subject like this *at and from the beginning*, in the way indicated in the second paragraph of the article by Mr. Hines, page 19. It may not unfrequently happen, as in my own case, that a man with an over-wrought brain will take in middle-life to mechanical pursuits, for the sake of exercise or mental diversion, without having the clearest ideas in his mind how to begin.

In such a predicament it appeared to me the most natural thing in the world to buy a lathe by one of the first makers with a cupboard of tools, and go-a-head cutting sundry blocks of box-wood and "African-black" into chessmen

Very little sooner said than done; and (thanks to a persevering turn of mind) done with a fair amount of success, excepting the heads of "Knights," which I will say little about, as they have not yet come into existence; but—to the main point of my letter—imagine my horror on reading a letter by Dr. Edmunds, and discovering simultaneously that I am working with a 9.45 mandrel!! with sundry accessories to fit; all which are new within four months, and at a cost not encouraging to reflect upon. What must I do? Can I get an adapter as used by microscopists for o.g's of varying threads? I (and perhaps others) pause for a reply, and am,

Very respectfully yours,
"HUDIBRAS."

Sir,—"Amateur Mechanics" No. 1, vol. 1, has been sent me by a friend, and I beg to tender a few remarks anent the new journal.

Firstly—I, and half-a-dozen other fellows, thank you for providing what we have long wanted. A journal *to* ourselves, *for* ourselves, and—to a great extent, I hope—*by* ourselves.

Secondly—Allow me to suggest that your title is not sufficiently comprehensive, unless you really mean to confine your pages to "Mechanics." I don't believe you intend to do *that*, and I hope to see some entertaining and instructive articles on amateur painting, paper-hanging, decorating, plumbing, glazing, and everything else which men—old and young—delight in as recreation.

Thirdly—I trust you will open a query and reply department, and afford your readers a channel for expressing each other's views on subjects compatible with the object of the journal.

Lastly—The journal will certainly be taken, and critically read, by practical mechanics—many of whom are *amateur musicians*, and would probably take an interest in *musical* mechanics—or the construction of small organs, harmoniums, and other instruments, which may be made by a good practical joiner. I have myself made several instruments, and am well acquainted with many amateur musicians who have, with with more or less success, done a bit of organ building and such work. Consequently I trust you will remember this class of "Amateur Mechanics" when laying your bearings, and kindly provide your musical readers with an occasional page of "instructive and entertaining information."

Believe me to remain, with best wishes for your success, yours,

"A JOINER-ORGANIST."

[We are disposed to consider our title sufficiently comprehensive to include all subjects of a mechanical nature. The articles which our correspondent suggests and hopes to see are for the most part excluded from our pages. Our correspondence section is open for the interchange of information, and it only remains for our readers to avail themselves of it. Another letter published in this issue should elicit opinions on musical matters.—Ed.]

Dear Sir,—You, as Editor and Amateur Mechanicians as readers, may well be congratulated on No. 1, vol. 1.

The Introductory Prospectus, the original articles, the exchanges, the miscellaneous notes—not to speak of Dr. Edmunds' excellent letter—the printing and the paper, from first word to last, even including the cover, are, one and all, readable, entertaining, instructive, and complete, so much so, that I can say with "Saxophone" whose *nom de plume* I am glad to see once more—"I am sure your new venture *is* not only a success, but *has been* hailed with delight by many thousands of British Amateurs."

Very truly yours,
GRAHAM.

P.S.—Besides the *theoretical* works named in the article, "What books shall an engineer read," there is a very useful *practical* one, and which all amateurs ought to read, viz., "The Mechanician—a treatise on the construction and manipulation of tools, for the use and instruction of young ehgineers and scientific amateurs," now published at a third of its original cost.

AMATEUR MECHANICS

AN

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THE ART OF TURNING.

By Paul N. Hasluck.

(For Illustrations, see Lithograph Supplement.)

PART III.

THE natives of India use a very primative form of turning apparatus. Mr. Holtzapffel says it is still in use, and describes the practice of the native turner to be as follows:—When any portion of the household furniture has to be turned, the wood-turner is sent for. He comes with all his outfit, and establishes himself at the very door of his employer. He commences by digging two holes in the ground, at a distance suitable to the length of the work, and in these he fixes two short wooden posts, securing them as strongly as he can by ramming the earth and driving in wedges and stones around them. The centres, scarcely more than round nails or spikes, are driven through the posts at about eight inches from the ground. A wooden rod for the support of the tools is either nailed or tied to the posts. The bar, if long, is additionally supported by being tied to one or two vertical sticks, driven into the ground. During most of his mechanical operations the Indian workman is seated on the ground; hence, the small elevation of his lathe centres. A boy, who gives motion to the work, sits or kneels on the opposite side, holding the ends of the cord wrapped around his hands, and pulling them alternately. The cutting is only effective during one half of the motion, that is when the work is revolving towards the turner. The tools used by the Indian turner are almost confined to the chisel and gouge. Their handles are long enough to suit his distant position; the cutting end he guides with his toes. He grasps the bar, on which the tool rests, with his smaller toes, and places the tool between the large toe and its neighbour. The accompanying illustration shows the Indian turner at work, a boy rotating the object on which he is operating.

The Persian turner uses an apparatus which is an advance on the Indian's. The centres are made to pass through the ends of an open box, the edges of which serve as a rest to support the tool. The centres are raised or lowered in a series of holes pierced in a vertical line, to suit different diameters of work. The box-like structure of this lathe makes it more portable than the Indian, but in other respects it is very similar. Small work is rotated by means of a drill-bow, as shown in the accompanying illustration. Large work is rotated by means of a cord worked by an assistant, who uses both hands, as shown in the previous illustration. Under these latter circumstances the lathe is fixed by stakes driven into the ground, so that it will not be pulled along by the action of the assistant.

At the present time, materials of all kinds are wrought into shape on the lathe amongst all nations that practice the mechanical arts. The animal, mineral, and vegetable kingdoms all furnish specimens on which the turner operates. All have claims on our attention for some peculiarity. The animal kingdom furnishes but a comparatively small number of specimens; but these are valuable and varied. Shells, bones and horny substances—not forgetting ivory—are available for turnery. Mother-of-pearl—a term which includes a very large number of shells—is extensively wrought on the lathe. Buttons of this material are universally known, and though they are chiefly manufactured by means of annular saws, yet they claim a place amongst things made by the turner. Bone, either in its natural state, bleached, or dyed, furnishes the material for many objects of turnery. Horn, by its elasticity and toughness, and the facility with which it is worked on the lathe, serves the turner for an infinite variety of purposes. For screwing with fine threads, horn is, perhaps, the most easily manipulated substance. The natural veining of horn is itself beautiful, and the effect is further improved by tinting with various dyes.

Ivory is, of all materials, the one most in request by the ornamental turner. It is costly, beautiful, and most easy to turn. Its brilliant whiteness, fine grain, and great solidity are qualities that recommend it. It is easy to work and clean, so that its value to the amateur has no detractions, the high price and the limited dimensions perhaps excepted. Elephants' tusks furnish the greatest part of the ivory used in the arts, but other animals also furnish it.

The mineral kingdom furnishes the most useful and the most extensive assortment of specimens available for turning. Stones and marbles are wrought on the lathe with excellent effect. Large columns of marble turned on the lathe are to be seen everywhere. The most minute work is also executed in stone on the lathe. Jewel-holes for watches, made of precious stones, are all turned. Apart from these, the mineral world furnishes all the metals, and in them we have an exhaustless supply of materials. Not only are the simple metals available, but the numberless alloys are, in many cases, equally so.

It would be scarcely possible to enumerate the many and varied uses to which the turner's art has put metal. It is scarcely an exaggeration to say that every machine that is constructed owes the essentials of its being to the art of turning. The cylinder produced on the lathe finds employment in every kind of mechanism. The most powerful mill or engine, and the most delicate machine that the accuracy of modern science requires—each emanate from the lathe. The softest metal may be turned, and the hardest likewise, with almost equal facility, by means of a diamond tool. Steel, in its various forms, is probably the most largely wrought of all materials on the lathe; it also forms the majority of the tools with which the art of turning is practised.

The vegetable kingdom furnishes the various woods which are fashioned into innumerable objects—both useful and ornamental—by the turner. These specimens alone constitute an array of material as exhaustless as the metals. Each are applicable to their respective uses; each have their special claims for usefulness. An enumeration of all the woods would not, however, exhaust the list of vegetable material available for turnery. Betel-nuts, cocoa-nutshells, and ivory-nuts, or vegetable ivory, are extensively used.

The materials available for working in this interesting art are therefore almost unlimited in their variety. Whether hard as ruby, or soft as plastic clay, heavy or light, malleable or brittle, these qualities recommend different materials. The speed at which turnery is executed varies as the substance turned. Soft wood may have a surface velocity of a mile a minute, and hard steel may run at a foot a minute. Intermediate speeds, according with different materials, are, of course, only natural.

The objects turned on a lathe vary in size from a great gun weighing a hundred tons, to a watch balance staff weighing but a fraction of a grain. The machines used for the two purposes show the two extremes in the sizes of modern lathes.

The extreme accuracy which is obtainable is strikingly exemplified in the manufacture of watches by machinery, the machinery being lathes. The essential exactness and agreement of the component parts of a fine specimen of a pocket timekeeper are proverbial. Until quite recently, every axis in a watch was turned by hand on the turn-bench; in this way each was a separate production. Skilled handwork was considered essential for the production of work of the necessary accuracy. Now, by means of an almost automatic lathe, the axes are turned each precisely like its fellow; and, indeed, so accurately are they, that they are interchangeable in the finished watch. This is an attainment that was doubtless considered impossible a generation ago. The Americans, however, perfected the necessary lathes for the work, and introduced machine-made watches, they having made clocks on the same principle previously. We have now in England some watch manufactories in which automatic lathes are extensively used, and some English watches are now made by machinery. To the lathe, its adaptation to the acquirements of the work, and to the perfection of the art of turning, must be attributed this astonishing revolution in the watchmaking industries of this country.

Turnery, both the art itself and the objects produced, has been now so far perfected, that it seems difficult to limit the range of its application. The lathe is itself a production of a former lathe. As skill has increased, so have the productions of the lathe increased in perfection. The centre lathe gave the means of making the mandrel-lathe: this produced the screw-cutting lathe, and so on through all the innumerable varieties of the machine now in every-day use. If lathes larger than the largest now used are wanted, they can be made on the machines now available. If mechanism is to be refined to a greater perfection than now exists, the tools to do it can be made on the lathes now in use.

The accompanying lithograph illustrations show the following types of turners:—Fig. 1, Egyptian; fig. 2, Hebrew; fig. 3, Syrian; fig. 4, German; fig. 5, Kabyles; fig. 6, Carpathian; fig. 7, Indian; fig. 8, Arabian. Particulars of which will be found in the letterpress.

WATCHWORK FOR AMATEURS.

Part III.—By Watchman.

(From "Design and Work.")

HAVING followed the instructions given in the previous article, we now have the verge movement entirely apart. Considering that these papers are addressed to those who have absolutely no experience in watchwork, I do not here give directions for ascertaining and correcting faults which would be quite beyond the beginner to comprehend or rectify.

Cleaning will be the next process. This is simply done by brushing each part lightly with a clean brush till all the adhering dirt, dried oil, &c., is removed. Hold the pieces in the fingers with tissue paper, and as cleaned put them under a glass cover; then clean all the wheel work. The plates, after being brushed, must have each hole cleaned out by the aid of peg wood, and every care must be taken to ensure the removal of every particle of dust, &c. No finger-marks must be allowed to stain the plates or other parts; and the beginner will have some trouble in putting a movement together without touching the gilding with his fingers.

The mainspring should be taken out of the barrel and cleaned. To get the spring out, first take the lid off the barrel by inserting the point of the tweezers in the notch which will be found at the edge of the barrel cover, and using them as a lever, with the edge of the barrel as fulcrum. The lid off, take out the barrel arbour, firstly unhooking it from the spring, then to get the spring out seize it by the centre part and draw it outwards, holding the barrel firmly the while. As soon as two or three coils are out the remainder will fly out of itself, and the operator should guard against damage by holding the spring in the barrel, and allowing it to come out gradually. Especial care will be necessary when the last coil comes out and the end has to be unhooked. Clean the inside of the barrel by wrapping a piece of tissue paper on the end of a stick of peg-wood, and with that mop out the barrel. The spring is cleaned by drawing it through between the jaws of the tweezers, which are covered with tissue paper. Thus the spring and the barrel will be cleaned of all the old oil.

To put the spring back is not a very easy job, and to explain how to do it is far more difficult. In the trade a special tool is used, called a spring winder, having a nose piece, corresponding to the barrel arbour, which is revolved by turning a handle, and so the spring is coiled up till small enough to go inside the barrel, then this is put on, and when the spring catches the barrel-hook, the job is done. In putting the spring in by hand, the barrel must be held in the left hand, and the outer end of the spring laid in it in such a position that the eye will catch on the hook, then by coiling the spring slightly it may be got in the barrel, a small piece at a time, the operation occupying but a few seconds of time; be careful to hold the spring inside the barrel in its place, or the whole lot is very apt to fly out. Clock springs are usually put in by hand in the way I have endeavoured to explain, and after little practice no difficulty will be found in putting the spring back in its place. Clean the barrel arbour, and also the holes in which it works in the lid and barrel, put it in its place, see that the hook catches the eye of the spring, and then snap on the cover; this is done with the fingers alone, or by pressing the cover against the edge of the bench. Do not forget that the friction on the barrel arbour is between it and the barrel, and not in the pivot holes of the plates, so that the oil must be applied to the barrel holes, and not to those in the plates. The spring itself should be well oiled when in the barrel, by putting two or three drops of oil on the coils; it will distribute itself all over the spring as soon as this is wound up and uncoiled again. When the barrel is oiled try that the spring is hooked at both ends before putting it down.

The chain is cleaned by wiping it with tissue paper, and running it round a stick of pegwood; no oil is put to the chain; when cleaned lay it out straight, ready for putting on.

The potence-cock must be well cleaned, and the dovetailed slip, which holds the endstone jewel against which the bottom verge pivot works, must be removed to allow the pivot hole to be cleaned. Before this cock is screwed into its place again put a very small quantity of oil in the verge pivot hole, as afterwards there will be no chance of getting at it. That only a small quantity of oil be used is most important, for if there is sufficient to flow into the body of the verge it is sure to reach the bottom pallet, and from this the oil will be conveyed to the escape wheel teeth, which must be guarded against. The escape wheel itself must be placed in its bearings, and there have to be oiled before the pivots are put into the holes. That some of the pivot holes must be oiled before the movement is put together must not be forgotten by beginners, as it is quite impossible to get at some bearings when the plates are together. The oil used must be that specially prepared for watchwork, and sold by material dealers. To apply the oil a very fine needle is used, either made of brass, or a pivot broach will do. A beginner usually errs in putting too much oil; in practice a small quantity is sufficient, and if more is put it runs away from its intended place, and is sure to get into some part where its presence will be a source of continual trouble.

The great wheel which forms part of the fusee must be lubricated, and it should be removed from the fusee arbour and properly cleaned. This is done by pushing out the pin, which is put diametrically through the fusee arbour just below the great wheel, between it and the bottom pivot. This pin holds on a steel collet which forms the flange against which the lower side of the great wheel takes its bearing, the upper side being against the base of the scroll part of the fusee; thus the wheel is free to revolve independent of the fusee. The clickwork is contained within the thickness of the fusee and great wheel, and will be seen as soon as the wheel is removed: the ratchet wheel being fixed to the fusee, and two clicks engaging in it on opposite sides, together with their springs, are fixed to the upper face of the great wheel. Clean all the clickwork and re-oil it before putting the fusee together. See that the pin holding the fusee collet does not project, or it will probably foul the centre wheel. Try the clickwork to see that it acts all right before laying the fusee aside as done.

At this stage we are ready to put the watch together. The pillar plate is the base on which the whole is built up, and this is the first piece to operate on. See that the bolt and bolt-spring are both screwed on; also the joint and any parts which may have been removed after the plates were taken asunder. This done, lay the plate on the top of the eyeglass, or on some other convenient stand, so that the centre pivot may go through freely. Have a glass at hand to cover the whole with as required. To hold the movement a special contrivance is sold which has three jaws to clip the plate with, and this forms a convenient means of handling the movement as it is being put together. These appliances are not, however, generally used by the trade, though they are certainly very handy for an amateur workman.

The first piece to be put on the pillar-plate is the wheel which lies next to it, generally the third wheel which lies in the circular cutting beneath the centre wheel; put this wheel in first, using the tweezers and holding by the pinion staff. See that the pivot is in its hole; then put in the next wheel, that is the centre wheel; then the fusee, and finally the crown wheel. These being all in position put the top plate on, and get the pillars into their respective holes, and then carefully and gradually get the pivots into their holes in the top plate. In putting on the plate the fusee square will be the most prominent pivot, and the plate is put over that before it comes to the pillars. The crown wheel requires special care in handling, as several things tend to make it liable to breakage. It is so high up on its pinion that it makes this top-heavy, and so the top pivot gets away from the hole in the top plate; the potence-cock and follower are apt to come in contact with the periphery of the wheel, and may, when the plates are brought together, break off the bottom pivot. As soon as the whole train is running in its bearings a slight pressure on the great wheel will cause the whole to revolve, and thus show that all is in running order. Now put the pins in the pillars, remembering that each pin has its special pillar, and that they are not interchangeable as a rule.

The barrel is now to be put in, and no difficulty will be found here. Place the barrel right side down in the circular opening of the top plate; in that the arbour passes through the hole in the pillar plate; then lay on the name bar and fix it with its two screws. If the pins through the pillars, which are covered by the name-bar, are too long, or even project much on only one side, the name bar cannot be screwed down; see to this as you go along. If the pins were re-placed in the holes they were taken from, the bar will fit on all right.

The chain must now be put on, and here the beginner will find a tedious job. Having the chain straightened out, hold the movement in such a position that that end of the chain on which the barrel-hook is may be passed from the fusee inside the pillar towards the barrel; get the hole in which the chain hooks in position, and hook the chain in; now get a key on the square of the barrel, and keeping the chain on the periphery of the barrel with the thumb, wind the chain on till the hook at the fusee end is in a convenient place for hooking, which do. Put the ratchet wheel on the barrel arbour, and set the spring up slightly by turning the barrel arbour in the direction indicated by the slope of the teeth of the ratchet wheel, and allow the click to hold the ratchet. Directly the power of the spring is felt by the chain the fusee will be made to turn, and the whole train of wheels will revolve rapidly; the noise made will at once indicate this. The spring must be set up as much as necessary, which will be known by remembering how much it was set up before taking the movement apart, screw the click down firmly, and that part is done.

The balance and verge are now to go in. Here you deal with very delicate parts. Put the verge in through the potence-cock, allowing it to fall by its own weight, then put the end of the hairspring through the stud, and get it to project to the point which was marked when taking apart, then pin firmly with the pin used before; when this pin is inserted see that the hairspring is quite flat, and take care it is not distorted when pinning. Be sure that the bottom pivot of the verge is in its hole, and then put on the cock, placing the steady-pins in first, and then adjusting the pivot into the hole. As soon as the verge is in its bearings at both ends, the balance will swing freely, and by giving the movement a slight oscillatory motion, the balance will swing whilst the cock is screwed on.

The watch must now be wound, to get the chain properly on to the fusee, and this must be guided as you go along to lead fairly into the groove of the fusee, or the chain may run up it and the barrel will then have to be taken out and all the chain-winding process done over again. Once having the chain wound on the fusee, it will, as the spring runs down, uncoil itself on the barrel, so as to be re-wound again correctly. The watch should now be in going order, and commence ticking; if it does not, there is something wrong, which must be found out and corrected before proceeding further.

Then put on the motion work, next the dial, which pin with the three pins, taking care to see that these do not project too far and become foul of any going part. Put on the hands with the minute hand at the XII. when the hour hand points to either hour, finally put the movement in the case, which should have been previously cleaned, and the cleaning of the watch is completed, and it is ready to hand to the wearer after being regulated to go fairly near to time.

Having fully detailed the processes of taking to pieces, cleaning, and putting together again, I now proceed to deal with those faults which are most commonly found in a verge watch. It cannot be expected that a beginner on examining a watch shall be able to determine whether certain parts are as they should be, for it is only after practice that one becomes familiar with what is right, and can then distinguish it from that which is wrong.

To direct a beginner to see that the depths are correct seems to be absurd without giving particulars to enable him to know how to recognise a correctly-pitched depth, and yet to do this will necessitate a treatise on depthing—as watchmakers term what engineers call gearing—involving a far more intimate knowledge of mechanics than I can reasonably hope to be possessed by a beginner.

Again, to see that the end-shake of a pinion is sufficient for freedom, and not enough to cause any danger of any part of the pinion, or the wheel on it, becoming foul of any adjacent part, is not the work of many seconds to an experienced watch-jobber; but how long a beginner would be in examining whether the end-shake was right and whether he would, when finished, arrive at a just conclusion, is a matter which it is difficult to decide. I must, however, do my best to make my meaning intelligible, and merely point out the difficulty in passing. The faults which we are interested in are only those which effect the going of a watch in a sensible manner; errors in the original design we need not trouble about.

In that part forming the escapement by far the largest number of causes for stopping and variation are found, and the verge itself claims our first attention. We must treat it as forming part of a whole, and its proper proportion to the various component parts must be studied; for, though perfect in itself, the verge may be unsuited to the escape-wheel, and perhaps useless. A slight alteration will sometimes so much affect the relationship of a verge and escape-wheel that they are quite unsuited to each other, though once perfectly in accordance.

The following elements, forming the verge escapement, are all mutually dependent one on another, and must be considered as a whole as well as independent parts:

The opening of the pallets.—That is, the angle at which the face of one pallet stands relatively to the face of the other. Watchmakers usually say that this opening should be a trifle more than a right angle, and the best authorities give 100° as the correct opening for practical purposes.

The Lift.—That is the angular motion of the balance during the time the escape-wheel is acting on the verge pallet. This should be about 40°, and on it will depend

The supplementary arc of vibration.—That is the vibration of the balance after the lift, and dependent on the weight of the balance, the freedom of its oscillation, and the power communicated during the lift. By adding the lift arc to the supplementary arc we get the entire vibration or angular motion of the balance, and this should be about half a complete revolution.

The recoil is that part of the angular motion of the balance which takes place while a tooth of the escape-wheel is against one of the verge pallets, and the balance is moving in the direction to cause the wheel to go backwards in spite of the motive power.

The Pallet, which receives the impulse, requires to be of a proper proportionate length, and this is a little more than half the space between the points of the adjacent teeth of the escape-wheel—that is, measuring from the centre of the verge axis to the edge of the pallet. On the length of the pallet depends not only the leverage of the escape-tooth, but also the relative distance of the verge from the escape-wheel. With short pallets the impulse of lift will be given near the centre of rotation of the balance, and will have less tendency to cause this to rotate through the short leverage; whilst when the lift is given on a lever too long, the power is too effective, and controlling or regulating by means of the balance is made difficult.

The teeth of the escape-wheel must have their faces inclined to the axis, so that during the recoil that part of the verge pallet which is beyond the point of contact with the tooth shall be free. And here it may be as well to point out that the principal cause of wear on the verge pallets is the recoil motion. Having mastered the above principles of the verge escapement, the beginner may proceed to a careful examination of it with some prospect of discovering any very palpable errors.

In the contrate-wheel depth generally occurs many causes of stoppage, and when the complicated form of depthing is considered it is no wonder that through it loss of power and oftentimes stoppage occurs. The contrate depth of a watch is a variety of skew-gearing, at all times difficult to manage, and rendered all the more so on account of the small size of the parts. Thus we use a straight pinion where it should be conical, and a wheel with straight teeth which should be cut angle ways, because the escape-pinion does not lie diametrically across the contrate-wheel, but on the skew to avoid the contrate pinion. Again, the verge escapement has necessarily, as we have previously shown, a considerable amount of recoil, and this in effect acts on the contrate-wheel to an appreciable extent. It is unnecessary for our present purpose to explain the peculiarities of the teeth of wheels used in various descriptions of gearing, suffice to say that two wheels gearing together have teeth formed differently as they are drivers or driven, and the difference becomes the more marked as the relative size of the two wheels becomes greater; and also, that a wheel and pinion have the teeth shaped very differently according as the one or other is driver, and that when arranged to act in one way the reverse motion is only accomplished at an immense expense of power, if at all. We have seen that the contrate-wheel drives the pinion under the disadvantages inherent to skew-gearing; and further, that the recoil of the escapement transforms the pinion into the driver, and from these circumstances the depth of the contrate-wheel is contrived in a way which a mechanician views as almost incredible, and a most careful adjustment of this portion of the watch should be made so as to reconcile as many of the errors as possible. The lower pivot of the contrate-pinion should have an end-stone to take the bearing from the shoulders of the pivot, but very seldom is this found.

Variation of the motive force materially affects the going of a verge watch, and it is therefore necessary to see that the power of the main-spring acts through the fusee, so that an equal force is available from the time the spring is fully wound till it has run down. This is tested by means of an adjusting-rod, consisting of a steel rod a foot or so in length, with an arrangement at one end by which it can be fixed to the fusee square, at right angles to the axis, and spheres of brass, acting as weights, slide along the rod. The adjusting-rod is fixed to the fusee, and the sliding weights adjusted to an equilibrium with the spring when this is fully unwound; and by winding up the watch with the adjusting-rod, the power of the spring is felt at each revolution of the fusee, and the effective force of the spring is thus gauged. Suppose it is stronger at the fully wound than when nearly down, the spring is not "set-up" sufficiently, but each fusee requires peculiarities of the spring which it would be in vain to try to point out here. A long spring, in which only some of the central coils are utilised—by central coils I mean those which act half-way between fully down and tightly wound—is the best; but in a barrel of limited size the thickness of spring required to produce sufficient motive power often precludes the possibility of using one of any considerable length. A large portion of the power of the spring is often wasted in the uncoiling, by friction against the inside of the barrel, and of the coils one against another. By examining the barrel and spring it will be easy to perceive bright places, showing where friction occurs, and every effort should be made to eliminate, or at any rate to reduce it. Oil is put to lubricate the spring, and sometimes this gets so gummy that a lot of power is wasted through it.

When the source of power is fairly constant in its action it must be conveyed through the train of wheels to the escapement, without being subjected to the variations caused by bad depths, wide holes, and so forth; for all the trouble taken in regulating the power of the spring will be of little practical value if the train is faulty, though, of course, I do not mean to suggest that a badly-regulated power will act well through a faulty train. Every pivot-hole and pivot should be examined separately, and on their own merits; and when the latter are found to be cut or worn they should be re-polished, and any holes that are found to be wide must be re-bushed, and the pivot fitted properly. In all cases of re-bushing pivot-holes the French *bouchons*, sold by material dealers, will be found the best things to use. When a hole is out of upright, or badly pitched, and requires re-drilling, then use a piece of hard brass wire to plug the old hole with. Of the inherent bad qualities, and the special attention to be paid to the contrate depth, I have already spoken. The verge itself must run with the shoulders of its pivot free of the bearings, and the lower pallet must be sufficiently far from the potence to guard against the possibility of the oil applied to the pivot-hole coming in contact with it. For a similar reason the top pivot must be long enough, or the oil will spread on the balance or hair-spring collet, and be apt to form a sticky film between it and the balance-cock.

The balance should run true, and be in perfect equipoise when the hair-spring is removed, and be free of the cock, the potence, and all adjacent parts. The verge pivots should be about three diameters long, and the ends should be flat, not pointed, so as to equalise the friction as much as possible when the watch is in a horizontal or vertical position. The hair-spring must be pinned quite tight to the collet on the verge, and this must be in the exact centre of the spring. The number of turns may be from six to eight, as it is found in practice that longer springs—that is, those with more coils—do not give such good results, a circumstance which may be explained by the short arc of vibration of the verge escapement.

Setting of the balance is the result of insufficiency of the motive power, and may be caused by anything which hampers the effect of the spring, or through a weak spring, or through the pallet being at wrong angle, so that the force is applied to it at a place and in a direction where the leverage is insufficient. The insufficiency of motive power may sometimes be caused by the excessive friction or weight of the balance, or anything which tends to make this difficult to move. Oil applied to the pallet will, when it becomes thick, very seriously impede the progress of the escape-tooth over the pallet face during the lift, and oil should not be used on the verge at all, and hence a stronger reason for seeing that the lower pallet does not gather oil from the bearing of the bottom pivot.

A verge which is itself bent, or has bent pivots, or in which these have been turned not exactly concentric with the body of the verge, will be always a source of trouble, and if the defect cannot be remedied a new verge should be put. If the escape-wheel axis is not properly at right angles with the balance axis, the action of one pallet will be deeper than that of the other, the lift greater, and the arc made on each side of the point of rest will be unequal. The above, I think, enumerate most of the defects which are the result of former injudicious alterations, or so-called repairs, and those caused by simple wear and tear.

The breakages of most frequent occurrence I will now notice, and give directions for mending.

Broken main-springs are perhaps the most serious and the most common of breakages. What causes springs to break has as yet not been satisfactorily explained, but probably peculiar variations in the temperature are the chief cause, as it is usual to find that a large number of springs break at the same time. This mishap is often accompanied by a broken chain, this latter being caused by the barrel running backwards on the spring pressure failing. A broken spring may be repaired, or at least used again, if the breakage has occurred near to the outer end, and the length of the spring not much shortened by the piece broken. It is then only necessary to soften the extreme end of the spring, and punch a hole in it to hook on to the pin projecting inside the barrels. After trimming off the broken edge smoothly, the spring is put back in its place, and will be as good as a new one usually. If a new one has to be put, it should be selected as nearly as possible of the same strength as the old one, and, of course, of the same width. Put the new spring in the barrel, and notice its length, or how much of the space it occupies. The proper proportion is this: the space of the arbour in the centre to the side of the barrel should be equally divided, and one half occupied by the spring. On the supposition that the old spring was correct for strength, you should always re-place it with one as nearly as possible like it. If the spring occupies more than half the space, take it out and break off a piece till the proper length is attained; now heat half an inch of the end not quite red hot, punch a round hole about $\frac{3}{8}$ of an inch from the end, then taper off the point of the spring, leaving it full width where the hole is. Some watches have the main-spring hook rivetted to the barrel, and some to the spring. If the former, you will have no trouble but to make the hole in your spring large enough to hook on; if you have to rivet the hook to the spring you may be able to make use of the old one.

The chain is repaired by first removing the broken piece of link from one end with a penknife, using it to slice apart the links; then the pair of links as well as the broken piece are removed from the other piece of chain by the same means. I have assumed that the breakage has occurred across a single link, as is invariably the case. On parting the links with the knife the rivets will become loose and fall out, and the chain can be put in position with the holes in the links one over the other. A piece of steel wire filed up slightly tapering is put through and cut close off on either side, then rivetted and made flush with the side of the chain by the aid of Arkansas stone. In placing the chain together for rivetting, take care that both hooks are towards the same side. Though easy to describe the mending of a chain is by no means easy to do, and it often happens that an experienced hand will break off two or three links before succeeding in getting the joint satisfactory.

The breakage of a spring is always liable to cause other damage, as bent teeth or pivots, or sometimes one of these gets broken, and it is necessary to ascertain whether such damage has been done before setting the watch going again.

Bent teeth are straightened by means of the screw-driver used as a lever against the root of the adjacent teeth, and bent pivots may be held in the jaws of the pliers and the pinion bent with the fingers in the direction and to the extent required. For such a purpose pliers having the jaws lined with brass are used, so that the pivot is not bruised and the bending has to be done with great care.

A broken verge must be re-placed by a new one, and this is a job requiring great skill and practice. A pair of turns having suitable centres—that is to say, very fine female ones—are wanted; also a small screw ferrule to fix on the verge, and a small whalebone drill-bow with a horse-hair in place of gut. A small graver will also be required to do the actual turning, and a proper tool, called a "Jacot," is almost essential on which to polish and finish off the pivots. Having procured a rough verge of the correct size, screw the ferrule on it and mount it on the turns; then knock the balance off the old verge, and use it as a guide in turning down the brass collet, which is the first part to be finished. Turn this to fit the balance and the hair-spring collet, and see that the shoulder of the former is at the proper distance from the pivot, and shape it properly for rivetting on the balance. Then turn the pivots nearly to size, and finish on the "Jacot" tool; and when the new verge fits the holes in both cock and potence, rivet the balance on. See that it runs true, and you have finished, with the exception of putting on the hair-spring.

The chain running flat on the barrel is generally caused by a faulty chain, though sometimes through the barrel being out of upright, and also if the chain is too wide for the spiral in the fusee. The chain should be examined to see that it goes into the groove in the fusee, and that it fills it entirely; then, if the barrel is square with the axis of the fusee, it is only necessary to stiffen the chain a bit by hammering it along the rivets, and then, unless a very bad one, it will not turn over flat.

Broken pivots may be re-placed by drilling up the old pinion, which may possibly require softening for the purpose, and putting a plug of steel in, which is then made into a pivot. To centre the broken pinion correctly the watchmaker proceeds thus: first the end is made tolerably flat with Arkansas stone, the pinion is then mounted in the turns with a screw ferrule on it, and the broken end resting in a groove cut across the T rest; the point of the graver is brought against the end, and the work turned with a drill-bow, its diameter always bearing in the groove, whilst the graver rests on the T, and with its point centres the pinion end.

Secrecy Amongst Mechanics.—There is a class of mechanics who affect great mystery about their work, and appear to imagine they can convey the impression that there is something occult or hidden in the processes they use and the materials they employ. Inventors are peculiarly sensitive about making known what they intend to do or the way they intend to do it, as though the world stood agape, ready to wonder and admire as soon as the letters patent were issued. Perpetual motion mongers are justified in keeping secret their experiments—they usually keep secret the result. But in nine cases out of ten the genuine inventor could obtain any money assistance he requires simply by trusting his proposed improvement in detail to judicious friends, and he might with safety and advantage frequently take a brother mechanic into his confidence. There are very few manipulations or manufacturing processes which are truly secrets, and in many of these cases the secret consists in the quality of the material used, a material perhaps not readily obtainable elsewhere. If a secret process involves much mental calculation or expertness of handling, a chance visitor must have rare observing faculties if he can carry it away with him and reproduce it at will from his memory. The laws of the science of mechanics are open to all investigators, and what one man has learned of them may be learned by another man. It is an absurd and ridiculous pretension generally that assumes that one man knows alone what many are anxious to learn, that the finished article carries no suggestion of the processes through which it has passed, and that on one man's will and life depends the success of some important manufacture.

French Polishing.—The materials required are French polish, cotton wadding, washed-out cotton rags, raw linseed oil, and spirits of wine. Make a ball of the wad about the size of a hen's egg; wrap it in a bit of cotton rag; then soak it with polish by turning the bottle up on it. Some polishers pour the polish into a saucer and put the polish on the rubber with a small spoon, or a flat camel-hair brush. The rubber being soaked, place over it a second rag; then dip the tip of your finger in raw oil, touch the rubber with it, and begin by a circular motion, generally in one direction (the oil is to keep the rubber from sticking). If the wood is soft and porous it will absorb a good deal of polish; if you previously size the wood with thin glue size, and paper smoothly, it will absorb less. This polishing must be kept up until the porousness disappears, when the polish will have a good body. Next apply a little spirits of wine to the rubber along with the polish, omitting the oil. This is the process of "working out the oil" (removing all the oil from the surface); and it is because this oil is not entirely removed, that the polish afterwards sinks and gets dim. The rubber should now pass over the work without leaving hardly any mark of its course. Next take a new rubber and apply spirits of wine only, and that sparingly; polish as before. This is called "clearing off." All marks of the rubber will now disappear, and a brilliant polish be the result.

TO MAKE A CHAIN FROM A SOLID BLOCK OF WOOD.

THIS is a process which effects but little ultimate good as to the value of the chain itself, though the job is often undertaken by amateurs as a test for skill, and the manufactured chain, itself of no use, serves to prove the manipulative ability of the artificer. I shall simply describe the *modus operandi*, and leave the execution of the work to those who spend part of their time in making such knick-nacks. Bergeron, in his "Manuel du Tourneur," gives the process:—

In making a chain out of a solid piece of wood the first thing will be to select a piece of homogeneous texture, so that it will not be liable to split during the process of manufacture. For round rings the length of the wood must be equal to the semi-diameter of one ring multiplied by the number of rings which the finished chain is intended to consist of, *plus* one semi-diameter.

Thus, supposing the exterior diameter of the rings was ½in., and the chain was to be twelve links in length, the wood would have to be ¼in. x 12 links x ¼in. = 3¼in. long; turn up a parallel cylinder to the correct length, the diameter being equal to or slightly exceeding that of the finished rings; these dimensions must be decided before commencing operations, and are matters for simple calculation on paper.

The length of the cylinder must now be divided into equal parts, equivalent to the number of links in the chain. This can be determined by the aid of a pair of dividers, and lines marked with a sharp-pointed hand tool, simply scratches must be made; the circumference of the cylinder must now be divided into four equal parts by lines drawn parallel with the axis, and having decided on the thickness for the rings draw four more lines parallel to these, and at a distance equal to the thickness of the rings; by joining the lines diametrically opposite across the ends of the cylinder the figure formed will resemble four wedges, with their thin ends in contact; however, if lines be drawn parallel with each other, so as to inclose a portion equal in width to the distance apart of the lines along the surface of the cylinder, the figure on the end will represent a Roman cross, the legs of which are of equal length, being cut off by the diameter of the cylinder.

Having drawn these figures, secure the piece of wood in the bench vice with one of the arms of the cross projecting upwards, and with a fine small saw, having a stiff back, cut down the parallel lines on each side of the projecting arm, taking care to make the saw-cut of equal depth all along, and not to damage the cross-arms, which are at right angles; shift the wood in the vice so that another arm is brought uppermost, and so continue till eight saw-cuts have been made. The wood contained within the four angles of the cross will thus be separated from the bulk and fall away. Thus the cylinder will be made into a piece having the section cross-shaped, each arm of which may be carefully filed up to the correct thickness, and well smoothed; along the edges will still remain the equidistant marks, made on the circumference of the circle, representing the semi-diameter of the rings or links.

Secure the wood by one of the cross-arms in the jaws of the vice, allowing the two crossing it to rest on the tops of the jaws; then, with a fine saw cut down the prolecting arm at each alternate division right to the cross piece. These saw-cuts must, of course, be made as straight as possible, and will be distant apart equivalent to the diameter determined for the rings. The wood is removed from the vice and refixed with the saw-cut arm between the jaws. The operation of cutting down the now uppermost arm at each alternate division is repeated, of course, at the diametrically opposite points. The arms at right angles are then treated in precisely the same manner, but the saw-cuts are made at the intermediate divisions. The projecting arm of each cross-piece will now be divided into rectangular pieces, all united in the centre of the cylinder, and the further shaping of the chain will now be obviously apparent.

Each straight saw-cut made towards the centre must be enlarged to a triangular notch; this will be done by sawing off the angles at each side, the greatest care being necessary to ensure cutting off the right amount, for if too much is removed, from one angle even, the entire chain will be spoiled; it is therefore advisable to make a template—which can readily be cut out of a piece of sheet tin, or some material of that sort—and frequently test the progress of the work. When the notches have all been sawn out, the rings or links of the chain must be drawn on each flat part of the wood. The centre of each ring will be at the exact centre of each notch; that is to say, the notches along one series of divisions will form the centre points from which the rings on the other series are drawn. The inner and outer circumference of each ring ought to be exactly concentric. Accuracy in this may be ensured by drawing both from the same centre; each ring must be of the same size, and should be exactly in the centre of the diametrical sides of the cylinder.

All the rings are drawn as true as possible from their respective centres; firstly, the outer diameters; then the compass points are brought together a distance representing the thickness of a ring; and then all the inner diameters are drawn. When all are marked as plainly and accurately as possible, the superfluous material round the outer part of the links is removed by filing, &c., so as to get the entire piece as nearly to form as possible. The material within the inner circumference of the rings has now to be got out. To do this, drill a hole through each semi-circular disc, as large as possible, without damaging the boundary lines; pierce the hole through each ring on both sides; then secure the wood carefully in the vice, and, by means of a small frame.saw—one of those such as are used by watchmakers is most suitable—cut away as much of the interior semi-circle as can be conveniently got at. When all this has been done, the entire lot of rings will be joined together by that part of the wood contained within the angles of the cross arms, being only a square strip, the size of which is equal to the width of the rings. To separate the contiguous rings of each series is very easy—a saw-cut right through from side to side, in the centre of each ring, will do it; the rings will still remain attached together in alternate series, and the separation of these must be effected by passing the saw through the openings in two rings, in an oblique direction. As the edges of each ring will be left very rough and unequal, from the kerfs of the frame-saw, they will require to be carefully trimmed up to shape by the aid of files, and at this stage the greatest caution will be necessary to guard against the accidental breaking of some of the rings, which are now all detached from each other, though they are, of course, interlinked, and are sadly in the way. This, coupled with their fragility, makes the chances of splitting unsatisfactorily preponderant. Whilst the rings are being held in the jaws of the vice, either cork clamps or soft leather should be used to protect the rings from indentation.

To put the rings in the lathe and turn them absolutely true is a task involving an immense amount of trouble, and one which scarcely repays itself. It will be at once apparent that these rings can only be turned by means of a back-and-to motion, as when one ring is chucked the two which interlink with it necessarily cover up a not inconsiderable portion of the circumferial surface. However, the rings may be mounted in a split wood chuck, with a good-sized notch cut in one side to allow the other parts of the chain to be kept as much out of the way as possible. The motion imparted to the lathe-mandrel would be simply backwards and forwards by the hand on the pulley, and the position of the ring in the chuck would have to be changed, so as to bring that part which was beneath the two rings into a position where the cutting tool could act on it. This process of turning the links is most tedious and unsatisfactory, it being far preferable to shape them with a file, using a template to work to.

There is another method of shaping the links on the exterior, which I will suggest rather than describe; it is to form the outside of the cylinder by turning. Suppose a coarse screw, or rather a twist, equal in pitch to the diameter of the rings required and to the shape of the semi-circular projections before described; and then an exactly similar twist was cut in the opposite direction—*i.e.*, one right-handed and one left—the thread being cut as deeply as possible, leaving just enough to hold the two twists together. If this double twist was divided into a four-armed cross at each end, and the material contained within the angles removed, the exterior part of every ring would be found correctly shaped by the intersection of the twists. The interior would have to be cut out, and the rings divided as previously described.

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Marine Glue.—The true marine glue is a combination of shellac and caoutchouc in proportions which vary according to the purpose for which the cement is to be used. Some are very hard, others quite soft. The degree of softness is regulated by the proportion of benzole used for dissolving the caoutchouc. Marine glue is more easily purchased than made; but when a small quantity is needed the following recipe is said to give very good results. Dissolve one part of India rubber in 12 parts of benzole, and to the solution add 20 parts of powdered shellac, heating the mixture *cautiously* over the fire. Apply with a brush. The following recipe, taken from "New Remedies," is said to yield a strong cement: 10 parts of caoutchouc or India rubber are dissolved in 120 parts of benzine or petroleum (?) naphtha with the aid of a gentle heat. When the solution is complete, which sometimes requires ten to fourteen days, 20 parts of asphalt are melted in an iron vessel, and the caoutchouc solution is poured in very slowly, in a fine stream, and under continued heating, until the mass has become homogeneous and nearly all of the solvent has been driven off. It is then poured out and cast into greased tin moulds. It forms dark brown or black cakes, which are very hard to break. This cement requires considerable heat to melt it; and to prevent it from being burned it is best to heat a capsule containing a piece of it fresh on a water-bath, until the cake softens and begins to be liquid. It is then carefully wiped dry, and heated over a naked flame, under constant stirring, up to about 300° Fah. The edges of the article to be mended should, if possible, also be heated to at least 212° F., so as to permit the cement to be applied at leisure and with care. The thinner the cement is applied the better it binds.

A TWELVE-INCH LATHE HEADSTOCK.

(For Illustration see Lithograph Supplements.)

IN the construction of machinery, the first requisite is correct drawings from which to work. So well is this understood at the present time, that in the best machine shops some system of working drawings is adapted—presumably the one best suited to the purpose—which is rigidly adhered to in their practice. That thousands of pounds are saved every year by this plan does not admit of question. We have always endeavoured to impress upon our younger readers—continues the *American Machinist*, to which we are indebted for the accompanying—the importance of devoting considerable time to the study of mechanical drawing. It is not only of importance to understand mechanical drawing in the event of being called upon to fill some other position than that of workmen at their trade, but to read drawings properly it is advisable to know how to make them, for which reason alone every mechanic should be able to make drawings. The general subject of mechanical drawing for industrial purposes comprehends not only the alienation of the details of machines and machinery, but also the best arrangement of these details to embrace a system convenient for use in the shop. In our present issue we have devoted considerable space to the reproduction from the original blue prints of a subject which illustrates the system of working drawings in use at the machine tool works of A. M. Powell & Co., of Worcester, Mass., the blue prints having been kindly furnished us by that firm for the purpose. We have chosen the subject because it serves to illustrate the system to our readers who are interested in such matters, and especially because it furnishes a varied example for practice seldom found in an equivalent space.

Working drawings offer great attractions to thoughtful mechanics. A glance into them will show what frequently could not otherwise be ascertained without entirely dismantling a machine. A writer on practical draughting points out that one of the great advantages resulting from a knowledge of practical draughting is, that it enables a mechanic to *read* a drawing when given him as a guide for his work. On the other hand, if a mechanic has not a knowledge of scales, and the drawings are not figured, he will find it a difficult task to work exactly to the designer's plans. It is a practice which is getting every day more general among draughtsmen, to figure exactly and minutely every part of their drawings which are drawn to a scale. Even in full-sized drawings this system of figuring is not objectionable. It is a system which should be followed whenever a drawing is made "to work to," for it allows the workman to comprehend at a glance the size of his work and the pieces he has to get made. Figuring makes a drawing comprehensible, even to those who cannot make drawings. It obviates the necessity of having the mechanic to measure with his rule (too often a very dirty and greasy one) the dimension on the drawing. Still further, it allows the draughtsman to make an alteration in the size of any part, by simply altering the written figure and not erasing the lines. Lastly, it adds to the correctness of the drawing, which, being on paper and affected slightly by the weather, all inaccuracies will be covered by the plain written dimension, as 48in. long, or 36in. diam.; or 6in. by 4in., &c. Drawings are almost generally made "finished size"—that is, the dimensions are for the work when it is completed. Consequently all the figures written on the different parts indicate the exact size of the work when finished, without any regard to the size of the drawing itself, which may be made to any reduced and convenient scale.

Drawings can be made full size, but to make them so is often inconvenient and sometimes impossible. Recourse must be had to a scale when all the parts can be delineated in proportion with as much accuracy and ease as in full-size drawings. Work of every description, and plans of buildings, machinery, or mechanical apparatus can be drawn to any scale. In practice the scales that are mostly employed are those which are to be found on the ordinary two-feet-rule. These are half size, one-fourth size, one-eight size, one-twelfth, and one-sixteenth size. These scales are easily understood and read by the workman, as being found on his standard of measurement. The best scales to work with are one-eighth and one-fourth size, viz., $1\frac{1}{2}$in. equal 1ft., and 3in. equal 1ft. These scales are those usually adopted when the size and description of the work will allow.

There are a great many persons who cannot fully understand how to use these scales. Here, then, are some very explicit instructions:—"Take off" on the compasses 3in., and make a line on paper exactly this length. This is now the measurement for 1ft. If any part of the work is to measure 12in., then it must be drawn as 3in. Again, if inches of this foot are wanting, divide the 3in. into twelve parts, and consequently every twelfth part will represent 1in. of the scale; these subdivided again will represent half inches. Now the reader will please observe that these divisions are already to his hand, and divided off for him on the ordinary two-feet rule. Inasmuch as 3in. equal 1ft., then $\frac{1}{4}$in. equals 1in., $\frac{1}{8}$in. equals $\frac{1}{2}$in., $\frac{1}{16}$in. equals $\frac{1}{4}$in., $\frac{1}{32}$in. equals $\frac{1}{8}$in., $\frac{1}{64}$in. equals $\frac{1}{16}$in., and similarly with one-eighth size, or $1\frac{1}{2}$in. equal 1ft., for $1\frac{1}{2}$in. contains just twelve-eighths, which of course serve as inches, sixteenths as half inches, and thirty-seconds as quarter inches.

A practical knowledge of actual work is quite necessary in order to make accurate working drawings to the best advantage. Some idea of the scope open for the draughtsman may be inferred from a letter written to a contemporary, and which we reproduce.

Some years ago, says the writer, we were frequently thrown in contact with a worthy draughtsman, and never left his office without feeling benefited by having been there. On one occasion he was putting the finishing touches to a drawing for some machinery.

A pillow block was shown of a somewhat unique design, and we ventured to ask our tall friend how he expected such a shape would ever be moulded. The reply was, "I don't care how they mould it; that is the business of the pattern maker and the moulder, not mine." This was a turn taken by our versatile friend that we were least expecting, and not wishing to have our question disposed of in so summary a manner, we undertook to show reasons why he should know how this pattern was to be made and how it was to come out of the sand. A desultory discussion ensued, and we separated without having settled the question to the satisfaction of both.

But by his plausible sophistry we were half persuaded that we had been practising wrongly, meddling with other men's business, and unnecessarily spending much time and thought on drawings.

Subsequent years, however, have confirmed us in the position then taken, and we have many times since then thought of this incident when seeing a moulder fishing out flanges or lugs from some inaccessible part of his flask; or perhaps trying to secure hanging sand that was almost sure to spoil the casting; or, again, when called upon to settle a disputed question between the moulder and pattern maker as to the proper way of moulding a certain piece.

Such experiences have caused us to believe that draughtsmen should have in mind methods for executing their designs, whether applied to the moulding room, blacksmith shop, pattern or machine shop, and to see, as far as possible, that their plans are properly carried out. In cases where the designer cannot be with his drawings, it is the more important that instructions thereon be as explicit as possible; even though such explanations seem superfluous to some, they may be needed by others.

This leads to a consideration of what a draughtsman should be, and the scope of knowledge to be possessed by the constructor of machinery.

It may be claimed by some that we are requiring a designer to know too much, and that our lifetime is too short to become master of a half-dozen trades; and so it is, in a certain sense, yet it must be admitted that the more thoroughly practical the draughtsman becomes the better fitted he will be to design and execute his plans.

Natural qualifications may deserve here a share of our attention. In starting a young man off in an avocation, it would be well if his natural fitness and inclinations could be consulted; but this is rarely done.

The manufacturer has a son in whom he takes pride and wishes to raise to the highest order of mechanics—a mechanical engineer. During his vacation the boy is put to work in the machine shop, and before entering a technical course he is kept at this employment a year or two. As a rule, such a boy chafes a good deal under the shop discipline, and gives the foreman a good deal of trouble. He has learned to grind a drill or cold chisel, and can do a fair job on a drill press, when he starts off to school. In due time he graduates, but by this time he has learned to part his hair in the middle, and knows entirely too much to go back into the machine shop; for in this case no one would know him from any other apprentice.

To encourage the boy and bring him out, his father places him at the head of the drawing room in his establishment. As for genius or originality, he never had any, and, as a result, the productions from such a source are simply copies of other men's designs with many of the essentials left out. Against such piracies the patent laws only partially protect. Such concerns sometimes fail, and then we are likely to have an addition to the list of patent solicitors.

The plan now employed by some of the schools of connecting workshops with them is a good one, and will afford excellent opportunities for judging of the natural fitness of students for the places they wish to fill. It would be well, if it were possible to do so without giving offence to the parents, or affecting the interest of the school, to send many of the applicants home to seek other avocations than those of mechanical engineers, or designers and constructors of machinery.

We are led to make these few comments in introducing drawings of a twelve-inch American lathe headstock, taken from "The American Machinist."

The accompanying lithographs are a sectional view of the complete headstock, and a sheet of details representing exactly what is used in the workshop as working drawings, with all dimensions marked in figures, the original being reduced in size by photography. The general arrangement of the parts in the sheet is preserved for reference, while the forms are presented for re-production. Capital practice will be afforded to the young mechanic by carefully re-drawing a full-size sectional view of the lathe as represented, or the dimensions may be varied to any scale. It will not be out of place to here mention that the back-gear wheel, shown broken to save space, has 67 teeth, 4 pitch, and the outside diameter is 17¼ inches. The bolts used to fix the head to the bed are ⅞ inch diameter. The lathe is what the Americans call a 24 inch swing, that is, equivalent to our 12 inch centre.

In re-producing these drawings it is not essential that it be done on the scale here shown. The scale can be enlarged at first and afterwards made the same, or less, if desired. It is also quite proper to improve on the arrangement of the parts on the sheet, if one sees a way to do so. Before trying to do this, the reason for the present arrangement should be closely studied. The plan of carefully marking dimensions so as to leave nothing of importance to be determined by measurement, should be rigidly adhered to. The examples given furnish abundant room for thought as to the ways and wherefores of machine construction, as well as examples in detail drawing, and the arrangement in sheets. Of their system A. M. Powell used to write as follows:—"We first make our drawings in pencil upon Manilla paper, showing all views full finished size, giving amount of finish necessary for the pattern maker. From these preliminary drawings patterns are made, and one complete machine built, noting all discrepancies of finish figures that may be found, also what improvements can be made from experience found in building this machine. This drawing is given one coat of white shellac and given into the draughtsman's hands to make complete working drawing."

These detailed drawings are made upon cards of uniform size 10 inch by 13½ inch. We make sectional elevations of the different parts of the machine—like the engravings you have—for use in setting up and also sheets showing complete details of machines, giving the different views necessary to show the workman what the part is, and how it is to be made. These parts are numbered to correspond with the number on the sectional drawing. Each drawing of casting is numbered to correspond with the number in the casting-book, from which orders are given to the foundry for castings. These sheets when finished are given one coat of white shellac, their dimensions are put on and tracings are taken from them and blue prints made. The cards are stored away in the drawing-room for reference.

Polishing Tortoise-shell.—A very perfect surface is first given by scraping; the scraper may be made of a razor-blade, the edge of which should be rubbed upon an oilstone, holding the blade nearly upright, so as to form an edge like that of a currier's knife, and which, like it, may be sharpened by burnishing. When properly scraped it is ready for polishing. To effect this it is to be rubbed with a buff, made of woollen cloth, perfectly free from grease; the cloth may be fixed upon a stick to be used by hand; but what the workmen call a "bob," or a wheel running in the lathe, and covered with a cloth, is much to be preferred, on account of the rapidity of the operation. The buff is to be covered with powdered charcoal and water, or fine brick-dust and water. After the work has been made as smooth as possible with this, it is followed by another buff or "bob," on which dry whiting is rubbed. The article to be polished is moistened slightly with vinegar, and the buff and whiting will produce a fine gloss, which may be completed by rubbing it with the palm of the hand and a small portion of dry whiting or rottenstone.

IMITATION IVORY ORNAMENT.

ARTIFICIAL ivory is a well-known substance frequently brought into requisition in the industrial arts, and a large number of patents have been secured at different times for the compounding of this material. A correspondent supplies the following account of a process for making and applying imitation carved ivory ornament to wood:—If the article to be ornamented is of mahogany, rosewood, or walnut, polished, the "carvings" can be applied without disturbing the polish; but if of common wood or without polish, it must be coloured white or ebonised. If, for instance, then, a work-box is not made of white wood, take ½oz. of isinglass, and boil it gently in half-pint of water till dissolved, then strain and add flake white, finely powdered, till it is as thick as cream. Give the box three or four coats of this solution, letting each dry before the other is laid on; then smooth it with a bit of damp rag.

When the composition is dry we can put on imitation ivory figures, which are to be made as follows:—Boil ½lb. of best rice in one quart of water till the grains are soft enough to bruise into a paste; when cold mix it with starch powder till it becomes as stiff as dough, roll it out about as thick as a shilling. Cut it into pieces about two inches square, and let it dry before a moderate fire. When required for use get a coarse cloth, make it thoroughly wet, then squeeze out the water, and put on a large dish four times double; place the rice cakes in rows between this cloth, and when sufficiently soft to knead into the consistence of new bread, make it into a small lump; if too wet mix it with more starch powder, but it must be sufficiently kneaded to lose all appearance of this powder before you take the cast.

The moulds are of guttapercha, about ½in. thick; cut the latter into pieces of 2in. square, and soften it in hot water, then obtain if possible some specimen of real carved ivory or other suitable work, cameo-heads, and take off the impression on a piece of guttapercha by pressing it carefully upon the carving till a deep impression is taken. When the moulds are quite dry and hard, with a small camel-hair brush touch lightly with oil the inside of the moulds, and then press the paste into them. If the impression is quite correct on removing it, take a thin, sharp, small knife, and cut the paste smoothly, so as to leave the impression perfect, then with a sharp-pointed penknife turn all the rough edges, and with a solution of acetic acid or liquid glue, place the figures on the box in large or small pieces, just as taste directs. The figures adhere better if put on before they are quite dry.

Sometimes, from frequent kneading, the paste gets discoloured; such pieces should be set aside and used separately, as they can be painted in water-colours to imitate tortoise-shell or carved oak; this should be done after being stuck to the box. Having completed the work, finish by varnishing it very carefully with ivory varnish, which should be almost colourless; paper varnish, or the best "white hard" will answer very well. Such articles so nearly resemble carved ivory that they have been mistaken for the latter when nicely done; and they are very strong if carefully cemented, and look well for boxes, card cases, &c., either as ivory or tortoise-shell. Instead of oiling the mould a pleasing effect can be produced by using powdered French chalk (steatite) or blacklead, as the lubricating medium between the paste and the guttapercha. The objects when cast may be readily dyed with liquid colours, such as the aniline dyes. The "carvings" must be thoroughly dried before the varnish is laid on, so the work must be put away in some place free from dust, till it can be completed.

There is a material called fictile ivory, prepared by intimately mixing and passing through a fine sieve superfine plaster of Paris and Italian yellow ochres, the proportions being about half an ounce of ochre to each pound weight of plaster. These ingredients are formed into a plaster cast by the usual methods. The cast is first dried in the open air, and then in an oven, and is then soaked for about fifteen minutes in a mixture of spermaceti, white wax, and stearine, equal parts of each, rendered fluid by heat. On removal from the wax bath the cast is allowed to drain, and any excess of wax in the crevices is brushed off; when quite cold, it is polished with a tuft of cotton wool. Artificial ivory is said to be made by adding finely-powdered egg-shells to a paste made of isinglass dissolved in brandy; this material may be tinted to any desired shade, and pressed into moulds and allowed to dry. The compound is rended fluid by heat, and should be poured, whilst warm, into oiled moulds; it is then allowed to set and dry, when its appearance is very similar to ivory.

THE LATHE A UNIVERSAL TOOL.

IF one had to carry on the machine business with small means, he could get along very well with a lathe and vice bench only. That is to say, there are few jobs in a shop that cannot be done with these simple tools. The lathe will not only turn work, but it will supplant the planer, the milling machine, the bolt cutter, and the gear cutter, for many of the jobs usually done in these several machines, can be done in the lathe. Where work can be held in a chuck it can be faced off to a flat surface much quicker, and quite as accurately, in a lathe as on a planer. Take a slide valve for example, and where it can be gripped readily the lathe will face it up true before the planer will, for equal surfaces. This for the reason that the valve can be set more quickly in the lathe, is constantly under the cutting tool, and can be run at a higher speed. A lathe may be called a circular planer, with the advantage that it can do other work that the planer cannot. When it comes to cutting gears, if a lathe is provided with simple fixtures having an index plate (such as the centres used on a planer for instance) the finest work in this class can be done. A gear cutter is nothing more than a special machine, with a revolving spindle, and a wider range of capacity than the lathe.

We might pursue this line of illustration at length, continues the "Mechanical Engineer," but what we have said sets forth the universal and indispensable character of the lathe as a machine tool, and this being admitted, the methods pursued in its construction are of the first importance. The first necessity is strength and stiffness. Everything else must be subordinate. Every appliance for convenience and facility of access should be sacrificed sooner than absolute rigidity and immobility. The bigger and heavier it is, the better it is. No man ever saw a lathe that was too heavy, and he never will. If the bed was a solid block of iron without ribs, legs, braces, struts or any other abomination, that would be the ideal bed. If the head stock and tail stock were similar, the cone pulley-solid throughout, a mere block of iron with the proper steps on it for speeds, a great advance would be made, for the object is to prevent all vibration, spring, and distortion. These ends are obtained only by absolute absence of elasticity, and the absorption of disturbing forces. Want of material in the tool is its greatest weakness, and one not compensated for by anything else.

A light lathe is a chattering lathe, for the reason that if it is put up to its utmost capacity, it springs and communicates its spring to the work, which in turn is acted on intermittently. Other things tend to make lathes chatter, such as light spindles and springy carriage, etc., etc., but a prime fault is want of material in the proper place. Why should a lathe bed not be solid down to the floor; a parallelogram of iron without legs or supports, other than its own bottom? Custom cocks it up on stilts on each end, because lathes always have been so made, and because it seems handy to have it so. When we say solid we mean like a box without a cover, turned upside down, not solid iron from one side to the other as we mentioned in a previous illustration. Some machines are so made now; milling machines and gear cutters, for example, and it would be just as reasonable to mount them on four long legs, as to build lathes in that manner. If the cost is an objection it should also be considered in the case of other machines, but the fact is that mere material is the least obstacle. It is so many pounds of iron, at so much a pound, which could easily be added to the price without demur from the purchaser. If lathes were made in this way there is no question of their rapid sale, the mere appearance and common sense of design would commend them on sight.

It seems to us that the machine tools of the future will be a great advance upon those now in use, and accepted as beyond improvement. New men coming into the business will bring new ideas. The technical schools will impart instruction which will be used to advantage by its pupils, to the great gain of the artisan of the rising generation.

* * *

To Polish Fancy Woods.—Soft woods may be turned so smooth as to require no other polishing than that produced by a few fine turnings or shavings of the same wood applied while revolving. Mahogany, walnut, and some other woods may be polished by the use of a mixture as follows: Dissolve by heat so much beeswax in spirits of turpentine that the mixture, when cold, shall be of about the thickness of honey. This may be applied to furniture or to work running in the lathe by means of a piece of clean cloth, and as much as possible should be rubbed off by using a clean flannel or other cloth. Hard woods may be readily turned very smooth; fine glass paper will suffice to give them a very perfect surface; a little linseed oil may then be rubbed on, and a portion of the turnings of the wood to be polished may then be held against the article, while it turns rapidly around, which will in general give it a fine gloss. You may also try alcoholic shellac varnish, 2 parts; boiled linseed oil, 1 part; shake well before using. Apply a small quantity with a cloth, and rub vigorously until the polish is secured.

Use Nails!—When a man's house is building, he never thinks the carpenter puts in one-third enough nails, and frequently, and with biting sarcasm, asks him if he doesn't think the house would stand if he just simply leaned it up against itself and saved all his nails? Then, a few years afterwards, when he tears down his summer kitchen to build a new one, he growls and scolds, and sarcastically wonders why that fellow didn't make the house entirely of nails, and just put in enough lumber to hold the nails together.

A UNIFORM SCREW GAUGE FOR SMALL SIZES.

SIR JOSEPH WHITWORTH brought the question of establishing a standard system of screw threads before the Institution of Civil Engineers; and the paper which he communicated in 1841 to the Institution remains to this day the recognised authority on screw threads from ¼ inch diameter upwards. Sir Joseph Whitworth not only succeeded in setting forth a uniform number of threads per inch for each diameter, but he also fixed the exact angle and depth of the threads. At the present time every mechanical shop of any standing uses threads more or less closely approaching Whitworth's Standard, at least, so far as concerns the British Empire; though, for some reason not easily understood, the Franklin Institute of the United States has recommended a new standard, differing in many points from Whitworth's. While we willingly allow that this United States standard remedies certain slight anomalies in the Whitworth system, still we do not think that these slight improvements warranted a departure from an original which met all practical needs: the result being to create confusion between the mechanical productions of two great countries.

Although Whitworth thus called order out of what had been confusion, and conferred a boon upon his fellow men which—had he done nothing else—would make his name famous for ever in the annals of applied science, his improvements really only dealt with screws for machinery and comparatively heavy work, and to the present time there is no standard system of screw threads suitable for light work, such as clocks, watches, mathematical instruments, electrical apparatus, and the smaller parts of guns, pistols, sewing machines, bicycles and other mechanism requiring very small screws. The result is that every maker is a law unto himself and a cause of confusion to his fellows.

This state of affairs is fast becoming intolerable, especially in face of the extraordinary multiplication of electrical apparatus for telegraphic and lighting purposes, and it is most urgently necessary to remedy it as soon as may be. With this laudable object in view the British Association in 1881 appointed a committee to go thoroughly into the question of screw threads for small diameters, and to report upon the same. That the confusion which now exists is as bad as well can be is proved by one fact brought to the notice of the committee by a manufacturer who had to execute an order for railway signal apparatus in accordance with three sample instruments. These three instruments contained among them twenty-one screws of different threads, not one of which happened to be in use in the shop of this manufacturer. Not only is there no recognised number of threads per inch for small screws, but there is not even any recognised form of thread, or standard range of diameters; everything is simply chaotic, and repairs are especially costly, because of the constant necessity for executing them far away from the place of original manufacture of the apparatus to be repaired. This diversity of threads and diameters necessitates a multiplicity of special and costly tools, and renders almost impossible any system of interchangeability of parts and division of labour.

The Société des Arts de Genève appointed a committee in December, 1876, to consider the question of uniform threads and diameters for small screws, and Professor Thury has fully described the system proposed by this committee. In conducting their inquiries the committee collected a large number of screws of all sizes from many factories, which they carefully measured, tabulating the results, and plotting the dimensions. Proceeding on these lines they formulated a standard system embracing the various points of diameter, form of thread and pitch. Their view was to adopt a system as nearly as possible conforming to the mean average of the proportions found to prevail in practice in the shops of various countries. They adopted one millimetre pitch as the basis of their system, and they decided that that pitch best suited a diameter of six millimetres. A triangular form of thread was adopted, differing somewhat from Whitworth's form, as will be seen by the following particulars. The Whitworth thread is triangular in form, and the angle made by the two sides of each thread is 55 degrees. One-sixth of the depth of the thread is rounded off from the top, and one-sixth from the bottom, and the actual depth of the thread is rather more than three-fifths, and less than two-thirds of the pitch, that is to say, between nine-fifteenths and ten-fifteenths. The Swiss thread is also triangular in form, but the angle included between the two sides of the thread is 47½ degrees; the depth is three-fifths of the pitch, and the thread is rounded off at the top by a radius equal to one-sixth, and at the bottom by a radius equal to one-fifth of the pitch. The screws given in the Swiss table are numbered from 0 to 25. The screw numbered 0 is 6 millimetres—equal to 236 thousandths of an inch—in diameter, and its pitch is 1 millimetre, or 39 thousandths of an inch. The pitch of each succeeding screw in the series is $\frac{9}{10}$ths of the next larger, which is an arrangement admirable in its simplicity, and rendering these screws suitable for many purposes besides the primary one of holding pieces of mechanism together. To go through the sizes of all the Swiss screws would be beyond the scope of this article, but we give the table furnished by the Committee. In explanation of this table we may say that the dimensions of the pitch and diameter are given in millimetres and mils; the mil being the thousandth of an English inch. It will be observed that the No. 25 screw has no less than 357 threads to an inch.

On many grounds it would be desirable in fixing upon standard sizes for small screws in England to adopt the metric system of measurement, but there are so many difficulties in the way that this can hardly be done; and it must be borne in mind that, although scientific men largely use metric measurements, almost all the tools, gauges and other appliances in use in the best English shops are based upon the inch, which, again, is the thirty-sixth part of the yard, the latter being the British legal standard of length. Hence the Committee of the British Association determined to recommend that the mil be taken as the standard of length, and that the decimal system should be adopted for expressing dimensions. After an exhaustive consideration of the questions affecting the pitch, form and depth of threads, they have determined that the Whitworth standard affords the best basis. That their decision is a wise one there can be no doubt, for Whitworth threads have proved themselves by long practice to be admirably adapted to engineers' requirements.

The points remaining to be decided are:—First, a table of diameters; secondly, a table of pitches to suit the same. On these points we may have something to say hereafter. In the meantime we trust that the British Association will instruct their Committee to carry their researches further; and also accede to the request of the Committee for a small grant to enable them to have some sample screws and gauges made, so as to apply a practical test to such standards as the Committee may propose.

Report of the Committee, consisting of Sir Joseph Whitworth, Dr. Siemens, Sir F. J. Bramwell, Mr. A.

Stroh, Mr. Beck, Mr. W. H. Preece, Mr. E. Crompton, Mr. E. Rigg, Mr. A. Le Neve Foster, Mr. Latimer Clark, Mr. Buckney and Mr. H. Trueman Wood (Secretary), appointed for the purpose of determining a gauge for the manufacture of the various small screws used in Telegraphic and Electrical Apparatus, in clockwork, and for other analogous purposes.

1. This committee was formed by the General Committee of the British Association assembled at York in August and September, 1881, for the purpose of determining a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in clockwork, and for other analogous purposes.

2. At that meeting a paper was read by Mr. Preece, pointing out the desirability of establishing such a gauge. Although the Whitworth gauge is almost invariably adopted for the bolts and screws used in millwork and engineering in England, no general system has been hitherto applied to the smaller screws, used either in clockwork, philosophical instrument work, or in the numerous practical applications of electricity that are now rapidly becoming so important. In fact, at the present time, gauges and screw-plates almost equal in number the makers engaged in the trade. One instance was brought to the attention of the committee, by a manufacturer who had to execute an order for railway signal apparatus, in accordance with three sample instruments, containing among them twenty-one screws of different threads, not one of which happened to be in use in his shop. There is now no recognised form of thread, no specified number of threads per inch—in fact, no generally accepted gauge, based on practice and experience. Great inconvenience is felt in providing for repairs, which are, in consequence, more costly and less efficient.

The employment of some coherent and uniform system is manifestly required. It not only would render repairs easier, speedier, and cheaper, but it would introduce interchangeability of parts, and further the extension of piece-work; and it would reduce the equipment of workshops with special and costly tools.

3. The subject of uniformity in screws has been very warmly taken up by the Société des Arts de Genève, which appointed a committee in December, 1876, who, after assiduous labours, issued a report in 1878. The system proposed by them has been very fully described by Professor Thury in two pamphlets published in Geneva.[*] The committee collected numerous screws of all sizes from many factories, measured them carefully, tabulated their several dimensions, and plotted the results by the ordinary method of linear co-ordinates. They determined the mathematical equations to curves that most closely corresponded with the ratios of diameter to pitch thus found to have been employed in practice, and adopted the one which most nearly represented the mean average proportions of the screws in use at various shops, and in different countries.

The Swiss committee took one millimetre pitch as the basis of their system. It was agreed that such a pitch was best adapted to a screw having a diameter of 6 millimetres. The form of thread adopted was triangular, the angle made by producing the two sides being approximately 47½°; the depth being $\frac{3}{5}$ of the pitch, the top being rounded off by a radius $\frac{1}{6}$, and the bottom by a radius $\frac{1}{6}$ of the pitch.

The committee has had an opportunity of examining screw plates, and numerous packets of the corresponding screws manufactured on this system.

The following table gives the pitches and diameters, in millimetres and "mils,"[†] to two significant figures, and the number of threads per inch of all the screws comprised in the small screw series, which happens to cover the exact ground to which the attention of the committee has been specially directed, namely, diameters below the ¼ inch :—

TABLE OF SWISS SCREWS.

No.	Pitch.		Diameter.		Threads per inch.
	Mm.	Mil.	Mm.	Mil.	
25	0·072	2·8	0·25	10	357
24	0·080	3·1	0·29	11	323
23	0·089	3·5	0·33	13	286
22	0·098	3·9	0·37	15	256
21	0·11	4·3	0·42	17	233
20	0·12	4·8	0·48	19	208
19	0·14	5·3	0·51	21	189
18	0·15	5·9	0·62	24	170
17	0·17	6·6	0·70	28	152
16	0·19	7·3	0·79	31	137
15	0·21	8·1	0·90	35	124
14	0·23	9·0	1·00	40	111
13	0·25	10·0	1·2	46	100
12	0·28	11·	1·3	52	91
11	0·31	12·	1·5	59	83
10	0·35	14·	1·7	67	71·4
9	0·39	15·	1·9	76	66·7
8	0·43	17·	2·2	86	58·8
7	0·48	19·	2·5	97	52·6
6	0·53	21·	2·8	111	47·6
5	0·59	23·	3·2	126	43·5
4	0·66	26·	3·6	142	38·5
3	0·73	29·	4·1	162	34·5
2	0·81	32·	4·7	183	31·2
1	0·90	35·	5·4	208	28·6
0	1·00	39·	6·0	236	25·6

It is to be observed that the numbers by which the screws are designated, given in the first column, are not arbitrary. Each pitch of the series is $\frac{9}{10}$ths of that which succeeds it in the table.

Thus the several pitches are :—

$$1\text{mm.}\ ;\ \tfrac{9}{10}\text{mm.}\ ;\ \tfrac{9}{10})^2\text{mm.}\quad \tfrac{9}{10})^3\text{mm.};\ .\ .\ \tfrac{9}{10})^n\text{mm.}$$

This series may be expressed in the form :—

$$0{\cdot}9^0\ ;\ 0{\cdot}9^1\ ;\ 0{\cdot}9^2\ ;\ 0{\cdot}9^3\ ;\ .\ .\ .\ 0{\cdot}9n\ ;\ .\ .\ .\qquad (1)$$

whence it is at once evident that the designating number of the screw is the index of the power to which 0·9 must be raised in order to ascertain its exact pitch in millimetres.

The method by which the relation between pitch and diameter is arrived at will be gathered from the following explanation :—

Let D represent the diameter, and P the pitch. Then, generally,

$$D = f\ (P)$$

Evidently there can be no constant term, for when $D = O$, P must also $= O$. Moreover, D practically cannot be a simple multiple of P, for experience has shown that small screws must have a less number of threads per diameter than large screws.

Hence the formula will be of the form

$$D = m\ P^k\quad .\ .\ .\quad (2)$$

where m and k are constants to be determined.

Since 1^k is 1 whatever be the value of k, it follows that the co-efficient m represents the value of D when P is 1. The Swiss committee agreed that the unit pitch (1 millimetre) should be adopted for the screw having a diameter of 6 millimetres; in other words, they make $m = 6$.

The value of k must be ascertained by trial.

$k = 1$ would give a constant ratio, which we know is inadmissible.

$k = 2$ will be found on trial to give a far too rapid decrease in the ratio of diameter to pitch.

The several simple fractions between these limiting values were tried in succession, and the results

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[*] *Systematique des vis Horlogeres*, Genève, 1878. *Notice sur le Systeme des vis de la Filiere, Suisse*, Genève, 1880.

[†] The "mil" is the thousandth part of the British inch.

obtained when using $\frac{6}{5}$ were found to give results that best accord with practice and experience.

Substituting the values thus arrived at in (2), the formula becomes

$$D = 6P^{\frac{6}{5}} \quad . \quad . \quad . \quad (3)$$

The Swiss system is thus very complete, but there are reasons which prevent this committee from recommending its adoption in its entirety.

4. No one has done more to establish gauges of all kinds in England than Sir Joseph Whitworth. His classical paper on "An Uniform System of Screw Threads" was communicated, as far back as 1841, to the Institution of Civil Engineers. He had made an extensive collection of screw-bolts from the principal workshops throughout England, and the average thread was carefully measured for different diameters. The ¼, ½, 1, and 1½ inches were selected and taken as the fixed points of a scale by which the intermediate sizes were regulated. The result is an admirable thread for the large iron bolts and screws used in fitting up steam-engines and other machinery. The angle made by the sides of this thread is 55deg. One-sixth of the depth of the thread is rounded off from the top, and one-sixth from the bottom. The actual depth is rather more than three-fifths, and less than two-thirds of the pitch.

The slow adoption of such an admirable system was perhaps due, in great measure, to the fact that it was put forward by an individual, and not by an association. A single individual, however exalted his reputation, cannot secure that immediate and universal attention which is obtained by such an organisation as the British Association. The system of units of electrical measurements sanctioned by the Association obtained instant recognition, and has now, thanks to the Congress of Electricians, held in Paris in October, 1881, become universally accepted. It is hoped that the same result will follow the recommendations of this Committee.

5. The question of the introduction of the metrical system occupied the serious consideration of the Committee, but, considering the fact that it is not generally adopted in engineering or manufacture in England, and that it is as yet little understood by our workmen, it was thought better to suggest no change in this direction. The Committee is not insensible to the simplicity of the metrical system and to its possible universality, nor to the fact of its gradual introduction in scientific circles, but while the manufacturing interests are still wedded to the British inch, and its multiples and submultiples, and while the British legal standard of length is still the yard, the Committee has felt it impossible to suggest a change which has little chance of adoption, and which might jeopardise the introduction of that with which they are more concerned—viz., a uniform screw-thread.

Hence it was determined that the unit of length taken should be the "mil," and that the decimal system should be adopted for expressing dimensions.

6. The use of a screw is to draw together and to unite certain parts of apparatus in firm and intimate contact. To attain these ends, a screw must facilitate the application of mechanical power to draw the parts together, and it must possess strength to hold them so; it must not interfere with the easy separation of these united parts when necessary; it must possess durability—that is, it must be capable of repeated use without undue friction and without wear, otherwise it will speedily become loose and dangerous when frequently removed and restored. There has to be considered the pitch of the screw, its relation to the diameter of the bolt on which it is cut, the depth of the cut, and the form of the thread. The pitch primarily determines the power of the screw, for it determines, for each diameter, the angle of the inclined plane; the depth determines the section of core left to resist shear or rupture; while the form of the thread determines the durability and efficiency, and determines also the surface of thread to bear endway strain.

7. The committee have devoted very considerable attention to the pitch, form, and depth of screws, and they have compared together a large number of different kinds, some of which are in actual use, while others have only been suggested. They have, moreover, decided on recommending the adoption of the Whitworth form of thread, not only because it is so well known, but because experience has proved it excellent, and unsurpassed when employed for engineers' bolts. The committee, however, are not unanimous on all questions involved by this proposal, and as there are several points that require to be thoroughly sifted and tested, they ask to be re-constituted, and to be allowed a small grant to put their proposal to the test of practice, and to have a few gauges constructed for distribution or examination.

The following particulars, as to what has been done in the United States in relation to this subject, are taken from an article in the *Railroad Gazette*:—

The mechanical difficulties which have stood in the way of the general adoption of a uniform or interchangeable system of screw-threads were very great. These have been overcome by the enterprise of the Pratt and Whitney Company, of Hartford, and, through them, the Master Car-builders' Association has been able to secure a standard set of gauges, on the accuracy of which the most implicit reliance may be placed. There is, however, still one step to be taken. The Franklin Institute, years ago, took what may be called the legislative step, and formulated what the standard system of screw-threads should be. The Pratt and Whitney Company then assumed judicial functions, and decided, by actual and precise measurements, what that system is. But the executive part of the reform is not yet adequately provided for. To illustrate this, let it be supposed that a railroad company is disposed to adopt the Sellers' system of screw-threads. There are at present no convenient means which a master mechanic can employ, and which will enable him to be certain that the screw-threads conform with sufficient accuracy to the standard. They may, it is true, order taps and dies of the Pratt and Whitney Company, with very great confidence that they will be right; but, quite naturally, some companies say we do not wish to give a monopoly of this business to one firm or company. We want to buy taps and dies in the open market, and we want some ready means of knowing whether they are made with such precision that the interchangeability of bolts and nuts will be maintained.

The Pratt and Whitney Company is prepared to furnish duplicate gauges, but even then there comes up the question how near to the gauges, taps and dies must conform. Every good practical mechanic knows that absolute precision is unattainable, and, therefore, in the inspection of such tools, it will be necessary to determine how much difference is allowable.

The same thing is true of bar-iron. For a long time it has been the practice of rolling mills to roll round-iron over size. That is a ¾ inch bar would be 49-64ths or 25-32nds in diameter instead of 48-64ths and 24-32nds = ¾ inch. The reason for this practice, probably, was that the manufacturers found that by doing so they sold more pounds of iron. At any rate, instead of resisting the practice of the manufacturers, and to avoid cutting off the superfluous metal with the screw-cutting dies, the master mechanics and car-builders made their taps and dies of larger diameter, to suit the over-size of the iron.

With the introduction of the standard system of screw-threads, it has been found necessary to resist the practice of the iron makers in furnishing over-size bars; but here the same difficulty came up that is found in inspecting taps and dies, that is, to know how much variation in the diameter of bar-iron is permissible. Should it be 1-100th, or 1-64th of an inch, or half or double these amounts? Without some positive rule for receiving or rejecting iron, it is evident that what one man might accept, another would reject. It is therefore proposed to establish a limit-gauge for inspecting iron. This will consist of a plate, with two openings for each size of iron, similar to those in an ordinary wire-gauge. One of these openings will be made, say, 1-100th inch smaller than the standard size, and the other 1-1000th inch larger. It will then be specified that all bar-iron shall enter the one gauge, but not enter the other. This will supply a positive means of inspecting such material which will be certain, and will leave no room for question as to what should or should not be accepted.

The Pratt and Whitney Company will submit specimens of screw-limit gauges. These, we believe, are to consist of two screw-plugs for each size of screw. One of these is to be a small fraction of an inch larger than the standard size, and the other the same fraction smaller. Having such gauges, a master car-builder, on receiving a lot of taps, will simply cut a sample nut with each one, and then try it on the limit-gauges. If it will screw on the large gauge, the tap is too large; if it will not screw on the small one, it is too small. With such a guage it obviously will be easy to maintain a standard system of screw threads with a sufficient degree of precision to make bolts and nuts interchangeable, and that is all that need be aimed at.

We are indebted to Martineau and Smith's "Hardware Trade Journal" for the foregoing article.

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A Leviathan Lathe.—Messrs. Smith, Beacock and Tannett, of the Victoria Foundry, Leeds, have just completed a large treble-geared crank axle lathe, which has been made for a marine engineering firm in Marseilles, where it will be used for turning marine cranks, shafts, etc. It is probably the largest piece of work of its kind which has ever been constructed in Leeds. The height of the centres above the bed is 5 feet, so that an article 10 feet diameter can be turned on the lathe. The face plate, which is 10 feet 4 inches in diameter, is provided with jaws for gripping the work. The lathe bed is 9 feet wide, and is sufficiently long to allow of 34 feet between the centres. There are two saddles, each with compound slide rests, back and front, and having self-acting motions in all directions. The latest improvements have been adopted in the construction of the lathe. Amongst these may be mentioned the introduction of two screws within the bed, the advantage of this over the ordinary system of traversing the saddles by one screw or by a toothed rack and pinion, being that, with so wide a bed, the saddles slide more smoothly than they would otherwise do. Both the saddles and the loose headstock are moved quickly on the bed by a strap, separate from that which drives the lathe headstock. By this arrangement the necessity of running the driving-gear of the headstock to move the saddles and the loose headstock to their places for commencing work, is obviated. Some idea may be gathered as to the immense proportions of the lathe when it is stated that its total weight is about 90 tons.

THE WHYS AND WHEREFORES OF SHOP WORK.

SOME of the little things which enter into the every day practice of machinists are treated so differently by different men as to cause great surprise in the mind of the thinking observer, leading him to ask why two men who work side by side in the same room, at the same kind of work, should adopt methods in attempting to arrive at the same results, by no means alike, and often as exactly opposite in character as ingenuity could well devise?

If it be a fact that all learn from others what they know of machine building, as some assume, why should not two men who work in the same shop where they learned their trades—who have never worked at machine building in any other shop—learn to do the same things in the same way? Why does one man always adopt the correct method and always turn out good work, while the other man, who might at least learn from his more skilful shopmate, persists in doing the same things in a way which produces inferior work, and can produce no other? Or if it is not true that all learn simply what they are taught, but, on the other hand, is a fact that some learn to think (rather than learn to do things in some specific way), thereby becoming fertile in expedients, and always ready, no matter what difficult job presents itself, to at once think of a right method for doing it, why should there not be more such mechanics? The demand is for more men who work by methods, which they know by reasoning must be correct, without putting them to an experimental test, and who are confident, when they complete a job, that it is right, because, having been done properly, by a correct method, it could not be wrong.

Take, as an illustration, the difference between two men in securing a piece of work for planing to some given size, and which needs to have sides and edges exactly at right angles. Here is the way not to do it: The piece is clamped in position without first measuring to see how much is to be taken off; a tap with the hammer shows it is not down, and with some vigorous blows he tries to drive it down. After hammering till he is red in the face without getting the piece down, and without thinking why it cannot get down, or how much damage these continued whangings must be to the planer, our man proceeds to take off a good cut. Then he complacently turns it over for a repetition of the whanging, with the same result—but why follow him further? The pieces planed by him are never square. He intends to leave enough to take off with the file, so that they can be squared up; but he will often be found telling the foreman that "this piece would not clean up; took just as light a cut as I could first time, and when I turned it over, found it wouldn't clean."

Here is the way to do it: First the piece is measured to see if the right amount of stock is there. If at any point the piece is scant, a plan is devised whereby the surface can be removed from the first side and barely clean the scant place. Should the tap of the hammer show you the piece is not down, there will be no whanging. The man doing the job properly, knowing that there is a reason for it when a piece comes down at one side and not at the other, will relieve the clamping device, and with a little packing of tin, or sheet iron, or paper (perhaps the thinnest of tissue paper which he has carefully stowed away in his pocket), put where it will do the most good, he again clamps the piece, and taps it gently. It seems a part of the planer, no noise, no fuss, no bruising of work, nor planing of planer-table or chuck, but quietly and surely each piece that this thinking man secures for planing is brought to a bearing, which makes good work a certainty.

Why cannot the other man learn to think that the bearing which a piece takes on a planer is governed by the bearing against which it is clamped, and that hammering a piece down, or springing it down with clamps from above, against the natural position which it takes, either on account of its own shape, or the side bearings against which it is clamped, can only result in producing bad work?

Put the same two men on lathe work. If one has a taper to turn he will either measure the length of the piece to be turned, and calculate the necessary amount of set-off to produce the taper, or turning a short place at the end of the piece a little larger than that part is to be finished, he will at another point in the length of the piece turn another short place just as much above the finished size called for at that point; then setting the dead spindle over so that a tool set in the same position will touch both points alike, he has nothing to do but to boldly start the tool and let it run up. The other man guesses the spindle wants setting over some uncertain, indefinite amount; and feeling his way along, for fear he shall get too deep, he turns off chip after chip, changing the position of the back spindle a little each time, until he guesses it is near enough to file to it; then he files it. He never turned a taper to fit in his life except by accident, and the other man—why, he had his taper turned to a perfect fit before this unthinking, hardworking fellow had got half through turning, let alone the filing.

Give the same men some pieces of steel to clamp to the face plate of the lathe, and through which holes are to be made and turned out to an accurate size—smooth, true, and straight. The men who don't think (or, rather, don't think rightly) will use a blunt scraping tool, set above the centre, which does not cut at all; but, by dint of catching and snapping, so that it may be heard all over the shop, the metal is torn and bruised off. A hole is made, which is neither round, straight, smooth, nor concentric with the axis on which the piece revolved while the hole was being turned.

The man who thinks will take the same tool, grind it so that it shall have a good shearing cut, set it at the centre, and, with the only sound from it a satisfied purr, this tool that had to be ground half-a-dozen times to bruise out one bad hole in the first man's hands, will turn out, without re-grinding, half-a-dozen holes—smooth, straight, and round—all that could be asked for.

Give these two men each a crow-bar to move some heavy weight along the floor, and the man who thinks will, with a short bite, do some good every time he puts forth his strength, and do it easily; while the other man will run his bar away under the piece to be moved, and lifting until his back snaps and he sees stars, will possibly lift one side of the piece he is trying to move, only to see it drop back again in the same place.

It is probable that the reader, who has had patience to follow thus far, is beginning to ask, What of it?

Continues a correspondent of the "American Machinist," simply this: In the way in which a machinist does these little things, there is to be found a true index to his character as a machinist, and through it to the character of his work. For all things there must be a cause; and, while boys should learn trades, and should learn to do things in specific ways, because they are told that those ways have been tried and are known to be right, they should, at the same, be taught *why* the methods which they are told to adopt are the best. They should learn to reason from cause to effect, and *vice versâ*; should learn why a tool for cutting metal will, when properly hardened, ground, and set, stand to cut for hours, leaving a clean, smooth surface, while another tool needs grinding twice an hour, and does no decent work; why the man who, having a number of pieces of light work to plane up as nearly alike as possible, provides himself with templates by which to set his tools, and, leaving a tool set in the same position, takes a cut just alike from all the pieces, or two cuts from each piece if they are to be square. They should understand why this man does more work and better work than the man who sets his tools by measurement or guess, and persists in going all over one piece before commencing another.

In short, those acquiring a trade should learn to either find good reasons of their own why all methods coming under their observation are good or bad, or to understand the reasons given by others, thereby avoiding the waste of much valuable time spent in vain endeavours to produce good work by incorrect methods. This will save to the customer much money and time, which would otherwise be spent in "making machines go," which should, and might, "go" from the start.

Employers, superintendents, and foremen can well afford to explain to the boys and young men in their employ and under their charge the whys and wherefores. No investment in time and trouble will bring more sure returns to the employer, pecuniarily, and to the superintendent and foreman, in the greater ease with which thinking, close-reasoning men can be managed, and the satisfaction growing out of the fact that under their supervision good work is being done, bringing with it reputation to be most highly prized for all concerned.

"Yes, I see it now, but nobody ever told me before." This from a young man twenty-five years of age, who had served as an apprentice five years, and worked in a good shop a journeyman machinist for four years; when, after having spoiled a job and commenced with new stock to replace it, he was told by his new employer that the method he had adopted would as inevitably spoil the second job as it had the first; and given the reasons why, "I see it all now," said the willing, well-meaning blunderer. "Nobody ever explained anything to me in this way, but I was just told to do a thing so and so, and scolded if I did it any other way, but with no reasons given except that I must do what I was told. I am very much obliged for what you have shown me. Sorry to have troubled you with my blunders, and hope that you will set me right in future, for I am anxious to learn." Let's give the boys a chance.

* * *

Hard Polish on Sewing Machines.—The bright surface on sewing machines is obtained by using the best japan varnish, drying in an oven free from dust at a temperature of about 225 deg. Fahr. If the work is required to be very smooth, it must be rubbed down with fine sand-paper or ground pumice-stone in water, according to the requirements of the work, then put on another coat of japan and bake as before.

Common sense is the most uncommon of senses. It belongs to a practical mind, which is one capable of both accepting and rejecting theories.

PLANT'S GEOMETRIC CHUCK.
PART I.

(For Illustration see Supplement.)

THE geometric chuck is an instrument or machine so complicated in its details that only very few workmen have achieved the construction of a complete chuck. The intricate nature of the mechanism, and the absolute accuracy of fittings necessary to produce a satisfactory result, are such that only first-rate hands can succeed. Only a few such chucks are now in use. Their employment is limited, and their prime cost great. By some the term geometric chuck is applied to chucks of comparatively simple design, and only capable of producing mere ellipses and circles in various positions.

The definition of the instrument, as given by a dictionary, is: A chuck having a radial slider, to which the work is attached; this slider, oscillating in a plane at right angles to the axis of rotation, produces curved lines in various patterns. By means of toothed wheels the sliding and circular motions are made to act simultaneously in different ratios. The introduction of several sliders adds to the complexity of the patterns that may be produced. By these motions the patterns may be waved or interlaced lines of great intricacy, and which cannot be counterfeited.

It appears that the geometric chuck was first devised, or, at any rate, first constructed, some sixty to seventy years ago. The merit of the invention is claimed by John Holt Ibbetson, who, in 1833, published a small book, entitled, "A Brief Account of Ibbetson's Geometric Chuck, manufactured by Holtzapffel and Co." The author states that the object of his book was to bring under the notice of the public—particularly that of the amateur turner and of those who take pleasure in the investigation of the organical description of curves—the powers and capabilities of the instrument alluded to in the title-page. He says further that he contrived the instrument and constructed it with his own hands, even to every screw, from the raw materials of brass and steel.

These remarks appear to have been brought out in consequence of some statements made in "The Mechanic's Magazine," which cast some suspicion on the originality of Mr. Ibbetson's invention. In continuation he writes:—When I first made my chuck I called it "The Geometric Chuck," and certainly no other chuck had been so called. In "The Mechanic's Magazine" of the 26th September, 1829, there is a letter in which the writer says that he has "possessed geometric chucks, and compound geometric chucks, but that the idea of them came so easily, and must have occurred to so many others besides himself, that they did not appear to be worth communicating." The powers of my chuck have appeared before the public in various ways from the year 1817 to the present time. In 1820 I presented a book to the Society of Arts on the subject of preventing the forgery of bank-notes, which contained a large assortment of engravings executed with this chuck. The fact of its being an instrument that accomplishes its work in the most finished style, and in the greatest imaginable degree of correctness, symmetry, and beauty, has been further established by my publishing various other specimens, and by many presents to friends of the work done by it on ivory, wood, metals, and even on glass.

Ibbetson explains that he did not get any part of his idea of a geometric chuck from the "Machine Epicycloïde," which is described in Bergeron's "Manual du Tourneur," published in 1792. He states that at the time he constructed his first geometric chuck he had never seen or ever heard of Bergeron's book, which was then little known in England, and which is now out of print. He acknowledges a certain amount of indebtedness to a description of Suardi's geometric pen which he had seen, and some of the principles of which he applied.

In his description of the instrument, Ibbetson says:—I divide the geometric chuck, with reference to its powers, into three divisions or parts. The first part is made separately, and forms a chuck of itself. The second part can be added to the first, and the two combined possess the power of placing all the lines and curves that could be obtained from the first part alone in every conceivable direction and eccentricity, and of combining them in all sorts of ways. The third part consists in a further extension of the powers of the chuck, and gives it the property of dividing the ellipsis and any other curves into any even number of equal parts, and this principle of equal division of the ellipsis is the foundation also of many very various figures and curves.

In 1829 Mr. Ibbetson gave Messrs. Holtzapffel and Co. permission, and the necessary particulars, to manufacture his chuck, and that firm now continues to supply it—that is to say, they profess to be able to make the chucks, if orders are received, but they have not been favoured with orders for some years it appears.

In 1875 the Rev. T. S. Bazley, M.A., published a valuable book, entitled, "An Index to the Goemetric Chuck." This work has an immense number of lithographic illustrations, showing the capabilities of the chuck. The instrument used for producing the figures was Ibbetson's chuck, made by Holtzapffel. Only a hundred and fifty copies of the book were printed.

The instrument which is herewith illustrated by a perspective elevation of the complete chuck, and which is hereafter to be described, is that manufactured by Messrs. Plant, of Birmingham. It has been greatly improved by this firm, and now claims precedence over the original construction. The writer is indebted to Messrs. Plant for the loan of the instrument which is to be described, and as the detail drawings for the illustrations have all been made from the chuck itself, and will be printed by photo-lithography, their accuracy may be thoroughly relied upon.

The accompanying illustration, drawn by the author, is borrowed from "Design and Work."

(To be continued.)

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Solder.—The fusibility of soft solder is increased by adding bismuth to the composition. An alloy of lead 4 parts, tin 4 parts, and bismuth 1 part is easily melted; but this alloy may itself be soldered with an alloy of lead 2 parts, bismuth 2 parts, and tin 1 part. By adding mercury a still more fusible solder can be made. Equal parts of lead, bismuth, and mercury, with two parts of tin, will make a composition which melts at 122 Fahr.; or an alloy of tin 5 parts, lead 3 parts, and busmuth 3 parts will melt in boiling water. In mixing these solders melt the least fusible metal first in an iron ladle, then add the others in accordance with their infusibility. To cast strips of solder, pour the molten metal on a flat surface of stone or metal, drawing the ladle along the while to leave a thread of metal of the desired substance.

WOOD TURNING TOOLS.

By Paul N. Hasluck.

(From "Design and Work.")

THE use of makeshift tools will always be a source of monetary loss and inconvenience. Tools specially adapted for certain purposes will not only produce better work, but will do it in less time and at less expenditure of power and skill, so that the advantages of using the most appropriate machinery for doing certain work is obvious. It is by no means advisable to use tools of a superior class to produce work of a kind that can be made equally well with less expensive machinery, any more than it is commendable to use costly exotic wood to make a fire with when cheap waste is at hand.

The ordinary tools used by the wood-turner are the gouge and chisel. These tools must not be confounded with those named the same, and used in cabinet-making and joinery. The carpenter's and the turner's gouges are quite distinct tools, though they have a general similarity; and the same may be said of the chisels used in the respective trades. The turner's gouge is a much stronger tool, having more metal in it than its namesake; it is ground to a different shape, and has a handle some eight to sixteen inches in length, according to the size of the gouge, which ranges from one-eighth of an inch to two inches across the groove. Several sizes are always provided for use, and whilst the larger ones take off large shavings, and rough the material to shape quickly, the small ones are available for more accurate work, and may be used for turning in shoulders very nearly to an acute angle.

The turner's chisel, which is used for making the work smooth after it has been reduced to an approximate size, is ground from both sides, so that the cutting edge is in the middle of the thickness, and the edge, instead of being square across the blade, as in the carpenter's chisel, is ground off obliquely, the corners forming angles of about 110° and 70° respectively.

The chisel ends obliquely only for convenience in using. The result would be precisely the same if ground off square, but then the handle would be in an inconvenient position for holding when the edge was laid on the work, to cut properly. Chisels are made in all widths corresponding with the gouges, and the handles used with them are usually longer.

The length of handle is an item of importance in all hand-tools, as reflection will show. They are all, when in use, governed by the laws which act on a lever, the fulcrum being the point of support on the rest, the cutting edge then terminates the short arm of the lever, and the power over it is proportionate to the length of the handle end as compared with the length of the short end. The control over the tool is therefore greatest when the rest and fulcrum point is nearest to the work, and the hand holding the handle is nearest to the end. When the handle is not sufficiently long, the edge of the tool is liable, when caught by the work, to be drawn into cutting too deeply, through the hand not having complete control over it, and, from the same cause, but with greater force, the tool will be twisted out of the grasp, or the work forced from the chuck. In order to give greater freedom in the movement of the cutting edge, the tools used for wood-turning, and which are generally required to do a long range of surface, are used with the rest placed at some distance from the work, and this, in giving longer motion to the cutting edge, gives a much greater power on the leverage: and it is for this reason that such tools require to have long handles.

The cutting edges of tools used for turning soft wood are found to act best when ground to an angle of about 25° to 30°. This gives a keen edge, capable of withstanding the ordinary usage of such work. To work with tools which are ground less acutely is like cutting wood with a cold chisel — and here, by the way, it is as well to explain, for the benefit of those not conversant with the technical term, that a cold chisel is the name by which chisels used for cutting metal are known.

Economy of time is essential to the economic production of work, and it is therefore necessary to roughly round the material to be turned before putting it between the lathe centres, as there are ways of doing this at a less cost than by turning. In speaking of cost, it is here used in its abstract form, and means value of labour irrespective of the time employed; and if two unskilled hands can do more work than one skilled workman receiving double the wages, it would of course be cheaper to employ the two hands. Balks of wood may be trimmed up to a cylindrical shape with a hatchet, a paring knife, or a draw knife; and large chips of superfluous material are hewed off by these means quicker than could be done on the lathe, with a less expenditure of technical skill, and with appliances of far less cost. Thus there are many reasons for getting material roughly to shape before mounting it in the lathe. For the same reasons the centres of such balks should be marked, and so obviate delay in finding the centre when chucked, though a general and very good plan is to finally centre the work as the turning progresses, for it is only when the rough irregular figure is turned that its hollow places can be determined with certainty; and when the turning has reached the stage at which this shows itself, the work is driven by blows of a mallet on its full side to run so that the hollow will come up to the tool.

For work supported by the back centre the prong chuck is the one most generally used, and is the most convenient. As in all other things there are prong chucks and prong chucks. The proper way to make one is this: Drive a piece of round steel into a chuck, and turn it true with a central pip projecting about one-eighth of an inch, and conical in shape; then file down the steel from two diametrically opposite points till a diametrical edge about one-eighth of an inch wide is left. The central pip is now turned back further to make a cone about a quarter of an inch in length, and the diametrical ridge is filed away near the centre to allow of this. The two projections now left are made sharp by filing each from the back so as to make an edge like that of a carpenter's chisel. The work being got true on the central pin is then driven on to the chuck by blows of a mallet, and the chisel-like edges penetrate the work, and take a firm hold of it, much more so than would be the case if these edges had been filed up from both sides, leaving a diametrical edge bevelled off equally on both sides. A prong chuck properly made with a central point running accurately is most essential, as it enables the work to be taken out of the lathe and again re-placed to run perfectly true.

The first actual turning is done with the gouge, and large ones are used for large rough work. The correct angle for grinding the gouge and the proportion of handle have been previously mentioned. The rest is placed just clear of the revolving work, and the T adjusted to a convenient height, so that when the cutting edge is performing properly, and the tool resting on the top of the T, the handle will come to a convenient place at the right-hand side.

The height of the rest is therefore generally to a certain extent governed by the stature and habit of the workman.

The correct position for the cutting edge of the gouge is at a tangent to the circle which it is turning—that is, the circle left after the passage of the tool; and it is only necessary to thoroughly understand the meaning of this to be able to place the tool with precision and certainty in the best possible position for cutting. A tangent is a line which touches but does not cut into the circumference of a circle, and the bevel ground on the convex side of the gouge has to form a tangent to the circumference of the diameter being turned. It must be perfectly understood that a tangent may be formed at any point of the circumference, and equally well at the highest or lowest point. It is generally said that the height of a tool should be exactly of the same height as the lathe centres, and though this is perfectly correct in the case of slide-rest tools as usually ground, yet the axiom has no bearing if applied to hand-tools, though in turning metal the same rule is advisable, as it affords a rigid rest at the most convenient place. No matter at what height the rest is fixed the tool can be placed at a tangent to the work by elevating or depressing the handle as may be required.

Suppose the gouge is laid on to a true cylinder so that its bevel forms a tangent to the cylinder, it cannot cut the material; but directly the handle is raised the cutting edge is depressed into the cylinder, and all that material lying outside of the diameter of the edge is removed. The position of the gouge is best determined by the sense of touch, and the tool is laid on the T rest with its end overhanging the work considerably. The lathe being in motion, the tool is then drawn gradually forward, all the while keeping its point on the cylinder, till the edge reaches the point at which it forms the tangent, and then it commences to cut. By slightly tilting the tool the edge is brought to act on a smaller diameter, and turnings are removed under the most advantageous circumstances. The first cut of the gouge is usually made at a short distance from the right-hand end of the rough balk, and when a groove is turned the tool is inclined towards the left, so as to remove the material between it and the end. A new cut is then made towards the left, and this is made continuous with the previous one by inclining the point of the gouge as before ; thus by a continual shifting of the tool, and turning a small distance at a time, the entire cylinder is brought roughly to form. The size is gauged by means of callipers, and if much in excess of what is required a further application of the gouge is the best way of reducing it; and the cylinder is made as straight and even as possible by this tool, before employing the chisel. In this levelling operation the gouge is slid along the top of the T rest, guided by the left hand, and tracing on the work a regular spiral path. An expert hand can by this means produce a very tolerably smooth surface to the work, the gouge being traversed from both ends alternately, and the parallelism is checked by callipering.

The chisel used for smoothing the work is applied similarly to the gouge, and all that has been said applies to both tools, subject to any modifications rendered necessary by their different forms. The chisel is always applied so that its edge lies obliquely across the surface of the cylinder, the handle being also slightly inclined to place the edge of the chisel—which is, as has been already stated, ground obliquely—at a slightly greater angle with the line of centres than that it makes with the chisel blade. This tool is held with the left hand, grasping the blade close to the bevel end, with the knuckles above; the right hand grasps the handle near to its end, holding it near to the right hip, and the chisel blade rests on the T, one of its lower corners only in contact. The tool is slid along with the obtuse angle first, and may be used from either right or left. To reverse the direction it is only necessary to turn over the tool.

Through the tool being presented with its edge obliquely, only the central part cuts, the two corners not coming in contact with the work, and the extreme central part cuts deepest, the shaving cut by the chisel being thickest in the centre, and tapering off to a feather-edge on each side. By carefully considering this, the necessity of correct tangential position will be better understood. If the chisel is laid on to cut with the entire breadth of its edge, the tool becomes unmanageable from the quantity of material it has to cut, and the production of straight level work will depend on maintaining, during the entire longitudinal traverse of the tool, a perfectly equal amount of tilting from the T, and the same relative position of the handle held in the right hand. It must be remembered that the chisel lying obliquely across the surface of the cylinder, and forming a tangent to it, will not cut at all, acting just as a gouge under the same conditions, but directly the handle is raised, and the edge penetrates the diameter, then the tool lies at a tangent to a circle of smaller diameter, and all material outside of that circle will be cut off.

With the gouge and chisel nearly all wood-turning is done, and a perfect mastery of these tools, only to be obtained by the practical application of the rules which govern their action, will enable one to execute work of every description that may be comprised under the heading of plain wood-turning, and in addition, mouldings are for the most part produced by the use of the same tools; in short, for flat surfaces and the exterior of cylinder work, the gouge and chisel are all-important. The theoretical principles which have been given in this article will hold good if applied to other classes of turning tools applied to any material, and at some future date the action of tools used in the slide-rest, for turning metal, may form the subject of another short chapter on the elementary principles of turning, an art that has been described as the father of mechanism.

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To Cleanse Soiled Chamois Leather.—Many workshops contain a dirty wash leather, which is thrown aside and wasted for the want of knowing how to clean it. Make a solution of weak soda and warm water, rub plenty of soft soap into the leather, and allow it to remain in soak for two hours, then rub it well until it is quite clean. Afterwards rinse it well in a weak solution composed of warm water, soda, and yellow soap. It must not be rinsed in water only, for then it would be so hard, when dry, as to be unfit for use. It is the small quantity of soap left in the leather that allows the finer particles of the leather to separate and become soft like silk. After rinsing, wring it well in a rough towel and dry quickly, then pull it about and brush it well, and it will become softer and better than most new leathers. In using a rough leather to touch up highly-polished surfaces, it is frequently observed to scratch the work. This is caused by particles of dust, and even hard rouge, that are left in the leather, and if removed by a clean rougy brush it will then give the brightest and best finish, which all good workmen like to see on their work.

BRAZING AND SOLDERING.

THE term *soldering* is generally applied when fusible alloys of lead and tin are employed for uniting metals. When hard metals, such as copper, brass, or silver are used, the term *brazing* (derived from brass) is more appropriate.

In uniting tin, copper, brass, etc., with any of the soft solders, a copper soldering-iron is generally used. This tool and the manner of using it are too well known to need description. In many cases, however, the work may be done more neatly without the soldering-iron, by filing or turning the joints so that they fit closely, moistening them with the soldering fluid described hereafter, placing a piece of smooth tin-foil between them, tying them together with binding wire, and heating the whole in a lamp or fire till the tin-foil melts. We have often joined pieces of brass in this way so that the joints were quite invisible. Indeed, with good soft solder almost all work may be done over a spirit-lamp, or even a candle, without the use of a soldering-iron.

Advantage may be taken of the varying degrees of fusibility of solders to make several joints in the same piece of work. Thus, if the first joint has been made with fine tinner's solder, there would be no danger of melting it in making a joint near it with bismuth solder, composed of lead, 4; tin, 4; and bismuth, 1; and the melting point of both is far enough removed from that of a solder composed of lead, 2; tin, 1; and bismuth, 2; to be in no danger of fusion during the use of the latter.

Soft solders do not make malleable joints. To join brass, copper, or iron, so as to have the joint very strong and malleable, hard solder must be used. For this purpose equal parts of silver and brass will be found excellent, though for iron, copper, or very infusible brass, nothing is better than silver coin rolled out thin, which may be done by any silversmith or dentist. This makes decidedly the toughest of all joints, and as a little silver goes a long way it is not very expensive.

For most hard solders borax is the best flux. It dissolves any oxides which may exist on the surface of the metal, and protects the latter from the further action of the air, so that the solder is enabled to come into actual contact with the surfaces which are to be joined. For soft solders the best flux is a soldering fluid which may be prepared by saturating hydrochloric acid (spirit of salt) with zinc. The addition of a little salammoniac improves it. It is said that a solution of phosphoric acid in alcohol makes an excellent soldering fluid, which has some advantages over chloride of zinc.

In using ordinary tinner's solder for uniting surfaces that are already tinned—such as tinned plate and tinned copper—resin is the best and cheapest flux, but when surfaces of iron, brass, or copper, that have not been tinned are to be joined by soft solder, the soldering fluid is by far the most convenient. Resin possesses this important advantage over soldering fluid, that it does not induce subsequent corrosion of the article to which it is applied. When acid fluxes have been applied to anything that is liable to rust, it is necessary to see that they are thoroughly washed off with clean warm water, and the articles carefully and thoroughly dried.

Oil and powdered resin mixed together make a good flux for tinned articles. The mixture can be applied with a small brush or a swab, tied to the end of a stick.

In preparing solders, whether hard or soft, great care is requisite to avoid two faults—a want of uniformity in the melted mass, and a change in the proportions of the constituents by the loss of volatile or oxidable ingredients. Thus, where copper, silver, and similar metals are to be mixed with tin, zinc, etc., it is necessary to melt the more infusible metal first. When copper and zinc are heated together, a large portion of the zinc passes off in fumes. In preparing soft solders the material should be melted under tallow to prevent waste by oxidation; and in melting hard solders the same object is accomplished by covering them with a thick layer of powdered charcoal.

To obtain hard solders of uniform composition they are generally granulated by pouring them into water through a wet broom. Sometimes they are cast in solid masses and reduced to powder by filing. Silver solders for jewellers are generally rolled into thin plates, and sometimes the soft solders, especially those that are very fusible, are rolled into sheets and cut into narrow strips, which are very convenient for small work that is to be heated by a lamp.

The following simple mode of making solder wire, which is very handy for small work, will be found useful: Take a sheet of stiff writing or drawing paper and roll it in a conical form, rather broad in comparison with its length; make a ring of stiff wire, to hold it in, attaching a suitable handle to the ring. The point of the cone may first of all be cut off to leave an orifice of the size required. When filled with molten solder it should be held above a pail of cold water, and the stream of solder flowing from the cone will congeal as it runs and form the wire. If held a little higher, so that the stream of solder breaks into drops before striking the water, it will form handy, elongated "tears" of metal; but, by holding it still higher, each drop forms a thin concave cup or shell, and, as each of these forms have their own peculiar uses in business, many a mechanic will find this hint very useful.

Hard solders are usually reduced to powder, either by granulation or filing, and then spread along the joints after being mixed with borax, which has been fused and powdered. It is not necessary that the grains of solder should be placed *between* the pieces to be joined, as with the aid of the borax they will "sweat" into the joint as soon as fusion takes place. The same is true of soft solder applied with a soldering fluid. One of the essential requisites of success, however, is that the surfaces be clean, bright, and free from all rust.

The best solder for platinum is fine gold. The joint is not only very infusible, but it is not easily acted upon by common agents. For German silver joints, an excellent solder is composed of equal parts of silver, brass, and zinc. The proper flux is borax.

Chinese Gold Lacquer.—An excellent imitation of the celebrated Chinese gold lacquer may be prepared by melting two parts of copal and one of shellac, so as to form a perfect fluid mixture, and then add two parts of hot boiled oil. The vessel is then to be removed from the fire, and ten parts of oil of turpentine gradually added. To improve the colour, an addition is made of a solution in turpentine of gum gutta for yellow, and dragon's blood for red. These are to be in sufficient quantity to give the desired shade. The Chinese apparently use tin-foil to form a ground upon which the lacquer varnish is laid.

A MODEL AMERICAN MACHINE WORKS.

“ORDER is Heaven's first law,” saith the proverb, and “cleanliness is next to godliness,” saith another. If we accept these sentiments then, the Brown and Sharpe Manufacturing Company's Works at Providence, Rhode Island, is a heavenly place, for both the cleanliness and the order of it strike the visitor on its threshold. Many of our readers have heard of it and the work produced by the company, but unless they have been in the works they have never seen a modern model machine shop in its best exposition. We say this advisedly and with no exceptions. There are many handsome structures in various parts of the country which are in themselves commendable and worthy of note, but for a working commercial machine shop—complete in every part and appointment—that can be visited at any time, in any portion, and always be found up to the mark, we have never seen its equal. We have visited these works many times under many conditions, but to all outward appearances there was no change or hitch in the routine. There was no conflict of authority, or any question as to this or that man's duties, but everything moved quietly, in obedience to the system laid down to govern the works. This is the secret, if it can be called such, of the success of the concern. Definite aims, clear ideas as to what is to be attempted and to do it—the simplest rules that can be devised. It would be beyond the limits of “The Mechanical Engineer,” continues an editorial in that journal, to undertake to tell all about the workings of this concern in an article. It is not possible, and we shall only mention salient features in a general way. By them the reader will get an idea of what a modern American machine works, devoted to the construction of light shop tools, etc., is like.

Established in 1833 by David Brown and his son Joseph R. Brown, the business has passed through the various transitions of David Brown and Son, Joseph R. Brown, J. R. Brown, and Sharpe, and finally assumed the present style of Brown and Sharpe Manufacturing Company. The new factory which they now occupy is centrally located a short distance from the railway station, and is a commodious building, constructed of brick with iron beams and iron columns, in all respects strictly fire-proof. The main building is 163 × 51 feet, with a west wing 75 × 43 feet, and an east wing 49 × 51 feet. The main building and the wings are three stories in addition to the basement.

A one-story building of the same construction is attached to the main building for use as a blacksmith's shop and stables, and is 131 × 51 feet. Adjoining the west wing is a boiler house 47 × 28 feet, also of the same fire-proof construction. The area of floors equals 59,375 square feet. The buildings combine all of the most improved appointments calculated to facilitate economical manufacture, and are in every way adapted in the most minute detail for the business. This detail seems to an observer infinite, because, as he goes through the works, he grasps the whole of it in his own person, and sees it all, but in carrying it out, if he were one of the body corporate, he would find his own share not beyond his execution in quantity, and, withal, clearly defined.

Example: In the office there is a printed and framed list of signals to the stable, so that the man there knows exactly what he is to do when he gets one. Certain signals mean hitch a certain horse to an express wagon, others mean a truck is to be brought round to the door; others mean that the superintendent's horse and buggy is wanted, and so on. The amount of work and time saved by this one code is infinite. It is a part of the whole which leaves nothing to be inferred, or guessed at, or supposed. Certain signals mean specific things and not general duties. A signal might summon a hostler to come to the office and get orders; when he got there the person who called him might be away, accidentally. The man would wait for his orders, and then go back and execute them, while those who summoned him in turn waited. No such roundabout of wasted time occurs. To some, perhaps, this seems trifling, possibly, but it is by no means so in importance. It is attention to details that shows the master mind and manager.

What we have said about the signals and the system in this one particular, goes all through the concern. The wash room, for example, in the basement of the building, is fitted with running water and soap. This place is not left to take care of itself, and the end is not attained when the place is provided. A man is in charge whose sole business is to keep the troughs clean, and the floor and place in order, and he does it; even the soap is a part of the system. It is bought by the company in quantities, is placed conveniently where it is needed, and the cost of it charged quarterly to the men, by taking a a few cents out of their pay. The horses in the stable are fed on system. Racks are provided which swing outward from the stall and prevent the beasts from eating except at stated hours. When these arrive the racks are turned in and the animals are fed.

From these citations which are purposely made upon subjects not necessarily connected with the machine business, our reader will have clear ideas as to the method pursued in these works. Every branch of the business and every part of it is divided and sub-divided into marked routes and thoroughfares, so that by no possibility can anyone err as to what his duty is. In a sense it may be be said to be automatic, for once the routine is settled the business runs itself. That is where the great value of all this expense and labour, and thought, and elaboration comes in. It is costly to originate, costly to develop, but inexpensive to keep up, for if a hitch occurs (though we cannot see how this is possible) it can be located at once. “Time saved is money earned,” never had a better corroboration than in these works.

As to the work done by the company, that is, in a general sense, well known, for their productions are scattered all over the world. Perhaps the best known of them, among the people at large, are the small tools for machinists. We allude to steel scales, standard gauges, micrometers, and vernier callipers, etc. The processes by which these are made are kept secret, no visitors being allowed in the rooms, therefore we must disappoint those who expected an account of them. These scales are in themselves no small factors in executing fine work, and have really done more (on the ground floor) for interchangeable work than any other starting point. They made standard sizes to measure from, or sizes that were alike on similar tools, and were unchangeable. They educated mechanics in the rudiments, and they first brought 100ths of an inch to the attention of the rank and file. The steel scale is an indispensable agent, and is the honoured pioneer of the fine, fractional, and infinitessimal one 250,000th of an inch size detectors! A machine which will measure to this fraction is used by the Brown and Sharpe Manufacturing Company.

In the manufacture of the Universal Milling Machine, there is marked system and concentration of labour. One little item connected with it may interest our readers. A large number of these machines—generally about 100—that is, parts of them, are put in hand at once. One man, therefore, will have a lot of spindles or any other piece belonging to the machine; when these are finished, as far as his work goes, they are not thrown in a pile, or laid on a bench, but are set endwise in a box or case made purposely for them. This box sets on a kind of truck, which is then wheeled over to the next man who has to work on the job. In this way time is saved, the work is never bruised or dirty, and is kept going from one man to another, until it is completed.

We might fill our paper with similar instances of the plans adopted to insure promptness, cleanliness and order. A large planer has a counter shaft in the centre of the uprights, connected by bevel gears with the screws that raise the cross-head. All the attendant has to do is to shift a belt and run the cross-head where he pleases. (N.B.—He slacks up the bolts first—some might think, perhaps, that they were always slack!) It saves time, said the Superintendent, and is easier for the men. Everywhere, this consideration for the men is apparent. By the side of every machine there is a seat. Inquiring if this privilege was not abused sometimes, the Superintendent said "No."

As regards apprentices, the Brown & Sharpe Manufacturing Company require them to serve three years, and if they do not lose more than eighteen days yearly, it is not counted against them. They are charged with lost time, of course, but they are held to have served their time out if they have only eighteen days "backlash" charged against them. The first year they are paid 40 cents per day, the second 70 cents, and the third 100 cents. They are under the control of the contractor by whom the work is executed, and have all the opportunities given them to learn that they wish. It depends here, as elsewhere in the world, upon the individual—"the survival of the fittest."

Attached to the works, and under charge of librarians, is a library of 1000 volumes, to which all the men have access under certain restrictions. These are upon all subjects, fiction, history, mechanics, etc., and are a popular feature of the works.

The tool room occupies a large space in the works, and several men are employed in taking and giving out tools. Each workman has ten brass checks given him which he uses to obtain what he needs. When he wants a tap, for instance, he passes in his check, which is then placed where the tool was. On returning it his check is returned. All tools must be handed in to the tool room on Saturday, and taken out again on Monday.

Regarding the quality of the work done by the Brown & Sharpe Manufacturing Company, but little need be said by us. So many persons have specimens of it in one form or another that it carries its own certificate. We may say, however, as an incident of our visit, that we saw a couple of hardened, steel-faced surface plates, about 12in. square, that had been ground upon one of their surface grinding machines. The work was not touched after grinding it, but one plate readily lifted the other and held it suspended for a moment or so. They have also one of the largest, if not *the* largest, surface plates in the country—in superficies. It is 5in. long by 3in. wide, is 10in. deep, and weighs 1000lbs. It is a master plate, and is used in the construction of other smaller ones.

The new foundry of the company is certainly one of the most complete in plan and appurtenance of any we have ever seen, and this opinion is shared by all others who have been in it and are unbiassed. Naturally where dirt is, there dirt may be expected to gather, but beyond that used in the business itself there is none. It is a phenomenal and exceptional foundry in all respects. The floor is hard concrete (for the work is all flask work), and all the sides, and part of the roof, are glass, that is, all except the supports of the building. Added to this, the overhead frame-timbers are all planned and painted with white lead and oil, so that in appearance at least, it cannot be criticised adversely. This is not done for appearance sake merely, but to give all the light possible. "When you pay men good wages to smooth over holes in black sand," say the company, "it is economy to give them all the light possible." The cupolas are in the centre of the shop, and can be worked from both ways, and all the supplies of material, coal, sand, iron, etc., go the shortest road to their respective places. A feature of this foundry is the wash-rooms and water-closets, which are so arranged as to be convenient, and also in sight of the foreman at all times. There are a limited number of bath-rooms, where any one can take a bath all-over when desired. Before building this foundry, an agent was sent by the company in all directions on a tour of inspection to see other shops; the result of his experiences is shown in the building mentioned. It has been greatly admired by all, except some who have nothing like it, and affect to deride it, because it has unusual features. The painted overhead timbers particularly excite the sniffs of antediluvians, who see no good in innovations and cannot understand either the moral or material advantages of cleanliness, order, and method.

We must close our comments on this machine shop for want of space, not for want of material, for it would take a volume to do justice to it in all its aspects. It has not sprung into being in a day, but is the outcome of the ripe experiences of many men. We conclude by saying only about half as much as we would like to, and append a list of some of the company's principal lines.

They have made over two hundred thousand of the Wilcox and Gibbs Sewing Machines, the success of which is largely due to the remarkable accuracy shown in its manufacture, it being regarded by experts as the best in this respect of all now before the public. This branch of the Brown and Sharpe Manufacturing Company's business has developed a variety of machine tools, which they manufacture largely, such as Revolving Head Screw Machines, Universal and Plain Milling Machines, Tapping Machines, Screw Slotting Machines, Universal Grinding Machines, etc., the last-named machine providing, as it does, a substitute, in some degree, for the turning lathe. Spindles, arbors, reamers, mills, cast steel boxes, shafts, straight or tapering, hard or soft, angular cutters, as well as an endless variety of work, can be performed with extreme nicety upon this comprehensive machine. This company also manufacture Roving and Yarn Scales and Reels, and Yarn Testers for Cotton Manufacturers' use; also Patent Cutters for the teeth of gear wheels, which can be sharpened by grinding without changing their form. Fine Gear cutting and Index Plate making has long been a speciality with them.

We are also under obligations for the fullest information on all points, and liberty to go about the premises. This is accorded to all who wish to avail themselves of it. Those who want to know what a representative American machine shop of the future will be should examine it, for it is in most respects a long way ahead of its time. It is a pioneer. It is the machine shop regenerated.

MAKING A CABINET-MAKER'S TOOL CHEST.

By A. Cabe.

From "Design and Work."

(For Illustration, see Lithograph Supplement.)

MANY of our amateur friends are, doubtless, sufficiently advanced in the art of cabinet-making to be able to construct a tool chest, and in order to assist any who may be disposed to undertake the task, I show drawings of one, with description of its construction. I may mention that the sketches here shown are from my own chest, made over twenty years ago, and as there is not much improvement in tool chests since that period, it will serve our present purpose. First of all, as to dimensions. It is 3ft. 1in. by 1ft. 8in. by 1ft. 8in. inside measurement, with a till the full length of the inside, 9in. broad and 10¼in. deep. The body of the chest is made of ⅞in. best yellow pine, with a skirting of oak round the lid. The till and the inside of the lid are veneered with rosewood and walnut. Now, as to the construction. Two sides are squared up 3ft. 3in. long and 1ft. 8in. broad, and two ends 1ft. 10in. long and 1ft. 8in. broad. They are previously slipped on the upper edge—that is, a thin slip of plain walnut, say ⅝in. thick, is glued on what is to be the upper edge of each piece. These four pieces are to be dovetailed together, the dovetails 1½in. apart, and all going quite through the thickness of the wood. Before glueing the pieces together, two fillets of mahogany, 1in. broad and ⅝in. thick, with a groove in the centre, are to be glued and screwed to the inside of the ends at a distance of 10¾in. from the upper edge; these are for the till to slide upon. An examination of fig. 2, which is a cross-section of the chest, shows these fillets underneath the till. The grooves are to receive a sliding board 11in. broad, which slides underneath the till, which, when pushed back, covers the planes and tools in the space, *d*, and, when pulled forward, covers the tools in the space, *c*. This board may very well be left out, however, as I have always found it more in the way than anything else.

There is a partition board between *c* and *d*, which comes nearly up to the sliding-board, and is grooved into the two ends. A second partition in the middle of the space *d*, is 4in. broad, and is also let into the ends. These two partitions are made of ½in. wood, and these grooves must be made in the ends to receive them before the body is knocked together.

It should receive a stain of Venetian red and ochre, with a little glue size. This stain is made somewhat thin, and is applied hot to the wood with a piece of cotton rag; then, after standing for a few minutes, as much as will come off is rubbed with another piece of rag, stroking always with the grain. In a short time this stain will dry, when it is sandpapered, using the finest.

The body is now to be put together with thin glue, using a small brush for the dovetails, and taking care that no glue gets on to the inner surface, as taking it off afterwards leaves an unsightly mark. It must be borne in mind that in dovetailing a box such as this, the "pins" are always on the end pieces; consequently they are cut first. In "rapping" the body together, a somewhat heavy hammer is used, and always with a piece of wood to protect the work from injury. The four corners are glued and rapped up close. The box has to be squared. A rod of wood, made like a wedge at one end, and applied from corner to corner diagonally inside, is the readiest method of squaring, a pencil mark being made on the side of the rod just where the side and end meet; then the rod being placed diagonally from the other two corners, the pencil mark will show at once whether the box is squared or not; and, if not, the *long* corner must be pressed or pushed to bring it to the square. By the term square, here used, we mean rectangular, as the box is not square, but oblong.

A bottom is nailed on of ⅝in. wood, with the grain running across—*i.e.*, from back to front. Then a band of wood, 2½in. broad, and 1in. thick, is nailed over the bottom, and flush with the outside of the box all round. The two long ones are nailed on first, and the end ones are fitted between them. To secure these bars or bands properly, a few 1¼in. screws should be passed through the bottom from the inside into them.

The box has now to be planed truly on the outside all round, finishing with a hand-plane and sandpaper. Then a band is made to go round the sides at the bottom, and another at the top or upper edge; that at the bottom is 3½in. broad and ⅝in. thick, and that at the top 2½in. broad and ⅝in. thick. It makes the best job to dovetail these bands at the corners, making them of a size to slip exactly on to the body of the chest. The upper edge of the bottom band, and the lower edge of the upper, are moulded either with an ogee or quarter round. When the bottom band is in a position for nailing it covers the bottom bars and the edge of the bottom, coming up the sides of the box about 2in. The upper band is fixed ⅝in. below the edge of the body; this forms a check for the lid, the bottling for the lid being made to check down on this band.

The lid is made of pine, ⅞in. or 1in. thick; it has cross ends, 2½in. broad mortised on. These prevent the lid splitting or warping. After they are glued and cramped on, the lid is evenly planed and squared to the proper size, which is 1-16 inch larger than the body of the box on front and ends, and ¼in. over the back. The lid should now be fitted with hinges; these are brass butts 3in. long, and three in number. The lid, being temporarily fitted, is taken off, and a skirting put round it—that is, on front and ends. This skirting is 1½in. broad, and ⅝in. thick, of hard wood—oak or black birch.

To make a first-rate job of this skirting it should be grooved, as also the chest-lid and slip feathers inserted. It should also be nailed with fine wrought brads. After it is firmly fixed and dry, it is rounded on the outer edge. The extent of the rounding is found by shutting down the lid and drawing all round at the edge of the band, over which the skirting projects about 5-16in.

In the sketch (fig. 1), the inside of the lid is shown panelled. This panelling is simply a flat veneered surface, the two panels being root walnut, and the borders rosewood; and this veneering must be done before the skirting above-mentioned is put on. The two panels are laid first, and when dry the cutting gauge is set to 2¼in., and cuts away the over veneer all round, which, of course, gives a border of 2¼in. to be veneered with the rosewood; 2¼in. also divides the two panels in the centre, and the eight corners are marked off with compasses set to 1½in., and cut clean out with a gouge. All the edges are now planed with the iron plane, and the rosewood border planed and jutted all round in the form of "banding"—that is, with the grain running across and not the lengthway of the borders. The round corners are fitted in in two pieces mitred in the centre, as indicated in the sketch.

A till has now to be made. The body or carcase of this is made entirely of ½in. wood. It has two drawers in the length at the bottom, 3in. deep on the face; three in the centre in the length, 2½in. deep on the face; and over these is a tray, covered by a lid. The face of this tray is in the form of four drawers, which are, of course, shams. These drawers are 9in. broad from front to back, and run on shelves ½in. thick, with divisions between of the same thickness. The shelves and divisions, as also the edge of the lifting lid, are slipped with rosewood on the fore edges, and the drawers being veneered with root walnut, the whole has a good effect. The lifting lid is panelled with veneer, similar to the lid of the chest, the rosewood border being 1½in. broad. It is hinged with three brass butts, 1½in. long, to the back of the till, which projects upwards the thickness of the lid, and is veneered also with rosewood. This lid may be made of bay mahogany or good pine; and if of the latter, it must be veneered on the under side with plain walnut or mahogany, to counteract that on the top and prevent warping.

The carcase—that is the case—of this till is constructed as follows:— The two ends are cross-headed on the upper edge; these are 1¼in. broad, and may be put on with the ploughs. Then the bottom and two shelves are squared up to the length of inside of the chest, having been previously slipped on the fore-edges with rosewood ⅛in. thick. The bottom is dovetailed into the two ends, while the two shelves are mortised into, or let into, the ends with square tenons, which pass quite through, and are wedged. The divisions between the drawers are let through, and wedged in the same manner. The front of the tray, which has the appearance of four drawers, is of ½in. mahogany, veneered with root walnut, like the drawer fronts, and an imitation of the fore edges made on it by glueing slips of rosewood, ½in. broad, to represent the fore edges. The walnut front must, of course, be sand-papered before these are put on. The five drawers are made entirely of straight, plain, bay mahogany, ¼in. thick, excepting the fronts, which are ½in. The nine knobs are of rosewood, ¾in. diameter. The tray, covered by the hinged lid, is as deep as hold the brace or tools of the like bulk. In my chest the left-hand end is occupied with three shallow trays, one over the other, for holding the several bits belonging to the brace, and are very handy, as the bits can be arranged in order, and the trays may be lifted out to the bench, when a number of the bits are wanted. The remainder of the tray is lined with green frieze, and holds the brace, spirit-level, gauges, squares, and other of the finer tools. The two long drawers at the bottom are used for chisels, gouges, spokeshaves, mitre-squares, etc., while the three upper ones are for gimlets, bradawls, compasses, pliers, and sundry small tools. In the space marked *d*, fig. 2, in the body of the chest and under the till, the planes are arranged as shown in the figure. In front of them is a space 4in. broad and the full length of the chest. In it long tools, such as the trammels, are kept, and any planes that the back space will not admit, such as raglets or grooving planes, which have two wedges. It is also useful for holding drawings of large dimensions, rolled up, where they are safe from damage, and in cases of removal it is the receptacle for the hand-saws and other tools which usually hang upon the wall. A small block of hard white soap should be procured, and when drawers of any sort are quite finished, rub their sides, and all parts that come in contact with the case, as well as the guides and interior parts of the case subject to friction from the drawers with the soap. This soap will, in a short time, get very hard, if kept dry, and the harder the better, as when soft it is apt to give a stickiness to the parts rubbed with it. Any drawers or sliding parts of a job so treated will move very much more sweetly and easily; but let it be borne in mind that in order that a drawer may, in the hands of the possessor, move easily and pleasantly, it must be properly fitted in the making, as no amount of soaping will make a good fit of an ill-fitted drawer. The chest, when finished, is painted according to the fancy of the owner. It is generally a plain dark brown. Many chests are fitted with a spring lock—that is, when the lid is shut down the key must be used in order to open it again. This is handy, if one's mates cannot be trusted. Mine has an ordinary lock, that does not lock of itself, neither has the chest been locked for many years, and I am not aware that I have lost any tools on that account.

When the chest is finished in the painting, a pair of strong iron handles are put on the ends, a covered shield over the key-hole, and the job is finished.

HOW TO TEST A LATHE.

THE following directions are not intended for professional men but, to help amateur turners, who already know the use of a lathe, to choose one for themselves that will not prove a disappointment. The writer is a trained mechanic who has relapsed into an amateur through ill-health. He hopes to be able to make plain to amateurs what he learnt as a mechanic.

Let us first deal with the *plain* lathe. We will suppose you have before you a lathe of about 5 inch centres, priced at £10, and that you are willing to give up polish, etc., but knowing that other makers charge double and treble for similar machines you hesitate, fearing you may also sacrifice truth and accuracy. A lathe by the best makers should need no testing by an amateur, but amongst the cheaper tools with which most of us have to be contented there is a very great difference, and a careful attention to the following points may prevent disappointment.

First, you should ascertain whether the heads are in line with each other and parallel with the bed. Examine the movable head first; try whether it will slide freely and without shake over every part of the bed; if it is loose and you can twist it sideways so as to alter the direction of its centre-line, it is useless to examine further, since its centre-line has no certain direction. If it fits well, put in the dead-centre, tighten the fixing screw and slide up the headstock till the centre points meet, and observe whether they do so exactly. This is almost always the case. Now draw back the head, loosen the fixing screw, screw out the dead-centre barrel as far as it will go, fix again, slide up the head as before and observe whether the centres still meet truly. If they do so in both cases, the movable headstock is true.

Next examine the fixed headstock. Loosen the bolt and try whether you can twist it on the bed; if you find it a little loose so that you can alter the position of the running centre 1/16 inch or so, it will not much matter if you know how to set it truly before securing the bolt. Now we have already compared the running-centre with the back-centre, but though the centre lines of the two headstocks coincide at this point, it does not follow that the headstocks are in line; this is only proved to be the case when we have shown that *two* points in the centre line of each headstock are in line with a point in the other. We have already applied this test to the movable headstock; to apply it to the fixed one, prolong the mandrel by fixing a roller of wood into a chuck, let the roller project at least a foot further than the running centre does, melt some wax upon the end of this roller, and mark the centre upon it with a tool point while revolving; now slide up the back-centre and observe whether it exactly enters the centre hole in the wax, if it does so your headstocks are true. This is, perhaps, the most likely of any test to show the way in which the lathe has been fitted together; only the best lathes will prove true in this respect, their headstocks having been bored on the bed. If, however, you do not intend to do the most accurate work, you need not reject the lathe if you find the centre is within $\frac{1}{32}$ inch of absolute truth, the wax centre mark being about a foot beyond the position of running centre when in its place.

If there is a conical hole in the mandrel-nose it should be carefully examined. Wipe out the hole, wipe the running centre and place it in position, put on the fastest speed, and, with a pencil on the rest, try if the centre runs truly. If it does so, turn it half round in the conical hole and try again; if in either position the centre does not run "dead true" you should keep trying it till you find in what position it will run truly, then make a mark on the centre and on the mandrel-nose so that you can always put it in in exactly the same position. This, however, is a defect, and must be considered to detract from the value of the lathe.

The construction of the headstock is most important. An amateur desiring a lathe for wood may put on a speed of 8 to 1, and try whether the lathe runs easily and continues to run by itself some time after the foot is taken off the treadle. He can also take out the mandrel and see whether it and the collar touch all over, and whether the surfaces have a fine polished appearance, and he can try with a small saw file whether the surfaces are hard. The back-centre of the mandrel should pass through a plain hole and not be screwed, as its direction and firmness cannot be so well secured, and it should point truly to the centre of the mandrel collar; to test this point turn a roller of wood to fit the hole of the back-centre and push it through this hole till it reaches the collar, and see whether it takes up a position in the centre of the collar or to one side; I think $\frac{1}{16}$ inch to one side in a 5 inch lathe need not be objected to.

We now come to the *slide* lathe having a saddle and a leading-screw. When of 5 inch centres, the price varies from £20 to about £100, and the workmanship varies proportionately. All the above tests should be applied as described for the plain lathe, they are of more importance now, and then proceed to test for parallel sliding. To do this, take a bar about as long as the lathe will take in, and of, say, $\frac{3}{4}$ inch or 1 inch diam., centre it and turn up a bit about $\frac{1}{4}$ inch long at one end. Take off the carrier, and, turning the bar round with the left hand, screw up the tool till you feel it graze the turned part; now take out the bar, rack the saddle to the other end, put in the bar end for end, and try whether the tool will graze the turned part as before. This is a very severe test, and if $\frac{1}{64}$ inch out of truth it would not be of great consequence on a 5 foot bed, as the tool might wear that amount while turning up a long bar.

To test for surfacing, take the largest face-plate and lay a straight-edge across it to see whether it is flat. Put it on the mandrel and place a tool in the slide-rest so as just to touch it, the cross slide of saddle being at one extremity of its course. Now move the saddle slide to the opposite extremity and try whether the tool still touches as before. It should do so if the lathe is worth having, but this point, like the last, is usually attended to, and there are means of adjustment.

As to parallel boring, if you have applied the test for parallel turning, you have proved the bed to be parallel with the centres, and if you have applied the roller test fixed in the chuck, you have proved that the centre line of the mandrel is also parallel with the bed; you need, therefore, go no further; the lathe is true. This may, however, seem to be not the case, for if you have to bore a hole, say 2 or 3 inches deep, you may find it smaller at the mouth by an amount just perceptible by the callipers; this would not prove the lathe at fault, as it may be due to the pressure of the tool forcing the neck of the mandrel against one side of the collar and so slightly altering its alignment.

F.A.M.

THE AMATEUR WOOD TURNER.

By A. CABE.

No. 1.

(For Illustration, see Lithographic Supplement.)

TO the amateur mechanic there is no tool so useful as the turning lathe. Without it, the sphere of his operations would be very limited indeed. With it, he has the means of producing an endless variety of objects, whether for use, for ornament, or neither.

It is here proposed to describe the process of wood turning in plain terms, so that any student of the art may readily understand what is meant; and, as the writer is a practical turner, and an old hand, full reliance may be placed on his remarks on the subject, as being the outcome of everyday shop practice.

In order to be fully understood when treating of wood turning, it will be necessary to say a few words about the turning machine itself, in order that the veriest novice may become acquainted with the names and uses of the various parts.

As distinguished from a metal turning lathe, a wood turning lathe has neither back gear nor slide-rest. It is termed a plain lathe, and consists of two headstocks, T rests, bed, standards, fly-wheel, and treadle, the fly-wheel and treadle indicating that it is a foot lathe, that is, driven by the foot of the operator.

A first-rate plain foot lathe would have all the above parts, with the exception, perhaps, of the treadle-board, made of iron and steel; but very many wood turning lathes are mounted on a wooden bed and standards, and very many good turners never use an iron bed lathe.

Plain lathes are made from 2¼in. up to 7in. or 8in. centres. What is meant by "centres" is the height of the centre of the spindle or mandrel above the upper surface of the bed.

The best plain lathe that the amateur can have for all-round work is one about 5in. centres; it is not too large to drive by the foot, and while it does work up to its own capacity, it will also do small work equally well as a smaller lathe.

A lathe with wooden standards and bed is generally much cheaper than one all iron; indeed, a good plain lathe may be bought, second-hand, for £2 or £3. The amateur, by procuring two headstocks, fly-wheel, and crank-shaft, may make for himself the wood parts; and, for the benefit of such, I give drawings of my own lathe, which has done long and good service.

In fig. 1 the two headstocks, **A** and **B**, are mounted upon a wooden bed (**C**) of good red pine; it is made of two pieces 4½ft. long, 6in. deep, and 2in. thick. The two standards (**DD**) are 6in. broad (see fig. 2), and 2½in. thick: they support the bed at a height from the floor of 38 inches; they are cut away on both edges at the top (fig. 2), giving a rest for the bed, which has a gap, or opening, exactly the width of the projecting parts on the soles of the headstocks. The two parts of the bed are bolted to the standards, the bolts passing through the whole. (See dotted line, fig. 2.)

The secondary standards (E) are 2½in. square, as also the bottom pieces (F), which receives the standards by mortising, and serve to fix the whole to the floor. Two short rails are mortised to the top of the secondary standards to support a tool shelf (G), some 15in. broad.

In fig. 1 will be seen a short standard supporting the end of the crank-shaft. This is only necessary when the shaft will not reach to the main standard.

The crank shaft in this case is 3ft. 6in. long, and is double cranked—that is, has two cranks, with rods suspending the treadle.

I have heard the notion put forth that the double crank gave additional power in driving the lathe. This is a fallacy, as no additional power is gained; the fact being, there is a slight loss by the additional friction. The only benefit of the double crank is, it admits of a long, steady pedal-board, so that the operator may travel along it with his foot in turning a lengthy piece of work.

We have now to notice the two headstocks—we call them heads for short. That on the left (A) carries the revolving spindle, which rotates the work to be turned; two wooden pulleys, a 3in. and a 5in. diameter, are fixed on it. The nose of this spindle is screwed to receive various chucks, and it has a square hole running back as far as the wood pulley to receive a square shank, prong, chuck, or driver (see fig. 3); we call it a swallow-tail. This is commonly used for turning wood between centres.

Fig. 4 shows another form of prong chuck somewhat more elaborate in finish. The illustration needs no description.

The headstock B is made to slide along the bed, and to fix down at any desired part of it by the holding down bolt A; a similar bolt fixes the rest-socket in the same manner. The nuts of these bolts have bent lever handles, as shown. This headstock B has a hollow barrel, inside of which is a sliding cylinder carrying the cone centre, and is actuated by a screw attached to the hand-wheel on the right hand end.

Now we come to the driving or fly-wheel. The lathe under consideration has two speeds, as will be seen from fig. 1. Two wheels are keyed to the shaft, their combined weight being over 70lbs. And I may here remark that a 5in. lathe should have its fly-wheel not less than 70lbs.; and if a single wheel only, not less than 30in. diameter. The two wheels in this case are 30in. and 25in. diameter. I use two belts 1¼in. broad. For turning work of small radius, I use the quick speed, having the belt on the 30in. fly-wheel and 3in. pulley. For discs or flanges of from 12in. to 16in. diameter, I use the small fly-wheel and large pulley. In this case the spindle is going at a slower speed, but the power is greatly increased.

This acquisition of power is a very great advantage, even in a wood turning lathe, from the fact that large discs of say 15in. or 18in. offer a greatly increased resistance to the motion of the lathe, as the further the cutting tool is removed from the centre, the greater is the leverage against the driving power. Then, again, a disc, though running on a spindle of reduced speed, is really running at a very high speed towards its periphery; for example, a 15in. disc travels some 45 inches at its outer edge for every revolution of the spindle, while the part of the same disc one inch from the spindle only travels some 6in. in the same time; in other words, the outer edge of a 15in. disc is running nearly eight times faster than that part an inch from the centre.

In a properly-fitted up lathe the cone point in the headstock B should be exactly in line with the central point of the prong-chuck in the revolving spindle, both as to height above the bed and sideways. This is called the line of centres, and is an imaginary line passing through the centre of the revolving spindle, and also through the centre of sliding-piece in headstock B. In other words, the two heads should be so placed that this line would pass exactly through their centres.

The socket that carries the T-rests is made to slide on the bolt head, so it may be readily adjusted to the work. The T has a shank to fit the socket; it may be turned round, raised, or lowered as wanted, and is held firmly by a set screw. Two Ts, a 6in. and a 10in., are about sufficient for ordinary purposes. For long jobs, such as pillars, mangle-rollers, broom-handles, &c., a long T is used; it has two shanks to fit into two sockets, thus enabling the turner to do a long stretch of work without shifting his T.

A fully-equipped lathe has a lot of accessories, such as chucks, face-plates, &c., but one may get along comfortably with very few of these. A 6in. and a 9in. face-plate, and one or two cup chucks, are about sufficient. The face-plates are made to screw on to the nose of the spindle. The 6in. should have a conical screw in the centre, with a coarse deep thread, about ⅝in. long; the plate has also a number of holes to fix the work on with screws from the back, but discs up to the size of the plate, and even larger, never need these screws, the central one being sufficient.

The 9in. face-plate should have a very small, sharp conical stud in its centre, and be truly central; the work is centred on this stud, and fixed with screws through the plate. This face-plate comes in frequently in pattern making.

Two cup chucks are necessary, one about 2in., the other about 4in. diameter, and from 1½in. to 2in. deep. They are used to hold pieces of wood that have to be manipulated on the end projecting out of the chuck, and that could not be held on a face-plate. The smaller cup chuck is often used as a drill or boring chuck. The turner fits any number of pieces of hard wood to this chuck, in the centre of each he drives a drill or boring bit firmly; every bit is thus provided with a wooden chuck, and the cup chuck fits the whole. The turner selects the bit or drill he wants, inserts its block in the cup chuck, gives the block a few taps with a hammer while the lathe is running, and the bit is immediately running true.

A few taps on the side of the block which projects about an inch out of the cup, releases it from the cup, or the lathe is run backwards, thus allowing the cup to screw off the nose, and the block with its bit are driven out with a round pin of wood in the screw hole at the back.

As to the necessary tools, they are but few, and consist of chisels, gouges, callipers, a pair of compasses, oil-stone, and two or three slips for setting up the gouges, a side tool and a parting tool are also very useful, and, of course, a grind-stone, for the use of one cannot well be dispensed with.

The most useful gouges are ¼in., ⅜in., ⅝in. and ⅞in., and the same sizes in chisels, with the addition, perhaps, of a 1¼in. chisel for large plane surfaces.

There should be at least half a dozen pairs of callipers of various sizes, the largest taking in about 12in. or 14in., a pair or two of inside callipers, and also one or two pairs of double or out-and-in callipers, sometimes called the dancing master. The ordinary callipers are too well known to need illustration.

Our next paper will give the first lesson in wood turning, preceded by instructions to grind and set up the chisels and gouges.

SPEED AND FEED FOR LATHE-WORK.

MANIPULATIONS in metals are becoming gradually reduced to a system of rules which makes no note of personal peculiarities, different jobs, and different styles of machines. We have, says the " Boston Journal of Commerce," an established system for screw threads—their form, grade, and pitch, with the relation between pitch and size of bolt. In many other matters in which rules can be used, manufacturers of tools have adopted systems peculiar to themselves, although perhaps used by others. In no respect has this peculiarity been more noticeable than in the relation between speed and feed in the reduction of metals from their crude state as they come from the forge or foundry. Hardly any two planers or lathes, from different manufacturers of tools, have the same relation between the speed of the article to be wrought and the speed of the feed at which the tool is carried. Some mechanics in working iron prefer a swift speed and slow feed for the first cut, whether on planer or lathe, and a reversal of these rules—that is, a slow speed and fast feed—for the finishing cut. Others prefer a very different arrangement—in fact, exactly the opposite; and to suit all these personal specialities, tool makers have adapted their tools with the express purpose of meeting the demands of their users. As modern tools are made, the speed for cutting iron, either on the planer or on the lathe, is from eighteen to twenty feet per minute, while good work is done on tools which run but fourteen feet per minute. Indeed, it has been claimed by good practical mechanics, of many years' experience, that better work can be done at fourteen feet speed than by a higher speed; and there are others who assert that a slow speed for the first cut in turning or planing gives the better results, and a fast speed for finishing is preferable. It would be difficult to establish a rule meeting these personal, and, in most cases, real objections. It would be better if all our planers and lathes were constructed, not only with varying speeds, as by the use of cones where belting is the intermediate, or by a change of gears where gearing is the intermediate; but it would be well if these were numbered or named in their order for finishing or roughing, so that a neophyte should be at no loss for information as to what feed should be used, and what speed should be used for the work on the tool. And there is a difference between the relations of a countershaft and cone of lathes, and counter and driver of planers made by different manufacturers; so that a workman using a tool emanating from one concern, being placed upon a similar tool from another concern, finds himself all at sea. If it were a question of cutting a thread for a screw: a reference to his chart, or a counting of the leading screw threads, and an examination of his cone of gears, would give him an insight, and direct him at once to the proper gears to be used for producing the thread desired; but in the matter of speeds and feeds, there is no rule or guide by which he can lay his course. A tool from one shop gives him a rank feed with a slow speed, and a similar tool from another shop gives him a fine feed with a rapid speed. Now there is no sense in this distinction. There should be some rule by which the workman, running any lathe or planer, would know tolerably well what the relations were between speed and feed.

The writer has known a case where a lathe was purchased from a somewhat celebrated manufacturer of tools, which was adapted for turning and boring. Attempting to use it for the latter purpose, he found it impossible to keep the cutting tools in working order after a few revolutions. The trouble was, the feed was too fast. Testing it on turning, there was the same trouble. The connection between the live spindle and feed-screw was made by gears. There were two gears for changes of feed—neither of these two gears furnished the proper speed for the work which the lathe was intended to perform. It was absolutely necessary to remove the gears, attach a small cone to the projecting end of the live spindle, make a large cone for the feed spindle, and use a round belt. Now there was no reason why the manufacturer should not have adapted his speed and feed for the work which the lathe was competent to perform, or given a sufficient number of changes of speed for feed.

One of the most prominent establishments of machinists' tools in the country makes its feed for its lathes so fine that complaint has been heard that while they are adapted for roughing work, in finishing, the tendency is for the tool to ride instead of cut. Perhaps it is impossible to meet all the demands and whims of practical workers, but it seems that some general rule might be established, or be at least recommended, if not adopted, by the prominent tool manufacturers of the country in regard to the working of iron, leaving the intelligent mechanic to judge for himself what changes from that should be made for the working of steel. It is evident that there is a need for a reform in this direction. Perhaps the result might be reached readily by manufacturers of lathes and planers giving greater range to the difference between feed and speed. As it is now, there are many cases in which a tool coming perfect from the hands of the manufacturers, well tested, excellently well fitted in its running parts, to all appearances a finished tool, needs little or more—at least *some*—manipulation and adaptation before it is fitted for the uses of the man who is the purchaser.

* * *

BORING STANDARD HOLES.

MR. JOSHUA ROSE writes: I have remarked that it was impracticable to bore with a single-pointed tool a hole that should be true, parallel and smooth; but let me explain just what was meant by that. There is no difficulty whatever in boring a hole cylindrically true, and in a good lathe, parallel and smooth, in the common acceptation of the term; that is to say, the tool marks will be visible to the eye, but not to the sense of touch. I have never found any difficulty in the matter while the work was in the lathe nor after it left the lathe chuck, unless the work was in two halves, as a pair of brasses, or an eccentric. But these, though bored cylindrically true, are always oval as soon as relieved of the pressure of the chuck, or holding bolts. Nor have I ever found much difficulty in boring holes to standard diameter, especially if the lathe has a compound slide rest, because the top slide can be set at an angle, and used to put the feed on. In any event, however, the little feed adjusting attachment may be used to prevent the cut being too much, or what is the same thing, to prevent the feed-screw handle from moving too much. But this feed attachment is no use as a stop to enable a number of bores to be cut to one standard diameter —no use at all for that purpose—though of much use to give you an idea of when you are approaching the size, providing you set its position with that end in view, and, as before stated, to prevent the slide rest from being moved too much. The reason is, as will appear presently, that the slides must, for boring, fit *tightly*; and under this condition it is impracticable to know just when the feed-adjusting attachment is acting as a stop, or to bring just the same amount of pressure to bear against it. With a loose slide you may come pretty near it; with a tight one, no.

Again, every time you take the tool out to grind it you destroy the combination of the tool point, with the contacts of the stop motion, and cannot set it again, but by trial. Now to finish a hole with the highest degree of perfection known to the art, a single pointed boring tool *must* be ground up for the last cut, and this " knocks spots" out of the adjustment of the feed regulating or adjusting attachment, because, in proportion as the tool is dull, it springs away from the work; hence, in putting the tool back, after grinding it, it is of no use to set it to the bore of the work, for that has left the tool-spring out of the question.

While on this subject, I may as well make a remark on the use of this feed-adjusting attachment for external diameters, which, for putting on roughing out cuts, or as a stop gauge for screw cutting, is excellent and useful, but for finishing plain work to standard size, or to ordinarily accurate calliper measurement, it is, generally, almost useless, because there is a certain amount of spring in the rest as well as elasticity about the attachment, as may be found by moving the feed-screw handle until the adjusting nut of the attachment is felt, at the handle, to touch, and then continuing the handle motion until the crosspiece of the stop moves, when it will be found that there is considerable spring of the parts, and it is not practicable to bring the stop nuts up to the crosspiece with an equal force of contact every time.

When I was a lathe hand, working piece-work, I found it a better plan to rough out all pieces and then finish them. In taking the roughing cuts, I used the feed stop attachment, so as to leave about an equal depth of cut for finishing, and saved using callipers except on the first piece. Then I ground up the tool for the finishing cut, put the first bolt, pin, or whatever it might be, in the lathe, set the tool to cut dead to the required diameter, and when the cut was up to the head, instead of winding it out and upsetting its set, I stopped the lathe and took the work out, *then* I traversed the carriage back, put in a new piece of work, and finished the next piece, and so on; thus I had but one tool setting for each tool grinding, and got more accurate results with far less trouble and risk than by the use of the feed-stop attachment.

While on this subject let me also say that in my experience I have found that lathes not having a compound rest, and not elevating with a screw at the back of the cross slide, always have a cross-feed screw of too coarse a pitch, as is proven thus: A 1-32 inch difference in the deviance of the tool point from the line of centres makes 1-16 inch difference in the diameter of the work. Now take a feed screw of 4 pitch and having a feed-handle, say 4 inches long. The handle, in a rotation, moves say 12 inches, and this moves the slide rest ¼ inch, causing the tool to turn to a diameter ½ inch larger. Now suppose it is required to move the tool enough to take a cut of 1-100 inch, the tool must be moved 1-200 inch and the amount of handle movement for this will be a trifle over one-tenth of an inch. Now, in truing, the tool stands away out from the tool post, and any play on the slide allows a tool point movement—a play increased as its distance from the slide rest. Furthermore, the leverage of the tool point increases with any given depth of cut, the strain on the slide rest causing it to spring, hence to bore a good hole the slide rest must firmly fit the cross slide. Now is it practicable, with this condition of slide tightness, to move a handle or a hand wheel 1-10 inch with any degree of certainty? Does not every mechanic who works at a lathe for a daily living know that as soon as the slide rest gets enough handle pressure acting on it to move it from a state of rest, it starts off with a jump, and is just as likely to move 3-10 as 1-10 inch? As a consequence, we see the workman take hold of the handle with both hands, one exerting a pressure to move the handle, the other a very slight pressure to stop it, as soon as motion is felt to have taken place; or else a light piece of iron is used to tap the handle, first a light blow, then a heavier one until the handle moves. For such lathes, then, a fine pitch feed-screw is a boon.

Reverting now to the hole-finishing subject, small holes must be finished by reamer, and up to about two inches all holes are best so finished. The question before us is: What shape shall the reamer be; how many cutting edges should it have; what clearance ought it to have, and what shall the shape of each tooth, individually, be?

First, as to general shape. To ream parallel, it must have parallel cutting edges; but if it be parallel, from end to end, there is nothing to steady it when entering and prevent its cutting the mouth of the hole too large; hence it is better to slightly taper the end for a distance equal to at least the diameter.

Next, as to how many cutting edges. In England they say three, in the United States they say not less than four, but as many more as convenient. Now I am a good deal more than half inclined to believe that they are both wrong, and that a single cutting edge (or, at most, two) is the best, and as it is more than likely that this will turn out to be the universal plan in the future, I want to make it a matter of record, that I name one cutting tooth in a reamer as the best for accurate work; and now for the reasons.

It is a very easy matter to grind one cutting edge straight and true, and to re-sharpen it. With one cutter, the principle of making that cutter adjustable for cutting diameter, may be applied to reamers of smaller diameter, and the cutter can be held firmer in the stock. The body of the stock in a reamer, adjustable to take up the wear, can be made to stand size hardened, and the half circumference on the cutting edge side can be eased away, thus obtaining two great advantages. First, that the reamer cannot ream a hole too small, because of the stock being a full half circle on one side; second, that this half circle will steady the reamer, an end very difficult of attainment if the holes are short.

A single tooth can be easier fed to its cut, since it will be easier to rotate and pass to its cut. In the case of taper holes, a single tooth can be fed very much easier and will be free from the sudden release from the cut, which reamers having much taper and a number of teeth are subject to, while a finer degree of cut can be taken. This is of importance in a taper hole, because wherever the teeth leave off cutting the hole must be out of round to the depth of the cut, hence this cut should be as fine as possible. It may be that the half-circular side of the stock should have some grooves, to free any dirt that might get in between it and the hole.

The clearance is the next consideration. The more the clearance the more a given amount of wear will decrease the size of the reamer, but the easier the reamer can be moved or fed to its cut. The less the clearance (so long as there is clearance) the easier the reamer may be kept to standard size, but the more the power required to operate it and feed or push it to its cut. The more the number of cutting edges the more the clearance must be, which is another point in favour of a single-tooth reamer; hence the clearance is a quantity varying with the conditions. On taper holes, however, ample clearance is a decided advantage.

The angle of the groove or flute face at and near the cutting edges is the next consideration. Whitworth makes the grooves half circles or nearly so; some make the faces radial, others an acute angle to the tooth. I have used them all. I am of the emphatic opinion—in fact, I have no opinion about it—I am sure that a radial face is too keen for good work—the tool loses its edge too soon; an obtuse angle is better, the degree increasing as the number of teeth decreases, but never varying more than about 40° from a radial line except for brass, for which a variation of 20° is permissible in a reamer having a single cutting edge.

In discussing both clearance and radial face angle, however, it has been assumed that such clearance and angle are to be equal at all parts of the reamer's length, and to facilitate the sharpening process this is very desirable; but if both the clearance and the angle be enough to enable the reamer to cut freely at the tapered entering end, the clearance may gradually be reduced towards the other end, while the angle may be made more obtuse, which gives the very best form of reamer for standard work.

Let us now suppose that we have a hole reamed parallel, and to standard gauge size, and a bolt or pin has to be made for it. If this bolt be finished in the lathe by steel-cutting tools, it cannot be made a thoroughly good fit; because, if it be left as finished by the lathe tool, only the tops of the tool marks will be to the standard size. This may be improved by finishing with the lathe tool, leaving the tool marks as shallow and as smooth as possible, and the diameter so much above the required size that if a dead smooth file be used, with the lathe running at a quick speed, the work will be of standard diameter when the tool marks are just effaced. If the work is made to the standard collar gauge it cannot be made a really good fit, because it will not do to try it forcibly in the gauge, so as to leave bearing marks, which may be eased away so as to fit the work, and the fit has therefore to be taken on faith, as it were. Now, a file, even though a dead smooth one, used on lathe-work, does not cut true; but it cuts so nearly true as to improve a steel-tool finished surface, leaving its surface more level, to a degree that far more than compensates for the small amount of cylindrical error it induces. If, after this filing, a piece of *fine* emery paper, or a piece of No. 0 French paper, be evenly applied to the work, it will smooth down the file marks and improve the job; but the amount taken off by the emery paper will be measurable and discernible in the fit. A better fit, and greater truth, may be given the work if it be finished with a revolving emery wheel instead of a file, providing that the grinding wheel be so balanced that it runs without vibration. But the highest order of fit in a parallel pin or bolt is only to be obtained by fit and trial, using either a grinding process, or by a file used in the hands.

Let it be distinctly understood that I am not advocating that it is practicable to finish general work with a file used by hand; I am only stating a mechanical fact, and it is a mechanical fact that neither by any grinding or other process can a fit be produced equal to that I can make by fitting a parallel piece of work with a file. It can be done so that the surface is a mirror, and the fit such as to wipe off the oil, leaving the oiled piece dry after passing through the collar. The time, the judgment, the delicacy of touch necessary to such an operation, make it a mechanical feat only, and not a possible workshop practice.

To resume, however: The trouble in parallel fits is that *the contact of the surfaces can only be adjusted after the surfaces are produced*, or in other words, the *fitting must be done* after the work is down to its finished size. But *where then is there any metal to fit on?* This brings us face to face with the fact: The actual fit must be attained by making the work as cylindrically true and parallel as the machines will produce it, and be satisfied with the degree of fit thus produced. Let it now be noticed that I have been careful, while on this part of the subject, to use the word parallel, because all these difficulties as to fit disappear if the work be made taper, because the work can, in that case, be tried for fit before being reduced to its finished diameter, and fitted during the subsequent reduction. The enveloped may be pressed into the enveloping piece, and by rotation the contact marks will show the high spots and places. It is proven then that a taper fit is more easily made than a parallel one, a fact that is not generally acknowledged, because the kind of parallel fits usually made are not the kind of fits I refer to—*they* simply have no play, while I mean no play and *surfaces in contact all over*. If, however, in order to obtain the fit, the work be made taper, what becomes of the standard gauge system?

On account of the difficulty of turning a cylindrical piece parallel to standard gauge and to accurate fit, I was considerably puzzled to account for some of the superbly fitted work I have occasionally seen, presuming that the parts were to standard gauge; and never having seen, in the course of a very long experience, any fit and finish to equal that in the engines made by Chas. H. Brown, of Fetchburg, Mass., I recently sent him a number of questions upon his polishing processes, and at the end I added a question or two as to how he finished the holes and fitted the pins. I was considerably taken aback when he answered that they made them taper, fitted them while soft, hardened them and ground them together, adding: "We find a great advantage in making the pins tapering, as the pins can be made easier than if made straight." Now, there is no question but this is correct, when the fit as well and as much as the size is valued; indeed, for quality of product the fit more than the precise diameter is the most superior. It is indeed better for the user, but worse for the manufacturer of the engine. In this connection, however, one thing more must be said, which is that of ordinary workmen. Not one in twenty is a good judge of a fit—perhaps not one in fifty; hence, work merely made to correct size is often stated to be fitted, and so it is in one sense, but it is very often what Mr. Brown would call fitted for the scrap heap.

In concluding my remarks on this subject let me say, frankly, that I believe with the quality of skilled mechanics at command—unused as they are to *fitting* work, and the refinement belonging to it—are not up to a standard that makes it possible to drop the standard gauge system in its entirety and adopt the fit and gauge principle. I believe that, under ordinary conditions, better work will be turned out by a shop using standard gauges than by one not doing so, not because it is the best conceivable plan, but because it is the best attainable one. To do Brown's work one must have his men and his system, and his sense of mechanical refinement, his watchfulness, and at the same time not too big an establishment: for such work can only be done and kept up to its standard by the fact that the fit of every piece, the nature of its surface, its finish, etc., will, at some time or other, before it leaves the shop, come under the eye of one of the two leading minds of the shop; I say two, because such men are so scarce that it would be almost a miracle to find three of them in one shop, and indeed one of them is a luxury not experienced *very* often in a lifetime. Why, in this great city of New York, I know, at this moment, a mechanic, who, so far as the quality of his work is concerned, is second to no machinist in the United States; he was foreman in a shop whose very name is, to all who know it, a guarantee of superior workmanship. That man, when the proprietor died, was out of work a year and now has a little candy store. I have often asked myself *why*, *how* such a thing could be, and the answer comes at once he *would* make his work *fit*. If he fitted up a lathe tail block you could put the spindle in ¼ inch only and it was as firm as a rock, or when put together one pull of the wheel would cause it to slide at full length; no lost motion in his slide rests: everything fitted and was dead—*dead* true, and when his "boss" died people said, "Yes, it's fine work, but it don't pay; people won't pay for it." Why, it wouldn't have taken him half the time to make his work to standard gauge and let the fit (contact fit) take care of itself.

The finest piece of machine-made and finished work I ever saw is a Morse Twist Drill Co.'s Stetson's improved Beach chuck (made, of course, to gauges), now lying before me. Picking it up and trying its fit is a pleasure. It is the largest piece of *machine-finished* work I ever examined and found to give satisfaction *for fit* and finish. The surfaces touch—touch *all over*; there's no mistake about it, and it works as easy, as smooth, as a die; and this brings me to a concluding remark, which is, that there is enough merit in the standard gauge system to make it unnecessary to assign to it a perfection it does not possess. It does possess advantages over all other ordinarily practicable systems for new works of not too large a size, and commands the advocacy of us all on that sphere.

* * *

Power of Nails.—The ordinary nail plays a by no means insignificant part in construction, and the following records of experiments to discover the holding power of nails are of interest: Haupt in his "Military Bridges," gives a table of the holding power of wrought iron tenpenny nails, 77 to the pound, about 3in. long. The nails were driven through a 1in. board into a block from which it was dragged in a direction perpendicular to length of nails. Taking a pine plank nailed to a pine block, with eight nails to the square foot, the average breaking weight per nail was found to be 380lb.; in oak the power was 415lb.; with 12 nails per square foot, the holding power was 542·5lb.; and with six nails in pine 463·5lb. The highest result obtained for 12 nails per square foot in pine, the breaking weight being 612lbs. per nail. The average strength decreased with the increase of surface. In Tredgold (Bevan's experiments) the force in pounds required to extract threepenny brads from dry Christiania deal, at right angles to grain of wood, was 58lbs.; the force required to draw a wrought iron sixpenny nail was 187lbs., the length forced into the wood being 1·00in. The relative adhesion, when driven transversely and longitudinally, is in deal about 2 to 1. To extract a common sixpenny nail from a depth of 1in., in dry beach, across grain, required 167lbs.; in dry Christiania deal, across grain, 187lbs., and with grain 87lbs.; in elm the required force was 327lbs., across grain; and 257lbs. with grain, and in oak 507lbs. across grain. From Lieutenant Fraser's experiments, it would appear that the holding power of spike nails in fir is 460lbs. to 730lbs. per inch in length; while the adhesive power of screws 2in. long and 22·100 diameter, at exterior of threads, 12 to the inch, driven into ½in. board, was 790lbs. in hard wood, and about half that amount in soft wood.

HOW TO MAKE A SMALL-POWER STEAM ENGINE.

By H. R. Phelps.

(For Illustrations, see Lithograph Supplement).

THERE is now such an extensive demand for small steam engines that can exert a considerable amount of power in proportion to size, and not knock themselves to pieces, as many of the low-priced and flimsily-built engines do. I have selected the design, herewith to be described, as being one which I have found to fully meet these requirements. This engine, worked at a mean pressure in the cylinder of about 45lbs. of steam per square inch, and being run at 1,000 revolutions per minute, will be over ¼-h.p., the power resulting principally from the high speed. Many will doubt the possibility of running the engine at such a speed, though I very often run such engines at much higher speeds. One advantage of high speed is, that the controlling power of the fly-wheel, and consequently the regular working of the engine, increases as the square of the speed—that is, a fly-wheel running at 1,000 revolutions per minute has four times the controlling power that it would have if running at 500 revolutions. Another very great advantage of high speed is, that it approximately enables the engine to over-run the resistance, and this, especially in the case of very small engines, is of the greatest benefit in ensuring regularity of speeds. Having explained the reasons for choosing this design, I will, with the assistance of drawings, proceed to give directions how to construct the engine.

The best way to commence operations will be by boring the cylinder, turning the flanges, etc. In this case, this will be best to proceed in the following way: —Having first burred up one end of the cylinder, so as to get it square with the flanges, solder it with ordinary tin solder on the face of a perfectly true brass chuck, which chuck will be useful for several other parts as well, and turn the front end of the cylinder true, the flange being 3/16in. thick. The casting is then reversed on the chuck, and re-soldered, the flanges being got to run as true as possible. The cylinder is then bored out to 1½in. diameter. The bore must be perfectly parallel throughout, as upon this the satisfactory working of the engine greatly depends. The flanges are made 2 7/16in. diameter, and both sides of the lugs for holding down the cylinder can be turned at the same time. If the seats in the bed-plate are made square with the bed, the axis of cylinder will be parallel with the bed. The outsides of lugs are 2 7/16in. apart, the width of each being 7/16in., and the thickness 3/16in. The centre of cylinder bore must be 1in. from under-side of lugs, to correspond with centre of plummer blocks. The reason for soldering the cylinder on the chuck is that it holds much firmer than the ordinary ways of chucking, and also that it can be bored, and both flanges and lugs turned at one chucking, thus getting everything quite true with the bore, which is difficult to do if the cylinder has to be chucked several times. The length of cylinder over flanges is 2 13/16in.

The next thing is to true up the cylinder valve face, which must be quite square with under side of lugs, and project 1/16in. beyond flanges of cylinder. The length of face is 2 7/16in., and width 1 9/16in. The steam ports are ½in. long, and 3/16in. broad. The exhaust port ½in. long and 5/16in. broad, and distance between ports ⅜in. In making the steam ports, it will be easiest to drill several holes, and chip the ports to required size. The passages in cylinder are drilled up from the ends to meet those in face, and the ends of cylinder are chipped away on the side next the bore to a depth of 3/16in., and the same width as steam port, thus leaving a passage for steam into cylinder, when the covers are on. The spigots of cylinder covers are also chipped away the same width as the port, and 3/16in. from the edge, to prevent them blocking up the port when they are on the cylinder. The slide valve is ¾in. long, and 1 1/16in. broad on the outside, the length of the valve being understood as being across the face. The exhaust cavity is ¼in. long, 9/16in. wide, and 3/16in. deep. There is a projection cast on the back of the valve, through which the valve spindle passes, and is secured in its place by two collars and set screws. As it is always desirable that the steam should enter the cylinder as instantaneously as possible at the commencement of the stroke, the ports ought to be as long as convenient, more particularly, when the engine is intended to run at a very high speed. For instance, suppose this engine is required to run at 1000 revolutions per minute, which it can easily do when doing work, the cylinder has to be filled with steam 2000 times and as often emptied, in the course of one minute, which it is evident cannot be done unless the steam and exhaust ports are of ample capacity. And not only must they be large enough, but properly designed, in order that the valve may open a large enough area of the port at once to ensure a quick supply of steam to keep the piston moving at the required speed. The exhaust also should be as sudden and ample as possible, otherwise there will be a considerable loss of power from back pressure. The lap, lead, and compression will be explained when directions are given for putting the engine together. For those who have not a planing machine, the easiest way of facing up valve box will be to solder it on a chuck and turn one face, then reverse it and turn the other, at the same time making it the right thickness, viz., 27/32in.

The box must then be put on its face on the surface plate, and the centres of the stuffing boxes carefully marked with the scribing block, and a hole 3/16in. in diameter bored through each, care being taken to have both holes in a straight line with each other. The box can then be put between centres in the lathe and the flanges of stuffing boxes turned to ¾in. diameter, and ⅛in. in thickness. The end flanges of the box can be turned at the same time, the length of box over flanges being same as the cylinder face. It must again be put on the surface plate and the centre of flange for throttle valve, and the piece cast on underside of box be marked off from face and ends of box. The top and bottom flanges may then be turned to the right size, the flange for throttle valve being ¾in. diameter, and 3/32in. thick. A smooth file can then be passed over flanges to lay a straight grain. This way of making the valve box will be found to be much easier than filing it to shape, and also make a much better job. The recess in stuffing boxes for glands are 11/32in. diameter, and reach within 3/16in. of the inside of the box. The glands are 3/16in. long, and just slip into the recess; the flanges being same diameter and thickness as those of stuffing boxes. The flanges of glands and stuffing boxes are then filed at the sides so as to make them oval, the greatest diameter being vertical, and the least 9/16in. The holes through the glands for valve spindle are 3/16in. full. The valve spindle is a parallel piece of 3/16in. bright steel wire. The back of valve box cover, if filed flat, can be temporarily soldered to valve box, so that its edges can be turned at the same time as those of box. The ribs and edges are got up bright with a file, the spaces between ribs being painted the same as rough parts of valve box. The studs for nuts in valve box and glands are 1/16in. full in diameter, and are placed as shown on drawings. The inside of box must be filed out to ⅞in. wide, so as to allow the valve to work freely. Carrying the valve spindle through both ends of box, causes valve to work much better, and also helps to prevent leakage at the stuffing-box. The piston-rod does not require to be carried through both covers, as the cross-head and guides prevent any tilting action that could wear the hole in the gland oval, and thus cause leakage. To turn the cylinder cover, it will be best to chuck it by the stuffing-box, and turn the back, making the spigot to project a bare ⅛in., and sufficiently large to fit very tightly into the cylinder; two or three grooves must also be turned on face of cover to help to keep in the red lead with which the joint is made. A 5/16in. hole is to be drilled right through centre of cover, for piston rod. Similar grooves are also required on each end of the cylinder. The cylinder bottom is then turned in the same way, then put it and the cover on the cylinder, and put them between centres in the lathe, when the flanges can be turned the same size as those of the cylinder, thereby making a much truer joint than if they were turned separately. A 1/16in. hole has to be drilled through centre of bottom cover to hold it in the lathe; it can be filled up afterwards. The covers are the same thickness as the flanges of cylinder, and are slightly turned out as shown on drawings. The stuffing box on cover is ¾in. in diameter outside, the flange being 1 5/32in. in diameter and 5/32in. thick. It is bored out for the gland to 9/16in. full diameter, and within ¼in. of the inside, the bottom of the hole being rounded out, to cause the packing to press against piston rod. The gland is 9/16in. diameter, ¾in. long, the flange being same diameter and thickness as that of stuffing box. The hole through gland for piston rod is 5/16in. full diameter, and is rounded out at end for packing. The studs in cylinder flanges and stuffing boxes are ⅛in. diameter, as shown on drawing. The piston rod is a piece of 5/16in. bright steel wire 5in. long. It must be centred perfectly true, and the end for piston turned tapering to a diameter of ¼in., for a length of ⅜in., commencing ⅜in. from the end of rod, the other ¼in. in length, being screwed with a ¼in. thread. The piston has a taper hole bored through it, 5/16in. diameter at one end, and ¼in. at the other, into which the tapered end of piston rod is forced as tightly as possible, and a ¼in. nut screwed on the small end of rod to keep the piston in its place. The piston rod is then put in the lathe, and the piston turned till it will just go into the cylinder easily. The thickness of piston is ⅜in. It is then turned for a distance of 1/16in. from the back, that is, the side the nut is on, to a diameter of 1¼in., leaving a flange at the front, of the same diameter as the cylinder, and 1/16in. thick. The back of the piston is then turned away to a depth of 1/16in., excepting the boss in the centre where the piston rod nut presses against, which is ½in. diameter. A disc is required the same diameter as the front flange of piston, and 1/16in. thick, with a ½in. hole through it. This is put over boss on back of piston, and four holes ⅛in. diameter are drilled through into piston, into which four studs are tightly tapped, and on which nuts are put, to keep piston back in its place. The holes in back must of course be large enough to allow studs to slip through, so that it can be taken off when the nuts are removed.

For the packing rings it will be best to obtain two steel forgings large enough to turn into rings 1½in. (full) diameter and ⅛in. square. They can be easily turned by soldering them on the chuck and turning one side, then reversing and turning the other side till each ring is ⅛in. thick. The two can then be soldered together and on the chuck, and the inside bored out to 1¼in. diameter, the outside being made about $\frac{1}{32}$in. too large to go into cylinder. The edge of rings must be carefully polished to prevent them scratching the cylinder, and a piece about $\frac{3}{32}$in. long, cut out of each, to allow them to be sprung into cylinder, all burr being removed from the edges of cut. They are then ground into their place on piston, to insure a steam-tight joint, the rings being left just free enough to spring open, when the back is screwed up tight. The cuts in the rings are placed on opposite sides of piston, so that the steam which passes one cut cannot pass the other ring.

The illustration showing the engine in elevation is just half size. A plan view and a sheet of details will be given subsequently.

(To be continued.)

AMERICAN CLOTHES PEGS.

PROBABLY very few realize the extent of the manufacture of these clothes pegs, and the amount of capital employed in the business. Their manufacture is mostly confined to New England, and the State of Main produces its share of the commodity.

One of the most complete and extensive clothes peg factories is located at Vanceboro, U.S.A. The process of manufacturing the pegs, as carried on at the Vanceboro Wooden Ware Company's factory, is given.

The wood used is mainly white birch and beech. The logs are cut and hauled to the shores of the lake or the streams emptying into it, whence they are floated down to the mill. As fast as required they are hauled into the mill by a windlass and chain worked by steam power, and sawed into lengths of 16 or 22 inches—the former to be made into pegs, and the latter into boards for the boxes required in packing. The 16-inch lengths are next sawed into boards of the requisite thickness by a shingle machine, then into strips of the proper size by a gang of 12 circular saws, and finally into 5-inch lengths by a gang of three saws.

The logs have now been cut up into blocks about five inches long and three-fourths of an inch square. Falling, as they leave the saws, on an elevator belt, they are carried into an upper story, and returning to the first floor are deposited into troughs, whence they are fed to the turning lathes, of which there are several—each being capable of turning 80 pegs per minute. They are then passed to the slotting machines, in which a peculiar arrangement of knives inserted in a circular saw gives the slot the proper flange, after which they are automatically carried by elevator belts to the drying bins on the second floor, where they are subjected to a high temperature, generated by steam pipes, until thoroughly seasoned. There are several of these bins, the largest of which has a capacity of 100 boxes, 72,000 pegs, and the smaller ones 50.

The pegs are now ready for polishing and packing. The polishing is accomplished by means of perforated cylinders or drums, each capable of holding 40 bushels, in which the pegs are placed and kept constantly revolving until they become as smooth as if polished by hand with the finest sand paper. A few minutes before this process is completed, a small amount of tallow is thrown in the drums with the pegs, after which a few more revolutions gives them a beautiful glossy appearance. These polishing drums are suspended directly over the packing counter on the first floor of the mill, and being thus immediately beneath the ceiling of the floor above, are readily filled through scuttles from the drying bins on the second floor, and as easily emptied upon the counter below, where they are sorted into first and second grades, and packed in boxes of five gross each. The sorting and packing are done by girls. Two hundred and fifty boxes are packed per day.

The market for clothes pegs is not confined to any special locality, but is found nearly all over the world. Ten thousand boxes have been shipped to Melbourne, Australia, within the past four months. Ten firms in London carry a stock of ten thousand boxes each, and two firms in Boston carry a like amount. One thousand boxes constitute a load.

CORRESPONDENCE.

SLIDE-REST SCREWS.

Sir,—I have read your January and February numbers of the "Amateur Mechanics" with much pleasure, and being very partial to iron and brass work in the self-acting foot-lathe, I am desirous to obtain an opinion on the best screws for slide-rests. Square threads as compared with V threads: which is the strongest and most durable, and how far as to fineness it may be carried? What should be the number of threads to the inch, in order to be able to take the finest cuts with the quickest and greatest certainty? My object in the query is to solicit a scientific and practical opinion as to the advantage of a square thread in slide-rests over a V thread. In fine screws, ranging from eight to sixteen threads per inch, I have noticed square threads appear much more worn by time than the V threads. I have a slide-rest with V screw, 16 threads to the inch, and there is no perceptible wear, although much cast steel has been cut in the small lathe of only 3 inch centre. The leading screw happens to be the same, I have noticed, in many slide-rests—eight threads to the inch; this, like the slide-rest screws, shows much wear, although not one-twentieth part of the work has been done with it. These facts lead to the query asked. In taking a fine cut there is more motion in the hand with a screw 10 or 12 to the inch than if only 8 threads to the inch. By noticing the position of the hand in the last cut, there is little danger in over-cutting or over-straining the lathe, which is very likely to be done by an amateur with a screw in slide-rest, six or eight threads to the inch.

I know of a gentleman contemplating having a lathe for the like purpose of mine, but about 4 to 5 inch centres, and I did not like to advise, but sought your opinion, which I would much rather rely on than my own.

Yours faithfully,
"S. S."

ELECTRO-METALLURGY.

Dear Sir,—The first number of your new journal is now before me, and I am pleased alike to note the varied character of its contents together with their selection, with a view to serve a definite purpose. That purpose is evidently to provide for the wants of a large class of persons who delight in spending their leisure time in the practice of amateur mechanics. Such persons will hail the advent of your new venture with pleasure, and look forward hopefully expecting the good things it may provide in the future. Your intention to allow the magazine to carve a groove for itself instead of running in one prepared for it by another, is most commendable, for you will thereby secure for it an independent position, supplanting no other journal whilst supplementing many old favourites. All amateurs who feel any interest in machinery, turnery, joinery, and kindred pursuits will surely not grudge the modest sum of 6d. per month for "Amateur Mechanics," and as the number of such persons must be large, you should be well supported. Although the title and sub-title of the magazine excludes my favourite pursuit, there may be some among your readers who may desire a little advice in electro-metallurgy; to them I offer my services, and questions under this head shall receive the careful attention of,

Yours truly,
"GALVANOPLAST."

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MAKING A KITCHEN TABLE.

By. A. Cabe.

(For Illustrations, see Lithograph Supplement.)

THIS piece of cabinet work is one that is found in every house without exception—it is a table, commonly called the "kitchen table." This article is represented in fig. 1, front, and fig. 2, end. The size almost universally adopted for a small size kitchen table is 3ft. 6in. by 1ft. 10in. on the top, larger sizes being for the kitchen of large houses.

For the four legs get either a piece of first-rate clean yellow pine, 30in. long, 8in. broad, and 2in. thick, or a rod that will make four legs 30in. long, and 2in. square. If the former, line it out with a straight-edge and pencil, as shown, fig. 3, where you will observe each piece has a taper; this is what is called cutting the one out of the other. The proper method to line the wood out is this:—Draw a line down the middle, which will give two halves, each 4in. broad; from the edge of each half mark 2¼in. at *a*, and 1¾in. at *b*. Draw lines to these marks 2in. thick, and saw up; you thus have four pieces, each tapering from 2¼in. to 1¾in.

Now plane up the two best adjacent faces of each piece, and square them; when planed, mark their faces with pencil. Set marking gauge to bare 2in., and gauge from the dressed faces for about 6in. in length at the broad end or top of each piece. This is the part of the leg that comes opposite the rails and has no taper. Plane and square the four pieces to their gauge marks, and this done, place them together on the bench, even at the bottom. Mark from the bottom 24in., which will be 6in. from the top, and square across with square and pencil; continue this line round the remaining side, opposite the dressed one, and this is the line the tapering commences from. Set the marking gauge to 1½in., and gauge the bottom end of each piece from the dressed side. Now taper from the pencil lines mentioned above, stopping at the gauge marks on the end. Now the legs will be 2in. square for 6in. of their length, and the remainder tapered to 1½in. square at the bottom.

Now for the rest of the stuff: Plane one back rail 35in. long, 5in. broad, and 1in. thick; two end rails 19in. long, 5in. broad, and 1in. thick; one front rail over the drawer, 35in. by 2in. by ¾in.; one do. under the drawer, 35in. by 2in. by 1in.; two end stretchers, *a*, fig. 2, 19in. by 2in. by 1in.; and two long do., 35in. by 2in. by 1in. These are to be planed and squared with bench square. These pieces prepared, we have to draw in the legs for mortising. Place them on the bench in two pairs, each pair having a taper side up, and the remaining taper sides opposite each other, as in fig. 4. Here we have the parallel portions of all four lying close, and the bottoms of each pair about an inch apart. There are to be two mortises made in each leg to receive the 5in. rail. First draw a line across all four at the beginning of the taper, *a*, fig. 4; set a pair of compasses to 1½in., and mark from *a* to *b*. Mark 1in. from *b* to *c*, then 1½in. with the compasses to *d*. Now you have two mortises, each 1½in. long, with an inch space between. This portion between is called a bridge. During this operation the legs should be clipped by their ends in a hand-screw to prevent them shifting. Now draw in the mortises for stretchers, by making the line, *e*, 6in. from the bottom, and *f* 1⅜in. from it. Now set the mortise gauge to ⅜in. mortise line, and set the head ⅜in. from the inner spike. Gauge with this all the mortises both for rails and stretchers, from the marked faces of the legs. Now square over *one* pair of the legs for the 5in. long or back rail, which will be on the remaining taper sides, as in fig. 5, and the other pair square across for a rail beneath the drawer, 1in. thick, the mortise being 1/16in. less than the thickness of rail (see fig. 6). Gauge for mortises as before, from the marked faces, as in the case of fig. 6 from both faces, as there are two mortises in the breadth.

In using the mortise gauge, it is a good plan never to gauge further than to the cross lines, as it does not look neat to see the gauge line continued beyond the mortises in a finished job.

Now place the legs for mortising on the bench as in fig. 4. Mortise for the rails 1½in. deep. Mark lightly the back of mortise-iron with a saw-file 1½in. up; this will be a guide for the depth. Mortise for the stretchers 1¼in. deep. Great care must be taken not to drive the iron through. When mortised clean out blaze with a 5/16in. chisel, taking care not to bruise the edge of the mortises, as in the finished job this is a sign of bad workmanship. The mortises should be smoothed on the sides a little with a chisel, but not pared wider, or they will be too wide for tenons. A mortise should always be filled for its whole depth, otherwise the glue will not take hold.

Now we have to draw in the rails and stretchers—first of all for the two ends, as they are cramped together first. Draw in the two end rails 16in. long between the shoulders; this will give two tenons 1½in. long. Draw in the back rail and the two front rails over and under the drawers, 32in. long. This drawing-in means marking them across with square and cutting-knife for shouldering. Place the two end rails edges up on the bench, mark off 16in., and square both across. Then from these lines square and mark both sides of each rail. The cutting-knife is best for this marking, making a good deep cut, which serves as a channel or guide for the dovetail saw.

Though the shoulders of the 5in. rails are square across, it will be evident that the shoulders of the stretchers *a*, fig. 2, are bevelled, arising from the taper on the feet or legs, and the stretcher is also somewhat longer than the rail. Now to find this length, and this bevel, proceed as follows:—To find the length, place a pair of the legs together with a hand-screw at top, mortises together; at the stretcher mortise they will be apart about ¾in., and this is the extra length over the rails. To find the bevel: Square across any part of the taper of a leg from the outer face with bench square and pencil, and with a bevel square or bevel stock set the blade to this line. The stock being on the inner or taper side of leg, the bevel thus found is that for stretcher shoulders, the bevel stock being worked from upper edge of stretcher. The shoulders being marked, shift the head of mortise gauge ⅛in. nearer the spikes, and gauge rails and stretchers from the outer face. Thus they will be ⅛in. within the surface of the legs when cramped together.

For the rail under the drawer, this is flush with the legs, and must be gauged same as the mortises, then shifted to fit the second or inner mortise; see fig. 6. For this reason the rails and legs should be gauged together, as it saves time and shifting of the gauge. The shoulders are cut in with dovetail saw, and the tenons are ripped with a tenon saw. Then the rails have a piece cut out for the bridge in the mortises, and a rebate of 1in. at the upper edge, which will leave two tenons a little over 1½in. broad. They should be a little less in length than the depth of mortises; this will be easily ascertained with the foot-rule. The tenoning being finished, the two stretchers, *a*, fig. 2, are to be mortised for long stretchers, *b*, fig. 1. These mortises are shown at *a*, fig. 2, where the tenons come through and are wedged. The long stretchers are 6in. apart, and the mortising is exactly as that for the rail below drawers where let into legs, and also at the division between the drawers. This being done, the inside of the legs are to be hand-planed and sand-papered, as also the face of 5in. rails and stretchers all round. Now the ends are ready to cramp together. Cut a little off the corner of each tenon, and see that they enter their respective mortises before glueing.

All being ready, the glue should be somewhat thin, and while one heats the tenons at a fire another puts glue in the mortises with a bit of lath. A very little glue will do on the tenons. The object of heating is to prevent the glue getting chilled. In cramping up, protect the work with bits of wood under the jaws of the cramps. When cramped, see that it is square by gauging with a rod from corner to corner, diagonally between stretcher and rail; also see that it is out of twist. If the work is well done, the cramp may come off at once, as the shoulders will stay close. If ill-performed, no amount of cramping will ever make it a good job. Another important thing in cramping these table ends, and in all kinds of mortised framing, is to see that the legs are not pressed out of the plane of the rails. If the jaws of the cramp are kept too high, then the legs are slanted inwards. If, on the other hand, the cramp be too low, the legs are turned outwards, so that the point of pressure should be opposite the centre of the thickness of the rails. When cramping, place a straight edge across the two legs; the straight edge should touch the legs on the whole of their breadth—then they will not be in winding.

We have now got the two ends of the kitchen table framed together. Our next operation is to fill in the two ends for drawer guides. This consists of a piece of wood 2in. broad, and thick enough to flush the table feet, or legs more properly, fitted in between the legs and glued to the rails, being kept flush with the bottom edge of rail. These should be fixed down with hand-screws, and laid aside for an hour or so, after which they are planed straight and flush with the legs, testing them with the straight edge. The tops of the two front legs are now to be cut off flush with the edge of the rails and planed; then the ¾in. rail over the drawers is drawn in same length as that under, and a dovetail made on each end about 1¼in. long. These dovetails are drawn on the tops of the legs, and then cut out to the depth required—namely ¾in. The space from this to the two mortises under the drawer is the length to make the short upright division, or fore-edge between the drawers. This has a double tenon each end, same as for the stretchers, the two rails being mortised to receive it, see fig. 7, which is the frame without drawers or top. Now the rail below the drawers is to be mortised to receive the cross rail, *a* (see fig. 7), which is a rest for both drawers. It is 3in. broad, and same thickness as front rail. The one end is tenoned to enter the front rail, while the opposite or back end has a dovetail, and is let in flush into the under edge of the back rail; its position is, of course, from front to back, and in the centre of the frame.

The mortise and tenon being prepared, the proper length of this rail will be found when the frame is cramped up, and stood on its legs. Now we have to find the length of the long stretchers. For this purpose, place the two ends together, with the mortises towards each other; catch them in a hand-screw at top, when you can measure the gap between the end stretchers; and this is the length that the long stretchers are to be in excess of the rails at back and front. Tenon the long stretchers to fit the mortises in cross ones; and, all mortising and tenoning being done, hand-plane all the parts that cannot afterwards be reached, before glueing up. Being now ready to glue the frame up, set a cramp to about 3ft. 2in., which will allow of two pieces of wood to protect the job. The back rail, front rail below drawer, and two long stretchers are all to receive glue, and be fitted in their places at once. Insert them all into one end, first with the hands, then turn them over, and insert them in the other end; now rap them nearly home with a piece of wood and a hammer; then apply the cramp. It is almost necessary for two persons to be at this part of the job, one heating tenons, and afterwards assisting with the cramp. Cramp all the shoulders close, wedging the long stretchers with the cramp in the centre between them.

Now you have to glue and insert the short upright rail between the drawers, then above this, the rail with two dovetails; press the short upright home with a small cramp or a hand-screw on either side of the projecting tenons, and drive in wedges as explained in glueing the long stretchers. Now rap home the dovetailed ends, and drive a 2in. nail through them into each leg. You will now find the correct length of the rail across the centre, which fit by dovetailing into back rail. Now make two bearing fillets, 1in. square, and nail them inside of each end and level with the front rail, when they will be on the same level with the centre bearing rail, and support the drawers properly on both sides. The two drawers are to be made; the fronts are ⅞in. thick, and are fitted closely into the apertures to receive them. Mark the front on the outside thus, Λ, when you will always know the end to be kept uppermost. Plane the bottom edge first, then make one end square, assuming that the aperture is square, or, more properly speaking, rectangular. Now place the front against the aperture, with the squared end in its place, and draw the other on the inside with drawpoint. Saw off and square this end with the plane on the shooting board. Having got the ends to the exact length, place the front against the aperture again, letting the lower edge enter a little way. Draw again along the upper edge inside, and plane down to this mark. These fronts should be fitted tight, and at present it is sufficient if they just enter. Cut out four sides of ⅝in. wood, dress and square the ends, on the shooting-board ½in. shorter than the width from face of rail to inside of back rail. These four sides may be at present a little broader than the finished side. Groove the sides and front with a drawer-bottom plane, and make two backs exactly same length as fronts, and 1in. narrower; these are also ⅝in. thick, and have no grooves like the sides have. Now, being ready to dovetail, set the cutting-gauge to a shaving less than the thickness of sides; gauge all the pieces with this—the fronts on the inner face and also on the end wood, gauging from the inside; then the backs and sides on both sides. Now mark on the fronts four pins, as in fig. 8 enlarged, and on the backs three pins, as in fig. 9 enlarged, cutting down to the gauge lines. For dovetailing, the chisels must be thin and sharp, and they are struck with the wooden mallet. The backs are cut from both sides, as is all *through* dovetailing, while the fronts are only cut to a depth of ⅝in.

To draw the sides for dovetailing: Place a pair of sides in position, groove to groove (see fig. 10 enlarged), and, taking a front, stand on the end of the side flush with gauge line, and flush on grooved edge. See also fig. 10; draw close to each pin with the drawpoint, reverse the front, and draw on other side same way. Now turn the sides end for end, and draw the backs in the same way, having each back marked so that you make no mistake when fitting the drawers together. You will observe by fig. 11 enlarged that in drawing the back pins, the back is placed even with the groove in the side, as the bottom slips in under it—in other words, the groove in the sides is clear of the back to receive the bottom. Now the pieces to be taken out of the sides are to be ripped with a dovetail saw, and cut out with a ⅜in. chisel; these pieces are three at the back end, and two at the front, with the two corners cut out, as shown in fig. 12. In dovetailing, it must be observed that the thickness taken by the cut of the saw must come off the piece to be cut out—in other words, the piece cut out is exactly the portion within the drawpoint lines, so that the pins from which they were drawn will fit exactly into the openings thus made. In *through* dovetailing, which is cut from both sides, the chisel is inclined slightly to cut inwards (see fig. 13), which allows the sharp edges to come closely and neatly against the adjoining part when glued up; this is called making it "*lean*" in the centre. The same remark applies in dovetails, *not* through, as on the drawer fronts, which are slightly "lean" at the bottom both ways—that is, both from face to end.

The dovetails should be cleaned neatly out with narrow chisels, and the corners of the sides pared, after sawing off, to the gauge lines. The drawer stuff all dovetailed, has to be planed on the inside and sand-papered; then try if the fronts and backs enter their respective sides; after which glue them as follows, and this rule will hold good in all work of a similar kind:—Take a drawer front and the corresponding side, put some glue with a small brush into the recesses in end of front, taking care to allow none to get on to the inner face; now put a little on the end wood of the side and on the two cut out corners; stand the front on the bench, glued end up, enter the side, and rap it home with hammer and a bit of wood; now turn it over on the bench, the side standing vertically, see that the junction inside is perfectly close, apply a large square inside, and press the side to agree with the square. This done, take the back belonging to this drawer, put glue on the pins to enter this same side, enter it, and rap home as with the front. Now glue the remaining end of front and back, and rap on the remaining side. See that the inside junctions are all close. Lay the drawer flat down on the bench, and square it with a foot-rule, applied from corner to corner.

Both drawers being glued, lay them aside, and prepare the bottoms. These are of ⅜in. wood, and if not broad enough may be jointed with ⅜in. match ploughs. To do this jointing, mark the *best* side of each piece, place in the bench-vice lug with marked side next you, plane straight with half-long. It is usual to work the *feather* in the narrower piece, if there is a broad and a narrow; and it is also usual to work the feather first. The groove and feather made, rap the joint up *dry* to see it is close. If it is a perfect joint, use thin glue made by dipping the brush in the boiler of glue-pot. Apply the glue quickly with one stroke of brush, and rap the pieces together very smartly with a mallet; when this is done smartly, they will need no cramping.

When glueing of the bottoms is set, plane up both sides with half-long. Plane one edge and one end *squared* to each other. Now hand-plane inside of each bottom. Next take the drawer bottom—plane, and make a gauge by running a groove in a piece of wood 4in. or 5in. long. Lay the bottoms face down on the bench, and bevel the edges now uppermost for about 1½in. inwards, bringing the thickness down to the size of groove in gauge, see fig. 14, in which *g* is the gauge, and *b* the bottom.

When this is done on front edge and one end, find the length to cut the bottom by, placing one corner in the groove at back of the drawer; mark at the bottom of opposite groove. From this mark cut the bottom to the square, and bevel the back to fit gauge as before, sand-paper the bottoms inside, and before driving them into their places, try that they enter both grooves by inserting the bottom, both back and front edges, because, if wider at the back, they will burst or split the sides. All being correct, drive them down gently with mallet, and see that they enter the groove in the front to the full depth; see also that the sides are perfectly straight and not bulged in the middle. Now you have to block the bottoms, by glueing on fillets ¾in. broad, and ½in. thick. These are fitted to the drawers along the bottom and side, and must be bevelled to the required angle. They are well glued and rubbed in with a motion, the lengthway, when they will take hold. If they do not lie close along their length, cut them into two or more pieces before glueing. Two or three short blockings of this kind are also to be glued on behind the front; these may be 3in. or 4in. apart; whereas those on the sides are continuous, being subject to wear in after use. These blockings should harden for six or seven hours, after which drive three nails about 1¼in. long through the bottom into the back.

Now fit the drawers to the table frame by planing with jack and half-long. First reduce the breadth of the sides to enter easily, then place a piece of board across the bench, catch the drawer in the bench lug, and let the side rest upon this board. Plane both sides and try into frame: when they push in with an easy motion, but not loose enough to shake, then they may be hand-planed, the back dressed off, and the front planed to stand even with the face of the frame. Now they must be stopped at the back by glueing small pieces of wood to the back rail. Push the drawer in ⅛in. beyond the face of the frame, and fit the bits of wood in the space left at the back. A guiding fillet is also to be fitted between the two drawers, and running from the short upright to the back; this should not be too tight. The drawers should pull out and in easily, and without sticking or shaking. The drawer fronts are often veneered with mahogany, which improves the appearance of these tables. If you wish to do this, teeth the two fronts, and lay the veneer with a caul, glue both fronts, and heat the caul both sides; place it on one front, and turn the other over upon it, and apply hand-screws.

The table frame is now to be cleaned off with the hand-plane in all its parts, the tops of the back legs cut off, and the upper edges of rails planed, to receive the top. This frame is 3ft. long by 1ft. 8in. broad, and the top 3ft. 6in. by 1ft. 10in. It is planed both sides with half-long and squared, then it is nailed down to frame at back and ends; the front is fastened by four screws passing upwards through the rail over the drawers. After this the top is planed flat to agree with a straight edge, then hand-planed and sand-papered; each corner is rounded off and sand-papered. The nail holes in the top are to be stopped with a bit of white putty. Now the bottoms of the legs are to be cut all to the same length. Turn the table, feet up, take two straight edges, and place one across each pair of feet; the eye will at once detect whether the legs are all one length or not. Cut a little off the foot that carries the straight edge too high. If the drawer fronts are veneered they require French polishing; then bore a ⅜in. hole in the centre of each for a 2¼in. patent zebra knob; this is shown in section, fig. 15. Now our table is completed. It is usually left white, without any paint or varnish, and is kept clean by washing.

Brush for Lacquering.—The best kind of brush for this purpose is one made in the following manner:—Take a piece of wood a little broader than the work to be lacquered, and make into the shape of an ordinary white-wash brush handle. Then cut a slit into it lengthwise with a thick saw; next take a narrow strip of clean flannel, as long as the wood is broad, and fold it the longest way; then take a piece of white nankeen cloth and fold it round the outside of the flannel, and put them both in the slit cut in the wood, with their folded edge outward, and fasten the cloth to the wood by means of screws passing through the side. Before fastening tight, however, a piece of straight wire, about a quarter of an inch thick, must be put through the bow of the folded cloth, and the cloth pulled tight against the wire so as to make it smooth and straight. After the cloth is fastened tight to the wood, the wire is pulled out, and the tool specially fitted to be used as a lacquer brush. The woollen cloth holds the lacquer, while the nankeen cloth prevents it flowing too freely, and presents a smooth surface to the metal that is to be lacquered, while it also prevents any particles coming off the woollen cloth on to the lacquered surface. This kind of brush must not be dipped into a bowl of lacquer, but the lacquer put on to it by means of a common brush. By means of a brush made in this way, large flat surfaces are lacquered very beautifully. The benefits of first coating the work with alcohol, or very thin lacquer, become greater in this kind of work, causing the lacquer, when it is applied, to flow more easily and regular. The brush must be laid on to the work very light, and with a slight curved motion at the beginning of the stroke, so that it will miss the sharp edge of the work by which a portion of the lacquer would be pressed out and flow irregularly over the edge. The brush must then be drawn straight, and with equal pressure along the surface of the brass, and lifted off the instant it reaches the other edge. In moderately broad surfaces a brush the full breadth of the work should be used; but in very large surfaces, and especially where there are a number of large holes in the work, an ordinary brush is not suitable. When work is newly lacquered the lacquer is soft, and the work ought to be exposed to a gentle heat for a short time to evaporate the alcohol and harden the lacquer. Small gas cooking stoves are very suitable for this purpose, and it will be found that after newly lacquered work has been baked for a short time, any little unevenness in the laying on the lacquer will be much improved.

HOW TO REPAIR CLOCKS.

Part I.

THE following article is based upon information given by a practical workman, and which was contributed to "Design and Work." The object of the writer was to lay before his readers a useful and practical guide to the successful repair and adjustment of clocks; embracing all the details connected with the same, and written in such a style as to be readily understood by all persons of ordinary education.

In writing these papers our object is to supply a want long felt, not only by the ingenious amateur who takes delight in delicate and intricate mechanism, but also by many others who, although engaged in the trade, feel their practical ability to be very small when thoroughly put to the test. In order that it may be useful to the largest number possible who may be interested in the subject, we shall endeavour to explain, as clearly as we can, the various kinds of mechanism met with in clocks, and, whenever necessary, describe with minuteness the tools and appliances used in repairing any damaged part, or replacing it with new, so as to enable anyone of ordinary intelligence having a mechanical taste, who faithfully follows the instructions given, with patience and perseverance to have no difficulty, after a little practice, to efficiently remedy any defect that may exist in any timekeeper likely to come under notice. We shall try to avoid unnecessary wordiness; for nothing is more tiresome to an intelligent, knowledge-seeking person than to have to read several columns to obtain a little information such as might be condensed into one paragraph.

Until the last few years, the general literature on horological matters was very scanty, and though there are now some valuable books by authors of undoubted ability, still many of them are comparatively useless to the clock and watch repairer. Perhaps the most useful of them is the well-known "Treatise on Clocks, Watches, and Bells," by Sir E. Beckett. This book should be in the hands of everyone who takes interest in horology, but to the majority this is almost a sealed book, owing to the fact that much of it is written in terms only understood by the learned. Many a working watch and clock jobber has again and again wished that the author had written it like his "Astronomy *without mathematics*," or at least without so many algebraical solutions of arithmetical problems. We shall endeavour to confine ourselves to simple rules of arithmetic in any calculations we may have to make, and, though the results may not be quite correct theoretically, they will be found sufficiently so *practically*. The early history of clocks seems to be involved in obscurity, and as this branch of clockwork has little, if anything, to do with our present object, we will not attempt to unravel the history of horology. We at once pass on to consider the construction of clocks now in general use. The countries which produce clocks in any considerable numbers are England, France, Germany, and America. The manufacture of clocks in England at the present time is principally confined to spring dials, high class regulators, skeleton, bracket, chime, electric, and turret clocks. The trade in ordinary house clocks has long since become very small, the cheaper productions of America and Germany, or the more artistic and less cumbrous designs from France, having almost entirely supplied our wants. At the same time there will be found in English homes, especially in rural districts, a very large number of English house clocks, testifying to the skill and ability of our forefathers. These clocks are of two kinds: the "thirty hour," which requires winding daily, and the "eight day," which requires winding once a week. They are generally characterised by their solidity, both of mechanism and case; and are certainly the most durable and best timekeepers for general use; the only objection which can be fairly raised against them is their cost. As to the shape of the case, against which some pronounce, there is many a piece of furniture still retained, much less ornamental, and certainly not so useful as the old English long-case clock. Respecting their durability, we may say that we have seen some which have faithfully discharged their duty for upwards of a hundred years without being anything like so much worn as most modern clocks are in the course of seven. They were made formerly in every town of importance, each maker cutting his own wheels and finishing the movement throughout, the case often being supplied by the local cabinet-maker.

The *spring-dial* is the kind of timepiece or clock usually hung on the wall in offices, shops, and railway stations. There are two forms, one circular, and the other also circular, with a drop added, through a glass in which the pendulum may be seen swinging. These latter are termed "drop" or "trunk" dials. The pendulums vary in length from 7in. to 20in., according to the style; and the motive power is produced, as the name implies, by the uncoiling of a spring. Those of English make may be distinguished from the American by the "fusee," found only in the former, and also by the pendulum being hung behind the movement in the English, and in front of it in the American ones. Some German dials, recently introduced, so much resemble those made here that an amateur would be unable readily to discern the difference. The spring dial is the most largely used of any English-made clock.

Regulators are timepieces of the most approved construction, finished with the greatest possible care, and in which every precaution is taken to ensure reliable and correct time-keeping. They are mostly to be found in astronomical observatories, watchmakers' shops, and in the houses of persons who value the advantage of having the correct time.

Skeleton clocks are those in which the wheels and escapement are visible, the plates being pierced to some design and polished. They require to be kept under a glass shade, or the dust would rapidly accumulate upon the works and stop them.

Bracket clocks are essentially like spring dials in mechanism, but have different shaped cases adapted for standing them on a bracket.

Chime clocks properly are those which, in addition to striking the hour, play changes on a certain number of bells every quarter of an hour. Those clocks which play a tune every three or four hours are not, strictly speaking, chime, but musical clocks. Chime clocks are made either as bracket, skeleton, or long-case clocks.

Electric clocks are of two kinds, first, those in which the pendulum is kept in motion by the combined magnetism of permanent and electro-magnets, the poles of the latter being changed at every beat by the action of the pendulum, and another kind, which would more properly be called controlled clocks, as the only work that electricity performs is to make the pendulum beat in unison with another belonging to a standard clock, driven by a weight in the usual manner.

Turret clocks are those designed for public use generally, and are found in church towers, the clock rooms of town halls, and similar places. As far as principle is concerned, they resemble ordinary house clocks, with this difference, that the wheels are set in a frame instead of within plates, and of course the machinery is very much larger and stronger, according to the work that the clock has to perform.

French clocks are of a different style of manufacture altogether from the English, being distinguished externally by their elaborate gilt, wood, or stone cases, and internally by finer mechanism, usually set within *round* plates, with short pendulum rods and heavy bobs in proportion to the length. There are several varieties: timepieces, clocks which strike at the hour and at the half-hour, carriage clocks, and drum timepieces of various kinds, besides a large number of curious and fancy styles. With the exception of the drum timepieces, French clocks, as a rule, perform uncommonly well, and give the repairer very little trouble. Vienna regulators, or Austrian clocks, are of late introduction, very much resemble French workmanship, and are excellent timekeepers.

German clocks, or, at least, most of them, may be easily known from those of any other nationality by their plates being made of wood, with brass bushes for the pivots to run in; no other country produces clocks made in this manner. The manufacture of clocks in Germany is almost entirely confined to the locality of Black Forest, and forms there an important branch of industry: nearly every form of ordinary clock being made, in addition to large numbers of "cuckoo," "trumpeter," musical, automaton, and curious clocks.

American clocks are so well known that they scarcely need any description, for during the last twenty years such an enormous number of these clocks have been sold that there is scarcely a house which has not one of some sort or other. They are of a totally distinct kind from any of the preceding, and are manufactured so cheaply as to defy competition. The causes of their great popularity may be said to be their cheapness, compactness, and tolerably good performance. The prices of American clocks are within the range of all; the cases are light and neat, and occupy only a small space; they keep time sufficiently well for the majority of the public, and, at the price, wear very well. The cases of the ordinary American house clocks are made in a few patterns of veneered moulding, in the cheapest manner possible. The wheels and frame are stamped to shape; the pinions used are those known as "lanterns," and are nearly all machine-made. American clocks are mostly of the useful class—thirty-hour and eight-day timepieces and clocks, dials, and calendar clocks.

There is also a variety called Anglo-American, the movements of which are made in America, and the wood-cases, which are more elaborate than the ordinary American cases, are made here in England.

This list, we believe, comprises all the clocks in general use in England at the present time, and will be found a sufficient guide to enable anyone to know at sight the nationality of any clock likely to be met with.

Repairing.—In entering upon this part of our subject, we must beg our readers to follow with their best attention, while we endeavour to convey to them that which is often very difficult to learn, even from oral instruction and witnessing the actual execution of the repairs. We may add here these words of preliminary advice. Do nothing in a slovenly way, but strive to do every job as well as it is possible for it to be done. Never mind the trouble of doing a thing more than once or twice, if it can be improved thereby; and never hesitate to take a clock to pieces, though it is supposedly finished, to alter anything that may have been overlooked and might, perchance, cause it to stop. In the first place, we shall require a workboard and a small selection of tools. The board should be sufficiently thick not to bend easily, and be well fixed, so as to be perfectly secure and steady. Towards that end, which would be at the right hand when facing the board, a vice must be secured, for holding pieces to be filed, and other uses. The tools required before commencing are one flat-faced and one round-faced hammer, one or two different-sized screw-drivers, a pair of strong pliers, an assortment of files, a hack-saw for sawing metal, two or three good stiff hair clock-brushes, a few taper strips of strong chamois leather, and the following, of which we give a short description:—

A pair of *cutting nippers*. These somewhat resemble pliers, but, instead of terminating in flat jaws, form two wide knife-shaped pieces of steel which meet together at their thin edges, and is used for nipping or cutting pieces of wire, etc., and is one of the most useful tools used.

Hand-vice. This is like an ordinary vice on a small scale, only both parts, back and front, are the same shape, and jointed at the extreme end; it is used principally for firmly holding wire or any piece of metal requiring to be filed.

Cane-bow. Which is simply a piece of ordinary cane, about 18in. long, bent into a bow shape by fixing a piece of catgut across from end to end.

Drill-stock. Made of a piece of round steel, about 2½in. long, into one end of which a hole is drilled about ¼in. deep, and a slot filed down crosswise to meet the end of the hole, and near the other end is a brass ferrule for receiving the gut of the "bow," terminating in a male centre.

A few different-sized *broaches*, of which there are two kinds: those which are taper, five-sided pieces of steel, with sharp edges about 4in. or 5in. long, are called cutting broaches, and are used for enlarging holes; the others are used for the same purpose when the hole is nearly the required size, and it is desired to harden the inside of it, and known as round broaches.

One or two *filing-blocks*. These are little blocks of hard wood or bone, but generally boxwood, from 2in. to 3in. long, about 1in. deep, and ⅝in. wide. Upon the edges there are two or three parallel grooves, different sizes, which receive pieces of wire while being filed into shape for pins or other purposes. To these may be added a few lengths of iron and brass wire of different sizes. Other tools will be introduced from time to time, as their use will have occasion to want explaining.

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Putting on a Fusee Chain.—The method of putting the chain on a watch is this:—Get the barrel and fusee in such positions that the holes for the chain hooks are towards the outside edge of the movement; then put the ratchet wheel on the barrel and put the chain through from the fusee side, under the pillar, and put the hook in the hole in the barrel. Now wind the barrel round, keeping the chain tight the while with the fingers, and when all is wound on the barrel, let the click fall in the ratchet, and hook the other end of the chain in the fusee. There should be just sufficient tension on the chain to prevent its slipping off, and you can now regulate the coils on the periphery of the barrel so that the chain will lead properly on to the groove cut in the fusee. Then set up the spring by giving the barrel arbor half a turn; this gives the necessary tension to afford the power required to make the watch go. Now wind the watch in the usual way, carefully guiding the chain, if requisite, so that it passes into the groove in the fusee, and the job is done. Setting up the spring is a process which should not be done by an inexperienced person who does not understand the rationale of it.

THE AMATEUR WOOD TURNER.

By A. Cabe.

PART II.

(For Illustrations, see Lithograph Supplement.)

AN Irishman, on being asked if he could play on the violin, replied that "it looked so 'aizy' he had no doubt he could play pretty well, if he only had a fiddle and a bow."

An observer of an expert wood turner at work is very apt to think the same thing. He sees a rough piece of wood converted, in a few minutes, into a beautiful piece of turned work with great ease on the part of the operator, who is, perhaps, keeping up a conversation, and only at intervals glancing at his work, which is rapidly changing its form at every cut, while he is all the time using the best of all callipers —his own pair of eyes—measuring, with those alone, every thickness, curve, hollow, or projection, with wonderful accuracy, never once stopping his machine till the last and finest touch of sand-paper is given. An observer, seeing all this, is apt to conclude the thing so easy, that if he only had a lathe and some tools he could do it immediately.

Well, there is not much in the driving of the lathe, but there is much more than most people imagine, for a regular steady motion has to be kept up. The difficulty with learners is, that, as all their attention is concentrated upon the piece of revolving wood in the lathe, they forget they are driving: the lathe immediately slows down, and the speed has to he recovered with a few vigorous strokes of the foot. All this disappears with lengthened practice; so much so, that the turner keeps up a steady treading motion for hours together without special effort—without even thinking or remembering that he is all the time acting as his own engine. I often work at the lathe for three or four hours at a stretch, and my experience is that my whole attention is devoted to the work being turned, while I am unconsciously keeping a steady motion, and frequently changing from one leg to the other, without being aware of it.

As to the tools, however, there is a great deal in the keeping of them in a proper condition for work; and the amateur turner has got this to learn before he begins to learn turning itself. New tools require to be ground and set before they can be used. Gouges are ground wholly on the back or round part. This ground part in all tools we call the cannel. Why this name I cannot tell; perhaps it is for want of a better; but, when understood, it serves the purpose as well as any other.

In fig. 1 (litho. supplement) *a*, *b*, and *c* show three views of a ¾in. gouge; *a* is the upper or hollow side, showing the form of the cutting edge from *c* round to *c*; no part of the cannel is visible on this side; *b* shows the side or edge of the gouge, where the form of the cannel is readily seen. From *d* the heel to *d* the extreme cutting edge, it should be perfectly straight. This is a difficulty with learners that is only got over with time, the earlier efforts generally resulting in a round cannel, stumpy at the point, and therefore in a bad working condition; whereas an experienced hand can grind not only straight but hollow, especially if the stone is of small diameter.

These gouges are very much thicker and stronger than joiners' gouges, and their cutting faces are entirely different. *C* is the back of the gouge, showing all the cannel; and I think from these figures the reader will derive a pretty accurate knowledge of how to grind his gouge. In the operation of grinding itself, the tool is kept continually turning round, from *c* to *c*, on the stone, so as to get a uniform parabolic curve all round the cutting edge, at the same time giving it a straight cannel from *d* to *d* of ½in. for soft woods; for hard woods the cannel may be shorter, consequently stronger at the point. In setting up gouges, the turner has an ordinary set-stone, with a number of different-sized hollows worn into it. He selects a hollow the size of the gouge, rubs the back or cannel part along it, at the same time turning the tool round, as at the grinding. Then, with a slip, having a rounded edge, he takes off the wire-edge, which will be found all round the cutting edge in the hollow side. In doing this, great care must be taken to rub the burr down only level with the surface on the hollow side, because tilting up the back end of the slip would produce a slight cannel on the hollow side of the tool, and this is not desirable. The operation, however, turns the barb backwards, when the tool must again be lightly applied to the hollow set-stone; and, finally, one or two more rubs on the inside with the slip, after which it is wiped with a piece of soft leather, or on the palm of the hand, which removes any remaining wire-edge; and the tool is now ready for work. This tool, as well as the other gouges and chisels, should, with their handles, be not less than 15in. to 18in. in length. The handles are made straight, as in fig. 2, which shows a gouge with handle complete. All the gouges, large and small, are ground and set up as described above, different-sized slips being used. The chisels are ground on both sides, with an equal cannel, the cutting edge being in the centre of the thickness, as in fig. 3. *a. b.* This cutting edge is not at right angles with the sides of the tool, but at an angle of about 10°, thus presenting an acute and an obtuse corner. The utility of this will be seen when we come to practical turning.

The side and front cutting tool comes now to be noticed; it is shown in fig. 4—*a* the back, *b* the cutting edge. Its use is to cut recesses in work held on the face plate, the rest being turned across the bed, and the tool held parallel with the bed, such as in turning out the inside of boxes having parallel sides and a flat bottom. It is always ground on the left side, as the work in the lathe is always running towards you, and the tool operating on the near side.

Another useful tool of this class is shown, fig. 5, back view. It has its cannel on both edges, and round the front, which is circular. Its use, like the last, is for finishing recesses end-ways in all articles having a rounded bottom, such as egg cups. Both the above are finishing tools, coming after the ordinary gouges. The parting-tool is in shape like fig. 6 *a b*. It is about ⅜in. broad, and ⅛in. thick. It is used for cutting off pieces of finished work from the block, held in the cup chuck, or on a face plate, such as bosses, patellas, draught-men, &c. It works best when the grain of the wood is running at right angles to the lathe centres, or what we call plank-ways. Turners have usually a second tool of this pattern, about ¼in. thick, which comes in for many purposes.

The above tools are about sufficient for most amateurs. There are, however, a variety of other tools of peculiar forms required by turners who do a great variety of work. The shape of these suggest themselves from the nature of the work to be done. Old files of various forms are then utilised, by grinding into the required form. The great thing in the grinding of all these tools is to see that the ground part or cannel is a straight line from the heel to the cutting edge, and in setting on the stone this surface should lie nearly close on the stone, that is, the heel slightly raised, so that the cutting edge comes in contact with the stone, but no more, as if the hand is held high, a new cannel is immediately formed at a less acute angle than the ground part, and the tool will not work until it is re-ground.

Now for the operation of turning. We will begin with the very simplest of work, namely, a plain cylinder, running between centres (see fig. 7); say it is 9in. long and 2in. diameter; say you have a piece of pine-wood 10in. x 2¼in. x 2¼in. First of all it is centred; this is usually done with a joiners' marking-gauge. The gauge is set by guess to reach to about the centre of the end of the block. It is now gauged from all four sides, and on both ends, the scratches will, if exactly in the centre, form a cross, or they may show a very small square, in the centre of which an indentation is made with a centre-punch. In the absence of the gauge the turner finds his centres with a pair of compasses, but not so expeditiously.

The block now centred, one end of it is pressed against the central point of the prong-chuck, when it receives a stroke from a hammer to make the prongs enter the wood. The poppet-head is now pushed along till its centre enters the right-hand end of the wood, an inch or so of the sliding cylinder protruding out of the barrel. Here the head is firmly fixed down, and the centre brought forward by turning the hand-wheel till it takes a good hold of the wood; now the set screw, on the top or side of the head, is turned till it binds the sliding cylinder. A drop of oil is now applied to the centre, where it enters the wood; all the working parts of the lathe, as well, being properly lubricated, and you are ready for work. In ordinary lathes, when the fly-wheel is not counter-balanced, the cranks are always hanging downwards, the treadle being at the bottom of its stroke. The lathe is usually started by catching the belt with the left hand, close up to the pulley, and giving it a pull downwards, when the cranks come over the top centre; the foot is applied to the treadle, and the machine started at a good speed.

Previously to putting the block of wood in the lathe to be turned, the corners should be taken off with a hatchet, making it somewhat octagonal in section. The rest is placed with the socket, opposite the centre of the wood, the T inserted; then the socket is pushed forward till the rest will just clear the wood where it is fixed to the bed; then the rest is raised to about a quarter of an inch above the centre, and fixed firmly in the socket by the set screw. A ¾in. gouge may be used for this job to rough down. Beginning at the right hand, the gouge is held with its round side on the rest, and pointing upwards, so that it forms nearly a tangent with the surface of the revolving wood, as in fig. 8. The right hand grasps the back end of the handle, while the left hand grasps the tool close up to the rest, the thumb against the left edge, and the fingers passing round the back and over the upper side of the gouge. In roughing down, the turner begins by turning the gouge over on its edge somewhat, and the point slightly directed to the right; he begins by making a series of circular cuts round the stuff, shifting the gouge for every fresh cut about a quarter of an inch, and working towards the left till he comes near the end of his rest. These cuts are made in rapid succession, and rough down very rapidly, the cylinder now presenting a series of grooves; on getting to the left-hand end, and without pausing, he runs back again, this time sliding the tool along and making a spiral or continuous cut all along, when the surface, though still grooved, is much finer. The flat sides of the wood will now have disappeared, or nearly so. A calliper is now set to fully 2in.; the gouge reduces the cylinder at both ends till they will pass, then the gouge, keeping the sliding cut, removes all the intermediate wood—measuring with the eye to the diameter of the ends.

Now, assuming the cylinder to be $\frac{1}{16}$in. more than finishing size, a chisel an inch broad or thereby is used. A beginner is safer to begin with this in the middle and work to both ends, right and left. If he works to the left he places the chisel with its left corner on the rest, holds the tool at an angle pointing to the left, has the cannel resting on the surface of the cylinder, so that the centre only of the cutting edge will cut. The two corners, but very especially the upper acute one, must always be well clear of the work, for if it only gets a hold, it will make a frightful dig into your work, and ruin it.

The tool properly held, as above, is slidden along the rest, great care being necessary in keeping the handle always at the same elevation, so that a uniform shaving may be removed to the end. Then to work from the centre to the right, he simply reverses the positions of the chisel already laid down.

The callipers are now set to the finishing size and tried, and the work reduced all along by careful shaving till the callipers will pass, touching, but no more, as the callipers may be thrust over a cylinder considerably thicker than they are set for, in consequence of the spring in the legs. Having worked the cylinder to a uniform thickness by callipering, it may be further tested by applying a true straight-edge: even the hand passed along when revolving will detect inequalities. The ends of the cylinder have now to be cut in. To get the exact length, a pair of compasses are set, their points brought against the work by resting the legs on the rest; a very light mark is made while the work is revolving, marking off an equal portion at either end to be cut away. The ends are now cut in at the marks with a ½in. or ⅝in. chisel resting on edge with the acute corner down, and held slightly elevated at the point, raising the handle as the cut gets deeper. A ⅝in. or ½in. gouge is now used to cut away the ends to near the centre. In this operation the gouge is rested on one edge and has its back or round side turned towards the end of the cylinder, the extreme point doing the cutting. In this way the ends can be cut in very nearly square, that is, at right angles with the centre, leaving only a thin shaving to be taken off by the chisel. This last cut is the most difficult of the whole operation, and success depends entirely upon the way the chisel is held; as before stated the acute angle is under. The danger is in its first contact with the surface of the cylinder. The cannel side of the chisel next the body of the cylinder must be held exactly at right angles with the centre of the spindle, and with the top corner slightly inclined away from the work, for if allowed to approach it, the result is an ugly spiral cut two or three inches along the finished surface of the cylinder, which effectually spoils the whole thing. To cut in these ends properly the chisel must be well ground, straight in the cannel, and very sharp. In next paper we will further operate upon this cylinder.

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Quick-speed Circular Saws.—Soft-iron discs running at a circumferential speed of 12,000ft. per minute will cut hard steel, but 5,000ft. per minute will not cut iron. This fact is taken advantage of in rolling mills to cut large bars and beams to exact lengths. Circular saws for cutting hot steel have a velocity of 13,000ft. per minute at the periphery, equal to a speed of about 150 miles per hour. The saws are 7ft. diameter, and $\frac{5}{16}$in. thick, driven through gearing in one case by a pair of locomotive cylinders 17in. diameter and 2ft. stroke; in another instance the saw is driven direct by a three-cylinder engine, 14in. diameter and 8in. stroke. At another works a saw of 4ft. 6in. diameter is run at 1,200 revolutions per minute, equal to 17,000ft. per minute. A jet of water plays on circumference of saws to keep them cool.

CYLINDER ESCAPEMENTS.

THE cylinder escapement was invented by Graham early in the eighteenth century, but Berthould, the famous French horologist, first perfected and brought it into use, and at that time the escape wheels were made of brass, and were very thick. It is now adopted for the larger portion of Swiss and French watches, being cheap in construction, and allowing the watch to be made very flat. Though excellent for ordinary pocket watches, yet the cylinder escapement cannot be said to equal the lever and some others, where greater accuracy is required. The "drop" of the escapement is the cause of much trouble to amateur watch jobbers, but by the following means he can ascertain how far the drops are equal and correct. The movement being slightly wound up, with a fine wire or strip of paper turn the balance till a tooth falls; now try how much shake the escape wheel has, and allow the tooth to escape; then try again, and go all around the wheel to see how all the teeth and spaces agree in size. To correct any inequality is certainly a job for an expert hand, and directions will avail much to an amateur, unless he be an expert. When the tooth contained within the cylinder has no freedom, and rubs at the point and heel, there is no internal drop; when the tooth has escaped, and the cylinder shell rubs on the point of one tooth and the heel of the next, then the outside drop is too small. The internal drop is increased by reducing the length of the teeth, the external by increasing the space between the teeth. When the drop is very slight, the watch is very liable to stop through the excessive friction; in the case of unequal drop the rate of a watch cannot be maintained, and occasional stoppages will occur. This fault is found out by dotting the balance with spots of rouge and carefully noting the oscillations, which, if unequal, indicate unequal drops. Though this is the usual course, the same effect may be the result of some teeth lifting more than others. A noisy drop is caused by badly polished surfaces, and in such a case the heel of the cylinder should be carefully noticed. If the escape wheel pivot holes are too large an immense amount of trouble will be caused, and, in fact, all the end-shakes and side-shakes of the cylinder and escapement require most careful adjustment. An excess of oil will also cause an infinity of errors to arise, and should be most carefully guarded against. The points of the escape wheel teeth may catch in a slight burr which is sometimes left at the lips of the cylinder, and of course stop the watch. This is remedied by polishing the cylinder and rounding off the points of the teeth.

The spring should be pinned up to have the escapement in perfect beat. This is done by pinning the stud on the spring so that it is exactly over a dot marked in the balance for the purpose of showing the position. Sometimes the lower corner of the heel of the escape wheel tooth touches the inside of the cylinder and stops the watch. But all these defects may be seen, or rather felt, by careful trial. If there is any doubt of parts touching where they should not, just put a dot of rouge on and you will at once see the mark it touches.

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Liquid Glue.—In preference to the treatment of glue with nitric acid, the following is recommended:—So-called gelatine is dissolved in the water-bath in its own weight of strong vinegar, a quarter part of alcohol, and a very little alum. This glue remains liquid when cold and is much used for cementing mother of pearl, horn, etc., upon wood or metal.

SCREWING APPARATUS: TAPS, DIES, AND DIE-STOCKS.

By Paul N. Hasluck.

(*For Illustrations, see Lithograph Supplement.*)

PART I.

SCREWS are in such continual demand by the amateur that it is desirable to make him thoroughly acquainted with the means of manufacturing, for himself, those required in the course of his manipulations. Screws of all shapes and sizes are found in work turned out from various shops, amateur and otherwise, and it is difficult to fix on any particular sizes and rates, as an universal standard. The only threads in general use are Whitworth's; they form the basis of the threads on the ordinary coach bolts, and all users of screws and bolts should possess a set of Whitworth taps, embracing all those sizes he commonly uses. The angle of these threads is 55°, and ⅙ of the depth is rounded off the tops and bottoms of the teeth. The following table gives sizes and number of threads per inch up to one inch:—

Diameter in in.—3/16, ¼, 5/16, ⅜, 7/16, ½, ⅝, ¾, ⅞, 1.
Threads per in.—24, 20, 18, 16, 14, 12, 11, 10, 9, 8.

A useful set of screwing tackle, embracing the sizes which are usually met with, is indispensable when good work has to be executed, for good screws are the mainstay of nearly every piece of machinery. The ease with which distinct parts can be united, the firmness with which they are held in position, and the readiness with which they may be separated, are most important considerations. The utility of bolts and screws, combining, as they do, these primary requisites, is too obvious to need comment; though it often happens that excessive familiarity with a thing conduces to want of adequate observation as to its theory and adaptability. The chief points required in a screw are—*power*, to draw the parts it unites into due contact; *strength*, to withstand any strains to which it may be subjected; and *durability*, to stand the wear and tear of fixing and unfixing.

The characteristics of any particular thread are divided into pitch, depth, and shape. The power of a screw depends on the pitch, the strength and durability depending on the depth and shape of the thread. In selecting a thread for any particular purpose, no definite rule can be given for determining either pitch, depth, or shape. It may be obvious that some are too coarse or too fine, and an equally apparent discrepancy of depth may be noticed, but the intermediate rate which has to be selected must be left to the judgment. Fine and deep threads are evidently unsuited for use in cast-iron, as the material would crumble away; whereas coarse screws are not suited for fine adjustment or shallow holes. Whitworth's standard rates are now almost universally adopted for the ordinary bolts and nuts used in general engineering work, and should be employed in all cases where their characteristics do not virtually debar them. Particulars of sizes are given above.

In most of the smaller sizes of threads, such as are used by amateurs for model work and such like, the pitch is comparatively much finer, it being governed principally by reference to the depth; the extra depth of a coarser thread would weaken the centre part of the thread to an inordinate extent; while a finer rate, necessarily shallower, would be liable to wear out by friction. The shape of a thread is governed by the nature of the material into which the screw is to be put; if it be homogeneous and tenacious, a sharp, angular thread will remain intact, but for material of a friable nature the tops and bottoms of the thread require to be rounded off, as are those manufactured by Whitworth, which are meant for using in all metal work, cast-iron or wrought, etc., indiscriminately.

There are three ways of describing the number of threads on a screw; thus the ¾ above might be described as having 10 threads to the inch, being 1/10 pitch, or as ·1 pitch; these two latter measurements representing the distance apart of the threads. It will be well to bear in mind these three definitions when speaking of screws.

Screws are cut or sometimes "murdered" out in various ways:—1. In the screw-cutting lathe with a single point tool ground to the proper shape held in the slide rest, which is moved at the required rate by the leading screw and suitable wheels. 2. By a comb-screw tool used in a similar manner. 3. By a hand comb-screw tool used on the T rest, to guide which requires considerable manual dexterity. 4. By dies held in a die-stock, and (5) by screw plates.

When one has the opportunity of using a screw-cutting lathe, the first method should be adopted in commencing to make anything like a perfect screw. With a single-point tool held in the slide rest a perfectly true thread (*i.e.*, not drunken) is cut, and the proper shape can be given afterwards, with dies or, better still, a screw-plate, which leaves the work properly finished to the exact size. It is impossible to form a good screw of more than ⅛ diameter, with a screw plate only; but, having cut out the greater part of the metal and made a perfectly true thread, a properly-made screw plate is the most convenient and effective tool to use for the purpose of perfecting the shape and diameter of any screw. By the second method we dispense entirely with the use of screw plates or dies, the screw being finished completely in the lathe; this is the plan to adopt when cutting an out-of-the-way thread, and one has no plate or dies with which to regulate the size and shape. In the slide-rest the comb-screw tool requires using carefully, or the whole thread may be torn off. Care must also be taken that the process of screw-cutting is not continued too long, or the screw will be reduced to too small a diameter.

The third method is only available to those able to handle the hand-screw tools tolerably well; the only means of learning to do so is practice. I may here mention that all the inside screw tools sold at the tool shops are made with the teeth slanting the *wrong way*, through being cut on a right-handed hub. They should be cut on a left-handed hub, which would give the teeth the requisite amount of lead in the right direction. Anyhow, as now made, they are quite wrong for right-hand inside threads, being really cut as they should be for striking a left-handed thread; few people seem to be aware of this fact. The fourth method is the most usual, and gives general satisfaction.

By means of the die-stock, screws can be cut near enough for ordinary purposes, without the use of the screw-cutting lathe, varying in diameter from, say ⅛ to 1in., which is about the largest size an amateur is likely to require. For this range of sizes three die-stocks would be necessary, thus: small size to take from ⅛ to ¼, the sizes varying by 32nds of an inch, thus: ⅛, 5/32, 3/16, 7/32. Medium size to take from ¼ to ½, varying by 16ths, would give ¼, 5/16, ⅜, 7/16; the large size, to take dies from ½ to 1in., varying by 8ths, thus: ½, ⅝, ¾, 1in. This would furnish a very good stock of screwing tackle for general use. Special threads, such as square, left-handed, double-threaded, etc., could be added at any time by making new dies. The fifth method of making screws by screw-plates, though in general use, is by no means to be recommended; the screws, being formed by a combination of squeezing, pressing, tearing, and burnishing, and sometimes a little cutting, are not to be put forward as models. Screw-plates do very well for small screws, from the smallest made, up to, say, $\frac{1}{8}$; but for any larger size, the metal should be cut out before applying the screw-plate, which is, as I said before, very convenient for regulating the diameter.

Now, a few words about making the various forms of screwing tackle above alluded to. Taps claim the first attention, supposing we had to make the sizes previously mentioned (from $\frac{1}{8}$ to 1in. inclusive). The very best quality of cast steel should be used; select that which shows, where fractured, an uniform texture of not too fine a grain, and having a bluish hue; cut off lengths of the various sizes required and *carefully* anneal them. I italicise advisedly, as, should the steel be made too hot, it will be rendered useless, and if not made hot enough it cannot be worked satisfactorily; heat it to a good blood-red, and let it cool gradually. Now file up the ends of each piece; see that they are the correct length, and centre punch them; put each between the lathe centres to make sure of their being punched truly central. They must now have the ends drilled to a suitable size and depth, say $\frac{1}{16}$ for the small, $\frac{3}{32}$ for the medium, and $\frac{1}{8}$ for the large sizes, drilling to about the same depth as the diameter of the drill; then chamfer, just to take off the sharp edge; now put each piece successively between the centres of the lathe, and with a graver true up the ends. These minute directions are not trivial, and must be carried out if good tools are required; if not adhered to, the resulting taps will be comparatively useless. Having proceeded so far, we shall have, reckoning three taps, a plug, taper, and entry, for each thread, 36 pieces of steel of 12 different sizes; and before going any further, carefully look through each set of 3, and see that there are no defects, either in the material or workmanship, so far. See that they are all of equal length and diameter, which must be just a trifle more than the nominal diameter of the finished tap.

I give illustrations of two good forms for taps. Fig. 1 is Whitworth's pattern, and allows the shank of the tap to pass through the hole it has screwed. Fig. 2 has a shoulder at *b*, the full size of the tap; this shape allows of a much larger square for the wrench; the collar, *b*, is left the exact diameter of the tap, and serves as a calliper gauge when drilling a clearing hole. This form of tap must be screwed all the way back after tapping a hole, whereas the other (fig. 1) will pass right through. This saving of time, though important in the manufacturer's workshop, is perhaps too insignificant to be taken into consideration by amateurs. Sections of each form are given at *a*, *b*, *c*, and *d*.

Having decided on the shape, our next job is to rough out our pieces of steel as nearly to it as possible, measure off the length of thread from *c* to *d*, for each size, and mark it, also the length of square head of top, from *a* to *b*; when they are all marked, take a cut over the shank part, *b* to *c*, working as near the gauge lines as is quite safe, for up to the present we are only roughing out our taps. Before cutting the thread and finishing they must be again carefully annealed; the repetition of this process is necessary in consequence of the large bulk of metal removed since annealing the first time, and if not repeated the taps would go out of shape in the process of hardening; besides, it is requisite to have the steel as soft as possible, in order to cut the threads satisfactorily.

On putting the blank taps into the lathe after this second annealing, probably some may be found to have warped; they must be turned up true. That part of the tap which is to take the thread must now be very carefully got to size, a superfine cut file being used to eliminate all traces of the slide-rest tool. Now they are ready for being screwed, this can be done by either of the methods previously described. The best is to remove the bulk of the metal with a single-point slide-rest tool in a screw-cutting lathe, and finish with a properly-made comb-screw tool, also in the slide-rest. When the thread is finished it is easy to turn down the plain part of the shank to the size of the bottom of the thread by observing the scratches left on it by the tool when cutting the full depth of the thread; the best way to finish is with a superfine cut file. In a properly-made tap, fig. 2 pattern, the shank, *c*, forms a calliper gauge for a drill to bore a hole the tapping size, and the collar, *b*, serves the same purpose for a clearing drill. A fine line should be turned at *b* to show the length of the wrench square, which is made to fit the tap wrench, fig. 3, of which there should be 3 sizes, each having 2 different sized square holes, so that taps from $\frac{1}{4}$ to $\frac{7}{16}$ fit the same wrench, the $\frac{1}{4}$ and $\frac{5}{16}$ in the smaller hole, and the $\frac{3}{8}$ to $\frac{7}{16}$ in the larger (see drawing). On this principle all the taps belonging to one die-stock fit one wrench, and each lot forms a complete set so far as its range of sizes permits.

There are several shapes of tap in use, other than the now generally used machine made fluted, the small sizes being difficult to flute, or rather they are usually made by people who have not got proper appliances for cutting the grooves properly. Taps of square, triangular, half-round, and other section being variously estimated as best, but there is no doubt that a properly-grooved tap is superior to any others, not only with regard to actual cutting, but for strength and durability; but as home-made taps are not likely to be so made it is advisable to describe the other means of obtaining a similar, though perhaps not quite such a satisfactory result, by means of the file. When one has overhead gear, a live spindle, and the necessary paraphernalia for driving a circular cutter, taps should be fluted, using a circular-edged cutter, which cuts a semi-circular groove, the diameter of which equals one-half of the diameter of the tap; on cutting three grooves with a cutter this size three-sixths of the circumference of the tap will be removed, and three-sixths will be left for the thread. In order to carry out the correct proportion it would require a different circular cutter for each diameter of tap. These cutters being rather expensive, it is seldom that any great quantity is to be found in an amateur's workshop, hence the comparative rarity of *fluted* home-made taps.

If it is not possible to get them thus fluted, they must be filed square, or, better, with the overhead gear and the "live spindle" in the slide-rest; holding the tap in position with the division peg, take a trip along at four equi-distant places. When making several taps, the following method of squaring them up will be found much superior to filing, but in this case also the overhead gear is required, though the multiplicity of cutters is dispensed with:—Mount a "face-cutter"—*i.e.*, a circular cutter, having teeth on its front side or face—on the spindle, put the tap to be squared between the lathe centres; the carrier being fixed to the throw of the point-chuck and the division peg in action, set the top slide of the rest to a slight angle to give the requisite taper to the tap, set the spindle in motion and take a cut along the tap, shift the division plate, and continue the operations till the four flats of the tap are finished; by this means absolute uniformity is ensured, which is not *usually* the case with filed taps turned out by amateurs. One face-cutter will serve for taps of any diameter, and of course by so adjusting the divisions three flats can be made instead of four. The plug tap is squared parallel, and the slide-rest set to the requisite angle for the taper and entry tap, which should be cut down at the point, so that the measurement across the angles is just the same size as the bottom of the thread, which is left just full at the end, *c* (see fig. 2). The sizes of the taps and number of threads per inch should be legibly stamped on the shank of each one, and having smoothed them all up, they will be ready for hardening.

Get plenty of water, such as a bucketful; add a handful of salt, and heat the taps one at a time in a clear fire till they are well red hot, but don't allow any of them to get hot enough to blister. When at the right heat, stir round the water so as to make a miniature whirlpool in the bucket; take the tap and plunge it perpendicularly, threaded end first, quickly but steadily, into the *centre* of the whirlpool. If this is done carefully there need be no fear of the taps going out of shape, if they have been thoroughly annealed twice, as directed. For the smallest sizes, to guard against the points of the threads being burned and spoilt, rub a quantity of common soap on them before putting them into the fire. When all have been treated thus, with a file try each one at both ends to make sure that they are hard all through, and then get ready for tempering. Make both ends and one of the flats of the wrench-square, quite bright with emery paper, and also, if square, one of the flats, or, if grooved, one of the grooves along the thread. See that these bright parts are quite clean. The actual tempering had best be done over the gas, using a Bunsen burner; in order to heat the tap evenly, get a piece of stout metal to interpose between it and the flame—a piece of angle iron will answer the purpose very well—and make the taps hot enough to change the colour on the bright parts to a deep yellow—don't let it get to purple—then dip in cold water. The foregoing particulars are, I hope, explicit enough to enable anyone to make a set of thorough good taps.

The wrench figured is made from a piece of iron ⅝ by ⅜, and 7in. long, centred at each end, and the handles turned up to the pattern sketched; the square holes are first drilled round and then punched out square; the whole thing, after being finished off, is case hardened all over.

(To be continued.)

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Hardening Long Pieces of Steel.—Appreciating the difficulty of hardening a long piece of steel and withdrawing it from the water straight, a correspondent writes:—"My practice has been to heat the steel uniformly to a low red heat and then dip it perpendicularly and slowly, cooling it gradually as it descends. Don't let it lean to either side, but keep it up straight. It will harden as well as if it was all plunged at once. I have made long knives this way with good success.

To Put in a Pivot.—The pinion must first be made sufficiently soft to drill. Very great care is necessary in applying heat, and even in the most obstinate cases the heat should be applied to the extreme end of the axis, and the discolouration only extend for a space of about two diameters along the staff or pinion. A frequent cause of failure in getting good drills, is that they are not hardened properly, because, with a good drill, it is often possible to drill up a pinion without softening it. When this has to be resorted to, however, the best way to do it is this: Make a piece of metal red hot, take it from the flame, and put the extreme end of the axis to be softened against it; as soon as you see the colour turn, take it away and try if you cannot drill it, using a drill that is as hard as you can make it at the point. A good pivot drill is very hard to make; they generally get burned when being hardened.

HORN AND ITS USES.

UNDER the general name of horn may be included a great variety of tough, somewhat flexible, semi-transparent organs intended by nature for defence or covering; of this kind are the hollow horns of the ox, goat, ram, and some other animals, the hoof, the horny claw and nail, and the horny scale of certain insects and animals, chiefly cold blooded, such as the shell (so called) of the tortoise. All these resemble each other very closely in chemical character though they differ considerably from some of the harder and bony defences of some animals, such as the stag's horn, ivory, and the hard tusks of the sea cow, and many others.

Horn, using the term in the above general sense, has various degrees of hardness, but is always in some degree tough and flexible, even in the cold, so that, however dried, it cannot be bruised to powder as bone can. It is also distinguished from bone very remarkably, in being softened very completely by heat, either naked or through the medium of water, so as then to be readily bent, moulded and made to adhere by pressure to other pieces of horn in the same state. No such change takes place with bone.

The experiments of chemists have also shown a most decided chemical difference between horn and bone. When bone is boiled with water in an open vessel, a large quantity of gelatine is extracted, and the insoluble residue consists of the earth of bone, together with albuminous cartilage, so that the texture remains unbroken. On the other hand the different species of horn boiled with water, even for many days, give to it but very little gelatine, the softer and more flexible horns giving the most. The horn itself during the digestion is softened considerably by the hot water, but on being taken out and dried, it becomes more brittle than at first, and in proportion to the loss of gelatine. Bone therefore contains much gelatine, and horn scarcely any.

Another difference appears after the utmost action of fire on each. When bone is burnt, a number of substances are procured, and the last residue is an earthy salt, chiefly phosphate of lime, amounting on an average to from half to one-third of the entire weight of the bone. When horn is treated in the same way, the volatile products are indeed the same or nearly so, but instead of a large earthy residue, scarcely any earth or any other combustible matter remains. Bone therefore contains much phosphate of lime, but horn hardly any.

But the substance which they possess in common is that condensed tough matter, insoluble in water and weak acids, which has been shown to resemble albumen in all essential properties, and which in bone forms the original organic cartilage on which the earth is deposited during the growth of the animal, and in horn forms almost the whole substance.

Horn seems to consist in by far the largest proportion of condensed albumen, combined however with a small and varying portion of gelatine, which modifies its texture and flexibility, and also with a small portion of phosphate of lime.

It has been mentioned that boiling water in open vessels had hardly any action on horn, but when confined in a digester, horn as well as bone is totally soluble, because water assisted by the strong heat of a digester will dissolve condensed albumen as well as gelatine. This method therefore is not sufficiently distinctive for chemical analysis.

The fixed alkalies readily and totally dissolve horn into a yellow saponaceous liquor. The products obtainable from horn and bone of all kinds by distillation *per se*, were early attended to by chemists, as it is from these substances that a variety of valuable ammoniacal salts and preparations are obtained.

The products from bone and horn by fire are very similar, and it is only the soft parts, such as gelatine and albumen, that are decomposed in the process, the earthy phosphate remaining inert without adding to or modifying the volatile products. These latter are a weak ammoniacal phlegm or water, on the first impression of the fire, to which succeeds an oil, thin and limpid at first, but afterwards brown and foul, and at last of a pitchy colour and consistence, and an extremely fetid and empyreumatic smell. During the whole of the distillation, carbonate of ammonia comes over, partly dissolved in all the liquid products and partly concreting on the sides of the receiver in crystalline plates. A second distillation with regulated heat is used to procure the ammonia purer; but it can hardly ever be totally freed by this means from the volatile oil; so that, though limpid and gratefully ammoniacal, the alkaline liquor or salt thus obtained always retains somewhat of the peculiar smell of the oil, as must be observed by everyone who compares the scent of common spirits of hartshorn with that of the pure carbonate of ammonia or sal volatile, which is prepared in a different way, and from other materials.

Horn, properly speaking, is seldom employed for the purpose of distillation, being too valuable as an article of manufacture to be thus sacrificed. The only horn ever used is the stag's horn or hart's horn, which, as above mentioned, partakes much more of the nature of bone, is not flexible like ox and other horn; when in shavings, readily dissolves by boiling water into a pure nutritious jelly, entangling the phosphate of lime along with it, which makes it slightly opaque. Stag's horn, therefore, is somewhat intermediate between bone and true horn.

Horn and tortoise-shell being applied to a number of mechanical purposes, must be cut, bent, and shaped in an infinite variety of ways. This is done in most instances by the assistance of heat applied either dry or by softening the horn in boiling water, and sometimes with the assistance of a weak alkaline liquor. When thus softened, one part may be made to adhere to another by mere pressure as firmly as the undivided substance. Thus, for example, to make the horn ring that surrounds a common opera glass, a flat piece of horn is cut out of the requisite shape, the ends intended to join are thinned down by a file, the piece is then put into boiling water till sufficiently supple, and is then rolled round a warm iron cylinder, and held in that position by a vice, so that the ends envelop each other. Another piece of iron heated and grooved is then laid upon the seam of the jointed ends, and pressed upon the cylinder, and confined there by iron wire; and the heat of the two partially melts that portion of the horn and cements the ends so completely that no seam or joining can be observed when cold.

In a similar manner two pieces of tortoise-shell may be joined together by first neatly shaping with a file the parts that are to be united, then tying a thick paper doubled in several folds over the joining, and pressing the whole together with a hot iron instrument like curling irons, heated just sufficiently that the shell when warmed by it will begin to bend by its own weight. When cold the joining is perfect, and without seam. Too great heat would make the shell rise in opaque blisters, and spoil its beauty.

Horn is made to imitate tortoise-shell in the following manner: Make a paste with two parts of quicklime, one of litharge, and a little soap-maker's lye, or solution of caustic potash; apply it skilfully on a thin plate of horn in a way that will best imitate the natural spots of the tortoise-shell, leaving the light parts untouched; let this paste dry on, then brush it off, and the horn will be permanently stained. The effect is much improved by laying beneath it, when used, a piece of brass leaf. This staining may be varied at pleasure by substituting other coloured substances for the litharge.

The tips of horns are used for knife handles, buttons, and other purposes. Horn for knife and whip handles is sawed into blanks, heated, pared, and partially shaped; then heated in water and pressed between dies. It is afterwards scraped, buffed, and polished. Deer horns are worked like bone or ivory.

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Watch Mainsprings.—To take the mainspring out of its box or barrel proceed as follows: Take the lid off the barrel by inserting the points of the tweezers in the notch cut in it, and remember to replace the lid in the same place; then take out the barrel arbor. The spring is got out by seizing its central coil with the tweezers and drawing it out. It will then expand, and without further assistance will come right out. However, take care to hold the barrel and spring well in your hands to prevent their "flying" away. With a little practice you will learn how to do this. To replace the spring, a watchmaker usually uses a "spring-winder," as described below, but often does it with his fingers only. This is effected by placing the outer coil of the spring in the barrel. See that you get the eye on the hook and the spring the right side up for winding properly; then coil the spring slightly with the fingers, and so get a little more in the barrel, always holding, with the thumb of the left hand, that part which is already in well down, or it will most likely fly out. By continuing the coiling the spring will be got in, bit by bit, very quickly. To put a spring in a barrel by the aid of a mainspring winder: First, clean the barrel and spring properly, and notice which way the spring coils in the barrel (this will depend on the position of the cover, whether top or bottom); then lay the barrel aside; put the spring on the nose of the winder, which is held in the bench vice; see that the eye in the centre catches on the hook, and that the spring is the right side outward to go in the barrel. There is a little ratchet-wheel to the winder, which you must adjust to act in the right direction. Now proceed to wind the handle, at the same time holding the spring in the hand. It will be found to gradually wind up on the nose, so that it will easily go into the barrel. You have to keep tight hold of it with the fingers or, of course, it will uncoil. Let go of the handle, pick up the barrel, and put it over the spring. Directly this is released by the fingers, it will uncoil till the hook of the barrel catches; then the barrel itself is allowed to revolve between the fingers, from the force of the mainspring, till this has expanded fully; then barrel and contents are taken off the spring-winder, and the mainspring will be found coiled in the barrel as it should be. The arbor is put into the barrel, and any necessary oiling, etc., is done; then the cover is put on and snapped tight. The stopwork has next to be adjusted, so that the spring has some power left in it when the stopwork stops its action. There is no trouble in using a winder, and it is a very convenient tool, though many workmen use their fingers only to put mainsprings in with, in the manner described above. A steel arm, with a bent end coming over the spring, is usually attached to spring-winders for the purpose of hooking into the outer eye; but it is never used in practice. The ratchet-wheel, previously mentioned, has conical teeth and a double-ended click; so that it acts either way according as the click is put.

SOME IDEAS IN FURNITURE.

THE "American Cabinet-maker," commenting on some of the luxurious articles of furniture now manufactured, says:—The forests of the Southern States are contributing a variety of woods for decorative purposes, and amaranth wood, from South America, is in high favour for the construction of elegant articles. Of this latter wood we saw a sideboard, a semi-circle, like some of the oldfashioned bureaus, the top being of Mexican onyx. Three deep but narrow drawers, one above the other, divided the sideboard down the middle fronts, parting the two doors of old gold colour and which bore the appearance of canes interlaced. These and the inlaid work were of citron wood, contrasting well with the lustrous brown of the amaranth wood.

An easel, entirely covered with scarlet velvet, which concealed the frame work, supported a piece of framed Japanese embroidery in dull blue velvet for ground, with chest worked in gold, a fan, a mask and pines with cones; gold green and brown silks being employed.

An antique cabinet of ebony was inlaid with woods of pale brown and bore oval medallions, human figures carved in the light coloured woods, and framed in carved brass. Of course these ancient articles of virtu give rise, each one, to a thousand reproductions in self and other styles.

Another cabinet, which at sight gave the impression of one of the old-time, spindle-legged upright pianos, had shelves down the centre. The doors opening at either side showed Watteau landscapes, in bluish green or green blue, of shepherdesses and waterfalls on gold background; the one long drawer below the shelves, carrying out in wreaths this style of ornamentation, while two shorter drawers bore wheat sheaves in carved brass.

A marked feature in tables, cabinets and chairs, was the covering of the rungs, legs and spokes in plush or velvet as the case might be, overlaying the wood entirely.

An octagon table about two feet diameter, covered in grey blue velours, has the four covered legs setting out, in what we call bench-fashion and at a distance of one foot from the floor, a one foot square board, covered also, bringing back memory of the washstand of other days. A strip of passementerie braid matching in colour, traversed by a tinsel thread runs the length of the legs, and a short fringe depends from the top and lower slab. The extreme feet are covered with a contrivance giving the appearance of a horse's foot, or a small bowl reversed. It is stiffened into shape by paper or leather, and lined, the outside being of course, of the velours; and above, the setting on is concealed by a band of the passementerie fringe. These *couvre pieds* (in a new sense) are about two and a half inches deep. Brass rollers are concealed by this contrivance. The table, however, is light.

Work tables, writing tables, with and without drawers, are covered in the same way. A slim legged workstand for a lady was overlaid with quaker drab velvet, the rings to the drawers being of brass.

In strong contrast to the quiet suggestions of this article of household belonging, stood a luxurious jewel chest and its supporting entablature of ruby velvet and gold. The table is three feet by two, inlaid at top like a library table. The corners are carved. At each end are four spindle-legs, partly covered with velvet, that is, alternating the velvet and the gold in successive bands of about three inches each. Under the centre of the table is a cornice about four inches deep, supported by arches, and these supported by four Doric columns wherein the ruby and gilded decoration again appears as in the other four legs. I say legs, for such these columns are—they have no base. The table panels are of velvet inlaid. The jewel chest itself is a marvel of richness. It is two feet high, two feet long, and one foot in depth from back to front. This is covered in ruby velvet, the corners being of brass. Carved brass rings in lions' mouths form the handles in each end. The hinges, three inches broad, set on transversely, are of carved brass, two to each door; the keyhole plate matches, and four *couchant* lions in brass, three inches long, form the feet. The top shows rich embroidery in gold and white silk, of a double-headed eagle, each beak holding a tulip spray, of conventional arrangement. The embroidered door panels show each the design of rampant lions storming a castle, enwreathed with tulips.

A kidney-shaped desk presents a somewhat novel effect. In the concave is a place for the writer's seat, while carved drawers stand to each side of him. The top is of Carmelite grey velvet.

Sombre hues of plush and velvet seem to be much in favour, sage green, drab, and all the greys being displayed.

Teapoy and every manner of table are shown—some sombre, some gorgeous in ornamentation and upholstering, but for all cabinet purposes the standard materials seem to be mahogany and cherry, with corners, clasps and general decorations of brass. Little railings an inch or an inch and a half in depth, enclose the top edges of sideboards, bureaus and cabinets.

Heavy woollen serge is much used for chairs, its decoration being in *appliqué* of ancient embroidery, or rather its imitation set on according to taste. The human figure, bugs, butterflies, and flowers, are scattered here and there on the serge in heterogeneous design.

A light reception chair, with all its rungs and supports four-sided instead of round, is entirely covered with terra cotta velvet.

A pair of chairs, style Louis XVI., are of carved and gilded frame work, and caned in the usual fashion, having the canes gilded also. Mats, embroidered, or embroidered cushions, according to taste, are laid in the seats.

A Superior Polish for Fine Carved Work.—Half-pint of linseed oil, half-pint of old ale, the white of an egg, 1 oz. spirits of wine, 1 oz. spirits of salts; well shake before using. A little to be applied to the face of soft linen pad, and lightly rubbed for a minute or two over the article to be restored, which must afterwards be polished off with an old silk handkerchief. This will keep any length of time, if well corked. This polish is invaluable for delicate cabinet work; it is also recommended for *papier maché* work.

Inventors and Inventions.—Invention is, in every instance, the result of two things: first, of the sagacity which has discerned *want;* secondly, of the resolute effort to *supply that want,* whether it be to obviate or overcome an existing difficulty or to furnish a totally new condition to certain phases of life or of industry. "*Necessity* is the mother of invention," in the broad sense of the axiom. It is *not,* in all instances, so as regards individual examples. It has frequently happened that important inventions have been brought about by what we might call the *hobbies of leisure.* A naturally ingenious person, with a practical insight into certain particular applications of skill, finds solace in the elaboration of an idea, and that idea finds expression in the solution of some problem, whether scientific or purely mechanical, or both. In fact, he blossoms into an inventor, and yields seed in an invention.

HOW TO REPAIR WATCHES.

PERHAPS of all mechanism the watch has the greatest charm for the ingenious amateur. There is something so pleasing in watching the rapid movements of its balance, so regular and continuous in action, and in listening to the music of its tick, that the ingenuity becomes excited, and the fingers itch to examine, dissect, and re-adjust the delicate assemblage of wheels and parts forming the watch. The smallness of the pieces and the cleanliness that is indispensable in all operations connected with watch repairing, form an additional reason for its general favour amongst those of a mechanical turn of mind.

The invention and introduction of the watch as an article of usefulness or luxury is involved in obscurity, and, as with clocks, authorities differ. Some assert that England has a fair right to the honour, whilst others, with apparent good reason, claim that Nuremburg is entitled to it. We have no intention of discussing this matter here, but merely say that of the various forms still existing which have been really serviceable, those of English manufacture form the greater part. The watch, like nearly everything else, has been the subject of very great improvement during the past century, and has gradually developed from a very expensive, cumbrous, unreliable, instrument to one that is elegant in design, accurate as a timekeeper, and low in price.

It has been said that "watch-repairing cannot be learned from books," and undoubtedly there is a great deal of truth in the assertion; but at the same time it is almost as correct to say that watchmaking cannot be learned *without* books, for such a comprehensive knowledge, mechanical and scientific, is necessary to ensure uniform success that incessant book-study is quite as necessary as workshop tuition.

A number of books may now be found, treating on the principles involved in the construction and details of the manufacture of watchwork. Some of these are justly celebrated as standard works, but, for the most part, they are far too advanced to be of use to the amateur watch jobber.

We purpose to supply our readers with the manipulative details of watch-repairing as clearly and fully as our ability permits; to take the place of the workshop instructor as far as possible; and to impart a knowledge of the best methods of correcting the various derangements to which watches are liable, either through faulty manufacture, bad treatment, accident, or wear. Those who patiently strive to learn, thoughtfully reading our lessons from time to time, using every opportunity to acquire an insight into the actual work, and obtaining a fair amount of practice, will probably prove in the end that much of watch-repairing may be learned from books.

At the commencement, it may be well to impress upon our readers that *carefulness* is the first necessary quality in all operations connected with watchwork. The greatest care should be exercised. Think twice before doing anything not previously done, and do not attempt to hurry a job. It is also a good plan to be methodical. Continually varying the order of working, will cause confusion and loss of time. Follow the instructions we shall give, and always proceed in the same manner.

As it is impossible to work without tools, we shall first give a list of those necessary for the most simple, and then describe those required for the more advanced repairs.

The Workboard.—This should be made of well-seasoned wood, rather large than small, and securely fixed at a convenient height in a good position as regards the light. Along the front edge should be a strip or "bead" of wood standing up about three-eighths of an inch, and at the ends and back pieces, standing up from four to eight inches, may form the border. Hooks and nails may be driven in these wide pieces for holding tools and other things. For the benefit of amateurs who may have limited space, we may suggest a portable tray, with a similar border, which could be placed upon any table when required. The principal point to be attended to is that there are no cracks or crevices of any kind.

Verge Stake.—A round piece of steel, with a small narrow slit in the centre, mounted in a brass block used for resting the brass collet of a verge upon, whilst the balance is riveted on.

Pinion Stake.—A piece of brass or steel, about two inches long, with a number of graduated holes drilled in it, used for resting pinions on, when the wheels need securing or mounting anew.

Bumping-up-Stake.—A steel stake, either round, square, or triangular at one end and hollow at the other; the solid end being used for hammering work on, and the hollow end for resting wheels and balances on when the arms require slightly bending by a gentle tap with the hammer.

Pin Vice.—A miniature vice with a long tail, by means of which it may be easily twirled between the thumb and first and second fingers.

Filing Block.—A small piece of box-wood, used for resting wire upon whilst it is filed up into pins.

Sliding Tongs.—A tool somewhat resembling a stout pair of plyers with straight handles, having a slide upon them by which the jaws may be tightly closed.

Chalk Box.—This is a little box for holding a lump of chalk upon which to rub the brushes used in cleaning, to free them from grease and dirt. It may be made by nailing up a small box from three to four inches square underneath the work-board, with a small piece of wood to prevent the chalk falling out in front; or by fixing a piece of wood from the right-hand support to a place underneath the work-board, when the chalk will wedge itself sufficiently firm for the purpose.

Mainspring Winder.—A tool used for winding up a mainspring, so that it may be easily placed in the barrel.

Callipers.—A double-ended pair of brass callipers is the kind required. A small sink should be made in each end of one pair of arms; and a sink and a short male centre opposite, in the ends of the other pair of arms. Used for testing the truth of wheels, balances, etc.

Burnishers.—One flat and one oval will be necessary for burnishing the pins which hold the frame together and other purposes.

Jewel Screw-drivers.—Very diminutive screwdrivers, made of small steel wire and fitted into a brass wire handle, used for turning jewel screws.

An Oiler.—A small sewing-needle, fitted into a piece of brass wire for a handle. It should be filed down very fine, and then slightly flattened at the point, so as to take up a very minute quantity of oil, used for oiling the watch.

Pivot Broaches.—Exceedingly fine taper pieces of steel—some round, others hexagon shaped—used for making pivot-holes a little larger, or hardening the acting surface of them.

Bottoming Broaches.—Small tools, something like the preceding, only that they are "four-square," and intended to cut only at the point or end.

Set of Bench Keys, or of variously sized keys of the ordinary sort, bench vice, eye-glass, tweezers, watch pliers, nippers, screw-drivers, round and flat faced hammers, two brushes, oil-cup, knife, two or three files, covering glasses, French chalk, pegwood, tissue paper, pith, a cork or two, and four small examining pins.

As a general rule, all tools except specialities are much better bought ready-made at the tool-shops than made at home. This list includes all the tools necessary for a first attempt.

It is customary for apprentices to try their hands on a verge watch first, and there are several good reasons for following their example, amongst others, it is larger and stronger than watches with the cylinder or lever escapement, more simple in its construction, and if any part should be broken not so difficult or expensive to replace. We should, therefore, advise our readers, if possible, to select a verge watch for their first experiments, and we will suppose one to be accessible which only requires *cleaning and examining*, and proceed to lay before them the method of doing this.

In the main, the same method must always be followed whatever kind of watch is in hand, and these instructions must be understood to apply to every kind of watch in general use, no matter what sort of escapement it may have. Having neatly arranged the tools upon the work-board at the right hand, and placed a clean sheet of note paper in the centre, we are quite ready to commence our task. Careful examination is the great secret of success in watch-repairing, and although there may be every reason for believing the watch to be in perfect condition, we must carefully look for any defects that might exist.

Take the watch in hand, and opening the bezel, attend to the following points before taking the movement out of the case. See that the enamel dial is not cracked or broken—that the hands fit properly, are of the right length, and quite free of the hole in the dial—that the cannon-pinion is free of the glass, and that the second's pivot is not to long and also free of the hole in the dial, that the joint pin fits tight, that the bolt and spring act correctly, that the cap is clear of the case when opening the movement, and comes freely from the frame when taken off; and that the winding-square is free of the case. Having done this, push out the joint-pin, and carefully examine the movement as a whole. See that the wheels and the barrel are upright within the frame; that the wheels are free of each other, and the frame or any part connected with it; that the chain is free of the pillar and the stop-stud; that the dial feet are not in the way; and that the dial, or brass-edge, as the case may be, fits properly against the pillar-plate.

This done, the movement may be taken to pieces. Commence by taking off the hands with a pair of nippers (if it is carefully done, the hands will not be marked), then draw out the pins which hold the dial, and remove it. These pins are sometimes very troublesome to get out with the nippers or pliers, and are often best removed by pressing the edge of a knife into them close to the dial feet and using the blade as a lever. The mainspring must now be "let down." Unscrew the click-screw a little, place a fitting watch-key upon the barrel-arbor square, relieve the ratchet, and gradually let the spring down. Beginners should always make it a rule to let down the mainspring at the commencement, and if the watch has maintaining power, as most lever watches have, also to relieve the dettent, for it is a very bad plan to let the train "run" down, and if by any chance the top plate is removed with the spring wound up, the effect would be probably most disastrous. The motion work, including the cannon-pinion, being removed and the spring let down, proceed to unturn the cock-screw, and take off the cock. The cock is the piece that receives the top pivot of the verge, staff, or cylinder. See that none of the screws overturn; it is important that all screws should be perfect in this respect. If any should overturn make a note in pencil on the board paper so that it will not be forgotten.

Carefully withdraw the pin that secures the balance-spring to the stud, and turn round the balance until the spring is free of the stud and remove the balance.

In some watches the curb pins will be found bent over to prevent the balance-spring from escaping from between, or more than one coil getting in. In such cases the balance-spring must be freed from the curb pins as well as the stud before attempting to remove the balance. Proceed to take off the name-plate and regulator slide, push out the pillar pins, and remove the top plate, when the wheels may be removed from their positions, and the watch will then be "taken to pieces." We must now clean the various parts before proceeding with the examination. Before beginning to brush, the oil and dirt must be wiped off the plates with a small piece of clean chamois leather.

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In Turning Steel, or other Hard Metal, use a lubricant composed of petroleum two parts, and turpentine one part. This will ensure easy cutting and good tools, when otherwise the work would stop, owing to the breakage of tools from the severe strain.

Silver Soldering as applied to silversmith's work, is an art which requires great care and practice to perform it neatly and properly. The solder should in every way be well suited to the particular metal to which it is to be applied, and should possess a powerful chemical affinity to it; if this is not the case, strong, clean, and invisible connections cannot be effected, and that is partly the cause of roughness in goods, and not, as may more frequently be supposed, from the want of skill on the part of the workman. The best connections are made when the metal and solder agree as nearly as possible in uniformity as regards fusibility, hardness, and malleability. Soldering is more perfect and more tenacious as the point of fusion of the solder rises. Thus tin, which greatly increases the fusibility of its alloys, should not be used for solders excepting when a very easy running solder is wanted, as in soldering silver which has been alloyed with zinc. Solders made with tin are not so malleable and tenacious as those prepared without it. Solders made from silver and copper only are, as a rule, too infusible to be applied to the general run of silver goods. Solders are manufactured of all degrees of hardness, the hardest being an alloy of silver and copper; the next silver, copper, and zinc; the most fusible, silver, copper, and tin, or silver, brass, and tin. Arsenic is sometimes used to promote fusion, but its poisonous vapours render its use inadmissible. In applying solder, of whatever composition, it is of the utmost importance that the edges, or parts to be united, should be chemically clean; and for the purpose of protecting these parts from the action of the air and oxidation during the soldering process they are covered with a flux, always borax, which not only effects the objects just pointed out, but greatly facilitates the flow of the solder to the required places. Silver may be soldered with silver of a lower quality, but easy running solder may be made of 13dwt. fine silver, 6dwt. brass; the composition of brass being so uncertain, it is best to fuse zinc and copper with the silver, and the following proportions make a very easy running solder: 12dwt. fine silver, 6dwt. pure copper, 1dwt. zinc. Brass sometimes contains lead, which burns away in soldering and must be carefully guarded against. Solder for filigree-work is prepared by reducing easy flowing solder filings and mixing it with burnt borax powdered fine. In this state it is sprinkled over the work to be soldered, or the parts to be soldered are painted with wet borax, and the solder filings are sifted on and adhere to the borax. The flux which adheres to the work after soldering is removed by boiling the article in a pickle of sulphuric acid and water, 1 part to 30.

OIL HOLES IN MACHINERY.

A SEMI-HUMOROUS account of these essentials of machinery is given by a writer in an American paper as follows:—The early history of oil holes is clouded in mystery. Some historians state that Noah used oil holes in the machinery of the ark, while others claim that the hinges of the gate of the garden of Eden had oil holes in them, and that Adam went round every Monday morning with a tenpenny nail to clean them out. However that may be, since oil has been used on machinery oil holes have been in vogue.

For the benefit of those who do not know what an oil hole is, I will state that it is a small canal to conduct oil to the working surface of machinery. Sometimes it fails to conduct it, then a tenpenny nail is the thing to use.

I have read in the History of Grease about some kind of patent oil hole for loose pulleys. I have never seen any of them; in fact, all that I have ever seen were straight holes—regular centrifugal pumps, throwing out all the oil that does not happen to soak into the joint before the wheels start.

When I oiled line shafts, I used to carry a lot of pine plugs in my pocket, and when one was missing I replaced it with a new one, not because I was ambitious to do a good thing, but because I had to do it. A plug in the oil hole of a loose pulley is a good thing. How much machinery comes to us into which we cannot get oil? If we are fortunate enough to find the place we oil it once. You have a lathe in the shop with oil holes in the apron for every stud and gear except one or two. When you put up the lathe you notice these places and resolve to keep them oiled; so you make a tin eave spout to run oil into them, and hold it in one hand and pour oil into it with the other. That is all right, but after awhile you put a new hand on the lathe who never saw that make of lathe before. He knows that some machines have hidden oil holes, thinks he will oil all the places he can see, and trusts to Providence until he learns the machine better. He finds out at the end of two or three weeks that Providence is not in the oil hole business.

Farmers in general do not find the oil holes in their machinery. If I were making agricultural machinery, I think I would paint a regular bull's eye around every hole, and then print a circular telling them to oil all the bull's eyes, and everything will be all right. If they did not understand that, I would paint oil cans all over the machines; then they might take the hint if they did not think that it meant they were self-oiling. Do not counter-bore oil holes unless you do it on the other end, for it makes a bigger place to catch dirt and dust.

In shops where they use axle grease, oil holes must be big enough to let it down. Who ever saw an oil hole stopped up because it was too big? When grooves are made in boxes they should be large. It is a good practice to counter-bore oil holes on the inside if it can be done, as in the case of half-boxes, oil holes through studs and the like. For loose cones in back-geared machinery I like a piece of leather in a counter-bored recess better than a screw, because the cone can be oiled without a screw driver.

The longest lubricating hole I ever saw in proportion to its size was in the Remington shops—a hole four feet long in a ¼in. rod used rifling. The object is to lubricate the tool. I asked how they got the hole through it. "Oh, drill it. We do not consider that difficult." Some things come with brass oil cups on them designed to put wicking in. We generally leave the candle wicking out, as we are out of candle wicking. Then we start that thing, and leave it until we get the next ball. My opinion is that the wick is good, and pays to put it in. However, the brass cup is a good thing without the wick, as the cover keeps out the dirt, and men like to oil brass. That is why they put brass in connecting rods. There is a new vice being introduced. One of the good points is a neatly fitted pine plug in the oil hole. Until we get a better thing to stop up oil holes with, I hope we will have plenty of pine.

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In Engineering, reading makes the full man, sketching the ready man, and drawing the exact man.

Blue Process for Copying Tracings.—Take 240 grains of red prussiate of potash, and 240 grains of ammonia citrate of iron, and dissolve each of them in 4ozs. of distilled water. Mix these together, and keep in a dark place. Float your paper in a non-actinic light, and hang to dry, keep it dark, and print as an ordinary silver sheet. Watch your print carefully, and as soon as a metallic lustre appears on the surface, remove from the frame and wash thoroughly in cold water. The lines come up white, and the ground an intense blue if thoroughly done. Be careful not to overdo it, or the lines will come out a pale blue. The tracing must be done with a thoroughly black ink, or else red and no blue lines should be on it, or they will not appear at all. For large sheets, brush the solution on with an ordinary copying brush.

Notes on Screw Threads.—The idea of a screw to the unmechanical mind probably reaches no further than that it is used as a fastener in some shape or other, such as a bolt, wood or set-screw, for binding some two pieces together in a given position, and for releasing them at pleasure, or for further adjustment. In this sense they act a more economical part than nails and rivets in the long run, but in common fixtures of wood or iron joining with screws is out of question on account of the cost. Screws as fasteners are of the V thread shape, but when they are for transmitting power, giving motion, or altering the position of two parts, mechanics use the square thread screw, which is rectangular in section, and consequently exerts less friction and wear, and there is no tendency to burst the nut as with the triangular thread. The square would be much preferable for many jobs, even as a fastener, but for its cost, having to be cut in the lathe with a single pointed tool, the only way of making a clean square thread screw, it is almost out of question. One kind of thread may be cheaply cut, but it requires as coarse a pitch as the square thread, as it is really of that description—rounded at the top and bottom to the true section of a circle; but this sort of screw is not adapted for any other reason than rough usage, where the edges are liable to be knocked and burred. Triangular threads for bolting purposes are best, and are rather stronger than square-threaded bolts, and they have only half the pitch. V threads are inclined at 55° by Whitworth, and ⅙th of the depth is rounded off both at the top and bottom. The depth of a square thread is $\frac{19}{40}$ of the pitch; that is, if the length of a thread and a space were to be divided into 40 parts, 19 of these parts describe its depth. Clean-cut threads and well fitted to the nut are always of the greatest importance for good machinery; and where a purchaser does not find these qualities, it is sure evidence that a replacement will be required at a much earlier date than he anticipated. The accuracy of the screw parts of machines are as important as the buttons of a man's coat or his watch, and when worn or ill-fitted should be condemned as an element of unsafety.

THEORY V. PRACTICE.

(From the "American Machinist.")

WHY will some persistently exclaim—"That'll work all right in theory, but won't work in practice." "That may be all right theoretically, but practically it is no good."

These are examples of the stereotyped phrases that come ringing in our ears almost any day from the good mechanic and from the poor mechanic. They come from those occupying high and responsible positions, as well as from the most menial. They come from all trades and occupations; both early and late the air is pregnant with them, for they often come ringing into our ears in the "stilly night as well as in the dewy morn," until we wonder whether the lives of those who thus keep the atmosphere in constant vibration are not theoretical successes, but practical failures. What seems incomprehensible to our beclouded mind is the statement that a thing can be all right in theory, and wrong in practice. If a thing is wrong in practice, how can it be right in theory?

What is theory and what is practice? Perhaps an answer to this question will help us a little. Theory, in short, is simply an exact and correct explanation of any phenomenon or phenomena. Practice, of course, everybody understands to be the daily business and occupation of man, or, more specifically, the execution of methods and the adoption of means in accomplishing any desired end.

From these definitions (though in a condensed form) we can find no antagonism between theory and practice. On the contrary, they seem almost inseparable, bearing the relation of guide to tourist or teacher to pupil. Theory says: Do so and so, and you will get such and such a result. It is the wide-awake man—the man who is constantly making useful improvements and discovering new methods and means—who is obeying the dictates of theory to the greatest extent. It was this obedience that led to the discovery of the planet Neptune; Watts to build the first steam engine; Stephenson the first locomotive, and Fulton the first steam-boat. The only way we can conceive of theory as being in opposition to practice is in an exclusive sense; that is, theory considered purely as such, in contradistinction to practice as a different field of action. As to the utility of both, it seems there can be no doubt. Those who speak disparagingly of the relations between theory and practice do so with very little consideration, and certainly do not overburden themselves by study.

But here steps up Tom, and says there are differences between theory and practice; "for," says he, "theory says that friction is independent of surface—but 'tisn't. I tried it once, and the more surface I used the harder it pulled." Upon inquiry, it was found that he made his "experiments" with a belt on a pulley and varied the surface by varying the arc of contact. Further comments are unnecessary.

Dick heard once, in connection with the mechanical theory of heat, that dry steam, at a high pressure, issuing from an orifice, would not burn the hand when placed in the jet. Being somewhat incredulous he concluded to try the experiment, and accordingly, as soon as an opportunity presented itself, he placed his hand over the mouth of a tea-kettle from which was seen to issue a considerable quantity of steam. It is not necessary to explain how much interest he took in withdrawing the intruding hand and denouncing, most vociferously, both theory and theorist. Of course he concluded that theory was all wrong. The *ego* is never on the erring side of a question. It does seem so hard for some people to acknowledge an honest error on their part.

Again, we see Harry turning up a shaft of peculiar shape. It is quite thick in the middle and tapers irregularly towards both ends. Our first impression is that it is a connecting rod, but then we see that it is rather long for a connecting rod, and then it has no "square ends" on it for straps to fit to; so we venture to satisfy curiosity by making some inquiries. Harry courteously replies: "This is a shaft which I want to have as light as possible and at the same time as strong as I can have it, hence I make it to a parabolic form, which is the form for uniform strength, you know. There, in the middle, where that straight part is, I am going to put a pulley, which will be subjected to variable strains, and near the ends there, are the bearings."

"Would your shaft not be just as good if turned to a 'straight taper,' and save a great deal of time in turning?"

"No; it would be weakest, then, between the middle and its ends. The outline must be a parabolic curve, to be of uniform strength."

It would have taken too much time to explain to Harry, and convince him that it was not a parabolic curve he should have used in this case; but, if he wants to be "very nice" in forming his shaft, he should use the curve known as the *cubical parabola*, which has nothing in common with the ordinary parabola, or any of the conic sections, and can be laid out only by means of its equation. But, suppose our friend Harry should adopt this amendment, and lay out his curve very carefully by means of the proper equation, he would then not have a shaft of "uniform strength." He would have to modify the form further, to provide against shearing stress. After this, he should modify it still further, to allow for the weight of the shaft itself. After this is all done—the curve nicely calculated and the shaft nicely turned to it—he then has a shaft of "uniform strength" for only *one* definite load. As soon as the load on the shaft is varied, it ceases to be a "shaft of uniform strength," and would have to be re-constructed to make it such, for the new load. Harry does not seem to comprehend these points, and when he puts his shaft up and finds that it does not give the desired result, then *theory* will have to be the scapegoat of the sins in the case, both of omission and commission.

Tom, Dick, and Harry never have any doubt but that their experiments and practice are in perfect conformity to the theories they are attempting to follow; but it is obvious that they comprehend them only partially. It is true sometimes a theory is not complete; that is, it does not completely explain *all* the phenomena of the given subject. As long as men are liable to err, this cannot be avoided, and no respectable man would claim to be infallible, nor would he expect infallibility in a fellow-being. If, then, we find any discrepancy between theory and practice, let us not hasten to put the *ego* upon the throne, and consign the theorist, with his theory, to eternal perdition. The errors lie oftener on the side of practice than on the side of theory. The man who devotes a great deal of his time to pure theory is certainly more likely to be correct than the practitioner who has no time to give to pure theory as such.

Theory and practice must go hand in hand, mutually helping each other. We could not separate them if we would. An important lesson for all to learn is, in case we find any discrepancy between our practice and somebody else's practice, to always look for the errors at home before we charge them to others.

FEEDS FOR LATHE TOOLS.

(From the "American Machinist.")

THE lathe-feed topic will bear a great deal more stirring up. The product of the lathe is of course not determined alone by the feed employed. It may often occur that one using a fine feed will turn out a quicker and better job than one using a coarse feed upon a similar piece of work. We often hear it remarked that no two men will do a job alike. Certainly not. Still there is but one best way, and where men differ in practice there is something that one can learn of the other. It will generally happen, perhaps, that even in such a case the advantage is not all upon one side, and in some particulars each may learn of the other. The actual exchange of ideas is always mutually profitable, but there is plenty of gab perpetrated, which involves no transfer of mental currency. The man who says the most is not the man who has the most to say. A machinist "learning the trade"—and that he always is—finds himself in the position of a young man whom a fond father was sending forth into the world to seek his fortune. "My son," said he, "no one ever embarked in life under more favourable auspices: *you have everything to gain and nothing to lose.*" There is everything to gain by acquiring, nothing to lose by imparting, any knowable thing. Have no trade secrets. I hold nothing that I am not ready to impart to whoever asks it. I do not seek, I will not accept any technical knowledge which I may not be at liberty to exchange as I choose. I would not value money that I might never spend.

A latheman to become expert should make a study of feeds and exercise his judgment in the choice of them. He should experiment continually. The study of feeds he would find that he could not pursue as an isolated study. The mere changing of the belt upon his feed cone and watching its effect would be but a very little part of it. He would find that he would have immediately to consider the shape and temper and material of the tool used, the mode in which it was held, its height, pitch, and distance to reach to the work, the notice and strength of the tool holder, and the strength and design of the whole lathe, and its comparative merits and deficiencies as compared with other lathes. Then the material upon which he was operating, the way in which his work was held in the lathe, the mode of driving if upon the centres, would all call for consideration.

The art of learning is the art of asking questions. The great mistake in the practice of the art is that the questions are asked of men. They are the very last instead of the first sources of knowledge. Ask your questions of things, and ask persistently, and if you can't possibly find an answer there, then try the best man you know, but don't try very confidently. Some of the most expert workmen I have ever known have learnt the trade—as far as they have got—without asking a half-dozen questions of men. Many, if not most things in the trade, are to be learned without shaping a question. When we are ready to ask the question it is already answered. I worked a good many years at the trade before I discovered that a washer with a square hole in it could be turned upon a round mandrel. When the idea did strike me, the time of questioning about it was past. When a fellow has to re-sew a belt and asks me whether it is opened or crossed, when I want a screw cut like a given screw and he asks me to tell him the pitch, when he asks me whether a piece of square iron can be centred truly in a three-jawed centring machine, he is not learning, he is only dodging the asking of the real question and betraying himself.

When you see a man who has a wide variety of work persistently using the same feed for everything, you may be sure there is something wrong about him. If a man is utterly without pride in his calling, and of course with it is without ambition or hope of betterment, and just wants to fill his time and draw his wages, he will use the finest feed upon his lathe as persistently as he thinks it safe to; and he will use his finest feed simply because there is no finer, just as the man rode third class upon the railroad because there was no fourth class.

What you eat and how you eat it determines your digestion. What ideas you swallow will determine your mental action. One who has hastily and without examination bolted the pseudo doctrine of the irrepressible conflict between employer and employé is in a bad way. He is the middle-feed man in our shops, and few shops are without him. I would not speak of him with severity, for he is more to be pitied. He is frightened, and has lost his wits. His middle feed is his compromise of what to him is a grave difficulty. He is between two fires, and hopes to dodge them both. His employer must not grumble, and say that he is not doing his best, because it is evident that he could use his finest feed and not do as well. His fellows cannot say that he is rushing things, that he is guilty of the nefarious design of making work scarce, for he still has his coarsest feed in reserve; and so day after day he pursues his way of hopeless and monotonous mediocrity. Oh, I would have to jump up and down and tear around, and smash things, to stir my vital fluids occasionally.

I tried a little experiment on one of these middle-feed men the other day. He has gone now, poor fellow. We have a lathe which has a small cone—three steps—geared to the feed rod, which runs along the front of the lathe. The cone had a gear of thirty teeth and the rod one of forty-five teeth, and I found that they were by design interchangeable, and I thought the idea a good one, as giving a desirable change of feed for some special kinds of work without cost to anybody. I changed these gears, thereby more than doubling the feed of his lathe, and my middle-feed man went right along just the same as ever, perfectly safe and satisfied with his middle feed. The experiment showed me what I knew very well before, how much the requirements of his had to do with the feed that he used.

I don't know what kind of a bargain is tacitly made when a man is hired to run a lathe. He generally talks beforehand as if he meant to get all that he could out of it. If a man wants to get along in the world, and doesn't do his best, he is a fool. The proprietor of a shop has an indisputable right to dictate how his tools shall be operated. But dictating feeds is too much like quarreling with the cook. The cook has the game in his own hands, and has too many opportunities of revenge. The cultivation of a healthy emulation is better than too frequent specific criticisms.

I think I know that usually our lathes do not have a sufficient range of feed. I find myself wanting both finer and coarser feeds than we have. For instance, if I were boring a piece in the chuck, or turning something very irregular on the outside, and required to carry a deep cut to keep under the scale, I would use as fine a feed as might be necessary to hold it. In doing heavy work in the chuck, a man is very often troubled by its chattering. Nothing is more uncomfortable than to have a cut which just lifts the weight of the spindle and its load. Chattering from this cause may be cured by taking a much heavier cut, as well as by carrying a lighter one.

POLISHING STEEL CUTLERY.

IN order to obtain the finest degree of lustre, the steel should be selected from the best cast-bar, having a fine grain. After this has been forged, filed, or otherwise shaped, to the required form — forging always improves steel if care is taken not to burn it—it passes through the following processes in the order indicated :—Grinding, glazing, fine glazing, lapping, buffing, and, in some cases, burnishing. If possible, it should be hardened at least to a dark brown temper, as hardened steel takes better polish than soft steel. The black steel is ground first on a grindstone, running at a great velocity from the operator, as do all the wheels in the subsequent processes. The size of the stone depends on the class of work; for large surfaces, or quick cheap grinding, the stone being often 10ft. diameter and 1ft. broad on the face ; whilst for knives, razors, and scissors requiring to be hollow, it rarely exceeds 1ft., and often only 6in. diameter. Having uniformly ground off the scale and all indentations, it is transferred to the glazing wheel, consisting of a wooden wheel, varying in size like the grindstone, according to the character of the work, but rarely exceeding 2ft. in diameter, generally only 12 or 15in., and for small work 6 or 8in. Round the periphery of this wheel is glued and pegged, with wooden pegs, a strip of thick leather, which is put on wet and allowed to dry ; on this a layer of glue is put, and then rolled in No. 1 emery. The work is cautiously applied to this glazer, as it is called, which is revolved with great rapidity, care being taken not to allow the work to become so hot as to lose its temper, which would likewise cause the operator to do the same, unless he enjoys burning his fingers. From this it is removed to the fine glazer, which is a coarse glazer which has worn smooth. By this time the work will have a very respectable appearance, and, for many purposes, it is fit for the market; but it is yet full of long scratches. The next wheel is called the lap wheel, which consists of a wooden wheel, round the outer rim of which is cast a ring of lead about ¼in. thick. This is turned up perfectly true, and then rolled with pressure in flour emery. This lap converts the large scratches into very fine ones, and as the lead is a good conductor of heat, less care is required to keep the article cool. At this stage, in most cases, comes the final buffing; but, for the very best work, it is first polished on a leather-edged wheel covered with a paste of flour, emery, and tallow, which removes all but the most superficial scratches. The grease must most carefully be cleaned off to ensure success in the final process. The wheel in this process is covered round the rim with thick buckskin, and turned up true with a sharp turning tool. For small work this is not necessary, provided the wooden part is turned true in its place, and thin leather is used. In putting on the leather, the two ends must be pared to a chamfer, so as not to cause a lump, and the direction of rotation is such as not to cause the work to open the joining. This wheel is charged with dry rouge powder. If the preceding operations have been properly performed, the work will assume an exquisite polish. If the work requires to be accurately flat on any part, the wheels are replaced by discs, the surfaces of which take the place of the rims in the above wheels; an experienced man, however, will do flat work of considerable size on the wheels without deteriorating much the truth of the surface. No doubt the process will seem to be a long one, especially as knives and scissors are got up so cheap; but it is surprising with what rapidity, owing to the division of labour, the successive operations are gone through; and it must be remembered that round articles, and even flat ones, are often ground and glazed, a dozen at a time, by one man.

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To Mend a Watch Chain.—Rest the broken chain upon a piece of hard wood, and with the edge of a sharp penknife slightly raise one end ot the outside (double) link nearest the end of the chain, keeping the thumbnail of the left hand upon it in such a manner that only one rivet is loosened in the link. Turn the chain over and loosen the corresponding end of the opposite link in the same manner; take the chain in one hand and hold the short, broken, single link with a pair of watch-pliers in the other and give a sharp pull, when the piece will easily come out, leaving the free ends of the double links ready to receive the inside link of the other part of the chain. Temper a sewing needle to a blue colour, and file with a smooth file until it passes easily through the holes in the links. Place the chain in position upon a piece of soft wood and join up with the needle. Press it in quite tight, then with the nippers cut off as close as possible and file off with a very smooth file until nearly level with the chain. A few taps with a small round-faced hammer will rivet the pin, which is then cut off close to the other side, and after having the end filed flat it is rivetted.

Lathe Saws.—The diminutive circular saws so often used in the lathe for slotting and cutting off should be more extensively employed than they are, and they probably would be, only for the difficulty of tempering them without springing. It is scarcely to to be expected that verbal directions alone can remove this difficulty, but it can be removed by practice. There is a "knack" of tempering, which although not at all mysterious, is very difficult to impart to another. As a retired machinist said, a few weeks ago, he had never succeeded in teaching his method of tempering springs—a department of work in which he was an adept—and he left his successor quite depressed because he could not catch the trick. But after a few failures the trick was found, and the new man rivalled the old hand in spring tempering. Saws should be cut or punched out of sheet or plate steel, not forged and faced up in the lathe. Let the thickness or gauge of the steel determine the thickness of the saw; for differing thicknesses of saw, select different gauges of steel. It is better, after drilling, to turn several saws at once and cut the teeth of several at the same time, than to work on a single saw. The arbour ought to be of steel, and not less than ten inches long; large enough to turn up at the end for the reception of the saw, and leave a generous shoulder. The saw should be secured against this shoulder by a nut threaded on the arbour. A small check-pin is not objectionable. No turning, grinding, or other finishing should be permitted on the sides of the saw. Leave the old scale as the steel plate came from the rollers. To harden and temper, fix the saw by its hole to a bar or rod, as though it were an arbour. Heat evenly over a charcoal fire to a good cherry red. Dip it evenly in a horizontal—level—position into a bath of whale or lard oil, moving it horizontally until it is cool. Remove it, and with the oil on it heat it over the fire until the oil flashes or flits over the surface. Do not allow the oil to burn. In some cases this after-drawing is not required, and for work in very hard metals, water hardening and colour drawing may be necessary. But in all cases the saw must be hardened horizontally, not vertically.

PLASTER CASTING.

By H. C. Standage.

PART II.

We will now turn our attention to forming a sulphur mould. It is always useful to know many ways of forming a mould, and often sulphur can be used when wax would be entirely useless. Probably by this time the modeller has several plaster casts of medallions and similar objects, obtained by the instructions in our last. If so, well blacklead one, and fix a strip of paper round it; next melt some brimstone in an iron ladle or crucible—a "nest" of Hessian crucibles can be obtained for 7s.—over a fire or lamp. The fire should not be blazing or too fierce, else the sulphur will pass into another of its modifications, and so become unfit for our purpose. The condition requisite is when it begins to flow easily—that is, when it is not too hot, and hence thick. Should it ignite while melting, do not attempt to extinguish the flames with water, but smother them by placing a cover over the vessel. The requisite condition being obtained, pour the sulphur over the surface of the plaster medallion, so that it forms a skin, which should be thickened to ¼in. or ⅜in. by the addition of sulphur.

We have now a mould similar to our first wax one, but with this advantage, that casts can be obtained from it when the casting material is heated, as, for instance, in the case of sealing-wax—a material we frequently employ in copying seals, cameos, etc. This can be melted and dropped into the sulphur mould, whereas the paraffin wax one would be destroyed.

Passing now from coin and medals, the beginner will be anxious to try his hand at larger work. For this purpose he should obtain some medals and other objects, of little value if damaged, from the Italian hawker of plaster casts, etc. Having obtained a bust or bracket, he can multiply it indefinitely, when by-and-bye we will show him how to bronze, colour, and otherwise decorate it.

In preparation for our next instructions it would be as well for him to get ready the core—*i.e.*, the *body*—of one or two vases, roughly modelled or cast in halves, as given above, that he may decorate them with leaves and ornaments subsequently.

Having become slightly expert in the manipulation of our materials, we will now attempt a more delicate task, taking for a model something from the animal or vegetable world. Taking the vegetable world first, from the instructions already given, we shall be able to cast the forms of fruit—such as apples, pears, grapes, etc.—without further instruction, as likewise the larger sorts of stems and branches. The more delicate operation consists in casting the leaves; and since a dish of fruit would be unnatural without leaves and many ornamental forms—such as baskets of fruit, ornamental borders of leaves, and small fruits, and many decorations can be made with the combinations of the two—it is requisite to know how to cast from leaves.

Such being the case, we will collect our materials, and set to work. The materials will be silver-sand, wax, Burgundy pitch, fine plaster of Paris, small pencil of camel-hair, spatula, or paper knife, and a large stock of patience. All things being ready, we must decide upon the model to be cast from. What shall it be—a leaf, a frond, or a flower? We choose the first. Having selected one to our fancy—and here let me give a word of caution: for the first attempt, choose one of tough structure, such as a myrtle, laurel, ivy, or holly—pile up some silver-sand in a heap, roughly shaping it to the form of the model. Lay the leaf on the heap—let us suppose we have chosen a holly leaf, being the most picturesque of those named—face uppermost. With the spatula push up the sand into every crevice under the leaf. Having done so, melt some wax and a little Burgundy pitch in an evaporating dish over a lamp. Take the pencil and dexterously cover the exposed surface of the leaf with this mixture of wax and pitch. In doing so avoid disturbing the leaf, and let the wax form a sufficiently thick coat to bear handling, and let it cover every part of the leaf.

After a few minutes it will be sufficiently set to allow the leaf being removed from the sand. This is best accomplished by making use of a pair of small nippers or tweezers, so that the sand is disturbed as little as possible. The next thing is to cool the wax suddenly by plunging the leaf into cold water, then separate the wax, which is now our mould, from the leaf, lay the mould on the sand in the same place occupied by the leaf, bank up the sand round the edges to prevent the plaster overflowing, mix a little fine plaster of Paris and pour it on the mould—the plaster should not be thick, or else it will not penetrate every part. The plaster having hardened, we can separate the wax from it, and use this for our mould, the cast being made from it, in wax, or sulphur, by oiling the face of it, or in plaster by blackleading the face of our present mould. In casting the leaves from it, the thickness of the casts should be made suitable for the object in hand.

Instead of making two moulds, time can be saved by using only one—thus: Carefully place the leaf face downwards into an evaporating dish containing boiling paraffin wax, and, keeping the surface only immersed, plunge the dish suddenly into very cold water to set the wax at once. This should be done without allowing the water to flow over into the dish. When set the leaf can be separated from the wax, which thus forms a mould from which casts in plaster and sulphur can be taken direct.

Several dozens of various leaves having thus been obtained, use for them can be found in a variety of ways. They form useful and tasteful borders, they can be employed to ornament the frieze of a cornice, the face of a bracket, a vase, or stand, or, in fact, anything that wants ornamentation suggesting itself to the modeller's eye.

With various kinds of fruits and flowers, if the modeller be sufficiently patient and persevering to undertake the task of modelling a flower, an infinite variety of subjects will suggest themselves as objects in which the casts can be made use of, especially if the modeller be capable of so colouring them to match their originals' appearance. Besides mere ornamentation, tasks of greater delicacy, such as the casting of a vase or bracket entire may be undertaken. If such be the desire there are two ways of accomplishing it—first, to make a "core," model the ornamental parts in clay, stick them on the core according to taste, and cast from the core and clay at once. Thus, out of a lump of modelling clay scoop a hole sufficiently large to form a core or body, into this pour some course plaster, when set break away the clay and we have a core or body on which ornaments already modelled in modelling clay are to be arranged as desired; from the whole now a cast is to be made in two halves. In some parts the clay ornaments will most probably be found to have stuck; these are to be washed away, and then the half moulds, being well blackleaded, the halves are to be joined together and fine plaster poured into the mould thus formed, the halves being subsequently chipped away.

The second method is, however, less vexatious and easier in execution, because, first of all, no modelling is required, and in separating the mould from the cast there is less chance of damaging the cast. The materials we shall need are whitening, thin glue, and guttapercha; these being at hand we can set to work thus:—Scrape up a quantity of whitening very fine, and mix it into a thick paste or dough with thin glue; take a lump of this and fashion it into a core with the aid of a knife or the spatula. This "compo" quickly hardens, so it should be done at once. Next warm some guttapercha in warm water until it is pliable, and taking lumps sufficient to cover the surface of each ornament of which we wish to obtain a duplicate, press the plastic guttapercha all over the surface of each ornament, let it harden, and then separate the two. These pieces of guttapercha will now bear the impression of the ornament—in fact, they form our moulds.

Into them press some of the compo, and let that harden sufficiently to bear cutting with a knife. Separate this compo and guttapercha, which may be done easily; the surface of the mould having been oiled, trim up the backs of the "compo" casts obtained, and stick them round the core by the aid of a little thin glue. This done, melt a quantity of guttapercha and press it over the surface of the whole vase and let harden slightly; then with a sharp knife make a clean cut from top to bottom; hold the whole over a steam bath—*i.e.*, a saucepan of boiling water—to slightly moisten. Get some kind friend to open the incision made in the guttapercha by holding it apart at this cut while you carefully draw out the compo vase. The elasticity of the guttapercha will allow you to do this without material damage. The inside being extracted the edges of the incision spring together again, and are easily connected by a little warming. You have now but to pour in a quantity of fine plaster of Paris in a liquid condition to obtain a cast of the model you had prepared. To allow the vase proving useful as well as ornamental, a hole should be left in the body of it that a tin lining may be placed there to hold cut flowers. It is better to make this hole in the casting than to have to cut it out after the plaster has set. To accomplish this part of the vase, a glass tumbler or cup should be held in the centre of the guttapercha mould while the liquid plaster is being poured in.

We have now but to separate the cast and mould and the thing is complete. This apparent difficulty is overcome by holding the mould in a basin of hot water, when it can be cut into broad strips, if the ornaments be intricate, or two halves, if simple in ornamentation, by cuts from top to bottom.

In place of the guttapercha mould one of sulphur could have been used if the model were small (a large bath of sulphur would be difficult to melt), the model being afterwards extracted by plunging the whole in hot water, which would soften the compo.

The operator has now had sufficient experience to judge which material he finds easiest to work in, and likewise, having a number of materials in which to form casts, need never be at a loss to cast from whatever he wishes to obtain a duplicate of, be the original in wax, plaster, or metal.

The compo above mentioned is that which is employed in the ornamentation of picture-frames, the pattern being formed by boxwood, blocks being used as moulds, while the compo is pressed into them, under hard pressure, in a press.

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Use of Oil-Stones.—Instead of oil, which thickens and makes the stones dirty, a mixture of glycerine and alcohol is used by many. The proportions of the mixture vary according to the instrument operated upon. An article with a large surface, a razor for instance, sharpens best with a limpid liquid, as three parts of glycerine to one of alcohol. For a graving tool, the cutting surface of which is very small, as is also the pressure exercised on the stone in sharpening, it is necessary to employ glycerine almost pure, with but two or three drops of alcohol.

Oilstone Powder for Grinding Purposes.—Although modern practice discards as far a possible the grinding together of surfaces where accuracy of fit is required, because the abrasive powder used, particularly emery, is apt to get imbedded in the metal, and then it will continue to grind, and of course ultimately deteriorate the fittings. Pieces of oilstone finely pulverised, sifted and washed, are used by mathematical instrument makers in preference to pumice-stone powder for grinding and polishing superior brass or gun-metal work. It is used also by watchmakers and mechanicians on rubbers of pewter, for polishing steel, as well as in slips or square pieces a few inches long, used after the manner of files.

Use Glue Hot.—The hotter the glue is when applied, the greater will be its binding power in holding surfaces together; therefore, in all large and long joints glue should be applied at once after boiling. Glue loses much of its strength by frequently re-melting, and that which is freshly made is preferable to that which is re-boiled. In melting ordinary glue in the double vessel containing water, it is an excellent plan to add salt to the water in the outer vessel. It will not boil then until heated considerably above its ordinary boiling point; in consequence, the heat is retained longer, and when the water boils the glue will be found to be evenly and thoroughly melted.

Use of the Blowpipe.—For soldering small articles of jewellery, the common blowpipe, such as may be bought at any tool shop for about sixpence, is used. The solder is sold at dealers in jewellers' requisites ready for use. Several sorts are used. Silver solder for silver goods, in different qualities to suit different qualities of work. You have only to specify the purpose for which you intend to use it, when buying, and the correct quality will be given you. Gold solder, to be used for gold jewellery, is subject to the same condition. The quality of the solder is always a trifle less than the metal on which it is to be used. This is necessary, in order that the solder may melt before the article does. The flux used with both gold and silver solder is borax. Working jewellers generally rub a lump of borax on a piece of slate with a few drops of water, just as water colours are ground, to a cream-like consistency. The solder is scraped clean to remove all trace of oxide, cut into little pieces, and mixed with the borax. The actual process of soldering will be modified to suit the peculiarities of the article which is to be treated. Usually the edges to be soldered are cleaned, wetted with the borax fluid, and placed closely in contact. If possible the article is bound tightly together with binding wire. This is fine wire of soft iron, made specially for such purposes. A piece of pumice-stone or charcoal is used to rest the work on whilst it is being heated. It is laid on this, with the joint uppermost; a few pieces of solder and a little borax are placed along the joint, and the article is ready for being heated. So long as there is sufficient for the purpose, the less solder and borax used the better. Gas is generally used for heating with, but failing that, a spirit lamp will answer for all small work. A small lamp suited for the purpose, to burn methylated spirit, can be bought for a shilling. With the blowpipe direct a jet of flame along the joint, at the same time heating the entire article till the solder runs, then the soldering is accomplished.

SAWING SILHOUETTES.

(From the "Young Scientist.")

THERE is no branch of scroll-sawing that will give pleasanter results or afford more amusement than the cutting of silhouettes. Sheets of designs for this purpose can be obtained at almost any book store for a very small sum. Many excellent designs can be found in illustrated papers and books for children, wall papers, and illustrated labels. A silhouette is simply an outline of some figure, and when cut with a fret saw, as a rule, has no inside cutting. They should be cut from material not more than one-sixteenth thick. Hard rubber, ebony, black walnut, and rosewood on the one hand, and white holly, rock mapel, and basswood on the other, are used for this work. Silhouettes may be employed for a thousand decorative purposes; and if you possess a good treadle machine you can find, if you desire, employment enough in this direction in making an infinite number of ornaments for your own and your friends' homes. Cornices for windows, doors and rooms can be made by this process, that will be highly ornamental if neatly and properly done, and taste and judgment employed in the selection of patterns.

To form a cornice, say for a bedroom ceiling, paste a strip of dark coloured paper all round the room close into the angle, and on the upright wall. The strip of paper should not be less than half an inch wide for every foot in height of the room; thus, if a room is ten feet high, the strip should not be less than five inches in width. It may be wider, but will not admit of being narrower than as above. This strip forms a background for the whole work, and it may have a different coloured strip, or a gold bead, half an inch wide, running on its lower edge all round the room, or may be cut serated or wavy on the edge, as the taste of the workman may suggest. When this is done cut your silhouettes according to pattern chosen, of maple or white holly, four or five at a time; when the number cut is sufficient to go round the room, they should be glued on to the strip of paper, being careful not to daub the latter all over with surplus glue. When this is finished satisfactorily, if desirable, a smaller pattern of walnut or ebony may be cut and glued on the white holly or maple, and this again touched with gold leaf in the centre, or a small flower in colours might be painted on each piece. Making a cornice of this kind is a very simple matter, but when completed is sure to give pleasure to all who see it. The workman of tact will find suggestions crowding on him thick and fast as he proceeds with his work, and more elaborate cornices will be easy of design after the first one is completed.

Borders for panels, corner ornaments, and centrepieces for door panels, pictures, cartoons and animals, can be cut out of veneers with very little practice. If you wish to saw out a perfect likeness of anyone, in profile, stretch a piece of strong white paper over a frame prepared for the purpose, and about two feet square; let the subject sit between a strong light and the paper, and in such a position that the shadow in profile will fall directly on the latter, which must be held securely in its place. Now trace the outlines of the shadow on the paper with a soft lead pencil, on the dark side of the frame. If neatly done you will have an exact likeness in profile of the sitter, which can be reduced, preserving the features correctly, by using a good pantograph. With a little practice in this line you will be astonished at the excellence of your own work. If you wish to make the likenesses distorted, and still have them preserve the general character of outline, you can do so by holding the paper at different angles, and by a little adjustment of the frame you will soon discover what position will ensure the funniest results. Once having obtained a good likeness, you should keep it for a pattern, and you will not be long in finding use for all the duplicates you may make. If you are the happy possessor of a printing press you can find plenty of employment for your saw in cutting letters of every description for use in your press. Cut the letters from hard veneers and glue them on blocks of maple or beech, taking care that the type when completed are the exact height of other type. I have known a country printing office where all the display type for large bills and posters were made this way, and satisfaction was given every time they were used, and the saving in expense was considerable. Borders, corner ornaments, figures, and many other things for printers use can be made with a good saw in skilful hands.

Although I have made no use of the word or words "overlaying," I have treated somewhat on the subject. It simply consists in cutting out fine ornaments and fastening them on a dead surface of some kind, such as panels, drawer fronts, box lids, album covers, etc., etc. Ordinary flat picture frames can be overlaid with vines or fine tracery. Very nice photograph frames can be made by taking a thin pine board and sawing an oval out of the centre, and covering the pine with velvet. Fasten the overlaying on the velvet. Designs for overlaying, such as corner ornaments, vines, flowers, heads, borders, monograms, fancy letters and other pretty devices can be picked up in books, prints, and illustrated papers; or they can be bought from the regular dealers in scroll-sawing materials.

* * *

Cutting Hard Steel.—For cutting narrow slots in a hardened steel plate a disc made of Muntz metal, revolving at about the speed that would be used for turning wrought iron of the size of the disc, and using fine quartz sand and water has been found to work better than discs of other material.

Watch Dials.—If you have an enamel dial made expressly for a movement the holes for both hour and seconds hands would be made sufficiently large by the dial-maker, unless he were instructed to the contrary. Foreign dials may be purchased at tool dealers' shops, and these have very small holes. The object is probably to allow the holes to be opened sideways to suit the particular movement to which they may be ultimately fitted. It is a tedious operation to enlarge the holes, the best way to do it being with an emery bob, made of shellac and emery, driven with a drill-bow. This will cut the enamel, and the copper is operated upon with a file. Careful treatment is necessary to guard against chipping or cracking the dial. Old copper dial plates are never re-enamelled, but an entirely new dial costs only about 3s. To those who do not know anything of the process of dial-making, it may not be superfluous to tell how to proceed if a new dial is wanted. Take the watch movement entirely apart; put the pillar-plate and dial-plate, or brass edge, in the case without being pinned together, not even with the joint pin. Leave the old dial out. Send these portions—the case and plates—to the dial-maker with an order for a dial as required, with sunk seconds or otherwise. In the course of a few days the dial will be finished, and you will have to drill small holes through the copper feet for the pins which secure the dial. The hole for the hour hand socket will probably be large enough, also the hole for the cannon of the seconds hand. If not, they may be enlarged by the method already mentioned. A dial made specially is far superior to those bought ready made.

PLANT'S GEOMETRIC CHUCK.

PART II.

(For Illustrations, see Lithograph Supplement.)

A BOOK on geometric turning, written by the late Rev. H. S. Savory, was published in 1873, in which Plant's geometric chuck is described, and about five hundred and seventy blocks illustrating some of the capabilities of the chuck are printed. This book contains much valuable information on the method of using the chuck, but no attempt is made to describe the construction of the instrument. In fact the author disclaims any intention of giving any account of the chuck, except so far as it is used for producing certain patterns.

The Rev. H. S. Savory cut the whole of the patterns used to illustrate his book, and the blocks printed herewith are borrowed from his work. The writer is also indebted to him for some of the information which is now given on the use of the geometric chuck. As to the force required for working the chuck, the motion of the lathe is so easy when using high numbers that when all arrangements have been made the motion can be kept up by a slight pressure of the foot. When using low numbers, the mandrel turns very stiffly and slow motion is necessary. When the chuck is put together the parts should be screwed up to slide stiffly, as the slightest amount of play will spoil patterns. When the chuck is used simply to face up a block of wood, and has to be revolved fast, the whole of the mechanism must be very carefully balanced. By this simple precaution the vibration is eliminated. It is easy to effect an equipoise by shifting the position of the two upper slides till the eccentric weight balances the overhanging wheels and radius plate of the lower slide.

A horizontal position is more suited to the action of a geometric chuck, and it is often arranged to work in that manner. A special table with a vertical mandrel and an arrangement for holding a pencil or writing tool is all that is required. The chuck is turned by hand, something like a lapidary's wheel, by means of a winch-handle and a band.

An idea of the complicated nature of the patterns that can be produced by this instrument can be formed from Mr. Savory's statement. There is hardly a curve that it is incapable of producing. The field in which, very probably, the forms of greatest beauty lie is that in which the first and second parts of the chuck are used to produce the pattern, and the slide of the third part is used to dispose the patterns in different relations to one another. There is also a very wide field laid open in the use of all the three parts with the low numbers, say from ellipse up to six loops on each part. With the first part you can make from ellipse to seventy-two loops, with the second from ellipse to thirty-six loops, and the same with the third; and each of these can be made internal or external. Each part has a slide, which can be moved eccentrically from zero to 2in. The tool for the cutting may be placed at any distance from the mandrel centre. With these combinations there is enough variety to satisfy the most comprehensive mind.

If the chuck was arranged for all its loops, it would produce 93,312, and 15 hours would be required to complete the pattern with the mandrel running 100 revolutions a minute. Such a combination has probably not been attempted, but it is interesting to consider what the chuck can do.

It might be an exceedingly interesting subject for a scientific person to give an account of the principles on which the chuck works, but it would be of very little or no assistance whatever to the person who aims at using it only for practical purposes. The scientific knowledge required to understand a three-part chuck would be so great that I doubt, says Mr. Savory, if there is a person existing who could describe the course of a line that would be produced by the chuck when all parts are arranged for low numbers. There are four axes, the axis of the lathe, and an axis to each of the three parts; each of these latter may be revolved either way. The epicyclic axis of one part becomes the deferent axis of another part, and it is quite certain that if we have to wait for a scientific knowledge of the chuck before we commenced using it, we shall have to wait a very long time indeed.

The geometric chuck consists of one, two, or three parts. Each part consists of a slide similar to that of the eccentric chuck, but carries a large toothed wheel, which is rotated by a train of wheels; thus each part is nothing more than a self-acting eccentric chuck. The large wheel of the first part of the chuck (*h*, fig. 2) has its motion imparted to it by a toothed wheel (*m*) on the boss of the chuck. This wheel (*m*) is held still by a pointer, that takes into a hole in it (*m*, fig. 5) and holds it fast to the headstock. This wheel gears into another wheel (*o*, fig. 2) and so drives the pinion (*q*). This pinion (*p*, fig. 4) gives motion to the train of wheels which drive the large wheel of the first part. When the first part only is used, every rotation of the lathe mandrel produces one loop. If the detent was not in the hole (*m*, fig. 5) a circle would be produced, the radius of which would be the distance of the cutting point from the true centre. When the detent is in, and the train of wheels are in motion, the first part of the chuck is moved round a certain distance, according to the number of loops arranged, at the same time that the lathe mandrel revolves once. The second part of the chuck is set in motion much in the same way, and the third part is precisely similar to the second. In describing the perspective elevation we will commence at the top, where the nose is, and proceed to the bottom, where there are two wheels shown behind the foundation plate. Where possible, I shall make cross reference to the parts which will be described separately.

Commencing at the nose, we have fig. 18 in perspective. The nose thread is precisely like that on the nose of the mandrel. The wheel, forming the base of the nose, is driven through a series of four change wheels by the small planet wheel projecting from a cannon screwed to the face of the main wheel. This cannon and planet wheel is shown in full size section at fig. 21. Links connect the planet wheel to the radius plate of the top slide (fig. 7). The radius plate is shown fixed to the slide by a square-headed clamp screw. The slide is shown in section at fig. 18, and the screw, which projects from the lower part of it, is shown in full size at fig. 10. The graduated collet shown on the square near the slide is for the purpose of showing the amount that the screw is moved.

The large wheel, concentric with the lathe nose, which forms the base of the first slide, is shown by *b* in fig. 16. The planet wheel, which drives the train shown on the second radius plate, is on the rear side of the chuck, and consequently is not shown. The radius plate is fig. 6. The screw holes shown in it are made to take screws which form the axes of the change wheels. These holes are spaced so as to suit wheels of various sizes.

The slide just beneath this second radius plate is fig. 16. The square end of the screw which actuates it is shown on the right-hand side. This screw is precisely like the one used for the first slide, and shown at fig. 10. Though no marks are shown on the collar of this screw, yet it is graduated in the same manner as the other one. The first and second slides are reversed in position so that the train of wheels which are fixed to the second radius plate are hidden, and, therefore, do not complicate matters unnecessarily. It must be understood that the rear side of the second slide is fitted with the planet arbor and cannon shown at fig. 20, in a similar manner to that illustrated at the right of the first slide.

The wheel which carries the second slide has been shown full size at fig. 14, where it is marked *b*. The sliding piece to which it is fixed is not very conspicuous in the large illustration, but a portion of it may be seen just above the square end of the leading screw shown at the left-hand part of the base plate. One of the strips which form the guides for the sliding piece is shown partly.

The screw, of which only a small piece of the square head is seen at the left-hand part of the drawing, is shown full size at fig. 9. The lower radius plate which projects above the base plate is not illustrated elsewhere, but in form it is like figs. 6 and 7; the size is of course larger. The position of this radius plate is shown at *c*, in fig. 14.

A train of wheels, eight in number, connect the back to front gear with the base wheel of the lower side. Only seven of the wheels are shown, one being covered by another, the largest of the series.

The two wheels in the foreground under the base plate are those marked *c* and *b* in fig. 12. The upper one is a ratchet wheel, and the lower one is driven from a wheel fitted to the centre of the chuck and held by a stop fixed to the front of the headstock. In fig. 2 these wheels are marked *o* and *p*. The ear projecting on the left from below the foundation plate is part of the plate for the reversing wheels, and shown full size at fig. 8.

The whole of the illustrations numbered from 9 to 20 inclusive, represent parts of the chuck which is shown complete in the perspective elevation. Complete particulars will be found in the descriptive matter specially referring to the particular parts. All these parts have been drawn from the chuck itself, and they are shown full size, so that any one who contemplates making a geometric chuck will find it easy to arrive at correct dimensions, as has been previously mentioned. Messrs. George Plant and Son, of Birmingham, supply the necessary castings, and these may be had in the rough or partially finished.

With a first-class lathe as a foundation, a good workman should be able to construct a geometric chuck from the particulars to be given. It would be mere waste of time to make such a costly and complicated instrument to any but a first-class lathe. In fact, probably the better plan would be to mount the chuck on a specially-contrived vertical spindle, arranged so that the ornamental slide rest could be brought into position for operating.

Every chuck must be made on the particular lathe for which it is intended, in order that it shall perform accurately. The base plate after being screwed to fit the nose of the lathe, is turned up true on the mandrel. It is not possible to get chucks to fit two mandrels and run equally true on both. When the foundation plate is perfectly true, the lower slide is fitted on it, and the ring on which the wheel *b*, fig. 14, fits, is then turned perfectly true. In the same manner the rings on the sliding pieces which receive the main wheels must each be turned on the lathe itself, or their absolute truth cannot be depended upon. The main wheels may be recessed out to receive the rings, and have the teeth cut in the periphery concentric with the recess, without any special precautions for a particular chuck. The dovetail slides may also be made irrespective of their applications. All that is necessary to insure every centre of motion acting truly, is that the projecting ring on the slides must be turned on the lathe itself.

When the sliding piece has been adjusted to fit accurately between the side strips it should be placed as nearly central as possible, and a hole drilled through both the sliding piece and base on which it slides. This hole is carefully broached out to a slight taper, and a pin fitted accurately to it. This pin is used to hold the slide whilst the ring is turned, and subsequently any particular slide, or all of them, may be made to run dead true. This is an important consideration, and must not be neglected when making the chuck, or it will be difficult to rectify the omission. When work is mounted on the chuck for turning, though it is generally fashioned roughly to shape, yet a finishing cut is invariably necessary. This is always taken with the slides all at centre, and to insure this the taper pins are both easy and efficacious to use. To adjust the position of the slides by means of the leading screws is a tedious and unsatisfactory operation compared with the taper pin method.

The practical application of the chuck for cutting various patterns can only be learned by experiment. Savory's "Geometric Turning" contains much useful information, a sample of which I have transcribed. It is, however, difficult to follow the meaning of the author without having a chuck beside one to put the instructions into practice. Some elementary information as to the figures formed by each motion, and the effect of combining various motions would be very acceptable to any one desirous of studying the action of the chuck. These have yet to be furnished by someone.

The construction of the chuck I have endeavoured to make clear, and the few hints that I have given on its application may suffice for the present. The foregoing particulars, together with the drawings which they describe, will enable any one to attempt the construction of the chuck with a fair chance of succeeding.

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Elegant Little Tables are now covered in deep crimson plush, and the bordering, instead of being equal all round, is in panels, some long, some oval, and others short and square. Upon the surface of the table a design in flowers is worked in fine ribbons, while leaves and tendrils are in arasene. Each panel is finished off with tassels of different colour, to match the design, and they depend from brass ornaments in the shape of a crescent. These brass crescents are very much in favour for ornamenting lambrequins, bracket hangings, and the many decorative objects to which needlework is devoted. They make a very pretty finish to fringes, etc.

Velocities of Wood-working Tools.—The velocities required for wood-working machinery are as follows:—Circular saws at periphery, 6,000 to 7,000 feet per minute; band saws, 2,500 feet; gang saws, 20in. stroke, 120 strokes per minute; planing machine cutters at periphery, 4,000 to 6,000 feet. Work under planing machine 1/20in. for each cut. Molding machine cutters, 3,500 to 4,000 feet; squaring up machine cutters, 7,000 to 8,000 feet; wood-carving drills, 5,000 revolutions; machine augers, 1½in. diameter, 900 revolutions; ditto, ¾in. diameter, 1,200 revolutions; gang saws require for 45 superficial feet of pine per hour, 1 horse-power. Circular saws require 75 superficial feet per hour, 1 horse-power. In oak or hard wood three-fourths of the above quantity require 1 horse-power. Sharpening angles of machine cutters—adzing soft wood across the grain, 30°; planing machines, ordinary soft wood, 30°; gauges and ploughing machines, 40°; hard-wood tool cutters, 50° to 55°.

GAUGES FOR MACHINE WORK.

BY JOSHUA ROSE.

(From the "Boston Journal of Commerce.")

IT has been supposed, in my previous remarks, that either the plug or the collar gauge was made and maintained accurate to its designated diameter. But this is not actually practicable, because, to whatever amount the plug wears, it gets smaller, while the wear of the collar bore causes its enlargement. Now it takes a long time, with proper usage, to impair the value of gauges by reason of the wear, and work made to gauges will always (with reasonable care as to the usage and maintenance of the standard of the gauge) be more nearly accurate to its designated size than work not made to gauge, because the limit of error in the gauge will be less than the limit of error incident to calliper measurement. But, at the same time, the wear serving, as stated, to enlarge the collar and diminish the plug is, in a direction, in both cases, to impair the fit by making it a more loose one. In the course of time, then, this wear will become so great as to render a correction, or restoration, of the gauge necessary; at what intervals this time will recur, of course, depends upon how much, and how carefully, the gauges have been used—supposing them to have been applied directly to the work. In restoring them, it is necessary to have recourse to some other standard; but even this standard is subject to the same conditions of wear in proportion to its use, and so we might go on interminably, but the requirements of practice are found to be met when the workmen are provided with standard plugs and collars to set their callipers by or apply directly to the work, and a second set of gauges are preserved, to be used solely to test the gauges so supplied to the workmen. The latter will be best preserved if lightly applied to the work while it is at rest, in no case being either forced into or upon the work, and they may be to some degree, tested by comparison, one with another; thus if a ¾in. and a ¼in. plug gauge fit the inch collar, the three may reasonably be presumed to be correct, but if they do not fit, it remains to discover which one is in error. Then the ¾ gauge may be tested with the ½ and ¼ gauges, and the inch collar with the ⅝ and the ⅜, and so on. But when these gauges are referred for trial to the shops' standard gauge, it is essential that it be at the temperature it was at, or under, when its own standard size was determined, because of the difference of its diameter under varying temperatures. Thus a plug measuring an inch when at a temperature of 40°, will measure more than an inch when at a temperature of 90°. It follows, also, that to carry this refinement further, the work to be measured, if of the same material as the gauge, should be at the same temperature, in which case it may be assumed that it will fit the gauge if applied under varying temperatures; but if a piece of work composed, say, of copper, or brass, be made a certain fit to a gauge, both being at a temperature of 40°, the fit will not be the same when both are at temperature of 90°, because copper and brass expand more than steel under a given increase of temperature. To carry the refinement to its extreme limit then, the gauge should be of the same metal as the work it is applied to—whenever the two fitting parts of the work are of the same material. But suppose a steel pin is to be fitted as accurately as possible to a brass bush, how is it to be done to secure as accurate a fit as possible under varying temperatures? The two must be fitted at some equal temperature; if this be the lowest they will be subject to, the fit will vary by getting looser, if the highest, by getting tighter—in either case all the variation will be in one direction. If the medium temperature be selected, the fit will get tighter and looser as the temperature falls or rises. Now in workshop practice, where fit is the object sought and not a theoretical standard of size, the range of variation due to temperature and, generally, that due to a difference between the metals, is too minute to be of practical importance. To the latter, however, attention must, in the case of work of large diameter, be paid; thus a brass piston a free fit at a temperature of 100°, to a 12in. cast iron cylinder, will seize fast when both are at a temperature of say 250°. In such cases an allowance is made, in conformity with the co-efficients of expansion.

In the case of the gauges, all that is practicable for ordinary workshop variation of temperature is to make them of one kind and quality of material—as hard as possible and of standard diameter, when at about the mean temperature at which they will be when in use. In this case the limit of error, so far as variation from temperature is concerned, will be simply that due to the varying co-efficients of expansion of the metals of which the work is composed.

In determining the limit to which the gauges may be allowed to wear before being restored and referred to the shop standard, the requirements as to the fit of the work, or rather the limit of fit error permissible in the work, must of course be considered, but in this matter we are, if the work is to be tested by the workman's gauges, confronted with another difficulty. In the production of holes of the limited diameters to which plug gauges are applied in practice, it is not practicable, where great accuracy is required, to bore the holes with an ordinary single pointed boring tool, because of the wear of the tool—its spring away from the work—as it gets dull (which it does to some extent from the moment it is put to the cut) and because such a tool will leave tool marks unless it has a very broad cutting edge standing parallel to its line of feed motion. If it has this broad cutting edge (which must be broader than the amount of its feed per revolution of the work), it is liable to follow the texture of the metal, cutting less in the harder and more in the softer parts of the metal, dipping into seams or porus parts, and so on. For three reasons such holes must be finished by standard cutters, reamers, or bits, which has a bearing either at two opposite or at more diametrically opposite parts of the bore. If a cutter be used having two diametrically opposite contacts in the hole and performing cutting duty on the end faces, a reasonable and, for most fitting purposes, a sufficiently accurate gauge and fitting fit may be secured but not great smoothness and truth; thus it would be quite impracticable to make a good collar gauge with such a tool. For greater accuracy a reamer must be used, but even a reamer cannot be made to finish, with sufficient parallelism, cylindrical truth and accuracy of diameter, a standard collar gauge, hence fitting processes by grinding are resorted to. In ordinary workshop practice grinding to a precisely *parallel gauge diameter* is too slow and costly to be practicable, hence the holes are usually finished by the reamer, grinding only being resorted to when great accuracy is considered a necessity. Suppose a solid reamer to be used in a hole which is six inches deep, its end being enclosed by solid metal. Let the reamer be made parallel, and it will, if its cutting edge or edges extend along the full length to which it enters the hole, make the hole largest at its exposed end. The amount of taper will increase with the amount of clearance allowed to the cutting edges of the reamer. The taper occurs because, while the whole of the operating part of the reamer has passed through the entrance of the hole, only the extreme end has reached the bottom, and the exposed end is largest from its increased contact with the cutting edges. Were the reamer body quite parallel, its cutting edges pointing in a perfect circle, its rotation dead true to its axis, and its line of feed motion a straight line dead true to the axis of the hole in the work (which may be supposed to be cylindrical and parallel and to require a very fine cut to bring it to diameter), the hole could be reamed true providing that the cutting edge at the end of the reamer (which must have done all the cutting) be supposed not to have worn at all; but these conditions of truth and alignment of motion are not found in practice, hence such a hole cannot be reamed to theorectical truth. For such a job a rose bill or reamer, cutting at its slightly rounder corner at its end only, and parallel along its body, or even very slightly tapered, as say $\frac{1}{1000}$ inch in the 6 inches, would give the nearest result. In this case, if the reamer were parallel, its friction against the sides of the hole, or if tapered, its liberty to move or spring and not rotate in a perfect circle, would be disturbing elements. As a rule greater accuracy can be attained by hand reaming than by machine reaming, on account of the wear in the parts of the machine and of the difficulty of rotating the reamer in perfect alignment with the axis of the hole. In hand reaming the reamer may be made tapered at the end so that it may enter the hole sufficiently to steady itself, or it may be steadied in guides, but in any event we have the wear of the cutting edge or edges to contend against.

If the reamer be solid every successive hole it reams will be smaller, hence, if the plug or male pieces of work be made of the required fit to the first hole reamed, the fit will get tighter and tighter to each successive hole reamed, until finally the fit becomes too tight and the reamer must be restored to its original diameter. How much duty a reamer will perform before this restoration becomes necessary depends upon the required accuracy of the work. Now suppose that it be determined in a particular case that a limit of error in work diameter equal to $\frac{1}{1000}$ of an inch is permissible, then it is to be considered that if the reamer be made to the gauge diameter and correct when new, the fit will gradually become tighter until the limit of $\frac{1}{1000}$ inch is reached. Suppose, however, that accuracy of fit be essential, and that accuracy of gauge diameter as near as it can be obtained is simply desired, then, in any case, the holes must either be ground after reaming or else the male or plug pieces of the work must be fitted to the individual holes into which they are to fit, and the reamer must have a limit of wear as small as the exigencies of the case will permit. In this case fit takes precedence of standard diameter, hence we may reverse it and suppose that standard diameter is of more importance than the fit, providing a limit of $\frac{1}{1000}$ inch is the maximum—now what shall be the diameter of the reamer when new? If we make it to the correct plug gauge diameter the reamer wear will cause increased tightness of the fit, and any wear that may have taken place in the collar gauge will increase the diameter of work gauged by it, the errors will thus be added. But for a working fit $\frac{1}{1000}$ inch too tight is destructive of the parts by reason of the undue abrasion, though in a forcing or driving fit the error would generally be quite permissible; hence for working fits the new reamer must be as much above the standard diameter as the limit of error allowed. In this case, then, the new reamer will bore a hole having the greatest permissible limit of error and will wear better until the correct size is reached. But suppose a case in which the nearest approach to standard gauge diameter is of prime importance rather than the nature of the fit, while the limit of wear is $\frac{1}{1000}$ inch, then the new reamer may be made $\frac{1}{2000}$ inch above the standard size and allowed to wear down to the $\frac{1}{2000}$ of an inch below the standard size. But in both cases the great majority of the holes will not be to standard size nor accurate in fit unless the plug or male parts of the work are varied in diameter to suit the wear of the reamer. This brings us to the necessity of using reamers so constructed that their cutting diameters may be adjusted to take up the wear, because by this means the limit of wear may be reduced, if necessary, to that induced by reaming a single hole or any number that may be determined upon. Thus a solid reamer worn down to its limit of error must either be reduced to a lesser standard measurement, or else its teeth must be upset to enable the restoration of diameter and the truing of the cutting edges. Now this involves a softening of the steel which deteriorates it; an upsetting which deteriorates it, and a reheating for hardening which again deteriorates it; whereas in an adjustable reamer a movement of the cutters in the stock holding them restores their diameter. This brings us to a consideration of the most desirable shape and amount of clearance in a reamer in which maintenance of diameter and smoothness of the cut is of the first importance rather than strength to remove a mass of metal.

Notes on Warped Wood.—It is very often found that wood which in the board or plank is perfectly straight, or appears to be so, will twist and wind in every conceivable manner when cut up into long, narrow, lengths, or cross-cut into short, broad panels. When wood is "winding," the only remedy is to plane off the high corners and make it true by reducing the thickness; but if it be simply cast (one side hollow and the other round), the defect may be easily got over. If the man, by working on some other portion of his job, can let the defective pieces stand for a day or two, then by placing the wood "hollow side" down on a plane surface, or by putting two such boards one on the top of the other, with the hollow sides facing each other, the wood will draw straight without any more trouble. It is always best, when possible, to work wood in its natural state, as even if the tendency to cast be overcome previous to working it, there is always the probability of its returning to its normal condition. Some men, when pressed for time, heat the round side on the stove. This does indeed make the wood straight, but there is a great risk of opening and splitting under this toasting treatment, and this liability is very much increased if the wood be at all shaky. If required, the wood can at once be straightened without this risk, by damping the hollow side with water, when the expansion of the fibre on that side pulls it straight. It sometimes happens that a piece of wood of some considerable width, such as a carcase end or a wardrobe panel, has to be reduced from ¾-inch to ½-inch thickness. If this superfluous wood be all taken off one side, that side will become hollow, whereas if it be taken off equally on both sides the wood remains as before. In veneering panels, etc., it is always best to veneer on the outside, that is, the side opposite the heart side, the reason for this being that veneer is apt to swell with glue being laid on, and must therefore contract after it is fixed. As the heart side has always a decided tendency to curl, the two forces counteract each other, and the wood remains the same. For this same reason, it is always best to inlay on the outside.

UNIFORMITY IN MACHINE TOOLS.

(From the "American Machinist.")

AN important matter for reform in machine tools is in regard to uniformity of certain parts among different makers, even though the machines may be quite unlike in general design. This applies chiefly to lathes, but, in a lesser degree, to other tools also.

The chief points about lathes which need bringing to standard are the centre shanks, the mandrel nose screws, and the tool posts. The latter do not vary as much as do some of the other matters, but should undoubtedly be made more uniform in regard to size of tool slot and distance which bottom of tool can be set below line of centres. Emphatically, the worst annoyance that occurs amongst a number of lathes of different makes, and of slightly varying sizes, is not being able to interchange the various chucks on account of the mandrel nose screws being of as many diameters, pitches, and angles as there are lathes. Why in some cases there should be a mysterious virtue in a very fine pitch of thread, and in others an extra coarse pitch should be found necessary, must remain unknown. A simple remedy for these differences of pitch and angle would be to use a standard already provided—the United States standard for screw threads. Screw gauges of great accuracy, and taps nearly as accurate, can now be procured already made. Thus a great deal of the trouble might be obviated, and the lathe owner could cheaply fit various chucks to his lathes.

It is true he might still require a good many sizes, but this is an evil to be put up with until lathe makers can come to some common agreement about the proper diameters for their mandrels. At that happy time all that would be necessary to change would be some of the diameters. The adoption of the United States standard is something that each maker could cheaply undertake *now*, without waiting for some general lathe standard—that is, if he chose to.

Like arguments with those above given, with a like temporary remedy for the evil, may be applied to the matter of centre shanks. The evil is that no two are of the same diameter, length, or degree of taper. Thus any odd centres, and other special tools fitting in either live or dead spindle, have to be made in full sets for each individual lathe, and there is no standard to make them by except a measurement of some old centre. This is often taken with a pair of imbecile callipers (perhaps afflicted with the rickets), at a point on the taper part some indefinite distance from somewhere. As the sample centre was probably made in like slipshod manner from some other one, and that from still another, the final result is a set of tools as varied as the lengths of a lot of sticks of firewood that a boy makes by cutting up a fence rail when he measures each stick by the last one cut. If that boy's mother's hair grows grey before she gets all those sticks adapted to their environment—the cook-stove—what will happen to the systematic tool "boss" who attempts to arrange and classify the odd lot of stuff pertaining to his different lathes?

The remedy is simply to use the "Morse taper"—the same as mentioned below for drill press spindles. This is a ready-made standard, and one for which the reamers can be easily procured. Though not, perhaps, the best set of sizes that could be devised, they will answer very well until something better can be generally agreed upon. If it be objected that the hole made with one of these reamers is not deep enough to reach back to the drift slot, in case such a construction is used, I reply that the centre may have a cylindrical "tail" reaching back as far as desired beyond the taper part against which to drive. The taper part is plenty long enough for a secure hold.

A better plan is, I think, the old-fashioned one, which is being somewhat revived of late. In this construction a short prismatic portion (square, or, more neatly, hexagon in form) allows the use of an ordinary wrench, by which to twist the centre loose when removing it from the spindle.

In regard to a standard angle for the working point of lathe centres, the matter seems to be arranging itself at 60°—probably because of the extended sale and use of "centre gauges," which are made to that angle. It is a very convenient one to make, and probably, on the whole, the best that can be devised. It, of course, holds the work against lateral strains better than any more obtuse angle, but it requires some care to keep the point from getting broken off. With the "slam-bang" style of workman, centres will undoubtedly last longer if made 70° or 75°. In this matter, however, it is especially important that all should conform to one standard, as it affects the interchangeability of *work* as well as of tools.

Every shaft in every machine in the country is liable at some time to be put into some lathe far away from where it was made. It should certainly run on more than a mere line of bearing, or it will soon wear "out of true."

Regarding drill presses, a yet more important point arises, to wit, the size and shape of the hole in spindle to receive the drill shank. Undoubtedly, the best thing to do now is to make it to fit what is known as a "Morse-taper" twist drill shank—say the largest of the sizes which the drill press in question is, at its maximum capacity, adapted for. Any smaller sizes of shanks can then be used by bushing with the very convenient "Morse sleeves" or "sockets" (according to the length wanted), which can now be procured as ordinary machinists' supplies.

It would not be in good taste in an article like this to recommend any particular wares, but I believe these "tapers" are now made by more than one house—at any rate, the "Morse" who originated them is no longer connected with the business. They are advocated because they seem to be the standard most in use in this country, and to be practically well fitted for their work. They should remain in use until some competent engineering authority (perhaps the hoped-for National Commission on Tests and Standards, which may be born in halcyon days to come) shall decide upon something better. The only objection to these tapers that I know of is that they do not seem to be founded upon any regular progression of sizes, and that nearly all their dimensions must be written in odd thousandths of an inch, instead of sixteenths or eighths. The amount of taper appears to be about $\frac{1}{20}$in. for each 1in. in length, but I am informed that the original intention was to make it $\frac{5}{8}$in. per foot. Just why this beautiful and convenient ratio of ($\frac{5}{96}$!) was chosen by the mythical Morse to puzzle the brains of poor apprentices who have to fit boring-bar shanks and other tools, history faileth to tell.

In the case of planers, the principal parts, where the most commonplace common sense would dictate that a standard should be adopted, are the slots and holes in the tables. In regard to the T part of the slots, the most obvious and simple plan would be to make them fit "United States Standard" square-headed bolts—say $\frac{5}{8}$in., $\frac{3}{4}$in. and $\frac{7}{8}$in. for small, medium, and large planers respectively. Possibly, however, an uniform size of $\frac{3}{4}$in. would be better. The narrow part of the T slot should be planed out parallel to some exact standard size—say $\frac{1}{16}$in. larger than the nominal size of the bolt—in order that various attachments (such as angle plates, V-blocks, etc.) may be accurately guided in position. For obvious reasons, the pinholes in a planer table should also be of standard size.

The remarks in the last paragraph apply with equal force to the tables of shapers, slotters, milling machines, drill presses, and other tools requiring their work to be bolted to a flat surface. Other things that need bringing to a standard size are the "arbors" of milling machines and gear cutters, where the cutters are put on. It is much to be regretted that even the most scientific makers of these cutters provide them with so many-sized holes that a constant recourse to bushings is necessary. Such a bushing is a very annoying little pet, especially if it is $\frac{1}{16}$in. or so thick, and must contain a key seat to fit over the feather in the arbor, and a feather of its own to drive the cutter. Is there any earthly reason for the atrocious wickedness of putting three different-sized holes in a set of gear-tooth cutters, varying from five to ten diametrical pitch, except a romantic desire to make said holes somewhat in proportion to the outside size of the cutter? And why do the cutters need to have so many outside diameters—who knows?

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AN UNIVERSAL DOME CHUCK.

(*For Illustrations, see Lithograph Supplement.*)

WE are indebted to the maker of the chuck, herewith illustrated, for the privilege of placing a description of it before our readers. The photographs are from a chuck made from ideas suggested by Mr. Jesse Lowe, of medallion cutting fame. The embodiment of the ideas has been most successfully accomplished by an accomplished amateur, who is an ardent supporter of "Amateur Mechanics." Of the workmanship we may safely say that it is unexcelled, and from it some of our so-called practical mechanics might take a lesson in imitation with benefit to their trade. Having spent some hours in looking through the work produced by the gentleman alluded to, we speak with every confidence.

Our correspondent wrote: I am pleased to notice the appearance of your magazine, and consider that it supplies a want that amateurs have long felt. The excellent style in which you send out the magazine with the edges ready cut, the good paper, clear type, and real working drawings, are each deserving special eulogy. I think we should all do what we can amongst ourselves to render the work as interesting as possible to each other. Most likely every reader could supply some scrap of information that would be valuable to a large proportion of his fellow readers. We, amateurs, work so much alone that our ideas are often quite peculiar to ourselves. By interchanging them we cannot but profit mutually. As a practical proof in endorsement of my views I herewith send you photographs of a compound dome chuck.

This compound dome chuck enables the amateur to do much work that cannot be done on dome chucks of ordinary construction, and it will also do much of the work that usually has to be done by the spherical slide-rest. It will be found a useful addition to any amateur's outfit. The chuck is not difficult to make, and from the illustrations the reader will be able to infer an idea of its general construction. The main slide, at right angles with the mandrel axis, is precisely like that of the ordinary dome chuck. Instead of a solid sliding piece, as in the ordinary arrangement, this piece of this chuck rotates at its base, near the face of the arm. For this purpose it is provided with a worm wheel and tangent screw micrometer adjustment, as shown in the photographs. By this arrangement the work may be readily thrown at an oblique angle with the line of centres. The sliding piece is forked at the end, and the nose piece is gunballed to swivel at right angles to the former motion. That is, when the micrometer wheel is in its normal position the nose piece may be swivelled at right angles to the mandrel axis, so that the work may be brought to stand out in a line parallel to the mandrel if wished.

This portion is also indexed on the underside, which enables the user to readily set it at any desired angle; unfortunately, this is not shown in the photos. The working of this movement could also be done with a segment of a worm wheel, and tangent screw; but in practice this arrangement is not found so good or so convenient as the one shown. To work this movement you slacken the two studs upon which the nose-plate revolves—half a turn will be found sufficient—when the work can be readily fixed at the desired angle. Then, of course, the two studs are again screwed home, and this portion of the chuck is as solid as if the fork and nose-plate were of one piece—the importance of which I am sure all who have had any experience in the use of the dome chuck will bear me out, as the jar is sometimes considerable.

The detent wheel shown is held by the three screws, but is made interchangeable, so that detent wheels variously divided may be used in accordance with the requirements of the work in hand. By means of the two steady pins, shown in the face of the detent wheel, which are fixed in the base of the nose piece, any other detent wheel may be readily centred. The spiral, eccentric, and other chucks should be fitted in exactly the same manner, so that any wheel will fit on either chuck. This plan gives the advantage of a long range of divisions without necessitating the use of the slow working micrometer screw arrangement. Of course this system of interchangeable detent wheels is available for all kinds of ornamental chucks and apparatus, and does not necessarily form part of the improved dome chuck, which I have briefly described.

These index wheels are so figured and marked as to read at sight—an arrangement which I am certain will be appreciated by all who use them, more especially those unfortunate individuals who happen to be short sighted. This arrangement will also be found very beneficial if applied to the division plate of a lathe, the proof of which I can vouch for from experience. The sub-dividing of index wheels was suggested to me by a *very clever* amateur, hailing from the Lake district, and whose ideas I should be pleased to see occasionally appearing in "Amateur Mechanics."

It is only due to say that I am indebted to Mr. Jesse Lowe, who originally invented the chuck many a year ago, for the idea here embodied, and in his generous unassuming manner he has kindly consented to the publication of these particulars.

In conclusion, I may add that the chuck is made throughout with the Whitworth pitch of thread with the single exception of the main screw, and it may not be out of place here to mention, that I should like to see the screw pitch question thoroughly ventilated in "Amateur Mechanics," as I, for one, think the time has come when the use of none but aliquot pitches should be permissible.

G. B. M.

It only remains for us to thank our correspondent for the trouble he has taken, and to express a hope that others amongst our readers will follow the good example he has set.

ON THE CHOICE OF WOOD FOR CARVING.

It will facilitate the progress of the amateur materially if wood of a suitable nature be used to carry out his intention. With regard to this no laws can be laid down; a few instances, however, of woods which are especially applicable may be of service. Limetree is soft and pliable to the tool, and less liable to split and splinter than almost any other wood, which qualities render it of great utility to carvers for carrying out designs when lightness and boldness are equally required. It takes a stain well, and a fair polish, or it may be varnished without greatly altering the colour of the wood, but giving to it a very agreeable boxwood appearance. It is suitable, as well as for large festoons, for smaller works, such as book-stands, miniature and portrait frames.

American walnut is s very good wood for amateurs, and is much in favour with them for its dark colour. It has, however, a more open grain than lime, and therefore requires more care to avoid accidents. It is used for many small works where much projection is unnecessary, as book-racks, letter-boxes, and watch-stands.

Sycamore, holly, and chesnut are amongst the lightest of our woods. The first is greatly, and, in fact, principally used for bread-plates, potato-bowls, and other articles, when a light tint is a consideration.

When the amateur has gained a certain proficiency in the art, harder woods may be worked without a great amount of additional exertion, as so much depends on the mode of using the implements.

Oak, Italian and English walnut may then be used. The former, from its hard and enduring nature, should as a rule be chosen for executing the finials or pew-heads, alms-boxes, church, and Gothic work in general. It is also much used for clock and hall brackets, and for other pieces of solid furniture.

Italian walnut is a rich and beautiful wood for a variety of purposes, such as cabinets, panels, book-cases and frames. It is hard, but the effect produced by its use amply repays the extra labour caused by the close texture of the material.

When any very delicate designs have to be executed, and the most minute finish is required, box-wood, ebony, or any other equally hard and close-grained woods are decidedly the best to choose.

Pear-tree is a pleasant wood for working, and a good piece resembles lime in its pliability. It is extensively used in France for the purposes for which we employ lime.

Woods with ornamental grains, as bird's-eye maple, satinwood, yew, and laburnum, are not desirable woods for carving purposes; the grain and colour often interfere with the effect we are endeavouring to produce. Thus one of the eyes of the maple might graze the nose of a Venus, or the white stains of yew or laburnum show like deep gashes across her otherwise lovely face.

These are only general ideas, as there must be of necessity many exceptions to any rule for the selection of proper woods for particular subjects; for the choice of material must in all cases be subservient to the character of the design, as also to the taste of the operator.

To procure good wood for our purposes the trees should be felled at a proper time and age, and the wood thoroughly seasoned. The proper time to fell oaks and most other trees is when they fail to increase in size more than 2ft. per annum. If cut down before that period of their existence, the heart will not be fully developed, and will not be as hard as the other part. When oaks are about thirty years old their growth is most rapid. Autumn is generally considered the best time to fell.

If wood be used in an unseasoned state it is sure to warp and twist; and when it is so used for panels fitted into loose grooves, it shrinks away from the edge which happens to be the most slightly held; but when restrained by nails, mortises, or other unyielding attachments, which do not allow them the power of contraction, they split with irresistible force, and the material and the workmanship are thus brought to no useful service. It is therefore very necessary that the natural juices of the tree be got rid of by seasoning it before use. After a tree is lopped, barked, and roughly squared, it is left some time exposed to the weather, and may be soaked in fresh running water with advantage, and boiled or steamed. Any of these processes tend to dilute and wash out the juices, and the water readily evaporates from the wood at a subsequent period. Thin planks, if properly exposed to the air, will be seasoned in about a year, but the thicker the wood the longer the time it will take.

NEED OF ADAPTED TOOLS.

(From the "Boston Journal of Commerce.")

The time is past when job shop tools, appliances and methods can be successfully used in the production of tools for general use, designed to have a steady market standard and recognized value. The "rule of thumb" method is not adapted to the production of "tools of precision," under which head all our present manufacturing tools may properly rank as compared with those of twenty years ago. To be sure the job shop, itself is the job shop, and will be to the end of the chapter. Tools of accuracy—drills, reamers, and others of exact and unvarying sizes—are not absolutely necessary in a job shop, and such appliances as "jigs" and gauges are not required. Tools must be made over and new appliances must be contrived for almost every new job that comes into the shop. Nothing is standard in the job shop, and there is no re-duplication of parts of any machine. But in the manufacture of tools for the general market uniformity of parts as aid to a ready re-duplication in case of breakage is absolutely necessary; and for this uniformity there must be adapted tools and appliances. There must also be some original and radical schedule of forms, dimensions, and proportions of parts. This is to be found in the draughting department—a department that has generally no existence in the job shop.

Yet there are producers of valuable machine tools and manfacturing machines who never had a drawing beyond a mere sketch, and whose dimensions and proportions of parts are held only on their casting patterns or in figures in a note book. The writer knows of one establishment that makes excellent tools, the subjects of several patents, that cannot duplicate unless the broken or worn-out part is returned to the shop as a copy. The builder has no drawings; his shop does not possess a "jig" nor a fixed gauge for any one article he makes; he has no draughtsman, but depends on his patterns and on the ordinary shop rule of inches and their parts. His sale is limited, and probably largely on this account. Purchasers are vexed at delays in getting duplicates, and although they are well satisfied with a new purchase, find trouble in keeping up the integrity of the tools once purchased. The builder and patentee appears to be satisfied with his present hand-to-mouth arrangement, and will probably continue it until bitter experience in the falling off of orders and a transfer of work to better managed shops convinces him that he is making a mistake.

A recent letter from a live mechanic who has taken the control of an important establishment shows a similar state of affairs. But he has set men at work to produce, under his direction, the necessary appliances for sizing and duplication. He will build up a business that was languishing for want of an intelligent head, and before long will put into the market work that possesses uniformity in all its details, any portion of which can be duplicated at call, without loss of time and without the risk of the "cut and try" system—or lack of system.

Another illustration, on the other side, is that of a tool-builder, who started some six or eight months ago, and has only recently begun to put his finished tools on the market. But he begun at the beginning, and has scale or full-sized drawings for every piece, even to bolt and nut, and his array of gauges, jigs, and other appliances is pleasant to the contemplative and observant mechanic. He can now send out a perfectly finished good-working tool, capable of being re-duplicated to order, which is destined to become a standard. This man worked hard and long to get ready to produce work. His preparations cost money and time, but he is beginning to reap the benefit of his outlay, and will eventually build up a prosperous and lucrative business.

The purchasing public want good tools, and are willing to pay fair prices. But they want, also, something they can rely upon when they send a second order, and they want a responsible builder, whose means of production can meet an exigency without a long wait. The duplication of parts (the uniformity of production) is a very necessary element in the success of those who assume to cater for the patronage of the exacting manufacturing public.

THE USE OF GLUE.

GLUE is used by the joiner for joints, veneering, &c. A minimum amount of glue should be used in good work, and it should be applied as hot as possible. The surfaces of the wood to be united should be clean, dry, and true; they should be brought together as tightly as possible, so that the superfluous glue is squeezed out. The cohesion of a piece of solid glue, or the force required to separate one square inch, is found to be four thousand pounds. From other experiments it was found that the adhesion of two pieces of oak glued end to end amounted to at least seven hundred and fifteen pounds per square inch. The lateral adhesion of a piece of board cut out of Scotch fir, which had been quite dry and seasoned, was five hundred and sixty-two pounds to the square inch. Therefore if two pieces of this board had been well glued together the wood would have yielded in its substance before the glue. The strength of common glue for coarse work is increased by the addition of a little powdered chalk.

Glue is prepared from waste pieces of skin, horns, hoofs, and other animal offal. These are steeped, washed, boiled, strained, melted, re-boiled, and cast into square cakes, which are then dried. The strongest kind of glue is made from the hides of oxen; that from the bones and sinews is weaker. The older the animal, the stronger the glue. Good glue should be hard in the cake, of a strong, dark colour, almost transparent, free from black or cloudy spots, and with little or no smell. The best sorts are transparent, and of a clear amber colour. Inferior kinds are sometimes contaminated with the lime used for removing the hair from the skins of which they are made. The best glue swells considerably (the more the better) when immersed in cold water, but does not dissolve, and returns to its former size when dry. Inferior glue, made from bones, will, however, dissolve almost entirely in cold water.

To prepare glue for use it should be broken up into small pieces, and soaked in as much cold water as will cover it, for about twelve hours. It should then be melted in a double glue pot, covered to keep the glue from dirt. Care must be taken to keep the outer vessel full of water, so that the glue shall not burn, or be brought to a temperature higher than that of boiling water. The glue is allowed to simmer for two or three hours, then gradually melted, so much hot water being added as will make it liquid enough just to run off a brush, in a continuous stream, without breaking into drops. When the glue is done with, some boiling water should be added to make it very thin before it is put away. Freshly made glue is stronger than that which has been repeatedly melted. Too large a quantity should not therefore be made at a time. Glue may be freed from the foreign animal matter generally in it by softening it in cold water, washing it with the same several times till it no longer gives out any colour, then bruising it with the hand, and suspending it in a linen bag beneath the surface of a large quantity of water at 66° Fahr. By doing this the pure glue is retained in the bag, and the soluble impurities pass through. If the softened glue be heated to 122° without water, and filtered, some other impurities will be retained by the filter, and a colourless solution of glue be obtained.

Transferring Prints and Leaf-Forms to Wood.—To transfer pictures to sycamore or white pine, you must first plane your wood perfectly smooth, and give a few coats of French polish; then take your picture, and damp it with a sponge soaked in spirits of wine; place the picture on the wood, and then place a piece of thickish cloth over the picture; then get a warm iron and rub gently over the cloth, being careful not to shift the picture. You must keep rubbing the iron backwards and forwards for ten or fifteen minutes, then take off your cloth and leave it for some hours. Then you must get some cold water and damp your finger in it and rub the paper. Great care must be taken in this, or you will disturb the impression. Keep damping your finger as you go on. When you have got it all off you can polish over. Any kind of picture will do with the exception of glazed ones. Ink pictures take off best. There is another method by which the effect of white leaves prettily grouped on a dark, softly graduated ground is produced. The leaf or pattern is fastened temporarily to the wood, which must, of course, be nice and smooth, fit for varnishing. Then take a brush of stiffish bristles filled with some pigment, bend back the bristles towards you, and away from your pattern, then let go suddenly; some of the pigment will then be precipitated on the wood where not covered by the pattern. You proceed in this way till your judgment tells you the pattern is well defined, taking care to vignette or allow the shadow thus produced to fade away towards the edges. You may advantageously practice with a blacking brush, using blacking thinned down with gum water for the pigment on a sheet of paper, using a fern leaf or two for patterns.

GRINDING AND POLISHING METAL SURFACES BY HAND.

(From the "American Machinist.")

THERE is no job the worker in metals is called on to do that requires the exercise of his brain and muscle in the proper direction more than the grinding and polishing of metal surfaces on that class of work where machinery cannot aid him. The more he exercises his brain, the more saving he will be both of his time and muscle. The practice generally employed by machinists in grinding and polishing either new or old work is to mix the polishing material with oil, usually refuse machinery oil; in most cases this is a great mistake, and has caused the loss of time, patience, and money. Take, for instance, the grinding to a true bearing of a stop cock, a valve seat, or a slide valve. There are few machinists but what have had more or less of that class of work to do, particularly in jobbing shops, and we seldom find one who uses the same method of accomplishing the job that is practised in shops where that class of work is made a speciality. In fitting and grinding the plug into the barrel of a cock, a little judgment and care will save a great deal of hard labour, and in no case should oil be mixed with any of the grinding material, for the following reasons: If fine emery, ground glass, or sand are used with oil, it requires but a few turns of the plug in the barrel to break up the grains of the grinding material into very fine particles; the metal surfaces also grind off, and the fine particles of metal mixing in with the grinding material and oil, make a thick paste of the mass. At this stage it is impossible to grind or bring the metal surfaces to a bearing, as the gluey paste keeps the metal apart; if more grinding stuff is applied it will prevent the operator from seeing what part of the barrel and plug bears the hardest. Again, if the grinding material be distributed over the whole surface, the parts that do not bear will grind off as fast as the parts that touch hard, as the particles work freely between the surfaces; should the barrel and plug bear equally all over when fitted it requires more care than if it were a top or bottom bearing, as that part of the barrel and plug across the "waterway" grinds twice as fast as the other parts; therefore, it should be kept the driest. Now this objection holds good in the grinding of valve seats or slide valves, to wit: the separation of the surfaces of the metal by a thick, pasty grinding material. In order to bring the surfaces to a perfect bearing rapidly and with little labour, the following directions will be found worth a trial:—

To grind a stop cock of any kind, first see that the plug fits the barrel before it is taken from the lathe. Run a half-round smooth file up and down the barrel to break any rings that may be in it; a few rubs of a smooth file back and forth over the plug will break any rings or tool marks on it. Wipe both parts clean. Use for grinding material fine moulders' sand sifted through a fine sieve. Mix with *water* in a cup, and apply a small quantity to the parts that bear the hardest. Turn rapidly, pressing gently every few turns; if the work is large and the lathe is used, run slowly; press and pull back rapidly to prevent sticking and ringing; apply grinding sand and water until a bearing shows on another part, then use no more new sand, but spread the old that has worked out over the whole surface. Turn rapidly, pressing gently while turning; withdraw the plug and wipe part of the dirt off, and rub on the place a little brown soap; moisten with water and press the surfaces together with all the force at hand, turning at the same time. Remove the plug and wipe both parts clean; next try the condition of the bearing by pressing the dry surfaces together with great force. If the parts have been kept closely together while grinding, and the plug has not rubbed against the lower part of the barrel, the surfaces will be found bright all over and a perfect bearing obtained. If an iron barrel and a brass plug are used, or two kinds of brass, a hard and soft metal, soap should be used freely when finishing up, as the tendency to form rings is greater when two different metals are used.

In grinding a slide valve which has been in use until hollow places have worn in the surface, emery mixed with water, or sand and water, will be found better than oil, unless a light body of oil, such as kerosene, is used. If water is used with the grinding material, soap should be rubbed on hollow places, and the grinding stuff should be applied to the high parts in small quantities, keeping the low parts clean and dry until an even surface is obtained all over; then the worn-out stuff should be used for finishing up. In polishing metal, oil that will "gum up" should not be used with the polishing material unless for a dead fine polish. In polishing old brass work which has been scratched and tarnished by wear, pumice stone or bathbrick should be used with soap and water for scouring off with, and rotten stone with kerosene oil for the wet finish, and dry for the final polish. The same method should be used for new brass work.

New work should require, after leaving the lathe and vice tools, but little polishing or grinding, and every good workman should try to avoid using an emery stick or emery cloth, as with proper care in the use of tools a great deal of grinding and polishing can be dispensed with.

CHOICE OF TIMBER FOR PATTERN MAKING.

ANY mechanic may find it necessary to make a pattern, some time or other, to replace a broken casting or carry out his own ideas in private; and pattern makers are not always get-at-able for odd jobs in busy times. Wood for patterns is best when suitably and finely seasoned, and time is the best seasoner, so get that piece, if obtainable, which is so aged for working, of whatever quality it may be. But if you have to season it artificially, follow the usual directions:—First get the wood, or it may be difficult to make the patterns; expose it to free dry air, and it is all the better to protect it from the sun's rays and winds; bear it up from the ground. Some may forget that drying is more rapid when it has been in water a week or two previously. In quick drying, the more gentle the heat, and the more dry the air, the better. Nearly all kinds of wood are used in making patterns. Large, long and flat patterns are constructed of white or yellow pine, on account of its lightness, cheapness, and freedom from warping and splitting, but it has, of course, the other disadvantage of being soft and more liable to receive injury when made up. Choice Canadian red pine is harder, but should be selected as free from knots and turpentine as possible. Still harder is white American fir, or spruce, which are very suitable for large wheel patterns. The harder the wood is the finer it looks after the saw, but the working of this material is troublesome when catfaced, that is, some parts smooth and some rough. Teak is light, strong and durable, also easily worked, but punishes the tools a little, and is somewhat prone to splitting. Any part of a pattern which has to be turned may be made of beech; it has an uniform grain. Yet there is plenty of elm, oak, maple and sycamore used also.

For small patterns the Germans use cherry-tree wood, well seasoned, it is hard and close grained; but in England, mahogany (chiefly baywood) comes into use for all small work, in fact it will suit nearly all patterns; it warps less than any other wood, and shrinks very little in drying. It can be worked at the ends easily, and its corners kept sharp (in hands handling good sharp tools), but if both man and tools are not sharp, the casting will show it.

It is better perhaps to add, as a reminder, the well-known allowance which has to be made in size for the shrinkage of the casting when cooling. All patterns larger than 3 or 4 inches should be measured with a contraction rule, purchasable, now made in steel as well as wood. The contraction foot rule is about the tenth of an inch longer than the standard foot, but still more than this must be allowed in a wood pattern, if the casting is intended for an iron pattern, say for a blank to be turned up; in this case judgment must be exercised. White wood patterns should be painted or varnished before they are put into the sand, or some of the woods, such as oak, will draw the moisture from the sand, knit with it, and the patterns will be bad to draw. Cedar and deal are good to draw, even unpainted, but much depends upon the finish. The parts under sand, when moulding, should have an inward taper. Amateurs will have the benefit of the last hint. The paint just named, as a thin coating, is oil paint made of red lead (or acetate or sugar of lead) and a hard drying oil; sometimes they are blackleaded afterwards, and others sandpaper them and rub them with powdered chalk. Pumice stone also is often used instead of glasspaper, and then a coating of blacklead and beer. The latter will do put on the bare wood if the pattern is fairly finished, and only two or three castings are wanted off it. Hard wood patterns will draw well, if coated with Copal varnish. Coarse work has very often a coating of common lead colour paint. Another protection is weak shellac varnish, one part to ten of methylated spirits. It hardly need be added that where sprigs and nails can be used in making patterns, they are always preferable to glue.

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A New Kind of Nail has been introduced in Germany, which appears to be in certain respects superior to anything yet invented. Like other finish nails in general use, the new variety is made of wire, but instead of being round, the section of the wire is an equilateral triangle, with concave sides. The stiffness of the nail is much increased by the angular form of its section, and a reduction of 25 or 30 per cent. in weight can be made without injury to the strength. Moreover, as the surface of the prismatic nail is much greater than that of a cylindrical one of the same strength, its friction in the wood, and consequently its resistance to a force tending to draw it out, are correspondingly multiplied.

Removal of Particles from the Eye.—For removing steel chips or emery from the eyeball, take a wooden toothpick or small wire, and wind the end with a shred of lamp wicking, or cotton, or wool fibre. This forms a small pad, which, under the microscope, shows a snarl and tangle of threads, which will catch on to almost anything. If there is any projecting point, or the foreign substance be not completely embedded in the eye, a gentle, sweeping touch with this pad will take it out instantly and painlessly; and the beauty of it is, that no harm can be done if the eye flinches or rolls, and a false stroke is made. The old use of the knife is always dangerous, even in a steady hand, and should be avoided, except in cases of thoroughly embedded particles, which make its use absolutely necessary.

REVIEWS.

CLOCKS, WATCHES, AND BELLS.

By Sir Edmund Beckett, Bart.

Seventh Edition. London: Crosby Lockwood & Co.

This rudimentary treatise has attained such a world wide reputation that general comment is scarcely called for. The seventh edition has about twenty pages of matter added to the last, published in 1874. The author in his preface says: "It should be understood that this professes to be a rudimentary treatise in the sense of teaching the principles of horology, and so much practical knowledge as may be useful both to clockmakers and to amateurs who wish to make, or direct the making of their own clocks of superior character; and I have had abundant information that it has been useful in that way, besides vastly improving the general character of public clocks, especially in all the English speaking world, and wherever large English clocks go. As I have had more leisure than for many years, I have endeavoured to make it as complete as possible, and have introduced more new matter and alterations than any edition since the fourth."

We can only add that every one interested in clock work should secure a copy of this treatise, which is the only modern work on horology purely English.

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

A WRINKLE FOR A HANDY SET OF DRAWERS.

Sir,—A set of small drawers is a workshop necessity. They are bothersome to make and costly to buy. Wooden drawers do well for some things; but powders, such as fine emery or prussiate of potash, leak through bottom joinings. Here is how I made a set, which can hold even liquids, and which look as well as the most costly. They are old sardine boxes, largest size; I got any quantity for the taking of them away from a good going "pub." If the top was cut raggedly open, I laid the box, top downward, for a second on my stove. As soon as the solder began to melt I lifted the box, and a slight knock brought away the top, leaving edges "solderly" smooth. After cleaning out the oily deposit I put on each box a facing of black-stained wood, a little larger than the end, and about one quarter-inch thick. This I fastened by means of two small screws, put through two punched holes from inside. In centre of this wooden facing I screwed, outside, a little brass picture ring (a knob, or even a screw-nail would do as well), for a catch. It was easy to make a neat rack to fit my boxes; they are all so exact in size. And now I have a set of drawers which cost me almost nothing, yet it looks well (varnished), and my drawers are all but air-tight.

"ROSELEA."

[Several letters are held over, waiting for illustrations.
—Ed.]

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SCREWING APPARATUS: TAPS, DIES, AND DIE STOCKS.

By Paul N. Hasluck.

PART II.

(For Illustrations, see Lithograph Supplement.)

SOME long time ago, before screw-cutting lathes and accurate measurements were so well known, Messrs. Holtzapffel tabulated a series of threads which were then used in their workshops. This series seems to be now very generally adopted, though it is much to be regretted that such small fractional parts of threads should exist, causing so much trouble in calculating a set of change wheels actuating a leading screw of integral pitch. That these rates were not originated in such a manner is obvious. They were probably chased up by hand, and the question of any definite number of threads per inch received no consideration, as it would not affect in any way the result, and aliquot diametrical measurement was likewise disregarded for the same reason. The particular threads having been extensively used, it became necessary to have screwing tackle to produce identical screws for reparation, and so forth. By this means the source of production became distributed amongst various workshops, and thus these Holtzapffel threads have become a standard.

The following is their rate; they are numbered consecutively, commencing at No. 1, which is the largest, there being in all twelve sizes:—No. 1, 6·58 threads per inch; No. 2, 8.25; No. 3, 9·45; No. 4, 13·09; No. 5, 16·50; No. 6, 19.89; No. 7, 22·12; No. 8, 25·71; No. 9, 28·88; No. 10, 36·10; No. 11, 39·83; No. 12, 55·11.

These threads are cut in with sharp angles, and are not rounded either at top or bottom. Hand-screw tools of the correct shape may be bought at most tool shops—the lathes supplied by the firm, with traversing mandrels, have screw guides of the proper rates.

There is such a multiplicity of shapes and rates for small threads, of, say, under ¼in. diameter, that it is impossible to tabulate a series of standard sizes; hundreds would be required if it was necessary to match the variety in common use, and a dozen or so ranging from ¼in. to ⅜in. will be found useful for small work. They might be divided in 32nds in., giving four, and it will be found convenient to have three distinct threads for each size—a coarse, a medium, and a fine. Such a set will enable an amateur to deal with work of every description within that particular range of sizes, and it is comparatively very seldom that screws smaller than ⅛ diameter are wanted; if they are a simple screw-plate answers the purpose. However, when such tiny screws are often used it is far better to have a tiny die-stock adequate to their manufacture, and taps from 1/16th to ⅛th, increasing by 64ths, will do all that can be required.

The lithograph illustrates a small single-handed die-stock suitable for threads of about ¼in. diameter. For making such a die-stock, it is best to get a forging made nearly to shape, the iron being all the better for a good hammering; but it is easy to use a piece of plain bar iron and cut the stock out of the solid metal, which is not such a long job as might be imagined. Procure a piece of good sound iron 1⅛in. x ⅜in., and about 6in. long; centre the two ends accurately, and drill in the centres with a small drill, run the iron in the lathe, and take a cut along it, from end to end, with a tool in the slide-rest, so as to take the black skin entirely off from both edges; also, at the same time, true up the two ends. Put the work in the vice and file up the two sides flat and truly equi-distant from the axial line. Having done so, mark out the shape of the die-stock on one side of the iron; replace the piece in the lathe and turn up that part forming the handle. So far it is only required to shape the tool roughly, and the handle need only be turned as a parallel cylinder fully ⅜in. in diameter. Reverse the ends between the centres and turn the corners off at that end where the clamping screw is tapped through. It is advisable to drill the hole for this screw full tapping size, and to chamfer out the end deeply, so that when the tap is put through the hole, the work will not be thrown out of truth between the lathe centres. In fact, this hole may be drilled, chamfered, and tapped as soon as ever the truth of the centres is assured; it may be bored to a depth reaching the bottom of the slot in which the dies are to be fitted.

Having turned the exterior roughly to shape, next mark out the slot for the dies. Scribe a line down the centre of one side, and centre punch three dots for drilling three ⅜in. holes through the iron, bore these holes, taking care to see that the drill runs through truly, and with a file break the three holes into one. This will make a rough rectangular hole 1⅛in. x ⅜; now square it out very carefully and accurately to 7/16ths wide, the central position of the slot being continually verified by measuring from the two outer edges. Too much care cannot be bestowed on this part of the work, as absolute truth in the plain hole will assist very materially in guiding the bevelled angles on which the dies slide. These bevels may now be filed up, and a carefully-scribed line drawn along from the outer edge and parallel with it will form the best guide for filing to. A small ridge must be left in the centre part of the slot to form a "witness," and when the four facets of the bevels are filed, the sides may be reduced in thickness from ⅜in. to 5/16ths, or even ¼in. Before commencing to reduce the thickness draw lines along both edges as guides for filing to; then file from both sides, using the file at right angles to the length of the die-stock, and cutting out a groove equal in width to the length of the slot. When reduced nearly to gauge, file lengthways of the stock, to take off the metal at the corners, carefully preserving the continuity of the ½in. cylindrical portion as turned at both ends of the die-stock, one forming the handle, and the other the boss for the screw to be tapped through. This part should be done carefully, as a blemish detracts very much from the look of the finished stock, though probably it would not impair its working qualities. Considerable caution must be exercised in using the file over these circular protuberances, or an ugly scratch will assuredly be made.

The handle may now be turned tapering, to give it a lighter and neater appearance. Set the slide-rest over, so that it will make the cylinder about ⅜in. diameter at that part where the side pieces swell out, and ½in. at the extreme end; turn it down to these dimensions, and then file up the continuance of the cone to exactly the same angle. This will require even more care than the previously-described cylindrical parts. The terminations of these cylindrical parts of the slot should be bevelled off, as shown in the sectional sketch to the right of the drawing. It now remains but to file away the bevel in the slot at that end next the screw, so as to allow the dies to be put in, and the die-stock is finished. File away a distance of ⅜in., that being the depth of the dies; round off the end of the handle with a graver, and "touch-up" the boss for the screw. Smooth up the entire stock with emery paper, using oil with it, and when all the file marks are taken out of the flats, and the turning-tool marks out of the handle part, etc., the stock is ready for hardening.

Being made of iron, the die-stock can only be case-hardened. The process which I employ, and consider to fulfil the requirements of such a job, is this. A compound is made of prussiate of potash, sal-ammoniac, and common salt, of each equal parts by weight (there is no great accuracy of proportions necessary); pulverise each separately and mix thoroughly. This mixture should be put by in a stoppered jar, and may be labelled "Case-hardening Compound." Make the die-stock red hot, as hot as possible without scaling; draw it out of the fire, lay it on a sheet of metal, and cover with the compound, rubbing on as much as possible. When the iron gets cool, and there is a good coating of compound adhering, replace it in a clear fire and reheat it gradually. When it is of a good cherry red it may be quenched in clean water, and will become flint hard on the exterior surfaces only, where the compound has acted; it is, however, better to give the article a second coating of hardening powder, reheating, as before, before quenching. Even a third coating will not be thrown away when a particularly good job is required. The more compound which can be got into the thing the deeper will the hardening penetrate, but care must be exercised in heating, so as not to burn the metal and scale it. After the stock is thoroughly hardened it may be made bright again by the aid of emery-paper.

There is very little chance of the iron being distorted in the hardening process, but I should have mentioned at a previous part that it is advisable to put the thing through the fire when the bulk of the material has been removed in roughing out. The work must be heated to a full blood heat and allowed to cool gradually. See also notes on hardening taps in the previous article.

The screw belonging to this die-stock is, as will be seen by the drawing, rather peculiarly shaped; it is made of steel—good cast steel—½in. diameter, and the head has, in addition to the one or two "tommy holes," a series of small grooves cut longitudinally on its diameter. These are to afford a grip for the fingers, so that the screw may be rolled in and out half-a-dozen turns between the finger and thumb when changing a pair of dies; about a dozen grooves, say 1/16in. wide, will be about the best. With a plain round screw head it is difficult to turn it, unless the fitting is abominably loose, but with the serrated head considerable force can be applied with the fingers only. Sometimes a flat thumb-screw is used, but the wings often come in the way when the die-stock is in use. This clamping screw should be hardened and tempered, and made to the exact length—whether too long or too short it looks equally bad. The illustration shows half-a-dozen pairs of dies of different form, which are not dealt with in the text. I will now proceed to particularise their characteristics, and, commencing at the left-hand side, will call that pair No. 1. The left-hand die of each pair being in every case the "top die," the die to the right being the "bottom," that is to say, the die which is first placed in the stock; the "top" one receiving the pressure of the point of the clamping screw. Very often no attention is paid to the identity of "top" or "bottom," the dies being put in indiscriminately, but the strongest die should always be put in to take the pressure of the screw, and the weaker one is made correspondingly strong by being supported all along its end by the flat bottom of the die-stock slot.

When making a pair of small dies it is best to make one only to do the cutting, the other die being simply a guide; it is impossible to utilise both successfully, and, if it is attempted, a pair of bad cutting dies will be the result. The theoretical principles involved in die making cannot be carried out properly in these two-part dies, and, as we are dealing only with very small ones, there is little need to go into the subject. The dies manufactured by the Whitworth Company on their patented principles are the best extant for work, but are likewise very nearly, if not quite, the most costly in the market, so far as price is concerned, though, on comparing with others, and noting the difference in the work, it is easy to see the immense superiority. In this pattern there are three dies, one being simply a guide, the other two cutting like chasing tools, one each way, and are advanced towards the centre in radial slots. These dies may be ground up on a grindstone in the same way as a chaser.

There is a "Patent Direct Action" die-stock now in the market, made very similarly to the genuine Whitworth, and it answers its purpose admirably; but these are for screw cutting on a larger scale than that we have at present under consideration.

Referring to the dies, they are all drawn to size for cutting a ¼in. Whitworth thread. Fig. 1 (on the bottom row) shows a design very frequently seen. The dies are made on tap ¼in. diameter, and the bottom die contains half the circumference of the thread, the top one being filed off considerably so much that the tops of the teeth of the thread in the die lie very nearly on a plane with the side flats. This top die only guides. The bottom die has a small groove cut across it to facilitate the escape of chips, but all the cutting is done by the two upper face corners of this die. There should be plenty of space left for the escape of chips between the two dies when they are closed to the proper size for finishing the screw. Dies of this form are very bad "guides" for the rate of thread, and do not cut quickly, but are very handy for finishing.

Fig. 2 is a pair of dies very similar, but that the top one is made like the bottom die in the former pair, and the bottom die has a large slot with undercut sides. These dies have nothing to recommend them particularly, though they are often to be seen.

They are very good for cutting threads of smaller diameter than that of the tap on which they were cut. Fig. 6 illustrates the same form cut on a master tap, the diameter of which is double the depth of thread larger than the size the dies are intended to cut. In these (fig. 2) all the cutting is performed by the four corners of the dies, each one doing an equal share, but, there being no space for the escape of chips, these dies soon get clogged up, and have to be cleaned out. It is, of course, obvious that none of the cutting can be done by the edges of the bottom slot till the work, being screwed, becomes smaller in diameter than was the tap with which the dies were cut, and consequently none of the "shavings" find an outlet by this channel till then.

Fig 3 shows a pair of dies shaped properly for cutting, having a slight angle of relief at all the corners; these dies act first-rate, and there is plenty of room for the chips to escape through the slots on each side of the centre. There are no slots across the bottom of these dies, as is the case with all the others figured (excepting the top die of fig. 1), consequently they will not cut any smaller than the full diameter of the tap on which they were made, and cannot be forced to do so. It is advisable to screw the pair of dies quite close together when tapping them, and thus make it easy to tell when the proper size is being cut by the dies in after use; it saves the trouble of gauging, etc. The best plan for making the clearance holes is to mark and drill the two holes, about ⅛ diameter, as near to the outer corners as the V groove will allow. The dies must be held quite firm and close together whilst doing this, and the holes must be made just through the dividing line; the dies are then taken out of the stock, and the angle of relief filed up with a smooth, flat file.

Fig. 4 shows the best form of dies that can be made without extra taps and other paraphernalia which is usually dispensed with by amateurs. It will be seen that fig. 4 embraces all the good points of the preceding three figures; the top die being the same as fig. 2, whilst the bottom die combines in itself figs. 2 and 3, the construction of which having been already detailed, it will be unnecessary to give further particulars. These dies will cut threads of smaller diameter than the original tap, the top die being of course reduced in depth as described for the top die of fig. 1. The cutting angle cannot be got out so easily by drilling, but may be easily managed by the aid of a small, round file to cut a semicircular groove, and the plane may then be filed up as before. A round file must always be used in making the corners of the slots of the bottom dies, as shown in figs. 2, 4, 5, and 6, as the corners must be rounded out, not filed in to a sharp angle, as this would tend to cause a fracture across the steel when hardening.

By the way, it is as well to note that these sharply-cut corners are the principal causes for steel splitting, for if a piece of steel is cut in to a very *sharp* angle, not necessarily a very acute one, it may be broken with much greater ease than could be a piece more deeply cut, but having the angle blunt in its extreme corner. I am now speaking of a bar of steel, such as would be "nicked" round with a file for breaking, and wish to point out that the *sharpness* of the nicking, rather than its depth, will prove effectual. Whenever a piece of steel is nicked in *sharp*, and then hardened, it is almost sure to crack at that part; therefore always be careful to use a file with a rounded edge when working out the corners of pieces which have to be hardened. Triangular files can be bought, having round corners, and are very useful for filing out the V grooves in the sides of the dies, when these latter cannot be milled up in lengths, and cut off all ready for the die-stock.

Fig. 5 differs entirely from the previous dies, inasmuch as it represents the two dies as cut with taps of different diameters, the top die being the same as that of fig. 4, whilst the bottom die is cut on a master-tap double the depth of the thread larger than the nominal diameter. This plan secures a better lead for the dies, as the bottom die in this pair embraces the blank bolt to about half its circumference, and touches all that amount at starting, which is, of course, the time when good guiding is most wanted. The difficulty in making this sort of die is, that it necessitates making an extra blank top die for use in cutting out the bottom die, figured, with the large master-tap, and it is not very often that one feels disposed to spend the extra time and trouble entailed.

Fig. 6 shows a precisely similar pair of dies, both being cut on a large master-tap. These dies lead excellently, but they are most "greedy" with the cutting just at the wrong time—*i.e.*, when the work is very nearly completed. They are the best dies for roughing down a thread, but another pair cut on a small tap would be better for finishing with. All Whitworth's dies are cut on large master-taps, and so are the majority of dies manufactured for sale; but with an amateur who only requires one pair of dies for each size, the cost of master-taps forms a large item in the cost of a set of screwing tackle. Taking all things into consideration, the dies here designated as No. 4 are the best for the purpose required, and that is the form of dies I should recommend for all sizes, though the "Whitworth," or "Patent Direct Action," are far superior when the size of the work entails an appreciable amount of muscular power to actuate the die stock.

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Sawing Cast Iron.—A correspondent to "The American Machinist" writes: "I think it will be new to many readers of your paper that cast iron can be cut with an ordinary hand saw. I saw a blacksmith about three years ago cut a cast iron segment for a rack, 1" thick by 6" wide, as quickly as a maple plank, 2" thick and about 8" wide, could be cut. He put the segment in the fire, and heated it as hot as possible without burning it; then, taking it out, he sawed as quickly as he could, with slight pressure on the saw. It made my eyes stick out to see how soon he got it in two."

Good Joints.—Our young friends who exercise their ingenuity in the construction of useful articles, and especially in making repairs about the homestead, should give particular attention to the formation of the joints by which the different parts are united. One of the highest authorities, the late Professor Rankine, sums up the principles which should be adhered to in designing joints and fastenings in carpentery, concisely as follows: First, to cut the joints and arrange the fastenings so as to weaken the pieces of timber they connect as little as possible. Second, to place each abutting surface in joint as nearly as possible perpendicular to the pressure which it has to transmit. Third, to proportion the area of each surface to the pressure which it has to bear, so that the timber may be safe against injury under the heaviest load that occurs in practice; and to form and fit every pair of such surfaces accurately, in order to distribute the stress uniformly. Fourth, to proportion the fastenings so that they may be of equal strength with the pieces which they connect. Fifth, to place the fastenings in each piece of timber so that there shall be sufficient resistance to the giving way of the joint by the fastenings shearing or crushing their way through the timber.

HOW TO MAKE A CLOTHES-HORSE.

(For Illustrations, see Lithograph Supplement.)

ABOUT the simplest, and certainly a very useful article of household furniture, is the clothes-horse, or clothes-screen. We are now about to begin the practical construction of cabinet furniture at the workbench; and, as we purpose to lead those who may choose to follow us step by step, it is proper that we should begin at the first or lowest step in the ladder of progress in this important, not to say pleasing, art. In other words, we must begin with the simplest and most easily constructed articles of household use, and progress onwards to the more elaborate. There are many forms of this laundry requisite, the Americans, as usual, having some very clever contrivances in this article. I, however, will at present describe the article as it may be seen in almost every household. The completed article is here shown in fig. 1, extended as it would be to receive clothes for drying, or, more properly, for hanging the clothes after ironing.

To set about making this article, the first thing is to procure the wood, and, as most of my readers are following the art as a pastime, they are not supposed to have a stock of seasoned wood laid in, but simply purchase what is suitable for the work in hand. And now a word as to the selection of the timber for our present job. It is to be the best yellow pine, clean and straight in the grain, and must be well seasoned. A little experience will show when a piece of board is seasoned; it is generally a little darkened or discoloured by exposure to the weather, dry to the feel, and light in weight, as distinguished from a board newly-cut from the log, which is white and clean, clammy or damp to the touch, and very heavy as compared with the same wood when thoroughly dry. Another thing to notice is twisted growth in a board. When a tree has a twisted growth, the fibres in their upward direction have a twisted or spiral form, not unlike a rope, and consequently boards cut from such a tree are what are called of twisted growth, or cross in the grain, the grain running through the thickness of the board to the length of 4in., 5in., or 6in., as the case may be. Indeed, in some pine trees this twist is so great as to make an entire circuit of the trunk from the ground to the lower branches. You will easily detect a cross grained board by examining its edge; you will then see whether the grain runs parallel with the face of the board or slanting through the thickness. The face of the board also is indicative of cross grain, as from the heart outwards the two halves of the board have quite a different shade or colour, even when newly from the saw mill; and, when planing such a board, the one half has to be planed from the edge to the centre with the grain, and the board reversed on the bench in order to plain the other half with the grain.

Such wood would be quite unsuitable for our present job, unless the twist was very slight. Indeed, such wood should never be used for any cabinet work, unless in inferior parts, where it cannot twist or warp, which it is very apt to do after it is finished.

Clothes-horses are made of various sizes, from 3ft. to 7ft. in height, and of two, three, and four leaves or divisions, the one shown, fig. 1, being of three divisions; and these divisions have generally a width of half the height. We will assume a medium size, and set to making one of three leaves, 5ft. high and 2ft. 6in. wide. The wood necessary for the job will be: A piece of 5ft. 2in. long, 1ft. 2in. broad, and 1in. thick; and another 2ft. 6½in. long, and 1ft. 6in. broad, and ⅞in. thick; the first for the uprights and the other for the crossrails. Now, assuming they are both of sound wood, without any waste, place each piece edge up in the bench lug, and plane the edges straight with jack and half-long. Then divide the piece for uprights with pencil into six equal parts at each end, and line with straight-edge and pencil. You will have six pieces that will finish easily at 2in. broad. The piece for rails is to be divided in the same manner into nine pieces; these will be when finished 1¾in.

Both are now to be cut with the rip or panel-saw. A beginner must do his utmost to "keep the draught"—that is, keep on the pencil line, and also to saw square through the thickness of the board. A beginner is apt to give the saw a curved instead of a straight up and down motion, the handle of the saw inclining towards him; consequently the draught gets off the square. It is usual for them to take the bench square and apply the stock to the board, and the blade against the saw, which tells at once if off the truth. The wood being sawn, it is now to be planed. Plane one side and one edge of each piece with the jack, and observe that the rule is, in planing wood, to keep it as thick as possible where finished; that is, it should be done with as little shaving away as possible; so in using the jack do not tear off thick shavings, but only what will take off the saw marks. Place each piece, as you plane it, on top of or alongside its neighbour, for there is nothing like neatness or system in working. Now, having gone over a side and an edge with the jack, go over each again with the half long. The side of each piece must be planed straight and even, and without twist. To see that it is level or even across, apply the edge of the bench square here and there. It will do no harm if it is slightly hollow under the square; but if the square "rocks" then it is round, and must be remedied. Turn the pieces on edge on the bench to do the edges, as, being so narrow, they would bend under the plane if fixed in the bench lug. Plane the edges to stand the square, taking off long shavings. Apply the square with the stock to the face, previously dressed, the blade resting on the edge. Cast your eye along the edge to see that you are planing straight, and finish with a shaving all the length of the piece. 'A straight edge will show if the pieces are planed straight on the edge, or two of the pieces placed edge to edge will, if they coincide, be straight.

Now, all the pieces having got one edge "dressed," set the marking gauge to 2in., and gauge all the long pieces, the stock running along the dressed edge and the mark on the dressed side. Set the gauge again to 1¾in., and gauge all the cross rails in the same manner. Now reduce with jack plane, coming down to near the gauge line, and with the half long come quite down to the line, but no further, and before taking off your last shaving apply the square as before, then lean the plane heaviest on the side that was highest under the square. All the pieces breadthened, set the gauge for the thickness of the long pieces. They should stand ⅞in., and gauge all of them on *both* edges. Set the gauge again ⅛in. less, and gauge all the cross rails in the same way, and those planed with jack and half-long down to the gauge lines; the wood is ready for "drawing in." Place the long pieces on the bench in three pairs, with faces first planed outwards. Mark their faces with pencil, and that at the end that is to be uppermost, and this mark of a nature that will show which edge is the outer or exposed one. Place the three pairs together, even at the ends, and draw in for mortising as in fig. 2. The crossrails being 1¾in. broad, the mortises must be $\frac{1}{16}$in. less in breadth for pine. Draw the lines across as at *a*, *b*, and *c*, fig. 2, using the bench square and a chisel; or better, a cutting knife. Fig. 3 is a steel drawpoint, with the opposite end thinned and sharpened as shown. The mortises at *a* are 2in. from the end, *b* 20in. from it, and *c* 20in. from *b*, measuring in each case from the top of the mortise.

The six pieces should be held together with two handscrews, and having drawn the edges as above, draw lightly with pencil these lines down the side of the outmost piece. Now turn the job over, and draw the other edges from these pencil lines, but making the mortises about ⅛in. longer on this side for wedging, as this is to be the outside when the article is finished. Now, both edges being lined across, lay them out in three pairs as before, and set the mortise gauge to fit ⅜in. mortise iron, and gauge each pair, putting the mortise exactly in the middle of the edge, and taking care that the gauge is always worked from the out or marked side. Having gauged both edges of each pair, lay them aside and draw in the rails; have one side marked of each, and place them all together, edges up, on the bench. Mark off 26 inches, leaving fully two inches at each end, and square across with cutting knife, then square from these lines on both sides of each piece, also with cutting knife; this done, set the gauge to make a tenon exactly in the centre of the thickness.

Now the long pieces are to be mortised by placing them all together on the bench, and fixing with two handscrews. It is usual to sit upon them when mortising. Mortise them fully half through, then turn over and mortise, that side meeting the other. In mortising the iron must be kept quite upright, and always within the two marks, which should be exactly the width of the chisel's edge. The mortising is begun in the centre of the space to be mortised and with the cannel—*i.e.*, ground side of the chisel—towards the cross lines, till the mortise is of the depth wanted, when the iron is reversed and the straight-face worked towards the cross lines. When reaching these the chisel must stand straight up with its face at right angles with the edge of the work, so that the mortise will be of equal breadth throughout its whole depth.

Smooth the mortises on the sides with a sharp chisel. The rails are now to be shouldered with dovetail saw, taking care not to go deeper than the gauge lines, and then taking the whole nine pieces in a hand screw, fix them in the bench lug, having about six inches projecting above the bench. They are now to be tenoned, and this must be very carefully done, taking care to leave exactly the portion within the two gauge lines. As they are gauged on both edges, as well as on the end wood, this difficulty is soon overcome. Begin by sawing on the end wood close to the line on the portion to be taken off, and let the point of the saw gradually become more elevated till you reach the shoulder line on the side next to you; and this done with all the pieces, turn the opposite edges towards you and work down to the shoulder; then bring the saw to a level till you reach the shoulder all through, when the "cheeks"—that is, the pieces taken off—will be free.

Both ends being tenoned in this way, and cleaned out at the shoulders with a sharp chisel, try if they fit the mortises the thickness way, which they will be sure to do if cut to the lines. Pare a little piece slantingly off the corner of each tenon to allow them to enter the mortises without bruising. Now you have to round one edge of each of the rails, as shown in the section fig. 4. This should be done with a No. 8 hollow casement plane, but in its absence it may be done with the jack and hand plane, finishing with sandpaper. The sides of these rails are also to be finished with hand plane before fitting together, and also the inner edges of the six uprights, but not until they are rounded on the top, as shown in fig. 1. Catch them all in two hand-screws, and draw the outsides with compasses set to radius of 1in., then work the whole together with chisel and hand plane, finishing with sandpaper.

This will form the head into a semi-circle, and they will be at least 1½in. above the edge of the upper rail. You have now to make thirty-six wedges. Plane a piece of wood to ⅜in. thick, and place it in the bench lug; saw it as shown in fig. 5, when you have the wedges without more ado.

Now, everything being ready for gluing, you need a cramp to take in about 32in., and pieces of wood should be used to prevent the paws of the cramp bruising the edges. The glue should be hot and rather thin, as pine does not need such thick glue as hard woods. A piece of wood about 1in. broad and ⅛in. thick is used to put glue in the mortises, and a small brush for the tenons.

We are now about to cramp and wedge up the three divisions of the clothes' screens. The cramp is set to 2ft. 8in., and two short pieces of pine an inch broad are in readiness to protect the work under the cramp. If the work bench is under 30in. broad, lay two pieces of wood across it, 3ft. long, and of equal thickness. These are to lay the frames on while cramping. Take a pair of the uprights and lay them edge up on the bench; then, with the thin lath of wood, put a moderate quantity of glue in each of the six mortises, and taking three of the cross rails, put some glue on both sides, also edges of each tenon—a very little will do—and place them in the mortises, pushing them home with the hands, and seeing that all the rounded edges of rails are towards the rounded end of the upright. The three rails being pushed home, turn them upside down, and enter the tenons in the mortises of other upright; then rap home with a mallet, using a bit of wood to protect the edge. Now lay the frame flat down and cramp up, placing the cramp always about half an inch from a cross rail. Cramp all three rails in this way before wedging any. They will not require severe cramping if well made. Now the wedges are to be inserted, and these must be no broader than the thickness of the tenon—⅜in. But before going further, a little operation which has been overlooked must be noticed, namely, to "slit" each tenon with a dovetail saw, as shown in fig. 6. Before beginning to glue up, these cuts are made about ¼in. from the edge of the tenon. The object of this will, I think, be obvious. The mortises being a little wider on the outer edge, when the wedges are driven into these slits the outer portions of the tenons are spread out, forming a kind of dovetail which cannot be pulled out afterwards. This will be readily understood by a reference to fig. 7.

With our job in hand, keeping on the cramp with a gentle pressure, square the frame before wedging; this is best done with a rod having the end thinned like a wedge. Place it diagonally from corner to corner in the division next the cramp; if not square, shift the cramp a little at one end to pull it square; try again with the rod, marking the edge with a pencil. When satisfied as to its being square, put a little glue on four wedges, two for each end, and drive them in, not too severely. Shift the cramp to the next rail, and treat in the same way, and then to the third. You may now try with the rod if this division is square, and if so remove the cramp. Now it has to be looked out for "thraw"—this is the Scotch word for twist or warp, which words are, to my mind, not nearly so expressive of the thing meant in this connection. Lift the frame by the centre of the upright next you, letting the opposite one rest on the bench till the face or surface of both are level with the eye; if the two sides coincide—that is, even with each other; or, geometrically speaking, "lie in the same plane"—then they are out of "thraw"; if, on the other hand, the one side is not level with the other, but is lower at one end, then the frame is twisted, and this is an evil that cannot now be remedied. The three frames thus wedged and truly squared, will lie evenly one over the other, whichever way they may be placed. Now saw off the projecting wood of tenons and wedge heads, and, placing the three frames evenly over each other, particularly at the rounded heads of uprights, fix on a couple of hand-screws. Now stand them on edge in front of the bench, and dress the edges with half long and smoothing plane. This being done on both edges, remove the hand-screws, and plane both sides of the uprights of each frame with smoothing plane. The cross rails are all $\frac{1}{16}$in. lower than the surface of the uprights, for which reason they were all planed before putting together. A piece of No. 0 sandpaper may now be used with a flat cork pad; and with this all the sharp edges may receive a slight "arras"—that is, the sharp edge may be taken off with the sandpaper. The feet or bottoms of the uprights are to be cut even while in the hand-screws, and each of them chamfered all round with a chisel. Our clothes-horse is now ready for hingeing. Many of them are hinged with metal hinges, but by this method they will not fold together both ways, and when in use will only stand in the form of an N, whereas when hinged with girth web they will fold both ways, and will stand in the form of N, or as three sides of a square, or as a triangle, if required. This universal hingeing is a matter of some difficulty, and it is a question if I shall be able to make myself understood at this particular point. The girth used is that in common use by upholsterers, and the method of hingeing is as follows: Take two of your leaves or frames, and catch two hand-screws on the edge opposite from that to be hinged. Now take a piece of girth about 18in. long. Fold in the end about $\frac{1}{2}$in., and begin nailing with tinned $\frac{5}{8}$in. tacks at the point, *a*, fig. 8; about 6in. from the top, drive in one tack. Now pass the girth through between the two leaves, and bring it round the back of *b*; pass it again between the leaves and bring it round the front of it, pull it tight and nail it at *c*, doubling in the end as at the beginning. It will be observed that the girth takes a diagonal course, each breadth keeping clear of its neighbour; five or six tacks are to be driven into each girth on the sides only, *none* in the *edges*. Hinge the bottom end in the same way, and this done take off the hand-screws and turn the two frames outside in; nail the girth now turned out on the side only, as before; now you have got one pair hinged, and they will fold both ways. Shut these together, and place the third leaf against them evenly, and catch them all three with two hand-screws. Having the previously hinged edge in the screws, the three opposite edges will all be free. Begin hingeing here as before, taking the centre leaf, and the outer unhinged one; hinge top and bottom as before, turn them outside in; after removing the hand-screws complete the nailing of the girth on this side, and the job is complete. The three leaves will now turn in all directions, provided there are no tacks in the edges.

I have been somewhat explicit in the details of this job, especially in preparing the wood; but we are beginners in the art, and advanced students must restrain their impatience for the sake of those just setting out on the road.

HOW TO REPAIR WATCHES.

PART II.

THE wheels and pinions must be well brushed, and the leaves of the pinions thoroughly cleaned with a pointed piece of pegwood. A small piece of elder pith will be best adapted for cleaning the pivots. When the dirt and oil are removed from every piece, and the pivot holes in the plates "pegged out" until the pegwood comes out quite clean, the movement is ready for further examination. Then see that the pillars are all tight in the frame, likewise the studs that secure the "brass-edge" to the frame when the dial is not pinned on direct. If either of the pillars are loose, pin on the top plate with four examining pins; then rest the end of the pillar to be tightened upon a filing block, and carefully rivet the pillar till it is quite firm. In a similar manner the brass-edge pillars or studs may be tightened, removing the dial and pinning on the brass-edge to the pillar-plate. If either of the pin holes are broken out, or the end of pillar broken off, it may be repaired in two ways. File off the broken end of the pillar till a little lower than the surface of the top-plate, make a centre mark and drill a deep hole with the largest drill it will safely bear, and then solder in a piece of brass wire to form a new pillar end, in which the pin hole may be drilled. The other way is to use a smaller drill, and fit a screw in. Proceed to try if all the wheels are tight on their pinions. Hold the pinion firmly between the smooth jaws of an old pair of pliers (or preferably a brass or copper lined pair), and see that the wheel has no movement either backwards and forwards, nor up and down. If a wheel is found to be loose, it must be secured at once. Place the arbor in one of the holes of a pinion-stake, so that the pinion-head rests firmly upon it, and, with a half-round punch and hammer, carefully rivet the pinion until the wheel is tight and runs true in flat.

Wheels mounted upon brass collets, like the contrate-wheel in the verge movement, and the escape-wheel in the lever, require to be treated rather differently. The collet must rest firmly upon the jaws of a "pair of clams," the clams being held in the vice, and then the brass rivet slightly burred over. In the case of a lever escape-wheel, great care must be exercised, or the wheel will be found out of flat, and it will not admit of being made true by the ordinary method of "bumping." We have found the best method of making it secure is to carefully fix the pinion arbor in the clams, and then use the sharp point of a needle as a punch, making two or three burrs on the rivet of the collet. By this means the wheel is rarely thrown out of flat. Ordinary flat wheels are rivetted as nearly true in flat as possible, and then, if necessary, "bumped"—that is, the wheel is set up between the ends of a pair of callipers, and by means of a little strip of brass—called a "toucher"—the crossings found, which require bending to make the wheel run flat. It is then laid across the end of a bumping-up stake, and the necessary crossings gently tapped with the hammer until the wheel runs true. The wheels must further be examined to see if any of the crossings are broken, or any of the teeth broken off or bent. If either of the crossings are broken, there is no good remedy but a new wheel; although sometimes, when the watch is an inferior article or old, the crossing may be neatly soldered, but in a good watch such a thing should not be countenanced. If a tooth is bent, it may frequently be raised to its proper position by the blade of a penknife, and sometimes by means of the tweezers.

If a tooth is broken off, a new tooth can be put in; it is never advisable to put in more than one tooth at the same part of the wheel. A wheel having three or four teeth broken off consecutively should be discarded as quite unfit for service, and replaced by a new one. If any of the pivots show signs of wear, are rusty, or in any way rough or uneven, they must be carefully burnished till quite smooth and straight, and the ends properly rounded up. When all these points are attended to, put the centre wheel in its place in the frame, and pin on the top plate with the examining pins, and see if the centre wheel runs flat with the pillar plate, or, in other words, that the pinion is upright. If it is not upright, rest the edge of the pillar plate on the workboard, and hold a small filing block upon the edge of the top plate in such a position that a few smart taps with the hammer will put the frame in its proper position. This being done, the depths, endshakes, and pivot holes claim attention. The method of examining depths having been already fully explained in previous articles, it only remains to indicate the order of procedure. First, try the great wheel depth with the centre pinion, observing particularly at the same time that the fusee stands quite upright in the frame, for if it leans at all towards the barrel, most likely the chain will not run on properly, but slip up the fusee. See that the pivot holes are right size, and endshakes correct; if not, alter as may be necessary. Try in the same manner the centre wheel depth with the third pinion, the third wheel depth with the fourth pinion, and the fourth wheel depth with the escape pinion, taking care to remember the pivot holes and endshakes. Observe, also, that the centre wheel is free of its bed and the third wheel of the pillar plate.

As we intend to treat each escapement separately, we leave that to the next and following articles, and just notice one or two points which are generally seen to after the movement is cleaned. In verge watches it is very essential that the mainspring should be adjusted to the fusee, for the vertical escapement is so sensitive to variations of the motive force, that the time indicated would vary with the force that reached the escapement. In other escapements in general use there is a kind of compensation in the action of the escapement which renders adjustment unnecessary in ordinary watches.

To adjust the mainspring, the barrel, fusee, and centre wheel are placed within the frame, and the top plate pinned on. The chain is then attached to the fusee by the small hook, and to the barrel by the large hook, and wound up tight round the latter by turning the barrel arbor with a bench key. The ratchet is placed on the barrel arbor, and the spring "set up" about half a turn—that is, the arbor is turned round about half a turn more than is required to pull the chain tight. The "adjusting rod" (which is merely a weighted lever with sliding weight) is then secured to the winding square, and about one turn given to the fusee. The weight is then moved along the rod, until it exactly counterbalances the force of the spring. The fusee is then turned till filled with the chain, and tested to see if the mainspring exerts the same power at the last turn as it did at the first. If the last turn will pull over the weight quicker than the first, the spring is not set up enough. If, however, it shows less power at the last turn than at the first, then it is set up too much. When the correct adjustment is found a slight mark is made upon the end of the top pivot of the barrel arbor, and a corresponding one on the name plate or top plate, as the case may be. Another item requiring attention is to see that the cannon pinion does not confine the shake of the centre wheel, and also that the cannon pinion teeth are free of the third-wheel teeth.

The examination of the watch being concluded, with the exception of the escapement—which for the present we assume to be correct—it only remains to clean the different parts and put them together again. The greatest care must now be taken to *thoroughly* clean each piece, and keep it clean until the movement is replaced in the case.

Several methods are followed by watchmakers to give the work a good appearance. Some dip the various parts into pure benzine, others into spirits of wine or some other liquid, which renders the removal of grease and dirt easy; but if our plan is followed, equally good results will be obtained. Use a good soft watch brush, occasionally rubbing it gently upon a piece of prepared chalk or burnt bone, holding the wheels, plates, and other parts in a piece of clean tissue paper, to prevent the perspiration from the skin soiling them. As each piece is cleaned it must be placed under a "covering glass" (a wineglass broken at the stem being generally used for the purpose), to keep it free from dust until the movement is put together again. The chain does not require brushing, but simply wiping with a clean piece of chamois leather or tissue paper. The "balance-spring" (usually known as the hair spring) is best cleaned by laying it flat on the board paper and gently patting it with the brush; when very dirty or oily, the quickest way is to place it in some spirits of wine for a few minutes and then pat with the brush.

All being ready for putting together, the first item to attend to is the oiling of the pivots which cannot be reached with the oiler after the movement is together. In the verge movement these are the foot hole of the pottance, the dovetail hole, follower hole, and the pivots of the barrel arbor, on which the barrel turns, and the jewel holes in the frame which have end-stones or cover-pieces in the lever.

Supposing we are still dealing with a verge movement, the plan of putting together is as follows:—Take the pottance, and, having oiled the foot and dovetail holes, screw it in its place upon the top plate, put in the escape wheel (called the "balance wheel" in the verge escapement *only*), and push in the follower and oil its hole. Care must be taken to apply only a very minute quantity of oil—too much oil is as bad a fault as none at all. See that the endshake of the balance-wheel pinion is only just sufficient to ensure freedom, and that the wheel turns freely. Next take the pillar plate and arrange the wheels in their proper places in the following order: third wheel, centre wheel, fusee, barrel, and lastly the contrate, or fourth wheel. Put the top plate in its position, and carefully guide the pivots into their respective holes, keeping the plate just tight down upon the pivots, but using no undue force. When all are in their right places secure the top plate with the examining pins, and see that the train of wheels run freely.

We may here observe that, in putting together, every piece must be either held in tissue paper or the tweezers, and that no "finger marks" must appear on the plates or elsewhere. If the wheels all turn freely the examining pins may be withdrawn one at the time and replaced with nicely-fitting burnished pins of suitable length.

Put the name plate on, likewise the slide containing the index, or regulator, and secure them with the screws. Now try all the endshakes, and see that each piece has the necessary amount of freedom without excess. Attach the chain by the small round-ended hook to the fusee, and by the large pointed hook to the barrel, and wind it regularly round the latter till the chain is pulled tight. Then set up the spring in accordance with the adjustment previously made. The pivot holes of the frame may now be sparingly oiled, also the hole in the cock which receives the top pivot of the verge. Proceed to put the verge in, exercising great care, for owing to its very fragile construction it is easily broken. Always see that the bottom pivot of the verge is fairly in the foot hole before attempting to put the cock on in its place.

In all watch escapements the arbor that carries the balance, whether it is called a verge, a cylinder, or a staff, has to be placed in a certain arbitrary position relatively to the next piece which moves it, in order to ensure the correct action of the escapement. When it occupies this position it is said to be "in beat;" when otherwise, "out of beat." This position is necessarily determined by the connection of the balance spring with the plate, and one of the functions of the balance spring is to continually restore the balance, and with it the arbor, to its neutral position. The operation of finding the exact place for the balance spring to be secured in the stud by means of a pin is called "setting the watch in beat," and the methods will be fully explained for the various escapements as we treat of them; for the present we give the practical method of setting the verge watch in beat, so that we may finish the task we have in hand.

Put the end of the hair spring through the stud so as to bring the verge approximately to its correct position, and pin it moderately tight, taking the precaution to have the spring within the curb pins and quite flat. Put on the cock and turn in the screw. Hold the movement in the left hand, and with the thumb of the right hand slowly and carefully press forward the contrate wheel, allowing each escape of a tooth to be quite distinct, and observe how much the balance is drawn to the right in order to allow the escape to take place, and how much to the left. If it is found that the distances are equal the watch is in beat; if unequal, the cock must be removed, the pin withdrawn a little, and the balance spring moved in the direction necessary to make the "draw" equal.

When this is correct the pin must be pressed in tight, the balance spring set quite flat, working equally between the curb pins, and finally the cock screwed firmly on. The chain can now be wound upon the fusee, guiding it carefully into the grooves by means of a pointed peg—the stopwork having been tested at the time of adjusting the mainspring.

All that now remains is to put on the cannon pinion, minute wheel, and hour wheel. Then pin on the dial, and the movement will be finished and ready for the case.

(*To be continued.*)

MALLEABLE CAST IRON.

OCCASIONALLY information is sought personally in regard to mechanical processes, and the character of the facts desired may sometimes make them of wider use than if restricted to personal reply. As an instance, two good mechanics differed widely as to the nature of malleable iron, one asserting that it was merely iron softened by annealing and that exposure to a red heat for an hour or two was all that was required. He was in error, and possibly his error arose from lack of mutual agreement as to the meaning of the term "malleable iron." Under this head is generally classed, in commerce, and particularly in English nomenclature, what Americans call wrought iron. The annealing of wrought iron is not often necessary, and when it is done it is one of the simplest mechanical processes—a heating for a limited period and a gradual cooling. But hard cast iron requires a long-continued heat to soften it. In some establishments where very minute iron castings are made, it is absolutely necessary to anneal them, even when they are not to be subjected to any tool processes. The mere attrition and collision of the tumbling barrel would reduce them to fragments. As they come from the sand mould they are as brittle as unannealed glass. To anneal these castings, they are packed in cast iron boxes with coarse sand—ordinary quartz sand—and subjected to a good red heat for forty-eight hours and then allowed to cool gradually. The heat is not sufficient to fuse the sand, nor even to efface the sprew sprint, or round the sharp corners of the castings. The sand is merely a vehicle for the heat and a means of retaining it, and this annealing is similar to that of wrought iron, or of steel. But the process of converting cast iron articles into malleable iron articles is different, its chemical operation is different, and its result is different. There was a time when possibilities were claimed for malleable iron castings which have gradually been abandoned until malleable cast iron has been relegated to its proper position, which while it trenches upon the province of wrought iron and somewhat extends the limit of cast iron in its uses, does not supplant the one, nor improve the other. It has been claimed that malleable cast iron could be forged, welded, and even be united to cast steel by a borax weld. Part of that is true, but none of it is economical or judicious. If the extravagant claims made for malleable cast iron thirty years ago had been half sustained, the manufactures of ordinary castings, and the products of the forge would have yielded much of their importance to the new process, and the new industry of drop forging would have been kept within very confined limits.

In a visit to a malleable iron foundry, some time ago, continues the writer in the "Boston Journal of Commerce," I was surprised by the fact that kitchen spoons to be tinned were cast perfectly flat, subjected to the malleable process, then struck up in dies, under a drop, just as though they were of wrought iron. They could not be made any cheaper than those from plate iron, but they finished nicer, and when ready for tinning, or nickelling, presented a better surface than the wrought iron. Skate irons—literally irons—are also made from cast iron, and subjected afterwards to the malleable process. It is claimed that these irons are much tougher than those of steel, that they are not affected by extreme cold, and that the case-hardened bottom keeps an edge much longer than the hardest steel.

The process of making cast iron articles malleable is a simple one, but it is limited to comparatively small articles. It would be difficult to render malleable the iron on a block of cast iron ten or twelve inches in diameter to a depth of one inch, while an article one and a half inches thick might be made malleable clear through, as the cementing—or annealing—process could act on and from both faces at the same time. The articles for treatment are packed in cast iron boxes with forge scales and powdered sal-ammoniac, and so packed that the forge scales and sal-ammoniac shall surround and isolate each piece. The boxes and contents are then placed in ovens, a fire started and the ovens gradually heated. When the interior has reached a bright red heat it is kept so for six, or even eight days, before the fire is allowed to die down. The result is shown on the articles when taken out; the surfaces are actually fused, the sprew prints are almost obliterated, the corners are smoothed off and when cut into metal shows a minute honey-combed appearance, gradually disappearing with depth from the surface.

Why sand should be used in the work of merely softening obdurate cast iron, and forged scales be required for the work of changing the texture and workable qualities of cast iron, are questions belonging more to chemistry than to mechanical manipulation. To be sure forge scales are oxide of iron, and sand is not. But what is known as "ferruginous oxide"—the oxide induced by moisture of salt, or acid, or atmosphere—would be useless in this process of converting cast iron articles into malleable iron forms. It is only what may be called the pyrogenous oxide of iron that can be so used. This is provided in abundance as may be seen around the anvil block of every country smith, the base of every drop hammer, in heaps on each side of the trains of rolls in a rolling mill, and around the head of each trip hammer and steam hammer. This waste of our most precious metal—or most valuable metal—is enormous. With every process of working, whether hot or cold, it is the iron itself that must always protect itself by giving up a portion of itself to its enemies.

Tempering Tools.—There is an old table of colours and temperatures, which has done duty in the Encyclopædias, in connection with the article on tempering steel tools, since before the memory of man. Its meaning, if it means anything at all, is that steel tools after being heated and quenched in water or oil, and hardened, are to be tempered—or as I would say—have their temper drawn, by heating to the temperature indicated by the colour of the oxidation. The following is the table: Very faint yellow for lancets, 420°; pale straw yellow, for razors, &c., 440°; orange for penknives and chisels, 470°; brown for scissors, &c., 490°; red for carpenters' tools, 510°; purple for watch springs, 530°; bright blue for lock springs, 550°; full blue for fine saws and needles, 560°; dark blue for common saws, 600°; greenish, 630°; grey, 750°. It will be observed that this table calls for "orange colour for penknives and *chisels*," "dark blue for *common saws*," and "red for *carpenters' tools*." Now what sort of a "kit" of carpenters' tools one would have after the chisels and saws were abstracted, I cannot understand; and it is not likely that the originator of this venerable fraud understood either, being, so to speak, but a table maker and not a regular carpenter. A correspondent to the *American Machinist* calls this table a fraud, because some of its most important items are grossly wrong, the "purple for watch springs," "bright blue for lock springs," and "dark blue for common saws" being instances. The table maker perhaps saw blue saws and purple watch-springs, but if his observation had extended further he could have seen bright saws, and straw-coloured watch-springs, and black lock-springs, the fact being that the temper of a saw is as near as may be that of a lock-spring, the polishing and blueing being done after the spring tempering. It may be superfluous to add that a spring temper is obtained by heating the article after hardening in water or oil, to a very low red heat, about 1,000 degrees, just visible in the dark. Such a heat is determined, in ordinary work, by the flashing and burning of animal oil with which the article is smeared, or with a heavy spring rubbing with a tool handle, and observing the sparkle of the particles of wood. If required for a finish, the spring may be polished dry, without oil, as oil will prevent the oxidation, and re-heated upon a hot iron until the required colour is obtained. The third heating produces no effect upon the temper of the spring, unless it reaches or exceeds the low red heat previously mentioned.

EXPERIMENTAL MECHANICS.

MECHANICS is not an exact science: it is the result of experiments, not only made a generation ago, but which are now being continually made. If it was not so the existence of periodical publications giving the adding and cumulative results of mechanical experience would be as impossible as that of a journal of arithmetic based on the facts of the multiplication table. So far the practice of mechanics is from being one of the exact sciences in the "Industrial World," writes Mr. J. H. Lord from the recent request of a prominent publication office to write a primary treatise on the steam engine. And yet all the principles of the steam engine, if not its construction and economic operation, are already comprehended in the textbooks of natural philosophy. But the fact is that the principle of the steam engine and its economic employment are two different things; and while the principle of the use of steam as a motor was well understood long before Watt's time, its economic employment was left to him; and his success was only the result of many futile experiments and wretched failures. Watt made a partial success of experiments. So far as his experiments established a fact they were adopted as a portion of mechanical science. But many of his experiments were made to establish a theory, and the facts overturned it. It is not so far away that some of our older mechanics can remember the influence of the Watt and Boulton notions on mechanics. The writer recalls the first stationary engine he ever saw, built by a worker in the Soho Works—Boulton and Watt. This machine had a cylinder bore of about—probably exact—12in., and a stroke of 48in. The piston speed was about 200ft. per minute. It is a wonder that with that long stroke of piston—no cut-off—the engine could have done any really effective service. And yet such engines were the antetypes of the present steam engines, which act on the same theory and are governed by the same natural laws as those of half a century ago. And if the theory is the same, why not the practical result the same? It is because all mechanical art is a series of experiments—it is not an exact science—the art of making a machine is simply the art of wielding tools and managing material. The builder cannot certify a perfect machine in productive action. And so comes the value of experiments, yet experiments are regarded with disfavour in and out of the shop. Outsiders believe, and proprietors profess to believe, that the end has been reached and perfection attained by what the one examines and the other produces. No sooner does a bright mechanic suggest some new process, or demonstrate the value of the use of some new material, than noses turn up and tongues sneer at any novelty. And yet there is not a day in the life of any metal-working concern, from the furnace for the reduction of ore, to the machine-shop for the turning out of tools of precision, that the work done is not the result of experiment—and daily experiment. The ironfoundry is only an experimental laboratory. The pattern may be approved, the mould be excellent, the mixture of iron in the cupola right, and yet the result be wrong. Each heat, and blow, and pour is an experiment. The proper admixture of iron and coal or coke, the proper time of tapping, the judicious management of the pours, are all parts of everyday experiments. It has been generally believed that the observation of a fracture of a bar of steel, or wrought iron, or pig iron, would inevitably show its absolute quality, or at least its relative value. But it does not. The writer has submitted to good judges the fractured ends of pieces of worthless and those of high steel, and both were equally accepted as fine steel. In fact, every handling of steel is an experiment; every forging, and hardening, and tempering, even from one single bar of steel, is an experiment in itself. Good forgers are very slow to commit themselves to bars of even the best steel. They test every bar before they will allow their work to go out. The writer has known a forger to refuse to temper a piece of steel until he had held it annealed for hours, and in other instances the judicious steelworker has put off the tool user with a makeshift until he could approve the bar on which he was working. When forgers of twenty years' experience refuse to risk their personal reputation until they test a single bar, it may well be believed that at least in the smith's department the mechanic art is one of experiment rather than of demonstration. And this record of experiment may be extended to the use of hand and machine tools, else there would be no encouragement for frequent applications for improvements by procuring letters patent. The practical mechanic is only an experimenter, his experiences extending through material, form, and tools, and no textbooks, nor formulated reports can take the place of his actual knowledge gained by actual practice in the grand university in the shop, that graduates the practical man.

HOW TO MAKE A BUFFET STOOL AND A BRACKET.

(For Illustrations, see Lithograph Supplement.)

BEFORE proceeding to treat of the larger articles of furniture, one or two articles of lesser dimensions, though no less useful, may be noticed. We will commence with a kitchen stool, fig. 9, known as the "buffet stool." Regarding this article of furniture I may here remark, that from its apparent insignificance most practical cabinet makers affect to despise it, yet it is a fact that very few of them really know how to make it as it ought to be made; and the same truth holds good with several other articles that might be mentioned, which they consider beneath their august notice, and are therefore generally left for young apprentices to make after their own fashion. Now, the following is how to make the buffet stool. We will take a medium size —the wood pine. Get a top, 20in. long, 10in. broad, and ⅞in. thick. Plane both sides smooth and even; mark the best side for the upper; square the two ends and breadthen—that is, plane the last edge after the ends, till the top has an equal breadth of 10in. Next plane and square two feet, each 10½in. square, and same thickness as top. After this two sides 20in. by 5in. by ⅝in. thick. Mark the two feet and sides, best sides out. Now, it will be noticed in fig. 9, that the feet are spread out at the bottom. Each foot has a spread outwards of one inch; consequently the upper ends of the feet must be bevelled a little in the squaring across. A bevel of 1/16 of an inch will do. Now make two grooves in the under-side of top to receive the feet. These grooves are ¼in. deep, and a shade less in width than the thickness of the feet, so that the latter may be fitted neatly into them.

The feet are to be cut out at bottom in the manner shown. To do this, divide their breadth into six equal parts, as in fig. 10. Mark them as shown—*a*, 1, 2, 3, *b*. From 1 set compasses, and draw quarter circle from *a* to *c*, and from 3, draw likewise from *d* to *b*; join *c d* with a straight line, and from 2 draw vertical line to *e*; from *e* as a centre, draw half circle, with the compasses still set the same, which will join *c d*. Cut out with bow saw all the wood within the curves thus obtained. Smooth the edges with a small spokeshave, and sandpaper. Fit the feet tightly into the grooves; then plane them smooth both sides, when they will be ready for glueing and nailing. With a bradawl bore four holes through the top, in the centre of each groove; put a little glue in the grooves, insert the feet, allowing their extra breadth to project beyond the top equally on each side, which will be ¼in. See by using the bevel that both feet have the same spread; drive to the bottom of the grooves; then drive four 2in. cut nails through the top into each foot. Now the two sides have to be fitted on; square their ends same length as top. They are to be grooved to receive the edges of the feet. Turn the stool over upon the sides, and draw for the grooves with drawpoint. This groove is not cut quite through the breadth of the side, else it would show on the edge when finished, and the depth of groove is exactly what the foot projects beyond the top. Mark the sides when drawing, so that you will know how to replace them. To shape out the sides, set compasses to 1½in. Draw a quarter circle in each corner, which will approach to ½in. from the groove for foot. Draw another quarter circle within the foot, keeping the same distance from the groove. Continue the curves along the central portion of the side with a straight line, find the centre of the length, and bore ½in. hole with centre bit, 1in. from the edge. Now curve the edge into this hole with compasses set to 1in. Having thus drawn one side, place both together in bench lug with the addition of two hand-screws. Saw out and finish up the edges with files and sandpaper before separating. The sides finished, bore them for nails, five along the upper edge to nail to top, and two through each groove to nail to the feet. Nail with 1½in. cut nails. Punch all the nails a little below the surface. Before nailing on these sides a little thin glue is put into the grooves, and also along the edge of the top. Clean the stool off with smoothing plane, then sandpaper all round, slightly rounding all edges and corners with the sandpaper. Find the centre of the top and bore a 1¼in. hole with a centre-bit. Take the rough edges off this; adjust the feet by standing the stool on a level board, and it is finished.

A stool of this sort, when thoroughly well made as here directed, will last a lifetime without giving way. It may be painted according to fancy, or kept white and clean.

Fig. 12 shows a very pretty bracket shelf for fixing to wall to support a timepiece, a few books, or any ornament. It may be made of pine; if for a parlour or other room, it may be of walnut, mahogany, or oak. I have made several of this design to hold a model ship or yacht, and many for American clocks, etc. For a medium size the top is 20in. by 6in. by ⅝in., moulded with a hollow or "cavetto" underneath. Two pieces are made of the form shown, fig. 11, and are placed under the shelf 3in. from the ends. A portion is cut out of the back of these to receive a piece, let in flush, and cut at the ends as in fig. 12. This is 2in. broad, and ⅝in. thick. Two short drops are turned or worked square, according to fancy, and placed under the tip, as shown. A piece 1½in. broad is fitted between these drops, and is pierced with the openings as shown, fig. 12, each opening being four holes bored with ½in. centre bit, running into each other and forming quatrefoil. This shelf is fixed to the wall with two brass plates, such as are used to fix wall mirrors. If made in pine, it may be painted or varnished to taste; if of any of the hard woods it should be French-polished.

WORK FOR INVENTORS TO DO.

WE have machines for doing almost all kinds of work in field, shop and factory; but most of the machines we find in them now will not be used twenty years hence. They will give place to something vastly better. All the machines now styled "perfection" will be found to be very imperfect.

The machines now employed for making paper, weaving cloth, printing, sewing, shaping brick, and working up lumber will soon be displaced. A very valuable invention is seldom very valuable, in itself, beyond the term for which it is patented. It is improved to such an extent that only a single principle remains to be kept in operation.

It is likely that much will be done in the future in restoring old processes, and in combining them for doing certain kinds of work. In many departments of industry little has been done to lighten the burdens of human labour. Kitchen work is performed in about the same way as it was when the first kitchen was constructed. Clothes, dishes and floors are washed after the most primitive fashion.

Our methods of doing all kinds of housework—continues the "Chicago Times"—are twenty centuries behind our methods of doing farm and factory work. Knives and forks are made by machinery, but are scoured by hand. A new tin dish is made in a factory quicker and with less trouble than an old one is cleaned in the kitchen. When drudgery was driven out of the field and workshop it took refuge in the kitchen, seemingly with the determination of making it its permanent place of abode. It clings to it with desperation. New dishes for the table and new garments for the person all make work, but the persons who bring them out produce no labour-saving machine for cleaning the first or keeping in order the last.

It is likely that most of the valuable inventions in the future will be made by persons who will devote themselves to inventing as a business. More knowledge, skill, time, money, and higher talent are now required to make inventions than were formerly needed. A person must now study to find out what is wanted in any department of industry, and then learn what has been accomplished. He must read many books and consult with many persons. If a proposed invention pertains to the application of any science to the arts, he must become familiar with both the science and the art for improving which it is designed.

The most illustrious inventors of our time afford good illustrations of what men of genius, judgment and perseverance can accomplish by devoting themselves to specialities. A technical education and a library are as necessary to an inventor as to any professional man. For a mechanical inventor a workshop is as necessary as it is to a mechanic. Some capital of course is necessary to enable a person to devote all his time to this business. Ability to concentrate one's thoughts on a particular subject is of prime importance to a successful inventor. A "happy idea" may occur to him, but patience is required to make it of any practical value. Many scientific men and mechanics can devote considerable time to inventing and go on with their regular pursuits, as they have unusual facilities. Much always depends on little things in the perfection of great inventions. Inventors have generally found their greatest difficulties with matters that at first appeared trifling.

HOW TO MAKE A SMALL POWER STEAM ENGINE.

By H. R. PHELPS.

PART II.

(For Illustrations, see Lithograph Supplements.)

THE cylinder is best made of gun-metal, as in such a small size it is much easier to work up than cast iron. The exhaust port is carried through to under-side of cylinder, where it is connected to exhaust pipe by a short length of ⅜in. copper tubing, with flanges on each end, and bent, as shown in full-size cross section of cylinder. To bend the tube, it will have to be filled with lead, when it can be easily bent to the required curve, after which the lead can be melted out again. The flange on end of pipe next to cylinder is oval, its greatest diameter being ⅞in., and its least ⅜in., the greatest diameter being parallel with cylinder. The pipe is fastened to cylinder by two ⅛in. studs and nuts, which pass through wide part of flange. The flanges can be made separately, and either brazed or silver soldered on ends of tube, the one on cylinder end being set back $\frac{3}{16}$in. from end of tube, so as to allow a leather or india-rubber washer between flange and cylinder. The flange on outer end of tube is $\frac{13}{16}$in. in diameter, and has four full $\frac{1}{16}$in. studs in it (see drawing). Both flanges are ⅛in. thick. The steam pipe has also four $\frac{1}{16}$in. studs, as shown.

The blow-off cocks are of the size shown in full-sized section of cylinder. It will be seen that one handle opens both cocks at the same time, the plugs of both cocks being connected, which is done as follows:—The plug of cock in front of cylinder has a rod left on it, as shown which has a square socket made in the end of it, into which the squared end of the second plug fits. In screwing the taps into the cylinder, the one next to the front has to be put in first, after which screw in the shell of the second one; then put in the plug, first placing the nut and washer in their place on the rod between shell and socket. The nut can be screwed up as the plug comes through shell, while, at the same time, the square on end of plug will slide into the socket. When the cocks are full open, the handle that works them will have to be at an angle of 45° from the vertical, so as to allow of the necessary motion for shutting off. The cylinder lubricator is shown on full-size details. The lagging of cylinder is best left till the engine is finished, as it is liable to get damaged in putting together.

The exact length of the piston-rod can be best determined when the guide-bars and cross-head, &c., are in their places. It will not be necessary to polish the cylinder until the engine is finished, as it will get tarnished and possibly scratched in the fitting together.

The bed-plate can now be proceeded with. The seatings for cylinder lugs must be filed or planed out perfectly square with the bed, so that the cylinder will fit tightly into them. The seatings for guide bar supports are each 1⅛in. long, the distance apart of the inner ends of each being $3\frac{7}{16}$in., and the centre of guide-bars to the centre of cylinder being $5\frac{1}{16}$in. bare. The plummer-block seating is 3¼in. long, and the centre to centre of cylinder is $10\frac{1}{16}$in. full. The guide-bars are $3\frac{15}{16}$in. in length from centre to centre of holes for studs, the width of bars being $\frac{9}{16}$in., and rounded at ends. The distance pieces between bars are $\frac{9}{16}$in. diameter, and ½in. long, the holes through them and bars being $\frac{3}{16}$in. full diameter. The distance from centre to centre of each set of slide-bars is 3in. The slide-block, which is of gun-metal, is shown in details, figs. 13, 14, and 15, and is 1⅛in. long, ½in. thick, and $\frac{9}{16}$in. wide on the working face, the flange on inner side being $\frac{3}{32}$in. thick, and the same in height. The hole for cross-head pin is ¼in. in diameter, and if the block is put on a mandrel the sides and ends can be turned up true; the rubbing surfaces will have to be filed or planed. If the ends of the block are left as they are turned, they will, on account of being rounded, ride over the oil on the guide bars, and not tend to scrape it up, as they would do if they were left quite square and sharp. If the holes are drilled through the ends of the guide-bars, the distance-pieces made, and a couple of bolts put through to hold them together, it will be much easier to file up the edges of bars, as, the two of them being some distance apart, will offer a better support to the file than the narrow edge of one would do. The slide-block should be made a tight fit between the bars, and should be put between them with some very fine silver sand and oil, and worked backwards and forwards till it works freely, and still is a tight fit; after which every particle of grit must be removed from the block and guide-bars.

The bars, which are of cast iron, have the edge of rib on top polished, the remainder being painted. Each of the top bars has a $\frac{3}{16}$in. hole tapped in the centre of boss, to receive an oil-cup, as shown on drawing. I ought to have mentioned that the rubbing faces of guide-bars are, of course, filed up as true as possible before the block is ground in. The guide-bars are $\frac{5}{32}$in. thick, the supports for bars being 1$\frac{3}{32}$in. high, and rounded at end on upper side to same shape as bars. The studs for holding down guide-bars are tapped into this block, which also has a $\frac{3}{16}$in. hole in centre of thin part for holding down bolt (see drawing). The thin part of support is $\frac{7}{32}$in. thick, and same width as guide-bars. The dimensions of cross-head pin are: Length over all, 3$\frac{9}{16}$in.; length between *outside* of collars at each end, 2¼in.; length of parallel part for cross-head, 1$\frac{3}{16}$in.; diameter of small end of tapered part and part that goes in slide block, ¼in.; diameter of large part and collars, $\frac{11}{32}$in.; thickness of collars, $\frac{1}{16}$in. The small end of tapered part is finished up to collars with a curve, as shown. This pin is best made of steel, and hardened in the middle to prevent wear. The cross-head is also of steel, and the easiest and best way of making it will be to drill a hole through it the same size as the small end of taper on piston-rod—viz., full ¼in.—and put it on a steel mandrel—getting it as near the end of the mandrel as possible to prevent springing—and then turn it to the following dimensions, and shape shown on plan: Diameter of collar on end next piston-rod, ⅝in.; diameter of hollow, $\frac{7}{16}$in. full; the length from square part of cross-head to outside of collar being $\frac{9}{16}$in.

In marking off the hole for cross-head pin, the truest way will be to mark the centre of hole on one side of cross-head 1⅛in. from outside of collar on end, and put between centres; then, having fixed a sharp-pointed tool in slide-rest, advance it till the point just enters the centre-punch mark previously made. Draw the tool away, turn the cross-head half round, and again advance the tool; then, by working the cross-head slightly round each way, another scratch will be made. A hole drilled through both of these marks is thus bound to be at right angles with axis of piston-rod; but it might be above or below it, which would not do, and this can be prevented thus: Turn the cross-head round till the original centre-punch mark exactly fits the point of tool in slide-rest; then, supposing the lathe has a divided pulley, notice the number the stop fits in; the tool will now have to be drawn back a little, and the mandrel turned round exactly half way—and, of course, the cross-head with it—and the tool point pressed pretty tightly against the cross-head. It can then be worked backwards and forwards by the slide-rest screw, thus making a scratch at right angles to and across the one previously made.

A hole drilled through the point of intersection of these two, and through centre-punch mark on opposite side, will thus be both at right angles to, and exactly through, axis of piston rod. Though it takes so long to tell how to do it, it is really only the work of a few minutes to do the centreing, and allows of the sides of the cross-head being turned, which they could not well be if the holes were out of truth. The hole for cross-head pin is to be bored at first $\frac{5}{16}$in. diameter. The ¼in. mandrel is then taken out, and a $\frac{5}{16}$in. one put in hole for pin. The sides of cross-head can then be turned to shape like drawing, and of the following dimensions: Extreme width of cross-head, 1⅜in.; width of square part, ⅝in.; depth of square part, ¾in.; and diameter of circular boss on each side of cross-head, ⅝in. The ends of cross-head are rounded, as shown. The width of opening for small end of connecting-rod is ⅜in., and depth back from centre of bosses $\frac{7}{16}$in.

Having proceeded thus far, the exact length of piston-rod can now be determined. The hole in cross-head must be broached out till the cross-head pin will nearly fit it; then the pin can be ground into its place, it being necessary that it should fit in the cross-head as tightly as possible, otherwise the engine will hammer a deal when working. Next put the slide-blocks on the ends of pin, and place them between the guide-bars, and push them towards the cylinder till the centre of pin is exactly 1in. from centre of guide-bar. Before fitting blocks in their places, however, the hole in cross-head for piston-rod will have to be broached out taper to a diameter of $\frac{5}{16}$in. at the outer end. The cylinder, without the bottom on, can now be put in its place on bed, and the piston pushed back till it is exactly $\frac{7}{32}$in. from end of cylinder. The position of end of cross-head can now be marked on piston-rod, which is then turned taper up to that point, so as to fit the hole in cross-head tightly. When the rod is fitted in cross-head, it should not go to within $\frac{1}{32}$in. of its proper position, this space being left for the key to pull up. The key is a piece of tapered steel ⅞in. long, ⅛in. full thick, ¼in. wide at top, and $\frac{3}{16}$in. at bottom. The slots in cross-head and piston-rod for key are each $\frac{1}{16}$in. wider than key, but in opposite directions to each other—that is, when cross-head is in its place on rod; the end of the slot in the rod on the end next to the piston is $\frac{1}{16}$in. nearer to piston than the corresponding end of slots in cross-head; and ends of slots in cross-head on side next the cross-head pin are $\frac{1}{16}$in. nearer to the pin than slot in piston-rod; and, consequently, when the key is forced in its place, it draws the piston-rod and cross-head closely together. A full-size detail, showing the construction of this part, will be given.

The plummer blocks, which are iron, have their bases filed up, so as to fit tightly in their places on bed, the edges of base being left bright, all the rest of the blocks and caps being painted, with the exception of the tops of circular bosses on which the nuts rest, which are bright. The plummer-blocks are 1⅜in. high from bed—that is, exclusive of cap—and are filed or planed out to take brasses to a width of ⅞in., the bottom being rounded to same curve as brasses, and being $\frac{9}{16}$in. from bed, thus bringing centre of brasses 1in. from bed. The bushes, which are of gun-metal, are ⅝in. diameter on inside, and ⅞in. on outside, and the flanges at ends are 1$\frac{3}{32}$in. diameter. The length over the flanges is 1⅝in., and between flanges—that is, where they fit in plummer-blocks—$\frac{3}{4}$in. The outer edges of flanges can either be rounded or chamfered off. The bushes can be bored and turned in the same way that the cylinder was, thereby doing away with the necessity of putting them on a mandrel, which might scratch them. They are then to be fitted in plummer-blocks; and, after making sure that the centre is just 1in. from bed, the plummer-block cap is fitted into its place over bush, the under-side of lugs on cap and top of plummer-block being $\frac{1}{8}$in. bare apart. The studs for holding down plummer-block and cap are $\frac{3}{16}$in. full diameter, and placed as shown. A hole is drilled through centre of cap and top of bush for oiling shaft journal; this is $\frac{1}{16}$in. diameter in bush and bottom of cap, the top being tapped with a $\frac{3}{16}$in. thread for oil-cup. A small pin is put through bottom of bush into plummer-block to prevent bush from turning round.

(To be continued.)

JAPANNING AND JAPANS.

WHEN finished wood, papier maché, composition, or materials are varnished in the usual manner, and left to dry in the air, the drying is in most cases imperfect, and the coating more or less uneven. If the surface thus varnished is heated for some time to a temperature of from 250° to 300° Fah., or higher, it is found that the whole of the solvent or vehicle of the gums or resins in the varnish is soon driven off, and the gummy residue becomes liquefied or semi-liquefied, in which state it adapts itself to all inequalities, and if the coating is thick enough presents a uniform glossy surface, which it retains on cooling. This process of drying out and fusion secures a firm contact and adhesion of the gums or resins to the surface of the substance varnished, and greatly increases the density of the coating, which enables it to resist wear and retain its gloss longer.

This process of hardening and finishing varnished or lacquered work by the aid of heat constitutes the chief feature of the japanner's art.

In practice, continues the "Scientific American," the work to be japanned is first thoroughly cleansed and dried. If of wood, composition, or other porous material, it is given, while warm, several coats of wood filler, or whiting mixed up with a rather thin glue size, and is, when this is hardened, rubbed down smooth with pumice-stone. It is then ready for the japan grounds. Metals, as a rule, require no special preparation, receiving the grounds directly on the clean dry surface.

In japanning, wood and similar substances require a much lower degree of heat, and usually a longer exposure in the oven than metals, and again a higher temperature may be advantageously employed when the japan is dark than when light coloured grounds are used, so that a definite knowledge of just how much heat can be safely applied and how long an exposure is required with different substances and different grounds can only be acquired by practical experience.

The japanner's oven is usually a room or large box constructed of sheet metal, and heated by stove drums or flues, so that the temperature—which is indicated by a thermometer or pyrometer hung up inside, or with its stem passing through the side wall midway between the top and bottom of the chamber—can be regularly regulated by dampers. The ovens are also provided with a chimney to carry off the vapours derived from the drying varnish, a small door through which the work can be entered and removed, and wire shelves and hooks for its support in the chamber. The oven must be kept perfectly free from dust, smoke and moisture.

A good cheap priming varnish for work to be japanned consists of—shellac (pale) 2oz., resin (pale) 2oz., rectified spirit 1 pint. Two or three coats of this is put on the work in a warm dry room. A good black ground is prepared by grinding fine ivory black with a sufficient quantity of alcoholic shellac varnish on a stone slab with a muller until a perfectly smooth black varnish is obtained. If other colours are required, the clear varnish is mixed and ground with the proper quantity of suitable pigments in a similar manner; for red, vermilion or indian red; green, chrome green or prussian blue and chrome yellow; blue, prussian blue, ultramarine, or indigo; yellow, chrome yellow, etc. But black is the hue commonly required. The following are good common black grounds:—Asphaltum 1lb., Balsam of Capivi 1lb., oil of turpentine q.s. The asphaltum is melted over a fire, and the balsam, previously heated, is mixed in with it. The mixture is then removed from the fire and mixed with the turpentine.

Moisten good lampblack with oil of turpentine, and grind it very fine with a muller on a stone plate. Then add a sufficient quantity of ordinary copal varnish, and rub well together. Asphaltum 3ozs., boiled oil 4 quarts, burnt umber 8 ozs., oil of turpentine q.s. Melt the asphaltum, stir in the oil, previously heated, then the umber, and when cooling thin down with the oil of turpentine.

An extra fine black is prepared from—Amber 12ozs., asphaltum (purified) 2ozs., boiled oil $\frac{1}{2}$ pint, resin 2ozs., oil of turpentine 16ozs. Fuse the gum and resin and asphaltum, add the hot oil, stir well together, and when cooling add the turpentine.

A white ground is prepared from copal varnish and zinc white or starch. Large japanners seldom make their own varnishes, as they can procure them more cheaply from the varnish maker.

From one to six or more coats of varnish are applied to work in japanning, each coat being hardened in the oven before the next is put on. The last coat in coloured work is usually of clear varnish, without colouring matters, and is in fine work sometimes finished with rotten-stone and chamois. For ordinary work the gloss developed in the oven under favourable conditions is sufficient.

Metal Castings of Insects, Flowers, etc.—The following process is recommended for producing metallic castings of flowers, leaves, insects, etc.: The object, a dead beetle, for example, is first arranged in a natural position, and the feet are connected with an oval rim of wax. It is then fixed in the centre of a paper or wooden box by means of pieces of fine wire, so that it is perfectly free, and thicker wires are run from the sides of the box to the object, which subsequently serve to form air channels in the mould by their removal. A wooden stick tapering toward the bottom, is placed upon the back of the insect to produce a runner for casting. The box is then filled up with a paste with three parts of plaster of Paris and one of brick-dust, made up with a solution of alum and sal-ammoniac. It is also well first to brush the object with this paste to prevent the formation of air bubbles. After the mould thus formed has set, the object is removed from the interior by first reducing it to ashes. It is therefore dried slowly, and finally heated gradually to a red heat, and then allowed to cool slowly to prevent the formation of flaws or cracks. The ashes are removed by pouring mercury into the cold mould and shaking it thoroughly before pouring it out, and repeating this operation several times. The thicker wires are then drawn out, and the mould needs simply to be thoroughly heated before it is filled with metal, in order that the latter may flow in all portions of it. After it has become cold it is softened and carefully broken away from the casting.

THE AMATEUR WOOD TURNER.

By A. Cabe.

(For Illustrations see Lithograph Supplement.)

PART III.

In our last lesson we finished a plain cylinder 9in. long. We now propose to convert that cylinder into a baluster. Fig. 9 shows a common form of baluster, known in architecture as of the Tuscan order. Now as to its various parts or members, beginning at the right-hand end, which is the bottom or base of the baluster. From 1 to 2 we have the straight part, called the plinth; at 2 we have a sunk fillet; from 2 to 3 is a large bead, called a torus; then at 3 is a fillet, and from 3 to 4 the sunk member, called a scotia; over the scotia is a fillet, and these various parts collectively constitute the base of the baluster. From 4 to 5 is the body, which is the full thickness of the cylinder immediately above the scotia, and recedes to the thickness of the neck at the small bead, 5, which is called an astragal. This astragal has a small square fillet underneath. Of course I am speaking of the baluster as if it stood on end in this description. The part above the fillet is the neck; the neck expands abruptly into a fillet, 6, which is surmounted by the spreading moulding, called an ovolo. In the cabinet trade we call it an inverted thumb. Over the ovolo is the abacus, which is straight like the plinth. The abacus, ovolo, neck, and astragal constitute the cap or capital of the baluster.

It is necessary to thus give the names of the various divisions, because in describing the process of turning it, these names will be used; and besides that, to know the names of the various members of a baluster will constitute a lesson in architecture, as they are architectural terms. Now as to the manipulation of our cylinder into a baluster of this pattern. First of all mark off the plinth ¾in. at right hand end, and the abacus ½in. at opposite end; I do this with a pair of spring dividers. The dividers are set to the size wanted, and the legs placed on the rest; the work is made to revolve, one leg of the dividers is placed against the end of the cylinder, the other allowed to touch the work, making a light scratch round it. If a turner had a number of these balusters to do, he would get a lath of wood and insert small sharp spikes in its edge at the distances wanted to mark on the cylinder. This gauge is shown, fig. 10. After turning his cylinder straight, he would hold this gauge against it, when each spike would make a light mark round it. Another way is to make small notches in the lath, and holding it in position on the rest and against the work, to place the point of a pencil in each notch, thus making a pencil circle in lieu of the scratch.

I may here remark that the form of baluster here shown, but of a more slender make, is commonly used for making balustrades on the top of panelled partitions in counting-houses, banks, etc.; such balusters usually have a tenon top and bottom let into the framing, but as we are only practising turning we may dispense with the tenons.

Now, having marked off on our cylinder the plinth and abacus, take a ½in. chisel, and resting it on edge on the rest and with the acute or long corner down, make a cut at 7, straight inwards, to a depth of about ⅛in. In doing this the chisel must be held exactly at right angles with the revolving work, for if held angled either to the right or left, it will run off, making a spiral cut along the cylinder before you can prevent it. Now, having made this cut in, place the opposite edge of the chisel on the rest, having the long corner uppermost, cant it over to the right to an angle of about 45°, cutting away the wood from the extreme top of the ovolo towards the previous cut, gradually turning the chisel over till it is once more on edge; another very light and clean finishing cut is made straight inwards, leaving a clean under surface to the abacus. The loose wood is removed out of the narrow angular hollow by making a very light cut to finish that part of the ovolo lying towards the abacus.

Now it will be observed that all the wood inside the dotted line, from 2 to 7, is to be removed; and at three different places besides the plinth and abacus—namely, the torus, body, and ovolo—are of the full diameter of the original cylinder, less as much as finish them.

Beginning, then, with a ⅜in. gouge at the top of the ovolo, work down towards the right, leaving as much thickness as form the astragal, 5. This astragal, including its fillet, is ⅜in. broad and ¼in. thick; the neck above the astragal being 1¼in. thick, the other sizes may be readily determined. The diameter of the fillet, 6, is 1½in. In turning the ovolo with the ⅜in. gouge, the tool is gradually canted over till, on reaching the fillet (6), it is resting on its side; a finishing cut is given to this part with narrow chisel, and the fillet formed with the same tool. Now the small gouge comes in to form the curve away from the fillet, reducing the neck to near the finished size; a narrow chisel doing the finishing cut. The astragal is now formed with the same chisel, and the fillet behind it. The body may now be roughly shaped. We now turn our attention to the plinth. It is first of all cut in same as directed for the the abacus, at 2; then, with the chisel canted over nearly flat, short corner cutting begin at top of torus head, and work towards plinth. A sunk fillet is here shown, ⅛in. broad and ¼in. deep; this is cleaned out with a narrow parting tool. The upper side of the torus and the scotia may now be worked down roughly with the gouge, the torus finished with the chisel, and fillet, 3, formed. The torus is the thickness or height of the plinth, and the scotia about the same; the fillets are 3/16in. Fillet 4 is somewhat less in diameter than 3. The scotia is turned down and finished with the gouge. The gouge, in order to cut the wood, and not scrape and tear it, must be turned on its side when starting the hollow away from the fillets; and here a difficulty presents itself. In the attempt to cut square, in making a clean sharp fillet, the gouge is held with its cannel at right angles with the line of centres. With a learner, the first contact of the gouge with the wood results in running sideways, destroying the fillet entirely. This may be guarded against by making a cut with the chisel for some little depth close to either fillet. The gouge will now remove the wood in the hollow between the cuts, and when turned on its side, with its point in the cut, it will not run into the fillet, having now a back to keep it in its place. The scotia, when finished, should calliper at least as thick as the neck of the baluster. It will be observed that the curve forming the scotia is much sharper towards fillet, 4; the fact being that the scotia is a reverse ovolo, or part of an ellipse.

Now, having finished the base and capital of our baluster, we turn our attention to the body. The curve of the body is a kind of ogee; at its lower part it is the full size of the plinth, in diameter.

Here let me remark that a practical turner in working curves such as this depends mainly on the education of his eye. With an educated eye, he can at all times form graceful and pleasing curves, so the body of this baluster might be finished in various forms of outline, all meeting at 5 and 4, but some of them would be positively ugly. But apart from mathematical rules for forming curves such as this, the hand and eye can produce them, without difficulty, to please cultivated taste.

If a turner was given a detailed drawing of a piece of work such as this, and told to work exactly to it, he would make a reverse or template from the drawing; he could then produce any number of exactly the same pattern. In like manner the stone cutter making round balusters by hand would work with a reverse mould, thus making them all alike in outline.

Now, the amateur, in practising on a bit of work of this kind will do well to train the eye, in working the body of his baluster. It is worked down to near the finishing size with the gouge, beginning at the largest diameter and working down on the right to fillet 4, and on the left to the astragal—where the body is finished same diameter as the neck.

It is a fixed rule that in order to cut the wood with the grain every projecting member must be cut away from its *centre* right and left, and every hollow or reversed member cut from its *sides* and finishing in its centre. To make this more clear, I refer you to figs. 11 and 12. In fig. 11 *a*, *b*, *c* is a torus bead on a plain cylinder. This would be formed by working from the crown at *a* towards *b* on the left, and from *a* again towards *c* on the right. In fig. 12, which shows a hollow in a cylinder, the cut is made from either side and finishing at the bottom. At the beginning of the cut at *a* and *b* the gouge is turned on its side and is gradually turned till on reaching *c* it has its hollow side up. To turn out a hollow like this, with the gouge always on its back, would be to tear out the wood, making a very rough job and leaving ragged edges at *a* and *b*, so there is all the difference in the world between cutting and scraping—cutting is turning, scraping is not—and with reference to our baluster, the more cutting in the process of manipulation the easier will it be to finish with sandpaper. A good turner would make it so smooth and clean cut with the tools that a very light sandpapering would suffice to finish it. A bad turner would labour with various grades of paper, trying in vain to make a smooth job, and succeeding only in rubbing off all the clean, sharp angles which always mark the finest and best specimens of turned work.

In addition to the foregoing, I have to show three different specimens of the very simplest of turned objects. Figs. 5 and 6 are ball feet. Ball feet are used on numerous articles, such as dressing glasses, foot stools, fern-cases, bird cages, &c. Fig. 13 is the simplest of all ball feet, and is found upon small boxes, caddies, and the like. It may be an inch in diameter as for a caddie, and 2½in. or 3in. as for a dressing glass. It is cut from the wood plankways with a bow saw, a hole is bored in the centre, and it is fixed on a screw chuck for turning in the lathe. This screw chuck is a very simple affair. It is simply a small block of wood fixed to the ordinary face-plate, and turned up true. In the centre of the face a common wood screw is secured, having about ½in. of its point projecting. If this is properly done, the screw will run true. The face of the chuck may be reduced to about an inch diameter; on this the circular pieces for ball feet are fixed, and as it is only the edge or periphery that is turned, you get readily round it on account of the narrow-faced chuck. In turning ball feet, the tools must be very sharp—as the wood running plankways presents, when revolving, two sides of side wood and two of end wood to every revolution. So in turning it is more of a scraping process. The rest is raised somewhat above the centre, and the chisel lies flat on the rest, with the handle somewhat lowered. With a blunt tool the wood, particularly on two sides, is only torn up, and will never paper smooth. These ball feet are fixed on to their destined places with screws passing through them.

Fig. 14 is a ball foot, with a fillet on the underside. This is an improvement when a somewhat high ball is wanted. It is fixed on in the same way as fig. 5.

Fig. 15 is another foot which is much used for chests of drawers, chests, and boxes. It is composed of a torus, an astragal, a hollow, and three fillets. It is hardly ever less than 4in. or 5in. diameter, and about the same height. It has a tenon for fixing to its purpose, and, unlike the ball feet, its grain runs lengthways, consequently it is turned between centres. The tenon is usually an inch or more in diameter. To gauge the tenon, a centre-bit is selected, a hole bored with it in a bit of wood, the hole is callipered, and the callipers used to gauge all the tenons of one diameter, so as they will make a good fit when glued in.

The operation of turning these three last objects is precisely the same as that given for the turning of the baluster.

PLANT'S GEOMETRIC CHUCK.

PART III.

(For Illustrations, see Lithograph Supplement.)

THE lithograph published herewith shows sectional details of various parts of the three-part chuck. The drawings are made to scale, and are full size.

The screws which actuate the sliding pieces are shown full size in figs. 9 and 10. They are precisely alike in all respects, except length. The one used to actuate the sliding piece on the foundation plate, marked *j* in the back view fig. 5, is shortest. It measures 3in. from end to end. The collar which confines the lateral motion leaves 2in. of threaded part. The other screw shows the size of those used in the other slides. Two are required in the three-part chuck, but only one in the two-part chuck. The square ends of these screws are shown in the side view of the latter chuck. (See fig. 2.)

The following measurements apply to all the leading screws:—Diameter of collar $\frac{7}{16}$in.; diameter of thread and shoulder part to where squared, $\frac{5}{16}$in.; thread, 20 to an inch, cut deep, as is usual in apparatus used for ornamental turning. This rate (20) is useful as affording an easy means of adjusting the eccentricity of the slides to decimal parts of an inch. It is also just double the rate of the usual slide-rest screw. The square end of the screw is as large as the metal will allow; it is ⅜in. long. A collet about ⅛in. thick is fitted on this square, and its edge is divided to form an index when altering their slides. The method by which these screws are held in position is this: A cannon is made to fit on the shoulder, its exterior diameter being the same as that of the collar. The lower part of the collar bears against the casting, which is bored out to receive it. The cannon is held by a pin passing through the casting, the hole for which is drilled at the diametrical line. The cap bearing shown screwed on the foundation plate may be recessed out to receive the collar, and so save the trouble of fitting the cannon. In the illustration, fig. 2, a plate secured by two screws is shown holding the leading screw. Either plan for confining the end motion of the screws may be adopted.

The nut for the leading screw of the lower slide, which is shown by *l*, fig. 5, is shown full size by fig. 11. The sliding plate of the lower slide *j*, fig. 2, is marked *a*. The nut *c* is held against it by the screw *b*, and *d* is the hole for the leading screw. The nut itself is a piece of gun-metal, about $\frac{1}{2}$in. square, and $\frac{3}{4}$in. long over all. A short length is turned circular, to fit in the hole through the plate under the head of the screw *b*. It is not necessary to fix these nuts by screws; and the other two, those in the two upper slides, are simply fitted into holes as in the illustration, the screw being omitted, and the circular part made longer, so as to get a better hold.

Fig. 12 is a full-size sectional view of the gearing which conveys the motion from the back to the front of the foundation plate. Fig. 3 shows the position of the part where the arbor is marked, *t*. In fig. 12 this is *a*, and it is also shown full size in elevation at fig. 13. This arbor is 1$\frac{3}{4}$in. long, $\frac{3}{8}$in. diameter, having a collar $\frac{1}{2}$in. diameter and about $\frac{3}{32}$in. wide. At one end it is squared for a distance of $\frac{1}{16}$in., and at the other it is shaped hexagonal a length of $\frac{7}{16}$in. The hexagon is about $\frac{5}{16}$in. across its faces. Referring to fig. 12, *a* is the arbor already described. Tapped into the two ends are the screws *e* and *f*, which secure the wheels *c* and *d* respectively. The wheel *b* is fixed on the arbor against the shoulder. It is a ratchet wheel, and has 72 teeth. The wheel *c*, marked *q* in fig. 3, turns on the arbor *a*, and is held by the click on its face, which catches in the wheel *b*. A reference to fig. 3 shows this arrangement at *q r s*. *D* is a change wheel. (*Q*, fig. 2.) It has a hexagonal hole, which fits the arbor, and it is held by the screw *f*. Wheels of various diameters are put in the place of *d*, according to the patterns which are to be traced.

The foundation plate is marked *h*, and into it the cannon *g* is screwed. This cannon is made of steel, and turned to the shape shown. It screws firmly into the foundation plate against the shoulder, and at its lower end forms a bearing for the collar of the arbor. Its front end is turned down to receive a washer *i*, and on the space between this washer and *g* the link to carry the change wheels is fitted. The front side of *i* is level with the end of *g*, and these form a shoulder for *d*, so that the end motion of the arbor *a* is confined. *I* fits tightly on *g*, and is adjusted by hammering when the arbor is removed. The link, though free to move, should be tight between *i* and the shoulder *g*.

Fig. 13 shows, in elevation, the arbor marked *a* in fig. 12.

A section of the lower sliding piece, and the wheel which revolves on it, is shown at fig. 14. The drawing is taken from the centre of the entire mechanism. The sliding piece is marked *a*. This is marked *b* in the two part chuck, shown at fig. 2. The section being full size, measurements can be taken from it. The plate is $\frac{1}{4}$in. thick, with the edges bevelled off to fit the dovetail slides. The extreme width is 3$\frac{3}{4}$in. Solid with the plate is a projecting ring 3in. in diameter. This ring is in the centre of the sliding plate. Its periphery is turned true to receive the wheel *b*, which fits it accurately and turns on it smoothly, without shake, when actuated by the first series of change wheels. This wheel *b* is 5in. in diameter, and $\frac{5}{16}$in. thick on the edge. It has 120 teeth, of the same pitch as the change wheels. It is fitted on the outer edge of the ring on the slide, and on its top surface. (See illustration.) The central part is quite clear, and no attempt must be made to fit any other parts but those named, as it would only end in failure.

The space below the ring on *b* is to allow the radius plate, fig. 6, to swing. This is confined sufficiently to prevent absolute shake, but on no account must the bearing of *a* against *b* be prevented by the thickness of the radius plate. The plate itself is held by clamp screws, as explained in the description of fig. 6. The wheel *b* is held against the face of *a* by the screw in the centre. This screw *d* is tapped with a stud, which is screwed into *a*, and forms the centre of the whole arrangement. This stud is shown in elevation by fig. 15, where its top view is also given. It will be seen by a glance at this last figure that the stud consists of a threaded part which screws into *a*. It has a round shoulder about $\frac{3}{16}$in. thick, and a hexagonal part $\frac{1}{4}$in. high.

Turning back to fig. 14, *e* is this stud in section. The round part is shown quite free from contact with the wheel *b*, as it must be. The hexagonal part serves to receive the wheel *f*. This is 1$\frac{1}{2}$in. in diameter, and has 36 teeth. Under it is a steel washer marked *h*. This is fitted carefully on to the hexagon, and bears against the recessed part of *b*. The washer thus forms the bearing which keeps *b* in contact with *c*. The wheel *f* is recessed out to receive the head of the screw *d*. By adjusting this, the amount of freedom of *b* on *a* can be regulated.

The wheel *f* is the centre of the sun-and-planet motion, and the semi-circular recess shown in the left-hand side of the wheel represents the hole sunk into *f* to receive the wheel marked *w* in fig. 3, and shown full size in fig. 12. The solid sectional part, a pin, is left solid on the wheel *b*, and having a groove sunk all round it to contain an idle wheel, which revolves on the pin, and conveys motion from *f* to the planet wheel. The recesses are shown $\frac{1}{4}$in. deep to clear wheels of that thickness, the central wheel being a trifle thicker for additional strength, and under it the washer is seen. The centre of the wheel *b* is considerably thicker than its edge, so that the extra depth of the recess containing *f* and *h* will not weaken the wheel. This completes the description of fig. 14.

The stud, fig. 15, is $\frac{7}{8}$in. high. The thread is $\frac{1}{2}$in. diameter, its length being governed by the thickness of the central part of the sliding piece into which it screws. (See section, fig. 14.) The round part forming the shoulder is $\frac{3}{4}$in. in diameter. The hexagon measures about $\frac{11}{16}$in. across the flats. The screw (*d* in the section) is $\frac{5}{16}$in. in diameter, with a head $\frac{7}{8}$in. This stud is marked *f* in fig. 3, and *e* in fig. 14.

The second slide is shown at fig. 16. In its general principles it is precisely like the one last described. The measurements, of course, differ. The sliding piece *a* is fitted in dovetails, but it has a flat plate on the top, which projects. The width of the plate is 3in., and the web cast solid with it is 2$\frac{3}{8}$in. wide at the widest part, tapering to 1$\frac{1}{2}$in. at the narrowest; the height of the dovetail is $\frac{1}{2}$in. In fitting this slide it should be made to bear on the tops of the strips, which afford a much better surface than the lower part of the web. In every way the first-mentioned method of fitting this form of slide is best. It gives a larger bearing surface and supports the slide at its weakest part. It is somewhat surprising that some makers of slides have failed to understand this fact, or at all events some do not fit in the correct manner. The wheel *b* is similar to the one described in fig. 14. It is 4$\frac{1}{8}$in. in diameter, and has 96 teeth. The thickness is $\frac{5}{16}$in. The space for the radius plate, fig. 7, is shown at *c*. *D* is the screw which holds the wheel *b* on its place. *E* is stud, shown by elevation and front end at fig. 17. The wheel fitted on to the hexagonal part of this stud marked *f* has 24 teeth, and is 1$\frac{1}{8}$in. in diameter. The washer *hh* serves the same purpose as the one in fig. 14. The pin has also been described. The slide *a* is represented by *h* in fig. 3, but the wheel *b* has no counterpart in the two-part chuck.

The stud, fig. 17, has a thread $\frac{1}{2}$in. diameter. The plain part is $\frac{5}{8}$in. diameter, and the hexagon about $\frac{7}{16}$in. across the face. The total length is $\frac{3}{4}$in., the thread, plain part, and hexagon each taking an equal share, the thread being perhaps a trifle longer according to the thickness of the casting in which it is screwed. This short stud is replaced by the long one illustrated by fig. 19 in the two-part chuck. The latter stud is marked *l* in fig. 3.

The top slide is figured No. 18. *A* is the slide. It is 2½in. wide. The dovetail is 1¾in. wide at the lowest part, and tapers like the last figure. This slide is fitted in the same manner with the bearing on the tops of the strips. The wheel *b* is solid with the nose-piece on which the chucks screw. The wheel is 3⅜in. in diameter, and has 72 teeth. It is ¾in. full in thickness. The ring on *a*, to which the wheel is fitted, is 2⅜in. in diameter. *Cc* show the space for the radius plate. *D* is the screw tapped into the stud *e*. This is shown in elevation at fig. 19. *H* is the washer fitted on the hexagonal part of the stud.

The stud, fig. 19, is 1⅝in. long; but its length will be determined by that of the nose screw, which is a duplicate of the one on the nose of the mandrel. A ⅜in. thread will hold the stud in the casting; the shoulder may be ⅝in., and the plain part from ⅜in. to ½in., according to the diameter of the nose. An end view of the stud is shown together with it at fig. 19. The screw in the end is ¼in. in diameter, and the hexagonal part nearly ⅜in. This stud is *l* in fig. 3, where it is much longer, through the nose having a ratchet wheel extra.

Fig. 20 is a full-size section of the planet arbor and wheels of the second slide. It serves the same purpose as fig. 12. *A* is a metal casting, with a cannon on it, through which the arbor *b* passes. *A* is secured on the face of the wheel *h* by two screws through the flange. This flange is shaped to the same form as the wheel itself. The two wheels on the arbor *b*, marked *c* and *d*, are fixed by feathers and keyways, or by octagonal fitting, or in some such manner. They are alike in size, having 16 teeth each, and are about ¾in. diameter. A collar or washer *e* fits on the cannon of *a* to hold the link, which goes on at the bottom of *e*, where the space for it is shown. The arbor *b* is $\frac{5}{16}$in. diameter, and 1$\frac{5}{32}$in. long. The wheels *c* and *d* are ¼in. thick. The other measurements are for the most part arbitrary, but a general idea of the proportion will be gleaned by inspecting the illustration. This planet gear is shown in fig. 3, where *y* is the arbor and *w* and *x* the wheels *c* and *d*. Screws are shown in the arbor at fig. 3, but they are not necessary, and not shown in fig. 20.

Fig. 21 is the planet wheel of the third slide. It is in every respect the same as the one last described, excepting inasmuch as the difference of measurements. In this the wheels at the ends of the axis are the only essential smaller parts. The cannon and the arbor may be the same size, but the wheels have 12 teeth only, and measure about ⅜in. in diameter. It will not be necessary to letter and describe each part of this drawing, as it is but a duplicate of fig. 20 in all respects but the one named, and will therefore require no further explanation. This mechanism does not exist in the two-part chuck.

The two-part geometric chuck will be illustrated and described in the next article.

◆

Oil for quick-running Machinery.—A correspondent writes:—"I will say that I have used sperm oil and mineral oil mixed, ⅓ sperm to ⅔ mineral, and have obtained better results than when I have used either alone. Of course the proportion may be varied, but the mineral oil has a heavier body than sperm, and one is too light while the other is too heavy, and a mixture of the two will give the best results."

CAPT. R. PUDSEY DAWSON'S SLIDE-REST FOR CUTTING GEOMETRIC FIGURES.

(For Illustrations, see Lithograph Supplement.)

THE rest is made on the same principle as the ordinary slide-rest for ornamental turning, only it has two slides; the upper slide carries the tool holder for the fixed tool, eccentric, drill, and other cutters, all of which can be used with the apparatus. The top slide has a screw to traverse the tool carriage; the lower slide has a spiral spring in the place of a screw, which is fastened to the right-hand end of the top slide by a steel pin; the other end of the spring passes through a small hole at the end of slide, and is kept in position by a nut and washer that screws on to the end of the steel spring. When the upper slide is pressed against the spring, it oscillates from the elasticity of the spring. At the back of the tool carriage there is a steel arm firmly screwed on to the end of slide, and at the end of this arm is fixed a small steel rubber, which acts against the cams. On the left-hand of the lower slide is a transverse slide, which moves along the slide as required, and is fixed with a set screw underneath; this slide carries a spindle, and the end nearest the lathe head has a screw cut on it and fitted with nut and washers, and carries any of the change wheels of the spiral apparatus.

Motion is given to the spindle by a tangent wheel and screw when the revolving cutters are used, but when a fixed tool is used motion is given by a winch handle that fits on to the square end of spindle, the tangent screw being then thrown out of gear. On this end of spindle a boss is fitted that carries the various cams.

To actuate the apparatus you first set the tool—say a fixed one—at centre, then push the slide that carries the cam forwards till the rubber on the tool slide presses against the cam—the spring is now extended; fix the slide by the binding screws underneath the slide.

Put a 72-wheel on the end of spindle, and 144-wheel on spiral chuck, an intermediate wheel on the radial arm to complete the connection; advance the cutting tool and regulate the depth of cut; turn the winch handle at the end of spindle, and the apparatus is put in motion, and the result will be a six-looped figure if you have an oval cam on shaft, the tool being moved 12 turns out from centre.

The patterns that can be cut from one cam by altering the change of wheels are endless.

When you use the revolving cutters in place of the fixed tool you actuate the apparatus by the tangent wheel, and regulate the fineness or coarseness of the pattern by the divisions of the micrometor screw, moving two or one or half a turn for each cut. Now withdraw the tool, move one turn and cut again, and so continue till the pattern is completed. There is no difficulty in working the apparatus, and after you have once arranged it you can cut the most intricate geometric figures in a few minutes. Should you make a mistake all you have to do is to take out the revolving cutter, put a round nose tool in tool slide and face up the material without disarranging the apparatus further than throwing the wheels out of gear; replace the revolving cutter, and you are ready to start again. This is a very great saving of time.

The illustrations show some specimens of the work done with this rest. When I cut the patterns I did not take a note of the settings, consequently cannot tell for certain what eccentricity was given to the *cam.* As all the discs are 2¼in. diameter, you have no trouble in arranging the settings. Of course you may enlarge the figure as much as you like, or reduce it. You can also vary the pattern by altering the wheels on the spindle.

In the rose engine figures a *stop* is placed on the slide-rest to cut off the length of traverse, and there is a micrometer screw to regulate each cut. The eccentric chuck is used in cutting the other figures. The boss of the chuck carries the change wheels of the spiral apparatus, and is fitted just the same as the boss of the spiral chuck. If you require the settings for *all* the patterns, I shall have to cut them all again, and note the setting down at the time. I should think if you had the settings for a few patterns that would be quite enough. So much depends upon how you arrange the apparatus, and you can make so many changes by altering the wheels or changing the cam. With an oval cam the figure is quite altered if you arrange the apparatus for the rubber to press against the major axis or the minor axis. I could cut hundreds of patterns from one cam. All patterns cut from an oval cam are very effective. I send you a lot of patterns that I have cut on purpose for you, to prove what can be done with the apparatus, and shall be glad to give you any information you may require.

R. PUDSEY DAWSON.

CHUCKS FOR WOODWORK.

BY PAUL N. HASLUCK.

HEREWITH are drawings of four useful chucks for wood-turning. Though the number might be increased almost indefinitely, yet by the aid of those shown most of the work coming under general turning may be mounted. For special purposes special tools are necessary, and often it is only after seeing the work to be executed that a suitable chuck can be devised.

Rods of wood are invariably turned by means of a prong chuck, the outer end being supported by the back centre. The usual form of prong chuck is illustrated in fig. 1, but several slight modifications of it are made. A plain cross is perhaps the most common substitute for the prong, but it is not so good. Referring to the illustration, fig. 1, it will be seen that the body of the chuck is a plain piece of iron, wrought or cast. The latter material answers every purpose, and is by far the easier to work; hence, when making such a chuck, use cast iron by preference.

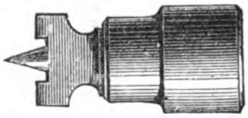

FIG. 1.—PRONG CHUCK.

The prong itself is made of steel. This is turned down to fit, and is driven into a hole in the body of the chuck. A shoulder on the prong comes against the face end of the chuck, and the prong must be driven in quite tight, so that it is practically solid. The projecting steel is filed flat, its front edge being left about an eighth of an inch wide. The small cone in the centre has to be turned to run perfectly true in the lathe; the point should be sharp to enter the wood easily. The object of the point is to keep the wood true when chucked, and by leaving a central indentation it allows the work to be re-placed perfectly true should it be removed from the lathe. The diametrical edge is filed up from different sides, leaving a chisel-like edge with the bevel on one side only. These bevels are on the sides away from the direction of rotation, leaving the face that drives the work nearly straight, and thus diminishing its tendency to come out of the wood whilst working. The extreme arris of each edge does not form a straight line, and this is very desirable, as a diametrical chisel-like cut would be very likely to split the wood. A careful inspection of the illustration will afford all other particulars. The steel prong is, of course, hardened and tempered to a deep blue.

When using the prong chuck, the rod of wood to be turned is placed as truly as possible on the central cone—if necessary, its truth may be tested by revolving the mandrel. A blow with a mallet on the outer end of the rod drives it on to the prong; the back centre point is then brought up, and the work is ready for turning. If the wood to be turned is very hard it is usual to drill a small hole to receive the central cone, and after marking the precise positions where the prongs take hold to indent the marks by means of a chisel.

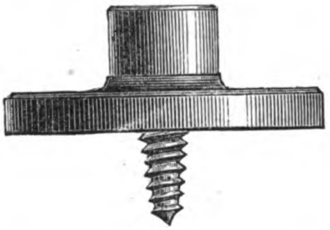

FIG. 2.—CONICAL SCREW CHUCK.

The next chuck illustrated is the conical screw chuck (fig. 2). This chuck is used for turning all kinds of wood plankways of the grain, when a central hole is allowable. The back centre is not used as a support for work mounted on this kind of chuck.

The body is made usually of cast iron, but sometimes of brass, gun-metal, etc. It may be from two to four inches in diameter for a 5in. lathe. The front face must be turned quite flat and true. The conical screw is of steel. The thread should be coarse and thin, similar to the thread of an ordinary wood screw but conical. A special screw tool is necessary for cutting conical threads, in order to make them upright. If cut with the ordinary form of chaser the thread would lean forward very much, and would have but comparatively slight hold on the wood into which it was screwed. The steel cone may be fixed into the casting by driving in from the back, or a fine thread will hold it very well, but it must be screwed very tight, and sometimes has to be rivetted at the back to prevent the screw being removed when unchucking work.

Fig. 3 shows the form of comb screw tool suited for cutting the thread of a taper screw so that the thread is itself upright. The teeth are cut in a slanting direction, and those cutting the small part of the cone have their points ground off.

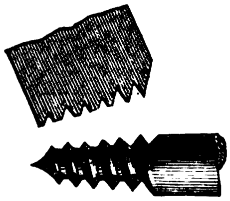

FIG. 3.—SCREW TOOL FOR CUTTING CONE THREAD.

Different sizes are employed, according to the dimensions of the work to be turned; two or three are sufficient for most purposes. To mount work on this chuck a hole is bored in it centrally, and of a size and shape suited to the dimensions of the cone screw. A conical half-round bit, such as is commonly used in the carpenter's brace, is a useful tool for this purpose. The wood is screwed on to the cone screw direct, the chief consideration being to get it flat against the face of the chuck. When this is secured the work may be taken off and replaced quite true. Discs of wood which would be spoiled by having a hole in them are frequently mounted on the cone screw chuck by being first glued or cemented on to another piece of wood, which is bored and screwed on to the chuck. If the surface of a piece of wood fitting the chuck is turned true, and the work to be turned has one of its surfaces planed flat, the two may be fixed together by glueing, and when finished the separation is easily managed with care. It is perhaps the best plan to make the joint with a piece of paper glued on both sides. This allows easy separation.

Work of large dimensions is sometimes further secured on the cone screw chuck by putting wood screws through the flange into the work, holes being bored through the flange to receive such screws. An ordinary wood screw is sometimes used for the central screw, but it is not nearly so strong as the steel screw, as illustrated. For some purposes, when the central screw is objectionable, a disc of wood may be held on a flange by three or four wood screws, the central screw being dispensed with.

The two chucks illustrated afford the means of dealing with wood in the form of both rods and discs, and they are those in most general request by the wood-turner.

The fourth illustration shows a spring chuck which is employed to clamp small pieces of wood. This chuck is practically self-centreing, and is the kind used by pipe-makers and others; it is suitable for chucking tobacco pipes, etc. The drawing shows a chuck with six grooves, but the number is immaterial. Some workmen use those with only one saw-cut, dividing the chuck into two parts, giving only two jaws. This is undesirable, as the work so chucked is not held firmly. Three jaws would act very well, but it is difficult to cut only three saw kerfs, and for that reason six is the number more generally made. Good sound boxwood is the best material from which to make such chucks, and at the termination of each saw-cut a hole should be drilled. This not only lessens the liability to split, but also, by decreasing the amount of material near the butt end, makes the chuck more flexible at that point—a desirable quality.

In order to insure the jaws bending near to the butt end, the interior of the chuck should be hollowed out where the holes are bored. This method of reducing the substance of the wood is a better one than that of a drilling large holes, because it reduces the strength in the right direction, and does not make the chuck weak, as is the case with large holes.

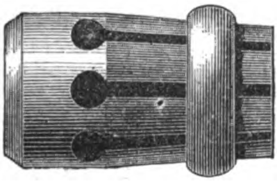

FIG. 4.—BARREL CHUCK.

The outside of this chuck is turned slightly conical so that the iron ring, shown in fig. 4, when forced on it closes the points of the jaws, thereby gripping any work that may be placed within them. The range of motion in the jaws of this form of chuck is not very great and hence it becomes necessary to have several spring chucks in accordance with the various sizes of work to be executed. In order to prevent the wood from splitting an iron ring is often put around it at the butt end.

It is important to see that the ring which binds the staves together runs true as, if otherwise, the jaws are not brought together equally, and the work chucked in them will be eccentric. The inside of the ring should be rounded, so that its edge will not catch and cut into the surface of the chuck.

To use this chuck the ring is first pressed on to the jaws moderately tight, so that it holds them firmly. A recess is then turned in the end very slightly smaller than the diameter of the object to be chucked; the ring is then pushed towards the front end, thereby allowing the jaws to open. The work is put into the previously turned recess, and there securely fixed by pushing the ring back till the jaws clip it firmly. The ring is often driven on by slight blows at various points of its circumference, always remembering to get it to run quite true.

This chuck is used principally for work which has already been turned true at some part by which it may be conveniently chucked. When a large quantity of objects are to be turned, the dimensions of which are approximately the same, this chuck is the most useful in place of a solid wood chuck, in which it would be impossible to fix any but those of exactly one size. As an example, a set of men for draught playing would be chucked with the greatest ease in a spring chuck, of the pattern illustrated, for the purpose of ornamenting one of their sides. Some objects with a projecting piece are most easily turned in this chuck. The bowl of an ordinary briar-root tobacco-pipe may be chucked for boring, by merely cutting away a space to allow the stem to be free of the jaws.

In the next figure is illustrated a chuck specially designed for turning discs having a central hole; or it may be used for mounting any work which has a true hole in its centre, the diameter of which is sufficient to allow the screw shown in fig. 5 to pass.

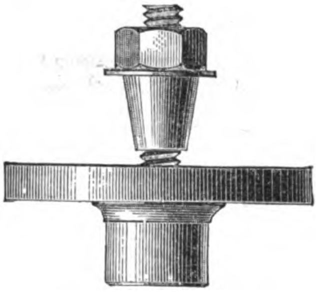

FIG. 5.—CHUCK FOR TURNING DISCS.

Numerous central screws of different lengths and diameters to suit various objects may be fitted to such a chuck as this. Plain steel spindles, with a thread at the extremity only, are stronger than those with a thread cut all their length, but they do not afford so great a range.

The body part of fig. 5 is the same as the cone screw chuck fig. 2. It must be faced up true to afford a bearing for any discs mounted on it, and in the centre it has a hole to receive the screw shown projecting with a cone and nut on it. This screw is an ordinary bolt thread cut on steel, and must be quite straight. The length will be governed by the work it has to do; those from two to six inches are commonly exployed. The diameter is restricted by the size of the hole in the work, otherwise it is well to have it large enough to be quite stiff under the heaviest cut to which it is likely to be subjected. The cone shown is bored to fit without shake on the thread, and must be turned quite true, as it is by its outside that the work is centred. Hard wood is frequently sufficiently durable for cones, and only for light wood work; but metal is better, and when the chuck is used for metal work, metal cones are necessary, and they are often made of steel. Any number of cones may be made to fit on one screw, and several are required to suit holes of different sizes.

An ordinary hexagon nut is used to force the cone up to its work, a plain washer being interposed between it and the outer end of the cone. It will be understood that the disc mounted on this chuck is kept flat by the face of the flange, which also bears against the work with sufficient friction to carry it round with it, and will hold firm against any moderate cut. The centrality of the disc is maintained by the cone, which bears against the inner edge of the hole in the work, and is kept there by the hexagon screw nut. The cone itself penetrates the work till its diameter is greater than that of the hole; it then wedges the disc against the flange. This wedging force is liable to split wood which is not very tenacious, though it is not in any way detrimental to metal, and some hard woods will stand well under the pressure.

To secure wood that would be split by forcing the cone in far enough to wedge sufficiently tight for turning, another piece is fitted to this chuck. This may be thus described. The screw must be considerably longer for using this piece, which consists of a cup-like casting, the hollow of which is sufficiently large to contain the hexagon nuts and projecting portion of the cone. The bottom of the cup is bored to accurately fit the screw, and the edge is turned flat and true; another nut has to be provided similar to the one shown, its purpose being to force the cup against the work on the chuck. To use this extra piece, the disc is first mounted in the manner already described, with the cone screwed up just sufficiently tight to keep the work central. The cup is put on next with its edge resting against the disc. A nut being screwed on behind the cup causes its edge to grip the work and wedge it against the face of the flange. By this arrangement a disc may be secured quite tightly, without in the least tending to split it. The broad surface of the flange will not indent any but very soft material, and even this can be protected with a disc of cardboard. The edge of the cup may also bear on the work through an interposed piece of wood, so that it will not mark finished work.

Fig. 6 shows a modified form of the chuck illustrated by fig. 2. The conical screw is replaced by an ordinary wood screw, and a couple of other wood screws near the edge of the disc further secure the work.

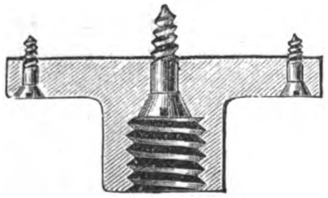

FIG. 6.—MODIFIED CONICAL SCREW CHUCK.

The foregoing will serve the purpose of this short article, which is simply intended to furnish beginners with an idea of a few of the most commonly used chucks which are employed by the general wood-turner.

HOW TO REPAIR CLOCKS.

PART II.

HAVING arranged the workboard, we are ready to commence our first job, which, we will suppose, is an ordinary eight-day English clock.

We select this for our first lesson because it is not easily injured, and is most likely to afford the largest amount of information. We will assume that the clock only requires examining and cleaning, and that no parts are missing or worn out.

When this clock is thoroughly understood, no difficulty will be found in repairing and attending to any other kinds, and we shall merely point out their respective common errors, and throw out any suggestions that may refer to the particular class under consideration.

Before taking the movement out of the case, it is often advisable to see whether we can find out the immediate cause of stopping. The points to which we direct attention are: The hands, to see if they are in any way bound; the catgut lines, to which the weights are attached; the striking parts, to see if there is any mishap connected with them; and the pendulum, to see if it is free. If all these things are correct, and the clock appears dirty, we conclude it wants cleaning, or that it needs some repairs which will necessitate its coming to pieces. Having satisfied ourselves on these points, we proceed to take off the two weights and the pendulum, and remove the movement to our workboard to undergo the requisite examination, cleaning and repairs. Placing it, dial downwards, on the board, we commence by unscrewing the screws by which the movement is fixed to the seat-board, and removing it. The bell-stud screw is now unturned, and the bell, bell-stud, and screw placed on the board; then the bridge or "cock" screws and the pallets taken out, and the cock screwed back in its place. The cock is replaced, so that we may turn the movement over without fear of scratching the back-plate, and it is left on till the last thing before the actual cleaning commences. The clock is now turned over face upwards, the small pin that secures the hands removed with the pliers, and the collet and hands taken off. In clock and watch work a "collet" very much resembles the washer or collar of other trades. Pull out the pins that hold the dial, and remove it.

Putting the movement on to the board with the back-plate downwards, it will be well to take a good view of the mechanism, and acquire a knowledge of the names of the different parts, and something of their relative positions and uses. In fig. 1 we give a rough sketch of the "back-plate," and in fig. 2 of the "top-plate," as it appears when the dial is removed, showing the position of the various parts.

The movement consists of two distinct sets of "trains" of wheels, set within two brass plates, which are kept the proper distance apart by turned pillars. These are rivetted to the back-plate by one end, while the other ends pass through holes in the corners of the top-plate, and are there secured by pins. One train of wheels and pinions constitutes the going part of the machine, and the other, with the various appurtenances connected with it, the striking mechanism.

The going train comprises the first or great-wheel and barrel, upon which the line runs; the centre wheel and pinion; third wheel and pinion, and the escape wheel and pinion. The striking train comprises the striking great-wheel and barrel; pin-wheel and pinion; gathering-pallet, pinion, and wheel; warning wheel and pinion; and the fly and its pinion. The names of the other parts of the clock are the pallets and crutch; cock; pendulum; bell-stud and bell; motion-work, embracing the cannon-pinion, minute-wheel, hour-wheel, and snail; the hammer and hammer-spring; lifter; dettent rack; rack-spring; rack-hook, and gathering-pallet.

The parts of a wheel are the teeth, the rim, the crossings, and the collet, or piece of brass on which the wheel is rivetted. The parts of a pinion are the leaves or teeth, the arbor, or axle, and the pivots which run in the holes.

The force of the falling weight is imparted to the wheels, whose motion is regulated by the pendulum so as to produce an equal division of time, which is indicated by the hands upon the dial. The train of wheels is made in proportion to the length of the pendulum. The use of the striking train is sufficiently indicated by the name, and the only thing observable at present is that the various wheels must revolve in certain exact proportions to each other, for the striking to be performed correctly.

It will be advisable to carefully observe the positions of the different wheels of the striking train, and by making it strike several times learn their action. The use of the pallets is to receive impulse from the escape-wheel teeth, allowing one tooth to pass or "escape" at each vibration of the pendulum. The cock, *a*, fig. 1, supports the pallet arbor at the back and also the pendulum. The pendulum regulates the velocity of the going train in such a manner that the centre wheel revolves once in an hour; and, though the vibrations are maintained by impulse received from the escapement, the number of vibrations per hour is regulated by the pendulum's length. The motion work, *a*, fig. 2, is a combination of wheelwork by which the centre-wheel arbor, revolving once every hour, is made to drive the hour-hand, which makes one revolution in twelve hours. The snail, *b*, which is usually fixed to the hour wheel, though sometimes mounted with a star-wheel upon a socket, and working upon a separate stud, regulates the fall of the rack, *e*. It is divided into twelve steps, and the falling of the rack tail, *l*, upon these steps, should allow the proper number of rack-teeth to be taken up by the gathering pallet when striking. The lifter, *c*, is a brass lever that is lifted every hour by a pin in the minute-wheel, and is connected with the steel dettent, *d*, which liberates the striking train at the proper time. The use of the rack, *e*, is to limit the number of blows struck by the hammer upon the bell. The blows vary with the depth of the step upon the snail, on which it is caused to fall by the rack-spring, *f*. The rack-hook, *g*, detains the rack, *e*, as it is gathered up, one tooth at a time, by the gathering-pallet, *h*, or allows it to fall when lifted up out of the way by the dettent, *d*. The use of the gathering-pallet, *h*, is to gather up the proper number of rack teeth, and then stop the running of the striking train by catching against a pin which projects from the rack.

Having obtained a good general idea of the mechanism, we proceed to take the clock to pieces. Remove the motion-work, and the various parts connected with the striking, which are under the dial; pull out the pins which hold the top plate on, take it off, and remove the wheels. Take off the hammer, tail spring, and the cock, and the clock will be ready for cleaning.

Different workmen have different methods of cleaning a clock, each supposing his own to be best; the one we give will be found as good as any. Mix up some rotten-stone with any good oil, and with a stiff clock-brush rub thoroughly over every part until all tarnish is removed. In brushing the plates, the brush must take one direction only, namely, lengthways of the plate, so that the scratches may appear in straight lines, otherwise it will look bad when finished.

Should there be any rust on any of the steel work, it must be removed with fine emery cloth, and then rotten-stoned. Remove as much as possible of the rotten-stone and oil with an old duster, finish with a clean brush wetted with turpentine, and wipe dry with a clean duster. In cleaning the wheels, etc., care must be taken not to bend the teeth, or any other delicate parts; and not to rub sufficiently hard and long in one place to take off the corners and destroy the proper shape. Take especial care to clean out the teeth of the wheels, the leaves of the pinion, and round the shoulders of the pivots. The holes in the plates must also be well cleaned out with thin strips of leather, holding the plates in the bench-vice. Wrap a duster round the part that goes in the vice, unless the jaws are provided with lead clamps, so as not to mark the plates. When every part is thoroughly clean, it will be ready for "examining." It will now be necessary to make about half-a-dozen "examining pins," which are merely taper iron pins, with a loop formed at one end, for affording facility in picking them up off the board. The examining pins require to be made about the length shown in fig. 3, and are only to be used for this one purpose. Cut off the required number of pieces of iron wire, and form the loops at the ends; put them one at a time in the hand-vice, and, resting the free end upon the filing-block held in the bench-vice, file them to the proper taper. Keep turning the pin round towards you, but only move it when the file is going in the opposite direction, that is, away from you. When filed to shape, they must be draw-filed with a smooth file, and finally burnished with a flat burnisher. A flat burnisher is simply a smooth piece of flat steel, and requires rubbing on the emery stick, so as to produce a grain crossways.

The first thing to be done in examining is to see that the wheels are tight on their pinions or collets; that they have no bent or injured teeth; and that the pillars are tight in the back-plate. If a wheel is found loose, it must at once be riveted tight, by placing a stake in the vice, and passing the arbor through a hole in it of sufficient size to allow the pinion or collet, as the case may be, to have a good bearing. Then with a half-round punch and a hammer, carefully rivet it tight, bearing in mind to keep the wheel so that it runs flat when finished. If any teeth are bent they must be straightened, either with a pair of pliers, or by the insertion of the edge of a knife, gradually raising the tooth to its proper position. Supposing we find a tooth broken out, it will be necessary to put in a new one, which is best accomplished in this manner:—With a fine saw cut out from the rim of the wheel, where the tooth is broken off, a dovetail-shaped piece, similar to that shown in fig. 4, taking care not to damage it in doing so. Accurately fit a piece of brass, a little thicker than the wheel, into the dovetail, with enough projecting to form a new tooth. When it is well fitted, scrape off the sharp edges of the dovetail; put in the piece, and rivet it well, so as to make it firm, taking care not to spread or damage the wheel. If the wheel is thin, and liable to be injured by the hammering, it is advisable to put a little tinning fluid to the edges of the piece before putting it in its place, rivet it slightly, and then neatly run in a little solder. When the new piece is thoroughly arm, file it flush with the wheel on both sides, and file up the tooth to the same shape and size as the perfect ones, keeping it midway between the adjoining teeth. It occasionally happens that more than one tooth is broken out—it may be four or five consecutively, and then considerable difficulty is found in making a good job. The following plan, which is original, so far as we know, will give a most satisfactory result if carefully followed. Proceed by fitting in a suitable piece of brass, as already described. Then procure a slip of zinc, drill a hole through it, and fit it tightly on the pinion or arbor upon which the wheel is mounted. Secure it at a part where the teeth are sound, and cut it to the shape of the wheel; then, with a slitting file or saw, cut out a pattern of five or six teeth more than you require in the new piece. When the zinc pattern is an exact copy of that part, bring it round to the new piece, allowing two or three of the zinc teeth to intersect with the wheel teeth at both ends of the new piece. Fix it in this position, and the new teeth may be then cut with the greatest ease and accuracy.

Another method of putting in a new tooth is to drill a hole, and tap in a steel wire, which is then filed to shape. This is not such a good plan as the other, and does not look so well, but might be preferable in some few peculiar cases.

The proper way to tighten a pillar is to pin on the top plate with the examining pins, rest the end of the pillar upon a hard wood block, and rivet it tight with a round-faced hammer.

Now try the pallets and crutch, and see that they are tight on their arbor. Observe the clicks and click-springs of the great wheels to see they are sound in their action, and that the great wheels are properly pinned up; neither so tight as to make it difficult to wind up the clock, nor so loose as to give the wheel too much freedom, or the click-work insecurity. Examine the pins of the striking pin-wheel, and the shape of the winding squares.

We now examine the wheels and pinions when in their places between the plates. The points requiring attention are the end-shakes, depths, pivots, and pivot-holes; also seeing that the wheels run free of each other and the plates. Put the great wheel and the centre wheel in, and pin the plates together with examining pins. Try the end-shakes by seeing that there is a fair amount of play between the pivots' shoulders and the plates. It should be just sufficient to allow of easy movement, and no more—about $\frac{1}{32}$in. or $\frac{1}{64}$in.

Next see that the pivot-holes are of proper size. The best way to test this is to spin the wheels round separately between the plates, when they should turn quite smoothly, yet not shake in their holes.

The "depth" or gearing of the teeth is next examined. Try the shake of the wheels in the pinions; if it is scarcely perceptible it is probably too deep; if it appears excessive it is probably too shallow. Gently press the wheel round in one direction, and the pinion in the other direction, allowing the force exerted on the wheel to overcome that exerted on the pinion.

If the depth is too shallow or too deep, the teeth of the wheel and the leaves of the pinion will lock or catch instead of running smooth. If the depth is incorrect, a new pivot-hole must be made. There are two methods of doing this, preference being given to the following:—Broach open the old hole to a fair size, leaving it irregular in shape, so as to prevent the stopping from turning round. Chamfer the edges of the hole, cut the rivet off close to the plate, and rivet it in tight with round-faced hammer. With a fine file remove any excess of rivet, making it smooth and level with the plate, and finishing with fine emery cloth and rotten-stone. Now mark with a centre-punch where the hole is to be made, and drill to nearly the right size. Enlarge the hole with a cutting broach till the point of the pivot will just enter, and then, by using a round broach, increase its size till the pivot runs quite freely. The outside will require chamfering to hold a supply of oil for the pivot. The ordinary form of chamfering tool is shown, fig. 5. It is a piece of round steel, pointed with three sides at the proper angle to produce a good shaped hollow, and with a ferrule upon it to receive the bow gut. Fig. 6 produces better results. It is a steel cutting wheel, working loose upon its axis in a slit made in one end of a brass handle. In the other end is a wheel that burnishes. The last named is twirled between the fingers; the first by the cane bow. It is always necessary, when a new hole has been put in, to try the wheel in by itself, and see that it runs free, resting on both plates. If, upon trial, it is found to have no end-shake, the best way is to free it with a sinking-tool, of the shape shown in fig. 7. It is a chisel-shaped cutter, with a brass guide-pin in the centre. Put the pin in the hole, and a few strokes of the bow will remove enough to give the necessary freedom. Particular attention must be given in putting new holes, not to get the wheels out of upright.

Having assured ourselves that the depths and endshakes are right, or corrected the errors, we notice that the tail of the click and the click-spring are free of the centre pinion, and then proceed to examine the centre wheel and third pinion in a similar manner. Having placed the centre wheel and third pinion in the plates, we will suppose in this case we find one of the pivots of the latter much too small for its hole, being worn or "cut" very badly, presenting a rough, uneven surface, instead of a smooth and straight one. If so, and it will admit of it, the pivot must be "run"—that is, filed down until it is smooth and straight, and a new hole put in the plate. In fig. 8 we give a drawing of the turns, and some of the most frequently used centres. To "run" the pivot, fix the turns in the vice, and put in a female centre at one end, and a running centre at the other. Secure a screw-ferrule, fig. 9, upon the sound end of the arbor, and, putting the point of the sound pivot in the female centre, *a*, adjust the position of the running centre, *b*, so that its groove receives the imperfect pivot, and allows it to have a good bearing. Put the gut of the cane bow round the ferrule in such a manner that the downstroke may cause it to revolve towards you; then, placing the plain edge of a fine file against the shoulder, file down the pivot until quite smooth and straight, taking care that with every downstroke of the bow the file is pushed away from you, and at the upstroke drawn towards you. Lastly burnish with a flat burnisher.

To put in a new pivot, the old one being broken off, file the end of the arbor quite flat, and make a slight centre mark exactly in the centre. Put on a screw-ferrule as before, and with a drill fitted into the centre, *c*, proceed to drill a hole of suitable size and depth to hold the new pivot. Cause the *arbor* to revolve, keeping the drill tight up to the work, by which means the hole will be drilled straight and true with the centre mark. Drawfile a piece of tempered steel to fit the hole nicely, and drive it in tight. Cut off to about the required length, and centre it, so that the wheel and pinion run exactly true. Turn the pivot down with a graver to nearly the size, and then "run" it with a smooth file till quite right; burnish, and round up the end in the rounding up centre, *d*. Should a new hole be necessary, put it in as previously directed. Having rectified any errors found to exist with the centre wheel and third pinion, examine in a similar manner the third wheel and escape pinion, and correct if requisite.

We now come to the escapement, and this is the most important part of the clock. The form which is usually found in eight-day English clocks, and, in fact, in all ordinary house clocks, is known as the "recoil," so called from the action of the pallets producing a certain amount of recoil at the escape wheel, and more or less throughout the train. It is also termed the "anchor" escapement, from the fancied resemblance of the pallets, as originally made, to an anchor. Its chief fault is its sensibility to any variation of force in the train; but it is strong, not easily damaged or deranged, does not require any great exactness in its construction, and is therefore cheap. Its performance, when well made, is such as to give satisfaction to most people.

In repairing this escapement it is well to spare no pains to make it as perfect as circumstances will admit, so as to obtain the best possible results. To do this we must reduce the friction by making the acting faces of the pallets very smooth and of good shape, avoid all excessive drop and consequent loss of power, and render it as free as possible from liability to the variation of the motive force. To examine the escapement, place the third wheel and escape wheel in the plates, and pin together with the examining pins. See that the pallets and crutch are tight on their arbor, and observe whether the pallets are worn by the action of the escape wheel teeth. Now put in the pallets and screw on the cock, and see whether the holes of the pallet-arbor pivots are of proper size, as it is very important that these holes should be only large enough for the pivots to be just free. If found to be too large, remedy at once by putting new ones; return the pallets to their place again, and proceed to test the action of the escape wheels upon the pallets by pressing forward the third wheel with one hand, and confining the action of the pallets by holding the crutch with the other, and then slowly moving it from side to side a sufficient distance to let each successive tooth "escape" the pallets. For the escapement to be correct it should fulfil these conditions:—The drop-on to each pallet should be equal, and only sufficient to give safe clearance to the tooth at the back of the pallet from which it has dropped; there should be as little recoil as can be obtained from the shape of the escape wheel; the pallets should not scrape the back of the escape wheel teeth; and the faces of the pallets should be perfectly smooth, and of such shape as to require to be moved by the escape wheel before "escaping" a sufficient distance to ensure a "good action" or movement of the pendulum. As a general rule it will be found sufficient if the end of the crutch moves about ½in. from drop to drop of the wheel teeth. If the pallets are worn the wearings must be filed out, at the same time taking advantage of the opportunity to make them a good shape.

Escape wheels being cut so variously, and the pallets pitched at no definite distance from the escape wheel, but only according to the maker's fancy, we can give no method by which the shape of the pallets may be struck out. As a rule, they should nearly fit the wheel, when pressed into it either side, as far as it is possible for them to go, the great object being to have as little recoil as possible. The first thing to be done before taking out the wearings, or altering the shape of the pallets, is to let down the temper. This is done by heating them to a cherry red, and allowing them to *gradually* cool again. Having thus softened them, file the wearings nearly out with a rather fine file, and alter to proper shape. Then smooth-file them, and lastly, with a bell-metal or soft steel rubber and oilstone dust, finish them very smooth and free from file marks. They can now be hardened by heating to cherry redness and plunging into cold water, and afterwards tempered by warming till a part previously brightened with emery turns to a straw colour. If, upon trial, there is found to be too much "drop" off the outside pallet, on to the inside one, the pallets need "closing," or bringing closer together, which is best effected by placing them upon the jaws of the vice, opened to a suitable distance, and giving them a tap with a small hammer, so as to bend them nearer to each other. Take great care in doing this, and see that the pallet arms have first been softened by heating as before directed, or they will break. If there is too much "drop" off the inside pallet on to the outside one, the pallets require bringing nearer the wheel. If the excess is not very great, it may be conveniently altered by lowering the cock a little. To do this, remove the steady pins from the cock, and move it round so that the "drop" is corrected; then drill new holes in the plate for the steady-pins, so that the cock will be kept in its new place. When the drop is very excessive, new holes must be put in the back plate nearer to the escape wheel for the cock screws, and the cock lowered as much as is necessary to make the drop equal and correct.

Fig. 10 shows the escape-wheel and pallets. The arrow indicates the direction in which the escape-wheel revolves; *a* is the outside pallet, *b* the inside pallet.

We may here remark that, though it is proper to leave as little "drop" as possible, do not carry this to extremes; but remember to give sufficient to ensure clearance after a little wear, and under disadvantageous circumstances, or else after going a few weeks, the pallets will catch, and the clock will stop.

When the edge of the inside pallet catches upon a tooth, the pallets are too close to the wheel; when the edge of the outside pallet catches there is insufficient distance between the pallets. Some escape-wheels are cut so irregularly that it is impossible to get a good escapement.

When the escapement is corrected, we turn our attention to the opening in the crutch; it should be sufficiently large for the pendulum rod to move freely, with a little side shake and no more; if at all rough inside, it must be made smooth and burnished, and then closed in to the proper size.

See that the pendulum is sound everywhere. That the spring is not cracked or crippled. That the regulating nut and screw at the bottom act properly, and the bob slides easily on the rod. See also that its suspension is sound; it should rest well on the stud, and fit sufficiently tight as not to move at the top above the slit when swinging. This concludes the examination of the principal part of the clock, and should never be neglected if good results are desired.

The striking train is generally examined before taking to pieces in a less critical manner, as it is seldom so bad as to be likely to fail in striking; there being no resistance for the striking weight to overcome except the tension of the hammer tail-spring and rack-spring, and the inertia of the train wheels. Should it be thought necessary, however, to be more careful, the course of procedure would be exactly similar to that described for the going train. The examination of the dial work is usually left until the clock is put together, as any errors can be easily altered, without in any way interfering with the rest of the clock. The plates may now be carefully wiped with a clean duster; a leather strip passed through the holes, and the wheels, pinions, and other parts brushed nice and clean, ready for putting together.—[The illustrations referred to will be included in our next issue.—ED.]

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Soldering Platinum and Gold.—To make platinum adhere firmly to gold by soldering, it is necessary that a small quantity of fine or 18-carat gold shall be sweated into the surface of the platinum at nearly a white heat, so that the gold shall soak into the face of the platinum; ordinary solder will then adhere firmly to the face obtained in this manner. Hard solder acts by partially fusing and combining with the surfaces to be joined, and platinum alone will not fuse or combine with any solder at a temperature anything like the fusing point of ordinary gold solder.

FREAKS OF ABSENT-MINDED MECHANICS.

(From the "American Machinist.")

THE absent-minded mechanic seldom, if ever, appears in print, notwithstanding there is a great many of him.

We often read accounts of the peculiarities of absent-minded individuals in other pursuits and professions, but somehow in reference to the mechanic nearly every one seems to have kept silent. When we first entered a machine shop as an apprentice, the first specimen of absent-mindedness that we remember was that of a workman who took down the pump valves on a locomotive to grind them in. This individual had frequently performed the same task previous to that without any trouble, but somehow he put in the upper valve of the pump upside down. The locomotive went out, and while running at a high rate of speed the water was turned on, when a loud report announced the fact to the engineer that he was minus one pump, it having been split from end to end by the enormous pressure generated within it.

Another workman, in quartering a pair of driving wheels before pressing them upon the axle, had them placed left-handed, so that the left side of the engine would lead. In other words, when a person stands at the end of the axle facing the wheels, the nearest wheel should have the crank pin at the right of the axle, while the farthest crank should be directly over the axle, and the two precisely at right angles to each other, so that the right side would lead. Instead of placing them in this way, the workman had placed the nearest wheel so that the crank stood at the left side of the axle, while the other crank stood directly over the axle. This he stoutly maintained was all right, as the wheels could be turned around before putting them under the engine, which would bring them all right. It took considerable time and an exhaustless array of arguments to convince this individual that he was wrong, when the truth flashed upon him all at once, and he proceeded directly to heap all sorts of abuse upon himself, also expressing a desire to submit to the process of booting if we were willing to do our part. He knew how to do the work, as he was an old hand at the job, but he didn't think. We once knew an old hand who had worked for years upon round house repairs, who was one day told to put the side rods upon an engine in the round house. He pinched the driving wheels so that the main pin stood above the axle, while the back pin was below, and proceeded to connect up the rod with the pins in that condition. He had nearly completed the work when his attention was called to the position of the cranks by the foreman. Upon comprehending his mistake, this workman admitted that he did not think.

On one occasion we took a locomotive out of the shop, and were somewhat surprised to find that while the exhaust came out clearly from the right hand cylinder, the left could not be detected, except by one continual blow of the escaping steam. An examination of the exhaust nozzles revealed the snout of a squirt can protruding from the aperture. The can filled the pipe so completely that only a small portion of the exhaust steam could escape. A subsequent examination revealed the fact that the workman in putting up the pipes had very carefully concealed his squirt can within the exhaust pipe to prevent its being stolen, and had connected up the pipes without removing his oiler. The can was, however, sacrificed to save breaking the joints of the pipe again. We were once acquainted with a lathe hand, who seemed to constantly labour under the impression that a considerable quantity of stock was to be taken off his work. Upon placing a piece of round iron, such as a large bolt, a piston rod, or pump plunger, in his lathe, he would habitually start a rough cut and run some distance before measuring his work to see how much stock was to come off, when a measurement with the callipers often convinced him that he had botched the job. When fitting a piece of work to a taper hole, he neglected to try his work in the hole as often as he should have done, he would suddenly realise that he was unable to put on sufficient stock to make a proper fit, too much having been taken off through his allowing some foreign subject to occupy his mind when it should have been occupied by his work.

We have repeatedly seen planer hands, in planing off brass surfaces, use a tool with sufficient rake to the edge to freely cut wrought iron. Such a tool would work well for a short distance until the edge became somewhat dulled, when it would suddenly dig into the surface of the work, and either stop the planer or rip things up generally. The workman would then accuse himself for his stupidity for attempting to use such a tool, when he well knew what the result would be. He appeared to labour under the impression that possibly, through the aid of some supernatural agency, the surface might be planed without serious trouble.

A workman, answering to this description, used to keep his tools within the bed of the planer, upon a board placed upon the flange at the bottom. One day he put his hand in there to get a tool, and something attracting his attention, he did not withdraw his hand quickly enough. The consequence was that his hand was fearfully jammed, being nearly torn off at the wrist. Thousands of fingers are lost annually, limbs broken, arms torn off, eyes put out, and lives sacrificed, through the absent-mindedness of individuals in responsible positions.

The majority of the accidents that occur can be traced directly to this inexcusable fault. It is a common practice among lathe hands to centre and carefully face up the ends of axles and shafting, and then proceed to straighten them. After the work is turned and finished, they complain that the ends are not at right angles to the parallel sides, when they well knew that the work should have been straightened first and the ends squared up afterwards. An engineer once removed the steam gauge from his engine to have it repaired, and in the morning, after the gauge had been replaced, he fired up. When the usual time had elapsed for raising steam, he noticed that the gauge indicated no increase of pressure within the boiler. The engineer, becoming impatient, fired up with tremendous vigour and went into the engine room, for a few moments, to oil up, when suddenly he was astounded to hear the roar of steam escaping from the safety valve, which had been suddenly raised by the rapidly increasing pressure. The engineer rushed to the fire-room and was powerless to speak for a moment after inspecting the gauge, finding that it still remained as at first. A moment's reflection convinced him that he had neglected to open the cock in the pipe connecting the gauge with the boiler. The fact that the safety valve was in fair working condition was all that prevented an explosion, which would certainly have been attended with a tremendous loss of life. In putting on an eight-inch belt, a machinist took his station upon the wrong side of the shaft, where the belt ran on the pulley. He took up the belt and pressed it upon the pulley, when suddenly his arm was caught and torn off between the shoulder and the elbow. He is still alive, and has a lifetime in which to lament his absent-mindedness. This question often arises in his mind, "Why did I place myself upon the wrong side of the pulley, when I well knew what would be the consequence?" It is, and will probably always be to him, a mystery how he came to commit such a reckless act.

The foregoing incidents are all true, and a great many other similar ones might be added, but we trust that those herein recorded are sufficient to illustrate the frequency of the casualties brought about by absent-mindedness.

SPIRAL FLUTED IVORY CUP AND COVER.

(*For Illustration, see Supplement.*)

WE are again indebted to General Clarke for another specimen of ornamental turnery. The object which is illustrated by the accompanying photograph has been described in the journal of the Amateur Mechanical Society. The following particulars concerning its production will suffice for those who have some general knowledge of the tools employed in such work.

The engraving from which I got the idea of the ivory cup and cover shown in the illustration, may be found in the volume of the "Art Journal" for 1849, at page 59. The original represented there was in wood. The article shown here is about 9in. in height.

The base was formed from a round piece of ivory, about 3⅜in. in diameter, and ⅜ths of an inch in thickness. One face of this being made smooth and flat, a hole was made in the centre about ⅜ths of an inch in diameter, and a screw cut in it. The piece was then reversed, and, by means of the screw, chucked upon a wooden chuck somewhat smaller in diameter than the ivory, so as to leave the edge projecting beyond the wood. A screw having been formed in the centre to receive the stem supporting the cup, and the piece roughly turned to a conical form, the slide-rest was placed in front of the work, with the universal cutting-frame, set to cut vertically downwards, carrying a broad flat-ended tool, well sharpened. The tool being brought opposite the outer edge of the ivory, a series of twelve cuts was made all round, to as great a depth as the material would allow without making it too thin. The tool was then shifted $\frac{1}{10}$th of an inch to the right, and a second series of cuts made all round with the right corner of the tool, the depth of the cuts being diminished by about $\frac{1}{16}$th of an inch. The same operation was repeated till seven series of cuts had been made besides the broad one at the outer edge, each series being $\frac{1}{16}$th of an inch less deep than the last, till the whole was cut into steps, leaving a flat space in the centre of about 1¼in. in diameter. The slide-rest was then brought round, not quite parallel with the lathe-bed, but at an angle of about 30° with it, and, with the same tool as before, with the same settings of the division-plate, the outer edge had twelve scollops cut in it, corresponding with the steps.

The piece above this is a flat washer of ivory, having its edges cut into beads, which project beyond the upper steps of the base. It fits over the shoulder of the next piece. This was shaped by the universal cutting frame, working horizontally, and carrying a < shaped tool. The cutter being placed so that the sweep of the tool in its revolution would give the curve, was then drawn along by the slide-rest screw, so that the upper portion of each cut or fluting was straight. This piece has a male screw at each end the lower one screwing into the base, and the upper one into the next piece above. This screws into another of the same shape reversed, with a small washer with serrated edges between them. These two pieces were shaped by the universal cutter, the sweep of the tool giving the curve. The upper one has a male screw on the top, to which is screwed the conical body of the cup, in the bottom of which is a screwed circular groove to receive the upper screwed portion of the piece with scolloped edges seen below it. The scollops were made by drawing a pattern drill across the face of the ivory, after it had been reduced to a thin shell.

The body of the cup was made from a piece of ivory about 2¾in. long and 3in. in diameter at the larger end. The ivory being firmly chucked by its smaller end, was hollowed out and had the screw cut upon the larger end, to which the scolloped rim was to be attached. The hollowing out was done, or rather finished, with the strong right side cutter-bar, the slide-rest being set at the proper angle. The piece was then chucked by the upper screw, and brought to the proper conical form. The screws at the bottom were also made—that in the centre to receive the upper part of the stem, and that in the circular groove to which the lower rim is attached.

The spiral flutings on this piece were produced by the universal cutting-frame with a round-ended tool working vertically downwards, the spiral apparatus being employed to give the necessary twist to each cut. In order that the cuts might follow the slope of the cone, the curvilinear apparatus was used, but instead of a curved template a piece of sheet brass or iron was filed up into the shape shown in the cup, with a circular slot near one end, which enabled it to be set to any angle, so that, though the slide-rest remained parallel to the lathe-bed, the tool was guided in a direction corresponding with the required slope.

The scolloped rim at the top of the cup was shaped by cutting out circular portions just meeting each other round the edge, with the eccentric cutter, and then making suitable holes with the drill. This completes the cup itself.

The principal part of the cover, having spiral grooves on a curved surface, was, after being roughly turned to shape, finished by employing the spiral apparatus in combination with a template of the required form in the curvilinear apparatus, with the same tool as before in the universal cutting-frame. The slope of the curve in approaching the narrower part of the piece being very rapid, it was necessary to move the handle on the slide-rest screw very slowly and carefully, and with all the care I could use, there were more tool marks left on the ivory than I could wish. Some slide-rests are fitted with a worm-wheel and tangent screw to the micrometer head of the long screw, and this arrangement would be very useful in such work as I am now describing. The lower portion of this piece was formed with a screw for the convenience of chucking it while being shaped, and this screws into a plain piece which fits into the cup.

Above the piece with the spiral flutes rises a short stem, with a washer below it with a beaded edge. This stem is formed in the same manner as the portion into which it screws, with a spiral apparatus and a suitable template in the curvilinear apparatus. Next comes a piece shaped on the dome or spherical chuck with flutes cut with the vertical cutter carrying a Λ shaped tool. Into this is screwed the double spiral stem which carries the finial. This stem was made on the eccentric chuck. It is rather delicate work, and requires a good deal of care. In fact, what with accidents while working, and the action of energetic housemaids since I am afraid to say how often I have had to make the piece in question. A piece of good ivory, having been brought to the required length, including an allowance for a male screw at each end, was chucked by what was to be the smaller or upper end. It was then bored throughout its length with a pipe-boring tool, made from a long steel wire into a half-round borer about ⅛th of an inch in diameter. The screw by which the piece was to be attached to that below it was next formed, and then the bore was enlarged at the free end and made conical internally, the larger end of the hole being made as large as the screw would allow. The piece was then attached by that screw to a chuck on the eccentric chuck and reduced to the conical form externally. A small portion at the outer end was made into a fine screw of as small a diameter as the bore would allow, for the purpose of carrying the finial, and then the double spiral was commenced at the right-hand end, leaving a very small interval between the first steps and the screw. The tool in the slide-rest with which the steps were cut was about $\frac{4}{100}$ths of an inch wide. The eccentric chuck slide was thrown down about $\frac{8}{100}$ths of an inch. The tool being placed for cutting the first pair of steps, was advanced on both sides alternately until it was seen that the two corresponding cuts at each side had entered the bore of the ivory. After the first cuts, the click-wheel of the eccentric chuck was shifted round six teeth, and so on for the remainder, the tool each time being allowed to penetrate till the cuts at each side had shown themselves in the bore of the ivory.

The finial, which screws on the top of the double spiral stem, is formed of two pieces—the lower having its edge cut into little teeth by cuts made by a tool bevelled on the left side in the eccentric cutting-frame. The part above this is plain. The two together bear some resemblance to an acorn.

G. C. C.

Cleaning Screws from Rust.—Screws that are too small for separate treatment may be cleaned as follows: Take, say, one pound of screws, and place them in a small box; a cigar box will do. Put a small quantity of oil on them and shake for a minute; then put a piece of cotton waste in the box, and repeat for a minute; finally put a handful of sawdust in the box and shake for another minute or so, and remove the sawdust by sifting it from the screws in a fine sieve. The screws will be found to be as good as new. Larger quantities are apt to be ruined in a "churn," and sharp corners, threads and points rapidly disappear in a churn.

Gauge of Firearms.—The bores of fowling pieces are named from the number of spherical lead bullets to the pound, Avoirdupois, that they will carry. The curious in such matters will find the diameters by calculation in Act 18 and 19 Vict. cap. 148, lead being taken at 2,870 grains to 1 cubic inch. There is a difference between the proof-house gauges and the calculated sizes, as *e.g.* a 12-bore by calculation is .729in. diameter, while the gauge gives .739 or one-hundredth of an inch larger, and the same difference almost exactly exists from No. 8 size to No. 20, which are about the limits of ordinary shot-guns. An easy rule for finding the weight of a ball is to take the diameter in thousandths, and having cubed it strike off all but the first three figures, and take once and a half that number for the grains weight. Thus No. 12 gauge is ·729 diameter, of which the cube commences with ·3874, and $\frac{3}{2}$ times that is 581½, which is only two grains short of the calculated weight. Since spherical bullets have been discarded for military arms, those are usually spoken of by their measured diameters as ·577 Enfield, ·451 military small bore, and ·5 Express, &c.

BREAKING OF GLASS WATER GAUGES.

ONE of the greatest annoyances that I ever had to contend with since I took charge of a stationary engine has been the frequent breaking of glass water gauges. After breaking a glass I at once endeavoured to trace out the cause. The individual who sold me the glass maintained that it was all right, that no fault was there; while a competitor argued that Bohemian glass was not the best kind to use, and that common sense ought to have taught me to purchase Scotch flint. Still another asserted that he used a German glass that had been annealed several times, which made it so tough that the tube might be dropped upon the floor without breaking. I finally came to the conclusion that those men wanted to sell gauge glasses rather than to find out the cause of their breaking, so I went into an investigation with the determination to find out the true cause of the trouble. I found that my neighbour would often use glasses for six months without breaking, then he would break several in succession before getting one to stand.

A general practice for making tight joints in the stuffing boxes at each end of the gauge glass is to use rubber washers.

In many instances these washers, which are made and sold for this purpose, are too large for the glass, so that the nut upon the stuffing box has to be screwed down very tight to stop leaks, while in other cases the washers are cut from a sheet of rubber with a jack-knife. Everyone who has attempted to cut out a round washer with a pocket-knife knows it to be a positive fact that a round, smooth hole cannot be cut through a sheet of rubber by any such process; therefore, when these washers are put upon the glass and pressure applied, there must necessarily be an unequal pressure upon the glass, which will tend to collapse the tube. The best rubber washers for this purpose are composed of a nearly pure gum, with a hole of sufficient size to fit tightly over the glass tube; then, when the nut upon the stuffing box is tightened, a very little pressure will make a tight joint.

Almost all engineers who have had any experience with gauge glasses prefer the latter method. I maintain that rubber is not a proper substance to use for making the joints upon a glass water gauge. I never use it in making steam or hot water joints about engines or boilers. I will endeavour to support my assertion by quoting from facts that have been demonstrated by experience.

When a gauge glass has been inserted and the joints made by rubber washers, a few hours' exposure to the heat will stick the rubber firmly to the glass, after which the gum will gradually vulcanise, becoming as hard as a stone, and being so firmly attached to the glass that it is almost impossible to remove the glass without breaking it.

After the rubber becomes hardened up to a certain degree it will leak, then when the nuts upon the stuffing boxes are moved "pop" goes the glass, bringing forth an expression from the operator not found in the revised New Testament. The man who sold the glass to this party can hardly be blamed for the accident, so the loss is attributed to bad luck, and a new glass is purchased and applied.

Frequently, when glass gauges are used upon boilers, and without any apparent reason, the glass tube will snap like a pipe-stem; then the dealer has to take the blame. The true case generally is that the rubber sticks to the glass, as described, so that an excessive expansion of the glass or boiler will eventually break the tube, as the sticking of the gum prevents a free end movement of the glass. Without going into further details in reference to the various causes of the breaking of gauge glasses, I will explain how I successfully prevented their breaking. First: I purchased a glass tube of the best quality that could be found in the market, put it in place, and packed it with asbestos wicking, which can now be had in nearly all first-class supply stores. I was particular to pick the fibres apart, so as to get an even quantity on all sides of the tube. I then tightened it moderately. After steam was raised the nuts were again tightened just sufficiently to make a tight joint. The glass is thus left free to expand and contract without danger of breaking. A little graphite (blacklead) sprinkled among the fibres is an improvement, and will prevent any possible sticking of the glass. I have not broken a single glass since the adoption of this method of packing the joints, and the glass can be removed from the fittings at any time and replaced without danger of its breaking.

In swabbing out a glass I never use a wire, but use a stick instead, because a wire or other piece of metal coming in contact with the glass is liable to cause it to snap in two. I admit, concludes a writer in the "American Machinist," that these little details are sometimes bad for the dealers, but we wish to avoid the danger of being scalded by the breaking of gauge glasses.

MACHINE SHOP SYSTEM.

(From the "American Machinist.")

A LARGE part of the trouble and worry of machine-shop management, and the greater proportion of the waste and loss, comes through small things—trifles, presumably of not sufficient importance to command the effort of persistent looking after. The long-line shaft gets oiled and otherwise attended to because there is too much of it to be neglected; but the little piece, out of the way somewhere, runs dry, gets out of line, and finally fails some day when it is most needed. The long line assumes an importance because it is a long line, and it is the duty of someone to see that there is no trouble from it. The short piece is not worth an appointment, and causes trouble and expense, and comes to grief.

The machine that is run regularly by someone is always in order, with all its appointments, because it is the duty of that someone to keep it so; but the machine that is used only occasionally, and then by anyone and everyone, never gets oiled till it refuses to work without it; never is provided with decent tools to work with; never has a belt in condition to drive; never gets cleaned up, except in a spasm of general shop cleaning, and is in a state of universal demoralisation always.

As a matter of fact, the machine that breaks down when it is wanted, from which a good job never comes, and which wears out first, is the one that, in the common phraseology, is never used, and is not of enough importance to have the responsibility of anyone in particular connected with it. In other words, like the short shaft, it is one of the small things. The job that is not of sufficient importance to make provision for doing properly, and that any way is good enough for, is the one that costs the most, and the one that, when done, is just near enough right to be good for nothing.

So with the products of the machine shop; it is the small things that the customer finds fault with, and that vex the proprietor; things just large enough to grumble about, and from the effects of which to treasure up prejudice. The good points, which may be about all of them, are lost sight of in the petty trouble caused by some little feature overlooked, or passed because it is a trifle, and the general impression is unfavourable, when by all laws of average it ought to be favourable. The nut that gets suddenly tight in the thread; the cap bolt that just bottoms when it ought to bind; the little inconsequential bearing with no provision for oiling; these small things are sources of more trouble than the large shaft and the big screw which are right as a matter of course, or, if they are not right, against which there is room to lodge a respectable complaint, and to cover the complaint with a reason. If anything in the way of fault-finding can be said to be universal, it is the habit of grumbling about little details of machines and machinery, which is, perhaps, explainable on the theory that the principal parts are now made too perfect to complain about.

Present machine-shop system has done wonders in the way of providing for taking care of things by appointment, and making things right systematically; but it is difficult to devise a system that shall provide for everything. By and by it comes to require the addition of a pretty complicated system to look after the original one. It is easy enough to embrace and provide for the things of magnitude, but to make the same system cover the little points of shop management, and the minute details of work entirely to one's satisfaction, is not so easy.

One fault with many shop systems—perhaps, to some extent, with all—is in not taking sufficient advantage of the intelligence of the workmen. A good deal must always depend on those who do the work; and amongst other things a shop system must provide for having the right men in the right places—which are all places—as well as provide what they are to do in the line of that system. The workmen's method must become a part of the general method before the latter can accomplish all that it should accomplish, and perhaps their part is the most important of all, for without their co-operation the most elaborate system will never be above the probability of vexatious failures in small things. The machine shop is well provided in that respect, in which the system covers, so far as may be, everything, and those workmen are valuable who work in harmony with it, particularly so when the system comprehends and the workmen appreciate the importance of small things.

A POCKET SHOCKING COIL.

MINIATURE coils which will produce an overpowering shock, and especially those that can be carried in the waistcoat pocket, have long been popular. Electricity has, during the last few years, made such rapid progress that in many branches of the science the most perfect things of even a year ago are superseded. Small coils that are used for producing shocks and sparks have remained without much alteration, whilst the acumen of the electrical world has been directed to improvements in motors and lights. The small coil here described will be found to work well in practice. Its small size admits of it being carried in the pocket, and it is needless to add that a shocking coil may be made the source of great amusement.

The reel on which the wire is wound consists of a pair of flat discs for ends, and a paper tube in which the core is placed. The discs may be made of any hard wood, but it must be perfectly dry, and should be baked before use. Sheet ebonite, which may be purchased of most dealers in electrical requisites, is perhaps better than wood. The discs should be turned on a lathe if the use of this machine is possible. The tube is made by rolling a strip of brown paper around a cylinder. This paper tube answers all requirements; it may be coated with solid paraffin to improve the insulation. The tube for the coil reel is made upon a glass rod ¼in. in diameter. Make a paper tube upon this former of about three thicknesses of stout note-paper, gluing all one side, except that portion which comes in contact with the tube. The length of this tube is 2½in. when finished. Slide it off the former, and allow to dry hard. For the ends two discs of any hard wood are made, ⅛in. thick, and 1⅛in. in diameter—be accurate in all dimensions. Each disc has a hole in the centre, $\frac{5}{16}$in. in diameter. This will allow the tube just made to be $\frac{1}{32}$in. in thickness, and when making the tube its thickness should be made accordingly.

Slightly bevel the hole on the outer side of each disc, so that the tube may be partly opened at the end, giving it a better hold in cementing the disc on. When pressing on the discs it is better to have the tube upon the former on which it was rolled, so that sufficient force may be applied. The cement for fixing the ends to the tube is made by mixing gutta-percha and pitch together, but almost any strong cement will do, and glue answers well. It is very important to put the discs on square with the tube. This is easily done if a pair of callipers is used to gauge the distance between the discs. The eye will, however, generally suffice.

If the holes in the centres of the discs are bored through perfectly upright with the surface, and the paper tube fits, the ends will fit on truly without trouble.

Having completed the reel for winding the wire on, see to the wire itself. It is of two sizes, and is in two lengths, one being the primary the other the secondary. The thickest, or primary wire, is laid first on the tube, and is composed of two complete layers of No. 24 Birmingham wire gauge copper wire, and silk-covered. About one ounce will be the quantity required. Before commencing to wind this wire, pierce, with a red-hot wire, a small hole in one of the discs very near to the tube. Push one end of the wire through this hole from the inside for 6in., wind this length into a ball, and place in the tube, so that it may be out of the way. Commence winding the other wire upon the tube very evenly and closely. The wire should be wound on in a regular spiral, each turn quite close to its neighbour's, just as cotton is wound upon a reel. Pierce another hole in the disc, as near to the upper layer of wire as possible, and take out the finishing end of the wire, completing the primary coil. The two ends of wire will thus come out quite close together at the same end. A few inches of wire is all that is wanted to make connections, as explained further on. It is desirable to lay upon these two layers of primary wire a coat of melted paraffin wax, so that a smooth surface may be prepared for receiving the secondary coil, but this is not absolutely necessary if the maker is handy in the matter of winding. The paraffin is laid on in a melted state, and is made to saturate the under layer of wire by applying a heated iron near to the surface.

A strip of good note paper should be rolled round the primary wire to slightly overlap where it should be glued. This forms an even surface for the secondary wire to be wound upon.

The secondary coil will consist of about two ounces of No. 38 Birmingham wire gauge copper wire, silk-covered. The winding is commenced by piercing a hole through the opposite disc to where the primary wire commences and ends. Very great care is necessary in laying the secondary wire. It must not be simply wound on anyhow; it must be laid as regularly as silk or cotton thread is upon sewing-thread reels. Fine wire is much more difficult to wind than coarse, and every possible care will be necessary in the hands of the unskilled. Coils are best wound in some contrivance by which they may be revolved, as in a lathe, but slowly. The wire should be examined as it passes through the fingers, before laying, to find that no breaks occur. No "kinks"—*i.e.*, sudden bends doubled up—must be wound on. If a kink makes its unwelcome appearance, it is best to bend it back slowly as it came, and not to pull it out, which generally results in snapping the wire at this point. Before being covered with silk thread and varnish, see also that no skinned parts of the wire are wound on. Fill the reel, and take the finishing layer end out at the same disc as the first end of the secondary was pushed through. In making up a first class coil of this kind, it is better to give every layer of the secondary coil a thin coating of melted paraffin; but the layers must be very thin, as much space cannot be spared. If the coil is kept quite dry this is not necessary.

When the secondary coil has been wound on successfully, plug up the holes in the central core, and place the entire coil in a bath of melted paraffin wax. The paraffin must be kept quite hot whilst the coil is in it, so that the melted wax may soak into the secondary coil. A few hours should be allowed for this. The coil is then to be removed, and when the wax is set, all superfluous is scraped off. The continuity of the wires should be tested as the work proceeds, if there is any reason for suspecting a break. This is very easily detected as the wire passes through the fingers in winding.

The core for the centre of the coil has next to be made. The hole through the paper tube is to be filled with iron, which will become magnetised by the electric current and produce the shocks. The core of this coil is composed of iron wires. These iron wires form a round bundle, 2½in. long, and are packed into a brass tube 2½in. long also. The diameter of this tube is ¼in.—that is, it fits into the paper tube in the centre of the coil—and it should be of very thin brass. Fishing-tackle vendors have suitable sizes of tubing. The iron wire should be soft, No. 24 to 28 Birmingham wire gauge, and can be had in all sizes from cage makers or ironmongers. Cut as many pieces as will fill the tube, and make them straight before placing in by rolling on some flat surface with a flat-iron. See that they are all of the same length. After the wires are packed in the tube—not too tight—make the ends even, and pull one end of the bundle out for a short distance, and commence to wrap a length of fine binding-wire around it, pulling the bundle out as the winding proceeds, until the whole is out, and in a solid cylindrical form. Fasten off the end of the binding-wire, and place the bundle in a blood-red fire for a short time to soften, then bury in the ashes to cool; when nearly cold, dip into melted paraffin for a few minutes, take out, and cool down. Wind off the binding-wire, and scrape off the useless paraffin, leaving a compact bundle, held together by the paraffin, which will fit the brass tube with gentle friction. It is well to file one end of the bundle perfectly flat with a new file after it is taken out of the paraffin, and before the wire is wound off.

Place the core in the brass tube, and place both in the tube of the reel; have the ends even, draw the brass tube out for ¼in., leaving the core where it was, and run some cement into the ¼in. space left by the tube at one end; the object being to fix the core firmly at one end of the reel, so that when the tube is withdrawn the core remains as part of the reel. Wooden pins may be employed for fixing, if a suitable cement is not at hand, and a little plaster of Paris will make a good joint, as will also a little paraffin run in while hot. The end of the brass tube, drawn from the reel to make room for the joint, may have a small ivory ball, or such-like, fastened into it, to serve for a short handle to draw the tube out with, when we wish to increase the shock; or a brass folding ring may be fastened to it for a like purpose.

This brass tube forms a regulator, by which the force of the current may be reduced from its fullest extent to an unappreciable amount. When the tube is entirely withdrawn, the coil develops its greatest force, and as the brass is pushed in over the iron core, the force is diminished.

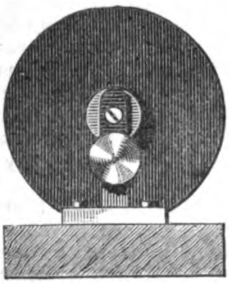


FIG. 1.

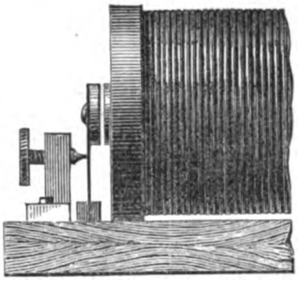


FIG. 2.

A reference to the illustrations will make the details of the contact breaker clear. Fig. 1 is an end view of the coil, showing the disc forming the end of the reel and the base board on which the coil is mounted. Fig. 2 is a side view of fig. 1. Referring to fig. 2, on the right is the coil end; the slight projection in the centre is the core of soft iron wire. Opposite the core-end is the clapper, which is attracted by the magnetism in the core. This clapper is a disc of soft iron, mounted on a hard brass spring, which spring is fixed to a small brass foot by which it may be fixed firmly to the base board. The milled headed screw shown on the left is the adjusting screw. It is tapped through a piece of brass, so shaped that it can be fixed firmly to the base board. The point of this screw is tipped with platinum, and the spring has also a piece of platinum foil soldered to it at the point where the screw makes contact. It is essential that all the parts of the contact are firmly fixed.

The parts of the break are shown sufficiently separated to allow of a clear definition; but in reality, the soft-iron disc, *p*, is very close to the core end, and the platinum point, *e*, touches the platinised end of the screw, *b*. A narrow base-board is screwed to the edges of the reel discs; it is fixed flush at one end (the end at which the brass tube draws), and at the other end, shown in the illustration, it projects past the disc ½in. This space is long enough to allow all the parts of the break shown to be fastened to it. The wood of which this base-board is made should be dry, hard material, ¼in. thick, 1in. wide, and 3in. long. The extra width not used by the break at the end may be utilised for holding small brass terminal screws for connecting the battery wires and handles to. Four of these screws are to be fastened in, two at each side. They are made to hold the wires by screwing, or the wires may be soldered to them. Having provided the break and screws, we may make the connections.

The coil is fixed to the base board by screws or by wire half hoops around the end discs, and passing through the board. Small nuts screwed on to the ends of the wire will hold the coil very firm. The ends of the primary and secondary wires should be passed through small holes made in the base board at convenient places near to where the discs rest. The wires have to be connected with the terminal screws, and grooves are cut in the bottom of the base-board to allow the wires to lie in. The secondary wire has its two ends soldered to two of the terminals, and these are called the secondary terminals.

The primary wire has to be arranged to pass the current through the contact breaker. Solder one end to one of the unused terminals. The other end solder to the base to which the spring carrying the clapper is fixed. Then connect, by means of a piece of copper wire, the base of the adjusting screw piece to the remaining unused terminal. The battery is connected to the terminals of the primary wire, and the electric current passes from one terminal, through the wire coiled round the core, to the clapper spring. It passes up the spring to the platinum pointed screw, and down that piece to the other terminal. It is easy to see that, as soon as the current passes, the core of the coil becomes magnetic, and attracts the clapper. As this is drawn towards the core, the connection between the platinum pointed screw and the spring is broken; the current circuit is broken, and the core loses its magnetism. The clapper returns to its original position by force of the spring, and couples the circuit again. In this way the circuit is continually made and broken at a very quick rate, the clapper buzzing.

Case for the Instrument.—We may now proceed to construct a box in which our coil, with its battery and directors, may be packed, and placed in the vest pocket. It may be of cigar-box wood, and the size of the case on one of those coils is accurately as follows:—3½in. deep, 3½in. long, 1¼in. wide, all *internal* measurements. This box can be easily carried in any pocket, and eight of those coils can be carried in a coat pocket. Surely this is small enough!

The Battery.—This is made on the chloride of silver principle, and is the best cell for this coil. It may be contained in a thin glass phial with the top cut off. Diameter of this phial may be 1in., and the length 3¼in. A wood cap is fitted to the top, and the plates of the cell are fitted by their ends to the under side of this cap. It is better to fasten them here by thin strips of silver. One plate is thin, and is of silver, and upon this plate is melted chloride of silver, forming "horn silver."

The other plate of this cell is of thick sheet zinc, and the plates are placed ⅛in. apart, between them being a few layers of blotting-paper, reaching nearly to the top, and thoroughly saturated with a solution of chloride of zinc. Silver or platinum wires are soldered to the plates and carried out through holes in the top, one being always fastened with clean connection to one of the primary studs of the coil. The other wire should have a kind of cap on it, so that it may at any moment be placed on the other stud, so completing the circuit, and causing the break hammer to work very rapidly, causing also strong *induced* currents to circulate in the secondary coil, when its circuit is closed through the hands, or otherwise. The capped wire of the battery is always kept off the stud, except at the moment we require shocks, and the oftener it is on the stud the sooner will the chloride of silver cell be exhausted and require renewing. The directors may be pieces of tube 3in. long, having covered copper wires attached, which may always be fastened to the secondary studs. If the coil is not carried about, a very small bichromate cell will work it powerfully, and is a more satisfactory battery to use than the chloride of silver.

* * *

To Make Furniture Paste.—Scrape two ounces of bees-wax into a pot or basin; then add as much spirits of turpentine as will moisten it through. At the same time, powder an eighth part of an ounce of resin, and add it, when dissolved to the consistence of paste, as much Indian red as will bring it to a deep mahogany colour. Stir it up, and it will be fit for use.

TESTING AND SELECTING STEEL.

BY S. W. GOODYEAR.

(From the "American Machinist.")

I MUST present some facts as they appear to me from observation and experiment of great importance, applying to the selection of steel for various purposes, ranging from its use in the construction of bridges, buildings, railways, etc., to the finest of dies and tools requiring the greatest amount of tenacity, and durability of cutting edge or working surface.

Beginning with the proposition that for any use in which steel has been known to fail there is no such thing as selecting that which is too good, remembering that different uses require different steel—that which is best for some uses not being even good for others—I wish to endeavour to make clear to those who read, as it is to myself, that *condition* in steel is of no less importance than *quality*, or rather, that the condition of steel controls its quality, as judged by practical results in its use, fully as much or more than do the constituent parts of which it is composed.

In my remarks upon this as upon other subjects, I am obliged to confine myself to the plain mechanic's understanding of the matter; drawing some conclusions from experiments made by some of the most prominent technically educated mechanics, others from my own rule of thumb experiments.

As safety from breakage under strain or shock, wearing qualities, quality of resistance to indentation or abrasion under pressure or friction are to be considered, it becomes necessary from the start that there shall be no misunderstanding of what certain tests, made with a view to show the quality and value of steel, actually do show. Especially is it necessary not to fall into the error of believing that because certain tests of certain particular steel have shown certain results, such results must of necessity follow other tests of the same steel; for, under different conditions, different results must be looked for in the same steel.

To the investigator there is probably no question presenting more anomalous and directly contradictory conditions. In practical use steel is often found to be the least safe in its condition of greatest strength, and strongest or safest when in its weakest condition. To illustrate: a steel requiring 140,000 lbs. to the square inch of tensile strain to produce rupture when tested in an unannealed condition, may, after annealing, be broken at 100,000 lbs., perhaps less, and still be in a practically stronger and safer condition than before for most uses, because it will stand an amount of deflection, or torsional strain, not as tested in pounds, but in relative change of position of parts composing the mass, which would have inevitably broken the stronger, because harder steel.

Steel is supposed to be brittle and weak when hardened by heating and suddenly cooling in cold water. So it appears as usually hardened, and to overcome the brittle condition the temper is drawn. I long since learned, by having been forced to resort to the sledge to break pieces of hardened steel with temper undrawn, which could easily be broken with a hand hammer before hardening, to contradict the *ipse dixits* of writers who positively assert that steel by hardening in water is made weaker, and will break under less strain than before. Does the reader say this is true? It is true, just as it would be true to say that tea and coffee are drank *with* sugar and cream. So they are *without*. "Steel *is* made weaker by hardening in cold water," but *not* necessarily. Proof: After seeing a number of pieces of steel in a semi-annealed condition broken by tensile strain, the ultimate strength being from 104,000 lbs. to 110,000 lbs. or 115,000 lbs. to the square inch, one piece only reaching 123,000 lbs., this steel being of a quality which would have shown without annealing about 140,000 lbs., I have taken other pieces of the same steel, from the same bars, and heating them in an open fire, laying them directly on a bed of coals, and plunging them when hot into cold water, have had them tested for tensile strength without drawing the temper. They were shown to be hard enough to cut glass, and I found that some of them broke at less than 100,000 lbs. Say the books and their champions, "We told you so." Wait a little: Several of the hardened pieces required a tensile strain of over 150,000 lbs. to the square inch to break them, and one piece *broke only at* 211,000 lbs. Was it not fully proven that the strength of steel *can be increased* by cold water hardening? That some of the pieces were not so strong as before hardening simply proved that they were heated too hot.

Are the tests by tensile, torsional, and transverse strain as indicated in pounds as conclusive as they are judged to be? Of two pieces of steel precisely alike, except in condition, one might be adjudged upon testing to be much inferior to the other, simply because it is annealed to a softer condition. Again, of two pieces, one of which is vastly superior to the other in strength, when in proper condition, the better might be condemned as the poorer.

I do not lack respect for, and appreciation of those tests in which resistance to torsion or deflection, as measured in pounds, is depended upon to determine the comparative merit of two steels. It strikes me, however, that there are many cases in which the mechanic's methods of testing will be a better guide in determining quality, and condition, than any array of the most carefully recorded figures taken from the results of tests as sometimes made for transverse or torsional strength, said methods having no reference to the amount of force required, but aiming simply to learn by the amount of deflection or torsion that steel will stand, what its powers of endurance are.

In some tests for transverse strength, each piece, when bent beyond the power to longer sustain the load by which it is bent, is recorded as broken. Its quality is adjudged by the number of pounds it sustained without deflection; by the load at different points of deflection, or amount of load at different amounts of deflection; and finally, by the maximum load and amount of deflection at which it is called broken, when it is not broken at all.

Where tests to determine torsional resistance merely are made, and record is kept of the force required to twist, or to twist off the piece in the "by the pound" method of testing, there will be danger of adjudging that piece the best which carries the greatest load. Yet by the plain simple test of the mechanic it will be found vastly inferior. To explain: Of two pieces deflected, each a like amount, but requiring different amounts of force to produce the deflection, the apparently stronger piece may be actually broken in an attempt to straighten it, while the supposed weaker piece (and too often judged to be inferior simply because of such apparent weakness) may be not only straightened, but deflected as far in the opposite direction, and so back and forth several times before breaking. In the torsional test the piece requiring the greatest force to twist it at all, may be broken at less than a single turn, while a piece of apparently less strength may be twisted round and round a dozen times without breaking, and still retain an almost perfect surface, and show a fracture without a flaw. Still the stronger piece as per avoirdupois test may at the same time have broken with an evident unsoundness of structure, and with every part of its surface broken up and disturbed. It is not simply strength to stand a certain amount of strain once, but power of endurance to stand under a *succession of shocks*, or deflections, or under continued transverse or torsional strain, that constitute the qualities which steel is often called upon to show. These qualities depend largely upon its condition of hardness, or softness and density as affected by working or annealing, making it necessary for the man who makes tests to determine quality, to know by what methods the steel has been put in the condition in which he is to test it. He must also be well posted as to the effect of these methods, and must know further whether they have been properly applied. For example, two pieces of steel may be annealed, one with great advantage for the use to which it is to be put, the other to great disadvantage—even to making it worthless. Still both are annealed.

To anneal a piece of steel which shows a fine, clear, uniform condition of structure as judged by fracture previous to annealing, so that it shall show after annealing a coarse uneven, open grained condition when judged by fracture, is to put the steel so treated in a condition of weakness, which will be shown when tested by the avoirdupois method, and also by the test for continued endurance. Those who believe that annealing necessarily removes the close-grained, reliable condition in which steel may be put by proper working, should learn by experiment that they have been mistaken.

There are thousands of complaints made daily of lack of uniform quality in steel where the *condition*, not the *quality*, is at fault, and in very many cases those who make the complaints are wholly to blame for the apparent lack of uniformity. Other cases are common in which the consumer using the material as he receives it from the manufacturer, and insisting upon applying certain tests, returns as worthless that which might, in proper condition, have been admirably adapted to his wants.

Differences in amount of heat, length of time taken to heat, heat at which steel is worked, heat at which the work ceases, manner in which the working is conducted, in what way the steel cools off after the working ceases, method of annealing and care with which the operation is performed, subsequent working, as in wire drawing or other manipulations of the steel in a cold state, whether much or little, and how; whether by successive gentle transformations of shape or size, or by some violent disturbance of molecular structure, are some only of the points which the plain mechanic has constantly before him in his efforts to give satisfaction to the customer, or to himself get satisfaction in the use of steel furnished to him by others. While with the care and good judgment growing out of long experience and observation, he places such steel as passes through his hands in condition to meet the requirements called for when put to either tests in use, or tests scientific, ought he not to have full credit for the crude methods of tests by which he determines whether his efforts are successful? Breaking the ingot or bar, and by the fracture judging of quality and condition; bending the sheet until broken for the same purpose; with a dexterous turn of the wrist and a pull learning in an instant whether the wire passing through his hands is being put in proper condition to meet the requirements of scientific tests to which it is to be subjected. The right steel he must have, but none the less must the steel have the right treatment. [We regret that the meaning of the writer is not expressed more precisely.—ED.]

Furniture Reviver.—Pale linseed oil, raw, 10 oz.; lac varnish and wood spirits, of each, 5 oz. Mix well before using.

The Repair Man.—No one can be universal, says a correspondent to "Cotton, Wool and Iron." A man may be a civil engineer by day and a mechanic by night, and take in the laying out of cams and fishways for knitting work; but to be proficient in one of these departments he must have a special talent, a natural ability, a liking and a taste for the work in the calling he has chosen. But with the repair man, talent or no talent, ability or no ability, he must by some means get order out of disorder, harmony out of confusion, and bring peace and quietness out from the rattle and clatter, the thump and pound of the different machines with which he may have to deal. He not only has the different points to repair, the worn out pieces to replace, but the work that has been laid out by professionals, and set up by those who know their business (?), to go through with from beginning to end. Work that has been pronounced by the designer to be perfection, by the draughtsman to be complete, and by the foreman of the machine shop to be all right, is to be remodelled by this tinker-at-all-trades, and by him have its parts adjusted before anything in the shape of satisfaction could be had, or work finished in proper shape for the market. When a concern orders a machine, it is sent from the machine works with a man to set it up; it is brought into the room and revealed; it shines from its newly-laid coat of varnish, and glistens from the effects of the buff-wheel, and is a marvel of beauty in appearance. It was made upon honour, and will stand on its own merits. There is nothing cheap about it. But as soon as the cash is paid, and the machine given to the care of the user, whoever he may be, then its faults begin to show themselves. Bolts with oval heads, and slotted for the screw-driver, are found beneath some over-projecting part of the machine. Cap-screws are used where they are liable to get loose, and are keyed on by filing a flat place on the shaft. Thin nuts with bevelled corners are used where the whole strain of the bolt comes, and there is no place for the wrench to turn them. These and many other things must be rectified before the one who has charge will even feel pleased, or the language of the machine fixer be improved. Machines are only built in the machine works, and worn out in the factories; the rest lies on this man of repairs, who has to equalise the strain and keep the work from its weakest part till at last, like the "deacon's one hoss shay," the machine caves in all at once with a crash, and its place is filled by another.

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

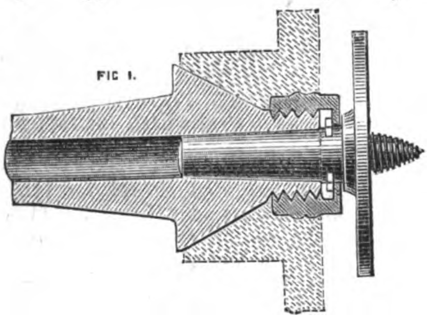
MANDREL-NOSES AND CONICAL FITTINGS.

Sir,—Are we always to have to give up our headstocks when we wish to have a new chuck fitted; cannot some plan be devised for making chucks interchangeable? I know it is supposed to be absolutely impossible to get a chuck to run "dead-true" upon any mandrel except the one upon which it was made, but is not this owing to the plan universally adopted for fitting chucks upon the mandrel? I think it is.

An eccentric-cutter and driller will become untrue when they are made to screw upon the same spindle, probably because the threads securing them wear after frequent removals and the parts screw up further round. The same thing may occur in lathe chucks, even when the chuck-face is fitted up well to the mandrel-face, probably from the same cause. One maker of lathes fits the head of the eccentric-cutter into the drilling spindle by means of a cone, and he tells me it remains perfectly true. I have also a set of small chucks, bought in France, which screw into a brass receptacle chuck against a conical shoulder, the plan being intended to secure absolute truth.

This leads me to suppose that some application of the cone-fitting instead of the simple screwed fitting might enable chucks to be made interchangeable. The object is certainly worth striving after, and I trust I shall not be deemed an enthusiast for attempting what has been considered impossible. Dr. Edmunds, at any rate, does not think the thing impossible, for I see that he proposes to attain the same result by means of a cylindrical fitting at the base of the screw of the mandrel-nose, which cylindrical fitting is to correspond exactly with a fitting on the chuck. The plan ought to succeed if only the cylindrical fittings are made perfect. I fancy this would be rather difficult, and could only be done by our best lathe makers. The cone-fitting I propose, looks simpler, and I think it might be applied upon all lathes. The shape I suggest would be something like fig. 1.

FIG 1.



The screw is shorter than usual, it being only used to hold the coned surfaces in contact, the truth of the chucks not depending upon it in any way; the cone to be turned to such an angle as will ensure its not binding; perhaps 60° would do. I propose to have these noses made to standard sizes, and the cones turned to standard gauges made in pairs (plug and ring) like the Whitworth gauges, and I think it would be found that any chuck would run with perfect truth on any mandrel made to the same size and gauge. We should then be able to order a new chuck from any lathe maker without sending up the headstock; we might borrow a chuck from a friend who had a lathe of the same size, and the American chucks might come over ready fitted; besides all this a whole set of chucks would not require rebacking owing to a failure of the mandrel. The plan, however, makes it necessary to put the mandrel in from the front, which will be considered a disadvantage by those who like the back-centre.

I now come to the conical hole in the mandrel. This is admitted to be the best plan for fitting the running-centre, and I propose to fit into this recess all the smaller chucks and to secure them by a screw-ferrule, a front view of which is seen at fig. 2. This screw-ferrule has a rim, the opposite quarters of which are removed; this rim takes into a groove, cut in the shanks of the small chucks; one side of the groove has also its opposite quarters removed, see fig. 3, and this allows the chucks to be slipped into position from the front, without taking off the screw-ferrule, which then only requires a turn of the hand to fix the chuck. To unfix it, turn the ferrule in the opposite direction; the rim of the ferrule then bears against the other side of the groove and disengages the cones, when the chuck can be taken out. By this means the small chucks may be very quickly fixed and unfixed without taking up either spanner or tommy and they will never become untrue. I would have all small chucks, milling cutters, etc., carried in this way, and then those without screwing tools would be able to fit them for themselves.

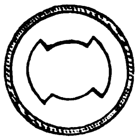


FIG.2

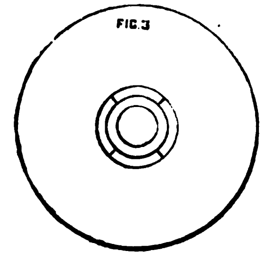


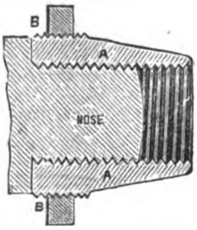
FIG.3

To make chucks interchangeable by this plan, we must have fixed sizes for mandrel-noses; the dimensions of the screws given and a pair of inside and outside gauges for the inside and for the outside cones.

This letter is written in the hope that the matter will not be allowed to rest where it is without some progress being made. J.L. suggests that the screw might be done away with altogether, and the cones secured by a thin key passing through the boss of the chuck and the nose of the mandrel; the cone might be made blunt enough to ensure that the chuck would come off when the key was withdrawn, or a second keyway might be made at right angles to the first, so fitted that when the key was inserted the cones would be separated. This plan would be available for mandrels supported by the back-centre.

F.A.M.

My dear Sir,—Having some time since required an additional chuck or two for my lathe, and finding it very inconvenient to send my headstock away at the time to have them fitted, I compromised the matter by adopting the following plan, which, having proved a success in my case, may perhaps be found of service by some of my brother amateurs; and perhaps a hint may be derived from it by a lathe-maker.



Having obtained a forging of a greater length than my lathe-nose and about ½in. more in diameter, I fitted it very carefully and turned it up while in its place (as a chuck) to a slightly taper cone, and leaving about ½in. of the left-hand end cylindric, cut on it a screw and fitted with a nut in the usual manner. When requiring a new chuck, I simply send this cone by post and have the required chuck fitted to *it* instead of to the mandrel nose direct.

I enclose sketch, which may perhaps explain further.

Very truly yours,
GRAHAM.

BOOKS RECEIVED.

From Cassell, Petter, Galpin & Co.

"Practical Mechanics." By John Perry, M.E.

"Cutting Tools Worked by Hand and Machine." By Robert H. Smith, M.I.M.E., &c.

From Crosby, Lockwood & Co.

"Details of Machinery." By Francis Campin, C.E.

"The Smithy and Forge." By W. J. E. Crane.

"The Whitworth Scholarships, and How to Obtain Them." By a Whitworth Scholar.

AMATEUR MECHANICS

AN

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PRACTICAL CABINET WORK FOR AMATEURS.

PART I.

WE are indebted to the proprietors of "Design and Work" for permission to reproduce, after careful revision, the following series of papers which were originally written by our old and esteemed friend, A. Cabe, a contributor to our pages, whose practical knowledge imparted in a clear style is of great value to amateurs. In this series will be found a full and minute description of the art of cabinet-making considered practically.

It is well known that a very large section of the youth and manhood of our country dabble in wood working to a greater or less extent; so much so, that the cottage, the villa, and the mansion are not requisitely furnished if wanting the amateur's bench and small kit of tools. Not that the owners have the remotest intention of ever earning their living by making chairs and tables, but that they derive in them a pleasing, healthful, and profitable pastime.

What is a cabinet-maker? "Walker" answers it by saying—"A cabinet-maker is one who makes small nice work in wood." Our own definition of a cabinet-maker is one who makes most of the articles in wood that go to furnish the house, whether for use or simply for ornament, and some of them are neither small nor very nice. However, it is principally small work that will most interest us in our present task, and we will endeavour to make it nice also.

Before going further I will here say a word regarding the system of production as practised in the workshop. In large workshops, especially the factories that have of late years sprung up, in which a large proportion of the work is done by machinery, the labour of production is divided—that is, one man executes only one part of the article being constructed, and thus it passes through several hands before being completed, just as it used to take nine men to make a pin. In most of the larger workshops, however, the work is divided into two departments, called carcase work and chair work, and the workman is trained to the one or the other. He is a carcase maker, and knows nothing of chair work, and *vice versa*.

Carcase work includes all those pieces of furniture having holding or storing capacity, such as sideboards, wardrobes, book-cases, chests, etc.

Chairwork includes those articles that come into the hands of the upholsterer, such as chairs, sofas, couches, stools, etc.; tables also are included under the head of chairwork.

In the small shops, especially in provincial towns, the case is different, for in them the apprentice is trained to all the departments of cabinet making; and it is in a shop of this class, and where a select and to order business has been done, that I have acquired my twenty years' experience. My amateur friends may, therefore, accept the information I communicate as thoroughly practical; not gathered from books, but at the bench, amid the dust and shavings, where only a trustworthy knowledge can be acquired worth communicating to others.

In this attempt to furnish practical details of cabinet-making, I propose to begin at the beginning, the turning of the first shaving so to speak, describing every succeeding process with a minuteness that might possibly be thought trivial by those who already possess a knowledge of the art.

One thing I shall mention here because of its great importance. It is this: An apprentice in the regular trade is trained to handle his tools; he is trained to construct a certain article as he sees older hands constructing it. The size and form of the various parts and the manner of putting them together are communicated to him by those superintending the work; but he has no intelligent notion of why these particular methods of construction have been adopted, or why particular form and proportion of parts is more suitable than another in the making of an article. At the bottom of all this is the fact that the person overseeing the work, in nine cases out of ten, knows no better than the apprentice the reason for doing this and that as he does it. He follows the methods of his predecessors, and communicates them to his successors, destitute of all intelligent knowledge of why it is best to do it this way or that way, and thus the young workman grows up a mere machine. By steady application he becomes capable of performing good work (so is a planing machine), but his reasoning powers have lain dormant: they have not been awakened by his instructors. He may also occasionally think a little for himself, and he may occasionally see a better and a more tasteful method of doing certain things; but he would be set down as a presumptuous fellow to venture to teach his intelligent foreman, and it is an experienced fact that the less intelligent a foreman is the less will he brook to be taught anything by those around him and under his supervision.

My aim in these somewhat digressive remarks is to impress upon my amateur friends the necessity of thinking out the reasons for adopting certain methods and forms in constructing the various articles that will be brought before their notice. They are free to think out and adopt better methods and better forms than those I am able to lay before them, for that is by no means impossible. There are men who originate, while others are mere copyists all their lives, and in this particular art, new forms and improved methods of construction may enter the head of the intelligent amateur that would perhaps fail to penetrate that of the professional tradesman.

I should like to know where the line of demarcation is to be drawn between the amateur and the professional. I have seen amateurs who could put professionals to the blush in their own trade. I have seen amateur actors do the thing better than those who made it their profession; and yet amateurs are held to be an inferior class of beings compared with professionals.

One point more in these introductory remarks, I should like to insist on—namely, the necessity of acquiring a certain proficiency in drawing. This is a branch of knowledge lamentably neglected by our young artisans. There are schools of design and mechanics' institutes in most towns of any consequence, yet there are not more than two or three in a hundred of our artisan population who take any advantage of this means of education. I should advise all those who peruse these papers to enter upon a study of practical geometry and mechanical drawing. They are accomplishments that are good to have, even though you may not be destined to follow any of the mechanical arts.

The order of procedure in these papers will be something after the following:—A concise notice of the principal woods used in cabinet-making.

The most approved form of bench for the amateur's use, with sundry appliances belonging to it.

The various indispensable tools, with suitable chest, after which our practical cabinet-making will begin by directing how to choose suitable wood for the work proposed, how to line it out before sawing, the manner of planing, squaring, gauging, drawing in, etc. Then we will begin by making some very simple article, and progress onwards and upwards to the most elaborate.

The following list is of the principal woods that are used in cabinet-making named in the order in which they are of most importance: Yellow pine, mahogany, walnut, oak, birch, ash, plane, maple, bird's-eye maple, beech, rose, satin, ebony, box, zebra, cedar, teak, purple, king, sandal, amboyna, partridge, cocus, canary, camphor, tulip, holly, japan, lime, cherry, locust, pear, apple, beef.

Of this list we proceed to briefly describe those that will be most in demand by the cabinet-maker, and to him the first in importance is yellow pine; for without yellow pine he would be pretty much in the position of a shoemaker without leather.

It is the material that forms the groundwork of the bulk of modern furniture, that is veneered over or otherwise made to assume the appearance of richer or costlier woods. Besides this, it is the material from which alone innumerable articles of furniture are constructed; and, apart from its importance to the cabinetmaker, it is the favourite and most suitable in point of economy for all kinds of interior joinery-furnishing. It is the most suitable wood for all kinds of engineers' patterns, excepting very small ones, which are made of plane, box, or mahogany. It is also the best for the planking of light-boats, such as skiffs, small yachts, and fishing-boats, and is, I believe, exclusively used in the manufacture of lucifer matches.

This yellow pine is a North American tree, and grows in immense numbers in the region from Virginia to British Canada. In the valleys and near the banks of rivers, where the soil is rich and soft, the tree reaches its grandest proportions, growing often to a height of 170ft. and 180ft., and from 4ft. to 5ft. diameter at the base. The trunk of this tree tapers but slightly, and is entirely free of limbs or branches for over two-thirds of its length.

Though we are in the habit of calling this wood American yellow pine, it is called by the Americans themselves white pine, not so much from the colour of the wood as the colour of the bark. It is known also amongst us as Weymouth pine, from the fact of Lord Weymouth having, in the last century, planted large numbers of it in Wiltshire. The utility of the wood in the hands of the cabinet-maker is the thing which concerns us most.

This pine was introduced into this country as an article of commerce about 60 years ago, and has entirely taken the place of the Baltic timber once used for the same purposes by the cabinet-maker. If you examine the interior of pieces of furniture made previously to the above date, you will find the wood to be what we now call white or red pine, a wood full of resin and small hard knots. A large proportion of the wood of this period is called Memel, being shipped from a port in the Baltic of that name; and, indeed, it is to be noted that almost all woods imported into this country, whether American or European, are known by the names of the ports from which they are shipped. How different, and how much more pleasant, the task of the modern cabinet-maker, with the clean, straight, soft, easily-wrought yellow pine for his veneering surfaces and constructive parts generally, to that of the workman of 60 or 70 years ago, who had to contend with a hard, reedy, knotty, resiny wood, in narrow widths that required numerous joinings, and was for ever twisting and shrinking. And the house joiner was no better off, as you may see by examining an old house, where the floors and finishing are of the red pine or Memel, in narrow widths and innumerable knots; or an old church, where the pews, if not of oak, are of the same material. Our principal supply of yellow pine has for a number of years been from St. John, New Brunswick, though much valuable timber is shipped from other ports. It is shipped in the form of squared logs, and is cut up into boards after reaching this country. Very much yellow pine is now imported in the form of deals, these being sawn before embarkation into deals or planks of from 7in. to 24in. broad and 3in. thick, and usually from 12ft. to 20ft. long. The quality of the timber is more easily discernible, and so they are picked and classed as 1sts, 2nds, 3rds, etc. They are now sawn at the mills into boards of the various thicknesses, to suit the requirements of the trade, from ⅛th in. upwards.

It is needless here, I think, to describe the process of seasoning and storing timber, as our readers will generally only want a small quantity, and will find that seasoned and ready for use in any well assorted timber yard.

Further on, when we come to the choosing of suitable wood for a specific article, we will endeavour to guide him in that choice. We will now pass on to the wood next in importance, namely:—

Mahogany.—There are three kinds of mahogany familiarly known to cabinet-makers, namely, Spanish, Cuba, and Honduras, or bay mahogany. It was introduced into this country in the latter part of the 17th century, although it was known in the days of Queen Elizabeth, Sir Walter Raleigh having had some repairs done in his ships in the island of Trinidad in 1595. Before the introduction of mahogany, oak, ash, elm, walnut, and other home grown woods were in use in furniture making. After its introduction, however, these fell almost entirely into disuse, and remained so for nearly a century and a half, everybody being so taken with the new and beautiful wood.

Spanish mahogany is grown in the island of St. Domingo or Hayti; its characteristics are hard and close grain, of a rich and beautifully mottled figure, varying in colour from a gold to a ruby, and takes a splendid polish. There is a great variety in this figure or mottle. If the wood has light and dark streaks running with the grain, and in unbroken lines, the wood is considered plain. If the light and dark shades are broken up and run across the grain in small patches, the wood is of a good figure. Curb, or curl, or "breek" as we call it, has the grain or dark and light shades running slant away from the centre, just as the water is divided by the rapid passage of a boat. This mottle may be often seen in panels, when the grain or figure always runs outwards or downwards, having the appearance of a parabolic figure resting on its base. It is very beautiful, but is not highly valued, as it is apt to become full of small cracks when used as a veneer.

Stop mottle is the most esteemed. The light and dark figure is produced by a regular grain running out and in like little waves, but not regularly across the plank, but broken up and running into each other, which gives a beautiful transparent lustre, much prized in this wood. Fiddle mottle has the waves running across the plank in almost regular lines like maple for violin backs.

Peacock mottle, so called from having small eyes like bird's-eye maple, and like the spots in a peacock's tail, is very rare, and a well-marked log of this mottle was sold in Liverpool for nearly £1,000.

Cuba mahogany, as distinguished from Spanish or bay, is imported from the Island of Cuba. In closeness of grain and in figure it is inferior to Spanish, and though some of it is rich in figure, it has not the lustre of good Spanish, and on exposure to the atmosphere and the sun it becomes pale and dead in colour. It is not so much cut into veneers as Spanish, though it is extensively used as veneer for large surfaces, such as wardrobe gables and panels, sideboard tops, where rich Spanish wood would be too costly. Cuba wood is much used for the solid parts of furniture, such as bed-posts, turned work, carved pillars, trusses, etc., and is much superior for most of these purposes to:—

Honduras or Bay Mahogany.—It is called with us bay wood, and is principally used for veneering upon, and is the best known wood for this purpose; it is free and straight in the grain, does not warp or shrink when seasoned, and holds the glue admirably. It is often cut into veneers for gables and inferior parts of cheap furniture, but its principal use to the cabinet-makers is in constructing the framework for doors and other exposed parts to be veneered on the outer face. The panels also are of bay mahogany, veneered on the face; and the backs of panel and framing being French polished, and being of the same colour as the richer wood on the face, the whole has an agreeable appearance.

Bay wood, from its freedom from warping or shrinkage, is valuable for many purposes besides cabinet-making. It is much used by machinists, carriage builders, shipbuilders, letter-press printers, for backing stereotype plates, and many other purposes for which few other woods are so well adapted.

Another quality that belongs to all mahogany, is that it does not decay. Sound mahogany put into a job never rots or suffers from moth-eat, like most of our home woods. Bury it in the ground along with oak, walnut, ash, teak, etc., and it will come out fresh after the others are decayed.

Birch.—There are various kinds of birch, but the black birch of America is that most in use amongst cabinet-makers. It has been extensively used for bedroom and kitchen furniture. It is of a whitish-brown colour, and harder to work than bay mahogany. Very much of it is beautifully figured. This is produced by the waves going across the grain like fiddle maple, but generally the waves are larger, from ½in. to 1in. These curled specimens are very beautiful. The rich specimens are called mahogany birch or mountain mahogany, from their resemblance to Spanish mahogany in figure. Indeed they are often coloured to represent mahogany, which is a mistake, as this species of birch never looks better than in its own natural tint, which is a golden transparent yellow, and if the figure is small it is sometimes difficult to tell it from the finest satinwood.

The richly-curled pieces are generally cut into veneers. It is a difficult wood to veneer in, however, from its great liability to shrink, and all veneering with it should be done with the caul and hand-screws, as the hot water applied to in the hammer process makes it swell, and it is sure to shrink afterwards and spoil the work. This wood—that is, the plain black birch—is used almost entirely for kitchen-chair and other plain hard-wood furniture.

Walnut.—There are three kinds of walnut in common use—namely, English, Italian, and American; or, more properly speaking, but two, as the name Italian may be taken to include all European walnut.

Italian walnut was a favourite wood for rich furniture in ancient times, and has continued to be so up till now, excepting the period when mahogany was the rage. This walnut is specifically very light and is easily worked, being rather soft and spongy, however. It is largely used for gun-stocks, from its lightness and toughness. In appearance the plainer wood is a dull grey, with darker streaks, sometimes waved across the grain, like fiddle maple. Much of it, however, is simply streaked dark and light, lengthways of the grain.

Trees that have had a slow growth in poor dry soil yield the best wood for veneers, being close and firm, and finely figured; but the richest veneers are got from the roots of the large trees, which are dug up, buried in dung, which, they say, has the effect of enriching the figure. They are cut into very thin veneers, and are used for drawing-room and bedroom furniture, the best specimens finding their way into the hands of the pianoforte case-makers. We now import largely American black walnut; this is inferior to European, being sold at not much more than half the price. At first it was used largely for the ground work of furniture to be veneered with rich Italian wood, just as bay wood is used as a backing to Spanish veneer. Now, however, a vast quantity of furniture is made from it without any veneer whatever, and while it, and all the walnuts, are destitute of that lustre and transparency which so markedly characterise mahogany and mahogany birch, yet it is a good wood for furniture in a light airy situation. It is the only wood used by sewing-machine makers, is largely used in making harmonium cases, and in furniture it ebonises well, and makes a good contrast when used along with ash, satin, or bird's eye maple. It is also very elegant when relieved by gold lines.

Oak.—Botanists enumerate about 150 different species of oak. We will reduce the number to the notice of three: British, European, and American. Oak has been used as a furniture wood from all time, being found in almost every country on the globe.

In England it was almost the staple wood used for furniture by those who had any. Our splendid ecclesiastical buildings have their interior work entirely constructed of oak. So also were the castles and mansions of our nobility, and in these the furniture also was made of the same material; and all this from our own British oak, which for strength, toughness, and durability is unrivalled for shipbuilding.

It is difficult to conceive how this wood was such a favourite for furniture and carved work, unless that it was the most plentiful. It is a coarse-grained porous wood, destitute of lustre or beauty of any kind. To be sure, it has a beauty of its own, when the figure or "champ" is well marked; but its preference seems to consist in its association with our ecclesiastical and maritime institutions. Oak furniture began to give way to walnut, and later on to mahogany, but is still largely made. The oak, however, of our day is not British, but from Northern Europe, being shipped from Memel, Riga, and Dantzig, in the Baltic. This oak, being easier worked and the champ much more distinct and in strong contrast to the ground wood, is much better suited for furniture and interior finishing. The best specimens of this oak are shipped from the port of Riga, and fetch the highest prices.

A vast quantity of oak is annually shipped from Quebec; this is a coarse reedy oak not so good for ship-building as English, and not so good for furniture as Dantzig or Riga. When not twisted in the growth it may be split evenly into thin pieces, and a large quantity is imported thus split for the use of coopers. It is also used for numerous other purposes, and occasionally in cheap furniture. The "champ" in oak is the principal feature of beauty which commends it in furniture. In the oak tree there are thin veins called medullary rays, that run from the pith to the bark, something like the spokes in a bicycle wheel. In the end of a billet of oak they appear like hard white threads radiating from the centre, and as they run the whole length of the tree, it is by judicious cutting up that their "champs" or rays are best shown. Very much depends on the intelligent cutting up of oak, as well as many other woods.

As these remarks have become somewhat extended we will defer the description of the other woods, which will be less in our work, until we come to notice them in the construction of specific articles.

(To be continued.)

ORNAMENTAL TURNING IN IVORY.

(For Illustration, see Lithograph Supplement.)

THE specimen of ornamental turnery, which we publish herewith, is thus described by the maker in the journal of the Amateur Mechanical Society:

I really hardly know what to call the somewhat nondescript piece of turning represented in the engraving. It is a kind of shallow box, supported on a spiral stem rising from a base which rests upon four feet. The cover of the box has a similar spiral stem rising from it, which ends in a cube with five points, one at each side and one at the top. The whole is of ivory, and measures to the top of the finial about 9in. in height, the diameter of the largest part being about 4¼in.

The base is formed from a flat piece of ivory ⅜ of an inch in thickness, having below four holes into which are screwed the little feet. A disc of ivory of the proper size and thickness having been chucked by its outer edge, the surface was smoothed and polished, and the screw-hole, about 1⅜in. in diameter and $\frac{3}{16}$ of an inch in depth, formed, into which the upper part was to be screwed. The piece was then chucked by that screw upon a wooden chuck, mounted on the eccentric chuck. The under surface of the disc was made true and flat, and the piece shaped by cutting portions from its edge with the eccentric cutting frame carrying a tool of this form (fig. 1.) Fig. 2. shows the shape of the base; it is drawn full size. It will be seen that each side is formed by four circular cuts intersecting one another. The slide-rest being placed across the lathe-bed, with the cutter set very accurately to the centre, the slide of the eccentric chuck was thrown out about 2⅜in., and the chuck fixed by the index in such a position that the slide was quite vertical. The eccentric cutter, set to cut a circle of about 2in. in diameter, was brought outwards, that is towards the operator about 1$\frac{3}{16}$in. from the centre, and cut No. 1 made, by gradually and carefully advancing the cutter, until the superfluous piece dropped out. The cutter was then moved the same distance from the centre, viz., 1$\frac{3}{16}$in. from the operator, and cut No. 4 was made. The same operations were performed at the other three sides of the base piece, the wheel of the eccentric chuck being moved round 24 teeth for each setting. The slide of the chuck then had its eccentricity diminished to about 1½in., and the cutter set to cut a circle of 1in., and cuts 2 and 3 were made by placing the cutter at about $\frac{7}{16}$ of an inch at each side of the centre alternately, the same operations being repeated as before for the other sides of the square. In all operations of this kind, when there is a considerable thickness of material to be cut through, it is best to set the cutter for a somewhat smaller circle than the finished one, and make cuts all round in the proper places; then to enlarge the circle a little and go over the cuts again, thus leaving very little for the tool to take off in making the final cuts. Of course it is necessary to make a careful note of the position of each cut, so as to be sure of bringing the tool to the same spot when going round the second time. It is as well, too, in making such a piece as this, to remove a portion of the edge with a fine saw from each of the four sides, so as to reduce the piece roughly to the form of a square, thus leaving less material for the cutter to work through. Of course care must be taken not to encroach upon what is to remain.

FIG. 1.

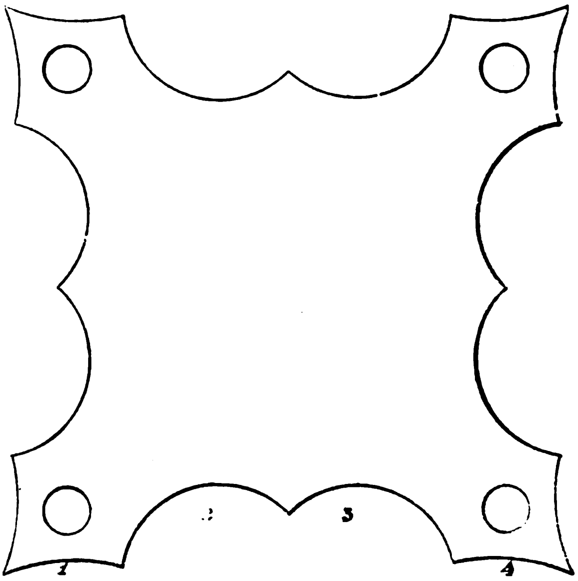

FIG. 2.

The piece being shaped, pencil lines, drawn diagonally, indicated the direction in which the holes for the feet were to be made. The slide of the eccentric chuck was thrown out about 1⅝in., and the eccentric chuck wheel adjusted, so that the position of one of the holes was brought exactly into the centre of rotation of the mandrel. A hole of about $\frac{3}{16}$ of an inch in depth was made with a flat-ended drill, and afterwards enlarged by setting the lathe in motion, and using a right-side tool in the slide-rest. The same operation being repeated for the other holes, the most difficult job came next—that of cutting a fine screw in each of the holes. This required some care, on account of the great eccentricity of the chuck, and I think could hardly be done without a traversing mandrel. The tool must be held very firmly, and the work allowed to come to it very quietly, or there is sure to be a slip, and a drunken screw made.

The feet were shaped, the lower part with the flying cutter working horizontally, with a cutter of this form (fig. 3), the smaller part above that with a pattern-drill. Each piece in turn, having had its screw fitted to one of the holes in the base-piece, was screwed on the same wooden chuck, and, with one setting of the slide-rest, all were reduced to the same length. The slide-rest being brought parallel with the lathe-bed, each piece in turn had its lower part shaped with the flying cutter, and afterwards the upper part of each was made with the same setting of the drill, so that all were precisely the same in shape and size.

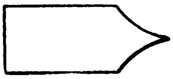
Fig. 3.

The piece next above the base, and screwing into it, has 24 points, formed by the flying cutter working horizontally with a < shaped tool. In this kind of work it is essential that the portion which rests upon the flat surface below it should be made perfectly flat, and not, as it is very apt to be, unless sufficient care be taken, a little hollowed out beyond the edge as in fig. 4, where the dotted line shows the flat surface upon which the edge is to rest, and where the hollowing out has been purposely somewhat exaggerated. Unless this is attended to, it is obvious that, when the piece is finished, even supposing the points to remain unbroken, it will rest entirely on the extremities of those points, showing a gap between the base and the portions within those points. Besides this, when the portion between the edge and the screw is not perfectly flat, there is a much greater probability of the points giving way from the action of the tool, and also of the work slipping on the chuck before it is finished. However tightly the piece of ivory may be screwed on to the chuck, when so large a portion of its circumference comes to be removed it is almost sure to slip when only supported by a few slender points as the cuts are nearly finished. For the same reason the surface of the wooden chuck which carries the work while it is being shaped must also be perfectly flat, so as to give support to the whole, and not to the edge only. The upper part of the chuck should be brought to the same diameter as the ivory upon it, and the cuts made through wood and ivory together. The rotation of the cutting tool must be from the outer edge of the ivory towards the centre.

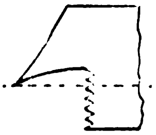
Fig. 4.

It is not unimportant to consider in which direction the mandrel pulley should move when being shifted from one hole of the division plate to another. As after the first cut has been made the others are formed by one side only of the < shaped cutter, the other side merely passing through the gap already made, it is clear that more pressure is exerted by the cutting side of the tool than by the other. If that pressure is in such a direction that it has a tendency to unscrew the work from its chuck, it may happen, when the pattern is partly finished, that the material is becoming loose on its chuck, and it may perhaps be spoiled before the evil is discovered. The mandrel pulley should therefore be moved in such a direction that the working side of the tool should be on the side which has rather a tendency to screw the work up more tightly; therefore in such a piece as we are now considering, after the first cut has been made, the pulley should be moved with the upper part of its circumference *towards* the operator, instead of from him, for each succeeding cut.

The next piece screws into the one last described. It has round it a ring of beads, while its upper edge is cut out by drawing a pattern drill across it, the slide-rest being placed across the lathe-bed.

Into this piece is screwed the spiral column, formed from a cylinder of ivory $\frac{15}{16}$ of an inch in diameter, and $1\frac{7}{10}$in. long, exclusive of the screw at each end. It was made on the eccentric chuck in the manner described at page 149, vol. II. of this journal, having been previously bored throughout its length by a hole $\frac{7}{16}$ of an inch in diameter, which was afterwards plugged with a polished ivory stem just fitting it.

Upon the upper end of the spiral column is screwed a piece executed with pattern drills, and this screws into one formed on the dome chuck, with flutings cut with the flying cutting frame, carrying such a tool as that used for shaping the feet. In this case the dome chuck was mounted on the oval chuck in order that the curve described by the work in passing in front of the tool should be a portion of a flattened ellipse, and not that of a circle. This piece has a projecting screw at the top, entering into the bottom of the kind of box which forms the principal and widest portion of the work.

This box was made from a solid round block of ivory, about $1\frac{1}{2}$in. in depth, and $4\frac{1}{4}$in. in diameter. Having been hollowed out to a sufficient depth, leaving plenty of substance in the side, so as to form it into a box, the screw-hole by which it is attached to the piece below it was made, and the box was then chucked by that screw, and its outer edge shaped in the following manner:—Figs. 5, 6 and 7 show it in different stages of progress. First, two deep grooves were cut in the ivory, leaving the surfaces *a* and *b*, fig. 5. These were then polished. Next, with a pattern drill, two series of holes, 72 in each, were made to a depth of $\frac{5}{16}$ of an inch, as shown at *c* and *d*, fig. 4, every second hole of the 144 division of the division-plate being used. At every third hole of the 72 the drill was carried along by the slide-rest screw until it met the corresponding hole of the other series, thus forming 24 deep furrows, and leaving 24 projecting portions of the original surface between them. The eccentric cutting-frame was now substituted for the drill, carry-

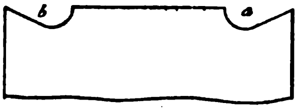

Fig. 5.

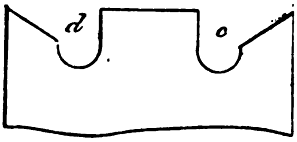

Fig. 6.

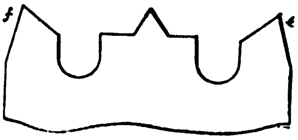

Fig. 7.

Fig [illegible].

ing a tool which I had to make for myself. It was of the form fig. 8, *a* and *b* being the cutting edges. This tool being so adjusted in the cutting-frame that the dotted line *c* was in the centre of rotation, the instrument being set half-way between the two edges of the ivory, and the index at one of the holes midway between those which had determined the position of two of the furrows, the tool, revolving rapidly, was slowly and carefully advanced, till it had cut away the ivory, leaving one of the little nipples or cones in the middle of a flat facet, as fig. 7, the face *a* of the tool forming the facet, and the sloping face *b* the cone. The slide-rest being placed not quite square across the lathe-bed, but at a slight angle, the 24 scollops, *f* in fig. 7, on one edge of the ivory, were cut by drawing across the face of the work the flying cutter, set to cut vertically and carrying a round-ended tool. The ivory having been previously fitted by its interior to another chuck, was then reversed by being mounted on that chuck, and the corresponding scollops were cut at the other end with the same setting of the slide-rest. Some care was required in this case in adjusting the work so that the scollops should come exactly in line with the facets and cones. This completed the box and stand.

The cover having been fitted so as to lie loosely on the box, was shaped and fluted by the flying cutter, with a tool of the same shape as for the portion below the box, working horizontally, and guided by a template of the proper form in the curvilinear apparatus. The next piece and the upper spiral stem were made in the same manner as the corresponding pieces below the box, but the spiral stem was of smaller dimensions than the other, being made from a cylinder 1¾in. long, exclusive of the screws at each end, and $\frac{13}{16}$ of an inch in diameter, bored with a hole ⅜ of an inch in diameter. Upon this is screwed the finial, the lower part having its edge cut with a pattern drill, and above that is a small cube, the sides formed by drawing past each in turn a drill of the form fig. 9. The cones projecting from the sides and top of this cube were turned separately and fitted and cemented into holes made for them.

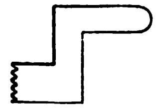

FIG. 9.

G. C. C.

DETAILS OF LATHES.

By OBERLIN SMITH.

From The American Machinist.

IN a recent article upon lathe spindles, and how the designing of them appeared, in many cases, to have a benumbing effect on otherwise wide-awake intellects, the writer proposed such a radical enlargement of diameters as to introduce certain new difficulties, the method of overcoming which may here be discussed.

In diagonising the case and its symptoms let us assume that we have our old patient, the 20in. swing lathe. Having given it an enormous amount of "backbone" to support, in the shape of a live spindle with its right journal (say) 7in. in diameter and a left one 3½in., we might discover that the smallest pulley of the spindle cone was of but little, if any, greater diameter than the largest journal—that is, if the usual practice in designing cones was followed. Under these circumstances the thing would probably revolve, because the lateral (upward) pressure of the belt would occur at a point near the small journal, and the friction of the oiled metallic surfaces would not be as great as that of leather and iron, but there would not be a great surplus of power left for doing cutting work. The practical minimum size for this pulley in proportion to the journals can best be determined by experiment, as we have no data to consult regarding driven pulleys, which are smaller than their shafts. It is clear, however, that the pulleys must in this case be made larger than they are with the usual small spindles. Probably the lathe in question would work well with the small pulley, 9in. or 10in. in diameter. This, with the larger pulleys of the cone in proportion, the old school designers would object to, because they would have to cut down the sides of the "live-head" low, and thereby lose the important bracing which they now give to the delicate structure that stands up at each end of the head to support the journals. It may be interesting just here to mention that a lathe-maker of excellent repute, dwelling in the immediate vicinity of William Penn's "only headquarters," makes a good, solid looking (by the old ideas) live-head, and takes the trouble to core out the upright parts, nearly up to the bottom of the journals, leaving them mere shells, perhaps ⅛in. or ¾in. thick. Whether the few shillings worth of metal thus thrown out is for the benefit of the worthy guilds of pattern-makers and moulders, by creating a larger demand for their labours, or whether this membranous construction is intended to develop a "*vibratory force*," in opposition to its true and only inventor, is as yet an unsolved conundrum.

The matter of connecting and bracing the upright parts of the head can easily be arranged by throwing further out the side "webs," which connect the two uprights, allowing the cone to be partially down between them. If it is objected that this makes the head (and consequently the bed and carriage) too wide, let it commence to be wider at a point above the carraige, and swell enough to clear the cone—leaving it at the bottom as narrow as usual. This, however, is in case the designer wishes the bed of the ordinary width. A considerable amount of widening is, in the writer's opinion, of no detriment to the machine. In the short, heavy 20in. swing lathes, referred to in a former article, he made the head (which was cast in one piece with the bed) wide enough for the back-gearing to be entirely within it, directly *below* the spindle. This arrangement seems, so far, to work very nicely; it allows the side webs of the head to run up nearly to the centre of the cone. Their outside width is 16in., and the extreme width of the bed 20in. The latter is perfectly flat upon the top, with a large bearing surface for the large and heavy carriage. All this, of course, allows for plenty of the "anvil-principle" in the various parts.

For another reason, besides the presence of a large spindle, should the cone-pulleys of a lathe be made as large in diameter as it is possible to contrive them, namely, to obtain a higher belt speed—a point that is shamefully neglected in almost all machine tools, except planers.

There is but one objection to fast running pulleys of large diameter, and consequently heavy weight upon lathes and other machines which must be started and stopped frequently and suddenly. This is their inertia—using the word in its sense which includes momentum. Even with the small cones generally used, there is time wasted in stopping the lathe when it is running at the fastest speed. The usual remedy adopted by the machinist who feels in a hurry, and doesn't want to "nurse his job," is to use the palm of his hand, as a brake, upon the largest pulley, or the teeth of the large gear. This helps to keep them clean and bright (the iron, not the skin), but still takes too long in stopping. The starting also occupies too much time, but the pleasant little squeak frequently accompanying it, makes things seem cheery like, and tests the quality of the belt oftener. These difficulties are, as before stated, aggravated by the use of very large cone pulleys and other revolving parts. The trouble becomes still greater if the driven pulleys upon the countershaft are made much larger, which increase I hope to have the pleasure of advocating anon, when treating countershafts in general.

The principal difficulty—that of stopping quickly enough—may be easily obviated by a simple, self-acting brake arrangement, attached to the shipper, and operating against the upper cone pulley. A better plan—although involving a more radical change in construction—would be to have some good clutch arrangement (either frictional or otherwise) upon the spindle itself, by which to disconnect it from its large gear. This would practically eliminate the factors of inertia and momentum; would enable the spindle to be either stopped or started instantaneously; would bring the operating handle down to a convenient position; and would make the machine complete in itself, that is, as far as delicately working parts were concerned. An ordinary shifting belt could be used to stop the countershaft, when out of use, if desired. Having anticipated all objections that may probably be made to the enormous spindles recommended (I do not consider the loss of power by increased friction at all worth mentioning, in view of the advantages gained), I will briefly hint at a few other points in regard to which the lathes of our day need improving. The most vital reforms necessary have been fully pointed out in this and two preceding papers—viz., excessive weight, and consequent inertia, in all stationary and slowly moving parts; very large live and dead spindle; long journal bearings; large pulleys, and consequent high belt speeds; proper methods of starting and stopping, etc.

Beginning with the bed (in treating the other points alluded to), it should be very much deeper than usually built, to avoid deflection by gravity, and should *not* be trussed like a railway bridge, or a North river steamboat (not to mention again the frame of a fiddle), to prevent a tendency to sag. The upper and lower ribs should be very wide to prevent lateral spring, and the webs should be connected by numerous cross-stays, to avoid spreading and twisting.

In regard to spreading, it may not be amiss to here relate a bit of the writer's experience, some years ago, when just out of his apprenticeship, in building an "improved" lathe for his own use. He was full of Whitworth-Sellers-istic enthusiasm, and thought that if it was a good thing to make the outside edges of the "ways" in "dovetail" form, for the benefit of the carriage, it would be a better thing to make the inside edges likewise, for the benefit of the heads. By a nicely arranged system of gibs and cams underneath the heads, they were made to fit snugly, and all the wear of the dead-head was to be taken up as fast as it "matured." The same arrangement answered, with wonderful convenience, to lock the heads in position. This lathe was 18in. swing, and the bed was 12in. long. Its cross-stays were only 12in. apart, were made extra strong at the top, and came up within 1in. of the upper face of the bed—all this being intended to resist the spreading action of the head gibs. A cross section of this bed is shown in the annexed sketch, fig. 1. The thing was started up, but its owner noticed about it the slight peculiarity that when the heads were locked fast the carriage was locked also, and *vice versâ*.

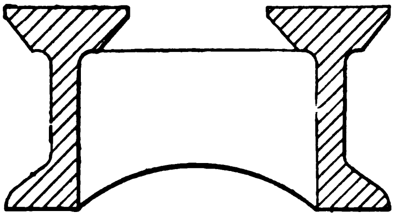

FIG. 1.

With a realistic consciousness of the elasticity of cast iron that he had never possessed before, he proceeded to evolve from his brain-molecules (or from them and their motions too?) a temporary milling apparatus, travelling upon the ways with the carriage, and driven by a worm-gear and a high-speed cotton-rope belt. This was necessary because there was no long planer at hand. The resulting shape is shown in fig. 2. The heads were clamped down in the usual way, and the lathe has been doing excellent service ever since. The trouble had, of course, been caused by the actual stretching of the stays; they being too close together, and the heads too long, for any bending between them to be worth considering. The above referred to milling cutter, and its spindle, are shown in fig. 3. After being thus milled out the bed was, of course, not of the strongest design, but it was the best that could be done to secure a place, along which could slide the clamps for bolting down head and steady rest.

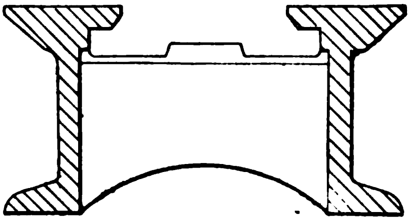

FIG 2.

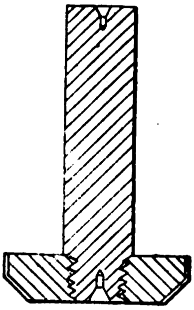

FIG. 3.

The last paragraph is undoubtedly a pure specimen of the genus *digression*, but it may serve as a warning to some novice, and will possibly give a hint regarding a makeshift method of correcting mistakes in cast iron that are not discovered till it has *cooled*.

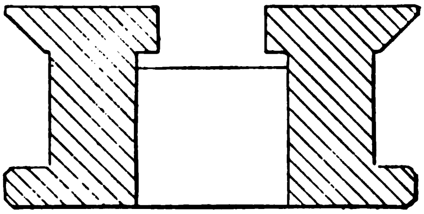

FIG. 4.

To proceed with the requisites for our ideal lathe bed (which, by the way, the writer thinks is much better with *flat* than with V top surfaces), it should be so clumsily designed as to resemble, in cross section, fig. 4, rather than figs. 1 or 2. The supports of this bed, whether legs or box cupboards, should be broader than usually made (from back to front) at their bearings upon the floor. These bearing points should be four or six in number. The three-legged principle, recently advocated in the "American Machinist," is excellent in theory, but it does not give sufficient stability against forward and backward oscillations, caused by work which is out of balance, etc. This action is likely to take place at either end of the lathe, and therefore it would be difficult to decide *where* to put the single leg, if there were but three. The æsthetic part of the matter would also, I imagine, be somewhat troublesome to arrange, as a long narrow parallelopipedon, like a lathe bed, does not harmonise well with a tripod. If a lathe is set upon as good a foundation as it ought, for other reasons, to be, and a few minutes are spent, with the aid of a spirit level, in setting it "out of twist," it will be, practically, good enough.

To glance briefly at other parts of this ideal lathe: The carriage should have a much larger bearing than is usual upon the ways, and the dovetail for cross-slide should be both wide and deep. To suit this writer, it should be sunk, as in fig. 5, rather than standing above the general flat surface, as in fig. 6; both being back views.

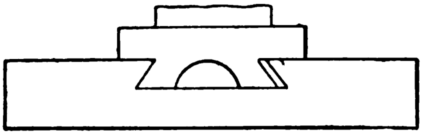

FIG. 5.

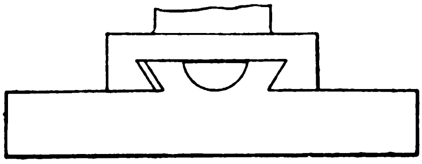

FIG. 6.

This construction is not only stiffer, but it gives a flat surface on which to lay work, in certain odd jobs of boring, etc.; and also gives more "swing over carriage." The angle of all the dovetails should be 45°. This holds the parts more firmly than the 60° or 70° often used, and yet does not leave the metal with so thin an edge as to cause it to spring or break. The tool-holder should be heavier than usual, and should have some good elevating arrangement (if the spirit of Archimedes could be invoked to come down and invent one), which would move vertically, without revolving, *after* the tool was clamped in position. It should, above all, possess the valuable quality of *staying put*.

The sacred precincts underneath the front of the carriage must be spoken of reverently, and touched upon tenderly. A touch, not quite tender, in this delicate region has too often caused the "shop dentist" to work late without his supper, e'en into wee, sma' hours. There are lathes that in these parts are simple and dignified. Why cannot they all be so? Whether partly in this domain, or, more properly, principally out in open sight at the left hand end of the machine, the feed gearing should be so arranged that various finer and coarser feeds can be instantly brought into action—especially the coarser ones. If the operator has to go to the end of his lathe to take off and put on a gear before relieving his conscience of a "scratch-cut," the said conscience will soon be ready for the tragic fate which befell Mark Twain's conscience, in Connecticut. The feed gears that do have to be changed, for screw-cutting purposes, should be arranged with a little snap-spring, or some other device, which will allow rapid manipulation. The usual hexagon nut —capable of giving a ton pressure, to hold against a gear which has no tendency to move endwise, except by a general jarring action—is too absurd for continued use.

The "back-gearing" should have something which the average lathe-maker thinks beneath his notice—viz., a snap of some sort to hold it in gear. This is very easily arranged, and saves a good deal of string and old lacers in the course of a year. This gearing should also be protected from getting soiled by mashed thumbs and such like grewsome objects. Simple guards can be placed for this purpose, near the points where the wheels mesh.

The dead-head (otherwise yclept puppet-head, tail-head, tail-stock, etc.) does not seem to need as much reform in the matter of strength as some other members of the average lathe. Besides carrying the very large dead spindle, before advocated, and being abundantly stiff (though not too heavy), it should possess a good clamping-down device, operated by a single motion. It should *not* have the two nuts and wrench which, strange to say, are still known to this generation of machinists. The spindle feed-screw should have a double nut, adjustable for taking up end wear, in order that annoying lost motion be avoided. This arrangement should also be applied to the main-feed and cross-feed screws.

Among the minor requisites of a good lathe are all sorts of small conveniences, too numerous to mention here. One of them is being able to measure distances, moved by the tool, on the micrometer principle. For this it is best to have the pitches of the feed-screws either 1in., ½in., ¼in., or ⅛in, and their collars graduated so as to measure 64ths, and binary subdivisions thereof. All crank handles should, of course, be balanced. The connection between the spindle cone and gear should be so made as to be instantly worked with the fingers without using a wrench. The locking, or unlocking, should not take over one second. Most of the devices mentioned in these last four paragraphs have been in use for fifteen years upon the lathe, whose bed is shown in fig. 2, and have never been out of order for an hour.

Another very important point, but one which must be left for a future occasion, is the making of certain parts of a lathe to certain standard dimensions. Regarding some of these, it will be necessary also to ascertain *who* is to establish these standards.

* * *

Mixing White Lead.—To mix the white lead it should be placed in a can or pot, and an admixture of oil and turpentine being at hand, small quantity should be poured over the white lead, and the whole stirred about with a stiff palette-knife, or a stopping knife, till the dilutent has become thoroughly incorporated with the white lead. The mixture may now be stained to the required tint. For this purpose the staining colour should be ground in oil, and added cautiously to the diluted white lead, some colours staining much more powerfully than others. The staining colour should never be added in a powdered or dry state.

Polishing Stag-Horn. — Use pumice-powder and water with a brush, and finish with rottenstone and oil. If you want portions of the creamy inner substance to show, rasp off and grind smooth, or scrape with a bit of glass.

HOW TO REPAIR WATCHES.

PART III.

BEFORE passing on to escapements, it may be advantageous to our readers if we consider the methods of repairing and remedying some of the accidents and defects to which watches are liable, that are common to all kinds of watches of whatever escapement or design. As one of the most frequent accidents is a broken mainspring, and as few persons know how to replace it properly, we will commence with repairs to the barrel.

To put in a new mainspring.—The barrel-cover being removed by the blade of a small watch screw-driver, the arbor is first taken out and then the broken spring. If, without doubt, the broken spring was the original spring, and the watch is of fair quality, it is well to follow the rule generally adopted by the trade and replace it with another of "the same width and strength." Frequently, however, it happens that the spring is not the original, but one put in by some careless workman either ignorant of what conditions a spring should fulfil, or contented with the nearest spring to the original that he happened to possess. In such a case the general rule does not apply; it would only be a case of the blind following the blind, with the usual result. We will suppose, by way of example, that we have a broken spring to replace, which evidently is not of the proper width and strength for the barrel it occupied, and consequently not adapted to the watch. The first consideration is its *width*, which should be as great as the barrel will fairly admit, reaching from the bottom of the barrel to the groove *barely*, excepting where the barrel cover is hollowed out, when it may reach it fully. If the spring is not wide enough its working will be irregular; if too wide then it will bind in the barrel. The next point is the thickness, and it is most important that this should be correct for the watch to perform satisfactorily. If the spring is too thick the action of the escapement will be hurried, and its rate unsteady, and the chain more liable to break; while, if too thin, the escapement will be sluggish, and the watch apt to stop altogether. The *strength* of the spring should be such that, when of the proper length, hooked in the barrel and wound up, it may cause the barrel to make about three-quarters of a turn more than is required by the length of a chain that occupies the fusee when fully wound. The *length* of a spring should be such that when wound in the barrel it should occupy about one-third of its diameter. Having gauged the width and found the corresponding springs, one of the proper strength will be found as a rule to be one that is a little larger in diameter than the barrel, or one that would almost fill the barrel if it were wound in, so that it is necessary to break off a short piece that the barrel may not be too full. This applies to the springs as bought from the makers, coiled within a wire ring, and is merely given as an approximate guide to selection. Having selected a spring apparently suitable, it must be shortened as much as is necessary and "hooked in," when it must be finally tested by holding the barrel tight in the left hand and winding up the spring by means of a pair of sliding tongs attached to the squared end of the barrel arbor, and observing how many times it causes the barrel to revolve. If it makes an insufficient number of turns the spring is too thick; if too many, then it is too thin. Although this may be stated as a general rule, it is not without exceptions, as, for example, in verge watches it is occasionally expedient to use a somewhat weaker spring than will only make the proper number of turns, owing to an imperfect and unequal balance-wheel not admitting of a close and correct escapement. There are two methods of hooking in mainsprings: in one the hook is in the barrel, and the spring only requires a hole in it near the end; in the other the hook is attached to the spring, a hole being formed in the barrel to receive it. In replacing a spring which only requires a hole in the end, it must be carefully tempered by means of a *very small* flame so applied that the spring may be gradually and equally tempered from the end where the hole is to be, which should be rather soft, to about half an inch of its length. The hole should be square, as being the least liable to constrain the spring, and prevent its proper action in the barrel. It is usual, after making the hole, which is punched with a pair of mainspring-nippers, to pass a file lightly across the end of the spring and round off the corners, giving it a neat and workmanlike appearance. When the hook is to be attached to the spring, the latter is tempered in the manner already described, and a small round hole punched in it. A piece of "hooking-in" wire is then fitted to the hole in the barrel, and placed in the jaws of a pair of sliding-tongs in such a manner that a pivot may be filed on it to fit the hole in the spring, and cause the piece of hooking-in wire to form a hook standing at the proper angle to suit the hole in the barrel. The hooking-in wire is then put in the vice, and the mainspring firmly secured to it by rivetting, when the length of the wire is cut off, leaving only sufficient to form the hook. The end of the spring is usually finished like the other, but left pointed instead of round.

To put in a new barrel-hook.—When this is necessary, it is always a good plan to put in one of *steel*, and not brass, as they frequently are. The hook should be "tapped" in very tight and nicely shaped, not standing up too high in the barrel.

To tighten a barrel cover.—When a barrel cover is loose, it should be covered over with a piece of thin paper and gently tapped with a round-faced hammer all round the edge, which, if carefully done, will spread the cover a little without marking it.

To put in a new barrel arbor.—There are three kinds of arbors commonly in use—the plain English arbor, the plain Geneva arbor, and the Geneva arbor with solid ratchet. The fitting of a new one of either kind requires to be done very carefully, it being absolutely necessary that the pivots should be accurately fitted, and the end-shakes very exact, for the barrel to run true and give satisfaction. Either of the plain arbors can be made from a piece of ordinary round steel, or an "arbor in the rough" may be obtained from the tool shops. In the former case it will be necessary to turn the steel somewhat to shape in the lathe; but when bought in the rough the arbor is quite ready for the more exact turning which is done in "the turns."

A screw ferrule is attached to one end of the arbor, and the body or centre part is first turned to the proper width and diameter, the measurement being taken from the old arbor by means of the pinion-gauge. The arbor is then turned down and polished until it fits the holes in the barrel just tight, when a round broach passed lightly into the holes will give the necessary freedom. If an English arbor, the next step will be to turn the top pivot and fit it into the name-plate, and afterwards file the square on the other end of the arbor to receive the ratchet. If, however, it is a Geneva arbor, the square for the stopwork finger-piece must be made, and the lower pivot finished first, and the top or winding square (which also receives the ratchet) last.

In filing these squares, great care must be taken to make them really squares. The best plan to ensure success is to turn a line where the square is to end, and file them up in the turns between the centres. The ends of the squares and pivots are usually finished in the screw-head tool. The hook to take the mainspring is formed by drilling an oblique hole in the body, and driving in very tight a piece of good tempered steel, which is then filed to shape.

In case of a Geneva arbor with solid ratchet, it is necessary to buy the arbor in the rough, and advisable to have that kind which are half finished, for the body is then screwed on and the ratchet polished. It is almost impossible to tap a good thread with the ordinary screw-plates suitable for this purpose; and if an arbor not already screwed by the proper plates must be used, it will be found much better to accurately fit on the body with a plain round hole, and secure it with a good steel pin. This latter kind of arbor is generally found where the barrel is "hanging" on the bottom pivot of the arbor, unsupported, and no one unaccustomed to fine turning is likely to make a good job of fitting a new one.

To put in a new barrel.—When it becomes necessary to put in a new barrel, as it sometimes does, either from the barrel cracking across where the "hooking" is, or from unskilful treatment having spoilt it, the best plan is to send the arbor and old barrel to the material dealers, and have a new one of the same diameter fitted to the arbor. The new barrel will require very little finishing, and it is much better and cheaper than attempting to make one.

To repair the chain.—A very frequent occurrence is the breaking of the chain, and to repair it neatly and strongly only a small amount of application is required. One end of the broken chain must consist of a double, and the other end of a single link. It is easy enough, by means of a sharp penknife, to get the single link, but the double one is sometimes more difficult to obtain. The best plan is to rest that end of the chain at which the double link is required upon the filing-block, and, with the thumb-nail of the left hand, keep one end of the pair forming the double link tight together, while with the penknife you gently separate the other, so as to loosen the rivet first from one side and then the other. If the chain is then held in the left hand and the small piece of broken link firmly grasped with the pliers and a sharp pull given, it will be found that the double link is made and ready to receive the single one. When the ends to be joined are placed in position, they should be secured by a rivet made of chain wire; but in the absence of this a needle, properly tempered to a blue colour, may be used, taking care not to leave the rivet too long. It must also be remembered that the hooks are placed the right way to hook in the barrel and fusee. When a new chain-hook only is required, it will be found much easier to turn the chain than the hook, when the latter happens to lie the wrong way.

To remedy a chain running flat or off the fusee.—When a chain runs flat, when working back on to the barrel, or slips up the fusee when winding, it must be carefully examined, and the cause found out. Sometimes it results from the chain being too large; then the only remedy is a new chain. At other times it will be found that the delicate spiral projections on the fusee which separate each turn of the chain from the next have become bruised and perhaps broken in places, so that the safe retention of the chain cannot be relied on. If the damage is very serious, the fusee should be re-cut, but if only trifling, it may be rectified by carefully raising the injured part to its proper position and then placing it in the turns, and allowing a graver of suitable shape held in the right hand to lightly scrape out the grooves as the fusee is slowly turned with the left.

When the chain runs off without any apparent cause it may be frequently altered by changing it end for end, or by taking a very little off from the outer lower edge of the chain along its entire length. When all these means fail, by putting in a new hole for the top fusee pivot, so that the fusee inclines away from the barrel, a certain cure will be effected, as this must evidently cause the chain to run in its proper position.

ODD TERMS CURRENT AMONG MECHANICS.

VARIOUS terms in common use by mechanics sound very strangely when they fall upon the ears of the uninitiated. The origin of many of the names of tools, and parts of work, which we employ every day, is shrouded in obscurity, and if traced out would be not only an interesting topic of study for the student, but full of suggestiveness to the general reader. It is wonderful, upon investigation, to find how many terms used in mechanical pursuits are borrowed from other departments of arts. A workshop is an odd place for learning natural history, yet in it one hears continually of rabbits, camel-backs, frogs, swans-necks, dogs, dog-legs, horsing, donkey-engines, etc.

Some whimsical notes on the technical terms employed by builders have lately appeared in one of our foreign exchanges. From what follows it will hardly be necessary to say that the paper referred to is published in Dublin, Ireland; for the Irish excel all other people in quaintness of expression and originality of terms. From the notes referred to we cull the following, as likely to amuse our readers:—

Some workmen who have to work at what they don't like, and others who do not like to work at all, are said to be "working against the grain." Whether the particular "grain" in question is in their flesh or in their minds, science does not say, but perhaps it is in both. No carpenter or joiner, with a grain of sense, would, if he could possibly avoid it, work his plane or chisel against the grain of the wood he is operating upon, although he might be a most skilful operative.

A grainer may be a painter, but every painter is not necessarily a grainer. A painter who grains a piece of timber begins by painting out the grain, or successfully painting it over. As nature is said to abhor a vacuum, the grainer abhors the reality.

"Come out, Jack," said a jocular journeyman to a young builder's apprentice, "till I give you your first lesson in circular work; and Jack," continued the journeyman, "bring a can of water with you." Jack, like a dutiful apprentice, did what he was bid, and his first lesson was half an hour's turning of the grinding-stone on a very frosty morning. Young Jack's mother excused the boy's absence on the following day by sending word to his master that her boy was bad with the chilblains. When the boy returned to his work in a couple of days' time, he betrayed no ambition to take any more lessons in circular work.

"By the holy poker, that division is not in the centre of the framing!" said a workman, who discovered that he was wrong in his "setting out," and had worked accordingly. "Work the sum over again," said a practical joker beside him, "and perhaps you'll find out your mistake. Remember, mate," continued the joker, "a mistake is no botch, but a botch is a dreadful mistake, and always spells S-A-C-K."

A cant is a sweep—not a chimney sweeper, but a portion of a curve. A cant may also be an external angle or quoin, or any inclination from a horizontal line. A workman may cant or turn over a log or balk of timber without deserving the name of a canting fellow, although he cants.

In old times of trade combinations, a "slater" was not a workman who slated houses, but men, or "black sheep." The sawyers had formerly the reputation of being great slaters, and they combed many an obstinate fellow-workman's head, and harrowed his feelings. Sawyers were great adepts with the chalk-line, and walking in their cups in other places besides the top of the log. The sawyer was truly the cock-of-the-walk; and the top sawyer was always above his work, and looked down on it as beneath him. Poor fellows! though sad days came to their trade in our time, they have contributed some expressive phrases to the English language. To be top sawyer in many fields is to be the chief workman, leader, spokesman, or director, in connection with one's business or profession.

Coming now to the names of tools in the hands of our own mechanics, the number of puns which can be made from them is almost endless. At a Christmas oyster supper, chronicled by one of our American exchanges, an eccentric character, called "Wood Butcher," welcomed the guests, and responded to a toast in which the oyster was the principal idea, in the following language:—

I welcome you not only with my heart, but with "awl" that is within my "chest." It is "plane" that I must "gauge" my remarks very fine to keep within the "compass" of the time "chalked" out for me, so I will come "square" up to the "line" and do my "level" best. The oyster, the subject I propose to discuss, is one that lies very near my heart. In fact, I may now be properly said to be full of it, and it is in this condition that I find myself best "braced" when I attempt to make a "bit" of a speech. The oyster is an article which I think should be in all correct "board" bills, and I never feel the necessity of guarding my temper more than when there is a prospect of my being "chiseled" out of my share of him. No such "gouging" will ever be submitted to by me. The oyster in his native condition has no "vice," but after his bed has been "ploughed," and he has been raised and had his "frame" "wrenched" apart by an instrument which is neither a "screw-driver" nor a "cold chisel," but a cross between the two, he loses his power of resistance, and whether surrounded by good or bad persons, sinks to a depth from which he rarely rises; and if he does rise, he receives the contempt of all mankind. Unlike the little busy bee, he is not much of a "builder," though I have heard the old "saw"—as dumb as an oyster—applied to a number of builders. His shell is sometimes made into lime, and used in making plaster. After having their "roofs" so unceremoniously taken off by a "cutting thrust," the oysters are thrown on a "bench" and they then "file" down to the "filletster," who drops them "plumb" into one of the products of the "drawing knife"—that is, a little "shave" keg. Though the oyster is not a wild animal, he is frequently a table companion of the "rabbit." The authorities have not yet agreed whether the oyster is an animal or a fowl. I do not believe he is a fowl, for they cannot "hatchet." It "augers" well for the future of natural history that naturalists have recently come to the conclusion that he is not a vegetable. When first taken and "punched," the price "set" on him is low, but as every one who handles him must make a profit, these "adze" make him sufficiently expensive to cause him to be looked upon as a luxury. I regard him as a necessity, though the extortionate "ax" of the vendors "rasp" my soul. Often in lying words has such a one "spoke-shave" being his desire, but they are the hardest kind of "shavings" to lie on. I have seen oysters advertised for sale in every "stile," but have never seen them sold under the "hammer." In conclusion, I would say that the oyster is neither an oblong nor a "square," yet he is a perfect "jointer."

ON THE MODERN SYSTEM OF CUTTING METALS.

A MOST interesting paper on the above subject was recently read before the members of the Institution of Mechanical Engineers by the author, Mr. Ford Smith, of the firm of Smith and Coventry, Salford, Manchester. The method of making and maintaining the various cutting tools, and the application of the system to all the machines used in workshop practice for cutting metals, was exhaustively treated upon. The paper was in some sort a continuation of one read by Mr. Smith before the Institution as long ago as 1866, and may, therefore, be taken to contain the results of long experience with the particular kinds of tools described. The paper may be divided into three divisions: (1) Toolholders, (2) Twist Drills, and (3) Milling Tools. The first division contained descriptions of the various toolholders for all the possible applications of planing, shaping, turning, etc., the actual cutter in each case being a comparatively small piece of tool steel of uniform section, and the toolholder, when required, permitting the cutter to be readily adjusted into different angular positions. The advantages claimed for the system are that all forging of the tool is dispensed with, and the operation of grinding is simplified, as it merely consists of grinding upon the end of the piece of bar steel, which is done to a constant angle in a machine. In the second division of the paper the form and manufacture of twist drills are dealt with, and a machine is described for grinding them, it being of particular importance that they should be ground with extreme accuracy, and that each side of the drill should perform its due share of work. Full numerical particulars are given, showing the performance of this description of drilling tool, and showing that it possesses extraordinary efficiency and endurance. The third, and probably the most interesting, part of the paper contained the author's experience with milling tools. It was shown that almost all the operations of shaping and planing machines may be advantageously performed with milling tools, and in illustration of the varied use to which they may be put, it was stated that they are now made from about ¼in. up to 20ft. in diameter, the larger ones being built up by rigidly fixing hard steel cutters into discs or centres of mild steel or wrought iron, and sharpening when in place. The successful use of milling tools depends upon their being of exactly circular form, so that each tooth shall do the same amount of work. To insure this they must be finished after they are tempered; and a machine was shown and described in which this finishing and also the re-sharpening were effected with a small emery wheel. With milling tools properly prepared it was said that no more power is necessary to remove a given weight of shaving than when using the ordinary tools. The paper was abundantly illustrated with specimens of all the tools and grinding machines described, and also with samples of the work produced by them, the latter being generally accompanied with similar pieces of work done by ordinary tools. This paper was followed by a long discussion, the adjournment on Wednesday taking place in the midst of it. Mr. Wickstead stated that the most important point with regard to drills was that they should be thin at the point, and he thought that the care taken by Mr. Smith to insure accurate grinding was likely to be without much result, in consequence of his drills being thick at that part. He was of opinion that toolholders were of use in cases where it was necessary for the cutting edge to overhang the rest for some distance, and unless that were the case solid tools were generally preferable. Mr. Fielding advocated the use of cast-iron chilled tools, and showed specimens of such tools. Mr. Hulse alluded to attempts which, to his knowledge, had been made to introduce the systematic use of toolholders, and which had failed. He also showed some heavy lathe cuttings, as an illustration of the kind of work which is required from modern machine tools, and which he thought could not be obtained except by the use of large solid tools. Mr. Kitson strongly advocated the use of milling tools, and, as a sample of milled work, exhibited a crosshead finished all over by milling. He recommended the use of fluted milling-cutters for roughing. The Chairman referred to the use of milling-cutters at Elswick, and spoke in favour of their extended use, stating that the operation of milling had a great future before it. At the same time it was necessary, in order to produce good work, that the supports both of the cutter and the work should be exceedingly rigid and unyielding. He had found it necessary when using ordinary milling-cutters upon brass to remove every alternate tooth to prevent choking, but upon doing that they had been found to answer perfectly. He was of opinion that for all heavy cutting it was advisable to use large solid cutters, not only for the sake of increased rigidity but also because it was desirable that the cutting point should be in immediate connection with a large mass of metal to facilitate the dispersion of the heat generated by the cutting. He advocated the use of Mushet steel tools for heavy cutting, since it worked best when hot, and did not require tempering. With regard to drills, he thought that much of the success attending the use of twist drills was due to the care expended in making and grinding them, and that if flat drills were used in the same careful way they would be more efficient than the others. Mr. Smith replied, shortly noticing the remarks of each speaker, but adding nothing of interest to the comprehensive account given in the paper, except the statement that he *did* adopt special means of keeping the point of his drills thin as they wore away.

Mr. Smith, in introducing the subject, stated that he proposed to treat of some of the processes of cutting metals, which he had adopted since reading a paper on "Toolholders" before the institution (Proceedings 1866, p. 288). The success of the round toolholders then described had led to the further adoption of mechanical means of making and maintaining the tools used in various machines for cutting and finishing metals in their cold state. Such machines are commonly known by the term "machine tools," and comprise lathes, planing, shaping, and slotting machines, milling machines, drilling and boring machines, screwing and chasing machines, etc. The former paper described mainly what have since become known as right and left hand round toolholders. They are used in different machine tools, principally for "roughing out," or, in other words, for rapidly reducing castings, forgings, etc., from their rough state nearly to their finished forms and dimensions. The toolholders are so called from their cutters being made of round steel cut from the bar. Notwithstanding that they are very widely applicable, take heavy cuts, and do the bulk of all machine work in lathes, and in planing, shaping, and slotting machines, it was soon found that they could not compass the whole of the work required in the shops, and it was therefore necessary still to allow the use of some of the common forged tools in conjunction with the round toolholders. This, however, was objectionable, as no positive rule could then be laid down to define what number of forged tools should be allowed to each workman; and it became apparent that the toolholder system, in order to reach the highest degree of efficiency, must be made complete and independent in itself. This led to the designing of another toolholder of the most general kind the writer could possibly devise, in the hope thereby to complete the system. With this object in view, all the remaining forged tools then in use were collected together, and the swivel toolholder (Figs. 1 and 2) was schemed, with cutters so adjustable that they could not only be swivelled round and then fixed to any desired angle, but could be made to project at pleasure to any required distance, in order to reach and cut into all sorts of difficult and awkward corners—in fact, to machine any work which the round toolholder could not finish. Two of the principal objects aimed at were to devise a system of cutters which should not require any forging or smithing, and yet should be capable of being adapted by the simplest possible means, and by grinding the ends only to all forms which the round cutters would not admit. The special section of steel decided upon was a sort of deep V section, the lower part of which is slightly rounded, as shown at fig. 2*a*. The angles of the sides give the same amount of clearance (1 in 8) as that given in the round toolholders, and this same angle of clearance is given to the ground parts. The section of the swivel cutter is made very deep, in order to obtain ample strength in the direction of the pressure it has to support when cutting. The angle in fig. 1 is common to every swivel toolholder. In the cutter for the round toolholder two angles had been fixed upon as standards, one to cut all kinds of wrought metals, the other all cast metals. To avoid complication, however, in the swivel toolholders one cutting angle was fixed upon for all metals, and applied to all cutters. The angle selected is one slightly differing from that of the round cutters, but is that which worked the best in practice. The cutters of the round toolholder system are found most advantageous in producing and finishing standard-size round corners in journals of shafts, etc., and in other cases, where the engineer of the present day is anxious to preserve all the strength he can in the parts he is constructing; but there are still cases where square, angular, or undercut surfaces must be produced, as illustrated by figs. 3 to 8. These are front views, showing the toolholders at work planing or shaping. They are supposed to be travelling forward, or the work to be moving in the opposite direction; and the arrows in each figure indicate the direction in which the toolholder is being fed at each stroke of the machine to take the next cut.

Fig. 4 shows the mode of planing the under horizontal surface of a lathe bed. The cutter shown in use is ground to an angle of 86°, or 4° less than a right angle, and thus has a clearance of 2° at each side when cutting either horizontally or vertically. This cutter is very general in its applicability, and is devised so as to finish with one setting both the vertical surface A and the horizontal surface H without the necessity for disturbing the cutter in any way. The ordinary system is to use at least two tools for roughing out and two for finishing on two surfaces at right angles with each other. Fig. 3 shows the method of planing in a very limited space the under horizontal surface S. The corresponding surface on the opposite side (not shown) is planed afterwards, without disturbing the toolholder, by simply swivelling the cutter half-way round in the holder and securing it there by the nut. Fig. 7 shows a swivel toolholder clearing without difficulty a boss which projects and would be very much in the way of any ordinary tool. The cutter in this case planes not only the horizontal surface C but the vertical surface V also with one setting, and without being disturbed in the tool-box. Fig. 5 shows the method of cutting a vertical slot in a horizontal surface of metal. The cutter in this case is called a parting tool. Figs. 6 and 8 are toolholders with cutters of rather special forms. The former is shown planing out or under-cutting a T-shaped slot, and the latter is planing out a small rectangular clearance corner. Figs. 10 and 11 show a swivel toolholder with a round shank, such as is used on the slide rest of a screw-cutting lathe, for cutting square threads. It is carried on a wrought-iron or steel block, provided with a groove, semicircular in section, in which the round shank of the toolholder lies, and is clamped down in the usual way. The cutters for cutting out the spaces between the square threads are of very simple form, and by aid of this toolholder any tool of the correct width of the space will cut either right-hand or left-hand screws, no matter whether they are single threads, double threads, or any other. To cover the same ground with forged tools, no less than six expensive cutters would be required, each one forged from square steel, and carefully filed up and hardened. With the toolholder only one cutter is required, and it costs probably not more than 10 per cent. of one of the six forged tools, while it maintains its size much better, and consequently lasts much longer. It also takes about twice the weight of cuttings per hour as compared with an ordinary forged tool. This system is useful where many screws of odd forms and pitches are required; but where there are sufficient numbers to be cut, special chasing lathes are far preferable to ordinary screw-cutting lathes, as they will do about six times as much chasing of V threads, or cutting of square threads, as can be accomplished in the ordinary lathe in the same time. Instead of carrying one chaser, the chasing lathes carry, in a chasing apparatus, three or four chasers, and these have their threads, whether square, V, rounded, or any other form, cut in their places by aid of a master tap. They are then tapered at the mouths, backed off, and hardened ready for work. The number of shavings cut simultaneously from a screw by this process varies from 12 to 24, according to the size, strength, and pitch of the thread. Screws up to 6in. diameter can be very rapidly cut by this system, on which very much more might be said if time permitted. [A few screws cut by this process were exhibited.]

When the two systems—the round and the swivel tool-holder—are worked in conjunction with each other, their universality of application is so thorough that almost every difficulty is met; and it was only in the case of paring and shaping articles in the slotting machine that two modifications had to be made in the holders, the same cutters being still applicable.

The capstan-bed chasing lathes made by the writer's firm have now become much used, and as a large amount of their work is done upon black bars of iron, steel, or other metals, each of which has to be finished at its extremities and cut or parted off, it was found advisable to make one special toolholder (Fig. 25) to carry tools of the correct sections to produce the desired shapes for the ends. The tedious and unreliable process of turning the ends with hand-turning tools is thus avoided. Each cutter is of absolutely the same section throughout its entire length, and the re-sharpening is done by grinding the end of the cutter only, so that it can only produce the same standard form so long as it lasts—that is to say, till it is ground too short to be used any longer. The parting-off might have been accomplished by the swivel tool-holder; but a special form (Fig. 24) is found to be more convenient in parting-off close up to the chuck or lathe spindle.

To produce a maximum amount of cutting in a minimum space of time, there are two main points which must be carefully attended to. These seem to be applicable to all cutters for cutting metals, whether they happen to be those fixed rigidly in tool-boxes, as in turning lathes, planers, shapers, slotters, &c., or those which cut while they revolve, as milling-cutters, twist-drills, boring-bits, &c.

These two important points are: (1) The angle of the cutting surface or cutting angle (Fig. 21), *i.e.*, that surface which removes the shavings of metal, and upon which the pressure of the cut comes, as shown by the arrow. (2) The angle of the clearance surface or clearance angle, *i.e.*, that surface which passes over the surface of the metal which has been cut, and does not come in contact with the metal at all.

To produce the best results, and to insure the utmost simplicity, it is important that these two angles be correctly constructed in the first instance. The best measure for both angles has been arrived at from actual practice and a series of experiments. When once obtained and started with, they should not alter by use, but always remain constant, if the greatest amount of cutting efficiency is to be achieved. When aided by a mechanical system of re-grinding, and the use of standard angle gauges (figs. 22 to 23) there is no difficulty in maintaining the exact angles. The only changes which take place are that the cutters in toolholders become gradually shorter by grinding, and that milling-cutters during a long period of time become very gradually smaller in diameter, by the process of re-sharpening them on a fine emery wheel. In the case of the tool holders, as already explained, the cutting angle is maintained by the system of re-grinding, and the tool-holder itself always maintains the clearance angle. The system is thus simplified, as will be clearly understood when it is remembered that each one of the toolholder cutters (no matter of what description) is ground on its end only. The section is thus never altered, no smithing or alteration in form is necessitated, and consequently no repairing has to be done in the smiths' shops. The objects aimed at have been :—

1. To produce the highest class of workmanship by providing the best known form of cutters, carefully made, and capable of having the cutting edges accurately re-ground, so that the surfaces of the machined work may be produced direct from the cutters so highly finished that no hand-work could possibly improve them. All the turning of wrought iron, for instance, is so perfectly finished that there is no necessity to polish it by means of emery or emery cloth.

2. To make all the cutters so free from complication and simple to keep in order that no difficulty or error may take place in re-grinding them.

3. Since finely-polished surfaces cannot be obtained without the most perfect cutting edges, to make all cutters not only of the best steel, but with their cutting edges most accurately and carefully ground up, in almost all cases by mechanical means. The durability of the cutters, from their construction and high class of material, is very great, and they are thus capable of removing a great weight of metal in a given time.

The grinding or re-sharpening of all cutting edges is reduced to the greatest simplicity; and only three descriptions of machines are requisite for this purpose. They are all arranged to grind mechanically—that is to say, the cutters while being ground are carried and pressed on the grindstone or emery wheel by mechanism; the required forms and angles are also obtained by mechanism, it being found in practice that sufficient accuracy cannot be secured by hand-grinding. The machines are as follows:—

1. A grindstone, with slide rest, for grinding all the cutters used in tool-holders.

2. A twist-drill grinder. This also is by preference a grindstone, with mechanism for holding and guiding the twist drills. A machine with an emery wheel in place of the stone is also used for the grinding of twist drills, with much the same mechanism for carrying the drills. In practice, however, the stone grinds about double the number of drills per day, and with less risk of drawing the temper. Both stone and emery wheel are run at a high speed, and used with water.

3. A small but very complete machine, one of which is exhibited, as used for regrinding milling cutters. In this case gritstone does not answer, and the grinding wheels are obliged to be of emery or corundum. They are very small in diameter, and many of them are exceedingly thin, and so delicate in form that if made of gritstone they would rapidly lose their shapes. They are run at a high speed, and are turned into form while revolving by means of a diamond. A milling-cutter will work for a day, and in many cases for two days, without showing signs of distress. Before the cutting edges are visibly blunted, but as soon as the sense of touch shows their keenness to be diminished, the cutter should be put into this machine. The sense of touch, in passing the finger over the cutting edges, conveys the idea of slight bluntness better than it can be detected by the eye. The probability is that not more than $\frac{1}{1000}$in. need be ground off each tooth before it is restored again to a cutting edge almost as fine as that of a wood-chisel. Each cutting edge, or, in other words, each tooth of the milling-cutter, is only passed rapidly once or twice under the revolving wheel, which is itself of very fine emery. It can therefore be readily understood how delicate an operation this is, and why emery alone will answer for it. In order to maintain the correct forms and angles of all cutters for tool-holders, sheet steel angle-gauges, as shown in fig 22, are provided, and the process of grinding is thus reduced to a complete and exceedingly simple system. In well-regulated shops a young man is selected to work each machine for cutter grinding; and in practice each man so engaged can keep a works employing 150 men (exclusive of moulders or boiler men) well supplied with all the necessary cutting tools from day to day. A very great saving is thus effected, as no machine need ever stand idle for want of cutters. Take, for instance, an engineering works employing 250 men. The requisite number of improved grinding machines with special mechanical appliances is as follows:—

Two patent grindstones for re-sharpening cutters mechanically.

One patent twist-drill grinder for re-sharpening twist-drills mechanically.

One improved cutter grinder, with small emery wheel, for the re-sharpening of cutters used in milling machines.

To follow the system out satisfactorily, the man working the grindstone goes round to each machine every morning, collects together those cutters which have been blunted by use the previous day, carries them to his grindstone, re-sharpens them, and distributes them out again to each machine, which is thus kept well stocked with an ample number of cutters always ready for immediate use. The cutters for tool-holders do not require any repairing in the smithy; consequently that operation, which is costly in so many ways, is avoided, and jobbing or tool smiths, with their strikers, are almost entirely dispensed with. For rehardening the cutters a rule is made that when the grinder meets with cutters which are not as hard at their cutting points as they ought to be, he puts them on one side, and periodically, say once each fortnight, he sends the lot into the smithy for the end of each to be retempered. This is a very inexpensive operation. They are placed in a small oven by dozens, and very slowly heated up to a dull red; the end of each cutter is then plunged into a perforated iron box, the bottom of which is covered with the required depth of water to harden the cutter to the proper distance from its point. The cutters are left standing in a nearly vertical position in the box of water until they have gradually cooled down sufficiently to be removed. They are then sent to the grindstone, reground, and given out with the other cutters to be again used in the different machines. With steel of the highest quality for cutters it is most important to keep it out of the smith's fire entirely if possible. That object is here attained, the cutters never going to the fire except for rehardening. During the life of a cutter it only sees the fire, probably, six times. As the weight of each cutter is small, not probably more than from $\frac{1}{15}$th to $\frac{1}{20}$th that of a forged tool used for the same purpose, the outlay for best tool steel is not heavy, and the engineer is not tempted to purchase any but that of the highest quality. With such steel, especially when used in the best manner, each machine is capable of cutting at a high rate of speed, and the cuts may be coarser than those ordinarily taken. When the swivel toolholders were first used on planing machines, cutting slots 1in. broad into solid castings, it was found that two teeth of the feed could be used at each stroke. Previously a forged tool of the same breadth, ground to form by the planer to the best of his ability, had been used in the same machines; but he found, on trial, from time to time, that it was impossible to use more than one tooth of the feed, or, in other words, the toolholder cut a given depth into the metal in half the time of the forged tool. Again, when the swivel toolholders were first used in cutting square-threaded screws, the utmost the lathe could do with forged tools was to take four degrees of feed at each cut, as indicated by the micrometer feed-wheel. The toolholder, on the other hand, took seven degrees of feed in the same lathe, doing the same work, and producing quite as good or a better finish with the same expenditure of steam power. The cutters for the swivel toolholders can not only be made at the outset, but also constantly maintained, at the best and most efficient angles which practice can teach. It therefore follows that a very much better class of machine work can be produced. The finished surfaces obtained from the toolholders show a striking superiority over those from forged tools, especially when in the latter the angles are ground by hand by each man or boy working a machine. The tendency then is to grind the cutters to all sorts of incorrect forms, which more or less tear the surfaces of the machined work, and leave bad finishes, such as require a considerable amount of hand-labour bestowed upon them afterwards in filing, scraping, and polishing. Again, the toolholders have led up to a considerable extension of what is called broad-finishing in planing, turning, shaping, slotting, etc.

Broad-cutting feeds, varying from $\frac{1}{2}$in. to $1\frac{1}{2}$in. in width, are very commonly taken by the swivel toolholders, and more accurate surfaces produced than with finer feeds. The advantages in point of time saved are very great, the time occupied in finishing by broadcutting being from $\frac{1}{12}$th to $\frac{1}{20}$th of that consumed by finishing with ordinary feeds and in the usual manner. Some samples of this kind of finishing lie on the table, together with the cutter which was used. The width of broadcutting can be increased to any desired limit, and there have been special cases where it has been advantageous to take thin shavings 3in. to 6in. in width. The principal limits to broadcutting are as follows:—

1. The power of grinding the cutting tool to a sufficiently straight or true cutting edge, the best plan of course being to do this by mechanical means.

2. The securing a sufficient stability in the machine tool to hold the broadcutter so rigidly up to its work that neither the cutter itself nor the work may spring away, and that no jarring or injurious vibration may be produced and impart its evil effect to the finished surface.

3. The securing of sufficiently accurate work to answer the purpose for which it may be required. For instance, the piece of work planed or turned by this process may be a portion of a large railway bridge, where absolute accuracy is not required, or it may be some portion of a machine tool, where the utmost accuracy is needed, or, again, some portion of an engine, where the builder is anxious to obtain all the accuracy which can possibly be produced direct from the machine tool.

During the last thirty years many attempts have been made to introduce a better system of drilling and boring, and on this subject very much might be written if time permitted. Many engineers have used square bar steel, which the blacksmith has twisted and then flattened at one end to form a drill. The object of the twisted stem was to screw the cuttings out of the hole, and to some extent this succeeded, but not perfectly.

The twisted square section revolving in the round hole had a tendency to crush or grind up the cuttings; and if they were once reduced to powder, it was difficult (especially in drilling vertically) for the drill to lift the powdered metal out of the hole. In most cases the lips of these drills were of such form that the cutting angle, or face of each lip, which ought to have been about 60°, fig. 21, was 90°, or even still more obtuse; this being an angle which would scrape only, but could hardly be expected to cut sweetly or rapidly.

Again, there were attempts to make the cutting angles of the two lips of much the same number of degrees as that given by the twist itself in a good twist drill. This was done by forging or filing a semi-circular or curved groove on the lower face, *f*, of each lip, figs. 17 and 18. For a short time lips thus formed cut fairly well, but a very small amount of re-grinding soon put them out of shape and made them of such obtuse cutting angles that good results could no longer be expected from them, and to be constantly sending such drills to the jobbing or tool smith, and then to the fitter to file into form again before they were re-hardened, was found to be too tedious and too expensive.

Again, to arrive at the best results in drilling each of the cutting lips should make the same angle with a central line taken through the body of the drill; in other words, the angles, *a* and *b*, fig. 12, should each have exactly the same number of degrees, say 60°. The clearance angles also should be identical, and the leading point, *p*, should form the exact centre point of the drill.

From practice it is found that if these proportions are not correct, the drill cannot pierce the metal it is drilling at more than about half the proper speed, and the hole produced will also be larger than the drill itself, as will be exemplified a little later on.

To give an idea of the extreme accuracy which must be imparted to a twist-drill, we must bear in mind that even a good feed is only $\frac{1}{100}$in. to each revolution; and as two lips are employed to remove this thickness of metal, each lip has only half that quantity to cut, or $\frac{1}{200}$in. This $\frac{1}{00}$in. is as much as can be taken in practice by each lip in drills of ordinary sizes.

It will therefore be readily understood that if one lip of a drill stands before the other to the extent of $\frac{1}{100}$in. only, the prominent lip, or portion of a lip, will have to remove the whole thickness of the metal from the hole at each turn. The lip of a drill will not stand such treatment; and it is therefore obvious that if this were attempted the prominent lip would either break or become too rapidly blunted. To get over these difficulties, the driller would no doubt reduce his feed by one-half, or to $\frac{1}{200}$in. per turn, which would mean about half the number of holes drilled in a given time. This nice accuracy, although absolutely required, cannot be produced by hand-grinding; neither can a common drill, having a rough black stem more or less eccentric, be ground accurately, even by aid of a grinding machine with mechanism for holding it. To grind any drill accurately, it must be concentric and perfectly true throughout with the shank, as that part has to be held by the drill-grinding machine. If the drilling is to be done in the most rapid manner—in other words, at the smallest cost—and if the best class of work is also desired, it seems certain that a twist drill, with all the accuracy which can possibly be imparted to it in its manufacture, and the greatest care employed in the re-sharpening, is the only instrument that can be employed.

About a quarter of a centry ago both Sir Joseph Whitworth and the late Mr. Greenwood, of Leeds, made some twist drills; but it is to be presumed that a large amount of success was not achieved with them, and for some reason the system was not persevered with. After that period the Manhattan Firearms Company, in America, produced some beautifully-finished twist drills. Though the workmanship in these was of a superior description, the drills would not endure hardship. It was found that the two lips were too keen in their cutting angles, and that they were too apt to drag themselves into the metal they were cutting, finally to dig in and to jam fast, and to twist themselves into fragments. Mr. Morse then took the matter up, and by diminishing by about 50 per cent. the keenness of the cutting lips of twist drills, made a great success of them. He used the grinding line, *a b*, fig. 19, and an increasing twist. In such a drill of the standard length, and before it is worn shorter by grinding, the twist is so rapid towards the lips that the angle they present, or what has been already referred to as the angle of the cutting surface, is very nearly the same as that the writer had previously established for cutters cutting metals, as in fig. 21.

If, however, the angle of twist is made to increase towards the lips, it will, of course, decrease towards the shank, as in fig. 19. The shorter the drill is worn the more obtuse the cutting angle becomes, and the less freedom will it have, supposing, of course, that the angle, when the drill was new, was the most efficient. Suppose this decrease of twist were carried still further by lengthening the drill, a cutting angle of 90° would eventually be arrived at. The old common style of drill usually has a cutting edge which is so obtuse as not to cut the metal sweetly; but, on the contrary, to have more of a tearing action, and thus put so much torsional strain on the drill that fracture is almost certain to take place, even if what the writer would now consider a moderate feed was put on by the drilling machine.

It is therefore obviously advantageous to adopt from the first the best cutting angle for all twist drills, and to preserve this same angle through the whole length of the twisted part, so that, however short the drill may be worn, it always presents the same angle, and that the most efficient which can be obtained. This cutting angle is easy to fix, and becomes an unalterable standard which will give the best attainable results.

A common drill may "run," as it is usually termed, and produce a hole which is anything but straight. This means that the point of the drill will run away from the denser parts of the metal it is cutting, and penetrate into the opposite side, which is soft and spongy. This is especially the case in castings, where, for instance, a boss may be quite sound on the one side, while on the other a mass of metal may be full of blow-holes, or so drawn away by contraction in cooling as to be very soft and porous. In such cases it is perfectly impossible to prevent a common drill from running into the soft side. This sort of imperfect hole is most trying to the fitter or erector, and if it has to be tapped to receive a screwed bolt or stud, is most destructive to steel taps. The taps are very liable to be broken, and an immense loss of time may also take place in attempting to tap the hole square with the planed face. A twist drill, on the other hand, from its construction, is bound to penetrate truly, and produce holes which are as perfect as it is possible to make them.

The next important step in twist drills has been to fix a standard shape and angle of clearance for both lips, which should also give the best attainable result. This angle might be tampered with if the re-grinding were done by hand, and too much or too little clearance might easily be imparted to the drill from want of sufficient knowledge on the part of the workman. If too little clearance, fig. 15, or in some cases none at all, is given to the drill, the cutting lips then cannot reach the metal; consequently they cannot cut. The self-acting feed of the drilling machine keeps crowding on the feed until either the machine or the drill gives way. Usually it will be the latter. Again, if too much clearance is given, fig. 16, the keen edges of the lips dig into the metal, and embed themselves there, and of course break off. The grinding line *a b*, fig. 19, was introduced in the States to assist the operator in keeping both lips of the drill identically the same. To arrive at this, however, is more than can be accomplished by hand-grinding, as not less than three points have to be carefully watched, viz.: 1st. That both lips are exactly the same length. 2nd. That both have the same clearance angles. 3rd. That both make the same angle with the centre line on the body of the drill. If these are not attended to, the drill lips may, for instance, be both ground so as to converge exactly to the grinding lines at the point or centre of the drill, and may still be of such different lengths and angles as to produce very bad results in drilling.

Much ingenuity has been expended on machines for the grinding of the two lips with mechanical accuracy. The one which has been the most successful in the United States has three motions, ingeniously combined with each other. So many motions, however, entail complication, and this, added to a system of holding the drill which was not sufficiently reliable, failed to produce the extreme accuracy it is requisite to impart to the two angles. The grinding line, too, is found to be more or less a source of weakness. It is therefore advisable to dispense with it, if possible; and where a good twist-drill grinding machine is used, the grinding line is seldom or never looked at, and in that case is useless. If it is still desirable to have grinding lines (as in some cases where hand-grinding has to be relied upon), they should be made as faint as possible, and not cut deeply into the thin central part of the drill, so as to weaken it. Fig. 14 is drawn exaggerated in order to show the ill effect of grinding one lip of a drill longer than the other.

A simple and efficient twist-drill grinding machine was so much needed that within the last three years the writer has designed one. The twist-drill in this machine has only one motion imparted to it, to produce the two lips of each drill as perfect facsimiles of each other, and with the desired amount of clearance. Many of these machines are now at work. That the drills ground by them are accurate, is proved by the holes drilled being so nearly the size of the twist-drill itself that in many cases the drill will not afterwards drop vertically through the drilled hole by its own gravity—in other words, the hole is no larger than the drill which has drilled it. It is not generally known that this is the most severe test that can be made of the accuracy of re-grinding, and of the uniformity of all parts of the twist-drill. [One of the smallest sized machines was exhibited.] The largest machine grinds drills 3in. diameter.

The whole of the drilling in many establishments is now done entirely by twist drills. Since their introduction it is found that the self-acting feed can be increased about 90 per cent.; and in some engineering works the feeds in some machines have been increased by fully 200 per cent., and consequently three holes are now being drilled in the same time that one was originally drilled with the old style of drill and with old machines. It may be interesting to give a few results out of numerous tests and experiments made with the twist drills. Many thousands of holes ½in. in diameter and 2¾in. deep have been drilled, by improved ½in. twist drills, at so high a rate of feed that the spindle of the drilling machine could be seen visibly descending and driving the drill before it. The time occupied from the starting of each hole, in a hammered scrap-iron bar till the drill pierced through it, varied from 1 minute 20 seconds to 1¼ minutes. The holes drilled were perfectly straight. The speed at which the drill was cutting was nearly 20ft. per minute at its periphery, and the feed was 100 revolutions per inch of depth drilled. The drill was lubricated with soap and water, and went clean through the 2¾in. without being withdrawn; and after it had drilled each hole it felt quite cool to the hand, its temperature being about 75° It is found that 120 to 130 such holes can be drilled before it is advisable to re-sharpen the twist drill. This ought to be done immediately the drill exhibits the slightest sign of distress. If carefully examined, after this number of holes has been drilled, the prominent cutting parts of the lips, which have removed the metal, will be found very slightly blunted or rounded, to the extent of about $\frac{1}{100}$ of an inch; and on this length being carefully ground by the machine off the end of the twist drill, the lips are brought up to perfectly sharp cutting edges again.

The same-sized holes, ½in. diameter and 2¾in. deep, have been drilled through the same hammered scrap-iron at the extraordinary speed of 2¾in. deep in one minute and five seconds, the number of revolutions per inch being 75. An average number of 70 holes can be drilled in this case before the drill requires re-sharpening. The writer considers this test to be rather too severe, and prefers the former speed. The drills in each case were driven by a true-running drilling-machine spindle, having a round taper hole, which also was perfectly true; and the taper shank and body, or twisted part of the drills also ran perfectly concentric when placed in the spindle, or in a reducer, or socket having a taper end to fit the spindle. When the drills run without any eccentricity, there is no pressure, and next to no friction, on the sides of the flutes, the whole of the pressure and work being taken on the ends of the drills. Consequently, they are not found to wear smaller in diameter at the lip end, and they retain their sizes, with careful usage, in a wonderful manner. The drills used were carefully sharpened in one of the twist-drill grinders, mentioned above. In London upwards of 3,000 holes were drilled ⅝in. diameter, and ⅜in. deep, through steel bars, by one drill without re-grinding it. The cutting speed was in this instance too great for cutting steel, being from 18ft. to 20ft. per minute; and the result is extraordinary. Many thousands of holes were drilled $\frac{1}{8}$in. diameter, through cast iron $\frac{7}{16}$in. deep, with straight-shanked twist drill gripped by an eccentric chuck in the end of the spindle of a quick-speed drilling machine. The time occupied for each hole was from nine to ten seconds only. Again, $\frac{1}{4}$in. holes have been drilled through wrought copper, $1\frac{3}{8}$in. thick, at the speed of one hole in ten seconds. With special twist drills, made for piercing hard Bessemer steel rail holes, $\frac{13}{16}$in. deep and $\frac{23}{32}$in. diameter, have been drilled at the rate of one hole in one minute and twenty seconds, in an ordinary drilling machine. Had the machine been stiffer and more powerful, better results could have been obtained. A similar twist drill, $\frac{23}{32}$in. in diameter, drilled a hard steel rail $\frac{13}{16}$in. deep in one minute, and another in one minute ten seconds. Another drill, $\frac{3}{8}$in. diameter, drilled $\frac{3}{4}$in. deep in 38 seconds, the cutting speed being 22ft. per minute. This speed of cutting rather distressed the drill; a speed of 16ft. per minute would have been better. The steel rail was specially selected as being one of the hardest of the lot.

(To be continued, with illustrations, in next issue.)

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A Tack, says the Detroit "Free Press," is a simple, unpretending sort of a young nail, noted for its keen repartee when pressed for a reply, and possessing the peculiar power, when standing on its head, of causing the cold shivers to run down the back of a man, in mere anticipation of what might be. Tacks are in season all the year round, but the early spring is usually the time selected by them for a grand combined effort, and then they flourish everywhere for at least a month. Since the inauguration of the time-honoured ceremonies of house-cleaning, every thorough housekeeper, with long experience in the line of duty, so takes up the carpet as to retain all the tacks in their original places, thus preventing it slipping from the shaker's hand, unless the tack breaks or his fingers give out. But the triumph of the tack is not complete at this early stage; it patiently abides its time, and on the relaying of the carpet issues forth with double force. After searching the entire house for a paper of tacks, without success, the unfortunate man drops on his hands and knees to begin, and immediately discovers four tacks at least, and as he rolls over and sits down to extract these, finds the rest of the paper directly under him, and then, unless he is accustomed to put up stoves and join stovepipe, the chances of laying the carpet on that evening are slight. In selecting tacks from a saucer, he always inspects the points with his forefinger, as the tack instantly loses its head when they come to blows. In argument the tack is sharp and pointed, but the display of either or both depends largely on the amount of pressure employed by its opponent. In direct contrast to a good joke, the amusement generally begins before you see the point, and this fact is easily demonstrated by walking the floor in your stocking feet, a well-kept floor on such an occasion averaging two tacks to the square foot. The future of the tack gives great promise of more extended usefulness and greater possibilities, as several of our most eminent college professors, having carefully studied the effect of a sharp tack of reasonable length placed properly in a chair or under a cot, are about to introduce tacks and do away with spring-boards in our college gymnasiums.

PROGRESS IN MACHINE AND ENGINE DESIGN.

WHEN we consider the crude construction in original engine design coupled with the untutored adaptation of any handy appliance to effect the required motion of primitive engines and machinery, we cannot but look with admiration upon the general progress attained in these features since the original conception. The grace and adaptation with which the several parts are now designed and constructed, compare admirably with older constructions, while the general appearance of well-constructed machinery calls for and easily attracts the attention of the artistic eye. With progress in particular manipulation of the several metals, more delicate and graceful yet reliable adaptation of the means and material to the end has been reached, and in this consists the whole beauty of design in machinery.

Of course, as with every art or profession, there is the accompanying cheap, crude and quack stock in imitation of the more refined and admirable productions. A natural, yet educated attention to the requirements of the work bring about perfection and beauty as well in the constructed machine as in the architectural design of building, the sculptured object, the scene painting or the portrait. If the necessities of the case, the adaptation to the locality, the refined discrimination as to highest and more necessary requirements of the surroundings, and the proper outlining of the hidden life-giving parts are neglected, the design has not been properly made, and the machine does not in itself portray its mission.

There are very many able examples of admirable work in machine design, embodying all the requirements of beauty, adaptation, and fitness for the work to be performed. The addition of architectural ornamentation, the putting on of the mouldings, the reverse curves, the annulets, the groove or glyph, the taenia, the corona, the splay or plinth for the purposes of accomplishing the so-called ornamentation of the design are entirely out of place, are expensive as well as offensive. They add costly material, weight, and workmanship, and are, in the great majority of cases, entirely superfluous and unnecessary.

The greater the simplicity in machine design the more admirable are the results. The proper shaping of the metal to the passages, the faces, the joints and the bolt requirements will prove the most efficacious and ornamental. In architectural design every feature of its construction is for a purpose, and such ornamentation as may be applied is subservient to that purpose. The cornice of the present style of house is adapted to overhang the front that the water wash or drippings may reach the ground direct and not trace its way over the masonry or front of the building, soaking and rotting the material, be it wood, stone, or iron, in its downward path. The outlines of windows and stones are for a like purpose, and within the broad expanse of a house or building front there is more room for the adaptation or even mere application of artistic ornamentation, without giving offence.

To attempt to place such architectural ornamentation upon the small surfaces and shapes even of the largest machinery is not only questionable but in almost every case detrimental to the uses and construction of the machine or engine. In only very few cases has the attempt at architectural ornamentation been what might be considered at all successful.

Where no attempt has been made to add architectural elaboration and ornamentation to individual requirement of machine design, there has marked success been attained. As examples of this success, continues the "American Engineer," we have only to look to the engines of the ocean steamships, where a maximum of usefulness and minimum of material has been aimed at and most successfully accomplished; to the large pumping engines scattered throughout the country; to the steam pumps, that have almost reached the confines of perfection; and finally to the better class of stationary engine, whether it be the horizontal or the vertical.

Simplicity of design, the adaptation and location of the several parts, is all that is necessary to develop appropriate beauty and elegance. The aim of the designer need only be the accomplishment of a successful result; outside ornamentation may be left to the imitator.

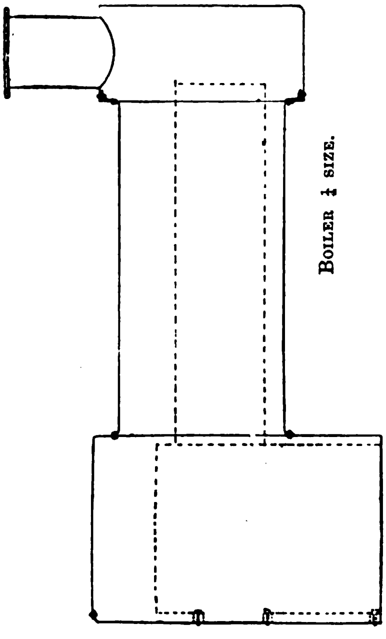
MODEL ENGINE CONSTRUCTION.

By G. Sumner.

PART I.

(For Illustrations, see Lithograph Supplement.)

FOR the benefit of those who are interested in model engine construction, I will give instructions in making a model of the portable type. The engine is arranged on the top of the boiler. In this engine I shall commence making the boiler. The illustrations show boiler quarter-size. It will be seen that only one large tube passes from fire box to smoke box, instead of a number of small ones. It has been found that for small models, intended to burn charcoal, one large tube gives better results than a number of smaller tubes.



The first thing will be to get some sheet copper, No. 16 or 18, B.W.G., and have it put through the flatting mill. To those who possess the skill the boiler may be brazed together; to others who have not the conveniences for brazing, riveting will do, but it will be found to take very much longer time.

In either case it requires care to avoid burning the copper, in brazing, and on the other hand to keep from bruising the boiler in the process of riveting.

We will make that part of boiler that contains fire box first. Cut two pieces of the copper 6¼in. by 4½in.; this will leave ¼in. to flange over for riveting. The other plate must be cut as fig. 2. The oval hole in fig. 1 is the fire hole. The round hole in fig. 2 is where the body of boiler takes on. Now we want to flange both plates, and to do this we require some tinplate workers' tools, but in the absence of them we must get a piece of iron, 2in. diam., and square up one end, fix this in vice after having carefully marked the plate all round ¼in. from edge, lay it on the iron, and, with a hammer, bring the edge over square. It will be better to cut out fire hole, etc., after the edge is turned over. Now we want another piece 4 inches wide to rivet ends to, and to get the length measure round the edge of one of the plates with a piece of string. This plate must be bent in shape of a U, fig. 3, and riveted to the two plates. To do this we shall want a riveting stake made round at the end, and some copper rivets $\frac{1}{16}$ thick; they can be made from copper wire, or purchased at the ironmonger's.

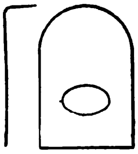


Fig. 1

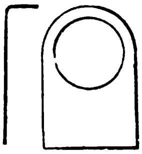


Fig. 2

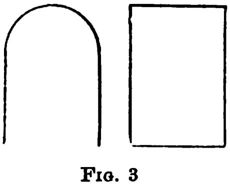


Fig. 3

It will be best to drill the holes for rivets. Put one at the top and one on each side near bottom corner, divide holes with a pair of compasses—they may be ⅜in. apart; rivet with a small hammer, and finish with a snap. This is made by drilling a conical hole in the end of a piece of steel. To use it give the rivets a few blows with a hammer, then place on the punch, and strike the end with the hammer until you have a nice conical rivet head. The body of boiler is 7 inches long, and flanged at both ends. The copper must be cut off 7½in. by 11in., and bent round, the seam either brazed or riveted, and the flanges at the ends brought out. One end is riveted to the fire box part, the other carries the tube plate at smoke box end. In riveting these parts together they may be counter-sunk on the outside, and the punch or snap dispensed with, as the lagging will cover these rivets. The tube plate at the end of boiler must be thicker than the rest, made from No. 12 B.W.G., and the hole for tube bored out so that the tube can be nicely driven in. This plate is also flanged to take the smoke box, which is 2in. wide by 4¼in.; one end is flanged inwards to form a ledge for door. The chimney bottom may be either made from sheet copper or cast brass. The fire box must be made in the same manner as the boiler, and riveted; one side that the tube fits in must be made of No. 12 B.W.G., and ¼in. space left all round for water. A ring is put round the fire hole, and riveted through. The same with the bottom, only this will want to be square, and made to fit well between boiler and fire box; the whole is riveted all round. Before putting in the fire box the hole for tube must be made. It should be screwed with a fine thread, and tube made to fit before putting it together. When all is riveted the joints may be smelted with soft solder, which will make it steam tight.

(*To be continued.*)

HOW TO REPAIR CLOCKS.

PART III.

ALL now being ready for putting together, commence by screwing on the hammer spring and the cock. The cock is put on in order to allow the pivots to go through the holes until the shoulders rest on the plates, as the wheels do not fall about so much then as they otherwise would, and also to prevent the back plate being scratched by the workboard. Place the lower part of the plate towards you, and put the wheels, &c., in their proper places in the following order :—Centre wheel, third wheel, two great wheels, hammer, pin wheel, escape wheel, gathering-pallet wheel, warning wheel, and last, the fly. Take care to have the catgut lines running the proper side of the pillars. If there is arbor for a "strike or silent" arrangement, remember now to put it in, or it may necessitate taking the clock all to pieces when nearly finished. When these parts are in their proper position, carefully put on the top plate, and, pressing it moderately tight, guide the pivots into their respective holes, starting from the lower part of the frame. It is sometimes a great assistance to put the point of an examining pin into the holes of the lower pillars, when the top plate is on sufficiently far, as you have only then to attend to the top part. For the clock to look well when finished, there must be no finger marks upon any part; to avoid which hold the plates, etc., with a clean duster when putting together, and keep it as bright as possible. When each pivot is in its place, and the top plate resting fairly on the shoulders of the pillars, pin up with the examining pins, and test the correctness of the relative positions of the wheels. There cannot, very well, be any mistake with the "going" train, but it is advisable just to press round the great wheel a turn or so, and see that all runs freely. The wheels of the striking train, however, require to be placed in certain arbitrary positions in regard to each other, except the great wheel and fly, which are exempt. The first position to be tested is that existing between the pin wheel and the gathering-pallet pinion. In order to do this, put on temporarily the rack, rack spring, hook, and gathering-pallet. Let the rack-hook hold the rack gathered up, with the exception of one tooth, and move round the pin wheel very slowly until the hammer tail just drops off; at that instant the tail of the gathering-pallet should have about ¼in. from the pin in the rack which stops the striking. If there is an excess of this, or if the hammer tail is resting on a pin, the top plate must be slightly raised, and the pin wheel moved a tooth farther on in the pinion until it is as near this condition as possible. The reason for making the striking chain cease running, as soon as can safely be done after the hammer falls, is that there may be as much run as possible *before* it has to raise the hammer and overcome the tension of the hammer spring. Under no circumstances leave the hammer tail "on the rise"—that is, resting on one of the pins of the pin wheel—when finished striking. Having adjusted this, we must see that "the run" of the warning wheel is right. Put on the lifter, and gradually raise it till the rack-hook liberates the train, and "warns." The distance the warning-pin should run is half a turn, so that immediately before it "warns" it should be exactly opposite the piece on the detent, against which it is stopped, until the lifter falls and the clock strikes. See that the warning-pin catches fairly on the stop-piece of the detent; if it does not, it is because the rack-hook is raised either too soon or too late by the detent, and alter as may be necessary. When the train is quite correct, remove the rack, &c., and pin up the plates finally with good shaped pins.

We may here remark that nothing betrays a careless or incompetent workman sooner than the pins he uses in his work, and the manner in which they are put in; and it matters little what care may be bestowed upon repairing and cleaning if the clock is badly pinned up, for no certainty of performance can be expected in such a case. Therefore make a proper shaped pin, not too thorny nor too straight, but gradually tapering, round and smooth, and well fitting the hole it is intended to occupy; then drive it in tight, and cut off at an equal length each side of the hole.

The front plate will then be ready for oiling. To make an "oiler" file up a piece of iron wire something like an examining pin, but about 4in. long, and then flatten out the end like a drill. A very good oil for all large size house clocks, is made by mixing equal parts of the best olive and salad oils together. Pour a little of the oil into some small vessel, and with the point of the oiler proceed to oil the pivots of the front plate by putting a little into each sink. A very little is sufficient, or it will flow over, and run down the plates, giving a very bad appearance. Slightly oil the studs upon which the rack and other parts work. The cannon pinion spring may now be put on the centre arbor, and the cannon pinion and minute wheel in their places. The cannon pinion and minute wheel must work together in such a manner that the lifter falls exactly when the minute hand is upright; put the minute hand on the square of the cannon pinion, and see that it does so, or move the cannon pinion a few teeth in the minute wheel until right. The remainder of the dial work may now be put on, and the only items to observe are that the hour wheel works into the minute wheel pinion, so that the hour hand is in its proper position when the clock strikes, and that the proportions and fall of the rack are correct. These are very important matters, and must be left exactly right, or the clock will be continually striking wrong. Judging from the large number of clocks we find with mutilated rack tails, it would seem very few clock repairers understand the proportion which should exist between the rack and rack tail. The simple diagram [The illustrations will appear in the next issue.], fig. 11, will probably make the matter quite plain. To test the rack in its place allow it to fall until the tail rests on the lowest step of the snail; the rack hook should then hold the rack, so that there are twelve teeth to be gathered up; then try it on the highest step—it should now exactly fit in the first rack tooth, leaving only that one to be gathered up. Supposing the clock strikes thirteen when on the lowest step and two when on the highest, it shows that the end of the rack tail is a little too far off from the snail, and must accordingly be set a little closer. If, however, it strikes the *right* number when on the lowest step, and two when on the highest, then the proportion between the rack and rack tail is wrong; the rack tail travel being too great for the rack. To make the matter plain, we will suppose that we have to make a new rack tail, which is often necessary in badly used clocks. Measure first with a pair of spring dividers the proper distance that the rack teeth fall for twelve to be struck by the clock, and mark that distance on a piece of paper, as shown *b* to *a*; then take the distance from the points of the rack teeth to the centre of the stud, upon which the rack works, and mark that as shown *b* to *c*; then from *a* draw a straight line to *c*. Take the total distance the rack tail has to fall—viz., from the top step of the snail to the lowest, and from where the two lines, *a c* and *b c*, are that distance apart, to the point, *c*, is the length required for the new rack tail.

In the diagram the distance from the highest to the lowest step of the snail is supposed to be from *e* to *d*, therefore the length of the rack-tail would be from *d* to *c*.

When all is set right, pin on the dial, and put on the hands. There should be sufficient tension in the spring for the hands to move tolerably tight, or the hands will stop when the minute wheel has to raise the lifter. It is always best to use a steel pin to hold the hands on. The clock is now turned over, and the pallets put in.

It is necessary to put a very little oil on the pallets where they touch the escape wheel teeth, the pins of pin wheel, acting portions of the hammer spring, and crutch. See that the hammer acts properly on the bell; screw on the seat board, and oil the pulleys.

It now remains to put up the clock in the case, and the following remarks may not be out of place. Fix the case as firm as circumstances will admit, then see that the seat board has a good bearing, that the dial is upright and does not lean either backward or forward, and that the crutch is free of the back of the case. Hang on the weights, and wind them up carefully, observing that the lines run properly on the barrels. It sometimes happens that the line is longer than sufficient to fill the barrel, and, instead of forming a second layer across the barrel, rises perpendicularly, until it interferes with the clickwork. The best way to rectify this error is to put a piece of wire across the hole in the seat-board in such a manner as to throw it off as desired. Put on the pendulum and set the clock "in beat." The meaning of "in beat" is, that the escape takes place at equal distances each side of the pendulum's centre of gravity. When the pendulum is at rest it should require to be moved as much to the right before you hear the "tick" as it does to the left, and *vice versâ*. When "in beat" it sounds regular, and nearly equal, the differences of drop making it slightly uneven. The general rule for setting in beat is this:—If the right-hand beat of the pendulum comes too quick, the bottom of the crutch requires bending to the right; if the left-hand beat comes too quick, then the crutch must be bent towards the left. The clock may now be considered finished; and set going, with full assurance that it will give satisfactory results, and reflect credit upon its repairer. There will be no need to give the pendulum "a good swing" and hurry off before it can stop, as some so-called clock repairers often do, but just move the pendulum until the escape has taken place, then gently let it go, and, after regulating, it will indicate the time faithfully till it requires cleaning again. Regulation is effected by raising the pendulum-bob to make the clock go faster, and lowering it to make it go slower.

Having minutely explained the method of cleaning, examining, and repairing the eight-day English clock, it will not be necessary to go into the same details with other kinds of clocks, but merely point out their peculiarities, it being understood that the same course of examining is to be pursued in every instance, and the repairs executed where needed in the manner already described.

Thirty-hour English Clocks.—Although the manufacture of these clocks has entirely ceased, there are still a large number in use which occasionally require cleaning and repairing. There are two styles met with; in one the wheels are set within a square frame formed of several pieces, and known as "the birdcage;" and in the other the wheels are between two plates similar to the eight-day. The first of these is comparatively rare, and is undoubtedly the oldest kind of English clock doing actual service. There are two points of difference which require attention—the endless chain, and the striking mechanism. The endless chain is said to have been invented by Huyghens, and the only merit attached to it is that the clock continues to go whilst it is being wound up, but it is very irregular in action. It must be put upon the spiked pulleys in such a manner that the wheels turn the right way when the weight is put on, and the part that requires pulling to raise the weight should always come to the front, so that the weight passes quite free behind it, fig. 12. Sometimes the chains will be found to be twisted, and the links, gathering up into a knot, stop the clock. The way to rectify this is to draw up the weight, separate the chain at the lowest part, let it hang free, straighten both pieces, and then unite again, when it will be found to work properly. A lead ring, of sufficient weight to keep the chain just tight, is used to prevent the liability to twist. When a chain breaks from wear or rust, or jumps from being the wrong size, it becomes necessary to put a new one. They are made from iron wire, by means of the tool shown, fig. 13.

Its construction will be easily understood, the only part needing explanation being the piece at the end, *s*, which is for holding and shaping the links. This is made of hardened and tempered steel, oval in section and very smooth, the part near the frame of the tool being the exact shape and size required for the inside of the links. About three different sizes will be found sufficient for all ordinary chains. To make a clock chain, select a piece of wire of suitable size, bend up the end, and put it in the slot of the steel piece; turn the handle, and wind on the wire tightly until it is close up to the frame, forming a number of oval links. Cut off the piece bent into the slot, and, pulling the wire moderately tight again, turn the handle, when the wire will force off a link at each turn, making any length that may be required of uncut links exactly alike in shape and size. With the points of a stout pair of shears cut each link in the centre, and join up into a chain by using two pairs of pliers.

The striking mechanism usually found in thirty hour clocks is known as "the locking plate," and though it is more liable to derangement than the rack movement, still it is very largely used in French, American and German clocks. It is much more simple than the rack, and one explanation of its construction will be sufficient for every case. The various parts are shown in figs. 14 and 15. *A*, the hoop-wheel; *b*, lifter; *c*, hoop-wheel detent; *d*, warning detent; *e*, locking-plate; *f*, locking-plate detent; *g*, lifting pin to raise hoop-wheel detent; *h*, spring; *l*, warning pin. In testing the relative positions of the striking-wheels when put together, proceed by moving the wheels round very slowly until the hammer-tail drops off a pin; at that moment the hoop-wheel detent should fall into the hoop, so as to allow the hoop-wheel about ¼in. run before it reaches the end of the detent and stops the striking. When the hoop is resting against the detent, the warning-pin should have half a turn to run, the same as in the eight day clock. The locking plate detent, *f*, is connected by an arbor with the hoop-wheel detent, *c*, and must be adjusted so that the latter can fall in the hoop-wheel sufficiently far to stop the striking only when the end of the locking-plate detent falls into one of the notches of the locking-plate. This is easily done by moving round the wheel to that the locking plate is attached, tooth at a time, in the pinion which drives it, until it is in the correct position, and slightly bending the detent *f*, if necessary. When a clock with a locking-plate striking arrangement strikes till it runs right down, it is generally because the hoop-wheel detent does not fall freely, or the locking-plate detent does not enter the notches properly. It sometimes happens that the edge of the end of the hoop becomes worn and rounded by long use, and if the weight is excessive, it will cause the detent to jump out, and the clock to continue striking until run down. The remedy is obvious—file the end square. The locking-plates are often cut irregularly; but on no account interfere by filing or spreading the edges, or perchance greater difficulties may arise, and there is always a position where it will answer well, which can easily be found by trial.

Spring Dials, Skeleton, and Bracket Clocks.—In these, the motive power being produced by the uncoiling of a spring, several parts are introduced which are not found in weight clocks—namely, the spring barrel, fusee, and stopwork. The cover of the barrel ought always to be removed when cleaning the clock, to ascertain the condition of the main-spring, and, if the latter is found at all dirty, it should be carefully removed with a pair of pliers, and cleaned with a little turpentine on a piece of rag. It may be replaced by winding it round its own arbor, which should be screwed in the vice by the squared end. Take hold of the end of the spring with a pair of strong pliers, and wind it as tight as possible; then slip the barrel over it, and carefully let go the spring, holding the barrel tight with the left hand until the spring has hooked. To try that it has hooked securely, before putting it back in the clock put on the cover, secure the end of the arbor in the vice, and turn round the barrel until you can feel the spring is quite up. A new spring can be put in in the same manner. Always oil the main-spring after it has been handled. When a new barrel-hook is required, select a piece of good steel, and file up a *square* pivot with a nicely-fitting shoulder, and fit in the hole in the barrel; then shape the hook, and rivet in its place.

The only accidents to which the fusee is liable are those to the clickwork, and when a chain is used, breakage of the chain hook-pin. There are two kinds of line used to connect the fusee with the barrel—the catgut and the metallic. We should always advise the use of metallic lines, as they wear better, look better, and are quite as cheap as the gut lines. To ascertain the length required for a new line, fix one end in the fusee, and wind the line round in the groove till it is filled up; then allow a sufficient length beyond to go round the spring-barrel one turn and a half. When catgut lines are used, they should be slightly oiled. The method of fastening the ends is so simple as to need but little description. The fusee end is passed through the hole in the fusee, and tied in a simple knot, the end being slightly singed to render it less liable to slip. The barrel end is passed through the holes in the barrel in the following manner:—Down through the first hole, up through the second, and down through the third; the end is then pushed through the loop formed by passing the line through the first and second holes, as shown in fig. 16.

In putting together, take especial care to see that the line is free, and on the right side of the pillars. When ready to put the line on in its place, wind it upon the spring-barrel by turning the arbor; and when it is all on, and the fusee pulled round as far as it will go, set up the spring one turn, and secure the click in the ratchet. Wind the clock up, carefully guiding the line on the fusee, and see that the stopwork acts properly, and does not cut the line when it rubs against it. The snail in the fusee should catch against the stop directly the fusee grooves are filled up with the line.

Chime, Musical and Quarter Clocks call for no especial remarks, beyond that it is advisable to well understand the action of the "letting off" work, and the "run" allowed, before taking to pieces. The arrangements are so different that there are scarcely two exactly alike; but they seldom offer any great difficulty when ordinary care is taken. It is wise in some cases to keep the striking and chime parts distinct while cleaning. Most of these clocks present favourable points for improvement by reducing the friction, and, when it can be safely done, it is well to do it; for, though the weights are unusually heavy, there is generally no power to spare.

Church and Turret Clocks.—In these large clocks, the course of examining strictly enjoined as absolutely necessary in all house clocks may be generally dispensed with, for the cause of stopping is usually apparent, and by trying the side-shake of the pivots in their holes, it can be readily seen if any new ones are required. The depths are nearly always correct, and the end-shakes can be tried the last thing when put together. There are two ways of treating church clocks: one consists of cleaning them as well as it is possible with emery cloth, and turpentine upon a brush, *without* removing any of the wheels from the frame, called "wiping out;" and the other in taking them all to pieces and thoroughly cleaning, in the same manner as small clocks. Which method is necessary or desirable must be decided by judgment. It will be found usually sufficient to thoroughly clean them about every five or six years, and "wipe them out" once every year—about autumn being the best time, before the cold weather sets in to influence the oil.

When the clock drives one or more pairs of hands, it is very necessary to see that the leading-off rods and universal joints do not bind in any part of their movement. When the dial work stands in a very oblique position in regard to the driving-wheel of the train, it is often much better to use bevelled wheels than the ordinary leading-off rods and universal joints, and small-sized straight-drawn iron gas tubes will be found very serviceable for making the connections, by simply fitting turned pieces of steel into the ends, to carry the wheels.

When a new hemp line has been put to a turret clock, and continued wet weather follows, it will oftentimes be found to twist and gather round so considerably as to stop the clock. The way to remedy this is to take the weight off, straighten out the line, and then replace it, giving it a few turns in the opposite direction to its twist. If this fails, as it sometimes does, the following plan will be successful:—Mix together about half a pound of soft soap and a packet of blacklead until well incorporated, and work it well into the rope along its entire length, laying it out in one long straight line, and quite free to turn during the operation. It is rather a dirty job, but very efficacious, and well repays the trouble when hemp ropes are used; for we have never found them twist afterwards in working, and it hardens the rope, making it last longer and work better.

Drum Timepieces are often very troublesome to the clock repairer, and seldom go satisfactorily for any length of time with the treatment they ordinarily receive. From a large and successful experience we can confidently recommend the following method of dealing with them, as being at once the best, cheapest, and in the end most satisfactory. In addition to the ordinary careful examination of depths, endshakes, sizes of holes, etc., it is necessary to bear in mind the following principal causes of their bad performance—defective calibre, roughness of finish, and faulty escapements. We must consider defective calibre unalterable, for we cannot prudently make any useful alteration in the proportions of the various parts, as the expense would probably be more than the timepiece would be worth. There is, however, one very important part which demands attention, and that is the mainspring. The mainspring usually has to make such a large number of turns for the timepiece to go the prescribed eight days that considerable skill is required to make an escapement which will give a fairly uniform rate. Therefore it is always desirable to have a thin mainspring, in order to obtain as many turns as the size of the barrel will admit.

Roughness of finish must be remedied, especially in the parts furthest from the motive force. To this end, thin down the third, fourth and escape wheels, when found unnecessarily thick, by filing with a fine-cut file, and finish smooth with a piece of water-of-ayr stone. Take care not to raise a "burr" by using too coarse a file, and look out for imperfections in the teeth. If the pivots of the escape-pinion and pallet-arbor are left any too large, reduce the size of them by "running" in the turns, and burnish them well.

Faulty escapements are almost invariably found in these timepieces, and may be considered their greatest defect. With the object of rendering the pendulum insensitive to the varying power of the mainspring, the pallets are made as close to the arbor as possible, embracing only one or two teeth of the escape-wheel. The inside pallet communicates impulse to the pendulum, but the outside one, forming part of a circle struck from the centre of motion, gives no appreciable impulse, as the escape-wheel teeth merely rest "dead" on it. Unfortunately, this principle is carried too far, and the result is that at times there is insufficient force at the escape-wheel with such a small amount of leverage to maintain the vibrations of the pendulum, and the timepiece stops. As no beneficial alteration of the original pallets can be made in a proper workmanlike manner, it is best at once to condemn them, and make a new pair. By very carefully following the instructions here given, no great difficulty will be experienced in making them give favourable results. The object of making new pallets is to obtain a longer leverage, so that the occasional diminished force may prove sufficient to keep the pendulum vibrating; and the difficulty which arises is to make them of such a shape that this varying power of the escape-wheel does not influence the *time* of the pendulum's vibrations, however much it may the *extent*. The *object* is attained by making the pallets embrace a larger number of teeth, which brings them a greater distance from the centre of movement, and thus increases the leverage. The *difficulty* is overcome by making the pallets of such a shape that the escape-wheel teeth rest as "dead" as possible during the excursion of the pendulum beyond the distance necessary for the escape to take place. From a consideration of the shape of the escape-wheel teeth, and the distance the pallet arbor is pitched from the escape-wheel, it will be readily seen that, though the outside pallet can be easily made to give the desired effect, it is impossible to make the inside one of any shape that will not produce more recoil than is desirable. To render this recoil as insignificant as circumstances admit, great care must be bestowed in suiting the pallet to the wheel, and for the same purpose it is advisable to make it nearer than the outside one to the pallet arbor.

Before making the new pallets, file off the old ones, guarding the pivot so that the file cannot slip and break it off, and leaving the arbor round, smooth, and slightly taper. Procure a small piece of card, and make a straight line down the centre; then, with a pair of compasses, take the distance from the escape wheel pivot-hole to the pallet arbor pivot-hole, and make two small holes through the card upon the straight line that distance apart. In one of these holes fit the escape-wheel arbor so that the wheel rests flat upon the card, and in the other fit the pallet arbor. The number of teeth most suitable for the new pallets to embrace must be decided by the character of the train; if it is fairly good, four will be found sufficient; if very rough, five had better be the number. Select a piece of good steel, of suitable thickness, and, having softened it, drill a hole through it, and fit the pallet arbor in to the proper distance. Put the escape-wheel arbor through one of the holes in the card, and the pallet arbor with the piece of steel on it in the other, and see how much requires filing off, so as to leave only sufficient to make the pallets of the proper length. Now mark off the position of the opening between the pallets, the distance of the inside pallet from the line of centres being equal to the space between two of the escape-wheel teeth, leaving the space between the points of three teeth on the opposite side of the line of centres. Fig. 17 shows the escapement enlarged, so as to make it plain. It is advisable not to file out the full width until the pallets are roughly shaped out and ready for escaping. They should be made the shape shown in sketch, keeping them flat across the surface, and may be roughly "scaped" for trial upon the card, which, by bending, can be made to move the pallets nearer or further off, as desired.

When nearly right, finish the escaping in the frame, taking great care not to get too much drop on to the inside pallet, as there is no way of altering it should there be an excess. The drop on to the outside pallet is easily adjusted, as the hole in the front plate is in a movable piece, which can be turned with a screw-driver. Respecting the shape of the inside pallet, it will be seen that its point resembles a half tooth of an ordinary wheel; this is to cause the friction and recoil, which are unavoidable, to take place, with the least impediment to the pendulum, as this shaped-point *rolls* upon the faces of the escape-wheel teeth, whilst the ordinary form *scrapes* them. When the pallets are properly "scaped," it only remains to finish their appearance in a workmanlike manner, and harden and temper them. The sides should be nicely "greyed" by rubbing them on a flat piece of steel with oilstone-dust and oil, and the acting faces polished with diamantine or redstuff. It will be generally found sufficient to secure them by driving the pallet-arbor in tight, but if thought necessary they may be pinned on. The timepiece may then be cleaned and put together, observing that it is nicely "in beat," according to the conditions already stated, and its performance will be found all that can be expected from an eight-day spring movement, without a fusee, and in such a limited space.

Sometimes these drum timepiece movements are fitted into large gilt or bronze cases, where there is plenty of room for any motion the pendulum might take. Under these circumstances it is a great improvement to suspend the pendulum with a spring, for the pallet-arbor pivots, being relieved of the dead weight of the pendulum, do not wear the holes so quickly as otherwise, and, as the friction is considerably reduced, the pendulum is kept in motion with less power. The best way to put a spring suspension is as follows :—If there is sufficient substance in the cock above the pivot hole, drill a hole through the cock and tap in a piece of $\frac{3}{16}$th brass wire, with a slight shoulder, and rivet it in secure. Cut off so as to leave it about $\frac{1}{4}$in. long, and make a saw-cut to receive the brass mount of the pendulum spring. The underneath part of this stud should be left nearly in a line with the centre of the pivot-hole. When the pivot-hole is too near the top edge of the cock to allow this to be done, a piece of brass must be fitted on to the cock to receive the stud, and a very convenient shape is shown in A, fig. 18. Procure one of the thinnest and most suitable French clock pendulum springs, and fit one of the brass mounts into the saw-cut in the stud, and arrange it so that the spring, when in action, may bend as near as possible in a line with the centre of the pivot-hole; then drill a hole through the stud and brass mount, and secure it with a pin. Fit a steel pin on which to hang the pendulum, in the hole through the other brass mount. The pendulum-rod should be a piece of straight, small-size steel wire tapped with a thread at both ends. Make the hook exactly like the ordinary French clock pendulum hooks, only very much smaller and lighter, and fit it on one end of the pendulum-rod; screw the pendulum-bob upon the other. Cut the old pendulum-rod in two, so that the piece remaining attached to the pallet-arbor reaches to opposite the centre wheel hole; file a short pivot on the end, and fit on it a crutch. All the parts must be as small and light as possible, and the pendulum-bob must be *round* and turn tolerably tight.

Silk suspensions are sometimes used, but rarely give satisfactory results, as they are so sensible to atmospheric changes.

German and American Clocks of the ordinary construction call for no especial remarks; in the former the principal point to notice is the back hole of the pallet-arbor, which will be generally found much too large. It is an easy matter to put a new one. In American clocks try the pinions to see if they are tight on the arbors, for they are often loose. The best way to secure them is with a little soft solder, taking great care afterwards to thoroughly clean off all the "tinning" fluid with chalk and water, and finally oil them slightly all over. When the pendulum wabbles it is owing to the spring being crippled, or loose in the stud, or for want of proper freedom in the crutch.

French Clocks.—The mechanism of these being finer than any we have yet considered, they require to be handled with greater care. The holes in the plates, being too small to admit a strip of leather, must be cleaned out with a pointed piece of pegwood as many times as may be necessary, so that the last time it is withdrawn from the hole it may not show the slightest sign of dirt. They seldom require much repairing. Most of those that were made some years ago have the locking-plate striking mechanism; but more recently a neat rack arrangement has been introduced, which we show in fig. 19; *a*, the lifter; *b*, rack-hook; *c*, detent; *d*, gathering pallet; *e*, rack; *f*, rack-tail; *g*, snail; *h*, cannon pinion with lifting pin. The gathering pallet fits on a round arbor, and, when the clock has finished striking, should be in the position shown in the sketch; the wheel will then have the greatest possible run before it lifts the rack.

In French clocks with visible escapements there is one item that requires especial attention — the spring-tight collet, which is used so that the clock will set itself in beat. The crutch frequently moves too easy, and the clock stops. If it is thought desirable for the clock still to set itself in beat, the best way to make the collet hold better is to remove it from the arbor, and close it in by driving it into a taper hole. When it is convenient to make it a fixture drill a small hole through the collet and pallet-arbor, and put a steel pin through.

Particular attention should be given to the fixing of French clocks in the cases, as insecurity of the movement is a frequent cause of irregular going and stoppage.

In handling the pendulum-spring use great care, or it will inevitably become crippled, causing the pendulum to wabble. When a French clock pendulum wabbles the quickest and best way to cure it is to put a new spring.

Cuckoo Clocks often give considerable trouble from the bad mechanical arrangement of the various parts. The great secret in repairing them is to reduce the friction as much as possible. The resistance to the rising of the "lifter" is often enormous, and with a little ingenuity it may sometimes be reduced very much. The mechanism of the cuckoo clock, as usually met with, is shown in figs. 20, 21, and 22.

There are three distinct movements to be considered: first, for the production of the sounds; second, the appearance and retirement of the "cuckoo;" and third, the movement of the wings and beak. Fig. 20 shows the first. The dotted circle, *a*, represents the position of the pin-wheel set within the frame, the pins of which have to raise three levers. Those numbered 1 and 2 raise the bellows, *b*, *b*; and No. 3 corresponds to the ordinary hammer-tail. The bellows are connected with two small "stopped" organ pipes, *d*, *d*, measuring externally about 6in. long and 1in. square; and the "stops" are pushed in till the right note is obtained. The bellows are about 2½in. long by 1½in. wide, and are connected with the lifting levers by the wires, *c*, *c*. Fig. 21 shows the second movement. *A* is the hoop wheel, and *b* the detent, which, falling in the notch, stops the running of the striking train. *C* is a wire lever attached to the arbor of the detent, and moves with it. *D* is a vertical arbor carrying a piece, *f*, at right angles, on which is fixed the bird on the perch, *g*. A spiral spring, *e*, keeps the short lever, *h*, in proper position, to be acted upon by the long lever, *c*. As shown in the sketch, the cuckoo would be in; when the clock strikes, the detent, *b*, rises up to the edge of the hoop-wheel, moving the vertical arbor, *d*, with it, and the cuckoo on the perch, *g*, opens the door by means of a wire link, *k*, which unites the perch with the door. The bird remains out until the locking-plate detent allows the detent, *b*, to again fall into the hoop-wheel, when the spiral spring, *e*, causes the bird to retire and close the door. Fig. 22 shows the mechanism of the cuckoo. The body of the bird is hollow, and *a* is a block of wood in the centre of the body, firmly fixed upon the perch, *g*. A pin, *b*, passes through the bird and block of wood; it serves for an axis, upon which the bird works when the tail is raised. The lower part of the beak, *c*, is pivoted at *d*, and has a piece of wire attached in the manner shown; a wire projecting from the fixed wood block, *a*, terminates in a small ring which embraces the wire of the bill. When the tail is raised, the head lowers and the beak opens.

The flapping of the wings, *e e*, takes place in a somewhat similar manner; they are united to the body by wire-ring joints at *f*, and a short wire lever is fixed in the upper edge of the wings. The end of this lever is joined by a ring joint to a fixed wire on the block. When the tail is raised, and the body moves further from the centre of motion, the wings open; when the tail is lowered, they close. A piece of wire, fixed in the tail at *l*, is bent until exactly over one of the bellows. When the bellows are raised, they lift the wire of the tail, and thus cause the beak to open and the wings to flap.

In putting the train together, be careful to have neither of the levers resting on the pins when finished striking, and endeavour to make the other parts work as easily as possibly.

These may be safely said to complete the list of clocks that are to be found in ordinary use.

Cleaning Bronze Statuary or Other Bronze Ornaments.—Where the ordinary process of dusting is not sufficient to remove the dust which causes such ornaments to assume a gray, dingy appearance, weak soapsuds or aqua ammonia will be found useful for cleaning such bronzes.

TOUCHING UP REPAIR WORK.

A CORRESPONDENT to "The Blacksmith and Wheelwright" writes:—Blacksmiths and woodworkers have occasion quite often to touch up their repair work with paint, when there is not time for the job to be finished in the paint shop. Some men have paint dishes in the shop to use themselves as may be necessary, while in other shops the painters attend to these things. Very often this takes a painter away from something he can't leave very well, while some of the other hands could have done it while he was coming downstairs. But blacksmiths and woodworkers generally daub up and do more damage than good in their attempts at painting. We have a spoke or two that must be used immediately; if it is black we generally put on black varnish, but paint, dark lead or something heavy would be much better. Black varnish will come off gradually and won't keep the grain from raising; of course it has a little shine, but you can't get one coat on very well without making it look streaked. So take it on the whole it doesn't look very well, and it is in no shape to paint up again.

But whatever is put on should be applied properly; if you have a large brush and the paint or varnish is old and sticky, and you daub all over, it looks bad, besides making lots of work for the painter when the job comes to be painted. You can't get this stuff off, or a spat of it when it gets dry without the use of a sharp knife, and you can hardly ever succeed in preventing a spot that will show always. The paint should be mixed with oil, japan and turpentine in equal parts, or keg lead mixed with japan and turpentine. It should be mixed up once a week, so to be fresh, and dry quickly and well. Have an inch and a half bristle brush, not an old stick of a thing, but a good brush, and keep it soft in the paint or water. A spoke is about the worst thing to get around without touching the hub or other spokes, but take a brush part full of paint and put down as near the hub as possible, then tip up the brush a little and work crosswise of the spoke and you will touch all bare wood without getting on the old paint. If you should, why wipe off with a rag or finger. Go around the butt of the spoke in this way, then at the felloe to the same, cutting close, and then fill in between hub and felloe and smooth up nicely. This will perhaps take a moment longer on a spoke, but it will be enough better to pay.

When a smith heats an iron that has been painted, and dosen't heat the whole of it, the paint will fry up back a little way, and cinders will stick. These should be filed or sand-papered off, and dusted or rubbed off with the hand before the paint is applied. If you will only take a little pains and work slow around these places at first you will soon get so you can do it about as quick as if you were merely daubing. One should take as much pains in patching up a job as he would in making a new article, but there are not many who do. When taking off clips on irons on a painted job the paint is liable to break up away from the clip. Now if you will take a knife with a sharp point and cut around the clip it will come and go right back, and will not need to be touched up. When hammering or pounding on a painted iron or surface, take a piece of harness leather and hold under the hammer; remember that an ounce of prevention is worth a pound of cure.

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Black Wax.—Add one ounce of beeswax to half an ounce of Burgundy pitch; melt them together, and add one ounce and a half of ivory-black, ground very fine, and dried.

PLANT'S GEOMETRIC CHUCK.

PART IV.

(*For Illustrations, see Lithograph Supplement.*)

REFERRING to fig. 2, *a* is the nose screw, cut to precisely match the thread on the mandrel. On this the work is mounted for turning. *B* is the shoulder, against which the chucks are screwed, and it should match the shoulder on the mandrel. *C* is the ratchet wheel, having 96 teeth, marked *m* in the sectional drawing. *A b* and *c* is a solid casting, the wheel being about 3in. in diameter. *D* is the wheel revolved on the slide *f* by gear wheels from the wheel *r*. *D* is shown in section at *k*. The smaller radius plate is seen on edge at *c*. The portion marked *f* is the sliding piece, actuated by the screw with the square end. This slides between the strips *gg*, screwed on the wheel *h*. The section of the slide *f* is shown by *h* in fig. 3.

The wheel *h* is shown in section by *e*. Immediately behind it is the larger radius plate. *J* is the sliding piece, fitted between the strips *kk*. It is marked *b* in the sectional view, and is actuated by the screw shown at the back of the foundation plate *l*. *M* is the wheel fitted on the boss of the chuck, to which it is secured by the ring nut *n*. This wheel is held stationary by a spring catch whilst the chuck is revolved. *O* is driven by *n* through wheels shown in fig. 5, but not shown in this cut, these forming a reversing motion, driving either backwards or forwards as may be required. *P* is the ratchet wheel, allowing any adjustment of *o*, and carrying the spindle, having at its other end *q*, shown by *s* in the section. *R* is the wheel which receives motion from the centre of *h* and communicates it to the wheel *d*. *R* is shown in section by *s*.

These two figures should be referred to together, as they will thus be the more readily understood. The various small fittings, which are of a complicated nature, have been shown on an enlarged scale, and have a more extended description where specially shown as belonging to the three-part chuck. The mode of fitting up this chuck is precisely similar, and it only differs inasmuch that one of the sliding pieces and the gearing and other parts incidental to it are omitted. This saves a corresponding amount of labour in the making, and for this reason a two-part chuck would probably be made in preference to the three-part chuck. The additional slide could be fitted to the two-part chuck when desired.

A reference to the sectional illustration, fig. 3, will enable the reader to recognise the various parts as lettered, and which we now proceed to describe, and give dimensions of. *A* is the foundation plate on which the entire chuck is constructed. It is a circular disc $\frac{1}{16}$ of an inch thick and 8 inches in diameter. Cast iron answers the purpose, but brass or gun-metal looks better, and is easier to work. The extra cost of this latter material is scarcely worth considering when the value of the entire chuck is reckoned. On the back of the disc and solid with it is the boss, into which the lathe nose screws. This should be long enough to prevent the possibility of the nose projecting beyond the level of the front surface, but otherwise the shorter the better. In every case a chuck should be kept as near to the lathe nose as possible, and this ruling applies with even more force to such chucks as this one, which must necessarily be prolonged to a considerable distance beyond the lathe nose. When making a geometric chuck the foundation plate *a* is the first part to be finished.

The first sliding piece on the chuck is marked *b*. This is a plate 8 inches long and 3¾ inches wide. Its edges are dovetailed to slide between strips fixed on to the face of *a*. A quarter of an inch is sufficient thickness for this sliding plate *b*, and its ends are turned concentric with the foundation plate. In the centre of *b* a projecting ring is cast on solid, around which the wheel *h*, fig. 2, revolves. The exterior diameter of this ring is 3 inches, and it projects from the surface of the slide ⅜ of an inch. The central part is hollowed out, as shown in the illustration, leaving a thickness of about ⅜ of an inch in the centre to hold the stud marked *f*. A full size illustration of this stud will be found in the description of the three-part chuck.

The strips which hold the slide are marked *cc*. They are bevelled off to match the slide, and are each held by three screws to the foundation plate. These are shown marked *n* in the back view fig. 5. The screws may be tapped either into the strips or into the plate, but they are generally put through from the back. Steady pins at each end of the two strips are the best means of securing them, perfectly parallel, with the certainty of replacing them precisely as before, when the chuck is taken apart for any purpose. None of the slides require any means of adjustment, as they are not much used. The strips are about ¾ of an inch wide, and the same thickness as the slide, viz., ¼ of an inch.

A radius plate is shown at *d*. This plate fits on the projecting ring of the slide *b*. It is secured by clamping screws, slots for which are shown in the figure just named. The plate is nearly $\frac{3}{16}$ inch thick. It is made of brass or gun-metal usually.

The wheel *e* is fitted on to the ring on *b* to revolve smoothly without any shake. It is held down by the screw *g*, tapped into the stud *f*. The wheel is 5 inches in diameter, and has 120 teeth. It is $\frac{5}{16}$ inch thick on the edge, the projecting piece, which fits on to *b*, being about $\frac{9}{32}$in. above the back surface. The front carries the two strips *ii*, which are secured by two screws each. The surface is recessed out to allow the wheels *v w* and *o* to be contained in it below the surface. These wheels are more fully explained in another figure, which should be referred to. (See sectional drawing of lower sliding piece in the three-part chuck.)

The strips *ii* form bearings for the sliding piece *h*, which is similar to *b* already described. The slide *h* is 5 inches long and about 1¾ inch wide between the dovetails. The part above the slides is extended to 3 inches, and thus allows a projecting ring 2⅜ inch in diameter. On this the radius plate *j* is fitted.

The wheel *k* revolves freely on *h*, as *e* does on *b*. The central stud *l*, screwed into *h*, forms the axis on which *m* turns. It will be seen that *m* is a wheel having a projecting stud cut to match the nose of the mandrel, and on this any work to be treated on the geometric chuck is screwed. The edge of *m* is cut with ratchet teeth, usually 96, and a click fixed on the face of *k* allows the work to be turned round independently of the chuck and set to any required position with respect to former patterns. Fig. 4 shows these details as seen from the face.

The stud *l* is screwed into *h* tightly. Its front end is made hexagonal, to take the washer shown beneath the screw *n*. It is necessary that this washer be fitted to the stud, or when the wheel *m* is moved it will be apt to turn the washer with it, and tighten or slacken the screw *n*. A full size illustration of this stud has been given in the plate illustrating the details.

Referring back to the other side of the chuck, *o* is a wheel fitted on to the boss on the foundation plate. It is secured in its place by the nut *p*, which is a plain ring, screwed on to the boss against a shoulder, as seen in the drawing. The wheel *o* turns freely on the boss, and is precisely like the wheel *q* —that is, each is 3½ inches diameter, and has 84 teeth. These wheels are about $\frac{9}{32}$ inch thick. *O* has a hole drilled into it, by which it may be held with a catch whilst the chuck is revolved. This is shown in another illustration, fig. 5, where all these details are shown more clearly.

The spindle *t* is fitted to revolve freely in a cannon screwed into the base plate near its edge. The wheel *r* is fixed on to this spindle. This is a ratchet wheel with 96 teeth, and the face of the wheel *q* carries the click. The click and ratchet wheel afford the means of adjusting the position of the patterns to be cut in the same way that *m* is used. *Q* is held against *r* by the screw, as shown, which has a washer, fitting the square end of *t*, beneath its head.

The small wheel *s* is fitted on to a hexagonal part of *t*, and secured with a screw. Thus *s* is always revolved together with *r*, and it is through *t*, the axes of these two, that motion is conveyed to the wheel *e*.

The cannon which carries *t* forms a centre, on which the link carrying the gear wheels from *s* to *e* turns. The radius plate *d* also carries the last wheel, which gears into *e*.

In the centre of *e* is the wheel *o*. This wheel is fitted on to the stud *f* hexagonally, and turns with it irrespective of the motion of the wheel *e*. The wheel *o* forms a bearing for *e*, and keeps that wheel close against the surface of the ring on *b*. The screw *g* secures the wheel *o* on the stud. A steel washer is usually put between *o* and *e*. The illustration, showing an enlarged view of the stud *f*, makes the details more plain.

The wheel *o* is about 1⅜ inch diameter, and has 32 teeth. It is about ¼ inch thick, but should be as thick as possible, compatible with leaving sufficient substance behind the wheel *v*. The central stud on which this wheel turns is solid with *e*, though by an error it is not shown so in the engraving.

The wheel *v* is simply an idle wheel, which conveys motion from *o* to *w*. It is 1⅛in. in diameter, and has 24 teeth. The stud on which it turns is solid with the wheel *e*. Though the wheel is shown secured to the stud by a small screw, this is not necessary, as the strip *i* prevents the wheel coming off, which is all that is required, as the wheel *v* has no force moving it sideways.

The wheel *w* is secured to the spindle *y* by riveting. It is ¾in. in diameter, and has 16 teeth. The recess in the face of *e* is turned or bored out of the solid metal sufficiently large to admit the wheel. The spindle is fitted in the cannon held on the face of *e* by the screws. The wheel *x* is put on to the other end of *y* by a hexagonal fitting. It is held by a screw as shown. The spindle *y* and its fittings are shown in detail in a subsequent fig. The screw shown in fig. 3, as holding *w* on *y*, is unnecessary if the wheel is riveted as stated above.

The wheel *x* conveys the motion from *o* to the wheel *k* through wheels fixed on a link frame, centred on the cannon containing *y*, and reaching the radius plate *j*, which is shown at fig.

The foregoing description will explain the construction of the chuck figured in section in fig. 3. The same is shown in elevation by fig. 2, and to this I have referred. Each part will be recognised from the description given of fig. 3, this being the sectional elevation.

IN WHAT DOES KNOWLEDGE CONSIST?

IT is one of the chief boasts of America, says a correspondent to the "Mechanical Engineer," that her sons and daughters are largely self-educated. By that it is implied that the "masses" have risen to the surface by their own exertions, unassisted by school or college training, unaided, in fact, by anything except such as chance threw in their way.

The average "educated" man assumes a superiority over his mechanic brother of the shop that is in a large degree a false assumption, inasmuch as knowledge is only comparative.

Emerson holds that no man can be called ignorant, the most illiterate man having observant faculties. Nay, more; his very lack of book knowledge sharpens his observation. The cause of the discrepancy between the rank of the working man and the employer, between the ignorant and the educated, is bound up in custom; the laws of caste, the constant repression exercised over the weak by the strong, and the feeling of self depreciation in the minds of the so-styled "lower orders." But more than all this are the technical difficulties in the way of students at the outset. Since the days of Grecian sages and the Egyptian priesthood there has been an all-pervading mystery surrounding the attainment of knowledge that has lasted to our day; and why? Because custom and tradition lay so many thorns in the path of learning by clothing the language of science in technical phrases, symbols, and equations.

A musician cannot speak half a dozen sentences without bringing in his "staccato," "pianissimo," "over tones," "crescendo," "diminuendo," "harmonics," etc. An electrician likewise in speaking wants at once to mention his "ohms," "volts," "crosses," "grounds," "shunts," "polarization," etc. A mathematician would not think his essay complete without his $x\ y—q\ z \times a\ b$. A chemist must clothe his thoughts in HO_2 and "chloride of sodium," even when speaking of common things. So it is that every specialist, being wedded to his methods and technology, unconsciously, perhaps, helps to build the Chinese wall, shutting in knowledge much higher than ever by means of his secret cipher.

How often has the remark been made, "Oh, that's too deep for me!" The chief trouble lies at the outset in mastering the phraseology of each and every individual science. The bare facts are not such mysterious things when one gets the nut cracked open. It is not such an idle boast as it might seem for a man to assert that he has run through the whole gamut of human intelligence! Such a thing might be, and has been, done by men endowed with quick eyes and ears, and having a practical application combined with a fair concentration of thought. A man does not therefore have to be so very wise, in order to grasp the whole of knowledge known in the world; by this is meant the skeleton of facts and not the multiplicity of detail. It is not necessary, in order that a man understand jurisprudence, that he should read all the statute books of the world. The best lawyers are those whose memory and reading tell them where to look for the latest form of law on a given subject. So with any other department of knowledge; knowledge consists more in application, concentration, and digestion, than it does in mere learning by rote, and familiarizing a set of rules and tables.

A collegiate course is only superior to individual study, in so far that it trains the mind in given channels and methods of education. The appliances of an institute or university are much superior to any means one can have of studying alone, but there are exceptional minds who learn better by desultory study when they are in the humour for it.

To sum up, then, knowledge or education is something of one's self, it is more than book-learning; and the educated man is he whose individual experiences, observation, and reading give him the basi on which to found his life's work.

Principles of Screw Cutting.—"Chordal" writes in "The American Machinist": Stand twenty lathesmen up in a row, start catechising them, and you will only find two who understand the principles of a screw-cutting lathe. Any of the twenty can put gears on a lathe, and cut screws, if there is a brass plate around somewhere telling them what gears to put on. But only one out of ten can figure out the right gears in the absence of the table. This looks like a big percentage of ignorance, but I will go still further, and say that not one out of ten really understands the subject, notwithstanding he can figure out the gears. I know lots of lathesmen who know how to figure change gears for lathes, and still have no conception of the principle involved. They know how to do it, and that is all. They have at some time learned one of the formulas. As the pitch of the lead-screw is to the pitch to be cut, so is one of the gears to the other gear. That is one of the pat formulas. Here is another: Count the threads in a certain number of inches of the lead-screw, and count the threads in the same number of inches of the screw to be cut, and you have the number of teeth in each of the gears to be used. And again, the same thing differently expressed: Multiply each of the pitches by one number, and you have the number of teeth in each of the gears. The one lathesman out of ten knows one of these things, and probably figures it every day in the week. But if he gets the thread coarser than the lead-screw, he gets left. About one in twenty understands the subject thoroughly, and is perfectly independent of any rule which may have been handed down to him. He is not bothered when he finds out that the stud runs only half as fast as the lathe arbor, and he can easily find out what gears to use to cut a thread of 1¼in. pitch. The one in ten that I have referred to cannot figure out the gears for this pitch, or any other similar pitch. There are two things involved in this screw-cutting problem. One is a knowledge of mathematics, as far as the Rule of Three, and another is ordinary commonplace reasoning power. I do not think a man ought to be called an intelligent machinist who cannot prove that he possesses both to the degree required in this screw-cutting operation.

Artificial Walnut.—To give to ordinary wood the appearance of the most beautiful specimens of walnut, adapted to the very finest cabinet work, the wood must first be thoroughly dried and warmed, then coated once or twice with a liquid composed of one part by weight of walnut peel, dissolved in six parts of soft water by heating it to boiling point, and stirring. The wood thus treated is, when half dry, brushed with a solution of one part by weight of bichromate of potash in five parts of boiling water, and, after drying, is rubbed and polished. The colour is thus said to be fixed in the wood to a depth of one or two lines, and in the case of red beech or alder, for instance, the walnut appears the most perfect.

THE MANUFACTURE OF TIN PLATE.

TIN plate or tinned iron (*Fer Blanc* of the French) holds an intermediate place between an alloy and a coating. It is made simply by immersing plates of iron into melted tin, whereby they not only become covered with a perfect coating of this metal, but a very intimate union of the two metals takes place, to a certain depth in the substance of the iron, which is seen by cutting it transversely, and when the tinning has been repeated two or three times the whole plate is more or less alloyed, or as it were soaked with the tin.

Tin plate is manufactured in several countries; the English, however, seem to have the lead both in the quality and quantity of its production, to judge by the amount they export. The finest kind when highly polished has a lustre and whiteness scarcely inferior to silver, and the peculiar excellence of the English plate appears to be chiefly owing to the perfect smoothness given to the plate before tinning, and the great uniformity in the application of the metallic coating.

The general process is extremely simple, and, as carried on in some of the great factories in South Wales, is as follows:—

The iron ore is smelted with charcoal, so as to produce a metal of great purity, extensibility and closeness of texture, which qualities are particularly required in this manufacture. The reduced ore is smelted in the usual manner and cast into pigs, which are then wrought by the hammer into long flat bars, that are afterwards cut into pieces of about ten inches in length. These are then wrought into plates by being heated red hot, and passed through a flatting mill, which consists of two large cylinders of steel, case hardened and secured in a frame of iron. These are placed contiguous to each other, but with a certain interval of space, and revolve in a contrary direction, so that when one end of the bar is thrust in the space between the cylinders, the whole is drawn through and proportionately extended and flattened in the passage. The distance between the cylinders, which of course determines the thickness of the plate, is maintained and regulated by screws, which can be altered at pleasure. When the bar is thus made into a plate of twice the thickness of the ordinary plates, it is heated red hot, cut in two by a pair of shears, and one piece folded exactly over the other, and both repassed repeatedly through the cylinders till the folded plate has extended to the same length and breadth as the plate was before cutting. It is then clipped round the edges and the two plates torn asunder (which requires some little force), after which they are each finished by passing through a finer rolling press, so as to take out every crease or inequality in the plate, and those that are too rough to pass through this finer press are thrown aside.

The plates are then steeped in a very weak acid liquor, and when taken out are scoured thoroughly with bran, so as to be quite bright and polished, to enable the tin to adhere. The tin is melted in deep rectangular crucibles, and kept fluid by a moderate charcoal fire beneath. To prevent its calcination a quantity of grease, prepared from linseed oil and suet, is constantly kept floating on the surface of the tin, and renewed as it evaporates off, which gives an excessively nauseous stench. The plate is then taken up by one corner by a pair of pincers and dipped vertically into the tin, and when withdrawn is found beautifully white and resplendent with the coating of this metal that adheres to it. This dipping is repeated three times for what is called single tin plate, and six times for the double plate. The plates are then only cleaned and sorted, and are fit for use.

In many manufactories the iron plates before tinning are cleaned by being immersed in large barrels full of a mixture of rye flour and water, sometimes with verjuice which by fermentation has become very acid. In Bohemia the plates remain three times twenty-four hours in tubs filled with this acescent mixture, in three different states, after which they are washed, scoured with sand and water, and kept under water till just before they are used, to avoid rusting again.

Attention is to be paid to the heat of the melted tin; if too hot, the plate comes out yellow. The plates are immersed quite wet into the melted tin, passing in their way through the melted suet which covers it. Just before dipping, some water is thrown on the melted suet, which causes a violent ebullition and makes the surface of the metal quite clean and bright. The plates when tinned are set up to drain, by which a number of drops of tin collect in small knobs at the lower part. These are taken off by a second immersion into a separate cauldron of tin, but only to the depth of a few inches, by which the drops of tin melt down and the whole tinning is made more uniform in thickness. They are then cleaned with a rag and sawdust or bran. About 19¼ lbs. of tin are required for 300 plates, measuring each 1 foot by 9 inches.

In the manufacture of tin plate on the Continent a quantity of copper is always added to the tin, but in very small proportion. The exact quantity is regulated by slight circumstances which only experience can teach. It appears to be in general from 1-80 to 1-120 of the tin. The copper prevents the tin from adhering in too great quantity to the iron, and causes the superfluous part to drain off more freely. Too much copper gives a dull yellow tint.

The process in Pittsburgh is as follows: The sheets, cut into the desired sizes, are "pickled" by immersion in a bath of dilute sulphuric acid for 10 to 20 minutes. They are then annealed for from six to seven hours; then rolled cold to give them a surface polish. This operation hardens the iron, so that the plates are again annealed with greater care and at a lower temperature, for six or seven hours. The plates are then again pickled in an acid bath for some ten minutes to remove the scale of oxide, washed in water to remove the acid, and then plunged for a few moments into a bath of palm oil or melted tallow. The plates are then put, 40 or 50 at a time, in a tin bath, where they remain about 15 minutes. On leaving this, the plates are plunged into a second tin bath, on leaving which they have the dross brushed off, and go to the third tin bath; from that they go into a tallow or oil bath, from which they are drawn by passing between rolls, which smooths them. They are then rubbed with shorts, or bran and leather, to clean them, sorted and boxed, each box of I. C. plate containing 112 pounds, or 112 plates, the plates having a gauge of about No. 30, and weighing one pound each; I. X. brand weighs 140 pounds to the 112 sheets.

Tin plate is used for numerous purposes in and about the house, from the roof and eave-spouting to the culinary vessels in the kitchen, and its various applications are too many to enumerate here.

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To Clean Brass.—Rub the surface of the metal with rotten stone and sweet oil, then rub off with a piece of cotton flannel, and polish with soft leather. A solution of oxalic acid rubbed over tarnished brass soon removes the tarnish, rendering the metal bright. The acid must be washed off with water, and the brass rubbed with whiting and soft leather. A mixture of muriatic acid and alum dissolved in water imparts a golden colour to brass articles that are steeped in it for a few seconds.

MACHINE TOOL PROGRESS.

THE delicacy of operation with corresponding results, and the almost human adaptability of the wood and metal working machines to the work required of them, is a cause of immense congratulation to the manufacturers of the present day. The neatness of finish, the quality of material, and the automatic operations of the several parts, are enough to cause surprise even to the present generation, at the widespread development of such appliances.

The planer of the present day with its improvement in bed, its symmetry of parts, and the adaptation of every detail to the special local strains clearly shows a marked improvement over the old-fashioned machines still kept in use through a matter of economy, as well as a natural inclination to stick to old friends.

While there are still the same general notions and theories connected with the operation of the planer as of old, its several parts are much altered in detail. Whenever there has been an apparent necessity for improvement, then it has been studiously attended to.

The heavy, self-balancing, substantially constructed platen is not, as of old, supplied with the roughly cast and carelessly located slots and holes for securing the work, but all are closely gauge-lined, laid out, planed and bored to the snug fits suitable to the accomplishment, neat finish, and accurate work demanded of them.

The side uprights too, in conformity with the heavier work required of them, are much improved in construction and appearance. The width of base, the curve of strength to the backing, accompanied by a general appearance of lightness, present features which, while pleasing to the eye, at once convinces the experienced manipulator that any specific requirement he may think of has been studiously met and provided for.

The cross-head, with its varying heavy or light cut, works just as accurately and reliably in the highest elevation as in the lowest, and while every conceivable demand for strength is complied with, the design is still so adapted to the work, that all necessary light is provided for, and free access to every part of the machine is assured. In the better make of machines, and this constitutes the majority, the operating racks and pinions are all cut gear and the operating gear fitted to such a nicety as to safely insure first-class, smooth and true work.

The feed motions, a special feature in themselves, are so adapted as to be closely adjustable to the finest or coarsest grades of feed, in all directions and with the extremest economy. Everything is within easy reach of operation, and the delays of adjustment are at a minimum as regards time, while the feed motion only operates at the time of change to reverse or move the tool. The one well-known objection in planer practice, the squeaking of the belts, is about done away with, and the reverse strains on the gears and consequent jar and vibrations are stopped.

The same may be said of the lathe as of the planer; the improvements, the general symmetry and the adaptation of its details all place it in the highest rank of machine tools. The demands for perfection are alike in the lathe and the planer, and the success of the one is fully as marked as the success of the other. The smooth working, the reliable contact of parts, the true lining of the whole machine as well as the adjustment of all the motions to operate parallel to or concentric with the line of centres, and the absence of all spring from the several details, all constitute absolute requirements for a lathe of the first order. In proportion as these requirements are met and accomplished, so will the perfection in performance be rated.

In detail the points aimed at and without doubt fully attained by the experienced manufacturers, are the true lining up and perfect contact of the slide-rest and tail-stock with the bed; the true lining up of the tail-stock with the head-stock, as well as a true parallel movement of the slide rest with all parts of the lathe and with the centre line through the head and tail stocks of the machine. The shears themselves must be so fitted as to make it a certainty that the slide rest shall at any portion of the length of sweep move parallel to and follow the centre line of the end stocks.

The slide rest and carriage are the weak points in the lathe structure. They being the moving parts and sliding on the flat surfaces of the bed cause more wear by their contact with and motion from the neighbourhood of the running centre of the lathe to a distance of about one-half the length of the bed. According as the work performed on the lathe is long or short compared to the length of the machine or shears, so is the local wear increased.

The mode of operating the slide rest and carriage, especially with reference to the construction and contact, as well as the amount of bearing, determines the amount of wear, and has quite an influence on the vibrations or stiffness of the tool while at work. In many lathes, however, close attention has been paid to this requirement, and an additional side wearing surface is provided in the shape of V grooves in the bottom of the carriage, fitting upon V tracks along the whole length of the bed. With this V method a minimum of wear is attained, and there is no necessity of wedging or binding to prevent racking. If the weight of the carriage is not enough to keep it steady a substantial assisting weight may be added.

In addition to the several advantages conceded to the V method in the use of the slide rest and carriage, the tail stock requiring adjustment to every new piece of work, is made also to slide on the same V tracks, assuring a better alignment of the parts as the lathe is worn by use. If, however, the V tracks be not used and the tail stock as well as the other portions of the lathe is fitted to work between the ordinary dovetail flat sides of the shears, then as the uneven wear takes place due to varying lengths of work, the adjustment of the tail stock becomes doubtful to say the least, and the resulting work unsatisfactory. Hence the adoption of the V tracks in preference to the flat dovetail sides. As reasons display themselves for an improvement, and a remedy is pointed out the corrections are made, and a more perfect machine results.

So too with the shaping machine, the drilling and boring machines, large and small, all are studiously adapted to the minutest demands both of theory and practice. With the shaper the special attention is directed to the capacity, operation and stiffness of the bed and ram. The motions are direct, and sufficient length, as in the planer, is given to the ram, that it never runs over a proper balance and support.

In the slotter as in the planer and lathe, cut gear is used to warrant correct motion, and the operating connections are adjusted and fitted to an equal nicety. Alike also is the slotter fitted for strength and good appearance, and the general result is pleasing to the eye as well as faithful in its operation.

While holding that the machines are almost perfection as suitable to the work of to-day, still, concludes "The American Engineer," we concede that improvements not apparently required now will be added as reasons display themselves therefor. Corrections will be made, facilities enlarged, beauty of operation improved, as such demands are made apparent by competition and the necessities of work to be produced.

SOMETHING ABOUT SAWS.

THE grand secret of putting any saw in the best possible cutting order consists in filing the teeth at a given angle to cut rapidly, and of uniform length, so that the points will all touch a straight-edged rule without showing a variation of a hundredth part of an inch. Besides this, there should be just enough set in the teeth to cut a kerf as narrow as it can be made, and at the same time allow the blade to work freely without pinching. On the contrary, the kerf must not be so wide as to permit the blade to rattle when in motion. The very points of teeth do the cutting. If one tooth is a twentieth of an inch longer than two or three on each side of it, the long tooth will be required to do so much more cutting than it should, that the sawing cannot be done well. Hence the saw goes jumping along, working hard and cutting slowly. If one tooth is longer than those on either side of it, the short ones do not cut, although the points may be sharp. When putting a cross-cut saw in order, it will pay well to dress the points with an old file, and afterwards sharpen them with a fine whetstone. Much mechanical skill is requisite to put a saw in prime order. One careless thrust with a file will shorten a tooth so that it will be utterly useless, so far as cutting is concerned. The teeth should be set with much care, and the filing should be done with great accuracy. If the teeth are uneven at the points a large flat file should be secured to a block of wood in such a manner that the very points only may be jointed, so that the cutting edge may be a complete line or circle. Every tooth should cut a little as the saw is worked. The teeth of a hand-saw, for all sorts of work, should be filed fleaming, or at an angle on the front edge, while the back edges may be filed fleaming or square across the blade. The best way to file a circular saw for cutting wood across the grain is to dress every fifth tooth square across and about one-twentieth of an inch shorter than the others, which should be filed fleaming at an angle of about 40 degrees.

Perhaps the best saw set is a good vice; a vice that has straight and smooth jaws; jaws that will pinch thin paper their entire length. By placing the saw in such a vice as this with not more than one-half of the tooth projecting above the jaw, and using a nice punch and suitable sized hammer, the saw can be set better, perhaps, than with any other saw-set ever invented. Of course a wide saw cannot be set in a common-sized vice; but wide hand-saws or any other kind of wide saws do not work as well as narrow ones. A saw should only be of sufficient width to give it strength and stiffness, and all saws should be thinner on the back than on the edge. There is no economy in using a poor saw.

In filing cut-off hand-saws, always point the file upward, and towards the point of the saw. The more the file is inclined upward and forward, the better the saw will cut, provided the saw is filed by an expert. It must be borne in mind, that the more the file is inclined the more difficult is the filing.

Rip saws should be filed exactly the reverse of a cut-off saw, only the less inclination the better. A rip saw will do good work filed straight across, and is very much less work to keep it in running order.

Rip circular saws, as well as cut-off circular saws, should have a fly-wheel when they can be used without being in the way; and when saws of different sizes are used on the same shaft, there should be pulleys of different sizes that could be changed in an instant. As the edge of all saws require the same speed, which is, perhaps, about from 7,000 to 9,000 feet per minute, if the power is limited, 7,000 feet per minute will do very well.

Saw tables should be made to raise or lower in an instant to any desired point, not only for sawing rabbets, grooves, etc., but to place the table so that the saw will just reach through the lumber. It requires only about one-half of the power to saw inch lumber with a 12 or 14 inch saw when the table is raised so that the saw will only just reach through, than with the same saw when the table is down to its lowest. The saving of power is not the only advantage in having the saw just reach through the lumber, for lumber can be sawed much straighter, and far less liable to heat the saw.

It is always better to have the fence the whole length of the table, but there should be an offset from the centre of the saw to the farther end of the fence of not less than an eighth of an inch. There should also be a relieving lever, to throw the fence out of line; as in case there is to be fine sawing done of thin pieces, for instance, strips for lattice work, where a good many pieces are to be sawed from one piece of plank. In this case the fence should be thrown out of line so that the lumber will hug the fence, and saw each piece exactly the same thickness. But if rough sawing is to be done, the lever must be reversed, and the fence thrown out of line in the opposite direction, so that the lumber will pass along freely without binding between the saw and fence.

Rollers that are put on springs to press the lumber to the fence should have a slight inclination forward, which will make them have a tendency to climb the lumber, holding it firmly.

A cutting-off saw, either hand, band, or circular, should never be used in sawing obliquely across the grain of more than 25 or 30 degrees. All mitres should be sawed with a rip saw, either by hand or with power. A common-sized tooth circular rip saw, if properly filed and set, will make better mitre joints than any cutting-off saw that ever was hung.

Bronze Powder and Bronzing. — Bronze powder is finely pulverized metal or powder having a metallic base, applied to the surface of various articles for the purpose of imparting a metallic colour or lustre. Gold powder for bronzing is made by grinding leaf gold with honey, dissolving the mixture to obtain the gold by deposition, the honey water being decanted. German gold is a yellow alloy leaf similarly treated. Mosaic gold is prepared by incorporating and grinding: tin, 16; flower of sulphur, 7; mercury, 8; and sal ammoniac, 8; then subliming the amalgam. A flaky gold coloured powder remains in the matrass. Copper powder is obtained by saturating nitrous acid with copper, and then precipitating the copper by exposing iron bars in the solution. Bisulphide of tin has a golden lustre, flaky texture, and is used for ornamental work, such as paper hangings, and a substitute for gold leaf. Dutch foil, reduced to a powder by grinding, is also used, and powdered plumbago gives an iron coloured shade. Another kind is made from verdigris, 8; putty powder, 4; borax, 2; nitre, 2; bichloride of mercury, ¼; grind into a paste with oil, and fuse them together. Another (red): sulph. copper, 100; carb. soda, 60; mix and incorporate by heat; cool, powder, and add copper filings, 15; mix; keep at a white heat for twenty minutes; cool, powder, wash and dry.

HOW VENEERS ARE CUT.

THE "American Cabinet Maker" publishes the following interesting particulars of the above process as observed by a visitor to the Grand Rapids Veneer Co.:—

In the first place the log is drawn up an inclined plane by means of a tackle and brought under a drag saw on a platform at the top, where it is cut to the length required in order to fit the cutting machine. On one side of this platform, which is outside the factory building, is a row of steam boxes, in one of which the log is now placed and allowed to remain about twelve hours, emerging in a very soft and pliable state. This is necessary to prevent chipping and breaking while going through the cutting process, and also to render it more easy to cut. It is lifted from this place by a powerful crane, and after the bark has been peeled off, placed upon the cutter.

A veneer cutter resembles a gigantic turning lathe, with a knife ground to a razor-like edge running the whole length of the log to be cut. It is very massive, the knife being backed with an enormous iron beam, and the other portions are fixed in an equally solid manner; for the slightest tremor or yielding in any part would tear the veneer and render it useless. The machine used by this company weighs ten tons. The chuck consists of a large iron shaft, which is hammered into place by a heavy swinging maul.

The log now having been placed in position, the cutter is set in motion. The log revolves against the knife, and the veneer is pared off in a continuous sheet. So smoothly and easily does the machine work that it is almost impossible to conceive of the enormous power that is exerted. The huge log is cut with, apparently, the use of as little force as would be required to pare an apple. The feed is supplied by means of a revolving screw, which may be gauged to produce a veneer of any thickness from that of a sheet of tissue paper to three-eighths of an inch.

Of course there is a limit to the diameter which the machine can cut, and after it has done its work a piece seven inches in diameter is left. In plain native woods this can be easily put to other uses, but in French burls, which cost from twenty-five cents to as high as several dollars a pound, it is too valuable to be lost. In such cases, therefore, the knot is fastened to a stay log on whose centre it revolves, and thus very little, and that the least valuable part, of the costly material is wasted. The ash burls, which the company are now cutting, are brought in from the surrounding country, and they avoid the necessity of a stay log by having a sufficient part of the trunk on which the burl grew left to serve for this purpose.

As the sheets of veneer come off the cutter they are taken to a saw which divides them into the required widths, and are then put through the drying machine to remove the moisture with which the thorough steam bath that they have received has saturated them.

The subject of drying has been one of the most serious problems with which those in the veneer business have had to deal. A dryer is used by this company, who claim that it is both thorough and rapid in its operation. It consists of two series of steam heated rollers, enclosed in an iron box, between which the sheets of veneer pass as through a planer, emerging in a thoroughly dry state and pressed perfectly flat. The drying is still further expedited by a blast of hot air forced into the iron box referred to by a fan blower.

After going through this process the veneers are taken to the second floor, and such of them as are intended to be sold in this state are packed away, while the remainder is made into three-ply panels to be used in the manufacture of bedsteads, for looking-glass backs, etc. These three-ply panels are made by passing the veneers through a glue machine and then placing them in a press. Great strength is secured in these panels by having the grain of the middle layer of veneer run at right angles with that of the two outer layers.

APPLICATION OF VARNISHES.

PRELIMINARY to applying the varnish the pores of the wood should be filled. Sufficient time should be allowed for the filler to become perfectly hard, and if any lumps or inequalities remain, the surface should be made perfectly smooth by the use of glass paper. All dust, specks, etc., should be carefully removed by the brush made for that purpose, and the work is then ready for the varnish.

Varnishes of all kinds should be uniformly applied, in very thin coats, sparingly upon the edges and angles, where the varnish is liable to accumulate. In first placing the brush on the surface, it should be applied, not close to the edge, which would be liable to give too thick a coat at that part, but at a little distance from the edge, and the strokes of the brush should be directed towards the ends alternately, with steady rapid strokes, and only very moderate pressure. If the surface is small, the whole may be passed over in one operation, and then the brush may be returned to the edge at which work was begun, and it may be passed over the surface a second or a third time, to distribute the varnish uniformly, and work out the air bubbles. Sometimes, in small surfaces, the second series of strokes is made at right angles to the first, in order to distribute the varnish more equally, and the third is laid on in the same direction as the first; but unless this is done expeditiously and equally, it leaves cross-lines, which injure the appearance of the work.

Large surfaces are more difficult, as the varnish thickens too rapidly to allow of the entire surface being covered at one operation. They must, therefore, either be worked gradually from the one edge to the other, as in laying a tint of water-colour, or the varnish must be applied upon separate portions successively; but it is rather difficult to join the portions without leaving irregular marks. It may, however, be successfully accomplished by thinning off the edge with light strokes of the brush, made in the same direction as those on the finished portion; but some care is required to avoid disturbing the former coat while it is still soft and easily acted upon by the fresh varnish. In the same manner, in laying on a second or any subsequent coat of varnish, care must be taken not to continue the application of the brush sufficiently long to disturb the previous coat, which is speedily softened by the fresh varnish; and if the application of the brush were continued too long, the preceding coat would be disturbed, giving to the work an irregular or chilled appearance. A sufficient interval of time should be allowed between each coat for the perfect evaporation of the solvent, whether alcohol, turpentine, or oil. The time required for this depends partly upon the kind of varnish employed, and partly on the state of the atmosphere. Under ordinary circumstances, spirit varnishes generally require from two to three hours between every coat; turpentine varnishes mostly require six or eight hours; and oil varnishes still longer—sometimes as much as twenty-four hours. But whatever time may be required, the second layer should never be added until the first is permanently hard; as when one layer is defended from the air by a second, its drying is almost stopped, and it remains soft and adhesive.

In applying spirit varnish, some little tact and expedition are necessary, in order to spread the varnish uniformly over the surface before it becomes too much thickened by evaporation, or it will exhibit a very irregular surface when finished. If the surface does not exceed a few inches square, no material difficulty is experienced, as the whole may be brushed over two or three times before the varnish becomes too thick; but surfaces containing two or three square feet present much greater difficulty, as it is necessary that the varnish should be sufficiently worked with the brush to exclude all minute air-bubbles, which would spoil the appearance of the work, and can seldom be entirely removed until just before the varnish is becoming too thick to *flow* or spread uniformly after the brush has passed over it.

Turpentine and oil varnishes are applied in the same general manner as spirit varnishes, but as they dry more slowly, more time may be occupied in laying on the varnish, and therefore large surfaces may be more easily and uniformly covered; but the same precautions with respect to the dryness and warmth of the atmosphere are likewise desirable when it is wished to produce a brilliant surface.

Every precaution should also be taken to prevent any dust, or loose hairs from the brush, becoming accidentally attached to the varnish. Should this occur, they will require to be carefully picked out with the point of a pen-knife and the surface of the varnish levelled with fine glass-paper, prior to the application of the next coat.

In using spirit varnishes, it is at all times of the first importance that particular attention should be given to doing the varnishing in a dry atmosphere; as all solutions of resins in alcohol are precipitated by the addition of water, not only as visible moisture, but even as vapour, which is at all times deposited by the atmosphere at a reduced temperature, in the form of invisible dew, and in this state it precipitates the resin in the thin coat of varnish, and gives the surface a milky, clouded, or opaque appearance, when the varnish is said to be chilled. But this effect is frequently produced even on a warm and apparently fine summer day, when the atmosphere happens to be more than usually charged with moisture. This is a frequent stumbling-block in varnishing, and is only to be obviated by carrying on the process in a room sufficiently warmed to keep the moisture suspended in the air until the solvent has completely evaporated.

Not only should the room be sufficiently heated, but all currents of cold air must be avoided, as cold draughts, if suffered to pass over the recently varnished surface, are quite sufficient to dull the varnish wherever they extend. When the varnish has been chilled, the brilliancy and clearness may frequently be restored by giving the chilled surface another thin coat of varnish, taking care to avoid the causes of the former failure, and immediately holding the varnished surface at a moderate distance from a fire, so as to warm it sufficiently to partially redissolve the chilled coat; but care is necessary to avoid heating the varnish so much as to raise blisters, in which case no remedy would remain but to scrape off the entire coat.

The temperature generally preferred for the varnish room is about 72° Fah., but a few degrees more or less are not important.

Brushes for Varnishing.—For spirit varnishes, camels-hair pencils and brushes are used, the sizes of which vary from one-quarter to three-quarters of an inch in diameter, according to the size of the work. When the surfaces are very large, flat camel-hair brushes are used; but from their comparative thinness, they scarcely contain a sufficient quantity of varnish to preserve the brush uniformly charged in passing over a large surface. Turpentine and oil varnishes require less delicacy; and flat brushes, made of fine soft bristles, are generally used, or sometimes ordinary painting brushes are employed, but they are rather harsh, and, owing to the adhesion of the varnish, the hairs are apt to be loosened, and come out. Brushes should always be kept perfectly soft and clean, and therefore should never be laid aside when through work, without cleaning. For this purpose turpentine is best; the brushes can either be washed out quite clean in it, dried on a cloth, and laid aside, or the bristles can be partially immersed in turpentine, and allowed to remain in it until wanted for use. Warm water and soap will also serve to clean the brushes. If, however, the brushes are laid aside without being thoroughly cleaned, they will certainly be ruined by the hardening of the varnish.

Varnish Pan.—This can be procured at the colour shops. It is constructed of tin, with a false bottom; the interval between the two bottoms is filled with sand, which, being heated over the fire, keeps the varnish fluid, and it flows more readily from the brush. There is a tin handle to it, and the false bottom slopes from one end to the other, which gives sufficient depth when the varnish is low. It should also have a wire fixed across the top to wipe the brush against. An ordinary preserve jar is frequently used for containing the varnish, and is sufficiently suitable; but it also should have a wire or string stretched across the top, for reducing the quantity of varnish taken up by the brush. The quantity of varnish poured into the jar should be sufficient to nearly cover the hairs of the brush in order to keep it soft. Too small a quantity of varnish is liable to thicken rapidly by evaporation, which should at all times be prevented as far as possible, by keeping the vessel closely covered when not in actual use.

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How Tacks are Made.—The process of making tacks is as follows: The iron is received from the rolling mills in sheets from three inches to twelve inches wide, and from three feet to nine feet in length, the thickness varying, according to the kind of work into which it is to be made, from one-eighth to one-thirty-second of an inch. These sheets are all cut in about thirty inch pieces, and by immersion in acid cleaned of the hard outside flinty scale. They are then chopped into strips of a width corresponding to the length of the nail or tack required. Supposing the tack to be cut is an eight-ounce carpet tack, the strip of iron, as chopped and ready for the machine, would be about eleven-sixteenths of an inch thick and thirty inches long. This piece is placed firmly in the feeding apparatus, and by this arrangement carried between the knives of the machine. At each revolution of the balance-wheel the knives cut off a small piece from the end of this plate. The piece cut off is pointed at one end, and square for forming the head at the other. It is then carried between two dies by the action of the knives, and these dies, coming together, form the body of the tack under the head. Enough of the iron projects beyond the face of the dies to form the head, and while held firmly by them, a lever strikes this projecting piece into a round head. This, as we have said before, is all done during one revolution of the balance-wheel, and the knives, as soon as the tack drops from the machine, are ready to cut off another piece. These machines are run at the rate of about two hundred and fifty revolutions per minute. The shoe-nail machines, for cutting headless shoe-nails, are run at about five hundred revolutions per minute, and cut from three to five nails at each revolution.

An Improved Polish.—To a pint of spirits of wine add, in fine powder, one ounce seedlac, two drachms of gum guaiacum, two drachms of dragon's blood, and two drachms of gum mastic; expose them, in a vessel stopped close, to a moderate heat for three hours, until you find the gums dissolved; strain the whole into a bottle for use, with a quarter of a gill of the best linseed oil, to be shaken up well with it. This polish is more particularly intended for dark-coloured woods—for it is apt to give a tinge to light ones, as satin wood, or air wood, &c.,—owing to the admixture of the dragon's-blood, which gives it a red appearance.

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CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

SOLDERING FLUID.

Sir,—I have no doubt it is not generally known by "Amateur Mechanics" that the preparation known as "Sir William Burnett's Disinfecting Fluid" may also be used as a flux for soldering, and it answers the purpose admirably. It has one advantage over soldering fluids made with acids, viz., it is non-rustable, but it is poisonous, so all domestic or cooking utensils which are soldered with this as a flux must be well scalded afterwards. It is sold by chemists in half-pint bottles at sixpence each, and pint bottles at one shilling.

A. F. D.

DUPLICATING FRET-SAW PATTERNS.

Dear Sir,—In your "Amateur Mechanics" (the best book I have ever seen), No. 2, I see in your Miscellaneous "Duplicating Fret-Saw Patterns." It is on page 51. I take the liberty to enclose you my plan; it is original, and I have never seen others do it. When your pattern is cut out and still on the wood, take it off by putting it in a dish of hot water (I have used at times a large tea tray, my patterns being so large), being particular to keep turning your wood over to keep it from warping. This will take the pattern off without tearing. Then stand your wood *on end* in a warm place to dry. Get a piece of newspaper, pass it under the design in the water (the design will be upside down), and float it out; and when all open, raise one end gently out and you will find the most frail patterns come out quite smooth. Dry the pattern with blotting paper, gum it, place a clean sheet of paper over it, and pass your hand over, gently smoothing it down. You will find the design has adhered. By this plan, which I have never seen others do, you can keep the original; and when wanting a duplicate, take a sheet of thinnish white paper (white tea-paper), place over the pattern, and by rubbing it with a piece of heel-ball you get an exact pattern, and with little trouble, and can repeat by thousands.

Yours faithfully, J. C.

INDUCTION COIL.

Sir,—I have long felt the want of a magazine (as, doubtless, have many of my brother amateurs) in which to exchange correspondence, and also to express new ideas, which might be valuable, and would otherwise lie dormant.

This want has at last been supplied by your excellent magazine, which I have before me. And I, therefore, with your permission, avail myself of the use of a small space in its valuable correspondence column, by asking the following query: Some time ago, a friend of mine had a medical shocking coil, about 6in. long and 2in. diameter. It stood on one of its ends on the base-board, and in front of it, about an inch away, there was an upright glass tube; this also fixed on the base-board. This tube was about 2in. long and ½in. diameter, and was filled about ⅔ full with a cloudy white fluid. At the top of this tube was a rod of metal which, when pressed downwards, the end of it dipped into the fluid, causing the shock to become very powerful, the current varying in strength as the metallic rod became immersed. The contact breaker was on the top of the coil.

I wish to know what this fluid is, and what the rod is made of; also how the wires are connected with the fluid and rod, and which wires are connected with them. If any correspondent will kindly favour me with a reply, I shall be much obliged. "INSULATED."

PLASTER CASTING.

Dear Sir,—In reference to paragraph in your last—"Transferring prints and leaf forms to Wood"—allow me to suggest an improvement to one portion of it. The paragraph says: "Then take a brush of stiffish bristles filled with some pigment, bend back the bristles towards you and away from your pattern, then let go suddenly." I think this would be found a very awkward and dirty way. The best way to sprinkle the colour is to hold in the left hand a piece of wood—such as a ruler, or a piece of iron—say a poker; hold it over the pattern, about eight or nine inches above it, take the brush with the pigment and strike upon the wood or iron as the brush is full of colour or the reverse, and as it is struck sharply or gently against the ruler, etc., so will the sprinkling be heavy or light; in this way, and altering the height above the work at which the rod is held, the shade of colour can be graduated to any desired tint. For red colour, use red ochre; for brown, umber; for black, lamp-black. Any of these colours are to be mixed with a little paste or gum, and then thinned down with water to the required consistency.

Yours obediently,
J. W. KING.

SUGGESTIONS.

Sir,—I wish to offer you my heartiest congratulations, as editor of the "Amateur Mechanics."

I only ordered it a few weeks ago, and now that I have read it, I wish to testify my pleasure at having such a magazine devoted to Amateur Mechanics. I wish it every success.

I trust you will not consider me dictatorial when I express a hope that you will not allow your pages to be taken up with such recondite matters as violin making, or organ building.

I hope that we subscribers may have a few pages devoted to ourselves in asking and giving information. Undoubtedly such an interchange of views and knowledge will tend greatly to make the "Amateur Mechanics" vastly popular and useful.

I have bought your book, "The Metal Turner's Handbook" (a wonderful shillingsworth !), and have enjoyed the perusal of it greatly. I have looked in it with special reference to buying a screw-cutting lathe.

I hope you will be able ere long to give your readers some *clear* and *simple* descriptions to make such lathe apparatus as the Dome Chuck, the Universal Cutter Frame, etc., accompanied by working drawings. It would be a great convenience if the illustrations in "A.M." could appear *along with* the articles they illustrate.

Yours faithfully
J. W

AMATEUR MECHANICS

AN

Illustrated Monthly Magazine,

CONDUCTED BY PAUL N. HASLUCK.

No. 7.—Vol. 1.] JULY, 1883. [Price Sixpence.

DESCRIPTION OF A LATHE

Belonging to the Rev. Willoughby J. E. Rooke, of Little Wymondley.

THIS lathe was made by Mr. William Goyen, of Newton Abbot, who needs no special commendation, his name being so well known as one of the best makers of lathes, tools, etc. Not only is it a specimen of the perfection to which ornamental work in metal can be brought, but its accuracy in the fittings of the several parts for the purpose that is required makes it a most desirable tool for any one to work. The particulars are as follows:—

A 5½in. centre lathe on iron bed, mounted on a double frame and fitted with extra stays so as to secure solidity, the whole being made of the best seasoned mahogany mortised together and secured by long screw bolts, having turned finished brass ends—double gearing to head for metal turning—reversing motion to ditto for right and left screw cutting — traversing mandrel for screw cutting — division plate completely divided—micrometer-tangent wheel and screw with complete set of wheels for dividing, and segment engine complete.

The main screw has four threads per inch, and extends to the whole length of bed.

Saddle actuated by main screw, with double clamping motion for fixing slide-rests; split clamping nut to main screw; quick return motion with rack, and special arrangement for working the large spiral apparatus from front of saddle; three ivory handles to ditto.

Complete set of 20 gun-metal machine-cut change wheels for screw cutting, and two arbors (one long and one short); steel spring index with micrometer adjustment.

Stop piece for segment engine, with adjusting screws; set of 16 change wheels for dividing engine and wheel cutting, with spring top and handle complete.

Set of six steel screw guides for traversing mandrel; guide for ditto or eccentric at back of head stock, and spiral washer for fitting same to mandrel.

Metal turning slide-rest to slide into saddle for sliding or surfacing; Willis's tool-holder; screw with micrometer stop-head for screw cutting, and gun-metal adjustable stop with clamping screw and micrometer screws for internal screw cutting; two loose handles.

Slender guide for back stay to fit on metal turning slide-rest, adjustable in all directions, and capstan-headed screws for fixing same.

Boring collar with plate, eight holes; stop and clamping nut complete with bow and screw bolt.

Back poppit head with cylinder and leading screw, and transverse motion for turning conical work; handwheel and clamping screw complete; two centres and drilling centres for ditto.

Ornamental slide-rest of most complete construction, to fit saddle, with all possible adjustments. The upper tool slide can be worked either by lever or screw. Two clamping screws for fixing tools and three clamping pieces; lever handle and two slide-screw handles and key, all (four) ivory handles. Pair of fluting stops complete; curvilinear apparatus, complete, with one template pulley, and tangent wheel motion for driving the slide screw from overhead motion.

Spherical slide-rest of complete construction to fit into saddle; three slides and tangent screw motion; two clamping screws for tool holder, and three clamping pieces; two stops for tangent wheel; (five) ivory handles to all slides.

Hand rests with cradle, with universal motion and three T's.

Spiral apparatus. Very complete arrangement for using the main screw and gun-metal change wheels as a spiral apparatus driven by special handle from saddle. A train of wheels and bevel wheels work a counter shaft the whole length of bed, which gears into the main screw by means of three machine-cut gun-metal wheels at right end of lathe. The centre wheel has tangent motion for throwing it into or out of gear.

Two large gun-metal stops to screw on lathe bed for limiting the traverse of saddle, with micrometer screws complete.

A smaller spiral apparatus consisting of spiral chuck for mandrel; improved worm wheel driving motion; two radial arms or wheel holders, with bolt, bow and handle; screw and washers for radial arm complete.

Set of ten machine-cut change wheels, and five bevel wheels for cylinder and surface spiral cutting.

Overhead motion consists of two cast iron standards (japanned), secured to the frame by bright turned bolts and washers—a main spindle carrying a pulley, and long mahogany drum for transmitting the power, from a rocking shaft, and bright finished levers with double brass pulleys for conveying the bands; this is driven from the counter shaft, and a very slow or excessively high speed is always at the workman's immediate disposal.

Heavy fly-wheel (turned bright), with five speeds, mounted outside frame at end of crank shaft with two cranks, supported on anti-friction rollers. From any of the grooves a band runs to a counter shaft situated on the tool board, and motion is again communicated from thence to the mandrel pulley. By this means great power and slow speed can be obtained for heavy work, or a very high speed can be produced for lighter work, and without any extra exertion on the part of the operator. A clever device for taking up the slack or loosening the various bands is attached under the bed to the counter shaft.

Drilling and cutting frame, etc., etc.

Steel drill spindle to fit ornamental and spherical slide-rests, driven by overhead motion.

Eccentric cutting frame to fit ditto.

A large powerful cutting frame to fit on metal turning slide for wheel cutting, milling, etc., with bevel gear; pulley and guide pulleys; two spindles for ditto; four sets of steel cutters for ditto.

Centre driving chuck, with two centres, two pins, etc.

Worm chuck, with centre screws; prong ditto.

American ("Victor") drill chuck, 0 to ¾in.

American 4in. scroll chuck, with three jaws (self-centring), key complete.

Four-jaw independent screw die chuck, with cross handle key.

Eccentric chuck, of most complete construction, and *highest possible finish.*

Oval chuck, *to match*, and improved guide frame for driving ditto from mandrel.

Dome chuck, improved, with tilting action to slide.

A perfect two-parts compound geometric chuck, of finest construction, re-arranged and enlarged by Messrs. George Plant & Son; perfect clamping motions to both slides, and quadrant plates; reversing motion to both parts; tangent screw, angular adjustment, and tangent screw front wheel motion; complete set of 30 pinions and 38 change wheels, all of gun-metal and machine cut.

Paper chuck for ditto, with two rings, and gun-metal spring chuck.

Spring pencil holder, and steel cutter for ornamental work.

Brass and boxwood chucks; steel spanners, etc., etc.

The whole of the lathe, with the exceptions mentioned, is of polished metal.

[We have been favoured with several photographs showing various parts and appliances of the above lathe, and we shall publish illustrations and descriptions of them as opportunity offers.—Ed.]

MODEL YACHTS.

PART I.

A FEW subjects which make their appearance in the pages of "Amateur Mechanics" will probably receive the practical attention of some readers for the first time. Indulgence in some hobbies is, up to a certain age, impracticable, often on pecuniary grounds, but as with a very limited capital one may commence model yacht building in a small way, this pursuit begins to find favour in the eyes of the amateur at a very early age.

Owing to want of funds, if on no other account, the desire to possess a lathe, a photographic camera, or even a model steam engine, is rarely gratified until schooldays are past, but the importance of owning a yacht, more or less perfect, is usually realised about the time that the amateur experiences promotion from petticoats to pants. And it is a noteworthy fact that not only do its charms first attract the youngster as early as the manufacture of mud pies, but they continue to exercise a fascinating influence even in middle age. In substantiation of this we find that the possession of model yachts in youth frequently makes the subsequent ownership of a real yacht appear "a consummation devoutly to be wished," and as a consequence, the yacht clubs may be said to owe their popularity in a measure to the enthusiasm with which the members once sailed their models. In fact, the model yacht clubs may, not inaptly, be termed nurseries for the future members of the others, the experience acquired by the youngster alongside the inland lake serving to impress upon him certain principles which are duly endorsed when, at a later period, he ventures into salt water as the proud skipper of his own yacht.

To the eyes of some people this pursuit is very frivolous, and only worth the attention of children; but this opinion is held only by those who never tried, or, at any rate, never succeeded in making a model that would behave respectably in the water. With such the fact is apt to be overlooked that by going the right way about it a model may, with a fair wind, be made to sail like a real ship in almost any given direction at a tolerable speed, and, if properly rigged, much of her performance may be executed without a rudder.

Play which so thoroughly tests the skill of children of a larger growth must involve a principle not always apparent to the casual observer, which principle is that of effectually turning to account the natural force of wind as a propelling power.

Balloons owe their existence to atmospheric support, the ships themselves to that afforded by water, and both depend upon the motion of the wind for propulsion.

There are those, however, who ridicule the idea of a model being made to maintain an indicated course like a ship at sea, although both are subject to the same influences; but when such attempts have proved success to be possible, surely greater credit is due than if a miniature crew really manned the little vessel. Thus we venture to say that of all the pastimes to which amateurs devote themselves, few are more attractive, and none are more worthy of the sons of Britannia—who boast of ruling the waves—than that of model yacht sailing.

It may rightly be inferred—from the sight of a good racing model being so rare in some towns—that this wholesome amusement has not so many patrons as, for instance, cricket, bicycling, or football; but the why and wherefore lie in the proverbial nutshell, for, while in almost every town a tolerably good sized field is for cricketing purposes withheld from the otherwise inevitable spread of bricks and mortar, and by public subscription made to resemble a grassy carpet, with, perhaps, the addition of a circumscribing track for the iron steeds, in few places is any actual provision made for the sailing of model yachts. Tastes differ, and there always will be a number of people who respect their shins too highly to engage in football, value their necks too greatly to risk them on a bicycle, or for sundry reasons refrain from the physical effect of such games, however excellent in their way, to say nothing of the younger members of the community who are afraid of a bicycle, and, if allowed to enter a cricket field, persist in tempting Providence. Model-sailing presents a peculiar charm to such as these. The movements of the little vessels in the water are to the youngsters matter of absorbing interest, and (an instance of extremes meeting) other eyes, old and probably dim, may be seen to twinkle with quiet enjoyment at the sight of the mimic regattas and—shipwrecks. But by-and-by the pond is filled in for building ground, and if no other suitable for the purpose is accessible, the little boats are neglected and eventually disappear. Even where the inhabitants boast a public park or recreation ground, the authorities are apt to begrudge the money laid out on the formation of a shallow lake, which, by encouraging the art of model yacht sailing, combines useful instruction with an interesting amusement. In cases where such a lake has been provided, the trifling charge made upon owners of the models during the summer is transferred to the skaters in the winter, and a revenue, more or less, is realised, which always helps to meet expenses.

That this pastime is not encouraged as it deserves is greatly to be regretted. The taste for it certainly abounds, needing only the opportunity to show itself in a practical manner.

We have called it a pastime. Some have gone so far as to dub it a scientific art, and not without reason, for only those who have tried to make a really successful model yacht can testify to the difficulties presented.

But here let it be understood that a model yacht worthy of the name is one thing, and the gaily-painted production of the toyshop is another. If the amateur desirous of possessing a model yacht is satisfied with, and wishes nothing nearer perfection than, the latter phenomenon by all means let him purchase one, and thus save himself much trouble and perhaps more disappointment. But if, on the other hand, he intends himself to produce a craft likely to give satisfaction, not only as regards appearance, but what should be more important, namely, sailing qualities, we trust the following papers will be of service to him:—

Exhibition or show models, which are intended to reproduce in miniature the details and general appearance of certain vessels, will not be discussed here. The present series of papers will have sole reference to the construction and management of such models as may be seen on fine afternoons and evenings, in summer, skimming across the surface of some quiet sheet of water, while their respective owners complacently watch their evolutions from the shore. Hints on designing such models will be followed by examples and full instructions for making them by several methods, and in various styles.

The rigs appropriate to the tiny yachts will also be illustrated and described in detail, while lead keels and other items will receive due attention.

The illustrated supplements which are to accompany the following papers will represent the hulls, and details drawn to as large a scale as space will allow.

The present chapter will merely discuss certain preliminaries which require consideration before even designing a model yacht.

Having spoken rather disparagingly of what may be called toy-shop models, it would be unfair not to add that others, excellent in all respects, may be obtained ready made, or built to order from any design, at a few establishments; but, as may be expected, they are expensive. The material used in the manufacture of these bears but a small proportion to the labour expended on them. When £ s. d. is no object, the purchase of a model such as this need not be other than satisfactory; but if she happened to win honours the owner could not honestly take to himself the credit of making her.

To do this an intimate acquaintance with the subject of ship-building is not necessary, as the marked success of some models made entirely by rule of thumb goes to prove, though some such knowledge would be of great assistance to the modern yacht-builder.

Excellent models are sometimes turned out with no other guide than a good eye and a steady hand; but the ability to do this is more a gift than aught else, and not many being blest in that respect, it would be foolish for a beginner to place too implicit a confidence in his optics, even if the steady hand were all there. By taking advantage of every opportunity to examine other good models, and a little practice in putting one's ideas of shape down on a plan, sufficient intimacy may be acquired with the subject to banish all prospects of failure.

Before proceeding further it will be well to understand what is meant by a yacht. Some persons invariably associate the cutter rig with their idea of the thing, possibly because yachts with this rig abound more than any other. The reason of this is not far to seek. A cutter is not only elegant in appearance but fast, and up to a certain size very handy, after which the huge mainsail is apt to become unmanageable. But a yacht signifies a pleasure boat, whether rigged as a cutter, yawl, lugger, schooner, brig, barque, or even ship, technically so-called; and if fitted with no rig whatever she may nevertheless be a yacht.

But here an important consideration is to be taken into account.

The main point in which model yachts differ from their larger sisters—which we may designate "real" yachts—is that they must manage themselves when afloat, the crew remaining on shore. This places yards and square sails (or those set *across* the mast) at a disadvantage, as it is difficult to make these trim themselves, while with fore and aft sails (those set in line with the masts) no such difficulty presents itself. On this account we banish square sails from the list of rigs applicable to a model yacht. Hence the sloop, square-rigged schooner, brig, barque, and ship are pronounced unsuitable, leaving ourselves the choice of cutter, yawl, schooner, lugger, or lateen. In respect of size no limit need be observed, so long as reasonable proportions are retained, and any of these latter rigs may be fitted to a boat of increased size until she ceases to be a model.

Only for the above reason do we advise the model-maker to eschew the square rigs in selecting a type of boat, but if he has a fancy for yards and the attendant paraphernalia, a square-rigged model *may*, with patience, be made to sail tolerably well, though the superiority of fore and aft sails alone will soon become apparent.

Sketches of various rigs will afterwards be given in a supplement, when the question of rigging is under consideration, but a short description of those mentioned above will be useful here.

The cutter carries one tall mast, placed about perpendicularly at a distance abaft the stem equal to say one-third the extreme length of the boat. The sails used under ordinary circumstances are:—Two jibs or foresails, and the large mainsail mentioned before. In light winds a gaff-topsail is set above the mainsail, and a balloon jib forward. This boat sits pretty low in the water, and has a long overhanging stern or counter. A design for the hull will be given with Chapter II. This rig sometimes needs a little humouring in the matter of balancing the quantity of sail and position of the mast to suit the shape of the boat. The position just suggested—namely, one-third the boat's length abaft the stemhead—may in most instances be depended upon to give satisfactory results, and not until the vessel has proved unsuccessful in the water should any alteration of the mast be contemplated. The way to deal with it will be described later on.

The yawl rig is almost identical with the cutter, the only difference being that the mainsail is made narrower at the foot, and a short supplementary mast and sail is placed right aft. The advantage of this rig over the cutter is increased facility in working the sails, as the short mast is of great assistance in balancing the amount of sail set, independent of any delicate adjustment in the position of masts. The hull is the same as a cutter.

The third type, a schooner, is unlike the previous ones, differing both in hull and rig. The hull is not so broad in proportion to its length as in the cutter. This will be seen, along with other differences, on examination of the design, which will also accompany Chapter II. The schooner rig requires two masts, the foremast placed nearer the stem than in the cutter and yawl, the mainmast a little abaft the half length of the boat; each carrying a trysail, while two jibs are set forward. The extra sails for light winds are the balloon (or flying) jib, and, of course, two gafftopsails. This rig has much to recommend it, combining speed and handiness with smartness in appearance. The two masts may seem to suggest more trouble than the others, but this is not the case in reality.

We leave a description of the lugger and lateen to the chapter on rigging.

In selecting a type of boat with a view to the construction of a model yacht, it would be advisable to visit some pond or lake, if such exist near at hand, where model sailing is carried on, and endeavour to form an idea as to the relative sailing merits of the specimens to be seen there. So far as different rigs go, there may not be any great variety to choose from, but a good model will soon show itself to be such.

Concerning selection some advice will naturally be expected in these columns, and if any be given, let it be in favour of a cutter as a commencement. Having only one mast, and three sails in general use, it presents no great difficulty to rig and manage, while for smartness, and, in most cases, speed, it ranks A1.

But, previous to commencing the actual model, the amateur must be his own naval architect to the extent of preparing a plan from which to construct the boat. The preparation of this plan is not only to be recommended here, but shown in the light of a necessity if the tyro wishes to avoid disappointment, and, probably, expense. Nothing is easier than to spoil a good model by cutting away a little too much in a place where it cannot be spared. Whatever style is decided upon, the dimensions — namely length, breadth, and depth — should first be definitely settled, and then a full-size working plan (of the hull alone) made before ever a tool is applied to the wood. Once taken, this precaution will never be regretted, though the omission of it may. Want of ability to make a highly-finished plan is not of great consequence, accuracy being more essential than artistic effect. So long as the maker can understand it and depend upon it, the main object is gained. Should he fortunately possess the ability to design a boat to suit his own individual taste, so much the better; but, lacking such familiarity with the subject, the safest course will be to re-produce (full size) either of the designs to be given with chapter 2.

Before fixing the dimensions of the proposed boat, attention should be directed to the following points, upon which the success of the model will greatly depend.

Firstly, the question of proportions. The beam or breadth may be taken as about one-fourth the length; the depth, exclusive of lead keel, say three-fourths of the beam. These proportions may be modified according to taste or circumstances, with the following effect:—

Increased length gives increased speed; greater beam (breadth) will enable the boat to carry more sail without undue inclination, while with an increase in depth she will keep a more direct course by presenting greater lateral resistance to the water. Hence a large model has in every way the advantage over a small one.

It will also be well to remember that a model less than two feet long will never achieve much as regards speed and sailing qualities. Below this size a very slight puff of wind serves to blow her away to leeward, and being unable to keep a definite course for any time, it is difficult to say at the outset where she will make the land. For racing purposes and general handiness a length of 2ft. 6in. will be found short enough, for a model appears much smaller in the water than she really is. The design for cutter will represent a boat 2ft. 8in. overall, 8in. extreme beam, and 6in. deep, without the lead keel. That for the schooner to be 4ft. long, 10in. beam, and 7½in. deep. These will be found very useful sizes, affording ample room to work, and in the rigging everything will be of a size to ensure freedom of action.

The above remarks on proportion require to be supplemented by others having reference to form, which may materially differ even in cases where the dimensions are identical.

The main object to be desired is, of course, speed, and with this in view the designer must aim at diminishing, as far as possible, the resistance offered by the vessel on her passage through the water. This is attained by making the immersed portion of the hull as small as the necessary buoyancy admits. While taking care that the fore end of the vessel (called the entrance) is not bluff or full, but of a shape calculated to divide the water almost silently, and allow it to glide smoothly aft, it must not be forgotten that unless the after part (technically, the run or delivery) is also well shaped, the water on its passage aft creates an eddy which interferes with the speed and steering qualities of the boat.

Shapely pleasure yachts of a few tons are not often seen in some places, but when such are to be found a careful inspection of the hull and general appearance will be of lasting value to the designer of model yachts. If private yachts are not easily accessible, many fishing smacks which abound at various places along the coast will be found to afford excellent models of shapeliness and proportion, the imitation of which cannot fail to give satisfaction. It is by no means rare for some of these boats to ride out weather which seals the fate of many larger craft.

The success of a model further depends upon the form of the midship section; hence the query suggests itself:—Which is the best form? Opinions vary on this point, so that a definite answer can hardly be given. Sometimes the speed of a boat is accredited to the midship section, when really the cause or hindrance is to be found elsewhere. The performances of certain fishing boats of various sections are often quoted with reference to the merits of each, those with a straight rise or slope seeming to deserve most credit, and such a section is perhaps as good as any for a model yacht. A lead keel being necessary in the model, however, a slight hollow close to the keel makes a more shapely connection. The part above the load water line should fall in very little, if at all. The boat is always at a considerable angle of inclination when under sail, and a full upper body prevents this inclination becoming too great. The sheer, or longitudinal curve of the deck, does not affect the speed of the boat in the least, but imparts elegance and smartness to the general appearance of the craft.

After having considered the question of dimensions and shape, and decided to commence a model yacht of approved size and type, the sheerdraught, or plan of the hull, should first receive attention. This is nothing more nor less than a piece of solid geometry, the mere reproduction of which is not so difficult as may be anticipated. A separate sketch is necessary for the rigging, but this we may safely leave to a later stage in the proceedings.

Supposing the boat decided upon to be the cutter, 2ft. 8in. extreme length, we require a sheet of stout drawing paper, at least 36in. by 24in.; but sheets exactly this size cannot be obtained ready made, the nearest size being that called double elephant, 40in. by 27in., which will answer much better, a fair margin being a decided advantage, as will be found when a commencement is made.

Drawing boards are sold by all the mathematical instrument makers to suit this size of paper, but if no suitable board is at hand a good joiner will be able to supply the deficiency for a smaller amount than the other. The practical value of the board depends entirely upon sound, well-seasoned material, square corners and straight edges. The back should be stiffened by a couple of cross pieces.

Should the amateur not possess a T-square one may perhaps be borrowed, but if not it had better be purchased rather than trust the manufacture of it to a joiner. A 30in. pear tree T-square, with tapered blade, costs 3s.

Our joiner friend may provide two or three hard wood set-squares (triangular pieces of wood about $\frac{1}{16}$in. thick, one angle of each to be 90°), together with three drawing battens of pitch pine, two of them being 30in. long, tapered from ¼in. square at one end to ¼in. by $\frac{1}{16}$in. at the other. The third batten to be about 42in. long, ¼in. square in the middle, tapered at both ends to ¼in. by $\frac{1}{16}$in.

For use with the battens a few lead weights are necessary—say a dozen. These, cast in blocks about 5in. by 2in. by 1½in., may be ordered of a plumber, after which they need facing with hard wood on one of the narrow sides, this facing to have a tapered ledge or projection ¾in. long at one end, which rests upon the batten.

Some drawing pins, a 3ft. straight-edge, a pair of 5in. dividers, a few thin wood curves of various shapes, a 2ft. rule, together with pencil and india-rubber, complete the list. If the drawing is intended to be inked in, as it should be, a drawing pen and a piece of Indian ink will be required in addition.

The draughtsman's requisites have been named at length, because by using makeshift materials in the process of designing, difficulties will present themselves where they would not otherwise exist. The omission of the lead weights and battens especially will be at the sacrifice of most reliable work. The description of the sheerdraught, which is to follow in our next chapter, is not only intended to describe the enlargement of the design which accompanies it, but also to indicate the mode of procedure to be followed in producing others. For the former purpose very few instruments will suffice, but for the latter, the list named above contains no unnecessary item.

(To be continued.)

PRACTICAL CABINET WORK FOR AMATEURS.

PART II.

WE have now to consider the kind of bench best suited to the young cabinet maker's wants. The ordinary cabinet maker's bench is about 7ft. long and 2ft. 6in. broad on the top, and there is no reason why the amateur's bench should differ from it in any way. It is too large, however, for the room at disposal in most private homes, and as it is only occasionally in use it should at other times be covered with a cloth and serve as a side table, and for this reason it should not be an unsightly article, but made to look like a piece of furniture. If, however, the amateur has a small room or outhouse entirely for his own use, his bench should not be less than 6ft. x 2ft., and made to serve the purpose of a bench only. To meet these two contingencies I will describe two benches—the smaller to stand in the kitchen, or living room, the larger to stand in the amateur workshop proper. The small bench to be first described is one I made many years ago, and which I have at present in my kitchen. It is, properly speaking, a bench and tool chest combined, and I think it must commend itself to a few at least of my readers. Fig. 1 will give a fair idea of the appearance of this bench. The top is 4ft. long, 22in. broad, and 2in. thick, of yellow pine. It may have a knot or two, but it should be free from shakes. A frame is made, also of yellow pine, 3in. shorter than the top, and 30in. in height, which with the top added makes the bench 32in. high. The two back legs and the right front one are 2in. square, and the left front leg, where the "lug" is to be attached, 4in. x 2in. These are framed together with rails, 2in. x 1½in., in the following manner:—The two ends (that is, a fore leg and a back leg) are framed up by mortise and tenon, having a rail at the top and another 4in. from the ground. These rails are put in flush with the outer face of the legs, as they form the framing for a covering or lining. The four long rails are let into the

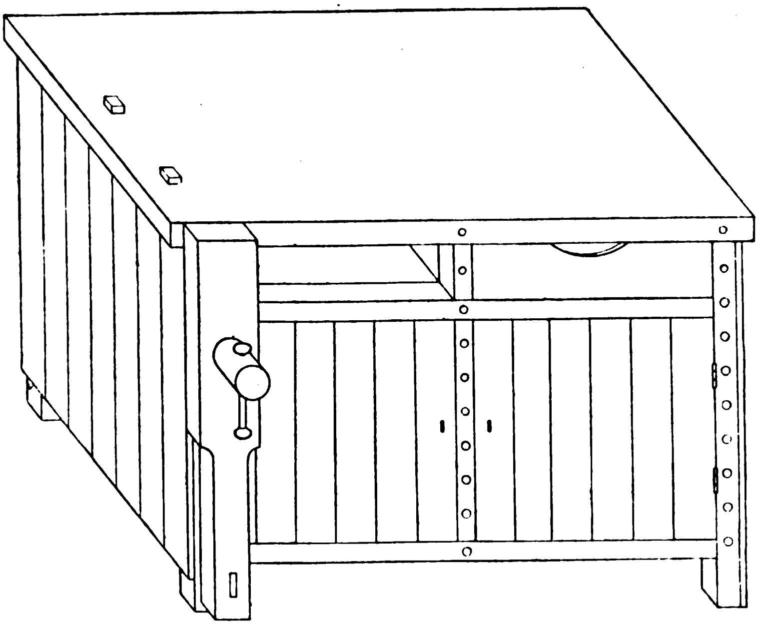


FIG. 1.—COMBINED BENCH AND TOOL CHEST.

legs by mortise and tenon; two of them, back and front, 4½in. from the top, and the other two in the same manner, 4in. from the floor, or on a level with the end rails. A bottom is now made of ⅝in. wood, the entire area of this frame, with the corners cut out for the legs. When it is fitted in and nailed to these four rails, which it entirely covers, the two ends and the back of this frame are to be covered with ½in. lining, in widths of about 3in., the joints running vertically. This lining comes up to the under side of the bench top, but need not go lower than within 3in. of the floor. Now, on looking at sketch, you will see on the front two doors, with an upright post between. Over the right door is a drawer, and over the other an empty space, between the rail and the bench top. This space is for thrusting in the end of a piece of board when you want to rip or cross-cut it. It rests upon the rail, and the left hand pressing it down its opposite end is pressed up against the bench top, and is thus held while being sawn. The drawer, 4½in. deep on the face, is made long enough to reach to the back lining. It is divided off inside for holding small tools. The space enclosed by the two doors, together with the drawer, constitute all the requirements of a tool chest. The saws may be hung along the back, horizontally, on racks. The planes will lie in the bottom, and it is very handy to have two or three shallow boxes for holding small tools, such as chisels, &c. These will pile one above the other, thus taking up little room. The "lug" for this bench is of oak, beech, or birch. It is 5in. broad, 1¾in. thick, and in length reaches from the top to within an inch of the floor; 9in. from the top the screw passes through it and the bench leg. This screw should be of iron, square threaded, and 1in. diameter, and may be bought in any tool shop. The nut is fastened to the bench leg behind. At the lower end of the "lug" is a piece of wood called the "sword;" this is 2in. broad and ½in. thick; it is let into the lug, and passes through a loose mortise in the bench leg, and having a number of ¼in. holes, a short iron pin is inserted through any of them in front of the bench leg, and thus the "lug" is kept parallel with the leg when work is being held in it. The screw and the sword are each about 12in. long, and will open to take in work up to 9in., which is sufficient for almost any purpose. The lower portion of this "lug" is cut away for about half its length to 3in. in breadth, in the manner shown in the drawing. The drawer is supported by guides running from front to back of the frame; they should be put in when the frame is being put together, and the drawer must be fitted before the top is fixed down. The top is fixed by screws passing upwards through the two end rails, and in front must be kept flush with the frame. It will thus project about 1in. over the two ends.

In the top of this bench you will observe two "stops," *i.e.*, small square pieces of hard wood, projecting upwards. Most benches have but one stop; two are much more handy for various things. One stop is placed about 4in. from the front, and about the same distance from the fore end; the other is about 6in. further back, and in line with the first. In planing short and broad pieces, these two stops are useful to prevent the piece slipping off the bench, for although this does not often happen with an expert, it is very apt to do so with a beginner having but one stop on his bench. These stops must be of one thickness throughout, and the holes made to let them pass through the top neatly and somewhat tightly; they are 5in. long, and are struck upwards with a hammer from the opening in front of the bench. There are other stops to fit the same holes; one has a piece of iron or steel screwed to its upper end, with a row of sharp teeth on one of its edges. A piece of work such as a rail to be moulded being thrust against these spikes is held firmly from slipping. This appliance is much tidier than nails driven into the bench to effect the same purpose.

In the upright post between the doors a number of ⅝in. holes are bored through; the right corner leg is also bored in the same way. An oak or ash pin having a head on it is turned to fit these holes; its use is to rest the lower edge of a board upon when fixed in the lug, for the purpose of planing the upper edge. The pin is placed in the hole, suitable to keep the board in a horizontal position. For short work the inner row of holes is used, and for longer work the outer row. When not in use this pin may be kept in the drawer, or any place where it will not get lost.

Instead of a handle, which would catch in the workman's clothes, the upper face of the drawer is cut away in the centre. This admits the hand far enough to allow the drawer to be pulled out.

It will be evident, I think, that to make this bench would require a considerable acquaintance with the use of the tools, and, indeed, the description here given is intended for such as have had some practice.

Those, therefore, to whom the use of tools is entirely new would do well to secure the assistance of some one in the trade, or if they can afford it, get the bench made to order by a master joiner. It

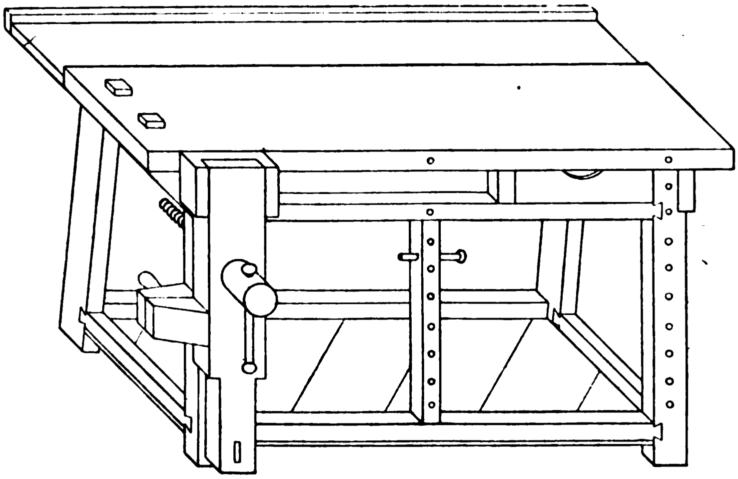


FIG. 2.—CABINET MAKER'S BENCH.

would cost from 30s. to 35s. If the wood is good and clean it may be varnished white, with a few black lines on the doors and drawer, or it may be painted any desired colour, excepting the top only and the inner face of the "lug." When got up in this way it makes a neat and useful piece of kitchen furniture, as the lug may be removed when not in use.

The bench now to be described is one suited to the small workshop. Fig. 2 is a sketch of, from which it will be observed that the top is in two pieces. This top is 6ft. long and 2ft. broad. The front portion is 15in. broad and 2½in. thick of red or yellow pine, free from shakes and twisted growth; the back piece, 9in. broad and 1½in. thick, both resting on a level rail, which makes the back pieces 1in. lower than the front. Along the back edge a rail of 1in. wood is screwed. It projects upwards 1in., and is therefore on a level with the front plank, so that broad work will lie solidly across the bench. The supporting frame of this bench consists of two ends, the rails screwed to the legs, as in the sketch. Three of the legs are 4in. x 2in., and the fourth, that behind the "lug," is 6in. x 2in., all of good red pine. The back legs have a lie inwards towards the thick plank of the top, the end of the rails being rounded off. These rails are 5in. deep and 2in. thick. The lower rails, 4in. from the floor, are 3in. x 2in. The other rails, three in number, are of a length to make the frame measure 5ft. Two of them are at the bottom, 3in. from the floor, back and front, and one in front, 4in. below the top. They are dovetailed into the legs, and fastened with large screws, so that the bench may be taken to pieces for removal. Under the lower rails a boarding is nailed for holding planes, mallets, hammers, &c., and a small drawer is often put in, as shown in the sketch.

The stops are put in as in the bench above described, but this time they come through outside of the front rail, instead of within it. The screw the same as before, but of larger dimensions. The sword is put in in the same way, but in addition to it there is a side screw, which I have adopted and found of advantage. A piece of wood is mortised into the edge of the "lug," and a similar piece into the edge of the leg—they project outwards 6in. A short wood screw works through the back piece, and its point presses against the piece projecting from the lug. The ordinary lug, when the end of a broad board is caught in it, cants over, less or more, the free side of the lug approaching the face of the bench; the pressure is all on the edge of the board, and is very hurtful to a piece of finished work. This side screw cures this evil, as it is turned out or in to suit the thickness of the work in the lug, so that its face is always in the same plane as the plane of the bench; the sword at the bottom being regulated by a pin.

In the front of this bench also is an upright post between the two rails. It is holed for a pin as before; as is also the right leg. To keep the pin from getting lost, a hole is bored through the post at right angles to the others, and in this it is kept when not in use.

The object of the back portion of this bench being an inch lower than the front is that nails and other small objects or chips may lie in it without hurt on the bench. It also prevents the tools rolling and falling off the bench, which they often do, and, setting amongst the shavings, are lost.

The lug of this bench should be of clean straight hardwood, 7in. broad, cut away at the bottom to 4in., and 2in. thick. The sword is 2½in. broad and ⅝in. thick. Sometimes the lug has a piece of hardwood screwed across its inner face at the upper end; this piece would be 10in. long, 6in. broad, and 1¼in. thick. For some purposes this is an advantage. The benth here shown is so fitted.

This bench, like the other, would require some considerable skill in the use of tools to make. If made by a joiner, it would cost, with an iron screw, about 30s.

We have now to notice sundry appliances which belong to the well-appointed cabinet-maker; and of course the amateur, to have the same advantages, ought to possess the same tools.

The bench "boy" is a piece of pine or mahogany, 10in. long and 6in. broad. It has a strip of wood about 1in. square across each end, but on opposite sides, so that when placed on the bench the under fillet catches against the edge, while the other fillet, which is uppermost and at the off end, is used for placing the work against when sawing, particularly when cutting in the shoulders of rails for tenoning. It is called the "boy" because it holds the work, instead of him, the difference being that it holds it much better. The paring block is a piece of hard wood, about 8in. square and of any thickness. It is for paring upon with chisels or gouges, and should be kept free from dirt. It requires dressing, smoothing with a plane, now and then, and should not be less than 1½in. when new.

A piece of wood 8in. square should always be kept for setting the glue pot upon.

The moulding board is another useful article. It is a long pad for placing narrow pieces upon, to be moulded or run with moulding planes, casements, &c. The cabinet-maker's vice, made entirely of wood, is a very handy tool.

The beam compass or trainers must also be noticed.

Then there is the mitre and shooting board in one, and the mitre block.

The above articles are all made entirely of wood, and may be made at very small cost—the price of the timber.

Two ring weights—a 14lb. and a 28lb.—are most useful articles to have handy at the bench, for grooving drawer slides and fielding the bottoms, or for holding any kind of work steady on the bench during the operation of grooving or moulding, there is nothing better.

The bench boy is represented in fig. 3. It is 9in. long and 6in. broad, and usually made of pine, ⅞in. thick. The two fillets are of mahogany, 1⅛in. square, and are sunk neatly into a groove in the board. They are glued in and fixed with two screws. They should be perfectly at right angles with the sides of the board, and the object of having them sunk in the board is that one or more saw-cuts are made across them quite down to the board, and the sunk portion, not being cut through, the pieces do not break off or get loose. These saw-cuts are useful for purposes that will be noticed at some future time.

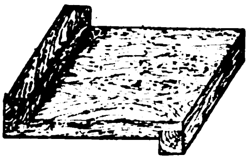


FIG. 3.—BENCH BOY.

Fig. 4 is a representation of the moulding board. This is a pad on which the pieces of dressed wood are placed to be "run" with the moulding plane. In a slovenly workshop the moulding board is simply a long piece of board with a second piece nailed along the upper side of it, against which the moulding is placed. A proper mould board, such as is here shown, is made of Bay mahogany. It is 6ft. long, and consists of a piece this length, 6in. broad and 1¼in. thick; over this is a movable guide bar 3in. broad; it is made to shift backwards and forwards, exactly the same as the fence of a filister, by having four slots across it 2in. long. These slots have a brass or iron plate, also slotted, let into them, and a flat-headed screw being placed in each slot and screwed into the under board, the bar is thus made to slide on the screws. It is placed so that it will move forwards to within ¾in. of the near edge of the under board, and, as it will slip back about 1¾in., it thus exposes 2½in. of the under board; and any moulding of a breadth between these extremes may be "run" on it. There should be three of these guide bars, ¼in., ½in., and ¾in. thick, all slotted in the same manner, so that any one will fit the same screws; and these three guides will suit for mouldings of almost any thickness wanted. These guide bars are simply to keep the moulding rigidly straight on the board while under the pressure of the moulding plane.

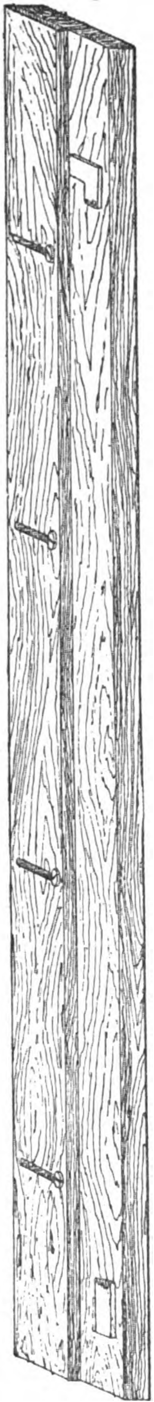


Fig. 4.—Moulding Board.

Some moulding planes have a deep fence that comes down over the front of the moulding board, such as the quarto round, the Welsh ogee, and many others. Other moulding planes, again, have a narrow fence, only the thickness of the finished edge of the moulding. In running a moulding, the operation is continued till the plane rubs upon the surface of the moulding board, the back fence, at the same time, rubbing upon an untouched part of the moulding, or upon the guide bar. Thus any number of mouldings are run off exactly the same size, providing that all the pieces of wood have been previously planed alike.

Usually a nail is driven in front of the moulding to prevent it slipping forward, but the proper stop for this board is a steel spring, having the end cut into two or three sharp teeth; the under side has a screw hole, and is sunk a little into the board, the tooth end being made to stand a little above the surface, so that the end of a moulding placed against it is effectually held there. To raise or lower this stop for thick or thin mouldings a second screw is passed through the middle of its length; by tightening this screw it is lowered, and it rises when the screw is loosened. This stop can be shifted backwards and forwards after the guide bar, by having other screw holes in the under board to suit any breadth of moulding. The opposite end of the moulding has also to be held in position on the board, and this is rather more difficult to accomplish; it is effected by having a similar piece of toothed steel, and for the purpose of making the board serviceable for various lengths of moulding this back stop must be made to shift along the board for at least half its length, and to effect this it is made to go under the guide bar, its edge being turned upwards into a narrow groove made in the guide bar. It may thus be moved along the groove to the desired place behind the moulding, and when the guide bar is screwed down tight, it holds effectually. Fig. 5 is the fore stop, fig. 6 the back stop just described. The moulding-board is held in its place by having two short strong dowels projecting from its under side near the ends; corresponding holes are bored in the bench top and the dowels fit into them, thus holding the board in its place.

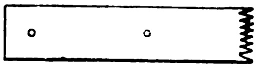


Fig. 5.—Fore Stop.

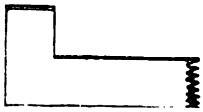


Fig. 6.—Back Stop.

Although two pieces of wood nailed together may serve to run mouldings upon, yet I think it is best to describe a properly constructed moulding board, such an article as a tasty workman would take pleasure in making and using afterwards; for it must ever be borne in mind that the better the tools and appliances in the hands of the workman the better and the speedier will his task be accomplished, and the greater pleasure will he have in executing it.

The shooting and mitre board, fig. 7, is our next consideration. This board lies upon the bench and against the stop. Its use is for squaring the ends of short pieces of stuff, such as in the making of small drawers and boxes, the plane being laid upon its side and pushed forward, and as a mitre board the plane is pushed in the same way, only the wood in this case is planed to an angle of 45°. This tool is made as follows:—Get two pieces of Bay mahogany, each 30in. long, 6in. broad, and 1in. thick. Overlap the one with the other 2in., and screw them together, thus forming a lower bed, 4in. broad, where the plane runs, and an upper bed 6in. broad. Here the fillet for shooting is fixed, and the triangular piece in the centre for doing the mitreing. The under-side of the board must be made up at the ends by two fillets 4in. long, 2in. broad, and 1in. thick, screwed on, which gives the board a level bearing surface 10in. broad. A fillet or stop of mahogany at the front on the upper side is made, and sunk into a shallow groove an inch from the fore end, and at exactly right angles with the edge or shoving direction of the plane. A triangular piece is made, having two adjacent edges at right angles to each other, and it must be placed upon the board about the middle of the length, with the

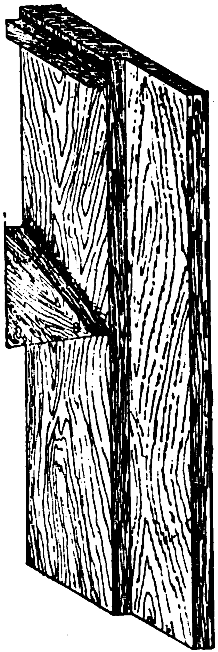


Fig. 7.—Shooting and Mitre Board.

right-angle corner pointing towards the sole of the plane, and the two edges exactly at an angle of 45° with the sole of the plane. It should be sunk into the board for about ⅛in., and fixed with two screws. It has occasionally to be taken off, to admit of using the whole length of the board as a shooting board.

This board is used for mitreing all mouldings of a thin flat description, such as those planted on the face of wardrobe and sideboard doors, &c. It is also used for small picture-frame mouldings of all kinds.

For heavy cabinet mouldings another instrument is used, called the mitre block. This is illustrated in fig. 8, and there is no more useful tool in the whole category of cabinet appliances. When truly made this instrument mitres the moulding to the exact fit the first time, thus saving a lot of fitting, trying, paring, loss of time, and spoiling of materials. This is not a difficult instrument to make, and no cabinet-maker should remain long without one.

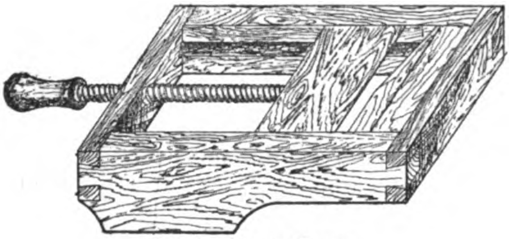


FIG. 8.—MITRE BLOCK.

Mine is made entirely of beech wood. The outer frame is 18in. long, 9in. broad, and 2½in. deep over all, and the thickness of wood is 1¼in. It is dovetailed at the corners, and one of the sides is about 4½in. broad for about half its length, this downward projection being to be caught in the bench "lug," in which position the instrument is held when being used. The interior block of beech is 9in. long, 6½in. broad, and 2½in. thick. It is to be planed to exactly the inside width of the frame. In each edge of this block two grooves are to be run with a plough, ⅜in. wide and ½in. deep, and two corresponding grooves are to be run in the long sides of the frame. Tongues of rosewood or box are to be fitted into the grooves in the beech block, and to project nearly ⅜in.; and they are to be fitted to slide in the grooves in the frame; but, while they slide, they are not to be too loose, to shake or rattle. In other words, the tongues are to fill the grooves exactly. This block is to be divided into exactly two equal parts by a cut made across it at an angle of 45° on the edge. This is the cut that forms the mitreing face.

In marking off this cut make a line with a square across the upper side 3¼in. from the one end, and a similar line on the under side, 4½in. from the other end, where the screw is attached. A line drawn on the edge of the block to meet these two will have an angle of 45° with the upper and under face. This is to be cut, and both pieces planed truly to the angles given, for on the accuracy of this depends the usefulness of the instrument, and if not truly made in this particular it is quite worthless.

The one half of this block is to be fixed in the off end of the frame, while the other is to slide backwards and forwards by the action of the screw. This screw is ¾in. diameter, and the screwed part is 9in. long. The end rail of the frame is tapped for it to work in, and the end of the screw is attached to the moving block by means of a plate and collar, shown in fig. 56. This consists of a piece of ¾in. brass tube, with a ring soldered on one end, which forms the collar. A piece of brass or iron plate is made 2½in. long, 1½in. broad, and ⅛in. thick, with a screw-hole in each corner. In the centre a circular hole is made ¾in. diameter to allow the tube, but not the collar, to pass through. This plate and tube are now sunk in the end of the moving block, the collar being at the back, and the open end of the tube standing out to receive the wood screw, and working freely in the hole. The various parts being ready to fit together, the grooves should be coated with moist black lead. The dovetailed corners should not be glued, but put together dry, and screws put into them. The screw is inserted, and its end made to fit into the brass tube, where it is fixed with short screws. This screw should also be black-leaded; by turning the screw the block should move easily in the grooves. The moving block is now to be pressed up close to the other, and the face of the instrument planed level and true. In mitreing with it, as much of the moulding is allowed to project above the surface as will make a full mitre. This is sawn off nearly flush with the mitre block, and the remainder planed until the plane will take off no more of the moulding, taking care at the same time to plane nothing off the surface of the mitre block. Two pieces of moulding thus mitred and placed together, mitre to mitre, form an exact right angle, if the mitre block is truly made.

Fig. 9 is another handy tool. It is the cabinet-maker's vice, and is made to be used in the bench lug. It is very useful for holding small work to be sawn with the bow saw, as this tool gets round about such work much better than when it caught in the lug itself; besides, the operator can then stand erect. It is also used for holding all kinds of small work to be operated upon with the chisel, file, spokeshave, or other tools, as well as for holding the smaller saws to be sharpened. It consists of two sides, or jaws, 13in. long, 5in. broad at the upper part, 3in. at the lower, and 1½in. thick, of beech or black birch. Through these jaws, 5in. from the top, passes a wood screw 1½in. thick, and 9in. long on the screwed part. It goes loosely through the front jaw, but is tapped into the other. Near the bottom is a ⅝in. screw, tapped in the front jaw, and pressing against the other; its use is to keep the jaws parallel, just as the sword does the bench lug. Projecting from the edge of the back jaw is a piece, 6in. long and 4in. broad; by this the vice is held in the bench lug. A small fillet is screwed to the back of the back jaw, which, resting upon the bench, prevents the vice slipping downwards when using it. The screw-head, 3in. diameter, and about the same length, has a wood lever pin, 9in. long and ¾in. in diameter, passing through it; this should be of ash or rosewood.

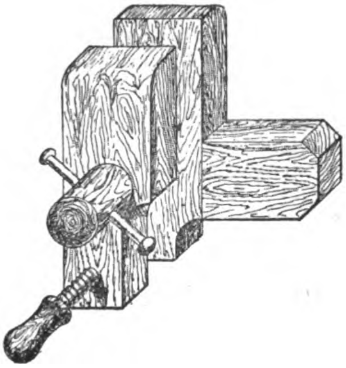


FIG. 9.—CABINET MAKER'S VICE.

While much work may be done without this last tool, very little can be done without the use of hand screws. One of these articles is shown, fig. 10. It consists of two jaws and two screwed pins. There are three or four sizes in a well appointed shop, and generally about a dozen of each size, the smaller sizes being provided by the workmen themselves. The large size has jaws about 20in. long, 3in. broad

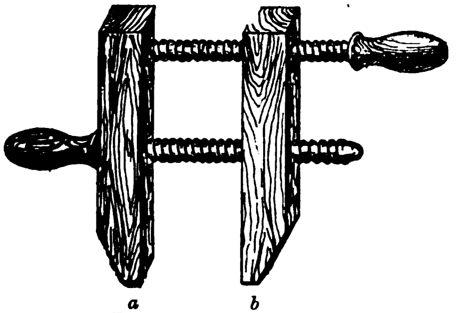


FIG. 10.—HAND SCREWS.

and 2½in. thick, with 1¼in. pins about the same length. The second size has jaws 14in. long, and pins in proportion. The third size has jaws 12in. long, 2in. broad, and 1½in. thick. The pins are ¾in. diameter, and have the screwed part 9in. long. The small size has jaws 7½in. long, 1⅝in. broad, and 1in. thick. The pins are ½in. diameter, and have 8in. screwed.

In making these screws the two jaws are planed parallel, and tapered off at the end on the outside. In the middle of the length of the jaw, *a*, a hole is bored to allow the pin to pass through before it is screwed. In the other jaw, *b*, a hole is made and tapped for the screw, and at the end a second hole is tapped for the second pin. In the first jaw, *a*, and opposite the point of the back pin, a shallow hollow is made. This is simply to prevent the point of the pin slipping when the hand-screw is being fixed upon the work. To open these screws speedily to the required width, you take the head of the middle pin in your left hand, and the head of the other in your right, and by twirling them over and over one way the jaws are opened, and by twirling them the other way they are as rapidly brought together. In order that this may be done easily, the screws should be black-leaded, and they then work easily in the jaws. Half a dozen of each of the two smaller sizes will be ample for the wants of most amateurs; although for the laying of large veneers, the larger screws or some substitute will be necessary.

The beam compass, or trammels, fig. 11, come next to be considered. This article is used for drawing circles or parts of circles, and consists of two heads with steel points, mounted on a bar about 3ft. long. Very fine ones are made of brass and sold in the tool shops, but a serviceable tool may be made without expense as follows:—Plane two pieces of beech, box, or rosewood, 5in. long and 1¾in. square; mortise them near one end for a bar, 1in. by ⅝in., to pass neatly through; then they are to be turned, the top finishing with a knob or button, and the opposite end tapering and fitted with a ferrule like a bradawl. An ordinary bradawl is inserted, cut to about half an inch, and sharpened to a point. One of these heads is fixed to the end of the bar, and the other slides along it, and is fixed in the desired place by a binding screw of boxwood passing through one side of the head. The bar should be of hard wood, or it will very soon get unsightly from the pressure of this screw.

For drawing ellipses, this instrument has three heads, together with other appliances, which will be fully described when we come to use it.

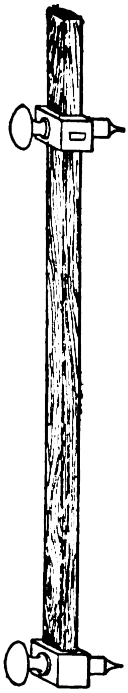


FIG. 11.—TRAMMELS.

The mallet is made of beech, and the handle of ash. For mortising, the head is 8in. at the outer end, tapering to 6½in., and 2¾in. thick. The breadth through the eye is 6in. The eye is made with a taper widening towards the outer end, and goes quite through the block. The handle, 8in. clear of the head, is inserted from the wide or outer side. The handle is rectangular at the part within the head, and oval at the part that is held by the workman.

The small mallet, for dovetailing and many other purposes, is 5½in. long, 4in. through the eye, and 2¼in. thick. It is made in the same taper form as the above, the handle being 9in. clear of the head. These two are sufficient for all purposes.

The articles above described are usually made by the cabinet-maker, so that anyone who has had some practice with tools may readily make them for himself.

We have now to consider the tools that are indispensable even to a beginner in the art of cabinet making. And although the names and the uses of many of the commoner tools are familiar to many readers, yet there are many more who do not know them, even by their names; so in order that all may become acquainted, both with their names and their uses, I now proceed to describe them.

(*To be continued.*)

* * *

Secret Drawers.—In making secret receptacles it is necessary to adapt the ornamental part of the bureau, or its visible arrangements, so as to conceal what is hidden in a natural manner. Any attempt at creating space with heavy cornices, or too wide a division between apparent drawers, will be at once perceived by the searcher. The upper part of the bureau is generally selected for the secret drawer. False backs and bottoms to the lower part are sometimes found, but these spaces are easily detected by measurement. Two secret drawers in one old bureau are found by the way the centre pigeon-holes were ornamented. Beautifully-made fluted pillars were placed in front of the divisions, and the pillars, instead of being the ordinary half-rounded column, appeared to be quite detached from the woodwork, and it required careful examination to discover that the partition behind them was double. The pillars drew out, and with them came high, long, and very narrow drawers, capable of containing bank notes or documents. In another bureau there was a long narrow drawer under the pigeon-holes. When this was removed, a plain piece of wood appeared that divided the lower from the upper part of the bureau. This piece of wood was so arranged that it could be taken out, and the space left between it and the real division used for concealing jewellery. A more common method of making a secret drawer is by shortening the length of one of the ordinary drawers, and using the space thus obtained at the back to insert a small drawer and a thin false back, which can only be touched when the visible drawer has been entirely removed. No one can detect this receptacle without comparing the lengths of the drawers together and removing them all. A tiny drawer fastened to the roof of an ordinary drawer will defy cursory inspection; it is fitted rather at the back, and the bigger drawer can be opened and even removed (if the back is made low) without the smaller one being detected; a watch spring or a groove arrangement is necessary to the secret drawer to keep it in position and to fix it and take it out with.

THE AMATEUR WOOD-TURNER.

PART IV.

WE purpose devoting the present lesson on wood-turning to the formation of tool handles :—Chisel and bradawl handles may be bought very cheaply; but the amateur turner may find himself in circumstances wherein he cannot readily procure them ; moreover, he may have a fancy to turn his own handles, or to do the like turn for a neighbour amateur who may not be the happy possessor of a lathe.

Bradawl handles vary in size a little, from the largest to the finest bradawl. They vary also a little in pattern or shape; a very neat pattern is shown in fig. 1.

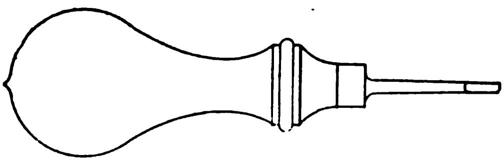


FIG. 1.—BRADAWL COMPLETE.

A medium-sized handle requires a piece of wood 5in. long and 1½in. thick. Beech is about the best wood; ash, elm, or hickory make very good handles.

Assuming the piece of wood to be square in section, it is first gauged on both ends to find the centres, as described in a former lesson. These centres found, a *dab* is made on each end with a centre punch. The corners are now taken off with a small axe or jack-plane, after which it is mounted in the lathe. It is then roughed down with ⅜in. or ¾in. gouge, till the flats disappear. Now a bradawl handle is shod with about half an inch of brass ferrule. These ferrules are made from a piece of brass tube, for large handles ⅜in., and for small ½in. diameter. Take a piece ofbrass tube, say 3in. long—this will make half a dozen,—mount a piece of wood in the lathe, say 4in. long, turn it down till the tube will fit on tight, mount again in the lathe, and cut the tube into lengths of from ⅜in. to ½in., with a narrow parting tool described in a former article. When they are all cut through to the wood core, it may be driven out, then the barb must be cleaned out of each ferrule with a ⅜in. rat-tail file.

Now to fit a ferrule to the cylinder of wood from which you purpose making your handle. Gauge the *interior* diameter of the ferrule with callipers; the out and in callipers are the proper things for this. In their absence the ordinary may be used. I may here mention that the expert never uses callipers for this bit of work, he simply places the ferrule on the projecting centre of his lathe, then mounts his bit of wood; he roughs down the bit of wood as already directed, then he reduces the right hand end to a little over the outer diameter of the ferrule, as shown in fig. 3. Then with a chisel he gauges off (with his eye) a little more than the length of the ferrule, cutting in a square shoulder, and reducing this part to admit the ferrule, see figs. 2 and 3. He tries the fit by merely moving the ferrule forward from the cone centre on to the wood, and if too tight he reduces a little, but in almost every case it fits at the first trial; so accurate does lengthened practice make the eye. The ferrule should be driven on pretty tightly home to the shoulder. To drive it home a second ferrule may be placed over the first and struck with a mallet, the second ferrule being necessary from the fact of the wood protruding about ¼in. through the first. This *over* wood is finally cut away close to the edge of the brass.

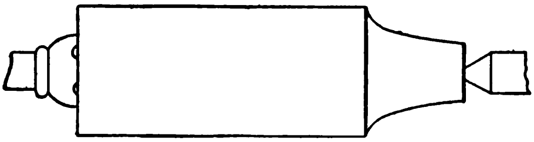


FIG. 2.—BRADAWL HANDLE: IN THE ROUGH.

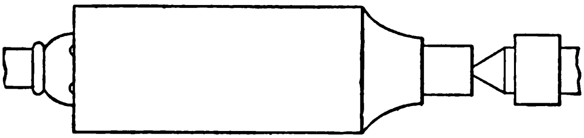


FIG. 3.—BRADAWL HANDLE: FERRULE FITTED.

Having got the ferrule on, re-mount in the lathe and begin the operation of shaping the handle to the desired form. Here again the eye must in a great measure be the guide. A well-shaped handle to copy from is, however, necessary to a beginner, until the eye gets accustomed to forms and dimensions. Use your callipers freely on the pattern at first, and you will come very near to making your handle after the pattern. A practical turner will throw off perhaps two dozen of these handles in an hour, all formed and proportioned alike, with no gauge or calliper but his eye and hand. The learner, however, need not be discouraged if he takes an hour to his first one, and finds it in the end not quite like the pattern. Turning cannot be learnt in a day.

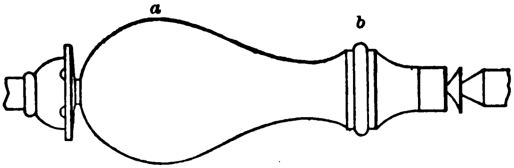


FIG. 4.—BRADAWL HANDLE: FINISHED.

In fig. 4 we have the finished handle with the turning centres still attached. At *a* it is the full size of the wood, namely, 1½in. From the point *a* the wood is worked down right and left with ⅜in. or ¾in. gouge. The projecting part at *b* shows two fillets and a bead between. The bead is ⅛in., and the fillets each 1/16in. broad. On either side of the fillets the wood is reduced by a curve, that on the right sweeping down to exactly the outer diameter of the ferrule, and making with it an unbroken surface. The curve on the left sweeps away from the fillet to *b*, where the handle is of the same diameter as the ferrule. From *b* the curve swells towards the left to *a*, the part from *b* to *a* thus forming an ogee, and from *a* to left end the form is semi-egg or semi-elliptic. The whole operation herein described is performed to nearly a finish with the gouge alone; then the chisel cuts a shaving right and left from *a*, the cut to the left leaving about ¼in. uncut. To the right the cut stops at *b*, the chisel is then reversed, and cutting from the fillet finishes at *b*, always using the obtuse corner of the chisel. The two fillets and bead are also finished with a chisel ⅜in. or ½in., beginning at the crown of the bead and working down to the fillet on either side. The fillets are finished by placing the chisel, flat side, on the rest, and cutting sideways into the bead with the obtuse corner.

All this done it is now sand-papered. The paper is held with the fingers, two grades being used, coarse grade first; care must be taken in papering the fillets and bead not to blunt them off. Take a short rod of wood planed at right angles on the edges, wrap it in fine grade sand-paper, and hold it square on the fillets, turning it over on the bead—this will leave the fillets clean and sharp. When thus papered, take a handful of the turnings and allow the work to revolve through them held in the hand; this gives a finishing gloss or skin to the work. It may now be cut off. First of all cut neatly in close to the end of the ferrule, nearly through—then cut in at the opposite end till it drops off. If, however, you wish to varnish, say a number of such handles, lay them aside when turned with the turning centres still on till all are turned, then remount, and while running give a coating of raw linseed oil by dipping a rag into it; wipe off the oil with clean rag, then, with a polishing rubber dipped in French polish and tipped with oil, coat the work while running slowly, moving the rubber lightly along the work, thus giving the rubber two motions, which will prevent sticking. Go over all your handles in this way, laying them aside for an hour or two. Again remount, and paper with finest flour paper, and with a flat brush or a bit of fine sponge give a coat of spirit varnish, called by French polishers "slake." The previously applied polish will prevent the slake sinking in, and handles thus treated will be found to have a good lasting varnish, easily and quickly applied, while the work is running in the lathe. The ends may now be cut in as previously described, but not until the varnish is quite dry.

All sorts of chisel, file, and other handles having ferrules, are manipulated in the way described above in the operation of fitting the ferrules.

Chisel handles are of various forms, some of them being neither pretty to look at, nor pleasing to the grip. About the best form of cabinet maker's chisel or gouge handle I have yet seen or used is shown in fig. 5. It looks neat, and fills the grip exactly.

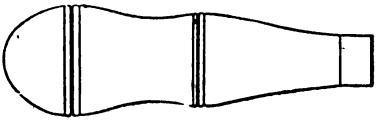


Fig. 5.—Chisel Handle.

File handles are generally of the form shown in fig. 6. File handles should not be made of very hard wood, such as beech. Willow, or white home-grown birch are better.

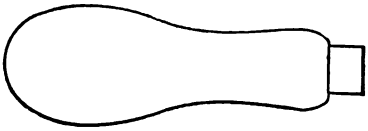


Fig. 6.—File Handle.

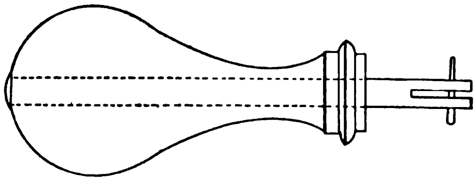


Fig. 7.—Bow Saw Handle.

Handles for bow saws have the form shown in fig. 7. They have a very short ferrule or plate attached to a spindle; the handle is bored right through to admit the spindle, which is firmly riveted on the outer end, the opposite end of the spindle being slit to receive the saw.

Handles for wringing machines are also bored through to turn easily on the pin or spindle, the outer end having a washer over which it is riveted.

Handles for cabinet makers' draw points, and for all sorts of small files, are made after the pattern of fig. 8. Handles for screw-drivers have much the form of those for bradawls. The ferrule is generally much thicker in the metal than ordinary ferrules, and after being fixed on the wood, is slit up about ¾in. to receive the blade. The blade where it leaves the handle should be of the same breadth as the diameter of the ferrule. The sides of the handle are planed off parallel with and in the plane of the blade. This is to give the hand a better leverage in turning it while using (see fig. 9). It also hinders the tool rolling about when laid down. Handles for choppers and very many knives such as curriers' and shoemakers', are made straight and reduced only at the ferrule, as in fig. 10.

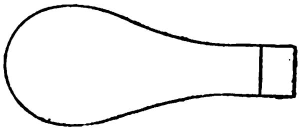


Fig. 8.—Small Handle.

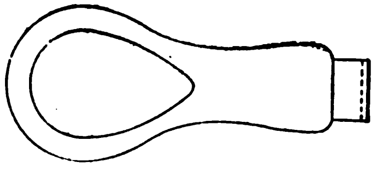


Fig. 9.—Screw-driver Handle.

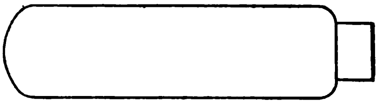


Fig. 10.—Straight Handle.

Besides the above, all of which will be found very useful practice for beginners at the lathe, not to speak of their necessity in rigging up the amateur's tool kit,there are a thousand and one little turned articles that he may practice upon, such as a foot off a bird's cage or work box, a patera or button off a piece of furniture, a knob off a drawer, etc. Again, among children's toys and playthings there are numerous objects of the simplest nature in turnery, such as a boy's tow gun—which is a wooden tube with a ramrod—a spinning top, or handles for a girl's skipping rope. Indeed there is no end of objects to meet the wishes and draw out the genius of the youth who has come into possession of a lathe and is panting to turn out some splendid examples of his skill in turnery.

Our next article will deal with some useful and ornamental articles in this art.

◆

Varnish for Foundry Patterns and Machinery.—A varnish has been patented in Germany for the above purpose, which, it is claimed, dries as soon as put on, gives the patterns a smooth surface, thus insuring an easy slip out of the mould, and which prevents them from warping, shrinking, or swelling, and is quite impervious to moisture. This varnish is prepared in the following manner: Thirty pounds of shellac, 10 pounds of Manila copal, and 10 pounds of Zanzibar copal are placed in a vessel, which is heated externally by steam, and stirred during four to six hours, after which 150 parts of the finest potato spirit are added, and the whole heated during four hours to 87° C. This liquid is dyed by the addition of orange colour, and can then be used for painting the patterns. When used for painting and glazing machinery, it consists of 35 pounds of shellac, 5 pounds of Manila copal, 10 pounds of Zanzibar copal, and 150 pounds of spirit.

Etching Liquid for Steel.—Mix 1 oz. sulphate of copper, ½ oz. of alum, and ½ a tea-spoonful of salt reduced to powder, with 1 gill of vinegar and 20 drops of nitric acid. This liquid may be used for either eating deeply into the metal or for imparting a beautiful frosted appearance to the surface, according to the time it is allowed to act. Cover the parts you wish to protect from its influence with beeswax, tallow, or some similar substance.

MODEL ENGINE CONSTRUCTION.

By. G. SUMNER.

PART II.

HAVING got the boiler finished, the next thing will be to make the working parts, commencing with the cylinder. A special casting will be required for this class of engine, having feet to fit on the boiler; but for those who do not care to make a pattern, the cylinders sold at model shops will do very well, as the feet can be made from brass rod, bent into shape to fit the boiler, and screwed to the flanges of cylinder. The cylinder illustrated is full size. It will be seen that the steam ports are near the end of cylinder, and that they can be made easily by drilling two or three holes 1/16, and chipping out with a small chisel, afterwards filed with a small flat file; they are 1/16 wide and 1/4 long. The exhaust passage is bored from the under side of the cylinder, and face of steam chest chipped as shown; the hole on the under side tapped with a fine thread to take 1/8in. brass tube, which must be made into an elbow.

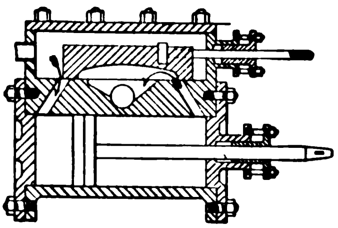


FIG. 4.
SECTION OF CYLINDER.

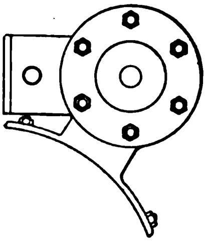


FIG. 5.
END OF CYLINDER.

Boring the cylinder is often a difficult job to accomplish by an amateur, unless he has had some experience at the lathe. There are several ways in which it can be done. First, by fixing the cylinder on an angle plate on the face-plate of lathe, with a clasp and two bolts; by placing the cylinder face next the angle plate it can be firmly secured, and at the same time easily centred; after being set true it can be bored out with a side tool fixed in the slide-rest, but this method requires skill in order to get the bore parallel. It can be done very well with a flat drill turned on the edges, and two pieces of half-round wood screwed on to it; the drill should then be turned parallel and size of bore, which is 3/4in.; the two pieces of wood can be removed, and the drill-point (which is made in same shape as an ordinary drill) hardened and tempered; the wood must then be put on the drill again. By holding this drill with a hooked spanner, and feeding up very carefully with back centre of lathe, a good bore can be got. The cylinder should then be placed on a perfectly true mandrel, and the flanges turned and faced up at one chucking.

The valve face of cylinder must be trued up and made perfectly parallel with the cylinder bore. To do this place it on a surface plate, and with the scribing block try which end of the cylinder flanges is the highest, and file it down till the scribing gauge shows that it is true with the bore. Having got the valve face so far straight, it must be scraped up to a true surface. Rub a little thin red lead and oil mixed on the surface plate; and by trying the face of cylinder, the lead will show the highest parts, which must be scraped down with a scraper made flat—almost like a chisel, but square at the end—which may be 1/2in. wide and 1/8in. thick. After taking off the highest parts with this it must again be tried on the surface plate until brought up to a true surface; the scraper must be lightly used towards the last. The slide valve must be got true in the same way: it is 1 3/16in. lcng, 3/8in. thick, and 1/2in. broad. The steam chest is 7/8in. deep over all, and the same depth inside as the valve, only just enough space left so that the valve will slide free, the length being 1 3/4in., and 1/2in. wide: it must be centred for the valve rod on the surface plate with the scribing block, so that the valve rod may be dead level with the piston rod. The steam chest can then be chucked on the lathe by the angle plate, and the stuffing box and face turned up true; the rest part must be filed up square. The back cover of steam chest can be made from a piece of sheet brass 1/16in. thick.

The steam chest and cover are secured to the cylinder by eight studs of nuts 1/16in. thick. The holes for these studs must be carefully marked and drilled, in order to get the steam chest true. The best way would be to fit one stud first, then set the steam chest true, and mark all the holes. The valve rod is 1/16in. thick, made from steel wire. A round nut is fitted on one end: this fits in a groove cut in valve, the other end screwed to take the joint for eccentric rod. The cylinder cover should be bored out for piston rod and gland, then placed on a true mandrel and turned up. The spigot part of the cover must be a good fit in the cylinder: by turning the covers on a true mandrel they can be removed from the lathe any number of times to try their fit, and replaced without fear of them being untrue. The back cover, or bottom, must have a hole drilled in the centre, and a mandrel screwed in, when it can be turned on both sides without removing. This hole will also do for the tallow cock. The glands must be drilled and turned in the same manner: they will not require filing oval, they must be left round, and same size as stuffing boxes. They are forced in by two studs, one on each side.

The piston rod can be made from a piece of steel rod, and is 1/8in. thick and 2 1/2in. long. It must be truly centred and made quite straight; one end is turned taper a 1/4in. from the end, and screwed. The other end is slightly tapered to fit into cross head, and a key-way cut through it: a small hole can be drilled, and then filed oval shape with a small round file.

The piston head is in two parts, and can be made from sheet brass: one must have a taper hole bored to fit the rod, the other half is made to answer the purpose of a nut. Having fitted and turned up the faces they may be fixed on the rod; the half that is for the nut must have two holes drilled in the back so that a fork screw turner can be used to screw up the piston; it can then be turned on the rod the exact size of cylinder bore, and the groove turned out for packing rings 3/16in. The rings can be cut from brass tube and made so that the two can pass in the groove of piston head. The rings at this stage must be larger than the bore of cylinder, about 1/16in. A diagonal cut should be made in each ring; they must then be placed in the piston and pressed together until the cuts are close up, then turned until they will just go in the cylinder. The rings must be ground down so that they will be free to expand when the piston plates are screwed together.

The slide bars are 1/4in. thick and 2 1/4in. long, turned down at each end to 1/8in. thick, and screwed. One end is screwed into the cylinder cover, the other passes through the guide column and is fitted with a nut. To set out the bars the cylinder must be placed on the surface plate—the steam chest side down—and with a scribing block draw a line across cylinder cover, passing through the centre of piston rod. The width between bars from centres is 1 1/8in.

The cross-head is made from steel, and must be fitted to the bars after they are fixed to the cover of cylinder and guide column. The end that the cross-head pins passes through has an oval shaped hole formed, and into this is fitted a pair of brasses, which are set up, as required, by a set-screw. The hole that takes the piston rod is made taper, and a key passes through it and the rod. In making the keyway, it must be so formed that the key, when driven in, will have a tendency to draw the rod into the cross-head.

The guide-column can be made from sheet brass, ¼in. thick. It also forms a stand for the governor, as well as being the support for slide bars. It is cut out so that it fits like a saddle on the boiler, and is screwed to it. Care must be taken to leave plenty of metal on this part, and also on cylinder feet, so that they can be filed, if necessary, when the process of erecting commences.

The connecting-rod, crank, etc., will be explained in a future number.

Wood Finish.—Richness of effect may be gained in decorative wood-work by using woods of different tone, such as amaranth and amboyna, by inlaying and veneering. The Hungarian ash and French walnut afford excellent veneers, especially the burs or gnarls. A few useful notes on the subject are given by a recent American authority. In varnishing, the varnishes used can be toned down to match the wood, or be made to darken it, by the addition of colouring matters. The patented preparations known as wood fillers are prepared in different colours for the purpose of preparing the surface of wood previous to the varnishing. They fill up the pores of the wood, rendering the surface hard and smooth. For polishing mahogany, walnut, etc., the following is recommended: Dissolve beeswax by heat in spirits of turpentine until the mixture becomes viscid: then apply by a clean cloth, and rub thoroughly with a flannel or cloth. A common mode of polishing mahogany is by rubbing it first with linseed oil, and then holding trimmings or shavings of the same material against the work in the lathe. Glass paper followed by rubbing also gives a good lustre. There are various means of toning or darkening woods for decorative effect. Logwood, lime, brown soft soap, dyed oil, sulphate of iron, nitrate of silver exposed to the sun's rays, carbonate of soda, bichromate and permanganate of potash, and other alkaline preparations are used for darkening the wood; the last three are specially recommended. The solution is applied by dissolving one ounce of the alkali in two gills of boiling water, diluted to the required tone. The surface is saturated with a sponge or flannel, and immediately dried with soft rags. The carbonate is used for dark woods. Oil tinged with rose madder may be applied to hard woods like birch, and a red oil is prepared from soaked alkanet root in linseed oil. The grain of yellow pine can be brought out by two or three coats of Japan much diluted with turpentine, and afterwards oiled and rubbed. To give mahogany the appearance of age, lime water used before oiling is a good plan. In staining wood, the best and most transparent effect is obtained by repeated light coats of the same. For oak stain a strong solution of oxalic acid is employed; for mahogany, dilute nitrous acid. A primary coat, or a coat of wood fillers, is advantageous. For mahogany stains the following are given: 2 oz. of dragon's blood dissolved in one quart of rectified spirits of wine, well shaken; or raw sienna in beer, with burnt sienna to give the required tone; for darker stains boil half a pound of madder and 2 oz. of logwood chips in one gallon of water, and brush the decoction while hot over the wood. When dry, paint with a solution of 2 oz. of potash in one quart of water. A solution of permanganate of potash forms a rapid and excellent brown stain.

SMITHING AND FORGING.

By J. L. Lowe, Brentford.

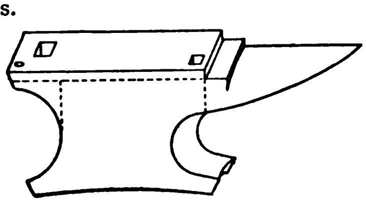
CHAPTER I.

IN the art of the ironworker the most important element is percussion. The mere weight or pressure of several tons would fail to produce the impression which can be made by a hammer whose weight is but an ounce, and that hammer wielded by the hand of a tiny child.

The apprentice smith is sometimes puzzled with the query—"Which was Tubal Càin's first job, hammer or tongs?" and there are but few first-class workmen who can finally answer it now. Whatever may be the correct reply to the last question, we are sure that he or his successors can do very little without an anvil; so we will commence our researches by considering this, one of the most indispensable of tools required by the children of Vulcan.

It can hardly be too heavy, for while heavy work cannot possibly be formed on a light anvil, the lightest work may very readily be forged on a heavy one. Three to four hundredweight is a fair average, and where real work has to be done it should never weigh less than two, and may with advantage weigh five.

The first and best test of quality is by ringing or tapping with a hammer; if the face, tail, and beck are soundly welded on to the body it will give out that clear, ringing, bell-like sound which is music in the ear of every true man, whether it be heard morning, noon, or night. The sound has inspired Handel and Longfellow, as well as other musicians and poets.



Smith's Anvil.

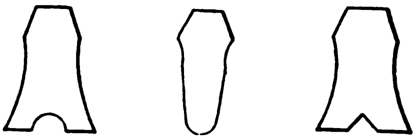
The form of the anvil is shown by the engraving. Most smiths prefer to work with the tail end to the right hand. The square end is the tail, the horn projecting at the other end being the beck iron.

A square hole, from 1⅛in. to 2½in. each way, is punched through the tail end, and is used for holding chisels for cutting hot iron and for bottom tools, or swages, drawings of some of which, together with their corresponding top tools, samples of the work produced with them, and a rod chisel are shown below. The rod by which the chisel is held is osier or withy, and all top tools should be held in the same way. The fibrous wood is preferable to an iron rod, as it absorbs percussion when the tool is struck with the sledge hammer, and prevents the unpleasant vibration experienced in the hand of the smith from the effects of a series of heavy and rapid blows on the head of the tool.

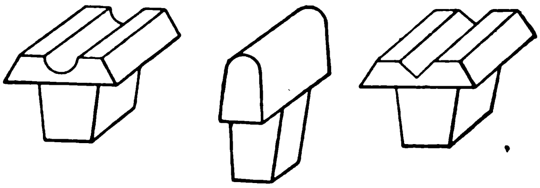
In addition to the large square hole in the tail of the anvil there is frequently one, and sometimes two others; if but one it is circular, from ⅝in. x 1in. diameter, and if two the second is of the same size, but square; they are used as bolsters, for punching holes through iron.

The very best anvils have a portion of the inside edge rounded off with about ¼in. radius, to prevent crippling or galling the iron when taking down a shoulder on the anvil edge.

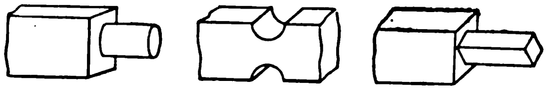
The next tool to be noticed is the hand hammer, and here the difference between the careful and careless workman tells with effect, inasmuch as a



Top Tools.

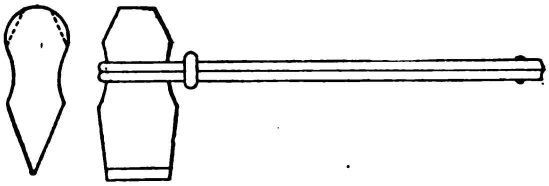


Bottom Tools.



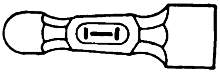
Work Produced.

(Rounding) (Fulling.) (Squaring.)



Rod Chisel.

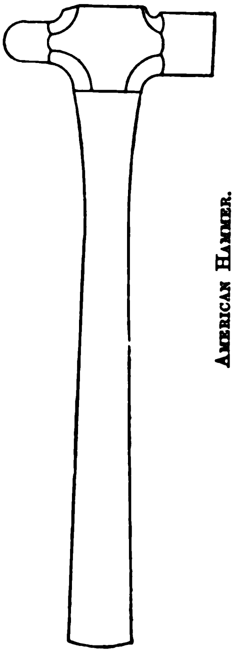
solid cast steel hammer will do double the work and last ten times as long as an iron hammer with a steel face, but if used by the latter would most likely fly in two pieces before he had used it a week. The class of work in hand will, of course, determine both form and weight of hammer. A very beautiful specimen of solid cast steel hammer, with handle of whiteheart hickory, of American manufacture, in the possession of the writer, is shown in the drawing; it is handled with the utmost precision, and if used for heavy chipping may be used for an indefinite time without fatigue.



Heavy work necessitates the assistance of a hammerman, who, using a sledge hammer with a handle from 42in. to 48in. in length, and standing in front of the anvil, strikes alternate blows with the smith, who uses his hand hammer, in that case, more to indicate the position to the hammerman of the next blow than with a view of largely assisting in the formation of the work.

Light work does not require the assistance of a hammerman, the very heaviest work necessitating the lightest hammer, for the reason given above; while if the smith works single-handed, and has to do the whole of the work himself, he will naturally require a much heavier one.

Our next chapter will treat of the general arrangement of a smith's shop, the requisite tools, and give an example of the manipulatory processes of forging a lathe carrier, or dog.



American Hammer.

SCREW MAKING BY MACHINERY.

THE various tiny screws used in watchwork are made entirely by machinery, and considerable ingenuity has been brought to bear on the designing and construction of the present perfected system. The American machine-made watches have every available part screwed together, instead of using pins, which are generally found in English-made watches. Even the brass "steady pins," which project from the seating of the cocks, and fit into holes drilled in the plates, like "dowel pins" in cabinet work, are screwed in their fixed places in American watches, and would, therefore, be more correctly denominated "steady screws"—in fact, to such an extent has modern improvement availed itself of this method of uniting certain parts in close and firm contact that in many modern watches the screw has totally superseded the pin, which is only used for pinning the hairspring to its stud and collet. Sir Joseph Whitworth says of the screw:—"Among all the applications of mechanics there is, perhaps, no instance of adaptation more remarkable. The ease with which distinct parts of machinery can be united, the firmness with which they are held together, and the facility with which they may be separated, are conditions of the utmost importance, which by no other contrivance could be combined in an equal degree."

Before making screws it is necessary to determine the size, rate, and shape of thread best adapted to the requirements of the particular purpose for which the screw is intended. Those which have to withstand the greatest amount of strain—as the cock, pillar, and case screws—must have a thread sufficiently large and coarse to insure there being no danger of their stripping or being overturned by use. Those which sustain but little strain, and require, possibly, nice adjustment to position, will allow and require finer threads; the jewel screws and balance screws are of this class. To those not in the habit of using watch screws, a statement of their size and rate will probably appear incredible; for rate, the usual limit, in practice, is from 100 to 200 turns per inch; and, for diameter, from about one-twentieth of an inch down to infinitesimal measurement. Size and shape, rate, &c., of thread having been decided on, standard gauges of hardened steel are made, and the productions of the machine are subjected to verification, as circumstances may require. The taps and dies used must, of course, coincide with these gauges, and, being in constant use, they must wear and deteriorate; this fact shows itself on the work produced, and hence the necessity for frequent examination and comparison with the gauge.

All screw-making lathes have hollow mandrels bored through to allow the stick of wire from which the screws are made to pass inside; they are fitted with split chucks suited to grip the various sizes of wire used; this is, in length, of a foot or so, quite straight, and bright outside, the size being selected to gauge just a trifle more than the diameter of the heads of the screws to be made. Besides the usual driving pulley, the mandrel has fixed on it another, over which a band passes within easy reach of the operator, who, by a pull, reverses the motion of the lathe when the thread has to be cut on the blank. The usual motion of the lathe is the reverse to the ordinary way—that is to say, the work runs *from* the operator—and it is by means of a pull with the hand that the workman rotates the lathe in the reverse direction for running the blank screw into the die; he is thereby enabled to feel, with great accuracy and precision, the moment when the head of the screw comes to the shoulder, and check the motion in time to prevent the thread being twisted off. The several operations, so tedious to describe, are performed with such rapidity, in practice, that it necessitates the utmost vigilance on the part of an onlooker to detect the different changes, and declare exactly when a screw is begun and when completed.

To describe the various cutters and special contrivances used in making these screws, a few woodcuts are necessary to render the description intelligible, and I therefore proceed with fig. 1. This represents the poppet headstock, as adapted for screw cutting; it is very unlike our usual back centre, which is accounted for by the very different purpose for which it has to serve. The piece forming the headstock is a casting, which fits on to the lathe bed, but it will be seen that it is not so high as the line of centres; the three round holes are bored out in a separate piece, which swings on a bolt, the hexagon head of which is shown. Opposite the holes are notches, into which a strong stop slips, and firmly fixes the respective holes exactly in the line of centres. Into each of these holes is fitted a cutter, shaped to perform some special detail in the process of making the screw; of course the swinging piece is fitted to turn without shake, and each hole is bored true with the axis of rotation. The three cutters are shown at figs. 2, 3, and 4, being the left-hand end portions of each of the figures, the piece to the left in each being the split chucks with the steel wire projecting.

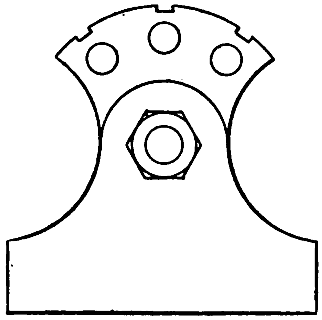


FIG. 1.

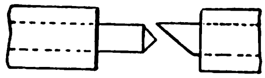


FIG. 2.

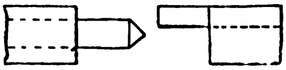


FIG. 3.

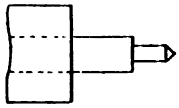


FIG. 4.

The *modus operandi* is first to push the wire through the jaws of the chuck sufficiently to allow a screw to be made of the part projecting, or, more correctly, a trifle over the length absolutely necessary is wanted to insure each screw being of the full length. The cutter shown at fig. 2 is then brought opposite the lathe centre, and advanced against the steel, as it revolves, towards the cutter, of course; fig. 2 shows the broken end of the steel, and fig. 3 shows the effect of the cutter—viz., it points the wire, and being arranged, like all the others, to work up to a stop, it reduces the projecting wire to a fixed amount, and thus determines the length of the screw; this cutter is merely the round wire filed off to its diametrical line, and then pointed at an angle of about 45° (see fig. 2.) The second cutter (fig. 3) is then swung over into its working position; and, on being pushed forward, it cuts down the part which is to receive the thread; fig. 4 shows the effect. This cutter is like a projecting tooth, sharpened at the end, and, of course, cuts a flat shoulder to the screw, being stopped, when it has performed its determined amount of work, by the same sort of stop as used for the first cutter. The blank is now ready for screwing. Swing round the die (fig. 5), and advance it towards the screw, at the same time taking hold of the hand band, and thus reversing the motion of the lathe. When the shoulder is reached the motion must cease, or the screw thread would be twisted off, and, remaining in the die, would occasion the loss of a lot of time in removing the broken piece; however, an exquisitely delicate sense of touch is cultivated by the operator, and it is very seldom that such an accident occurs.

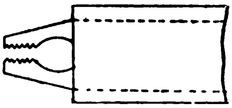


FIG. 5.

When one sees the usual accumulation of screw plates lying amongst the watch jobber's tools, with most of the useful holes plugged up with broken pieces of screw threads, reflection is apt to suggest either lamentable carelessness or ignorance of the cause of the screws breaking in the plate holes. The usual screw plates used by watchmakers have no cutting edges at all, the thread being simply jammed up instead of being cut out, and the indentation of the screw blank by the interior edge of the plate raises the adjacent metal to fill up the full thread, consequently the diameter of the blank must be a mean between the diameters of the bottom and top of the thread; the breaking off of the threads in the screw plate will be of very rare occurrence if the correct size of blank is used. Those people who employ such machines as I am now describing would not be likely to tolerate such ill-contrived tools as are the common screw plates, and we find that a properly-shaped die, having cutting edges like other tools used for cutting metal, is used, and this not only produces a more nearly perfect screw by cutting out a clean chip of metal, but does so with far less torsional strain on the blank—a matter of no small consideration in making screws by machinery.

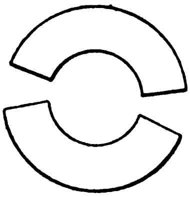


FIG. 6.

The illustration fig. 6 shows an end view of the die, being a vertical cross section; the radial cuts form two cutting edges, which act perfectly, and produce a screw thread equal to one cut by movable dies in a die stock; if it should happen, through carelessness or accident, that a screw blank gets twisted off, and is left in the die, the broken screw has to be slitted, by means of a hand file, through the diametrical opening in the die, and the piece is then driven right through with a screwdriver till it drops through the enlargement at the back part of the slit, shown at the right of fig. 4. When the die has been successfully run up to the shoulder of the blank, the lathe is immediately reversed, and the die withdrawn, leaving the thread part of the screw quite finished. The completed screw must now be cut off the rod, and for this purpose a cutting-off tool, as shown at fig. 7, which is fixed to an arm swinging from the back of the headstock, and regulated by a stop, is brought up, and cuts the screw nearly off, just behind the head; it must not be completely severed, however, as that would entail considerable extra trouble; the stop before mentioned will enable the cutter to be set to the proper depth.

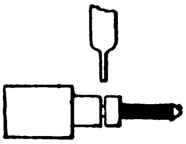


FIG. 7.

We now come to an important adjunct peculiar to screw-making, called the slitting disc, and illustrated at fig. 8; it is merely two discs of steel turned up perfectly true, say about 1¼in. diameter, one being fixed to an arbor, and the other clamped against it by the nut shown on the left side. The line of junction must run perfectly true, and round it are drilled a number of holes as near together as the screw heads will allow; these holes are all tapped to take one particular size of screw, perhaps fifty or a hundred being the complement. This disc is used in a lathe, and has a very slow revolving motion, whilst the circular saw (fig 8) rotates at a high speed, and cuts a "nick" in the head of each screw head as it passes; all the screws being nicked, they are taken out of the disc very quickly, by loosening the nut, and, on separating the two discs slightly, the screws fall out. Having the screw completed, and nearly cut off, as before described, the operator takes the slitting disc, which is screwed tightly together, and brings one of its screw holes to the point of the screw, which is run in right up to its shoulder, and then broken off where deeply notched by the cutting-off tool; this is repeated till all the holes in the periphery are filled, and the screws are then ready to be slitted as described. So far completed, the screws are ready for the market, being hardened, tempered, polished, blued, &c., by the watch jobber, as the nature of the job may require.

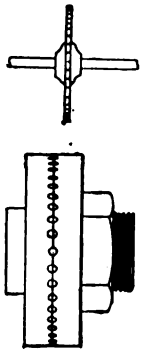


FIG. 8.

When the screws are being made for new work, all being required of a definite gauge, the heads are made to an absolutely accurate diameter, so that they will fill the recessed countersunk holes in which they will go—as the jewel screws, cock screws, and such. For this purpose a chuck (fig. 9) is used; the projecting arbor is made of steel, hardened and polished, and of the exact diameter that the head of the screw should be; the end of this arbor is drilled up and tapped to suit the particular size of screw which it is used for. At the point of fig. 9 will be seen the head of the screw, the diameter of which is just the same as that of the wire from which it was made, still in the condition of the drawn wire, no attention having thus far been given to finishing the screw head. A screw is run into the point, as shown in the cut, and the superfluous metal is taken off by filing, until the sides of the screw head are brought down to a level with the arbor, which forms the gauge. After being filed down to size, the screw head is burnished on the sides and top; this may be made rounding, or flat, as required, each screw being turned out exactly alike.

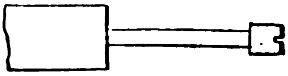


FIG. 9.

There are two methods of polishing those screws having flat heads; small ones are run into the chuck, and ground flat by a piece of Arkansas stone moved to and fro whilst the screw is revolving rapidly. The top of the screw head is polished in the same manner by a strip of lignum vitæ charged with polishing material and oil.

Another method is adopted for screws having large heads, such as pillar screws and cock screws; flat discs of steel are provided, about 2in. in diameter, the entire surface being pierced with holes as near together as possible, and each hole is tapped to take a screw. The disc is filled with screws, run in right up to the shoulder, and is then held against a revolving lap charged with emery, which reduces the heads to a uniform level, and makes them perfectly flat. After being ground down, the disc is cleaned from all traces of emery, and the screw heads are then held against another lap, which is charged with glassing powder, and rapidly polishes the whole lot of screws; these are then removed from the disc by a little machine, which is a screw-driver, run by an endless band, which passes round the pulley, and capable of up-and-down motion, by pressing the button on the top of the screw-driver shaft, a spiral spring effecting the return motion. This little machine very much resembles an upright driller, in miniature; the top button is, of course, only riveted on loosely, so that it does not revolve when the finger is applied to press the spindle down. The method of using this screw-driving machine is obvious: the disc full of screws is placed on the flat part just beneath the screw-driver, which is revolving rapidly, in the *unscrewing* direction, the spindle is brought down by pressure on the button, the disc adjusted to bring a screwhead exactly under the driver, and the instant it gets into the slit the screw is withdrawn; so quickly is this operation carried out that it is scarcely possible to follow the motions of the hand. The points of the screws are stoned up, and, in some cases, polished by seizing them, one at a time, by the head in the jaws of a chuck constructed specially for each particular size.

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A Polish for Fine Carved Work.—Half-pint linseed oil, half-pint of old ale, the white of an egg, 1 oz. spirits of wine, 1 oz. spirits of salts; well shake before using. A little to be applied to the face of soft linen pad, and lightly rubbed for a minute or two over the article to be restored, which must afterwards be polished off with old silk handkerchief. This will keep any length of time if well corked. This polish is useful for delicate cabinet work; it is also recommended for papier mâché work.

PARTING TOOLS FOR METAL.

MR. FRANK H. RICHARDS, writing to the "American Machinist," says:—Of course every machinist who knows how to run a lathe knows, as the first essential, how to make and keep his tools just right. Of course, he who knows how to keep his tools just right, does so keep them. Does he? Look over a few tool boards and express your opinion with caution.

I think there is no tool upon the board which will serve as a better gauge of the workman's status than a parting tool. A perfect parting tool, capable of cutting cleanly, truly and freely, to profoundest depths, is an instrument to be admired. There is something about the operation of a cutting-off tool that has always been a mystery to me. It is that a tool made with proper clearance, and hard enough to keep its corners sharp, cuts enough wider than itself to leave it perfectly free. This may be seen on the planer where a square-nosed tool, if working well, will not lift out of the cut as the work runs back. The traditional and notorious perversity of things which the mechanic does battle against at every step of his progress seems to fail here, and the failure is greatly to the advantage of the metal-working community.

Why a square-nosed tool does not jam in the groove that it cuts, but cuts wider than itself enough to make it perfectly free, is one of those things that I would be glad to have explained to me.

A good parting tool is incontrovertible evidence of more than one most desirable quality in its possessor.

It implies first, actual knowledge of the requirements of a good tool, the best shape for cutting, the right pitch and clearance, and temper. Secondly, as the tool in its preparation, even with all knowledge at command, requires some care and labour, and takes some time, it shows a habit of determined, intelligent and careful industry. Thirdly, and I think this not less important than the other particulars, it shows in the care and management of it the ability to "make haste slowly" by so grinding and using the tool that it will serve well for many future jobs besides the one in hand. If we go along thinking each job our last, we may grind the tool just for that, and after two or three grindings have to run to the blacksmith with it, and that is not good practice.

A man who is an enthusiast in his calling comes to have a respect, and even a kind of affection, for the tools whereby his successes are achieved. It touches his heart and raises his ire to have one of them abused; he could not abuse it himself; he likes well enough, though, to try its metal and put it to the proof.

Trusty is the crowning adjective for the instruments of human achievement. The trusty steed, the trusty blade and the trusty rifle, are historic. The trusty tool of the machinist is on the board of the expert workman, and it is not the tool that goes oftenest to the tool-dresser.

Tool-dressers are usually accommodating individuals; if one is not he is out of his place. I have never had any difficulty in getting what I wanted from him. Still, however kind and social he may be, I cannot recommend him for a frequent companion, nor as a rule does he desire the company of those who most persistently seek him. A prime objection to unnecessary redressing of lathe tools is that frequent re-heating impairs the steel, and besides that the temper of tools is a matter of considerable uncertainty.

The most expert and reliable tool-dresser cannot always temper tools alike, and when the temper of a tool is found to be just right, it should be kept in use as long as possible. I would very much rather have a tool a little too hard than too soft; then if it is found to break off at the edge, provided that it has not been over-heated, grinding back once or twice leaves a very reliable and lasting tool.

While a good parting tool does its work admirably, it is very exacting as to its conditions. It insists upon them imperatively, and will not accept compromises as other tools will. No tool upon the board will work so poorly if it is not right in itself and also rightly set.

The essentials of a good parting tool are several. The cutting edge must always be the widest part of the tool in the cut. There must be clearance both backward and downward. This clearance, while absolute in both directions, should not be great. If the tool is to cut to a great depth it should narrow only for a short distance back and then continue straight, as if made a straight taper all the way back to the root it would be too thin and weak, and be apt to break off. Clearance is as necessary to the tool downwards as backwards, but it is as essential that it be equal on both sides. And here I may note that it has actually been discovered that tool steel as it comes in the bar is not absolutely rectangular. Each side is more or less curved, the edges especially being high in the middle, and then it is rhomboidal. It leans over when you screw it up in the tool-post. Where is your equal vertical clearance then?

There have been about half a dozen machinists in the United States who at one time or another have been known to true the bottom edges of their tools so that they would stand upright in the tool-post. There was never a manufacturer of tool steel who thought it worth while to make true steel, and I am afraid many a tool-dresser, who shapes ever so carefully the point of a tool, would feel rather insulted if it was intimated to him that he had anything to do with truing the body of it.

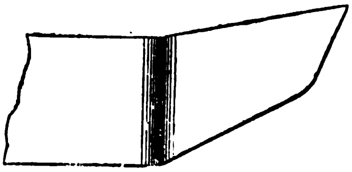

Fig. 1.

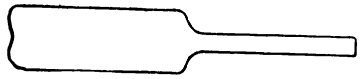

Fig. 2.

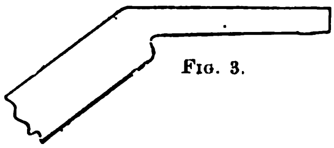

Fig. 3.

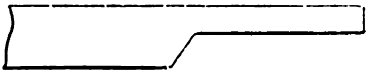

Fig. 4.

I offer fig. 1 as a profile of a parting tool. It may be straight like fig. 2 or bent like fig. 3. If a straight tool is wanted I would have it in the middle of the steel, and not at the side as fig. 4. Still, there may be peculiarities about a piece of work, or even something about your tool-post—don't ask me to imagine what—which make fig. 4 the best. The reason for having the tool in the middle of the steel is that with that form the clearance is more likely to be equal at the sides than with the other. When the tool is forged it is a good practice to true up the sides with a file, or, which is much better, with a good emery wheel before hardening. With the bent tool this initial grinding, especially of the inner side, is very necessary, as it is impossible to grind it upon the average grindstone.

It is barbarous to use a square-nosed tool just as it comes from the forge, without truing and polishing the sides of it by some means or other. The top of the tool should be level across. In the profile which I give the pitch of the top backwards is 10°. This may vary with the material it is used upon, but is a good average and would work well in anything but brass. The front edge of the tool must be straight and square; the projection of one corner in advance of the other would tend to deflect the tool to that side as it advanced into the cut. I have drawn the front at 60° to the top, which I think gives rather more clearance than is desirable for large work. This clearance will vary with the diameter of the piece operated upon. With a large diameter the tool, to retain the same cut, advances into the work at a less angle, and consequently requires less clearance than when working at a smaller diameter. Probably many men have noticed that in cutting off anything it requires actually and perceptibly more force to push the tool into the work as they get nearer the centre.

When the tool is ready for use the last touch of the grindstone should be upon the front or cutting edge of the tool. Don't touch the sides last, as you remove an imperceptible burr, which helps to give clearance to the tool. Also in finishing the edge, it makes quite a difference, as to the lasting quality of it, in which direction the grindstone runs. Some still think this a notion, but I have satisfied myself of it by experience, and there are plenty who stand with me. The tool being upright in front of the grindstone, in its natural position as in the lathe, the face of the stone should turn downward toward it, and not upward and away from it. This of course applies only to the last touch of the grindstone upon the cutting edge, and the "finish" thereby imparted.

A tool like fig. 1, if set in the tool-post perfectly true, with the cutting edge just the height of the centre, may be fed right in to the centre and cut right all the way. Without an elevating tool-post it is not an easy thing to set a cutting-off tool just to the height of the centre, or any other tool to any other desired elevation, and why tool makers will build, and proprietors of shops will buy small or medium sized lathes without means of raising and lowering the tool, is one of those things which they who run the lathes perpetually wonder at.

It is not customary for the tool-dresser to raise the point of the tool as I have it in fig. 1, because he finds that the average machinist will accept a tool with a flat top like fig. 5. If ground well and set as high as possible, this tool will cut pretty well. Of course, it cannot be fed in to the centre without lowering. When the point of the tool is found to be worn, though generally he waits until it is very badly worn and like a balky horse won't go any further, our machinist takes it to the grindstone, and, being industrious, he grinds it in a hurry, and, being a fellow of common sense, he of course grinds it where it is worn. This rounds off the top and squares up the front, and then we have fig. 6. This tool might be reshaped on the emery wheel to the dotted lines, and would do good service, but it would have to be reshaped by another man. He who brought it to that shape was never since the world began known to so reshape it. His next move is to grind the circular notch in the front like fig. 7.

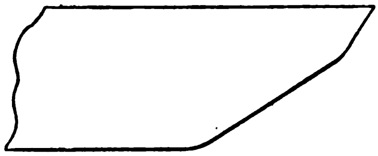

FIG. 5.

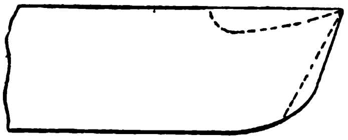

FIG. 6.

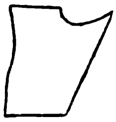

FIG. 7.

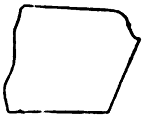

FIG. 8.

This is the tool-dresser's mortgage, and should be so recognised all through the trade. The inevitable forclosure occurs when the tool comes to about the shape of fig. 8, which is a sketch from life as accurate as my pencil can produce.

As a general rule, applying to all the forms of lathe tools I now think of except the diamond point, I would say keep the tops of your tools sacred. The grinding to make up for the wear that occurs should be almost entirely at the front of the tool, with only the slightest occasional touch at the top.

It is exasperating to look over a lot of tools and note how few men apparently realise, or care for, the necessity of having and preserving a good elevation to the point of a tool to give it an easy cut. If the grinding of tools were much more frequent, as soon as the least wear were discoverable, the tool would be found in the end to have done more and better and quicker work, and to have lasted longer.

The above are meant as hints of what may be said of a single tool upon the latheman's board. Any man of experience could doubtless add some valuable particulars. From the nature of its duty the actual performance of a parting tool—I mean any square-nosed tool cutting endwise into a groove—can be closely stated. The actual performance of a side tool, for instance, it would be difficult to measure.

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To Prevent the Dull Appearance of Shellac Varnish.—Any varnish made with alcohol will become dull in appearance by the evaporation of the spirits, which leaves water in excess in the varnish, as all alcohol contains water. To remedy this defect, procure a thin sheet of gelatine, cut it in strips, and put it into the varnish; it will absorb water leaving the spirits, thus making the varnish as good as new, and it can be used clear and bright to the last drop. The strips of gelatine may be removed when they become quite soft, and after being dried may be used again.

Malleable Bronze.—Dronier claims to have discovered a simple method of rendering bronze as malleable as copper, iron, etc. This consists in the addition of a very little mercury—½ to 2 per cent. It seems to act mechanically rather than chemically. The mercury may be combined with one of the metals of which bronze is made, before they are combined, by pouring it into the melted metal and stirring well, or it may be put into the melted copper along with tin, or just after the latter has been added, or an amalgam of tin is stirred into the melted copper.

FLUTED IVORY VASE.

BY GEORGE CALVERT CLARKE.

(For Illustration, see Lithograph Supplement.)

THE journal of the Amateur Mechanical Society contained a wood cut of the vase which we here illustrate by a photo-lithograph. General Clarke thus describes the method he adopted in making this graceful specimen of ornamental turnery.

The vase, of which an engraving is given here, seemed to meet with the approbation of many of the members of our society, who were present at the annual dinner; and perhaps some details connected with it may be useful to those who have not yet had much experience in turning.

The general outline is taken from an engraving of a cup in possession of the Corporation of Lynn, said by tradition, though no doubt erroneously, to have been presented to the town by King John. The engraving may be found in a work, published in 1851, by Cundall and Addey, Old Bond Street, called, "Choice Examples of Art Workmanship." My ivory vase, with its mere formal geometric ornamentation, is, of course, a very humble imitation of this beautiful cup, with its rich enamels, and its form moulded and chiselled by a skilful goldsmith; but still it bears some resemblance, though less than I could have wished, to the general shape of the original.

Having taken a tracing from the engraving, I examined my stock of ivory, to see on how large a scale I could attempt to produce my vase; for no doubt the larger such things can be made, the more effective is the result. Having ascertained the largest diameter I could give to the widest part of the vase, namely, the base or foot, I arranged a pair of proportional compasses in such a manner that, while the larger opening of the compasses gave me that diameter, the smaller opening agreed with the diameter of the corresponding part on my tracing. I then made, on paper, a kind of sectional elevation of the vase, to serve as a working drawing—measuring the diameter and height of each portion on the tracing with the smaller opening of the compasses, and by means of the larger opening, transferring the measurements on an enlarged scale to my working drawing. It mattered little that my working drawing had nothing artistic about it—all I wanted was such an outline as would enable me to see exactly the size of each portion of my work, and then, by using callipers for the diameter and a turning square or compasses for the length (making due allowance for the additional length required for the male screws to connect the various pieces), I could be sure of having everything in right proportion. And here I may remark how necessary it is, in executing any work composed of many pieces, to make a drawing, however rough, before commencing the work, and then to measure with instruments each piece while on the lathe, and not to trust to the eye, or the result will never be satisfactory. In this vase, as I made it, there are 27 pieces—22 in the cup, stem, foot, etc., and five in the cover. The various parts all screw into one another.

A few remarks about certain portions of the work may not be out of place. The foot is formed by cutting away circular discs, or portions of discs, from the ivory, which has been previously brought to shape and polished on the lathe, by means of the eccentric cutting frame, with a tool of this shape, which may be easily filed up from a suitable piece of flat bar steel, and tempered in the fire or in a spirit lamp. With such a tool, firmly fixed in a strong eccentric cutting frame, it is easy to cut through ivory of a quarter of an inch in thickness, but of course the tool must be advanced with care and not too rapidly, and must be allowed to penetrate until the point comes right through to the underside of the ivory, when the waste piece will drop quietly out.

The upper and lower portions of the enlarged bulb on the stem were both formed with a female screw, so that each in turn might take its place on the same chuck, in order that both might be cut with the same setting of the slide-rest, so as to be precisely similar. They were then connected by a short piece of boxwood, having a male screw cut on the whole of its length, the flat disc, with projecting teeth, being inserted between them. Of course the disc has a hole in its centre, through which the piece of boxwood passes.

The body of the cup itself was shaped and fluted by means of the "curvilinear apparatus," that is, a template, or sharper plate of stout sheet brass, fixed on standards above the slide-rest, against the edge of which a rubber, rising from the movable slide of the slide-rest, is forcibly pressed by means of the lever, while the tool or cutter is traversed along by a handle on the slide-rest screw. The tool, or cutter, moves in a path corresponding to the particular curve given to the edge of the template, instead of in a straight line, as in ordinary fluting.

One important point must be attended to in forming these templates. The rubber, or at least that portion of it which presses against the template, is the rounded edge of a piece of steel, perhaps the tenth of an inch, or less, in thickness, and may be considered as a mere point; and if the cutting portion of the tool is of the same shape, it will reproduce on the profile of the work the same curve as that of the template; but, in fluting with a flying cutter, working horizontally, it must be remembered that the revolving tool describes a circle of perhaps an inch in diameter, and, though the centre of that circle follows the same path as the rubbing point, its circumference is moving in a different curve altogether.

Probably the best way to overcome this difficulty is to use as a rubber, instead of a mere point, a small revolving horizontal wheel, of the same diameter as the circle described by the flying cutter, but if this cannot be conveniently had, the form of the template must be modified.

There is, however, still another point to be attended to. In my vase, the portion we are now considering is first brought nearly to the required form on the lathe, and finally shaped by a series of deep cuts, or flutes, produced by the flying cutter, whose point is of this pattern, these cuts being placed, by the dividing plate of the mandrel, at such a distance apart, that, at the widest portion of the work, they will just cut away the original surface of the material operated upon; but these cuts, as they approach the small end of the work, will be closer together, and cut away more of the material than required, and so cause the outline of the work, when completed, to be smaller than it should be towards its lower extremity. This, in fact, has been the case with my vase, in which the lower extremity of the cup itself is smaller in proportion than in the original drawing. This may be avoided by placing the template at an angle, with its right-hand end brought more forward towards the operator than the left. This will gradually withdraw the point of the cutter as it proceeds from left to right, and cause it to cut less deeply.

SURFACE GAUGES OR SCRIBING BLOCKS.

THESE may be classed amongst those tools which are easily made, and in constant use when at hand. A scribing block is seldom dispensed with in the amateur's workshop, excepting in cases where its very existence is unknown. These tools are made in an almost endless variety of shapes, according to the fancy of the designer, and it will be sufficient to illustrate three different styles; the details of either may be modified to suit tastes and requirements. There are so many and varied uses for this handy tool, that to attempt any details of its use would be tedious. A surface plate, or flat surface of some kind, such as the lathe bed or planer table, or even the wood-bench, is necessary on which to rest the scribing block while the point is being drawn along the work under operation.

Turning to the illustrations, fig. 1 shows the most simple form of block that it is possible to make combining utility. This block will bear any amount of hard knocks without injury; and for the purposes of a scribing block it can scarcely be surpassed for utility and handiness, even by those of the most costly and elaborate description. To make such a scribing block, procure a piece of hard wood—close grained mahogany will do capitally—and true it up very squarely on all the surfaces—a handy size is about 3in. x 2in. x 1½in. Then file out a pointer, rather pear-shaped, as shown, with a good large chamfered hole in the centre of the large end to take the head of a thick wood screw. This pointer must be made of sheet steel, and have all the edges rounded off, so that when screwed on to the block it will move freely; the point must be brought up nice and round, and be hardened and tempered. The pointer must be screwed on to the block, the hole for the screw being bored in such a place as to give the point command over all distances within the maximum limits. Thus, for a block of the size above named, the hole should be ½in. from the side to the left, and 1in. from the upper end. All four sides can be used for the base, and thus, with the pointer standing out at right angles to the perpendicular side of the block, we should get the following heights, with the different sides as bases:—With left, ½in.; with top, 1in.; with back, 1½in.; and with bottom, 2in.; and, allowing only ¼in. of angular movement for the pointer, all heights, from ¼in. to 2¼in., can be got. The pointer is adjusted by giving it a knock on the edge of a bench or other convenient place.

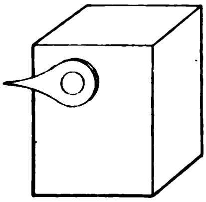
FIG. 1.

A block like fig. 1 should be found in all shops, to serve for rough work and save the more elaborate tool. It costs nothing for materials, and can be made by the merest tyro, whilst for efficacy it will bear favourable comparison with costly tools.

Fig. 2 shows a pattern commonly sold at the tool shops; it consists of a circular base with an upright of the shape shown usually cast solid; the slot down the upright received the squared end of the clamping screw—shown enlarged—allowing an up and down motion of about 2in.; two pointers, or needles, one straight and one hooked, are always on, and the one not wanted for use is left to drop out of the way when the milled head is slackened. This pattern, made in gun-metal, forms a fairly good specimen of workmanship, if got up with mouldings, &c., and the needles made from flat steel; but for utility it is not to be recommended.

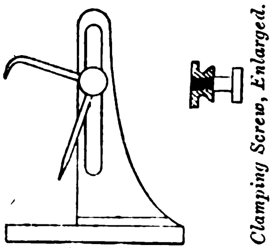

FIG. 2.

It may be somewhat improved by making the needles with long flats having slots in them, and so allowing the length of the projecting part to be altered to suit requirements. The base may be turned up true between the lathe centres, making a centre punch dot on the top of the upright, and one in the centre of the base. The upright itself and upper surface of the base is all hand filing, which is likely to test the patience and skill of the amateur. A brass or steel screw, with a milled head, will serve for the clamping screw; the points of the needles should be hardened and tempered for use.

Fig. 3 is one of the best sort of blocks; it is not very difficult to construct, though more complicated in details than either of the former ones; but, being correspondingly more handy in use, the extra labour is not thrown away. Full details are illustrated, to enable anyone to thoroughly comprehend its construction, and if so disposed to make a similar one for their own use, the job coming well within the scope of an amateur, being light, easy, and effective, whilst a certain amount of accuracy is required in fitting the collets on the clamping bolt.

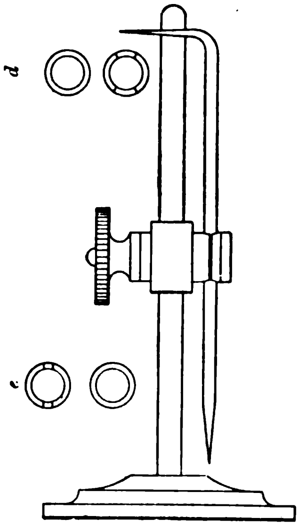

FIG. 3.

The upright pillar is a piece of round steel, and if a stick of "bright steel wire" is selected and carefully centred for turning the neck of the screw thread, which is tapped into the base, it will require no further treatment along its length, being sufficiently true and parallel for all the purposes intended. The thread must be run on straight, so that the rod will screw home square with the circular base. The length of this rod may be about 5in.—the elevation, fig. 3, may be scaled for verification of dimensions, the diameter about 3-16ths and a 64th. in., or 7-32nds.

The base is a circular gun-metal casting, about 2¼in diameter; it has a little fancy moulding turned on its upper side, the centre part into which the rod is tapped being fully ¼in. thick. This base has the bottom hollowed out, and stands on an outer circle about ¼in. wide only, which projects just above the level of the interior part. By this means a much better bearing is secured than if the bottom were made perfectly flat. Supposing the base and upright to be finished, we will now proceed with a description of the clamping arrangement. It is shown complete in the elevation. In fig. 4 it is shown at *a*. *B* is the bolt itself, showing the holes cut through it for the purpose of allowing angular adjustment of the needle; *c* shows the whole arrangement, being *a* shown in section *minus* the bolt, *b*; *d* is the collet, which goes on immediately before the milled head; *e* is one of the two collets, which are alike, between which the needle is clamped. See fig. 3.

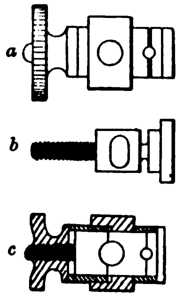

Fig. 4.

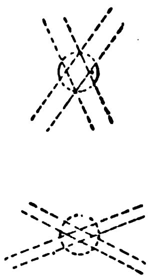

Fig. 5.

To make this part of the tool get a piece of gun-metal, or almost any other metal will do for the matter of that, a rectangular block about ⅝in. to ¾in. square, and ⅜in. thick. Bore a hole through it edgeways, just large enough to allow the rod to pass through; then centre one of the flat surfaces, and bore a hole through about ⅜in. diameter, to allow the bolt, *b*, to pass; this hole requires to be enlarged, for a length equal to about half the thickness of the block, to allow the collet, *d*, to go in and bear against the steel rod; the diameter of this recess should be full ½in. The block is now finished, all but filing up true and smooth.

Now make the bolt, *b*; good, sound, hard stick-brass is the material, or steel, fully ½in. diameter; ⅝in. stuff had best be used, to allow for truing up; turn down carefully to the shape and dimensions of fig. *b*, disregarding entirely the cross-cut mortise holes, which will have to be made subsequently. The thread for the milled head may be about 5/32nds. diameter; make the milled head to fit, and screw on and off easily; the head of this bolt need only be a 32nd or so thick. The collets or washers must now be made: bore up a piece of the ⅝ stick brass to fit the bolt, *b*, and cut off the collets with a parting tool, quite squarely, of the lengths shown, viz., two 5/32nds thick, and two ¼in. thick. The faces of these collets can be rubbed on a superfine flat file to make them quite even, so as to fit together exactly, and the whole of the parts may now be put together, and clamped tightly in their places, ready for drilling the transverse holes.

The hole for the needle must be drilled exactly on the dividing line of the two collars, and the hole must not be any larger than the needle itself; it should also be made truly across the diameter, and at right angles with the other hole for the rod. This hole must be drilled at the same time through the holes already bored in the rectangular block, which will serve as a guide for the drill. The diagrams, fig. 5, show the amount of side clearance to be given to each hole, to allow the requisite amount of up and down motion to the needle; the sketches show 90° of motion, but half that amount will be sufficient for all practical purposes. To cut out these holes to the shape, a round file may be used, or, what is better, the bolt may be readjusted to the correct position, and two fresh holes bored through, the intervening material being afterwards removed with a file. Of course it will be necessary to enlarge the diameter of these holes through the bolt, so that the rod and needle respectively will be quite free, excepting when clamped by the washers or collars when the milled head is tightened for that purpose. The method of making this clamping arrangement has been made clear, with the aid of the engraving.

The needle itself is made from a piece of bright steel wire about 4½in. long, both ends being nicely pointed, and one is, in addition, bent over at right angles, as shown on the upper part of fig. 3; the points are hardened and tempered, then ground up sharp on the oil stone. The straight point is used for scribing lines along the sides of work lying at right angles to the surface plate, the hooked end being for the purpose of reaching over the sides on to that part lying parallel with the surface, or for testing the relative thickness of a piece of material laid on the flat surface. In chucking a casting on the planing machine, it is handier to "level" the top surface by the aid of the hooked needle of the scriber than by continually testing with the planing tool fixed in its place—the same remarks apply equally well when mounting a piece of heavy work on the surface plate of the lathe for turning on the surface part. Put the surface chuck on the bench and place the work as nearly central as can be judged; then, by the aid of the hooked scribing point, test the upper surface for equidistance from the plate and pack up the "scant" parts, finally bolting the work home firm. This plan saves an infinity of time, for if the work has to be tested in the lathe there is the trouble of screwing on and off each time a correction has to be made, for if the bolts are slackened while the work is *en l'air* it is sure to drop out of centre. By the way, when scribing lines on iron always rub white chalk on those parts adjacent to where the lines will come, so that they (the lines) will show up well.

* * *

Staining Cherry in Imitation of Old Mahogany.—Digest logwood chips in vinegar or acetic acid for 24 hours or more. When ready to use, heat the solution, then dip the wood until the suitable colour is obtained.

To Prevent the Tarnishing of Silver Ware.—Silverware grows dark, and tarnishes in a very short time when exposed to the air, and even when put away in a dark place. This is especially the case where coal is used in the house, and the sulphur in the coal liberated by the heat is sure to stain all the silverware within reach. This tarnishing can be prevented by painting the silverware with a soft brush, dipped in alcohol in which some collodion has been dissolved. The liquid dries immediately, and forms a thin transparent, and absolutely invisible coating upon the silver, which completely protects it from the atmosphere. It can be removed at any time by dipping the article in hot water.

Black Dye for Wood.—First sponge the wood with a solution of chlorhydrate of aniline in water, to which a small quantity of copper chloride is added. Allow it to dry, and go over it with a solution of potassium bichromate. Repeat the process two or three times, and the wood will take a fine black colour, unaffected by light or chemicals.

HARDENING AND TEMPERING STEEL.

(From the "Blacksmith and Wheelwright.")

THERE are two distinct operations in the manipulation of steel in making tools, which require careful attention upon the part of the smith. The first of these is the hardening of steel. It is usually accomplished by heating the piece to a certain point and then plunging it suddenly into cold water. If this operation is properly performed the steel will become as hard as its peculiar quality admits. In this state it is generally too brittle to be of any practical use, and, therefore, it becomes necessary to temper it before it is exposed to strains on its tenacity. Before describing the operations of tempering, we desire to call attention to the degree of heat to which steel should be exposed before cooling in the process of hardening. This is a matter of vast importance, although it is sometimes neglected by mechanics whose experience should teach them the value of attention in this direction. Some steel will bear strong white heat and a plunge into cold water before it will assume its greatest hardness. Other steel, particularly cast steel, will not bear more than a brown or cherry-red heat. If carried beyond that point it burns, and becomes brittle in hardening. It may be safely concluded that steel which will not bear heat in forging will not bear it in hardening. The heat at which steel falls to pieces or melts is too high for hardening, because when hardened in such a heat it will fly or crack.

Referring now to the process of tempering, a common method often employed with small tools is to cover the surface of the steel after hardening with a film of tallow or oil. The steel is then heated until the oil diffuses a black smoke or burns. At this stage it is plunged into cold water. Picks, mattocks, blasting-tools and similar implements are tempered by heating the heavy part from behind the edge or point, thus driving the heat towards the point. One side of the edge being ground white shows the tempering of the colours, and when the proper colour is arrived at, the steel is cooled just at the point, but not the heavy iron behind it.

Some mechanics harden and temper their common tools in the same heat by merely dipping the hot point or edge in cold water. The heat of the heavier parts is then transmitted to the hardened edge after it is removed from the cold water.

When the proper colour is obtained, which may be ascertained by scratching with a dull file, the tool is cooled by dipping in water. This process requires some experience in order to obtain satisfactory results. In inexperienced hands the steel is apt to become either too hard or too soft, and thus require renewed hardening, which, of course, is injurious to the steel. Instruments which are designed to be very perfect are polished all over, and are then heated to the tempering colour. Small articles, such as knife-blades, are set in large numbers with their tongs in a heavy steel or iron plate. The plate is then heated and when the proper colour is on the blades, each is singly plunged into cold water.

Needles may be tempered in masses by burning oil upon them. Saw-blades and large articles generally are tempered in hot sand, the sand being heated to a certain point, which is ascertained by the thermometer. Where the thermometer is not employed, the course is to watch the articles until they obtain the requisite colour, at which time they are hardened either in the air or in water. The colours to which steel can be tempered may be approximately stated. The hardest articles which do not require much strength should assume a faint yellow. Surgical instruments, razors and engravers' tools should be brought to a pale straw colour. Knives, cold chisels and bore-bits are best tempered yellow. Chisels, shears, hammers, anvils and some varieties of saw-blades should assume a dark yellow. Axes, plane-irons, carpenters' tools generally and most edged tools should show a brownish-purple. Table-knives, weapons and scissors should be brought to a purple; watch-springs, saws and augers take a light blue. Common saws, heavy watch-springs, carriage-springs, and springs generally are tempered at blue. Articles which require strength, but in which hardness is a secondary consideration, should assume a dark blue. Beyond dark blue the colour is black, and the steel perfectly soft.

The colours above named are to be regarded as only approximating the best condition, for different kinds of steel will show a different degree of hardness in being tempered to the same colours.

Naturally soft steel should have a shade or two less temper than that of the hardest description.

◆

Why Some Mechanics Don't Get On.—We were much interested the other day in drawing from an old practical mechanic the secret of his success. Said he: "I have always made it a rule to do my work so well that it left a good impression on my employer." There is more in this than at first appears. Hard work is one thing; conscientious work is another. The hard worker may outwardly conform to all the requirements of the shop; he may always be in his place at the starting of the machinery; he may take short noonings, and he may be among the last to drop his tools at night, but after all he may utterly fail to get on in the world—and why? Let our experienced informant answer: "I know of a young man of just that kind. He works hard enough and wants to succeed, but somehow he can't. He came to me for counsel, and I found that he was slighting his work. That is, in his anxiety to turn off a large amount, he neglected the finish which always tells on good work. The consequence will be that, unless he makes a change, when times are dull he will be one of the first to be dropped by his employer." Superintendents and foremen notice these defects more closely than many are aware. The man who slides over his task, who lacks in thoroughness, who lets an unfinished piece of work leave his hands, is marked. In the unwritten law of the shop he is barred from promotion, while the conscientious workman is morally certain of advancement. Is the tendency of the day in the direction of a better finish to work? We think it is. As machinery is brought into competition the strife will be to secure superiority in cheapness, simplicity, and finish. Here it is that the thorough workman brings into play all the resources of his skill and honesty—his "mechanical moral sense," it has aptly been called. Here it is, too, that the slovenly, or careless, or hasty workman utterly fails. There are some forms of bad work that can be deftly covered up, but the compensations of life bring the inevitable result—failure to him who does not put his heart in the work, success to him who not only does his task, but does it well.

DAMASCUS STEEL.

THE term "Damascus steel," or, as it is frequently called, Damascus blades, is applied to a kind of steel which shows a variegated watery appearance on the polished surface. It came originally from Asia, and the scimitars or swords chiefly from Damascus, where the art of manufacturing blades appears to have been best understood. The excellent quality of this cutlery, particularly the scimitars, has long been proverbial; no other steel has been found to equal it in tenacity and hardness. The process by which this steel is worked is not known; it is a secret faithfully preserved among those who are engaged in the manufacture. European artisans and scientific men have endeavoured to imitate the Asiatic damask, but with ill success; the form and appearance of the steel has been counterfeited, but its quality has never been equalled. French manufacturers, particularly, have wasted a great deal of time and means in such attempts. The probable cause of the superior quality of this steel is in the raw material, the ore; and it may in some measure be attributable to the skill of the artisan who manufactures the blades. It has been ascertained that the ingots of wootz of which the oriental Damascus is made come from Golconda; and it is, therefore, probable that it is manufactured in the same manner as the Indian wootz. This supposition is strengthened by the great value of the blades, and the peculiarities of the wootz.

Alexander Burnes, in his journey to Cabul, tells us that a scimitar was shown him in that city which was valued at 5,000 rupees, and two others at 1,500 rupees each. The first was forged in Ispahan, in the time of Abbas the Great. The peculiar value of this weapon consisted in its uniform damask; the "water" could be traced upon it, like a skein of silk, the entire length of the blade. Had this "water" been interrupted by a curve or cross, the blade would have been of little value. One of the cheaper weapons was also of Persian make; its "water" did not run straight, parallel with the blade, but was waved like a watered silk fabric. It had belonged to Nadir Shah. The third scimitar was a Khorassan blade; there were neither straight nor waved lines in it, but it was mottled with black spots.

All three blades were strongly curved, but the first was more so than the others. They tinkled like a bell, and were said to improve by age.

Imitations of Damascus steel are made daily, and have been made for the last fifty years, and there is no doubt that some good has resulted from these experiments. The real value of the imitations, however, is quite limited. Damask steel has been made, and is made, of such perfectly developed veins—by welding together bundles of small slips of steel or iron, or steel of different kinds—that all imaginable figures which can be delineated by hand have been imitated. The smooth water, the waved water, a torsion of the damask, and the spotted damask, have all been produced; names, letters, inscriptions, leaves, and flowers, have been represented; but all these pretty things do not make Damascus blades of equal quality with those of Asiatic manufacture. It appears the Persians do not use so much skill in forging, but depend upon the elements. Recent experiments have shown that when blades are cooled slowly, as by swinging them in the air, a damask is produced on steel highly charged with carbon. This, however, is nothing new, for the next best blades to those of oriental manufacture—the blades of Solingen—have been hardened or tempered in that way for centuries. It is certainly the most perfect method of hardening steel, where tenacity also is desirable.

It is said that one hundred parts of soft iron and two parts of lamp-black, melted together, make a fine steel of great strength. It is also said that equal parts of cast and wrought-iron turnings make a fine steel, of damask quality, which is superior for arms and edged tools. There is no doubt that by such means as the foregoing an imitation of the appearance of damask steel may be effected; but it will depend entirely on the quality of the steel, the iron, the cast-iron, the lamp-black, or the crucibles whether the resemblance will extend to the *quality* of the steel. Impure materials will, under all circumstances, make bad steel; and if we have good, pure iron, we can make good steel in a cheaper way than that proposed.

Some experiments have been made by melting together cast-iron, carbon, and alumina, so that the molten iron contained aluminum.

A portion of this aluminous iron was melted together with blister steel, and the result was a steel very much like the wootz; it showed damask very distinctly. Other manufacturers than those who made the experiments, however, assert that aluminum is no necessary part of Damascus steel.

The damask veins may be made to appear on the surface of polished steel by washing it with a thin solution of sulphuric or muriatic acid, which will dissolve the softer parts of the steel first, on those points which contain the least carbon; after which the steel is washed in fresh water, and oiled or waxed. We do not know whether or not the Orientals bring out their damask in a similar way; but we are inclined to believe they do not. In some parts of Europe—Spain, Portugal, and portions of Italy—steel is buried under ground, often for months together, to improve its quality.

May not this be the manner in which the Orientals etch their blades?

Learning Various Trades.—Many who would like to learn more than one trade have been deterred by the constant iteration of the old saying, "Jack of all trades, master of none." Now, this is only partially true. Many trades, or rather branches of the same trade, are so closely related to each other that there is no reason why the young mechanic should not learn two or more of these branches. To do so would not only widen his horizon of thought, but would give him more self-reliance, enlarge his experience, and render him more independent of the fluctuating circumstances of hard times. If he gets out of work in one trade, it is more than probable that he can earn a livelihood by means of his reserve trade. Again, his manifold accomplishments render his employment more secure. When the time comes to reduce the number of men in a shop, those who are the most accomplished, and who can turn their hands to the greatest number of things, or who can change from one class of work to another, are the ones who are retained. It is well known to those who are observant, that the greatest part of the experiment in "making things work," in cases where two trades depend closely upon one another, such as the pattern maker and moulder, arises from the ignorance of the workmen in regard to the requirements of each other's trades. Both may be wrong, yet they will almost invariably charge the failure to produce a good job each upon the other. Now, if each understood the difficulties under which the other laboured, he would be able to point out the error at once, and there would be no necessity for jarring. Ignorance is the great producer of discord. Young mechanics never lose a chance to acquire more than one trade. Remember that he who can readily turn his hand from one branch of trade to another need never lack for either appreciation or profitable and steady employment.

PLANT'S GEOMETRIC CHUCK.

PART V.

(For Illustrations, see Lithograph Supplement.)

IN continuation we now give other illustrations of the complete two-part chuck, showing the back and front.

Fig. 4 is a front view of the two-part chuck. It is the reverse side of fig. 5, the circle representing the foundation plate. *A*, *b*, and *c* show the nose, the shoulder, and the ratchet wheel respectively, and correspond with the same letters on fig. 2. These parts have been already minutely described. *D* is a click, which engages in the teeth of *c*. It is shown fitting two spaces, thus distributing the pressure on two teeth. Perhaps this is unnecessary, more especially if the wheel *c* is a thick one. The wheel *e* is shown by *d* in fig. 2, and needs no further description. *F* is an idle wheel, which is fixed on the radius plate, and transmits motion from *g* to *e*. *G* is a wheel, solid, with the pinion seen below it, and driven by *h*. *H* is the planet arbor of the sun-and-planet motion of the second slide. It is marked *r* in fig. 2. The sliding piece which carries the wheel *e* is marked *i*. It is actuated by the screw *j*, a full size drawing of which is given at fig. 10. This sliding piece is shown better in fig. 2, where it is marked *f*. *K* is the wheel on which the strips of this sliding piece are fixed. It is marked *h* in fig. 2. *L* is a wheel and pinion, screwed to the radius plate, which drives *k*, the motion being derived from *p*, through the train of wheels *m*, *n*, *o*. *P* is the wheel fixed on the arbor, shown by fig. 13, and marked *t* in fig. 3. *Q* is the ratchet wheel fixed to the same shaft and against the face of the wheel *r*, to which the click *s* is fixed. This click engages in the teeth of *q*. The small portion of the wheel marked *t* is shown by *f*, fig. 5. *U* is the plate which takes the reversing wheels, only a small piece, just enough to take hold of, projecting. The leading screw of the first slide is marked *v*. (See fig. 10 for full-size drawing.) *W* is an engraved scale, by which the amount of eccentricity of the first slide can be read against the strip *x*. The other illustrations, figs. 2 and 3, should be referred to together to identify the parts more readily. A side view, section, and back view, are given in figs. 2, 3 and 5, respectively.

Fig. 5 is a back view of the chuck. The large circle is the base plate. *A* is the thread by which the chuck is attached to the mandrel nose, *b* being the shoulder. A reference to the elevation of the two-part chuck (fig. 2) will render an explanation of the details easier. *C*, fig. 5, is the screw collet *n*, fig. 2, the wheel *m* being marked *d* in the back view. The reversing motion, by means of which the wheels *d* and *g* may be made to revolve in the same or in opposite directions, is shown by the plate *h*, illustrated full size by fig. 8, the wheels *e* and *f* acting as intermediary runners, which merely transmit the motion. When in the position shown, the wheels *d* and *g* turn in the same direction. By shifting the plate *h*, the wheel *f* is drawn away from *g*, and at the same time *e* is put into gear with *g*, and still remaining in gear with *d* it (the wheel *e*) transmits motion from *d* to *g* direct, and causes the latter to turn in the opposite direction to the former. The plate *h* is more fully described by fig. 8. The dotted circle under *e* is the pin on which the plate turns, and the clamping screw which fixes the plate is shown by *i*. The leading screw *j* is shown full size by fig. 10; *k* is the bearing screwed on the foundation plate, and *l* is the nut, shown full size by fig. 11, which is screwed on to the first sliding piece *j*, in fig. 2. *M* is a hole through the wheel *d*, by means of which it is held stationary, whilst the chuck revolves, and so forms the well-known sun-and-planet gearing. The screw heads, marked *n*, five of which are shown, the sixth being covered by the reversing gear plate *h*, show the screws which secure the strips *k*, fig. 2, to the foundation plate. The wheel *g* is more fully described by *o*, fig. 2, and is shown in section at *c*. *Q*, fig. 3, represents the same wheel, and *r*, fig. 4, likewise. It is fitted to the shaft illustrated by fig. 13, on which it is free to revolve, and is held in the desired position by the click, as shown in fig. 4.

Figs. 6 and 7 show the two radius plates shown in section at fig. 3, where they are marked *d* and *j*. These illustrations are precisely half-size. The large circles are turned out to fit on the projecting rings of the first and second sliding pieces respectively. The dimensions of these are given elsewhere. The curvilinear slots are to allow the clamping screws to pass and give angular motion to the plates. These clamping screws are not seen in the perspective drawing, they being hidden beneath other parts. They are screwed into the sliding pieces, and have flat square heads, by which they may be tightened or slackened by means of a spanner. Half a turn of these clamping screws is all that is required when adjusting the radius plates. The portion shown solid is tapped with a number of holes at various distances, to suit different sized change wheels, so that these may be fixed as required by a screw on which they revolve freely.

Fig. 8 is the plate which carries the reversing wheels as shown by *h*, fig. 5, the back view of the complete chuck. It is here shown full size. A piece of flat iron will serve for material, and a trifle over an eighth of an inch in thickness will suffice. The hole in the centre fits on a pin driven into the base plate, and the curvilinear slot concentric with it is for the clamping screw, which holds the plate in the desired position. The two holes shown by double circles, representing screw threads, are to take the screws which form the studs on which the reversing wheels revolve. These are bored so that the wheels are at the correct distance apart to gear properly. The tail at the upper end is shaped to any form that may be fancied, so that it can be moved easily with the fingers. The illustration, fig. 8, is not precisely like the plate *h* in fig. 5, although there is but little difference between them.

Having described the construction of the two-part geometric chuck, we proceed to the three-part chuck. It will be unnecessary to repeat the large figures, viz., 2, 3, 4 and 5, with the modifications applied to the three-part chuck. In each figure it will be easy to add mentally the extra slide, and so arrive at an approximate idea of the construction of the three-part instrument. A perspective view of the complete three-part chuck has been given, and this will further elucidate the construction.

For the most part the particulars of the first and second slides, numbering from the mandrel nose, are equally applicable to both two and three-part chucks. In the illustrations it will be noticed that the two-part chuck has a ratchet wheel and click at the base of the nose, which allow the work to be adjusted circularly, without rotating the lathe. These are not seen on the three-part chuck; they may be added, and are equally useful on it. To an extent, this adjustment is only a refinement, which may be dispensed with.

The lower sliding piece, fig. 14, is precisely like the parts marked *b* and *e* in fig. 3, excepting, of course, the difference of the form of slides, which has been pointed out. The sliding piece shown at fig. 16 is like *h* in fig. 3. Instead of the wheel *b*, and all its belongings, the stud, fig. 19, is screwed into the slide *a*, fig. 16, and the wheel *b*, fig. 18, is mounted on it. The planet motion, fig. 21, is also not used in the two-part chuck.

The two radius plates, shown by figs. 6 and 7, belong to the slides, figs. 14 and 16 respectively. The former figures are half size and the latter full size. By measuring the holes in the plates, it will be seen that they fit on at the spaces marked *cc*, *cc*, in figs. 14 and 16. Another radius plate will be wanted for the three-part chuck, to fit on at *cc*, fig. 18. This is not shown, as it differs only in size from figs. 6 and 7.

The various screws used to hold the parts of the chuck together are not illustrated separately. Their size and form may be judged in most cases from the sectional and plan views.

The three slides and their fittings are shown separately in section. They are full size for the three-part chuck, and a glance at the half-size section of the complete two-part chuck will show the position of each. The material for the slides may be cast iron, though good brass or gun-metal castings are perhaps on the whole preferable. The strips between which they slide should be steel, though wrought and cast iron are sometimes used for the purpose. These strips are not illustrated, as their forms and positions are sufficiently obvious. The three-part chuck is fitted in plain dovetails.

The various illustrations referred to in this series of articles are shown on four lithograph supplements, the last of which is issued herewith.

We hope shortly to give an exhaustive treatise on another geometric chuck, and to show specimens of the work done by it.

Casing an Oil-stone.—About the first job an apprentice gets with his tools is to put a case on his oil-stone. The stone is bought in the tool shops without a cover; but it should not remain long without one, as it must be kept free from dust, and besides, in the event of falling off the bench, the cover protects it from breaking, so we will now give a description of how to case the stone. Supposing the stone to be 9in. long, 2in. broad, and 1in. thick, get two pieces of mahogany or other clean, straight, hard wood, each an inch longer, and an inch wider than the stone, and each ⅞in. thick. Plane one side of each piece so that they will lie closely together, and taking one of the pieces place the stone upon it, keeping the side of the stone that you mean to use upmost, and with a draw-point draw all round the wood close to the stone, when you will have a margin outside the line all round of ½in. Now with the brace and a ⅝in. or ¾in. centre bit, bore all over the portion within the line for ½in. deep, then with a sharp ⅞in. or 1in. chisel, you cut down to the draw-point line all round, clearing out all within to ½in. deep, and making the bottom level throughout. If it is pared square down at the edges, the stone will slip into it, taking care to put it in the same way as you previously drew it. When it is bottomed, ½in. will project above the wood, and this part is to receive the top or cover. The stone is placed upon the second piece of wood, which is to make the cover, and marked in the same way; and this piece is also to be bored and dug out to fully ½in. deep, and must have a smoother finish inside than the under piece It must be pared a little beyond the draw-point line, so that the cover will slip on to the stone easily, but without shaking. The stone being within, the case is to be planed on the edges and ends. This is best effected by catching it in the bench lug, when the corners may be rounded as well as the edge round the cover, and a ⅛in. bead may be run round where it joins the under part.

HOW TO HARDEN AND TEMPER STEEL.

By JOSHUA ROSE.

PART I.

NO practical subject possesses more interest to the mechanic than that of hardening and tempering of steel. And for this reason: that the steel of which all cutting tools are made depends more for its real value upon the degree of its temper than the quality of the steel itself. A piece of untempered steel, even the finest grade, will, under ordinary conditions, not cut at all; while a piece of steel of inferior quality may be made to cut well if judiciously hardened and tempered.

While the capacity of steel to cut is mainly due to the temper, the durability of the cutting edge is determined by the quality of the steel and its adaptability to the kind of work upon which it is employed. Hence it is that for cutting tools the best of cast steel is employed. The degree of temper is varied to accommodate the nature of the duty. The cost of steel of which a tool is made is of very little importance compared to its efficiency, because this cost is very little in comparison with that of performing the duty. For example, a steel turning tool weighing but two or three pounds will cut off many thousand pounds of iron, the operation lasting perhaps several weeks. The speed at which this tool will cut—or, in other words, the time it will take to cut off a given amount of iron—will vary 30 or 40 per cent. from a very slight difference in the quality of the steel of which the tool is made. The cost of the operator's time is so much greater than that of the steel used up in a given time as to render it, even in the case of cheap labour, always economical to employ the best of steel. With a given quality, however, the efficiency depends upon the skill employed in the forging, hardening, and tempering of the tool, as well as upon its shape. To the skilful performance of these operations we must look for the difference in the quantity of work performed by different workmen, even when using the same grade of steel for similar duty.

The art of hardening and tempering steel as applied to cutting tools is much more simple than when the same operations are resorted to, to give steel elasticity as well as durability of form, or to give durability to pieces of slight and irregular form sufficient hardness to withstand abrasion. The reason of this is that for tool purposes a special and uniform grade of steel is readily obtainable, which is known as tool steel. Special sizes and grades are made to suit the manufacture of any of the ordinary forms of tools. The steel purchased under the cognomen of steel, whether crucible or otherwise, and though of the same make and brand, may vary so much as to seriously affect the degree of hardness or temper obtained by any specific process. Most of the difficulties met with are in obtaining a uniform degree of temper or in tempering without loss from water cracks, etc. These defects may arise from rigidly adhering to some special process of hardening recommended by others, and can be overcome by varying the method to suit the quality of the steel. Very few steels are as yet sufficiently uniform to render it practicable to employ an unchangeable method of tempering, and to this fact is largely due the use of particular brands of steel. Manufacturers of special tools, such as saws for example, find that they must either manufacture their own steel or else use some well-known brand, and this is the case of most articles manufactured that require a fine and uniform degree of temper. This is not so much due to the good quality of the article as to the precise knowledge of the process necessary to temper such steel. We have as yet no known method of practically ascertaining in the workshops the quality of a piece of steel unless it be by use. As a rule, the steel that shows a fracture of fine dull grain, the face of the fracture being comparatively level, is of better quality than that showing a coarse or granulated surface; brightness denoting hardness, and fibrousness a toughness.

The soft steels approaching more or less in their nature to wrought iron are exceedingly difficult to harden and temper to a uniform degree, because of the difficulty experienced in producing them of uniform grade. Many kinds of these steels are made of so low a grade as to make it difficult to determine the line of demarkation separating them from wrought iron.

Considerable discussion has of late taken place as to what shall constitute the difference between wrought iron and steel. Mr. A. L. Holley said, in 1875: "Steel is a compound of iron, which is cast, while in a fluid state, into a malleable mass."

"I term steel," says M. A Grüner, "whether molten or not, any kind of iron which will harden by tempering, but malleable when hot or cold, if it has not been cooled rapidly. I call soft iron, whether molten or not, any kind of iron which will not harden by tempering, and is malleable when hot or cold."

To this Mr. Holley objects, and says: "If hardening in water is the characteristic of steel, who is to define hardening? As a matter of fact, all products of the crucible, open hearth, Bessemer vessel and puddling furnace, containing 0·25 per cent. or more of carbon, will perfectly harden in water just in proportion to the carbon contained. If the product will make a tool, it is 'steel,' says the smith. What kind of a tool? Is an agricultural tool iron, and a cold chisel steel, or does steel begin between cold chisels and razors? If so, where? A water-hardened tool, perfectly adapted to certain uses, may be made of Bessemer metal containing half per cent. of carbon; the same ingot may make a good rail. If one part of the ingot is steel, why is the other part iron? The line between steel and iron must be sharply defined. Does it lie between 0·75 and 0·76 per cent. of carbon, or 0·99 and 1 per cent.? Obviously, no two men will, or can, agree on the amount of hardening or carbon which constitutes steel, so that the whole range of structural steels, forming at least three-quarters of all the steels produced, could not be included in any classification."

Dr. Percy, in his "Metallurgy of Iron and Steel," defines steel as iron containing a small percentage of carbon, the alloy having the property of taking a temper, and this definition is substantially equivalent to those found in the works of Karsten, Wedding, and Tunner; on the other hand, Messrs. Jordon, Grüner, Gautier, Phillipart, Holley, and others, define as steel all alloys of iron which have been cast in malleable masses, whilst Sir Joseph Whitworth considers that steel should be defined mechanically by a coefficient representing the sum of its strength and ductility.

With the object of having universally adopted names which should indicate the nature and the distinction between iron and steels, an International Committee was appointed at Philadelphia by the Institute of American Mining Engineers. The committee resolved that the following should be recommended:—

1. That all malleable compounds of iron, with its ordinary ingredients, which are aggregated from pasty masses, or from piles, or from any form of iron not in a fluid state, and which will not sensibly harden and temper, and which generally resemble what is called wrought iron, shall be called weld iron (German, *Schweisseisen*; French, *fer soude*). 2. That such compounds when they will from any cause harden and temper, and which resemble what is now called "puddled steel," shall be called weld steel (German, *Schweiss-stahl*; French, *acier soude*). 3. That all compounds of iron, with its ordinary ingredients, which have been cast from a fluid state into malleable masses, and which will not sensibly harden by being quenched in water while at a red heat, shall be called ingot iron (German, *Flusseisen*; French, *fer fondu*). 4. That all such compounds, when they shall from any cause so harden, shall be called ingot steel (German, *Fluss stahl*; French, *acier fondu*).

The main line of demarkation here laid down lies in the capability to harden. Steel which will harden from any cause, that is to say, by heating to any temperature and using any quenching liquid, is termed weld steel. That which will harden by being heated to redness and quenched in water is termed steel.

Professor Kick, of Prague, after several experiments with nitric, sulphuric, and hydrochloric acids, and their combinations, with mordants composed of the salts of copper, etc., has arrived at the conclusion that a mixture of equal parts of hydrochloric acid and water, to which is added a trace of solution of chloride of antimony, constitutes a mordant especially applicable for the purpose of testing iron and steel. The last ingredient, which was recommended to him by Professor Gintl, renders the surface attacked more capable of resisting oxidation, and has the effect, after well washing with hot water and the application of a coat of protecting varnish composed of damar resin, of preserving the surface attacked sufficiently pure.

The method of proceeding is always to surround the surfaces, previously prepared by means of a file or hone, with a wall of wax fully ¾ of an inch high, in the same way that copper plates are prepared for being eaten in with acid in engraving; the acid, heated to a temperature of 53° to 86° Fahr., is poured on to the surfaces, and soon begins to act, as will become manifest by the disengagement of gas. In winter, owing to the low temperature, the operation cannot be performed so favourably. Its duration is usually from one to two hours, and it should be continued, as a general rule, until the texture of the iron be exposed. The progress of the action may be easily ascertained by pouring out the acid every half hour without breaking the wax border, removing by means of a brush or piece of rag the carbon (graphite) deposited on the surface, washing and again pouring on more acid if the action appears insufficient. If the chloride of antimony has been added to the acid in proper proportion, but little time will elapse, after the action has commenced, before it will begin to throw down a black precipitate. This is easy to distinguish from the graphite, inasmuch as the latter is not very appreciable, when, for about 1¾ pints, is added only a single drop of the concentrated solution of chloride of antimony, which is sufficient.

When the action of the acid has been continued long enough, the wax wall is destroyed, and the surface of the iron is washed by means of a brush with several waters, the first of which is rendered slightly alkaline by the addition of a little lye; it is then carefully dried, and a coat of varnish is applied. If, at the end of a few hours, there are any signs of oxidation, the varnish must be dissolved with spirit of turpentine, the oxide removed, and the varnish again applied.

The indications given by the different kinds of iron are as follows:—Soft or fibrous iron; when of very good quality, this iron is attacked by the acid—even when the action is continued for several hours—in a manner so uniform, and with an elimination of the carbon so limited, that the surface acted upon retains a dull lustre—a few incised specks and cinder-like holes being only observable.

Fine-grained iron gives exactly the same indications; the surface generally remains uniform, but it is not quite so bright.

Coarse-grained iron and hot-short iron are attacked by the acid with much greater energy than the two kinds above mentioned. Even at the end of about ten minutes, the surface, especially that of the latter kind, becomes quite black. If the acid be allowed to act for nearly half an hour, a black muddy deposit (schlamm) may be removed by washing, and no amount of washing will prevent the surface from remaining black; there will also be a considerable number of small holes distributed over the surface. Some portions of the iron are generally attacked more deeply in this way; others, although they may have become black and a little porous, are better preserved. This appearance will be the more manifest if, after about an hour's action, repeated washing and drying, a fine file be passed over the surface.

Malleable iron, or annealed iron, becomes rusty, as is well known, more readily than wrought iron; but an interesting fact is that the action of the acid is very violent and irregular.

Puddled steel, after being treated with acid and washing, is grey, and of a tolerably uniform shade, the weldings being but little apparent.

Blister steel: The appearance exhibited is very like that of puddled steel, and the weldings are also but slightly apparent.

Bessemer steel—cast steel: The surfaces of these steels are uniformly grey—the non-homogeneous parts are rare, and but little apparent. The softer the steel, the more approaching to grey is the colour. The action of the acid produces very fine fissures. In a sample of Mushet steel the prepared surface was perfectly uniform, but after the treatment with acid, narrow transverse fissures were observed over the whole extent. It is probable that the proportion of titanium in this steel was the cause of the surface attacked presenting the dark grey colour.

The old blacksmith's method of calling that steel which can be hardened, is one recognised method. To harden, however, is one thing, but to harden when heated to a definite degree is another, and to possess a definite degree of elasticity when tempered to a particular point of temperature after hardening, is yet another. So that in the absence of great uniformity in the grade of the metal, the blacksmith or the temperer must rely upon his judgment and perception. If under a given process the work is not considered hard enough, he may heat the metal to a greater temperature, providing its shape and size will admit of that without injury or causing it to crack in the quenching. In this case he will try to make up for the deficiency in the metal to temper by chemical additions to the quenching liquids.

Supposing that steel as operated upon be of uniform grade, the operation of the hardener would not always make it uniform, because steel decarbonizes somewhat by being heated, hence a small tool deteriorates by being heated in the open fire, and one often heated to sharpen or repair suffers in proportion. From all these and other considerations, hardening and tempering processes of steel differ according to the size and nature of the work, the amount of uniformity required, and the duty to which the work is to be put. The only information of value to the practical man is such as will instruct him in the practice of our workshops, giving the conditions and the processes in connection with each other.

If we heat a piece of cast steel to redness and plunge it into clean water until its temperature is reduced to that of the water, the result will be that the steel will be hardened. The degree of the hardness will depend upon the quality of the steel, the temperature to which it was heated, and to a small degree upon the temperature of the water in which it was cooled. In any event the operation will be termed that of hardening. If we reheat the steel a softening process will accompany the increasing temperature, until upon becoming again red hot it will assume its normal softness, and if allowed to cool in the atmosphere the effects of the first hardening will be entirely removed. If, however, after the steel is hardened, we polish one of its surfaces and slowly reheat it, that surface will assume various colours, beginning with a pale yellow and ending in a blue, with a green tinge, each colour appearing when the steel has attained a definite degree of temperature; hence by the appearance of the colours we are informed of the temperature of the steel, or in other words, how far, or to what extent, the resoftening has progressed. This chemical fact is taken advantage of by the machinist to obtain in steel any required degree of hardness less than that of the absolute hardness obtained by hardening, and is termed tempering. The temperatures at which these respective colours will appear are as follows:

Very pale yellow	430°	Fahr.
Straw yellow	460°	„
Brown yellow	500°	„
Light purple	530°	„
Dark purple	550°	„
Clear blue	570°	„
Pale blue	610°	„
Blue tinged with green	630°	„

To say, then, that a piece of steel has been tempered to a straw colour implies that it was first hardened and then re-heated until the straw yellow appeared upon it, the temperature having arrived at 460° Fahr., and that the reheating process was then discontinued. The presence of the straw colour, however, while evidence of temperature to which the heating took place, is no indication of the actual degree of hardness of the steel, because that depends upon the degree to which the steel was hardened before the colour test tempering was resorted to. And since the degree of the first hardening depended upon the quality of the steel, the degree to which it was heated, and the temperature of the water in which it was cooled, it follows that the above quality, heating, and temperature must be uniform in all cases if uniform results are to be reached.

The higher the grade of steel, the lower the temperature at which it will harden, and the harder it will be if cooled in water from a given temperature; but any degree of hardness obtained from a temperature equal or less than the highest at which a colour would appear—that is, 430° Fahr.—will obviously be representable under the colour process by a colour, providing, of course, that the steel was first thoroughly hardened.

Now it is manifestly desirable to obtain any required degree of hardness by a single process if possible; and hence by heating a known quality of steel to a definite temperature, and quenching it in water or other liquid or mixtures maintained at about an even temperature, the colour test is becoming, in some cases, dispensed with, the conditions of heating and cooling being varied to give any degree of hardness from the highest attainable down to normal softness. Another and very desirable method of hardening and tempering is to heat in a flue of some kind maintained at the required temperature over the fire, and cool either in water or a quenching or cooling liquid; and then, instead of applying the colour test, to provide a tempering bath composed of some substance that will heat, in the open air, to a temperature of about 450°. By placing the articles (after hardening them) in the tempering bath and heating it to a temperature equal to the colour of temper (under the colour test) required, we have but to cease supplying heat to the tempering bath when a thermometer standing therein marks the required temperature, and a uniform degree of temper will be given to all the articles, and the operation will occupy much less time than would tempering either individually or collectively by the colour test, because a liquid is much more easily kept at an equal temperature throughout its mass than are the heated sand, hot pieces of iron, or iron tubes resorted to in tempering by the colour test. Another method of tempering —which, if capable of reduction to uniformity, would be the quickest and hence most desirable of any—is to heat the steel to a definite temperature, and cool or quench it in a liquid having sufficient greasiness or other quality which acts to retard its retraction of the heat from the steel, and thus give a temper at one operation. As an example of this kind of tempering, it may be mentioned that milk and water, mixed in proportions determined by experiment upon the steel for which it was employed, has been found to give an excellent spring temper. Nor is there any doubt but that, carefully conducted, such tempering may be of the very best quality. A great deal, however, in this case depends upon the judgment of the operator, because very little variation in heating the steel or in the proportions of milk to water produces a wide variation in the degree of temper. If, on trial, the temper is too soft, the steel may be made hotter, or more water added to the milk. If the steel was heated as hot as practicable without increasing the danger of burning it, more water must be added; while, if the steel was made red hot without being hot enough to cause the formation of clearly perceptible scale, the steel may be heated more. It is desirable, in all cases, but especially with a high grade of steel, to heat the steel not above a blood red heat, although sheer and spring steel may be, and often must be, made hotter, in order to cause it to harden when quenched in water.

(To be continued.)

A Useful Kind of Solder.—A soft alloy which attaches itself so firmly to the surface of metals, glass, and porcelain that it can be employed to solder articles that will not bear a very high temperature can be made as follows:—Copper dust obtained by precipitation from a solution of the sulphate by means of zinc is put in a cast iron or porcelain lined mortar and mixed with strong sulphuric acid, specific gravity 1·85. From 20 to 30 or 36 parts of the copper are taken, according to the hardness desired. To the cake formed of acid and copper there is added, under constant stirring, 70 parts of mercury. When well mixed the amalgam is carefully rinsed with warm water to remove all the acid, and then set aside to cool. In ten or twelve hours it is hard enough to scratch tin. If it is to be used now, it must be heated so hot that when worked over and brayed in an iron mortar it becomes as soft as wax. In this ductile form it can be spread out on any surface, to which it adheres with great tenacity when it gets cold and hard.

CIRCULAR SAWS AND THEIR MANAGEMENT.

THE subject of circular saws is an interesting one, says "Wood and Iron." Reciprocating saws were at one time almost exclusively used in the preparing of lumber, but the obvious disadvantages arising from their intermittent motion, in spite of many improvements made on them, has led to their partial abandonment, and the substitution of circular saws in their place. The day cannot be far distant when (except for scroll work), straight saws will be numbered among the things that were, for circular saws possess many advantages over them, especially as regards the greater speed at which they can be driven, and the greater quantity of work they can turn out in a given time—as much time is lost with the straight saws in getting ready to work—and often in keeping in repair when ready.

The tendency to heat in circular saws is the greatest difficulty in their management. Wherever there is much friction experienced in one, it will get hot and expand, and in that condition will not make good lumber, and sometimes, indeed, it will buckle, and thus become materially injured. If the heating of a saw be uniform throughout, no further harm will result than its becoming "limber," and unable to sustain itself under a strong feed, but whenever it is reduced in temperature it assumes its original form. It is very seldom, however, that the expansion of a circular saw, when heated, is uniform, as the friction is always greatest on the side next the log, owing to the plank yielding. Friction is caused by too much kerf being cut out of the log, and also by the springing of the timber. In the latter case, when a line is cut, each portion of the log has a tendency to assume the form of an arc with the bark turned inwards; this presses that portion of the log between the head blocks against the saw, while at the same time the opposite side of the saw is entirely relieved, thus causing unequal friction and expansion.

In adjusting a circular saw to timber, the blade is not placed parallel to the log, but has what is termed "rake," that is, the cutting edge of the saw comes nearer the log than the opposite edge. This is done for the purpose of allowing the saw teeth to ascend without scratching the face of the log, and also to relieve the centre of the saw, where the tendency to heat is greatest. If, however, too much rake be given the saw, it will cause undue friction, and the inner side of the saw will heat and expand, and cause a great deal of trouble in straightening it out and making it work properly.

The saw should never be allowed to get hot, and the arbor should be kept well lubricated, so that the heat will not be transferred to the centre of the saw. Whenever the centre of a circular saw becomes heated, it has a tendency to cup. The side of the saw which expands most by heat becomes convex, and if run too long it will not return to its former shape when cooled, but will require hammering on the edge to straighten it. This is a job which requires considerable skill, and, besides, few who use such saws have suitable anvils to straighten them upon. To such the following will be useful information:—Prepare a suitable number of annular papers with their inside diameter about one inch less than that of the hub, and place them on the shaft adjoining the concave side of the saw. Prepare a lot of similar papers with their inside diameter equal to that of the hole in the centre of the saw, and their outside diameter about one inch greater, and place these on the saw shaft adjoining the convex side of the saw. A sufficient number of these being so placed in, they are tightened up in the hub and the saw is brought up true in the face. Care must be taken to put in no more papers than will straighten the saw. It is not, however, absolutely necessary to take the cup out of a saw until it becomes of a considerable size, for a saw will do good work even when cupped a quarter of an inch; the increased difficulty, however, of managing it in this condition renders it advisable not to work it in such a state. In working cupped saws the teeth should be made to fill a wider gauge on the convex than on the concave side; and if the tendency to heat at the centre continues, it should have more rake, if cupped towards it. The teeth of a cupped saw in ascending, in all likelihood, will scratch either the face of the log or the plank, which is a sufficient reason to at once straighten it. Wooden pins or rollers are often used to guide the edge of the saw; they are placed just below the log, and near the front edge. Pins are preferable to rollers, for they do not pack a ring of sawdust on the saw when it passes between them as rollers do. The proper position of these guides relative to the saw varies under different circumstances, but in no case should both press against the saw at the same time, as they would be sure to heat it. When a saw heats on the edge, it is far more difficult to manage than when heated in the centre, for a cupped saw still presents a straight line on the edge, while a buckled saw (one stretched on the edge) does not.

The edge of a saw may become heated on account of the teeth not being in proper shape. If any part of a tooth, except the edge, rubs on the log, the friction at that point will heat it. If sufficient depth of tooth is not preserved, there will not be sufficient room to free itself from sawdust, which will crowd in the kerf, causing undue friction on the sides of the teeth. If the saw cuts out of a true line it will press hard against one of the guides, and thus also cause undue friction. It should never be forgotten that the heating of a circular saw, causing cupping or buckling, is always the result of undue friction; to avoid this, therefore, every effort should be exercised. A saw sometimes gets buckled from other causes than heating. Its roller guides are sometimes placed to bear too hard against it, and when this is the case the sawdust is pressed between them with a force sufficient to thrust the rollers out of place; or if the rollers be so rigidly fixed as not to be moved by such a pressure, they tend to stretch the saw at the point where it passes between them, but the edge of the saw is often stretched by gumming machines. It is seldom necessary to straighten a buckled saw on an anvil, especially if only a narrow ring near the edge of the saw is stretched, as it may be remedied by cutting through it, either by drilling a hole at the root of each tooth, or filing towards the centre of the saw until the stretched part is cut through.

Water is sometimes used to cool a saw; it also enables a saw to work in a smaller kerf, thus saving power; and it also acts as a partial lubricator. It should be directed in jets on each side of the saw near the centre. Its use, however, should be avoided in cold freezing weather. Allowing the saw shaft to play endwise is one of the most effectual means of keeping the saw cool. When the timber springs against the saw, tending to heat it at the centre, the end play of the shaft allows the centre of the saw to yield; at the same time the guide pins at its periphery keep it in line, and the friction is thereby reduced, and liability to heat diminished in a corresponding degree.

These are some of the difficulties experienced in operating large circular saws.

FINISHING.

FINISHING is the process of applying to the surface of wood a thin coating of varnish or other substance to render it durable, enhance its beauty, or change its appearance. There are numerous methods of finishing, and a variety of materials are used; the varieties of varnish being the principal.

In their natural state all woods are more or less porous, consisting of bundles of hard fibres, with interstices filled with a softer substance. These constitute the grain, and as the hard or soft parts predominate the wood is said to be hard, fine, or close-grained, or soft and open-grained. To fill these softer parts, or pores, and give to the whole an even, uniform surface, hard, and capable of a brilliant polish, is the object of the finishers' art. This hard, firm surface was formerly gained by the successive application of several coats of varnish, at least three preliminary coats being required to fill the pores; the inequalities were then reduced by fine sand or glass-paper, and several additional coats laid on, the last, after becoming thoroughly hard, being polished if desired. In this operation, however, a great quantity of varnish is absorbed by the open pores of the wood, and it is consequently so expensive that it is now seldom used. Recourse is therefore had to various plans to render the wood non-absorbent before applying varnishes, and certain compounds, called fillers, are largely used for this purpose.

The Processes.—Finishing, although comprehending many minute sub-divisions, may be divided into four principal processes—viz., filling, varnishing, rubbing, flowing and polishing—but here we give a general view of the entire operation, without details. The process described is for fine work. First make the article to be finished quite clean and free from dust; then apply the proper filler with a brush; rub it well into the grain with excelsior or tow, rubbing across the grain when practicable, then clean all the surplus filler from the surface with rags; after filling, allow the article to stand for several hours, during which time the filler should become quite hard and dry. Before proceeding to apply the varnish, if necessary, make the surface of the filler quite smooth, with sand-paper; then apply a coat of varnish, allowing it to get quite hard; after the last coat of varnish, with fine sand-paper, sand-paper the surface sufficiently to make it entirely smooth and remove any lumps or irregularities. The number of coats required depends greatly upon the quality of filler used. It is said that with some fillers one coat of varnish is sufficient, but this can scarcely be the case with fine work, as it is not possible for one coat of varnish to give sufficient body to rub; four, or possibly three, coats are more desirable. When the last coat of varnish has been applied, the article is ready for "rubbing" with pumice stone, moistened with linseed oil and applied with a bit of hair cloth or coarse rag. This is for the purpose of making the varnish perfectly smooth and preparing it for the polishing. After rubbing, if a dead finish is desired, the work is complete, but the body of the work is generally cleaned up with a little oil well rubbed in, which gives it a lustre, afterwards rubbed with a cloth dampened with alcohol, which removes the surplus oil from the surface. The veneered panels are either "flowed" or "polished."

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Tracing Paper. — A good firm tissue paper washed with a mixture of six parts spirits of wine, one of resin, and one of nut oil. Apply with a sponge.

HOW TO MAKE A SMALL POWER STEAM ENGINE.

By H. R. Phelps.

PART III.

(For Illustrations, see Lithograph Supplement.)

A FULL-SIZE detail of crosshead pin is given on the sheet of details, fig. 20. Having finished the plummer blocks, we are now ready to commence the crank shaft, for which a wrought iron forging will have to be obtained, about 1/8in. larger in every way than the finished size, which is as follows:—Length, 8 1/8in.; diameter of shaft, 3/4in.; diameter of journals, 5/8in.; distance apart of journals, centre to centre, 3 5/16in; length of journals, 15/16in.; centre of crank pin to centre of shaft, 1in.; diameter of crank pin, 5/8in.; length of crank pin, 5/8in.; entire width of crank, 1 9/16in.; the width of each web thus being 15/32in., the thickness of the webs is 13/16in.; the crank is in the centre between both journals, but it will be seen that the centre of crank is 5/8in. nearer to one end of the shaft than it is to the other end; the length of the crank webs is 1 13/16in. The crank is much better forged up solid, and the crank pin cut out afterwards, as a much sounder job is thus made of it than if the crank pin and slot were worked out in the forging.

For the purpose of turning the crank pin, I always have a piece worked on each end of the forging to correspond to the crank. These pieces have small holes drilled in them to correspond to the centre of crank pin, and thus serve to carry the shaft while the pin is being turned, after which they can be cut off and the ends of shaft turned up. It will be best to turn the shaft and outsides of the crank webs first, after which the insides, and the pin can be turned after. As it is most important that the crank pin should in every way be quite parallel with the shaft, in order that there may be no fear of the connecting rod end binding on it when it is bolted up tight, it will be best to mark off the centres for turning it by, as follows: the shaft should be laid on a flat surface, with the crank piece horizontal, that is, parallel to the surface it is laying on, and a line cutting through the centres on which the shaft was turned is to be marked along each of the arms on end of shaft, this line to be *strictly parallel* with the surface on which the shaft lays. Now take the dividers, and setting oft 1in. on them, place one leg of them in the shaft centres, and scribe a line cutting at right angles across the ones previously made. If this is carefully done at each end of the shaft, the point of intersection of each two lines will represent the true centre of the crank pin, and a small hole can be drilled in each mark to take the lathe centres, so as to turn the pin. It will be noticed that the shaft and crank pin are finished up to the crank webs with a hollow curve; the journals must also be finished in the same way, as the shaft is much stronger and less likely to break than if they are finished up square. The ends of the crank webs can be turned one end at the same time as the shaft, the other when the pin is being done. The edges can be filed or planed, as most convenient.

The plan and elevation of engine can be measured from by taking the scale attached to the details, and making 1in. on it represent 2in. on the plan and elevation.

The ends of shaft outside the journals may be turned just an ideal taper, as the fly-wheel, eccentric, and belt wheel can then be forced tightly on, though it will be as well to put a key in each also. The key ways in shaft may be 1/4in. wide and 3/32in. deep, and extend from the ends to within 1/8in. of the journals. In the absence of a milling machine, it can be cut by fixing a parting tool in the slide-rest, and working it along the shaft, afterwards finishing up with a file. To make a perfect fit of the shaft in its bearings it will be as well to slightly grind it in. To do this, the plummer blocks must be firmly fixed in their places, and the shaft put in them with a little silver sand, or what is better, powdered pumice stone and oil, the longest end ot shaft being to the left side of bed plate, as shown on drawing.

The top halves of the brasses and the caps must be put on, and the shaft turned round pretty quickly, the caps being pressed down as the brasses wear, until it is found on inspection that the shaft bears equally all over the brasses, when both shaft and brasses must be thoroughly cleaned from all grit.

We are now ready to commence the connecting rod, which will require an iron forging, large enough to work to the following finished dimensions:—Length from centre of hole for crosshead pin to big end (outside) 5 1/8in.; diameter of boss, little end, 3/4in. full; width of boss, 5/8in. bare; width of big end, where bolts go through, 7/16in.; depth of do., 1 7/16in.; thickness of do., 1/4in.; width of rod, 1/4in., and parallel from end to end; depth of rod, little end, 11/32in.; big end, 1/2in. full. If the rod is put between centres, the flange for bolts at big end can be turned at top and bottom, and back and front, the sides being turned when it is bolted on the brasses. The hole in little end can either be bored out the right size and case hardened, or a small hardened steel bush can be made and forced into the rod, the bush being about 1/16in. thick all round, and of course forced very tightly into the rod. Great care must be taken that the hole is perfectly square with the rod. The crosshead pin must be as tight a fit in the rod as possible, consistent with working properly. A small hole must be drilled through top ot boss on rod, for the purpose of lubricating the pin. It will be better to have a small oil cup fitted on, with a cap to keep out the dirt. The brasses for big end of rod are gun-metal castings, and are to be worked up to 1 1/32in. in length, that is, parallel with connecting rod; depth, 1 7/16in.; width, 7/16in.; width across boss in centre, 5/8in. bare; diameter of boss, 13/16in., and rounded off as shown. In making the brasses, the first thing is to file the two inner faces square and smooth, and then solder them together; they can then be fixed on a chuck and the centre bored out for the crank pin to a diameter of 5/8in. very bare, it being finished to the size by grinding. It is now put on a mandrel, and the two sides and bosses turned to the requisite width and diameter. The two ends will now have to be turned flat and parallel, care being taken to keep the division line of brasses in the centre, both top and bottom. The top and bottom will have to be turned at the same time as the ends. Particular care must be taken that the end of brass which pulls against connecting-rod is perfectly square with axis of crank pin, otherwise the big end will be twisted and will bind on pin. A piece of iron, the same shape and size as end of brass, and 1/4in. thick, is required to go on outside of big end. The holes for the two bolts are full 3/16in. diameter, and are 1in. apart, centre to centre. The big end will now require to be ground to the crank pin; this can be done by fixing the little end in its place on the crosshead, and putting the pin through it and the guide blocks, and put the big end on the crank pin with some powdered pumice stone and oil, then by turning the shaft round and tightening the nuts on big end a good fit will be made of it. A hole will have to be drilled in the top of the big end to take an oil cup with a 3/16in. thread. The position of cup is shown on drawing.

(To be continued.)

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or neccssarily endorse the opinions expressed.

GEOMETRIC CHUCKS.

Sir,—In No. 5 of your journal (which, by accident, came under my notice the other day) I observed an article on "Plant's Geometric Chuck," and, having some knowledge of that gentleman's antecedents, I read the article through very carefully, and found, as I surmised might be the case, that the so-called "Plant's Geometric Chuck" therein described was no other than the chuck of an old and valued friend of mine, Mr. William Hartley, of Higher Broughton, near Manchester.

I know the whole history of that machine, having seen the greater part of it built up, and having also printed hundreds of specimens cut by it as far back as the year 1848. I remember, also, that Mr. Hartley sold that identical chuck to Mr. Plant, who at that time was residing at Alsager, Cheshire. This, I believe, was the first compound geometric chuck that gentleman had seen.

In justice, therefore, to my *two old friends* (the chuck and its maker), I could not silently pass by what appeared to me to be an attempt to appropriate the honour of its construction; and I am sorry to have to add that this is not the first time I have deemed it necessary thus publicly to dispute Mr. Plant's claim to be considered in any way the originator of the chuck in question.

In the lithograph supplement appended to the article, and showing the working details of the machine, I observe *one* alteration from the arrangement adopted by Mr. Hartley in the original chuck—viz., the fitting of the wheels upon the rim of the slides. In the hands of a really competent workman, I venture to assert that such an arrangement would be entirely unnecessary. The manner of its execution, moreover, is such as to render the chuck incapable of producing really accurate geometric figures, or of cutting delicate lines of an even depth. This plan may probably have been adopted in order to avoid the difficulty of fitting the recess in the underside of the wheel upon the rim of the slide.

I am, Sir, yours faithfully,

WM. S. BARLOW.

[We have some letters from Mr. Hartley, which we purpose publishing.]

APPRENTICES.

Sir,—If we examine a boy on entering a workshop, we shall find that in nine cases out of ten he knows next to nothing of what he will have to do at first. He thinks that if he is made to sweep up, and keep the tools and such like in their proper places, he is very badly used. I should like to give such youths a few words of advice: I will suppose that a boy is on the point of leaving school, and that he has decided to be a wood turner. He enters a turner's shop as an apprentice. They (the foreman, or a leading hand) start him, we will say, with stacking wood that has been sawn into lengths. At the end of the week he is told to sweep up, and make things a little tidy, and when Monday comes he is told to move this lot of wood to such and such a lathe. Well, he is at this sort of work for some months very likely, week after week it is the same. At last another boy enters the shop as an apprentice and takes his place: he is then, perhaps, put to a small circular saw. Of course he has seen this saw at work from the first day he came into the shop, and knows something about it, or he should do if he has kept his eyes open. He works at the saw for several months, and then is put to a lathe, where the most simple and plain work is done, and he remains there also for some length of time, and then put to a lathe where a better class of work is done, and after that put to a better lathe still, where undercut work has to be done. He now finds himself a good distance up the tree, but allow me to tell him he has much to learn before he gains the top. He has been at lathes where the same class of work is done over and over again, but let let us see how he gets on at the odd-job lathe; he gets a piece of work given him to do that stumps him at once. He now begins to see how little he knows about the trade he has chosen to get his livelihood by, but do not let him be disheartened by this; if he watches and takes notice how his better workmen do their work, and does not try to know too much, he will live, prosper, and learn, and when his apprenticeship is up will be a good workman. His stock of tools when he first enters the shop should not be many, or he may brag, and say his tools are better than Bill's or Jack's, and his fellow apprentices will quite expect him to teach them something, but when it comes to the push they will teach him something, although their tools only consist of a pair of inside and a pair of outside callipers, two gouges, two chisels, a parting tool, a hand saw, and a two-foot rule. Apprentices, always keep your tools in good order; you cannot do work well unless your tools are well sharpened.

Buy your tools as you require them, and have them of first-class make; do not upon any account buy cheap tools.

GEO. F. JACKSON,
Mechanical Engineering Instructor, All Saints' School,
Bloxham.

MANDREL NOSES AND CHUCKS.

Sir,—Much has been said at various times, and in various places, about the intolerable nuisance of sending away one's mandrel or headstock when one wants a chuck fitting to it. It is undoubtedly a nuisance and an expense. One of your correspondents, "Graham," mentions an ingenious way out of the difficulty. I can see only one drawback to his plan, viz., that it tends to throw the work further away from the mandrel nose, which is undesirable when turning or boring articles held by the chuck only. Now, I am but a humble amateur at the best, and any opinion I form I am almost afraid to put forward lest it be erroneous or impracticable. I venture to suggest that every buyer of a lathe gets a *duplicate* of his mandrel nose from the maker. It may be made from wrought iron, and I think would not cost much. This, of course, applies only to those buying new lathes. But those who possess screw-cutting lathes ought to be able to make one for themselves. This duplicate mandrel nose could then be sent away instead of the original.

If you, sir, think this suggestion worth inserting in the columns of "Amateur Mechanics" I shall be glad; and remain yours, &c., J. W.

ON MISCELLANEOUS ITEMS.

Dear Sir,—I am in sad tribulation! Some fine boxwood that I had cut down last winter has cracked in all directions, and will, I fear, be next to useless.

Can you recommend any plan which will obviate this disappointment and loss, for the future? I have also some fine cherry and yew, which, I fear, will go wrong unless something is done. What is the best chuck for holding small pieces of ivory? would not a four jaw American answer well?

Could you not descend to something easier in your magazine than the ivory work, requiring expensive lathes and chucks, which none but a wealthy man is likely to have? A few simple suggestions as to turning ivory studs, ring stands, &c., would, I believe, be very welcome to many of your readers. A short list of useful and ornamental articles, in various materials, requiring only an ordinary lathe, with back-gear and a slide rest, would be of immense use to me and probably to others; with hints on turning particular form, also on polishing, staining, &c.

Forgive my presumption in suggesting anything to you, Mr. Editor, but if we do not make known our wants how can you supply them?

Yours very truly, J. C. E.

[NOTE.—Owing to the non-completion of engravings some of the serial papers are discontinued in the present issue. They will be resumed next month.—ED.]

AMATEUR MECHANICS

AN

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HOW TO MAKE A KITCHEN DRESSER.

We are about to construct that important piece of kitchen furniture—the dresser. The form of the dresser differs in different localities and different countries. The usual form in England resembles a low counter with drawers, and a narrow ledge round the top, and may be called a kitchen sideboard. The same form, or something like it, exists in many parts of Scotland. The dresser here shown is designed for the movable property of the tenant, and not, as is usually the case, a fixture belonging to the landlord.

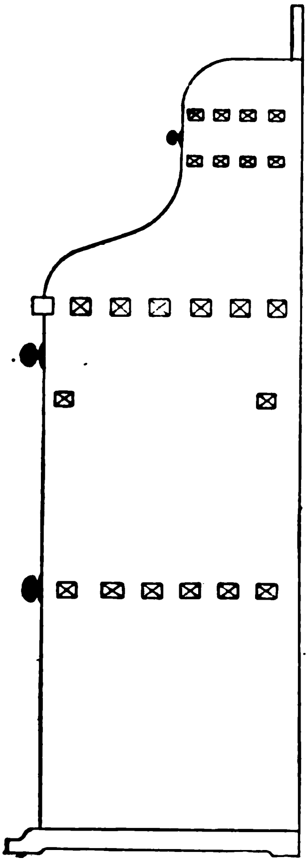

Fig. 2.

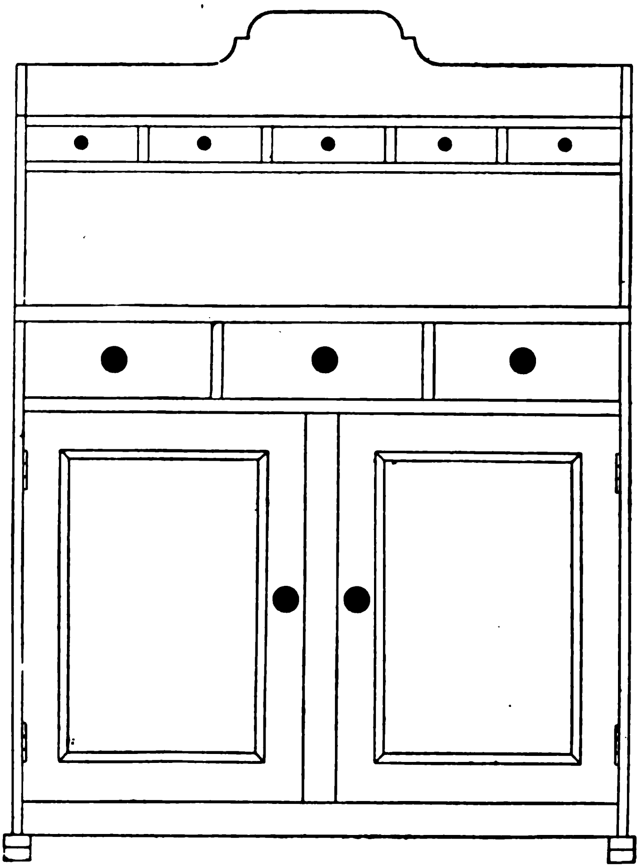

Fig. 1.

In some parts of Scotland it is invariably found in the house of a working man, and is considered an indispensable part of his bride's outfit. In other parts again, it is rare to see a modern kitchen dresser, such as here illustrated; so much does this prevail where I locate that I have made but three during twenty years. I should feel proud if some of our handy amateur friends took up the task of making such a dresser as this in localities where it may not yet have been seen, as I am confident it would be highly appreciated, and for this purpose I shall be as minute and clear in its description as I possibly can. The dresser, fig. 1, is made of best clean yellow pine, with the exception of the drawer fronts, which are either of solid mahogany or veneered. It consists of two gables of the form shown in fig. 2. Their extreme length is 5ft. 2in.; breadth at the body, 20in.; breadth at the small drawers, 10in.; thickness of stuff, 1in. Cross-pieces, 2in. square, are mortised on the lower ends of these gables, and project 2½in. in front, with an "ogee toe." Over the three large drawers is a top 1¼in. thick; it is 3ft. 2in. from the floor, and projects over the drawers ¾in. This top is of the same breadth as the gable, and reaches to within ¾in. of their back edges, where a gauge line is drawn for the back lining.

The five small drawers have a board above and below them 9¼in. broad, ¾in. stuff, the four divisions being of the same thickness. The clear space between the top and this range of drawers is 10½in. The small drawer fronts are 2¾in. broad; the large ones 6in. broad.

It will be observed by reference to fig. 2 that the pieces over and under the drawers, and also a shelf opposite the centre of the drawers, are all let through the gables by tenons, and diagonally wedged. These tenons are the full thickness of the respective pieces they hold. Begin by dressing up two pieces for the gables, which should be of ¾in. stuff, and in one piece, without jointing. Prepare in the same way a piece for the top 20in. wide, of 1¼in. stuff; a shelf 18in. wide, of 1in. stuff; two pieces to go above and below the small drawers, each 9¼in. wide, of ¾in. stuff; and a fore edge and back edge to go under the large drawers 3in. wide, of 1in. stuff. These pieces being planed carefully to thickness, square their ends to 4ft. long, being careful that all the pieces are truly squared and exactly of the same length. This done, take the thickness of each respective piece and mark two parallel lines on gables with cutting-knife and large square; these marks are to be a shade less apart than the thickness of the pieces to be tenoned in. Mark the gables in this way carefully on both sides for mortises, always working with the large square from the *front* edge. On the outside the marks are to be a little more apart, to allow for wedging. Set the cutting gauge to the thickness of the gables, and gauge the ends of each piece for tenons. Divide the ends of top into thirteen equal parts; rip with dovetail saw down to gauge line, and cut out six of the parts, leaving seven pins. For the shelf below divide into eleven parts; cut out five, leaving six pins. The pieces above and below the five small drawers are divided into seven equal parts, after allowing a ½in. shoulder at the front. Three of these are cut out. Cut ½in. shoulders on the ends of the front edge and back edge. This done, proceed to gauge the gables ¾in. deep for back lining. Now draw the mortises on the gables by means of the tenons already made. Lay the gables flat down on the bench; have all the tenoned pieces marked with pencil in the order they are ultimately to be fixed, place them flat down on the gables, and draw each with their pins lying on the mortise lines, keeping their back edges flush with the checks in gables; draw with the drawpoint on each side of each pin between the parallel lines on the gables. Turn the gables over and draw on outside exactly in the same way, taking particular care that the pins lie exactly where they did before, so that the mortise holes may come square through the gable. The surest way to do this is to set marking gauge to ¾in., and gauge very lightly on outside of gables, as previously done for back lining; the various pieces are placed for drawing even with this line. Having thus marked all the mortises, take a centre-bit and brace and bore a hole through the centre of each mortise; this opens it up. Now, with sharp thin ground chisels, cut down by the lines from both sides, taking care not to bruise the edges of mortises. This done, try the various pieces, and see that they enter their respective row of holes. Now square the bottoms of gables for the 2in. by 2in. cross-pieces.

Draw for four mortises 3in. long, with spaces of 2in. between them upon the cross pieces, and gauge them along the centre with two parallel lines, ½in. apart. Mortise these end pieces right through. Gauge the ends of the gables—also in the centre of their thickness—to form tenons, which are 2in. long. The ogee toes are to be worked on these pieces, and hollowed out beneath, as fig. 2. These ready, the gables are to be shaped at top, as in fig. 2. The front curve is a quarter circle of 4in. radius, the second a reversed quarter circle of 5½in. radius, and these two are joined by a straight line. The part opposite the small drawers is straight, and projects ½in. Above this is a quarter circle of 4in. radius, then a list of 1in., and the top part level. Cut out one gable, and finish it with spoke-shave and chisels; then draw the other from it. Saw out and place both evenly together, catching them with hand-screws and bench lug; in this position finish both with sandpaper.

The next step is to make a base rail—that is, the one underneath the two doors, fig. 1. It is 2½in. broad, and 1¼in. thick, and is mortised into the two gables with its under edge resting on the cross-pieces. The mounter—that is, the pieces between the two doors—is also 2½in. broad, and 1¼in. thick. It is let into the base rail at bottom, and into the fore-edge underneath the drawers; in both cases it is let through and wedged.

We now have the two gables shaped out—mortised to receive the various shelves and top; tenoned at bottom to receive the cross pieces; and marked at back for lining.

Our next work is to put together the carcase or case for the five small drawers. This consists of the upper and lower boards, 9¼in. broad and ¾in. thick, and four divisions of the same thickness. The four divisions need not extend to the back, but may be made 7in. long, their breadth being 3½in. Make pins on the ends of these divisions, as shown in fig. 3, ¾in. square and ⅜in. long. It should be observed that the grain of the wood runs in the direction of the height of the divisions.

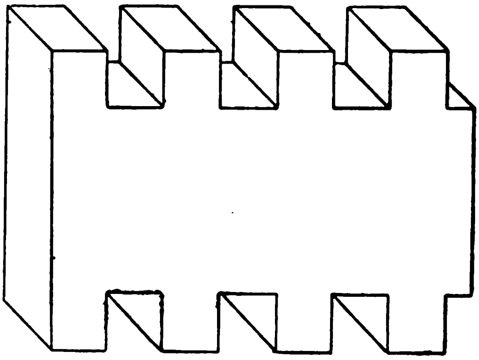

Fig. 3.

Divide the upper and lower boards into five parts, by parallel lines, ¾in. apart, between which the mortises are to be made. Some makers groove these divisions in and nail them—others make dovetailed grooves; this latter is a difficult job to do well. The method by mortising is easier done, and certainly the strongest of the three.

Finish marking for the mortises, using the pins as a gauge. With a ¾in. mortise chisel cut out the mortises from one side, to the depth of ⅜in. or ½in., being careful to have the sides of mortises straight and well cleared out. See that the pins fit nicely into the mortises. They are ready now for gluing, after being smoothing planed. Place the divisions in the bench lug, and make diagonal cuts with dovetail saw in their ends for wedges, as shown fig. 1. Make some 50 or 60 small wedges, about ¾in. wide, $\frac{1}{16}$in. at the thick end, and ½in. long. They may be rapidly sharpened, and cut from a long strip of the right width and thickness, with a sharp paring chisel.

Begin wedging by inserting the ends of the wedges into the diagonal slits, splitting a second wedge up the centre, and placing a half on each side of the whole one. Lay the lower board upon the bench, mortises upwards; put a little glue in each. Now drive all the tenons on the ends of divisions into the mortises. The wedges will be driven into the slit, and, spreading the tenon, will hold the whole together by a kind of dovetail.

Treat all the divisions in this way, and see that the job is square by applying a bench square across its face. If a division coincides with the blade of square, then it will do.

A frame is next made for the large drawers. It consists of the front and back edges, already referred to, into which two cross rails, 3in. wide, are mortised exactly under the divisions between the drawers.

These divisions are 6in. in width, and have tenons top and bottom. These tenons are 2in. long; they are fixed into mortises made in the top and cross rails, in the same way as adopted for small drawers. The mortises go right through the cross rails, and are wedged firmly after the tenons are in.

The length to make the two cross rails will be found by placing the front and back rails in their respective mortises in the gables and measuring between. They may be thinner than the front and back edges, but they must be all flush on the upper side, as their object is to carry the drawers.

The upright mounter between the two doors is 2½in. wide, 1¼in. thick, and 30in. long. It has a ½in. tenon on each end, and is let through the base rail and rail below the drawers, the whole being flush on the face. The length of the mounter will, of course. be found by measuring on the gable between the respective mortises for the two rails.

In the operation of glueing up, the front and back rails and two cross pieces forming the frame under the large drawers, are first glued and fixed. The two divisions are glued and wedged into the cross-pieces, the top having already been wedged to the divisions as directed above. When dry, the ends and edges are cleaned off. The gables are now smoothing planed on inside and lower part of outside. The bottom cross pieces are cramped on to the gables and wedged, the inner sides being cleaned off.

The top, small drawer case, frame under large drawers, and mid shelf being all cleaned off and papered, the ends of the pins on all the parts are to be diagonally slit for wedges as above directed. Wedges are to be made as broad as to fill the diagonal cut in each piece, when they will be ready for glueing together.

You should have two cramps, taking in about 4ft. 3in., and two pieces of wood as long as the breadth of the gables—two persons are necessary to do this part of the work. Cramp the mounter and base-rail into the top, and lift it altogether, placing each part into its proper place in one of the gables. Place the other upon the upstanding ends, enter, and rap down with hammer and piece of wood. Stand the job now in an upright position, and cramp with long cramps, and cross sticks, using shorter sticks at the small drawers above. When cramped quite close, wedge as before directed —one whole and two half wedges.

Go over the whole of the tenons in this way; try if the job is square, either with rod diagonally or with large wood square. Apply a cramp to press home the centre mounter, and wedge it up. Two fillets are to be made and screwed to the gables for drawer guides. They are 1¼in. square, and must be level with the upper side of frame. They are bored for three screws, and also glued to the gables. Two other fillets are fixed on the frame. These are also guides between the drawers; they are of the same breadth as the thickness of the short uprights in front. As these two are side guides (not bottom guides like the former two), it is usual not to fit them in until the three drawers are neatly fitted in their places; then they are fitted to slide easily but not loosely, between the drawers from behind, when they are rubbed in with a little glue, and afterwards nailed to the rails under them.

This part of the work done, we have now to fit in a bottom; this is fitted close behind the base-rail, and reaches to the check in the back of gables. Its length is exactly the width between the two gables, and the ends rest upon the cross pieces at bottom of gables, which project ½in. inwards, and in this position it is screwed to these cross pieces and also in front to the base rail. The method of screwing to the base rail must be explained, however. Gouge pieces out of the under side of the bottom to about ½in. in depth, stopping ¾in. from the front edge. With a ¼in. bit, bore holes through the edge into these gougings; these are for 1½in. screws; the screws are inserted from the gougings and enter the base rail. These gougings for screws may be 9in. apart, distributed along the front, and the bottom fixed in this way makes a firm and durable job. This is illustrated fig. 4.

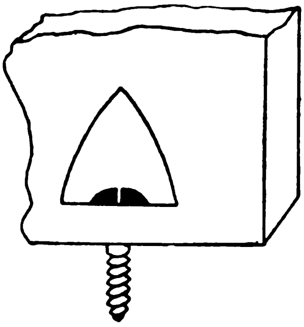

FIG. 4.

Now we have got the carcase ready for the drawers and doors, and before cleaning it off on the outside we should make these.

The drawers are fitted and made precisely as described for kitchen table drawers. The fronts may be Bay or Tabasco mahogany, or if something richer is wanted, they may be made of pine and covered with good veneer. In either case fit the fronts into their openings neatly—first the under edge, then the ends one after the other, and, lastly, the upper edge, by drawing from the inside with draw point. If the front just enters the aperture, it is sufficient, but see that it is quite close all round. Mark the fronts 1, 2, 3, so that you make no mistake while working, and in grooving for bottoms see you don't turn them upside down. Treat the five small drawers in the same way. The three large fronts are ⅞in. thick; the five small ones are thick enough at ¾in. The sides and backs of large drawers are ⅝in., and for small drawers ½in. wood. Mark the sides in pairs, and number them like the fronts. Plane the under edges only, and square both ends to half an inch less than the length from front of carcase to back check. It is the practice to run the grooves for the bottoms before squaring the ends, then two small tongues of wood are inserted in the grooves, which hold each pair of sides evenly together, and in this way the ends are squared in pairs. The backs are squared exactly same length as fronts. Take two of the tongues used in squaring sides, place them in the groove in the front near the ends, then place the under edge of the back against these tongues, lay them on the bench with front uppermost, and draw back along the ends of front with cutting knife; plane exactly to those cuts on the shooting board. Gauge the back 1in. narrower than the front, so that, as groove takes ¾in., the back will be ¼in. below edge of sides in the finished drawer. The small drawers are treated in the same way, the sides may be ¼in. shorter than the depth of the case to receive them. The drawer bottom plane should be not more than ½in. in width, with a ⅛in. iron.

We have now got to dovetail the drawers. The fronts, sides, and backs having been cut to length, squared and grooved, set a cutting gauge to the thickness of the sides. First take the fronts and gauge them on the ends, both on *inner face* and on the *end*. The first for the depth to which the side is let into the front; and the second, for the distance that the end of side comes towards the face of the fronts. Both ends of the sides and backs are to be gauged with the same setting of the gauge. In the same way set the gauge for the five small drawers. Proceed now to cut five pins on the ends of the fronts, and four on the backs, as shown in figs. 5 and 6. Mark off a pin on each corner—one in the middle, and one in the middle of each remaining half. Saw them by placing the front in the bench lug, inside face towards you. The saw cut must reach only to the line gauged on the end wood, and downwards to that on the face. In sawing the backs the saw cuts level through and down to the line on both sides. With the backs also, and indeed with all kinds of dovetailing, the inner face, or the wide side of the pins, is kept towards you when sawing down. Divide the ends of backs into four pins equally distant, as in fig. 6. Cut out all wood between the pins with thin sharp chisels and mallet, taking care not to go too deep with the fronts, which are not dove-tailed through. In drawing the sides from the pins, lay a pair of sides on the bench. Stand the front on them at the proper end, flush at bottom edge, when the two grooves will coincide, the front of the pins being exactly at the gauged line; draw carefully on each side of the pins with draw point. Draw for the backs in the same way, keeping lower edge of back flush with the groove in the side. The portions that were covered by the ends of the pins are now to be carefully sawn, and cut out with chisels, the outer corners of side (fig. 5) being cut both ways with the saw, and afterwards pared to gauge-line with chisel.

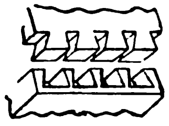
Fig. 5.

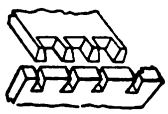
Fig. 6.

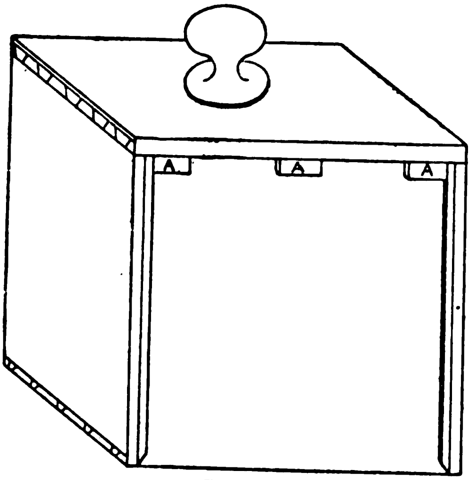

Fig. 7.

It will be sufficient to give the small drawers four pins on the fronts and three on the backs. When these are well dovetailed, clean and sandpaper them on the insides, and put them together with thin glue as described for kitchen table drawers. The bottoms for the three large drawers are of ⅜in. wood, those for small drawers of ¼in. wood. They are also put in exactly as described for kitchen table drawers. When the bottoms are in they are to have fillets, ⅜in. square, glued on the under side, carefully fitted to side and bottom, also two or three fitted behind the front. Fig. 7 shows a drawer when finished and having the filleting, as here described. The short fillets (*a*, *a*, *a*) are of hard wood, as they are to act against stops on the frame, to stop the drawer at the proper place. These stops will be described further on.

These drawers, having hardened for some time are to be planed and fitted into their respective places as originally marked. Plane the fillets on the bottom flush; then gauge the sides to same breadth as front. Try if they now enter the apertures; if not, take off another shaving or two, but do not take off more than just enough. Plane the sides level with front and back, and try it again. Note where it appears too tight in the frame, and reduce this part. When the draw pushes in all the way, though stiffly, leave it for the hand-plane and sandpaper to make easier. Fit all the drawers in this way, then go over them with hand-plane, until they glide smoothly and easily. Drive two or three 1¼in. nails through the bottoms into the backs. Clean off the backs, and, lastly, the fronts, seeing that the whole front of each stands evenly with the face of the frame. If the fronts are pine, and are to be veneered, teeth them now, and proceed to veneer them with a hot caul.

Before putting on a veneer, if it is a good Spanish, it will likely show the figure better one way than another. The way to find this is to hold the veneer in the position it will occupy on the job, and also at the proper height from the floor. When in this position turn it upside down and back foremost—you will see at once in which position the figure shows best to the light. Having found this, mark it with pencil, and place it on the front in the same posiion.

You may veneer two fronts at once by heating the caul both sides. Have the caul well soaked with linseed oil to prevent the glue sticking.

When the drawers are veneered, they must stand aside for a day before cleaning off.

Our next operation is to make two doors. Make four stiles, 3in. broad, and 1¼in. thick. They should be 2in. longer than the height of the aperture to receive them. Then make four rails same breadth and thickness. Note:—*All upright pieces of framing are called stiles, and all lying or horizontal pieces are called rails.* Draw in the stiles for mortising and the rails for tenoning. Find the height and width of the apertures in the dresser front, place the stiles on edge on the bench, and draw at each end with pencil, the breadth of a rail at the *outer lines* being a little further apart than the height of the opening. Then mark off ½in. from the *inner lines* towards the ends. From this line mark off 1¾ in. towards the ends. Between these last two lines is the portion to be mortised, leaving ¾in. at the extreme end to give strength to the frame. When drawing in the rails deduct the breadth of the two stiles from the width of opening, allowing ⅛in. for fitting; draw in the shoulders at this with cutting knife. Now gauge for ⅜in. mortise-iron in the centre of the stuff. Mortise about 2in. deep, taking care to have all mortises in the centre of the stuff for their whole depth, otherwise the framing will be twisted. When the rails are tenoned the thickness way, gauge the inner edge of tenons ½in. to be ripped off, and ¾in. bare to rip off the outer edge; then the tenon should fill the mortise. Cut it to within ⅛in. of the depth of the mortise. All these pieces, being mortised and tenoned, are to be grooved for the panels. This is done in the centre of the stuff with a flit plough and

¼in. iron, the groove being ½in. deep. All this grooving must be done with the outer face of each piece towards you, and, to avoid mistakes, they should previously be marked with pencil.

Now rap one of the frames together; dry, and find the size to make the panels, measuring to the bottom of the grooves. Make the panels a shaving less than this size; run a groove in a bit of wood with the plough, which will serve for a gauge for thickness of panel at edges. The panels are ½in. wood, carefully dressed on both sides and squared up to size; then they are "fielded" on the front. This fielding consists of a splay with a list; this splay is 2in. broad, and when in the groove 1½in. is shown. Planes are sold in pairs, or rather threes, the third being for the end wood for this fielding; but in their absence it may be done with a skew rabbet. These panels are to be papered both sides; after which the whole may be glued up. A small moulding is made and mitred round the frames against the panels. It may be a quarter round, or a ⅝in. ogee, as in the example shown fig. 8, which is a section of the door through the stiles, showing the grooving-fielded panel and ogee moulding. Sometimes the edges of stiles and rails are stop-chamfered, and have no mouldings whatever. The doors are put together with cramps, which should remain on for an hour or two. When cramping together see that the stiles are level—that is, that they touch a straight edge in their whole breadth. When fitting these doors to their respective apertures, first of all plane both sides level with half long. If the ogee moulding is to be inserted it may now be put in and nailed with fine brads. The ends of small mouldings like this are usually mitred on the mitre-board, by shooting the plane on its side. Fit the doors now by cutting off the over ends of stiles. Plane one edge and the bottom, then see that these two coincide with the side and bottom of the aperture. This being correct, place a piece of thick veneer at each corner below the door, and draw along the top on the inside. Plane to this line, when the door will have a clearance of the thickness of the veneer. Plane the door to width, giving $\frac{1}{16}$in. of clearance. Both being fitted in this way, are to be smoothing-planed on both sides and sandpapered; they will be hinged and fixed on when the carcase is quite finished.

Fig. 8.

Our next work is to put a back lining on our dresser. This may be put on in two ways: one way being to have all the wood running across, and the other to have the lower portion from the bottom to the dresser top running up and down, and the remaining portion, where it is seen below and above the five small drawers, running across. It may be done whichever way the wood suits best; and if done the latter way the joining of the two portions will be in the centre of the thickness of the dresser top.

This back lining is ⅝in. thick, and the various pieces must be joined together by match ploughs, with what is called groove and feather jointing. A $\frac{3}{16}$in. bead is run on the face at the feather edge, to make the join look better when the pieces are put together. The portion of the back that is shown above the main top should be done in two pieces, the joint coming in behind the row of small drawers. By a reference to fig. 1, where the completed dresser is shown, it will be seen that the middle part of the back is higher than its sides. The shoulders are formed of a hollow and round, divided by a list; the hollow and round are drawn with compasses set to 2in. radius. This back should be planed both sides, but especially smooth on the exposed part.

See that the bottom, mid shelf, back rail of frame, top, and the case of small drawers are all level or flush with the check at back of the gables which is to receive the back lining; and this being so, proceed to put it on by fitting the edge of the first board neatly into the check in the gables. Square the upper end and let it reach from a line drawn in the centre of the thickness of top to an inch below the bottom, which rests on the cross pieces at the floor. This fitted, run $\frac{3}{16}$in. bead along the edge which abuts on the check. Nail this board with 1½in. nails. Proceed to fit the second board by cutting the ends as before; drive it into the groins of the first by using a piece of wood to protect the edge. The aim should be to finish with a board of the same breadth as the first one, but this, though it looks better, is immaterial. The upper ends of these boards being even, proceed to fit the first board over them—this is the one seen in front underneath the small drawers. This one has a groove in its upper edge to receive the second board, which should be shaped as directed before fixing. Both these boards are to be nailed on like the others, or, better still, put on with 1¼in. No. 8 screws.

Now we are ready to stop the drawers. If the back lining is screwed on as above, the five small drawers may be stopped by sticking pieces of wood of the proper thickness on the back behind the drawers—two pieces for each. The drawer fronts should go within the face of the frame $\frac{1}{16}$in.

As to the large drawers, two stops are made for each as in fig. 9. They are of hard wood, such as oak or mahogany, 2in. square and ¾in. thick. They are glued and nailed on the frame under the drawers $\frac{1}{16}$in. further from the face than the drawer-front blocking reaches, so that the drawers, when pushed in, will go $\frac{1}{16}$in. within the face of the frame. If these drawers are veneered on the face, a word may be said as to cleaning them off. They are first planed with hard wood hand-plane, set very close. I may here remark that all veneers are planed, however thin they may be, excepting perhaps root walnut. When it is exceptionally thin it is scraped with a steel scraper. This is a piece of steel about 4¼in. x 3in., and the thickness of a saw blade. The manner of setting it up for working is somewhat peculiar, and should be seen performed by a practical hand. The scraper is first ground on the edge, the object being to have the edge at right angles with the sides and slightly convex in the length. After this grinding there is a slight barb on either side; this is removed by rubbing the scraper with the sides lying flat on the set stone; then the edge is rubbed by holding it upright. The object also being to have the edge square. All the rough marks of the grindstone being now removed, the scraper-sharpener comes into use. This is a rod of hard steel fixed in a handle. It is about 4in. long and ¼in. thick, and should be very smoothly polished. The scraper is held in the left hand, with its end against the bench, and the steel sharpener is applied to its edge at a slight angle, as in fig. 10, and rubbed firmly with strokes beginning next you and ending at the bench. This has the effect of turning the edge over towards the side with a fine barb. The opposite corner of the same edge is turned over in the same way, and the other edge of the scraper treated in the same way. When this scraper is properly set up it will take a fine shaving off

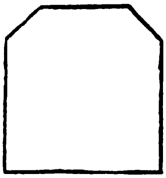

Fig. 9.

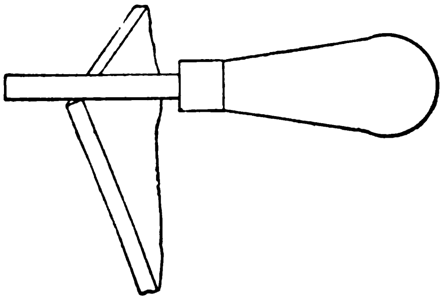

Fig. 10.

mahogany, 2in. broad, at every stroke. When using it is held with the fingers and thumbs of both hands, and the upper edge inclined forward, as in fig. 11, the cutting stroke being in the direction of the arrow. When one edge gets blunt turn another, till all four are used up, when you re-sharpen. This is done as follows:—Lay the scraper flat down on the bench at the front, run the sharpener smartly several times along the side of the scraper, which will turn any remaining barb towards the edge, then turn it up as before, and turn the barb over as at first. This sharpening may be repeated five or six times before the scraper needs re-grinding.

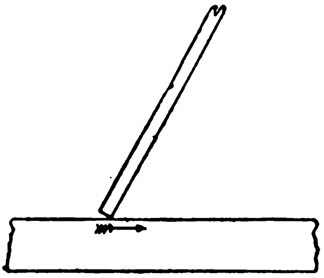

Fig. 11.

Having planed your drawer fronts, scrape them as above till all roughness has disappeared. When they are finished with Nos. 1½, 1, and 0 sandpaper, they are then bored in the centre for a 2in. patent zebra knob, all glue cleansed from inside, and they are finished. The small drawers being finished in the same way are bored for 1in. patent zebra knobs.

Now for hingeing the doors. Get two pairs 3in. brass butts, sink them into the edge of the door stiles 3in. from the top and bottom, with the round or pin edge to the front; they are to be sunk a shaving less than the thickness of the hinges doubled up, and the centre of the pin in the hinge is to be flush with the face of the door. Make two little conical pieces of wood like fig. 12, which is full size; shut one inside of each hinge with the point sticking through. Place two little bits of veneer on the base; put the door in its place resting on these veneers. Push the door against the gable and the two cones will make a mark; bore in these marks with a bradawl, and hang the doors with one screw in each hinge. See that it shuts without rubbing at any part, and also that it remains shut without springing outwards. Both doors being hung thus, see that they stand flush with the face of the dresser all round—if not, this may be put right by easing the screws and moving the door in or out as wanted. When it hangs properly the other screws are screwed in. The doors are fastened with two "turnbuckles." One of these is shown complete, fig. 13, and consists of a zebra knob, with an iron spindle. A portion of this is squared and screwed for a small nut; behind the nut is the projecting tongue of metal. When the knob is turned round, this tongue catches behind the mounter, thus securing the doors.

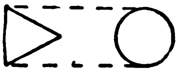

Fig. 12.

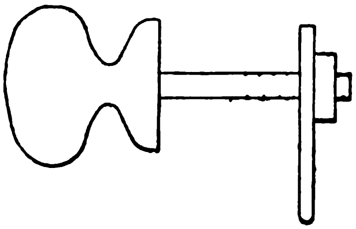

Fig. 13.

The whole job is now to be gone over, and all marks of fingers, etc., removed with a very fine plane and fine sandpaper.

We may now consider our kitchen dresser about finished. The eight drawers should be French polished and all the pine work may be left white or varnished at discretion. When left white the new appearance soon goes off, and the dresser requires frequent washing. Some housewives have a very hurtful way of cleaning the dresser by using fine sand on the cloth with water, and the result is that all the clean sharp corners are rounded and rubbed off, the hard grains in the wood stand out, and the whole thing soon assumes a very unsightly appearance. Sometimes the dresser is made to look very pretty by being painted and grained oak, but I am not an advocate of make-believes. Good pine has no need of disguising, or being made to look something it is not.

I may here mention that a "brand new" dresser is at this moment coming into the market, something after the style of the present so-called art furniture. It is very handsome, being a mixture of pine and mahogany, or pine and American walnut.

I shall next show this new design, with a short description sufficient to enable anyone who has studied the construction of the one just finished to make the other.

* * *

To Polish Fancy Woods.—Soft wood may be turned so smooth as to require no other polishing than that produced by holding it against a few fine turnings or shavings of the same wood while revolving. Mahogany, walnut, and some other woods may be polished by the use of a mixture as follows: Dissolve by heat so much bees-wax in spirits of turpentine that the mixture, when cold, shall be of about the thickness of honey. This may be applied to furniture or to work running in the lathe by means of a piece of clean cloth, and as much as possible should be rubbed off by using a clean flannel or other cloth. Hard woods may be readily turned very smooth; fine sandpaper will suffice to give them a very perfect surface; a little linseed oil may then be rubbed on, and a portion of the turnings of the wood to be polished may then be held against the article while it turns rapidly around, which will in general give it a fine gloss.

To Clean Brass.—The government method prescribed for cleaning brass, and in use at the United States arsenals, is claimed to be the best in the world. The plan is to make a mixture of one part common nitric acid and one half part sulphuric acid in a stone jar, having also ready a pail of fresh water and a box of sawdust. The articles to be treated are dipped into the water and finally rubbed with sawdust. This immediately changes them to a brilliant colour. If the brass has become greasy, it is first dipped in a strong solution of potash and soda in warm water. This cuts the grease so that the acid has free power to act.

HARDENING AND TEMPERING STEEL.

BY JOSHUA ROSE.

PART II.

IN former times the hardening by fire and water and tempering by the colour test were exclusively employed for hardening and tempering, except in cases where elasticity was the property sought to be imparted to the steel, and in this case a process termed blazing off (which will hereafter be treated of) was substituted for the colour test, and in those days the term *hardening* was understood to denote the process of heating to a cherry red and cooling in cold water; this was sometimes further defined if either of the terms "giving the steel all the water" or "hardened right out" were used to particularly specify that the steel was not to be extracted until reduced to the temperature of the water. The necessity for these terms arose from a practice, that sometimes obtained, of withdrawing the steel from the water before it was quite cold, and many excellent hardeners and temperers there are, who, at the present day, withdraw the steel from the water when it has sufficient heat left in it to rapidly dry off the water adhering to it, the result being, it is claimed, to alter the degree of hardness to a practically imperceptible degree but to add considerably to the strength of the hardened steel.

In those days tempering was understood to mean the second process, whose object was to modify, to a definite degree, by the colour tests, the effects of the first hardening. Since the introduction of the other methods of hardening and tempering above referred to, the terms hardening and tempering have come to be used by many persons indiscriminately, and it is a fairly debateable question what process should be termed hardening and what tempering. First, then, any degree of hardness less than that obtainable in a given quality of steel, heated to the brightest degree without causing the chemical change known to smiths as "burning the steel" to set in, must be a degree of temper, notwithstanding that it would have no representative colour under the colour test, because it is a degree of hardness less than the maximum.

In practice a toolsmith usually heats cast steel to what he terms a cherry red; anybody, however, who has watched an ordinary blacksmith heating tools to harden will have observed that "cherry red" practically includes all ranges of temperature between blood red and a red verging upon deep yellow, the blacksmith being perfectly satisfied so long as the steel was not burned. The difference in the hardness obtainable by these two extremes of heating is not of practical importance in steels of fine grade; but in steels of inferior grade, as some grades of spring and sheer steel, it is so great that a blood red will not appreciably harden, while a yellow red will harden beyond the highest degree attainable under a colour test. The question arises, then, shall a piece of steel possessing any of the degrees of hardness laying between that denoted by a yellow under the colour gauge and the highest attainable by giving the steel a maximum of heat (short of burning the steel) and "all the water," be termed hardened or tempered? Now of these degrees of hardness we have no clear conception, having no practical means of gauging it. If we give to a machinist a tool of a particular shape, he has such a clear idea of the hardness and strength it will possess when tempered to a colour, that he can determine how hard it can be made to perform a given duty, or about to what colour it must be made to leave it strong enough to withstand the strain due to a given duty. Or if we give him a piece of steel soft at one end and hard at the other end, the graduation proceeding uniformly from end to end, he can take a file and, after testing the hardness, mark upon the steel with tolerable accuracy the sections corresponding in hardness to a blue, a purple, a brown, and a straw colour, and would know of what hardness to make a tool that would cut the steel at any particular section not too hard to entirely resist cutting. This knowledge he has obtained from manipulations performed upon steel of all degrees of colour temper; but if we were to give him a piece of steel harder than any degree denoted by a colour and yet not of maximum hardness, he would be dealing with an utterly unknown quantity.

"Tempering," applied to define the degrees of hardness denoted by the shades of colour ranging between the palest yellow and the deepest blue, conveys (in connection with a colour as, say, tempered to a straw colour) a clear idea of a definite and recognisable degree of hardness; but made to include a greater degree of hardness than is denotable under the colour test, it would cover in its meaning a number of unknown quantities which seriously impair if not even destroy its whole value.

From this it appears that the word *tempered* (as applied to steel) should properly apply to all degrees of hardness denotable by colour in the colour test, and that "hardened" should include all degrees of hardness above that denoted by the palest yellow on the colour test. Under this interpretation the meaning of the word will be extended to include all single processes which give degrees of hardness denotable by colours, hence the original meaning will be preserved to that extent. On the other hand, however, there is little doubt that the word was originally applied to the process because that process *tempered* or *modified* the degree of hardness of the steel, as indeed is proved by the fact that it was and is very often used interchangeably with the term *lowered*; thus, to *lower* to a blue was and is to temper to a blue. This is further attested by an old expression which is still in common use, viz., to draw the temper; thus, *drawn* to a blue implies that a piece of steel, "hardened right out" or "given all the water," has had its hardness reduced, or drawn, to the degree denoted by a blue colour.

We have, however, another consideration, in that steel given a definite degree of temper (corresponding to a colour under the colour test) by a single heating and quenching process has not been *tempered* in the sense that it has been lowered or suffered a reduction of hardness; on the contrary, it has received an increased degree of hardness. We may, indeed, stretch a point and claim that it has suffered a reduction of softness, but then *temper* is understood to mean, directly, a degree of hardness, because normal softness is in practice understood to be the condition as regards softness in which steel is supplied by the manufacturers. If from this condition it is rendered softer by softening processes, that is termed softening, while all degrees of hardness above that must come under the head of either hardened or tempered.

We have then to choose between including in the term "tempered" all processes which act to reduce the hardness of the steel to a degree recognisable under the colour test by a colour, or to confine its meaning to all processes by which the degree of hardness is modified, lowered, tempered or lessened. In view of the fact that the result reached and the object sought in either case is to obtain a definite degree of hardness comparable to that obtained under the colour test, the former interpretation is undoubtedly the best. In any event it is an error to apply the term *tempered* to processes which, at one operation, leave the steel harder than any degree answerable to a colour in the colour test; while it has been shown that a process which reduces the hardness of the steel without bringing it down to a degree denoted by a colour in the colour test should be termed hardening.

This matter would be considerably simplified if, instead of the colour, the degrees of temperature were specified; thus tempered to 460°, would mean the same degree of hardness as a straw colour, and all the degrees of hardness above that would be specified in less degrees of temperature, and all degrees of softness down to a blue with a green tinge would be included in ranges of temperature up to 630°. The degrees of softness below that, being indistinguishable by either a colour test or any other known indication save the ease with which it can be cut, would still remain unknown quantities or degrees. This plan would remove another technical objection to the colour test, which is that the presence of a colour obtained on a piece of steel by subjecting it to heat is no evidence that the steel possesses any above its normal degree of hardness; for steel, wrought iron, or even cast iron that has been softened to the lowest degree, will assume, on a polished surface, all the colours, providing that they are heated to the necessary temperature; hence the presence of colour is simply proof that the steel has been heated to a certain temperature, but by no means proof that it possesses temper, or indeed that the process of heating has in any way modified the degree of hardness or softness.

Tempering, when performed by a second operation, reducing the hardness obtained by a previous one, is dependent for its uniformity upon the uniformity of the first one; hence, if a number of pieces of steel of the same grade be heated to an equal temperature and plunged in water until cooled, and are subsequently tempered to the same shade of colour, they will all possess an equal degree of hardness; but if other pieces of steel of a different quality or grade (this may be further specified by saying "containing a different percentage of carbon") be subjected to precisely the same processes, leaving upon them the same temper colour, while this latter batch will be uniform in hardness, it will not possess the same degree of hardness as the pieces of the first batch; hence temper colour may be used as proof of equality in the degree of temper in pieces of the same steel, but is not indicative of any determinate and uniform degree of hardness. In tool hardening, this fact assumes but little practicable difference, because for tools a special quality of steel, termed tool-steel, is supplied, which will harden sufficiently to give accuracy to the colour test tempering, when heated to any degree of heat answerable to from a blood red to a yellow red, the difference of hardness in steel quenched, from either of these degrees of heat, being too small to be of practical moment in all tools comparatively inexpensive to make. In tools that *are* expensive, it is desirable to give the exact degree of temper which experiment has determined as the best. It will be noted that in the colour test the shades of yellow alone extend over a range of 70° of temperature, and tool users know that within these 70° lies a wide range of hardness. It is better, then, to adopt a tempering process that will determine with approximate accuracy the first heating temperature, such, for example, as by heating the article in some flux, such as melted lead, melted salt, or melted glass, plunging it into a cooling mixture or liquid whose temperature can be maintained, by suitable means, somewhat equable, and drawing the temper in a bath maintained at the required thermometrical temperature. By this means, the steel used being a brand known for its uniformity, both the hardening and the tempering will have the greatest practically obtainable degree of temper, and the tools will be hardened more answerably to the requirements of the duty than is obtainable under the colour test. This plan is, indeed, largely resorted to when large numbers of pieces require tempering; but if the articles are large, or tempering requires to be done piecemeal and at odd times, it will not pay, as a rule, to keep heating and tempering mixtures constantly ready upon the fire, and the open fire and colour gauge must be resorted to. It is under these latter conditions that the whole of the skill of the hardener and temperer is called into play, since, from the moment the steel is placed in the fire until it is cooled, all through to the temperature of the water, judgment and expertness are qualities absolutely essential to entire success.

In heating steel to harden it there arise many considerations, the principal of which are as follows:—

As the steel becomes heated it expands; and if one part becomes hotter than another, it expands more, and the form of the steel undergoes the change necessary to accommodate this local expansion, and this alteration of shape becomes permanent. In work finished and fitted this is of very great consideration, and, in the case of tools, it often assumes sufficient importance to entirely destroy their value. If, then, an article has a thin side, it requires to be so manipulated in the fire that such side shall not become heated in advance of the rest of the body of the metal, or it will become locally distorted or warped, because, though there exist but little difference in the temperature of the various parts, the more solid parts are too strong to give way to permit the expansion; hence the latter is accommodated at the expense of form of the weakest part of the article. It does not follow, however, that the part having the smallest sectional area is the weakest when in the fire, unless it is as hot as the rest of the body. For example, suppose we have an eccentric ring, say half-inch thicker on one side than the other, and heat it midway between the thick and thin sides to a cherry-red; while those sides are barely red-hot, the part heated to cherry-red will be the weakest, and will give way most to accommodate the expansion, because the strength due to its sectional area has been more than compensated for by the reduction of strength due to its increased temperature. The necessity of heating an article according to its shape then becomes apparent, and it follows that the aim should be to heat the article evenly all over, taking care especially that the thin parts shall not get hot first. If, then, the steel is heated in the open fire, it may be necessary to take it from the fire occasionally, and cool it with water, and to so hold it in the fire that the thin part is least exposed to the heat. If the article is large enough the thin part may be covered, or partially so, during the first of the heating by wet ashes. If, however, the article is of equal sectional area all over, it is necessary to so turn it in the fire as to heat it uniformly all over; and in either case care should be taken not to heat the steel too quickly, unless, indeed, it is desirable to leave the middle somewhat softer than the outside, so as to have the outside fully hardened and the inside somewhat soft, which will leave the steel stronger than if hardened equally all through. Sometimes the outside of an article is heated more than the inside, so as to modify the tendency to crack from the contraction during the quenching; for to whatever degree the article expands during the heating, it must contract during the cooling. Whether the heating be done in the open fire or in a heating mixture, it must be done uniformly, so that it may often be necessary to hold the article, for a time, with the thick part only in the melted lead or other heating material; but in this case it should not be held quite still, but raised and lowered gradually and continuously, to ensure even heating.

The size of an article will often be an important element for consideration in heating it, because, by heating steel in the open fire, it becomes decarbonized; and it follows that, the smaller the article in sectional area, the more rapidly this decarbonization takes place. In large bodies of metal the decarbonization due to a single heating is not sufficient to have much practical significance; but if a tool requires frequent renewal by forging, the constant re-heating will seriously impair its value, and in any event it is an advantage to maintain the quality of the steel at its maximum. To prevent decarbonization for ordinary work, charcoal instead of coal is sometimes used, and where hardening is not done continuously it is a good practice, because a few pieces of charcoal can be thrown upon the fire and be ready for use at a few minutes' notice. Charcoal should be used for the heating for the forging as well as for that for the hardening. Green coal should never be used for heating the steel for the hardening, even if it is for the forging process, because, while the steel is being well forged its quality is maintained, but afterwards the deterioration due to heating is much more rapid. A coke suitable for heating to harden should be made and always kept on hand. To obtain such a coke make a large fire of small soft coal, well wetted and banked up upon the fire, and with a round bar make holes for the blast to come through. When the gas is burnt out of the interior coal, and the outside is well caked, it may be broken up with a bar, so that the gas may be burned out of the outside, and then the blast may be stopped and the coke placed away ready for use at a moment's notice. Good blacksmiths always keep a store of this coke for use in taking welding heats, as well as for hardening processes. It is desirable that the article be heated as quickly as possible so as to avoid decarbonization as much as possible. If an article has a very weak part, it is necessary to avoid resting that part upon the coal or charcoal of the fire, otherwise the weight may bend it; and in heating long slender pieces they should bed evenly in the fire or furnace, or, when red hot, the unsupported parts will sag. In taking such pieces from the fire the object is to lift the edges vertically, so that the lifting shall not bend them; and this requires considerable skill, because it must be done quickly, or parts will get cooled and will warp, as well as not harden so much as the hotter parts.

We now come to the cooling or quenching, which requires as much skill as the heating to prevent warping and cracking, and to straighten the article as much as possible during the cooling process. The cooling should be performed with a view to prevent the contraction of the metal from warping the weaker parts; and to aid this those parts are sometimes made a little hotter than the more solid parts of the article, the extra heat required to be extracted compensating in some degree for the diminution of sectional area from which the heat must be extracted. Water for cooling must be kept clean, and in that case it becomes better from use. It may be kept heated to about 100° Fahr., which will diminish the risk of having the article crack. Cracking occurs from the weaker parts having to give way to suit the contraction of other parts, and usually takes place in the sharp corners or necks of the articles, or through the weakest section; hence, in articles found to be liable to crack, such corners are made as rounded as possible. If the water is very cold, and the heat is hence extracted very rapidly from the outside, the liability to crack is increased, and in many cases the water is heated to nearly the boiling point, so as to retard the extraction of the heat. Since, however, the hardening of the steel is due to the rapid extraction of its heat, increasing the temperature of the water diminishes the hardness of the steel, and it is necessary to counteract this effect as far as possible, which is done by adding salt to the water, the steel hardening more thoroughly in the saline mixture.

All articles that are straight or of the proper form when leaving the fire should be dipped vertically, and lowered steadily into the water; and if of weak section, or liable to crack or warp, they should be held, quite still, low down in the water until cooled quite through to the temperature of the water. If the article is taken from the water too soon, it will crack; and this is a common occurrence, the cracking often being accompanied by a sharp audible "click." Pieces of blade form should be dipped edgeways, the length of the article lying horizontally and the article lowered vertically and held quite still, because, by moving it laterally, the advancing side becomes cooled the quickest, and warping and cracking may ensue. Straight cylindrical pieces are dipped endwise, and vertically. When, however, the dipping process is performed with a view to leave sufficient heat in the body of the article to lower or temper the part dipped, the method of procedure is slightly varied.

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To Restore the Colour of Kid.—If calf-kid begins to look reddish and rusty, give it a slight application of oil, which will probably restore the colours, but if not, put on blacking. When the blacking has dried, brush it off, and go over it again very lightly with oil, when it will be as good as new. Patent leather will not only be made softer, but the lustre will also be improved by oiling. For pebbled calf, or any kind of grained leather that has become brown, apply the same. When only a little red, an application of oil or tallow will often restore the colour. When it is very brown, black it thoroughly, and oil it afterwards, giving it a nice dressing of dissolved gum tragacanth to finish.

How to Melt Babbitt Metal.—I wish to say a few words in reference to the treatment of Babbitt and other similar anti-friction metals. Workmen who are accustomed to mixing or treating metals while in liquid state, will generally melt such metal upon a blacksmith's forge by applying heat so rapidly that the ladle will become red hot before the metal within begins to melt. When it has melted a dross rises to the surface and is skimmed off by the workman and thrown away. The skimming process is kept up as long as the ladle is kept on the fire. Now such a course is all wrong, because, by applying heat too suddenly, the metals which fuse at lower degrees of heat sweat out, and are burned before those which melt at higher temperatures become fluid. The dross, as it is commonly called, which rises to the surface, is in many cases the antimony or hardening property of the alloy, and should not be thrown away. The surface of the melted metal should be kept covered with fine charcoal, which will prevent oxidation. A small lump of sal-ammoniac should also be kept upon the surface of the metal. The metal should always be stirred before pouring, otherwise the heaviest metals will separate and sink to the bottom of the ladle, and a constantly varying quality of metal will be the result. By melting the metal slowly and keeping it properly fluxed as described, it will run sharp, each casting will be found uniform throughout, and the metal be of equal hardness. In observing these simple precautions, much of the dissatisfaction now experienced in using Babbitt and other anti-friction metals will disappear, and the metal not be condemned because it simply obeys the laws of nature and separates when improperly treated.

MODEL YACHTS.

PART II.

(For Illustrations, see Lithograph Supplement.)

IN the present chapter we propose to describe the preparation of the sheer-draught. Designing a yacht on paper will fairly test the patience required in a model yacht builder, so that the completion of a good plan speaks well for the success of the practical part which is to follow. Assuming at the outset, that whoever takes this affair in hand is not limited to time, no little defect should be overlooked with the mere remark that it is near enough.

The board, paper, pins, T-square, etc., having been duly obtained, the first thing to do is stretch your sheet—a simple enough matter, but there are two ways of doing even that. This is the right way: Cut your sheet at least one inch shorter than the board, then, keeping it as far as possible from the front or working edge, pin down say the nearest left hand corner firmly. Pass the right hand smoothly across the paper in a diagonal direction, and fix the remote right hand corner. The other two are to be fastened by placing one hand in the centre of the paper and smoothing away to each corner. Don't pull, but do it gently, because a sheet of paper cannot be stretched perfectly tight with drawing pins alone. However flat it may be at first, it will be found to expand and contract, more or less, after being on a while, but this will not affect progress. The sheet stretched, and T-square at hand, the pencil needs attention, not only here but often hereafter. As a good joiner may be identified by the condition of his tools, so is a draughtsman by his drawing instruments, especially the pencil points. From first to last keep a good point on your pencil, otherwise little satisfaction can be experienced in the use of it. It should have a long taper with a flat chisel-shaped extremity, and may be kept in capital trim by occasionally rubbing on a smooth file kept for the purpose. A slip of fine sandpaper or emery cloth affords an excellent substitute for the file. Take particular care that the said file or sandpaper is kept well out of reach of elbows, or some startling consequences may follow. It will be advisable to test the truth of the drawing board and T-square before commencing work. Place the square against the front or nearest edge of the board, and draw a faint but definite vertical line right up the sheet. Move the square to the left hand edge of the board, and draw a similar line horizontally. The use of the pencil compasses will soon decide whether the intersection gives a right angle or not. In many apparently excellent boards the angles are considerably out of truth, so that for the sake of safety it will be well to work entirely from the front edge, which, if not quite straight already, can soon be made so by a joiner. This means that the T-square is only to be used for vertical lines; the way to obtain horizontal ones will be shown presently.

We commence with Plate I. The names given to the respective parts of the sheer-draught are the sheer-plan or side elevation, the body-plan or end elevation, and the half-breadth plan. The sheer-plan is seen at the top of the sheet, and shows the sheer or upward curve of the deck at each end, the profiles of stem and stern, and the buttock lines or vertical longitudinal sections. The body-plan consists of two parts, the fore body or view from the fore end on the left side, and the after body or view from the after end on the right. The body-plan gives the shape of all the vertical cross sections, whatever position they may occupy on the sheer-plan. The half-breadth plan represents the outlines of the deck and the forms of the various water-lines or horizontal sections, the relative positions of which are to be seen on the sheer-plan and body-plan.

Having the paper duly stretched and pencil sharpened, draw with the T-square a vertical line exactly up the centre of the sheet. This is the centre line, from which set off 1ft. 4in. at each side, and draw the perpendiculars *a* and *f* in the same manner. Keeping the T-square still on the front edge of the board, make a spot on the vertical line *a* about 24 inches below the top edge of the paper, slide the square close up, and, making a slight mark on the blade to correspond, slide it along to the right and transfer the position of the spot to the fore perpendicular *f*. The horizontal centre-line *a f* may now be drawn with the straightedge. By adopting this method of drawing a horizontal line, namely, working from the front edge only, we diminish the possibility of any inaccuracy arising from a faulty board, as only that one edge need be straight, the others not being used. A good T-square is, in any case, indispensable. Having here one horizontal line to work from, the others may be obtained by setting off from it the height on the perpendiculars *a* and *f*, and joining with the straightedge as before. In this manner draw the base-lines of the body-plan and sheer-plan, the first 5 inches above the line already drawn, and the second 13½ inches above. That for the body-plan need not, of course, extend right across the plan, as it is only required for about 4 inches each side of the centre line. Now lay your rule full length on the centre-line of the half-breadth plan and make spots for each of the vertical sections, viz., 1, 2, 3, 5, 6, and 7. These are spaced 4in. apart, an intermediate section being introduced between Nos. 1 and 2 to assist in "fairing" the stern lines. Place the T-square on the front of the drawing-board, and draw up a line, say about 4in. long, at each spot, and at the same time draw the vertical sections on the sheer-plan, which are, of course, directly above those on the half-breadth plan. Nos. 3 and 5 may be drawn up in one length, giving us the side lines of the body-plan, which is to be 8in. wide. Mark the base-lines of the sheer-plan and body-plan to prevent mistakes, and number each of the sections on both sheer-plan and half-breadth plan. Now set up from the base-line on sheer-plan the heights of deckline. The lowest point of the deck is at the midship section, No. 4, which gives 6 inches, Plate I. being one-fourth full size. At the aft perpendicular we have 6⅝in., and the fore perpendicular 7in. The heights of Nos. 2 and 6 may be taken approximately from the plate. The remaining heights need not be transferred. Next take the long batten, and laying it so that the narrow edges are vertical, set it up to the mark on No. 4 and place a weight upon it. Fix the fore end on the spots at No. 6 and the fore perpendicular, and then the aft end on No. 2 and the aft perpendicular. At the fore end of the batten you must hold the end with your right hand, gently bending it to the spots while your left hand adjusts the weights. At the aft end the position of the hands is reversed. Lift the weights carefully one by one to give the batten freedom, and when you get it to look satisfactory, draw the line lightly but distinctly from one perpendicular to the other. Remove the weights and batten, and examine the line well. If you think it might be improved, set about it at once. So long as the line passes through the spots at the midship section No. 4, and at the perpendiculars, the batten may be allowed a moderate amount of freedom at Nos. 2 and 6. When the deck-line is quite satisfactory, the height at each section must be taken from it and transferred to the body-plan. This is not to be done with the rule, but by the use of slips of drawing paper, say 9in. long and ½in. wide, cut with a sharp knife and a straightedge. It will be as well to make a number of these slips when you are about it, say twenty or thirty, as they are in constant requisition in making a sheer-draught. Make a pencil mark on the edge of the slip about ½in. from the end, then, placing it on the sheer-plan at the aft perpendicular, set the mark to correspond with the base-line. Make a pencil mark on the slip at the height of the deck, and mark that *a p*. Move the slip along to the vertical sections 1, 1½, 2, 3, and No. 4. Turn it round and use the other edge for the fore heights from No. 4 to the fore perpendicular. When all the heights are marked on the slip, the spots must be transferred to the body-plan, those for the after body being set off a little to the right of the centre line, and those for the fore body to the left. Place the T-square on the front of the board again, and sliding a set-square up the edge, draw horizontal lines through each spot from the centre to the side line (see plan). No. 4 being the midship one will go right across. Set off ⅛in. at each side to represent half the width of the stem and stern-posts, and draw with the T-square vertical lines through each.

Leaving the body-plan for the present, draw the deck-line on the half-breadth plan, carefully measuring on Plate I. the distances from centre at each section, and setting off four times that size. Notice particularly that the greatest half-breadth on deck, which is at No. 4, is not exactly half the width of the boat, but a trifle less, say 1/16in. On referring to the midship section, it will be seen that the extreme width of the vessel is reached about the load water-line, which comes between Nos. 4 and 5. Above the load water-line it is usual for the sides of the vessel to fall in slightly, which accounts for the deck-line being within the full width of the boat. This "fall in" above water is technically called the "tumble-home." At the same time, we may add that this custom may be disregarded in the case of model yachts (as it often is in real yachts), and even without disadvantage to the boat. The reason of this was given in Chap. I., but the appearance of the craft is enhanced by a slight "tumble-home," and in the case before us it is *so* slight that the benefit to be derived by ignoring it can only exist in theory. Before placing the batten and weights in position, set off the half-width of the stem as before, and the length ¼in. abaft the fore perpendicular. Now lay the batten on its narrow side; set it up to the spots, commencing with the midship one and working to each end. Go carefully over every weight as before, allowing the batten as much freedom as possible. In this operation of *setting* the batten, the fewer weights used the better; but when ready for the line to be drawn, additional weights may be applied to keep it from moving at the touch of the pencil. Having got the deck-line in, proceed to lift on another slip of paper the half-breadths of each section from the centre-line, commencing at the aft perpendicular, keeping the fore and after breadths on separate edges of the slip, and numbering each one as it is lifted. Now return to the body plan, and set off these distances on the horizontal height lines, taking care that each half-breadth is on its own line; then, with the wood curves or moulds, draw lines through the points of intersection on each body, as per plan. Turn to the sheer-plan: set up spots above the base-line at both stem and stern for the water-lines 1, 2, 3, 4, and 5, at intervals of an inch; with the straight-edge draw the water-lines full length, and then number them at both ends. Measure with a slip the distances of the front of stem before No. 7 vertical section on the base-line, and water-lines 1, 2, and 3. The line will be seen to meet the perpendicular at No. 4 water-line. Set these off on the full size plan, but leave drawing the line until the lower edge of the lead keel is approximately shown. The depths of the keel below the base-lane must be taken and set down, from No. 1½ to No. 7 inclusive. Place the long batten and weights in position, and draw this line lightly; then turn the board round, or go round yourself, and put in the stern-line from the other side. By doing this you will be able to see the bottom line of keel which you have just drawn, and bring the stem line in through the spots to meet it. Mark off the inside line ¼in. within all the way from the deck to the base line, and having drawn that, proceed to put in the stern, working from the front of the board this time. The knuckle-line (see sheer-plan) is ⅝in. below the deck-line and parallel to it, terminating 1in. in from the aft perpendicular. The knuckle need not extend further forward than No. 1 section. Draw the sloping line from deck to knuckle. Make a spot on No. 5 water-line ⅞in. abaft No. 1 section, and draw through it the counter line from the extremity of the knuckle. This line is not straight but slightly curved (see plan). For the rake of sternpost, measure the distance from No. 1 section to where the aft side of the post cuts No 4 water-line, and draw a straight line up from the intersection of No. 1 with the base line. Show another line ¼in. within and parallel to it to represent the foreside of stern post. Now take the T-square in hand, and square down on the half-breadth plan the aft extremity of the knuckle (see plan), and likewise at the centre the points where the base-line and water-lines terminate on the fore side of stern-post. This done, move to the fore end and in the same manner square down where they meet the after side of stem, represented by the inside line. If the draughtsman should desire to modify the outline of the stem or even the rake of the sternpost, to suit his own taste, he may do so, bearing in mind that any such alteration on the sheer-plan or elevation affects the half-breadth plan also. The stem in the cutter before us is cut well away below, not merely for appearance but for safety in shallow water, as the boat will more readily jump on to and over a stone, instead of striking the stem up against it. On the other hand, let the outline of stem be brought further down, and the result would be advantageous to the boat in sailing. If the craft is intended for actual competition, the nearer the fore foot, as it is called, approaches a right angle, the better for sailing purposes, but if not, the ugly appearance of such a fore end should be avoided.

With regard to the stern a word or two may be said. The rake of the stern-post is entirely a matter of appearance; but, at the same time, an excessive rake is worse than none at all. In the instance of a racing boat just given, the best position for the stern-post and rudder would be at right angles to the load water-line, so that the rake would be slightly forward instead of aft. We are not, of course, bound to such a nicety as this, but it is well to know where the exercise of the designer's taste will affect the model advantageously or otherwise. Having these decided, draw the base-line on the half-breadth plan. You will notice it is curved, almost like one of the water-lines; this is to give the lead keel a firmer hold, but you may make it parallel if you choose. The half-breadth at the midship section is ⅜in., which set off. We have already squared the extremities down from the sheer-plan, so now allow half the thickness of the stem and stern-post at each end; set the batten to the midship and end spots, and draw the line. Take a slip, mark on it the half-breadths of the base-line from centre on every section from 1 to 7 inclusive, and number each mark on the slip. In lifting these, take care that the fore-body half-breadths are taken on another part of the slip from the after ones, to avoid confusion. This applies equally to water-lines, deck-breadths, heights, &c. Having the half-breadths of base-line marked on the slip, transfer them to the body-plan on the base-line there, setting off Nos. 4, 5, 6, and 7 to the left of the centre-line, and Nos. 4, 3, 2, 1½, and 1 to the right. We have here the points at which the respective sections meet the base-line. Having previously obtained the position of each one at the deck, we may now proceed to the sections themselves. The most important of these, it is unnecessary to repeat, is the midship section, which is to receive attention first of all. Make a pencil mark on the centre-line of body-plan ⅜in. above base-line, and on each of the vertical side-lines a similar mark 3½in. above base-line, or midway between Nos. 3 and 4 water-lines. Now draw straight pencil lines from the first spot to each of the others, and you have the "rise"-lines of the midship section. The points at which the section-line begins to curve will be found by running a horizontal pencil line across the body-plan midway between Nos. 1 and 2 water-lines, or 1½in. above base, and another ¼in. below No. 3 water-line, or 2¾in. above base. Set off spots on No. 1 water-line ⅞in. each side of centre, on No. 3 at $3\frac{5}{16}$in., and on No. 4 at $3\frac{15}{16}$in. on each side. The rise-lines already shown indicate the breadth of No. 2 water-line; No. 5 will find itself presently. Make spots on the vertical side-lines half-way between Nos. 4 and 5 water-lines to represent the point where the midship section meets the side-lines. The wood curves come into requisition now. Apply them one by one to the spots of the midship section until you are able to draw the lower part from the base to where it intersects the rise line. With a little patience it may be made to pass through the spots and meet the rise-line very neatly. Refer constantly to the plate, and see that you are following it correctly. The lower part being satisfactorily done, the upper part is to be drawn from the deck downwards. This will be easiest accomplished by turning the board round, or altering your position so that you can see the spot where the section meets the rise-line. Finish one side of the section first, then do the other; and when both are drawn carefully test with a slip the half-breadth on each water-line to see that both sides correspond. Any difference, however trifling, must be rectified at once, and both sides of the midship section made exactly alike before going any further. Supposing them to be duly checked, and corrected if need be, show in the knuckle-line on the body-plan. Measure on the sheer-plan the height of its after extremity above the base-line; set it off a little to the right of centre on body-plan, and draw a horizontal line through it to the side. Refer to the enlarged plan, and take the corresponding half-breadth from centre to the deck-line, which in this case represents the knuckle also. Set that off on the body-plan to the right; join this spot and that above, which represents the deck-breadth at aft perpendicular (see plate); then from the same spot draw a short line to represent the knuckle, parallel to the deck-line, as shown.

Now we come to the actual shaping of the hull. Plate I. shows on the half-breadth plan a line parallel to the centre, and marked "buttock-line." Set that off 1¼in. from centre-line, and extending from the aft perpendicular to where it cuts the deck-line forward. Show it on the body-plan also, 1¼in. each side of centre, and run up vertical lines from base-line to deck, intersecting the midship section between Nos. 1 and 2 water-lines. The shape of the vessel at this line is required to be shown in elevation on the sheer-plan. Refer to the plate, where you will see this has been done. Measure on the plate the height above base-line where the buttock-line crosses each section, and set these off on your full-size plan. Now take the dividers, or a slip, and see if the height above base for the midship one corresponds exactly with that shown on the body-plan. If not, alter the height on sheer-plan to suit. Take the T-square, and square up from the half-breadth plan to the sheer-plan the point where the buttock-line meets the deck-line forward. It will, of course, terminate at the knuckle-aft. With the long batten and weights proceed to put in the buttock-line in elevation on sheer-plan, laying the batten on one of its narrow sides, as in drawing the deck-line. Be particularly careful with this buttock-line, as it is of great importance. Take it exactly through the spots at the midship section and ends, and follow the intermediate ones as closely as possible. It may happen that the batten will not quite meet all of them, but by altering the position of the weights here and there you will be able to make a good line without much trouble. It *must* be right at No. 4 and the ends. When you have it in, proceed to lift the actual heights above base from the line itself, as it may have left the spots in one or two places. This, of course, is to be done with a slip of paper, as before. The fore and after body measurements should be kept separate in all cases where heights or breadths are taken thus. Transfer to the buttock-line on body-plan the heights just taken. You may now sketch lightly on the body-plan the form of each section (freehand), beginning at the proper spot on deck-line, and passing through that on buttock-line bring it down to its own place on the base. A safer plan would be to take from the plate the points where the sections cut Nos. 2 and 4 water-lines, and set them off on the full-size drawing before sketching in the approximate shape of each. The sections roughly outlined, lay a slip of paper on the body-plan with the edge on No. 5 water-line, and first making a mark at the centre, lift the approximate position of the sections at each side of it, including the midship one. Mark each spot with the number of the section, figure on the slip the number of the water-line it represents, then proceed with water-lines Nos. 4, 3, 2, and 1 in the same manner, and on separate slips if possible. Take them one by one, and set off the spots of each water-line on the half-breadth plan. With the T-square transfer from sheer-plan to half-breadth plan the points where the buttock line is crossed by the water-lines 2, 3, 4, and 5. This done, draw in the water-lines one by one with the batten and weights. No. 5 water-line may be taken from 1½ section forward with the batten, the part abaft that section to be afterwards drawn with the curves. The other water-lines may be done entirely with the batten and weights. If possible use the long batten, so that the whole length of the line is done at once; but if you find it difficult to do this, take the short batten to it, drawing first the after part of the line to a little forward of midships, and then turning the batten end for end, add the fore part from midships to stem. Keep *exactly* to the spots on No. 4 section, to those on the buttock-line, and to the correct endings at stem and stern. Follow those on the section lines as near as the batten will allow with a fair amount of freedom. The use of the weights and battens may seem awkward at first, but a little patience will do wonders. Resume the paper slips for the half-breadths on water-lines, and check these at all the sections, correcting the spots where necessary. Apply them once more to the body plan, and set off the corrected half-breadths on each water-line. Now take your wood curves and draw the shape of each section to pass neatly through the corrected spots and those on the buttock-line. Do this lightly, so that it may be erased, if necessary, without risk of rubbing a hole in the paper. Nos. 1 and 1½ will require the most care and patience in getting true. The lines should pass through the spots on the buttock-line, both on body-plan and half-breadth plan, and probably some alteration will become necessary to accomplish this. Bear in mind that alteration in the form of one vertical section may affect more than one water-line, and *vice versa*. To complete the after end of No. 5 water-line, square down from sheer-plan to half-breadth plan the extremity of that line on the counter or overhanging part of the stern, and also the intersection with the buttock-line, if you have not already got that. Then with the curves draw on the half-breadth plan a line to pass through these spots, and meet the line left unfinished by the batten. The outline of the rudder may either be copied as it is, or modified according to taste. As a check upon what you have done it will be advisable to set off another buttock-line on body-plan and half-breadth plan 2½in. from centre. Square up from half-breadth plan to sheer-plan the points where it terminates on the deck line, and lift with a slip of paper the heights above base line at the various sections, which transfer to the sheer-plan, and run the line with batten and weights as before. If the previous work has been quite fair and true, the batten will meet all the spots with ease. The after end of this buttock line will finish on the knuckle line at a point directly below that on the deck. Should you require the shape of a vertical cross section at any other position than those given, it will only be necessary to square a line across the half-breadth plan at that particular place, lift on a slip the half-breadths of the water-lines and deck-line there, and transfer them to the body-plan, when you have the spots for the line at once. If nothing of this kind remains to be done, you may proceed to ink in and finish the plan; a pleasant enough operation, and one affording an excellent opportunity to display neatness, etc. The pencil lines must be faithfully followed with the drawing pen throughout. The proper way to do it is to use black, red, and blue inks. On the sheer-plan the deck-line, knuckle, stem, stern (including rudder), base-line, and lead-keel will be black; the vertical sections and buttock-lines red; the horizontal water-lines blue. On the body-plan the centre-line, buttock-lines, side and base-lines will be red; the water-lines blue, and the remainder black. The deck-line, knuckle, and base-line, on the half breadth are to be black; centre-line, buttock-line and cross sections red; water-lines blue. The perpendiculars at *a* and *f* will be red. A neat border-line and heading will complete the sheer-draught of the cutter, after which a good clean up with india-rubber will doubtless have a wholesome effect upon it.

The schooner, Plate II., will be found to correspond in the main features with Plate I,, the clipper stem carrying the deck-line rather forward of the water-lines in this instance. The dimensions of the schooner are 48in. extreme length of hull, 10in. extreme beam, and 7½in. midship depth without the lead keel. Limited space prevents us giving this plan on a larger scale than ⅙th full size, so that great care will be necessary in taking from it the measurements for the full size plan.

In our next chapter we will proceed to describe the hull and different methods of making it.

[NOTE.—The lithograph sheets of working drawings illustrating this series will all be issued before the articles are completed. We have them in hand. —ED.]

(To be continued.)

French-Polish Receipt.—1 pint naphtha, 3½ oz. orange shellac, ½ oz. elima. Darken with red saunders wood.

SOLDERS, SOLDERING, AND BRAZING.

A PRACTICAL mechanic furnishes the "American Artisan" an article on soldering and brazing, which contains useful information for the young metal worker, and if the facts given are not new to some of the older and more experienced tin and copper smiths, they may find it convenient to have their memory quickened.

In uniting tin, copper, brass, etc., with any of the soft solders, a copper soldering iron is generally used. In many cases, however, better work may be done without the soldering iron, by filing or turning the joints so that they fit closely, moistening them with soldering fluid, placing a piece of smooth tinfoil between them, tying them together with binding wire, and heating the whole in a lamp or fire until the tinfoil melts. We have often joined pieces of brass in this way, says the writer, so that the joints were quite invisible. Indeed, with soft solder, and especially with bismuth solder, No. 19 or 21, almost all work may be done over a lamp without the use of a soldering iron or fire.

Advantage may be taken of the different degrees of fusibility of the solders in the table to make several joints in the same piece of work. Thus, if the first joint has been made with fine tinner's solder, there would be no danger of melting it in making a joint near it with bismuth solder, No. 16, and the melting point of both is far enough removed from No. 19 to be in no danger of fusion during the use of that solder. Soft solders do not make malleable joints. To join brass, copper, or iron, so as to have the joint very strong and malleable, hard solder must be used. For this purpose No. 12 will be found excellent; though for iron, copper, or very infusible brass, nothing is better than silver coin, rolled out thin, which may be done by any silversmith or dentist. This makes decidedly the toughest of all joints, and, as a litttle silver goes a long way, it is not very expensive.

In preparing solders, whether hard or soft, great care is requisite to avoid two faults—first, a want of uniformity in the melted mass, and second, a change in the proportions by the loss of volatile or oxidizable ingredients. To obtain hard solders of uniform composition, they are generally granulated by pouring them into water through a wet broom. Sometimes they are cast in solid masses, and reduced to powder by filing. Nos. 10, 11, 12, 13, 14 and 15 are generally rolled into thin plates, and sometimes the soft solders, especially No. 21, are rolled into sheets, and cut into narrow strips, which are very convenient for small work that is to be heated by lamp. Of course, where copper, silver, and similar metals are to be mixed with tin, zinc, etc., it is necessary to melt the more infusible metal first. When copper and zinc are heated together, half the zinc passes off in fumes. In preparing soft solders, the material should be melted under tallow, to prevent waste by oxidation; and in melting hard solders, the same object is accomplished, by covering them with a thick layer of powdered charcoal.

Hard solders, Nos. 6, 7, 8 and 9, are usually reduced to powder, either by granulation or filing, and then spread along the joints, after being mixed with borax which has been fused and powdered. It is not necessary that the grains of solder should be placed between the pieces to be joined, as, with the aid of the borax they will sweat into the joint as soon as fusion takes place. The same is true of soft solder applied with soldering fluid. One of the essential requisites of success, however, is that the surfaces be clean, bright, and free from all rust. The best solder for platinum is fine gold. The joint is not only very infusible, but is not easily acted upon by common agents. For German silver joints, No. 14 is excellent.

For most hard solders, borax is the best flux. It dissolves any oxides which may exist on the surface of metal, and protects the latter from the further action of the air, so that the solder is thus enabled to come into actual contact with the surfaces that are to be joined. For soft solders the best flux is a soldering fluid which may be made by saturating equal parts of water and hydrochloric acid (spirit of salt) with zinc. The addition of a little sal ammoniac is said to improve it. It is not impossible that fluxes of even greater efficiency might be discovered by a little well directed effort; but for the present these answer every purpose. In using ordinary tinner's solder resin is the best and cheapest flux, and possesses this important advantage over chloride of zinc—it does not induce subsequent corrosion of the article to which it is applied. When chlorides have been applied to anything that is liable to rust, it is necessary to see that they are thoroughly washed off and the article carefully dried. The following table gives recipes the writer has tried, and which he says will be found reliable.

TABLE OF SOLDERS.

No.	Name.	Composition.	Flux.	Fluxing Point.
1	Plumber's coarse solder	Tin, 1; Lead, 3	R	800° Fahr.
2	,, sealed ,,	,, 1; ,, 2	R	441°
3	,, fine ,,	,, 1; ,, 2	R	370°
4	Tinner's solder	,, 1½; ,, 1	R or *Z*	334°
5	,, fine solder	,, 2; ,, 1	R or *Z*	340°
6	Hard solder for copper, brass, iron	Copper, 2; zinc, 1	B	
7	,, ,, ,, ,, ,, ,,	Good tough brass, 5; zinc, 1	B	
8	,, ,, ,, ,, ,, ,, more fusible than 6 or 7	Copper, 1; zinc, 1	B	
9	Hard solder for copper, brass, iron	Good tough plate brass	B	
10	Silver solder for jewellers	Silver, 19; copper, 1; brass, 1	B	
11	,, ,, ,, plating	,, 2; brass, 1	B	
12	,, ,, ,, silver, brass, iron	,, 1; ,, 1	B	
13	,, ,, ,, steel joints	,, 19; copper, 1; brass, 1	B	
14	,, ,, more fusible	,, 5; brass, 5; zinc, 5	B	
15	Gold solder	Gold, 12; silver, 2; copper, 4	B	
16	Bismuth solder	Lead, 4; tin, 4; bismuth, 1	R or *Z*	320°
17	,, ,,	,, 3; ,, 3; ,, 1	R or *Z*	310°
18	,, ,,	,, 2; ,, 2; ,, 1	R or *Z*	292°
19	,, ,,	,, 2; ,, 1; ,, 2	R or *Z*	236°
20	,, ,,	,, 3; ,, 5; ,, 3	R or *Z*	202°
21	Pewterer's solder	,, 4; ,, 3; ,, 2	R or *Z*	

Abbreviations: R, Resin; B, Borax; *Z*, Chloride of Zinc.

THE AMATEUR WOOD TURNER.

By A. Cabe.

PART V.

We propose giving in this paper an exercise requiring the use of the cup chuck mentioned in a previous paper, in the turning of those useful as well as ornamental little articles called egg-cups. The accompanying illustrations show the egg-cup in process of conversion from the rough block as in fig. 1, to the finished cup as in fig. 5, together with an egg-cup stand which I made many years since, and have found to be a very useful breakfast table adjunct, when eggs were in season, and at a purchasable price.

Egg-cups may be made from plain box, beech, mahogany, and many other hard woods.

A block of wood, 3in. long and 2in. diameter, is sufficient to make an egg-cup, but when turned from a cup chuck, the block requires to be an inch or so longer.

The first operation is to prepare the block with an axe, as in fig. 1, then to mount it between centres in the lathe, when one end is turned down to fit the interior of the cup chuck (see fig. 2, also fig. 4), into which it is driven firmly with a mallet. The sliding headstock is moved out of the way to the right hand end of bed, the fork chuck removed, and the cup chuck with its block placed on the mandrel nose.

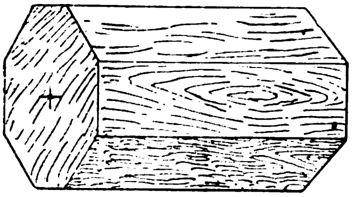


Fig. 1.—Block of Rough Wood.

If on starting the lathe the block is not running true it must be further tapped with the hammer, at the same time rotating the mandrel by turning it with the left hand. The block must also have a tight hold in the chuck so that it may not work loose, or get out of truth under the resistance imparted by the cutting tool, as in the event of the work shifting in the chuck even in the slightest degree, especially towards the finish, the job is entirely spoiled.

The first operation is to reduce the block to a cylindrical form, as in fig. 2, the diameter being nearly 2in. The next is to cut in the face, or right-

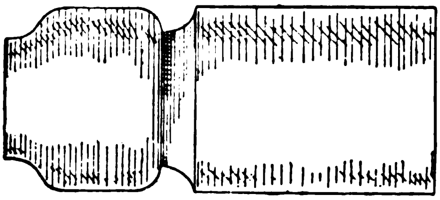


Fig. 2.—Wood Fitted in Cup Chuck.

hand end, which is to form the mouth of the cup. This is performed, as described in former papers, namely, by placing the chisel, say a ⅝in., edgeways on the rest, long corner down, and cutting square into the centre. This done, the rest is now placed *across* the bed, or at right angles to its former position, which will be parallel with the face just cut.

The rest may be placed ¼in. below the centre, and ¼in. distant from the work. The operation of hollowing out has now to be done in the end wood. This is done with a ⅝in. or ½in. gouge; the most expeditious way is to enter the gouge exactly in the centre of the work, its back on the rest, holding it level and exactly at right angles with the face of the work. By pressing it firmly it will bore a hole like a boring-bit, very quickly, to the required depth, 1¼in. Then begin at the mouth of the hold, cant the hollow side of the gouge towards you slightly, depress the handle, and cut away the wood on the side next you, always working inwards to nearly the depth of the central hole. This is continued till the internal diameter is 1½in., and the bottom having something of the form of a hemisphere.

The round-nosed tool, mentioned in a former paper, now comes into requisition, as the ordinary gouge, unless very sharp and very carefully handled, makes a rough torn surface. The round-nosed tool should also be very sharp, and held quite level on the rest. It works cleanest by beginning to cut at the bottom, and working carefully to the lip of the cup.

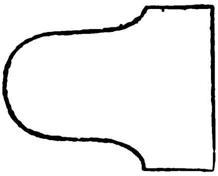


Fig 3.—Template for Inside of Egg-Cup.

Fig. 3 is a thin slip of wood, shaped to fit the interior of the cup. The curved part is not circular, but somewhat elliptic in form. Everybody knows the shape of an egg, and that eggs, in general, are not shaped alike on both ends, one being somewhat pointed. Most people also know that the pointed end should be placed in the cup, although I have heard of a worthy couple who quarrelled and separated on this *point*.

Most people would say it doesn't matter how an egg-cup is shaped, so long as it holds the egg from tumbling about; but there is a right and a wrong way of doing things. We aim at doing the right way, and in this case it is to make the cup to fit the egg. The egg end is parabolic, or elliptic, and so the slip in fig. 3 should be of that form, and applied when finishing the interior of the cup, thus forming a mould or gauge for the depth and form. With a sharp tool the interior surface should be tolerably smooth. It will be noticed from section, fig. 4, that the interior, just at the lip, is curved outwards. This part is done with the chisel. The diameter inside of this curve should measure 1⅝in.

Now as to the exterior. Fig. 4 will be the best guide. It shows the cup in section not yet cut away from the chuck. The total length is 3in., so the sole or bottom may be cut in with chisel at that, but not so deep as to damage the stability of the job. The finished diameter of the sole is 1¾in.; the extreme diameter at the mouth 2in. Beginning at the lip, the outside has first a hollow curve to the bead. This bead is ⅛in. broad, and is down the side ¼in. From the bead, the side curves down to the shank or pillar, the thickness of stuff left round the interior gradually thickening towards the bottom, where it is ¼in. thick. Feeling with the fingers will determine this thickness very nearly. To give the exterior of the cup a graceful contour, unaided by mechanical means, requires considerable practice and a good eye for forms, as this job, like most jobs in turnery, depends on the eye and hand alone for its beauty of form. The curve in question is an out-and-in one from the lip to the stalk, the bead near the lip looking as if stuck on. At the bottom of the curve is a short curve running into it from the opposite direction, leaving the stalk or pillar ½in. thick at this part. From the short curve is one termed the scotia, sweeping downwards, then upwards to the fillet on the top of the sole. The narrowest part, at the bottom of the scotia, callipers a little over ⅝in. The fillet callipers 1in., and the moulding from the fillet outwards, which forms the edge of the sole, we call an ovolo, or thumb.

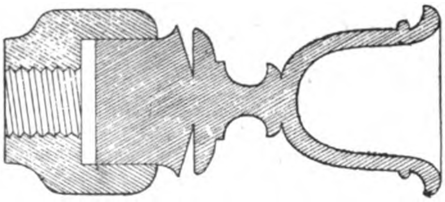


Fig. 4.—Section of Egg-Cup and Cup Chuck.

In the operation of turning the exterior, a gouge is used for blocking out to a rough outline. The bead is cut in with a chisel. From the lip to the bead the hollow is finished with small—say ¼in.—gouge. The chisel does the large curve from the bead downwards, together with the small curve under it. The sole thumb is done with a chisel down to the fillet, and, lastly, the scotia with small gouge. If all this is nicely cut with the proper tools, very little sandpaper is needed—2 grades, fine 1 and No. 0, should be sufficient, not forgetting to paper the interior as carefully as outside.

If you wish to polish the cups before cutting them away from the chuck, first of all wet the work out and in with a sponge and clean water, let stand till dry, when it will be found to be rather rough, the fibre having risen considerably; paper again with flour paper, and wipe off the dust by letting the work run through a clean rag; apply French polish with muslin rag and cotton in the usual way, holding it very lightly on the work and rotating the lathe very slowly. A few coats given in this way, then allowed to dry, when you again paper lightly with flour paper. Now you apply one or two coats of spirit varnish with a flat camel hair brush; this should be done in a warm place, as the varnish on getting chilled becomes milky looking and very unsightly. If the cup thus varnished appears rough give it a few turns of the polishing rubber, which will materially assist in giving it a smooth, glossy surface.

The cup may now be carefully cut from the chuck, the chuck taken from the lathe-nose, and the piece of wood driven out from the back with a wooden drift and mallet. Fig. 5 shows the complete egg-cup.

I once heard an old turner remark that "there was little difficulty in turning an article of graceful form with the eye, but when you had two or more to turn exactly the same, it was there the difficulty came in." So if you wish to turn half-a-dozen egg-cups you must endeavour to have them all alike, so that it may be worth while placing them upon a stand such as that shown in the annexed illustration. The sole of this stand is 8in. in diameter on the upper side; around this the six cups are placed equidistant from each other. They are held in place by a pin or dowel placed firmly in the sole, and a hole to fit loosely bored in the bottom of the cup. This sole requires a circular piece of wood, 9in. in diameter, cut plankways and chucked on a face plate; it is ⅞in. thick, and will be somewhat less when finished. The edge moulding is turned with gouge and chisel both of the small order. As the revolving plate presents side wood and end wood alternately at every revolution, the operation is more scraping than cutting, the tools being held level on the rest. It will cut better, however, to have the rest an inch *above* the centre.

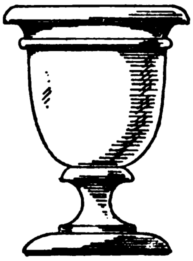


FIG. 5.—EGG-CUP COMPLETE.

The moulding finished, the rest is turned across the bed, in order to turn the face of the plate. This is trued by cutting lightly with the gouge, using the left side of the cutting edge, and depressing the handle. After it the face is finished with a broad chisel, held square on and level, working from the edge to the centre. The face should be tested with a small straight-edge, as it should be level. After the plate is nicely papered, it may receive a polish, while running, in the same manner as the cups. Then a central hole has to be cut to receive the pillar; this hole is 1in. diameter. It is sunk nearly through with a gouge—pretty much after the style of turning inside of the cups. A pair of inside callipers are set. Then a side cutting tool is used, making a parallel hole quite through when the plate will drop off the face-chuck.

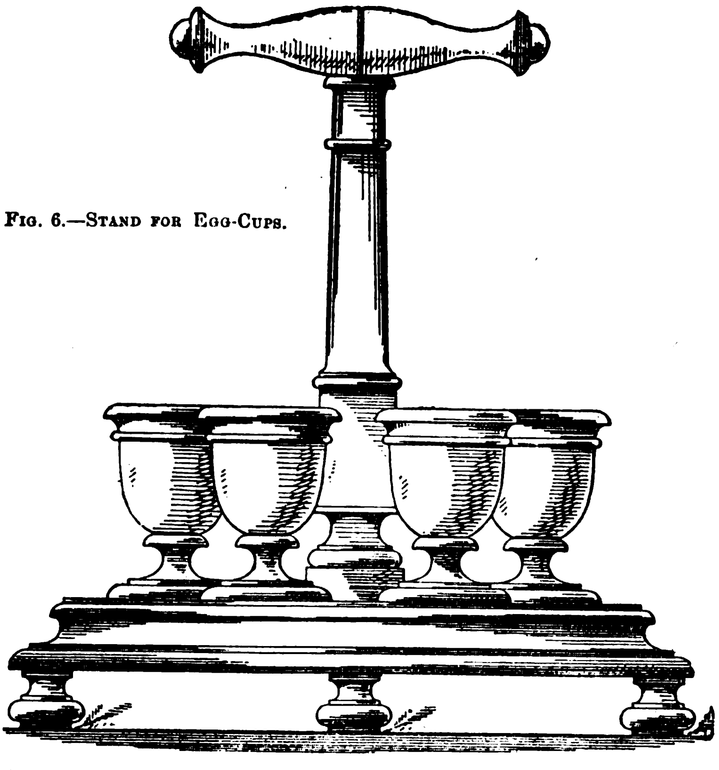


FIG. 6.—STAND FOR EGG-CUPS.

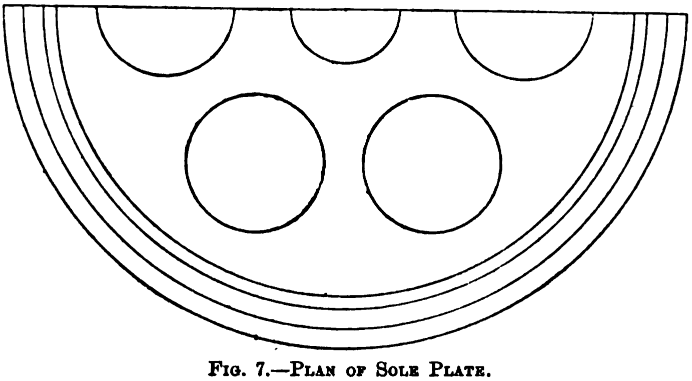


FIG. 7.—PLAN OF SOLE PLATE.

The pillar is 7in. long, and the cross handle 3in. long. The pillar, at bottom, is 1¾in. thick, the narrowest part, near the top, being ⅝in.; its outline is sufficiently indicated by reference to the illustration, fig. 6. The cross handle is ¾in. in the centre, it has a ½in. round hole bored nearly through to receive a tenon turned on the upper end of the pillar, the bottom having a 1in. tenon to fit the sole plate. Fig. 7 is a half plan of the sole plate, showing the position of the cups. The little pins, on which the cups sit, are also turned; they are ¼in. thick, and stand out of the plate ½in. The cups sit loosely on the pins, so that they may be lifted off without upsetting the stand.

The job herein described will form an excellent exercise to the amateur turner, every part, including the fitting together and polishing, being done in the lathe, and the result being a very nice shelf ornament, as well as a most useful household requisite.

SMITHING AND FORGING.

By J. L. Lowe, Brentford.

CHAPTER II.

HAMMERS, as used by smiths and engineers, vary considerably in form and size. They may be classified as follows, viz.:—Sledge-hammers: double face, fig. 1; cross pane, fig. 2; straight pane, fig. 3. Hand hammers: straight pane, fig. 4; cross pane, fig. 5; ball pane, fig. 6, also shown in Chap. I. Fig. 7 shows the most usual form of boiler maker's hammer.

Many special forms of hammers, in addition to the above, are used. Among them we may name some adapted for edge tool making, with skew panes; curved body hammers, with eye at one end, the hammer being of round section; also hammers for flatting, plating, raising or *repoussé* work, embossing, riveting, straightening, curving, chipping, etc.

Hand hammers are used from 1lb. to 4lbs. weight, according to the form and weight of the work (see Chap. I.), and principally of the shapes illustrated.

Chipping hammers must be well balanced, and may be of any shape in the pane; 8ozs. to 22ozs. comprise all the requisite sizes.

Riveting hammers are used from 1oz. to 2lbs. in weight, the smallest in lock work, model making, or any similar uses; while if required to rivet up boilers, bridge work, tanks, girders, iron buildings, ship frames or plates, they are often required fully 2lbs. each.

When we come to treat more specifically of forging, the shapes and points of the hammer will receive detailed attention. All hammers of less weight than 4ozs. may be of solid steel.

Perhaps before we begin work it would be well to see that our shop is well arranged and in order. At present we will confine our remarks to the amateur's or jobbing shop, which, if it contain more than one forge, should be, if possible, rectangular and oblong. Twenty to thirty feet, by ten to sixteen in width, make a very pretty shop. The first forge should be fixed with a hand-blower and water-tue iron, and be as near to the centre of one side wall as is convenient, the flue, of galvanised steel 18 or 20 gauge, going through the roof, and if the coast be clear should be about sixteen feet vertical above the roof, and surmounted by a lobster back swivelling cowl. Do not decrease the diameter. Rivet a ring of half-round iron about a quarter or a third of the distance from the top; into this ring rivet or screw three ½in. eyes at equal distances, and with galvanised steel wire guys and setting up swivels make fast at convenient points. With our anvil in position we shall require a few pairs of tongs to start with, and must for this time consider them made, although this does not relieve us of the necessity of forging and putting them together when in due course the time arrives.

HAMMERS.

SLEDGE:

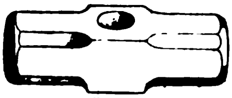


FIG. 1.—DOUBLE FACE.

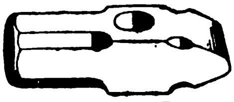


FIG. 2.—CROSS PANE.

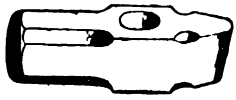


FIG. 3.—STRAIGHT PANE.

HAND:

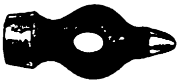


FIG. 4.—STRAIGHT PANE.

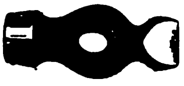


FIG. 5.—CROSS PANE.

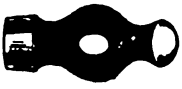


FIG. 6.—BALL PANE.

FIG. 7.—BOILER.

Sledge-hammers up to 8lbs. in weight are called "uphand," because the assistant or hammerman, simply grasping the helve in both hands, raises the hammer before him a little higher than his shoulder, making it describe a segment of a circle, bringing the face to rest on the forging, parallel with it, and with a force suited to the work in hand.

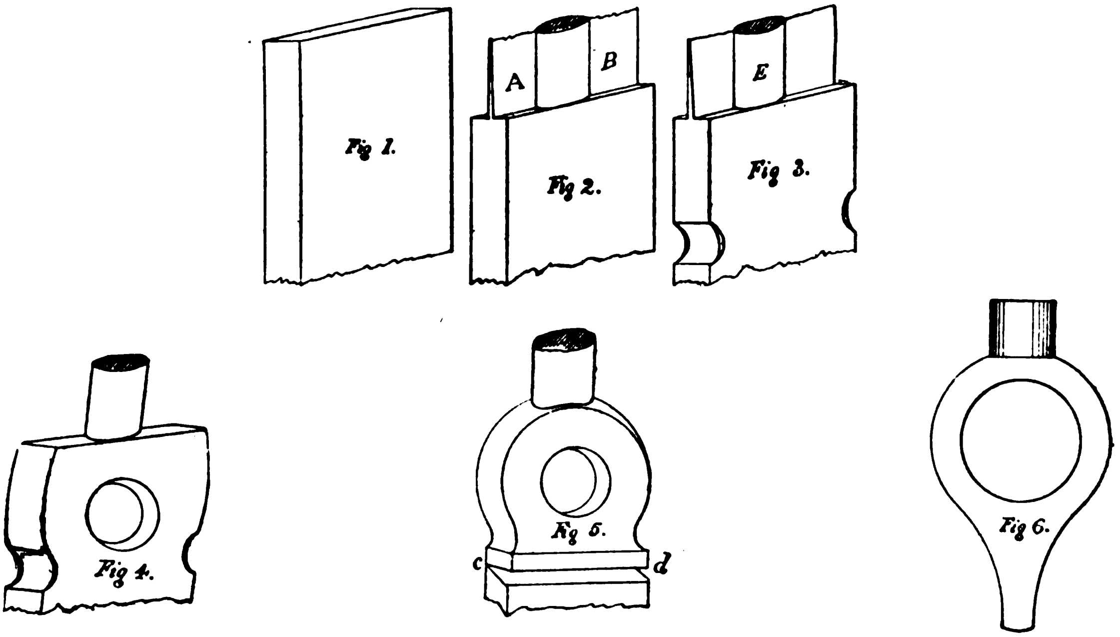
For heavier work, and where the greatest strength of the operator must be employed, the sledge is "swung." In this case the hammerman, holding the helve near the end with both hands close together, causes the hammer to perform a complete circle by swinging it under his arm and continuing the circuit described by bringing it over his shoulder, causing the face to come to rest — as in the last case—exactly parallel to the work which is being operated upon. These hammers range from 8lbs. to 16lbs. each.

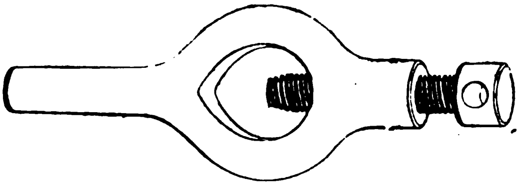
In both uphand and swinging blows the hammerman's arms act as radius rods, the forward hand in each case sliding on the handle.

There is a certain style commenced and kept up by most educated workmen which conduces to great comfort in a shop. Having had the advantage of working as mate to a good forgeman, and being now promoted from the front to the back of the anvil, we first watch him light his fire. After clearing away the ashes from the tue iron with the slice he inserts a lighted wisp of straw, a handful of oakum, a bit of rag, an old newspaper or a few shavings, and carefully drawing the best of the cinders over it gently turns the handle of the blower or jogs, the rockstaff or lever, if it is so constructed. Putting on a bit of damp coal and continuing to blow he inserts the point of the poker well in the tue iron, and chopping the caked coal down at the back with the edge of the slice, draws out the poker and finds the heart of his fire, six or eight inches in front of the forge back; it must not be allowed at any time to recede, but at each renewal kept well forward.

We will watch him, with the assistance of his mate, forging a lathe carrier to take work 2in. in diameter. Selecting a bar which is not too large, as that would involve unprofitable labour, and on the other hand big enough, or he will not have sufficient scantling for his job, he takes into account the size of his finished work, which will be at its greatest width 3in. to 3¼in., and at its greatest thickness about ¾in. From its form he knows that in manufacture it will be considerably extended, and therefore selects a bar of iron, 2in. x ⅞in. Taking a good heat at the end and slightly upsetting it for the purpose of solidification, he lays about 2in. of its length on a ⅞in. bottom rounding tool or swage, holding the corresponding top tool exactly over the bottom one. The hammerman now strikes three or four smart blows on the top tool when the heat is turned over or reversed between the tools, while the hammering by the sledge is repeated. A hole ⅞in. diameter is next punched behind the portion last operated. The bar is now fullered behind the hole with top and bottom tools, and presents somewhat the appearance of the sketch marked 4. It is cut off as shown at *d* No. 5, the portion from *c* to *d* struck edgeways and drawn down in a ½in. top and bottom rounding tool. The next and final heat is to swell the hole by means of graduated mandrels or punches driven in from each side alternately and finished at 2in. diameter. Cut out the superfluous fins or wings marked *a b*, and dress down the swaged portion *e* No. 3 to full ¾in. diameter. Set true, and the carrier is now ready to go to the fitter, who will bore, file and turn it, and lastly drilling a $\frac{7}{16}$in. hole longitudinally through *e* will tap it parallel throughout and fit a screw pin with turned head and reduced case-hardened point, the article being now finished for use.

Lathe Carrier, Showing Process of Forging.





Finished Carrier of Conventional Form.

Before closing this chapter the writer wishes to state that he will endeavour to provide an illustrated description each month of some article likely to be required in the workshop of the amateur engineer. He will, therefore, describe in the September number the process of forging small engine cranks, both in the solid—where it is intended that the space between the webs shall be slotted—and also of round iron or steel, bent and finished similar in form to those seen across the boilers of portable engines, which cranks, by the way, are usually crushed into shape in special dies, a process which would be found too expensive unless duplicated copies in very large quantities are required.

These descriptions, however, must *not* be taken to be the main object of the author's papers, but merely subsidiary to it. No amount of letterpress, no array of diagrams or drawings will do more than assist a workman; it can never make one out of raw material, or even lead on the unskilled labourer to become the skilled mechanic. The attempt must be made personally, failures must be met and fought with till they are overcome. It would hardly be too much to assert that material must be spoilt, inasmuch as we are very certain that it will be before skilfulness in the mechanical arts be imparted to the fingers. To him whose heart is in the grand processes of mastering the stubborn metal we would commend the following few rules, maxims, and axioms:—Begin as early as possible. Should you find a clock, lock, or any instrument, implement, machine or toy taken to pieces by a young gentleman in your establishment whose age may be anything you choose to name between six and ten years, before allowing your vexation to find expression quietly ascertain the motives which led to it. It may be that you have an embryo Stephenson, Whitworth or Watt in short jacket and turn-down collar, and it would be pity of pities that you should have to blame yourself for nipping his talents in the bud and diverting one who might have proved a very giant amongst men to the occupation, perhaps, of gambling on the Stock Exchange, trying to sermonise his fellow men, or vegetating as village doctor or lawyer while some cleverer man runs off with his practice. Associate yourself or your child, as the case may be, with as good a workman as you can fall in with; under his guidance and instruction you will start fair, beginning at the right instead of the wrong end, saving endless expense in improper or useless tools, abortive experiments and wasted materials, and most probably, after wasting time and money, the throwing up of your plans in disgust at your want of success.

After starting fairly buy no fresh tools till you require them, taking every precaution to discover the best and most efficient for the job. It is worse than useless to buy what you do not want because it seems cheap. Rubbish accumulates fast enough anywhere, and the amateur engineer need not try to be mistaken for a dealer in old metal. Materials of most sorts are best bought from hand to mouth; it is not ruinous on a small scale, and you will have the satisfaction of using just what you ought, you will then have no excuse for dropping into slovenly habits by acquiring that horror of every good mechanic, "making shift." If your holes are ½in. you can get ½in. bolts to fit instead of using the $\frac{7}{16}$in. which you might have had by you; if your copper boiler wants a patch you need not use brass, because at the metal warehouse they would be quite as pleased to sell you the proper article. Do not "make shift" till you have made up your mind to turn tinker.

While you will be wise not to put unlimited faith in theory, you certainly must not despise it, as practice is but its application, and far more improvements emanate from the drawing office than from the workshop: when the skilled mechanic is in a corner the draughtsman usually has to be called to the rescue. Neither can do without the other; but if you want to know who stands the highest, try to get the question answered: Which is the easiest—for the unlettered workman to become draughtsman, or for the draughtsman to turn mechanic? There is but one reply possible.

Keep your tools and your shop in first-class order. Do not be satisfied with wiping down tools after a fashion, but do it very thoroughly; at the same time examine them and see if they are all right. You cannot tell what your next job may be, nor in how much hurry it may be wanted; neither does it matter if all your tools are in order. Hammers should have their faces and panes re-dressed at the forge, hardened, ground and re-handled often as necessary; chisels dressed, hardened and ground; tongs looked to—shaky bits broken off and new ones forged and welded on, rivets tightened up; anvil well fastened down if on a wood block, and levelled by removing scales and dirt from beneath if on an iron one; water trough filled, coal trough ditto, fire well turned back, clinkers or slag removed, water tank of tue iron filled up, short ends of iron stacked away, sand box filled, vice screw and collars greased, files cleaned with scratch brush and put away in rack according to size, hot chisels and punches mended; rods looked to and new ones put on if necessary, the same to cold chisels and punches; shop well swept up, drilling machine well cleaned, benzoline run through all bearings and wiped off everywhere, self-acting feed thrown off, drills ground and placed in order in the rack. It may be mentioned, while on workshop tools, that all chisels, drills, lathe tools, and every instrument for cutting cold metal cannot have too smooth an edge; they should, therefore, be set on a hone after being ground to the proper angle. It is a sign of want of knowledge to suppose that either emery wheel or grindstone finish is good enough for drilling, chipping, turning, slotting or planing. A properly-set tool, if rightly tempered and used, will never break, and will cut faster and smoother by at least a hundred per cent. than others.

The Process of Graining.—If there are any knots or sappy places in the article, they should be covered with one or two coats of glue size, or parchment size, to prevent them showing through. The work is then ready for the paint, three different shades being necessary. These are called the ground colour, the stippling colour, and the graining or oil colour, and they are laid in the order named. An infinite number of combinations of colours are possible, obtained by the use of various colouring pigments in the different coats, and no two grainers agree as to the precise proportion of the ingredients to be used in imitating different woods; the learner can vary the proportions to suit his taste, as experience dictates, and to suit the work in hand. The ground colour is used to represent the lightest part of the grain of the wood, the stippling colour the intermediate shades, and the graining colour the darkest parts; a close study of natural woods will, therefore, be necessary to determine the colour and depth of each. The proper ground being selected, apply one or more coats—as many as are necessary to thoroughly cover the surface. As soon as the ground colour is hard, the stippling coat may be applied. This is prepared by mixing the dry pigments without oil, with either very thin gum-water, stale beer, or vinegar containing a small portion of dissolved fish-glue. The pigments to be used are usually about the same as those used for the ground colour, but of different proportions to produce a deeper shade. Apply the stippling colour, and before it dries beat it softly with the side of the stippler, the long elastic hairs of which, disturbing the surface of the laid coat, cause the lighter coat beneath to become indistinctly visible, and produce the effect of the pores of wood. Next apply the graining colour; as soon as it is laid, take the rubber and with it wipe out the larger veins to be shown, after each stroke wiping the paint from the rubber with a cloth, held in the other hand, for that purpose. Some grainers use a small sponge for veining, and others a small piece of cloth over the thumb, but the rubber is probably the most convenient. When the veins have been put in, to imitate as closely as possible the markings of natural wood, the various steel combs are brought into use, and the edges of the veins, and sometimes other portions of the work, combed with them, to soften the abrupt transition from the dark to the lighter shades. The blender is also now brought into use, and wherever the work may require it, the colours are still more softened and blended by its soft hairs. When too much colour has been removed in veining, or when a certain figure, such as a knot, is required, the work is touched up with a fine brush, and again softened with the blender. When dry a coat of transparent varnish should be applied, having considerable oil to render it durable, as grained work is frequently washed. Ready-made graining colours are recommended as best and cheapest.

ON THE MODERN SYSTEM OF CUTTING METALS.

(*Continued from page* 177.)

THE writer considers milling the most important system used in the cutting of metals, and would willingly dwell more upon it if time would permit. He will confine himself, however, to giving a few particulars as to the time occupied and the finish produced by milling machines, in comparison with the planing machine, the shaping machine, and the slotting machine. It is found practicable, and in most cases it is exceedingly advantageous, to finish (or, as it is usually termed, to "machine") almost every class of work, such as is now usually finished by planing, shaping, or slotting machines, in one or other of the numerous kinds of milling machines already in use.

It may not be generally known that in this class of machine milling cutters are being used of diameters ranging from 12ft., used for heavy engine-work, down to ¾in. or ½in., used principally for the intricate work required in sewing machines, small-arms, etc. By the former, the work done is what is known as face-milling: the mill itself is somewhat similar to a large lathe face-plate, and the several cutting portions are steel tools inserted into it and firmly secured by a series of set-screws or keys. On the other hand, the milling cutters of the small sizes, from ½in. up to about 8in. diameter, are made from solid blocks of cast steel, or blanks, as shown in figs. 33 to 38.

The term "milling" is more generally understood in the United States than in this country. It means the cutting of metals by aid of serrated revolving cutters, each having a number of cutting teeth. Milling cutters have been used in this country for many years, but until recently with only a limited amount of success, owing to the expense and difficulty of producing their cutting edges and keeping them in order. This was next to impossible before the introduction of a machine, with a small emery wheel and compound slides, etc., for carrying the milling cutter whilst being re-sharpened. Hence in the old system of milling, which did not permit of the re-sharpening of the hard teeth, the results were, that after much expense and time had been bestowed on a cutter (including a quantity of hand-labour spent upon it while in its unhardened state), the whole was as it were upset by the process of tempering; the accuracy which had previously been imparted to it being usually quite destroyed by the action of the fire and sudden cooling. In some cases the cutter would be found slightly warped or twisted; in others it would be oval or eccentric; and most frequently, when set to work on a truly-running mandrel in the milling machine, not more than one-third of the number of its teeth were found to be cutting at all, the others not coming in contact with the work. This really meant that not more than one-third of the proper feed per revolution could be applied, and not more than one-third of the proper work produced. Nor was this the only drawback: the quality of the workmanship produced by such a milling cutter was not of the best, and deteriorated hourly from blunting and wear. Such a cutter would probably not work for more than two whole days before it would require to be again softened by being heated red hot and allowed to cool gradually. The expensive and unreliable process of re-sharpening by hand-filing had to be gone through once more; then the re-tempering, which caused the cutter again to become warped, swelled, or eccentric; and each time it was subjected to the heat of the fire, it ran the risk of being destroyed by cracking when plunged into the cold bath.

It is necessary now to describe the modern system of making and maintaining the improved milling cutters. A cast-steel forging, or blank as it is usually styled, is bored, and then turned to its proper shape in a lathe. The teeth are then machined out of the solid to their required forms, in a universal milling or other machine. This work is so accurately produced, direct from the machine, that no costly hand labour need be expended upon the milled cutter, which is taken direct from the milling machine to the hardening furnace, and tempered. The hole in the centre of the cutter is then carefully ground out to standard size, so that it may fit accurately, and without shake, on the mandrels both of the grinding machine and of its own milling machine.

The cutter, or mill *c*, fig. 39, is now placed on the mandrel *m* of the small cutter grinding machine; the mandrel itself is adjusted vertically and horizontally by ordinary slides, and by means of a worm, *w*, and worm-wheel, *b*, to its required angular position; and each tooth is ground or re-sharpened by passing it once rapidly forward and backward under the small revolving emery-wheel *h*. The mandrel fits easily into the cutter which is being ground, so that the latter may be readily turned round by the thumb and finger of the operator.

The exact mode of setting such cutters is as follows:—The clearance angle, *l j k*, on each tooth is obtained, and maintained by the emery-wheel *h*, of which a specimen is exhibited. The clearance is obtained by adjusting the centre *i* of the emery-wheel *h* a short distance horizontally behind the vertical line *d m* through the centre of the milling cutter. The shorter this distance, *d i*, the less the amount of clearance imparted to each tooth of the milling cutter *c*. The upper dotted line, *j l*, is a tangent to the circumference of the milling cutter, drawn from the point of contact *j*; and the lower dotted line, *j k*, is a tangent to the emery-wheel from the same point. The angle formed by these two lines is the angle of clearance.

Each tooth is held in its correct position by means of a stop *s*, while the milling cutter is rapidly traversed once forward and backward under the emery-wheel. As will be seen by the arrows, the tendency of the emery-wheel is to keep the cutting edge which is being ground close up against the stop *s*. There is no more difficulty in grinding spiral cutting edges than straight ones; and face and conical cutters can also be ground correctly, and with the same amount of ease.

Milling cutters are made of the required forms to suit the various shapes they are intended to produce; and all the ordinary forms can be used in any milling machine, either of the horizontal or vertical class.

The face milling cutters, figs. 40 and 41, are of disc form, and are among the most useful. They are constructed to cut on one face and on the periphery, and they produce very perfect finish, especially on cast iron. This form is also very useful for stepped work, which, even when not of the simplest form, can be readily and reliably finished to standard breadths and depths, so that the pieces may be interchangeable, and fit together without the slightest shake or play, just as they leave the machine, and without any hand labour bestowed on them.

Another ordinary and very useful form is the cylindrical cutter, fig. 42, with teeth cut spirally over its circumference. This is largely employed for cutting flat, vertical, or horizontal surfaces; for finishing concave and convex curves; and for complicated forms, made up of straight lines and curves. With this spiral arrangement of the teeth, and with reliable means of re-grinding or re-sharpening them, very high-class machine work can be produced. Some experiments have been made by cutting a spiral groove or thread into the outer surface of one of this

COMPARISONS OF TIME OCCUPIED IN ROUGHING-OUT AND FINISHING METAL SURFACES IN MACHINE TOOLS.

Class of Work.	Kind of Metal.	Size and number of Surfaces.	Shape of Surface machined.	Time occupied by				Remarks.
				Milling Machine.	Planing Machine.	Shaping Machine.	Slotting Machine.	
Lower part of 4½" pedestal . . .	Cast iron	18" X 6"	Flat under surface	One cut over, 7¾ minutes	One cut over 11¼ minutes			
Ditto	Cast iron	18" 6"	Ditto	2 cuts, 16 min.	2 cuts, 22 min.			
Ditto	Cast iron	Two 6" X $\frac{9}{16}$" Two 6" X ½"	Vertical surfaces Horizontal surfaces	4½ minutes	. . . . . .	38 minutes	. . . .	In the milling machine all these four surfaces were roughed out and finished at one pass, whereas four passes are needed in the shaping machine.
Ditto	Cast iron	Two 2¾" diam. each	The upper surfaces of two bosses	2 minutes each	. . . . . .	3½ minutes		
Cap for ditto . .	Cast iron	One 1⅝ diam. Two 2½ „	Horizontal surface Ditto	1½ minutes 3 „ each	. . . . . . ,	. . . .	. . . .	Cannot be done except in a milling machine.
Ditto	Cast iron	Two 6" X $\frac{9}{16}$" Two 6" X ½"	Horizontal surface Vertical surface	4½ minutes	. . . . . .	38 minutes		
Plate	Wrought iron	6¼" X 3"	One flat surface	Finished in 6 minutes at one cut	. . . . . .	8 mins. roughing 3 „ finishing — 11 „ total	. . . .	The milled surface quite as good as the shaped.
End of Flat Joint	Wrought iron	One convex & two concave surfaces	. . . .	18 minutes roughing and finishing	. . . . . .	. . . .	44 minutes roughing and finishing	
Plate	Mild steel	2¾" X 6"	One flat surface	5¼ minutes finished at one cut	. . . . . .	13 mins. roughing 7 „ finishing — 20 „ total		
Surfaces of Pawl .	Mild steel	Three curves .	. . . .	18 minutes roughing and finishing on curves	. . . . . .	. . . .	36 minutes roughing and finishing curves	
End of a reversing lever	Mild steel	. . . . . .	Two flat surfaces and 2 curves	17 minutes				

class of mills, and thus reducing the aggregate length of its cutting surface. The results appear to be, practically, as follows:—If half the length of cutting edges are dispensed with, only about half the maximum feed per revolution of the cutter can be applied by the machine; if three-quarters of the length of the cutting lips are left intact, three-quarters only of the aggregate feed can be used; and so on in the same proportion.

Other mills, again, are made in the form of small circular saws, varying from ¼in. to 1½in., or more, in thickness. The teeth in some of these are simply cut around the circumference; others have their teeth extending some distance down each side, their edges radiating from the centre of the mill, as in figs. 43 to 45. Towards the centre they are reduced in thickness, so as to clear themselves. These cutters are useful for a very great variety of work; for instance, the cutting of key-ways, parting off or cutting through pieces of metal, and making parallel slots of various widths, for the broader of which two or more cutters may be used side by side.

Conical and angular milling cutters, figs. 33 to 38, are much employed for a great variety of work, such as the cutting of rymers, the making of milling cutters themselves, bevelling, cutting the serrated part of hand and thumb screws, nuts, etc. Figs. 34 to 37 are edge views of four of these cutters; fig. 33 is a face view, and fig. 38 a section of one of them.

Any complex forms, such as the spaces between the teeth of spur, mitre, and other wheels, can be machined by using what are known as the patent cutters, which can be re-sharpened as often as required by simply grinding the face of each tooth. They are so constructed that, however often they are re-ground, they never lose their original curved forms, and always produce the same depths of cut. One of these cutters, for instance, will cut the same standard shapes of teeth in a spur-wheel, after it has been used for years, as it did the first day it was started.

There is risk of fracture in making large milling cutters out of one solid cast steel blank, the principal difficulty being in the tempering. In practice, it is found that if they are required of larger diameter than about 8in., they are better made of wrought iron or mild steel discs, with hardened cast steel teeth so securely fitted into them that they do not require to be removed. The cutting edges can then be re-sharpened in their own places, as in the case of the ordinary milling cutters; thus ensuring that each shall have the same angle of cutting and clearance, run perfectly concentric, and therefore do a maximum amount of cutting in a given time. It must, however, be borne in mind that the smaller the diameter of the milling cutter, the better finish it will produce; and cutters of large diameters should only be used to reach into depths where one of smaller diameter could not, or to do the heavier classes of work. Again, the smaller the cutter, the less does it cost to make and maintain.

The writer has not had an opportunity of actually testing the relative amounts of engine power required for driving milling machines, but, as far as he can judge from ordinary practice in doing ordinary work, he has not perceived that any more power is required to remove a given weight of shavings than that required for a lathe, planing machine, or shaping machine, with efficient cutting tools in each case.

The cutting speed which can be employed in milling is much greater than that which can be used in any of the ordinary operations of turning in the lathe, or of planing, shaping, or slotting. A milling cutter, with a plentiful supply of oil, or soap and water, can be run at from 80ft. to 100ft. per minute when cutting wrought iron. The same metal can only be turned in a lathe, with a tool-holder having a good cutter, at the rate of 30ft. per minute, or at about one-third the speed of milling. Again, a milling cutter will cut cast steel at the rate of 25ft. to 30ft. per minute.

The increased cutting speed is due to the fact that a milling cutter, having some thirty cutting points, has rarely more than three of these cutting at the same time. Each cutting point, therefore, is only in contact with the metal during one-tenth of each revolution. Thus, if we suppose it is cutting for one second, it is out of contact, and therefore cooling, for the succeeding nine seconds, before it has made a complete revolution and commences to cut again. On the other hand, a turning tool, while cutting, is constantly in contact with the metal, and there is no time for it to cool down and lose the heat imparted to it by the cutting. Hence, if the cutting speed exceeds 30ft. per minute, so much heat will be produced that the temper will be drawn from the tool. The same difficulty, to a great extent, applies to the cutting tools in planing, shaping, and slotting machines. The speed of cutting is governed also by the thickness of the shaving, and by the hardness and tenacity of the metal which is being cut; for instance, in cutting mild steel, with a traverse of ⅜in. per revolution or stroke, and with a shaving about $\frac{3}{16}$in. thick, the speed of cutting must be reduced to about 8ft. per minute. A good average cutting speed for wrought or cast iron is 20ft. per minute, whether for the lathe, planing, shaping, or slotting machine.

By the courtesy of the Institution of Mechanical Engineers we are enabled to present illustrations in *fac-simile* of those published in the proceedings of the Institution. Some of the figures referred to in our first article are numbered differently, as we did not intend to illustrate the subject so freely as we have been enabled to do. The reader can, however, easily correct the discrepancy.

Two full-page illustrations accompany this part. The next issue will contain two similar illustrations, and the discussion on Mr. Ford Smith's paper.

(To be continued.)

* * *

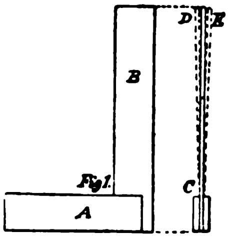
Brazing Band-Saws.—A large proportion of the users of band-saws are occasionally puzzled as to the method of repairing easily. The only really satisfactory way is to make a thick, heavy pair of tongs bright red hot, and clamp the joint with them. The heat melts the spelter instantly, and makes a good joint without scaling or damaging the steel. For a joint which has to stand constant heavy strains and bending, it is better to use an alloy of equal parts of coin, silver and copper, melted together and rolled out thin. This alloy, it is said, never burns, cannot be overheated, and makes first-rate joints which will stand hammering and bending to almost any extent.

Working Glass.—For drilling holes in glass, a common steel drill, well made and well tempered, the "Glassware Review" claims to be the best tool. The steel should be forged at a low temperature, so as to be sure not to burn it, and then tempered as hard as possible in a bath of salt water that has been well boiled. Such a drill will go through glass very rapidly, if kept well moistened with turpentine in which some camphor has been dissolved. Dilute sulphuric acids is equally good, if not better. It is stated that at Berlin glass castings for pump barrels, etc., are drilled, planed, and bored like iron ones, and in the same lathes and machines, by aid of sulphuric acid. A little practice with these different plans will enable the operator to cut and work glass as easily as brass or iron.

THE TRY SQUARE AND ITS USES.

MR. LEWIS F. LYNE writes to the "American Machinist":—The two sides of a try square should form an angle of 90°, or the one-fourth part of a circle; but in hundreds of machine shops that exist in our land there are found all sorts of tools resembling try squares in appearance, and so named, which, when the test is applied to them, are found entirely inaccurate. In other words, the angle is found to be in some instances more, and in others it is less, than a right angle.

After an apprentice becomes somewhat accustomed to a shop, he tries his hand at making a pair of callipers, working at them during his spare time. Occasionally he becomes so much absorbed in making these tools that he encroaches too much upon the time of his employers, and therefore receives a mild sort of reprimand. When he has succeeded in making a satisfactory pair of callipers, he next tries his skill in making a square. The way these tools are generally made is by taking a piece of steel for the back, planing it up to the right size, and squaring up the ends, after which a slot is cut in one end to receive the blade. The blade is neatly fitted and held securely by two or three rivets passing through the end of the back and blade. It is a very difficult undertaking, with ordinary appliances, to cut this slot precisely at right angles to the sides and ends of the back; and, when the blade is finally secured, it will be found that the blade leans to one side or the other, as shown in fig. 1 of the accompanying sketches, where *a* represents the back, and *b* the blade. *C* is an end view, the dotted lines showing the position of blade, as described.



The best way to make a square without special tools is to make a complete flat try square of the size desired out of thin sheet steel, the thickness depending upon the size of square desired.

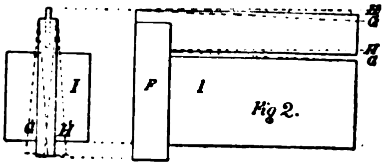
In almost every instance where squares are made by amateurs at tool making, the blades are left too thick.

After the square above described has been trued up and finished upon the sides, two pieces of flat steel should be made exactly alike as to size, to be riveted upon the sides of the short arm of the square to form the back.

To properly locate these pieces, the square should be placed upon a surface plate, and the parts clamped in position, care being taken to get them all to bear equally upon the surface plate, after which holes may be drilled and countersunk, and the rivets inserted. The angle formed by the cutting edges of the drills for countersinking the holes should be about 60°, so that when the rivets are driven, and the sides of the back finished, there will be no trace left of the rivets, which should always be of steel.

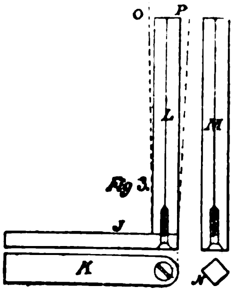
When a square has been thus far completed, a search is made about the premises for the best and truest square in the shop. A loan of the same is solicited to test the accuracy of the square being finished. Repeated attempts enable the young workman to secure a close approximation to the accuracy of the borrowed square, with which he is satisfied for the time being.

When he is required to do an accurate piece of work, he finds that in reversing his square the indications do not agree, so he tries to find the difficulty. A close examination reveals the fact that the blade is winding, besides it is slightly inclined to one side. If inclined, as shown at *e*, in fig. 1, the end of the blade only will touch a square piece of work when the tool is held in a proper position, as shown in fig. 2, where *i* represents the piece of work, and *f* the square.



It is a custom among machinists to tip the back, as shown at *g'* and *h'*, to enable the workman to see light under the blade. This only aggravates any imperfection in the squareness of the blade, for when the back is tipped, as shown at *g*, it will touch the work at *g*, occupying the position indicated by the dotted lines, *g*, *g*; whereas, if the back be tipped, as shown at *h'*, the blade will assume the position indicated by the dotted lines, *h*, *h*. These conditions will exist when the blade of the square is inclined, as shown at *e*, in fig. 1. If the blade is inclined towards *d*, a precisely similar condition will exist, except in the reverse order. It is next to an impossibility to perform accurate work, or test the same with a square having a thick edge, because of the reason already stated that the light cannot be seen between the edge of the blade and the work. We therefore conclude that the ordinary steel square, as shown in fig. 1, is not just the implement required for producing accurate work.

The most ingenious tool that I ever saw for overcoming the foregoing difficulties was a sort of self-proving square, made by a machinist in New York City. This tool is shown in fig. 3, and consists of a steel beam, *j*, showing a bottom view at *k*. In the end of this beam is a hole for the reception of a screw, with a common bevelled head. A square piece of steel, *l*, *m*, forms the blade of this square, *n* representing the end of the blade. The blade is first planed, then tapped and hardened, after which it is ground to bring the sides exactly parallel and of equal size, which makes the bar perfectly square. The back is of rectangular section, and, with this exception, is hardened and ground in the same manner as the blade. The end for the screw is then carefully ground at right angles to the sides, after which the parts are put together and the screw tightened. If the blade is not precisely at right angles to the back, it will occupy a position indicated by the dotted line, *o*; then, if the screw be loosened and the blade turned half a revolution, the edge will stand as shown by the dotted line at *p*.



The end must be so ground that the blade will occupy precisely the same relation to the beam when turned in all positions. When this is accomplished, we have a square that is a very close approximation to perfection. We test the accuracy of work with one of the corners, and when it becomes worn another may be turned into position and worn; and when all are worn the blade is removed and trued up by grinding, as at first. In testing the accuracy of the ordinary square, it is usually placed upon a flat surface having a straight edge, as shown in fig. 4, where *s* represents the surface with the square upon it. The back is pressed firmly against the edge of the surface, and with a scriber a fine line is drawn along the edge of the blade. The square is then turned to the position *t*, indicated by the dotted lines, and a second line is drawn along the edge of the blade. If the tool is less than a right angle, the line with the square in the former position will incline towards *q*, while in the latter position will appear as shown at *r*; whereas, if the square be correct, the two lines will exactly coincide with each other, as shown at *u*.

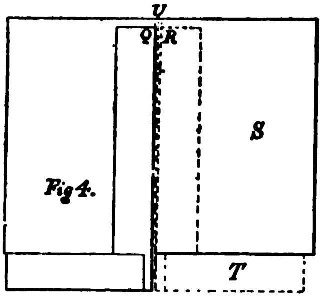


Fig 4.

This is not a reliable test for the accuracy of a square, but it answers very well in case of emergency.

It is difficult to draw the lines to exactly represent the edge of the blade, owing to the fact that the slightest inclination of the scriber to either side will make a crooked line. The form of square shown in fig. 3 always presents a fine edge to work to, and may always be relied upon for accuracy when properly fitted up. This square would seem to be quite as easily made as the common one, but the construction of an accurate try square with the ordinary machine shop appliances is a job that will test the skill of a good workman.

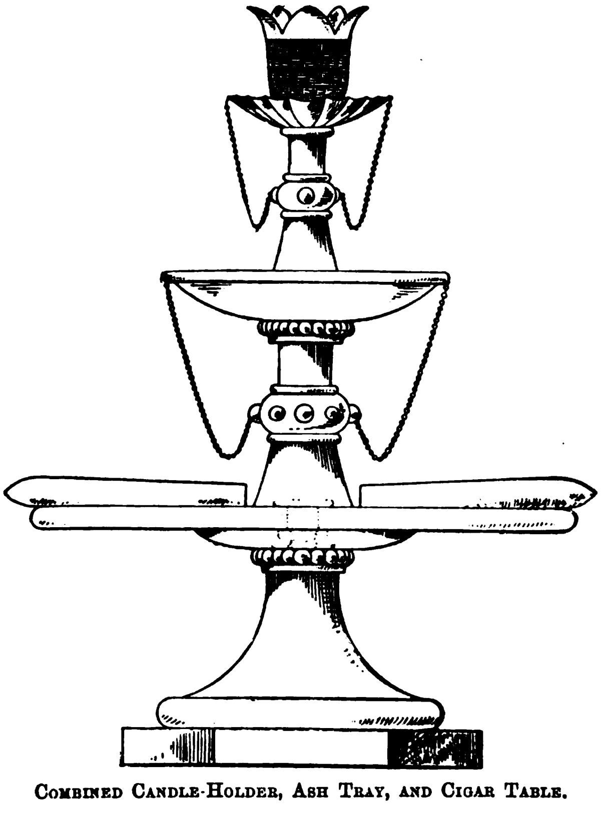
* * *

COMBINED CANDLE-HOLDER, ASH TRAY, AND CIGAR TABLE.

DESIGNED by Asurd Keysor, Esq., amateur, and executed in ivory and African black wood by him, with assistance from E. F. Baker. The plateau, or disc, was made of sheet ivory, about three-sixteenths of an inch thick, or substance, cemented on a backing of oak wood. The face of the ivory plateau or disc was fluted, or grooved out for the reception of the cigars. The ash tray was of ivory, plainly turned, similar to a very thin saucer.

The candle, or match-holder, also was ivory, shaped similar to illustration, and ornamented by the vertical cutter into the well-known basket pattern; the edge, by a large ornamental drill. The stems, or pedestals, were of African black wood, each of which being fluted by a rotating drill in its holder, or stem. The whole was united together by screws, or threads, cut on, and in their ends.

The base, or bottom, was ornamented round its edge with tools in the universal cutter. The base, or bottom, can be made round, square, hexagon, or any other figure agreeable to the taste and abilities of the operator.



Combined Candle-Holder, Ash Tray, and Cigar Table.

The chief difficulty attendant was in preventing the tremor, or vibration, of the ivory disc or table, while the rotating tools were in contact with it. The flutes, or grooves made in face of disc, were finished with a large double chamfered round nose drill while rotating.

Amateurs may, and can, achieve a great acquisition towards one another also, prospectives, by endeavouring to carry out their notions, or designs, practically. Beside being beneficial as a healthful occupation, they might be acceptable to the members of the Amateur Mechanical Society, in return for which I feel sure some would suggest (kindly) any appropriate alterations, or improvements, solicited through the agency of the "Amateur Mechanics" magazine.

COUNSEL

Fix upon that course of life which has been proven the best;—
Practice and habit will render it most delightful.

Pythagoras (slightly altered).

E. F. B.

PRACTICAL CABINET WORK FOR AMATEURS.

PART III.

SAWS.

FIRST in the list of tools are saws, as it is with these that the first operation is performed upon wood by the worker. The ordinary cabinet maker has some six or eight saws, including the rip, cross-cut, panel, tenon, dovetail, bow, and keyhole. The first is used for cutting wood in the direction of the grain. It is 28in. long in the blade, and the teeth, three to the inch at the handle, are sharpened square across the blade, and pretty much set forward, or "hooked," as we call it.

The cross-cut saw is 26in. long in the blade, and the teeth of this, 4 to the inch, are not sharpened square across but at an angle with the blade of about 60 deg., the back and front of each tooth having the angle turned in opposite directions. Or, to put it differently, every second notch is filed with the file pointing to the right, at an angle of 60 deg.: and the remaining notches are filed with the file pointing to the left at the same angle. By this means the outer corner of each tooth is brought up to a sharp point, and looking along a properly set cross-cut saw you see an angular furrow all along the teeth. The teeth of these saws are set to clear the draught in sawing, for without *set* they would not saw at all.

This *set* consists in every alternate tooth being turned by means of a hammer or punch outwards one way, the remaining teeth being turned in an equal degree the other way.

This is rather a nice job to do well, so much so that very many cabinet makers and joiners prefer to give their saws to professional saw-doctors.

The panel saw is the same length as the cross-cut, but has seven teeth to the inch. The teeth are sharpened at right angles with the blade like the rip saw, but are not so much hooked forward by this means; it is an excellent saw for either light ripping or cross cutting, and with this saw in his possession the young cabinet maker may very well dispense with the other two described above—they being used only for heavy sawing. The cost of the panel saw in London is 5s.

The tenon or sash saw and the dovetail saw are two you cannot get along without. The cabinet maker's sash saw has a thin blade, 14in. long, with a brass or iron back to stiffen it, and a close handle. It is used for every kind of sawing, whether with the grain or across, and particularly for ripping off the cheeks of tenons.

The dovetail saw is used for dovetailing, as its name implies, besides an infinity of small work. It has a very thin blade, 10in. long, a brass back, like the tenon saw, very fine teeth, and an open handle. Each of these saws costs about 5s.

The bow saw though, properly speaking, not a bow, is a most useful tool for all kinds of small curved sawing. It consists of two ends, made of beech or rosewood; these are held apart by a stretcher let into them by a short tenon; near the middle of their length, through the lower ends, the handles are inserted, having short brass rods riveted through them; the inner ends of the rods are slit to receive the saw blade. Round the opposite ends of the frame a strong cord is wound, and by means of the short wooden lever the cord is tightened, by twisting, which pulls apart the lower ends and tightens the saw blade. Both handles turn in the holes, carrying the blade, which is 12in. long, with them, and thus facilitate getting round curves. In using this saw the work is held in the "lug," and the saw is held by one handle, the forefinger passing round the frame in front of the handle. The teeth of the saw are pointing from you; consequently, the sawing is done with the push forward, not with the pull back. The bow saw is sold complete for 4s. 6d., but the cabinet makers mostly make the frames themselves.

The keyhole consists of a handle about 9in. long, with a brass ferrule. It is pierced with a narrow slit from end to end, and the blade, which is very narrow at the point, and has five teeth to the inch, may be shortened or lengthened at pleasure by means of the hole in the handle, and fixed at any desired length by two binding screws in the ferrule. This saw is very handy where the bow saw cannot be used, and costs about 2s.

PLANES.

The jack plane is the first that is applied to the wood after being sawn; it is made of beechwood, is 17 inches long, and has an iron or cutter 2⅛in. broad. Immediately behind the iron is a handle similar to that of a saw. In using it, it is grasped by the right hand only in planing fir, but in heavy planing, and especially hard wood, it is necessary to place the left hand across the front of the plane to press it down, as it is too light of itself for the iron to take hold of the wood. When using both hands to the plane, the left is placed with the four fingers lying across the top near the fore end, the thumb passing down the near side. In order to remove the irons for sharpening, the plane is tapped on the upper side, and near the fore end, with a hammer. Two taps should loosen the wedge and the irons. In setting up after sharpening, the back end of the cutting iron is tapped to give more iron, and to give less iron the fore end is tapped gently. To set the iron evenly with the mouth, it is tapped on the edge behind the wedge. During this process of setting the iron, the eye is travelling along the sole of the plane, the end resting on the bench. A little practice enables the operator to set his iron very quickly.

The half long plane is also made of beechwood, and is from 22in. to 30in. long; the longer sizes being called jointers. Twenty-four inches is the most suitable length for ordinary purposes. It has an iron like the jack, 2½in. broad, and a slightly different handle. This plane is used for dressing the wood after the jack, as it takes off the ridges left by that plane, and produces a more even surface. It is also used for squaring up and bringing the pieces to the desired breadth or girth previous to framing them together—and from its great length is well adapted for making long pieces practically straight on the edges—and for joining two or more pieces together to form a broad piece, it is indispensable.

The smoothing plane, for fine or other soft woods, is made of beech, 9in. long, having an iron 2¼in. on the cutting face. The cutting iron has the same pitch, that is, angle with the sole, as the half-long. The stock of this plane has the sole and top parallel, but the sides are curved, making the two ends narrower than the centre. The irons are held in place by a wedge similar to those already described, but it has no handle, and when using it is held by both hands, the right behind, and the left before, unless occasionally when it is necessary to hold or steady the work with the left hand, then the right grasps the back part of the plane. This plane is used to put the finishing "skin" or surface on the work in hand. After the drawing in, mortising, tenoning, dovetailing, etc., have been done, and before a job is put together, all the parts that cannot afterwards be operated upon, are finished with the hand plane. For instance, a drawer: the pieces after leaving the jack and half-long would be dovetailed and grooved for the bottom, then the *inside* of all the parts, including the bottom, would be finished with the hand plane, before putting together, because they could not be reached afterwards, and so with every other similar kind of work.

The smoothing plane for hard woods is in shape the same as the above, but only 7½in. or 8in. long, with a 2in. iron. This iron is set at a higher pitch than the fir hand plane—that is, it does not slant back so much. This plane is used for the same purpose in the finishing of hard woods as the other is for pine, and is in common use for cleaning veneers, for which purpose it holds its own with all the iron planes yet invented.

The teething plane has a stock similar to the hard wood hand plane, but the iron, instead of having a cutting edge, presents a series of sharp teeth to the wood. This serrated edge is formed by long narrow grooves on the face of the iron next the wedge, and when the iron is ground in the usual manner these ridges terminate in sharp points. In setting-up this iron on the oil-stone only the ground back is applied to the stone. The position of this iron in the stock is nearly perpendicular, so that it is simply a scratch plane, and to do this it needs no cover like the others. Its use is to roughen the surfaces of pieces to be glued together, for while it takes off the ridges left by the half-long or panel plane, it roughens the surface by scratching, thereby adapting it better to hold the glue. All surfaces to be veneered upon, as well as the veneer itself, are scratched with this plane.

The above are usually called the hand planes, and when we come to begin operations at the bench a word more will be said regarding the sharpening and setting up of the irons.

IRON PLANES.

No modern cabinet maker's kit is considered complete without iron planes; they bear the same names and are used for the same purposes as those already described. They are, however, costly, and the amateur need not despair if they are therefore out of his reach, for the cabinet makers of the olden times knew nothing of iron planes, and nobody will venture to say they did not turn out good work. Nevertheless, iron planes have a decided advantage over wooden ones for many purposes. For instance, the iron half-long being planed accurately on the sole, makes the joints for large table tops with much greater facility, and, moreover, does not get out of truth like the wooden one.

The iron panel plane gets up a smooth surface on hard wood much better than the wooden one. The iron smoothing plane, too, has a similar advantage over that of wood, and the iron rabbet plane may almost be said to be indispensable.

These rabbet planes are made with the soles from ½in. to 1in. wide, the sole and sides being iron filled in with wood. The most useful size is ⅝in., and has two irons, one being near the front. It is used for cleaning out the square, angular corners of mouldings, checks for panels, etc.

A great variety of iron planes are now imported from America. These are generally made of cast iron or cast steel, while the home-made ones are malleable iron plates, dovetailed together, and filled in with wood. They have a more substantial appearance, and will stand much more wear and tear than the Americans'. The latter, however, are largely used by cabinet makers, being cheaper and generally lighter to handle. There is at least one that the amateur should endeavour to possess, namely, the American iron smoothing plane. It has a handle similar to a half-long plane; behind this handle is an adjusting screw, by which the cutting iron can be moved backwards or forwards to a nicety, and the means used to fasten the iron is very simple and effective. The plane is light, and, having the handle, can be used with one hand. It is invaluable for cleaning off veneers or smoothing cross-grained hard woods.

The kind of plane to use on the shooting board and mitre block is called a mitre plane, and is made of iron filled in with wood. The iron of this plane is 2½in. broad, lies very flat down, and has the cannel, *i.e.*, the ground side, uppermost; consequently it has no cover, and the opening in the sole is a mere slit. This plane is rather dear, costing about 16s., and while it is the best for hardwood mouldings, good work may be and is done with the half-long for the shooting board, and the hand plane for the mitre block.

Apart from the bench planes there are a host of others, and some of them cannot well be done without, even by a beginner, such as the plough, ploughs in pairs, called match ploughs, fillister, hollows and rounds, beads, cope bead, draw-bottom plough, etc.

The plough has eight irons, ranging from ⅛in. to ⅝in. It has a moving "fence," and is used for all kinds of joining by feather and tongue, and grooving with the grain of the wood.

The rabbet plane, for hard wood, is ⅞in. broad, the cutting it makes being of the same breadth; the mouth runs square across the sole. That for soft woods is 1¼in. broad, and has the mouth and cutter running obliquely across the sole, and the iron is not so high in "pitch" as the hardwood.

The fillister is a rabbet plane with a "fence" and a guide for working to a given depth and width.

The hollows and rounds are very useful, as with them a great variety of mouldings may be worked in the absence of regular moulding planes. They go in pairs, each round having its corresponding hollow; and there are sixteen pairs in a full set, from ⅛in. to 2in. Most cabinet makers have but eight pairs or a half set.

The bead planes range from ⅜in. to 1¼in. Some of the smaller sizes are very useful. Two or three pairs of match ploughs, from ⅜in. upwards, are also indispensable. The drawer bottom plane, as its name implies, is simply for making a shallow groove in the sides and front of a drawer to receive the bottom.

For fear of being tedious, we will leave off further notice of planes, as even to name all the planes in use by well appointed cabinet makers would be tiresome.

SQUARES, etc.

The square has a handle of wood with a steel blade set at right angles, 6in. long, both handle and blade being straight edges.

The bevel is somewhat similar, but the blade is adjustable to any angle.

The mitre-stock is made of wood, and resembles the square and bevel; its blade is fixed at an angle of 45°. The blade is $\frac{1}{16}$in. thick, and the stock $\frac{3}{8}$in., both being about 2in. broad. This is useful for marking off pieces to be cut at an angle of 45°, such as picture frames, or pieces of any sort to be mitred together.

Besides these there are other squares—the 12in. steel bladed and large wooden ones up to 3ft. in length.

GAUGES.

There are three gauges that cannot be done without—the marking, the cutting, and the mortise gauge.

The marking gauge has a shank about 9in. long, with a head or block to slide along it. A spike is inserted near the end of the shank, and the movable head is fixed at any desirable distance from the spike by a screw or a wedge. Its use is to make a mark on the wood, parallel to an edge previously straightened, and along which the head of the gauge is guided. In dressing up several pieces of wood to exactly the same breadths this gauge is an unerring guide.

The cutting gauge has a shank and head like the above, but instead of the spike there is a thin steel plate passing through the shank, and bound by a screw. This plate being sharpened makes a cut either with or across the grain. It is used for gauging all kinds of dovetailed work, for cutting through veneer to a given breadth, and many similar purposes.

The mortise gauge has also a shank about 6in. long, with a moving head shod with brass. It has two spikes, one fixed and the other movable by means of a screw in the end of the shank. It is used for gauging all kinds of mortise and tenon work.

The other indispensable tools are:—2-foot rule, oilstone, slips, oilcan, glue-pot, two mallets, veneering hammer, spokeshave, nail punch, pliers, pincers, compasses, rasp and file, brace and bits, dowelplate scraper, hatchet, three screwdrivers, and a set each of chisels, gouges, gimlets and bradawls.

There are many kinds of oilstone, "Niagara" ranking high in the estimation of most tradesmen. The oilstone is inserted in a piece of hard wood to about half its depth, a similar piece being made for a cover, to keep it clean when out of use.

The mallet may be home made or bought. The handle is put through the head tail first, so that the head will not come off while being used.

The veneering hammer is the most useful, as it is an ordinary hammer with a thin broad end for veneering narrow work, while the round end is used for nailing, setting the planes, etc.

The spokeshave has its blade in the centre, and a handle at each end, and is used for taking off shavings from narrow surfaces where perfect evenness is not essential.

The nail punch is used to punch the heads of nails under the surface out of sight.

Screw-drivers are, as their name implies, for driving in screws.

Gimlets are for boring holes to receive screws.

Bradawls are for boring holes to receive brads.

Chisels and gouges are for paring away wood, and clearing out mortise holes, etc.

Compasses, used for drawing small curves and circles.

Pliers and pincers, for drawing out nails, etc.

Hatchet, roughly shaping preparatory to using the chisels.

The glue-pot will not admit of any substitute such as a gallipot or saucepan.

The brace and bits is another indispensable tool. The bits are 36 in number, and comprise centre, gouge, scallop, drill, rimmer, counter-sink and various others.

The dowel plate is a steel plate about ½in. thick, with holes from $\frac{3}{16}$in. to ½in., and the bits are fitted and marked so that dowel pins made in the holes will fit holes made by the corresponding bits.

The scraper is a bit of steel plate about the thickness of a handsaw blade; it is 5in. by 3in. Its use is to take off any ridges left by the smoothing-plane in planing hard wood, produces a surface perfectly free from lumpiness, and is used before the sandpaper. Sandpapering is done with the paper wrapped round a piece of cork. The usual size for large flat surfaces is 5in. by 4in., and about 1in. thick. One side is made quite flat, and on this the paper is placed. Pieces of cork are used for all kinds of sandpapering, hollows, rounds, mouldings, etc., the cork being shaped with the rasp, to fit the part to be papered.

Among indispensable tools is the cramp, made wholly of iron. These should go in pairs, as two of a size are always necessary to cramp chairs and tables. A very useful cramp is one that will take in 3ft. This should have a lengthening bar, which will enable it to take in another 3ft. The lengthening bar is attached with two short bolts and nuts. With this cramp, a pair to take in 30in., and another pair to take in 20in., the amateur's workshop might be considered furnished with cramps.

The holdfast is made of iron, and is used to hold work firmly on the bench to be mortised, or otherwise operated upon. It consists of a round bar 1¼in. thick, with a forked piece, curved as shown. In this fork is a lever, fixed between the jaws with a pin. The back end of the lever has a square-threaded screw passing through, with its point coming in contact with the heel or end of the long bar. In using the holdfast, the bar is dropped through a hole in the bench top, the curved end of the lever coming down upon the work to be held. The pressure is applied by turning the screw at the back end of this lever, as will be seen by looking at the sketch.

(*To be continued.*)

CALLIPERS AND FIXED GAUGES.

FOR fine work in the machine shop, the old fashioned bow callipers are going out of date, and are being superseded by more reliable gauges. Callipers may still be useful for gauging coarse work and making comparisons of relative sizes of considerable difference; but the growing demand for exact work, and increasing adoption of unvarying standards of sizes in the shops, are fast driving out all adjustable gauges, and particularly the unreliable callipers.

There are two elements of uncertainty and inaccuracy in callipers—the screw adjustment and the length and comparative weakness of the bows. The slightest touch is sufficient to start the "butterfly" nut on the screw, and the nut and screw are never threaded with sufficient accuracy to prevent backlash. Besides this, the riveted end of the screw allows of more or less play, imperceptible, it may be, just at that point, but causing a serious mismeasurement at the points of the bows—the points where the accuracy is demanded. Then the bows themselves are so slender as to "give" quite readily under even a slight pressure. As all measurements by callipers, or similar gauges, are determined by the sense of feeling, and not by sight, it is obvious that the utmost rigidity is necessary in the measuring implement. This rigidity is impossible in a pair of callipers.

In place of this implement, which is adapted to any and all variations of diameters between certain fixed limits, the best shops are adopting solid tool steel gauges of standard sizes, varying by fractions of an inch as on the ordinary rule, sixty-fourths and thirty-seconds, or by thousandths of an inch, five-thousandths usually. The gauges are horse-shoe shaped jaws, with parallel faces ground to one fifty-thousandth of an inch for exactness, and furnished with handles convenient for lathe use, or for bench use—the handle for the lathe gauge being in line with the parallel jaws, and that for the bench gauge being at right angles to their faces, making it handy for use as a snap gauge. The gauges are hardened, and then ground to finish size. The limit of exactness of these solid gauges is fixed at one fifty-thousandth of an inch, as that has been found to be the limit of sensibility in the experienced workman's fingers; a skilful workman can detect errors in measurement by feeling up to that almost insignificant fraction of an inch.

Such delicacy of measurement is not practicable with callipers, nor can a much lower limit of accuracy be assured by the callipers. When, therefore, first-class shops permit no fits to pass which do not come up to the standard of one four-thousandth or one five-thousandth of an inch, it is manifest that some gauge of greater accuracy than the spring callipers is required.

◆

Painting Venetian Blind Laths.—Forty-seven or forty-eight years ago, Venetian blinds were very rarely painted any other colour but green, the pigment used being mineral green, which was a very difficult one to grind, and it required laborious and constant work to grind it smooth. The mineral green is ground in turpentine, is mixed for painting the laths with resin varnish, and the laths are given one coat of this, on two coats of ordinary oil colour green. Sometimes they were painted solely with mineral green and varnish. Painting blinds cost money then. This old style of painting them is not much practised in these days of progress, except in some out-of-the-way place, where the march of improvement has as yet failed to reach. Now-a-days all the pigments are procured prepared, and many of the varnish and colour manufacturers supply enamel colours which dry quick and hard, suitable for the painting of blind laths, which is, of course, much cheaper and better than they could be prepared. Three coats of paint and varnishing is a very laborious and expensive way of doing them. The best plan of painting Venetian blind laths is to first give them one or two coats of patent knotting; if one coat, then two coats of enamel green on that, but if two coats of knotting, then one coat of green laid on full. This will be found a clean and cheap method; much time will be saved and a better job will result. Varnish enamel colour may be procured in all the shades of colour used for blinds, so that the same process will answer for the one as the other, the difference being that possibly some of the colours will require two coats to make the enamel cover. Size is often used for first coating upon the laths, but that is a dangerous method and should not be used, as it is almost certain to cause the colour to crack when exposed to the heat of the sun.

TOOL DRESSING, HARDENING, AND TEMPERING.

WITH the fact existing that upon the correct shape and quality of tools which come from the tool-dresser's hands depend the quality and quantity of work produced by machinists, more largely than upon almost any other cause, is not this a most important subject? In most shops the man holding the position of tool dresser has not only the forging of all sorts of tools to do, but the principal part of the hardening and tempering to do, on such tools as first pass through the machinists' or tool makers' hands, and then go back to the forge for hardening, in addition to the hardening and tempering of lathe and planer tools and chisels, and tools of like character, which are hardened direct from the forging.

What abuses constitute ground for growling about the average tool dresser's practices, and the quality of tools which he gives us? Where shall we begin? Let us begin with the proprietor, or superintendent, or foreman, or others in authority, who begin by putting their tool dressers, as they would a horse, in harness, where they can only exert themselves in one way, and that in the direction of driving and hurrying.

Of all false economy in shop practice, that which hurries the man who forges or hardens tools for machinists' use is the most ruinous. To illustrate: a lathe tool is to be forged, for which a machinist is waiting. With little fuel and much blast the steel is heated to a good yellow heat, and forged to shape in a hurry, with none of the careful manipulations and gauging of weight of blows or heat at which the forging should cease, which are required to produce good tools, and reheated again in a hurry much hotter at the extreme point where the first work will come than at any other part. It is hardened, and with a rub of emery stick, or otherwise brightening the surface, the temper is drawn to a straw-colour, or brown, or purple, according to the belief or practice of the tool dresser or machinist. In from ten to fifteen minutes the tool is ready to grind. In ten to fifteen minutes more it is ground and in the tool post. In ten to fifteen seconds more the point is broken off, from $\frac{1}{16}$in. to $\frac{3}{16}$in., or more. Ten to twenty minutes spent in grinding again. Breaks again. It is ground again, and just when the point is reached where the tool don't break it is found to be too soft to stand. There is no need of enlarging upon this subject. Every machinist knows all about it, and most tool dressers know what it is to have twenty jobs waiting, and to be hurried to do some one particular job, just as quick as possible, while many of them know what it is to be snappishly told by some one in authority that they are wasting fuel, if they are found with more than a hatful of coal ignited at once.

Drawing from an actual transaction for an illustration of what may be done, let us direct the tool dresser in forging and hardening a diamond-point tool, for use in planing a steel forging which has resisted all efforts of the machinist to plane it, or the blacksmith to anneal it. Says the foreman: "We have not a tool in the shop that will cut it, and it can't be annealed; twenty-four hours' annealing, the last time, did no good." As we look at the glazed, shining, hummocky line, a quarter-inch in width, where tool after tool has been coaxed to cut and would not, after it had been settled in the mind of the machinist with the job in hand that a chip could not be started at the edge of the piece, we can readily believe that the piece is hard.

Now, let us instruct this same tool dresser how to make a tool to plane this piece. First, a good big fire, not too hot. Not too much blast, but just enough. Heat the steel evenly, being careful to have no part at any time too hot. Let the blows, which are required to shape the blade of the tool, be so delivered as to cause no more violent distortion of the metal than is necessary, and continue the hammering until the heat is sufficiently low to insure a thoroughly condensed condition, which cannot be secured if the hammering ceases while the steel is still yellow hot.

Now for hardening. Heat slowly and with great care to have the extreme point of the tool not quite as hot as it is further up. Heat the blade hot enough to harden for its entire length. Let the heat be the lowest that will produce a sufficient degree of hardness. Plunge the blade into cold water clear up to the shank. Don't hold it still in the water while it is cooling. Move it about, to bring it in contact with a fresh body of cold water in place of that which becomes instantly warmed by contact with the heated steel. If the degree of heat is right, you cannot cool the tool too quickly. Now souse it in all over. No need of keeping heat enough in the shank to draw the temper, as, for cutting this extremely hard piece of steel, the temper of the tool must not be drawn.

We (continues the "American Machinist") give this tool to the same man who said, twenty minutes ago, that no tool in the shop would cut the piece on which he had spent hours, and hardly made a mark. With an incredulous smile, he grinds and sets this tool and starts the planer, and, with not the slightest difficulty, this tool is fed down through the glazed surface to a cut at the deepest point of $\frac{1}{8}$in., or more, and, with the feed thrown in, it marches along as steadily as any ordinary tool would do in planing soft steel or cast iron. It is cutting clean—no glazing; no dodging in and out, leaving great ugly hummocks.

Why does this tool act so? Because it is enough harder than the piece it is cutting, so that it does not become dull at once, and has sufficient tenacity to stand the strain without breaking. And we have what? Simply a tool which makes it possible to plane this hard piece of steel, when it was impossible before? Aye! that, and more. We have a tool which may be ground and re-ground till it is worn clear to the shank, and which is not only better on hard work, but will prove better on all ordinary work, just in proportion as it is possessed of greater hardness and tenacity, and fineness of grain and consequent fineness of edge, than is possessed by the ordinary tool, which must have the temper drawn to prevent breaking.

Employers, give your tool dressers time to do good work. Five minutes' time saved in the dressing of a tool often makes five hours' loss of time in the machine shop. Tool dressers, you who feel overburdened with work, make for yourselves an easy job, by making tools which will last to do ten times as much work. If you use charcoal, don't be too saving of it. A good body of coal and moderate blast should be the rule. If you use bituminous coal, bank up well with fresh coal, but let your heating steel only come in contact with that which is well coked. Don't let all hands and the apprentice boys from the machine shop dip into your fire to harden all sorts of tools. Don't let some old machinist taunt you with the fact that he has a chisel, or some other tool, that he has kept for years to do special work that can be done with no other tool, without showing him that you can make tools equally as good or better. And you can, if you will take time. Try it.

TAZZA IN BLACKWOOD AND IVORY.

(For Illustration, see Lithograph Supplement.)

The accompanying lithograph shows a nice specimen of ornamental turnery, in which fluting and drilling are both utilised to render the design. The photographer shows so clearly the form of the tazza, and as it may be made to any dimensions, any special description is hardly called for. The original from which the illustration was taken was executed by General Clarke, in the style which he has practised so successfully. Several specimens of the General's ornamental turnery have been published in former issues, and in each case some particulars of the mode of manufacture have been given from the pen of a skilled artificer.—The present illustration must be allowed to speak for itself.

What Paint Best Protects Iron?—Among the things that require the most protective paint for iron are carriages, farm wagons, ploughs, and agricultural implements, from which fact it seems feasible that manufacturers of the like ought to be able to give the best information required. Any mineral paint would answer the purpose much better, and I maintain that the paint that most effectually protects iron is red lead. Not in colour is it as well suited; but that is only a secondary consideration, and easily overcome by painting it over with any colour desired. It contains the following advantages for the preservation of the iron, which is the main object to be gained:—(1.) Dries easily with raw linseed oil, without an oil-destroying drier. (2.) After drying, it remains elastic, giving way both to the extension and contraction of the iron, without causing the paint to crack. (3.) It imparts no oxygen to iron, even when constantly exposed to damp—a fact to which all farm wagon makers can testify. (4.) It hardens, where it has been spread thickly, without shrivelling, forming the toughest and most perfect insoluble combination of all paints. As proof of this assertion, it is used by calico printers for red figure prints, holding out against soap and water; by gas pipe fitters, as the best paint to resist ammonia and tar; by the English iron ship builders, for painting the hulls of iron ships, namely, two coats of red lead and two of zinc white; by wagon and plough makers, for painting wagon gears and ploughs; by knowing carpenters, for painting wood that comes in contact with damp brick in walls, as it preserves wood from rot, insects, etc. For those among us who are uninstructed how to mix pure red lead for paint, it should be made known that pure red lead powder, after being slightly pressed down with the finger, shows no lead crystals. When they are visible, it is merely partly converted, and not first quality. It should be ground in pure, old linseed oil, and if possible used up the same day, to prevent it combining with the oil before it is applied, losing in quality. No drier is necessary, as in the course of a few days the oil forms a perfect hard combination with the lead. American linseed oil is as good as any imported, where the manufacturer has given it age, and not subjected it to heat, as is the custom, by steaming it in a cistern, to qualify it quickly for the market. It deteriorates in quality when heated above 160 F. This red lead paint spreads very easily over a surface, and the best of finish can be made with it, even by a novice in painting.

ABOUT TWIST DRILLS.

A TWIST drill certainly is not a perfect instrument, writes a correspondent to the "American Machinist." The dead flat point at the centre of the drill is a great objection, and there seems to be no way to make it thinner with safety. When you start the drill upon a flat surface, it is very apt to waltz around in an ungraceful and most exasperating style. But don't fool with it long in that way. If you have had any experience in drilling, you have sometime struck a blow-hole in a casting, and you know how it will coax your drill from the path of rectitude. Well, let the blow-hole teach you a valuable lesson. Place a blow-hole where you want your drill to go, and you may be sure that your drill will follow it. Drill an ⅛in. hole in your centre, deep enough to let your twist drill cut its full size ¼in. deep or so before the little hole is obliterated, and there should then be no trouble about the drill getting out of place. Just shut your eyes, and feed it down steadily and confidently. When I say drill an ⅛in. hole, I don't mean a ¼in. The little hole should be no larger than the blunt, flat centre of the drill. Another way to start a twist drill is to clamp a plate upon the piece of work, with a hole in it just the size of the drill, and serving as a guide for it. One might, by suitable means, fix his drill firmly, point downwards, in a vertical position, and fasten his piece of work upon a revolving table, the centre of the desired hole coincident with the axis of revolution. Then, the table being set in motion, and at the same time steadily raised by a feed screw, a very satisfactory hole should result, if our friend conducted the operation as carefully as he tells us he grinds his drill. We might fasten our front door, and swing our house around upon the hinges when we wanted to go in and out. We have plenty of that operation on the planer, and there is no reason why it should not be equally satisfactory with a drill.

Running the drill fast has nothing to do with starting it truly. We use speed for circular saws and centrifugal drying machines, but with a different object.

As to the twist of the drill leaving its mark upon the side of the hole, it is an experience I never encountered. I should say that one lip of the drill was longer than the other, so that the point of the drill was not in the centre, and the lip of the drill was thus crowded against the side of the hole, and of course it made its mark there. It might be also that the lip was ground away too much behind. The grinding of the drill as it comes from the maker is about right, and subsequent regrinding should accurately preserve this shape.

As a general rule in machine shop practice, the better the tool the less the liberty allowed as to the conditions under which it is to be used. A twist drill is exacting in its requirements, and only by compliance with them can the best work be done. It cannot be operated with the highest success by a slouch. The work must be firmly held in position, and in the right position, and the drill must be absolutely true and rigid to do a first-class job. The drill must be ground truly, *and must be kept sharp*, if you want it to enjoy a long and useful life. It will work better, just as a man will work better, by being crowded a little. It is made to roll out respectable shavings, and not to scrape away impalpable dust. It has so little clearance at the side that, if the corner of the lip be not kept perfectly sharp, it works hard and heats up, and then wears very fast. The lack of sufficient clearance in the factory-made twist drill renders it incapable of the very highest performance.

In 1857 I drilled with a home-made twist drill 40 feet of ¼in. holes in cast iron without grinding the drill. I have never been able to do as well with a factory-made drill. Though I instance the performance of a small drill, I have a great respect for larger ones and have seen admirable work done by them up to 2in., and our friend's experience must have been peculiarly unfortunate when it leads him to disparage them.

Speaking of feeding a drill reasonably fast, I am quite of the opinion that a tool will retain its cutting edge longer and better under a liberal cut than when only working to one-quarter or one-tenth of its capacity. A tool advancing steadily into its work may be said to be running down hill, and is by that means preserving its clearance, while a tool that is just scratching the surface is running on level ground and wearing away what clearance it originally had. This is an argument for feeding planer tools while cutting, instead of during the return stroke.

A twist drill is not very suitable for brass work, having too much hook to the lip and drawing itself into the work, especially when going through the hole. It may be made to work pretty well by grinding away the front of the lip. The Farmer lathe drill seems to be better suited, and is extensively used for brass work. It has, however, a weakness of its own. Any straight drill of that type is ill-adapted to resist torsion, and the least catch or overcrowding gives it a backward twist, which not only deranges its external dimensions but makes it very hard for the chips to get out.

I would call the attention of our younger mechanics to the fact that the twist drill is much better shaped than the straight fluted one to resist the twisting strain, and would recommend them to understand the why of it. The length of the spiral cutting edge of the twist drill is, of course, considerably greater than that of the Farmer lathe drill, or its equivalent, and would at first sight seem to be therefore more flexible than the other, but to unwind the twist would lengthen it, and this tendency to elongation is resisted by the tensile strength of the centre of the drill.

I advocate a liberal use of twist drills. Besides a full set of standard sizes, I find it a great comfort to keep a set $\frac{1}{64}$in. smaller than each size in common use. These, while drilling pretty good holes, leave stock enough for a reamer, and after putting that through carefully you have a hole altogether lovely.

Now I wouldn't say anything personal for the world. But I project it as a general, lamentable, and incontrovertible truth that to do a thing carefully is by no means, necessarily, to do it right. The successful things of the world are done with a certain ease and slam-bang that the word carefully is far from expressing. I know a fellow who tries a square upon eight sides of a tap, and he can't tap a hole truly to save his neck. Another one I have in mind can't drill a hole in a piece of sheet-iron without trying a level upon it lengthwise, crosswise, and cornerwise yet, if he were doing anything for which I felt in any way responsible, I would keep a sharp and constant eye upon him.

I suppose it must be a most trying thing for a sensitive individual to begin an unfamiliar job in a strange shop. I hope I am able to treat one in such a predicament with just and charitable consideration. But if you get into such a fix, don't be so putteringly painstaking as to show that you are utterly ignorant of the conditions of good workmanship. Nothing more readily betrays the poor workman than useless and unmeaning precaution. The man who is over-careful is, as to reliability, immeasurably below the one who is just careful enough.

The twist drill, as an article of manufacture, marks an important epoch in the history of the trade. If the production of the twist drill originated with a single individual, he is deserving of a monument. The twist drill was the first (or nearly the first) of the modern race of machine tools. From its advent the trade of the machinist has undergone a great transformation. The whole race of taps, dies, reamers, chucks, dogs, mandrels, etc., has followed the twist drill until the machinist has lost his independence and almost his identity. And with the tools have come in the long line of bolts, set-screws, studs, etc., and when I think of them I recall my suggestion of a monument to the wretch who opened the flood-gates to the tide of "Machinists' Supplies."

REVIEWS.

"THE SMITHY AND FORGE," by W. J. E. Crane. (London: Crosby, Lockwood & Co.) An illustrated *brochure*, forming No. 237, "Weales Series," commences with asserting the antiquity of the art; proceeds with a number of Scriptural quotations relative to it; indulges in a little classical lore about the early workers in bronze; gives a considerable catalogue of various steels produced in the fourth century, which, we have no doubt, is quite correct; and subsequently comes down to our own time. With regard to the information offered at this stage—with the exception of the chapters on carriage and mediæval ironwork, which are acknowledged to be borrowed—it reminds us of the contents of the beggar's wallet. The author does not appear to have been fortunate in his selection of draughtsmen, who have caricatured, at any rate, the anvils, hammers, and tongs. We are thankful, however, for this, the first work professing to treat generally of Vulcan's art, but hope shortly to find successors in the book market.

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

MANDREL NOSES AND CHUCKS.

Sir,—I notice a letter in your issue of last month which contains a very good suggestion for getting over a difficulty which seems to exist among amateur turners, in having to send their lathe heads to the makers, when they require a new chuck, in order to have it properly fitted. Now, in my opinion, a still better plan would be to have a tap made of exactly the same size and pitch of thread as the mandrel nose, so that when ordering a new chuck it would only be necessary to specify correct diameter of nose at both top and bottom of threads, pitch of screw, length of nose from collar to point, and also diameter and thickness of collar, or a rough sketch of mandrel nose, with all the above named dimensions given on it in plain figures, at the same time asking the maker to keep the hole a trifle small, so that, by running the tap through it, it would then fit the mandrel nose correctly; and furthermore, the tap could be sent with the order, which would undoubtedly be the best plan, as the maker would then deliver the chuck complete. In addition, the tap would be found an exceedingly useful adjunct to the possessor, as he would then be able to make for himself any simple chuck, either of wood or metal, to meet his requirements from time to time.

Hoping you will deem this worthy of a place in the pages of your excellent journal, and wishing "Amateur Mechanics" the success it deserves,

I am, yours faithfully,
A. M. C.

Sir,—If we do not discuss the projects put forward by other correspondents, I fear much progress will not be made. I therefore offer a few observations upon the suggestions of "Graham" and "J. W.," in your issues of May and July, for fitting chucks apart from the mandrel on which they are to run.

First, then, "J. W." proposes that we should buy with our lathes "duplicates" of the mandrel nose, which duplicate could at any time be sent up to a maker, when a new chuck was required, instead of the headstock. This plan would ensure that the new chuck would screw on, but would not ensure its running truly. "J. W.'s" proposal is a very natural one, and if he is thinking of simple chucks such as "cup" chucks, "screw nose," etc., which he could true up himself, he might find the plan useful, though I think very likely his maker *has* such a duplicate nose as he proposes, and would undertake to make him a chuck that would go on to his mandrel, and even fit well, without requiring to have the headstock sent; but to ensure its running perfectly true is quite another matter.

It ought to be known that if two lathes are made having their mandrel noses as nearly alike as possible, and a set of chucks made for each, the chucks upon the one lathe will not run truly upon the other except by chance. They will fit well on both, no doubt, and may run nearly true, but not perfectly so; and why that is, I believe has never been explained.

The cone-fitting appears to me to offer the best hope of meeting the difficulty. It has long been known as the best way of ensuring truth in drills and drilling machines, and many other ways, and I believe it only needs a few careful experiments to prove it able to give us interchangeable chucks; and, what is perhaps of more importance to amateurs, to enable one to screw one chuck upon another, with the certainty of its running perfectly true.

This brings me to "Graham's" suggestion. He has made use of the cone-fitting, but I am not sure I quite understand his plan. Will he kindly write again, and say whether he relies entirely upon the conical fitting to keep the chuck on—a piece of hollow work, for instance, 6in. over neck, and no boring collar to support it? I should expect that the jarring caused by the turning tool would unfix the most acute and best fitted cones, and am anxious to know whether I am right.

I am, sir, yours faithfully,
F. A. M.

ELECTRO-METALLURGY.

Sir,—I have read the first six numbers of the "Amateur Mechanics" with much pleasure, and cannot but think with most of our readers, that it has supplied a want long felt. Being of a handy size, and very neatly got up, to say nothing of its valuable contents, it will in future not only make a very good reference book, but unlike many other periodicals is worth putting into a good binding.

I have been anxiously waiting for some reply to "Galvanoplast's" letter in No. 3, but as it does not seem to have been noticed, I take upon myself to answer it. I have no doubt that I am not the only one of our readers besides "Galvanoplast," who takes interest in some branch of Electro-Metallurgy.

For my own part I should be glad to read, through your valuable columns, a series of articles on the "Electro Deposition of Copper" and construction of plant for the same. I do not mean as regards small medals and coins—of which we have so much in every elementary book—but for large work, such as copies of works of art, of statuettes, tablets, etc., or such subjects as are generally adopted in bronze ornaments.

Wishing your paper every success, and hoping at some future time to be able to contribute to it myself,

I am, yours etc.
"MOTIVE POWER."

ALLOYS, AND REMARKS ON ALLOYS.

Sir,—The following is a copy of a very valuable table given to my late father by Capt. Saxby. I am not aware that it has been published in any of his works:—

Name.	Composition.					Remarks.
	Copper.	Zinc.	Tin.			
Brass	66	33				Average.
"	75	25				Melts at 1,750°. More zinc increases fusibility.
"	70.1	29.9				Works well under the hammer.
" (Muntz Metal)..	60	40				Can be rolled when hot. Very tough.
"	64.6	37.7	Lead. 1.5			Best for lathe purposes.
Bronze	96	0	Tin. 4			For accurate castings.
"	95	1	4			When suddenly cooled, may be hammered. If annealed it hardens.
"	89	3	8			Assumes an appearance of antiquity.
"	87	3	10			Average for medals.
" (Gun Metal) ..	90	0	10			For ordnance, zinc or lead are never added, and more copper causes the metals to separate into layers on cooling.
Bell Metals	78	0	22			Very fusible and sonorous.
"	82	0	18			For Chinese gongs (cooled very suddenly).
"	80	5.6	10.1			Old English bell metal.
"	75	0	25			Best church bells.
"	72	0	26.5	Iron. 1.5		For French clock bells. A little zinc increases sharpness of tone.
Speculum Metal......	68.2	0	31.8			Lord Ross's. Very brittle. Light blow or heat breaks it.
For Sheathing Ships..	60	38.2		1.8		Gedge's alloy. It is very hard.
German Silver	59	19		Nickel. 24		
Britannia Metal......	1.78	Bismuth. 2	89.3	Antimony. 7.13		
Fusible Metal........	0	50	25	Lead. 25		
Pewter	0	0	80	Antimony. 20		Common, made of lead instead of antimony.
Type Metal	0	0	25	Lead. 50	Very Best Antimony. 25	Best type.
Queen's Metal........		1	9	1	1	
Very Brittle Alloy				50	50	
White Alloy..........		Zinc. 50	50			Very hard, and as tough as brass.
Plumber's Solder			50	50		
Fine "			66	33		
Coarse "			33	66		
Hard "	Brass, 66.7, and 33 of Zinc. (Note.—This may be a clerical error.)					

Yours truly, T. H. SLADE.

ENGINEERING APPRENTICES.

Sir,—Parents who have sons that are going to be engineers should not, in my opinion, allow them to leave school and go at once into the engineer's shop, but should for twelve or eighteen months attend a school, or class, where they could learn a little lathe work, a little chipping, and a little filing. This arrangement would be bad for one reason only that I can see. We will suppose a boy has attended a mechanical class, and at that class he has learnt something about screw-cutting; he knows what wheels to use for the threads in common use, or he thinks he does. Now, suppose one of his change wheels goes wrong—that is, gets broken. He may have been using to cut ten threads his 20 and his 100 wheels (that is, if his guide screw is two threads per inch). Well, his 20 tooth wheel is broken; what is he to do? Why, he does not know; but his instructor soon puts him right. Now if this had happened in an engineer's workshop, it would have been very unpleasant for the apprentice who had been to a mechanical class, for no doubt he would tell the workmen that he had learnt screw-cutting, etc., and they would quite expect him to understand how to find wheels for any thread. He might also tell them that he had learnt to chip and use a file, but when put to a vice and given some work that required chipping, it would not look well to see him take hold of the hammer shaft close to the hammer head, and hold of the chisel low down instead of at the top, and when corrected by a workman to knock some portion off his hand. My advice to those who have been to a school where metal turning, chipping, and filing are taught, is, that when they, if ever they do, enter an engineer's shop as an apprentice, not to say a word about what they know as regards lathe and vice work, but start at some small machine first, and then they will find out for themselves that they have much to learn before they can be considered good workmen. Try and keep all your tools in good order, and then if some work comes in in a hurry you can start at it at once. By so doing you will keep in your foreman's and your leading hands' good books.

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AMATEUR MECHANICS

AN

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METAL CASTING.

PART I.

INTRODUCTION.—*Our Oldest Knowledge of the Art—The Possible Origin of Casting—The Comparative Want of Progress—Definitions—Jokes—Largest Founders—Fine Iron Casting—Colossus of Rhodes.*

TO inform an amateur how to make a casting is by no means so easy as it appears.

The boy who is apprenticed to the trade is put into a shop, and everything is made clear by ocular demonstration. A great difficulty arises in attempting a description, which shall be at once clear and free from obscure technicalities.

The science of casting is not, at first sight, particularly suggestive of comicality. But, as all dry weather and *no* rain would be unpleasant—and as plain food generally requires seasoning—the author of these papers will, with the kind permission of his readers, shake the joke-dredger somewhat sparingly over his columns, in the hope of rendering them a trifle more palatable.

A word or two in review of the art of casting may, perhaps, be acceptable.

That casting, as an art, is of very early date is evident.

The first founder of whom there is any record is TUBAL CAIN. I founder[*]—I mean, found *him*—in Genesis iv., 22. He is there spoken of as "the instructor of every artificer in brass and iron." Dr. Charles Mackay celebrates him in a capital song, and to have done him justice should have added—

"And he sang 'Hurrah, for the caster's art!
For the mould and the melting-pot!
Hurrah, for the sand and the counterpart!
That comes from the furnace hot!'"

Josephus, the Jewish historian, in his "Antiquities of the Jews," Book I., chap. ii., sec. 2, says of TUBAL CAIN, he "first of all invented the art of making brass."

The same author in the same work, Book XI., chap. v., sec. 2, speaks of "vessels of brass that was more precious than gold." To which is appended a foot-note to this effect:—"Dr. Hudson takes notice here that this kind of brass, or copper—or rather mixture of gold and brass, or copper—was called auriehalcum, and was of old esteemed the most precious of all metals."

While speaking of Biblical reference to the subject, I may quote the following in support of my idea of the evident antiquity of the art:—

"Thou shalt cast four rings of gold for it."—Exodus xxv., 12.

"His mother took two hundred shekels of silver, and gave them to the founder, who made thereof a graven image and a molten image."—Judges xvii., 4.

"The bellows are burned the lead is consumed in the fire. The founder melteth in vain."—Jeremiah vi., 29.

"Every founder is con*founded*[*] by the graven image."—Jeremiah x., 14.

"The poor widow casting in two mites."[†]—Luke xxi., 2.

Shakespeare, Milton, and Tennyson speak as follows:—

"The casting forth to crows."—"Winter's Tale," Act iii., sc. 2.
"There was casting up of eyes."—*Ibid*, Act v., sc. 3.
—*Shakespeare.*

"Storied windows richly dight,
Casting a dim religious light."
—*Milton*'s "Il Pensero."

"Not only cunning casts in clay."
—*Tennyson*'s "In Memoriam," cxix., 5.

Moulding is, unquestionably, one of the finest of the fine arts. It interests us at all points—whether in the construction of the gigantic necessities of machinery, or the merely ornamental fancies of artistic humanity. The immense statues of ancient and modern heroes are not only monuments of those they represent, but also of the skill and genius of the artists who conceived and the workmen who produced them.

My quotations from the Bible and Josephus prove the origin of founding to be too far back in the mists of the earliest ages of the world for it to be of any use for me to attempt to tell you anything of its discovery, as no record of it is in existence, to my knowledge. But we may easily surmise it:—Metal would, at some time or other, have been dropped into a fire; it would have melted, and, when cold, would have been discovered to have retained the impression of the article against which it had cooled. This would have struck the thinking mind of an *observant* observer as containing a possibility;—here would have been the germ of a mighty art, and the first mould to his hand would have been the earth beneath his feet. We can imagine the look of wonder rising and gradually overspreading the face of the first founder as he watched the progress of his work—the cooling of the metal into the required shape, and the slow development in his mind of the future uses to which his discovery might be put. Improvements would gradually arise, until our present standard would have been reached, which must have been very many years ago, for we have not advanced much for a very long period. I believe my opinion is pretty generally shared by most practical founders—that the art of casting has hardly been improved upon for centuries. Other trades advance—hit upon some better methods of procedure—but the founder seems destined to plod on without much progression.

A casting, according to Webster's Unabridged Dictionary, is "anything which is formed by pouring melted metal into a mould."

A founder is "one who casts."

Founding, or foundery, is "the act of casting."

A foundry is "the place in which the act of casting is performed."

It is called a *found-dry* because it would be very awkward for the men employed there if it were found wet!—the slightest appearance of damp being

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[*] One of those puns of which I spoke above. It crept in by accident. My dredger slipped.—*Author.*

[*] Jeremiah's dredger had been going it, apparently.—*Author.*
[†] This is nonsense.—*Ed.*

fatal to good casting—the presence of wet in the mould causing the molten metal to explode, or technically "to blow."

The appearance of a piece of blown casting may be perhaps imagined, when I mention it is sometimes termed "spongy." The part that is blown presents a holey surface. (This is in no wise connected with my Biblical references.) It is dotted over with air bubbles, and looks something like a slice of Gruyere cheese. A polished or burnished casting that is "blown" is very unworkmanlike. Sometimes severe accidents happen, through the presence of moisture in a mould. One of my own employés has had several accidents happen to him, probably sometimes the result of his own carelessness in not assuring himself that the moulds were thoroughly dry. Small splashes of the boiling metal have been blown on him, and on two occasions into his eyes. The pieces have been taken out, and resembled small shots. (Not the first man who has had a cast in his eye, eh?—Beg pardon, this shan't occur again.)

An early and very celebrated firm of founders were twins—no, I do not mean *Castor* and Pollux, but Romulus and Remus. They were in a very large way of business. One of them was the greatest founder the world has ever seen: he was the Founder of Rome. At our establishment, we do not undertake such large jobs.

Some of the finest works of art in the world are castings in bronze, brass, copper, or iron.

"Fluid iron, suitable for small castings, and the use of good fine sand, will make ornaments finer and sharper in expression than castings in any other metal. Horse-hair and cotton-thread may be imitated to perfection. The wings of a fly, with its microscopic nerves, may be copied in iron; and green leaves, stiffened so as to be applicable as patterns, may be cast in iron without difficulty."

My authority for that interesting statement is a Fred Overman, the author of an American handbook on the subject.

The art of casting bronze statues has been traced to remote antiquity, and to all appearances the ancients were more skilful than the moderns in this art. Bronze statues were so plentiful in Greece at the time of Alexander the Great, that Pliny calls them "the mob of Alexander."

It is recorded that the Romans found three thousand statues when they were *roamin'* in Athens, and as many in the roads of Rhodes.

We read of the golden calf in the very earliest times, and the brazen serpent, so that the Children of Israel must have travelled with their own founders.

The Temple of Solomon was adorned with heavy and richly ornamented castings. The *molten sea* (for the priests to wash in), the pillars of *Jachin* and *Boaz*, and the metal basins at the entrances were all cast.

The renowned Colossus of Rhodes—one of the wonders of the world—was a cast statue, 130ft. high. It was broken by an earthquake fifty-six years after its erection, and its remains lay scattered over the ground for nearly nine hundred years, when they were sold by a king to a Jew, who carried away three hundred and sixty tons—at that time amounting to, perhaps, about £36,000.

[The Jews seem to have been early in the metal business; and they are in it now—we buy old metal of them at the present time.]

More recently—in the Middle Ages—doors and gates of churches and cities have been cast. The doors of the Battisterio in Florence were of such exquisite workmanship that Michael Angelo, the great architect of St. Peter's, Rome, declared that these gates were worthy to be the gates of Heaven.

This is a somewhat lengthy, and I fear somewhat prosy, preface. In my next article I hope to be able to give a description of the method of casting.

MODEL YACHTS.

PART III.

(For Illustrations, see Lithograph Supplement.)

LEAVING the drawing office, we now enter the "ship yard." A good workshop is a great boon to the model-maker, and much annoyance may be saved by seeing that it is quite dry and well-lighted before commencing work. A damp shop will damage tools, timber, and probably temper, so it is worth while to attend to this in time. The more light the better; at any rate, arrange to make the most of what you have. The bench should be about 2ft. 9in. high, level, and clean, of course; and if no vice is accessible, fit an ordinary joiner's wedge cramp instead. The requisite tools are those used by every joiner. In addition to the usual planes, we require another similar to the smoothing plane but with face rounded lengthways; three gouges, 1½in. flat blade, 1in. flat, 1in. hollow, and two smaller ones if possible; three chisels, 1½in., 1in., and ½in.; hand, keyhole, and tenon saws; 12in. joiner's square; brace and bits; two screw drivers, and two hammers, large and small. Gimlets, bradawls, etc., need no special mention.

For the construction of the hull we have several methods to choose from:—1st, the solid block model; 2nd, the system of using horizontal boards to represent the various waterlines (called by some the bread-and-butter style); 3rd, those built with wood planks overlapping one another; 4th, tin-built hulls; and 5th, paper hulls. These are the principal methods. In deciding which to adopt, a great deal depends on the ability of the builder; for instance, a tinsmith would probably find least difficulty with a tin hull, where anyone unaccustomed to the soldering iron, etc., would prefer to work in wood. But although built boats call for greater skill than the solid block model, experience has proved that the latter is best adapted for actual sailing. Shallow water and stony bottom are especially fatal to water-tightness in built hulls, and we need not await a collision to start the wood planks or knock the tin sides out of shape. A block model, if not made too thin, will certainly stand such knocking about best of any, and as there are no plank edges to interfere with speed, the hull under water may be polished to a perfectly glassy surface. It is often difficult, however, to obtain a piece of timber suited to the purpose and of the required size. In such a case the best plan would be to adopt the second method. But taste and circumstances must decide the point; we would merely recommend the amateur not to venture upon a built model until he has produced a successful solid one.

To follow the first method in making a model from the design on plate 1, the first step would be to choose the wood, and as it is important that this selection should be properly made, see that it is left to someone who understands it. Let it be the best yellow pine, white fir, or other soft, straight-grained wood, thoroughly dry, clean, and well-seasoned, knots and shakes being entirely absent. The minimum dimensions may be 2ft. 9in. long, 8½in. broad, and 7¼in. deep. Dress it truly on both sides and bottom; the upper side may be left rough. Turn it bottom upwards, bisect the length on bottom, and mark off 1ft. 4in. each way. These marks correspond with the extreme perpendiculars on plan, and leave ½in. to spare at each end. Next decide which are to be bow and stern, and set off the intermediate sections as they appear on plan. Take the 12in. square and draw lines right across at each mark, then turn the block over and continue these up each side (see fig. 1 on plate 3). Number them with lead pencil, and set up the deck height on each. Draw the deck-line through the spots on each side, then cut out the sheer. If you can get this done at a fretsaw, do so. When you have it roughed out, plane down to the line at each side, taking the precaution to test your work here and there with a short straightedge held crosswise. Rub down with sandpaper stretched on the usual flat cork, then square across it the sections and perpendiculars. Show the centre-line full length by bending a light straightedge into the sheer; then draw the deck-line. Mark on each side of the block the elevation of stern; that for the stem is not needed. Turn the log bottom upwards once more, and draw the curved base line extending from No. 1 to 7. With the log in that position, saw out the waste wood abaft sternpost. The centre-line may then be drawn up both ends, and the thickness of stem and sternposts shown. Plate 3 represents the lower part of block cut away to the correct stem-line, but for the present the fore end is better left square. In making a solid model from a sheerdraught, some persons draw the horizontal waterlines on each side, as in fig. 1, and bore holes into the block at the points where these intersect the vertical lines. The depth of each hole is to be ascertained from the body plan, and the sides of the block should be dressed down to the midship breadth of the boat, to correspond with the side-lines on plan. To proceed:—Get a piece of tracing paper, and carefully trace from the body plan Nos. 2, 4, and 6 sections from base-line to deck. Lay this paper on a thin piece of wood, and prick through with a penknife each section separately, not forgetting the deck and base on each. The wood is to be carefully cut away inside the line, giving the proper mould for the hull at that place. Similar moulds may be cut for the stem and stern, after which we may commence cutting. Saw off each corner at the fore end; this will save considerable labour, and the same may be done aft. Model making is apt to become a tedious operation when the block is not held secure while cutting out. The usual position is keel uppermost on the bench, but the handiest one is found by fixing two uprights, about 3ft. long, to the front of bench, and passing a screw through the upper end of each horizontally into the deck of the model. This is most convenient as regards light, and besides being very firm, there is no necessity to turn the model end for end in order to finish one side, but each may be completed with one fixing up. Assuming that the edge tools are all properly sharpened, take the inch chisel and pare away to the deck-line, commencing amidships and working off to each end, but take care not to cut away the stempost forward. Rub a piece of common chalk along the line as a guide in cutting. Now commence with the large, flattish gouge, and—go slow! With model making, like many other things, more haste, less speed. Many beginners imagine they know all about it right away, and proceed to take huge slices instead of little chips, but the result is usually disastrous. Apply your moulds repeatedly, and use the greatest care when cutting near the keel, stem and sternpost. The large flat gouge should presently be laid aside, and the inch hollow gouge used instead, which eventually gives place to the small flat one. On round and flattish parts of the hull a chisel will be found very useful. A small plane will also be of great assistance in finishing up, especially near the deck. The American planes of metal, usually sold for a shilling, are particularly handy for this purpose. Finish one side of the hull first, and if you should happen to cut a little too deep in anyplace, remember to make the other side correspond. Further, don't use the wood-rasp anywhere, the spokeshave as little as possible, and don't apply the sandpaper until entirely finished with chisels and gouges. Sandpaper is intended to smooth the surface, not to remove perceptible humps and hollows, and the job should be made thoroughly presentable before sandpapering at all. Make a neat finish about the keel, stem, and stern, then commence to hollow out the inside. It may be found difficult to prop up the boat firmly during this operation without risk of damaging stem and stern. A simple and effective way is to fit a strong chock to the midship form of the hull, and rest one end against the back of the bench whilst scooping out the other. Thick padding should be introduced in both places to prevent the hull getting scratched or otherwise disfigured. Here again, in hollowing out, quite as much caution is necessary as in shaping the exterior, or we may pass the gouge through the bottom in endeavouring to make her light and buoyant. It is best to reduce the whole by degrees, constantly moving from one part to another, and work slower and more carefully the deeper the tool goes, until you leave an even thickness of about ¼in. throughout, except in way of the centre of bottom, which should be rather more substantial. A good deal may be taken out of the extreme ends, and where too low for the thickness to be ascertained with the fingers, hold the boat up to the light now and then to prevent mistakes. When the hollowing is complete, give the outside a rub down with sandpaper, lay the craft bottom upwards on the bench, supported by two pieces of wood to keep the stem and stern from being damaged. Apply a coat of thin spirit varnish as she lies, using a flat tin-bound brush, and allow a few hours to dry; Then varnish again, and leave her overnight. Now prop up the craft in the chock and padding, and varnish the inside thoroughly in the same way.

While *that* varnish is drying we leave block models, and pass on to the construction of another on the bread-and-butter system. Here the hull is to be composed of several horizontal boards, instead of one piece. The surfaces of these are made to represent waterlines, and as they require individual attention, the model is in a fairly advanced state before being permanently fixed together. The five waterlines on plate 1 are spaced 1in. apart, beginning at the base; hence we require five yellow pine boards of that thickness, and another rather more than 2in. thick for the sheerpiece. That and the two pieces next below it, namely, Nos. 5 and 4, should be the full width of the boat with a trifle to spare; Nos. 3, 2, and 1 may be 7in., 4½in., and 2in. wide respectively. Make the sheerpiece say 2ft. 9in. long, the others 2ft. 5in. It will be seen at once that as regards subsequent labour in cutting out, this method has the advantage of the solid block system. The sizes given here are for the dressed stuff, and every care should be taken to ensure good planing. We will suppose the dressing to be satisfactorily attended to, the sheerpiece planed on both sides and bottom, the boards planed true on all sides, and the fore end of every piece neatly cut square. Nothing should be cut off the lower boards forward by way of allowing for the round on stem, but all should extend forward to the perpendicular. Lay the sheerpiece bottom upwards, and show a centre line full length; square it up the fore end, then set off the various sections from plan, beginning exactly at the fore end which represents that perpendicular. Square these across and up both sides, and transfer the deck heights from plan, but measuring above No. 5 waterline instead of the base. No. 5 may be drawn aft to the perpendicular on sheerplan to obtain the height there. Mark the heights on both sides of sheerpiece, and bend the batten (with stout needles stuck past it into the wood) to the lines. Put the sheerpiece aside, show the centre line full length on each board, and, after squaring it down the ends, draw it along the under side also.

Mark the cross sections on the upper side of each, measuring throughout from the fore end which corresponds with the perpendicular on plan, and was cut square for the purpose. Next set off and draw with batten and weights the various waterlines. The spare wood at the fore ends of Nos. 1, 2, and 3, must not be cut away, but left until the model is glued up. The cross sections on No. 1 board must be squared round to the under side, and the curved base line shown there. Cut your sheerpiece to the side lines; plane it true, and mark the deck-line on top. Take the boards one by one, and carefully saw away the waste wood outside the line; but instead of following it throughout its entire length, leave a breadth of 2in. at the ends to secure a good glued joint at stem and stern. By puncturing the wood with a lead pencil the shape of the waterlines in way of the solid part may be followed with ease in cutting out. The lowest board is only 1¼in. wide amidships, so should be left its full breadth throughout, the shape of the upper line being pricked out from end to end. This done, saw out the interior of Nos. 2, 3, 4, and 5. Lay No. 5 bottom upwards on the bench, and No. 4 on top of it, also bottom up. Set the fore ends exactly together, and the centre lines to correspond aft. Run a pencil along the edge of the upper board to transfer the shape to the lower. Remove No. 4, and roughly pencil another line about ½in. inside the first. Saw out to the inner line, leaving the extreme ends rather solid for screwing together, then mark and cut out No. 4 from No. 3 in the same manner, No. 3 from No. 2, and No. 2 from No. 1; the latter is to be left quite solid. Lay the sheerpiece upside down on the bench, lay No. 5 board in place upon it, and bore a screwhole through each end into the sheerpiece, close inside the stem and sternposts. Insert the screws, and screw them firmly down. Proceed with No. 4, and so on, allowing each time for the positions of the screws in the next board. Then unscrew them, and commence to glue together, for which operation you will require assistance. Marine glue is to be used, exposure to the water causing the ordinary kind to yield. It should not be too thick, but allowed to boil a few hours before using. Fix the sheerpiece firmly first of all, then apply the glue briskly with a large brush to prevent it getting cold. Take No. 5 board, rub it back and forwards a few times, using all your weight to force the glue out from between the boards, and screw up one end quickly while your assistant does the other. Add the other boards, and if when screwed down they should be a little out of truth, a tap with the hammer will correct the variation. When finished lay the craft aside in a dry place over night before commencing to cut out. Sections similar to those used in cutting out a block model may be prepared for this one, but they are almost unnecessary, as the waterlines should be quite sufficient to work to. This model will require very little hollowing out, but great care must be taken at the ends, in order to avoid the screws. Their presence is perhaps the greatest drawback about this system, but they cannot well be omitted, except by using weights or cramps instead, and allowing the glue of each board some hours to harden before applying the next. If this were done a much more satisfactory job would be the result, and the extreme ends of each waterline could then be properly hollowed. But as our little boat is intended for active service the ends of the boards require a more substantial connection than glue alone.

While models built of wood, planks, etc., afford ample scope for skilful workmanship, and when finished present the most attractive appearance, yet their construction places them in only a secondary position as racing boats. Light weight is certainly a great recommendation, but a block model may be made quite as light. Sections of wood and tin models are given on plate 3, which will give a fair idea of their construction.

In making a wood-built model to the design on plate 1, proceed as follows:—Get a piece of hardwood for the wood keel (see fig. 3), elm preferred, about 2ft. 3in. long, 1¼in. wide, and ½in. thick; plane it true and square, then draw the centre line down each of the broad sides. Make a spot midway between the ends, mark it No. 4, and set off the others at each side, omitting No. 1½. Draw the curved base line on the under side, and a similar line on top, the half-breadths of the upper line being specially taken from the sheerdraught by showing a waterline on body plan, ½in. above base. The distance it extends before No. 7 is to be obtained by showing the same waterline in elevation on the sheerplan. Shape the piece to the lines shown on top and bottom, then prepare the stem and sternpost, which should also be of some hard wood. Dress a piece of board to the thickness of ¼in., mark on it the outline of stem from sheerdraught, making it ½in. wide throughout, and allow the heel of stem to extend aft to about No. 7 section. The sternpost, which is also ½in. wide and ¼in. thick, should be cut to form a knee at the foot, as shown in fig. 3. Both posts will require to be rabbeted or grooved to receive the plank-ends (figs. 4 and 5), and the rabbet continued to the lower side of wood keel. The latter may have a similar rabbet, if desired (see fig. 8), but as a lead keel is to be fitted, we may with advantage extend the planking to meet it. The stem and sternpost may either be mortised into the keel, or made to overlap it flush. Now get a board about 3ft. long, say 6in. wide, and at least ¾in. thick, which, turned on edge, is to answer the purpose of building stocks for our diminutive ship-yard. Fit strong brackets, or chocks, at each end to keep it perfectly upright and steady on the bench, to which it may be fixed, if desired; then with 1¼in. screws fasten the wood keel (with stem and sternpost in position) to the upper edge. Insert one screw say an inch abaft No. 2 section, another an inch before No. 3, another an inch abaft No. 5, and one more the same distance before No. 6. Next cut out the building sections of yellow pine, ¾in. broad and ⅛in. thick. These are formed of two side pieces, properly shaped from plan, and connected by cross-pieces at top and bottom. The upper cross-piece or beam (fig. 6 *b*) is rounded up about ¼in. in the centre for the midship section, and on the others slightly less. The ends of these cross-pieces, as also the top of each frame, *f r*, must be cut away, as shown, to admit the margin-plank *s*, ½in. by ¼in., to which the deck is afterwards screwed. The cross-pieces at bottom of Nos. 2, 4 and 6 sections are ¾in. deep and ¼in. thick, with a shallow notch cut in the upper edge ½in. wide and ¼in. deep, over which passes the keelson or inner keel, *k s*, which we fit later on. Fig. 3 shows these sections solid and on every section, but framed sections are much handier, and four will be sufficient for a craft of this size, namely, Nos. 1, 2, 4 and 6. The lower part or heel of No. 1 should be slightly lengthened, and rest in a notch on sternpost (fig. 3). In making the others, allow for them to stand on the ½in. wood keel instead of extending to the base line. Fix them in position with fine nails, and prepare a strip of wood (about ¼in. thick) to extend full length of the boat on top of sections. Tack this to the centre of each, and to the stem and sternpost. It should project a few inches abaft the latter to support the stern, which need not yet be fitted. Now commence the planking. Cedar, pitch pine, pear tree, or other tough yet pliable wood will be found best adapted to this operation. Cut long strips, about ¾in. wide, and not less than $\frac{1}{16}$in. thick when planed up. Begin at the keel and work upwards at each side alternately. Much time and trouble may be saved by fitting cardboard strips to the hull as you proceed, and shape the wood planks from them, steaming the wood where necessary before applying to its place. The top outer edge and bottom inner edge of each plank should be slightly bevelled to make a better connection, and white lead applied to the joint before closing. Small copper nails are used throughout, and neatly clenched inside. Bore all holes carefully before inserting the nails, to prevent splitting. When so far advanced that the after end of plank lands on No. 1 section, make the counter or crosspiece aft, and secure it by a temporary sheerstrake or ribband fitted close to the deck (fig. 3). For the counter get a piece of hard wood ¼in. thick, and 1¾in. wide. The lower edge will be 4½in. long, the upper 4in., a ⅜in. chamfer being made along the former, and a ⅜in. chamfer on the opposite upper edge. Cut the ribband to project the proper distance abaft No. 1 section as on sheerplan, and fit the counter in place between them with a couple of light tacks for the present. Then resume planking, the after ends of which may now be fastened to the lower edge of counter. On reaching the deck, remove the ribband, and apply the topmost plank, or sheerstrake proper, which should be slightly thicker than the others, say ⅛in. All seams and joints, inside and out, may now be carefully filled in with white lead, and small corner pieces of wood glued in to connect the mould sections to planking; then varnish thoroughly inside and out. While the varnish is drying, prepare a hard wood keelson, or inner keel, *k s*, fig. 6. It will be 16¼in. long, ¾in. deep, ½in. thick, and lies close down to keel. The under side is notched to clear No. 4 section, and the ends form ledges which rest on the lower part of Nos. 2 and 6. Fasten it to the wood keel with four brass inch screws, placing one an inch in from each end, and the others 2⅜in. before and abaft the midship section.

A short explanation of fig. 7 will enable the reader to understand the construction of a tin-built model. In this case the lead keel is cast first, and the stem and sternpost, which may be of brass, ⅜in. by ⅛in., soldered on to it. Erect solid building sections, and fit temporary ribbands at side in addition to that along the centre. Then commence plating from the keel by fitting the cardboard templates or patterns full length, and as wide as convenient. Allow the bottom strake to overlap the keel about ¼in. throughout its length. The seams or laps, *l l l*, may be first arranged on plan, and the building sections marked accordingly. The soldering is done either with blowpipe or soldering iron. The topmost strake should stand ¼in. or more above the height of deck to form a low bulwark, *g*, all fore and aft. This admits of either soldering or riveting the deck to the hull, the former being also of tin and flanged all round to form a tray. The wood building frames may be fastened in permanently, or, what is better, remove them before decking and fit tin ones at all sections, of the shape shown in fig. 7, and soldered in.

Paper boats require to be made on a mould or block model laid upside down. They consist of several thicknesses of coarse brown paper laid on wet, each one being well glued or pasted over before applying the next, and the whole allowed to dry and harden before removing from the mould. Then the trouble begins. If the model has a moderate "tumble home" the paper boat may be pulled about a good deal before leaving the block, so that this method requires the model to be widest at the deck. A wood keel, stem and sternpost, and midship section are afterwards fitted inside, and the lead keel screwed on from within. The deck is secured to the paper bulwark (which stands a little above it, as in the tin model) by a light strip of wood glued and tacked in from end to end. The hull must be kept well painted in every part, or the moisture may gradually soften the glue here and there.

Lead keels, decks, and deck-fittings will receive attention in our next.

THE PECULIAR PROPERTY OF STEEL.

ALTHOUGH the characteristic property of steel upon which its usefulness mainly depends consists in its capacity for hardening, the question, Why does steel harden? has never been satisfactorily answered. Until it is fully answered, all the different methods of hardening must necessarily partake more or less of the nature of experiments. It is generally accepted that by heating and cooling steel in different degrees and at different rates of rapidity we may not only obtain a great difference between extremes of hardness and softness, but also almost any intermediate degree of hardness and softness between these extremes. Recent investigations have demonstrated the fact that, aside from its chemical composition, the temperability of steel is also largely influenced by the degree of heat at which it is tempered, and also by the temperature, the conductivity and the capacity for heat, and the boiling point of the cooling liquid. Various degrees of hardness are required for various purposes. The following simple experiment will serve to ascertain the proper heat at which steel should be cooled—say in water—so as to obtain the requisite hardness for a given purpose:—Take from the lot under consideration a bar of ordinary size — say 1 by ½ inch—and heat the end of it, for from 8 to 10 inches, to a dull red, and then nick the heated part all around at intervals of about ¾in. Next return the bar to the fire, heating only the end of it to a white or scintillating heat. Allow the nicked spaces to become heated by conduction, diminishing gradually from the white heat at the end in the fire to a black heat in the nicked space furthest from it. Then quench the bar in cold water, and keep it there till quite cold. If the heating has been properly performed, the successive nicked spaces have been cooled at the following heats:—(1) White; (2) Yellow; (3) Orange; (4) Bright Red; (5) Cherry; (6) Dark Cherry; (7) Black.

Next wipe the cooled part perfectly dry, especially in the notches, and break off the pieces over the corner of an anvil, taking care to catch the pieces in a dry box, so as to keep the fractures clean and bright. Then "up end" the fractures, and it will be seen, numbering the pieces from the fire end to the cold end, that the appearance of fractures and hardness are as follows:—

No.	FRACTURE.	HARDNESS.
1..	Coarse, yellowish cast; very lustrous.	Will scratch glass.
2..	Finer than No. 1, coarser than No. 7; fiery lustre.	Excessively hard.
3..	As above, with finer grain.	Will hardly take the file.
4..	About same grain as No. 7, but still fiery lustre.	Sharp file will make impression.
5..	Much finer grain than No. 4; no fiery lustre; very strong; hard through.	Not so hard as No. 4.
6..	Refined and hard on corners and edges, and rather coarse and not so hard in the centre; silky on the edges.	About right for tap teeth, milling tools, rose bits, etc.
7..	Original grain of bar.	Strength and hardness corresponding to appearance.

It may be expected that the heated end will show a water crack extending up to No. 5, but never into

No. 6. In order to restore any of the first pieces to the grain of No. 7, it is only necessary to replace it in the fire, heat to a good, but not bright, red, and leave it there from 15 to 30 minutes, and then cool slowly. This restoring is not peculiar to any kind of steel, but holds good for all—yet a restored piece of steel is never as good as it was before. If the user of steel will carefully study the results of this experiment, he will have no difficulty in knowing where to look for defective work. If steel, heated uniformly and moderately, cracks in the bath, it will be but right to condemn it as unreliable, but care must be taken to entrust the test only to a person who really knows how to make it, and who has satisfied himself by previous experiments that every visible variation of temperature is assuredly followed in the hardened piece by an equally visible difference in colour and grain.

As to the influence of the cooling liquid upon the tempering of the steel, there is yet a large field of inquiry to be traversed. In the first place, then, it is an established fact that the temperature of the cooling liquid in itself furnishes no criterion of the hardness to be obtained. Steel may be hardened not only in cold water, but also in boiling water, boiling oil, melted lead, tin or zinc. Considering the established fact that steel loses a good deal of its hardness—"that the temper is drawn"—by heating it to about 600° F., it seems paradoxical to assert that cooling it in a metal bath of 750° to 800° F. should harden it. Yet we know that steel wire will harden in passing through a zinc bath, and loses its temper again by being allowed to remain for a longer time in the same bath. Knowing that hardening and tempering is accompanied by a change of the internal structure of steel, and that no such change can take place at a lower temperature than 900° F., we must conclude that the hardening of steel depends chiefly on the rapidity with which it is cooled from a temperature of about 950° F. to one below 950° F.—or, in other words, the rapidity with which its redness is destroyed. On the other hand, the softening of steel, or drawing of the temper, is due to exposure to temperature differences between other limits. This recognised, the tempering of steel can no longer be admitted to be dependent on the temperature or conductivity of the cooling liquid alone. In fact, we know that fused metals possess remarkable power of hardening. With this in view, then, let us start with steel hardening below 900° F.; then, taking the difference between the temperature of the steel and the cooling fluid, and multiplying the difference by the co-efficient of conductivity of the cooling liquid, we find:

For	At a temperature of	Difference between it and 900° F.	Coefficient of conductivity.	Product.
Water	32°	868	1.0	868
Zinc	800°	100	15.0	1,500
Lead	650°	250	8.5	2,125
Tin..................	470°	430	14.5	6,235

According to these results, it would follow that any of these metals would harden steel much more than water, which, however, is not the case. Hence it follows that the hardening power does not depend merely on the temperature and conductivity of the cooling fluid, but also on its capacity for heat and the height of its boiling point. This being so, it follows that the great hardening power of water must be explained upon the ground of its production of vapour rather than its conductivity. And this becomes at once evident when it is remembered that water in contact with metal at a temperature of from 900° to 950° F. cannot, under ordinary pressure, remain in the liquid state, but must be rapidly converted into steam. Therefore, the heated steel remains enveloped by a film of steam until cooled, which formation of steam renders a great deal of heat latent, thereby assisting the hardening process. From the well-known fact that rapid motion of the steel greatly aids hardening under water, we must further conclude that steel will be all the better hardened the more rapidly the steam formed is drawn away. With a view of accomplishing this, slow dipping, hardening under a running stream of water and finally hardening with a spray have been successfully employed, and have all given better results as to degree of hardness and uniformity than the ordinary method of hardening under water. For tempering small articles, melted metal baths, especially tin, give the best results for uniformity of hardness, and since the certainty of the temperature of the bath is an important factor in the process of hardening, their use commends them to very favourable consideration.

In softening steel, the first consideration is the purpose of the operation. If it is merely intended to draw the temper of an over-hardened piece of steel, its ultimate use will entirely decide the question. Uniform and careful heating, and good judgment, acquired by intelligent practice, are the only safe guides. If, on the other hand, annealing for the purpose of restoration of ductility is intended, then the treatment the material has received, and the heat at which it was last worked become most important considerations. No specific rules applicable to all cases can possibly be laid down, and the experience and good judgment of the steel worker must be given proper scope. The general rules governing annealing may be summed up as follows: Heat slowly and uniformly the entire piece to a temperature higher than that at which the metal was last worked—if hammered or straightened cold, to a bright red. Allow cooling to take place as slowly as possible and under exclusion of air. If annealing cannot be performed in pots or muffles annealing in dry lime or in an oil bath will give excellent results. If the steel has not been heated above dark cherry red and is low in carbon, annealing in boiling water will give excellent results.—*Blacksmith and Wheelwright.*

* * *

Cork.—Corks are so important in many operations, that a little knowledge of the best methods of working them is indispensable. They form the best material for a holder for sandpaper in rubbing down flat surfaces, and they afford the simplest and most effectual means of closing bottles in many cases. Cork is easily cut by means of a thin, sharp knife, which should not have a *smooth* edge, however, but one set on a dry stone, moderately fine. After having been cut to nearly the right form, corks are easily worked to the proper size and shape by means of files. Holes are easily made through corks by means of tin or brass tubes, which must be thin and well sharpened on the edge by means of a file. The sharp edge being slightly oiled, is pressed against the cork and at the same time turned round, when it quickly cuts a smooth straight hole through the material. When it is desired to make corks airtight and water-tight, the best method is to allow them to remain for about five minutes beneath the surface of melted paraffin in a suitable vessel, the corks being held down either by a perforated lid, wire screen, or similar device. Corks thus prepared can be easily cut and bored, have a perfectly smooth exterior, may be introduced and removed from the neck of a flask with ease, and make a perfect seal.

ON THE MODERN SYSTEM OF CUTTING METALS.

Abstract of Discussion on the Above Paper.

For Illustrations, see Four Full-Page Supplements.

(*Continued from page* 246.)

MR. FORD SMITH exhibited and explained many of the tools referred to during the reading of the paper; also specimens of work done by various tools; and two machines, one for grinding milling cutters, and the other for grinding twist drills. He also referred to the accompanying table (page 245), which gave the speeds at which some of the work exhibited had been produced. The experiments described in this table had been made principally to test the speed of milling against that of shaping, planing, slotting, or turning. For instance, the lower portions of two pedestals had been one of them shaped, and the other milled with a milling cutter. The time occupied on the former had been 11¼ mins. for each surface once passed over, and on the latter 8 mins., the area being 18in. by 6in. The other experiments were of a similar character. In another case, of two wrought-iron forgings for the ends of flat joints, one was given to a man at the milling machine, and the other to one of the best slotters in the works. These men knew that they were working against each other, and did their best; and the time came out, with the milling machine 18 mins. and with the shaping machine 44 mins., which was a great disparity. One reason was that the latter required three settings, as almost all such convex and concave curves did. When a milling cutter large enough in diameter to form the corners could be used, it could be set to machine the required breadth, and by once feeding it round the end of the joint, finish it. Again, *fac-similes* of the pedestals referred to at the top of the table—which had been produced in large quantities—were all machined so absolutely to standard breadths and depths, direct from the milling machine, that, for instance, any cap would fit any lower piece with such perfect precision as to be quite free from shake, and thus require no fitter's hand labour to be spent upon it. In other words the lower pieces and the caps were interchangeable; and as the under surface of each pedestal had also been milled over—the milling system having been employed throughout—the height of the centre of each pedestal from its base was ensured correct to one standard uniform measurement. Such accurate results could not possibly be produced in the same short space of time by any other means. Reference to the table showed 4½ mins. for milling against 38 mins. for shaping, for the parts of each cap and each lower piece, where they fitted together.

Mr. J. H. Wicksteed said the question of drills seemed to him to be not entirely worked out. There was part of an ordinary drill, close to the point p, fig 26, which did not cut at all. If it was looked at from below, as in fig. 28, there was an oblique line $i\,j$, forming the connection of the two ground edges of the drill. That line, $i\,j$, was not cutting; it merely ran round and rubbed; and that was the part which required all the force on the top of the drill to drive it into the metal. However much the cutting angle of the drill might be improved at the edges $p\,m$, $p\,n$, fig. 26, that would not improve the connecting line $i\,j$, fig. 28; hence, in any material, if you had a small core-hole to start with, you could employ at once a feed four times as rapid as you could employ when drilling through a solid piece. However quickly the drill was rotated, it did not give too high a cutting speed at the point p, fig. 26; it was too near the centre for that. Therefore he was not quite sure whether Mr. Ford Smith's system repaid him for his trouble, and for the extreme accuracy required in arranging the cuts; because it was not for the sake of the cutting edges, even if they were not particularly good, that you needed so low a rate of downward feed as one hundred cuts to the inch; but it was for the sake of preserving the point and giving it time to force itself into the metal, that you were obliged to employ fine feeds. He was a little surprised at Mr. Smith's proportion of feed to number of revolutions. He made the drills revolve with a circumferential speed of about 20ft. per minute, and gave them about 100 revolutions to the inch of downward traverse. He himself should have used 200 revolutions to the inch of downward traverse, and a cutting speed of 40ft. per minute, in cases where water could be used. With regard to the rests, he would ask members to look at the swivel tool-holder, figs. 1 and 3, and compare it with an ordinary slide-rest, as in fig. 12A. In the latter the whole of the tool was bearing on the rest, and that was down upon the bed of the lathe, and held to it by the V's. It was quite clear that the tool was supported under its heel, and could not spring away from the cut. That was the right position for taking a heavy cut without jar. Not only was the tool supported under the heel, but the rest was supported by the lathe bed, and the point of pressure was not outside the point of support; so that there was no tipping action against the inverted V. He did not see that the arrangement of movable tools lent itself so well to heavy cuts, although it facilitated getting a thoroughly good edge, and was first-rate for giving the high finishes which Mr. Smith produced. There were also a great many instances where you must have an overhang, whether you liked it or not—for instance, with a parting tool; and there Mr. Smith's form of tool-holder was right and convenient. Thus the parting tool, fig. 9, was in a very good position, because the spring that inevitably took place when the tool projected beyond the support, took place in the direction indicated by the dotted arc $p\,q$, with the centre c, and tended to relieve the tool out of its work, instead of making it dig into it. Again, if you were roughing with a tool in a strong planing machine, and could bring the planing machine box down to the position shown in fig. 9*a*, you were in the best position for taking a heavy cut. But if you were obliged, for the sake of a parting cut, to make the tool project below the tool-box, that tool should be of the form shown in fig. 9; otherwise, since the spring of the tool would come from c, the point of the tool would gather into the work, as shown in fig. 9*b*. But with Mr. Smith's tool, having thrown the tool back to the position shown, the point of the tool relieved itself; and you could get on a great deal better for that reason. He had no doubt that this was the explanation why the composite tool in the particular experiment given first in the table got on nearly twice as well as an ordinary solid tool, which was probably made as indicated in fig. 9*b*.

Mr. Arthur Paget wished to ask Mr. Ford Smith whether there was any means at present in use of obviating the one defect which he had constantly found to exist in twist drills. It was very analogous to the defect pointed out by Mr. Wicksteed in the old form of flat drill—namely that the front part of the drill, on the line $i\,j$ as shown by Mr. Wicksteed, fig. 28, did not *cut* the metal at all, but was forced into it by a sort of bruising or crushing action; but he had imagined that nobody but the traditional village blacksmith now made flat drills according to the form shown by Mr. Wicksteed. Flat drills should always be made to the shape shown in figs. 27*a* and 28*a*, thick at the shoulders of the drill and coming to a thin edge at the point. The drills in his works, for the last twenty years, had been made to that shape; and then there was very little of that forcing the point into the metal which Mr. Wicksteed had spoken of. The only difficulty that he had noted in twist-drills was that there was in these drills no means of reducing the blunt point (or line *i j*, fig. 28), between the two grooves, which did not cut at all, but merely squeezed itself into the metal. There must be proportionately much more work concentrated on that little spot than on all the rest of the metal being drilled. He should be glad if Mr. Ford Smith could tell them of some means of obviating that defect. It was of more importance in small drills than in large ones; because that blunt point (or line *i j*) in the smaller drills bore a much larger proportion to the whole area.

Mr. William Anderson wished to compare the finish of the two specimens of flat joint ends in the table, one made with a milling cutter, the other in a shaping machine. He could tell by feeling, with his eyes shut, which was which. The one that was done by a milling cutter was all in ridges, and the one done by the shaping machine was quite true and smooth. The author had been comparing the cost of the two processes; but such comparison could not fairly be made, because the quality of the work was so different. If appearance were all that was wanted, the comparison might hold; but for real quality of work, necessary, for instance, if the joint ends were meant to work against a bearing, the shaping machine had alone done satisfactory work.

Mr. Daniel Longworth said the author stated that he had adopted one cutting angle both for cast and for wrought iron, simply for the purpose of having uniformity. But all writers on the subject, and those who had experimented in the workshop, had come to the conclusion that two angles were really necessary; and sometimes even more, according to the hardness of the material. He wished to ask Mr. Smith what angle he had finally adopted, as in his former paper he had taken 50° for wrought iron and 60° for cast iron. In the paper reference was made to broad cutting; and he should have thought that the angles shown in figs. 1 and 3 would not do very well for broad cutting. He thought Mr. Smith deserved credit for again drawing the attention of engineers to the great importance of having uniformity, if possible, in their workshop tools. At the same time the author perhaps gave more credit to the tool-holder than was really due to it. The success obtained was rather due to the accuracy of the cutting edge; for in comparing work done by the tool-holder with work done by one of his workmen with an ordinary tool, Mr. Smith's superior knowledge of the best cutting edge in that particular case had been put against that of the workman. No doubt, if the one tool had had the same cutting edge as the other, the result would have been precisely the same. Another question he wished to ask was whether Mr. Smith had succeeded in dispensing with the rose bit; that is, in making holes, by the drill alone, to fit accurately a pin turned to gauge. If he had done that, he had certainly made a great step in advance; because in ordinary work, where a pin was required to fit a hole accurately, it was necessary to use a rose bit, even after the hole had been drilled by a twist-drill ground carefully by hand. As to milling cutters, Mr. Smith was right in stating that the introduction of the little emery-wheel and its attachments for sharpening the cutters had been one of the greatest improvements made. Milling machines had been tried, to his own knowledge, fifteen years ago for grooving steel; and they were abandoned after great expense had been gone to because of the difficulty and cost of sharpening and maintaining the cutters. Mr. Smith had not shown any samples of brass-work finished by milling. Milling had been tried from time to time for brass, but had never succeeded to any extent, because of the difficulty met with in the grooves getting clogged up, and because the ordinary single fly-cutter or tool was durable and accurate enough for most purposes. He should like to ask, therefore, if the author had made any improvements in milling brass. For cutting cast iron to standard forms the milling cutter was the best tool to use; he knew of cases where small milling cutters were successfully employed on cast iron at a speed of 250 feet per minute.

Mr. Jeremiah Head thought they had scarcely yet complimented Mr. Smith sufficiently on his valuable paper. Papers of that kind, even although they might contain nothing absolutely new, yet, if carefully worked out, as Mr. Smith's had been, certainly did an enormous amount of good by spreading among the whole body of the members information which, so far, might have been confined to a few. But Mr. Ford Smith had done more than that. He had concentrated his attention on a department of mechanical engineering which was of extreme importance, although it had hitherto attracted but little attention. That department included the form and maintenance of cutting tools, the work they would do in a given time, and so forth. He noticed that Mr. Smith had not said anything about the kind of steel which he used or recommended for tools; but he gathered from the general tone of his remarks that his desire was to avoid smith work as much as possible—to take a piece of steel which was originally of the proper hardness and temper, and, if possible, to use it up simply by grinding it gradually away. Now it was well known that there were certain alloys of iron and other elementary substances forming steels, such as chromium steel, titanic steel, etc., with peculiar characteristics. There was also "Mushet's special steel," which was said to be more enduring than ordinary cast steel; and it would be interesting to know whether Mr. Smith's arrangements necessitated having steels of these or any other special kinds. With regard to the term "milling," he remembered many years ago that it was used simply for a little tool that made a serrated edge on small nuts in brass work. He presumed that the carrying on of the name to a kind of work which was entirely different had come from the tools used in the two processes somewhat resembling one another. The paper seemed to show that milling in its new sense had been wonderfully perfected in recent years, and for many operations in engineering work was destined to supersede ordinary cutting tools.

Mr. John Fielding agreed with Mr. Head in thanking the author for the able manner in which he had brought his paper before them; but he should like to ask him some questions about the maximum speed he had been able to obtain in cutting with his tools. As bearing upon that question, he had brought with him two cast iron tools having chilled points. While he did not assert that the use of cast iron for tools was new (it was really very old), he should like to ask why it had not come more generally into use. The tools were simply copies of an ordinary forged tool, cast with a piece of iron in the mould to chill the face; and with these tools he had been able to turn cast iron, wrought iron, and gun metal at speeds from 50 to 100 per cent. greater than with the best special steel. His firm had tried Mushet steel, as good as they could get it; but with cast iron tools they had been able to do from 50 to 100 per cent. more work. It had struck him, in hearing Mr. Smith speak of broad finishing cuts, that cast iron chilled tools were applicable for such work, because you could thus get a heavy tool at a minimum cost. A broad tool necessarily meant a heavy tool, in order to get sufficient rigidity—to which Mr. Smith rightly attached great importance—and the cutting edge in chilled iron being extremely hard, it would stand its work very well, as was shown by the fact that cast iron was used in turning chilled rolls. While such tools could not compare with Mr. Smith's as a complete system, he thought they afforded some advantages in heavy cutting. They were able to furnish the correct angles at a moderate cost—about 1d. per pound—whereas the cost of steel was twelve or fifteen times that amount. With regard to milling machinery, the value of that part of the paper would have been vastly enhanced if it had shown the different forms of machines used, both with vertical and horizontal spindles, and had described how they would replace slotting, planing, and shaping machines.

Mr. John Robinson joined with Mr. Head in thanking Mr. Ford Smith for bringing before them the means of arriving at correct cutting angles. He had no doubt that Mr. Smith would remember the "revolving cutters," as they were then called, which were formerly in use at the Atlas Works in Manchester. All the surfaces of four and six-sided nuts were dressed by that process, now improperly called milling. Another operation which at that time they carried out by the same means was that in cranked axles, after being forged quite solid, the two cranks were then cut out with the milling tools. Afterwards, he scarcely knew why, slotting tools were used for the purpose; and then the pieces left were taken out by means of a drill. On the whole he believed the milling process was the most economical; but the difficulty (which Mr. Smith seemed to have got over by the methods he had adopted) had been to keep the cutters in sufficiently good order. They had formerly no such thing as the grinders, which had been invented of late years; and the process of sharpening up and hardening was very tedious and very expensive. With reference to some of the forms of cutters—for instance, figs. 8 and 10—he should like to ask whether the cutter in fig. 10 had not been forged to the form which it possessed in order to take the under cut. The cutter in fig. 8, although it was "necked" in, as they would say in the North, seemed probably to be worked by simple grinding from an ordinary form of tool steel. With reference to such forms as in fig. 9, which was a planing machine tool, it seemed to him that the number of joints through which the stress on the tool had to pass, before it met with the ultimate resistance of the cross-head, was considerable and likely to create jarring. He admitted that all the other joints, except those on the tool itself, existed before, and were necessary in order to get the requisite motions; but now there were two or three other surfaces of divisions, which would have to be taken into account. He should like to ask Mr. Ford Smith, whether in practice he found it difficult to keep those surfaces so tightly bolted up as to prevent a jar in the tool, when it was cutting a surface in the way shown in fig. 9. The same observation applied perhaps to the swivelling tool-holder, fig. 3. It was exceedingly ingenious; still every one knew that such implements, when screwed up by workmen who were not so careful as they should be, were liable to get out of order. The forms of steel used for the several cutters represented in the drawings showed that Mr. Smith had taken all possible pains to produce nicety of work; and he could not but speak highly of the desire shown to keep the tools out of the hands of the smith, not only because of the expense of forging, but also to preserve the original temper of the steel, when that temper was well adapted to the object in view. The mode of grinding in fig. 39 was exceedingly ingenious, and showed how inexpensive the actual processes were, if only you had money to buy the tools first, and men to work them well afterwards; because, after all, it was a kind of machine that could not advantageously be put into a shop, unless it was carefully looked after by trustworthy men. The whole system was one which required organisation, a point in which Englishmen often fell behind their continental brethren. Mr. Smith had done wisely to arrange the system, and bring it to them ready cut and dried; and the only thing to be done was to persuade people to take it up and follow it out. With regard to cast-iron tools, what seemed to him to be a disadvantage in them was, that they could not be ground up very frequently. It was easy to make a casting from a pattern, but the cutting angle would soon be ground off, and then the whole mass of cast iron was thrown away, in regard to its usefulness as a tool. But in the form of tool which Mr. Smith had shown, the tool could be worked up until it was too short to be held in a holder; while $\frac{9}{10}$ of the cast iron tool had to be thrown away.

Mr. Fielding asked leave to make a remark with reference to the last point that Mr. Robinson had mentioned. By chilling $\frac{3}{8}$in. deep, the tool would wear for a very long time; and when it was worn away, the cost of melting it up, and running it into a mould again, was much less than the cost of forging a fresh tool.

Mr. W. W. Hulse thought they must all admire the tenacity with which Mr. Smith and his firm adhered to the question of tool-holders. That subject was one in reference to which there had been a good deal of experience at the works of Messrs. Whitworth & Co. From time to time it was resuscitated, but it always had to be as it were flogged into activity. The tool-holder, no doubt, was a valuable thing, but it was very limited in application to general workshop practice. One reason he supposed was that engineers looked every day more and more, not merely to polishing the outside of a piece of metal with a machine tool, but to doing a large portion of the work which was formerly left to the forge. He had with him some cuttings which were taken from a lathe recently made by his firm; these showed what description of cutting was expected of a machine tool in the present day; and he would ask any one to say whether any form of independent tool-holder could support a cutting tool that would deliver cuttings of that kind. The cuttings were just as they came from the lathe off a piece of good tough steel, 28in. in diameter, cut at the rate of 6 feet per minute circumferential speed; they were about 1½in. deep by ¼in. thick, the traverse being ¼in. in each revolution. That was what the modern lathe was expected to do, and no tool-holder had been introduced that could do it (unless the slide-rest might be called a tool-holder), nor anything but a solid bar of steel, 2½in. or 3in. square, absorbing the heat as it was generated. The twist-drill, no doubt, was also a very excellent thing; and Mr. Smith's firm deserved credit for the tenacity with which they kept those small tools in view; but he had recently had sent to him some samples of cutting from a new drilling machine, just made, for dealing with the couplings of propellers, in which the bolt holes were to be drilled out of the solid, each at one operation. The cuttings came from a flat drill, 3in. diameter, at the rate of $\frac{1}{80}$in. per revolution, and they were equal to if not greater than anything that would come from a twist-drill. No doubt one advantage of the twist-drill was the maintenance of shape and size; but the readiness with which the workman could deal with a flat drill would, he was afraid, keep it always in the workshop.

That milling or (speaking more correctly) circular cutting machines would displace planing, shaping, and slotting machines, he did not believe. Circular cutters certainly had their uses, notably for articles of which a large number were required; but the bar tool was ready at all times for any change of form. The planing, shaping, and slotting machines, with bar tools, could undoubtedly produce truer planes than circular cutting machines, unless in the latter case each tooth of the revolving cutter acted throughout its whole length upon the surface to be planed, or unless all the teeth revolved in one plane, which in practice could not be ensured after hardening. Nevertheless circular cutting machines, if properly arranged so as always to keep a firm hold on the revolving cutters, were most useful additions to engineering workshops, especially for shaping frequently repeated articles and forms; and for such work, where the configuration was principally to be considered, the circular cutting machine was undoubtedly most expeditious and sufficiently accurate.

Mr. J. Hawthorn Kitson said that for some time he had been working with revolving cutters of considerable dimensions; and he had put on the table two specimens of the kind of work they were doing. One was a cross-head, the jaws of which were cut out of the solid with two cuts of a revolving cutter. It was done at a very considerable speed, and after the first cut there was only about ⅛in. left for the second cut. It would be seen that the finish was as good as could be desired. The other specimen was a large eccentric joint. They had previously tried punching out the middle of the joint under the hammer; but they found that with a set of cutters cutting out the middle, and finishing the two outside faces at the same time, they could work as rapidly cutting out of the solid, and it was decidedly cheaper. The finish was not perfect; but a file, or something like it, had to be applied to all such work for its final adjustment, as the work altered its shape when cut out; and the cutter gave what they considered a sufficiently good workshop finish. The work had also been milled all over outside. The paper stated that a cylindrical cutter with a spiral groove dividing the teeth would not do as much work as one with solid teeth. But he had found that for roughing work, they could take double as great a cut, either in depth only, or in depth and traversed combined, with the groove cutter, fig. 46, as they could with the plain cutter. In finishing work they required to have the solid cutter. On some of the foreign railways milling had been studied very minutely and scientifically. Figs. 47 to 49 showed a French cutter sent to him from the Paris and Lyons Railway. It was found that the angle of the teeth was a question of very great importance; and after careful study the conclusion arrived at was that the pitch should be six times the diameter. The tool did very beautiful work, but only at a quarter of the speed at which the work could be done with the grooved cutters, fig. 46. The latter broke off pieces ¼ or ⅜in. wide, instead of long thin shavings, and the cutters seemed to relieve themselves in that way.

The President said, before asking Mr. Smith to reply, he would say a few words. He could confirm all that Mr. Smith had said, and even more, with regard to the advantage of milling. First, as to the endurance of the tool. If the tool were held firmly, without vibration, it would last an extraordinary length of time. The inequalities that were noticed in milling were not due to the tool but to the machine, the parts not being sufficiently strong and rigid to prevent vibration. A remark had been made by Mr. Anderson with regard to two pieces he held in his hand, that he could tell with his eyes shut which was which. In that case probably the spindle which held the cutter was too weak, or else the rest in which it was held vibrated, producing the ridges which were felt by the touch; but, where the tool was firmly held, he had seen milling turn out work as accurately as slotting or planing could do. He believed there was a great future for milling. With regard to the question of endurance, he had one tool which had been in constant use for eighteen months, with a little grinding up occasionally; and it still did its work admirably. Of course they were expensive tools to get up; and great care should be taken to get a good steel, and to anneal it properly. He could confirm Mr. Kitson's statement with regard to the grooving of cylindrical milling tools. He found that, for rough cutting, the groove certainly did enable them to take a heavier cut than they could take with the plain tool. A question had been asked by Mr. Longworth as to the milling of brass. His experience was that tools such as were shown in the drawings which were for cast iron or wrought iron, would not answer for brass; a greater pitch between the teeth and a higher speed were necessary for brass. He thought Mr. Ford Smith's perseverance in carrying out all his arrangements deserved great credit. Some years ago, when endeavouring to introduce the system, he himself had found that, in a shop where there was a great variety of work, heavy and light, they were not able to carry it out thoroughly; but they still used a good many of the tools for certain work. For really heavy work the system did not answer so well, and chiefly for this reason, that in very heavy work it was absolutely necessary to have a large heavy tool, and to have the point supported immediately underneath by the rest—in fact, to make the whole as rigid as possible. It was also necessary to have plenty of steel in the tool, to carry off the heat induced by a heavy cut. In the tools described in the paper, where there was necessarily an overhang, and where the tool-holder was composed of several parts, there was not sufficient rigidity to take off a tearing cut. Mention had been made of Mushet steel; and for some purposes that steel was unsurpassed. It was a very peculiar metal. It had to be worked up to a good heat and simply allowed to cool in the open, and it must not be tempered or used with water. It did not do its work properly until it had got fairly hot. In one machine, used for turning up hydraulic rams, with three tools—two rough cuts and a finishing cut—they had turned with one set of tools eleven rams, 10in. diam. and 12ft. long; they never touched the tools once, putting in ram after ram, and the last was as good as the first. But that machine gripped the work like a bull-dog, so that there was no vibration between the tool and the work. With regard to drills, he did not look upon the twist drill by any means as a universal tool. For some purposes the flat drill—if properly made, with the same care and precision as were expended in making twist drills—was superior. Hitherto one of the great advantages of the twist drill had been that so much care and pains had been expended in getting it up; but he had found that, using flat drills, and taking the same amount of care to ensure the sides being parallel and the angles cut even, and also pointing the edge truly so as to do away with the blunt nose, the drill would work freely, and the shavings come off even better than from the twist-drill. In drilling through cast-steel, about 11in. deep, he had seen shavings coming out, on either side of the drill, from 10 to 12in. long, or even more; and he did not think that a twist drill would enable them to accomplish that. There was, of course, this difference between the plain drill and the twist drill, that in forming the latter you sacrificed a great quantity of material in cutting out the groove; and it was of course a much more expensive tool to get up. In the flat drill there was very little waste of material, and it could be drawn down when it got too short; whereas when a twist drill got too short, it became valueless. In going through bad castings, however, there was no doubt the twist drill would make a straighter hole.

Mr. Paget asked leave to put a question as to the objection made to the tool-holder, namely, the want of a mass of metal to take away the heat. A former member of the Institution—the late Colonel Clay, of Liverpool—had produced some years ago before the Institution (Proceedings, 1872, p. 288) a tool with a hole bored through it, so that water could be made to pass along the inside to absorb the heat. He wished to ask Mr. Ford Smith whether he had tried that plan in connection with his tool holder.

The President said he had found that the less one dealt with water the better. If steel of sufficient size were used, very little water was required; in fact, cutting steel with steel, water was not wanted at all. With regard to cast iron tools, he might say that he had tried them only for castings which were so exceedingly hard that steel would not touch them. But, for the reasons given by Mr. Robinson, he did not think they were universally applicable.

Mr. Thomas R. Crampton asked permission to say a word upon some experiments he had made to show the bad effects of jarring, when using revolving disc-cutters for shaving off chalk or stone. He found that, when the cutters and cutter-head were too light, the material was simply disintegrated; but when the whole was firm and solid, shavings were cut off quite smooth even in sandstone, which was so easily broken when thin. The shavings on being cut ran up the revolving cutters like ribbons. The firmness of the tool also reduced considerably the power required to do the work.

Mr. W. Ford Smith, in reply, said that Mr. Wicksteed had alluded to the thickness of the point of the drill being an objection, and Mr. Paget had also referred to the same subject. The difficulty of boring with a large drill which had a thick point was by many engineers overcome by first drilling a small leading hole, and afterwards opening it out to the required size by using a large drill, the point of which, entering into the small hole, had no cutting to perform. There were two objections to that plan; the first being that the point of the larger drill, not having any metal before it to support and steady it, was free to run eccentrically, oscillate transversely, and revolve with a series of jerks, thus producing a badly finished hole, which, upon examination, would be found to be much jarred, and any thing but round. The second objection was, that it was too tedious and expensive to drill a small leading hole first, as a considerable amount of time would be occupied in changing the speed of the drilling machine from the slow speed, which had last been used for the larger drill, to a speed quick enough for drilling advantageously the smaller or leading hole. The change of speed entailed the altering of the strap on the cones of the drilling machine, and in many cases the disengaging and again engaging of the double gearing of the machine. Both these objections were surmounted by using a twist drill. If preferred, its point might be thinned down, in a grinding machine with small emery-wheel, to any degree of thinness which might be found best for penetrating without fracturing, as in fig. 29*a*; this was a simple mode of reducing the blunt end between the two grooves to any extent, thus meeting the requirements of Mr. Paget. By this system the point only needed to be thinned after about every sixth time the lips were re-ground; of course, each re-grinding of the lips gradually caused the point to become thicker, until it was found advisable to reduce it again by grinding.

With this system very heavy feeds might be employed, and a twist drill 2in. diameter had drilled one inch deep in wrought iron for every 62 revolutions; such a feed, however, he considered too heavy for every-day practice, and he preferred to use a feed, for drills over ½in. diam., of 100 revs. per inch, as given in the paper, and not 200 revs. per inch, as suggested by one of the speakers. While agreeing with Mr. Wicksteed that the less overhang a cutting tool or tool-holder could have the better, yet in actual workshop practice it was found impossible to avoid overhang altogether; and it would be found in going the round of any works, say for example the machine shop of a marine-engine builder, that probably forty-nine out of every fifty tools were obliged to overhang the slide-rests or the tool-boxes which carried them—in most cases to the extent of many inches of overhang—in order to reach the part which had to be operated upon. In numerous instances the cutting tool had to reach into deep corners and recesses, often as much as one or two feet deep: the tool or tool-holder having in many such instances to be made specially long. The few cases where overhang could be dispensed with were in turning a long hydraulic ram in a lathe, or a large straight propeller-shaft: the slide-rests of the lathe could then be brought almost touching the work, as in these examples there were no projecting arms, bosses, or anything of that sort to prevent it. Where, however, it was desirable to avoid overhang, the swivel tool-holder could be cramped diagonally on the rest or tool-box; and even though a cutter of great length were then used, it might project as short a distance out of the holder as desired, so as to overhang not more than ¼ or ½in., as illustrated in fig. 50. Again, where in some special case exceedingly heavy cutting was required from the round tool-holders, then if it was considered advisable a narrow portion of the front part of the rest or tool-box might be recessed for the curved part of the tool-holder to lie solidly in, as shown in figs. 51 and 52. By this means the round cutter might be brought up so close to the front of the slide-rest as almost to touch it; or else the old style of straight tool-holder could be used, drawn back on the top of the rest until there was no overhang. For such heavy cutting the tool-holder and cutter must also be sufficiently heavy and massive to convey the heat away. There was no particular limit to the size the tool-holders might be made; and they were all constructed of steel. To test the stability and cutting powers of round tool-holders, he had made an experiment in a heavy 15in. treble-geared lathe with 5ft. face-plate, turning a hard Bessemer-steel shaft 8in. diameter with a traverse of ⅜in. to each revolution. Care was taken to examine the amount of spring which really took place in the short overhanging portion of the tool-holder; a gauge was applied, resting on the solid saddle of the lathe, and high enough nearly to touch the cutter. Very little spring was discovered at this point, the slide-rest and tool-holder proving to be more stable than other parts of the lathe. The loose headstock, though very massive and secured to the bed by three large holding-down bolts, proved to be the weakest part of the lathe; its centre could be seen perceptibly to spring and rise when the cut was put on. For roughing out very heavy iron and steel forgings, such as Mr. Hulse had alluded to, there was no doubt that the most speedy and least expensive system was to employ powerful machine-tools. From his own experience this applied also to smaller articles, such as pins and set-screws with collars and heads, studs, etc., which were roughed out and finished direct from the black bar-iron and then cut off: the whole being accomplished at one setting, and expensive smith's work being entirely avoided.

Mr. Anderson had referred to the finish of two joints, and asked which was the best. To all appearance the milling gave the finest finish; but by passing the fingers carefully over the milled part very slight undulations could be detected. This was simply because there was only one vertical milling machine at liberty to do that work at the time, and it was far too light and delicate for the purpose. Its circular table, which carried the joint, was only about 8in. diameter; while the table of the slotting machine on which the corresponding joint was finished was about 24in. diameter, and the machine proportionately heavy. The fact, however, must not be lost sight of that the milling was done in one-third of the time occupied for the slotting. Milled work generally was better finished than shaped or slotted work. Take, for example, the admirable specimens of workmanship sent from America, such as lathe and drill chucks, etc., which were finished direct from the milling machine with such wonderful accuracy that any hand labour bestowed on them would only injure the fit; and this would apply, to a great extent, to the larger work. There was no reason why he should be biassed in favour of milling any more than of slotting or shaping. All he desired was to produce work in the best way and at the cheapest rate. Mr. Longworth had asked why he did not adopt two cutting angles—one for cast metals, the other for wrought metals—as in the case of the round tool-holders. The objection to doing so was that there would have been much more complication, as double the number of tool-holders and cutters would have been required. The question had also been asked whether broad-cutting could be done with the tool-holder as correctly as with an ordinary tool. All he could say was he was constantly doing broad-cutting with tool-holders, and found that the machined work was better than he could produce by any other means in the planing machine. It was advisable in this case, when grinding the cutter, to give it as little clearance as possible. One of these cutters, which he had examined in the works, had not been re-ground for nine months, having been simply rubbed up on its cutting edge occasionally with an oilstone. The shavings taken by these cutters, though broad, were exceedingly thin; the cutters were probably not cutting one-twentieth of the time of the roughing-out cutters, but in any case their endurance was extraordinary. It had also been asked whether the rose-bit could be dispensed with. Though wonderfully good drilling could be done by good and correctly ground twist drills, yet for exceedingly accurate holes, into which standard-sized bolts or steady-pins had to drive tightly, or for holes in joints, links, etc., in which pins had to work with perfect template fit, he himself used an adjustable rymer having three blades, which were capable of the finest adjustment in case of wear, in order to maintain the standard sizes. Hard gun-metal, he found, might be quite as easily milled as cast iron; and the yellow brass and softer gun-metals could be even more easily operated upon, provided the milling cutters were coarse in pitch, so that there was ample room between the teeth to receive the cuttings. The milling cutters were particularly suited for finishing soft brass, and could be worked with double the feed used for iron, producing brass mouldings or other complicated forms with great accuracy, and with a very highly finished surface. Such mouldings had been milled at the rate of 2½in. in length per minute. As to cast steel for cutting, he simply used the best qualities which were found to be the most suitable for each purpose, using one make for twist drills, another for milling cutters, and so on. He had made numerous experiments on different kinds of cast tool-steel; testing a tool made of any quality of steel which he had not previously used, against a tool made of steel which had hitherto given the best results. The trials were usually made in a planing machine having two tool-boxes on its cross-slide. One tool was fixed in the first box, and the other in the second one; and both were started to cut on the same casting (usually a lathe bed or planing-machine bed or table), cutting of course at the same speed, and with the same feed and depth of cut applied, so that the trial might be a perfectly fair one. But there was an extraordinary difference between steels. Some very hard steels, which would resist the file, seemed in cutting to perish away at the point. Steel which was hardened by simply heating and laying it down, seemed, as far as he had tried it to cut very satisfactorily, and to stand well; but there seemed to be one peculiarity about it: the quality of the tool, as it was ground away, became softer than it was at first. That difficulty was obviated by taking it to the smith, and re-hardening it. As to cast iron, he had had much the same experience as the President. One of the greatest difficulties with a chilled iron tool was, that if the point of the tool did give way, it was exceedingly difficult to re-grind it; and although it was excessively hard, it did not seem to have great endurance. He had not yet, however, tried the effect of cutting chilled metal with a chilled cast iron tool. Mr. Fielding had asked the maximum speed of cutting. That was alluded to in the paper. The maximum speed for cutting wrought iron with a single tool was about 40ft. per min. In his small lathes, it was quite common to cut at the rate of 30ft. per min. Of course the speed had to vary, as remarked in the paper, with the depth of cut and the quality of the metal. Mr. Reynolds, had he been present, could, he believed, have told them that he had taken off with one tool, running at a slow speed, half a ton of steel shavings per day. He had been invited to go into a description of the machines used in connection with the tools; but to introduce any such matter would have made the paper far too long, though he might perhaps do so on a future occasion. Mr. Robinson had called his attention to the milling machines made long ago at the Atlas Works, which no doubt would still do good work if proper cutters were supplied to them. One practical difficulty, as Mr. Robinson had said, was in maintaining the cutters, before the emery-wheel and the mechanical system of grinding were adopted. The difficulty and expense of the old method were described in the paper. Not only the making and finishing of the milling cutter, but also the maintaining of it in its proper state of efficiency, were exceedingly inexpensive. For instance, a cutter would probably last a day without being re-ground; and to re-grind it occupied four minutes only. The cutter was simply placed in the grinding machine on a mandrel, adjusting it by worm and worm-wheel till the teeth to be ground were parallel to the lower slides. The cutter was then passed rapidly, once forward and back, for the grinding of each tooth. The actual grinding of the whole cutter would not occupy more than 2½ to 3 minutes. Replying to Mr. Robinson, the tools shown in figs. 8 and 10 were the only two special forms out of the whole of the cutters shown, and only one of these required any forging. They were tools which were rarely used. All parts of the swivel tool-holders being made of tough forged steel, and the cutter being gripped with great rigidity by a powerful screw and nut, the whole was wonderfully free from jar. Regarding the organisation of the best systems in workshops, his experience was that when this tool-holder system was once introduced the work went on with less supervision and anxiety to the overlookers, cost much less, and maintained a much higher standard of excellence. Mr. Paget had mentioned the introduction of water through the tool to cool it. He had made a number of experiments for Col. Clay on that principle, and managed to cut at 40ft. per min.; but at the end of the day from one difficulty and another he found it had not finished more work than an ordinary tool, and consequently it was abandoned. Mr. Hulse had alluded to the practice at Sir Joseph Whitworth's with regard to tool-holders, as to which it was not needful to go into details; and also to the tool-holders not being able to take heavy cuts. If for tools doing exceedingly heavy work, and taking such cuts as Mr. Hulse spoke of, any advantage was found in using the slide-rest, by all means let it be used. What he said of the tool-holder system was, that for 100 machines out of 101 it was applicable; and not only applicable, but it was cheaper and produced better work. Mr. Hulse also alluded to a single-pointed tool doing more accurate work than a number of cutting teeth; but surely it stood to reason that a single point could not last as long as a number of teeth, and maintain the same accuracy. Mr. Kitson had alluded to the milling cutter with a spiral groove in it, cutting a portion of the teeth away. His own experience was that when you began to cut a portion of the teeth away, you were obliged to reduce the speed, or else sacrifice the quality of the work. Many trials had been made at the Gresley Works from time to time with ¾in. drills of ordinary form manufactured by himself, or by different engineers who had wished to see the effect of working a common against a twist drill. The result had been that if a feed were put on the common drill, approaching that used for the same size of twist drill, the former was invariably fractured, while on the contrary the twist drill escaped fracture in a marvellous manner. The feed used was often so heavy that the spindle of the drilling machine could be seen by the eye visibly descending. The drilling machines originally constructed by himself were provided with self-acting feeds, as coarse as could safely be applied for feeding forward the common drill. Since the twist drill had been found to accomplish so much more work in a given time, he had increased all the feeds in his new drilling machines by about 90 per cent.

The President had described the work done by a flat drill, which drill was apparently machined all over and finished with great care, thus costing probably quite as much as a twist drill could be purchased for. By that means no doubt all parts of the drill were made true and concentric with each other; and it would therefore be practicable to grind the cutting lips by machine so accurately, and to flute the cutting angles of the lips in such a manner, as to produce excellent cutting results for the short space of time the two flutes would keep in order. But he imagined that when the drill was worn, say ⅛in. shorter, the proper angles for cutting would be found no longer existing; and to restore them, ¼in. of the length of the drill would have to be ground to waste, before two new flutes could be again ground into the lips, so as to restore the proper cutting angles. Or, worse still, in a work where the flutes could not be mechanically ground in, the drill would have to be heated to soften it. Immediately this was resorted to, the finished accuracy of the drill was more or less destroyed; whereas in a good twist drill, used with care and re-ground mechanically, the cutting angles remained the same, however short the drill might be ground. This, coupled with the fact that the wear took place only at the end of the drill and that the drill was hardened its whole length, produced the result that no softening had ever to be resorted to; the grinding or shortening of the drill was excessively slow; and, there being no waste or expense in repairs, the cost of the twist drill, spread over its life-time, was exceedingly small.

In Lancashire, on an approximate calculation based upon the employment of one hundred workmen, thirty of whom were turners and machine men, the saving in wages where the tool-holder system was exclusively used, as compared with the old system of forged tools where each man reground them for himself, was £8 0s. 10d. per week. This did not include the advantage of producing a greatly increased quantity of work per day from each machine, nor any of the advantages derived from the twist drill system.

NOTES ON MACHINE CONSTRUCTION.

THE advantages of good tools are felt and acknowledged by all, yet how few are there who can specify the actual necessities constituting a good tool! Every machine-tool operator has his varied experience, as well as his varied methods, and mainly upon these personal methods depend the shaping, hardness and tempering of the tool applied to the work. The superiority of a cutting tool is gauged by its endurance, though chance accident may mar a perfect tool in very quick time. Carelessness in forging may have its concealed effects upon the tool, while a false temper for the work to be operated upon may be equally unfortunate, resulting in a tool of poor effect. The value of a good tool dresser in a machine shop is past all mention. The qualifications of a tool, as of everything else, depend chiefly upon the care, attention, and ability bestowed upon its manufacture. All defects, no matter of what nature they may be, and such as are so often detected in cutting tools of all kinds, may generally be traced to some imperfect manipulation on the part of the tool dresser, rather than to any imperfection or lack of quality in the original metal. All these facts and features had been noticed by the old school tool manufacturers, in years gone by, and while we have in our day made progress and brought about almost perfection in machine and machine construction and operation, still the manufacturers of 30 and 35 years ago presented the actual gross requirements in full detail.

The uniformity of the screw thread as a system was suggested in an essay as far back as 1850 by Sir Joseph Whitworth. He suggested the uniformity in its complete applications to machines, engines, and other appliances; also the difficulty of arriving at the exact pitch of any particular thread, especially when it was not an exact multiple of common measurement; and that such troubles could be obviated by a uniform system, and one having a constant thread for a given diameter of bolt. As the result of such a system Sir Joseph Whitworth held that the great variety of screw threading machines required would be done away with, as well as the general confusion and delay occasioned. It would also save much of the heavy cost and expense consequent upon an unavoidable waste of bolts and nuts from lack of chance to use them. A line of progress and improvement is here marked, in that the above uniformity in screw threads has finally been attained. There is now a recognised standard, and manufacturers and users are gradually falling in line and adopting it. It might here be noted that upon a comparison of the present standard size with those of the original table of Sir Joseph Whitworth, there is but a slight difference between the two standards, and the number of threads to the inch are almost identical for all sizes of bolts from the ¼in. to the 6in. diameters. A similar history might be given of the screw stock taps and dies, but it is hardly necessary at this time to enter any further into the discussion of cutting tools themselves.

In taking up the lathe we again enter a field which was in its operating principles pretty well canvassed at least 30 or 40 years ago, not only as to general construction but as to the speeds at which the tools should be operated to bring about the best results. In one volume published over 30 years ago we find the following: "It cannot, we apprehend, have escaped the observation of such of our readers who are in the habit of turning metal, that if a velocity exceeding certain prescribed limits be imparted to the material, the edge of a cutting tool applied to reduce the surface of that material is brought to a soft state and rendered obtuse." This is the whole of it in one sentence, and now, as then, the endeavour is to so regulate the speed of the machine (more especially the lathe) as to suit the hardness of metal and the diameter turned. A slow, easy, and steady motion is necessary for iron either wrought or cast, more especially cast iron, wherein the metal removed is not so much cut as it is forced off or seemingly pushed out of the way, the reliability of the edge of the tool governing the smoothness of the resulting work. The opinion of experts in the matter differed fully as widely then as now: some held the maximum velocity at from 10 to 15 feet, while others placed it at from 30 to 40 feet. This we believe gives about as great a sweep as is held at the present day. The facilities for varying the speed of lathes was about the same as now, the cone pulley and the back gears were already in use, and a regulation of speed with nice precision was considered of the highest importance. Such regulation was attended to, and resulted, in one instance—that of Mr. Armengaud, in France—in the arrangement of a table of speeds and velocities of movement to be applied to the various machine tool operations. A velocity of about 3 inches per second was accorded to the ordinary turning or planing of cast iron, while for boring, about one-half that speed was allowed. The velocity for hand tool finishing was at the rate of about 10 inches per second. This difference of speed allowed in the use of hand tools, or fixed tools, was governed by the fact that with the fixed tool it was under constant and steady employment, while with the hand tool relief was given every few moments. For turning and boring also special speeds of revolution were laid out according to diameters to be worked.

Thus we see quite close attention was given to the regulation of speed and economy of manipulation and to all the several operations of machine tools, as well as the saving of the cutter and the trueness of the work. Even the speed of revolution in regard to surface turning had been attended to and worked out, and the application of increasing speed of revolution to decreasing diameters was determined in the interest of economy and the saving of time, as by allowing the same speed of revolution throughout the whole turning of a plane surface, at least one-half the time necessary to a variation of speed of revolution would be lost.

To take up the lathe as a whole in its development, its route of progress has not been so direct. The slide-rest, or that upon which depends the solid holding of the tool, was and is at the present time the base of all operation and improvement in this branch of machine tool construction. This has undergone considerable change in detail as it advanced, some of the changes, however, being rather for the worse, and, of course, quietly dropping out of use. In a comparison of the slide-rest and carriage of to-day with those of original conception dating as far back as 1847 to 1850, we find similar demands and similar operations effected as those of to-day either in the more simple or more complicated tool carriage.

In detail and finish of actual parts, there is, however, considerable change and a marked improvement. The tool-holder itself remains about the same, whether for heavy or light tool. The original saddle or carriage is still in use. moved to and fro the length of the lathe bed or shears. The same slides, turned to an angle of 60 degrees or thereabouts, as constructed by Sir Joseph Whitworth, are still in successful use. These are planed true, finished and scraped to their several fixed and wearing surfaces of contact, and being secured to the bottom side of the saddle on both sides and matching the shapes of the lathe shears, and being capable of adjustment (of more marked nicety than when originally designed) they enable the tool to traverse the whole length of the shears with ease, yet free from all side motion, shake or jar. The adjustability of the several parts of the slide-rest to permit of varied action and position of the tool were neatly and substantially provided for by the use of the angle slides operated by hand screws. The guide-screw was made use of to move the tool carriage to and fro the length of the shears, and to operate the tool while at work. A maximum width of bearing between the saddle and lathe bed was provided for to prevent hasty wear or chance of vibration or side weakness sufficient to strain the operation of the tool.

The same dispute or discussion was in order at the earlier dates of the machine tool concerning the advantages of the V grooves and uprights, and well worthy of discussion are the several points and features connected with the accurate operation of the slide-rest, for upon it mainly depends the success of the whole working of a lathe. With a loose fitting slide-rest there is a positive impossibility of successful results, for wherever there happens to be a variation in the density or hardness of the metal, there will the tool either depress or spring out, but if there be a firm and rigid grip upon the tool, it will shove its way through with very slight chances of uneven work.

Next in order to the slide-rest, among the lathe details, come the two stocks, the head and tail stock. These three indispensable parts of a lathe, the slide-rest, the head-stock and the tail-stock, with the bed upon which they rest and operate, form one of the most valuable machine tools in existence. Upon the lathe, to a very great extent, depends the life, value, accuracy and durability of all other machines, and even the machine tools themselves, and upon its shoulders may rest all the modern perfections in machinery and machine application. Upon the accuracy of make and proper alignment of the lathe depend the results of its work. The first and most necessary feature of a lathe is that the three important facts, the head-stock, the slide-rest and the tail-stock shall at all times and under all circumstances be in a proper alignment, and the movement of all three shall be in a line favourable with the centre line of the machine. The accurate alignment also of the several parts of the head-stock itself is just as important. The bearings, spindles and operating parts should be of such construction and metal that stiffness and stability, as well as smooth wearing, shall always be the prevailing features. The formation of the tail-stock of to-day is in every respect similar to the original construction, the neater finish, closer fit and better metal being the only real points of change or improvement, description of the one being applicable to the other. A slight change in the method of clamping the spindle is the only noticeable feature, and even this change is not universal, the older method being still in use by some makers.

In the lathe bed or shears there is no marked variation in the design to accommodate the changed location of the various parts of the machine. Here there might still be some valuable improvements made. Both in appearance and economy of construction the bed with the legs might be improved to a considerable degree. This improvement can be effected too in the heavier lathes where no legs or standards are used. In the first case a more judicial use of the metal might be made, by its more appropriate distribution, to accommodate the local strains and provide for their transmission so that no portion may be compelled to take upon itself any extra share. These results may be brought about by giving a more even thickness throughout the casting; by ribbing up the several parts and reducing the total weight; by taking out panels wherever practicable; by thinning off the general thickness of metal and adding to the depth of sides, and by giving more spread and less thickness to the sides and ends. More than one attempt has been made to "beautify," as it was termed, the shape and appearance of the beds of both lathe and planer, by shaping the sides in a reverse curve. This, unless the sides were firmly attached to each other, would permit instead of prevent a substantial and noticeable spring whenever serious work was put upon it. With perpendicular sides properly flanged, a minimum of bracing is necessary to insure the requisite stability. Then out of the reach of the line of strain might be located upon panels enough to reduce the weight materially without reducing the actual stiffness.

In the second case, or where the lathe being of large proportions no standards or legs are necessary, the points already advanced concerning the shears or bed of the lighter lathe are fully as applicable to the sides, ends, shapes and general construction of that of the heavier lathe. A maximum of strength does not at all pre-suppose a maximum amount of metal, but on the contrary an undue amount of metal located at a certain point in a casting may be more detrimental than serviceable, while a wholesale use of unnecessary metal is not only uneconomical but unwise and injurious. Such criticism applies equally well to the planer bed of large or small dimensions as it does to that of the lathe. A bed constructed to accommodate and safely secure all the several parts, attachments and motions with which the operations or results are effected, and with all these parts so connected as to act as a whole should be the aim in machine-tool construction. Then may be considered the possible ornamentation of the structure to make it attractive as a whole, but under no circumstances should, in these machine tools, extra metal be added for the purposes of such ornamentation. If the original metal can be so distributed as to develop ornamentation without waste, then may it be done, and that to advantage, as a general thing.—"American Machinist."

Staining.—Staining is the process of imparting to the surface of wood a colour different from its natural one. It consists of two varieties, surface-staining and body-staining. In the former, as the name implies, the staining is effected by various compounds in the nature of pigments, laid upon the surface like paint, and forming a thin opaque coating, which does not to any considerable degree affect the fibre of the wood. In the latter, the changes are chemical, the stain being usually applied as a thin wash, which, entering the pores of the wood, colours it to some depth below the surface. Staining requires no preliminary preparation, the stain being applied directly to the wood. As most stains raise the grain of the wood to a considerable extent, it is necessary before applying the varnish to sandpaper the wood enough to render the grain quite smooth; this sometimes renders a second coat necessary, after which the sandpaper must be again applied.

HOW GUN BARRELS ARE STRAIGHTENED.

THE straightening of a gun barrel is a very delicate and difficult mechanical operation, in which no machinery has as yet successfully competed with the human hand and eye. In addition to long experience, a natural adaptation to the work is necessary in order to attain any considerable degree of proficiency. The business is understood by comparatively few; indeed, many who attempt to learn it can make no progress whatever.

A plate of ground glass, size about 12 x 15 inches, and set in a dark frame, hangs against a window, some twenty feet from the workman. Horizontally across this glass is a bar of dark coloured wood, three-eighths of an inch in width. Upon a convenient rest the operator lays a gun barrel, looking through it at the bar, which casts two fine lines or "shades" in the barrel. These join at the farther end, and gradually diverge, a break occurring in them wherever there is a "crook" in the barrel; the workman thus being enabled to detect the slightest deviation. In order to straighten the barrel it is put on a straightening block, and the mechanic strikes it a blow with a steel hammer (these hammers vary in weight from three and a half to four pounds), the force of which is graduated according to kind of crook, size of barrel, and quality of steel. This alternate sighting and hammering is many times repeated, the barrel being turned slowly around while sighting, in order to locate any inequality which may exist at any point.

An inexperienced man may soon learn to tell if the barrel is straight, but it requires much practice to strike in exactly the right spot and with the proper force. The blow must be made in the exact place where the crook occurs, and if too hard, is worse than no blow at all. The barrel is thus treated six or seven times; and is re-bored after each successive straightening.

Towards the last finer crooks, known as "kinks," appear. These are shown by waves, instead of breaks, in the lines, and require light taps rather than blows. The nearer the barrel approaches perfection the more skill is required to manipulate these kinks into unbroken lines. This is but one of many interesting operations through which a gun passes during the process of manufacture, in any of which its shooting qualities may be seriously impaired. A blow too light, or too heavy, too many, or too few; a discrepancy of one-thousandth of an inch in the boring or rifling may transpose into a very poor gun one that would otherwise have been beyond criticism.

Formerly the process of straightening was effected in a very different manner, which, compared with the present mode, is both crude and unsatisfactory. One end of a silk or seaweed thread was attached to a bow a few inches longer than the barrel to be operated upon, the other end to a small lead weight known as a "sinker." This being dropped through the barrel, the bow was sprung, the thread drawn taut, and fastened thereon. The workman then looked through the barrel, observing where the light shone under the thread, thus detecting any imperfections. A barrel straightened in this manner, however, shows numerous defects when subjected to the modern method. In the old way the workman, standing near a window, examines and straightens the half nearest him; in the new he is away from the light, and operates upon the other half, looking through either end as occasion requires.

The process described never fails to attract the attention of visitors at an armoury, and is always looked upon as an interesting novelty. In view of the fact that the accuracy of a bullet's flight is dependent upon the perfection of less than one yard of barrel, it is wonderful that such good shooting can be done at more than one thousand times that distance.

SMITHING AND FORGING.

By J. L. Lowe, Brentford.

CHAPTER III.

Cranks.

It may be taken for granted that all readers of "Amateur Mechanics" are both interested in and have a knowledge of the elements of mechanics; thus the necessity is obviated of commencing each chapter with an explanation.

We will, therefore, begin at once with an examination of the various methods of crank making. The range of size and weight appears astounding: a diminutive speck of wire, fixed but the one-hundredth of an inch from the axis of a revolving disc, smaller than a spangle, is to all intents a perfect crank. Now taking a giant stride we look on a marvel of workmanship, a single crank of polished steel, weighing by itself, and without any shafting, 10 tons! Such a crank was lately exhibited to the public at the Engineering Exhibition in London, and was produced at the factory of Sir Joseph Whitworth & Co., Manchester.

Crank making may be roughly divided into four methods. First, the bent crank, which, for strength, is unquestionably the best, taking into account the area of the section. Those made by Messrs. Clark, of Lincoln, are crushed into form when heated by powerful hydraulic presses, a process which we shall describe farther on, thanks to the kind courtesy of Messrs. Clark, to whom we are indebted for the information.

The second method is the forged crank, built up by fagotting. These are intended for heavy engines, and are called block cranks, being usually formed solid; the block is slotted by self-acting machinery. In forging the fibre should be interlaced, in order to lessen the liability to fracture across the web, as shown in diagram 5.

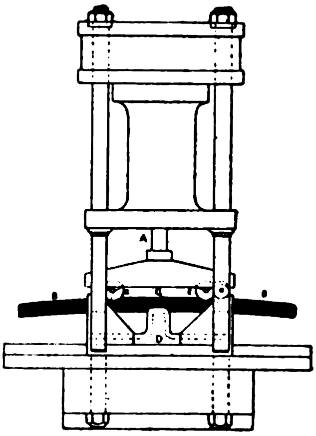

Fig. 1.

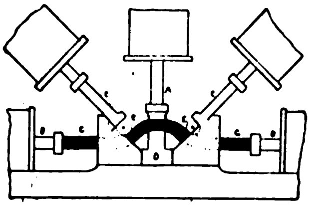

Fig. 2.

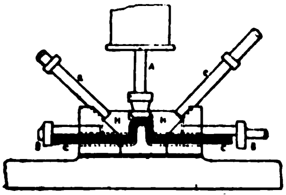

Fig. 3.

Crushing Cranks by Hydraulic Power.

The third method is to forge the webs separately, and after carefully fitting, to key them on to the horizontal shaft. This is an excellent and very convenient plan, obviating the necessity of moving heavy masses of metal when required to be erected at a great distance.

Cranks made by the fourth plan are used for the largest size ocean steamers; they are of cast steel compressed in the mould, one of which was referred to at the commencement of the chapter.

We shall next describe Messrs. Clark's method, illustrated by the diagrams numbered 1, 2 and 3.

In diagram 1 the first press is shown. Commencing operations on the round bar, which is to form the crank, the whole process occupies from five to ten minutes for a crank of from 2in. to 4in. diameter. By the ordinary method of forging it would occupy a smith and two or three strikers about three hours, so we find a very remarkable economy of time, averaging two thousand per cent.; or in other words, by this process twenty cranks are produced for one by the hand forging method. Neither must it be supposed that the quality of the last-named approaches that of the other; every practical forgeman knows that to produce a sound crank by hand forging is but a lottery. The continuous hammering at the various bends damages the fibre to a dangerous extent; this is only to be lessened by overheating, and it is hard to say which is the most detrimental to the work. Crippling or galling are the consequences of the system, and although the smith himself probably knows how sound or how unsound his forging may be, no one can detect it when finished, and it goes to the lathe to have more labour and capital squandered on it; is next fitted in its place, and one fine day, probably when making three or four hundred revolutions a minute, fractures instantly; perhaps making a score of widows and a hundred or so orphans. Now a peculiarity of good fibrous iron is that, slowly treated—coaxed, as it were—it is very amenable to pressure; its fibre, being either compressed or drawn *slowly*, retains nearly all its strength and does not rupture. An illustration of this may be simply shown with a stick of sealing wax; bent slowly at an ordinary temperature it may be doubled back till the two ends touch, yet if we attempt this operation quickly, although it may be heated 10 degrees hotter, it will inevitably fracture across the bend.

Diagram No. 2 shows the second process adopted by Messrs. Clark. Here it will be seen that no fewer than five hydraulic presses are used at once, viz., one at each end, one in centre over what will be the crank pin, and one in each inner angle. Cast iron blocks are introduced to give the requisite shape, and at a certain part of the operation are removed out of the way. The above system allows

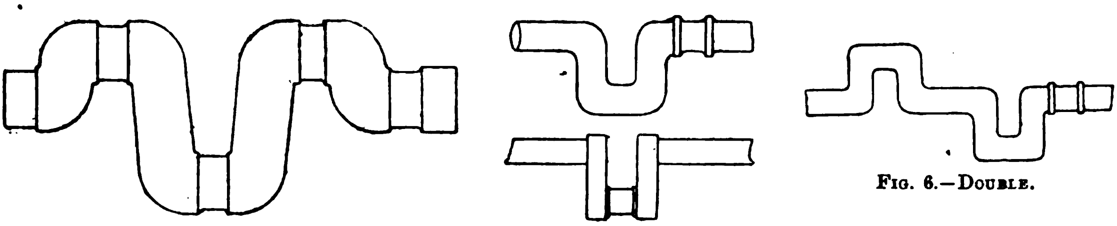

Fig. 7.—Single.

Fig. 4.—Treble.

Fig. 5.

Fig. 6.—Double.

CRANKS.

the fibre to arrange itself without stress or fracture, and what is called the flow of the metal is not interrupted. Violent percussion, rapidly performed, disintegrates the fibre of iron; the result is a forging which may appear externally sound, but really containing either undiscoverable flaws or planes of weakness. Mr. Haswell, engineer-in-chief of the Austrian State Locomotive Works, has long made a most valuable practical application of the ascertained value of the element of time in the operations involving the flow of iron. His methods of producing pressed forgings have become common on the Continent, though their application has not been favourably received in England. Attention to this condition is one of the chief sources of the success of Messrs. Clark's system of making bent cranks. Though it may seem paradoxical, it enables them to produce a crank or a given bend in less total time than was necessary by the old methods of forging. By the latter a crank was made chiefly by hammering, and each successive blow was attended by a change of form, effected in so short a period that it may be considered as without assignable duration, the iron being much distressed in the process, as its particles were not allowed time to flow or re-arrange themselves while under the pressure due to the blow. Only very good and ductile iron could withstand the treatment.

Diagram 5 shows a block crank on the built up or taken down principle. If of large size it will require to be built up or fagotted. In this case the fibre may be arranged to follow the bend of the crank; and in that case, although not equal to a bent crank, for tensile strength it may yet be sufficiently strong to resist the strain to which it will require to be subjected. If, however, for a model, it will probably, to save time and labour, be taken down from flat iron as thick as the scantling of the crank is intended to be. The plan of the side will be of U pattern, and the block will be short grained, exactly similar to what it would be if cut out of a straight-grained piece of timber. It will readily be seen in this case that the weakest part is the block, and when slotted, if an undue strain be put on the crank the fracture shown will be the probable result.

In order to present the readers of "Amateur Mechanics" with a plan to make cranks on Messrs. Clark's system without the assistance of hydraulic presses—which they may not have in their workshops—the following plan has been devised. It must, however, be understood that it is not proposed to use this system for anything larger than 1in. diameter if round, or 1in. scantling if square. The diagram marked 1 may be a cast iron plate from 1 to 2 inches thick and from 12 to 24 inches

Fig. 3.—Finished Crank Ready for Turning.

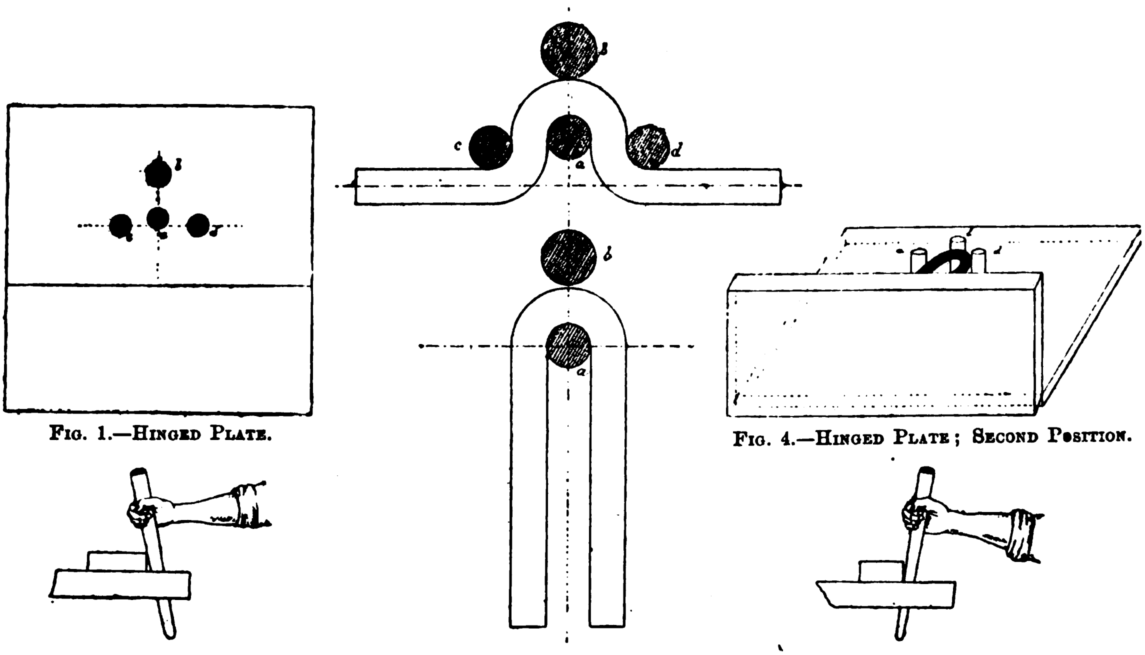

Fig. 1.—Hinged Plate.

Fig. 4.—Hinged Plate; Second Position.

Fig. 5.—Pushing.

Fig. 2.—First Operation.

Fig. 6.—Pulling.

APPARATUS FOR MAKING MODEL ENGINE CRANKS.

each way, according to the size of the crank required. If it is wished to make cranks of various sizes by this method it would be well to drill a number of holes arranged in parallel lines over the entire surface; in the drawing, however, this is not shown, it being confined to one size only. In this case it will be seen that four holes only are requisite; the one marked *b* at the top is to contain a stiff pin, inside of which the iron for the crank is placed. The pin *c* is next placed in its hole, clipping or holding the iron tight. The said iron, heated to redness, is now pulled down by both ends towards the operator till they are parallel. The pins *a* and *d* are then placed in position, and the ends bent back right and left against them as nearly horizontally as can be done, but preferably rather outside ot the square.

It will be seen that the plate is in two parts, hinged together. The portion nearest to the workman is made to turn up exactly at right angles to the remainder; this must be done while the iron is hot and after the ends have been turned back; the crank may then be pressed against the vertical side, and may be considered finished as far as its forging or pressing is concerned.

SQUARE THREADED SCREWS AND TAPS.

"CHORDAL," writing to the "American Machinist," says:—It has been my fortune, whether good or bad, to make a great many square threaded screws from 1½in. to 3in. in diameter. These screws were generally for saw mill head blocks or cider presses, or something of that kind, made in quantities; and I have also had a limited experience on the finer grades of square thread screw work, as found in machine tool construction.

In reciting my own experience, I do it upon the presumption that it is about like the experience of most others who have had much to do with this kind of work. There are ugly features about this square thread work, and it takes a great deal less time to discover these features than to discover a means for their correction.

I believe the practice in all such work is to fit the screw to the nut; a general practice, by the way, which will probably hold good in all kinds of fitting. That is, first produce the hole and then fit the internal piece to the hole. The reason is obvious; the hole is generally produced, or at least sized, by some sort of a tool like a tap or reamer.

A nut for a square thread screw is generally somewhere in the neighbourhood of three diameters of the screw in length. Nuts vary, of course, from two diameters to six in length, but three will do to talk about for our present purpose.

Taps for 2in. work, three threads to the inch, are generally monstrous affairs, having not less than 18in. of cutting length. They are generally cut parallel and then tapered off outside the thread so as to gradually produce the desired depth—in fact, regular nut taps.

Let such a tap as this be cut in an engine lathe geared to cut three threads to the inch, and when it is done it will contain certain errors of pitch. The lead screw of a lathe is not of the exact pitch it pretends to be, and furthermore it is not of uniform pitch. Still, we can say that this tap after it is cut is practically three threads to the inch. We temper this tap and it shrinks or expands in length, it is hard to say which, and as a consequence is not three threads to the inch. A screw properly cut in the same lathe which cut this tap cannot therefore be expected to fit in the nut produced by the tap. The trick of making these screws fit, if fit it can be called, is well understood by lathesmen. The trick is simply to keep thinning the threads of the screw until it can be got into the nut; it will then have every appearance and have the feeling of a fair and perfect fit, but the fit is only on the first and last thread of the nut, and as a consequence such screws very early show lost motion by reason of the concentrated wear upon these two threads.

In cider mill work this defect in square-threaded work is a trifling matter; but in machine tool work and saw-mill head block work (the latter really a very rough piece of machine construction comparatively, but at the same time requiring accuracy) the matter is very important.

How to make a screw to properly fit a hole made by such a tap as I have described is a problem which has been treated scientifically more than once. One method of theorising on the problem is as follows: A tap, say three to the inch, when it is soft, after hardening becomes something else. Find out by proper measurement what that something else is, and figure up change gear for the lathe until that new pitch will be produced. It looks as though it was easy enough, but my experience is that it will be found a very difficult matter to ascertain the pitch of a tempered tap, or the pitch of a hole that it taps, even if you cut the hole open and measure it. The hole will be too short to measure accurately, and the tap will have peculiar variations in its pitch, so that its measurement is unreliable. I have put such taps in a lathe and tried change gear after change gear; even going to the trouble of making special gears, trying to make a tool follow the tapped thread nicely, but never succeeded in getting any satisfaction out of the process. I never got such a tap to run true in a lathe after tempering, and I never got a tool that filled the thread to run more than 1in. without strain. Still I have made fancy change gear which would cut a screw to fit a tapped nut a great deal better than the natural change gear would. I suppose my experience in this regard is about like everybody else's.

A few weeks ago I was talking with John Grant, a man whose opinions regarding screw threads are worthy of every respect, and this subject of square thread taps came up. Mr. Grant made me feel cheap by saying that the proper way to tap these long nuts is with a tap not hardened except at the point, and not tapered except at the point. He explained this tap to me, not as a novelty in any degree, but as a contrivance well known among machine tool makers. I don't like to assume superior ignorance for myself, and therefore have thought that what Mr. Grant told to me might have a value for some others.

The square thread tap, as Mr. Grant describes it, is cut parallel, and has two or three threads at the end tapered off. It is then fluted, and the flutes need not necessarily run up much past the tapered portion. The tap is then hardened at the point only. Thus a few teeth at the point are to do all the work. It will at once be seen that such a tap embodies the shrinkage or expansion due only to about an inch of its length; the untempered body of the tap acts simply as a leader following behind, if I may use such an expression. The end teeth do the cutting, and the soft body after it gets at it governs the pitch. It looks reasonable that such a tap should produce a nut having the pitch of the soft body, the same as produced in the lathe, and that any screw cut in the same lathe, with the same gear, will fit the nut so tapped.

It will be at once seen that this method involves the tapping of a big hole having a heavy thread, by means of a plug tap. The word "plug" may be misleading. Some machinists look upon any tap, not tapering, as a plug tap; but, for my own part, I have always been led to apply the term "plug tap" to a tap whittled off somewhat at the point to follow a tapering starting tap, and to be followed in turn by a regular bottoming tap.

Mr. Grant's square thread tap is, therefore, a genuine plug tap, as distinguished from a taper tap, a machine tap, or a bottoming tap.

I have omitted to mention that this tap is to have a long nose at its point to enter the hole and guide the tap properly; and I should also state that a complete nut is to be produced by using several of these taps—say from three to six of differing sizes at the thread.

The idea of doing heavy work with a plug tap did not at first strike me very favourably. I looked upon the long tapered body of the regular tap as the proper, and only proper, contrivance for such work. In fact, I questioned the possibility of forcing plug taps of these large sizes through a nut.

Mr. Grant said that one of the great mistakes in regard to tapping was the idea that a great many teeth in a tap cutting at once—as is supposed to result from the tapering of the body of a nut tap—rendered the work easier, and he asked me squarely if I had not in my own experience noticed how easy it was to run a plug tap through a nut when compared with using a common nut tap. I had never thought of this before, but was bound to acknowledge that on those occasions, when I had violated all rule by using a plug tap in an odd nut, the job was quickly and easily performed—very much more so than when using the eternal nut tap by hand.

I figured up the case of a four-thread tap as follows:—The thread is an eighth of an inch deep; the taper of the thread 12in. long, five flutes in a tap. This gives 240 cutting teeth, which follow one after another in tapping the hole, each one doing its mite. The depth of the thread to be cut is an eighth of an inch, which gives about the two-thousandth part of an inch as the depth of cut to be taken by each tooth. Mr. Grant explained that this fine figuring showed up an inherent fault of the taper-bodied tap. If such a tap be examined after slight use, most of the teeth will be found shiny, showing that they had positively refused to take the delicate little bites figured out for them. As a consequence they become mere rubbers, not knowing whether to cut or rub, and a few of the more earnest teeth have all the work to do under the most unfavourable circumstances. It is analogous to trying to take a very delicate water cut with a lathe tool which is not sharp. The tool will take a big cut willingly, otherwise it wants to slide. A tool may be a very sharp tool for one kind of work, and still be a very dull tool for another kind of work. The tap tooth, too dull to catch on to the 2,000ths part of an inch, might take hold of a 32nd part of an inch with real zest. In short, the ten teeth on the end of Mr. Grant's plug tap represent ten sharp cutters able and willing to do their work. There are so few of them that they will be kept sharp.

Another feature of the nut tap is this: Taking a tap of the dimensions above given in a nut 3in. long, one-quarter of the teeth of the tap are supposed to be at work at once; or in a nut 12in. long they would all be at work at once. It is very questionable whether such a tap could possibly be forced through a cast-iron nut 12in. long; but there is no doubt but what three or four plug taps could be put through, and without very hard work.

The thought of the taper cut involved in the nut tap brings up other questions. Suppose we have an inch hole, and wish to make it $1\frac{1}{16}$in.; we take a drill with two cutting teeth, or a blunt rose bit with twenty, and enlarge this hole with little labour upon a drill press. But if we would take a taper reamer 12in. long, 1in. in diameter at the point, and $1\frac{1}{16}$in. at the butt, and try to enlarge this hole, it would be a very slow and tedious job, if the hole had any length. Anyone who has fitted up connecting-rod ends having taper holes for the bolts understands well the difficulty of removing much metal with a taper reamer. The common plan is to drill holes of different sizes and depths, and use the taper reamer to give taper and finish. If it is found that a reamer, after properly tapering the hole, has still to go an inch deeper, this reamer will be found the worst possible tool to take the metal out with. The strain upon the shank of a taper reamer, when working at its nicest, is terrible, and always risky.

This brings up the question of many teeth in a milling tool or gear cutter, and leads me to revert to a case of gear cutting which I mentioned in a former letter some time ago.

Some very heavy spur gearing, 2in. pitch, 5in. face, was cut with 5in. cutters having lots of teeth, and lots of time was used. An end cutter, the shape of the space, was then tried. It averaged only an inch in diameter, and had but five or six teeth, but the time consumed in doing the work was greatly reduced. The work was then done in a shaping machine, and the time was very much more reduced. I gave the figures when I first mentioned this subject. I have forgotten them now. The thing has always been a puzzle to me, and the only thing I understand about the matter is that the facts are there.

The relative efficiency of many teeth in a cutter may be illustrated by a simple drilling operation. We drill a hole by means of a drill having two cutting edges in a certain length of time. Can that hole be drilled by a butt mill having many cutters in the same length of time, even provided that clearance for the chips is arranged for? I think not.

On the other side of the question, take a hand scraper with its single cutting edge; will it remove as much metal in a given time as a file will? I think not. We may say that a file works over a large surface at one time, while a scraper is only cutting at one spot; but we may say the same in regard to the butt mill used as a drill.

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Cheese Cement for Mending China, etc.—Take skim milk cheese, cut it in slices, and boil it in water. Wash it in cold water and knead it in warm water several times. Place it warm on a levigating stone and knead it with quicklime. It will join marble, stone, or earthenware so that the joining is scarcely to be observed.

Chinese Cement (Schio-liao).—To three parts of fresh beaten blood are added four parts of slaked lime and a little alum; a thin, pasty mass is produced, which can be used immediately. Objects which are to be made specially water-proof are painted by the Chinese twice, or at the most three times. Dr. Scherzer saw in Pekin a wooden box which had travelled the tedious road *viâ* Siberia to St. Petersburg and back, and which was found to be perfectly sound and water-proof. Even baskets made of straw became, by the use of this cement, perfectly serviceable in the transportation of oil. Pasteboard treated therewith receives the appearance and strength of wood. Most of the wooden public buildings of China are painted with schio-liao, which gives them an unpleasant reddish appearance, but adds to their durability. This cement was tried in the Austrian department of Agriculture, and by the "Vienna Association of Industry," and in both cases the statements of Dr. Scherzer were found to be strictly accurate.

PRACTICAL CABINET WORK FOR AMATEURS.

PART IV.

WE have now to describe sundry appliances used in the process of veneering. There are ordinarily two methods of veneering. As to the term veneering, most people know that it means covering or overlaying an inferior wood with a costlier one; the richer wood being cut into very thin slices with fine saws or knives. For ordinary cabinet-making purposes, oak, mahogany, birch, etc., veneers are usually about 16 to an inch in thickness. Many veneers, however, are cut much thinner, such as root walnut; and our clever brethren across the Atlantic cut them as thin as wall paper, and use them for that purpose. So it is no uncommon thing to see a room with its walls veneered with mahogany, walnut, birdseye maple, or some other of the woods that abound in that great country.

The two processes of "laying" veneers are termed cauling and hammering. Both are performed with the aid of heat, and may be termed the dry heat and wet heat processes—cauling being the dry heat, and hammering the wet heat process. A caul is a board or other substance heated and applied to the veneer which has been laid on the ground or inferior wood with glue, and a heavy pressure applied, by which means the heat is made to penetrate the veneer, and melt the glue, which gets chilled almost as soon as laid on. The glue thus re-melted, as it were, is distributed evenly over the surface between the veneer and the wood, and runs out all round the edges, thus showing that sufficient heat and pressure have been applied to bring the veneer and ground in close and perfect contact, for it must be observed that the more glue runs out at the edges, the more surely will the veneer be properly laid, there being always sufficient left to effect a perfect adhesion of the two woods. It may be remarked that all veneering should be done by the cauling process, unless on rare occasions when it is not practicable, and it is mostly on account of the cost of cauls and other necessary appliances that hammering is so extensively resorted to. This latter process requires so much water applied to the veneer that in many cases it is greatly swelled, and in drying it shrinks, leaving open joints and spoiling the work.

For laying veneers of small dimensions and on flat surfaces, cauls of wood are generally used. They are of good yellow pine, about 1in. thick. They are evenly planed on both sides, and to one thickness throughout. Then they are teethed, and well saturated with linseed oil. The oil, while it augments the heat, also prevents any glue sticking to the caul.

The pressure is applied to these small cauls with the hand-screws already described. If the caul be from 3in. to 5in. broad, such as for door stiles, the screws would be put on with the jaws reaching quite across, one on each side alternately, and at intervals of about 6in. If the caul be, say, 10in. broad, the screws would be put on reaching to the centre in pairs opposite each other, and at intervals of about 6in. The screws are first put in the centre of the length, and finish at the end, the glue being thus, as it were, carried along, and flowing out at the ends and sides.

To veneer large surfaces, such as large panels, wardrobe gables, sideboard tops, etc., by the cauling process, other and somewhat costly appliances are necessary, and various devices have been tried to communicate the desired amount of heat expeditiously. One of these is a steam chest. This is a large table of iron, made in the form of a shallow box, into which a jet of steam is allowed to pass. The upper surface of the table is truly planed, and the work to be veneered placed upon it, veneer downwards, when cross-bars are brought down with a strong pressure, communicated by iron screws. The heat in the iron penetrates the veneer and melts the glue. This contrivance is of use only where steam is at hand.

A very effective machine for applying the pressure, in lieu of hand-screws, for veneering large surfaces, is the veneering frame here shown (fig. 12). This is a rectangular frame, strongly made, and of hard wood. The upright posts are 3½in. square, and the upper and lower rails let into them are 3½in. by 3in. These rails have a clear space between them of 10in., and in this space another rail is made to rise and fall by means of the three screws. This movable rail is 3in. by 2½in. thick, and is slightly curved on the under side, so that the pressure is effectually applied by tightening the centre screw, and then the outer ones, which have the effect of curving the bar on the upper side, and making the whole of the under side bear equally on the caul. The screws in these frames are iron square threaded, and ⅞in. or 1in. diameter. They have a nut with two ears, which are screwed to the under side of the rail in the frame. The centre screw only is made to lift the movable bar by means of a collar and plate; the outer ones simply press upon small iron plates in the back of the bars. These frames admit a board of 24in. or 25in. in breadth, and to veneer a board, say, 6ft. long, ten would be necessary.

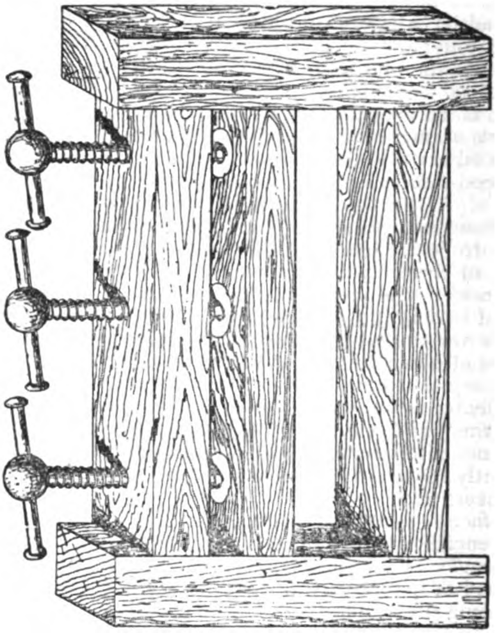

Fig. 12.—Veneering Frame.

Now as to cauls for this large class of work. While cauls of wood may be used, and are much used where there are good facilities for heating them, cauls made of zinc are much better. These are from ¼in. to ⅜in. thick, with perfectly smooth surfaces. They absorb heat very quickly, and are therefore much easier heated. Another important property is, that in laying veneers of a soft or porous nature, and where the glue is apt to penetrate to the caul, it does not stick to the zinc; so that zinc cauls are removed with the utmost freedom. In the case of wooden ones they very often adhere to the veneer from the glue having penetrated, and sometimes it is found impossible to remove them without lifting away portions of the veneer, and thus seriously damaging the job; indeed, in the case of root walnut and other veneers of a like nature, it is very unsafe to attempt laying them with cauls of wood.

Zinc cauls are made both for flat surfaces and curved, such as hollows, rounds, ogees, and even mouldings.

In veneering a large surface, say 6ft. by 2ft., it is not necessary to have the zinc caul in one sheet, as it would be very unwieldy, and, besides, would not be serviceable but for large work. The caul may be in four pieces, two in the length and two in the breadth; and as they are all of one thickness, and join together edge to edge closely, they, when heated and placed together edge to edge, serve the purpose just as well as a whole caul. The pieces are, moreover, serviceable for cauling all kinds of work within their dimensions. Two of the pieces placed end to end form a long narrow caul, and two placed side to side form a broad short one, and so on.

Now suppose we have, say, the two gables of a wardrobe to veneer, 6ft. by 21in. broad. We have ten of these frames, fig. 12, and a zinc caul in four pieces. We place a piece of board upon two trestles, and on this board arrange the ten frames in a row, and about 8in. apart, and with the movable bars all raised. We have the two gables planed of an equal thickness throughout: the side to be veneered (this should be the heart side) is well teethed and sized all over with thin glue. This sizing, after being thoroughly dry, is again teethed lightly to remove any lumpiness in the size. The veneers are cut a little larger all round than the surface to be covered, and afterwards marked with a pencil to show how they are to be laid down when gluing. This operation must be done with as much speed as possible, but a mistake in the hurry of placing the veneer is irreparable. The veneer being marked as above, it is teethed on the gluing side. A pot of glue, not very thick, and boiling, together with a large brush, are now brought into the field. The gables and veneers are swept clean of dust, and the former, placed edge to edge, are rapidly coated all over with the glue. Two hands, with brushes apiece, should do this, and place the veneers in their position before the glue chills, while a third is heating the cauls both sides. One of the gables with its veneer is slipped within the frames, the veneer being uppermost. The cauls, which are hot quite through, are now placed upon this veneer edge to edge, when the other gable is placed in the frames, with its veneer towards the caul, and all being carefully placed the moving bars are lowered by the centre screw in each of the ten frames, beginning with the centre frames of the row, and finishing with the endmost ones; then going back to the centre frames, the end screws are brought down; thus the glue is made to flow from the centre towards the edges. After the glue has begun to flow, the whole of the screws may be gone over again, beginning with the centre ones, as before, and giving each a little more pressure. In three or four hours the work may be removed from the frames. All this should be done in a warm room or workshop free from cold draughts, as a whiff of cold air chills the glue in a moment.

This plant is somewhat costly, and is in consequence not found in every cabinet shop. A kind of makeshift is employed. Two of the largest hand-screws, and two bars of wood slightly curved, are used as substitutes for the frames. In veneering with these one bar is placed across the work above and another beneath, when the ends of both are grasped by the hand-screws, and the pressure applied in this way.

To veneer these gables by the hammering process a tool called a veneering hammer is necessary, This is shown in fig. 13. A piece of hard wood, 6in. square and 1in. thick, has a hole bored in the centre for a handle, 12in. long and 1in. thick. In the end of one edge a slit with a thick saw is made, about 1in. deep, and in this slit a piece of iron or steel plate 6in. long and 2in. broad is inserted, and fixed by two rivets passing through the wood and it. The wood is now to be rounded off towards the iron plate, while the opposite end is rounded or formed into a kind of knob for the hand to rest upon. The edge of the iron plate is rounded, so as not to tear and cut the veneer when using. This size of hammer is used for the largest work; the veneering hammer, mentioned before, is very useful for most kinds of small work.

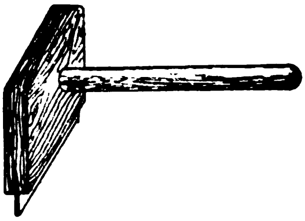

FIG. 13.—VENEERING HAMMER.

The two gables are prepared as before, but they are, of course, only veneered one at a time; so we will describe the process with one only. The gable is placed upon the bench, veneering side up, the veneer teethed as before and placed upon it teethed side down. Now, the glue must be boiling, or, at any rate, the water in the boiler, the room very warm, by means of a stove or hot plate. Two ordinary laundry smoothing irons are kept very hot on the stove. All things being ready, we dip a sponge in the hot water, and wet the upper side of the veneer all over, and, laying it aside, we coat the ground work freely with the hot glue, beginning at the centre and coating one-half of the gable only. Now we place the veneer carefully in its place, and rap it smartly all over the glued half with the veneering hammer. We now begin in the centre, which is the extremity of the glued part, and with the sponge we give it a copious supply of the hot water; then with the hot iron we iron it rapidly, the portion ironed each time being about 1ft. broad, and quite across the gable, which gives about two square feet of surface to be gone over with the hammer. The iron must not be allowed to rest for an instant on the veneer, or it will stick and lift a piece out—a few rapid strokes, adding more water wherever a portion appears dry. Now we apply the hammer, which is held with the handle in one hand, the other pressing upon the head; now we give the handle a motion from side to side, at the same time pushing forward when the hammer performs the zigzag, as indicated in fig. 14, carrying the glue in front of it When the ironed portion has thus been gone over, the glue should run out at the edges. Now a few rubs are given to it with the hammer, giving long instead of zigzag strokes. In order to find if it is lying solid, it is tapped lightly all over with the handle of the hammer. By this means the smallest blister will be detected in a moment. When a blister is detected, it may at once be laid by a little more rubbing, but, if obstinate, a little bit of paper placed over it with a piece of wood and a weight over all will in most cases effect a cure.

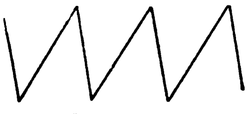

FIG. 14.—ZIGZAG MOTION OF VENEERING HAMMER.

Now there is a thick body of glue lying just where we left off rubbing. Again we apply the water and iron, doing a portion quite across as before, taking care not to go over on the portion already finished, at the same time taking care that we quite reach it. Again we commence rubbing, always taking care that the glue carried before the hammer is retreating away from the portion already finished. In this way the rubbing and ironing are continued till we arrive at the end of the glued half. Now, to glue the other half, we turn the veneer up and apply the glue to the ground. Taking care that we cover all the surface not previously glued, we rub down the veneer as before, and begin sponging and ironing in the centre, just where the first portion was finished, and cause the glue to travel away towards the end. A surface of this area will thus require six or seven ironings. If the glue runs out freely all round, then there is a surety that the heating has been sufficient, and, if free from blister, the work may be said to be satisfactory. The two gables thus veneered may be placed face to face with a large sheet of paper between, and a few small hand-screws fixed on them; thus they must stand for 24 hours or so, before any attempt is made to plane the veneer, as having imbibed much water in laying, they take long to dry. Veneers laid with a caul may be cleaned in half that time.

We must now notice the process of veneering curved surfaces. Fig. 16 is a section of an ogee drawer front of pine, to be veneered with, say, mahogany. The ground is moulded with casements to the required form, taking care that it has the same contour through its entire length. The hollow part is roughened with a rasp, and the round part teethed; then it is glue-sized. A caul has now to be made to fit exactly in every part of this ogee; this caul is represented in fig. 15, and is an exact reverse of fig. 16. This caul has to be saturated with oil, or, what is much better, it may be covered with a sheet of No. 12 zinc, made to assume the proper curvature; it is tacked lightly to the wood at the edges. Before applying the veneer it must be made to assume the ogee form. To effect this, mark the veneer as it is to lie; then take the sponge and hot water and wet the veneer on the outside the whole length and but half the breadth; then turn it over and wet the remaining half on the opposite side, and it will assume the ogee form. Before veneering we place the caul and the ground together, and set the largest hand-screws to the required width, to be ready. Now the caul is made very hot, the ground is copiously glued, and the veneer laid thereon. To prevent it shifting, a tack is usually driven through it at each end into the ground, which is generally a little longer than required in the finished job. A piece of thin cloth is first placed over the veneer, and then the hot caul, which is pressed down with the hand-screws, those about the centre being tightened first.

Fig. 15.—Caul Fitting Drawer Front.

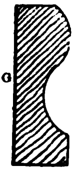

Fig. 16.—Section of Drawer Front.

Fig. 17 is an instrument with which forms having one curve may be veneered by the wet or hammering process. It consists of a board of hard wood, a little longer and not quite so broad as the work to be veneered. Through the centre of this piece a series of wood screws pass at intervals of six or seven inches. A piece of stout canvas is tacked to the hard wood as shown, so as to form a bag with open ends. Now, to veneer a surface which is a semicircle in section, the ground with the veneer on it would be placed in the canvas bag, the flat back of the work being parallel to the board above it, and the veneer next the canvas. The screws are now brought to bear upon the back of the work, which tightens the canvas and forces the veneer close to the ground. The canvas is now well saturated with hot water, and held to the fire, all the screws receiving an occasional turn. The glue now runs out at the ends, the canvas is rubbed all round with the veneering hammer, and a little more pressure applied to the screws; then it is laid aside for 24 hours to dry. This is a very simple, effective, and expeditious method of veneering many of the forms used in cabinet-making. As the canvas accommodates itself to the form placed in it, it matters not whether the form is circular or elliptic, or a combination of both, and it will veneer anything, from a little over a semicircle or semi-ellipse down to the smallest arc of either. By having several boards with canvas of a width to suit the various requirements, the screw-pins of the one may be made to fit the others.

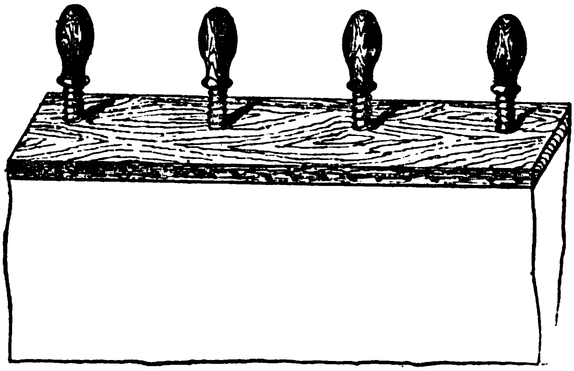

Fig. 17.—Instrument for Curved Veneering.

Before we begin practical operations at the bench, a few observations have to be made regarding putting the tools in order. The bench planes—namely, the jack, the half-long, and the smoothing plane—have to be properly sharpened, or, as we call it, "set up," and this first operation requires some experience.

If the plane irons are new, they are very probably thick on the edge and require to be ground. This is done on a grindstone; and it would be well for a beginner to get a practical hand to do this for a time or two: but if he has access to a grindstone, the sooner he begins to try for himself the better. Then they have to be "set" on the oil stone, or, as we call it, the "set" stone. In grinding the jack-plane iron the cutting edge should be somewhat round, so that the shaving taken off is thicker in the centre than the edges. The half-long iron is also slightly round, but so slight that it is hardly noticeable. The smoothing-plane iron should be a straight line on the cutting edge, with the corners very slightly rounded—but on no account should the edge be hollow, as it would only make ridgy work. These irons are all ground on the back only—that is, the under side—and the "cannel" or ground part is about half an inch long. It is not good to have the "cannel" too long, as the iron when working is apt to jump.

With a new oil-stone the irons keep straight on the edge for some time, but the set-stone gets hollow in the breadth as well as the length, and consequently the irons set upon it become round at the edge. This is no evil so far as the jack is concerned, but with the smoothing-plane round you can never make a good smooth and even job of a piece of wood.

Now to cure a hollow set-stone, various methods are employed, such as rubbing on a flat sandstone, with plenty of water, or on the side of a grindstone. I have found emery to be about the best. The method employed is to plane up two or three pieces of pine, 9in. or 10in. long, and 2½ft. broad, to coat them well with glue, and pour the emery all over it, letting all remain on that will stick. Laid aside for about a day, they will be ready for use. The oil is cleaned off the stone, and it is rubbed with the emery stick, which will soon take it down, the hollow in the centre being the last to disappear.

Now, with your iron ground and your set-stone in good condition, you pour a little *sperm* oil along the centre of it, and holding the back part of the iron in your right hand, with the fingers of the left lying along the top side rear the front and the thumb underneath, you apply the cannel or ground side of the iron to the stone, and begin rubbing backwards and forwards nearly the whole length of the stone. During this operation the iron is to be held slightly higher than it was when at the grindstone, so that the cutting edge may come in contact with the stone. After five or six rubs on the cannel, as directed, it is to be turned over and receive one or two light rubs when lying quite flat on the stone, and this operation is to be repeated, five or six rubs on the back for one or two light on the front, flat down, until a keen sharp edge is obtained. If the irons are freshly ground very little setting is required, but as they are very soon blunted by working, a fresh edge has to be brought up, and this sharpening may go on for twenty or thirty times before they require re-grinding. A blunt iron is very easily observed with the eye by looking at it on the cannel side. It presents a whitish rounded or worn appearance, and the sharpening has to be continued until this white worn edge disappears. A practical man ascertains this not by looking at, but by touching the edge lightly with his thumb. Another thing to observe is that when an iron is sharpened or set, a very fine barb remains all along the edge. This is removed by a dexterous slapping backwards and forwards on the heel of the hand, and is the same in effect as finishing the setting of a razor by stropping on a piece of leather. The three irons above referred to, being sharpened, are put together as follows:—Taking first the jack you take the cover and put the head of the screw through the hole in the iron, and slide it forward to within $\frac{1}{16}$in. of the cutting edge, and seeing that the cover is even with the iron at the edges you rest it on the bench with the screw head uppermost and turn it somewhat tightly with a screwdriver; then, taking the stock of the plane, you rest the back end on the bench and the fore end towards your face, so that your eye travels along the sole. While in this position you insert the iron with the right hand, holding the plane with the left, and slip it forward until you see the cutting edge appear through, when you place your left thumb on the screw head, holding the iron firmly till you insert the wedge, which you push in as far as it will go, and give it two or three taps with a hammer. Then remove your thumb from the screw and regulate the iron by tapping it lightly on the back end when you want *more* iron, and tapping the stock on the top side, about an inch from the front, when you want less iron. Two or three smart taps on the top of the stock, in front, will loosen the wedge and iron, and while doing this the plane is held by the middle of the side. Many tradesmen turn the plane over, and, striking the front of it smartly on the bench, the iron and wedge drop out into the left hand, held to receive them. The half-long is fitted exactly as the jack, only the cover is a little nearer the cutting edge, being about $\frac{1}{20}$in. for working pine or soft woods. The smoothing plane is also set in the same way, but with the cover a little nearer the front still, being about $\frac{1}{32}$in. The covers should fit quite closely all along the breadth of the iron; otherwise shavings will get in and choke the plane, and the margin between the cover and the cutting edge should in all cases be of the same width across the whole breadth of the iron; otherwise the iron is off the square, and will not fit the stock properly, but will show one corner projecting further than the other.

If the half-long and jack were set up for hardwood the margin between the cover and the edge would in both cases be only about half that given above, and the smoothing-plane, which is smaller in size, and has a higher pitch, would have the cover very close to the cutting edge, being about the thickness of a thin card, and for cleaning veneers it would be so near that the margin would be scarcely visible, being little more than the thickness of common writing paper. In grinding and setting up the guillaumes, the irons should always appear an equal distance through the sole throughout their whole breadth, and the cutting edge should be perfectly straight, with the corners square and sharp. The cannel of these should not be too long, or they will jump when working, and leave the work ridged.

The bead planes are generally set up ready for use when bought, but when they require setting, it is done with a stone called a slip. Several of these are necessary for the various beads and other moulding planes. They are usually about 6in. long and 2in. broad, and from ⅛in. to ½in. thick. They have one edge rounded to fit the irons to be set, and the square edge of the largest slip is used to set up spokeshaves. The cutting part of a bead-plane iron is something like a semi-circle, and is a little smaller than the corresponding curve in the stock of the plane, the difference being the thickness of the shaving taken off. When the iron has been set up a number of times, the curve has a tendency to get wider, and soon gets as wide as the curve in the stock, so that the iron will not take off a shaving of equal thickness throughout the whole curve, and when this is so the iron must be re-ground and set up anew by the plane-maker, who has grindstones for the purpose. The same thing occurs with most of the other moulding-planes—an ogee, for instance, which consists of a kind of serpentine curve called a "hollow-and-round." In setting it up with the slip, the hollow part is continually getting wider, and the round part, which is set on the ordinary oil-stone, is getting smaller, and so the moulding begins to get out of proportion and shape. Besides this, the iron does not fit the stock with an even cutting edge throughout its whole breadth, and so it will not turn a good shaving as before; to put it right the plane-maker must re-grind the iron.

It is of the utmost importance that plane-irons and, indeed, all other cutting tools should be kept sharp, as good work cannot otherwise be done.

Chisels, gouges, bits, scraper, and spokeshave, etc., are sharpened with the oil-stone and slip. In the case of the spokeshave, the iron is taken out and sharpened from the inner side.

Ivy Poisoning.—The best remedy for ivy poisoning is said to be sweet spirits of nitre. Bathe the parts affected freely with this fluid three or four times during the day, and the next morning scarcely any trace of poison will be found. If the blisters be broken, so as to allow the spirits to penetrate the cuticle, a single application will be sufficient.

BRASS AND ITS USES.

(From the "American Artisan.")

IT is an interesting fact that all the principal metals, with their amalgamations and alloys, have certain distinct and exclusive uses to which they are adapted, and for which no other metal can be substituted with as good results. The fact that for many uses one metal may be substituted for another to advantage does not change the other fact that there are certain adaptations, and a certain fitness of things, which give exclusive value to certain metals for certain uses. Thus, no matter how golden the age in which we live, the use of gold for fireplace fenders would be out of place, and not alone on account of its costliness. So the use of brass for personal ornament is equally unfitting.

Brass is mentioned in the earliest writings, although in many instances the word bronze would more correctly represent the character of the metal spoken of. Among the ancients, those who could not ornament with pure, solid gold seized that which looked the most like it, and answered, practically, the same purposes. Brass, as an alloy, will bear a variety of metals. Corinthian brass of the ancients combined, in its make, a proportion of gold and silver, as well as copper, tin, and other metals. Metallurgy is now so well understood that copper, zinc, tin, magnesia, sal ammonia, crude tartar, and other chemicals, in the hands of practical artisans, may be so combined that a metal can be made which will not only look like gold, but take a finer finish, and remain longer bright, whether in use or in a state of rest, than the purest gold of California! For this higher grade of brass, there is an increasing demand for many purposes. First-class banking houses become resplendent when finished up with choice rolled, perforated, polished, and otherwise ornamented brass, according to the position it is to occupy in forming divisions of the departments. Such brass shields may be so finely finished that for months, with a very little daily care, they will remain as bright and beautiful as a newly-coined double eagle. For these good reasons, perforated plate brass is in demand for not only bank work, but in first-class offices of all kinds.

Then, however comfortable our best automatic furnaces, or soft and diffusive the warmth of our extra plated and ornamented base heaters, gentlemen who are finishing up fine dwellings for their own use, in which they expect to spend the greater proportion of their remaining days, like to retain the good old style of both their European and American ancestors, who sat before an open log fire, or an open grate of coals! These, in every double parlour, under ample mantels, require not only grates of the most improved kind, but a variety of furniture, the ornamentation of which draws largely on the brass founder and his most skilful and ingenious workers. These very beautiful brass-decorated open grates have proved to be extremely attractive to young children, and genius of a high order has been in demand to concentrate its best powers to furnish such a "tender" as shall prove a guard, not only for the uncertain steps of childhood, but for the influence which a strong current of air has over the apron and pinafore; for these articles also need a barrier to the attractive draught of a glowing fire of coals. These brass fenders admit of very great elaboration. While very beautiful as shields, they must neither hide the glowing coals, nor obstruct their light or warmth. For these adjuncts of the open grate no metal has yet been discovered so good as brass, for, while it reflects much warmth, it is not injuriously affected, her in texture or polish, by an ordinary grate fire of coals. It is, therefore, an admirable metal for all stove and grate furniture or ornaments. Fenders, fire-irons, etc., in polished brass, with coal vases, fire-brasses, and dogs *en suite*, are in demand on both sides of the sea. A staple trade is done in polished all-brass fenders and curbs, composed of reeded rails and spindles, alternating with *repousse* or cast panels. A brass embossed Japanese fender in panels, with bright steel bottom, gives a pleasing effect. Pretty designs in Berlin black, relieved by puffing, supply cheaper goods. An effective fire-dog is a T-shaped tubular rest, with reeded base and knobs, and connecting scrolls in the Renaissance style. Another popular design is of tubular brass, with cast supports, in the Renaissance style, relieved by portions in gilding metal.

Among late and most beautiful tea and coffee urns may be seen those of brass. Mounted on a base or stand of the same metal, they are suspended on trunnions—similar to the latest style of ice pitchers—or hinged to their base, they tip easily, and pour their contents with scarcely a perceptible effort on the part of the waiter. These goods are both exceedingly attractive and useful.

There is also a richness and beauty about a fine harness, all of whose hardware is brass, that cannot be gained by any other combination. The pure polished black and yellow give the finest "jet and gold" that can readily be obtained.

The tendency in carriage, railway coach, and, indeed, in house furniture generally, is in the same direction. Butts, hinges, door knobs for passenger cars, have for some time been of bronze, as have been the hand-bag racks in the finest passenger car coaches, but fine brass wire or perforated rolls are now preferred, on account of superior brightness and beauty; and for draw knobs, brass "half shell" handles are, by all who use draws, greatly preferred, both for beauty and convenience.

These are but a few of the tendencies of the times which indicate a wiser and more extensive use of fine brass than heretofore. Time and space would fail to give merely a synopsis of its uses in the arts; its necessity to the machinist, especially machinery of the finest kinds, clocks, watches, chronometers, and philosophical instruments of all kinds; its adaptableness for lamps, chandeliers, gas-fittings, meters, and all kinds of scales. In proportion, therefore, as a people advance toward the highest kind of knowledge—that of best adapting means to ends—will there be an increasing demand for brass in machinery, in scientific instruments, and in all efforts to give permanent ornamentation, which shall be excelled only by pure gold.

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Arsenic.—Paris Green.—By *arsenic* is generally meant the white oxide of the metal arsenic. It is also known as *arsenious* acid. Paris green is well known, and owes its deadly properties to arsenic. In all cases in which poisonous doses of arsenic have been swallowed, our great dependence must be placed upon emetics and purgatives. Persons who take arsenic upon a full stomach frequently escape its effects, and therefore it is always well to give copious draughts of milk, or, if more convenient, raw eggs beaten up. Then, as soon as possible, administer an emetic (mustard is as good as any), and keep up its action by giving milk during the intervals of the paroxysms of vomiting. When the stomach no longer rejects what is swallowed, give a good dose of castor oil.

THE AMATEUR WOOD TURNER.

By A. Cabe.

PART VI.

THE illustrations accompanying the present paper on wood turning show two useful, as well as ornamental, little articles.

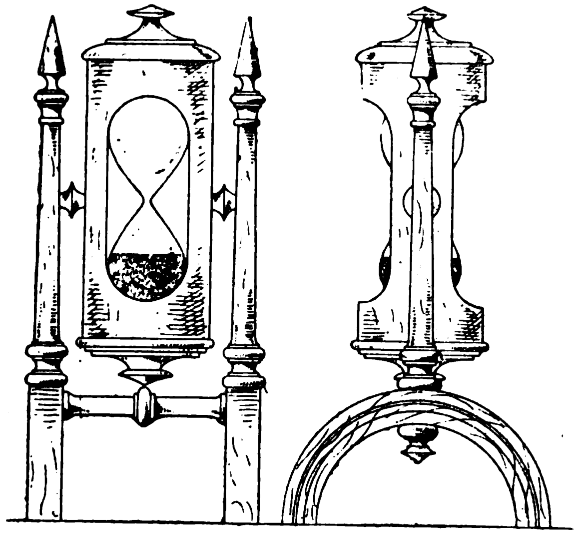
The first to be described is the sand-glass, generally used to denote the time required to boil an egg. The glass itself, containing the sand, may be bought for two or three pence. Our present work is how to make the stand, or holder, for the glass. It is composed entirely of turned work, and therefore affords a very appropriate lesson to the amateur turner.

We have first of all to turn a circle, which is afterwards cut in two, thus forming four feet. The wood may be mahogany, rosewood, maple, or other wood, according to fancy.

The piece of wood to form the circle is cut from a piece a little over ⅜in. thick, with a bow-saw. It is then fixed on a face-plate, having a centre screw. The circle is finished at 2¾in. outside diameter, and in section ⅜in. either way. In the centre of the face is a semi-circular hollow, ⅛in. broad.

In turning this circle, it should be cut inside, almost through; then nicely sandpapered out and in; then it may be cut quite through to the face-plate, when it will drop off. The arras on the inside may now be papered off. It is now to be cut in two exact halves, with a fine saw. A ¼in. hole is now bored through the centre of the edge of each half, and also a similar hole on each inner face, to receive the tie-rod. This latter hole is only bored into the former one, which receives the pillar. The tie-rod is 1¾in. long, and at ends and centre is nearly ⅜in. It consists of a filleted shoulder at ends, two fillets, and a torus bead in the centre. The ends are turned with tenons to fit into the above-mentioned semi-circular pieces.

Now we have the pillars: their total length, clear of the circles into which they are fitted, is 4in. At the bottom and top they are nearly ⅜in. thick, the plain central parts being a little less than ⅜in. Their design will be clearly seen from the illustration.



Two little drops are now turned to fit in the centre of the semi-circles, underneath. They are intended to represent a continuation of the pillars, and help to give a neat finish to them. They have each a tenon to fit into the holes that have been bored through to receive them.

Now we have the body, which is to contain the sand-glass. The straight part is 3in. long, and 1¼in. outside diameter.

This is the most difficult part of the whole job. It was among the first jobs I attempted when learning the art, and this is how I proceeded:—I took a piece of wood, fully 3in. long, and, with a very sharp 1in. centre-bit, bored a hole quite through the length. Centre-bits are not meant to bore end wood, but they do it in certain kinds of wood, if they are made sharp and set up on a hone.

After boring the 1in. hole, I turned a plain 1in. cylinder of pine wood, and fitted on my bored piece. I now turned down the body to 1¼in. diameter, and cut in the ends, leaving a length of 3in., thus forming a wooden tube of a thickness of stuff of ⅛in. The tube removed from the wooden mandrel has now to get its ends closed by two caps. These are shown somewhat different in design, but they may be alike with propriety.

In turning them, they are made to fit the interior of the tube, which they enter about ¼in. When finished, they should project over the outside of the body, showing a ⅛in. bead all round, or more properly an ovolo.

The interior ends of the caps are hollowed out to receive the globular ends of the sand-glass, thus holding it steadily and without shake.

These caps are turned from wood running between centres in the lathe, so that the grain runs in the same direction as the body piece, and when fitted on, the whole looks as if turned from one piece.

Now the body has to be cut open to expose the central part of the glass. This is readily done by boring two holes on both sides of the tube part, opposite each other, with a ¾in. centre-bit; then a sharp penknife will cut away the stuff between the holes, thus making an oblong opening quite through, with circular ends. The edges of the opening should be nicely papered. One cap may now be glued in, and the glass dropped into the body; then the other cap (which should fit close round the edge, and at the same time hold the glass without shaking) may be glued in also.

Two pivots have now to be made, as shown in the design. They are nearly ⅝in. in length, and have a round tenon on both ends, of $\frac{3}{16}$in. diameter, to fit into the body and into the pillars. The body is hung on these pivots, exactly in its centre, so that it may have the same position in the frame when reversed. The pillars are bored nearly through to receive the pivot tenons; the body is bored quite through, and in the centre of the wood left between the openings.

The pivots may be glued into the body, but they must be left dry in the pillars, in order that they may turn freely.

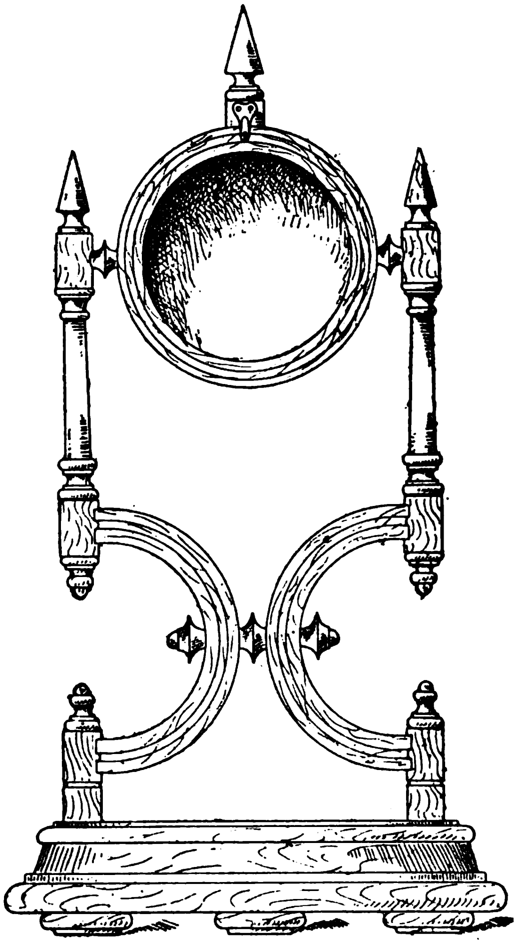
This completes the construction of the egg-boiler. It may be polished during the progress of turning, as described in previous papers; or, if the amateur is unwilling to endure the tedium of polishing, he may complete the job, and give it over to a French-polisher.

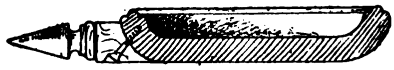
The watch-stand, here illustrated, is a job after the same character as the egg-boiler, being composed mainly of circles and pillars.

First of all we have the sole, supported on three ball feet. This sole is, at the broadest part, 5¼in. diameter, and ¾in. thick. It is hollowed out on the upper side, as shown by a dotted line, to receive a watch-guard, coiled up.

This piece is, of course, turned plankways on a face-plate.

Next we turn a circle, 2¾in. diameter, and ½in. square in section. This is cut in halves, and has a hole bored through the centre of each half. A small piece is now turned exactly like the pivots above-





mentioned, and the semi-circles are united, back to back, by gluing in this piece between them. Two little buttons are now made, and glued in, in continuation of the centre piece.

Next we make two short pillars, and fit them into the sole. Then we hollow the ends of our semicircles to fit the straight turned part of the pillars.

The pillars have each a hole bored to receive a fine ¾in. screw, which passes through and enters the end of the semi-circle. The screw head should be sunk into the pillar, and plugged up with a bit of the same wood. The long upper pillars are fastened to the circles in exactly the same way. These are 4¾in. long, and ⅝in. thick at the straight part, where they join the semi-circles and watch-holder. Their design is sufficiently clear to need no description.

The top fig. is the front elevation of the stand complete, the lower is a section of the watch-holder. It is turned plankways; is 2¾in. outside diameter, 2⅛in. inside, the thickness of wood to make it being ⅝in. In the operation of turning, it is fixed on face-plate without any central screw, being stuck on with turners' cement, which is composed of common resin and wax, melted together. A piece of wood is fixed on the face-plate; the face of the wood is faired up, thus making a wooden face-plate. While the lathe is running, the lump of cement is held against the revolving face; the friction dissolves the cement, thus coating the wooden chuck face. The bit of wood is now held against the still revolving chuck, with its coating of cement. Friction again heats it up, and the wood immediately adheres to the chuck firmly. If it runs out of truth, it must be knocked off and tried again.

This operation of cementing is only done when a screw hole would deface the job being turned, as in the case in hand. Having got the work *stuck* on, it must be roughed down with care, as it is apt to be driven off, and if this happens when the work is nearly reduced to a size, it is very difficult to stick it on again to run true.

Having turned the edge, and hollowed out the face as per design, it must be nicely papered, excepting the hollow part, which may be left somewhat rough, as it receives a circular piece of velvet, fixed in with glue. It is now struck off the chuck, and the back has to be turned. To effect this, fix a piece of pine on the face-plate, true up its face, then hollow out until the finished side of the watch-holder fits in tightly. When made to run true, the back may be finished, as per section.

The central pinnacle is now made, and fitted to the top of the watch-holder. Two pivots are now made, same as for egg-boiler: one end glued into the centre of each side of watch-holder, and the other to revolve in the pillars; or the holder may be canted back to an angle of 75° or 80°, and there fixed by gluing in the pivots both ends. A little hook is made, and fastened to the base of the central pinnacle, for hanging the watch on. It will also be necessary to remove a portion of the beaded rim of the holder, immediately under the hook, to receive the ring, or bow, on top of the watch.

After polishing, a little bit of velvet is cut circular, and fitted neatly with glue or paste into the holder, and so our watch-stand is finished.

Our next paper will give a design for another useful household ornament, called a lady's bobbin-stand, which will give an excellent exercise in face-plate and 'tween centre turning.

WATCH OILS.

AN oil fit to be used as a lubricator for fine mechanism should possess the following essential qualities: It should neither thicken nor dry up, nor get hard at a low temperature, nor should it be subject to oxidation. In spite of the vast progress natural science has made of late years, it has not succeeded in discovering an animal or vegetable oil possessing these combined properties without previous artificial manipulation. Let us mention a few instances:

Almond oil has the valuable property not to become firm till below 17 deg. R., but it oxidates sooner than any other oil. Poppy-seed oil will withstand cold to 15 deg. R., and preserves itself well from oxidation; but it is one of the "drying oils," and therefore useless as a watch oil. Olive oil, up to the present the most useful among watch oils, does not dry or thicken, nor does it oxidate for a comparatively long time, but it hardens already at 2 deg. R. The properties of neat's foot oil are similar to those of olive oil, but it exceeds the latter in resistance against oxidation. These few observations will sufficiently show why technical chemistry always considered the production of an oil, fulfilling in every respect the requirements of fine mechanics, as one of the most difficult tasks. Most of the oils supplied to the trade answer this purpose but imperfectly. It is, therefore, not to be wondered at when conscientious men act with caution in introducing any novelty in that department; the more so, because the hitherto employed methods for testing oils required considerable time, and were often attended with loss. We think it will be useful to our readers if we point out the means by which such tests can be made with the least trouble and cost, and in the shortest time. We will first divide the oils into two classes:

Drying Oils.—The best known among which are: Linseed, hemp-seed, poppy-seed, and castor oil.

Non-drying Oils.—To which belong olive and colza oils, and those from the larger kernels, as almonds, hazel and beech nuts, etc.

That drying oils are useless and objectionable for fine mechanism is evident, because they dry on exposure to the air by absorbing oxygen and generate carbonic acid. The quicker or slower drying depends simply upon the thickness with which the oil has been applied. A higher temperature will considerably accelerate the effects of oxygen, an advantage of which painters and cabinet-makers—the principal consumers of this kind of oils—avail themselves when despatch in their work is required. Oils, as regards this point, are, therefore, very easily proved. The article to be examined is laid as thin as possible on a piece of glass or china, and the latter is then put on a stove, care being taken not to expose it to too high a temperature, to prevent the oil from boiling, which would take place at 240 deg. R.—is quite sufficient to dry a thin layer of such an oil into a glassy substance in a few days. This simple process supersedes all others. There are oils which do not belong to this class, but gradually thicken because they contain considerable quantities of mucilage, pectic acid, etc. Such is the case with oils from the larger kernels, as almonds, beech and hazel nuts. An exposure of these oils to a high temperature will, in a few hours, manifest this defect also. The next evil lies in the little resistance which oils offer to lower degrees of temperature. Every fat is, again, a conglomeration of other solid and liquid substances. The former are called stearine, margarin, palmitin; and the latter, olein, elain. According to the proportions of solid and liquid substances, the fat requires a higher or lower temperature to become liquid or solid. Tallow, for instance, melts only at 32 deg. R., while linseed oil remains still liquid at 22 deg. R. An oil which can resist 10 deg. R. will do very well for general purposes. The temperature in a room, even without a fire, will, at 25 deg. R. in the open air, not sink below 8 deg. to 10 deg. R., and besides, in the watch pocket, next to the body, the watch is safely guarded from extreme cold. The watch manufacturer has not to consider extraordinary cases, and if inhabitants of the frigid zone and Arctic navigators expose their chronometers to extreme degrees of cold in the open air, he is not answerable for the rash treatment of his work. If oils have to be tried as to their capability of withstanding a low temperature in summer time, the necessary degrees of cold may be produced as follows: 15 parts of Glauber's salt (the small crystallized sort) are put in a vessel of glass or china, and the flask of oil to be tested is immersed in it. This done, a mixture of 5 parts of muriatic acid and 5 parts of cold water is poured over the salt. By means of a thermometer, such as is used for liquids, the temperature can be controlled, and when it shows 8 deg. to 10 deg. R., the flask may be taken out and the oil examined. If it has remained perfectly liquid, it has satisfactorily undergone the required test. Chemists can without difficulty separate the firm ingredients from oil, and produce an article which will stand 25 deg. R., but this cannot be done without injuring it in other respects.

We come now to the most serious of all defects in watch oils, viz., oxidation, and therefore give our special attention thereto. Fats in general (liquid as well as solid) belong to the saline bodies, although they have in appearance nothing in common with salt. Salt is the name chemists give to a combination of an acid with a base, and under these bases they understand the oxides of iron, copper, etc., the alkalies, the alkaline earths, as lime, baryta, etc. The well-known Glauber's salt is also a combination of sulphuric acid with sodium for its base. The same base with carbonic makes our soda; and kitchen salt consists of chlorine with sodium for its base; or, more exactly, with the elementary substance of sodium, the natrium. If, in this combination, the acid is predominant, it is called acetic salt; if the base, basic salt; and if they are both alike, neutral salt. Such neutral salts are all our natural healthy fats. The acids they contain are called pyroleic acids (stearic acid, elaic acid, etc.), and the base, not yet known in its elementary state, is termed lipyloxyd, which, by further development, produces the better-known glycerine. Although these pyroleic acids are naturally neutral, and when bound to their bases cannot act as acids, yet they have an inclination to absorb oxygen from the surrounding atmosphere, especially at higher degrees of heat. This is what, in chemistry, is called oxidation. If this process continues, the acid in the oil becomes predominant, and then acts on metals precisely in the same way as any other acid, only its damage is slower and less apparent to the eye. The result is evident. Fine works, lubricated with such an oil, lose in volume, and the injury, which is often attributed to friction, is in reality the effects of this change in the oil. But this condition of the oil does not manifest itself till it has attained a highly injurious degree, and the work of destruction has already begun. The organs of taste and smell are therefore insufficient to ascertain what degree of inclination an oil has to become rancid, or even to indicate at once when it has actually become so. The following method will answer this purpose: Pour the oil in a bottle, together with an equal quantity of water, in which soda (carbonic natrium) has been dissolved; then shake it violently and let the mixture stand for some hours. If the two liquids separate perfectly, particularly under a higher temperature, it is a proof that the oil is free from acid. On the contrary, if a whitey substance shows itself between the two, it is certain that acid is present. Another method is based on the great sensibility of litmus paper in regard to acids. Litmus paper can be bought at the chemist's, but may be easily prepared as follows: Bring powdered litmus in contact with pure water (distilled is best) until the latter has absorbed enough colouring matter to dye dark blue immersed slips of paper. These slips are then thoroughly dried, and any acid applied to them will change their colour to a violet, or even red, according to the strength of it. Acids which have become free in an oil will have the same effect. It must be remarked that litmus blue, held to the light, is of a reddish tinge in itself; and that litmus tincture, well shaken, will present rays of glaring red in the sunlight, and, as the papers immersed in the oil become transparent, they will show a light reddish hue even in the purest oil. But a little practice and comparison will soon enable one to distinguish the effects of an acid on litmus blue.

In conclusion, we may correct a few traditional errors. Many think that the clearer an oil the better it is. A bad colour certainly indicates impurities, but if colourless or yellow it is in this respect immaterial. In fact, those very clear oils are generally most apt to become rancid, because the methods employed for the clearing process tend mostly to forward oxidation. To test the fluidity of oils by letting different sorts run off an inclined plane is also a doubtful experiment. Not only are there oils so poor in body that they flow too freely, and do not give the required protection against friction, like the sesame oil, but many other obstacles—scarcely observable with the naked eye—such as a slight unevenness in the surface of the plain, may influence the trial. A far more reliable way of ascertaining the desired degree of fluidity is to saturate a slip of blotting-paper with the oil, and watch whether the drops will fall off in pearls, or show an inclination to spread out. The latter is a certain sign of a viscid oil.—"German Watchmakers' Journal."

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THE BEST FORM FOR CUTTING TOOLS.

By Joshua Rose.

THE shape of a cutting tool for metal-working machine tools varies, first, with the nature or kind of metal to be cut; secondly, with the distance the circumstances may require the cutting edge to stand out from the tool-post, or tool-clamp; and, thirdly, with the nature of the cut, as whether it be intended to rough the work out, in which case the object is to remove the mass of the superfluous stock (in which case the smoothness of the surface it leaves is comparatively unimportant), or to finish the surface, leaving it true or smooth.

There is a great deal of difference in the shapes given by different workmen to cutting tools used for precisely the same duty; but I have found that those used by very expert workmen bear a very close resemblance in general form, and in the most important points are identical.

First come the roughing tools for cutting wrought iron, and the very best form of tool for this purpose is shown in fig. 1, the cutting edge being at *a*. The keenness of the tool is mainly obtained by giving the top face rake from *b* to *a*, so that the pressure of the chip on that face tends to push the tool along its traverse, thus helping to feed it, and thus relieve the feeding mechanism of strain. The only variation I have found in this tool, whether in the United States or in England, is in the height of the cutting edge from the body of the steel. In fig. 1 it is shown but little above the top of the tool steel, but I have seen it made considerably above, as in fig. 1*a*. This matter must be governed to some extent by the vertical distance between the top of the slide-rest and the line of lathe centres, and the depth of the tool steel, the object being to so adjust the height of edge *a* that the tool will be at the proper height with relation to the work when lying horizontally on the slide-rest. It is obvious, however, that on account of being chucked down at *c*, the tool in fig. 1 is much easier to forge, and that from the shortness of its bottom faces, as *d*, it has less surface to grind when being sharpened, which operation may therefore be most easily performed. As a very slight difference in shape makes a great variation in the tool duty, it may be as well to point out the elements to be considered in forming this tool. The degree of angle of face *ab* should be about 30°. The greater this angle the greater the tendency to feed itself along the traverse, and under a very heavy cut this tendency may become so great, if the angle of 30° be exceeded, that a single screw will not hold the tool, and two screws become necessary.

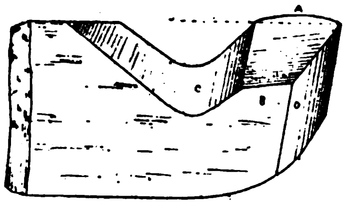


Fig. 1.

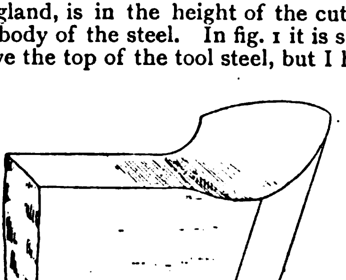


Fig. 1*a*.

The plane at the length of the cutting edge is another important consideration. In figs. 2, 3 and 4 is shown the other side of the tool, the plane of cutting edge *a* being, as denoted by the dotted line *d*, parallel to the body of the tool steel, so that if the tool is set horizontal there will be no tendency for the tool to run in and deepen its cut, or to recede and lessen its cut. But suppose, while still giving a side angle of 30° as before, the plane of the cutting edge be made as denoted by the dotted line *ee*, then the pressure of the chip on the top face would tend to force the tool to take a deeper cut on the work. Or suppose the plane to be made as denoted by the dotted line *ff*, then the chip pressure would tend to force the tool out from its depth of cut. Suppose, then, that a cut be put on by winding the tool in towards the cut, then the contact between the cross feed-screw and feed-rest will be on the sides of the threads facing the line of lathe centres, and all the play between those threads will be on their other sides, but so soon as the tool meets the cut it will jump forward and into the work to the amount that the play between the threads will allow it. If, then, the feed-screw be again operated to deepen the cut, it may not move the slide-rest until all its thread play is again taken up, in which case the tool, when

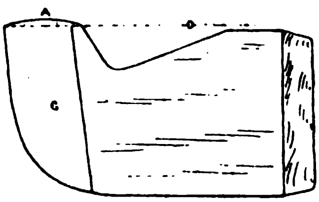


Fig. 2.

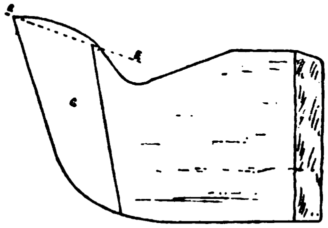


Fig. 3.

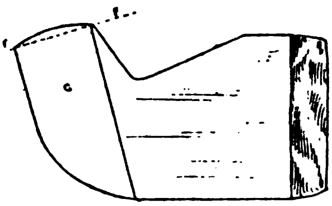


Fig. 4.

it again takes hold of the work, will cut in with a jump very liable to break the tool point. On the other hand, with the plane at *ff*, the tool will require a cross feed-screw pressure to force it to its cut, and the slide-rest will operate very steadily when the cut is put on. It is obvious, then, that the plane of *a* should not incline as at *e*, and it remains to discuss its proper degree of angle in the direction of *ff*. The maximum of such angle is shown at *ff*, and when this maximum is given the side rake of face *ab*, fig. 1, may be increased from 30° to 35° of angle, because the point of the tool is stronger (as will be seen by comparing the two degrees of angle *ee* and *ff* in the figures). The minimum of angle is denoted in fig. 1 by the dotted line, there being just sufficient to give the tool a slight inclination to recede from the cut, thus causing the feed-nut thread to bear quietly against the feed-screw on the sides of the thread having contact, when the tool is fed into the work.

We may now consider the angle of the bottom faces as *d* fig. 1, and *g* fig. 3, and this must vary with the diameter of the work and the rate of tool feed.

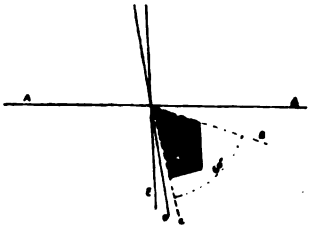


FIG. 5.

Suppose, for example, that in fig. 5 *a* represents the axial line of the work and *b c* the angles of the two faces of the tool *t*, being at 60° one to the other; suppose that the line *d* be the path of the cut around the work under a certain rate of feed, then the clearance between *c* and *d* will be, say 3°; but suppose the feed be finer, then the path of the cut around the work will be *ee*, then the amount of clearance on the same work and with the same tool will be as *e* to *c*, or say 7°. Now suppose the rate of feed remains constant, then the clearance, or angle of the bottom face, will vary with the diameter of the work. Thus let *d* represent in its length the circumference of a piece of work, and *e* the circumference of another piece of less diameter, and the clearance or angle between the tool face *c* and the cut is shown to vary with the diameter of the work; hence it appears that no constant angle can be given, as proper, for the bottom face, though it may be stated that it should be from 3 to 7° from the line or path of the cut around the work. Fig. 1, therefore, represents the very best form of tool for roughing out wrought iron, but it may be added that, on account of its keenness and propensity to traverse to its cut (which is a valuable feature, since it relieves the strain on the feeding mechanism), it should be brought to its cut by the self-acting feed of the lathe, so that all the play between the lathe-carriage and the feeding mechanism may be taken up. Otherwise, when it meets the work, such play will let it rush forward and dig into the work.

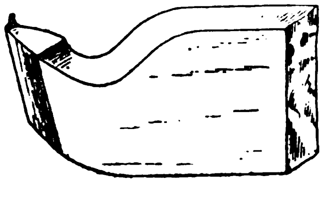


FIG. 6.

For finishing wrought iron the tool shown in fig. 6 is the best, its top face having rake or angle from *a* to *b* only, and not across as in fig. 1, the point *b* being rounded. On small work on which but light cuts are taken, this tool may be used for the roughing as well as the finishing cuts. The cutting edges are here essentially the same as those on the ordinary diamond point tool, but this tool is more easily

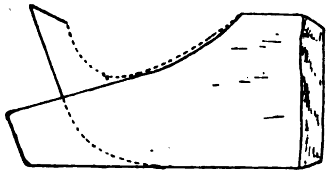


FIG. 7

forged as may be perceived from fig. 7, the end being simply drawn out to the full lines and then bent up to the dotted lines and trimmed to shape.

For cast iron, either for the roughing or finishing

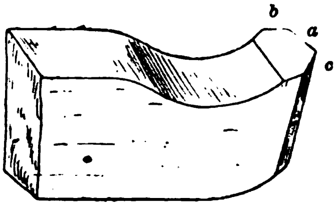


FIG. 8

cuts, the tool in fig. 8 is the best, the front edge *a* being placed parallel to the work. The corners, *b*, *c*, are merely bevelled, as shown, instead of being rounded. The object of these bevelled corners is to leave the corners less pointed, because a sharp point becomes dulled too quickly, impairing the keenness of the tool and causing it to endeavour to recede from its cut. A rounded corner may be used for this tool, but the bevelled one is preferable for cast iron because it can be more easily ground up with the face, *a*, left straight, than would be the case were the corner rounded.

The best shape for a slide-rest boring tool for

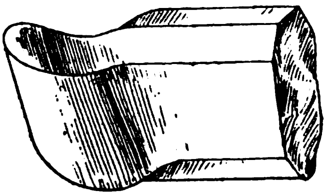


FIG. 9.

wrought iron is shown in fig. 9. All these tools may be used for steel and for copper, but for steel the angles should be slightly modified to make the cutting edges less keen, while for copper they should be increased to make the edges more keen.

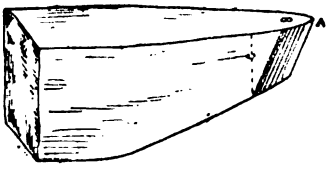


FIG. 10.

Fig. 10 represents a front tool for brass work, which is used for the finishing as well as for the roughing cuts, the only difference being that for finishing cuts the corner *a* should be slightly more rounded. The top face of this tool must be either in the same plane as the top of the tool steel or slightly depressed towards *a*. The width, *b*, and the depth, *c*, is increased as the size of the work (and therefore the depth of cut requiring to be taken) increases. If these be made too slight (but more especially the depth *c*) the tool will chatter, as will also occur if the top face be given rake. The proper shape for a side tool for brass is shown in fig. 11, the point *a* being more or less rounded according to the sharpness of the corner it is to cut up to in the work.

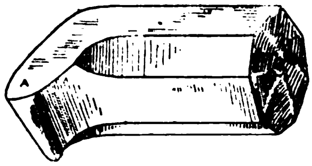


Fig. 11.

The proper shape for a side tool for iron or steel is shown in fig. 12. The cutting edges *a*, *b* should be at an acute angle, one to the other, so that when the tool is used in a right-angled corner both their edges cannot cut simultaneously, which would cause the tool to spring, and if placed above the work centre to also run into the work. The best shape for slide-rest boring tools for brass work is shown in fig. 13, the two bevels being necessary to reduce the keenness of the point and thus prevent the tool from chattering. In cases, however, where the tool point requires to cut up to a sharp corner the form of tool shown in fig. 13 (which presents a top and end view) may be used. Its end face *c* is at an obtuse angle to the length of the tool, so that on passing up a bore and meeting a radial face the point only will meet that face. This angle, however, gives to the tool a keenness that will cause chattering unless the top face be bevelled to the tool body as is *a* to *b* in the figure.

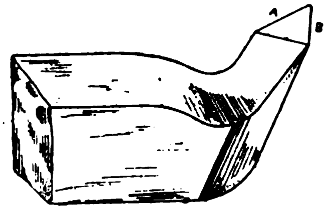


Fig. 12.

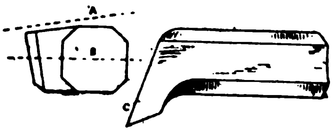


Fig. 13.

WOOD CARVING.

WOOD carving is not a difficult work to any one who has some knowledge of drawing, and it is a very fascinating employment too when once the mastery over the tools has been acquired, the holding of them so as to make the necessary cuts being the greatest difficulty. A beginner should not commence with a a difficult design, but should learn how to handle and manage the instruments while working at something easy and in low relief, and when more confident, take to "round" objects. The tools should be of the best English make, it being folly to spend money upon inferior articles. A complete set consists of thirty instruments, not including carpenter's tools; but it is a better plan to buy the tools separately and commence with a dozen, and then add the others as required. The handles should be of well-seasoned ash, and not more than 3in. long; long handled tools are not so easy to manage as short handled ones, and should be avoided at first. French brads and glue must be provided. Measure, square, mallet, pincers, and other carpenter's tools are required, but not at first. A strong deal table is an absolute necessity, and should be secured to the wall or the floor, and the table cramp, or holdfast, fitted to it, so as to screw the wood to be carved firmly to the table. Let a beginner buy the table and cramp, half a dozen flat and curved gouges of various sizes and depths, some chisels, two punches, the pattern wheel, mallet, glass paper, a square measure, some glue, and tracing paper, and commence with these. A stock of wood can be obtained from a cabinet maker or carpenter. The pieces are sold by measurement, and cost so much the foot. American walnut, lime, sandal, pear, mahogany, and oak are used—the last two are the hardest and best. The wood must be well seasoned, evenly planed and free from knots, holes, or cracks.

To commence the work ("The American Cabinet Maker" says): Trace out an easy flat arabesque design, 5in. in width, 10in. in depth, with well rounded curves, etc., upon a piece of tracing paper, and select a well-seasoned piece of American walnut, larger than the design, and from ¾in. to 1in. in thickness; fasten the tracing to the wood with drawing pins. Fasten the wood firmly to the table, and then take the pattern wheel and run it over the pattern lines, so that its points press the paper into the wood and by so doing prick the wood in regular lines. Having transferred the pattern, take the smallest gouge and cut upon each side of the line a fine groove; always slope the tool outward, away from the pattern line, and hold it firmly in the right hand, with the left wrist upon the wood, and its forefingers guiding the gouge as it moves, but kept well behind its point, for fear of its cutting them. Cut the grooves very lightly and slowly and take off very little wood at a time, as, if deep cutting is attempted, a slip is sure to occur and the work will be spoilt. The great secret of successful carving is to fasten the wood firmly down, and then to work at it slowly, only shaving the wood off on each side of the pattern lines until a certain depth has been reached. A straight groove is easily made, but a curved groove line requires the wood to be turned round so that the grain always lends itself to the cutting. Repeat the cutting until the grooves on each side of the pattern lines are deep enough; then take a small chisel, and remove the wood between the pattern lines, using the same care as before, and making a clean, but not deep, cut. Level the ground between the patterns with a chisel, or curved file, or rasp, and rub the edges of the outline smooth with the rasp or sandpaper; then take one of the punches, and with the mallet strike it down on the groundwork, so as to make a deep indenture. Fill up the whole of the groundwork with these holes made by the punches; then wipe the wood quite clean, rub in plenty of sweet oil and polish with a pine stick. If any cracks are made in the wood, fill them up with wood dust and glue. Always keep the tools very sharp, and have them constantly ground at the ironmonger's or smith's; gouges should be sharpened inside their points as well as out, chisels on both sides, and when in use keep filing them on an oilstone and rubbing them on a strop or leather.

POISONS.

MANY of the substances used in the arts are highly poisonous. Indeed, some of the most virulent poisons are employed in very common operations. Thus arsenic is used for colouring brass; the strong acids are used in every machine shop and foundry, and even prussic acid may be occasionally produced during the employment of prussiate of potash. The extremely poisonous cyanide of potassium is used by every photographer and electroplater. Even into the household poisons too frequently find their way. Our matches are tipped with a strong poison, and housekeepers are often too ready with poison for the destruction of vermin. Phosphorus, arsenic and corrosive sublimate, are too frequently thus used. Paris green also we have actually seen used for the destruction of cockroaches in pantries, and corrosive sublimate is in common use as a poison for bed-bugs. As a bug poison it is generally dissolved in alcohol or whiskey, and the odour and taste have sometimes proved a strong temptation to persons who did not fully realise its dangerous character. All bottles containing such mixtures should therefore be carefully labelled " POISON," in large letters, and when emptied they should either be broken or very carefully cleansed, since accidents have arisen from careless persons pouring drinkable liquids into bottles that have contained solutions of corrosive sublimate, which solutions, after drying up, have left the bottle apparently empty, but in reality containing an amount of poison sufficient to destroy several lives.

In all cases where poisons have been swallowed the proper course is first to neutralise the deleterious agent, and then to procure its rejection by means either of the stomach-pump or an emetic. The stomach-pump is, of course, the best and most expeditious agent. It requires but a few moments to insert it and remove the contents of the stomach; fresh supplies of water and the proper antidotes can then be poured into the organ, so that in a few minutes the last traces of the poison can be removed. But as the stomach-pump is to be found in the possession of physicians only, reliance must in general be placed upon emetics, of which the best is, unquestionably, mustard—an article which is to be found in almost every household. It is generally conceded by physicians that mustard is the mildest, most rapid, and most efficient emetic known. It is prepared for use as follows: Take about a plump dessert-spoonful of genuine flour of mustard (if it be mixed with wheat flour or turmeric, more will be needed), mix it rapidly in a cup with water to the consistency of thin gruel, and let this be swallowed without delay or hesitation. In a very few seconds the contents of the stomach will be ejected. Before the emetic action has entirely ceased, a little lukewarm water—or still better, warm milk—should be forced down. This will be thrown off immediately, and will serve to rinse out the stomach and remove the last traces of deleterious matter.

By the time the operation of the emetic has ceased, a physician will probably be in attendance, and to his care the patient should be at once confided.

The following notes on special poisons will prove useful:

Strong Acid.—Where nitric, sulphuric, or hydrochloric acid has been swallowed, it is well to administer carbonate of soda before giving the emetic.

Oxalic Acid.—This acid is often found among the articles provided for household use, being used for cleaning brass and various metals, as well as for removing stains of ink and iron mould. In former times it was used for cleaning boot tops and for some other purposes. In appearance it resembles epsom salts so closely that even experienced chemists might be deceived if it were not for the taste, for while the acid is intensely sour the salts are as intensely bitter.

The proper antidote for oxalic acid is some form of lime, and the best method of administering it is to mix finely pulverized chalk with water to the consistency of cream, and swallow it. It is a singular fact that when oxalic acid is largely diluted with water it acts very rapidly and energetically, destroying life almost with the rapidity of prussic acid. Hence to administer soapy water, or any other very diluted remedy, would be almost fatal. And yet this course was actually recommended by a popular scientific journal.

Prussic Acid.—As this is one of the most rapid of all poisons in its action, prompt and energetic measures are demanded. Cold affusion to the head and spine has been found the most efficacious mode of treatment. Internal remedies appear to be of no service. The vapour of ammonia may be cautiously applied to the nostrils, and stimulating liniments by friction to the chest and abdomen, but unless the dose is small, and the patient is seen early, there can be little hope of benefit from any treatment. Certain chemical substances (cyanides), from which prussic acid is slowly evolved by the action of the air, are used in electro-plating and photography. These substances are themselves very strong poisons, and if accidentally swallowed they cause death with such rapidity that there is scarcely any time to apply any remedies. Green copperas (sulphate of iron) dissolved in water and administered would decompose and neutralise the poison, after which the directions given for prussic acid should be followed. When poisoning occurs from breathing the vapours arising from these salts, it is caused by prussic acid, and should be treated accordingly.

Corrosive Sublimate.—When corrosive sublimate has been swallowed, the first thing to be done is, if possible, to get rid of it either by means of emetics or the stomach-pump. If the poison has been taken on a full stomach, an emetic or the pump is the first thing in order; if the stomach be empty it will be better to administer, in the first place, as much white of egg, or milk, or mixture of both, as the patient can be made to swallow, and immediately afterwards give an emetic. The white of egg is the great antidote for corrosive sublimate, but it is of no use where the poison has been absorbed into the system, and if, after administering white of egg, we neglect to procure its rejection, the compound that is formed may be destroyed by the action of the gastric juice, and left free to act with all its original virulence.

Phosphorus.—There is no efficient antidote or remedy for poisoning by phosphorus. Taylor recommends the administration of emetics, and of albuminous or mucilaginous drinks, holding hydrate of magnesia suspended. The exhibition of oil would be decidedly injurious, as this dissolves and tends to diffuse the poison. Saline purgatives should therefore be preferred.

* * *

French-Polish.—Take one ounce each of mastic, sandarac, seedlac, shellac, gumlac, and gum-Arabic; reduce them to powder; and add a quarter of an ounce of virgin wax; put the whole into a bottle, with one quart of rectified spirits of wine; let it stand twelve hours, and it will be fit for use.

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

MISCELLANEOUS ITEMS.

Sir,—I notice in the "Amateur Mechanics" of July, 1883, that "J.C.E." describes himself as being in a sad tribulation.

Now, if "J.C.E." will, with a brush, place a layer of varnish all over the ends of his freshly cut box, or other woods, the cause of its cracking or splitting will be obviated or arrested. I think the best copal varnish is preferable for the purpose.

2nd—Some kinds of American chucks are good for holding small pieces of ivory, hard wood, or metal; but, unfortunately, some of the noticed chucks gradually relinquish their hold when the cutting resistance is brought to bear against the rotating material which they contain.

I believe, through extensive practice, there is no chuck which holds so firm or secure as the one called the six-seven chuck, one of which "J.C.E." can see if he calls at the Amateur Mechanical Society's rooms.

3rd—If "J.C.E." wishes for the outlines or contours of figures for turning copies in the lathe, the writer is willing to supply some, which will be the first best practice, or acquisition, an aspirant can have.

4th—The articles "J.C.E." has named are scarcely adapted for manipulating with the ordinary metal turning slide-rest and back-geared lathe. By all means, learn to be master of your natural fingers, &c., before you attempt utilising mechanical ones.

5th—The writer is in hope that neither "J.C.E.," nor others, will consider it presumptious to suggest anything in, or through, the pages of the "Amateur Mechanics" magazine, however simple, providing it is good and valuable.

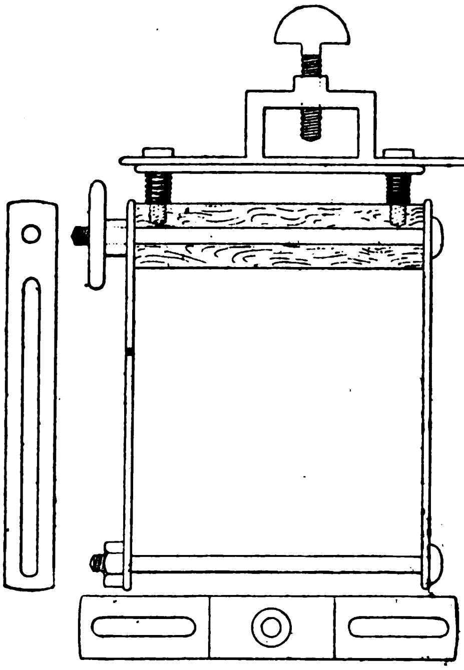
E.F.B.

GUIDE FOR GRINDING EDGE TOOLS.

Sir,—To grind an edge tool, and grind it accurately, requires both care and practice, and is an accomplishment well worth cultivating, as it will repay any amount of trouble taken to acquire it. It is, however, almost, if not entirely, impossible for the human hand, aided only by the human eye, to grind a large tool, or, say, a Morse drill, with perfect accuracy, therefore various guides have been designed to ensure the required correctness of angle. These guides consist of a means of clamping the tool and advancing it to the stone, and, generally speaking, some means of traversing it across the face of the stone, so that not only the tool, but also the stone face, may be worn away equally.

Most of these devices are, however, either too large, too complex, or too expensive for the amateur's workshop, and, with the exception of the G (used almost entirely by the ornamental turner to both grind and hone his minute cutters and small slide-rest tools), are not to be advised. A small holder has, however, been lately introduced at a very low price, by means of which the ordinary tools, such as chisels and plane irons, can be ground, with care, by an almost unpractised hand, to a sufficiently accurate edge or angle. At the same time it is by no means impossible, even by its aid, to give that ever-to-be-avoided double or treble bevel so commonly made by amateurs.

The guide, described and illustrated in this number, was designed by the writer to enable him to sharpen his tools with greater accuracy than usual, and, he must add, with less trouble to himself.



The drawing almost explains itself, and any amateur mechanic can get the apparatus up for himself by its aid. The two iron side supports are bolted to the framework of the grindstone by the bolts shown; the slots in the supports enable the whole affair to be set either high or low, close or distant from the stone, as required. The swivelling bar is of wood 2in. square, bored throughout to take the ½in. bolt, the square neck of which (fitting the square hole in the right hand support) prevents the bolt from rotating, while the bar can be set to any angle and clamped by the fly nut, as shown. The tool clamp (shown, also, in plan) is slotted to allow of its traverse across the face of the stone. It is kept in place by the two bolts shown in sketch, the spiral springs keeping the tool free from "grind," except when pressed down by the hand, which is placed on the head of the clamping screw.

To set the tool properly, adjust the supports for position, set the tool-holder at the angle required and clamp it; when the stone is revolving, press down the tool, as above stated. By releasing the pressure the edge of the tool can be at any time inspected.

"GRAHAM."

MANDREL NOSES AND CONICAL FITTINGS.

My dear Sir,—I have only just seen the letter of "F.A.M." in your issue for August, and hasten to reply to his query.

I rely entirely on the conical fitting for keeping the chuck in its place, and with those chucks which I have used in connection with the taper fitting I have never found the slightest jar, nor even a tendency to turn on the taper portion of the plug chuck. I took my idea from the plugs used for the Acme drill and other chucks, the only difference in the fitting being that, whereas the usual taper plug is fitted *into* the mandrel nose, my taper plug chuck is screwed to it in the usual manner. There is an advantage in this—viz., that the extra chuck is placed immediately about the nose, and thus lessens the strain upon it. I have never used the chucks for the work mentioned by "F.A.M.," but will try an experiment or two, and publish the result. If lathes were fitted with conical instead of screwed noses, I should prefer to have something more to rely upon than the mere cone; in any case I should do away with the nose altogether, make the mandrels much larger, and have them with an *internal* rather than an *external* cone, the same as a drilling mandrel.

Very truly yours,
J. GRAHAM.

AMATEUR MECHANICS

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CENTRING ROD METAL FOR TURNING.

By Paul N. Hasluck.

TO centre a piece of metal rod so that it will run absolutely true is a task perhaps seldom attempted by an inexperienced hand, and by many it is looked upon as unaccomplishable. For this reason we find that ⅞th stuff is used for turning ¾ cylinders, though the labour involved in removing the superfluous eighth-of-an-inch is quite wasted. Really it is not any more difficult to centre a rod truly than to set it between the centres considerably out of centre, or at least the trouble of getting an absolutely true centre is comparatively inappreciable.

In the first place, when about to turn a rod of metal between centres, select a suitable piece of material, just sufficiently large to clean up to finished size. See that the rod is straight, and cut off a suitable length; if the entire length is to be used for one particular object, cut off just enough and not more than is required. Of course the error of, say $\frac{1}{16}$in. in length, when it is on the right side, will not signify, but a superfluous ¼in. will entail a lot of unnecessary labour to no purpose whatever. The rod cut off, file up its ends perfectly flat, and at right angles to the length of the rod. If the end faces are at an inclination it is very difficult to correctly judge by the eye the exact centre. When the ends are squared the centres must be found and marked. There are several ways of doing this, and the best will greatly depend on the special practice of the operator and the peculiarities of the work. Probably the one most generally easy is to mark the place with a fine centre punch; this is an operation which, though extremely simple in itself, has many details in the manipulation.

For rods of small diameter the centre may generally be judged sufficiently near for practical purposes by the eye alone. The rod is fixed upright in the vice, and a light dot punched with a centre punch. The ends are then reversed and a corresponding operation carried out at the other end. The rod is then put between the centres of the lathe, and the amount of its eccentricity noted by turning the rod with the thumb and finger, at the same time applying a piece of chalk so that it touches the most prominent side of the rod. This is marked with the chalk, and the rod replaced in the vice. The punch is applied in such a direction as to drive the hole towards the more prominent or the marked side, and the work again tested. The indentation made by the centre punch should be as small as possible, to just hold on the lathe centre.

By continued trial between the lathe centres and subsequent correction with the centre punch, the centre punch indention can be brought to the exact centre of the rod. When this is accomplished, the centre is deepened by striking the centre punch in the direction of a straight line with the axis of the rod. By means of a blunt-pointed punch and a prick punch—one having a sharp, acute angled point—the indention may be made sufficiently deep to hold the centres during the process of turning; but in all cases it is advisable to drill in the centres with a small drill, which will prevent the centre point of the lathe "bottoming" in the hole, and thus causing the centre to run out. This drilling in should be done in every case when the work is likely to be liable to be run between the centres at some future occasion. To attempt to turn any but the very commonest of work on plain punched centres is a most unwise practice.

To show the effect of drilling in the centres before straightening the work, a glance at figs. 1 and 2 will suffice. The illustrations given in this article are copied from some drawings by Mr. Joshua Rose. In fig. 1 we have the section of a rod very much bowed but correctly centred at each end. The centres are shown drilled in very much deeper than they should be in practice, to better illustrate the effect. When the rod, fig. 1, is put between centres on the lathe, the part *w* will, of course, be found to run very much out of true. If the rod is then straightened to run true in the centre, as shown at fig. 2, the direction of the drilled centres will not be in a line with the axis of rotation.

Fig. 1.—Showing drill centres in a bowed rod.

Fig. 2.—Showing the effect of straightening the rod.

The dotted lines in fig. 2 show the direction of the holes. If the work is rotated very long, and the centres become worn much deeper, the work will run out of true. An inspection of the two illustrations will make the effect obvious. In many cases the straightening of a rod can be done more accurately after it is mounted on the lathe centres; but it should always be done before drilling in the centres. Usually it is best to cut off a piece of rod the length required, then straighten it tolerably true; next centre it truly at the ends. When mounted on the lathe observe if the rod is crooked, and finally straighten before drilling. After drilling in, the centres must be countersunk properly; of this more later on.

Another method of centring, which is usually adopted in cases where large quantities of rod pieces have to be centred, is to fix a stiff short drill in the back centre socket. This drill must be quite rigid, and it forms a centre. The work is then run between the centres, dots having been first punched at the ends, their central position being in this case of little importance. The rod has a carrier put on one end, and the lathe is set in motion. The drill will now cut if the back centre be brought forward, but this must be carefully avoided till the central position of the hole has been assured. This is got by placing a tool—the hook of the ordinary arm-rest acting very well for the purpose—against the revolving rod in such a position that the highest side will bear heavily against the tool, whilst the "scant" or least prominent side barely touches. The point of the drill on which the work revolves, being a cutting edge, will gradually cut in the direction of the high side of the work, the tool held against it forcing the rod in the opposite direction. To prevent the work from becoming loose between the centres, and at the same time to assist the cutting of the drill, the back centre must be kept up to its work by slightly advancing the barrel of the poppet.

The drill fitted into the poppet barrel is usually called a square centre, and is often made of the shape shown in fig. 3. The end is simply filed up to a four-sided point, then hardened and tempered for use. The facets marked *a* and *b* in the figure may be ground to make the point sharp again after being blunted by use.

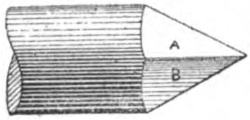

Fig. 3.—Ordinary square centre.

The quantity of metal that has to be ground away each time this square centre requires sharpening is considerable. In order to reduce this labour the form of the centre is frequently modified to that shown at fig. 4. In this the diameter is reduced very considerably. If the centre be kept short, as it should be, the reduction of diameter does not weaken it disadvantageously. In fig. 5 another modification is shown. The sides of the centre are grooved out (as shown in *a* and *b*) so as to reduce the grinding surfaces.

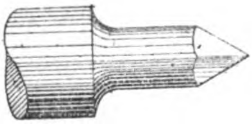

Fig. 4.—Squared centre reduced to economise grinding.

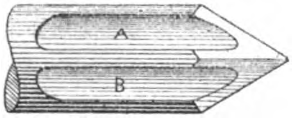

Fig. 5.—Grooved or fluted uare centre.

By means of the square centre, in a short space of time, the hollow made by the centre punch will become drilled at the exact centre. Sometimes a strip of metal, having a < shaped notch in its end, is fixed in the tool-holder of the slide rest, and brought to bear against the end of the rod. The rod rests between the forks of the <, and its highest side continually impinging against one or other side of the slot, the tool being advanced by the slide screw till the rod revolves in the slot with an equal bearing at all points. This is an excellent plan to be commended, principally when large numbers of rods of similar size require to be centred. One end being centred, the rod is reversed in the lathe, and the other end centred similarly. The rod must have centres drilled in with a small drill, and countersunk to ensure the work running true for any length of time. When preparing a quantity of rods all the centrings are done first, and the drilling in is a subsequent operation, and finally the counter sinking.

Some tools are made, for boring in centres, combining the drill and countersink. The most simple form is shown at fig. 6. It is formed by simply flattening a cylindrical piece of steel as in making an ordinary drill. The end is then shaped to the form shown, the small part being the drill and the large part forming the chamfer. Such a tool must be used with care, as the drill point is very liable to breakage through being jammed in the hole by the shavings.

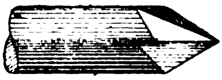

Fig. 7.

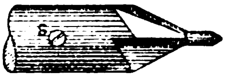

Fig. 8.

Fig. 6.

Fig. 7 shows a rose countersink. The end is turned to the correct cone, and then about six teeth are filed on it. These countersinks cut very well. In fig. 8 we have a combination. It is like fig. 7, but drilled through the centre to take a small twist drill. The small screw shown at *s* fixes the drill at any desired point. It may be removed for sharpening, or replaced if broken.

The ordinary form of countersink is shown at fig. 9. The cone point is filed away to the diameter line, leaving *a*; a small facet, as at *b*, is sometimes made for clearance. This countersink works very well in practice. It is easy to make and lasts a long time. The cone point should always be made to exactly match the lathe centres.

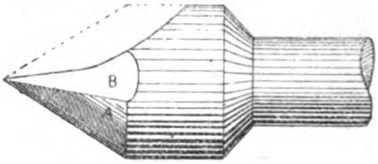

Fig. 9.—Ordinary countersink.

The effect of grinding this countersink is shown by fig. 10: the point becomes a curved line. When this curve extends further than the diameter of the small hole bored up the centre, the countersink ceases to act properly. A countersink made of good steel well hardened will last with fair usage a very long while, so that an anticipation of the result shown in fig. 10 need not trouble us much.

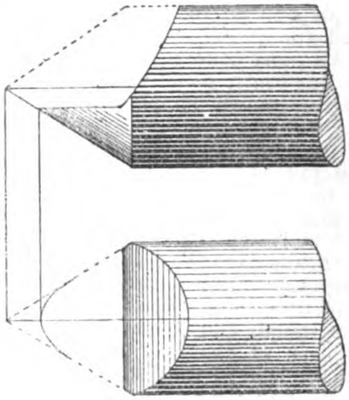

Fig. 10.—Showing effect of grinding the countersink.

Another method, which finds favour amongst amateurs principally, is centring by means of a centre punch fitted to the apex of a hollow cone. The cone is put on the end of the rod, and then the punch is brought down to touch the end of the rod, and a blow from a hammer causes the point to make an indentation, which, theoretically, would be in the centre of the rod. Practically, however, there are many causes which upset the theoretical principles. If the end of the rod is not exactly square with its length, or if the punch is not held perfectly straight with the rod, the point marked will be out of centre. This cone centre punch is not a tool to be commended for use in workshop practice, and its use is principally confined to amateurs.

When centring rod work with a plain punch, as first described, the chief difficulty lies in judging the exact spot which is the centre, and of course the larger the area which forms the end of the rod the greater is the chance of error; or, more properly speaking, the greater will be the error in judgment. There are means of marking the centre of a rod which commend themselves to the notice of those adopting the firstly-described method of centring. By means of a scribing-block, the centre may be marked within a very small space. By the use of a gauge formed of two strips placed at an angle, and having a straight-edge exactly bisecting the angle, the centre can be got by scribing two lines at somewhere about right angles on the end of the rod, the intersection of these lines showing the exact centre. Either of these plans for finding the centre will be found very convenient.

Having accurately centred the work, the next operation will be to mount it between the lathe centres, and see how the rod runs for truth all along. Most probably it will be found that the part about midway will be out of truth more or less, caused by the rod not being quite straight. The high point must be marked, and the rod straightened by a blow of the hammer; this must be done on the anvil or some such tool. On no account should the work be struck with the hammer whilst between the lathe centres, unless it be very slender stuff, as much damage may result to the lathe through the incautious use of a hammer. Besides, the work is too springy to straighten when held supported by the centres only.

The chamfer countersunk in the end of the rod must fit the lathe centre. If the chamfer is either a greater or a less angle than the cone on which it has to work, the bearing will be only at one edge. The illustrations, figs. 11 and 12, show this.

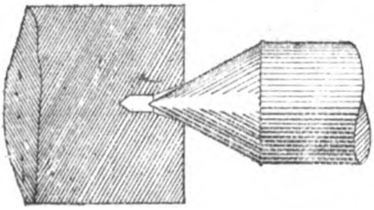

Fig. 11.—Hole countersunk at a too acute angle.

In fig. 11 the hole is shown countersunk at a much more acute angle than the centre point. Consequently the bearing is only at the extreme end of the rod. Having but a small amount of bearing surface the centre would, of course, wear rapidly.

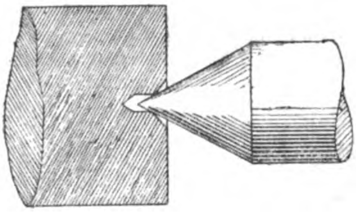

Fig. 12.—Hole countersunk at a too wide angle.

In fig. 12 the hole is shown countersunk at a much wider angle, and the effect is practically the same, so far as a small bearing surface is concerned.

Curiously, some people are of opinion that countersinks should be made to an angle that is not precisely like that of the lathe centre. The absurdity of this opinion is self-evident; the strongest proof of its absurdity being, however, the fact that writers contend most hotly—some for the error shown at fig. 11, and some for that shown at fig. 12. If the one is correct the other must be wrong; but each has its advocates.

Undoubtedly the countersink should be made precisely to the same angle as the lathe centre. The angle of 55° has some advocates, but 60° is as good and a more convenient standard. A gauge is easily made by cutting a notch with a triangular file, which will be 60°, the angles of an equilateral triangle being 60°. This angle for lathe centres should be universal.

Fig 13 is intended to represent, in section, a rod of metal centred and countersunk properly, the countersunk being shown on the right. It will be observed that the central hole is drilled in sufficiently to just clear the point of the cone. An idea of the relative sizes may be inferred from this illustration, though the end is intended to be trued up on the lathe, for which purpose $\frac{1}{16}$in. is allowed.

Supposing the rod to be properly centred, quite straight, and the centres drilled in and chamfered, it will be advisable, preparatory to commencing to do the turning proper, to make the ends of the rod quite true. Square off the extreme end faces of the work, and whilst this is being done the rod may be made the proper length, if any special predetermined length is required. The object in turning the ends true is to get an equal surface round the chamfer in which the cone-point takes its bearing, which would not be the case if the rod ran between centres with its ends out of flat. The centres of the work should always be kept lubricated, for if allowed to get dry they will cut and tear, and most likely entirely spoil all previous centralism of the chamfer.

Too much importance cannot be placed on the proper carrying out of these simple processes of mechanical manipulation. A proper attention to these makes all the difference between good and bad work. Owing to not taking the precaution to

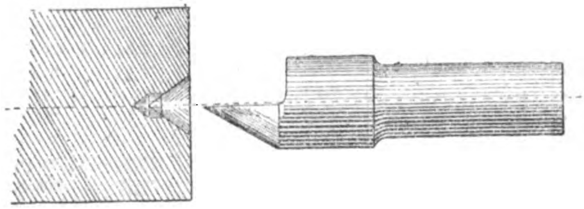

Fig. 13.—Correctly-formed hole and countersink

properly centre and prepare the ends of a rod, many contrivances, sometimes the work of months, are thrown on one side simply because a spindle will not run true between the centres on which it was turned. Amateur mechanics should never consider time spent in attending to the minute details of the work they have in hand lost time; on the contrary, it is time well spent, and will be amply repaid in the long run by the subsequent saving effected.

SUGGESTIONS FOR A STANDARD MANDREL.

DR. EDMUNDS has prepared for the consideration of the members of the Amateur Mechanical Society the following valuable paper, which is interesting to all engaged in lathe work, and which we extract from the journal of the society:—

Having given considerable attention to designing a standard mandrel for the geometric lathe, with a view to combine the greatest advantages for all round scientific work, and also enable costly chucks, when made accurately to its gauge, to be interchangeable, I took occasion to suggest the project on the occasion of Mr. Evans' recent lecture before the Society of Arts.* In the course of the discussion which then followed, Mr. Evans pronounced my interchangeable mandrel impracticable, and in the general catalogue published by Holtzapffel and Co. (page 36) I find the following remarks:—

"Although all lathes of the same size, say of 5in. centre, have their screws exactly alike as to diameter and thread, it is only by mere accident that the same chuck runs truly upon different lathes."

It is well known that, for every important chuck that is added to the ornamental lathe, the makers now require to have the mandrel-head forwarded to their works; but, on inquiring why, if the mandrels "*have their screws exactly alike as to diameter and thread*," properly gauged chucks will not all fit upon them equally well, I could obtain no reply more conclusive than used to be urged by microscope makers against making high-power objectives interchangeable. I then proceeded to examine for myself the best existing ornamental mandrel noses, and the following data are the results of careful measurements which I have made upon the lathes to which, by the kindness of various members of the Amateur Mechanical Society, I have had access. (See Table.)

The Holtzapffel mandrel nose is "usually ·8125in. for the 5in., and ·9375in. for the 6in." ·8125 = $\frac{13}{16}$in., and ·9375 = $\frac{15}{16}$in. It will be seen that of the seven Holtzapffel lathes which I have noted, five were 5in. traversing mandrels of the class generally used by amateurs for the finest work, and of which Mr. Holtzapffel gives the standard diameter as ·8125in. The average of the real noses proves to be ·8000, a difference of 12¼ thousandths of an inch below the standard diameter. The nose numbered 1 in the series, and measuring ·787in. outside the thread, was reduced at its base to ·632in., while its centre was bored out ·284in. Number 4, measuring ·805 outside the thread, was grooved out at the root of the nose to ·628in., a depth which must make its continuity very precarious if ever called upon for real work. It was bored out to ·140. Looking at the variations in these noses, it is seen that their construction has been determined by no scientific principles, and that in no one point are they "exactly alike," as stated in the catalogue. The grooves at the base, which are not subject to diminution under long use, vary in their diameters from 628 to 660 mils. Several cases of fracture of Holtzapffel noses have been recently referred to.

The Evans nose-standard is ·875in., one-sixteenth larger than the Holtzapffel standard, but I have no means of knowing whether Mr. Evans has ever professed to make all his noses "exactly alike as to diameter and thread." The measurements show that of the similar series of five noses, the average is ·872in., a divergence only of three-thousandths of an inch from his standard. As the weakest of his noses is turned out only to ·730in. = ·1in. more in diameter than the weakest Holtzapffel nose, there is a great difference in strength between the mandrel noses of the two makers. I have not been able to hear of any case in which an Evans nose has broken off.

The great Dublin lathe-master, James Kennan, never made so many lathes as his London *confrères*, and I have only had access to three of his lathes. One is a five-inch traversing mandrel, the property of Colonel Sandeman; one a six-inch traversing mandrel, the property of Lord Otho FitzGerald; and the third a six-inch back-gear traversing mandrel, belonging to myself. Each of these lathe-noses

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* Vide "Journal of the Society of Arts," February 9th, 1883.

TABLE.

No.	Makers.	Description.	Length of Nose.	Diam. of Nose outside Thread.	Diam. of Base of Nose.	Diam. of Bore.	Diam. of Face.	Diam. of Shoulder.
			inch.					
1	H. & Co.	5in. Traversing	·627	·787	·632	·284	1·164	1·278
2	H. & Co.	,, ,,	·684	·800	·645	·290	1·170	1·250
3	H. & Co.	,, ,,	·690	·802	·660	·290	1·190	1·260
4	H. & Co.	,, ,,	·665	·805	·628	·140	1·230	1·272
5	H. & Co.	,, ,,	·634	·805	·636	·275	1·160	1·235
6	H. & Co.	,, Back centre	·632	·792	·677	·000	1·104	1·104
7	H. & Co.	7in. Rose engine	·630	·955	·836	·437	1·635	1·753
8	Evans	5in. Traversing	·803	·880	·784	·280	1·300	1·325
9	Evans	,, ,,	·780	·865	·835	·283	1·280	1·329
10	Evans	,, ,,	·817	·860	·730	·278	1·240	1·310
11	Evans	,, ,,	·812	·885	·730	·280	1·293	1·390
12	Evans	,, ,,	·805	·872	...	·300	1·294	1·422
13	Evans	,, Back gear	·865	·875	·736	·000	1·375	1·480
14	Evans	,, Back centre	·806	·877	·750	·000	1·232	1·232

[No. 14 was threaded ⅞ standard Whitworth, all the rest were threaded No. 3, *i.e.*, "9·45 approximately."]

measures 1·005in. in diameter, by a little less than an inch in length; is bored ·375in., and screwed Whitworth's standard. One of these mandrels has its bore coned out about 4° to ·5in. at its mouth in order to take the centres. The chucks of the three lathes fit interchangeably, so far as the feel of the screws go, and they appear to run practically true. None of these mandrels are turned out at all freely at the root of the nose. It is curious that Kennan's lathes should be thus ·005in. larger than the standard inch, and I imagine that some error must have crept into his gauge. But it is evident that all his lathes really were accurately gauged, and so I have found with all the parts of his lathes. I have never heard of a Kennan nose being fractured. The Kennan face is very much wider than either of the London makers, being 1·75in. in diameter, and the shoulder is square behind, instead of being coned into the collar.

As to the practice of grooving out the screw nose at its base, Mr. J. J. Holtzapffel directs this to be done "in order that the screw-tool may cease to cut, and to allow time for it to be withdrawn before the traverse carries the side of the tool into contact with the shoulder of the work—an accident which, by suddenly checking the traverse of the tool, damages the thread." (*Vide* "Turning and Mechanical Manipulation," vol. iv., 1879, page 373.)

The groove, in fact, is made to facilitate a defective method of cutting the screw. But, as the thread may be automatically cut full up to a shoulder, with perfect precision, by means of a revolving cutter, there is no need to sacrifice the strength of the mandrel-nose by grooving out its base. In connection with the above extract, Mr. Holtzapffel gives an engraving representing his ideal of a model for turning "the hard wood, or ivory external screw" (vol. iv., p. 374). Certainly the engraving represents the shallow thread used for ivory, hard wood, or cast iron, and is flattened off at the top much more than is the deep thread used upon the steel mandrel-nose; but the measurements of lathe-noses (see table) show that, in other respects, it represents very fairly Mr. J. J. Holtzapffel's notion of an ideal screw-nose. Against that ideal for a screw-nose of any sort—wood, ivory, or metal—I beg leave to enter a protest. Mr. Holtzapffel's engraving (fig. 512) of his model screw-nose has the following dimensions in "mils." (thousandths of an inch):—Length, 870 mils.; diameter, outside thread, 770 mils.; diameter, at bottom of thread, 570 mils.; diameter in groove at base of nose, 470 mils.—*i.e.*, the base of the screw-nose is grooved out to a diameter ·1in. less than that of the stem at bottom of thread, and ·2in. less than that of the screwed nose itself! The sectional areas of this model nose in square inches will be as follows:—Full cylinder of nose; diameter ·77in., area of its cross section, ·4657 square inch: threaded cylinder; diameter ·67in., area of cross section, ·3526 square inch: stem of nose at bottom of thread; diameter ·57in., area of cross section, ·2552 square inch: base of nose as grooved out; diameter, ·47in.; area of cross section, ·1735 square inch. Mr. Holtzapffel's model, therefore, is so constructed that, whereas the screw-nose itself has a sectional area of ·3526 square inch, its base—the place where all the strain is concentrated—has a sectional area of ·1735 square inch, or less than half as much. This represents the character of the sacrifice made by thus grooving out the base of a screw-nose. Were this nose tubulated, the disparity would be greater.

If from the table we calculate the sectional areas of the steel mandrel-noses, No. 1 gives the following results:—

Section of full cylinder, ·486 square inch; section of nose through groove at base, ·314 square inch; area of central bore, ·063 square inch. The continuity of this nose therefore depends upon a cross section of ·251in., one quarter of a square inch, or the area of a square prism whose side measures half an inch. Where the steel is of fine quality, perfectly homogeneous, *and left in fine condition in the finished mandrel*, as is generally accomplished with great success by Holtzapffel and Co., this area suffices to resist the torsional and disruptive strain of ornamental turning. But that ruinous fractures occur is a fact beyond question. Is it sound construction thus to weaken the nose at its base? When an amateur invests hundreds of pounds in a scientific lathe, why should his apparatus be built up upon such a foundation that moderately heavy amateur metal-turning should be excluded from his range of work? Again, as an educational influence, the form of the mandrel is a continual teacher either for good or for evil, and we want not only scientific method in the design and arrangement of the lathe apparatus, but we also want a sort of Greek ideal in the mechanical form of our tools—not an ideal such as that which is set up before us in fig. 512.

Excluding the carefully gauged lathes of Kennan, it appears that our ornamental mandrels have been finished to just such size as the material held up to; that the chucks were fitted upon their own mandrel by the mere method of trial, and then turned up in their places. And it is pretty well known that on these mandrels a chuck with delicate work on it will often not return accurately to its place if removed from the mandrel before the work is finished. Considering that the screwed bolt has long been superseded by the plain cylinder in keeping the back-centre mandrel true, it is remarkable that ornamental lathe makers have continued to rely upon a screwed mandrel-nose for centring the chuck. Without a proper cylinder on the mandrel-nose, chucks can neither be made interchangeable, nor can they be relied upon even to return accurately upon their own mandrel in consecutive fixings. It is therefore obvious that the existing methods of manufacture have not demonstrated that it is impracticable to make our mandrels interchangeable. As the introduction of interchangeable mandrels would be a vast advance in the manufacture of geometric lathe apparatus, the subject is so well entitled to the consideration of the members of the Amateur Mechanical Society, that I venture now to submit the following suggestions upon the construction of a standard mandrel:—

I. The face of the mandrel to be made much larger than at present, with a view to minimise the tendency to angular variation in the setting of the chucks.

II. The base of the mandrel-nose to be a true cylinder, palpably larger than the outside of the thread, and to which the first part of the chuck-bore will be accurately gauged, so as to minimise the tendency to excentric variation in the position of the chucks.

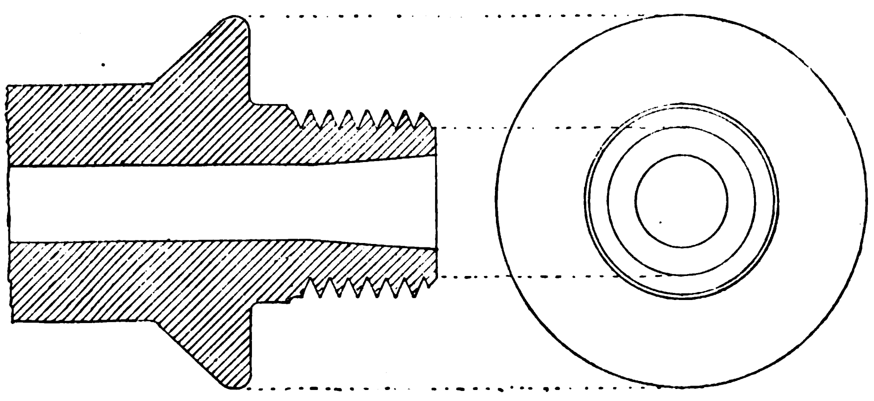
III. The face and nose of the mandrel to be finished as hard as may be without risk of chipping or fracture, so as to secure permanent exactitude in the form of those surfaces upon which the fit of the chuck depends.

IV. The mandrel to be drilled throughout, and its bore to be finished truly and accurately like that of a rifle, with a view to carry slender rods, wires, etc., through from behind without unshipping anything.

V. The mandrel-nose to be coned out in front to receive centres, and small chucks for delicate work, after the manner of a watch lathe.

VI. The nose of the mandrel to be screwed with the thread I have described, and at the rate of ten threads to the inch.

Having made many experimental models for an improved mandrel on the above principles, I should adopt the following dimensions. In all cases the dimensions should err rather on the side of extra



Section and End View of Proposed Standard Mandrel.

strength and rigidity. (See accompanying illustration.)

1. The nose of the mandrel to extend one inch from the plane of its face, and its diameter outside the thread to be one inch.

2. The base of the nose to be a true cylinder, extending ·2in. from the plane of the face, and 1·05in. in diameter. Its surface to be continued into the face and nose by minute quarter-round curves, so as to leave no sharp internal angles to weaken the base of the nose.

3. The face to extend ·4in. radially around the base of the nose, giving a true face 1·85in. in diameter, and to be continued by a quarter-round curve into the outside of the shoulder, so as to protect the edge of the face.

4. The shoulder to be 2in. in diameter outside measurement.

5. The bore to be ·4in. in diameter.

6. The front cone to be turned out at 5° from the lathe axis, so as to leave the base of the hollow cone ·5in. in diameter.

7. The nose to be threaded out by means of a revolving cutter full up to the edge of the cylinder base, but so as not to encroach upon its margin. The thread at the end of the nose to be turned off at 45° from the lathe axis, but so as to leave the stem of the nose intact and square at the end. The inner edge of the end of the stem to be turned out at 30° from the lathe axis, just so far as to protect the edge of the inner cone.

8. The nose to be tempered down to blue, and the mandrel-face at its periphery down to straw colour. The face, the cylinder base, and the thread to be finished off with emery or diamond dust glazers, so as to leave the surfaces true and accurately gauged. The surfaces and the interior of the cone must run dead true. When carefully tested by means of a candle-flame in a dark room, the image reflected from each surface into the eye should appear as if reflected from a fixed mirror, while the mandrel is revolving in its collar at various rates. The screw should be well fitted, but so easy as to allow the cylinder and mandrel-face to determine the seat of the chuck.

9. In making interchangeable chucks, a base 2in. in diameter may be surfaced up, and a true hole fully ·816in. in diameter be drilled out so far as to leave a clear 1·1in. in depth in the finished chuck. The chuck-hole should then be enlarged to 1·002in. in diameter for a depth of ·25in., and the first half of this quarter-inch be further enlarged to 1.015in. The cutter being now set—as for the nose-screw, but for cutting the internal thread—so that its top does not mark the 1.015 portion but does groove the 1·002 portion, the chuck-hole may be fully threaded out for an inch from the base and, if the cutter has been accurately shaped and set, the thread will be found cut nearly up to an edge, as with the external thread upon the mandrel-nose. In fact the threads will be counter-parts of each other with ·001in. play between their surfaces. The first quarter inch must now be finally finished out to 1·050in. in diameter, so as to fit solidly upon a gauge for the cylinder base. The edge of the hole must be slightly rounded out, so that the chuck may engage upon the cylinder base without abrading its edge, and may allow space for its minutely rounded junction with the mandrel face. The first part of the chuck-thread must be cut off, so as to leave vacant about half a turn of the groove at the base of the nose, and the chuck-face rounded off outside like the mandrel face, so as to protect its edge from bruising. Between the nose and the chucks thus constructed there will be six full threads to engage with each other, besides proper vacancies at each end of the thread for all such casual dirt as should be possible.

It is upon the truth of the wide face and of the cylinder that accurate consecutive fittings of the chuck upon its mandrel will depend as well as the interchangeability of the model mandrels. To secure permanent exactitude, and to enable the thread of the nose to resist injury, these surfaces should be left as hard as may safely be done. An ornamental mandrel is spoiled as effectually by the bending of its nose as by its fracture, and with scientific means the tempering may be accurately graduated, so as not only to leave the surfaces extremely enduring, but also the substance even stronger than if left soft.

The screw thread is merely a means of holding the chuck in its place, and for this purpose a Whitworth or any other thread will answer the purpose equally well. But if valuable chucks are to be exchangeable, the model mandrel nose must have a standard thread. The deep angular V thread which I have described is intrinsically the simpler, better, and more durable thread. Ten threads to the inch is the pitch already adopted for the slide-rest screws, and recommended for the back-centre screws.

With work unsupported by the back centre, it will be important not to allow the internal chucks to vibrate or revolve so as to deteriorate the truth of the cone. To prevent this, such chucks may be held in place by a cap chuck screwed on outside the nose. (See illustration on page 160 "Amateur Mechanics.") By this, all chucks whose base is not larger than the stem of the mandrel-nose may be solidly fixed, while those of larger size may be held by steady pins, or bayonet catches, between the back of the internal chuck base and the top or exterior of the cap chuck. The half turn of a double screw-thread might be made to answer perfectly in fixing these small chucks.

The mandrel-nose thus proposed as the basis for the costly apparatus of our geometric lathes has a face, a cylinder base, a nose, a thread, and an inner cone, each accurately defined at all points. Anything under ·4in. in diameter may be passed in from behind without unshipping anything. Its coned mouth receives all the centres, as well as any number of minute chucks for watchwork, delicate pieces of ivory, etc. The cylinder base might be gauged to within $\frac{1}{20000}$ of an inch, and would then reduce the excentric variations of properly gauged-chucks to within $\frac{1}{100000}$ of an inch; the large true face will practically abolish angular variations. In short, we should get a mandrel which, with foreign chucks made upon the same data, would interchange more accurately than the finest existing ornamental mandrel will fit its own chucks at consecutive fixings.

The model mandrels which were shown at the meeting of the Society of Arts, were made as follows:—Turn up, bore out, and finish very carefully a blank to the following dimensions:—Bore ·3in.; shoulder 2in. in diameter and ·4in. thick; face 1·85in. in diameter; face to flow into shoulder by a quarter-round surface to protect its edge from being bruised and the set of the chucks being interfered with; nose 1·6in. in length and 1·05in. in diameter: surface of nose to flow into that of face by a minute quarter-round curve, so that no sharp re-entering angle is left to weaken the base of the nose. The material having been brought into approximate shape, carefully enlarge the bore to ·375in., and then mark off the blank nose into five portions by delicate lines which will not interfere with the finished work. Counting these portions in order from the finished face of the mandrel, make the first portion ·2in. long, the second ·8in. long, and the third, fourth, and fifth, each ·2in. long. Now, leaving part No. 1 to form the cylinder-base of the finished nose; turn down part No. 2 exactly to 1in. in diameter, and join it to part No. 1 by a minute quarter-round curve like that by which the cylinder-base has already been continued out of the face. Now turn down part No. 3 to 1·0145in.; part No. 4 to ·8145in.; part No. 5 to ·8in. These dimensions may be verified by vernier callipers to within a fraction of a thousandth of an inch. By Whitworth gauges they may, in refined workshop practice, be verified to $\frac{1}{20000}$ of an inch.

It will now be seen that the end portion, ·8in. in diameter, represents the tubulated stem which is to be left intact in cutting the screw. The next portion, ·8145in. in diameter, represents the stem plus a radial addition, which is equal to the amount to be truncated from the full triangular thread of 50°, and which therefore measures the full amount to which the point of the cutter may be flattened down. The third portion, 1·0145in. in diameter, represents the cylinder upon which the full triangular thread of 50° might be cut, in order, after subsequently truncating ·00723in., to leave a screwed nose exactly 1in. in diameter. The second portion—exactly 1in. in diameter—is the cylinder upon which the thread is to be cut up short of the ·00723in., so as to leave the finished surface of the cylinder to form the flattened tops of the thread, instead of having to truncate them after they are cut.

The thread of the nose is now to be cut. The cutter—accurately ground to an angular point of 50°, its edge relieved, and its point rounded off or flattened down to any extent that may be chosen, less than a truncation of ·00723in.—is to be centred in the slide-rest with its cutting-face set to the pitch of the thread. The traversing slide being adjusted exactly parallel to the lathe-axis, the cutter is brought up by handing round the mandrel pulley, and is put into cut so far that its point—while running free of the stem portion of the nose—will groove portion No. 4 much or little, according to whether the point has been truncated little or much. By handing round the mandrel-pulley very slowly so as to give an extremely fine feed, the revolving cutter is now traversed up till it reaches the shoulder of the cylinder-base, and then—the mandrel being stopped—the cutter is withdrawn without being allowed to encroach upon the margin of the cylinder base. The blank nose has now been threaded, and, if it be examined with a lens, part No. 5, representing the stem, will be found remaining intact; part No. 4 will be found grooved with a spiral line; part No. 3 is cut actually up to a razor edge; part No. 2 is cut up to a beautiful flat-topped thread, which runs full up into the curve at the end of the cylinder-base, but leaves the edge of the cylinder intact.

The change-wheels being now disconnected, a sharp ·4in. D-bit is carefully centred and used to enlarge the bore to its final dimensions; the surplus portions, which have served as gauges by which to finish and accurately thread the permanent nose, are turned off so as to leave the nose extending exactly 1in. from the face; the bore is coned out by a tool at 5° from the lathe-axis, and its edge turned down to a narrow band so as to take a centre of 60°; the base of the hollow cone to be left ·5in. in diameter, and the end of the thread to be turned off at an angle of 45° from the lathe-axis, but so as to leave the outside of the stem intact.

A fixed tool must be set rigidly on a level with the lathe-axis in order that the axis of its face may enter radially, but a revolving cutter always gives a true counterpart of its cutting-face. The properties of parallelograms upon the same base and between the same parallels show how the angle of the cut will be narrowed as the pitch of the thread increases, and, to avoid this, the cutter must be set over to the pitch of the thread so that its face be kept normal to the track of the cut.

I have found the making of these model mandrels one of the most interesting and beautiful exercises in geometric turning. The exactitude of the results depends practically only upon the angular truth of the cutter, and the accurate callipering of the diameters upon the blank nose. If any one interested in this subject will favour me with a call any morning before one o'clock, at 8, Grafton Street, Bond Street, I shall have much pleasure in showing the very simple arrangements, and the extremely accurate results, which are obtainable by the method which I have attempted to describe.

Upon this subject I have written unflinchingly; but, I hope, within the lines of academic debate. I have previously recognised the splendid quality of the appliances manufactured by Messrs. Holtzapffel & Co., and to Mr. J. J. Holtzapffel I am indebted for kindness and courtesy on many occasions. But appeals upon this subject have been treated as attacks upon a piece of property rather than as efforts to obliterate a survival of pre-scientific methods. In order to defend a pecuniary interest in obstruction, a policy of passive resistance was adopted, and this obliged me to ask the Council to consider the question with a view to formulate a collective judgment. Probably no member of the Society, had he to furnish his workshop anew, would order anything but apparatus constructed with screws of aliquot rate. If this be so, the fact should be put upon record in the Society's Journal for the information of amateurs who may need to equip themselves with tools before they are prepared to form a judgment for themselves.

In a standard mandrel other dimensions than those which I have suggested may be preferable. I contend (concludes Dr. Edmunds) only for three things: 1. A screw-thread of scientific form properly defined.

2. A set of aliquot screw-rates such as may be originated with simple change-wheels. 3. A standard mandrel, such as does not exclude the possibility of making our chucks interchangeable.

[In our first issue, page 17, will be found some valuable memoranda on ornamental lathe screws, which readers interested in the subject will find instructive. The importance of the point at issue is not to be lightly estimated, and we shall be glad to see it freely discussed.—Ed. "A. M."]

METAL CASTING.

PART II.

The Moulder's Necessities — Furnace v. *Fireplace — Crucibles—Flasks (or Moulds) and Boards—Clamp Screw—Sand—How to Mould a Plain Article—Knife, Fork and Spoon.*

AFTER having been led further than I intended in my last article, by my remarks on the antiquity and possible origin of casting, I will endeavour in this to redeem my promise as to the methods of casting.

One of the first necessities is a furnace. Furnaces, it is almost needless to say, are constructed of different sizes to suit the different requirements of various foundries.

The amateur will, of course, not have the use of a furnace at command, consequently the kitchen fire will be his best substitute; but in this he will, most likely, be unable to melt the harder metals—iron, brass, etc.—but zinc, tin or lead, and others of a like soft nature will be easily fusible in an ordinary fire.

The second desideratum is a crucible, or melting pot. Crucibles are of various forms for various purposes, those used for melting iron, brass and gold, being all of different shapes. Fig. 1 will give their forms.

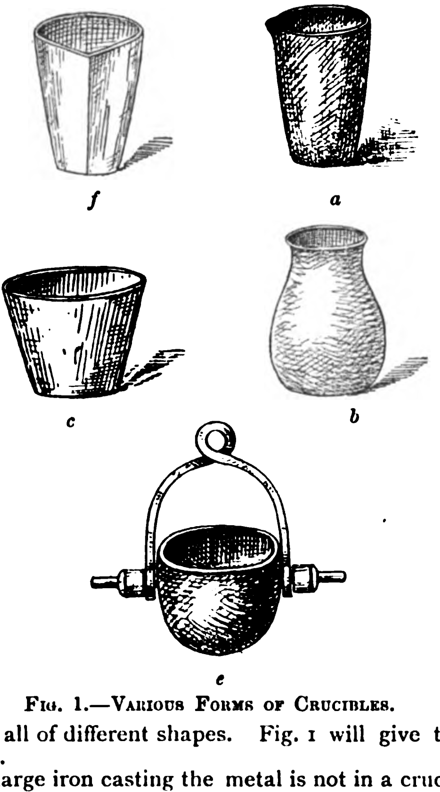


Fig. 1.—Various Forms of Crucibles.

In large iron casting the metal is not in a crucible at all, but thrown into the furnace, and at the proper time a clay-plugged hole at the bottom of it is opened and the molten metal caught in a pot, like fig. 2, and carried by two men to the moulds.

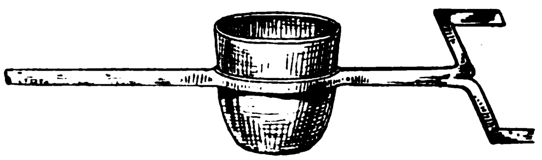


Fig. 2.—Iron Founder's Pot.

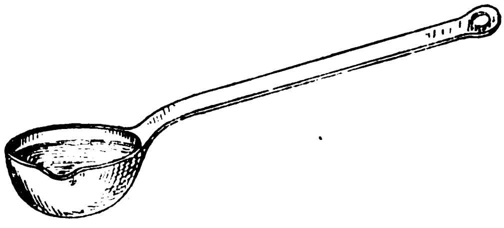


Fig. 3.—Iron Ladle.

The ordinary ladle, which is familiar to all (as shown at fig. 3), will answer for the amateur. The crucible, *a*, can be obtained in sizes capable of containing from two or three pounds to upwards of sixty pounds of metal. The shapes *b* and *f* are mostly used for gold.

The third necessity is a mould. Moulds are similar in shape for all kinds of metal, although slight variations are observable in those used for different materials. Fig. 4 gives us a mould, or flask, or box as it is variously termed.

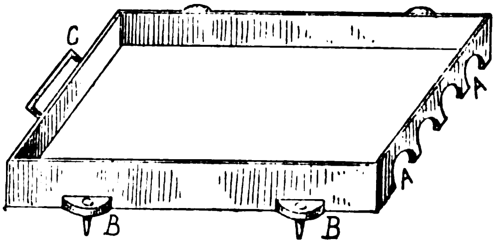


Fig. 4—A Flask or Mould.

The hollows *a* are the holes through which the metal is poured, it being understood the drawing represents half of the mould, the companion side having holes through the lugs *b*, to take the pins represented in the above sketch. There should be a slight groove around the interior of the box, to assist in the retention of the sand when rammed into it. *c* is a handle, by means of which, and by inserting his fingers in the holes *a* at the other end, the workman is enabled to lift one "side" of the flask from the other. The pins projecting from the lugs *b* are tapered to fit into the holes in the opposite side, firmly and evenly, and long enough to admit of the flask being lifted or replaced steadily, and without shifting or touching the pattern.

For round casting a round mould is often used, as it minimises the weight, doing away with unnecessary corners, which being filled with heavy sand would render the mould very unwieldy in the case of small work. Where large castings are being moulded a crane is generally used to lift the flasks about, and a trifle of extra weight is of no great moment.

The moulds are enclosed on the open top and bottom with thick boards, and when placed together ready for having the metal poured in, are in some cases fastened with a hook and eye which are fixed in the sides of the mould, but mostly held together with a clasp or clamp, denominated a "screw."

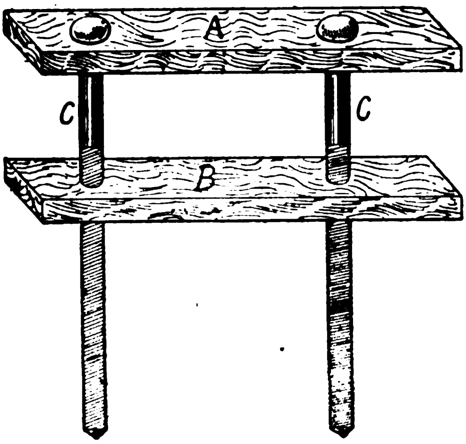
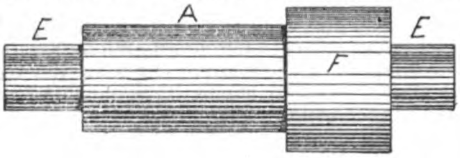


Fig. 5.—Clamp for Mould.

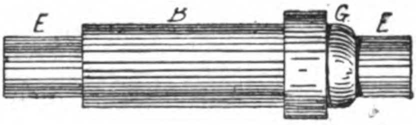
The mould with its top and bottom boards is slipped between the straight pieces of wood *a* and *b*, the nuts are run down the screws *c c* until they press tightly upon *b*, and so hold the flask together and prevent the introduction of the molten metal causing it to burst, and consequent egress of the fluid. The screws *c c* and nuts, fig. 6, are generally of metal, as the worms last longer than if they were simply of wood. The flasks are made of wood or iron.

Fig. 6.—Nut for Clamp.

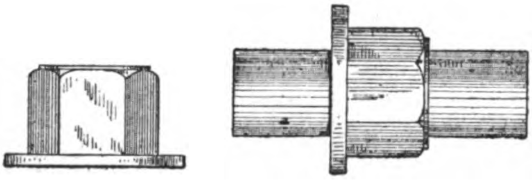
It is in sand that most castings are made. Plaster of Paris is used, as also are loam, and cut, carved, or engraved metal moulds. But to sand the caster looks for his best moulding material. Sand does not melt—a very desirable quality in casting, for if it were to be melted on coming into contact with the boiling metal it would, of course, be entirely useless. Moulding sand of the best quality was, at one time, taken from the pits at Hampstead, but they having become exhausted, or the Board having decided that taking sand from them spoilt the place, the sandboy has of late been less jolly than he was proverbially wont to be. The best moulding sand is now taken from the banks of large rivers. To discover if the sand is really good for the purpose, take up a handful, squeeze it, and if it remain in ball shape it is generally to be depended on. If it be of a fine quality it will not stick to the hand, and will take impressions of the skin, every line being clear and well defined. The sand is used over and over again, and, as it becomes weaker, is revived by the addition of a small quantity of finely pounded loam.



a.—Lump End.



b.—Lining.



c.—The Nut. *d*.—Complete Union.

Fig. 7.—Casting an Engine Union.

The moulding of a plain piece of work, technically called a "common" casting, say of an engine union, consisting of three pieces, is a comparatively simple matter. *a* is called the "lump end," *b* the "lining," *c* the "nut," *d* the complete union. The projections *e* are called "corestays," about which I shall have more to say later. *f* is screwed to fit into the nut *c*, and the part *g* is ground (steam tight) into the lump *f*, and passes through the nut at a hole. The production of a flat object, such as a wheel (fig. 8) is simplicity itself.

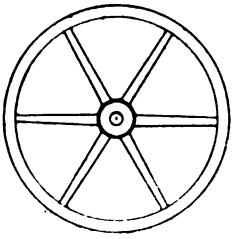


Fig. 8.—A Wheel.

To mould the latter, it is placed flattest side downwards, upon one of the boards before alluded to, slightly sprinkled with red brick dust through a coarse canvas bag, the pattern having been previously prepared according to the directions given on page 204, Part VII., Vol. 1. of this journal, under the head of "Varnish for Foundry Patterns;" the flask (fig. 4) without the pins is placed over it, a thin layer of stronger sand (strengthened with loam) sifted evenly over it and pressed into all its crannies, then the ordinary sand is thoroughly rammed into the mould. When filled, it is scraped flat with an iron bar kept for the purpose, a sprinkling of sand thrown over that, a board pressed evenly on it, and the two boards, with the mould between them, turned over; the board that previously formed the bottom, now being on the top, is taken off, revealing the reverse side of the pattern now half moulded. Any little irregularities that may exist, perhaps caused by the board upon which it has been rammed not being quite smooth, is now removed by means of a knife in shape something like the elongated blade of an oyster knife—a trifle more pliable—and with no handle (it can be easily fashioned from a clock spring). Some more red brick dust is shaken over it through the coarse canvas bag, holding say about three pints of pounded brick. Sometimes, in an ironfoundry, "parting-sand" is what is used. The companion "side" to the flask is now placed upon the one already full, and, after a thin layer of the stronger sand has been sifted on, it is filled and rammed as the other has been; a board is placed on it as before, and the double or complete mould turned over, a smart rapping is administered to the *now* top board with a wooden mallet, the fingers of the right hand are inserted in the holes, *a*, fig. 4, the left hand takes the handle, *c*, and the top side is gently lifted. The rapping with the mallet having loosened the pattern, it is now lying on the bottom side, whence it is easily lifted with the fingers. It is now necessary to make a channel through which the metal shall run into the impression left for it. This is done with a spoon—indeed, casting needs mostly the same as a boy at a boarding school used, "a knife, fork, and spoon." The use of the fork will be described in a subsequent article. The spoon scrapes a groove in the top and bottom sides from the impression to the holes, *a*, fig. 4; this is smoothed with the finger. A dusting of pea flour is now shaken over both sides — through another canvas bag — and the two sides joined together, placed in the clamp (fig. 5) as described, and the metal poured in.

I have already exceeded my limits, and in my next article I hope to be able to give further details. At any rate, this one article will, I think, teach any amateur enough to produce a "casting," if nothing more.

CASE-HARDENING IRON.

IRON may have a steel-like surface imparted to it by the process known as case-hardening. After going through the process the iron articles may often serve the purpose of steel. Articles to be case-hardened should be heated to redness, and then sprinkled with a little yellow prussiate of potash, and heated again. The heat decomposes the prussiate of potash, and the liberated carbon combining with the iron forms a coat of steel upon the surface. The article must then be plunged into cold water, and suddenly cooled. If the article be large, it is better to place it under a large tap, where a good succession of water will fall. The thickness of the hardened coating will be very slight. If a greater thickness be desired this process must be repeated. The process of case-hardening iron has been often described, but we now give full instructions for the special enlightenment of amateur mechanics. Any articles, if of good iron, can be hardened to equal steel, but the hardening only penetrates skin deep. There is no occasion to temper the iron at all after case-hardening, and parts of the objects can be operated on, only leaving the other parts in their normal condition. An ordinary fire will furnish all the heat requisite. In the first place, provide yourself with sufficient of the hardening compound, made as follows:—Take equal parts of prussiate of potash, sal ammoniac, and common salt; pulverise and thoroughly mix. The process of case-hardening iron is conducted as follows:—First make the iron hot, and spread the compound over that part to be made hard; again put the iron in the fire, and fuse the powder, allowing it to run all over the parts to be operated on. Up to this stage the metal should only be heated to a moderate extent, say, just bordering on red heat; the compound may be applied several times; the more put on, to a certain extent, the deeper will be the hardening; this is a detail which practice alone will enable you to determine. Having thoroughly melted a quantity of the powder on the iron and allowed it to soak in at a dull red heat, raise the temperature to that required for hardening steel, a full blood red, and quench the article in cold water. The surface which has been operated on by the hardening powder will now be as hard as hardened steel, whilst that part which has had no powder applied to it will be as soft as ever. This is the most simple process, and will be found very easy to perform; prussiate of potash only will effect the hardening, but the compound is better. A little practice will enable you to judge the exact quantity of powder requisite to produce the desired effect.

Exposing the iron to a red heat, for some hours, surrounded by leather cuttings or the parings of hoofs and horns, the whole being placed in a metal box of some kind, will likewise make the surface of the iron susceptible of being hardened on being cooled in cold water when at a red heat. The usual method of carrying out this last process is as follows:—Get a small sheet-iron box, according in size to the quantity and size of the object to be hardened, pulverise a sufficient quantity of bones into dust, and pack the iron in the bone dust. Place the box, when packed with objects and dust, in the fire of an ordinary smithy, and gradually get the whole to a cherry-red heat throughout. When all is of an uniform heat, plunge into cold water, and the iron will receive a coating of steel from the carbon of the bones. This latter process is comparatively so long and tedious that it is scarcely likely to be employed by an amateur in preference to the one first described. However, the second finds favour amongst large manufacturers, and is said to be more efficacious in producing a deeper and more uniform hardened skin. For all the purposes required in amateur's work, the prussiate of potash will answer to all intents equally well, and few amateurs would care to spend hours—from six to twenty-four—in giving the furnace and contents the requisite attention whilst carrying out the animal refuse process.

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Working and Polishing Ivory.—As a material to be worked by the mechanic, ivory stands midway between wood and brass, and is turned and cut by tools having more obtuse angles than those employed for wood, and yet sharper than those used for brass. It may be driven at a fair speed in the lathe, and is easily sawed by any saw having fine teeth. The tools used for cutting and turning ivory should have their edges very finely finished on an oilstone so that they may cut smoothly and cleanly. Turned works with plain surfaces may in general be left so smooth from the tool as to require but *very little polishing*, a point always aimed at with superior workmen by the employment of sharp tools. In the polishing of turned works very fine glass paper or emery paper is first used, and it is rendered still finer and smoother by rubbing two pieces together face to face; secondly, whiting and water as thick as cream is then applied on wash leather, linen, or cotton rag, which should be thin that the fingers may the more readily feel and avoid the keen fillets and edges of the ivory work, that would be rounded by excessive polishing; thirdly, the work is washed with clean water, applied by the same or another rag; fourthly, it is rubbed with a clean, dry cloth until all the moisture is absorbed, and, lastly, a very minute quantity of oil or tallow is put on the rag to give a gloss Scarcely any of the oil remains behind, and the apprehension of its being absorbed by the ivory and disposing it to turn yellow may be discarded; indeed, the quantity of oil used is quite insignificant, and its main purpose is to keep the surface of the ivory slightly lubricated, so that the rag may not hang to it and wear it into rings or groovy marks. Putty powder is sometimes used for polishing ivory work, but it is more expensive and scarcely better suited than whiting, which is sufficiently hard for the purpose. The polishing of irregular surfaces is generally done with a moderately hard nail brush, supplied with whiting and water, and lightly applied in all directions, to penetrate every interstice; after a period the work is brushed with plain water and a clean brush, to remove every vestige of the whiting. The ivory is dried by wiping and pressing it with a clean linen or cotton rag, and is afterwards allowed to dry in the air, or at a good distance from the fire; when dry a gloss is given with a clean brush on which a minute drop of oil is first applied. It is better to do too little polishing at first, so as to need a repetition of the process, rather than by injudicious activity to round and obliterate all the delicate points and edges of the works, upon the preservation of which their beauty mainly depends.

STEAM MACHINERY, AND THE METHODS OF OBTAINING THE PROPORTIONS OF THE SLIDE VALVE GEAR.

BY A. A. DORRINGTON.

PART I.

I. HOW STEAM PRODUCES MECHANICAL MOTION.

THE appliance by which steam accomplishes motion is almost always a piston moving in a cylinder. The piston is a solid plug fitting the cylinder tight enough to prevent steam passing from one side to the other. The ends of the cylinder are closed by means of covers, and fitted so that steam cannot escape at the joints. At each end of the cylinder apertures or ports are provided by which the steam is admitted and escapes. It will be easily understood that if steam be admitted at one side of the piston it will be blown to the other end of the cylinder, and if steam be admitted on the other side (the steam admitted previously being allowed to escape) the piston will be blown back again, so that, if we have an arrangement for admitting the steam alternately at each end of the cylinder, the piston will be blown backwards and forwards from end to end. Thus we see that the primary motion produced by steam is an alternate motion backwards and forwards, and by a number of well-known mechanical contrivances this alternate motion can be made to produce any other motion that may be desired.

II. HOW THE ENGINE IS WORKED.

Fig. 1, in which *A* is the cylinder, *B* the piston, *C* steam chest, *D* slide valve, *a*, *a* steam ports, *b* exhaust port, *E* piston rod, *F* connecting rod, and *G* crank. Suppose the slide valve to be in the position as shown in the figure, the steam will be rushing into the cylinder through the left port *a*, and forcing the piston forward in the direction of the arrow, while the steam previously admitted on the other side of the piston will be exhausting into the exhaust port *b*, and, on the piston arriving at the top of its stroke, the valve will have moved back to the other end of the steam chest, covering the bottom port and opening the top. There are several kinds of slide valves, but the one in the figure is the form generally used. In making a slide valve it is most important that the length of the valve should be at least sufficient to close both the steam ports at the time of changing the admission of steam, in order that the steam may not enter at both ends of the cylinder at once, and that it may release the steam at one end of the cylinder as soon as it is admitted at the other end. The motion of a slide valve is attained by means of an eccentric, and is precisely, on a smaller scale, what the motion of the piston is on a larger, as the eccentric is simply a crank of a small radius.

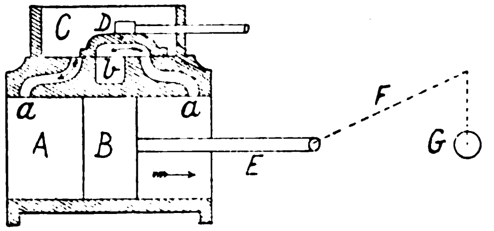

FIG. 1.—Section of Engine Cylinder.

III. POWER AND WORK.

The primary question in designing a steam engine has reference to the power required to accomplish a given amount of work in a given time. The meaning of the word work, in a mathematical sense, is the continuous overcoming of a resistance, and the quantity of work is the product of that resistance into the space travelled over. The English unit of work is the power necessary to raise a weight of one pound through a space of one foot. Thus the amount of work expended in raising a weight of 500lbs. 10ft. high = 5,000lbs. The quantity of work performed by the steam in the cylinder of a steam engine equals the mean effective pressure on the piston multiplied by the space passed over in a given time. Suppose the area of a piston is 1,000 square inches, and that the effective pressure on each square inch is 50lbs., then the total pressure = 1,000 X 50 = 50,000lbs., and if the crank makes 30 revolutions per minute, and stroke of piston to be 3 feet, the speed of the piston will equal 3 X 2 X 30 = 180 feet per minute, hence the quantity of work = 50,000 X 180 = 900,000 ft. lbs., and this, divided by 33,000, gives the horse-power. The term horse-power is a force capable of lifting 33,000lbs. weight one foot high in one minute. It has three denominations, viz., nominal, indicated and actual. Nominal horse-power is used particularly for commercial purposes; each maker has his private rule, hence the difference in opinion and dimensions of the same class and power. Indicated horse-power is the total unbalanced power of an engine employed in overcoming the combined resistances of friction and load. The actual or net horse-power is the total available power of an engine, hence it equals the indicated horse-power less an amount expended in overcoming the friction.

IV. ON PROPORTIONING THE CYLINDER (AREA OF THE STEAM PORT).

This dimension may be called the principal one of the engine; its value depends greatly upon the manner in which the port is employed, whether simply for admitting the steam to the cylinder, or for admission and release. In cases of admission it is evident that the pressure will be sustained at a constant quantity by the flow of steam from the boiler, but, in cases of exhaust, only a limited quantity of steam forced by a constant diminishing pressure into the atmosphere with less and less velocity. Very good results have been obtained by making the area of the port ·04 that of the piston, and a steam pipe area of ·025 of piston, when the piston speed does not exceed 200 revolutions per minute. For marine purposes the width of steam port is made equal to half the diameter of cylinder, depth $\frac{1}{6}$ of width, exhaust depth $\frac{1}{3}$ to $\frac{1}{4}$ of width, or the area of steam port = $\frac{1}{20}$ area of cylinder. The area of steam port commonly given in the best marine engines, working at a moderate speed, is about one square inch per nominal horse-power. For direct-acting screw engines $\frac{1}{16}$ area of cylinder. A very good formula for the steam and exhaust ports of high pressure engines is—length of port = ·7 diameter of cylinder, area = ·057 area of cylinder, width of exhaust = 1½ times width of steam port. In the moulding of a cylinder the cores for the steam and exhaust ports should be faced with great care, in order to secure smooth surfaces, so that the steam will flow with perfect freedom.

V. TO DETERMINE THE DIAMETER OF PISTON.

The rule is—multiply the power required by 33,000 and divide the product by the speed of piston in feet per minute multiplied by the mean available pressure.

Suppose we require to find the diameter of a cylinder for a 20 indicated horse-power engine, the steam pressure to be 60lbs. per square inch, and piston speed 200 feet per minute, then 33,000 X 20 = 660,000, and 60 X 200 = 12,000; hence, 660,000 divided by 12,000 = 55in. area of piston, which gives the diameter of piston to be 8½in. The stroke of the piston should be from 2 to 3 times the diameter of cylinder. The depth of piston for high-pressure engines will be found by multiplying the diameter of cylinder by ·25, but for marine purposes the depth is usually ⅕ to ⅙ the cylinder's diameter. The piston for all horizontal engines should be strong and light in construction, fitted with a packing ring, or two packing rings for pistons of large diameter. A simple form of piston is a plain casting, recessed for light steel springs, and is much used for small pistons, although, when the piston is supported by means of the piston rod passing through each end of the cylinder, it works well for cylinders of large diameter.

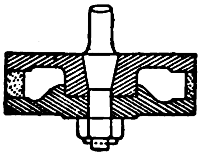

Fig. 2.—Section of Piston.

A simple and good piston is shown in fig. 2, and is suitable for cylinders up to 12in. in diameter. The rod where it enters the piston is made a little larger in diameter than the working part, and is tapered 1½in. to the foot, and secured by means of a nut, which should be locked with a D pin. The packing rings are of cast iron, and should be turned about 1/16in. larger than the cylinder up to 5in. diameter, 3/32in. up to 8in., and ⅛in. up to 12in. diameter. These rings should be made thicker on one side than the other, and cut on the thin side, which causes the ring to bear equally round the cylinder.

There are many styles of pistons, but the one just mentioned, or the block piston with three steel springs, are about the simplest for small engines and work well. The diameter of the piston rod is found by multiplying the diameter of the cylinder by ·15 or 1/10 diameter of cylinder for condensing engines, and ⅙ to ⅐ for high-pressure engines.

The following table of cylinders is from actual practice, the stroke of the piston being twice the diameter:—

Diameter of Cylinder. *inches.*	Thickness of Metal.	Size of Steam Port.	Size of Exhaust Port.	Depth of Piston.	Diameter of Piston Rod.	Diameter of Valve Spindle.
2½	5/16	¼ x 1	7/16 x 1	1	½	⅜
3	5/16	5/16 x 1¼	½ x 1¼	1¼	⅝	⅜
4	⅜	⅜ x 1½	⅝ x 1½	1½	¾	7/16
5	⅜	7/16 x 1⅞	¾ x 1⅞	1¾	⅞	7/16
6	9/16	9/16 x 2½	1 x 2½	2½	1¼	⅝
7	⅝	⅝ x 3	1 3/16 x 3	3	1⅜	¾
8	⅝ 1/32	¾ x 3½	1⅜ x 3½	3¼	1⅝	⅞
10	11/16	⅞ x 4½	1⅝ x 4½	3½	1¾	⅞
12	¾	1 x 5¼	1¾ x 5¼	3¾	2	1

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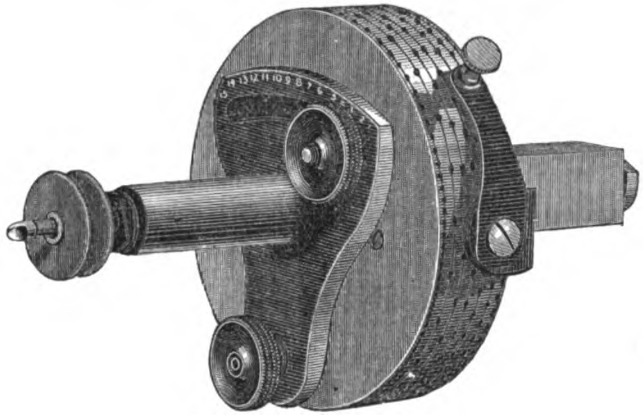
MACHINE FOR DOUBLE COUNTING ON THE CYLINDER.

THE enclosed photo. is of a machine for double counting on the cylinder. It has been sent to me by Mr. Jesse Lowe, with the request that I would photograph it for insertion in "Amateur Mechanics," in which journal, I may say, he has taken a lively interest from the commencement, and has always done the best in his power to further its success.

He has now arrived at that time of life when to undertake to write about even what has been to him a life's pleasurable study is found to be irksome; but it shows he has still a kindly feeling to the younger generation of amateur turners, and has set an example which might be followed by many under similar circumstances, not only with credit to themselves, but helping considerably to the success of "Amateur Mechanics." Not having used the machine under notice, I am not in a position to say much about its respective merits, so, necessarily, I shall confine myself to a description of the machine itself, but I have no doubt it will be readily understood from the engraving. It is so constructed as to suit his own peculiar lathe, which is only provided with one slide rest to answer for all purposes. The index plate has seven rows of divisions, containing 24, 28, 36, 48, 50, 72, and 120 holes respectively. The index pointer is attached by means of a brass bracket to the square stem which fits the tool post of slide-rest. Attached to the index plate is a round spindle, on one end of which is welded a flat disc; this disc is 2¼in. in diameter by 3/16in. thick; at the junction of the spindle with the disc is a short cone; the spindle is ½in. diameter and 4in. long; the end is screwed for a ⅜in. nut, and the spindle is reduced to the same diameter for about ⅜in. further, after allowing for thickness of the nut—the object of which will be explained shortly—on the tool post stem there is also a disc corresponding with the one on the spindle; this stem is bored right through, and coned on the disc end to fit the spindle just described. Before the nut is screwed on a short spiral spring is put on the reduced part of the spindle mentioned above—this is a favourite plan of Mr. Lowe's for mechanism of a similar nature as the one under discription, and is what he calls a spring-tight fit; it certainly gives a much freer action to the movement than would be the case if fitted solid up to the shoulders. I forgot to mention that the division plate is attached to the tool post spindle by means of six ¼in. set screws, which are screwed from the front of division plate, one of which is seen to the right hand of drill spindle plate. In fixing these screws care must be taken to see that none stand above the front of plate, or they will interfere with the working of the plate carrying the drill spindle. This plate is of a triangular shape, 7/32in. thick by 3½in. deep; from the centre of pivot stud to the centre of slot it is 2⅝in. Cast solid with this plate is a round boss 2⅛in. long by 1 1/16in. diameter, which is bored right through with



Machine for Double Counting on the Cylinder.

a ½in. hole. Secured to the plate end is a female hardened steel cone. The pulley end is enlarged, and screwed ⅝in. brass tube thread. Fitted to this screw is another female adjustable hardened steel cone, made a tight fit, with two sides filed flat, deep enough to allow a screw key to be used for adjusting the spindle, which is a straight piece of steel, coned at both ends. The end next to the driving pulley, of course, is extended to allow room for latter, and the necessary portion for attaching the drills.

The top of the triangular plate is made a true segment of a circle from the centre of lower stud; it is 2½in. across, and is divided into 15 equal parts. The drill spindle is concentric to the tool post spindle, as shown in the engraving; but by slacking out the two circular milled headed thumb screws, and bringing the drill spindle towards you, the amount of eccentricity obtained is in proportion to the number of divisions used.

The following is the maker's description of how to use the double counter:—

"Fix the counter in the rest so that the centre of cutter is the same height as the lathe centres, and if you want six loops to go round a cylinder or edge of a box, use a circle of holes on the counter that will divide any circle of holes on division plate of lathe; the 144 on the latter and 24 of tool will do this. To commence, set index pointer of lathe to the 144, and pointer of tool to 24, and take the first cut; now change a hole in each division plate, and cut again; and when you have gone once round the 144 circle the division plate of tool will have made six revolutions, and repeated the loops six times in going once round the cyclinder; or, suppose you want ten loops, take the 180 circle of holes and 18 on counter; the latter will then go 10 times round to the one revolution of the former; or, if the 24 circle in the counter was used, then it will have to make 2 revolutions to obtain 15 loops; but, in the latter case, the loops will have crossed one another."

In conclusion, I don't see why the machine should not be used with advantage on surface work. It sometimes happens, in ornamenting a surface, some very awkward spaces are left, which are often filled up by the use of the elliptical or epicycloidal cutting frames. In such cases the double counter could be substituted, as it could be brought to operate on any portion of the surface; and by using the division plate of counter a circle of beads or eccentric patterns could be obtained. The diameter of circle would depend on the amount of eccentricity given to drill spindle, so that circles within circles, or crossing each other, could be readily done, and with a judicious use of division plate of lathe and slide-rest some curious patterns, no doubt, would be obtained.

G. B. M.

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TO RESTORE A SILVER WATCH DIAL.

We proceed to describe several methods of doing this, but would at once observe that when the earlier ones are adopted, the hours, if they are painted, necessarily disappear. They can be retained by resorting to the third method, although great caution must in that case be taken; moreover, it is much more difficult to accomplish than the others.

First Method.—This is the most expeditious system, and at the same time the most certain of success. If the hours are in enamel, there need be no fear; if engraved and filled with black composition, this will disappear, but it can be replaced without difficulty. There remains the case of painted hours to be considered. First make thin marks with a fine point along the lines of all the figures, taking care not to pass beyond their ends, and do the same for the dots and lines that indicate the seconds. Begin by cleaning the dial with a brush and fine pumice-stone, so as to remove spots and slight scratches.

To Frost the Surface.—In order to frost the surface of the dial, take a spirit lamp with a large wick, and direct a blowpipe flame from it against the under side of the dial, which is held by one hand with a hooked support. If the flame is gently directed over the entire surface of the back, a good dead surface is obtained that resists a moderate degree of friction either in soaping with a fine sponge, or washing in a large quantity of water, or in applying soft bread and oil of lavender to erase irregularities or marks made in painting the figures. The application of the flame is several times repeated, so as to obtain a decisive and even frosting; but it is necessary, with a view to avoid distorting the thin metal, to place an iron or copper plate behind the dial. The flame oxidizes the surface of the metal; that is to say, it causes the oxygen of the air to combine with the copper which is alloyed with the silver.

Pickling or Bleaching the Dial.—Introduce sufficient warm water into a suitable flat vessel to completely cover the dial, and gently pour into it a few drops of sulphuric acid (oil of vitriol), so that the two liquids are in the proportion of about 1 to 10; then lay the dial in this dilute acid for a period that varies from half to one or two minutes. The frosting will first become yellow, and then of a beautiful white colour. Wash it in a large quantity of water, wipe with a fine linen rag, and apply the flame momentarily to the back, in order to prevent the formation of spots on the surface. When several dials have to be operated upon, the acid is put into a porcelain dish, and boiled by a lamp. Then place each dial for a moment in it, wash in an abundant supply of water, and dry with a fine linen rag.

Second Method.—For the benefit of such as care to experiment with it, we add the following method:—Brush the dial with a coarse brush, and pumice-stone reduced to an impalpable powder, until no scratches are visible. Make it red-hot, and allow to cool. Then dip, for two or three seconds, in a porcelain dish containing dilute sulphuric acid; on removal it will be found to be white, but rather dull. In order to produce a clear frosted surface, place the dial in a mixture of—

6 parts by weight of nitric acid of 1·22 sp. gr.*
21 „ „ sulphuric acid.
50 „ „ water.

Allow the metal to remain in this acid until no more globules are seen to form on its surface; then withdraw it, and immediately place in cold water. The dial will be observed to be nearly black; it is then pickled as above explained, washed well, heated red-hot, and, when cold, again pickled. The operation is concluded by thoroughly washing its surface.

Third Method.—Cover the surface of the dial with a thin layer of soap, and brush it over, taking care to avoid touching the hours, if these are not enamelled. This can best be done with a fine brush, and pumice-stone reduced to an impalpable powder. When the dial has been made as clean as possible by this means, wash it carefully with water and tartrate of potash (cream of tartar), then plunge it immediately in the hot solution of nitrate of silver, attaching it to the silver wire which is fastened to the zinc and copper discs; in two or three minutes the surface of the metal will be perfectly frosted, and, if each operation has been cautiously performed, the hours will remain intact. Each time the zinc and copper are used, they should be cleaned with nitric acid, and rubbed over with pumice-stone. As soon as the dial is clean, immerse it in the solution; the least delay is apt to cause the surface to become oxidized through contact with the air.

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A Cement To Fasten Handles.—A material for fastening knives and forks into their handles when they have become loosened by use is a much needed article. The best cement for this purpose consists of one pound of colophony (purchasable at the druggist's) and eight ounces of sulphur, which are to be melted together, and either kept in bars or reduced to powder. Two parts of the powder is to be mixed with one part of iron filings, fine sand or brick dust, and the cavity of the handle is then to be filled with this mixture. The tang of the knife or fork is then to be heated and inserted into the cavity, and when cold it will be found fixed in its place with great tenacity.

Gluing.—Use best Scotch glue; break it into small pieces, and put it into cold water to soak for 12 hours; put the pieces of soaked glue into the glue-pot, no extra water required. Take care to see that the outside pot has plenty of water in it, set on the fire to make hot; the glue will soon dissolve, and will be found to be about the right consistency for general use. If requisite, it may be thinned by adding water. A twisted wire across the pot is very convenient to press out superfluous glue from the brush. Always keep the glue clean, and, when making fresh, boil the inner pot in a saucepan to remove the old dried-up and partially-burned glue, so as to start with a clean pot.

LEARNING TO TURN.

(A Reminiscence of an Apprentice.)

I THOUGHT, when I went to be a watchmaker, that I was to be put to making watches right away. "Our maister" was one of those old-fashioned kind of workmen who would not allow his apprentices to make anything till they first understood the use of the tools, and how to handle them. I was not so openly rebellious, but my notions were about as far wrong as those of the boy of our town that went to sea, and at the end of the first voyage refused to go back for the reason that he did not go to sea to do the kind of work they gave him; that he went to learn to be a captain.

"Our maister's" tools were all of the finest description. The large lathe was a good one, and all the different chucks and centres were arranged in convenient order; and all were always ready for immediate use. The small lathes and turning benches were all of the same quality, and in the same good condition. The turning tools, too, were all fixed in handles of fancy woods, and, with the files, filled up a rack that extended the whole length of one end of the shop. Every tool had its special duty to perform, and every one had a proper place in which to be put when not in use. If a person acquainted with the shop should go into it in the dark in search of a tool, he could lay his hand upon it at once. The orderly arrangement, and clean, bright appearance of all the tools was quite an attractive feature of the shop; and visitors of all classes, whether merchants, farmers, mechanics, or sailors, universally acknowledged that they saw no such tools as "our maister's."

Only one person claimed to have a better tool than he could produce, and that was a carpenter who had a favourite saw. Of course a watchmaker was not to be expected to have a wood saw that excelled one belonging to a regular carpenter; and I only mention this to show how jealous the carpenter was of the possibility of "our maister's" tools detracting from the merit that was due to his saw. This saw was a fabulous one; it never needed setting or sharpening, and it would cut through any nail that stood in its way as easily as it would cut through a wooden pin. If any strangers went into the carpenter's shop, whenever he could get an opportunity of introducing the subject the saw was brought down, and its qualities discussed. While in the act of talking he would bend it till the handle and point met each other, so as to give ocular demonstration of the splendid quality and temper of the steel. But one day, as he was discoursing to a crowd of admiring listeners, the saw broke in two while he was in the act of bending it. The carpenter stood in astonishment, with a piece in each hand, and could not account for the unexpected occurrence; but as a proof of his sincerity and continued faith in the qualities of his saw, he innocently assured his listeners that he had never seen it break before, and did not think it would do so again. However, after this accident "our maister" was left in undisputed possession of the honour of having the best tools all round that part of the country, undisturbed by the pretentions of any jealous rival.

I very soon discovered that learning to turn would be a far greater source of annoyance to me than learning to file or to make pins; and certainly I thought that they were bad enough. First of all I had to cut up a rod of half-inch round iron into lengths of six inches, and then had to file squares on one end, and sharp centres on the other. It appeared to me that on iron as thick as half an inch hollow centres might do, and I suggested the idea

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* This contains about 1 part of pure acid, and 2 parts of water.

but only got a rebuke for an answer, and was told that before I could turn small articles I must first learn to make sharp centres, and I could learn to do that best by making centres on large iron first. I had to grip the iron in a hand vice, lay the iron on a block, and file the centres on, after the same manner as making pins. Although I could handle a seven-inch file tolerably well when making pins, I found it to be a more difficult task to handle a heavy fourteen-inch one with one hand when roughing down centres on half-inch iron. Sometimes I would grip the iron in the bench vice, and use the file with both hands; but this method was contrary to "our maister's" ideas, and he could tell by the sound that was made whether I did it his way or not; and if I did not proceed exactly in the manner he directed I was immediately corrected.

After all the centres were roughed down and smoothed, "our maister" proceeded to examine them. Some of them were not round, others were not in the centre of the iron, some were too long, some too short, others were not flat, and there was not one centre among the whole lot that pleased him. I filed them all over again, and this time some of them would do; but the greater portion had to be altered a third time, and some a fourth, and even more times, before the entire number would suit him. The squares had now to be made; and this too was a vexatious operation, because they had all to be the same size, and be square, and flat, and had to fit the chuck exactly; and I think I had to do them a dozen times over before they were correct. At length I either got them right, or "our maister's" faculties for finding fault with my work failed him, for when I did not expect it he said they would do; and then I had to turn the pieces of iron in the large lathe.

I thought that this would be an agreeable change; but a difficulty presented itself which was much against my being able to work the large lathe to advantage. Only a few months before, I was not tall enough to reach up to the vice when learning to make pins, and in the short interval that had elapsed since that time, I had not grown high enough to reach to a proper height to be able to hold the turning tool to advantage, and to have a proper command over it. My legs were too short to work the treadle without moving my whole body up and down with each motion of the crank. I am afraid that the picture of my first attempt at turning was not a graceful one, with my body jumping up and down, my head inclining to one side, and bobbing up and down, and my tongue hanging out, while I vainly tried my best to hold the turning tool steady. The resources of "our maister" were, however, sufficient for the occasion, and he got a stool made the proper shape to answer for the lathe, and of a sufficient height to raise me to a proper level, and at the same time he had the treadle altered so that it could be set to suit the height of either a boy or a man, and I could then learn to turn under less disadvantages. It was a long time before I could drive the lathe and keep my body as steady as "our maister" insisted that I should do—such a terrible torment he was to me and my awkwardness.

When the iron was running round in the lathe "our maister" would take hold of the turning tool by the handle with his right hand, clasp the upright portion of the rest with the four fingers of the left hand, bringing the thumb above the horizontal portion of the rest, and holding the tool firmly down on the rest with his thumb. "Now," says he, "this is the way: Present the edge of the tool to the metal that is running round, and let the highest parts strike the edge till all inequalities are removed, and the iron is perfectly round and true; but I could not make it cut at all, and only scraped the iron, or broke the turning tool. Then "our maister" would turn a little piece and I would begin where he left off, and would have a little better success, although at times when I thought that I was doing finely, my foot would slip from the treadle, and I would tumble down underneath the bench.

After a severe trial of the patience of all concerned, I could hold the tool steadily, and turn an untrue piece of iron true; and after learning to hold tools in various positions, and learning that peculiar kind of motion by which the turning tool is moved from one end of the rest to the other, without taking the point of the tool from off the work, I was set to learn to make large screws. I noticed that "our maister' at first was more particular about my making square shoulders on the screws than anything else about them. I was now able to turn a little, and my great desire was to turn some fancy articles, for at that period I had no taste for plain patterns, my taste being of that kind that inclined to those designs that had most inequalities on the surface. When I could not invent a design myself, I generally found something to suit me on the pillars of bed posts, or the legs of tables, or on the pillars of very old watch frames. These patterns I mixed up together, and at odd hours made little articles for my sisters and also for some other girls who were not my sisters.

After becoming partly master of the large lathe, I was set to work on a smaller one, and afterwards had to learn to work the "turns" with a bow. No professor of the violin could be more particular in learning a pupil to handle a bow than "our maister" was with me. "Come," says he, at one of my first attempts, "don't act like a blind fiddler, but use the whole of your bow." Then he would take hold of it with the forefinger and thumb of the left hand, just a little above the coil of catgut, and raise the bow till the end of the whalebone almost touched the split collet; then bringing it down again till the collet nearly touched the other end of the bow, would again immediately raise it up, moving only his left elbow and wrist. I soon learned to do that, but raising the tool off the work when raising up the bow, and then placing it in a proper position when bringing the bow down again, was more difficult, and I was bending and breaking things all the time, while "our maister" unweariedly put things to right for me to begin again.

One day, while he was instructing me, a customer was looking on; there was a stout piece of steel in the turns, and long spiral chips came from the edge of the tool. "Eh!" says the customer, "that is good steel!" "No!" answers "our maister," it shows good turning." In a few weeks after that, becoming more proficient, I was making some very long chips, which I saved, and when "our maister" came to see how I was getting on, I showed him the chips and asked if that did not show good turning. "No," says he, "it shows good steel." Although I was but a boy I did not like that remark, and all day I could not forget it. I was trying to do my best, and now when I could make as good chips as he did, he gave the credit to the quality of the steel in my case, and took credit for good turning in his own; and his chips were no longer than mine were. The more I thought over the matter, the worse I felt; and at last I resolved to run away. My heart was not in the business any way; my inclinations leaned to a seafaring life; and without informing my parents, I left the service of "our maister."

It is said that if a married couple live unhappily, and resolve to separate, and both leave the house at the same time and go in opposite directions, they will meet each other some time. It was equally fated that I was to be a watchmaker; and the first day after I left work, and when I was preparing to leave the town, my father heard of my intentions, and determined to frustrate them; but I heard that he was after me, and was equally determined to get out of his way. So I started to get out of the town without delay, but on turning a street corner I came right up against my father. Of course I was taken home, and dealt with in the manner that I deserved, and next morning was taken back again to "our maister." The good man acted with much tact and judgment. He made no reference to my running away, but acknowledged frankly that the long chips showed good turning in my case as well as in his own, and that confession satisfied me. "Our maister" and I began now to fairly understand each other, and a love for mechanical persuits began gradually to dawn upon me, and increased with increasing years.

I think that the use of the hand-tool is not so generally understood by mechanicians of the present day, as it should be. The facilities which a slide rest presents for turning plain surfaces renders an extensive use of the hand tool less necessary than it was a generation ago. Still, in fine work, when irregular surfaces have to be turned, a resort to the hand tool becomes absolutely necessary; and hence the skilful use of the hand tool becomes an important part in the training of watchmakers; in fact, it is a fundamental one. A slight touch with a sharp, smooth-edged graver, in the hands of a skilful workman, will produce results which, in their way, are not to be excelled by the brush of the painter, or the chisel of the sculptor.

MODEL YACHTS.
PART IV.

(For Illustrations, see Supplement.)

THE lead keel forms an important feature in sailing models, and invites special attention. The weight which is to immerse the hull of the model to its proper depth or draught of water will be divided between the deck, mast, and rigging above water-line, and the lead keel below. To apply it to advantage, the mast, etc., must be made as light as possible, fitting merely the necessary cordage, and all useless deckwork being omitted in order that the lead keel may be heavier and consequently more effective. Our object being to bring the centre of gravity low down, inside ballast is out of the question, and we may dismiss the idea of that at once.

In our last chapter we left the hull ready for the lead keel. A simple wood mould or trough in which to cast it is made by fixing two thin pieces of wood, 25in. long, to the sides of a ¼in. piece of the same length. The ends must be stopped with wood, and the side pieces broad enough to give a clear inside depth of 1¼in. at one end and 1in. at the other. To make the top of keel correspond with the curved base line on plan, fix a short crosspiece between the upper edges of the side pieces to hold them about ⅞in. apart. Take care that the inside of mould is made perfectly tight, as air-holes are apt to prove mischievous. Melt your lead in a large iron ladle over a clear fire, and, after skimming the dross from the surface, prepare to cast. Fix your mould firmly on the bench or floor, and elevate the shallow end slightly, to bring the upper edges of side pieces about level. Then commence to pour steadily, and without stopping until the mould is almost full. Leave it to cool in that position, and see that the casting is not bent in removing from the mould. The upper edge of the lead keel must now be planed quite true, and made to correspond with its place on the hull. The sides should be smooth enough already, but if not they also may be planed or filed. Only a practical hand could file the upper edge properly; planing, besides giving the best job, takes much less time to do.

In its present condition, the keel is too heavy for the boat, having been made so to allow for cutting down. Cut away the lower edge to about the shape shown in fig. 1, plate IV., then take two pieces of string, each 18 or 20in. long, and tie them round the lead at a few inches for each end, leaving the ends at liberty. Next, mark on each end of the model the draught or water-mark. Roughly speaking, this may be 2¾in. below the deck at the stem, and 4⅝in. above the lead keel on the stern-post. Attach the keel temporarily to the hull by the strings, and place her in still water. The lead will probably require further reduction; this should be taken from the lower edge only. In thus adjusting the weight of keel to the draught of the boat, allowance should be made for the subsequent addition of deck, masts, etc. In a cutter such as this, about ¼in. at each end will be ample, but in a schooner-rigged boat the difference would be greater. Cut away the lower edge only, until the model floats with the draught-marks at each end about ¼in. above water, so that when the extra weight of deck and rigging is applied the trim will be about correct.

The holes for the two upright screws are then bored with an ordinary bradawl to a depth of ½in., one being 6½in. from aft end of keel, the other 12in. from the first. The screws themselves are of stout brass wire 2½in. long, threaded for half their length on the upper end, and provided with substantial nuts. If the nuts are made circular, as in fig. 1, the circumference should be nicked to prevent the pliers slipping when screwing down, but square nuts answer quite as well. Now, we require two strips of strong sheet brass 1¼in. by ⅜in.; cut the ends round, drill a $\frac{1}{16}$in. hole through each, then bend them with the pliers and hammer to form the clips shown at stem and stern in figs. 1 and 2. See that they are the exact width of the lead keel, then solder them on about an inch from each end, and also the vertical screws in their position. To fix the keel, turn the boat bottom upwards, and mark on the wood from the screws themselves the places where the holes should be. Bore them with a bradawl exactly the size of the screw, that no waste space may be left round about it. Fig. 4 shows how the keel is secured inside the block model. The holes just bored are first countersunk inside with a small gouge, then white lead laid along the keel and round about each screw. Fit model and keel carefully together, but allow the screws themselves to press out the waste. Fill in white lead round each screw inside, then prepare two thick india-rubber washers (*i*, fig. 4), which must fit the screws tightly. Screw these on inside, then add the brass nuts. A short copper rivet fitted through the holes in each "clip" will secure the ends, after which the extremities of the lead may be finally trimmed off, the forefoot cut to make a fair line with stem, but the after-end allowed to project a distance of ¼in. abaft the stern-post to support the heel of rudder. The weight of lead having been adjusted, a narrow strip of sheet brass should be tacked along the bottom and well up the stem, to preserve the keel from damage in beaching.

Casting in sand is not so expeditious and cleanly a process as that already described, but if the yacht builder should desire a better finish it must be adopted.

First prepare a wood pattern, by securing a piece of yellow pine to the keel of the model *before cutting out*. Make it 1½in. deep and 1in. thick, the lower edge being cut to a width of ¼in. throughout its length. Once in place it must be treated as part of the model, and the sides, instead of being as before, nearly flat, will show a hollow about midships. Finish the whole exterior before removing the wood pattern. You may get a good lead casting made from it for a small sum at any plumber's shop, thus saving yourself a dirty operation, and, possibly, two or three failures before getting a satisfactory job. To perform our own foundry work, however, we must have a rough box, about 30in. long, 2in. wide, and 2in. deep; the heavier the better, to ensure steadiness. Fill it with dry loam sand; insert the wood pattern, having previously fixed two nails in the upper edge, by which to remove it, and pack the sand tightly round all sides. The upper edge of the pattern should lie quite level; then remove it slowly, taking care not to damage the form of the mould. Now fill in the lead very slowly, but without stopping, and give plenty of time to cool afterwards. It is not unusual to fit wooden pegs in the mould before casting, to make the necessary screw-holes in the lead, but it is much better to omit these and bore the holes, those cast in being more or less imperfect as a rule. Fit the keel with screws, etc., as already described.

Another method of attaching the lead keel to the hull is by means of ordinary brass screws about 1in. long, fitted from without, and passing through the lead in a slightly diagonal direction into the hull. The screw-heads are thus recessed into the lead, and covered over with putty or other cement. The difficulty is to tighten the screws in case the lead should work loose, which it is very liable to do when held by ordinary screws only.

So far our remarks have had reference to block models, or to those built on the bread-and-butter system. The connection suitable to the wood-built boat will be easily understood by consulting figs. 2 and 3. In the longitudinal section, fig. 2, the vertical sections or building frames are shown at *v s*; over these is fitted the inner keelson *k*, which is secured by screws to the wood keel. The vertical screws of lead keel *s c* pass through keel and keelson, and the end clips are fitted as before. Fig. 3 represents the cross-section.

Our boat is now to receive a good coat of paint inside and out, and two full days allowed for the keel to set and paint to dry; then proceed to fit the deck.

A strong cross beam 2in. by ⅝in., fig. 9 *m*, must be fitted across the hull in way of mast, which is placed about 10¾in. abaft the stem. Round the top of beam, to make the centre ⅛in. higher than sides. The gunwale should be notched to receive it, and the beam made to lie flush. If the mast is to pass through the deck and step in the boat's bottom, bore a ⅝in. hole in the beam before fitting. A similar piece, which stiffens the deck in way of bowsprit, extends from the beam to the stem, and should be neatly let into each. Another crossbeam will be required about half-way between the first and the stern.

Yellow pine makes a good light deck, although a harder wood is preferable. Get a piece of timber with a clear straight grain, 2ft. 9in. long by 8½in. wide and nearly ⅜in. thick. Dress one side, and pencil a centre line full length; set off ¼in. spaces at each end to represent the deck deals or planking, and pencil these in also. Next show the centre line on the underside of the piece. As the model stands in a chock on the bench apply the deck face downwards, and place a weight in the middle to bend it into the sheer. Set the centre line to correspond with both ends, then run a pencil round the deck line. Remove the deck, and cut away to within ⅛in. of this line. Fit it (right side upwards) on the model, and weight it as before; then bore a screw-hole ¾in. abaft the stemhead, and another 1in. in from stern at centre. Fasten the deck with ⅝in. brass screws at these places, and proceed to bore holes at intervals of about 2in. for the remaining screws along the bulwark. Unscrew the ends and lay white lead along the bulwarks and crossbeams, then replace the deck and screw down again, beginning at the midships, and alternately to each end. Use *brass* screws only, not longer than ⅜in. Now dress off the projecting edges with a sharp chisel and small plane if the edge of deck is to be flush, or it may form a moulding as in fig. 5. If any bulwark be fitted, let it consist of a slip of hard wood ⅜in. square extending in one length on each side from stem to stern, and secured by very small brass screws. It is of no use, however, and a model of this description is better without it. Whether a bulwark be fitted or not, a margin plank should be painted round the deck (see fig. 11). Make it ½in. wide throughout. For the inner line a light gauge mark may be set in from the side. The screw-heads should be countersunk and covered over.

Fig, 6 illustrates another method of fitting the deck by "sinking" it ¼in. or so below the bulwark *b*, which is reduced in thickness at that part, and carries a hard wood rail *r*. A very attractive job is the result, but besides being rather troublesome to fit, it interferes with speed and is easily damaged.

We now turn our attention to the rudder, an item which is usually considered indispensable in a model yacht, especially as the little craft must steer herself when afloat. This is a mistake; for the use, or rather mis-use, of the rudder is often the sole cause of the boat's failure. To a model yacht none but a free weighted rudder is of any use. If it is not intended to be weighted, it should either form part of the hull and thus be rigid at all times, or made to unship, and, like the Dutchman's anchor, be left at home. Eccentric as such a proceeding may appear, it is none the less practical, in fact nothing can so well teach the novice the proper use of the sails as the management of a rudderless model. And now to business.

If the rudder is to be controlled by a tiller on deck, the holes in hull and deck should be commenced with a long straight wire made redhot, which ensures the rudder head at deck being in line with the stern-post, after which they can be cut to the required diameter, and a short length of ¼in. brass tubing neatly fitted in, to form a watertight rudder trunk.

The rudder itself—or rather rudders, for a sailing model needs more than one—is shown at fig. 7, and consists of a piece of hard wood ½in. wide and not less than ⅛in. thick, bound with strips of sheet brass, *a*, *a*, *b*. Fit a brass pintle, *p*, in the heel of rudder, which works in a hole drilled in the projecting end of the keel (see fig. 8), a small brass washer being introduced to reduce the friction. The rudder head is cut square for ⅝in. above deck, and carries a short tiller of wood or brass. The tiller moves quite freely under a crescent-shaped rail of sheet brass, in which small holes are drilled ⅛in. apart. A stout pin passing through one of these holes checks the "play" of the tiller either way as may be required. Should it be desirable to dispense with the tiller above deck and leave the weighted rudder quite free, the trunk may be omitted, and the rudder head fitted with a vertical pintle similar to that at heel, but rather longer. The widths of rudders shown in fig. 7 are 1¼in., 1⅞in. and 2½in. respectively, but they should be made larger at first, and trimmed down afterwards. The use of each will be explained in due course.

We next proceed to the deck fittings: In sailing models such as ours the fewer of these the better. There are reasons for this: They are liable to damage in sailing, they hold an amount of wind, and further give to the deck a crowded appearance which a sailing boat should never have. In the present instance of a cutter we have very little deckwork; the only item which may be omitted we have already mentioned, namely, the tiller. The others are: The mast tube, bowsprit tube, chainplates and horses. The mast tube, *m t*, figs. 10 and 11, ⅝in. outside diameter, is shown 1in. high, but may be made lower. It is soldered to a circular disc 1½in. diameter, which is drilled to receive three or four screws. The mast is merely stepped in this socket *on* deck, which is preferable to passing it through.

The bowsprit tube *b t* is formed by two ½in. pieces of the same tubing soldered horizontally to a brass deck-plate 5in. by ½in., leaving sufficient space to admit end screws. A double eyelet of brass soldered to the forepart of the bowsprit tube, as in fig. 10, takes the lower end of the forestay.

The chain-plates are also of brass. Two to be 5in. long by ¼in. wide, and cut to correspond with the curve of the deck-line (fig. 11). Each carries five eyelets soldered 1in. apart, screwholes being drilled where shown. The chainplates are fitted on the margin plank with the foremost eyelet exactly opposite the mast tube. The smaller chainplates *c p*, fig. 11, are 1½in. long by ¼in. wide, and have two eyelets in each. These may be placed about an inch each side of the mast tube.

The horses are shown at *h h* and are made of strong brass wire bent to a slight curve, the ends turned down and screwed to margin plank. They may have a clear space of ½in. at the centre of deck.

Simplicity, strength and lightness are of the most importance in arranging the deckwork, and this applies equally to the rigging, the description of which we leave to our next chapter.

(To be continued.)

HOW TO MAKE A CHEST OF DRAWERS.

PART I.

In the following articles it is intended to describe, assisted with several diagrams and working details, the manufacture of the above article of furniture, as practised in the cabinet maker's workshop.

A chest of drawers is simply a case filled with drawers to contain clothing, etc. The example here shown consists of a base, surbase, and top carcase or body. In the usual method of construcure a large part of the work is veneered—the whole front included. The gables and top are solid, usually bay mahogany, ⅝in. thick, the top being clamped on the under-side with pine to 1½in. thick, and veneered round the edges to cover the whole. As to dimensions, the breadth across the front (fig. 1) is 4ft. 1in., and the depth from front to back, 20in. at the body or upper carcase (see fig. 2). The base, which may be called the foundation course, is 5in. high, having four ball feet under it; these raise it 3in. from the floor. Over this base is the surbase: this is made to contain a large drawer. This drawer is 12in. deep on the face, and has the mouldings mitred on the face of it, as shown in fig. 1. The fronts of these bases have semi-circular blocks on the ends; that on the base being 6in. broad, and that on the surbase 5in. broad; the ends of the drawer being fitted exactly between these two latter. The surbase is screwed to the base, and the latter projects beyond the former half an inch all round. The surbase is surmounted by a moulding, called a *thumb* moulding, ⅞in. thick, and over this the body or top carcase is placed. The top carcase contains five drawers; their depths on the face, starting from the bottom, being 9½, 8½, 7½, 6½, and the uppermost, that with the carving, 5in. The top over this last drawer is 1½in. thick, as already mentioned; the total height being 5ft. 4in. The base is made of ⅞in. pine, and

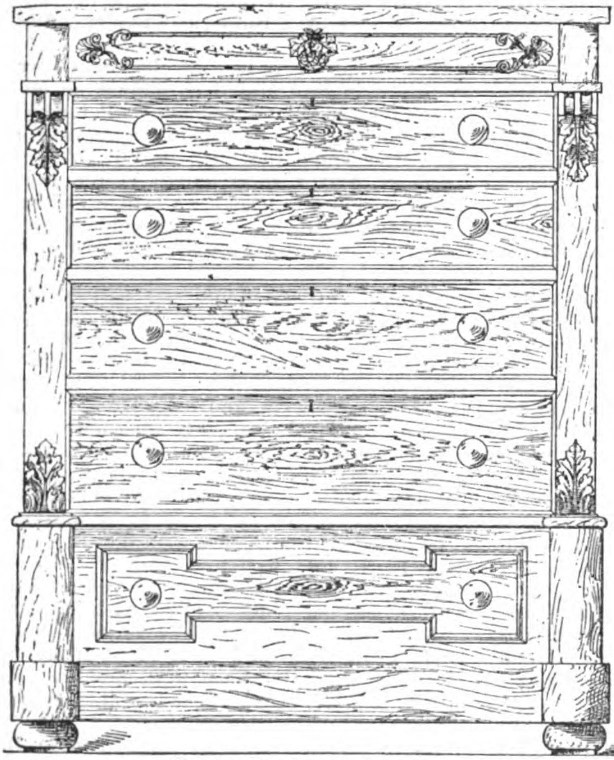


Fig. 1.—Front.


Fig. 2.—Gable.

veneered all round. The surbase has solid gables ⅝in. thick, and the semi-circular front blocks veneered. The top carcase has a "ground" up each side at the ends of the drawers. This, including the thickness of the gables, is 3½in. broad and 2in. thick. The faces of these grounds are veneered. At the top of these grounds are semi-circular blocks, 6in. long, at the end of the top drawer, and the top over all projects all round 1in. It is fixed on by mortise and tenon, the tenons being cut on the ends of the gables. It has also circular blocks in front. The fore edges of the shelves between the drawers are ⅞in. thick finished. These shelves are dovetailed into the thick grounds in front, and raggled into the gables; and are made fast by blockings glued in underneath. The various moving drawers have fronts made of 1in. pine, sides and backs ⅝in., and bottoms ⅜in. The fronts are covered with showy veneer; the most showy, but not the most durable, being those known as curls. These are short cuts of the log, having a strong feathery-like appearance diverging from the centre. They are usually about 2ft. long, and the practice is to take two, cut from each other, to make a drawer front, they being marked, when sawing, for this purpose. The drawer front has consequently a butt joint in the centre, the spreading ends of the pieces being carefully jointed, so that the same figure or marks in the veneer will appear going both ways from this centre joint. These veneers are very showy, but they are very apt, after a time, to get full of cracks, and with age they get very dark in colour. The drawer fronts are surrounded by a beading called a cope bead. It is ⅛in. thick, and projects from the face of the veneer half that thickness.

In the construction of the chest of drawers the first work is making the base. This base is 4ft. 3½in. long, 1ft. 10½in. broad, and 5in. deep. It is made of ⅞in. pine, and the method of procedure is as follows:—Make a front (fig. 3) 5in. broad, a back 4in. broad. These are to be planed both sides and to an equal thickness throughout. Square both ends to a length of 4ft. 3in. Plane and square up two end pieces in the same way, also 5in. broad same as front. These are to be 22½in. long when squared up. The front and back are now to be dovetailed into the ends, keeping the back flush on the upper side. The ends have a lip ¼in. thick, or, in other words, they are not dovetailed through, but made exactly as is done with a drawer front. Consequently, when the base is put together, it is 4ft. 3½in. long. This dovetailing is shown, fig. 3, where one of the circular blocks is removed. It is, of course, covered up when these blocks are glued in their places. The object of not dovetailing through is to avoid having any end-wood on the surface at any part to be covered with veneer. This rule holds good in all veneered surfaces—namely, avoid having end-wood and side-wood in the same veneering surface, as the two do not shrink alike. It may be said that the end-wood does not shrink at all; consequently in a short time any such portion covered by veneer is at once detected, as it always stands above the surrounding surface. There are cases in which this cannot be avoided, but in most cases it can, and it always should be guarded against.

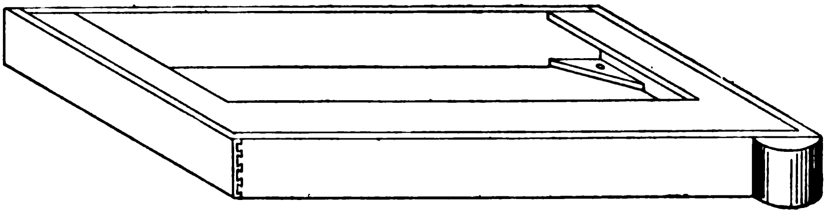


Fig. 3.—Base.

The base being dovetailed and glued together is to be "filled in." This filling in consists of pieces of ⅞in. wood fitted inside the base at the front and ends, and flush with the upper edges. The front piece is 2½in. broad, and is fitted in neatly between the two ends. The end pieces, which are broad enough if 1½in., are fitted in between the back of base and edge of front piece. These are glued in and pressed close with hand screws. Then the base is turned over, and the angle formed by the base and the filling in is filled at intervals of 5in. or 6in. with blockings 3in. long. A portion of the base blocked in this way is shown at fig. 4. The gluing surfaces of these blockings are about 1½in. broad. In planing them these two sides must be at right angles, and roughened with the teething plane. When the glue has set quite hard, the base is to be planed straight and level with a half-long plane, the ends being made square with the front, and these teethed ready for veneering. Before describing this process, we will proceed with the details of construction.

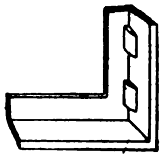


Fig. 4.—Blocking.

Now to describe the surbase, which rests upon base just described. It is 12in. high. It consists of two gables, either of solid mahogany or pine veneered. In either case, the grain of the wood runs vertically. These gables should be ⅞in. thick, but, if of solid mahogany, they are seldom made more than ⅝in., in which case they are clamped on the inside with pine to make up the thickness. The breadth of these gables is 1½in. less than the base below, not including the blocks, and in the back edges a check is made to receive a ⅜in. back lining.

The next operation is to make two frames of ⅞in. pine, to form a top and bottom to these gables. These frames are of a length to make the surbase 1in. shorter than the base beneath, so that the base projects all round ½in. beyond the surbase—that is, when the drawer front is in its place. The breadth of the frames is the distance from the front of gables to the check for back lining. Each frame consists of a front and back rail, 3in. broad, and two cross rails 5in. broad, let into the former by mortise and tenon. The ends of the front and back rails being dovetailed into the gables, the cross rails fit inside of these, and are then made more secure by having blockings of wood glued in the angles.

Two semi-circular blocks are now made of several layers of pine glued together as described for the base blocks. They are 5in. broad on the back, the semi-circle being drawn with compasses set to 2½in. The block is 3½in. thick, however, the additional inch being to allow for the thickness of drawer front, so that when this front is in its place the blocks show but 2½in. projecting. These blocks are veneered before putting on. The canvas bag and screws used for this purpose, together with details of the process, will be found subsequently. In all cases the veneer should be teethed on the gluing side before laying.

The blocks, when veneered and dry, are planed and scraped. Then they are carefully fitted to the face of the surbase and glued down. The veneer on the block where it joins the edge of the gable must be a good joint and both flush, as the veneer, being thin, it will not allow of much reducing when cleaning off.

When this surbase is made it should fit on to the lower base and show a margin of ½in. along the ends and round the blocks, and 1½in. along the central portion or drawer space. The upper side of the surbase is capped with a moulding, usually a *thumb*. This moulding is a section of an ellipse (see fig. 5), and is a very popular moulding with cabinet-makers. For the chest of drawers it is made of ⅞in. mahogany, and in order to economise that wood the necessary breadth is made up with pine, the two being glued together previously to running the thumb. The breadth of mahogany required is 1½in. backed by 2in. of pine. Fig 6 shows the upper side of the surbase with the line of junction of pine and mahogany, also the manner of mitring at the inner corner of the circular blocks. In ordinary chests of drawers the portions of thumb moulding covering the blocks are composed of a piece of ⅞in. mahogany turned in the lathe, and afterwards cut in halves, which do for both blocks. The portion of moulding along the front is mitred at the corners to these semi-circular pieces, and the end pieces are butt-jointed behind them.

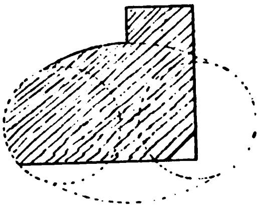


Fig. 5.—Section of Thumb Moulding.

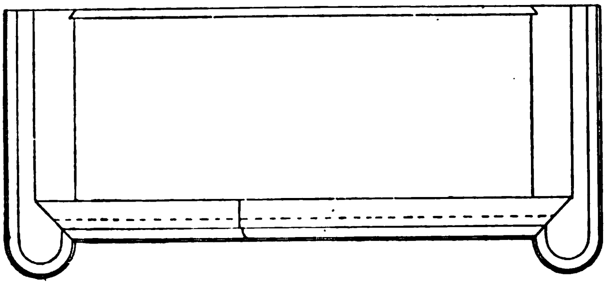


Fig. 6.—Upper Side of Surbase.

In a first-class chest of drawers, however, they are done differently. A piece of mahogany is cut large enough to make both pieces for the end mouldings and the circular portion over the blocks in one. Fig. 7 shows the method of cutting the one out of the other usually pursued. The thumb in this case is worked by hand, and the pieces do not require backing with pine. These mouldings are teethed on the under-side, and glued on to the base, a few screws being put in after the hand screws are removed. This base receives a ⅜in. back lining, but it is not put on until a drawer is made and fitted in. The drawer front is of pine, "slipped" with a piece of bay mahogany on the upper edge. This slipping is a process that has to be noticed. A piece of mahogany is cut about an inch broad and ½in. or ⅜in. thick. It should be as free from warping and bending as possible. It is truly planed on one side, and teethed. The edge of the drawer front is also planed to receive it. This must be planed perfectly straight with half-long plane, and teethed also. Then, with the drawer front in the bench lug, the slip of mahogany is wetted with a sponge, and turning its teethed side up, and on a level with the edge of pine front, both receive a coating of glue quickly applied. The slip is turned over on the edge of the front and rubbed firmly backwards and forwards lengthways, two persons being necessary for the operation. The sliding motion is gradually lessened till it stops with the slip in its proper place, when a few smart rubs with a veneering hammer complete the operation. In most cases a slip thus laid will be found to adhere perfectly in its whole length. When the front is dry it is planed up and fitted exactly in its place; care must be taken to have the *heart* side of the plank turned to the front for veneering upon. This drawer front is 12 inches broad, and when in its place rests upon the two ⅞in. fore-edges forming the frame of the surbase. The drawer sides pass between these fore-edges, they are consequently only 10¼in. broad, the extra breadth of front projecting ⅞in. downwards, and the same upwards of the sides, as in fig. 8, which shows the drawer side as dovetailed into the front. The drawer sides are ⅜in. thick; they are often made of pine, sometimes of American ash, but the best wood of all is cedar, as the strong but not unpleasant odour emitted is a sure prevention of moths, the annihilators of clothing. A groove run in ⅜in. wood for a drawer bottom makes the side

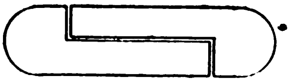


Fig. 7.—How to Cut the Moulding.

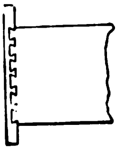


Fig. 8 —Drawer Side.

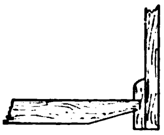


Fig. 9.—Filleted Drawer Bottom.

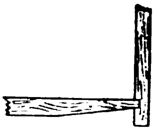


Fig. 10.—Ordinary Grooved Drawer Bottom.

very weak. A very great improvement is the fillet clamped to the inside of the drawer side, and the groove run in it. A section of this method is shown in fig. 9, fig. 10 being the ordinary method, in which the weakness will be at once apparent.

Our next work is the construction of the body or carcase of the chest of drawers. This is shown in the annexed figures. Fig. 11 shows the front and fig. 12 the gable. The carcase consists of two gables of solid mahogany, usually ⅝in. thick; but they ought to be at least ¾in. thick. The breadth to make these gables is ¼in. less than the breadth of the upper side of the surbase—that is, ¼in. within the thumb moulding. The length of the gables is sufficient to admit five drawers of the following breadths—namely, 9½, 8½, 7½, 6½, and 5 inches, with a ⅞in. fore-edge or shelf between each, and one-inch additional to cut into pins or tenons to enter the top (see fig. 12), which should show straight pins not dovetailed.

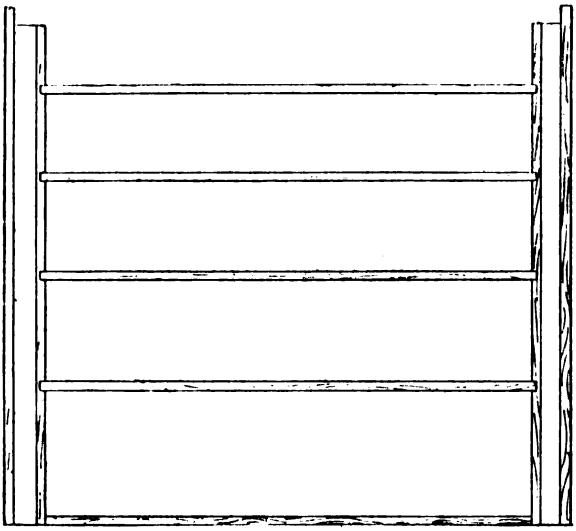


Fig. 11.—Front.

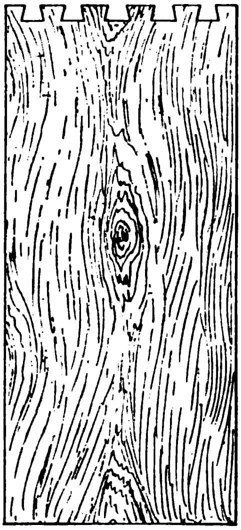


Fig. 12.—Gable.

The two gables are planed up on both sides, and "thicknessed." Then they are made to the breadth, and squared on the bottom ends. Then they are marked off on the insides for grooves to receive the shelves. The rabbet plane used is 1⅜in., and the depth of groove is ¼in. A guide for the plane is made by "stitching" with tacks a thin lath of wood to the gable alongside the groove to be run. These grooves run, the bottom ends are dovetailed—not through—to receive a ⅞in. carcase bottom (see fig. 11), and the top ends squared and cut into pins as already mentioned. Two grounds have now to be built to clamp on the inside of the gables. These are of pine, faced on the inner edges with mahogany, as indicated by the lines shown vertically on fig. 13. The method of building these grounds is to clamp two pieces of ⅞in. or 1in. wood together for the thickness, as this stands better than one piece all the thickness. Next a piece of ⅞in. bay mahogany is planed up and teethed on both sides. The edges of the ground pieces are also planed straight and teethed. The mahogany is heated both sides, and glue being applied to both pieces of pine the mahogany is placed between them and several hand-screws applied. When this is hard it is planed up and sawn through the centre of the mahogany, making a pair of grounds with mahogany slips about ⅜in. thick when finished.

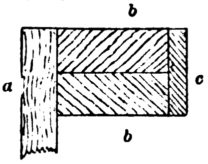


Fig. 13.—Section of Ground.

The grounds are planed to a breadth that when glued to the gables the total breadth of face is 3½in. Fig. 13 is a cross section of this arrangement of pieces; *a* is a portion of the gable, say ¾in. thick; *b* the two thicknesses of pine, 2⅜in. broad and 2in. thick; and *c* the clamp or slip of mahogany, ⅜in. thick. After these grounds are fixed to the gables they are squared with the gables on the face, and the inner edge *c* squared with the face. Then they are drawn for dovetails to receive the shelves in a line with the grooves in the gables. The dovetail is all on the under-side of the shelves, as will be seen from fig. 11, and enters into the ground about ⅜in. As these shelves must be quite level in their whole breadth to allow the drawers to run smoothly, great care must be taken to cut the dovetails in the grounds with exactitude. Otherwise the shelf when entering the dovetail will be bent up or down, as the case may be, and it is hardly possible to make a good fit of the drawers in such a carcase.

These shelves are not of one thickness, or one board throughout their breadth, but are known as "clamped" shelves. About three inches of the front portion is ⅞in. wood, the remainder being ⅜in. wood clamped at the ends with pieces of ½in. wood, which makes them up to ⅞in. The two are joined with match plows, glued, and clamped; they are carefully made of a thickness to fit the grooves in the gables; but, previously to this, the front edge has to receive a facing of mahogany. The general practice is to "band" them—that is, to put on scrap pieces of rich veneer, with the grain running across the thickness of the fore-edge. This has a showy effect, but it is false and ridiculous, as a shelf of solid wood put in in this way would be an impossibility. The result of such work is also bad, as pieces of this "banding" get easily chipped off with the pulling out of the drawers. The proper way is to "slip" them with good mahogany, at least ¼in. thick, with the grain of the mahogany running in the same direction as the shelf. This will last for an age without chipping; and this was the practice with the cabinet makers of the olden time, as may be seen by examining old chests of drawers. When the shelves are slipped and got to the proper thickness, the corners are cut out to admit the grounds, and the dovetails worked to fit the latter. The shelves should be fitted pretty tight into the grounds, and when driven home the mahogany slip should project beyond the face of the ground the thickness of a veneer, so that when the grounds are veneered the whole will be flush. The carcase bottom—that is, the lowest shelf that rests upon the surbase—has one dovetail into the end of the ground. This will be readily understood by reference to fig. 14,

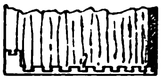


Fig. 14.—Under Side of Carcase.

which shows a portion of the under-side of the carcase. The back-edge of gables are checked to receive a back lining, which is nailed to the back-edge of the carcase, as shown on the right in fig. 14.

The gables, carcase bottom, and the shelves being ready, the carcase is put together by gluing and rapping up the carcase bottom first, then the top shelf, and after this the intermediate ones. A cramp is necessary to draw these shelves home, care being taken that they all project beyond the face of grounds only the thickness of veneer as above-mentioned. All the shelves have now to be "blocked" on the inside—that is, three-cornered blockings of wood, with their gluing faces at right angles, are glued in against the shelves and gables. Before these are glued in the carcase must be tested to see that it is square, and also that all the shelves are quite at the bottom of the grooves in the gables. After this is made sure the blockings, 4in. long, three to each shelf, are rubbed in with hot glue, the first one going forward pretty near the back of the ground. When these are hard the carcase will be perfectly rigid and strong.

It is usual to fit the drawer fronts and make the drawers before making a top, but we will now give a description of the top and upper blocks. These latter are same breadth as the grounds, semi-circular on the face, but are one inch thicker than the half circle, to allow for the drawer front between them, as this front projects 1in. over those beneath it. These blocks are veneered in one length in a canvas bag, as described for the base blocks. When glued on the grounds their lower ends are on a level with the upper side of the top shelf. The upper ends are faced with mahogany.

The top of this carcase is 1½in. thick. It is a board of ⅝in. mahogany, made up or clamped on the under-side with pine an inch thick. A piece of pine 5in. broad is glued along the front, the ends are made up with end cuts of pine 6in. or 7in. long. As the grain of all the clamping must run in the direction of the grain of the mahogany, a narrow clamp is fitted between the end ones at the back to nail the back lining to. These clamps are put on with large hand screws; when hard the top is planed to thickness and squared at the ends. The front edge of the top is veneered before the two semi-circular blocks are rubbed on. This veneering of the edge of the top is usually "banding," but it is as false as in the other cases, and should be done by slipping, as described when treating the base.

(To be concluded in our next.)

To Prepare Bones for Turning, etc.—Saw off both ends or knuckles, and get out the marrow. Put them to simmer for two hours, then let them cool; dry them in sawdust, and put by in quicklime till required for use. The bones of horses, asses, oxen, and sheep can be used. They may be bought at tripe shops, where they make neat's-foot oil and dress cow-heels.

TO TURN OR CUT AN EGG SHELL INTO TWO PARTS.

SELECT a nice uniform egg, and observe there are no cracks in it. Wash it clean with soap and warm water, using a nail or tooth brush for the occasion. If it comes out nice and clean, and free from stains, put it in a saucepan with cold water sufficient to cover it. Allow the water to become gradually hot, until it simmers. Keep it simmering five minutes; this will make the egg what is called hard. Be careful not to make the water what is called gallop, else it will, in all probability, crack the shell. That done, take it out, and wrap it up in any cloth you have convenient, allowing it to get gradually cold therein.

Now drive a piece of willow, birch, or alder wood into an ordinary metal cup chuck, and turn it out to fit your egg very nicely to about the middle, introducing the large end first. Damp the inside of chuck, and hold a piece of chalk in during its rotation. The damp chalk will cause it to adhere to the shell, and prevent it slipping out. Adjust your egg very nice and true; then take a very fine pointed tool, and carefully cut or divide it into two parts. The yolk of the egg being hard, and adhering together, prevents the one half, when severed, from falling down.

This done, take a thin pocket-knife blade, or anything else that will answer the purpose, and carefully sever the yolk through the incision of the shell which the tool has made, until it is in two parts. The writer has cut many with nothing more nor less than an ordinary saw file, ground to very long, conical, keen edge. The noticed files are usually made much harder than ordinary ones, and consequently better adapted for the class of tool used for the purpose of cutting through the enamel of an egg shell.

If it is wished to turn holes in the ends for the purpose of mounting them, the small end of the egg must be chucked first, and make your hole through the opposite one. To relieve it safely from the chuck some must be turned from its face or end, down nearly to the shell, just sufficient to weaken the fitting to be taken out. That done, chuck it by the larger half, and proceed to make the hole through it with the same tool. Then, as in the first operation, chuck your egg, and cut it in half.

The halves may be mounted very prettily in ivory, African black wood, or cannel coal, or various other ways; and the writer expresses a hope that amateurs will send photos. of their productions for illustration in "Amateur Mechanics," for the mutual benefit of their brethren in the craft, not forgetting that many can (unmistakably) help the one, or few, in word and deed.

E. F. B.

To Remove Lead from Gun-barrels, etc.—Pour some mercury into the barrel, and shake well; the lead will amalgamate with the quicksilver, and they will come away together.

To True-up a Grindstone.—Firmly fix a rest on the grindstone frame, and use, as a turning tool, a piece of iron wire about ⅛in. thick; or, if a large stone, a piece of small iron gas barrel, applied at a slight angle horizontally and pointing downwards. When using roll the wire over towards the cut, and thus present continually a fresh sharp edge. Hang the water-trough on a joint, and let the water in it be clear of the stone; when it requires wetting lift up the trough. A grindstone will turn best when slightly wetted.

WATERPROOFING.

POROUS goods are made waterproof according to two very distinct systems. According to the first the articles are made absolutely impervious to water and air by having their pores filled up with some oily or gummy substance, which becomes stiff and impenetrable. Caoutchouc, paints, oils, melted wax, etc., are of this kind. The other system consists in making the fabric *repellent* to water, while it remains quite porous and freely admits the passage of air. Goods so prepared will resist any ordinary rain, and we have seen a very porous fabric stretched over the mouth of a vessel and resist the passage of water one or two inches deep. The following recipes have been tried and found good. Most of those found in the recipe books are worthless.

To Render Leather Waterproof.—(1.) Melt together 2 oz. of Burgundy pitch, 2 oz. of soft wax, 2 oz. of turpentine, and one pint of raw linseed oil. Lay on with a brush while warm.

(2.) Melt 3 oz. lard and add 1 oz. powdered resin. This mixture remains soft at ordinary temperatures, and is an excellent application for leather.

Waterproof Canvas for Covering Carts, etc.—9½ gallons linseed oil, 1 lb. litharge, 1 lb. umber, boiled together for 24 hours. May be coloured with any paint. Lay on with a brush.

To Make Sailcloth Impervious to Water, and yet Pliant and Durable.—Grind 6 lbs. English ochre with boiled oil, and add 1 lb. of black paint, which mixture forms an indifferent black. An ounce of yellow soap, dissolved by heat in half a pint of water, is mixed while hot with the paint. This composition is laid upon dry canvas as stiff as can conveniently be done with the brush. Two days after, a second coat of ochre and black paint (without any soap) is laid on, and, allowing this coat time to dry, the canvas is finished with a coat of any desired colour. After three days it does not stick together when folded up. This is the formula used in the British navy yards, and it has given excellent results. We have seen a portable boat made of canvas prepared in this way and stretched on a skeleton frame.

Metallic Soap for Canvas.—The following is highly recommended as a cheap and simple process for coating canvas for wagon tops, tents, awnings, etc. It renders it impermeable to moisture, without making it stiff and likely to break. Soft soap is to be dissolved in hot water, and a solution of sulphate of iron added. The sulphuric acid combines with the potash of the soap, and the oxide of iron is precipitated with the fatty acid as insoluble iron soap. This is washed and dried, and mixed with linseed oil. The soap prevents the oil from getting hard and cracking, and at the same time water has no effect on it.

The following recipes are intended to be applied to woven fabrics, which they leave quite pervious to air but capable of resisting water.

(1.) Apply a strong solution of soap, not mere soap suds, to the wrong side of the cloth, and when dry wash the other side with a solution of alum.

(2.) The following recipe is substantially the same as the preceding, but if carefully followed in its details gives better results:

Take the material successively through baths of sulphate of alumina, of soap and of water; then dry and smother or calender. For the alumina bath, use the ordinary neutral sulphate of alumina of commerce (concentrated alum cake), dissolving 1 part in 10 of water, which is easily done without the application of heat. The soap is best prepared in this manner: Boil 1 part of light resin, 1 part of soda crystals, and 10 of water, till the resin is dissolved; salt the soap out by the addition of one-third of common salt; dissolve the soap with an equal amount of good palm oil soap (navy soap) in 30 parts of water. The soap bath should be kept hot while the goods are passing through it. It is best to have three vats alongside of each other, and by special arrangement to keep the goods down in the baths. Special care should be taken to have the fabric thoroughly soaked in the alumina bath.

(3.) Drs. Hager and Jacobson remark that during the last few years very good and cheap waterproof goods of this description have been manufactured in Berlin, which they believe is effected by steeping them first in a bath of sulphate of alumina and of copper, and then into one of water-glass and resin soap.

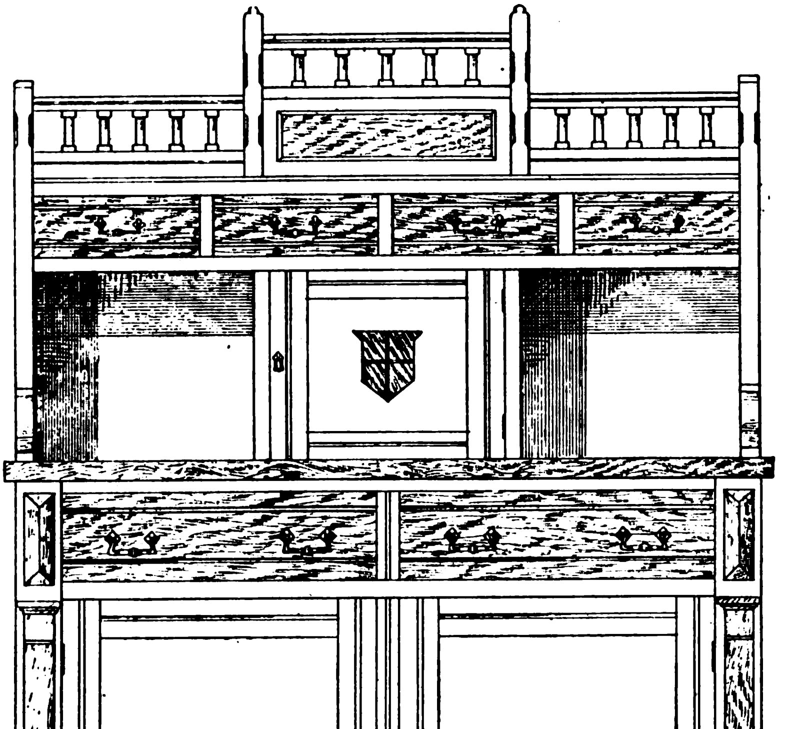
Cement for Joining Glass, etc.—Best isinglass, 1 oz.; strong acetic acid, 3 oz.; put in a glass bottle, and dissolve by standing in hot water. Will join glass, china, etc., etc. Make the edges of the pieces to be joined hot, and apply the fluid cement. When cold this cement is solid; it must be made hot for use.

French-Polishing.—This is a method of varnishing by rubbing the varnish upon the surface of the wood instead of applying it with brushes When varnish is applied simply with a brush, a comparatively uneven surface results, rendering necessary the subsequent processes of rubbing and polishing, but by the method of French-polishing, a smooth and continuous surface, hard and not easily scratched, is secured. All the polishes are applied very much in the same way, and a general description will therefore be sufficient. To obtain a good polish with lac varnish on wood, the quantity applied must be very small, and must be rubbed continuously until dry If the work be porous or coarse grained, it will be necessary to give it a coat of thin, clear size previous to commencing with the polish; when dry, the surface must be smoothed with fine glass or sandpaper. The size fills up the pores and saves the polish, and also saves considerable time in the operation. Make a wad of cotton-batting, covered with several folds of very fine, soft linen cloth; put the wad or cushion to the mouth of the bottle containing the preparation (or polish) and shake it sufficiently to damp the cloth; then proceed to lightly rub the work with circular motion; as the rubber becomes drier, the pressure may be increased, but care should be taken not to press too heavily when the rubber contains much polish, as streakiness will result. The circular motion should be continued until the rubber becomes quite dry, when more polish may be taken upon it and the rubbing renewed. It should be borne in mind that the rubber should never be raised directly from the work, but should be raised with a sweeping motion; also that it should never for a moment remain quiet upon the surface; and that its motion should be as even as possible; neglect of these precautions will produce a rough surface wherever the rubber remains quiet or is improperly removed. The circular rubbing must be continued until the surface appears perfectly smooth and the pores are no longer visible. Be very particular to keep the cloth covering the wad clean and soft; it is desirable to use a clean portion each time it is dipped in the polish It is quite likely that in about twelve hours after the above operation the surface of the work will be lustreless, and the grain plainly visible; in that case proceed over the work again until the grain is thoroughly filled. French-polishing is a process requiring particular care and skill, and considerable experience is necessary to produce good results.

KITCHEN DRESSER IN THE NEW ART STYLE.

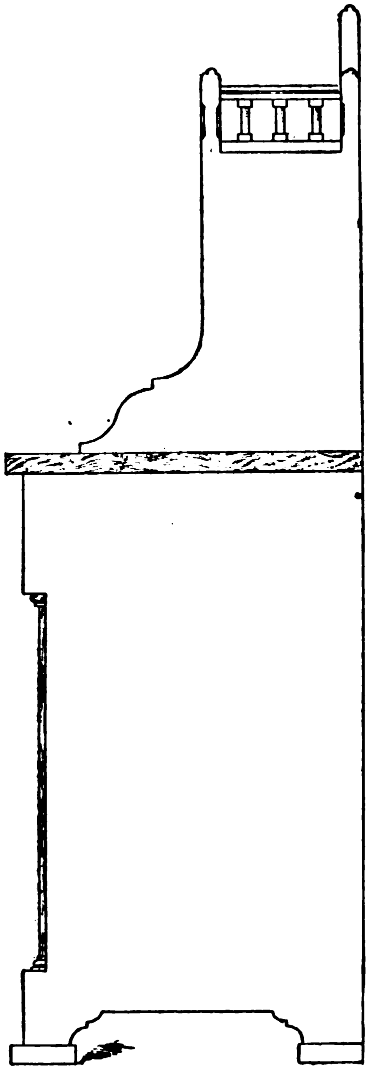
We now show a new thing in kitchen dressers, after what is called the "Art" style in furniture. It is a mixture of pine and mahogany, or pine and American walnut, which latter is, if anything, a better contrast. The design differs very materially from that shown on page 225. It may be argued that this design is too showy and too costly for a kitchen piece of furniture. The dresser is the principal piece of furniture in the kitchen or living room, and there is no reason why the dresser should not look elegant—a thing to take the eye and command the admiration of visitors upon entering the humble dwelling; and the cost, £5, is not extravagant.

We will consider this article as composed of pine and American walnut. Of course the distinction is not marked in a woodcut without colour, so it may be described briefly as follows:—The parts forming the carcase—that is, the body, including gables, back lining, doors, blocks at top and bottom, framing enclosing drawers, top, and the coping to the balusters at top—are of best clean yellow pine. The parts] composed of walnut are the drawer fronts, the two pilasters, four small panels on the blocks, the band around the main top, the balusters, the lying panel underneath the centre balusters, and the shields on the three doors. The two gables are 5ft. 3in. long, 20in. broad at the body, 10in. at the upper part where the small drawers are, and 1½in. thick; these go to the floor, with the exception of the small square blocks 1¼in. thick under them. The gables are clamped inside on the front edge with a piece of pine 1½in. square, and reaching from floor to top. This is to give a breadth of 3in. behind the pilasters, which cover the joints so made. The blocks on the front, top and bottom are 3in. broad and 1¼in. thick; these are rubbed on at the proper places, and the pilasters, which are 2in. broad, are fitted in between them. These pilasters have a small moulded cap and base on their ends 1in. thick; the moulding may be either a bevel or a hollow. The top is mortised through the gables same as described on page 225, but the tenons are hidden by the band of walnut planted along the gables, which gives the appearance of the upper portion being detachable from the under. This band, which is ⅜in. thick, is also carried along the front, being mitred at the corners and at the breaks inside the blocks. The accompanying illustrations show the front and end of the complete dresser.



Kitchen Dresser—Front View.

The case for the four small drawers, as also the carcase bottom and mid shelf behind the doors, are all raggle-dovetailed from the back, and not let through the gables as in our last job of the kind. The frame, under the two large drawers, is mortised into, but not through, the gables, as described for the former one's small drawers. The mounters between the doors and the base rail, and the rail under the drawers, are each 2in. broad, and all these have a sunk bead run in the centre of their breadth. The two doors, and the small one over the top, have this bead run in the centre of their stiles and rails. The same bead is also run on the drawer fronts an inch from the upper and under edge, and on the small drawers ½in. from the edges. The door stiles are 2¾in. broad, and 1¼in. thick, and are made with ⅝in. panels grooved in exactly as described before. Underneath the base rail is a drop rail shaped at the ends and centre as shown.



Kitchen Dresser—End View.

The breadth at the ends is 3in., and the narrow portions ¾in. This is fitted in after the job is framed together. The bottoms of the gables are shaped in a similar manner. The pilasters at either side of the front are ⅝in. thick, flat on the face, and have three narrow channels cut on front and edges, as shown in the figure. These are, of course, walnut. The small balusters are 2½in. long, ⅞in. thick, made all of one thickness in a lathe, and narrow channels cut round them ⅝in. from the ends, where they have a round tenon. The gables are checked for ¾in. back lining, which is put on same as in last job, but the portion above the small drawers is 1in. thick, and on its edge the balusters stand.

The short pillars, which divide the balusters into three fives, are 1½in. square, checked into the 1in. back, and are made in all respects same as the terminals on the gables. The lying panel under the centre balusters is 4in. broad and ¼in. thick, with a small hollow worked round the edge. The enclosed part underneath the four small drawers is a kind of press: it has a door 12in. square. The stiles and rails of this are 2¼in. broad and 1in. thick; the double lines show the sunk beads. The small gables on each side of this door are 1in. thick. The interior space is divided in the centre by a shelf, and sometimes two drawers are fitted in. All the drawer fronts are solid walnut. Veneer being unsuitable in this case, as the sunk beads would go through it.

The three shields on the doors are ¼in. thick, and left square on the edges. The two large ones are 6in. across the middle, and the small one 4½in. They are all glued on to the panels before putting in. The crossing bars on these shields are strips of pine, ¾in. broad, glued on top of the walnut; the drawer handles and brass being a revival of an old style in brass mounting. The large doors have 3in. and the small one 2in. brass-butt hinges. All these doors are furnished with small mortise latches, which are worked by the hanging brass handles.

Any one who has studied the construction of the dresser fully described in August part will be able to understand the construction of this, as the interior work in both is the same. Of course it is a piece of work to execute which in first-class style would require a first-class workman; but the same truth holds good with any piece of furniture, no matter how simple. At the same time I know there are many amateurs in the cabinet-making line who could put the average bred-professional to the blush, and there is nothing to deter such from undertaking a task like this. The construction is simplicity itself—all the parts are rectangular, no sweeps or circles to contend with. All you require is careful study along with practical working out of the directions previously given, careful measurements, and a determination to do every part as well as ever you can—then there is no fear of an unsatisfactory result.

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Dead Polish on Steel Articles.—A finely polished lustreless surface on tempered steel can be procured by either of the following operations: After the steel article has been tempered it should be rubbed on a smooth iron surface with some pulverised oil-stone until it is perfectly smooth and even, then laid upon a sheet of white paper and rubbed back and forth until it acquires a fine dead polish. Any screw holes or depressions in the steel must be cleaned and polished beforehand with a piece of wood and oil-stone. This delicate lustreless surface is quite sensitive, and should be rinsed with pure soft water only. A more durable polish is obtained by first smoothing the steel surface with an iron polisher and some powdered oil-stone, carefully washing and rinsing. Then mix, in a small vessel, some fresh oil and powdered oil-stone, dip into this mixture the end of a piece of elder-pith and polish the steel surface with a gentle pressure, cutting off the end of the pith as it commences to become soiled. In conclusion, it should be thoroughly cleaned in soft water, when the article will be found to have a fine white lustreless polish.

SMITHING AND FORGING.

By J. L. Lowe, Brentford.

CHAPTER IV.

Forging Small Articles. Slide Rest Tools. Tongs. Hammers.

In order to make good work the smith must always have a clean fire. Impurities rapidly collect in the neighbourhood of the forge, and they must be as rapidly removed. The first consideration is the quality of the coal. Screenings, of a good non-sulphurous description, will be found to answer well. Breeze or founder's ashes will make a beautifully clean and strong fire, and as they do not emit smoke the workman does not get so horribly black as is the case with the use of ordinary coal fires. If timber were not as scarce as it is we should see the English forges once more worked with charcoal, and the work would be very much improved thereby. We will now proceed to forge and put together a pair of flat-bitted smith's tongs, of the pattern in most frequent use. We may select a bar of 1in. square for a small pair; the iron must be of good quality, as the tongs get very rough usage. Laying about 3in. on the inside (fig. 1) edge of the anvil it must be taken down (reduced) to ½in. thick, at the same time it must be drawn edgeways, to keep it to 1in. in width; the above operation should take about one minute, and leave sufficient heat in the bar to go on with the second, which consists in turning the iron at right angles, and hanging the part already taken down (the bit) this time over the front edge of anvil, and proceed to flatten (fig. 2) the bar just behind it. If still hot enough, the third operation may be next performed. This is done by projecting the forging about 2in. forwarder on the anvil, and again turning at right angles (which will exactly reverse the position in which the iron was placed at the commencement), slightly elevating the back end, and striking the iron fairly over the front edge of the anvil, at the same time alternating the blows by turning and re-turning the iron at right angles (fig. 3). Next cut off the bit thus forged three or four inches behind (fig. 4) the part last treated. An exact counterpart of this must next be forged, and the end of each scarfed down. Now take a ½in. diameter rod, and upsetting one end, scarf it and weld on one of the bits; do the same with the other, and punch a three-eighth diameter hole in the centre of each joint; make a rivet the proper size, and with the rivet heated to redness, rivet the two together. The tongs are now made, but to finish them place the bits in the fire, and when hot dress them and the joint parallel; placing a piece of flat iron, ¼in. thick, between the jaws. Finally, and while still hot, plunge them in the water trough, working the handles or reins backwards and forwards till cold.

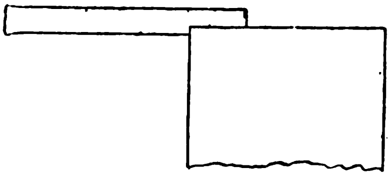
Fig. 1.

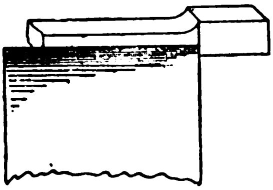
Fig. 2.

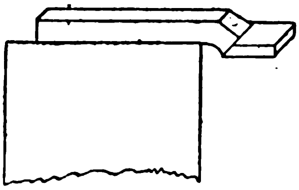
Fig. 3.

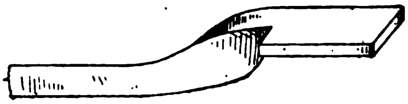
Fig. 4.

Hollow-bitted tongs must have the bits made wider, the edges thinned down and fullered in a top and bottom tool. After they are riveted they are to have a piece of round iron, the proper size, inserted in the bits or jaws, and dressed down to it. Figs. 5 to 12 show a variety of useful smith's tongs.

In forging tools for the slide rest, cast steel, of good quality, must be obtained, and the greatest care must be observed that they are not heated at any time hotter than blood red; for this reason it will not be found a very easy job to forge them. The spring planishing tool is to be made from steel, of square cross section; the first operation will be to flatten down three or four inches of one end, in the same way that flat-bitted tongs are commenced. As much work must be done as possible at each heat to avoid needlessly reheating the bar, and because hammering the steel till nearly cold condenses the grain and preserves its quality. In this job the sledge will be found greatly to assist the forgeman. After flattening the end as above, the portion so treated is to be turned back, angle outward, at right angles to the bar, then returned over the beck iron, and one or two inches, according to size of tool, laid parallel with the bar over a square edge of the anvil; the most critical part of the work has now to be done, viz., to dress the angle square.

The amateur smith cannot expect at first to make a good job of this unless he has a skilled companion to assist him, or has previously made very good use of his eyes in watching a professional smith working at a similar job. The thing to be avoided in getting an angle square, both internally and externally, is crippling or galling the steel. Watchfulness, during the operation, will enable him to see if there should appear the faintest dark line in the internal angle. This may readily be perceived while the metal is hot, and if seen the best thing to do is to throw it on one side and begin another, using more care this time. Supposing he is satisfied with his work, the front of the tool may next be cut off square from the bottom side and hammered till cold; it is now to be hardened and tempered to suit the work it is intended for, graduating from a blue colour for brass, to the lightest straw for steel.

The plain straight slide-rest tool scarcely needs description as to the best way of forging. From its very simple form it can be made at one or more heats by drawing on the beck iron, and should be hammer hardened before being finally heated for hardening in water.

The straightforward hooked tool is easy to make, and very useful when made. It is intended for rough work, and is therefore best at its full section, the front edge being merely slightly thinned. In each case the cutting edges are to be raised rather higher than the top of the shank; the exact angle can be given on the emery-wheel or grindstone before finishing with oil or Turkey stone.

The forms of slide-rest tools are legion; but the above examples are sufficient to indicate the processes used in making them. Modifications and variations will suggest themselves as they arise to the mind of the intelligent amateur.

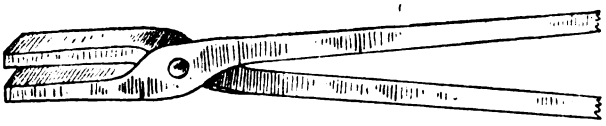
Fig. 5.

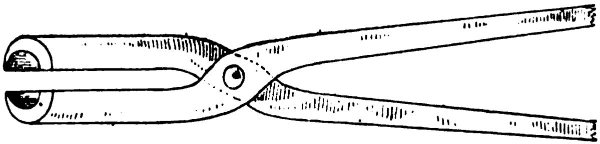
Fig. 6.

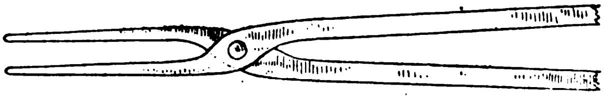
Fig. 7.

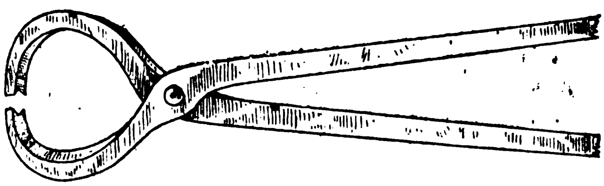
Fig. 8.

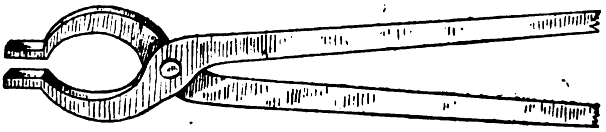
Fig. 9.

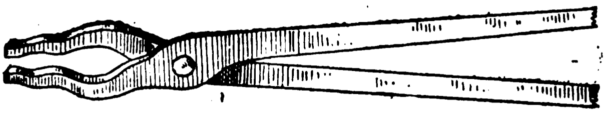
Fig. 10.

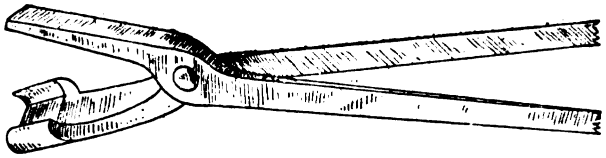
Fig. 11.

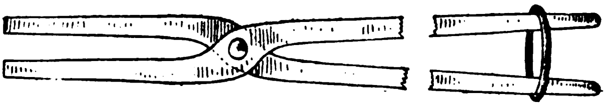
Fig. 12.

At the risk of becoming tedious, once more the writer emphatically warns his readers against overheating steel intended for metal-cutting tools.

It is as useful as practising scales in learning music, to experiment in turning a square steel bar at right angles without damaging it, and to make the external angle sharp and the internal one nearly so. Should a whole day or more be spent in this sort of work the time will not be wasted. Do not desist till you can do the job in a workmanlike manner, remembering that practice makes perfect. It is vastly better to do one thing in a superior manner than twenty in a slovenly way. The very repetition of a process will so impress it on the mind of the workman that he will not forget it, and when thoroughly learned some other may be commenced; so that as he proceeds he will be improving his manipulatory powers. First learn to do your work well, then learn to do it quickly.

The unlearned mechanic who has never seen a hammer forged, will probably think it a very difficult job, and would hardly be able to guess his way to make one. It is, however, simple enough, and provided he watches the various processes closely, and does not carelessly substitute the wrong for the right in any of them, will master this job in a short time. The system adopted by the writer scarcely varies, whatever may be the size of the tool; and with a little observation, the description of making a 2lb. or 3lb. hand hammer will suffice.

The iron may be either square or round, and the most important part of the job is to steel the two ends without burning or over-heating the faces. Some workmen cut a flat bar of steel about its own width from one end nearly through, then heating the bar from which the hammer is to be forged, and also the partly cut end of the steel bar at the same time in the fire till welding hot, they are taken out and with a light blow dabbed together; the remainder of the steel bar is then twisted off. This is quickly done, and the mass, still at welding heat, is jumped end on to the anvil to perfect the weld in the centre; then, being laid down, the edges are rapidly struck with a few smart blows on the end in addition. The above plan, although in very frequent use, is but an indifferent mode of facing a hammer with steel, for many reasons, such as, for instance, the rapid formation of oxide on the surfaces through exposure to the atmosphere, partly in, but mostly out of, the fire; the chances that a modicum of the said oxide may be adhering when the steel is placed on the iron: or again, iron or steel may be covered with a film of sulphur when brought out, and, of course, in either of the above cases, perfect amalgamation by welding cannot ensue. Again, a third reason: the piece of steel may be cut too far through, and may drop off the bar into the fire and be burned to destruction. Once more, the steel may not be cut far enough, and a hasty or nervous man, in twisting it off, may pull it off the bar altogether, and so spoil his job for that occasion. On account of the foregoing objections, the following process is recommended as a preferable one :—First, take a welding heat on end of bar, and jump it on anvil to solidify it ; then lay it on the outside of the fire while you knock down the extreme corners of your flat steel bar, something after the fashion of the shoeing smith when forming the clip or toe to a horseshoe. Cut off a short length slightly longer than the width of the bar, and, holding it with a pair of tongs, turn down the other two corners in similar fashion ; now hold the bit of steel on each corner alternately, and drive down the clips or tangs till they all point inwards at a slight angle from the vertical line. Leave it lying, tangs upward, on the anvil while you heat one end of your iron bar white hot; bring it out, place the heated end vertically on the cold steel, and with your hand hammer drive it bodily on to the steel tangs (fig. 13). Carefully and quickly insert in the heart of the fire, and blow up to a welding heat, peppering it with powdered burnt borax, and turning it round in the fire to insure uniformity. Carefully remove it from the fire, hold the end a little in advance of anvil front; strike it softly but squarely on end, draw back on anvil: dress the edges sharply, giving your hand hammer a pull towards yourself, again push it forward and this time time strike the steel endways more sharply than at first. Now with an oval rod punch drive a hole through, or rather let your mate do so with his sledge. This should be done from opposite sides, turning the bar before the punch gets more than three parts through, and holding the punch over a black mark you will find there. Have two or more graduated oval taper mandrels ready, and placing them in the hole drive through from each side (fig. 14) alternately, and you will find the hole to be smallest in the centre, and gradually tapering to each side. The hammer may now be held on the angle between the end and the hole on a bottom fuller (see Chap. I.) of suitable size, while the top fuller is held exactly over it by the rod. The hammerman strikes on it, and the bar is reversed and changed to each angle consecutively till the four hollows are of uniform depth. With a hot rod chisel next cut off the bar as shown at figure 15, and your hammer is more than half made. Now heat a bar of round iron, which will just go through the hole, turn back the end, and steel the remaining end of hammer exactly as you did the first; fuller down the pane end, and form your pane to your fancy. It will be seen that the draughtsman has reversed the hammer and shown it finished in diagram, fig. 16, whereas the unfinished or cut off end, or fig. 15, should have been the outside end of fig. 16.

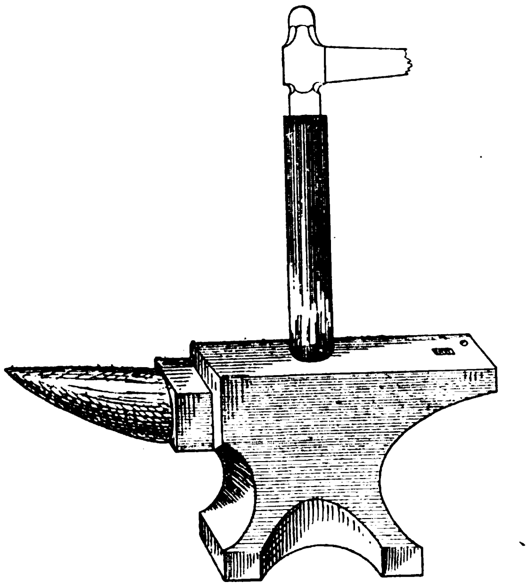

Fig. 13.

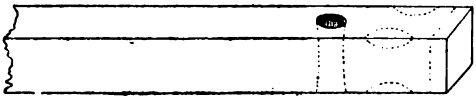

Fig. 14.

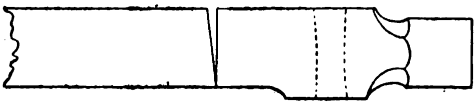

Fig. 15.

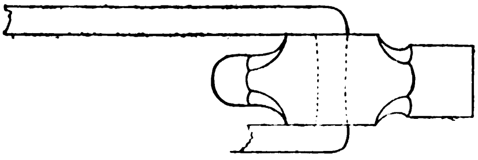

Fig. 16.

In the number of the "Amateur Mechanics" for November, the writer proposes to travel rather out of his usual course by describing the processes of ordinary drilling by hand or foot, in addition to the best methods of forging the drills.

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Covering Tables and Writing-Desks.—The following practical directions for covering tables, etc., with cloth or leather will interest our readers. Thick rye paste is boiled with thick turpentine—not the oil—slightly warmed. Thin strips of wood are then prepared not over 1⅜ inches wide and ¼in. thick, and the sharp edges trimmed off. The best thing is a shade roller cut lengthwise, and the round side put downward. The cloth is stretched at one end and one side, to such a lath and basted fast to it, but the lath must lie two inches from the edge of the veneering—inside— and the cloth must extend half an inch beyond the edge of the veneer, because it will be shorter in spite of the stretching. The lath may be tacked at intervals of six inches apart. After one end and one side are fastened the cloth may be stretched and basted around laths on the other two sides so as to form an inner border or frame two inches from the edges. The paste is then applied to the top of the table close to the veneer but not too near the lath, perhaps 1½ inches from it, and the cloth that projects beyond the laths is pressed down on the paste and rubbed against the edge of the veneer with the finger nail. There will be little folds in the cloth where it is basted, and these must be stretched out in pasting it down. It is then left to dry and the excess of cloth trimmed off with a sharp knife. Care must be taken in trimming it off, especially when the veneer is thin. If the cloth is cut back too far, a narrow strip should be pasted in between. The laths are then carefully removed and the cloth brushed off. The cloth should be put on so that the nap runs toward the front of the table, if its length permit of doing so. In covering a table with morocco, of course these strips of wood cannot be employed. To preserve its lustre the leather is evenly but not too strongly moistened on the wrong side with pure water to which a little vinegar is added. The whole top of the table is covered with paste and the leather laid on and smoothed out by scraping from the middle toward the sides. If one skin is too small they should not be joined in the middle, but a seam may be made near each end. The edges are cut with a rule and sharp knife, and placed both together. A modelling iron, to be had of any bookbinder, is run over these joints and along the edges. It is not necessary to heat the iron, but it is well to do this if the leather is not dry yet.

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Messrs. Churchill's New Catalogue.—We have seen proofs of a new and greatly enlarged catalogue which will be issued by the above firm about the time that this number of "Amateur Mechanics" is published. Messrs. Churchill, at their new premises, show an extensive and well-selected stock of American tools and machinery, for which the firm has such a well-deserved reputation.

OLD ENGLISH CLOCKS, AND HOW TO REPAIR THEM.

(For Illustrations, see Supplement.)

THE old-fashioned long-cased English eight-day clocks offer the best models on which to commence the study of practical horology. Although cumbersome when a removal is necessary, the immortalised "Grandfather's clock" is a piece of furniture which would adorn any hall or staircase.

When we look from the high standpoint of modern clockwork, in some instances the workmanship of these clocks is open to criticism. Still, the whole machine is the best that has yet been designed for reliable time-keeping. The solid construction of all its parts, and the regular geometrical proportions of the wheels—so far as their numbers and revolutions are concerned, and above all the seconds pendulum, and the long fall given to the weights, combine qualities which, notwithstanding the rude execution we may sometimes meet with, give better results than any other class of clocks made for household purposes.

Very few of the younger portion of the present generation have had opportunities afforded them to learn to repair one of these clocks thoroughly. In fact, of the many clockmakers who undertake the repairs of these clocks, few are thoroughly and conscientiously repaired with a view to restore them to their original condition, retaining as much of the old parts as is possible. When the clocks are relics, their owners generally desire this to be scrupulously attended to. To those of our readers interested in the subject, we propose to give a few hints on repairing this class of clock.

If the clock be very old, most likely the repairs necessary to restore it to its original condition will be very heavy. It is characteristic of these clocks, that if made in a manner only moderately accurate, and set going under conditions moderately favourable, when once set going they will run themselves almost to pieces before they stop. The pivot holes, the pivots and pinions, and the pallets, will all be found to be badly cut and worn. It is but seldom a new pivot will require to be introduced, because, as a general thing, the original pivots were all left thick enough to allow them to be reduced and polished when worn. Should a new pivot be necessary, either from the effects of wear, or from being broken accidentally, there are no pinions but what will admit of a new one being inserted. If the new pivot has to be put at the end of the arbor where the pinion head is, it will be best not to soften the pinion. If at the other end, a small part of the arbor may be softened with impunity. If you have no lathe with a chuck that will take hold of the pinion, to centre and bore the hole for the new pivot, you may centre it with a hollow drill, or by using a common drill, or a centre punch, always trying if the arbor and its pinion be true.

Before you commence to bore, try the pinion in a pair of turns, with sharp centres, and centre the new pivot hole true. Care must be taken in this method not to take anything from the shoulder of the old pivot, because too much end-shake to the pinion will be the result. After the pinion is centred, if it cannot be bored in the lathe, fix a split collet on it and turn it with the drill-bow, with the drill stationary in the vice. The best manner of making drills for such work was given in the first number of "Amateur Mechanics," page 13. Bore the hole well up, and clean the oil and chips of steel out of it thoroughly, and fit in the steel that is to make the new pivot. Fit it very carefully, in such a manner that, when put in its place, one tap from a light hammer will send it home, tight enough for every purpose. If fitted too tight, the arbor will be liable to be split; and if too loose, it will not hold; therefore, the necessity for fitting it with care in the first instance will be apparent. Should an arbor happen to get split, there is no other remedy but to put on a collar or ring over the split part, or solder the pivot in. Never solder a pivot unless as a last resource, and when you do solder it, always dip the soldered part in oil before it cools, to prevent rust from breaking out. The piece of steel being fastened in its place, from which the new pivot is to be formed, the rest of the operation will be comparatively easy. Centre it in such a manner that the pinion arbor will run exactly true, then turn the new pivot to the desired size, polish it, and round off the end.

In clockwork, when pivot holes are wide, never attempt to close them with punches. The frames are usually so thick that if they are punched a solid hole cannot be made all the way through. We have seen clocks that had the pivot holes closed by making deep marks with a centre punch all round the hole. This kind of treatment is "botching" in its worst form, and under no circumstances should it be resorted to. If a pivot hole be so wide that a smaller one is desirable, the object will be accomplished more satisfactorily, and an expert workman will do the work about as rapid, by putting in a new bush. The best way to proceed is to broach the old pivot hole three or four times larger than its original size, being careful to have a straight and round hole, widest towards the outside of the frames, and the edges of the hole carefully chamfered. The hole is now ready to receive the bush, which may be made encentric, so as to admit of being turned round to that position that will make the depth of the wheel and pinion most accurate.

An encentric bush can be made with ease and great rapidity, in any lathe that has a chuck that will hold a piece of wire. Grip the wire, which ought to be tough brass, in the chuck, and turn it to fit the hole already made in the frame. Set it a little out of truth, just as much as the bush is desired to be encentric, by tapping it with a hammer. Next cèntre the bush, as it runs in its new condition, and bore up a hole of the desired size. Cut off the newly-made bush just a little longer than the thickness of the frame, undercutting it a little at the same time. Open the hole with a broach till it fits tight on to its pivot, put the new bush in its place, and the necessary wheels into their places, and turn round the bush till the depth be right. The bush may now be riveted, and if fitted well, and not left to project too far above the level of the frame, a few taps of the hammer will tighten it, and the whole operation may be done in less time than it takes to write these directions. After riveting, the hole must again be broached out to give the necessary freedom to the pivot, and the hole polished with a round broach. The new bush must be properly countersunk, so as to retain the oil, and the frame repolished, where the bush was inserted, with blue-stone, and afterwards with rotten-stone and oil on a woollen cloth.

When the leaves of the pinions are badly cut, there is no use filing the marks out, because if the pinion has been right at first, filing will make the leaves too thin, and the pitching will be bad. It is better to shift the action of the wheels that work into the pinions. This is easiest accomplished by turning the necessary quantity off the shoulder of one of the pivots, and putting in a *raised* bush at the opposite end to fit the pivot. By this method two actions can be shifted by one alteration, and it is always better than disturbing the wheels on their arbors, which in old clocks are usually fastened to collets soldered with hard solder.

Sometimes it happens that a leaf gets broken out of a pinion, which is a serious matter when it is desirable that the old pinion be retained. In this class of clocks, where small solid pinions of seven and eight leaves are used, there is no way of saving the pinion except by fastening two collets near to the pinion head, and to these rings fasten a new leaf to take the place of the broken one. In the case of the centre and third pinions, where the wheel is riveted on to the pinion head, it will only be necessary to fasten one collet to hold a new leaf, because the wheel itself can be used in place of the other ring.

Even in the very oldest clocks we seldom see much wear on the teeth of the wheels, if the depths have been right when the clock was new. Sometimes a tooth, or a few teeth, get broken by accident, and these can be easily replaced in most instances. When a tooth or teeth have to be replaced, the most desirable method is to dovetail a piece of brass of the requisite size into the rim of the wheel, and fasten it by soft solder that will flow at a moderate heat. Soldering, in the present instance, is better than riveting, because an inexperienced person, and also the most experienced in some instances, will stretch the wheel in riveting and put it out of round. Soldering, if a moderate heat be used, is harmless; and if care has been taken to fit the brass exactly to the dovetail, the solder will not show much when the sides are polished off. The tooth or teeth may now be formed in the new brass that has been inserted in the wheel, and if done agreeable to the above instructions, the wheel, for all practical purposes, will be equally as good as when new. Sometimes, when a tooth or teeth are broken, small holes are drilled in the edge of the wheel, and pins driven in to take the place of teeth. This plan is good as a temporary method, and may be practised in temporarily repairing a clock which could not at the time be removed to a workshop. But although proper under such circumstances, it is not to be commended as an example to follow when a clock has to be put in thorough repair.

In repairing the escapement, probably in some instances there will be a difficulty in retaining all the original parts. If the escapement has been in action for a long time without oil, the points of the teeth of the scape-wheel may be worn. In most cases the wheel can be restored and rendered as good as new by putting it in the lathe and "topping" the teeth with a smooth file till they are all of equal length, and then dressing them up to the proper shape with files; but should the wheel have any inequalities in the division of the teeth there is no use troubling with it. Put in a new one at once, for this part of the clock cannot be saved and do justice to the other parts. A new wheel can be made very easily by any person who has a cutting engine, and understands how to use it. The pallets will be sure to be badly cut, because invariably they are the first part of these clocks to wear out. If they are recoiling pallets, in most instances they can be repaired, if judiciously managed. If they be hard, soften and file out the marks that have been worn in them. Then close the pallets by bending them till they closely embrace the number of teeth they originally did. This is done with the greatest safety by placing them between the jaws of a vice and closing the vice gently. It will be noticed that by this method of closing pallets, the part nearest the movable jaw of the vice will bend first; so, after closing them a little, it will be well to reverse the pallets in the vice that they may be closed evenly. This method of bending is better than that of using a hammer; the strain does not come on the steel so suddenly, and pallets very seldom break when closed in this manner. After the pallets have been filed and closed in the above manner, when they are placed in the frames along with the scape-wheel, it will be found that the "drop" on the perpendicular pallet will be considerable. This drop can only be reduced by altering the front pivot hole of the pallets, or by taking the steady pins out of the back cock and moving it down, or by both methods, care being taken to steady-pin the back cock after moving it to its new position. The "drop" of the horizontal pallet can only be altered by bending the pallets in the manner already described. The acting faces of the pallets, if it be a recoiling escapement, should be shaped so as to produce a slight recoil, or retrograde motion of the scape-wheel, after a tooth has escaped from the one pallet on to the other.

It is difficult to describe in writing the precise shape that these pallets should be. The shape is one of great importance, and if the workman is not conversant with the subject, his safest course is to notice and preserve the precise shape these acting faces were *before the pallets were bent*, and file them to the same shape afterwards. If this be carefully attended to, and the drops adjusted as described, the escapement will be as good as it was when the clock was new. If the escapement be a dead-beat one, and the pallets be much cut on the circular part, it will be difficult to retain the old pallets and make a good escapement. After the marks are taken out of the acting faces they will be too thin, a certain amount of thickness being necessary. In some instances, when they are not deeply worn, they may be repaired so as to last many years. The same directions for closing and altering the drops apply to this form of pallets as well as to recoiling ones. The inclined planes, or impulse faces, have to be filed so that the teeth of the wheel will strike just beyond the edge of the angle.

The "going" part of the clock having been repaired, it will be necessary to take a look at the striking part; and this part may be found to be considerably out of order. The method of lifting the hammer is of importance, but the action of the hammer spring is but seldom right, especially if it be a spring bent over to a right angle at its point. If there are two springs, one to force the hammer down after the clock has raised it up, and another shorter one, fastened on to the pillar, to act as a counter-spring, and prevent the hammer from jarring on the bell, there will seldom be any difficulty. The only operation necessary is to file out worn parts, polish the acting parts, set the springs a little stronger, and the thing is done. But if it be one of the first-mentioned construction, some further directions will be necessary, because the action of the one spring answers the purpose of the two in the last-named method. To arrange it so that the hammer will be lifted with the greatest ease, and then strike on the bell with the greatest force, and without jarring, requires some experience. That part of the hammer stem which the spring acts on should never be filed beyond the centre of the arbor, as is sometimes done, because in such a case the hammer spring has a sliding motion when it is in action, and some of the force of the spring is thereby lost. The point of the spring should also be made to work as near the centre of the arbor as it is possible to get it, and the flat end of the spring should be at a right angle with the edge of the frame. That part of the hammer stem that strikes against the flat end of the spring should be formed with a peculiar curve that will stop the hammer in a particular position, and prevent it jarring on the bell. This curve can only be determined by experience; but an arc of a circle six inches in diameter will be nearly right. The action of the pin-wheel on the hammer tail is also of importance. The acting face of the hammer tail should be in a line with the centre of the pin-wheel, or a very little above, but never below it, for then it becomes more difficult for the clock to lift the hammer. The hammer tail should be of such a length as to drop from the pins of the pin-wheel; and when it stops be about the distance of two teeth of the wheel from the next pin. This allows the wheel-work to gain a little force before lifting the hammer, which is desirable. In setting the hammer spring to work with greater force, it is always well to stop the fly with your finger when the clock is striking. If this remain stopped it indicates that the hammer spring is stronger than the power of the clock can bear, and it ought to be weakened, because the striking part will be sure to stop whenever the clock gets dirty.

That part of the mechanism that regulates the number of blows to be struck on the bell, may be in disorder, and worn in some parts. The rack, which must be considered as the segment of a wheel, should have its first tooth a little longer than the others, so that the other teeth will not grate on the point of the rack catch, and make a disagreeable noise when the clock warns before striking. The "tumbler," or gathering pallet, that works into the teeth of the rack may be split or worn out. The figure VI. is a good model to make a new one after. It is necessary to cause the tumbler to lift a little more than one tooth, and let the rack fall back again, to insure that one will always be lifted. If such were not the case the clock would strike irregularly, and would also be liable sometimes to strike on continually till it ran down. If the striking part be locked by the tail of the tumbler catching on a pin in the rack, the tail of the tumbler should be of such a shape that will best allow the rack to fall back when the clock warns for striking the next hour. Of course the acting faces must be perfectly smooth and polished. A guard pin ought to be put in the frame, if one does not already exist, to prevent the rack from going farther back than is necessary to strike twelve. Sometimes, when the striking part happens to run down first, the rack-arm rides on the snail on the hour wheel. The teeth of the rack are then, in some instances, allowed to go out of reach of the tumbler. When the clock is wound up, of course it will continue striking till it runs down, or the weight is taken off, or the rack again put in action. It is necessary for the rack-arm to be made so that it will ride on the snail easily, because if the striking part, from any cause, should be stopped and the other part going, the clock would stop altogether between the hours of XII. and I. Therefore, put a guard pin, as already stated, because it is necessary to guard against every possible contingency. The teeth of the rack may require dressing up in some cases, and to allow this to be done the rack may be stretched a little at the stem, with a smooth-faced hammer, on a smooth anvil. If it wants much stretching, take the pin of the hammer and strike on the back, with the front lying on the smooth anvil. The point of the rack catch will be much worn, and when dressing it up it will be safe to keep to the original shape or angle. The point of the rack catch is always broader than the rack, and the mark worn in it will be about the middle of the thickness; so enough will be left to show what the original shape was.

The collet in front of the hands is a little thing, but it is seldom right; one that will hold the hands firm, and allow them to be moved small portions of space with ease and certainty.

Before making a collet, first straighten the minute spring, and put it on its place on the centre pinion. Put the minute wheel on its place on the top of it, and then the minute hand on its place; now see the space there is from the surface of the hand to the pin hole in the centre pinion. Make the collet so high that it will just cover the hole, and then cut a slit in the collet just as deep as the hole is wide. Make the slit to correspond with the hole in every way, and in such a manner that when the pin is put in it will fit without shake. A collet made in this manner will last as long as the clock, and when the minute spring is set up the hands will always be firm, and at the same time move easily, and not affect the motion of the clock when they are set backward or forward. The square on the pipe of the minute wheel sometimes projects through the minute hand, and the collet presses on it in place of the hand. When this is the case it should be filed down, because the minute hand cannot be held firm unless the collet be very much hollowed at the back, which it is not always advisable to do.

The suspension of the pendulum, the pendulum spring, and the action of the crutch, or back fork, on the pendulum, are all of the most vital importance. The spring should be perfectly straight, and should fit into the slit of the cock without shake, and the slit should be perfectly straight, and at right angles to the dial of the clock.

The back fork should fit easily and without shake, and the acting part stand at right angles to the frames. The pendulum bob should swing exactly in a plane with the frames and the dial. After a clock has been put in its case, before putting on the head, it is well to get up high enough and look down to see that all these parts work as has been described.

In restoring the dials and brass work on the cases of these clocks, those unexperienced in the processes should not attempt doing the work. The bright work may be "dipped," or in particular cases the brass work may be gilt. Those not afraid of spoiling their clothes, or making their hands yellow, may dip the brass pieces in nitric acid, and rinse in clean water, after the old lacquer has been taken off by first boiling them in potash. The nitric acid will clean and bring the brass to its original colour, and it must be lacquered afterwards. The silvering of the dial can be done by following the instructions given elsewhere. Various methods of bluing the hands, after they have been thoroughly cleaned, are available.

Such are some of the hints necessary to an inexperienced workman when repairing and restoring an old-fashioned clock. We have never seen a clock of this class, however old, but could, with judicious care, be put in condition to do service for another generation, and preserve to its owner all the hallowed memories of the past that may be associated with the old clock.

Solution for Turning and Boring.—Common soap scraped into shreds and dissolved in water to the consistency of good milk, with oil added in the proportion of $\frac{1}{4}$ to $\frac{1}{10}$th is the best stuff to use when turning or boring wrought iron or steel. Keep the point of the tool well supplied with this liquid.

The Polytechnic Engineering Workshops.—The new session commences on October 1st. A new workshop has been fitted up during the recess. Several new lathes, a planing machine, and other tools have been added. We shall be pleased to see any of our readers interested in engineering workshop practice on any Monday or Tuesday evening, when the classes of the Polytechnic Institute assemble. The workshop is available for the use of amateurs; particulars as to terms and hours may be obtained on application.

THE AMATEUR WOOD TURNER.

By A. Cabe.

PART VII.

THE illustrations accompanying the present paper show what is called a bobbin-stand, or lady's companion. It will furnish a very nice exercise to the amateur turner, and, when completed, makes a very pretty, as well as useful, present to a lady.

The article, as will be seen, consists of three circular plates, or discs, supported on central pillars, and surmounted by a cushion-holder on a short pillar. Fig. 1 shows an elevation.

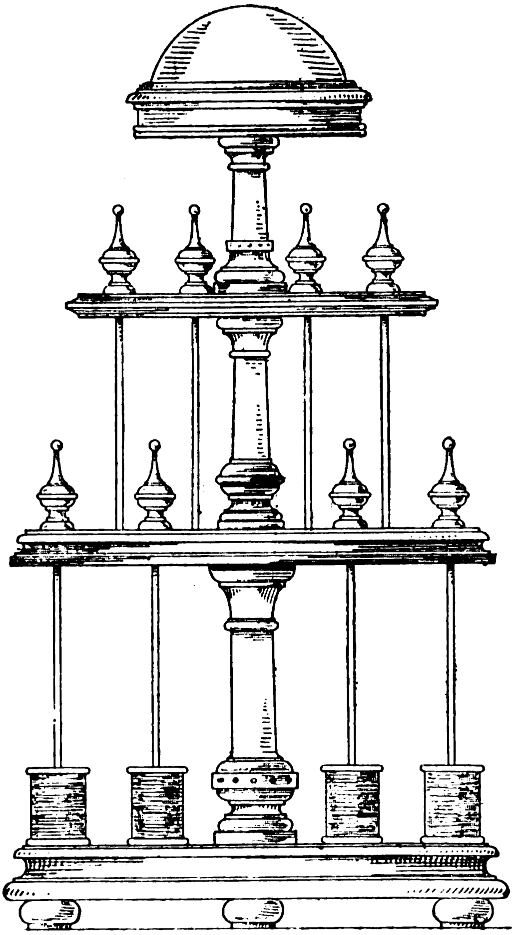


Fig. 1.—Elevation of Bobbin Stand.

I have made quite a number of these in walnut wood, as well as in mahogany and birdseye maple, the latter looking very pretty, though Italian or American walnut are preferred, because they afford a better contrast to the white and coloured bobbins with which the stand is meant to be filled.

The three plates, and the cushion-holder, will afford a good exercise in face-plate turning. They are all, of course, cut from the wood plankways. The lower, or sole-plate, is 9½in. diameter, and ⅞in. thick. When these plates are cut from the plank with the bow saw, I usually plane the back—that is, the under side of each—smooth and level, which side is placed next the chuck, or face-plate, and needs no turning. The face and edges are then operated upon, being moulded with chisels and gouges as per drawing; or if the operator has a good eye, and a good taste for fine moulding, he may adopt any other form of outline he may fancy.

The tools should be well ground, and have fine keen edges, or they will tear the wood, showing, at two places in the circular edge, a roughness which no amount of sandpapering will remove. This is a difficulty that always presents itself in turning the edges of discs plankways, as at two places in the revolution the end grain of the wood is coming directly against the cutting edge of the tool, and it is only with the keenest of tools that these parts can be cut, and not torn more or less.

When turning the face of the sole-plate, and after the edge is moulded, a light mark is made with the corner of a chisel, or with a draw-point. This mark is fully half an inch in from the edge, and indicates the line on which the holes are bored for the wires. Half an inch inside of this line a considerable hollow is commenced. It is about 1½in. broad, finishing near the base of the pillar, and is ⅜in. deep in the centre, being an arc of a circle. Its purpose is to hold sundry ladies' requisites, such as pins, hooks, buttons, etc.; besides, it lightens and smartens, so to speak, the job. After the hollow is made, it will be seen that there is fully an inch of level space outside of it for the bobbins to sit upon.

The second plate, which sits upon a pillar 5½in. long, is 9in. in diameter in the rough, and ⅝in. thick. It is moulded on the edge, and turned on the face as before. Again a light mark is made with a draw-point while the plate is revolving, the said mark making a circle exactly the same diameter as that on the sole-plate, and again a hollow is made ¼in. deep, and finishing near the base of the second pillar. These hollows are worked to nearly a finish with a ⅝in. or ¾in. gouge, and finished with a circular-faced chisel, made very keen and held flat on the rest. The hollow in this plate is necessarily narrower than that on the sole-plate, as level space is needed on this plate for the second tier of bobbins to sit within the line mentioned above, consequently a second line has to be marked, some ¾in. within the first on this plate, for the second tier of wires, the third plate having a line or circle of the same diameter for the same wires. This third plate is somewhat less than ½in. in thickness, and is 7in. in diameter; it also has a hollow on its upper side about an inch broad.

The lower pillar is 5½in. long, and 2in. diameter at its bulkiest part. The second pillar 4¼in. long, and 1⅝in. diameter. That supporting the cushion is 3in. long, and 1⅜in. thick.

Each of the three plates have a 1in. hole cut through them with gouge and side tool while running in the lathe, to receive the pillars. The manner of letting the pillars into each other is shown in section, fig. 2.

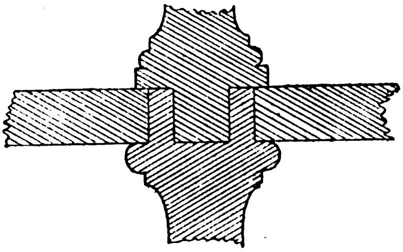


Fig. 2.—Mortising the Pillars.

The bottom of the second pillar has a ¾in. tenon turned on it, and is let into the top of the first, which comes quite through the plate. The third pillar is treated in exactly the same fashion, and when these are properly fitted, and well glued in, they make a firm substantial whole.

The cushion holder is 4¾in. diameter, and 1in. thick. It is moulded as shown, and hollowed out to a depth of ¾in., said hollow having a flat bottom. A ring (shown, section fig. 3) is fitted neatly into this recess, projecting above the surface ⅛in., and formed into a quarter-round. Inside the ring, and fitting loosely, is the saucer, fig. 4. It is a piece of pine ¾in. thick, hollowed out to contain sawdust. The sawdust is heaped up and pressed into it; over the sawdust is stretched a piece of calico, which is pulled tightly down and glued round the outer edge of the saucer. This cushion, if properly filled, should form a half ball above the ring. When the glue is dry, a piece of velvet or silk is laid over and the ring placed on from the upper side and pressed down, the covering being pulled tightly down at the same time. It will thus be seen that the purpose of the ring is to keep the covering neat and tight without wrinkles. The ring with its cushion will now fit into the holder, making a neat job. Of course the cushion is not put in until after the polishing.

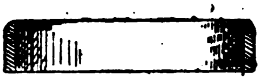


Fig. 3.—Ring of Cushion.

Fig. 4.—Inside of Ring.

The next job is to turn three ball feet, and twelve tops for the wires. The ball feet are 1in. in diameter, and ⅛in. thick.

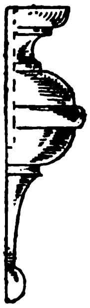


Fig. 5.—Finial Enlarged.

The top ornaments for the wires are shown, fig. 5, half elevation. They are 1⅛in. long and ⅜in. thick. They have a ⅛in. hole bored in the centre of their bottoms to receive the wires, which are brass, No. 10. They should be nicely straightened and polished with fine emery cloth. They must be of a length to allow ⅝in. for the finials thence to pass through the plate, and ½in. into the lower plate. The holes in the plates are fully ⅛in., to allow the wires to pass through easily. The ends of the wires that enter the vases are roughened with a file, and glued in. The lower ends are pointed, to enter the plates readily.

Now to mark off the wire holes for boring, take the radius in compasses from the centre of the plate to the circular mark. This radius will divide the circle into six equal parts. Mark the lower and second plate with this measure. Divide the third plate in the same way; also the upper side of the second plate. The holes may be in line with the first row, as in the plan, fig. 6, or the upper tier may fall intermediately between the lower. In gluing the plates to the pillars, care must be taken to have the holes in each pair of plates vertical the one above the other, else the wires will not stand plumb but appear twisted.

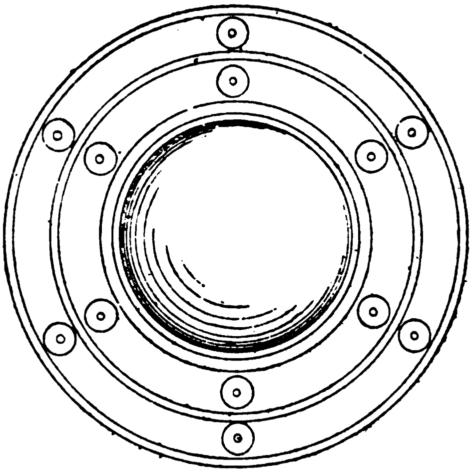


Fig. 6.—Plan.

In the elevation, fig. 1, the lower tier shows one bobbin on each wire. On this tier each wire will hold three or four bobbins. The upper tier will hold two or three, according to size.

The finials on the tops of the wires are used for holding thimbles, etc.

In making this job, the whole of the parts would be polished before putting together, after which it would get a finishing touch by the polisher.

The ball feet may be put on with small screws. They are three in number, and are put on equidistant round the sole.

Our next paper will show an article of the same character as the above, called the Dome Pincushion.

* * *

Imitation Wax Finish.—Apply three coats of white shellac; rub down with pumice-stone and oil; clean up with brown japan and spirits of turpentine mixed. Varnish-polish the panels.

To Temper Tools.—The quality of the steel should be uniform throughout; indeed, it is always better to have them tempered rather too hard than soft, for use will reduce the temper If at any time it is necessary to perform the operation yourself, the best method is to melt a sufficient quantity of lead to immerse the cutting part of the tool in. Having previously brightened its surface, plunge it into the melted lead for a few minutes, till it gets sufficiently hot to melt a candle, with which rub its surface; then plunge it in again, and keep it there till the steel assumes a straw colour; but be careful not to let it turn blue. When that is the case, take it out, rub it again with the tallow, and let it cool. If it should be too soft, wipe the grease off, repeat the process without the tallow; and, when it is sufficiently hot, plunge it into cold spring-water, or water and vinegar mixed. By a proper attention to these directions, and a little practice, every workman will have it in his power to give a proper temper to the tools he may use. If a saw is too hard, it may be tempered by the same means; but as it would be not only expensive, but in many cases impossible to do it at home, a plumber's shop is mostly at hand, where the process may be repeated when they are melting a pot of lead. But here observe that the temper necessary is different to other cutting tools: you must wait till the steel just begins to turn blue, which is a temper that will give it more elasticity, and, at the same time, sufficient hardness.

WHITEWASH.

THE process of whitewashing is known by various names, such as "calcimining," kalsomining," etc., most of them derived evidently from the Latin name for *lime*, which was the principal ingredient of all the older forms of whitewash.

Professors of the "Art of Kalsomining" affect a great deal of mystery, but the process is very simple. It consists simply in making a whitewash with some neutral substance which is made to adhere by means of size or glue. It contains no caustic material like lime. Several substances have been used with good results. The best is zinc white. It gives the most brilliant effect but is the most expensive. The next is Paris white or sulphate of baryta. This, when pure, is nearly equal to zinc white, but, unfortunately, common whiting is often sold for it, and more often mixed with it. It is not difficult, however, to detect common whiting either when alone or mixed with Paris white. When vinegar, or better still, spirits of salt, is poured on whiting, it foams or effervesces, but produces no effect on Paris white. Good whiting, however, gives very fair results and makes a far better finish than common lime as ordinarily used. When well made, however, good lime whitewash is very valuable for out-houses, and places where it is desirable to introduce a certain degree of disinfecting action. One of the best recipes for lime whitewash is that known as the "White House" whitewash, and sometimes called "Treasury Department" whitewash, from the fact that it is the recipe sent out by the Lighthouse Board of the Treasury Department. It has been found, by experience, to answer on wood, brick, and stone, nearly as well as oil paint, and is much cheaper. Slake one-half bushel unslaked lime with boiling water, keeping it covered during the process. Strain it and add a peck of salt, dissolved in warm water; three pounds ground rice, put in boiling water and boiled to a thin paste; one-half pound powdered Spanish whiting and a pound of clear glue, dissolved in warm water; mix these well together and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace, and when used put it on as hot as possible with painters' or whitewash brushes.

Kalsomine, as distinguished from lime whitewash, is best suited for the interior of rooms in the dwelling house. To kalsomine a good sized room with two coats, proceed as follows:

Select some very clear colourless glue and soak ¼ lb. in water for 12 hours. Then boil it, taking great care that it does not burn, and this is best done by setting the vessel with the glue in a pan of water over the fire. When completely dissolved add it to a large pail of hot water, and into any desired quantity of this stir as much of the white material used as will make a cream. The quality of the resulting work will depend on the skill of the operator, but we may remark that it is easier to get a smooth hard finish by using three coats of thin wash than by using one coat of thick. If you have time for but one coat, however, you must give it body enough. In giving more than one coat let the last coat contain less glue than the preceding ones.

Kalsomine, such as we have described, may be coloured by means of any of the cheap colouring stuffs.

The following is recommended as a good kalsomining fluid for walls: White glue, 1 lb.; white zinc, 10 lb.; Paris white, 5 lb.; water, sufficient. Soak the glue over night in three quarts of water, then add as much water again, and heat on a water bath till the glue is dissolved. In another pail put the two powders, and pour on hot water, stirring all the time, until the liquid appears like thick milk. Mingle the two liquids together, stir thoroughly, and apply to the wall with a whitewash brush.

It is often desirable to "kill" old whitewash, as it is called, as otherwise it would be impossible to get new whitewash or paper to stick to the walls. After scraping and washing off all loose material give the walls a thorough washing with a solution of sulphate of zinc (2 oz. to 1 gallon of water). The lime will be changed to plaster of Paris, and the zinc will be converted into zinc white, and if a coat of kalsomine be now given it will adhere very strongly and have great body.—American "Workshop Companion."

CORRESPONDENCE.

Readers are invited to avail themselves of this section for the interchange of information of any kind within the scope of the Magazine.

All communications, whether on Editorial or Publishing matters, or intended for publication in our columns, should be addressed to PAUL N. HASLUCK, Jeffrey's Road, Clapham, S.W.

Whatever is sent for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Be brief, write only on one side of the paper, send drawings on separate slips, and keep each subject distinct.

We cannot undertake to return manuscript or drawings, unless stamped and addressed envelopes are enclosed for the purpose.

We do not hold ourselves responsible for, or necessarily endorse the opinions expressed.

MECHANICAL DRAUGHTSMEN & ARCHITECTS.

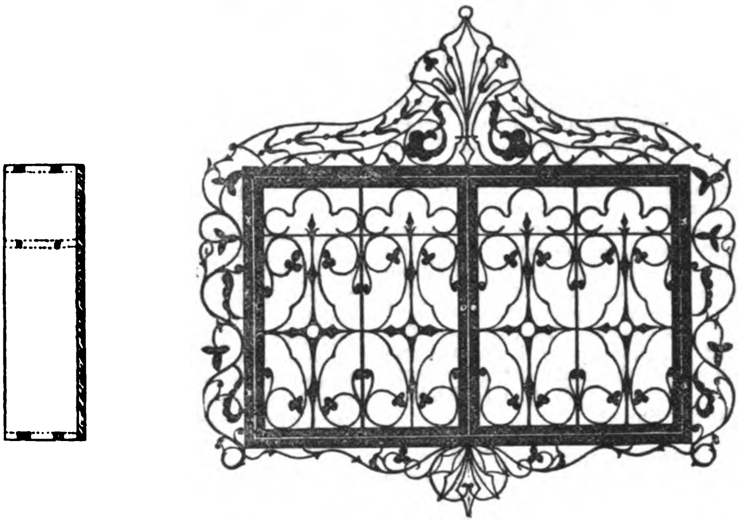
Sir,—Many of our readers know, as well as I do, that it is a blundering mistake for any man to call himself either a mechanical draughtsman or an architect unless he has been for three years at least in an engineer's or a builder's workshop, and worked with the other workmen at the bench. He might then know some little of the practical part. He then should have at least another three years in the engineer's or the builder's workshop, before he calls himself an architect or draughtsman, or in other words, "a professor of the art of building," whether it be building churches, bridges, engines, or whatsoever. In my opinion, a so-called draughtsman, or architect, who has not served some part of his apprenticeship in the workshop at the bench, is no good at all if he is required to make drawings for the workmen to carry out the designs practically. I remember a case very well, in which the mechanical draughtsman, as he called himself, played an important part. The facts of the case were these:—An old machine, which had seen its best days, was to be re-placed by a new one of the same kind. The draughtsman was ordered to make a working drawing to a scale of the machine; he, in the first place, took a rough sketch, and then went into the office to make the drawing. Well, when the drawing came into the shop it was at once seen he (the so-called draughtsman) was not a practical man; his mistake was that he had shown V threads running close to a square collar, instead of showing the thread to finish at $\frac{3}{16}$ or ¼ from the collar. This is only a small mistake, but large enough for the manager to discharge the so-called draughtsman. At the works where the above happened they were most particular, at that time having some very expensive machinery in the process of construction, and a slight mistake of the draughtsman might cause some hundreds of pounds damage if the workmen did not detect the mistake in time. I feel sure some of our readers can remember mistakes of a very stupid kind in drawings they may have looked over from time to time. I do not mean to say that a practical man would not make a mistake or a blunder, but he would, I think, in ninety-nine cases out of one hundred, find his mistake out himself; but the non-practical man would require to be told and even shown why it was a blunder or mistake.

Yours, etc., GEO. F. JACKSON,
Engineering Instructor, Bloxham.

PIPE RACK IN FRETWORK.

Sir,—This piece of fretwork, designed specially for this magazine, consists primarily of a shallow box, 10½ inches long, 6¾ inches wide, and 1¾ inches deep. These are the exterior measurements. The sides of the box are dovetailed, as the wood being thin is not sufficiently strengthened at the corners, if jointed by gluing alone. The dovetail can be easily and effectively cut by the fret-saw. The illustration shows a front and end view.

Then with a very fine bradawl—mine is a darning-needle, broken off, shaped and sharpened on an oil-stone, and soldered into a short stout piece of brass wire for a handle—pierce one of the lower corners of the doors. With a very fine saw cut out the part forming the two doors in one piece. This materially lightens the wood to be moved about. Now the frame thus formed has to be dealt with. File up this frame inside to take off any inequalities, but not too much, or the doors will be loose. Proceed to cut the remainder of the work in the ordinary manner. Next, hinge the doors. Quarter brass butt hinges, and ⅜in. *iron* screws—O's are best. Many hinge the doors before cutting the patterns and remove them to cut, but I have always cut the fretwork first, and have had no misfortunes, care being a large factor required in order to obtain success.



Pipe Rack in Fretwork.

The front is cut from a square of fretwork wood. The kind is left to the needs or tastes of the sawyer. Walnut or oak are very suitable; walnut specially so, the reason being, in the delicate parts of the work—as in the upper part of the front and in the two doors—where the lines in the original are scarcely $\frac{1}{16}$ wide, a uniformity of grain and great strength are necessary. Walnut possesses these qualifications to an eminent degree, while oak, slightly differing in the texture of the grain, is very strong and tough.

The dimensions of the wood necessary, are 12½ inches long, 12½ wide, and not less than ¼ thick.

The width may be reduced but not the height, or it will not allow sufficient room for the stems of the pipes.

Be cautious to paste the pattern on the wood so that the grain shall run up and down; not across, for if this be permitted the top will be sure to curl over.

Commence by sawing off the top corners so as to follow the outlines of the pattern approximately, not closely, otherwise it will weaken the structure too much at first to bear the sawing.

Turn or file up two knobs to fix in the doors for handles. The doors should be lined with dark silk, glued to the back of them, to show up the fretwork and screen the pipes.

The horizontal shelf, from which the pipes hang, is screwed to the back about 1¼ to 1½ inches from the top, and thus admits of an ordinary pipe hanging down suspended by the bowl.

The front should now be glued and bradded to the back, and the whole suspended by two nails passing through two holes, drilled at the top corners of the back or by any other convenient method.

"T. H. S."

ARTISTIC ORNAMENTAL TURNERY.

Sir,—Your correspondent, General Clarke, has not only wonderful skill in the use of the ornamental lathe, but also perfect taste and artistic feeling in the art of design. The cups which you have pictured for us are as far above the ordinary "Pagoda" work as ornamental turning is above plain turning. I refer more particularly to their artistic value, as we can only infer a perfect finish from the photo-lithograph. As the great master is always kind and considerate to the humble pupil, I am emboldened to ask him to re-solve me a difficulty I have met with. In the cup, shown in your February number, immediately above the base, is an ivory disc with its edges cut into beads. The beads are large and close together. Will he kindly tell me with what tool he cuts the beads; and if, as I presume, it is done with a bead tool in the drill frame, how he reduces the ground from which the beads spring to a plane surface? In my work I can get the bead cut well enough, but upon the edges of the disc, between the beads, there is a little triangular bit—the spandrel of the arch, so to speak—which the tool does not touch. General Clarke seems to have got rid of this so perfectly, that I am inclined to think it is done in some way in the lathe, and hence I appeal to him for information. His two cups have excited in me such admiration and such respect for ornamental turning (which I never had before I saw them) that I would esteem it a privilege to sit, as a humble pupil, at the feet of so great a master.

New York. "G. J. W."

[General Clarke has favoured us with an exhaustive reply, part of which is appended. The remainder, with illustrations, will appear in our next issue.—Ed.]

Dear Sir,—I feel much flattered by the very favourable remarks on my turned work in the letter of your New York correspondent, "G. J. W." I shall at any time be most happy to give any information in my power respecting the instruments and appliances employed in ornamental turning, so far as I am acquainted with them, through the pages of your publication, to anyone who applies to me personally. In forming "beads" with the drill it will sometimes be difficult to find any division of the dividing plate that will give exactly the space required between one bead and another. Of course the greater the variety of divided circles on the plate, the greater the chance of finding some division that will exactly suit, and in most cases it is immaterial what the number of beads may be, so long as they are placed just touching one another. I find, on examining the disc specially alluded to by "G. J. W.," that there are 45 beads, so I must have used a division of 90 (which I added to my dividing plate some years ago), taking 2 holes for the distance between each two. To get rid of the small triangular bit of ivory left by two consecutive operations of the tool, I used a small flat-ended drill, applied at the intermediate divisions on each side of the disc, adjusted so as just to clear the beads, and allowed to penetrate till its end was at the level of the neighbouring surface. There will always remain small projecting points of ivory, but they are so trifling that, with the point of a sharp knife, they may be removed, but I do not think it is possible to arrive at so perfectly smooth and polished a surface at these places as will satisfy a close observer. If the number selected for the spacing is not divisible by 2—as, for instance, if a distance of three holes is required—it is not so easy to place the flat-ended drill half-way between two beads. In this case the index must be shifted a little—up or down—till one of the divisions allows of the drill being properly adjusted. G. C. CLARKE.

Church House, Uckfield, Sussex.

REPRODUCING FRET-WORK PATTERNS.

Sir,—I notice in a recent issue of your valuable magazine a letter suggesting a method for duplicating, or rather reproducing fretwork patterns. The plan suggested I have no doubt will answer to a certain extent, but as the paper on which such patterns, as a rule, are printed, is thin and not very tough, I think in the process described the patterns would require extremely careful handling in order to obtain anything like success. Now, I hope to be pardoned for asking you to afford me space to place before your readers a method which I adopted some years ago when I first took to the art of fret-cutting as a recreation, both in the case of original designs and bought patterns. For original designs, I made use of good thin drawing paper, on which I sketched in pencil one-half only of the design. I then doubled up the piece of paper so that the fold formed exactly the middle of the design, pasted or gummed the edges of the paper together; then with a sharp pen or other suitable knife cut out the superfluous paper, leaving only the design. When completely cut out, open the pattern out flat, then gum or paste it on to a piece of drawing, or any other kind of moderately stout paper, of a size somewhat larger than the pattern, and when it is dry the design can be re-produced *ad infinitum*, by the use of thin paper and shoemakers' black heel ball. For bought patterns, paste or gum them on to a piece of paper, carefully double up to exactly the middle line, and proceed in cutting out as before directed. It will be readily understood that by thus manipulating it both sides of the pattern will be made exactly alike, which is not always the case in patterns as procured from the shops. A very little practice will enable an ordinarily expert hand to cut out a pattern very nicely, working free hand, but the use of "French curves" will be found of much assistance to the beginner. For rubbing off patterns, as a rule, "demy white"—or, as it is more familiarly termed, "tea paper"—is the best, but any kind of thin white paper will be found to answer and to produce good fac-similes. The pattern, with the paper stretched nicely over it, should be pinned to a smooth board—a drawing board answers well, but care should be taken to see that the surface is perfectly smooth, as any inequalities will show and probably spoil the "rub." The best black heel ball should be used. If these directions are carried out, no difficulty will be found in reproducing favourite patterns; friends may be supplied, and exchanges made with brother fret-workers, to any desirable extent. Some fret-cutters reproduce the patterns by taking "rubs" off the pieces of work after it has been cut out, but unless the operation has been performed in first-class style it will be obvious that this must be a very undesirable course to pursue, as the defects in workmanship are faithfully reproduced; and it must, therefore, be evident that each succeeding cut, if so reproduced, must get wrose and worse; in fact, I have seen such work reproduced until it was almost past recognition when comparedwith the original.

Yours, etc., "A. M. C."

ENGINEERING APPRENTICES.

Sir,—I must confess to having felt rather amused on reading the letter on the above subject which appeared in your issue for August, wherein the writer advises parents who intend sending their sons to learn the engineering trade not to send them straight from school, but to a school or class for twelve or eighteen months, where they would learn "a little lathe-work, a little chipping, and a little filing." The writer goes on to describe the unpleasantness that would occur to a youth who had attended a mechanical class and learnt something of screw-cutting, and yet be unable to find more than one set of wheels to cut certain pitches. I fail to grasp his meaning. Does he mean that there is a difference between a mechanical class and a class or school where metal-turning, chipping, and filing are taught? I opine not; else why does he go on to advise those who have been to a school where these arts are taught, not to say anything about it when they enter an engineer's workshop as an apprentice? Why should they be so reticent, as I at least should expect that a youth—unless he were a complete "duffer"—after having had twelve months' experience in the use of the tools would show at once, by the way he went about his work, that he was not altogether a novice; if he did not, I should say that the time so spent was utterly thrown away. Another piece of advice which the writer tenders to the young apprentice will be found rather misleading. He says they ought to take a small machine first, and they will find out how much they have to learn, etc. Now, my experience of workshops, engineering or otherwise, is that apprentices, and workmen as well, have no choice in the matter; they do as they are directed, so that it would be folly on the part of a youth to expect that he would be able to follow his own bent, and choose his own jobs in any concern, although no doubt a judicious foreman would accede to the request of an apprentice for a change of work, providing it was to the boy's benefit to do so, as well as in the interests of the master. The advice given to apprentices by Mr. Jackson, with reference to keeping their tools in order, is certainly good, and it would be well if many journeymen would act upon it, as it only too frequently happens that men often take as long to find the tools to do a job with as it takes them to accomplish the actual work. I do not mean to say that all men are the same; but there are certainly to be found too many by far who are addicted to habits of carelessness in the matter of tools. In concluding, I wish to assure Mr. Jackson that I have not written this in a captious spirit, but wholly with a view to ventilate the subject, and also that in my remarks I have assumed that boys who are grounded in the elements of mechanical engineering at schools and classes where lathe-work, chipping, and filing are taught, are employed at the work the whole of their time, but probably this is not the case, and that a portion of their time is taken up by other studies; still, even if such be the case, a youth who has applied himself diligently and learnt all he possibly could during the time allotted need not be ashamed to make it known, as no sensible workman would think of ridiculing a youth, nor expect too much from him, unless he displayed the spirit of a braggadocio. I shall feel extremely pleased, and I have no doubt many others of your readers will feel the same, to hear something of how mechanical classes are conducted, and if they are as a rule successful. I am aware that very good results are being obtained at some of the London colleges, and also in Birmingham and other large towns where practical mechanical engineering classes have been established, but I have not as yet been able to get any reliable information as to the terms on which pupils are admitted, and whether they are such as to enable the working classes to send their sons to such places, so as to gain for them the full advantages of a technical education. Apologising for the length of this letter.

Yours, etc., "M. A. C."

AMATEUR MECHANICS

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HOW TO MAKE A CHEST OF DRAWERS.

PART II.

(Concluded from Page 310.)

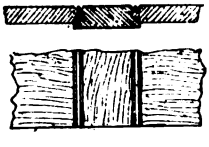
The carcase has now to be fitted with drawers. The drawer fronts are of pine ⅞in. thick. They must be fitted into the various openings in the carcase perfectly close all round, and with the *heart* side of each front *outward* for veneering upon.

The top drawer, that between the two semi-circular blocks immediately under the top, is slipped on its upper edge with a piece of ⅜in. bay mahogany previously to fitting it in, the same as already mentioned for the 12in. drawer in the surbase.

The other drawers are not slipped in this way; after they are veneered and cleaned off they receive a ⅛in. mahogany beading all round. This is called a "cope bead," and the manner of putting it on will be fully described when we come to that. When all the drawer fronts are fitted in, they should be each marked on the face in pencil with a Λ or similar figure pointing upwards, so that there be no mistakes afterwards in the fitting.

The drawer sides for a first-class job are of cedar wood ⅜in. thick. The grooves for the bottoms should not be run in this ⅜in. side for a good job, but in a clamp glued to the side, as shown in fig. 9 (page 308). The drawer backs may be of ⅜in. pine, and the bottoms of ⅜in. pine, but this thickness would be too weak without a centre mounter.

This mounter is a bar of wood 3in. broad and ⅝in. thick, passing across the centre of the drawer from front to back, and dividing the bottom into halves. It has grooves in its edges to receive the bottom, a pair of ½in. match plows being used—one to make a groove in the mounter, and the other a feather on the edge of the bottom, the whole being flush on the upper or inside. A ⅛in. bead is run on the mounter on this inside to abut against the drawer bottoms. This is called *breaking* the joint, and makes a neat finish inside the drawer. The annexed figs. (15 and 16) show this mounter and bottoms, fig. 15 showing the manner of grooving in, and fig. 16 the upper or inner side with the beaded joint.



Figs. 15 & 16.—Drawer Mounter.

The drawer fronts have a groove, corresponding to those in the sides, to receive the bottoms. The backs are so much narrower, and the bottoms nailed to them by 1¼in. brads. The direction of the grain of these bottoms runs the lengthway of the drawers; consequently the end wood of the bottoms enters the grooves in sides and mounters. This is indicated in fig. 16 by the filling-in lines to represent the grain.

These drawers are dovetailed, and put together in the usual manner. The bottoms are put in and filleted—that is, fillets are rubbed in with glue in the junction of the sides and bottoms, and afterwards planed off flush with the edges and sides, a few short ones being glued along the front in the same way. Of these latter one at each end is of mahogany, or other hard wood, these being to act against "stops" nailed to the shelves in the carcase to stop the drawers at their proper places.

It may be mentioned that fillets for drawer bottoms are in many cases omitted, and in good jobs, too, particularly when the bottoms are of American ash, which wood is very liable to shrink or expand with dry or damp situations, and the bottoms are left unfilleted to allow of this movement. But if the wood is as well-seasoned as it should be, little or no change in the breadth of the bottoms will take place, and a draw is infinitely better filleted.

When fitting the drawers in the carcase, no more should be taken off the breadth of the drawer sides than will just admit them between the shelves, as when too much is planed off at first they can never be a satisfactory job. The proper method is plane the under-side of the drawers—which is the edges of the sides and fillets, and also the short fillets along the front—all even and flush, using a straight-edge, these two edges to get in relation to each other to be out of winding. Then set a gauge to the breadth of the drawer front, and gauge the breadth of the sides from the bottom. When the sides are planed down to this mark, they should enter the opening between the shelves, though somewhat tightly. Next the two sides, or ends of the drawers, are planed down till the end wood of the front and back are touched at the dovetails. Now the drawers should enter the carcase the lengthway as well as the breadthway. They are all pushed in in this way, till the fronts are nearly flush with the face of the carcase, the fronts are drawn all round with a draw-point, and planed down on the bench to this mark. The method is to place two pieces of board across the bench, letting them project over the front seven or eight inches, and fastening them at the back with hand-screws. The drawer is hung on the ends of the boards, with its fore-end fixed in the bench lug, and in this position is planed and teethed. When planing, the front must be perfectly level across the ends. It will do no harm if a little round at the centre; the veneer has a tendency to draw the face hollow after a time.

As a rule, the base, the construction of which was described in the early part of this article, is veneered on what is termed the *banding* system—that is, the grain of the veneer runs up and down, not the length way of the base. This is a false principle in construction, because a base made of solid wood, with the grain upright, would be simply ridiculous. The method is resorted to for two reasons: It is easier done; and it is a means of using up small pieces of broken veneer, as any pieces may be used up if only long enough to cover the breadth of the base.

Two blocks have now to be made for this base, similar to the block shown detached, fig. 17. They are 6in. broad and 3in. thick, and semi-circular on the ends. These blocks are better built of several layers of wood, as shown in the figure, as they do not split or change their shape so readily as when made in one piece. Three pieces, long enough to make both blocks, are glued together. They are drawn on the ends with compasses, and carefully planed down to a semi-circle, after which they are teethed for veneering. Before veneering these blocks should be sized; this is a coat of very thin hot glue applied all over the surface to be veneered upon. When this is quite dry it is to be again lightly teethed. The best method to veneer these blocks is with a canvas bag and screws.

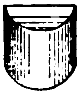


FIG. 17.—SEMI-CIRCULAR BLOCK.

This instrument is shown, fig. 18, and consists of a piece of hard wood 12in. by 5¼in. by 1¼in. It is tapped for two ¾in. wood screws, similar to hand-screw pins. A piece of canvas is nailed firmly to the edges of this wood with sufficient slack to allow placing the block with veneer within it.

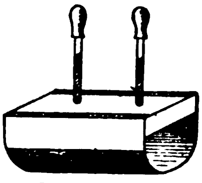


FIG. 18.—VENEERING INSTRUMENT.

To make the veneer assume the curvature of the block, wet the *outside* with a sponge, and hold the inside to the fire, when it will immediately become curved. Heat the block at the same time, and apply glue to both block and veneer; place the veneer on the block, and slip both into the canvas bag. Apply the screws lightly at first, wet the canvas copiously with hot water, hold to the fire, and apply more pressure of the screws. When the glue flows out at the ends all round, you may be satisfied the veneer is lying. Heat once more, and give a final turn of the screws, when it must be laid aside for about twenty-four hours to dry. This method of veneering the blocks is only suitable when the rest of the base is veneered on the banding principle; for, as you will observe, the grain of the veneer runs up and down on the block, so it must run in the same direction on the rest of the base. To veneer the base with banding, strip the edges of each piece with the plane on the shooting-board; then lay one piece at a time with the veneering hammer. The first piece being laid, the second is fitted against it and rubbed down, pressing against the piece previously laid, to ensure a close joint.

When the veneer is dry, which will be in about 24 hours, the front only is to be planed, scraped, and sandpapered, the over wood at the edges being previously pared off with a sharp chisel. When the veneered piece for blocks is cut in two, a portion of the veneer at the inner edge is to be planed and papered. The veneer on the front of the base cut to exactly the breadth of back of block, so that the veneer on the block and that on the end of the base will coincide, forming one surface, and, at the same time, a close joint. The blocks thus fitted are to be glued on, using hand-screws to ensure close contact. When the glue is hard, the upper edges of the base and blocks are planed quite level, and the end wood of the blocks receives a coat of glue size before veneering. A piece of veneer 3in. broad is now laid along the front, and two additional pieces over the ends of blocks. The strips of veneer along the ends of the base are 2in. broad. When the gluing of these are hard, the whole base is cleaned off, scraped, and sandpapered. After which, provision is made for attaching four turned feet by fitting two three-cornered pieces in the back corners or under side of base, and clamping two pieces inside the front, immediately behind the circular blocks. The ball feet have tenons turned on them, which fit into holes bored in the base.

We have now to describe the method of veneering the base of drawers in the true and proper fashion—namely, by having the grain of the veneer running in the same direction as the grain of the groundwork.

The body or groundwork of the base is made exactly as described, and the two blocks made and sized for veneering in the same manner also. Now the face of the base is covered with veneer, except at the two ends where the blocks are to be stuck on. This veneer should be laid with a caul. When properly hard it is planed and finished up with sandpaper; then the two blocks are fitted exactly in their places against the ends of the front veneer, and they are glued down without being previously veneered, as in last example.

Now comes the task of veneering the blocks and base ends with one piece of veneer. The method is shown in the annexed cut. A yellow pine caul is made the length of the base end, not including the semi-circular blocks; then a piece of No. 12 zinc is procured, long enough to reach from the small block of wood at the inner edge of the circular block, round the block itself, along the base end, and round the ends of the caul, as indicated by the double line in the cut. The caul should be 6in. broad, and the zinc fixed on with tacks along the edges.

A piece of veneer has now to be cut long enough to go round the block and along the base end, with a little margin both in length and breadth. The portion that goes round the block must be well teethed, and also scraped on the outside, before putting on. This is to thin it somewhat, as it has to be bent round the block. The next step is to glue a thin piece of cotton cloth on the scraped side of the veneer. This is to prevent it splitting across the grain of the wood while bending. A cut is made with a dovetail saw, close to the inner edge of the block, about ¼in. deep in the face of the base. The end of the veneer is now squared and fitted into this cut.

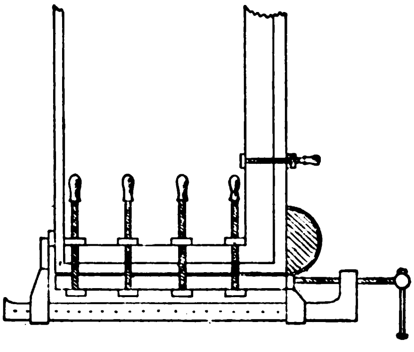


FIG. 19.—VENEERING THE BASE.

It will be seen, by a reference to fig. 19, that a cramp and five hand-screws are brought into use. There are really ten hand-screws, another five being placed exactly opposite those shown in the drawing. All being in readiness, the zinc caul is to be well heated, and a copious supply of glue applied to the groundwork to be veneered, and also a thin coat to the veneer. The end of the latter is fitted into the saw cut above mentioned.

The hot caul is applied by placing the end with the block, close to the circular block, and applying two hand-screws. Then the zinc with the veneer is bent gently round the block, and when laid along the base end several hand-screws are applied, and lastly the cramp, using a small block of wood at the back to keep the paw clear of the caul end. The exposed portion of the zinc round the block, which cools very quickly, must be heated with a smoothing iron and more pressure applied to the cramp, when the glue should run out at the edges. The hand-screws are then tightened up, when, if the whole thing has been managed properly, the veneer will be lying perfectly close. This caul should stay on for at least ten or twelve hours, when the same operation may be performed with the other end of the base.

This method of veneering is much more difficult than the slip-shod method of banding with scraps of veneer, but it is a much more tradesmanlike manner of doing it. In short, it is the method of making a first-class piece of furniture, if veneering of any sort can be called first-class work. When the gluing of the base is properly hard, the over-wood at the edges is cleaned off, the upper side is planed level, and veneered as before described.

The veneers for the drawer fronts are bought in sets of five or six. They are cut from each other, and are all of one figure, being numbered by the sawyers, and care being taken to place them on the fronts all in the same way, the various markings will appear almost alike in the whole fronts.

The sets of veneers may be so narrow that they will not entirely cover the 12in. drawer in the surbase, in which case a piece has to be added to the breadth; the joint thus made is easily concealed beneath one of the mouldings to be planted on the face.

If the veneers are of the feathery curl sort, two pieces to each front, the butt joint must be exactly in the centre of each, passing through the centre of the keyhole. In order to make this joint properly, the whole of the veneers are placed together exactly as they were when cut at the mill, and held together by two pieces of board and two hand-screws. The ends to be jointed are squared across, and cut with a dovetail saw all together, and afterwards planed with the iron plane. Then, being taken separately, each pair is carefully fitted to each other. This done, they are laid on a flat board with the joint placed close, and a few tacks driven in at the edges to keep it so. A piece of thin calico, about 2in. broad, is now glued along the joint. When this is dry, the veneers may be laid as one piece. Cauls of zinc, ¼in. thick, are best for this job, but very good work may be done with well-oiled pine cauls.

If wooden cauls are used to these fronts, they should remain in the screws not over two hours, as any glue adhering to the caul makes it difficult to remove, and some of the veneer is apt to peel off in the removal. The glue does not adhere to a zinc caul in the same way that it does to wood.

It is usual to veneer two of these drawers at one time, the caul being heated on both sides. The hand-screws require to be pretty large, with long jaws. They should be free from hard glue on the jaws, as it makes an unsightly mark on the inside of drawer fronts.

Help must be obtained to heat the caul while glue is applied copiously to the drawer fronts. The veneers must be previously teethed on the gluing side, and marked as they are to be laid. When laid upon the glued front, they are rubbed all over with the hands, and should project over the front ¼in. or so all round. At the places to be afterwards bored for the knobs, two tacks are driven through the veneer into the front to prevent them slipping under the hot caul while the hand-screws are being applied. These latter should be set to about the size before gluing, so that no time may be lost afterwards. Six large hand-screws for the front or inside, and six smaller for the back, are necessary to lay veneers on two fronts. Those that go inside the drawers should go quite to the bottom, so that the jaws require to be at least eight inches long. The diagram, fig. 20 will give a clear idea of this part of the work. It shows the two fronts with the caul and veneers between, and the hand-screws as applied. In applying the hand-screws to work of this kind, it is to be observed that the whole length of the jaws must bear equally on the breadth of surface pressed between them, as if they press only at the points, or at the heel, they are comparatively ineffective.

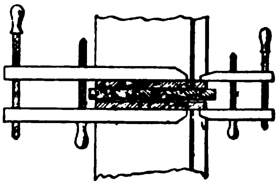


Fig. 20.—Veneering the Drawer Fronts.

When the veneers have dried for about twenty-four hours they may be cleaned off. They are always planed first with a high-pitched hand-plane, set very close, then scraped and sandpapered. The drawer in the surbase and that at the top are neatly fitted into their places. They should pull easily backwards and forwards and yet appear quite close both in length and breadth. The accuracy with which they are fitted when finished is a mark of excellence in the workmanship.

The four intermediate drawers are to receive cope beads. After the fronts are planed and sandpapered they are pushed in about ⅛in. beyond the face of the carcase, when a small gauge is made to gauge the thickness to check for the beads. This gauge is a small block of hard wood with a steel point in it fully ⅛in. from the edge. This gauge is passed all round each aperture in the carcase, the steel point making a mark on the drawer front the depth of the check to receive the beads. The checks are worked out with fillester and guillaume planes. That on the upper edge is made the whole thickness of the front, so that all the pine may be covered with the bead which now serves as a slip. The under edge and the two ends are not checked more than ⅜in. from the face. The ends are sawn down with a dovetail saw, and worked to the gauge marks with an iron guillaume. The cope bead is bought in boards $\frac{3}{16}$in. thick; the strips are cut off with a cutting gauge, and must be broad enough to project about ¼in. over the veneered front. When putting them on they are wetted on the upper side with a sponge, then the glue is applied to the dry side, and also to the check, when the slip is placed in position and rubbed backwards and forwards, two persons being necessary in the operation. When set in its place it should have a few rubs with a veneering hammer. To ascertain if it is *lying*, the glue is scraped gently off along the drawer front with a chisel. When some parts are found not close it is usual to drive in fine brads, but this is a sign of defective workmanship, as no brads are allowed except in putting on the *end* beads. When a drawer front is slipped top and bottom in this way the glue must be very carefully washed off with a sponge and hot water, a chisel being used to scrape it along the junction of the front with the slip. When these slips are quite dry the ends are cut off and planed flush with the drawer sides. Then the slips are stripped with the half-long plane on the sides, so that a thickness of fully ⅛in. is left, the drawer lying on the bench during the operation. The drawer is then tried in its place in the carcase. It should fit perfectly close against the shelves above and below, at the same time not tightly, the drawer front being in flush with the face of the carcase. When the four drawers are fitted in this way, the next thing is to *run* the beads. This is done with the cope-bead plane. This is a mall plane with a hollow along the centre of the sole the size of the bead to be run (see fig. 21), which is a portion of the end of this plane full size. The central portion is filled in with boxwood, in which the hollow is run. The drawer is now hung upon two boards on the bench, front up as before. The projecting edges of the slips are planed with a half-long till they stand above the front ⅛in.; then they are rounded with the cope-bead plane, which is run till the sole of the plane touches the drawer front. This, of course, leaves the bead all of one height in its whole length, is fully 1/16in. When the two beads are thus run, the drawer front is carefully papered, the beads included, using for the latter a small hollow cork, something like the sole of the plane shown. After all the drawers are thus treated, the end beads are to be put on. A piece of the cope-bead stuff is thinned to fully ⅛in., the edge made straight, and rounded with the cope-bead plane; then a strip is cut off with a cutting gauge of the required breadth, which should be ⅜in. This is cut into lengths to fit in between the long beads by mitring the one to the other and stripping to the exact breadth, so that the same height above the veneered front is obtained. When it lies close in the cheek, and also close at the mitres, it receives a little glue, and is nailed on with ¾in. fine brads, three or four to each. These are punched below the flush, the end beads carefully stripped; again the drawer is fitted into the carcase, and should fit quite close at the ends also. When in flush, it will look like a plain panel with a bead all round.

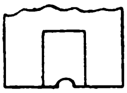


Fig. 21.—Cope-Bead Plane.

Now we have got the whole six drawers in their places. If they feel too tight they should be gently stripped where tightest. This will be readily ascertained by going to the back of the carcase and looking through between the drawers and shelves or grounds. The fitting of these drawers, done as they ought to be, is considered a very nice job in the trade, but it is seldom that this is accomplished. The drawers, while they show perfectly close all round the fronts, ought at the same time to pull out and push in with the utmost ease and freedom. This will only be the case when the carcase is perfect in construction, in which case the various shelves dividing the drawers are truly parallel with each other, and of the same width of aperture from front to back. The shelves must also be truly at right angles with the upright grounds—in other words, the carcase must be truly squared. Without these conditions the moving drawers, however well they in themselves may be made, can never be satisfactorily fitted into an ill-made carcase. When our drawers have received their final stripping, they are carefully sandpapered on all parts that come in contact with the carcase when moving; the cope beads also receive a final finish with sandpaper.

Now they are ready for the guides and stops. The guides are fillets of pine running from the back to the grounds at the ends of the drawers to guide them; they are 18in. by 1¼in. by 1in. The stops are pieces of hard wood, such as ash or oak, 2in. square and ¾in. thick, and shaped like fig. 22, having three holes for ¾in. wrought brads. Twelve guides and ten stops are required for the job, as the large drawer in the surbase requires no stop, the front stopping itself against the fore-edges. The stops are put on before the guides. To do this a gauge is used with a groove in the head, close to the shank or stalk, to admit the projecting bead on the drawer front. The drawer is turned bottom up and with this guage a line is drawn from the front over the mahogany blocking glued to the bottom behind the front, the gauge being set a little bit less than the width of the front and blocking. The piece thus marked off is carefully pared to the gauge line. this being done with all four drawers, the shelves are also gauged from the front edge with the same setting of gauge, and the stops glued and nailed on at the guage-lines. They will thus stop the drawers exactly flush with the face of the carcase, the beads only projecting. The top drawer (that between the circular blocks) stands out an inch beyond the face of the carcase—consequently for this drawer the stops are an inch nearer the front of the shelf.

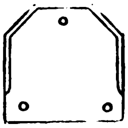


Fig 22.—Drawer Stop.

All the drawers being now in their places, we have now to provide mouldings and carvings. When mouldings or other projections are stuck on flat surfaces, the surfaces are French-polished before "planting" the moulding; the mouldings are also well coated with polish. This method is adopted because the fewer obstructions to the polishing-rubber the better the result. Another advantage is, the glue will not stick to a polished surface, so any superfluous glue, smeared about in putting on the mouldings, is easily cleaned off. In our present job, the exact place of the mouldings is marked lightly with drawpoint both outside and inside; the space between the markings is cleaned of polish, and teethed. The mouldings are carefully mitred to length on a mitre board, and before gluing they are heated at the fire, the glue being applied to the drawer front. If the mouldings are straight on the gluing side they will only require to be held firmly down with the hands for a minute or two. If inclined to warp, pieces of pine, 12in. long, are placed across them, and hand-screws applied to the ends. The drawer in the surbase receives a moulding 1⅜in. broad and ⅜in. thick. There are various forms of mouldings used for this job. Fig. 23 is a section half size of one, very easily worked with the hollows and rounds. Figs. 24, 25, and 26, are also very popular cabinet mouldings for such work as sideboard and wardrobe doors, and for the job in hand. This moulding is mitred on the drawer front in the manner shown in the sketch, fig. 1 (page 306), the double mitres towards the centre having a break of ⅜in. The two end portions form a square of 8in.—consequently a margin of 2in. is left outside of this

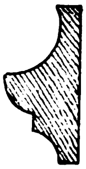


Fig. 23.

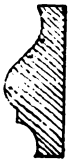


Fig. 24.

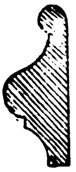


Fig. 25.

Fig. 26.

Various Forms of Mouldings.

portion of the moulding, and 2⅜in. along the centre. The two knobs are placed exactly in the centre of these squares. These mouldings are fixed on the face of the drawer with glue alone, the surface for nearly the breadth of the moulding being scraped and teethed, as also the back of the moulding. When the mouldings are "planted" and hard all the mitres are carefully dressed off and papered. We have next to put on the guides. All the drawers being stopped in their proper places, as above described, the guides, 18in. long, are bored for three or four nails. A little glue is applied to each guide, care being taken that no glue is allowed to spread and come in contact with the drawer sides; the guides are rubbed in from the back, pressing against the drawer sides; they are pushed forward to touch the back of the ground. After they stand for half an hour or so all the drawers are taken out, and the guides nailed with 1½in. wrought nails. Screws are better but are hardly ever put in. After this the surbase and body, or upper carcase, are to receive the back lining. This may consist of 5½in. narrow yellow pine boards. A first-class back would be framed and panelled. The surbase back consists of one board only, running horizontally, while the carcase back in narrow wood runs vertically. A fillet is glued to the under-side of the top to receive the upper ends of the back lining. They are nailed with 1½in. cut nails. The cedar ends of drawers being of reddish brown colour, the pine wood, that is the inside of front, back, and bottom, is stained the same hue. This stain consists of Venetian red and yellow ochre, equal parts, with a little thin glue and water. It is made to boil, and is applied hot to the wood with a rag; after standing a few minutes the residue is rubbed of with more rag, and is stroked in the direction of the grain; when quite dry it is papered with flour paper. All wood that is to be stained must be particularly well planed and sand-papered, as the stains at once show up defects. The same rule holds with all work to be painted or varnished.

* * *

To Protect Polished Steel from Rust.—Warm the metal sufficiently to melt paraffin-wax, which rub on; wipe carefully with a warm rag. The thin film of wax remaining will not be perceptible, and, being solid, it does not have the greasy feeling that oil or tallow does.

Soft Solders.—It is convenient—and, in fact, often necessary—to have solder which will melt at different degrees of temperature, to avoid the risk of spoiling the work by subjecting it to too great a heat, when with a little easy-flowing solder there would be no danger. The following table gives proportions, etc., and it will be found very convenient to have some of the sorts on hand ready for use. Either can be melted in an iron ladle, and cast in strips for convenience in applying. Any of them will flow readily with the ordinary fluid:—

No.	*Proportions.*						*Melts at*
1.	Tin	1			Lead	25	580° F.
2.	„	1			„	10	540
3.	„	1			„	5	510
4.	„	1			„	3	580
5.	„	1			„	2	440
6.	„	1			„	1	370
7.	„	1½			„	1	335
8.	„	2			„	1	340
9.	„	3			„	1	355
10.	„	4			„	1	365
11.	„	5			„	1	375
12.	„	6			„	1	380
13.	„	4	Bismuth	1	„	4	320
14.	„	3	„	1	„	3	310
15.	„	2	„	1	„	2	290
16.	„	1	„	1	„	1	255
17.	„	1	„	2	„	2	235
18.	„	5	„	3	„	3	200

No. 18 will melt at 120° by adding 3 parts of mercury

THE MODERN LATHE—ITS MANUFACTURE AND USES.[*]

ABOUT this time last year, an interesting paper was read by Mr. Hasluck in this room upon the lathe from an historical point of view. [This paper was reproduced with illustrations and additions in "Amateur Mechanics," January, February, and March last.] I now propose to treat the subject in its purely practical aspect, referring only to the lathe used in the present day; but with special regard to those ornamental and geometric uses of it in which I have been personally interested all my life.

It should be known that the size of the lathe is named after the radius of the cylinder that can be turned upon it, *i.e.*, the distance from the axis of the mandrel to the top of the lathe-bed; thus, when the distance is three inches the lathe is called a three-inch lathe; if eight or ten inches, it is called an eight or ten-inch lathe. For all ordinary amateur and ornamental turning a five-inch lathe is to be recommended.

The lathe-heads and bearers of a five-inch back centre lathe are made of cast-iron. The bearers or bed should be 3ft. 6in. long; solid enough to be perfectly rigid when finished, and planed up at the top and bottom and squared at the ends. The top of the bed should be finished off and surfaced truly; the slot between the bed should also be carefully finished and left parallel to its sides, and square to the surfaces, and the outside edges of the bearers must be also planed true. The bed should be supported on cast-iron standards, firmly bolted at the ends.

The mandrel-head should be nine inches long at the base, and the popit-head four inches, both having a solid tenon of such size as to true up to fit into the interval between the bearers. The mandrel-head must be carefully set out, its base and tenon planed true and accurately fitted to the bed; the face being planed up at a right angle to the lathe axis. The popit-head is then bored out with a hole three-quarter inch in diameter, and accurately ground out to receive the sliding cylinder. This hole is then used to carry what is termed the centring bar; a long cylinder with a point at each end, which is used for the purpose of setting the popit-head perfectly true, both vertically and horizontally. The popit-head must then be planed up correctly, and fitted to the lathe-bed very carefully, as the ultimate truth and accuracy of the lathe depends upon this point. Having the popit-head thus fitted to the lathe-bed, and centred to the axis, and the mandrel-head also accurately fitted, both heads are firmly bolted down upon their own bed. A drill with a long shaft, accurately fitting the cylinder hole of the popit-head, is passed through the front of the mandrel-head. The popit-head, kept facing the same way, is then lifted over to the other side of the mandrel-head and bolted down. Then the drill having been reversed, it is passed through the back of the mandrel-head. We now have three holes with their axes approximately in the same line, and in a plane parallel to the bed. A boring bar is now substituted for the long drill. This boring-bar is a cylindrical shaft, which accurately fits the hole in the popit-head, mortised through so as to carry steel cutters of various shapes and sizes, for shaping out the aperture in the front of the head to receive the steel collar, in which the mandrel is to permanently run. Other cutters are used to face up the mandrel-head at the back, so as to finish all the faces or bearing parts true and square to the lathe axis.

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[*] An abstract of a paper read before the Society of Arts, by Mr. J. H. Evens.

The heads—still firmly bolted to their own bed—are placed between the centres of another powerful and accurate lathe. The finished hole in the front of the mandrel-head, to receive the steel collar, is tapered about 1-16th inch in its length, which is about one inch, and the back part is shaped out to a curve, to leave the right length of collar-bearing. Finally, a vertical hole has to be drilled through from the top as a passage for oil to the mandrel. The back centre hole is left true by the drill.

In making the steel collar, a suitable ring of cast steel having been forged and properly annealed, is chucked and turned out true, slightly tapered from behind forward, and the hind part turned out to receive an obtuse cone of 45° from the axis. The collar is then fixed upon a true steel arbor and turned outside to fit the tapered hole in the mandrel-head; it should be of such size as to fit into the hole to within about 1-16th of its intended position. The front edge of the collar is then rounded off, and a hole is drilled through it to correspond with the hole drilled through the mandrel-head, and a slight groove for the passage of oil is filed parallel to its axis. The collar is then hardened by being made hot in a clear fire, and dipped into clean cold water. In order to fix the collar in its place, the mandrel-head is placed upon a hot-plate or stove, until the face becomes too hot to touch. It will then be found that the cold collar can be easily driven up to the desired position, and the head, on being cooled, will retain the collar in its place. The collar must, of course, be inserted so that the hole which has been drilled in it is in a line with the oil hole in the mandrel-head. The inside of the collar, having been turned with both its cones fitting a steel gauge plate, to which counter-gauge plates have been made, we use those gauges for turning up the corresponding cones on the mandrel.

The mandrel, which is made of the very best Lowmoor iron to be procured, has a ring of shear steel welded on the neck where it runs in the collar, and also at the end another piece of steel for the back centre. Having carefully centred the mandrel, it is turned up all over and the nose partially screwed. The neck is then fitted to the collar; but leaving sufficient to allow for the contingencies of hardening and final fitting. Now the neck or bearing must be hardened in clear cold water, and if the result be successful—though failure at this point at times occurs—the back centre is corrected, and counter-sunk to 55°, and finished, being hardened in the same way. The mandrel will generally have been distorted in the process of hardening. This has now to be corrected by grinding with an emery wheel, which is used quite dry and free from grease, and revolving at a very high speed. The emery wheel should revolve in a frame held in the slide-rest, the mandrel also being revolved between dead centres, by a small temporary pulley, in a direction opposite to that in which the emery wheel is revolving. In this way the bearing of the mandrel is ground perfectly true to its centre, and so as to enter the collar almost completely. The back-centre cylinder should next be taken; this is of cast steel forged to the desired shape. It is turned all over, and the cylinder accurately ground into the hole in the back of the mandrel-head. The point is then turned up to correspond with the centre in the mandrel, 55°, and is hardened. The cylinder slides truly in the hole at the back of the mandrel-head, and is brought forward by means of a circular nut, working against the front face of the casting, which has been trued by the cutter, as before mentioned. Now the final adjustment of the mandrel in its collar has to be effected by grinding in, which is done with oilstone powder, or in some cases with very fine emery. In doing this, the mandrel is kept up to its collar by means of its own back-centre cylinder sliding truly in the back part of the mandrel-head. Great care must be exercised in this process, the mandrel being worked backwards and forwards by the hand until its obtuse cone is brought up into its seat. Lastly, the face of the mandrel and the thread upon its nose are finished.

A steady pin now has to be fitted to the body of the mandrel for holding the pulley, which is fixed by a nut and washer from behind. The pulley may be of wood, brass, or iron; but for general purposes I prefer iron. The face should be broad enough to show clearly the necessary number of dividing circles.

The popit-head must then have its cylinder finally fitted in. This having been done, the cylinder is bored out to within an inch of its rear end, and coned out in front to take its centres. The rear end is then bored and tapped with a thread of ten to the inch. The leading screw is then fitted. This has a circular flange at its rear end to bear against the face of the casting, and also against the inside of the metal cap which is screwed on to the casting. The end projects for the purpose of receiving a winch-handle, wheel, or drop-lever. By graduating the circumference of the flange to hundredths, the traverse of the back-centre is shown to thousandths of an inch.

Having thus briefly described some of the most important points in making a lathe of this character, we will consider for a few moments a few of the simple tools adopted in metal-turning—that is iron, steel, etc. The lathe will, of course, be the same as used for wood-turning, although for heavy work a back-geared lathe is to be preferred, but this must be according to circumstances. As for hand-tools, a graver, chisel, round nose, triangle tools, and parting tool, will be sufficient for practical purposes. The graver is made of square steel, and ground to a diagonal or diamond shape. Now as to the correct angle at which such a tool should be ground. This is, and always has been, the subject of great comment; but my experience as a practical turner, is that after a very little practice, a workman will grind up the tools to such an angle as will suit his purpose, and cut clean and sharp without paying any attention to the many theories laid down by various authors. I should like it to be clearly understood that I do not wish to set my face against theoretical science on the point, but I speak from actual experience and observation. You may go in to factory after factory, and see dozens of men grind up tools, place them in the slide-rest, and proceed with the work; but you will not see them testing the tools, to see if they are at an angle of 50° or 60°; the tool cuts, and that is all that is required.

In centring a piece of iron or steel, it is important that it should be drilled up and counter-sunk. This is done with a small drill in the first place, and a half-round counter-sink to follow. The object is to prevent the point of the centre working against the bottom of the hole. The next process will be to face the ends up true. This is done with a triangle tool, which is a tool easily made from a worn-out saw file; I say a saw file, because these, for the purpose for which they are used, are left harder than other files of the same shape, and, consequently only require grinding. Two sides are ground up sharp, and the end diagonally. This tool can be used for either the right or left side of the work.

The object of facing the ends of the material is to prevent its running out of truth, which it will soon do from the unequal pressure upon the popit-head centre, caused by an uneven surface. The best way to hold this tool will be thus:—The handle grasped firmly in the right hand, with the knuckles upwards, and the tool itself passed between the third and fourth fingers of the left hand. The lower edge of the tool is then brought firmly on to the rest, and by inclining the cutting edge towards the work, it is brought into contact, and those parts that are uneven are soon reduced to flat surface.

To turn a cylindrical piece of steel or iron, the graver is necessary; this tool is held in a similar way, only brought to a different position, the right hand must be more to the front, and the T-rest so arranged that the point of the graver can be brought to the centre of the work. The character of this tool, like many others, will greatly assist the operator in finding the position of the T-rest, that is most suitable to the diameter of the work being turned. With these few remarks upon turning iron and steel, and holding the tools, I will take another branch of metal work, that is, drilling and boring.

In this branch of turning, which is a very important one, there are various ways and means adopted. Work that is held in a chuck must have a centre formed with a triangle tool, and the drill is made to pass through it by means of the popit-head; if the drill is used between the centres, it is held either by a carrier or a wrench, and sufficient pressure maintained by the popit-centre to keep the drill always cutting. In using a drill thus, it will be necessary to be careful to keep it against the centre when withdrawing; if the drill is allowed to get free, the revolution of the lathe will cause it to catch and break, and probably damage the operator's hand.

When a long cylinder is to be bored, the boring-collar must be brought into use; this is a circular plate, with a series of holes coned out from the back. The work is rounded on the front edge, and runs between the plate and the running centre. The centre must be formed in a similar manner, and the drill passed up in the same way. After which, a half-round bit must be used, the mouth of the hole is turned out to fit the bit, which is held in the same way as the drill; for steel and iron, a lubricant of some kind is necessary; either oil or soap suds will answer.

As far, the various chucks for holding drills and small work, our American cousins have made such rapid strides, that they need no comment from me; suffice it to say, that they are a most useful adjunct to any lathe.

I think a word or two on striking and chasing screws will be of interest to many, especially those not far advanced in the art of turning. This forms a very important part in general turnery; screws cut upon ivory or hard wood, for such purposes as boxes, can be cut with a screw-tool or chaser, without the assistance of any special apparatus; but to do this requires considerable practice, and is what is termed striking a thread.

It will be policy to practice upon inexpensive material, and for wood-screws, boxwood will be the best material. Having the wood chucked in a cup chuck, a plain cylinder, without a shoulder or obstruction of any kind, will be the best to begin upon. The cylinder may be about 2in. long, and 1in. in diameter, and the chaser should have about 20 threads to the inch. The tool will require to be held somewhat differently to the graver and chisel, the handle is held by the right hand with the knuckles underneath. The left hand is passed round the body of the rest, and the thumb placed on the top of the screw-tool. The T-rest is placed parallel to the work, not quite close to it, the height being so adjusted that it will allow the cutting face of the tool to be held at a slight angle. When central to the diameter of the material, and about to start the thread, the tool should scarcely touch the flat of the rest, but must be guided by the first finger of the right hand and the thumb of the left hand. When thus supported, it is moved in a curved line, in the opposite direction to the curved edge of the end of the iron, which must be rounded off. This action necessitates the movement of both wrists, the right going forward for the purpose of advancing the tools, while the thumb of the left hand regulates the speed at which the tool traverses, which rate will also mainly depend upon the pitch of the screw that is being struck. The curved path of the tool being in the opposite direction to the rounded edge of the work, the cut only takes place in the centre of the width of the tool, so that the greatest depth of cut is there. Supposing that a true lead is obtained, the same action must be repeated several times, to gradually lead the thread on to the cylindrical part of the work, where it is required. When practising striking screws it will form an important feature of the work, that the hand and foot work, so to speak, simultaneously; by this I mean, that the speed of one should coincide with the other; by way of further illustration, it would be impossible to cut a screw of, say, twenty threads to the inch with the lathe running at a high speed.

The practice of striking threads is productive of some very curious results, such as double where single threads are wanted, and what is commonly known as a drunken thread. This latter is the most common result, and although the term is extremely inelegant, it so forcibly expresses the meaning; and I venture to say that, as long as the practice of striking screws by hand is continued, it will be heard far and wide. I will ask the tyro not to be disheartened if his first trials prove fruitless, but to make a determination to overcome the difficulties of what will prove to him a most useful branch of the art of turning, and to bear in mind, at the same time, that if there were no difficulties to contend with, there would be no merit in endeavouring to become efficient.

I will now proceed to describe the traversing mandrel, which offers a means of cutting such screws mechanically. It is largely used by amateur turners, as striking screws with certainty requires continual practice. In the traversing mandrel the lathe-head casting is about the same substance of the ordinary back centre lathe, but both ends are more nearly alike. The mandrel is made sufficiently long to project at the rear. It is made of the very best cast-steel, and should always be bored throughout; its bearings are cylindrical, and the cylinder is hardened at those parts which run in the collars. The front of the mandrel has a cone left on it of 45° fitting to a corresponding cone in its collar, and this stands in the reverse direction to the obtuse cone of the back-centre lathe. When being used for plain turning it is kept in its place by a steel cap, fitting over the back end of the mandrel, and bearing against the face of the collar. This cap is prevented from turning by a pin in the end of the mandrel, passing through a corresponding hole in the cap, and is retained there by a screw in the end of the mandrel. On the end of the mandrel, steel screw-guides may be substituted for the cap and secured by the same screw. Six of these generally accompany a high-class lathe of this kind, and are found to be sufficient for all practical purposes.

The conductor is made of either brass or gun-metal, and consists of a ring cut into segments, severally screwed to correspond with the steel guides. The ring is then fitted on to an eccentric mounted on a stud under the centre of the mandrel at the back of the head. The metal conductor works freely on the eccentric, but to fix it will need the use of a lever. By means of this guide the mandrel is quite under control of the conductor, and, with the guide on the mandrel, is compelled to work backwards and forwards, according to the pitch of the guide and the direction in which it is turned. The fractional pitches I have now abolished, and I screw these guides with six convenient aliquot threads, each guide being clearly marked with the number of threads to the inch which it cuts.

The pulley, which is made of brass or gun-metal, should receive careful attention in its construction. It is made hollow to avoid weight, but is turned all over inside, so that it is equally balanced when put together. I find, from experience, that the best way to put such a pulley together is to shrink the face in; some makers solder them, but I think the former way preferable. The inside having been carefully turned all over, the front is then turned out $\frac{3}{16}$ths deep and under-cut. The face is then turned to a corresponding angle, and left $\frac{1}{16}$th larger than the recess. The body of the pulley is then placed on a heating-stove, until it expands sufficiently to admit the front, which is pushed in and then allowed to cool, when it will be as solid as if it were one piece. The centre hole is then turned out taper, and the mandrel fitted accurately to it. As only a small shoulder can be left on the mandrel, it is necessary to fit to it a steady pin, and the pulley being cut out to fit it, a nut and washer behind the pulley fix it securely.

On the face of the pulley eight circles of divisions are drilled, viz., 360, 192, 144, 120, 112, 96, 60, 12; an adjusting index is also an indispensable addition. I may mention that I put the division of 12 for dividing squares and hexagons, as it saves the wear of those that are required for ornamental turning. Such lathes are usually mounted on a strong double frame of mahogany, which checks vibration and deadens sound.

Having briefly described the construction of this lathe, I will give a few details of the manner in which it is used. It produces both internal and external screws, with absolute certainty, and reduces the difficulties of screw-cutting to a minimum. Where its advantages are most obvious, will be found in such work as an ivory box with a short screw, and only sufficient material to fit the top and bottom together, so that a failure in striking the screw would render it useless.

The work being turned to the size required, the cap at the rear end is removed, and the selected steel guide put on its place. The corresponding screw in the conductor is then placed under it, and the eccentric turned round until it comes in close contact with the guide, so that it will work without any shake. Motion being now given to the mandrel, it travels forward at the rate given to it by the pitch of the screw on the guide. The fly-wheel must not make an entire revolution, but work backwards and forwards, the throw of the crank pointing each way alternately. This will require a little practice. The action must be as regular as possible, and the foot should not leave the treadle. It will be observed that the fly-wheel, being very much larger in diameter than the pulley on the mandrel, its partial revolution causes the pulley to make several complete turns, sufficient for all short screws. Where a longer screw is required, the cap may be replaced, and the thread carried along by chasing, and having obtained a true lead, this will not be found such a difficult matter.

I will now proceed to a description of a few of the more complex tools, used for ornamental turning. First, I should like to dispel the prevailing idea that before any work of this kind can be accomplished, a very large outlay is necessary. It is no use trying to hide the fact that ornamental turning is a somewhat expensive hobby, but still, with a good lathe and some of the more simple instruments, a very fine collection of specimens may be produced.

A short list of the necessary instruments may be useful. Assuming that a well-made lathe (traversing mandrel will be best) is obtained, all that will be wanted, in the first place, will be an overhead motion, a compound ornamental turning slide-rest, an eccentric cutter, a vertical cutter, and a drill-spindle, with about three dozen cutters to each.

There are various descriptions of overhead motion. That upon the suspension plan is still made by some makers, and is a very useful form. But there is room for considerable improvement, inasmuch as where a number of instruments with any considerable difference in the size of the pulley are used, separate bands are necessary. In the one attached to the lathe I exhibit there are two standards, one being fixed to each side of the lathe-frame by strong bolts; across the top a triangular bar is fixed, by a nut at each end also. A rigid framework is thus formed; upon this bar a metal carriage is fitted, which slides from end to end; upon this carriage is fitted another crosspiece, working upon two centres, through which another long bar passes, having on the rear end a counterbalance weight and in the front a pair of guide-pulleys. These are for the purpose of conducting the band, from the drum that works below, on to the instruments that are used in the slide-rest. The round bar carries a long drum for spiral work, and a metal pulley, which is driven from the fly-wheel below. The advantages of this pattern are, in my opinion, first, that it facilitates using the whole length of the bed, if desired; secondly, that one band will answer for all the instruments; thirdly, that the tension upon the band can be more readily adjusted; fourthly, it is more steady and less likely to vibrate, which is an important thing.

We will now consider the ornamental turning slide-rest. This is an instrument which forms a most important part in ornamental turning, and one in which perhaps more improvements have been made than in any other parts of the lathe, especially within the last few years. The original rest was extremely short, and fitted only to a common rest-pedestal, without any means of adjusting the height of centre, or to turn a surface and cylinder, beyond using the T-square, and raising it by hand. These movements were, under any circumstances, uncertain. The first advance was a ring fitted under the top slide, to raise and depress the height of centre; but the means of setting with any certainty, to turn a surface or cylinder, were still wanting. Without dilating further upon obsolete tools, I will now give a few details of those now made.

A metal cradle is fitted to the lathe-bed, and a transverse fitting is planed perfectly square to it. When this is done the body of the rest is also planed to fit it; the metal cradle, having one side loose, can be adjusted to slide most accurately. The body of the rest is carefully chucked on a true face-plate and bored, or turned out to 1¼in. diameter. That part upon which the ring works must be screwed before it is removed from the chuck. In making a rest of this description, great accuracy is required, and this will depend in a great measure upon the truth of the chucking and turning. The body is ready to receive the stem of the main slide; this should be carefully planed up, and then chucked on the face-plate, and the stem fitted accurately to the hole. These form the most important fittings, and, if properly done, when put together, whichever way it is turned, or in whatever part of the slide the tool is used, it will be positively at the same height of centre. I need scarcely point out that, if the hole is not bored true to the face, the upper slide cannot be correct, and if the error is of the most minute degree, it will multiply to a very serious extent in the length of the slide. The metal ring used for raising and depressing the height of centre has now two screws fitted at opposite sides, their purpose being to fix the ring when the height is determined. Until these were introduced, considerable annoyance was felt by the tool being at different heights when turned from one point to another, and it was found that the weight of the top part of the rest carried the ring round with it, and consequently caused the difference; the fixing screws entirely overcome the difficulty.

We now come to the upper part; in this we have several improvements. First, by an extra collar on one of the adjusting screws, we are able to place the top slide under control without the use of the lever at all. Another addition is the metal cover to the main screw for the purpose of keeping the shavings and dirt out of the screw. This saves a deal of wear and tear and inconvenience. The main screws both for the long slide and the top are all made ten to the inch.

I am now making another slide-rest of a still more elaborate description. It has a longer main slide, and the upper part is fitted with a quadrant to the slide; this enables the tool to be set at an angle without altering the lower part, and is of great service when using moulding tools. On the end of the screw a tangent wheel is fixed, which forms the micrometer for the divisions in the front; a tangent screw fitted to a metal frame is thrown into gear by a cranked lever, and can be made to act instantaneously. This screw having a pulley on the end, it can be driven from the overhead motion, and a self-acting cut can be taken its entire length. I will point out an improvement I have made in the fluting stops, which, for accurate work, has been found a great help. The plain stops have a set screw which passes through the centre, and are sometimes divided on the head, a reading line being marked across the metal. As long as the head of the screw and the line are close together they will answer, but for doing large star patterns it was impossible to read accurately when the lines became separated, which they do by the movement of the screw. To overcome this I have introduced what may be called a spring reader; this being cut out to fit the screw head, the lines are always close together, and can be read with the greatest ease and accuracy. The metal-turning slide-rest is a most useful tool, not only for turning metal but for roughing out large pieces of wood. There are various descriptions of these rests. The one generally made to accompany ornamental lathes consists of a metal cradle fitted to the bed of the lathe, having on one side an angle, the other square; a massive cast-iron base is fitted to this, on the top of which another slide is fitted. I have now adopted a plan of arranging this slide to make it take a complete revolution, by fitting the holding-down bolts into a T-groove. There are several advantages derived from this. In the first place, the slide can be brought round so that a surface cut may be taken with the main or lower slide. This offers a considerable advantage over having to use the top slide, which must bear all on one end when used for the same purpose. Then being able to turn the slide to any desired position without removing the bolts to different holes is of great importance, and there being no quadrant slots for the bolts necessary, there is no opportunity for shavings to get in. Another improvement is having a powerful dovetail slide fitted to the lower part to hold it securely to the bed instead of relying upon the cradle to do so.

We will now pass on to consider the eccentric cutter. This is made to run in a steel stem, which fits into the tool-box of the slide-rest, and is driven from the overhead motion. It has been suggested that the eccentric cutter and the eccentric chuck are identical in their productions. To a certain extent the remark applies, inasmuch as many patterns that can be executed with the cutter may be done with the chuck, but in working them separately it will be found that a vast number of very beautiful patterns can be cut by means of the chuck that could not possibly be done by the cutter. Then we have the combination of the two, the effect of such work being very interesting. First with the eccentric cutter; all such patterns as represent the intersection of circles are easily cut, and the variety may be said to be infinite, for the simple reason that a very slight alteration in the settings will make quite a different pattern. There are various ways of altering the aspect of the work, either by a different division on the pulley, a more or less acute angle to the tool, or a larger amount of eccentricity to the cutter. The pattern that is generally practised first is what is termed the barleycorn. This is cut with a double angle tool, of about 45°, and a division which is most suitable to the diameter of the material. The diameter of the circle cut is also governed in the same way. Having cut a series of patterns with the double angle tool, it will be interesting to study the different effects to be obtained by two single angle tools, which are made to cut right and left, but otherwise used at precisely the same settings. As for the double angle tool, the different effects will be so apparent, that it will be unnecessary to expatiate further upon them.

Another great advantage of possessing an eccentric cutter is, that it is capable of being used for cutting squares, hexagons, octagons, etc. This is done by extending the eccentricity to cut a circle rather larger than the size of the surface required; the cutter is driven at a high speed, and passed along the surface by the movement of the slide-rest. A certain amount of work may be done on the dome or sphere chuck, by turning the work in the first instance to the shape required, and then adjusting the radius of the cutter to suit it; by a variety of setting in this way some very beautiful work is produced.

Having described a few of the capabilities of this instrument, I will pass on to a brief outline of the eccentric chuck, its movement and results. In making a chuck of this description, it will be necessary that the greatest care should be exercised, for the simple reason that if it is not absolutely true in all its parts, it will be impossible to do accurate work. The first thing to do will be to screw the back so that it will stand at a right angle to the bed of the lathe when the index points to zero. This done, the face must be carefully surfaced; the steel slides are then fixed to it, and the front plate fitted, equal care being given to this also. The slide is capable of being advanced from two to three inches. Now as to the work to be done by its aid; if for patterns similar to the minor productions of the cutter, it will only require the slide to be set out the required distance, and a fixed double angle tool in the slide-rest, then by dividing the front wheel of the chuck, a large variety of patterns may be executed.

A pattern, which is very effective, is what is termed the geometric staircase. This is done by extending the slide of the chuck, and using a fixed tool in the slide-rest, which should be a square-ended chisel. It will be as well to point out that for this pattern a larger diameter must be left than is required, in consequence of a considerable part being cut away on one side, caused by the eccentricity given to the slide. As an example of this pattern may be useful, I will give the details connected with it. In the first place, the work, which will consist of a plain cylinder, must be turned on the eccentric chuck, and if sufficiently long to cause vibration, the popit-head centre must be used to steady it; the end of the wood must be carefully faced up. It will be necessary to see that the dividing wheel in the front of the chuck is set at 96, the starting point. The tool in the slide-rest should be $\frac{1}{16}$th wide, and the reader on the main screw set at zero. Having all at centre, we may proceed with the first cut, having first set out the slide of the chuck two turns. The tool must then be carefully advanced until a complete circle is cut, and when this is done, the stop-screw of the top slide must be fixed. The tool must be withdrawn, and the popit centre released, the dividing wheel moved round 12 divisions, and the slide-rest moved one turn, which will be the exact width of the tool. This done, the second cut may be taken, but before doing so the popit centre must be replaced. It will now be seen that when this operation has been repeated eight times, the dividing wheel has made one complete turn, and that the end of the wood has eight separate centres.

We will now take a brief outline of the drilling instrument and its uses. This is made to run in a square stem in the same way as the eccentric cutter, and the drills are made of a variety of patterns. For fluting, cutting beads, piercing fine lace patterns, it is of course indispensable. It is an instrument that requires very little explanation, and the various shaped drills will denote the pattern they produce. Beautiful effects are to be produced by use of the division plate and slide-rest, in conjunction with it.

The next instrument I shall refer to is the vertical cutter. This is also made with a square stem, but the spindles run between two centres. There are several patterns of this instrument, the most useful, I think, being one invented by Dr. Stodarts. The spindle running in a collar, the frame is dispensed with, and enables the cutter to be brought closer to the collar of any work that is being turned. One of the most effective patterns to be cut with the vertical cutter is the basket pattern; of this a number of different designs may be made. The way to proceed is to take the first cut round, arranging the index point and division plate so that the points are brought up sharp. Having cut round the entire circle, taking, we will say, 12 divisions of the 96 circle, the slide-rest must be moved the exact width of the tool, the divisions advanced 3 holes, and a second cut all round, taking 12 divisions again; this must be repeated as many times as required to complete the pattern the entire length of the work. Another effect may be obtained by cutting half in each direction, that is, when the centre is reached, the divisions are taken in the reverse way. By varying the division, a great many different patterns are thus produced.

We have now taken a brief view of those instruments I named as forming a sufficient outfit to begin ornamental turning with.

Before concluding my remarks, I must refer to a very important discussion which has recently taken place in the Council of the Amateur Mechanical Society, and by means of which certain very necessary and desirable conclusions have been arrived at.*

In acknowledging the fact that this advance is due to the action of the Council of the Amateur Mechanical Society, I may perhaps venture to say, that when scientific amateurs, such as Mr Boord, Dr. Edmunds, Colonel Sandeman, Mr. Henry Perigal, and others, devote their attention to constructional questions, the result is always advantageous to science, and helpful to technical workers. To Dr. Edmunds, as a member of the Council, is to be ascribed the initiative and the zeal which has carried this matter through; and I am bound as a practical mechanician to testify to the advantages that will arise from the action thus taken by the Council of the Amateur Mechanical Society.

This is not the first time that the ornamental lathe is indebted for its progress to scientific amateurs. Professor Willis's tool-holder; the ellipse cutter, by Captain Ash, with its indispensable tangent compensator, by Mr. Perigal; the geometric slide-rest by Captain Dawson; the geometric chuck by Mr. Ibbetson, and many other improvements have emanated solely from the ideas of scientific amateurs.

Sketching for Mechanics.—While the value of a knowledge of mechanical draughting to a mechanic is indisputable, there is a sort of free hand drawing, or sketching, that is also useful. The faculty for its practice may be innate, and in that case but slight instruction is necessary to enable its possessor to illustrate his thought far better than he could impart it verbally. But even those whose natural tendency does not impel them to sketching as explanation can get enough facility by practice to make themselves understood readily. Probably nothing is more difficult to explain and exhibit by words alone than mechanical construction and mechanical movement. It is not only difficult for the narrator, but also for the listener. The memory must hold all the points of the information in contact ready to make a completed idea at the climax. But an appeal to the eye, however crudely made, presents the entire image at one view without any laborious action of the mind. And it is a noticeable fact that those mechanics who are of an inventive, improving, and originating turn of mind are most apt with pencil and paper, or chalk and slab. To them the mechanical idea has received a form in their own mind, and by a partial representation they seek to impart their knowledge to others. The practice of sketching, as illustrative of verbal statement, is an excellent one for mechanics generally to acquire. If one has not the natural impulse in this direction, a few lessons in free hand drawing will not be amiss. Some of the best improvements derive their historical and mechanical value from rough sketches, which told much more plainly than equally crude English the operations and conclusions of a constructive mind. In the annual meetings of mechanical engineers there is seldom a paper read that is not illustrated by the author, at the time of reading, by the blackboard or chalk, or else it had been made visible by prepared cartoons, or possibly lithographed charts. Shop work also demands the ready hand at sketching. There are many jobs which do not require the preliminary preparation of the draughting room that are greatly expedited if the foreman has a facility with pencil, crayon, or chalk.

Blackboards.—Various kinds of so-called "liquid slating" have been sold for converting any smooth board or wall into a blackboard for school or other purposes. The following give very good results; No. 1 is probably the best, but is somewhat expensive. (1.) Take alcohol (95 per cent.), 4 pints; shellac, 8 ounces; lamp-black, 12 drachms; ultramarine blue, 20 drachms; powdered rotten stone, 4 ounces; powdered pumice stone, 6 ounces. First dissolve the shellac in the alcohol, then add the other ingredients, finely powdered, and shake well. To apply the slating, have the surface of the board smooth and perfectly free from grease. Shake well the bottle containing the preparation, pour out a small quantity only into an old tea-cup, and apply it with a new flat varnish brush as quickly as possible. Keep the bottle well corked, and shake it up every time before pouring out the liquid. (2.) Instead of alcohol take a solution of borax in water; dissolve the shellac in this and colour with lamp-black. (3.) Dilute silicate of soda (water-glass) with an equal bulk of water, and add sufficient lamp-black to colour it. The lamp-black should be ground with water and a little of the silicate, before being added to the rest of the liquid.

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*These conclusions are embodied in a paper which has already appeared in our pages. The form and dimensions of the mandrel recommended by Dr. Edmunds have been also given.

MODEL YACHTS.

PART V.

(For Illustrations, see Supplement.)

PERHAPS the most interesting stage in model yacht making is reached when a commencement is made with the rigging. Of course, when masts and spars are ready for fitting, the workshop proper may be deserted, and the rigging proceeded with indoors.

The boat described in the previous chapters belongs to the cutter fraternity (or, rather, "sisterhood," since a ship is called "she"), and this type of rig is illustrated in fig. 1, plate 5, which, drawn to a scale of 1½in. to a foot, or ⅛in. full size, corresponds with the short description given on page 195.

Commence by making the mast and spars. Light weight is to be sought in this direction, but due allowance must be made for the strain they are to bear. Pitch-pine will be found a capital wood for masts, gaffs, and booms; it does not readily split, and, if varnished at first, its appearance rather improves with age. The bowsprit must be considerably tougher, and calculated to resist the rough treatment which falls to the lot of all sailing models. Elm is very good, but hickory is *the* thing—an old broom-stick, planed down, making the toughest bowsprit that can be desired. In making masts and spars, first plane the wood to a square form of the required diameter, then dress off the corners to an octagon, and round with a smaller plane. The Yankee metal planes, sold by all ironmongers, are very useful for this purpose.

The extreme lengths of our spars are—Mast, 34in. from deck; bowsprit, *b s*, 21½in.; boom, *b*, 23in.; gaff, *g*, 14½in.; gafftopsailyard, *g t y*, 11in.; forestaysailboom, *f b*, 8½in.; and jibboom, *j b*, 15½in. The greatest diameter of mast is at the deck, and corresponds with outside diameter of mast-socket, the heel of mast being reduced where it enters the socket. At the "hounds"—20in. above deck, where the lower shrouds are collected on the mast—the diameter is slightly less; at the topmasthead, *t m h*, 12in. above "hounds," it may be reduced to half diameter at deck; the short "pole," above topmasthead, is merely tapered for appearance. A hole is bored (in a fore-and-aft direction) through the mast at "hounds," and a brass pin fitted, shaped as at *h*, fig. 8. This carries the bent ring to which the shrouds are attached. At the "head," fig. 1, which is 4in. above the "hounds," a notch may be filed round the mast, and another at the topmasthead, *t m h*. A circular "truck" of hard wood finishes the mast-head. The bowsprit projects 16in. beyond the stem, 5½in. being "inboard" or on deck, the after part to slide freely through the bowsprit tube, and the fore end reduced to a diameter of ⅜in. On the fore end of bowsprit fit a short hoop of brass tubing (*h*, fig. 9), having a double eyelet soldered on the upper edge, and a single one below. This hoop is to preserve the bowsprit from splitting when in collision with stonework and other obstacles. Bore a hole horizontally through the heel or aft end of bowsprit, and insert a strong brass pin to hold the spar in place. The main boom, *b*, 23in. long by ½in. diameter, is reduced to ⅜in. aft, and $\frac{5}{16}$in. at fore end. Short hoops, similar to that on bowsprit, may be fitted to the boom. The outer end (fig. 5) carries a brass pin, or projecting eyelet, *a*. The inner end (fig. 4) is fitted with a hook, which works freely in a small socket soldered to the mast-tube, *m t*, or fixed in the mast. The gaff, *g* (fig. 1), 14½in. long by ⅜in. diameter, has the ends tapered to ¼in., and notches filed round at 2in. and 8in. from the upper end. The old-fashioned shape of the heel (fig. 7) is formed by fitting sidepieces, or jaws, to the gaff, *g* (which is tapered flat to receive them), and secured by glue and fine cord or wire. The inner end of the boom may be fitted with jaws in a similar manner, if desired. This method is simple enough, but rather clumsy. Fig. 8 represents a much neater arrangement, in which the gaff is hooped at *h* to receive an eyebolt, which works on the projecting guide, its position being regulated by an adjustable sling (or "throat halyard") from the "hounds" above. The gafftopsailyard, *g t y*, 11in. long by ¼in. diameter, is notched at 1½in. from head and 1in. from heel, as shown. The forestaysailboom, *f b*, and jibboom, *j b*, are respectively 8½in. and 15½in. long, by ¼in. diameter. The ends of each may be slightly notched with the file to hold the cord where lashed to the sails.

Step the mast in the deck socket, and prepare the mainshrouds, *s s s*, figs. 1 and 8. These are connected to the mast at "hounds" by a brass ring, 1in. diameter, bent to the form shown in fig. 8, and resting on the fore and aft pin *(h)* already fitted. The six shrouds must be each 26in. long, of strong cord (not string), and their upper ends at "hounds" neatly lapped and bound round with thick black thread (fig. 8). Fit the lower ends of shrouds with the arrangement shown in fig. 10, which, though remarkably simple, is equally efficient. It consists of two 8-shaped links, *e e*, the lower one of which hooks on at *a* to the deck-plate. The shroud, *b*, is passed through it, and the end forming a loop, *c*, is attached to the upper link, which acts as a "friction clutch" on the standing part of the shroud. Hold the shroud with one hand at *b*, and the upper link with the other. Draw the hands together to tighten the shroud, which remains so. This connection should be fitted to all shrouds, including those from topmasthead, marked *x x* at deck, fig. 1.

Leave the topmast backstays, *x x*, and topmaststay off for the present, and fit the two lower stays. The forestay is formed into a loop at the upper end (*f s*, fig. 8), which is passed over the masthead and allowed to rest on the brass pin, *h*. Fit the lower end with a strong brass hook, which attaches to the outer eye on bowsprit tube. Now fit the bowsprit, and secure it by inserting the brass pin. The jibstay is to be fitted in a similar manner, and its lower end taken to the outer eye on bowsprit.

A brass staple may now be fixed in stem near the water-line to take the inner end of bobstay, which must also be made adjustable as in fig. 10. The lower shrouds (extending from deck to "hounds"), forestay, jibstay, and bobstay, should all be of the same strong cord; but the topmast backstays (*x x*, fig. 1) and topmaststay may be somewhat finer, as also the whole of the running or moving rigging.

Having here the principal parts of the standing (or fixed) rigging in place, proceed to sling the gaff. The heel or inner end, whether fitted with jaws (fig. 7) or as in fig. 8, may be suspended from the "hounds" by the short adjustable "throat halyard," similar to fig. 10. The peak, or outer end of gaff, is "set" by a short bridle of cord, attached to the gaff as shown, and controlled by the "peak halyard," *p h* (fig. 1), which is also an adaptation of fig. 10, the lower eyelet working freely on the bridle, and the upper end fixed to the mast at "head." Or, instead of making the "peak halyards" a short length between mast and gaff, a single halyard may be taken from the bridle, through a small pulley-block or eyelet on the mast, and the lower end attached (by fig. 10) to one of the small deck-plates. Either arrangement works perfectly, but the short "peak halyard" is preferable.

Next sling the main boom *b* in position, by fitting a temporary "topping lift" from the "hounds" to outer end of boom. The use of this is to relieve the mainsail from the weight of boom, which in a moderate sized ship is considerable, but in a model it is quite unnecessary, the present one being merely to hold the boom in position until a paper pattern of the sail is obtained. "Peak" the outer end of boom well up, as the sketch, or when the boat heels over the foot of the sail will drag in the water. (This applies to *all* lower sails; see figs. 1 and 2 on plate 5, and figs. 1 and 2, plate 6.) The main "sheet" and "traveller" may be fitted at the same time. Fig. 6 represents the traveller *t*, which must move freely on the "horse." The "sheet" is a rope (or cord) having one end attached to the traveller, the other passing through a block or eyelet on the outer end of boom, and led inboard. The length of the sheet, and with it the sideward play of the sail, is regulated by various methods. One is, to bore a number of holes through the boom, and have the inner end of the sheet provided with a pin which is inserted in one or other of the holes, leaving more or less of the sheet at liberty. By another method, the inner end of sheet may be arranged as in fig. 10, and attached to an eye in the boom, or on deck. The first method is perhaps the simplest, but the holes should not be less than ¾in. apart.

The gafftopsailyard *g t y* is slung by a bridle similar to the gaff *g*. This halyard, instead of sliding freely upon the bridle, must be fixed to it, and led through a pulley block or eyelet on the mast of *t m h*; thence attached to chain-plate on deck by fig. 10. The gaff must be sewn to a brass ring, which slides easily on the mast.

Having spars and stays in position, commence to make paper patterns the exact shape of the sails. In cutting these, note that the after leech (or edge) of every sail is quite straight, but the foot or lower edge decidedly curved. The heads of mainsail *m* and gafftopsail *g t* are, of course straight where attached to the gaffs. The fore leech of mainsail lies close against the mast, on which it will be secured by rings, while the fore leech of the gafftopsail is cut to stand slightly before the mast at the head: the foot extending an inch or so below the gaff, as shown by the dotted line. This sail is not attached to the mast, but hangs freely by the halyard. The patterns for foresail and jib are very simple. The sails should be made of best linen, or the gafftopsail and balloon jib may be muslin. In cutting out, place the patterns with the after leech of each sail exactly on the "selvage" of the cloth, but leave at least ¼in. round the remaining edges, as allowance for "hemming," which may be either hand or machine sewn (the former preferred, if there is a good "hand" round about). A picturesque appearance is given by dividing the sails into "cloths" (see the sketches). Run single threads (of a brownish colour) down the sail, an inch apart, and parallel to the after leech. Sew a small loop of tape in the corners of foresail and jib, and in the lower corners only of mainsail and gafftopsail. The head of the latter may be sewn to the yard, but the mainsail secured to the gaff by small brass rings spaced not more than 1in. apart. Also sew to the fore leech of mainsail seven brass rings ⅜in. diam. (at distances of 2in.), which should slide freely on the mast. Bore a small hole in the mast immediately above the lowest ring, and fit a brass pin, which, together with a short cord taken from outer end of boom, suffices to keep the mainsail in position at foot. The fore boom *f b* and jibboom *j b* may be sewn full length to the foresail and jib, or merely at the ends, as shown. These sails slide on the stays by small brass rings, spaced at intervals of 1¼in., the lower corner secured by a short cord to the eyelet on bowsprit. From the topmost ring on each stay lead a cord over a small pulley or eyelet at the "hounds," and thence to the deck, fitting a long adjustment similar to fig. 10, which admits of lowering the sail on the stay. A light cord attached to the lower corner of gafftopsail is led down to the small deck plate, and the outer edge set as shown. The fore and main sheets work on "horses," but the jib sheet must pass through an eyelet on fore end of bowsprit tube, then be led either "inboard" or along the outer part of the bowsprit, and made adjustable as before. The bowsprit may be further strengthened by fitting shrouds from the outer end to eyelets on the boats' side, a little before the mast. Next fit the topmast stay and topmast backstays, and the rigging of our cutter is complete.

To convert fig. 1 into the second type of rig, viz., a yawl, add the short mizen mast and sail, shown at fig. 3. Its position (indicated at *m m*, fig. 1) necessitates a narrower mainsail, the boom of which must clear the mizen rigging. The extreme length of mizen mast is 17in., allowing 1½in. pole. Diameter at deck need not exceed ⅜in. Gaff *g*, extreme length, 10in., diameter, ¼in. Boom *b*, 10in. long by ⅜in. diameter. The sail is a kind of "lug," the yard extending a short distance before the mast, similar to the gafftopsail in fig. 1; but as "lugs" must be set on the leeward side of the mast in sailing they are to alter each time the boat is "put about." This, the only objectionable feature in the yawl rig, is easily met by making the mizen similar to the mainsail in fig. 1, with rings to slide on the mast. Fit two shrouds at each side, and a double stay; the latter led to the deck about 2in. before mast. As the mizen mast is placed so far aft, leaving no room for the usual horse and traveller, another arrangement must be substituted. A spar may be fixed on deck, projecting about 4in. beyond the stern, and carrying at its outer end an eyelet through which the sheet is led inboard, and regulated by means of fig. 10; or the outer end of sheet may be fixed to boom at about half its length and the inner end attached to the deckplate in centre, making it adjustable as before. The arrangement of sheets generally affords scope for a little ingenuity on the part of the builder, who may profit much by making occasional experiments in this direction.

The rigging plan of our third type, the ordinary schooner, is given in fig. 2, plate 5, on a scale of 1in. to the foot or $\frac{1}{12}$th full size. We have here two masts, fore and main (spaced 15½in. and 29½in. abaft stem), from which the various spars, sails, stays, etc., are named. The sails are—Mainsail, *m s*; foresail, *f s*; forestaysail, *f s s*; jib, *j*; fore and main gafftopsails, and foretopmaststaysail or flying jib (not shown). Schooners usually carry jib-headed gafftopsails, which have no gaff or yard, but slide on the mast by hoops or rings (similar to the "trysails," *m s* and *f s*), the head of the sail being hoisted by the usual halyard worked from deck. The dimensions of masts and spars are as follows: Foremast, extreme length, 39in.; deck to hounds, 24in.; hounds to head (topmast), 12in.; pole, 3in.; diameter at deck, ⅝in.; hounds, ½in. full; topmasthead, ⅜in. Mainmast, extreme length, 40½in.; deck to hounds, 25½in.; hounds to head, 12in.; pole, 3in.; diameters, same as foremast. Bowsprit, 22½in. extreme length; housing (part on deck), 6in.; diameter at heel, ½in.; forward, ⅜in. Foregaff, 9½in. extreme; pole, 2in.; diameter, ⅜in. Maingaff, 12in. extreme; pole, 2¼in.; diameter, ⅜in. Foreboom, 13in. long by ½in. diameter. Mainboom, 22in. long by ⅝in. diameter. Forestaysailboom, 12½in. long by ⅜in. diameter. Jibboom, 14½in. by ⅜in. The mast-sockets and bowsprit-tube are similar to those of the cutter, but increased diameters. Chain-plates and horses are the same. Fit a permanent maintopmaststay at *t*, and mainstays where shown (from mainmast hounds to fore chainplates, each side). The latter must simply hook on to the chain-plate, as the leeward stay is temporarily detached in sailing to clear the foreboom. The bowsprit shrouds, *s h r*, may be led 6in. or 7in. abaft the stem.

An alternative rig for the "cutter" hull is given in fig. 1, plate 6, on a scale of 1½in. to a foot, or ⅛in. full size. This, our fourth rig, which consists of two lug sails and a jib, is very fast for "reaching" or sailing with a side wind, but for sailing *into* the wind is surpassed by the cutter. The yards, or gaffs, must, however, be set on the leeside of the mast, necessitating removal each time the boat is "put about." The masts, spaced 8in. and 19½in. abaft stem, are each 24in. extreme length from deck: allow 2in. for "pole." Diameter at deck is ½in. Bowsprit, 17in. extreme length; housing on deck, 5in.; diameter, ½in. at heel or inner end. Foregaff, 12in. long by ¼in. diameter. Maingaff, 11in. by ¼in. diameter. Jibboom, 15in. by ⅜in. diameter. Booms are seldom fitted to this style of sail, but the mainsail will stand better with a boom 15in. by ½in. Two shrouds are fitted to each mast, spaced 2in. apart on deck. The mainstay must also be double, similar to that of the schooner just described, but need not be detachable. The gaffs are to be slung by bridles and halyards (see the gafftopsailyard of the cutter, plate 5), and sewn to a brass ring which moves freely on the mast.

Another variety of the schooner is illustrated in fig. 2, plate 6. Scale 1in. to a foot, or 1/12 full size. This rig has much to recommend it, the topmasts and gafftopsails being dispensed with, and the shrouds carried direct to the masthead. A forestaysail only is shown, but this may be divided into forestaysail and jib, if necessary. The sails are taller than those of the ordinary schooner, and narrower at the head, while taking the shrouds to the masthead allows the maintopmaststay to clear foregaff. Elegance, simplicity, and handiness, are most satisfactorily combined in this rig, and if a schooner is desired, preference should be given to this style. The dimensions of the masts, etc., are as follows:—Foremast, extreme length, 33in. from deck, 1½in. pole; diameter at deck, ⅝in.; at head, ⅜in. Mainmast, extreme length, 43in. from deck, 2in. pole; diameter, the same as foremast. Bowsprit, 25½in. extreme length, 9in. inboard; diameter at heel, ½in. Gaffs, each, 12½in. extreme length; ⅜in. diameter. Foreboom, 14in. long by ½in. diameter. Mainboom, 22in., by ⅝in. diameter. Jibboom, 27in. long by ⅜in. Masts are spaced 15in. and 29½in. abaft stem; six shrouds to each mast, spaced 2in. apart.

Another fore and aft rig (not illustrated) is the lateen, or latine—a style which, though very fast on a side wind, possesses the same disadvantage as the "lug," only in a greater degree. Imagine the foresail and jib of the lugger (fig. 1, plate 6) as *one sail*, the yard extended down to the bowsprit, with a huge boom the full length of the sail, and a fair idea of the lateen is obtained. Without the boom it will not stand flat, and with it the inconvenience of moving the sail to leeward is at once apparent. As a novelty this sail might be tolerated, but in comparison with the previous rigs it is practically nowhere.

Although polemasts must always take precedence in a sailing model, it may perhaps be desirable to fit "fidded" topmasts, which may be "housed" occasionally, if need be. A sketch of the doubling of such a mast for the cutter (plate 5) is given in figs. 3 and 4, plate 6, one-fourth full size. The upper part of lower mast (from hounds to head) is cut nearly square, and at the hounds is fitted a light "crosstree" of brass (fig. 4), in the fore part of which slides the topmast. The projecting arms take the topmast shrouds; and the necessary eyelets are fitted for shrouds, forestay, etc. The "cap" (at head) is a similar hoop, but without other projections than the eyelets shown. Through the heel of topmast, and supported by the crosstree, fit a brass "fid," *f*, which holds the topmast in position, and is removed to "house," or lower it.

The rigging of all models should be clear of "complications;" in short, everything should be as automatic as possible, and nothing introduced which is likely to "foul" or entangle.

[Plate VI. has the title "plate IV." under it, so that the reference to plate VI. refers to plate IV., and *vice versa*.]

SCREW CUTTING IN THE SELF-ACTING LATHE.

By Paul N. Hasluck.

THIS is accomplished by means of the apparatus attached to and forming part of what is termed in trade circles a screw-cutting lathe, which consists of the ordinary lathe supplemented with a screw running the entire length of the bed, and capable of being made to gear in or run free of the slide-rest, which is fitted to travel the whole length of the lathe bed. The revolutions of the mandrel are imparted to the screw—called the leading screw or guide screw—running the length of the bed by means of toothed wheels called change wheels. It will be at once apparent that the ratio of these wheels determines the comparative rate of revolution of the mandrel and the leading screw, and that the wheels control the rate, pitch, or number of threads to the inch of the thread to be cut on the work revolving between the lathe centres.

Before considering the points involved in calculating the ratio of the wheels required to cut a thread of predetermined rate, it will be advisable to consider what the process really is. Therefore let us clearly understand the theoretical principles before discussing the details of application of them in workshop practice. Though many methods have their special advocates and claims for consideration, yet the principle of all is nearly the same, and it is only the detail of explanation which makes the one or other course of calculation the better understood and consequently the more readily adapted. What to one may appear a process quite incomprehensible is to another, who may in no way be better qualified to comprehend, quite a simple and thoroughly understood process.

Before attempting to carry out its practical application, the theoretical principles of screw-cutting in the lathe should be thoroughly mastered. In fact, this truism holds good in all processes, though more especially those involving mechanical manipulation. Let us suppose a cylindrical rod turned perfectly true and running between the lathe centres and a cutting tool—attached to a nut working on a screw—revolving in fixed bearings parallel to the cylinder or line of centres, placed in a suitable position for turning or cutting the cylinder. Now, it is evident that, on the lathe being revolved and the rotary motion of the cylinder imparted to the screw, the tool attached to it will move in a direction parallel to the axis of rotation of the cylinder, and if the point of the tool be brought sufficiently near to cut the periphery of the cylinder, a spiral groove or thread will be traced thereon. It is also evident that if the cylinder and the guide screw make isochronous revolutions—that is, revolve at the same rate—the thread on the cylinder will be the same rate as that of the screw which guides. Further, if the guide screw and the cylinder revolve in the same direction, the threads will be in the same direction; but if these revolutions are in opposite directions, the threads will be reversed—that is to say, one will be right and the other left-handed. Again, when the ratio of the revolutions is made to vary, the ratio of the screw which guides and the screw which is cut will vary in the same proportion, and if the cylinder makes two revolutions to each one of the leading screws. the screw traced will be twice as quick as the one that guides.

We will suppose this guide screw—as above mentioned—to be right-handed, and to have four complete threads to each inch linear measurement, and that motion from the mandrel is imparted to the screw by a series of change wheels; and we will suppose them to have teeth cut on their peripheries, as of course they do have in practice. When a wheel is fixed to the mandrel, and another of the same size—that is, the same number of teeth—fixed to the guide screw, and these two wheels are brought into gearing, on revolving the mandrel will get the result explained above—viz., a thread of four threads per inch will be cut on the cylinder. As the wheels, and with them the screw and cylinder, revolve in opposite directions, the thread traced will be left-handed. However, to produce a right-handed thread, it is only necessary to separate the two wheels sufficiently to get their teeth out of gear, and connect up the motion by an intermediate wheel, the size of which will have no effect on the ratio of the rates cut. This will cause both cylinder and screw to turn in the same direction, and, as we have already demonstrated, a right-handed screw will be the result. The relative velocity of the mandrel, which is that of the work on which the screw is to be cut, to that of the guide screw may be regulated as required, and right or left-handed screws of any pitch—limited only by the number and variety of the change wheels available for use—can be cut by employing wheels proportioned. The rate of the leading screw being known, this proportion is simply a matter of calculation, involving no very intricate rules. This explanation of the theoretical principles will enable a mere tyro to comprehend the rationale of my subsequent theories, and will materially assist in making clear the process.

Let us now consider the terms we are dealing with, as a variety of synonymous expressions often perplex persons not thoroughly versed in a subject. Screw-threads are described in various ways. By way of example, the same thread may be said to be "¼in. pitch" meaning that the distance apart of the threads, measuring in a straight line from one thread to the corresponding part of the next convolution, is ¼in., or it may be said to have "four threads to the inch," meaning that if the same were revolved four times in a nut fitting it, the longitudinal motion would be 1in., or it could be termed "·25 pitch," which is precisely the same as the first example, the vulgar fraction being replaced by its decimal equivalent. Similarly, the word *pitch* is sometimes replaced by its equivalent term *rise*.

The rule for finding the relative sizes or number of teeth of wheels required to produce a screw of given pitch is most simply expressed in the form of a rule-of-three sum, thus :—The rate of the guide screw :, the rate of the screw to be cut : :, the diameter of the wheel on the mandrel :, the diameter of the wheel on the leading screw. Thus written the sum becomes comprehensible to all who have made themselves acquainted with the rudiments of arithmetic. As an example, suppose we want to cut four threads per inch with a guide screw of ¼in.-pitch:, then we should write out the proportion thus:—4 (guide screw) :, 4 (thread to be cut) : :, any convenient sized wheel on mandrel :, its duplicate on the guide screw. In this example it is seen at a glance that the rate of thread to be cut and that of the guide screw are the same, and by the theorem above given we know that the wheel will be similarly proportioned—that is identical—and also that the introduction of an intermediate wheel will be necessary to make the thread cut right-handed.

Another rule for obtaining the same result is this:—Write down in the form of a vulgar fraction the number of threads on a given length—it may be an inch, a foot, or any length—of the guide screw, and the number of threads on an equal length of the screw to be cut; then multiply both, which will not alter the relative proportions of the numbers, by a number which will produce a multiplicand in the form of numerator and denominator of a number equal to some two wheels in the set of change wheels available; then, by putting the quotient of the guide screw on the mandrel, and that of the rate required on the guide screw, the result will be a combination of the required ratio. Example wanted to cut a screw of 12 to the inch, with the same leading screw as before—viz., quarter pitch. Write down, as I have directed, $\frac{4}{12}$, and multiply by a number to produce figures equal to some two change wheels—say 5; then $\frac{4}{12} \times 5 = \frac{20}{60}$. If you have two wheels of these numbers, put 20 on the mandrel and 60 on the guide screw, and the desired result is attained. In exactly the same way, by using multiplicands of 8, 10, and 12, respectively, we find the following wheels will answer equally the purpose:—$\frac{4}{12} \times 8 = \frac{32}{96}$; or $\frac{4}{12} \times 10 = \frac{40}{120}$; or $\frac{4}{12} \times 12 = \frac{48}{144}$ and so on. The pair of wheels would be selected according to the suitability of the particular sizes; in any case the result would be the same—either combination would cut twelve threads per inch.

The foregoing examples are of the simplest character, and the method of working them out is superficially apparent. Let us now consider what does not come under this heading, and will require more elaborate calculations. First, there are some threads which positively cannot be cut with accuracy with certain sets of change wheels, and a ready means of distinguishing these is very desirable; they can be told at a glance by an experienced hand. In brief, all *prime* numbers which have not an equivalent wheel, or are not aliquot parts of some wheel in the set, cannot be cut. Prime numbers are those only divisible by unity, and some of the low ones are 3, 5, 7, 11, 13, 17, 19, etc., and when one of these numbers forms a figure in the calculation we at once know that the desired ratio cannot be found, except we have a wheel equal to a multiplicand of such prime number—*e.g.*, with a wheel of 30 we can cut three and five, 35 will do for seven, and 55 for eleven; nineteen can be cut with a wheel of 95, and so on; but when the primes become large, their multiples are beyond the range of an ordinary set of change wheels—say, twenty-seven, which would require a wheel of 135, and usually sets do not go beyond 120 as the largest. For all practical purposes those prime numbers over twenty have no claim on our attention, as 26 or 28 threads per inch would serve all the purposes of 27, and these two former can easily be cut with the ordinary wheels; it is only to guard against the possibility of tyro readers trying in vain to calculate a series of wheels to produce an impossible (with the means at hand) result.

A word as to the means at hand. By this we understand the change wheels. Very extensive sets are occasionally to be met with, but they are usually the special production of some enthusiast. Ordinary sets of change wheels consist of twenty-two wheels. The smallest is usually twenty, and the numbers increase by fives to one hundred and twenty, making twenty-one wheels. There is also a duplicate of one of the medium sizes, making the complete set of twenty-two.

Some specially machine-cut wheels are multiples of six, but these are seldom made, now that such good, serviceable and cheap cast-iron wheels can be obtained.

The preceding examples will make the theoretical principles plain, and the practical application of these principles has been shown as applicable to simple calculations. We will now consider the extension of the previously-demonstrated theorem to those cases involving more complicated calculations.

By placing two wheels of different diameters to rotate simultaneously on the same axis, we are enabled to introduce into the practical application a new element, and one which is capable of entirely changing our previous mode of reckoning. Two wheels of different sizes, placed on the stud which carries the intermediate or idle wheel and revolving together, will, when one is geared into the mandrel and the other into the screw-wheel, produce a complication in the results. Suppose 50 on mandrel geared into 100 on the screw of ¼-pitch, the rate of thread cut would be 50 : 100 : : 4 : *x*, which, on calculation, is 8 : By putting a compound wheel of 40 and 120 on the stud, with the large wheel gearing into the mandrel, and the small one into the screw, we shall obtain as a result a rate of 24 threads per inch with the ¼-pitch leading screw. Though by this proceeding we have brought a new factor into the sum, yet the original formula remains unaltered.

If the numerator and denominator of a fraction are both multiplied by the same number, the value of the fraction is unaltered, and in the same way the two component numbers of a fraction may be split up without altering its value. On applying this rule to our example, we must get numbers for denominator and numerator, which are equal to some of our change wheels, and when the simple fraction will not give such wheels, the equivalent may be found by making the one fraction two. Suppose we wish to cut 40 threads per inch with a ¼-pitch leading screw, we then get $\frac{4}{40}$, that is, a 4 on mandrel and a 40 on screw will suffice; but in point of fact there is no such wheel as a 4, and probably 20 is the smallest one of our set, and in that case $\frac{4}{40} \times 5 = \frac{20}{200}$, that is, a 20 on mandrel, and a 200 on the screw.

Here we have a new difficulty equally insurmountable, for no wheel so large as 200 is to be found in an ordinary set of change wheels. It is in a case like this that we use a compound wheel on the intermediate spindle, and the easiest way to determine on the wheels to be used is to split the single fraction representing the rate of guide screw and rate of thread to be cut into two equivalent fractions, thus: $\frac{4}{40} = \frac{2}{8} \times \frac{2}{5}$. Here we have figures easily dealt with, but before determining on the wheels, let us recollect what we have available. The ordinary set of change wheels consist of 22, ranging from 20 to 120, in multiples of 5, with an extra duplicate wheel to use when the relative speed is not to be changed.

To continue the former calculation, $\frac{2}{8} \times \frac{2}{5}$, commencing where we left off, we will convert the figures into some corresponding with the above wheels, and using a 10 to multiply by we get, serving *one* numerator and denominator, alike as before demonstrated, $\frac{20}{80} \times \frac{2}{5}$, and thus we get two wheels, 20 and 80.

To make the other two available we may use 15 as a multiplicand, and thus get $\frac{20}{80} \times \frac{30}{65}$, the numerators 20 and 30 being the drivers and the denominators 80 and 65 the driven. Put 20 on mandrel and 80 on screw, with the 30 and 65 on the stud, the larger of course being *driven*, that is, having motion imparted to it from the mandrel, and the smaller *driving*, that is, imparting the motion to the screw. In calculating the compound wheels, always recollect that the *drivers* are synonymous to the mandrel wheel, and the *driv.n* are those which are on the screw and receive motion. To give another example: Suppose we wish to cut 75 threads per inch with a ¼pitch leading screw, the proportion would stand thus: $\frac{4}{75}$, which may be split into $\frac{2}{5} \times \frac{2}{15}$. By multiplying two of the terms as before, we get $\frac{20}{150} \times \frac{2}{5}$, and again, multiplying as before, we get $\frac{20}{150} \times \frac{30}{75}$. Now, not having the 150, we must reduce the number, and taking two-thirds, leave 100 to equalise the process, we take two-thirds of 30 and get 20, the sum standing $\frac{20}{100} \times \frac{20}{75}$.

Having no duplicate of 20, we cannot succeed, so may introduce a second spindle or stud to carry another pair of wheels; the wheel plate should always allow of this, and a third spindle, with an idle wheel, will be wanted to produce right-handed threads. To resume the calculation: $\frac{20}{100} \times \frac{20}{75} = \frac{2}{4} \times \frac{10}{25} \times \frac{20}{75} = \frac{2}{4} \times \frac{40}{100} \times \frac{20}{75} = \frac{30}{60} \times \frac{40}{100} \times \frac{30}{75}$, which numbers might suit, always bearing in mind that the numerators are drivers and the larger wheels driven. If we had no duplicate 30, we should multiply by 1½ and get $\frac{45}{90} \times \frac{40}{100} \times \frac{30}{75}$. Here no difficulty exists if the wheel plate is large enough.

The last example gives some difficulties that are not found in dealing with some higher numbers. Suppose we wish to cut 80 threads then, thus: $\frac{4}{80} = \frac{2}{20} \times \frac{2}{4} = \frac{30}{120} \times \frac{20}{100}$. To prove the accuracy of the calculation, reduce the fraction to its lowest terms, which should equal the fraction showing the proportion between the leading screw and the screw to be cut.

Suppose we want to cut 60 threads per inch, the proportion is $\frac{4}{60} = \frac{2}{15} \times \frac{2}{4} = \frac{30}{15} \times \frac{2}{60} = \frac{30}{15} \times \frac{4}{120} = \frac{30}{75} \times \frac{20}{120}$. And the proof, 600 : 9000 : : 4 : 60.

It may be well to mention here that by placing the two smallest wheels as drivers and the two largest as driven, so as to cut the finest thread possible, we should cut a bastard rate of 105·6 threads per inch.

A great deal of trouble is often experienced by some in finding the wheels required to cut odd pitches and those rates containing a fraction of a thread, as 9½ per inch. The trouble, however, soon vanishes when we know how to manage these odd pitches. Taking as our first example the above rate, and supposing our leading screw to be ¼ pitch we proceed to calculate in the manner we have previously done, and get :—$\frac{9\frac{1}{2}}{4}$. Now by converting the vulgar fraction into a decimal, we get $\frac{9\cdot5}{4} = \frac{95}{40}$, and at once we have the wheels required, viz., 40 on the mandrel and 95 on the leading screw. Compound intermediate wheels not being required, we can use any wheel of suitable size to transmit and reverse the motion. In point of fact, cutting 9½ threads per inch with a leading screw of 4 per inch is equivalent to cutting 95 with a screw of 40; or again, there are 95 threads in the screw required, occupying the same length as 40 in the leading screw, viz., in 10 inches; and this last way of expressing an obvious fact is, perhaps, the most perspicuous, and we therefore endeavour to impress it on our readers. Suppose we want 9¾ threads, then we have $\frac{9\cdot75}{4}$, which is the same as 975, turns in 100 inches to be cut, and 400 turns in the same length of guide-screw, and putting this as a fraction $\frac{975}{400}$, it is only necessary to split up both numerator and denominator into convenient numbers, as before described, thus :—$\frac{975}{400} = \frac{65}{80} \times \frac{15}{50}$; the 15 being too small for our set of wheels, we multiply by 2, and get $\frac{65}{80} \times \frac{30}{100}$, which will suit our purpose, putting 100 on the screw, 30 on the mandrel, the other two going on the stud, 80 being driven by the mandrel-wheel, and 65 driving the leading screw. The proof is easily worked out, as in the previous examples.

* * *

Hard Solder for Silver.—Silver, 66 parts; copper, 23 parts; zinc, 16 parts (by weight).

PRACTICAL ELECTRICITY FOR AMATEURS.

By Sergeant Arthur Sharpe; Author of "Practical Notes on Telegraphy."

IN introducing this most important and beautiful science to the readers of "Amateur Mechanics" and my old friends, I wish to place before them a list of the various subjects on which I am writing, and which will be contained in my series of articles. I beg to say that I have spent several years in the study of this wonderful science, having passed through the various grades in the construction, maintenance, and manipulation of almost every kind of electrical apparatus, as now in use by the Royal Engineers, Postal Telegraph Departments, and by the various Railway Companies, together with various apparatus and all kinds of batteries as used for private purposes. I have fully gone through each subject, and have prepared articles in such a manner that I can introduce this science to the notice of amateurs and others who know, practically speaking, little or nothing whatever about electricity, and place before them in detail the way in which different apparatus are constructed, giving every item of practical interest, together with the sizes of the various parts; also giving a clear description of the use for each and every part, thus rendering it quite possible for amateurs to follow my instruction and construct for themselves good substantial and perfectly working models of almost every kind of electrical apparatus in use at the present day. Electrical engineering has become so prominent during the last year or two, and it is really so closely connected with mechanical engineering, that I think amateur mechanics ought to have a thorough knowledge of both subjects; at any rate, an electrical engineer must have a good knowledge of mechanism to master his work in a proper and scientific manner. Every kind of electrical apparatus requires to be fitted up with the greatest nicety and accuracy to obtain good results. Thus it shows only too clearly that a man, to become a good electrician, must also be a good mechanic. Both branches must be well studied before one becomes master of the electrical science. It is quite needless to attempt to enumerate the various applications of electricity which are most intimately connected with mechanical engineering, for, look in what direction we will, we can observe the rapid strides electricity is making in every branch of mechanism. In some instances electricity has replaced steam and horse power, and for lighting purposes it is taking the place of gas; and I fully believe that in the course of a few years we shall have electricity, as a motive and illuminating power, as a permanent arrangement.

It is, therefore, highly essential that our engineers should make a special study of this science. I have spent both money and time in this undertaking, and I sincerely trust that my endeavours may meet with the approval and appreciation of my readers. I am only too happy to offer my services, together with an extensive experience, for the benefit and instruction of our amateurs. Being the first, I believe, to introduce the electrical science to the readers of our magazine, I trust that they, one and all, will endeavour to avail themselves of the offer I make. I shall be glad, after readers have perused the introduction and list of subjects contained in this article, if they will kindly communicate their views to our Editor as to their approval of the introduction of this science to the pages of "Amateur Mechanics." My reason for asking this is on account of the magnitude of the subjects mentioned. It must be remembered that to clearly explain to amateurs the various electrical appliances in detail will extend over a considerable period, and to accomplish my work to the end I shall need the patronage of as many readers as we can possibly obtain. My old friends, I am sure, will be ready to offer me their support.

I have no wish to occupy valuable space with my articles if they do not meet with the appreciation of our readers. On the other hand, if my work is acceptable, rest fully assured that nothing shall be wanting on my part to make it interesting and instructive. My object will be simply to give instruction in a plain, easy, and yet a practical way; to give them a clear and perfect knowledge of the construction and use of electrical appliances generally. During my series of articles, if any reader does not perfectly understand my description, I shall be only too happy to give any further assistance as far as my abilities will allow, so that none need fear a chance of failure. For the instruction of our readers generally, I wish to point out that my list of subjects will be liable to alteration, should I find any additional apparatus of sufficient value to them for experiments or for practical use.

The subjects on which I propose to write are as follows:—Electricity, its production, etc.; technical terms, as applied to electricity; a minute description of *every* kind of battery, how constructed, how charged, and its action; the preparation of battery plates, including carbons, zincs, copper, platinum, silver, iron, and lead; casting of all kinds of battery zincs, electro-motive force of batteries, etc; the term "resistance," and laws of electrical energy; how to electro-type carbons, plates, and blocks; the construction of telegraph lines overhead and underground, together with a description of a few of the cables now in use for submarine telegraphy; how poles are prepared and erected; insulators, their use, etc.; making joints in line and gutta percha covered wires; earth connections, plates, etc.; direction of the electric current from place to place, its return by the earth, etc.; the construction of electro-magnets, their use in telegraphy and other purposes; electro-magnetism; magneto-electric currents; magnetism and magnetic induction; galvanometers and detectors, how made and used; how to construct all kinds of telegraph instruments, including Wheatstone's A B C apparatus, the single needle instrument, the Morse sounder and taper, automatic telegraph apparatus; duplex and quadruplex telegraphy; the bell sounders, giving the alphabet and code of signals as used for each apparatus; methods of manipulation and reading; the way to test batteries, apparatus, and line wires; a description of the block telegraph apparatus; electric bells, indicators, telephones, microphones, and switches, as used by our Railway Companies; electric bells, single stroke, and tremelo for private purposes; door contacts, window triggers, thief and fire alarms, electric motors and engines; intensity and medical coils, condensers, etc.; magneto-electric machines; bottle bichromatic batteries for the pocket and experimental work; electric lighting by battery at home. The whole of the above-named subjects, together with many more which I have been obliged to leave out of my list, I propose to describe in detail, giving a clear description of each apparatus, so as to enable amateurs to learn the electrical science, and fit up for themselves apparatus that will afford them years of instruction. I now leave this matter in the hands of my readers, trusting to receive their approval and support. Nothing will give me greater pleasure than to co-operate with all, and do my very best to assist as far as my ability will allow. In our next number I hope to commence our subject, and to be able to continue my work each month in our excellent magazine.

[We shall be glad to know the general opinion ot our readers on the above proposal.—Ed.]

HOW TO MAKE A SMALL POWER STEAM ENGINE.

By H. R. Phelps.

PART IV.

THE fly-wheel, which is of iron. is 9in. diameter and 1in. wide on rim, and should weigh about 9lbs., anything lighter not being sufficient to carry the engine over the centres steadily. Being too large to turn on a mandrel easily, it will have to be clamped on a face plate, and, after turning both sides and face, the hole for shaft must be carefully bored out to $\frac{3}{4}$in. diameter, and very slightly tapering to fit tightly on shaft. A key way will be required $\frac{1}{4}$in. wide and $\frac{3}{32}$in. deep, to correspond to that in shaft, and for which a steel key will be required. This key will require a head on large end $\frac{1}{8}$in. thicker than rest ot key, and $\frac{1}{4}$in. long. This head is for the purpose of extracting the key when in its place in wheel. The belt drum is $3\frac{1}{2}$in. diameter, and 1in. broad on face, and slightly curved, as shown in drawing, so as to prevent the belt from slipping off. This wheel can be fixed on a face plate, or, if preferred, in a boxwood chuck, and bored out the same as fly-wheel, after which it can be driven on a mandrel and the rim turned. A key way is also required same as in fly-wheel. The mandrel on which the wheel is turned ought to be as short as possible, and the wheel as near the back centre as it can be, in order to do away with the chattering that is inevitable on turning anything on a long mandrel.

The eccentric, which is an important part of the engine, will next engage our attention. A deal ot attention must be paid to the fitting of the strap on the sheave; otherwise they will work with a deal ot unnecessary friction. The following is the means I adopt in making eccentrics up to about 3in. in diameter. The strap, which is of gun-metal, is first soldered on a chuck and bored out to $1\frac{7}{8}$in. diameter, and the side is also turned; it can then be reversed on the chuck, and the other side turned until it is $\frac{3}{8}$in. thick. The holes in lugs for holding the two halves of strap together are next made for the bolts, which are $\frac{3}{16}$in. bare in diameter. These holes must be made before the strap is cut, so as to insure their being opposite each other in both lugs. The flat part of strap, for taking end of eccentric rod, is $1\frac{3}{16}$in. long, and $\frac{3}{8}$in. from inner edge of strap. This rod is fastened on by two $\frac{3}{16}$in. studs and nuts, as shown, the studs being tightly screwed into eccentric strap. An oil cup will be required on strap, as shown. A drawing showing the inside ot these cups will be given.

The eccentric sheave, which is of cast iron, can be soldered on a chuck, and turned on one side, then reversed, and turned on the other side, till it is $\frac{1}{2}$in. full in thickness. The edge is now turned till the sheave is $2\frac{1}{8}$in. in diameter, and a groove sunk in edge for the strap; this groove is $\frac{3}{8}$in. bare in width, and $1\frac{7}{8}$in. full in diameter. The strap, which can have been cut in two, is now carefully ground into this groove, with a little fine silver sand and oil, until it bears equally all over, but the grinding must stop when the two halves of strap are within $\frac{1}{32}$in. of each other, so as to allow room for tightening up. Having marked the centre of sheave, the chuck must now be warmed till the solder melts, and the sheave then pushed over $\frac{3}{8}$in. to one side. The centre of hole is now marked, and a $\frac{3}{8}$in. drill put through, and the hole then bored out with a tool in the slide rest, to the exact size of that part of shaft on which it is to fit.

The best way to fix the sheave on the shaft will be by a pointed steel screw passing through centre of widest part of sheave into a small hole in shaft. This screw, owing to the strain from it passing through the centre of sheave, always keeps sheave perfectly square with shaft, while a key, especially in filed key ways, almost always bears more on one side than the other, and thus twists the eccentric sheave, and causes the strap to bind in groove. The hole in shaft for the point of this screw must not be drilled till the slide valve has been set.

The eccentric rod, which also works the feed pump, is of wrought iron, and of the following dimensions: Length from end next eccentric strap to centre of pin for working valve gear, $6\frac{7}{8}$in.; from centre of valve gear pump to centre of pin in pump plunger, $2\frac{1}{8}$in.; depth of rod at large end, $\frac{3}{8}$in.; do. at small end, $\frac{3}{16}$in.; depth of block for valve gear pin, $\frac{5}{16}$in.; thickness of ditto, $\frac{7}{32}$in.; thickness of rod, $\frac{5}{32}$in. and parallel; thickness of end for eccentric strap, $\frac{3}{16}$in. full; length of do., $1\frac{3}{16}$in.; width of do., $\frac{3}{8}$in.; length of block for valve motion pin, $\frac{3}{8}$in.; diameter of pin for ditto, $\frac{3}{32}$in.; length of working part of do., $\frac{3}{16}$in.; diameter of hole for pin of pump plunger, $\frac{5}{32}$in.; diameter of boss on end o rod, $\frac{5}{16}$in.; thickness of do., $\frac{1}{4}$in.

The valve levers and supports will be the next articles to be made. These are clearly shown in the sheet of details, and are drawn full size. The eccentric rod lever, figs. 1 and 2, is $1\frac{5}{32}$in. long from centre of rocking shaft to centre of slot for sliding block; length of slot, $\frac{7}{16}$in.; width of do., $\frac{3}{16}$in. full; width of slotted end of rod, $\frac{5}{16}$in.; length of do., $\frac{9}{16}$in.; thickness of do., $\frac{3}{16}$in. bare; widths of tapered part of rod, large end, $\frac{1}{4}$in.; small end, $\frac{5}{32}$in.; thickness of do., $\frac{1}{8}$in.; diameter of circular head of rod, $\frac{11}{32}$in.; length of do., $\frac{1}{4}$in.; diameter of hole for rocking shaft, $\frac{3}{16}$in.

The small lever, figs. 3 and 4, is similar to the large one, with the exception that it is slightly bent, as shown, this being for the purpose of allowing the boss to clear the nut which holds down one of the guide bar supports. The rod can be made straight at first and cranked when finished, to the extent of $\frac{1}{16}$in. full, as shown. The outer edge of the tapered part is flush at bottom with edge of boss, as shown in fig. 4. The boss is $\frac{11}{32}$in. diam., and $\frac{1}{4}$in. long; diameter of hole in centre, $\frac{3}{16}$in.; distance from centre of do. to centre of slot, $\frac{19}{32}$in.; length of slot, $\frac{13}{32}$in.; width of do., $\frac{3}{16}$in.; full width of head, $\frac{5}{16}$in.; length do., $\frac{17}{32}$in.; thickness do., $\frac{3}{16}$in.; thickness of tapered part, $\frac{1}{8}$in.; width of wide end, $\frac{1}{4}$in.; do. of small end, $\frac{3}{16}$in. full. The distance apart of the two levers, that is, between the bosses on rocking shaft, is $\frac{3}{4}$in., the rocking shaft being $\frac{3}{16}$in. diameter, and the levers fixed to it by two small keys, as shown. The angle the two levers form with each other can be best determined in the process of erection. The small blocks that slide in the slots in levers are the same thickness as ends of levers, and are for the large lever, $\frac{5}{16}$in., bare, long, and for the small lever, $\frac{1}{2}$in. long. Each block has a full $\frac{3}{32}$in. hole through it for the pins to work in. These blocks are shown in figs. 8, 9, 11, 12, and must be a good working fit in the levers. Both the levers and blocks are best made in forged steel, for the sake of strength. The rocking shaft is a piece of bright steel wire. The steel pin for valve spindle crosshead is shown in fig. 10; it is $\frac{3}{32}$in. diameter, and is $\frac{3}{8}$in. long between nut and head.

The valve spindle crosshead is shown full size in figs. 5, 6, 7; it is screwed on the valve spindle with a $\frac{3}{16}$in. screw, and a pin put through, as shown, to prevent it turning. The dimensions of crosshead are: Length from centre of pin to end next valve, 13/32in.; diameter of beading on end, 3/8in.; diameter of circular part of sides, 1/4in.; depth of crosshead, 5/16in.; width of body of ditto, 5/16in.; width across circular bosses, 3/8in.; width of opening for rocking lever, 3/16in. full; depth, sufficient to allow lever to work freely. Hole for pin is 3/32in. diameter. The length of valve rod is 4 1/8in. exclusive of the part in the crosshead.

The pedestal marked 16, 17, 18, 19, on detail sheet of drawings, carries the valve lever rocking shaft, and is made of cast iron. It will be seen that the edge of the bed is square where it fits on, the hollow chamfer being stopped against the side of the square. The pedestal is bolted to the bed by two 1/8in. studs and nuts, the studs being firmly screwed into the bed. It is 3/4in. long, and 5/32in. thick where the studs go through, the curved rib in front being the same thickness. The depth is 1/2in. from top of bed to bottom of pedestal, and the centre of 3/16in. hole for rocking shaft is 13/16in. from top of bed, and the diameter of top of pedestal is 3/8in., and length of do. 3/4in. bare; the width of bearing surface of pedestal on top of bed, measuring from edge of bed inwards, is 9/32in., the rest of the length of the top of pedestal thus projecting over the bed. The distance from centre of pedestal to centre of cylinder is 2 7/16in.

The feed pump, of which full size sections will be given, may be made in gun metal. It is on the trunk principle, this form throwing much less friction on the gland than that with a solid plunger with the eccentric rod fixed to the outer end. It is of extra large dimensions, in order to allow the engine to be worked from a boiler of good size, besides which, it is very unpleasant to be working an engine the pump of which is barely able to keep up the supply of water; and there is also another reason, viz., that very small pumps often refuse to act. I have seen many a good model boiler spoiled through inability to keep up the water level.

The plunger of this pump is made of a piece of 3/8in. triblet brass tube 1 7/8in. long, into one end of which a disc of brass 1/8in. thick is to be silver soldered or brazed. (The former is the easiest, and quite as strong for all practical purposes.) In the centre of this, a 3/16in. hole is drilled and tapped. Into this is to be screwed a joint for eccentric rod of the shape and size figured on sectional drawings. A lock nut will be required on end of screw to prevent joint working loose. The pump will require three 1/8in. studs to hold it to bed plate; one in each foot on sides of stuffing box, and one under clack box as shown.

The barrel of pump is bored out to 3/8in. diameter to within 1/8in. of bottom, the stuffing box being afterwards enlarged to 5/8in. diameter and 3/16in. deep, the gland being 5/8in. long, diameter 5/8in. bare, thickness of flange 1/8in., length of ditto 1 1/16in., width of ditto 13/16in., and of shape shown. The outside diameter of pump barrel is 5/8in., and that of stuffing box 3/4in. full, and length of ditto 5/8in. From end to end of flange for fixing to bed is 1 5/16in., and width 1/2in. The centre line of pump is to be 13/32in. from face of bed, and the face of flange consequently this distance from centre. Thickness of flange 3/16in., and flange under clack box the same; length of flange being 1/2in., and depth 5/16in. The length of pump barrel from commencement of curve in stuffing box to upper side of first clack box is 11/16in. The diameter of both clack boxes is 9/16in., the length of first one being 3/4in., and the second one 11/16in., and the top raised 5/16in. above the first one, the two being connected by a square piece 3/8in. wide and 3/8in. deep. This piece is in one casting with pump, and serves as a passage for the water.

The construction and dimensions of the valves and seatings is so clearly shown on full sized drawings that it is not necessary to give sizes here, so I shall just give a few hints as to how to set about making it. If it is desired, a return pipe and tap can be screwed into pump between first and second delivery valves, as shown on details. This arrangement allows the pump to be always pumping water, which, when not being sent into boiler, can be returned to tank; and thus preventing valves getting stuck on their seats, and ensuring the water going into boiler immediately it is turned on. The amount of feed can also be regulated by it better than by shutting off the tap on suction pipe, as if this latter is done, the pump, owing to its not being filled properly at each stroke, will hammer very much. The barrel of the pump may be cored out in the casting, but it will be better to have the clack boxes cast solid and bore them out afterwards. The box next barrel is first carefully centred at top and bottom, and a full 3/16in. hole is to be drilled right through. A large hole of the diameter and depth figured on drawing is then drilled into each end, thus leaving a flat disc in about centre of box. On this disc the first delivery valve is seated. These holes will require to be tapped with a fine thread to size given. The 3/16in. hole in central disc will require to be very carefully smoothed on the upper edge to form a seating for valve. The two caps on top of clack boxes are as shown, with central pieces projecting inside to regulate lift of valves.

The exact length of these pieces can be determined when valves are in, and should be such as not to allow valves to lift more than 1/16in. bare. The suction valve is prevented from rising too much by a piece of 1/16in. brass wire passed through two holes in top of valve seating piece before it is screwed into clack box. Construction is shown in details full size.

The passage from first to second delivery valves can be made by drilling two holes 1/8in. diameter full through the piece joining the two clack boxes. They can be drilled from near the top of the first clack box slightly on the slant downwards to the bottom of second box, that is, within 1/8in. of the bottom. The second box is then to be centred top and bottom, and a 3/16in. hole drilled right through, if it is desired to put a return pipe to pump; if not, to within 1/8in. of bottom. This hole must have full communication with the two holes from first box. The top of box is bored out and tapped same as No. 1, and a cap fitted to it. The valve seat is also the same.

To connect the delivery pipe union there is a 3/8in. piece cast on the second clack box close to the top, as shown; this piece has a 3/8in. thread on it to take the union, and has a 3/16in. hole through it into box. The thread for suction pipe union is 7/16in. diameter.

The bore of suction pipe of pump is 1/4in., and delivery pipe 3/16in. Pipes have collars on end to keep unions on. The connection of suction pipe to pump with tank is made with a union and screw piece, same as to pump, but, of course, without a valve in it. The tap is shown full size on detail sheet of drawings.

Two sheets of working drawings, together with the conclusion of the descriptive matter, will appear in our next.

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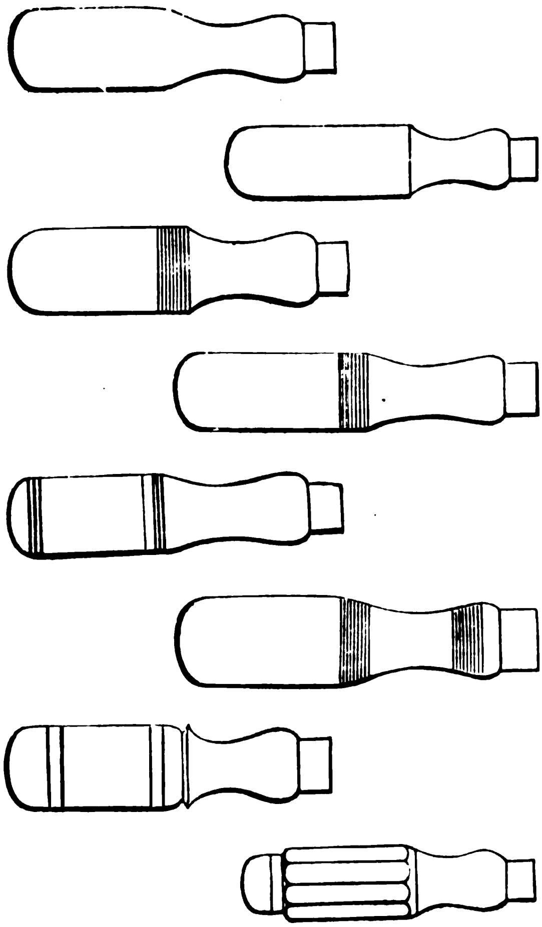
Solution for Cleaning Silver and Plated Ware.—Dissolve 1/8 lb. of cyanide of potassium and 1/8lb. of salts of tartar in 1 gallon of soft water. Dip the tarnished articles for a few seconds only; wash with clean hot water, and dry. The solution is a deadly poison.

TOOL HANDLES.

OUR July issue contained an article on turning tool handles, illustrated with several diagrams showing the method of procedure. See pp. 203 and 204. Finding that some readers wish to see various patterns we give a selection of the forms suited for various purposes. It is unnecessary to specify any particular use for each, as their adaptability rests with the maker. Any directions for making these handles would also be superfluous after the explicit instructions referred to above have already appeared.



* * *

Case-Hardening Compound.—Equal parts of prussiate of potash, sal-ammoniac, and common salt; pulverise, and thoroughly mix. Or quench the article in a solution of 2 oz. of potash, 4 oz. sal-ammoniac, dissolved in 1 gallon of water.

Soldering Fluid.—Put ½ pint of muriatic acid (*i.e.*, spirits of salts) into a glass, and add small pieces of clean zinc, which will be dissolved by the acid. Let it stand for several hours, till the acid has ceased to act; then add a small quantity of water—say a wineglass full—when ebullition will re-commence. Let it stand undisturbed for a few hours, and again add a small quantity of water. Continue this until the quantity of water added equals that of the acid (½ pint). When all action has ceased, add 1 oz. of sal-ammoniac; let it stand 12 hours, then decant the clear liquid into a bottle, which should be kept well when not in use. Throw away the sediment.

HOW TO MAKE A BI-UNIAL MAGIC LANTERN.

(For Illustrations see Supplement.)

THE instruction and amusement afforded by the magic lantern are subjects which have been frequently brought into prominent notice. We need not discuss them here.

Mr. Hardwick, formerly demonstrator of chemistry and lecturer on photography in King's College, London, in the course of some remarks on the subject, says:—"I have long used the lantern for educational purposes, and have recommended it to my brother clergy. The difficulty with many, however, has been that they cannot obtain coal gas; and they find the oxy-calcium process with spirits of wine not easy to manage." He expresses himself under an obligation to Mr. D. Highley for his valuable papers in the fourth vol. of "Cassell's Technical Educator." "They have added much to my stock of knowledge on the subject, both in the theory and practice. As an instance of the former, I may mention his remarks on the symmetrical condenser now so much in use; and of the latter the hint which he gives for steadying the jet and lime-holder by filing away the supporting rod on the side opposite to the screw. This simple plan is so effectual for the object designed that it ought to be generally known and adopted."

The sources of light will be the first point for consideration. The forms are as follows:—The lowest form of limelight is the oxcalcium, or spirit-lamp jet. In this form a jet of oxygen gas is thrown on to a spirit-lamp flame, and, striking on a cylinder of lime, produces the lowest form of limelight. This light, under usual conditions, is equal to 150 candles.

The next is the safety oxhydrogen jet. Here we use a jet of gas from the nearest gas fitting, and through this the oxygen jet is thrown, as described, on to the lime. This form is perfectly safe, and gives a light equal to 190 to 200 candles.

The most powerful of all is the true oxhydrogen jet. Here we have both gases (the oxygen and hydrogen) under a much higher pressure. The jet is so constructed that the two gases mix in the chamber of a jet, and pass through the jet into the lime cylinder. This jet is equal to 400 to 425 candles. The light is most intense, and with it views 35ft.diam. may be shown. Its great drawback is that it is only safe in the hands of an experienced operator. It is a form requiring careful manipulation in every respect, but if certain conditions are complied with, it can be used without danger.

Mr. S. Highley describes an oxy-spirit lamp which seems perfect in all its arrangements, but I have never met with one of that construction. My own plan has been to work with Pumphrey's vaporiser, when I cannot get coal gas. It is an inexpensive apparatus, and can be used with any lantern, the spirit being volatilised, and burnt without a wick at the mouth of an ordinary safety jet. There are, however, two or three points to be observed in order to ensure success. Much depends upon the construction of the *burner*. If you use an oxygen nozzle with a very small bore, and force the gas through it by strong pressure—say 56 pounds or more on the bag—there will be a dark neucleus in the centre of the incandescent lime spot, supposing the cylinder of lime to be somewhat near to the orifice of the jet. And not only so, but on looking into the anterior glass of the lens from the front, you will see the same dark centre, with a ring of light surrounding it, something like an annular eclipse of the sun. The explanation is that the two gases are travelling at so different a rate at the time of their emergence from the jet, that they do not mix properly, and hence there s an excess of oxygen in the middle of the flame, producing a cooling effect.

I have heard it said that the greater the pressure on the gas-bag in the oxy-calcium process, the better the light; but in my own practice I find quite the reverse, and have obtained the best results by using a low pressure not exceeding 28lbs. The oxygen then travels slowly, and mixes more thoroughly with the spirit vapour before the flame touches the lime. *Quantity* of oxygen, however is important, and hence I enlarge the bore to one-twentieth of an inch to compensate for the diminished pressure. A single trial will show the advantage of this enlargement of the bore, the light being better and more steady, whilst the lime requires to be turned seldom, or not at all.

Look at the matter from a common-sense point of view. In this oxycalcium process you have spirit of benzóline vapour escaping slowly through a large orifice of ¼in. diameter, and you send a small and rapid stream of oxygen into the centre of it. Unless, therefore, the lime cylinder be at some distance, the two gases cannot mix. When, however, you use a larger stream, and one whose rate of travelling corresponds more nearly with that of the spirit, the admixture is perfect : and complete combustion is the result. At all events, whatever the theory may be, there is no doubt that in practice the latter method gives the best result.

I have mentioned one-twentieth of an inch as a useful size for the oxygen orifice; but I may be asked, how is the hole to be measured by an amateur without the proper appliances? It may be done sufficiently nearly by stamping it on a sheet of paper, and making five impressions, side by side, which ought then to measure a quarter of an inch; or by picking out a stocking needle which exactly fits into the bore, and pricking a few holes on paper close together.

A beginner will perhaps find a difficulty in centring the jet in the lantern when it is heated by the small lamps employed with Pumphrey's vaporiser. To avoid this, let him cut a circle of paper the size of the condenser, with a small hole in the middle, and stick it on the back glass with a wafer. He will then see exactly the height at which the jet should be fixed to bring the lime spot on a line with the optical axis, and it will remain only to cut a half cork, or a piece of soft wood, and tie it, underneath, on to the supporting pillar, so that for the future the jet may be dropped on to it, and screwed up securely.

I have mentioned already that I work the oxy-calcium process with the lime cylinder rather near to the jet, although not quite so near as in the oxyhydrogen process. In all comparative experiments the distance from the jet should be noted, as it has an influence upon the result. I may add that the *soft* limes are preferable to the hard when low pressure is to be employed. With these few remarks on the lantern light, we will proceed to the construction. We may readily gain an idea of its appearance and construction by reference to the illustrations. If we suppose, side by side, two mahogany body lanterns, and if we place one of them on the top of the other, making the necessary arrangements as to carrying the trays, etc., we have the first principles of the bi-unial lantern. In doing this we find an obstacle arises, the disc of the upper lantern does not coincide or register with that from the lower one. Hence we are compelled to either tilt the upper lantern downwards, or in some way to obviate this. If we, therefore, allow the stage carrying the condenser, slide holder, telescope front, and focus lens of the lower lantern to remain as it is, but fit the upper stage to the mahogany body with a hinge, and arrange for its adjustment, which can be done by having a spring to press it outwards and two milled-head screws to draw it back, we then are able to cause both discs to coincide on the screen. This plan was the one adopted by Mr. Highley. Other makers adopt a preferable arrangement, and make both stages movable. Assuming that, instead of two lanterns, one on the other, we make a body specially adapted, we shall find that dimensions as follows would be suitable :—

Fig. 1 shows the wood body; height 18in., inside measurement 7 by 9in., bottom projecting 3½in. The bottom, fig. 2, being 13½ by 9½. It is easy to make a lantern which, for appearance, looks compact and portable; but nothing smaller than the sizes I have named will give an instrument that will work well with good ventilation. It is a somewhat costly matter if, in reducing space, we find some evening that the woodwork of the lantern is on fire, and that one or both condensers are damaged. Inside the body should be a lining of either sheet iron or tin plate. Figs. 3 to 6 show various views of this. It should be kept off the mahogany, so that an air space of ½in. or ⅜in. is left all round. This, when the lantern is in use, allows a current of air to pass up, and so prevents undue heating of the wood. Fig. 3 shows the side measuring 18⅜ by 9in., with holes 6in. square. Fig. 4 is the back, 6in. wide. A good way of holding up the lining is to screw it to wood blocks (the thickness of the air space), which, if placed in the angles, will not interfere with the air currents. At the bottom of the lantern, and secured to the feet, is a tray-holder of sheet iron; in this slides the bottom tray, measuring 3½ by 8½in., and shown at fig. 7. Half way up, also, we require to carry another tray to work with the second or upper system of lenses, and this is carried by another holder, which should be riveted, *not soldered*, to the metal lining. In work we should find that the heat of the lower jet would so heat the bottom of the upper holder, and, in consequence, the tray, that damage would result. To obviate this we use what is termed a flame guard or deflector. This is a piece of sheet iron, shown at fig 6, also riveted to the lining and tin below the bottom of the tray holder, the air space between being found to sufficiently protect the upper jet and tray from damage. Further up we find the lining is turned over on a wire, so as to terminate about 1in. below the mahogany work. By this means the hot air passing up the air space escapes into the upper chamber of the lantern, and so out by the hood. On the right hand side of the lantern should be the doors; they are 6in. square, with a hole 1¼in. diameter through the centre (see fig. 8). The doors, as well as the body itself, should have a tin or sheet-iron lining, kept off ½in., as described. In the centre of the doors should be a circular hole, 1¼in. diameter. The use of this is to be filled with a piece of dark blue glass (the tin lining being cut away to match) through which the operator can examine his limelight jet, without being exposed to its dazzling brilliancy or having to open the door.

Next we come to the back (see fig. 4); here we must cut away the wood and lining, so as to obtain an aperture through which the tray and limelight jet pass. At the front, fig. 5, two circular holes must be cut where the condensers pass through, and should be ½in. or ¾in. larger than their diameter.

Next we consider the arrangement of front. Stewart, Middleton, and many other well-known makers, fit the entire lens system to a brass plate or stage, fig. 9, which is hinged to the lantern body, and adjusted, as described; the condenser being carried by a short tube projecting into the lantern, whilst the power or focus lens is carried, as usual, at the end of the brass part. Wood, and several other manufacturers, on the other hand, fit, as it were, a mahogany door hinged to a cross bar running across the centre of the lantern front, and carrying the condenser on the inner side, and the brass front and focus lens as before described. In this form, fig. 10, the slide-holder and stage are of mahogany, and on this plan (which is superior in many points) all our highest class bi and tri-unial lanterns are constructed. This plan, though more costly, has advantages in appearance and facility of adjustment—the coincidence of the discs being secured with milled-head screws passing through the ends of a brass strap running across the doors. This has one great advantage: it dispenses with springs of any kind. The wood and cap for the top of the lantern are shown at fig. 11. The condensers should be either 3½in. or 4in. diameter. The focus lenses, which should be of the double achromatic form, with rack and pinion, are now made to give long and short focus.

The utility of this is that, supposing it is desired to work with a screen of given size, either 10ft., 12ft., 15ft., or 20ft., say, for instance. We will also assume we have an achromatic power, of which the short focus is 4½in., and the long 9in. In addition, we can utilise the concave of the back combination, as also the crossed bi-convex lens, to either further prolong or shorten the focus. Taking the example of a screen 20ft., and supposing we have to work in a room 25ft. long, our double combination just covers it nicely. But, supposing the room was 50ft. long, we should be just in the middle of the audience. We will use the long focus lens, and, placing ourselves at the further end of the room, we still throw the 20ft. disc. By the same mode, if we have a room larger still, by using the concave back we can still further lengthen the focus. By this means an expert operator can place himself at any convenient distance, and still maintain his given diameter of view on the screen.

We have now dealt with the lantern body, the condensers, and the focus lenses. Bearing on the latter it will be well to remark that the front or tubes of this form of lantern are so constructed as to slide one within the other, and by this means we are able to lengthen our tubular front when using long-focus lenses.

HOW SCREWS ARE THREADED.

SCREW THREADS are "originated" in the lathe usually. All lathe turning, with regular—constant—feed of the turning tool, is screw cutting, or threading; the tool cuts a spiral around a revolving cylinder.

It is evident, therefore, that by increasing the speed of the feed relative to that of the revolving cylinder, and having the point of the cutter properly shaped, a screw thread would be the result, instead of paring off the entire surface of the cylinder. All important actuating or working screws, as those for feeding on machine tools, are formed in this way, and large numbers, also, of ordinary machine screws, which when once seated are expected to remain *in situ* until the machine or implement of which they form a part is worn out.

Wood screws, as screws for fastening wood to wood, metal to wood, etc., are threaded in a similar manner, the thread being cut from the solid by a single cutter removing the material between the threads.

Large numbers of screws are threaded by dies, which may be called hollow screws, or nuts with cutting edges. These, by rotating, form the feed as well as the cutting device for threading the smooth cylindrical rod or bar. Some of these dies are worked by hand, others by power, but in either case the cut, by the modern and improved dies, is clean, and the thread is formed from the solid. The old fashioned dies were adjustable so as to be "set up," and could be made to cut several sizes of diameters. Much of their work was done by pressure, or squeezing, and a part of the thread was "raised" instead of being cut from the solid material. There are adjustable dies made now, but they are so formed as to do solid cutting.

There is another method of cutting threads direct from the solid, and that is by milling. It is the invention of the late Eli Horton, the chuck man of Windsor Locks, Conn. The machine is entirely automatic, the blank to be cut being rotated as in a lathe, and a rotary milling tool rotating against it at an angle adapted to the pitch of the thread desired. As the blank revolves slowly towards the cutter, the cutter revolving more rapidly forms the thread by being fed along over the blank as is the cutting tool in a lathe. The milling tool is so formed in cross section as to produce any shape of thread desired. This method is still in use by the successors of Mr. Horton to thread the steel screws of their chucks.

Threads on large cast iron screws are sometimes formed simply by being cast, and formerly there was much cheap small work of that sort in the market.

Threads may be raised by forging in dies, and some good work by this is produced. In both these cases, however, an after finish in the lathe is desirable.

For some peculiar purposes threads are formed by twisting a square or flat bar; a common form of hand drill that has superseded the bow drill being a case in point. The stock of this drill is a bar, square in cross section, twisted, and which is rotated by sliding a loosely fitting nut rapidly back and forth over its length. A familiar instance of a screw thread of this description is the ordinary auger or bit, the cross section of which is a flattened parallelogram like a flat bar.

One peculiar method of forming screw threads remains to be mentioned. It is that of raising a thread by rolling between dies under pressure. There is a great deal of what is known as "bright wire goods" in the market, which are threaded. In many cases these threads are formed by simply rolling—one revolution, or a little more—the wire between two hardened steel plates that are corrugated spirally to form, when combined, a continuous thread. Sufficient pressure is applied during the rolling—which, however, is very rapid—to raise the metal from the annealed wire enough to make a thread. In this case the threaded portion is considerably larger than the stock or wire, at least half the depth of the thread on each side.

The threads in nuts are produced either by the "originating" method, cutting them in a lathe, by being tapped, or sometimes by being cast of soft metal, as brass, on a threaded core of hard metal, as iron or steel. But nuts are mostly threaded by tapping, running one, two, or three successive taps through them either by hand or in a power machine. Nuts of very thin material, as sheet brass for lamp tops, jar covers, etc., are formed simply by rolling between spirally corrugated rolls, a work analogous to "beading" on tin ware.

Powder to Harden the Surface of Steel.—Bichromate of potash, 6 oz.; prussiate of potash, 6 oz.; chloride of sodium, 22 oz.; all to be finely pulverised and thoroughly mixed. Heat the steel to a dull red, cover with a thick coating of the powder, heat again to cherry red, and plunge in cold water. Fine steel, as well as iron, may be case-hardened with this powder if not made too hot; a few trials will determine the difference in the heat to use to thoroughly harden through, or merely case-harden. A strong solution of this powder will give a harder temper than common water.

MODEL ENGINEERING AND BOILER MAKING.

By Sergeant Arthur Sharpe.

Chapter I.—Introduction.

I AM anxious to write articles on the above subject for various reasons. First, because I have noticed that in almost every mechanical or scientific work this subject has been sorely neglected. During my previous experience as a writer I always had nine-tenths of the queries from readers on the construction of Model Engines and Boilers. This led me to study the matter seriously. I have now prepared a few articles on this subject simply for the instruction of amateurs (I trust our talented engineering readers will please remember this). My second reason for introducing this subject is, that I have spent a considerable period in this branch of industry. Having constructed both engines and boilers, I have gained, I may say, a fair stock of experience, which I sincerely trust will be of service to our engineering amateurs. Another reason for wishing to forward this subject is, that during the past six months I have received so many letters from old readers, asking me to publish information on engineering; therefore I am pleased to have an opportunity of writing on this matter for the benefit of amateur mechanics, thus giving them the same opportunity and facility of improving their present position and mechanical knowledge as amateurs, as that which has been offered to practical workmen in other mechanical journals. Our magazine, I am glad to see, is devoted solely to amateur instruction. This is really what our amateurs require. The practical workman may not desire amateur instruction, but our amateurs require thorough practical instruction, each subject being placed before them in such a way as to give the most practical information, in the plainest and clearest way possible: this I have found to be the most beneficial way in giving instructions to amateurs. I sincerely trust that in this instance, when addressing readers of a magazine devoted totally to the welfare and instruction of amateurs, I shall succeed in my endeavours to place this subject before them in a plain, easy, and also in a practical manner. If they receive some benefit from my instruction, I shall then feel repaid for the trouble I have taken in drawing up my article.

I simply wish to give my instruction to amateurs who feel disposed to construct for themselves good working model engines and boilers. I feel that they may be able to do this with the assistance of my articles, which are based on experience and knowledge obtained in constructing and experimenting with models of various sizes and patterns. A few inexpensive tools (except a handy lathe, which is rather an expensive item) will be all that an amateur will require. I will enumerate these later on. I consider that model engineering has always been a most neglected branch of industry, and attribute this to the very expensive work necessarily involved. The pattern making and castings were, until quite recently, a most expensive item. This alone has kept many from entering into this branch of study; but now, thanks to our enterprising engineers, beautifully-finished castings are turned out at such a low price that a set is within the reach of any young workman, whatever design he may feel disposed to fit up. Many amateurs who have a good lathe are, no doubt, anxious to turn up their own patterns. I shall, therefore, give instructions for this class of work. Model engineering is, I consider, a most important branch, and I trust that my endeavours are the means of keeping the subject fully alive in the minds of our amateurs. I candidly own that to minutely describe the construction and fitting up of the various parts of a working model engine and boiler is indeed a difficult task, but still I will endeavour to bring the whole subject to an instructive termination for the benefit of our amateur readers. I think I cannot do better than give a description of my own engine and boiler, as the size and pattern I think the most suitable for my purpose. Of course any amateur may enlarge his pattern in proportion to my model, so as to suit his own requirements. I have introduced several new features in my model which will, I feel sure, make models more useful and interesting. This model I shall describe fully during the course of my subject. From experience I have gained in model engineering, I find that the more substantial the model the better the work can be turned out when finishing. We often see toy model engines advertised for sale at a low rate, but I find the best way in which to obtain a good substantial working model engine is to make it. And where an amateur has a set of castings, either from his own patterns or purchased of a good model engineering firm, a lathe and a set of tools, a good model can be fitted up for a very reasonable price—not a simple toy, but a good and perfect model that will last for many years with ordinary care. I shall give a description of every part of a model engine and boiler, showing how each is made and fitted, and how kept in order. I ask our amateurs to follow my instructions carefully throughout, and I venture to say, with confidence, that they will be able to fit up a beautiful working model, and one that they may look upon with pride and satisfaction in years to come. I never agree with temporary or makeshift arrangements. Even in model work all fittings must be made correctly and perfectly, or the model cannot work properly. I always like to commence a task in the proper way, and to continue in the same way until I have completed it. This, in the end, gives greatest satisfaction, and saves endless trouble in making alterations, etc. In my experience I have seen models wretchedly fitted up—leaky slide-valves and pistons, glands improperly packed, brasses improperly fitted, and working parts out of truth. I have seen models composed of beautiful castings put together in this careless manner, thus rendering the whole affair a clumsy turn-out—in itself a discredit even to a beginner. On the other hand, I have seen engines composed of much worse castings, but where a little good sense has been employed, turned out in a most perfect condition, the model working as perfectly and as smoothly as our largest and most powerful engines. Yet in this case the maker has been but an amateur, but he has evidently worked on at his model with a steady determination to accomplish his object in a practical and workmanlike manner. The result of doing all his work properly has rewarded him with success, and he has a perfect working model engine which in itself repays him for all the trouble and anxiety its construction may have cost him. I want our amateurs to try and do likewise.

(To be continued.)

Turner's Cement.—Resin 4 parts, pitch 1 part, powdered brick-dust "at discretion." Roll into sticks whilst boiling hot. Another:—Burgundy pitch and resin, 1 lb. each; yellow wax, 1 oz. Melt in a pot over a slow fire. When thoroughly melted, add half a ball of whiting, finely powdered, and when properly mixed, mould into sticks. Another:—Common beeswax and resin melted together in equal parts forms a very useful cement for many purposes. It may be made more plastic by using a larger proportion of beeswax, and *vice versâ.*

THE AMATEUR WOOD TURNER.

By A. Cabe.

PART VIII.

THE present paper is a description of the construction of a pincushion and secretory. It is entirely of turned work, and may be made of walnut, mahogany, or other wood. The design is an imitation of a circular temple, erected on a platform of steps: the pillar supporting a cornice, and the roof represented by the cushion.

The cornice portion is made from wood 8½in. by 1⅜in. in the rough. One side may be planed quiet true; this will be the under side when placed in position in the finished article. This is placed next the face plate, and if the latter is a little less in diameter than the finished work, the whole operation of turning may be done with the one chucking. The face of the disc may be trued up first; then the edge is moulded, as shown in the elevation (fig. 1); taking care to make the diameter of the plate at the side towards the face plate 7½in. Now, the face has to be sunk to a depth of ¾in., making a level bottom with the sides cut square down to it, so that the cushion with its ring may slip neatly into it. The making of the cushion saucer and ring is exactly as described in our last job, the bobbin stand. This part of the sinking done, and the job finished by sandpapering, it is to be further sunk, or cut quite through, to receive the body. This opening will be 3¾in. in diameter, as the full diameter of the body is 4in. A shoulder of ⅛in. is cut thereon to butt against the cornice plate, as also the base. This body is 4in. long, and the pillars are, of course, exactly the same length. The body is hollowed out, leaving about ⅜in. thick of stuff, thus forming a hollow cylinder which constitutes the secretory or hiding place, the cushion when in its place closing it up. Of course, it is only a hiding place to those who don't know of its existence. In turning this body, a solid piece of wood would be fitted into a somewhat large cup chuck, the outer face cut in straight, and the interior sunk with gouge and side tools to a sufficient depth (4in.); the sides would be parallel, of course, so that the finished body would have the same thickness of stuff throughout its whole length. The diameter of the inside will be about 3¼in. The outside of the piece is now turned down to 4in. all along its length, and cut in, or shouldered to fit exactly the openings made for it in the two plates. It is well papered inside and out, then cut off.

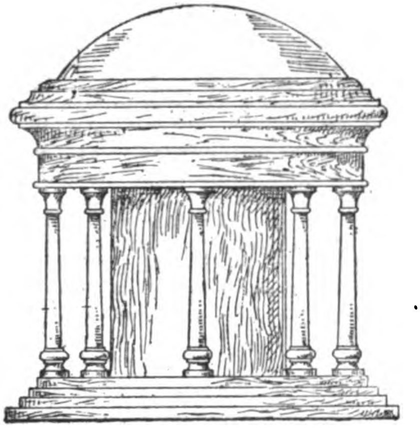


Fig. 1.—Elevation.

The pillars are ⅝in. thick, top and bottom, and may be turned of the pattern shown (fig. 1) or any pattern the maker may fancy. They are turned singly between centres, and have a ⅜in. tenon on each end to fit into the plates. The upper plate, or under side of the cornice piece, is, of course, bored for the pillars, exactly the same as base plate; in other words, they are both bored in circles of the same diameter.

The stepped platform is 7½in. broad on its upper surface. The steps are each ¼in. broad, and also rise ¼in. This base is turned from a piece of wood plank ways, and requires about 9in. in the rough. While on the face plate, the recess is made in the centre to receive the body, as shown in the section, fig. 2. The turning of the steps on the edge of this disc is a very easy matter, being done for the most part with a ⅝in. chisel, in first-rate order. The only careful part of the work is to see that the steps are perfectly rectangular; that is, that the treads are level and the risers vertical. Some care is, of course, necessary in turning the face of the plate where the pillars and body are to stand: a small straight edge should be used, and the face made perfectly level.

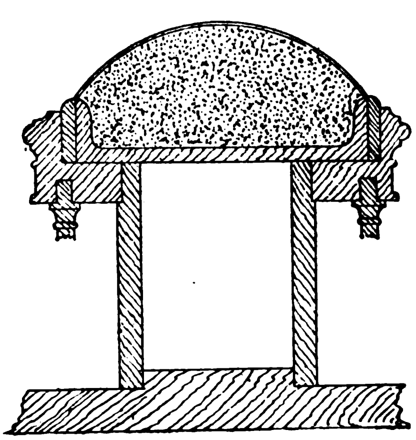


Fig. 2.—Section.

Before removing from the face plate, a light scratch should be made on the finished face, to mark the line of centres of the colonnade—that is the pillars. This circle is nearly ½in. in from the edge of the upper step. This circular scratch is divided with compasses into as many equal parts as there are pillars in the drawing of the plan (fig. 3). Holes are bored on these marks with a ⅜in. centre-bit, about ½in. deep.

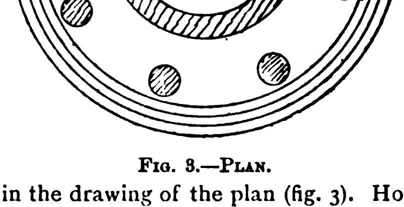


Fig. 3.—Plan.

In constructing this article I make the body of good pine, turning out the interior, then the exterior to the exact diameter; then, before cutting in the shoulders, and keeping the work still in the chuck, I veneer the body all round. When this is quite hard I remount in the lathe, turn the veneer part with a fine chisel, cut in the shoulders, and finish as above described; but, as this process requires some knowledge of the cabinetmaker's art, it could not well be adopted by amateur turners who may lack that knowledge. The ring which encircles the cushion may be made of planetree. It should fit the cushion neatly, but not too tightly, or it will break; then its outside should fit the recess made for it in the plate. The ring, however, is much better made in brass and nickel-plated; you cannot then put it on too tight. This job, like most others of that nature, is polished before fitting together, and if the ring is of wood it must be polished before fitting it on to the covered cushion.

This article will be found, to form a very good exercise for the amateur wood turner, and, when finished, it makes a very neat, useful ornament for the lady's work-table or a present, in which latter case the interior may be filled with needles, pins, thimbles, buttons, or any other of the many etceteras of ladies' use, or it may be filled with sweets or some absurdity, and the recipient left to find her way to the hiding-place.

Zincing Iron.—The following is an excellent and cheap method for protecting from rust iron articles exposed to the atmosphere, such as cramp-irons for stone, etc. They are to be first cleansed by placing them in open wooden vessels, in water containing three-fourths to one per cent. of common sulphuric acid, and allowed to remain in it until the surface appears clean, or may be rendered so by scouring with a rag or wet sand. According to the amount of acid, this may require from six to twenty-four hours. Fresh acid must be added according to the extent of use and of the liquid; when this is saturated with sulphate of iron, it must be renewed. After removal from this bath, the articles are rinsed in fresh water, and scoured until they acquire a clean metallic surface, and then kept in water in which a little slaked lime has been stirred, until the next operation. When thus freed from rust, they are to be coated with a thin film of zinc, while cold, by means of chloride of zinc, which may be made by filling a glazed earthen vessel, of about two-thirds gallon capacity, three-fourths full of muriatic acid, and adding zinc clippings until effervescence ceases. The liquid is then to be turned off from the undissolved zinc, and preserved in a glass vessel. For use, it is poured into a sheet-zinc vessel, of suitable size and shape for the objects, and about 1·30 per cent. of its weight of finely powdered sal ammoniac added. The articles are then immersed in it, a scum of fine bubbles forming on the surface in from one to two minutes, indicative of the completion of the operation. The articles are next drained, so that the excess may flow back into the vessel. The iron articles thus coated with a fine film of zinc are placed on clean sheet iron, heated from beneath, and perfectly dried, and then dipped piece by piece, by means of tongs, into very hot (though not glowing) molten zinc, for a short time, until they acquire the temperature of the zinc They are then removed and beaten, to cause the excess of zinc to fall off.

Hardening Tools.—A communication to the "English Mechanic" says: "Mercury is the best liquid for hardening steel cutting tools The best steel, when forged into shape and hardened in mercury, will cut almost anything. I have seen articles made from ordinary steel which have been hardened and tempered to a deep straw colour, turned with comparative ease with cutting tools from good tool steel, hardened in mercury."

METAL CASTING.

PART III.

Casting in Large Quantities.—Gates, or Gits.—The Three Phases of Moulding.—"Common" and its Sub-divisions.—Solid.—Cored, Stays, and Core Moulds.—Patterns that make their own Cores.—The advantage of Cored over Solid Work to the Finisher.

IN a large foundry where individual articles are produced by thousands, and from patterns which are likely to be used in exactly the same form for years, a much better plan is in vogue. The patterns are made in halves, each half being securely fastened to a smooth brass or iron-faced board,* while the reverse of the model is fastened upon the opposite side of the board, care being taken to have the lower portions exactly under the upper. The board to which they are thus affixed has a pivot on each side of it, to allow of its being easily turned over; the pivots fit into bearings in the sides of the sand-trough or moulding-bench, and swing over, presenting the reverse of the pattern to the mould. By these means a very flat surface is obtained, and without the tedious process of "clearing down"—*i.e.*, removing the superfluous sand and the inequalities that mostly surround the models—and without the labour of lifting a double-sided mould. The two sides are made independently of each other, and never meet until they are finally joined to receive the metal. Even "gates"—*i.e.*, the channels through which the molten metal is conducted to the impressions it has to occupy—can be moulded *with* each batch of patterns. Fig. 9 represents the face of a mould, showing impressions of patterns in the sand. The channels or "gates" for the metal are shown communicating with the holes *a a*. (See also fig. 4, page 296, in the October part of this magazine.) The channels may be compared to the veins and arteries in the human frame, conveying metal where the latter carry blood. For this illustration I have selected plain and meaningless figures for patterns, as they will call for no description.

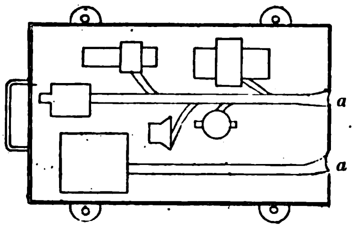


Fig. 9.—Face of Mould.

We have three phases of casting:—(1.) Plain, or, as it is technically called, "common" casting, subdivided into (*a*) solid, and (*b*) cored work, to be shortly described. (2.) "Fine," or ornamental, requiring more care in its production, and a better "face"—*i.e.*, a clearer impression, showing any matting, etc., more distinctly than ordinary or "common" work; and (3.) "False cored"—figures, etc.—work that will not lift from the sand, because of being undercut, without the addition of extra sides, or, as we call them, "false cores"; really additional moulds *in* the larger moulds—"vheels vithin vheels," as Sam Weller would have called them.

Let us deal with "common" casting first.

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*This plan is only applicable when each side of the model will *deliver*—that is, when it is not undercut. If it be undercut, it causes the sand to cling, and, as a natural consequence, break away.

In our last article we described the process of moulding a flat model. We will now devote a little space to the consideration of moulding a round pattern (fig. 10.) This a lathe chuck, round and solid; when cast it will be a lump of metal, without a hole in it. To produce this, the half of a flask or mould, without the pins (see fig. 4, part 2), is filled with sand, the pattern laid upon it, and the powdered brick, before described, shaken upon it. On removing the pattern a rough outline of it is observable on the sand. This gives the moulder an idea of how to dig away sufficient of the sand with the knife and spoon—to which allusion has been made—to admit of sinking the pattern in half-way. This is termed the "odd-side," and is not used for metal at all. The brick dust (parting sand) is now shaken over the "side"—the superfluous being blown off with bellows—the top-side placed upon it and filled in, etc., as before described, the bottom or "odd"-side acting in place of the brass-faced board spoken of in the second paragraph of this article. These are turned over, and the then top (the "odd"-side) removed, the face cleared of inequalities round the pattern, until the exact half is left above the sand. This is brick-dusted, the fellow flask placed up the lower one, rammed, etc., as before.

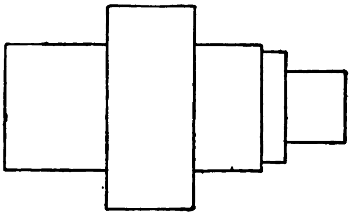
Fig. 10.—Round Pattern.

This is the process of moulding a solid pattern like fig. 10. The difference between the foregoing and sub-division (*b*) is as follows:—Fig. 11 represents the lump-end of a union (see part 2, fig. 7). In the sketch of the pattern will be seen two end projections; these are called "core-prints," or stays" (*e*, *e*, *e*, *e* in fig. 7, part 2.) They are to make impressions in the sand, into which a "core" or sand model of the interior of the casting is laid, and kept in its proper position by the placing together of the two sides of the mould; and when the molten metal is poured in, it runs round this core, and produces the casting required with a sand lining, which, being bored out*, leaves the shape desired inside. Dotted lines indicate the hollow; the space between the dotted and black lines shows the thickness of the casting when cleared of burr and gate (or "git.") Burr is *almost* sure to appear, however carefully the moulding is done, and however closely the flasks fit together. It is a slight roughness that comes on the casting where the moulds join, forming a sort of seam.

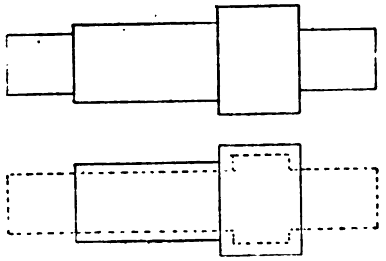
Fig. 11.—Lump End of Union Showing Coring.

To produce a core mould—the name of which speaks for itself—it is necessary to turn a "stay" the exact counterpart of the space required inside the casting. In fig. 11 the "stay" will be just like the pattern, but the size of the dotted line in the sketch of the casting. This should be sunk in a mould as if it were a pattern, and after a coating of black-lead has been put on it to prevent sticking, plaster of Paris is poured in, care being taken to leave it of sufficient thickness to obviate breakage; this, when dry, should be cleared to the exact half, then blackened, and the fellow side poured on, and the *core mould* is ready.

Fig. 12 is half a core mould—made in plaster of Paris, as above described, or cast from the plaster in zinc, brass, or lead. Sometimes it is gutta percha, pressed over the "stay." The fig. above is for the production of such a core as is necessary for the lump-end of a union (fig. 11). above is the "stay from which it is produced. The two sides of the core mould fit together with pins. Then "strong" or "core" sand is thrown loosely in, and rammed tight with a wooden ram-rod, care being taken not to make it *too* hard, or "blowing" is apt to take place if the sand be not porous enough to allow the escape of the air on contact with the metal, and a piece of wire to strengthen it pushed through. The core is loosened from the mould by slightly tapping the latter with a mallet, the two sides separated, and the core taken out; it is then like the stay (fig. 12.) It is now placed in an oven and thoroughly dried, for the reason mentioned in Part I. of this series. It is then dusted over with powdered wood ash, and it is ready for placing in the impression in the mould and receiving the metal. The core will now be thoroughly understood to be the moulder's means of forming a vacancy in his casting.

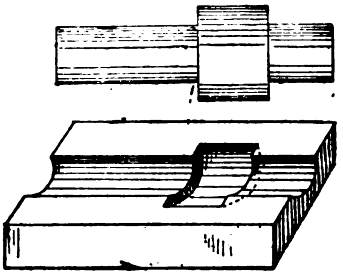
Fig. 12.—Core and Core Mould.

Our illustration—keeping to the union—gives only one form, but cores are, naturally, of unlimited shapes, varying to suit every article. A core intended to be entirely concealed by metal does not need to be made of so strong a sand as one that is partially exposed. A very long core is pierced with a thin wire, care being taken not to let the pricker penetrate the surface. These are vent holes to allow imprisoned air to escape. Should the core be circular or bent in any way, and not pierceable, a string is laid in with the strengthening wire, and, when the core is dry, withdrawn. Should any core be covered at one end, and the length of stay protruding at the other be insufficient to balance it, a staunchion is put in to support it. If for a brass casting, a brass nail or piece of copper wire will answer the purpose, as, when the molten metal meets it, either will readily amalgamate. If there be any danger of the metal moving the core out of its position—technically, "washing it up"—it should be wired down.

A core is a very important factor in a foundry; not only is it used to make *necessary* hollows, but frequently to save the finisher trouble; and it will be obvious to the most casual observer that a pattern turned like that in fig. 11 must be easier to make

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*Just one shake of the joke dredger—I trust my readers are *not.*

than one with the hollow turned in it, like the "casting" in the same diagram.

In my next article I shall have still more to say on the subject of cores.

WORK DONE BY ENGINEERS' MACHINERY.*

It must be understood throughout this paper that by tool work I mean the cutting off of metal by means of machine tools as ordinarily practised in engineers' workshops, and I must confine my attention chiefly to lathes, planing, shaping, slotting, and screwing machines. It will be obvious that these tools can be considered in regard to a few points only, since each tool in itself might form the subject of a paper.

It being assumed that metal has to be tooled off, how quickly and cheaply is it practicable to remove it?

One of the most important items of cost is the rate at which the work is tooled. This rate depends more upon the extent of the surface than upon the quantity of material to be removed. For in most cases it can be removed at one cut, and the speed of cut is not much affected by the depth. Where two cuts are needed the finishing cut should be as light as possible, with a broader advance.

For comparing the time required to tool various surfaces it is necessary to reduce it in each case to the same unit of surface and of time, such as the number of minutes required for tooling a square inch or a square foot, or the number of square feet or inches done in an hour. The numbers thus deduced have a constant value for all work tooled at the same speed with the same width of cut, and hence are called "constants."

"Constants," therefore, furnish the readiest means for estimating the time required to tool similar surfaces similarly situated, but of different dimensions. In choosing a "constant" for office purposes, such as for estimating, arranging piecework, etc., the time in minutes required to tool a square inch would do as well as any other. But for practical use in the workshop, where rapid mental calculations are required, these "constants" are too small in value, and involve the use of numbers too high to be convenient. A more useful "constant" is the number of square feet that can be tooled in one hour; such are those shown on all the tables.

The actual value in engineering practice of these "constants," and their possible maximum value, is one of the chief points which it is the object of this paper to call attention to.

Since an engineer's profits are often dependent on the time that may be saved in tooling work, it might naturally be expected by outsiders, not connected with engineering work, that the value of the "constants" for various classes of tool work with various machines had been most carefully attended to, had been tabulated by the cost department from year to year with a view to improvement; that they were well known, and that it was a subject of unremitting attention to improve their value by the use of improved tools, improved steel, improved methods, improved arrangements, etc. In other manufactories, such as woollen mills, corn mills, saw mills, etc., the rate at which each machine can be run has long been thus noted. It is often run at the highest practicable speed, even so near to its maximum that a very moderate increase in the speed of the engine (driving the machinery) would cause great mischief. If an improvement be brought out whereby the work can be increased 10 per cent., then often valuable machines are completely set aside to be replaced by the new improved ones.

Very different indeed is the case in most engineers' works. Who studies the greatest amount of work a lathe can be made to do, and sees that it is done? Ask an experienced turner at what rate in square feet per hour (or any other mode of measurement) he can turn. In nine cases out of ten he has never attempted to estimate it. Nay, go further, ask the foremen, the managers, or the partners, and in most instances I fear their knowledge is vague and scanty; they likewise have scarcely thought about the subject. In regard to the speed of cutting, in reply to my inquiries I have found but few who have actually observed it by means of a foot-rule and watch, their knowledge too often being mere hearsay. Again, inquire into the advance: for the most part it will be found to be roughly guessed, and while it is admitted that a broad advance is quicker than a fine one, to judge by practice it is too often treated as a matter of secondary consequence, or at least not worth much study. The amount of work done by engineers' tools has rarely been the subject of systematic analysis, but has been treated with an indifference that would long ago have led to ruin in any other trade, and must ultimately do so in this to any firms who may continue the present neglect, no matter how good their tools, extensive their plant, or great their capital.

Engineers have in general been behind other manufacturers in such matters because of the greater variety of their work. This supposed obstacle need no longer exist. The "store" system, as exemplified in the works of our best agricultural engineers, in some of the manufactories of small steam engines, and recently brought into prominence by the success of the American watches and sewing machines, is equally applicable to the most varied manufactures (if not on too small a scale), the objects being classified in the stores in readiness to supply the various tools.

If the difference between the work done per hour by one tool and another, or by the same tool at different times, was five or 10 per cent., it might make all the difference between a good profit and scarcely any profit. But the differences are not 10, 15, or 20 per cent., but often 100 to 200 per cent. I have noticed the rate of tooling small flywheels vary from two to eight square feet per hour without any sufficient reason. In regard to cutting at the highest speed, I have often observed that so little attention is given to the subject that the speed of the shaft driving the tools varies visibly. In one works, where a great deal was said about fast cutting, and old lathes were being replaced by new, I noticed the speed of the engine varied at least 25 per cent. frequently. Hence it follows either that all the cutting edges were constantly spoiled, or else it is certain that the average cutting speed was slow. In another instance, having mentioned to an engineer, as a fact worth knowing, that near Birmingham taps for screwing nuts were running at 15ft. per minute, he said it was quite an everyday occurrence; but when I had induced him to look at his own machine, the speed was under 6ft. per minute.

It is in special work repeated again and again that, particular attention having been directed to select a machine well suited to the work, "the rate of tooling" rises to its highest value. Yet in the same shop, at a few yards' distance, may be seen, day after day, work tooled at less than half speed, the slowness apparently being unperceived.

Hence the value of some ready means of testing the performance of each tool by comparing it with some standard. The constants already described should be such standards.

*** Abstract of a paper by Mr. W. Hartnell, read before the Leeds Association.**

"Constants," to be readily used and properly applied, should be founded on personal observation, by measuring the best examples of rapid and good work, and they should be corrected by experience and careful enquiry.

To determine a constant, the area of any surface tooled might be divided by the observed time. For example, if a pulley 7ft. diameter, 1ft. wide, were turned in five hours, as the area is 22 square feet, $\frac{22}{5}=4{\cdot}4$, so 4·4 square feet per hour would be the constant for such pulleys.

A 5ft. pulley, 6in. wide at the same rate would take about $\frac{7\frac{1}{2}}{4\frac{1}{2}}$, say less than 1¾ hours.

The best way to ascertain "constants" is to note the speed of cutting and the number of such cuts per inch in width.

Thus if the "speed of cut" were 15ft. per minute, and 11 cuts per inch, the area per hour would be $\frac{15 \times 60}{11 \times 12}$ or $\frac{15}{11} \times 5 = \frac{75}{11}$, say 7 square ft.

Hence the simple rule. To find the area in feet tooled per hour, divide five times the speed by the number of cuts per inch. As no fractions of a foot are needed, the calculation can easily be made mentally.

Speed 20ft. per minute, advance 32..

$\frac{100}{32}$ = about 3 sqr. ft.

In the first place the "advance," or the number of cuts per inch, should be observed by actually counting the cuts in 1 inch, or fraction of an inch. (If the advance be too fine to be readily counted, it is too fine for ordinary work, and should be altered.) The eye rapidly learns to judge the advance with surprising accuracy.

The speed in feet per minute equals five times the speed in inches per second. Thus 3in. per second equals 15ft. per minute.

To find the speed of small diameters, multiply the diameter in inches by the number of revolutions in 16 seconds—say a quarter of a minute. Example: If a 3in. shaft make 8 revolutions in a quarter of a minute, the speed will be 8 × 3=24ft. nearly.

For large diameters it may be remembered that at 16ft. per minute there will be as many seconds to one revolution as there are inches diameter. Hence divide the diameter in inches by the seconds to a revolution, and multiply by 16.

Thus a 5ft. wheel makes one revolution in 48 seconds. $\frac{60}{48} = 1\frac{1}{4}$ 1¼, 16 = 20ft.

In planing, shaping, and slotting machines, if the tool return at the same speed as in cutting, the effective average speed is half the actual cutting speed. If the return be at double the cutting speed, the effective speed is two-thirds of this.

Example: If the speed of a planing machine were 18ft. forward and 18ft. back, the effective speed would be 9ft.; but if it were 18ft. forward and 36ft. back, the effective cutting speed would be 12ft.

In this class of machine the cutting tool traverses beyond the work; obviously this is a loss of time, which is greatest in short lengths. In calculating the time required the extra travel must be added to the actual length to be planed.

Thus, suppose in a planing machine the tool travelled 6in. more than the work, in planing a surface 1ft. long the tool will travel 1ft. 6in., or 50 per cent. more; in planing a surface 10ft. long, the tool will travel 10ft. 6in., or only 5 per cent. more. Suppose in each case the surface was 1ft. wide, and the constant 3, the areas must be considered as 1½ sqr. ft. and 10½ sqr. ft. respectively, and the time will be $\frac{1\frac{1}{2}}{3} = \frac{1}{2}$ hour and $\frac{10\frac{1}{2}}{3} = 3\frac{1}{6}$ hours.

A tool is only actually at work when cutting shavings. The time spent in fixing, preparing, changing work, grinding tools, etc., is lost. The cutting edges are then idle. Judging by the number of shops in which machine-men grind their own tools, often idly watching their work, and then stopping it to grind, where no system of supplying ground tools has been introduced, where no centring machines are employed, no staff of "liners-out," few facilities for lifting and fixing, where one piece of work is not brought before another is removed, it appears that the time in which tools are not cutting out, but are (*i.e.*, the tools, not their attendants) simply idle, is very far from being generally appreciated. From observation made in a works employing over 1,000 men, I concluded that, with small tools on general work, from 40 to 60 per cent. were often in the above sense idle, whilst in the best-managed shops (all on piecework and doing the same class of work day after day) more often 30 than 20 per cent. were idle. I do not propose to discuss shop management to-night beyond calling attention to the fact that from this cause alone one foreman may turn out as much work with £3,000 of tools as another with £5,000, and I am of opinion that in most shops it would not be difficult to increase the work done 20 per cent., simply by remembering it is not sufficient for the attendant to be busy; his tool must be actually "in cut" as many hours as possible—say, not less than 40 to 45 hours per week, instead of perhaps 25.

Assuming that the time of cutting may be increased about quarter and the speed of tooling services twice, this would make an increase of 1¼ by 2, or 2½ times. This applies chiefly to tools smaller than a 12in. lathe or a 3ft. planing machine. As a rule large machines (if work be forthcoming) tool faster and lose less time.

There are various hindrances to rapid tool work that time will not permit me to discuss, such as the want of belt power or of sufficiently strong lathes. It seldom pays to use cheap lathes if too light. For example, if a lathe valued at £400 can tool 4ft. per hour, and one at £600 6ft. per hour, the man's wages being £70 per annum, and the cost of the tools 10 per cent., then the total annual expense will be £110 against £130. The dearer tool will cost 18 per cent. more, and turn out 50 per cent. more work. It might also be shown from simple calculation the economy of using the best steel, the best tool-smith, grindstones, grinding apparatus, etc., but time will not permit.

The actual speeds, as before remarked, vary very much indeed in practice, but the ordinary variations are far greater than necessity requires. In cutting wrought iron it will be readily admitted that a speed of 15ft. a minute can be maintained under nearly all circumstances; 20ft. will perhaps be admitted; 30ft. probably denied. The speed is chiefly limited because the tool gets warm. With an abundant stream of soapy water supplied by means of a pump, I have seen 30ft. maintained; with water supplied under the cutting edge, 45ft. in a short experiment; with heavy tools and a jet of water $\frac{1}{16}$in. diameter, supplied from the town waterworks under pressure, 20ft. to 25ft. per minute. But as I wish to speak of the ordinary lathe with ordinary conveniences, I shall assume no more than 20ft. per minute. For cast iron, I assume 16ft. per minute.

The advance varies from $\frac{1}{16}$ to $\frac{1}{80}$ on small work, often simply at the whim of the turner or the chance accident of the feed gear. The greatest loss of time is due to using an advance much finer than repeated experience has shown to be necessary. I assume that all roughing work above 3in. in diameter, with a second cut to follow, can be done at $\frac{1}{8}$in. advance. If the work is to be finished at one cut, the $\frac{1}{16}$in. advance could, I believe, be used for all sizes above 2in., but I have taken $\frac{1}{16}$in. to 3in., $\frac{1}{24}$in. to 2in., and $\frac{1}{32}$in. under 2in.

Circumstances affecting the cost of tooling: Skill, intelligence, will, energy, wages; situation of works, their arrangement; facilities of transport, tramways, cranes, etc.; nature of work to be done, repetition, stores, shop organisation and management, store system; drawings, designs easy to tool, templates, gauge chucks, stays, devices for fixing and changing work rapidly; kind of tools, multiple cutting tools, special tools, copying tools, milling tools, etc.; quality, strength, selection and suitableness of tools, accuracy and rigidity needed for broad cuts and high-class machine finishing; classification and arrangement of tools; shape of cutting tools, length of cutting edge, angles of cutting and supporting surfaces, quality and temper of steel, accurate grinding appliances, means of cooling, speed of cut, depth and width of cut, area tooled per hour.

Table B shows the number of revolutions per minute for various diameters at several surface speeds. These may be obtainéd thus: The revolutions in one quarter of a minute nearly equal the speed in feet divided by the diameter in inches.

Thus for a 2in. shaft, at 20ft. per minute, the revolutions per quarter of a minute are nearly $\frac{20}{2}$ = 10. Hence say 40 revolutions per minute.

Revolutions.

TABLE B.
Speed of Cut.

Diam.	ft. 20	ft. 16	ft. 12
½	152	120	90
¾	102	80	60
1	76	60	45
2	38	30	22·5
3	25	20	15
4	19	15	11·3
5	15	12	9
6	12·6	10	7·5
7	10·8	8·6	6·5
8	9·5	7·5	5·7

TABLE C.
Pulleys at 16 ft.

Diam.	Rev.	Time. sec.
10	6	10
20	3	20
30	2	30
40	1·5	40
50	1·2	50
60	1	59
70	·9	69
80	·8	79

Table C illustrates the simple means of observing if the speed of the wheel, etc., be more or less than 16ft., by noting if the number of seconds for one revolution be less or more than the number of inches in diameter.

Table D gives the number of square feet tooled per hour with speeds varying from 6ft. to 20ft. per minute, and an advance of feed varying from 64 to 3 cuts per inch.

TABLE D.—*Constants, or Sq. Ft. per Hour.*

Advance	... Speed	64	48	32	24	16	12	8	6	4	3
Wrought iron ...	20	1·6	2·1	3·1	4·2	6·2	8·4	12·5	16·6	24	33·3
Cast iron	16	1.2	1·6	2·5	3·3	5·	6·7	10·	13·4	20	26·6
Steel ...	12	·9	1·2	1·9	2·5	3·7	5·	7·5	10·	15	20
Boring...	10	·8	1·	1·5	2·1	3·1	4·2	6·2	8·3	12·5	16·6
„ ...	8	·6	·8	1.3	1·7	2·5	3·3	5·	6·7	10	13·4
„ ...	6	·5	·6	·9	1·2	1·9	2·5	3·8	5·	7·5	10

A prominent aim of this paper has been to show the necessity of actually measuring the performance of each tool from time to time, the convenience of adopting one square foot per hour as the unit of measurement, the rapid and ready means by which such measurement can be determined mentally by means of a watch and foot-rule, and the increase in production that may be obtained by determining a given average standard of performance for various descriptions of work which should at all times be maintained. Table D, therefore, may be called a table of "constants;" they vary from ½ to 33. With an advance of 48 per inch, they are less than 2; with an advance of 32, they are less than 3. With a coarse advance the "constant" rapidly rises until with 3 per inch advance it reaches 30, at 16ft., and 20 with so slow a speed as 12ft. per minute. A broad advance has far more effect than a quick speed. A quick speed requires a higher quality of steel and special means to cool the tool, but it does increase the strain on the tool, and in very light work may be indispensable. In heavy work rapidity may be obtained at a moderate speed by a broad advance.

Tables E and F show the effect of advance on the cost per square foot. The tool is assumed to be cutting seven hours per day, and the wage of the attendant nine hours at 7d. per hour. The cost per lineal foot is given as a means of comparison with well-known piecework prices.

TABLE E.—*Shafting.*

5s. 3d. per day; Speed 20ft.

ROUGHING.

Diameter	1	2	3	4	6	10
Advance	32	24	16	16	12	8
Constant	3·1	4·2	6·2	6·2	8·4	12·5
Seven hours area ...	21·7	29·4	43·4	43·4	58·8	87·5
Cost per sq. ft.... ...	3d.	2¼d.	1½d.	1½d.	1¼d.	¾d.
„ lineal foot ...	¾d.	1⅛d.	1¼d.	1½d.	1¾d.	2d.

TABLE F.—*Finishing.*

Advance	24	12	8	8	6	6
Constant	4·2	8·4	12·5	12·5	16·6	16·6
Seven hours area	29·4	58·8	87·5	87·5	116·2	116·2
Cost per sq. ft.	2¼d.	1¼d.	¾d.	¾d.	⅝d.	⅝d.
„ lineal ft.	⅝d.	⅝d.	⅝d.	¾d.	⅞d.	1½d.

These "constants" could readily be maintained in ordinary lathes with suitable tools. The best roughing tool I have met with is a square bar with a diagonal groove across it, forming the cutting edge at an angle of about ½in. per inch. The cutting surface inclined about ½in. to ⅜in. per inch, and the supporting surface inclined about ⅛in. per inch.

Time will not permit me to dwell on the close relation between the angles and position of the cutting surface and the actual strain, and therefore possible advance, nor upon cooling the tool, accurate grinding, etc.

Engineers' tools are generally not stiff enough. (Since reading the above paper the writer has noticed screw-shafting turned at three cuts per inch ⅜in. to ½in. deep, using a tool on both sides of the shaft, the tools being made of 2½in. square steel shaped, much as above described, the shaving being about 1in. wide.) The light finishing cut, with a stiff spring tool, was about 2½ per inch; as the speed was under 20 the "constants" would perhaps be 25 and 32, which are very high, and the cost of wages for each cut say under ⅜d. per square foot.

He has also been informed by Mr. Burrows that Messrs. Smith, Beacock, and Tannet have recently finished planing a surface of 200 square feet with a broad tool ground true by special appliances, each cut being 2⅜in. wide, and that the work on being tested with straight-edges was found to be very true. Assuming a mean speed of 10ft., the "constant"

TABLE G.

—	Pulleys. Speed 16ft. per Minute.					
Diameter	10	20	30	40	60	80
Advance	32	24	24	24	16	16
Constant	2·5	3·3	3·3	3·3	5·	5·
Length per hour	11½	7½	5	3¾	3¾	2⅞
Cost per sq. ft.	3½d.	2¾d.	2¾d.	2¾d.	1⅞d.	1⅞d.
Cost per lineal ft.	10d.	1s 2d.	1s 11d	2s 5d.	2s 5d.	3s 2d.

would be 180 square feet, and the time required 1 hour 40 minutes.

Only one cutting edge is supposed to be used. Where several cutting edges are used, the constant may be proportionately increased provided they are fixed and set in about the same time as before.

The subject of duplicate cutting edges, and the various means of fixing the work and the tools so that the latter shall be nearly always cutting, is one upon which much may be said, and with regard to which very much remains to be done.

Table G refers to pulleys where the advance is usually limited by their lightness.

Table H refers to the flywheels of small engines. The cost is shown to vary from 3½d. to 1d. per square foot on the conditions thereon named.

TABLE H.

—	Flywheels, 16 ft.			
Diameter	60	80	100	120
Advance	12	12	8	8
Constant	6·7	6·7	10	10
Length per hour ...	5⅛	3⅞	4½	3⅞
Cost per square foot...	1⅜d.	1⅜d.	1d.	1d.
Cost per lineal foot ...	1s. 9d.	2s. 4d.	2s.	2s. 4d.

Table K refers to boring holes with a lathe tool where the overhang of the tool limits the advance.

TABLE K.

—	Holes, 10 ft.			
Diameter	3	4	6	8
Advance	48	32	32	32
Constant	1·2	1·9	1·9	1·9
Length per hour ...	18	21	14	16
Cost per square foot...	7½d.	5d.	5d.	5d.
Cost per lineal foot ...	6d.	5d.	7½d.	10d.

Table L refers to boring bits; here the cost varies from 7½d. to 10d. per square foot.

TABLE L.

—	Boring Bit, 10ft.		
Diameter	1	2	3
Advance	64	45	32
Constant	·6	·6	·9
Length per hour... ...	27	14	14
Cost per square foot ...	1s. 3d.	1s. 3d.	10d.
Cost per lineal foot ...	4d.	8d.	8d.

In each case wages assumed to be 5s. 3d. per day, and the tool cutting for seven hours.

Table M refers to planing machines. It shows the disadvantage of planing short lengths, the cost varying from 6½d. to 9d. per square foot for roughing. It also shows the great advantage of finishing the work with a broad advance, the cost of two cuts being 7¾d. per foot instead of 1s. 0½d. In practice the loss due to short lengths is often obviated by placing things end to end. I have seen from 16 to 48 slide bars planed at once, and eight tools used, four cutting each way. This would reduce the cost to about 1d. per square foot.

Table N shows a large planing machine with broader advance. Here the cost becomes 2⅛d. per square foot for roughing and finishing, using one cutting tool at a time.

TABLE M.

—	Small Planing Machine.			
Length actual ...	1ft. 0in.	2ft. 0in.	4ft. 0in.	6ft. 6in.
Tool travels... ...	1ft. 6in.	2ft. 6in.	4ft. 6in.	6ft. 6in.
Advance	32 rgh.	...	8 fin.	
Constant	1·5	...	6·2	
Actual area... ...	10·5	...	43·4	
Net area roughing	7	8·7	9·7	10
„ finishing	28	35	39	40
Cost per square foot roughing ...	9d.	7½d.	6½d.	6¼d.
Cost per square foot finishing ...	2¼d.	2d.	1¾d.	1½d.
Total cost	11¼d.	9½d.	8¼d.	7¾d.

TABLE N.

—	Large Planing Machine.			
Length actual ...	6ft. 0in.	12ft.	6ft. 0in.	12ft.
Tool travels... ...	6ft. 6in.	12ft. 6in	6ft. 6in.	12ft. 6in
Advance	12 rgh.	4 fin.	8 rgh.	3 fin.
Constant	4·2	12·5	6·2	16·6
Actual area... ...				
Net area roughing	27	28	40	41
„ finishing	81	84	105	110
Cost per square foot roughing ...	2½d.	2¼d.	1⅝d.	1½d.
Cost per square foot finishing ...	¾d.	¾d.	⅝d.	⅝d.
Total cost	3¼d.	3d.	2¼d.	2⅛d.

In each case mean speed 10 ft. per minute; time cutting, 7 hours; wages, 5s. 3d. per day.

Table O shows the work done by shaping machines. Here the constants become much less, and the cost rises from 9d. to 13d. per square foot (assuming 7d. per hour for wages). The finishing cut with a broader advance costs much less, the total of the two cuts varying from 12d. to 18d. per square foot. Where there is a large repetition of similar articles it is better to arrange them in sets on a planing machine.

TABLE O.—*Shaping Machine.*

——	Large.			Small.	
Length actual...	6 in.	9 in.	12 in.	3 in.	6 in.
Tool travels ...	7½ in.	10½ in.	13½ in.	4½ in.	7½ in.
Advance	32 rgh.	...	12 fin.	48 rgh.	16 fin.
Constant	1·2	...	3·3	·8	2·5
Actual area ...	8·7	...	23	5·8	17·5
Net area rghng.	7	7·5	7·7	3·8	4·6
„ finishing	18	19	20	12	14
Cost per sq. foot roughing ...	9d.	8½d.	8¼d.	16½d.	13¼d.
Cost per sq. foot finishing ...	3½d.	3¼d.	3d.	5¾d.	4½d.
Total cost... ...	12½d.	11¾d.	11¼d.	22¼d.	17¾d.

In all cases mean speed 8 ft. per minute; time cutting, 7 hours, at 5s. 3d. per day.

Table P shows the work done by slotting machines If finished with swivel tools a broader advance can be used, and the surface is left smoother, but the time saved is comparatively small. The cost varies

TABLE P.—*Slotting Machine.*

——	Large.		Small.	
Length actual...	12in.	18in.	3in.	6in.
Tool travels ...	13½in.	19½in.	4½in.	7½in.
Advance	48 rgh.	24 finishing 16 finishing with swivel tool.	64 rgh.	32 fin.
Constant	.8	1.6 2.5	.6	1.2
Actual area ...	5.8	11.6 17.5	4.4	8.7
Net area r'ghing	5.2	5.3	.3.	3.5
„ finishing	10 16	11 16	5.8	7.
Cost per square foot roughing	12¼d.	12d.	21½d.	18d.
Cost per square foot finishing	6¼d. 4d.	6d. 4d.	11d.	9d.
Total cost	18½d 16¼d	18d. 16d.	32½d.	27d.

In all cases mean speed 8ft. per minute; time cutting 7 hours, at 5s. 3d. per day.

from 1s. 4d. to 2s. 8d. per square foot for a roughing and finishing cut. The tool need not always travel 1½in. further than the actual cut; but it is here so shown to illustrate the loss due to tooling short lengths.

Table R shows how a broad advance compensates for a slow speed.

TABLE R.—*Turning Hard Rolls.*

——	Speed.	Advance	Constant	Cost per sq. ft.
Roughing ...	6	12	2·5	3½
Finishing ...	3	3	5	2

Table S shows the cost of screwing per square foot and per foot lineal at a surface speed of 4ft., 8ft., and 16ft. per minute. It also shows the cost per gross of tapping, using three tapping spindles. Wages per day are still taken as 5s. 3d. for the sake of ready comparison of cost. In nut and bolt factories the wages paid would be about one-half; and as two nuts are tapped at once on each tap in small sizes, the cost per gross may be about one-third of that given. The actual "constants" for tapping are the same as for screwing, but the "effective constant" is reduced in proportion as the tap is longer than the nut, say ⅛ to ⅓. The cutting of large threads at one cut successfully, including square threads, effects a great saving of time as compared with the older methods. I have some fine specimens of such work, lent to me by Mr. Barrows, of Leeds, and done by his machine at a speed of cut from 6ft. to 8ft. per minute. The constant is large at these speeds, and higher speeds, although successful, do not at present seem desirable.

TABLE S.—*Screwing.*

Diameter	½			¾			1			2			3		
Threads per inch	12			10			8			4½			3½		
Speed in feet ...	4	8	16	4	8	16	4	8	16	4	8	16	4	8	16
Revolutions per minute	30	60	120	20	40	80	15	30	60	7·5	15	30	5	10	20
Constant	1·6	3·3	6·6	2	4	8	2·5	5	10	4·5	9	18	5·5	11	22
Cost per sq. foot	5¼d.	2½d.	1¼d.	4½d.	2¼d.	1d.	3⅓d.	2d.	1d.	2d.	1d.	½d.	1½d.	¾d.	½d.
Cost per lin. foot	¾d.	⅜d.	3/16d.	1d.	½d.	¼d.	1d.	½d.	¼d.	1	½	¼d.	1¼d.	⅝d.	¼d.
Tapping Nuts.															
Numb. in 7 hrs. at 42 revol. per nut	300	600	1200	200	400	800	150	300	600	75	150	300	50	100	200
Cost per gross using 3 spindles	10d.	5d.	2½d.	15d.	7½d	3¾d.	20d.	10d.	5d.	40d.	20d.	10d.	60d	30d.	15d.

Time of cutting, 7 hours per day; wages, 5s.

In concluding this paper I must again refer to the remarks with which it commenced—that for want of time I can only attempt to deal with one branch of the subject, and only partially with that. There is a vast disparity between the amount of work usually done by engineers' tools and the best performances of which they are capable, as proved both by reasoning and many examples. One means of raising the average performances here advocated is to introduce a system of measuring the work tooled in square feet per hour, to determine "constants" as here detailed, always to work up to, and as far as possible to exceed, those standards.

◆

Hard Solder for Gold.—Gold, 18 carats fine, 18 parts; silver, standard, 10 parts; copper, pure, 10 parts (by weight).

Gilding Steel.—Polished steel may be beautifully gilded by means of the ethereal solution of gold. Dissolve pure gold in aqua regia, evaporate gently to dryness, so as to drive off the superfluous acid, re-dissolve in water and add three times its bulk of sulphuric ether. Allow to stand for twenty-four hours in a stoppered bottle, and the ethereal solution of gold will float at top. Polished steel dipped in this is at once beautifully gilded, and by tracing patterns on the surface of the metal with any kind of varnish, beautiful devices in plain metal and gilt will be produced. For other metals the electro process is the best.

Dead-Finish.—This term is applied to the finish produced by the reduction of any of the rubbing varnishes with powdered pumice-stone and raw linseed oil, the surface thus produced being left in the semi-lustrous state, by omitting the polishing process. It is now more used than any other for body work, shellac varnish being generally employed because of its adaptation to the requirements of fine cabinet-work, and its properties of quick and hard drying. Copal, anime and amber varnishes are also used, but are slower drying. Veneered panels are usually "flowed" or "polished" when the body work is dead-finished. The number of coats required depends somewhat upon the quality of the filler, but usually three coats, and sometimes less are amply sufficient.

HOW TO MAKE AN ELECTRO-MOTOR.

By Frederick Walker.

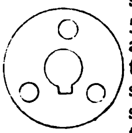
(For Illustrations see Supplement.)

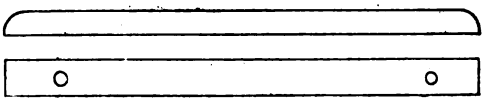
IT has been so often proved during the past year that electricity can be applied practically as a motive power, that it is, as it were, an old subject. Nevertheless, it may not be so generally known that it is an easy matter for an amateur to construct a very efficient electro-motor, which, when constructed, will prove to be the best source of power for his lathe, drill or sewing-machine, if these tools are in use intermittently. A steam engine of small power is a nuisance; it takes time to raise sufficient steam, and when only required for a short time, with long intervals of rest, it is far from an economical motor. Every one cannot buy or use a gas engine, and, indeed, few amateurs would go to the labour and expense of making patterns, etc., in order to construct one; and is it not the most pleasurable feeling in existence to be able to show a friend a motor, performing work, and behaving like a thing of life, and say, "It is entirely my own construction!"

Therefore I intend, in the course of this article, to describe a very efficient motor, which I have proved by experience to be capable of doing the work required, according to size, and assuring our readers at the same time that with a suitable battery, to be described later on, it will be found even more economical in action than treading the lathe or sewing machine by foot.

The size I am about to describe is large enough to drive a 5in. lathe with proper speeding, and half that size will work a sewing machine well. An electro-motor consists of two parts—one fixed, called the field magnet, or magnets, usually made of malleable iron, or wrought, because it should readily admit of magnetisation when a current passes through the coils of insulated wire surrounding it. The revolving part, termed the armature, should possess but little iron in its coils, and this should be divided or laminated as much as possible, because efficiency demands a rapid magnetisation and demagnetisation, which, to a certain extent, is impossible when the armature core consists of large masses of iron. Commencing with the

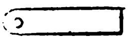
Armature, you must first procure a shaft of forged steel 7/16in. diameter and 10in. long, and turn this parallel to ⅜in., polishing and slightly rounding the ends. Then, taking a piece of box-wood, free from flaws, bore a hole centrally, so that it will drive tightly upon the shaft for turning. It should be faced off to 4⅝in. in length, and 1½in. of the shaft should overlap one end, and 4in. the other. Then procure a piece of 2½in. wrought iron piping, and cut it off true in the lathe to 4½in. long. This should then be heated to a white heat, and plunged into lime, to cool gradually. When cool, the bore should be cleaned out, so that no burrs remain, and the box-wood block upon the shaft may then be turned so that the pipe may be driven upon it, as shown in figure 1. This being done, a plate, *e*, having a keyway cut in it, may be keyed upon the shaft at the short end, and three ¾in. wood screws screwed through its three counter-sunk holes into the wood. Then six pieces of iron, shown in the accompanying figure, 5in. long, and ¼in. x ⅜in., should be annealed in lime, like the pipe, and their ends rounded, and two countersunk holes drilled to suit 1in. wood screws. Then, the circumference of the pipe being divided into six, the slips may be held to the lines ¼in. over-lapping, and holes may then be marked off and drilled through the pipe, so that the screws may take a





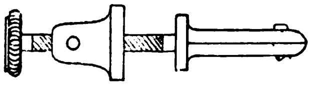
good ½in. in the box-wood, and firmly pin the strips to the pipe. Our armature being then completed, it may be run in the lathe to see if the edges of the strips are true; if not, they may be just tipped with a keen front tool, or better still, the high places may be drawfiled, till the whole armature will revolve close to the edge of the hand-rest without touching. Next, coming to a part of the armature called the

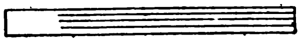
Commutator, whose duty it is to change the direction of the current through the armature, you will require a piece of ebonite, fig. 2, turned down to ⅝in., with a flange 1¾in. and ⅜in. thick. This should be bored so that it may fit the shaft nicely up to the wood on the long end. Three holes, very deeply countersunk, may be drilled ⅜in. from the edge of the flange, and then placing the ebonite against the wood, mark off these holes, and bore to receive 1½in. wood screws. Don't screw the ebonite on yet, but taking it off the shaft, screw in the screws so that they project 1in. out of the wood, for a purpose to be hereafter explained. Now take a piece of brass, and turn it down as shown in fig. 2, with a flange 1¼in. diameter and ⅛in. thick, the barrel being 13/16in. diameter, and ⅞in. long. This should be drilled with six holes in the flange, equally divided, and to take screws 3/32in. x ⅜in. Then, centrally between each hole, the brass may be sawn longitudinally into six pieces, using a thick and sharp hacksaw, taking care to trim the edges so that no projecting pieces of brass may intervene between the slits when the commutator is built up. Then cut six strips of brass sheet, shown annexed, about No. 26 gauge, and drill a hole in the end of each to correspond with the hole in each section of the commutator flange, and placing each strip behind the same, upon the ebonite, and testing to see whether the holes are true enough to admit of each strip being properly divided by the saw slits, right round, then you may take the commutator to pieces, and let it remain till after winding. Respecting the screws that we left screwed partly into the wood at the commutator end of the armature, cut three pieces of brass tube, ¾in. long, and of such bore that it will freely slide upon the screws, taking care that they are all of exactly equal length, and slip them upon the screws, and leave them in as before. These are intended to keep the commutator away from the armature so as to allow room for the wire when it is wound on, and as the commutator would be in the way during that operation, and we have finished the armature, we will turn to the



Field Magnets.—These may be made of cast, or better still, malleable cast iron, and for convenience in winding should be made in halves, as shown in fig. 3, the pole pieces having a dividing strip to screw between the flanges of the magnets to hold them firmly. These pole pieces should be 6in. long, so as to protrude ½in. each side of the magnets. When cast, a piece of hard wood should be turned slightly smaller than the armature, and placed inside the pole pieces, and so holding them truly in position while the holes are marked, drilled, and the screws fitted. Then a cut should be taken through, so as to allow 1/16in. as an easy fit for the armature to revolve. All parts should be marked, and, presuming that they have been fairly fitted together, they will present a true bore again after winding. Fig. 4 represents two brass castings to form bearings for the armature spindle, and, when being bored, the flange should be undercut, perfectly true, for $\frac{1}{16}$in., as shown, to fit the bore of the pole pieces, so that the bearing may be perfectly true. The boss must be turned to ¾in. diameter, and have a fine threaded screw cut up for ½in. of its length, for which a hexagon brass nut ¼in. thick should be provided. This is to hold the brush holder firmly in the position that may subsequently be found the best for the motor. In many motors this is too often made rigid, so adjustment is impossible, though often necessary. The other casting is simply flat, and is intended for the opposite end of the armature; however, it requires letting into the bore of the pole pieces as before. When all this is done the armature should be placed in the pole pieces, with loose collars or washers upon the spindle; on the one side to keep the commutator from rubbing, and on the other for protecting the wire. If it spins all right, and touches nowhere, you may drill the holes, fit the screws, and mark the brass ends, take them apart, and commence upon the brush holder.

This (fig. 5) is also of brass, and bored to fit the boss upon (fig. 4) easily. Two holes, $\frac{1}{16}$in. diameter, are drilled in each end. A slit is cut with the hacksaw to admit the brushes, and a small screw fitted to grip it together. When these are placed into their holes in the cross bar, care must be taken that they are thoroughly insulated everywhere; that is to say, there must be no metallic contact between either brush and the bar, this being prevented by a small tube and two small washers of ebonite. The terminal annexed is the connection between the brushes and their corresponding field magnet and circuit wires. The brushes, shown annexed, themselves are made from thin sheet copper, cut in strips nearly to the top, and 3in. long.





Before commencing the winding, a simple galvanometer will be necessary, and for this purpose procure a small pocket compass, with a needle at least 1½in. long, and, taking a glass bottle, or anything cylindrical, wrap a strip of paper, covered on the outside with shellac varnish, and while wet, wrap (not too tightly) eight or nine turns of No. 26, B.W.G. cotton, covered with copper wire, leaving two free ends. Now again paint this with shellac (or sealing wax dissolved in spirits), and turn up the edges of the paper so as to form a sort of flanged bobbin. When dry, and pulled off the bottle, it may be slightly flattened at one point and attached to a small stand, having two brass terminals connected to each end of the wire, and screwed to the stand. The compass is then placed in the centre, so that the axis of the needle is nearly equidistant from each part of the coil, fig. 6. When the stand is placed so that the coil is parallel to the magnetic meridian, that is, when the compass needle in pointing North and South is wholly in a line with the coil, and a current of electricity be passed through from a small battery, the needle will be deflected, either right or left, depending upon the direction of the current.

This deflection indicates that a current is passing, and that a circuit, or coil of wire, is open, and it also informs us of bad insulation, which will be described when we come to the winding. Any small battery will do for the testing, a Leclanchè, Bennett, Daniell, or Walker's dry cell the latter will not spill its contents. Failing these, a piece of rough carbon between two sheets of zinc, in a solution of sal-ammoniac, will serve the purpose, the two zincs being coupled to one wire, and the carbon to the other, care being taken that they do not touch each other in or out of the liquid.

The winding of an electro-motor is a matter requiring considerable care, and will form the subject of another paper, and should all the details be carefully carried out, the homes and workshops of our readers will soon be cheered by the hum of their industrious servant, reminding them of the "busy bee" in more ways than one.

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MECHANICAL CLASSES.

Sir,—I am very glad "M. A. C." was amused on reading my letter on the above subject. I hope the letter will amuse and be of use to many of our readers who are going into the engineering. I assure "M. A. C.," and all the other readers of "Amateur Mechanics," that I did not write the letter to mislead others, or for any gain to myself; but because I know that boys, when they leave school, are asked by their parents "What are you going to be?" A lad might answer, as often they do, without thinking, "Oh! I'll be an engineer." So away he is started to some engineering works on a month's trial. What is a month? How can a boy tell whether he likes it or not? However, at the end of the month he is bound an apprentice, and soon afterwards he finds he does not like it, or it may not suit his health; but he is bound, so it's no good grumbling. I fear I am not amusing "M. A. C.," for I have not answered what he requires. My advice is this: stick to the old motto "A still tongue makes a wise head." Now, generally, when a new apprentice enters a workshop, as soon as the foreman's back is turned, the questions are:—"Where do you come from?" "What are your parents?" "How many sisters have you?" "How many brothers have you?" "What are they?" and, "What have you been doing before you came here?" The lad might answer to the last question, "Oh! I 've been to such-and-such a school, and learnt all about a lathe. I can chip, and I can file quite true." The workmen will soon be putting him to the test. Suppose the leading hand says, "Well, here is a 12in. file, and here is a piece of 1in. cast iron: use 10in. of the file, and file across the iron square and true." Now, if the boy could use a file pretty well when left to himself, the very fact of his being in a strange shop and with strange men would make him nervous, and his work would be anything but square, or true. Now, perhaps "M. A. C." can see why I do not advise boys who have attended a mechanical class to say anything about it. A boy who is a good chipper when left to himself soon becomes nervous when two or three stand looking at him, and is nearly sure to hit his hand instead of the chisel. Again, I mean that an apprentice boy should be satisfied with the machine his foreman puts him to. His foreman knows what is best for him. But all the apprentices, or nearly all, that I have ever known, were always grumbling because they could not be put forward fast enough. I am sure there is much to be learnt at a small machine, and I still advise apprentices to stick to machines, and not be in such a hurry to get to a lathe. But still, I look upon a lathe as being the master-piec of machinery. When I wrote the letter "M. A. C." refers to, I was speaking of mechanical classes that are open only for three or four hours per day, and the rest of the time taken up with other study. I do not mean that a boy ought to be ashamed because he has attended a mechanical class, but that the workmen expect too much from him, and he is laughed at when he fails to do work properly. Yours, etc., **GEO. F. JACKSON,**

[Articles on "Smithing and Forging," by Mr. Lowe, and on "Steam Machinery," by A. A. Dorrington, will be continued in our next.—Ed.]

AMATEUR MECHANICS

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THE ORIGIN OF TOOLS.

TOOLS have played a highly important part in the history of civilization. Without tools, and the ability to use them, man were indeed but a "poor, bare, forked animal," worse clothed than the birds, worse housed than the beaver, worse fed than the jackal. "Weak in himself," says Carlyle, "and of small stature, he stands on a basis, at most for the flattest-soled, of some half-square foot, insecurely enough; has to straddle out his legs, lest the very wind supplant him. Feeblest of bipeds! Three quintals are a crushing load for him; the steer of the meadow tosses him aloft like a waste rag. Nevertheless he can use tools, can devise tools; with these the granite mountain melts into light dust before him; he kneads glowing iron as if it were soft paste; seas are his smooth highway; winds and fire his unvarying steeds. Nowhere do you find him without tools; without tools he is nothing; with tools he is all." His very first contrivances to support life were tools of the simplest and rudest construction; and his latest achievements in the substitution of machinery for the relief of the human hand and intellect are founded on the use of tools of a still higher order. Hence it is not without good reason that man has by some philosophers been defined as a *tool-making animal*.

Tools, like everything else, had small beginnings. With the primitive stone hammer and chisel very little could be done. The felling of a tree would occupy a workman a month, unless helped by the destructive action of fire. Dwellings could not be built, the soil could not be tilled, clothes could not be fashioned and made, and the hewing out of a boat was so tedious a process that the wood must have been far gone in decay before it could be launched. It was a great step in advance to discover the art of working in metals, more especially in steel, one of the few metals capable of taking a sharp edge and keeping it. From the date of this discovery, working in wood and stone could be found comparatively easy, and the results must speedily have been felt, not only in the improvement of man's daily food, but in his domestic and social condition. Clothing could then be made, the primitive forest could be cleared, and tillage carried on; abundant fuel could be obtained, dwellings erected, ships built, temples reared; every improvement in tools marking a new step in the development of the human intellect, and a further stage in the progress of human civilization.

The earliest tools were of the simplest possible character, consisting principally of modifications of the wedge; such as the knife, the shears (formed of two knives working on a joint), the chisel, and the axe. These, with the primitive hammer, formed the principal stock-in-trade of the early mechanics, who were handicraftsmen in the literal sense of the word. But the work which the early craftsmen in wood, stone, brass and iron contrived to execute sufficed to show how much expertness in the handling of tools will serve to compensate for their mechanical imperfections. Workmen then sought rather to aid muscular strength than to supersede it, and mainly to facilitate manual skill. Another tool became added to those mentioned above, which proved an additional source of power to the workman. We mean the saw, which was considered of so much importance that its inventor was honoured with a place among the gods in the mythology of the Greeks. This invention is said to have been suggested by the arrangement of the teeth in the jaw of a serpent, used by Talus, the nephew of Dædalus, in dividing a piece of wood. From the representation of ancient tools found in the paintings at Herculaneum, it appears that the frame-saw used by the ancients very nearly resembled that still in use; and we are informed that the tools employed in the carpenters' shops at Nazareth at this day are in most respects the same as those represented in the buried city. Another very ancient tool referred to in the Bible and Homer was the file, which was used to sharpen weapons and implements. Thus the Hebrews "had a file for the mattocks, and for the coulters, and for the forks, and for the axes, and to sharpen the goads." When to these we add the adze, plane-irons, the auger, and the chisel, we sum up the tools principally relied on by the early mechanics for working in wood and iron.

Such continued to be the chief tools in use down almost to our own day. The smith was at first the principal tool-maker; but special branches of trade were gradually established, devoted to tool-making. So long, however, as the workman relied mainly on his dexterity of hand, the amount of production was comparatively limited, for the number of skilled workmen was but small. The articles turned out by them, being the product of tedious manual labour, were too dear to come into common use, and were made almost exclusively for the richer classes of the community. It was not until machinery had been invented and become generally adopted that many of the ordinary articles of necessity and comfort were produced in sufficient abundance and at such prices as enabled them to enter into the consumption of the great body of the people.

But every improver of tools had a long and difficult battle to fight, for any improvement in their effective power was sure to touch the interest of some established craft. Especially was this the case with machines, which are but tools of a more complete though complicated kind than those above described. Take, for instance, the case of the saw. The tedious drudgery of dividing timber by the old-fashioned hand-saw is well known. To avoid it, some ingenious person suggested that a number of saws should be fixed to a frame in a mill, so contrived as to work with a reciprocating motion, upwards and downwards, or backward and forward, and that this frame so mounted should be yoked to the mill-wheel, and the saws driven by the power of wind or water. The plan was tried, and, as may readily be imagined, the amount of effective work done by this machine-saw was immense, compared with the tedious process of sawing by hand.

It will be observed, however, that the new method must have seriously interfered with the labour of the hand-sawyers; and it was but natural that they should regard the establishment of the saw-mills with suspicion and hostility. Hence a long period elapsed before the hand-sawyers would permit the new machinery to be set up and worked. The first saw mill in England was erected by a Dutchman, near London, in 1663, but was shortly abandoned in consequence of the determined hostility of the workmen. More than a century passed before a second saw mill was set up; when, in 1767, Mr. John Houghton, a London timber merchant, by the desire and with the approbation of the Society of Arts, erected one at Limehouse, to be driven by wind. But the mill was no sooner erected than a mob assembled and razed it to the ground. The principal rioters having been punished, and the loss to the proprietor having been made good by the nation, a new mill was shortly after built, and it was suffered to work without further molestation.

At a much more recent period new inventions have had to encounter serious rioting and machine-breaking fury. Even improved agricultural tools and machines have had the same opposition to encounter, and in our own time bands of rural labourers have gone from farm to farm breaking drill-ploughs, winnowing, threshing and other machines, down even to the common drills—not perceiving that if their policy had proved successful, and tools could have been effectually destroyed, the human race would have at once been reduced to their teeth and nails, and civilization summarily abolished.

Alcohol, or Spirits of Wine, is employed for dissolving sandarac and shellac, to make the white and brown hard spirit varnishes, and lacquer for hard wood or brass, and also French polish. The varnishes made with alcohol dry much quicker, harder, and more brilliant than those made with turpentine; but if the spirit contains more than a minute proportion of water, it will scarcely dissolve the resins, and when the varnish is applied, a very slight degree of moisture in the atmosphere will cause the resins to be precipitated from the solution, giving the varnish a dull, cloudy, or milky appearance. It is therefore of the first importance, in making spirit varnishes, to procure the alcohol as pure as possible. Ordinary spirits of wine, however, always contains a considerable proportion of water, and is commonly tested for varnish purposes by saturating a slip of writing-paper with the spirit, which is then ignited. If the flame of the spirit communicates to the paper, and the whole is burned, the spirit is considered to be sufficiently good, but if, as frequently happens, the paper should be so far saturated with the water remaining from the evaporation of the spirit as to prevent its burning, the spirit is rejected as unfit for varnish purposes. Nearly pure alcohol may be obtained from ordinary spirits of wine, by adding about one-third its weight of well-dried carbonate of potash, agitating the bottle and then allowing it to stand for ten or twelve hours, during which time the potash will absorb much of the water from the spirit and fall to the bottom; the spirit may then be poured off, and fresh alkali added, and the process repeated until the potash remains quite dry; the alcohol is then to be freed from the small portion of potash which it holds in solution by distillation in a water-bath.

Preparing Soft Solder.—The following directions for soldering without fire or lamp may suit the querist: Bismuth, ¼oz., quicksilver, ¼oz., block tin filing, 1oz., spirits of salts, 1oz. Mix the whole together. Another soft solder for tin, &c. Take lead 1 part, tin 1 part, bismuth 2 parts; this melts in boiling water.

ABRADING AND POLISHING POWDERS.

THE whole process of polishing consists merely of removing coarse scratches by substituting those which are finer, and so on till they are no longer visible to the naked eye; but even then the surface, if examined with a magnifying glass, will appear full of scratches. It is evident that great care must be taken to have the last polishing material uniformly fine, for even one or two grains of a coarser grit will produce visible scratches instead of a perfectly polished surface. Tripoli powder, rotten-stone, oxide of tin, or putty powder, crocus, and rouge are used to produce highly-polished surfaces. Glaze wheels covered with leather and dressed with crocus and water, or some other polishing material, are used.

The use of emery and corundum as abrading materials is a development of the century which has just closed. The lapidaries of the Greeks and Romans in all probability employed the emery of Asia Minor in cutting hard stones in which they had no little skill; but the quantity used by them, and by those who followed them for hundreds of years, is insignificant in comparison with the many tons annually used now. For several centuries before the year 1846, emery was supplied to the arts almost entirely from Naxos, an island of the Grecian Archipelago. It was easily obtained here, and of good uniform quality. About the year 1800 the price was from 40 to 50 dollars per ton, and between 1820 and 1835 at times even less. At this period "the monopoly of the Naxos emery was purchased from the Greek government by an English merchant, who so regulated the quantity given to commerce that the price gradually rose from 40 dollars to 140 dollars per ton—a price at which it was sold in 1846 and 1847." In the latter part of 1846 and the early part of 1847, Dr. Lawrence J. Smith commenced examining and developing the emery formation of Asia Minor, until then unknown. His discoveries and developments had very soon a great effect upon the trade in emery. It began to assume for the first time a commercial importance—an importance that has ever since been growing greater from the impetus then given. Dr. Smith made a report to the Turkish government, the monopoly of the emery of Turkey was sold to a mercantile house in Smyrna, and the price in the English market fell immediately to 50 and 70 dollars per ton, according to the quality. In 1848 the annual consumption was about 1,500 tons, now it is not far from 5,000 tons. Most of the crude emery is shipped directly to England. The researches of Dr. Smith in Asia Minor not only gave commercial life to the emery trade in the East, but the facts that he observed have led to other important results. As one of these, Mr. James M. Safford mentions the discovery of the emery vein of Chester, Massachusetts. Dr. Charles T. Jackson, who was the principal agent in making known the vein, says: "I found that the minerals, margarite and chloritoid (collected at the locality), in talcose, hornblende, and mica slate rocks, indicated the occurrence of emery, the association of the rocks and minerals being identical with conditions known to exist in the localities of emery in Asia Minor." These "conditions" being appreciated by Dr. Jackson and recognised at Chester, caused him to persevere until the vein was found.

Emery is granular corundum of black, greyish-black, or bluish-black colours, and contains intimately mixed magnetite or hematite. It may be fine or coarse grained, and often looks and feels like a black, fine grained iron ore, from which it may be distinguished by its scratching agate, and by its low specific gravity. Pure corundum, when in the proper granular condition, is a better abrasive material than emery. Its masses are, however, frequently cleavable, which forbids its preparation into the suitable roundish grains required in the arts. Corundum (sometimes in the form of emery) has been discovered at many points in the United States, and mostly within a long strip of country extending from Massachusetts to Alabama, and principally in what has been called the great chromiferous serpentine or chrysolite belt. The most numerous localities are in North Carolina. Dr. Smith points out the parallelism in the geology of the North Carolina and Turkish localities. The chrysolite or serpentine rock of the one region takes the place of the limestone of the other, as the gangue rock of the corundum. Very fine masses of corundum—in some instances of large size, weighing six to eight hundred pounds, having fine, large cleavages—are met with in North Carolina. The variety and beauty of the specimens are said to be greater than at any other known locality. They excel in colour, being grey, green, rose, ruby-red, emerald-green, sapphire-blue, with other shades to colourless. Some pieces have been cut and polished, making fair gems, but showing too many flaws to be of any great value. Notwithstanding the extensive development of the mineral in North Carolina, Georgia, and Alabama, it has not, as yet, proved to be of special interest to commerce or the arts.

The Grecian and Turkish emery is shipped in masses of various size, from 150lbs. in weight down to pieces the size of an egg. In its preparation, the masses are broken up under steam hammers, or hand sledge hammers, until of a proper size to be placed in the Blake rock-crushers, which reduce the emery to fragments as small as walnuts. These are placed under stampers, rollers, and crushing machines until the whole is reduced to the required fineness. It is then conveyed to the sifting machines to separate the various grades of grain. The meshes of wire (or lawn for the finer) used for obtaining the various grades vary from sixty to many thousand holes to the square inch. The grades have sizes and numbers corresponding respectively to the number of meshes in a lineal inch of bolting cloth. The very fine emery is suspended in water, and then assorted by precipitation. The finest floats in the atmosphere of the stamping room, and is deposited on the beams and shelves, from which it is occasionally collected. Many difficulties beset the manufacture of emery grains and flour. As a measure of safety, consumers should buy from trustworthy houses. It is always economy to purchase the best article, though it may appear high priced. This is true of many manufactured goods, but especially so of emery.

Nothing is more necessary to the successful use of polishing powder than equality in the grain. Fine dust clogs the action of coarse grinding powders, and prevents them from cutting with rapidity the object to be ground; coarse particles mixed with fine polishing powder scratch the article to be polished, and render grinding and polishing necessary again. To secure fineness and uniformity, no process equals that of elutriation, which is thus performed:—Suppose it were desired to separate the ordinary flour of emery into three different degrees of fineness. Take three vessels, such as tin pails or glass jars, and mix the emery with a large quantity of water—say, one quart of water to 1½oz. of emery. Stir the mixture until the emery is thoroughly diffused through the liquid, and allow it to stand five minutes. By this time all the heavier particles will have settled, and on pouring the fluid into a second jar only the finer portion will be carried over. So continue to wash the first residuum until nearly all the particles have subsided at the end of five minutes, and the water is left comparatively clear. You will now have the coarse portion (No. 1) by itself. So from the sediment collection from washings of No. 1 you may collect a portion (No. 2) having a second degree of coarseness. The last and finest will be obtained by letting the final washings stand ten or fifteen minutes, pouring off the liquid, and allowing it to settle.

The principal polishing powders are chalk or whiting, crocus or rouge, emery, oilstone powder, and putty or tutty, which latter consists chiefly of oxide of tin. Other powders, such as tripoli, bath-brick, sand, etc., are rarely used for the finer kinds of work. Commercial whiting contains particles of silica of varying size, which cut freely, but are apt to scratch. Pure whiting, which is easily got by careful elutriation, has very poor cutting qualities, and is therefore used chiefly as plate powder for cleaning gold, silver, glass, etc., and for absorbing grease from metals which have been polished by other means. Prepared chalk is manufactured by adding a solution of carbonate of soda to a solution of chloride of calcium (both cheap salts), so long as a precipitate is thrown down. The solutions should be carefully filtered through paper before being mixed, and dust should be rigorously excluded. The white powder which falls down is carbonate of lime, or chalk, and when carefully washed and dried it forms a most excellent polishing powder for the softer metals. The particles are almost impalpable, but seem to be crystalline, for they polish quickly and smoothly, though they seem to wear away the material so little that its form or sharpness is not injured to any perceptible degree. Crocus, or rouge, is manufactured at Liverpool, by persons who make it their sole occupation, in the following manner:—They take crystals of sulphate of iron (green vitriol or copperas), immediately from the crystallising vessels, in the copperas works there, so as to have them as clean as possible, and instantly put them into crucibles or cast-iron pots, and expose them to heat, without suffering the smallest particle of dust to get in, which would have a tendency to scratch the article to be polished. Those portions which are least calcined, and are of a scarlet colour, are fit to make rouge for polishing gold or silver, while those which are calcined, or have become red-purple or bluish-purple, form crocus fit for polishing brass or steel. Of these, the bluish-purple coloured parts are the hardest, and are found nearest to the bottom of the vessels, and consequently have been exposed to the greatest degree of heat.

Andrew Ross's mode of preparing oxide of iron was to dissolve crystals of sulphate of iron in water; filter the solution to separate some particles of silex which are generally present, and sometimes are abundant; then precipitate from this filtered solution the protoxide of iron, by the addition of a saturated solution of soda, which must also be filtered. This grey oxide is to be repeatedly washed and then dried; put it in this state into a crucible, and very gradually raise it to a dull red heat; then pour it into a clean metal or earthen dish, and while cooling it will absorb oxygen from the atmosphere, and acquire a beautiful dark-red colour. In this state it is fit for polishing the softer metals, as silver and gold, but will scarcely make any impression on hardened steel or glass. For these latter purposes, Professor Phin discovered that it is the black oxide that affected the polish (and this gives to the red oxide a purple hue, which is used as the criterion of its cutting quality in ordinary), therefore for polishing the harder materials the oxide must be heated to a bright red, and kept in that state until a sufficient quantity of it is converted into black oxide to give the mass a deep purple hue when exposed to the atmosphere. Professor Phin converted the whole into black oxide; but this is liable to scratch, and does not work so pleasantly as when mixed with the softer material. The powder must now be levigated with a soft wrought-iron spatula, upon a soft iron slab, and afterwards washed in a very weak solution of gum arabic. The oxide prepared in this manner is almost impalpable, and free from all extraneous matter, and has the requisite quality in an eminent degree for polishing steel, glass, the softer gems, etc. Lord Ross's mode of preparing the peroxide of iron was by precipitation with water of ammonia from a pure dilute solution of sulphate of iron. The precipitate is washed, pressed in a screw press till nearly dry, and exposed to a heat which in the dark appears a dull low red. The only points of importance are that the sulphate of iron should be pure, that the water of ammonia should be decidedly in excess, and that the heat should not exceed a bright red. The colour will be a bright crimson inclining to yellow.

Fragments of oilstone, when pulverised, sifted, and washed, are much in request by mechanicians. This abrasive is generally preferred for grinding together those fittings of mathematical instruments and machinery which are made wholly or in part of brass or gunmetal, for oilstone, being softer and more pulverulent than emery, is less liable to become embedded in the metal than emery, which latter is then apt continually to grind, and ultimately damage the accuracy of the fittings of brass works. In modern practice it is usual, however, as far as possible, to discard the grinding together of surfaces, with the view of producing accuracy of form or precision of contact. Oilstone powder is preferred to pumicestone powder for polishing superior brass works, and it is also used by the watchmaker on rubbers of pewter in polished steel.

Pumicestone is a volcanic product, and is obtained principally from the Campo Bianco, one of the Lipari islands, which is entirely composed of this substance. It is extensively employed in various branches of the arts, and particularly in the state of powder, for polishing the various articles of cut glass; it is also extensively used in dressing leather, and in grinding and polishing the surface of metallic plates, etc. Pumicestone is ground or crushed under a runner, and sifted, and in this state it is used for brass and other metal works; and also for japanned, varnished, and painted goods, for which latter purposes it is generally applied on woollen cloths with water.

Putty powder is the pulverised oxide of tin, or generally of tin and lead mixed in various proportions. The process of manufacture is alike in all cases—the metal is oxidised in an iron muffle, or a rectangular box, close on all sides, except a square hole in the front side. The retort is surrounded by fire, and kept at a red heat, so that its contents are partially ignited, and they are continually stirred to expose fresh portions to the heated air; the process is complete when the fluid metal entirely disappears, and the upper part of the oxide then produced sparkles somewhat like particles of incandescent charcoal. The oxide is then removed with ladles, and spread over the bottom of large iron cooling pans and allowed to cool. The lumps of oxide, which are as hard as marble, are then selected from the mass, and ground dry under the runner; the putty powder is afterwards carefully sifted through lawn. As a criterion of quality, it may be said that the whitest putty powder is the purest, provided it be heavy. Some of the common kinds are brown and yellow, while others, from the intentional admixture of a little ivory black, are known as grey putty The pure white putty—which is used by marble workers, opticians, and some others—is the smoothest and most cutting. It should consist of the oxide of tin alone; but to lessen the difficulty of manufacture, a very little lead (the linings of tea chests), or else an alloy called shruff (prepared in ingots by the pewterers) is added to assist the oxidation. The putty powder of commerce of good fair quality is made of about equal parts of tin and lead, or tin and shruff; the common dark coloured kinds are prepared of lead only, but these are much harsher to the touch, and altogether inferior. Perhaps the most extensive use of putty powder is in glass and marble works, but the best kind serves admirably as plate powder, and for the general purposes of polishing. Putty powder for fine optical purposes was prepared by Mr. A. Ross by the following method, which is the result of many experiments:—Metallic tin is dissolved in nitro-muriatic acid, and precipitated from the filtered solution by liquid ammonia, both fluids being largely diluted with water. The peroxide of tin is then washed in abundance of water, collected in a cloth filter, and squeezed as dry as possible in a piece of new clean linen. The mass is now subjected to pressure in a screw-press, or between lever boards, to make it as dry as possible. When the lump thus produced has been broken in pieces and dried in the air, it is finally levigated while dry on a plate of glass with an iron spatula, and afterwards exposed in a crucible to a low white heat. Before the peroxide has been heated, or while it is in the levigated hydrous state, the putty powder possesses but little cutting quality, as under the microscope the particles then appear to have no determined form, or to be amorphous, and, on being wetted, to resume the gelatinous condition of the hydrous precipitate, so as to be useless for polishing; whereas, when the powder is heated, to render it anhydrous, most of the particles take their natural form—that of lamellar crystals—and act with far more energy (yet without scratching) than any of the ordinary polishing powders. The whole mass requires to be washed or elutriated in the usual manner after having been heated, in order to separate the coarser particles. A little crocus is usually added to the putty powder by way of colouring matter, and it is then easier to learn the quantity of powder that remains on the polishing tool, and it may be added that this is the polishing powder employed by Mr. Ross in making his improved achromatic object-glasses for astronomical telescopes.

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Opium.—When a poisonous dose of opium has been taken, the first object should be to remove the poison, and this must frequently be accomplished by the stomach-pump, as emetics are of little service when the patient has lost the power of swallowing. Dashing cold water on the head, chest, and spine has been adopted with great success. In the treatment of infants, the plunging of the body into a warm bath, and suddenly removing it from the water into the cold air, has been found a most effectual method of rousing them. Severe whipping on the palms of the hands and soles of the feet or the back has also been successfully employed. A common plan for rousing an adult is to keep him in continual motion by making him walk between two assistants. Above all things, the tendency to fall into a state of lethargy must be prevented. A strong decoction of coffee has been frequently employed as a stimulant to promote recovery, and apparently with benefit.

Cracks in Drawing Boards.—The material generally used in stopping the above is a composition made of glue and chalk, worked up to the consistency of putty, and applied to the board in a soft state, allowed to dry, and smoothed off with sandpaper.

STEEL HARDENING FALLACIES.

MR. S. W. GOODYEAR, who from his large experience in the manipulation of steel for workshop tools should be a reliable authority, writes the following to the "American Machinist":—

It has occurred to me that a statement of some of the beliefs, practices, and fallacies of many men, who, fully believing that they know all about steel, fail to comprehend the most important, while most simple facts might put the subject in such light as to occasion research and experiment, resulting in much good.

Said a man in my hearing, "I have hardened steel for thirty years, and know how to heat steel, and how hot it should be for hardening; and I tell you, in relation to steel springing and getting out of shape in hardening, it all depends upon how it is dipped into the water. I can harden dies and cutters, and have them come out as true as when they left the tool-maker."

It is an unquestionable fact that the manner of dipping has much to do with this matter, but our friend should remember that his action is governed by natural law, as much as are the actions of others; that steel springs out of shape in the fire from uneven heating; that it springs in heating, owing to an unequal and unnatural tension of some parts produced in forging; that difference in section at different points in a piece will cause more sudden cooling and contracting in some parts than in others; that some steels at the hardening heat will, in dipping, change in volume more than others; that with different steels all the different heats may be required for hardening, ranging from a yellow heat by daylight to a dark red by twilight; and, finally, after considering all the tendencies toward distortion and change in volume, resulting from a variation in any way from the best treatment possible, or a variation of quality or condition of steel from the best, there still remains this fact, that the steel by heating is expanded, and by sudden cooling, for hardening, is very much contracted from its volume while heated. As the outer portions cool first sufficiently to become hard and unyielding, while the interior of the piece is still hot and largely expanded, there must be a change in shape or volume (or both) produced by hardening.

Was a piece of steel of any considerable size ever hardened, remaining exactly the same size and shape as before? Who believes the steel manufacturer, when he says his steel will do it; or the skilled steel worker who says, "I can do it every time?" No, my friend, you are mistaken all round; your work don't come out true, but only *nearer* than by some worse methods. And it is not *all* in the way you dip it. If what you say were strictly true, there would be "millions in it."

Say another class of men, "We want no case hardening, but want steel hardened clear through;" and when they see milling cutters or dies packed in burned leather for heating, they condemn that style of hardening, and insist upon doing their heating in an open fire. Good work can be done in either way, and heating by packing has its advantages over open fire heating, in that it is usually more even, and if the steel heated in this way is not too hot, when ready for dipping, it is pretty certain that no part of it has been too hot at any time during the heating process. This is too often not true of open fire heating. By packing with leather or charcoal the surface of the heated steel is kept clean until ready to dip; whereas, by open fire heating, the impurities in coal not thoroughly coked, or foreign substances or cinder in the fire, produce a coating which interferes with the action of the cooling medium, and prevents proper hardening.

Who believes that a piece of steel, of the same quality and temper, heated in an open fire to the same heat of another which is heated in a box packed with burned leather, will be hardened any deeper than the so-called case-hardened piece? If it be true—and who disputes it?—that heating steel to a certain heat and suddenly cooling it is what produces hardness, is it reasonable to suppose that there would be any appreciable difference in the depth of hardening between the two pieces, provided they were equally hot, their surfaces equally clean, and the same conditions in cooling were preserved? Why should there be?

But as to the hardening clear through, *no steel piece of any considerable size hardens clear through.* Harden a piece two inches square as hard as possible, and break it, and the hardened portion will be found to be a mere shell, less than ¼in. thick, and, in many cases, not exceeding ⅛in. Inside of this hardened shell it may be cut at pleasure with good tools. Still, there is much said about hardening clear through; and cases have been known where pieces of hardened steel, on being accidentally broken or cracked in hardening, have been condemned as nothing but case hardened iron, because they were found not to be hardened clear through, and the self-constituted judges have insisted upon the correctness of their decision, even against the most unquestionable evidence, that the pieces were a high-grade of cast steel.

There are those who believe that success depends almost entirely upon what the steel is dipped in, not how it is dipped—for many of these pour their heated work in haphazard—and so we have tallow, and tallow and oil; and tallow, oil, and resin; and tallow, oil, resin, and beeswax; while sperm, lard, fish, whale, neat's foot, linseed, and all other oils are recommended, each by itself, or mixed with some other or others, or with something else, until the list of compounds, each having its advocates, covers nearly everything which is greasy and sticky and disagreeable to use.

It is fully believed by some, that the peculiar toughness and elasticity required in steel springs are due to the action of the oil or tallow in which they are quenched for hardening. It is also thought in many articles of manufacture, which spring in hardening and are straightened during the process of drawing the temper, that the fact that hardened steel may be straightened or bent at pleasure, when heated to a proper degree, while still hard enough to snap like glass on cooling off, is due to their having been hardened in oil or some greasy compound.

In many places, the proprietor and one or two trusty men have guarded for years the important secret pertaining to the ingredients and proportions of a nasty mixture, in which steel may be hardened, and then, by warming up till the oil on the surface smokes well, or till the temper is nearly drawn to the required point, may be bent or straightened. Well does the writer remember seeing the proprietor of an establishment engaged in the manufacture of garden hoes and hay forks, more than thirty years ago, show up the wonderful possibilities in this direction contained in a forty-gallon cast-iron kettle, without the contents of which he appeared to honestly believe he would be obliged to give up business.

Says a watch-spring maker, "I know about this. I have tried hardening in water, and it won't do. I have tested the matter thoroughly; have heated springs exactly alike, and hardened part of them in water and the others in grease, and those which were hardened in water would not do at all, while the others were good. Repeated experiments have satisfied me on this point."

"But, my dear sir, you say that you heated to the same heat for dipping, in both the water and grease. That is not right. Did you ever experiment till you learned the lowest heat at which water would harden the springs—a heat, in fact, at which they would not have hardened in oil—and try them in that way?"

"No, I did not do that; I tried everything else," is the reply.

And now let us ask a question of the man who has been exhibiting his exceptional knowledge, by hardening a piece of steel in his pet compound and heating it up till it smokes well, bending it over the corner of the anvil with a hammer, after which he cools it off and shows us that it will snap like glass.

"Did you ever try a piece in the same way, hardened at proper heat in water, or a piece heated after hardening with no oil or grease of any kind used?"

"It would be no use," he replies.

Try it, my friends; and, to you who have not tried straightening hard steel, by heating it, let me say that you have missed learning a good thing.

About case hardening steel: Experience teaches that steel which will not harden by simply heating and suddenly cooling may be superficially hardened by the use of either cyanide of potassium or prussiate of potash, or other agents which will carbonize the surface, but such hardening is truly "case hardening." Experience teaches again that steel which will harden extremely hard in the ordinary way sometimes has upon its surface a skin which fails to harden, so that in trying with a file, unless much care is exercised, the piece, which is really very hard, will be condemned as soft. In such cases the use of cyanide is very valuable, as it operates to harden this thin skin of really decarbonised steel, or iron, on the surface, while beneath that the thing needed was simply to heat and cool suddenly.

Judgment should teach and experience will show that any piece of good cast steel, which will harden without "case hardening," will be hardened just as deep when the case hardening agent is used as it would be if hardened at the same heat without it, and that the use of cyanide of potassium in any case where anything more than a superficial hardening is needed will not permit a lower heat than would be required without it. To suppose that a piece of steel treated with cyanide at a lower heat than would harden it without the cyanide will be properly hardened, or that because "it can't be touched with a file" it is hard, is to be cheated.

Judgment should teach and experience will show that steel may be cracked in hardening by heating too hot, and also by uneven heating. The cyanide and low heating could hardly be blamed. The particular lot of "Hobson's choice" may have been to blame. I have usually found it pretty good steel, but am just enough of an American to believe as good—to say the least—can be had of home manufacture. First-class tool steel will harden to some considerable depth in water or brine without cyanide, and will not probably harden any deeper with it at the same heat, but just as deep. Good steel may be hardened equally well, in my judgment, with or without it, unless there is the surface spoken of which has been decarbonised.

The colour is no indication of temper, except when the character and condition of the steel is known before drawing Neither is the "file test" infallible, for a piece of steel may be case hardened and still not sufficiently deep to be of service, although no file will mark it; while there may be cases in which the hardening is admirable but for a film on the surface, which may be easily filed. I have often amused myself by first carefully measuring a piece of hardened steel having this unhardened envelope of decarbonised steel, and then removing all that could be filed away, made a second measurement. I have found the hardened piece reduced in size as much in some cases as ·015in., and as little in others as ·0005in. Still the piece of steel itself, with its skin off, was thoroughly hardened. Without saying that the use of cyanide would have made such pieces of steel all right, I am prepared to say that its use would have made them much better.

The greater difficulty experienced in hardening steel which has been repeatedly annealed grows out of the fact, probably, that the annealing is at too great a heat, or that the heat is too long continued. It is an easy matter to put the best piece of steel in the same condition by heating for hardening. Too much heat, or heat too long continued, will decarbonise the surface of steel, leading to the opinion that such steel does not harden because it can be filed. I like the hammer test better. If no bruises can be made with the well-hardened hammer on the surface of a piece of hardened steel, it is safe to suppose that it is both *hard* and hardened to a "*proper depth.*"

* * *

How Paper Boats are Made.—A wooden model is prepared in exact form of the desired boat, on which the paper skin is moulded, sheet after sheet being superposed, one upon another, until the desired thickness is obtained; the boat in process of construction being composed of nine thicknesses of strong manilla paper, making a thickness of about one-eighth of an inch. In preparing the paper, the lines of the boat are carefully drawn out full size, and the paper—which comes from the mills in rolls, similar to that which is made for printing on perfecting presses—is cut to the full size desired for covering the entire length and breadth of the boat, so as to leave no joint of any kind. For racing shells the best manilla paper is used, but for gigs, dingeys, canoes and skiffs, paper made from undressed linen stock only is used. In manufacturing the racing shells the first sheet is dampened, laid smoothly on the model, and securely fastened in place by tacking it to certain rough strips attached to its upper face. Other sheets are now superposed on this and on each other, and suitably cemented together, the number depending upon the size of the boat and the stiffness required. If linen paper is used, but one sheet is employed, of such weight and dimensions that, when dry, it will give just the thickness of skin necessary. Should the surface of the model be concave in parts, as in the run of boats with square sterns, for instance, the paper is made to conform to these surfaces by suitable convex moulds, which also hold the paper in place until, by drying, it has taken and will retain the desired form. The model with its enveloping coat of paper is now removed to the dry-room. As the paper skin dries, all wrinkles disappear, and it gradually assumes the desired shape. Finally, when all moisture has been evaporated, it is taken from the mould, an exact *fac-simile* of the model desired, exceedingly stiff, perfectly symmetrical and seamless. When the skin is removed the boat, as it then appears, is water-proofed, the frame and fittings completed, and the boat varnished. The advantages possessed by these boats over those constructed of wood are strength, stiffness, durability and being without joint, lap or seam to admit of leaking by strain or shrinkage; they have no grain to crack or split, never shrink, and paper being one of the best non-conductors, no ordinary degree of heat or cold affects them, thus rendering them admirably adapted for use in any and all climates.

ATTACHING HOOKS AND EYES TO CATGUT BANDS.

MANY readers have doubtless experienced the annoyance caused by the hook or eye of a gut band becoming detached; curiously the annoyance is frequently continually occurring to some, whilst others but very rarely experience it. The cause is usually to be found in the way in which the hooks and eyes are attached to the band.

There are various ways of effecting the simple process of screwing on either a hook or an eye. By carefully carrying out the following plan, a permanent attachment may be safely reckoned upon. The hook and eye must be of a size just suited to the diameter of the gut. The illustration shows the gut slightly too small; it should be very nearly as large as the eye measured just below where it swells out to allow the hole for the hook to enter. If the hook and eye are larger than the band, they cause an unpleasant jarring every time they pass on and off a pulley.

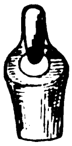

Fig. 1.

Fig. 2.

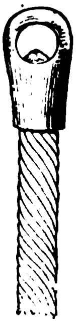

Fig. 3.

The gut should be carefully pared down tapering, as shown in fig. 2. This may be done with a sharp knife, or by means of a file the gut may be shaped equally well. The end of the gut should be pointed somewhat as shown, and the reduced part should be as large as can be got into the screwed hole in the hook. Fig. 1 shows the hook ready for screwing on to the gut. The way to hold the band, whilst screwing on the hook, is between two pieces of wood, having semi-circular grooves in them to grip the gut without squeezing it out of shape. These pieces of wood are held in the jaws of the bench vice. The hook is gripped in a hand vice and twisted on to the gut, taking care to do it in one operation, as to pause in the screwing is to court failure.

When the eye is screwed on as shown in fig. 3, the end of gut, shown protruding, should be pared off. It is customary to sear the end with a hot wire, but the process is an unsatisfactory one. If it is practised, great care must be exercised to prevent the metal becoming heated sufficiently to destroy the gut, which it is very liable to do. If the hook and eye are screwed on hard as directed above and nothing further done, they will probably remain as long as the band lasts.

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Phosphorus.—There is no efficient antidote or remedy for poisoning by phosphorus. Taylor recommends the administration of emetics, and of albuminous or mucilaginous drinks, holding hydrate of magnesia suspended. The exhibition of oil would be decidedly injurious, as this dissolves and tends to diffuse the poison. Saline purgatives should therefore be preferred.

WHAT VARNISH IS MADE OF.

HOW many, in looking at a handsomely varnished surface, stop to think that the varnish has other uses than that of imparting a fine finish? Few, we imagine, give it a second thought, so accustomed are they to seeing the lustrous, mirror-like surface of carriages and coaches; hence the curiosity which at first may have been excited, and the wonder as to how such results could be obtained, soon become dulled by every-day contact with the mystery.

We say mystery, and perhaps rightly so, for is there anything more common and yet so little understood? The class who have been initiated into the mysteries of the process by which the result is obtained is comparatively small.

What is varnish? Most of us have seen it, and know it to be a clear, limpid fluid. The degree of transparency or paleness is one of the means of determining the grade or quality of it. A fine syrup has much the appearance of a good varnish. The word varnish covers a very wide field, as the term in its fullest sense can embrace all the thousand and one preparations compounded for as many different purposes, but we shall refer only to one branch, that of varnishes for coach and car work, as it is here that the highest perfection is reached, and the greatest skill and intelligence are required in manufacturing.

The three principal ingredients used are copal gum, linseed oil, and spirits of turpentine. The nature of the two last named articles is generally known, owing to their commonness, linseed oil being the oil obtained by pressure from flaxseed, the grade or quality of which depends upon the locality where the seed is grown. Turpentine is a resinous substance, exuding from various species of trees; that which is used in the manufacture of varnish is almost entirely from pines; the Southern States—the Carolinas, Georgia and Alabama—furnishing the greater part. But the other article, gum copal, is more of a stranger. Gum animi, or Zanzibar gum (the latter term denoting that it comes from the island of Zanzibar, which lies just off the eastern coast of Africa), is the clearest and hardest of all the copal gums, and is used in the finest grades of varnishes. It can be distinguished by its rough or "goose-skinned" surface. Benguela gum, from the western coast of Africa, ranks next in commercial value. Kauri gum comes from New Zealand; it is a less expensive gum, and is largely used in the lower grades of varnishes. These gums are dug from the sand by natives and sold to merchants, by whom they are assorted, graded and prepared for the market. Beautiful specimens of gum are frequently found which contain insects and leaves imbedded in them, oftentimes of species long since extinct.

Professor W. D. Gunning makes the following interesting comments on this part of the subject:

"We no longer wonder how the insect got into the copal, but how long it has been there. We have no date by which we can fix the time, but we know enough to assure us that it must be reckoned by thousands of years. The revolutions of nature from forest to desert, are never achieved in a day. The crimes of men have 'dried up realms to deserts.' Nature has done the same, but she is never a swift architect of ruin. To have wrought the extinction of a race of trees from Africa, and buried the soil which bore them eighty feet under the sand, must have required many ages.

"The fly or moth which looks as if it had just lit in its crystal coffin, may have been there a hundred thousand years.

"We are sure that it was there, just as you see it to-day, long before there was any man upon the earth."

Almost any encyclopædia will give the constituent parts of varnish, but the *art* of making good varnish is not found in type, and can only be learned by patient, painstaking effort and intelligence.

An essential quality of varnish is that it must harden without losing its transparency, as it must not change the colours it is intended to preserve. It must exclude the action of air, because wood and metals are varnished to protect them from rust and decay. It must also be waterproof, else the effect of the varnish would not be permanent. And a point of primary importance is that it must possess durability.

In combining its various ingredients so that the varnish will answer these requirements, and at the same time work freely under the brush, lies the secret and mystery of varnish-making, and he who best succeeds in accomplishing it confers upon the world a blessing, and upon himself a fortune.

Let us look at a carriage and observe the brilliant surface—smooth as a mirror, and like it, reflecting one's features, though possibly somewhat distorted by a concave or convex panel, as the case may be. The lustre appears to have considerable depth, yet we know that it is but slightly removed from the bare wood. Would you suppose that fifteen or sixteen separate coats had been put on to attain this beginning with the priming or first coat, and following it with various layers, each successive coat suited for its special purpose in this out-growing process? All must be perfect, else the finished job will suffer, for one coat cannot remedy the defects of another. It is this unity of coats and the skill required in laying them which place carriage-building among the arts, for are not artistic taste, talent and skill all called into play in the production of a carriage of the highest class?

The first varnish made in the United States was at Cambridge, Mass., in the year 1820. It is claimed that prior to that time, some few were accustomed to itinerate over the country, mixing small quantities of varnish in shops where the services were required, but not until the year 1820 was it begun as a regular business, and made for general sale. The manufacturing was begun in a blacksmith's shop, and on such a small scale that only a portion of the shop was used, a single kettle for boiling answering all requirements.

This blacksmith's shop—or rather the history of it, for the shop was destroyed by fire about 1865—is interesting, apart from the interest naturally belonging to it as the commencement of an industry which was destined to become a great branch of trade, as it was this very shop which Longfellow mentions in his well-known poem, "The Village Blacksmith."

Only those acquainted with the varnish business sufficiently well to give them an insight into its ramifications understand the magnitude of the trade, and the immense amount of capital engaged in it. From an infant industry it has grown to wonderful proportions; new uses are constantly being found for varnish, by which it embellishes the article to which it is applied, affords satisfaction to the buyer, and profit to the manufacturer. For it is a truism that whatever adds to the appearance, whether of an animate or inanimate nature, whether the addition comes from "a grace snatched beyond the rules of art" or otherwise, increases the pleasing power of the one and the selling power of the other in corresponding degree. Art, which in one sense is synonymous with excellence, is entering more and more into the various mechanical pursuits, and the future will reveal a more decided advance than has yet been accomplished.

GUN-MAKING IN THE REMINGTON FACTORY.

A PARTY of students at the Polytechnic and other friends accompanied us on a visit to the Enfield Small Arms Factory in the early part of the month. After the inspection they will find the following article, clipped from a New York paper, particularly interesting:—

Ilion, N.Y., is known, world wide, as the seat of the Remington gun factory. Here have been filled contracts tor military rifles for the following Governments:—The United States, Denmark, Sweden, Spain, Cuba, Rome, France, Egypt, Japan, China, Persia, Mexico, and twelve of the States of Central and South America; also for the States of New York and South Carolina. The product of the armoury to date foots up 1,391,000 military rifles. There are contracts and contracts in gun-making. The Remington Company contracts to furnish so many guns. It then contracts with different men for different parts of the weapon—all within its own works. One man takes the contract to "draw out" the barrels; another to rough bore; another to polish; others to furnish the stock, the frame, the breech piece, etc. The combined product is the finished gun. The Remington works employ now 1,200 men and upwards, not all of whom, however, are found in the armoury. The sewing machine, type-writer, and agricultural departments divide the force of workmen.

The armoury is running on the contract with the Argentine Republic, which was to be completed by November 12. The contract was taken in May last, and calls for 1,500 military rifles, of the Argentine model, and 1,500 carbines. One thousand of the latter are to have 23½in. length of barrel, and the remainder 20½in. The rifle barrels are 36in. When these are delivered the Remington Arms Company will have furnished the Argentine Republic 100,000 stand of arms within the past three years. It is turning out at present 250 rifles a day. The number will be increased presently, as it becomes necessary to complete the job within the prescribed time, the works being capable, fully manned, of making 1,200 guns per day.

It may be of interest to follow the process of modern gun-making as illustrated at this armoury with the Argentine gun. Starting with the barrel: The material comes to the armoury in round bars of steel about 16ft. long, and 2in. in diameter. These are cut into pieces 6in. or 8in. long, as the carbine or rifle barrel is to be made. The latter weighs 8½lbs., and is reduced by the processes which follow to 7¼lbs. The carbine barrel is lighter by 2lbs. A hole 1⁄16in. in size is drilled through the bar. It goes then to the rolling mill, is heated to welding heat, and put through a grooved roller press, by which it is drawn out to the desired length. The rolls have eight grooves, each of different size, and eight passages through the rollers bring the steel to the required shape and length. In handling the steel a different mandrel is used for each groove, and at last the barrel bore is much smaller than it is ultimately to be. Four men compose a gang at each pair of rollers, and each gang does a full day's work in cool weather if it draws out 200 barrels. And here may be the proper place to say that the contractor for the rolling-mill work, William Onyans, is the son of the inventor of the process of drawing out gun barrels by machinery. He is a native of Birmingham, England, and was engaged by the United States Government to come to Springfield 25 years ago. He there put up the first machine for rolling gun barrels ever tried in this country.

From the rolling mill and straightening press the barrel goes to the annealing room, and is softened to the degree necessary for working. It then passes to the barrel room, and is "rough-straightened," then "nut-bored"—processes by which the bore is made uniform. Three processes of "quick-boring" follow, after each of which the barrel is straightened by the shade line. The operator puts the barrel in rest, and, looking through, determines by the shade lines within where to apply his hammer to remedy any crook that may exist. The barrel is next put in a lathe, and its outside turned to uniform size. It is next "muzzle-bored" for bayonet-fitting, after which the whole barrel is ground to the butt and filed at the muzzle to the exact size for the bayonet. "Proof-straightening" comes next, after which it goes to the proof room, called here "Sebastopol." There each barrel is loaded with a charge four times as heavy as the ordinary service charge. Eighty barrels are arranged in a bank, and securely fastened. A train of powder is laid, a percussion cap fitted on the end of an iron rod extending through into the operating room, and, the 6in. door being closed, a light stroke with a hammer on the outer end of the iron rod is followed by a discharge resembling that of a mitrailleuse. Occasionally a barrel bursts, and the walls of this "Sebastopol" are stuck full of iron from the shattered steel of years of proof-firing. By the closing of the firing room door and a red flag displayed over the little building, the initiated outside know that a volley is to be fired.

After proving, the barrel butt is given its octagonal cuts, which are the distinctive features of the Argentine pattern. Then one machine makes a cut to let in the sabre stud, and another machine makes a cut to let in the muzzle sight, and the stud and sight are affixed by hand. The barrel is then sent to the brazier, who hard-solders with brass the fixtures. After this it is left inverted in a bed of lime twenty-four hours to soften the fixtures, and at the end of that time it is put into vitriol pickle to remove the scales that may have attached by the previous process. The bayonet stud and the sight are next planed and filed to the desired finish. By this time the barrel needs straightening again, and is ready for final boring. It is straightened and then bored, again straightened and again bored, and yet a third time is each operation repeated. Each boring cuts out $\frac{1}{500}$in. The rear sight holes are next made, the exterior and interior are polished, and the barrel goes to the rifling department, where, after being thoroughly inspected inside and outside, the bore is given its rifle twist. Fine grooves are cut, a complete turn being made in 18in. One man attends to two machines, and will rifle 150 barrels in a day. Finally the barrel is "threaded" for the frame, trimmed at the butt, and chambered for the cartridge—six operations—and is ready for its place as one part of a gun.

There remain the frame, the breech piece, the hammer, the trigger, the spring, the stock, the butt piece, bayonet, and sling fixtures. The metal pieces are rough-fashioned at the forges by steam hammers, and go along up the scale towards perfection, passing from one hand and machine to others, until they reach the inspection room, trim, delicate, perfect. The frame alone runs through 75 separate operations, the breech piece through 40, and the hammer 30. These simple figures give as clear an idea as is practicable in print of the work required to fashion the smaller parts of the gun. Each piece is made at a rate to keep pace with the production in the barrel department, say, at the present, 250 per day. The stock is first roughly fashioned by saw and axe. It is then excavated by machinery for the frame, when a counterfeit of the latter is fitted into it, and it is turned to the required shape by aid of guides which traverse a metal model. The completed parts are taken to the inspection room, where each, even to the little screws, is inspected before putting together of the gun is permitted. General Miles is the official inspector in behalf of the Argentine Government. The parts are interchangeable, and if a person has one of each and the requisite skill, he can construct a perfect rifle of them. The Remington Works are turning out 30 double-barrelled shot-guns a day, a number of sporting rifles, and 50 pistols and revolvers, in addition to the complement of Argentine guns. The last-named are fitted with sights graduated for execution at 1,800 yards' range.

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HORSE-POWER OF SMALL ENGINES.

MR. ROBERT GRIMSHAW writes to the *Mechanical Engineer* that there is a good deal being said, and a great deal more being felt, on the subject of the horse-power of small engines. Now, every such engine has four horse-powers! There is the alleged horse-power, or what the maker claims for it (generally the largest of the lot); then there is the assumed horse-power, based on what some other engine has done, or might do, with a given grate surface or a stated heating surface, or a certain piston area and stroke, or other bases equally irrelevant; next we have the indicated horse-power, which is more nearly correct than any other, but which is very seldom taken, owing to the expense and difficulty of indicating such small, cramped machines; and last of all comes the only real, reliable, sensible, equitable, and legal one of the lot—the actual tested horse-power as measured by the Prony brake or its equivalent.

I was recently called to test one of a lot of "semi-portables" which were built by contract for a dealer to yield 4 horse-power. The brake showed that all that could be got out of the engine was 1⅞ (1.875) horse-power, or just $\frac{1·875}{4·000} = 46\frac{3}{4}$ per cent. of the rated capacity. This was clearly a bad case, and the question was, what was to be done? The first thing was to apply the indicator, to see what the trouble was, if any, with the cylinder and valve, also to measure the clearance. The latter was found to be about 20 per cent. of the piston displacement. The cards indicated that more lead should be given, and some other changes made in the valve-motion, etc. After these changes the brake showed the engine capable of exerting 3·18 horse-power with the same steaming capacity, a gain of $\frac{3·18 - 1·875}{1·875} =$ about 70 per cent. of power. The indicator showed the indicated horse-power to be 3·35 or $\frac{3·35 - 3·18}{3·18} = 5·4$ per cent. higher than the actual horse-power, as more correctly measured on the brake. I shall have the clearance space reduced by lengthening the piston head, and steaming power increased by dropping some circulating water tubes from the crown sheet into the combustion chamber, and hope to get nearer 5 than 4 horse-power out of the same engine that could not possibly be urged to yield over 1⅞ horse-power, as originally sent out of the shop.

The following table gives the calculated horse-power of this engine, with various initial cylinder pressures, assuming 15 per cent. of clearance and 5lb. back pressure, cut off at ⅞ stroke, and no throttling or other lowering causes. The horse-power is given at 100 revolutions per minute. At higher speeds it will be proportionately higher. Thus at 100 revolutions and 85lb. by the gauge the horse-power is 1·98, and at 200, the speed the engine ought to run (at which rate the piston speed would be only $\frac{200 \times 9 \times 2}{2 \times 12}$ = 150ft. per min.), it would be 3·96 horse-power.

Initial Pressure by Gauge.	Initial Pressure above Vacuum.	Average Total Pressure.	Mean Effective Pressure.	Horse-power at 100 Turns.
100	114·7	109·95	104·95	2·29
95	109·7	105·16	100·16	2·19
90	104·7	100·39	95·30	2·08
85	99·7	95·57	90·57	1·98
80	94·7	90·78	85·78	1·87
75	89·7	85·99	80·99	1·77
70	84·7	81·19	76·19	1·67
65	79·7	76·40	71·40	1·56
60	74·7	71·60	66·60	1·46

The above horse-powers are calculated as follows: Piston area, $3\frac{1}{2} \times 3\frac{1}{2} \times {\cdot}7854 = 9{\cdot}621$; nominal expansion rate, $\frac{8}{7} = 1{\cdot}1428$; *actual* expansion rate only $\frac{1{\cdot}15}{{\cdot}875 \times 15} = 1{\cdot}12$ if only 15 per cent. of clearance is allowed or assumed. The hyperbolic logarithm of 1·12 is about 0·113. The average total pressure above vacuum will be $1{\cdot}025 \times 1{\cdot}113 - {\cdot}15 = {\cdot}9586$ times the initial pressure above vacuum (mean effective pressure 5lb. less). The "factor of horse-power," or number of horse-power for each pound of mean effective pressure, at 100 revolutions per minute is $\frac{9 \times 9{\cdot}621 \times 100}{2 \times 12 \times 16500} = .02187$.

The mere fact of reducing that immense clearance space will have some trifling influence upon the economy and horse-power. Thus, suppose we bring it down to only 8 per cent. of the piston displacement (instead of 15, as in the table), we get an actual expansion rate of $\frac{1{\cdot}08}{{\cdot}875 \times .08} = 1{\cdot}14$ instead of 1·12, and if the cut-off were earlier, the difference would be still greater.

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Oil Varnishes.—Amber, anime, and copal are usually dissolved for making varnish by fusing the gum, and adding linseed-oil heated nearly to the boiling point. They are then amalgamated by stirring and boiling, and the varnish is reduced to the required degree of fluidity by the addition of oil of turpentine. They constitute the more important of what are called oil varnishes, are the most durable of all, possess considerable brilliancy, and are sufficiently hard to bear polishing. They are therefore employed for works of the best quality, that are exposed to the weather or to much friction; as coaches, house-decorations, and japanning.

Prepared Chalk.—This is a manufactured article, prepared by adding a solution of carbonate of soda to a solution of chloride of calcium (both cheap salts) so long as a precipitate is thrown down. The solutions should be carefully filtered through paper before being mixed, and dust should be rigorously excluded. The white powder which falls down is carbonate of lime, or chalk, and when carefully washed and dried, it forms a most excellent polishing powder for the softer metals. The particles are almost impalpable, but seem to be crystalline, for they polish quickly and smoothly, though they seem to wear away the material so little that its form or sharpness is not injured to any perceptible degree.

CUTTING KEY-WAYS.

THE "Mechanical Engineer" contains the following interesting particulars of this process as practised in American engineering workshops:—

Cutting key-ways through connecting rods is now accomplished by two methods, chiefly, the slotting machine and the cotter drilling machine. These two are used where large quantities of work, of one kind, are done, such as in locomotive shops, and in these the cotter drilling machine has the preference. The name of this tool arises from the English term for a key (cotter), and is somewhat confusing to those who have never seen the cutting tool used in the machine. This cutting tool is rather difficult to describe, but it may be understood when we say it is capable of cutting endwise and sidewise. It is like a square-ended drill in appearance, and is of the same size, nearly, as the key-way intended to be cut by it. When the key-way is to be started in the rod, the tool cuts endwise until it has all the cut it will carry sidewise, and is then fed horizontally along the key-way. The action is automatic, and the machine can be set to run a certain distance (like a planer) and then return. In this way the key-way is gradually worked out. As the machine requires very little attention when once started, it does its work economically. The other method of cutting key-ways is by the slotting machine, and is too well known to require mention. Both of these tools, however, are expensive, and but few shops possess them. Even the slotting machine is not by any means universally used. Small shops throughout the country are constantly cutting key-ways, and in some large ones for that matter, primitive methods—drilling machine, hammer and chisel, and file—are still in vogue.

Nothing is so sure a test of the workmanship turned out in a shop as the connections, for upon them very much depends for the working of the engine. Moreover, the fitting of them requires skilled labour; it is a slow and expensive job, which cannot be hurried, but must proceed by regular stages to the end. We say it cannot be hurried, but it can be expedited by the use of special tools, which are within the reach of any shop that makes steam engines.

One tool of this class is the drift, as it is commonly termed, and it is a most useful one when properly made. It is called by some a broach, but this is not correct, for the two are quite dissimilar in shape and appearance, and are used conjointly. The drift is nothing more than a flat-ended piece of hardened steel, slightly less in width than the key-way to be cut by it, and not less than three widths in length; that is, if it is halt an inch wide, it should be an inch and one-half long. Many persons have experienced difficulty with the drift, but this was because they endeavoured to do too much with it. They took too rank cuts, and under such circumstances it will not work properly. All the benefit to be derived is in leaving a clear straight path for the file to work on, and to reach portions in the centre of the stub-end that are hard to get at with a hammer and chisel. The drift should be made and used as follows:—The end of it should be square across, not filleted out hollow, and the wide side should have but little clearance. For a key-way six inches deep through the stub-end, and three-quarters wide, the drift should be eleven-sixteenths wide at the cutting end, and nine-sixteenths four inches from the end. It does not require to be the full depth of the stub-end, for the drift should be used from both sides of the key-way. The drift should be one clean sweep on the side, from the shank to the front cutting edges, not straight part of the way from the cutting end.

Made as above, it holds the cut better, and will not bind in its track and break off in the work.

To use it the fitter chips the key-way out, fair and clean, nearly to size, leaving but a sixteenth of an inch for the drift to remove. For half an inch from the outside of the key-way the drift should enter freely, when, if it is held straight, and hit squarely on the head, it will go through to the centre, carrying everything before it, leaving a bright, clean surface behind such as no other hand tool can in the same space of time. The whole secret of success with a drift lies in the management of it, and we use the expression secret because, simple as the tool and its management is, we have seen many in serious difficulties with it. Not once, but many times, we have seen connections bowed out on the sides of the stub-ends by too energetic drifters, who fancied they had only to hit hard enough to drive all before them. Though used by blows, it is by no means to be violently used. The drifter sees, when the tool is well down in the key-way, that the clearance between it and the drift is alike on both sides, and he knows by that the tool is going straight. Sometimes the key-way is so deep that it is necessary to use two drifts, one smaller than the other, but in this case, unless the second drift used can start on a square cut, or get hold of a cut, it does not work well, being apt to bind, or wedge in sideways. It does not get hold of the metal, but simply wedges it out sidewise.

In the hands of a skilled workman the drift is a most useful tool, but it requires a little humouring at all times to get the best results.

Tinning Iron.—The surface of the iron is cleaned from scale by vitriol or sulphuric acid, and then scoured with sand. It is now coated with a strong solutiion of chloride of zinc, and dipped into melted tin. The tin will instantly adhere to every spot that is clean.

Mr. Andrew Ross's Mode of Preparing Oxide of Iron.—Dissolve crystals of sulphate of iron in water; filter the solution to separate some particles of silex which are generally present, and sometimes are abundant; then precipitate from this filtered solution the protoxide of iron, by the addition of a saturated solution of soda, which must also be filtered. This grey oxide is to be repeatedly washed and then dried; put it in this state into a crucible, and very gradually raise it to a dull red heat; then pour it into a clean metal or earthen dish, and while cooling it will absorb oxygen from the atmosphere, and acquire a beautiful dark red colour. In this state it is fit for polishing the softer metals, as silver and gold, but will scarcely make any impression on hardened steel or glass. For these latter purposes I discovered that it is the black oxide that affected the polish (and this gives to the red oxide a purple hue, which is used as the criterion of its cutting quality in ordinary), therefore for polishing the harder materials the oxide must be heated to a bright red, and kept in that state until a sufficient quantity of it is converted into black oxide to give the mass a deep purple hue when exposed to the atmosphere. I have converted the whole into black oxide; but this is liable to scratch, and does not work so pleasantly as when mixed with the softer material. The powder must now be levigated with a soft wrought iron spatula, upon a soft iron slab, and afterwards washed in a very weak solution of gum arabic, as recommended by Dr. Green in his paper on specula. The oxide prepared in this manner is almost impalpable, and free from all extraneous matter, and has the requisite quality in an eminent degree for polishing steel, glass, the softer gems, etc.

THE MANUFACTURE OF GLUE.

GLUE is an inspissated jelly, made of the parings of hides or horns of any kind, the pelts obtained from furriers, the hoofs and ears of horses, oxen, calves, sheep, etc. These are first digested in lime water, to cleanse them from grease or dirt, they are then steeped in clean water with frequent stirring, afterwards laid in a heap and the water pressed out. They are then boiled in a large cauldron with clean water, skimming off the dirt as it rises, and it is further cleansed by putting in, after the whole is dissolved, a little melted alum or finely powdered lime. The skimming is continued for some time, after which the mass is strained through baskets, and suffered to settle, that the remaining impurities may subside. It is then poured gently into the kettle again, and further evaporated by boiling and skimming till it becomes of a clear darkish brown colour. When it is thought to be strong enough it is poured into frames or moulds about six feet long, one broad, and two deep, where it gradually hardens as it cools, and is cut out when cold into square cakes. Each of these is placed in a sort of wooden box open in three divisions to the back; in this the glue, while yet soft, is cut into three slices by an instrument like a bow, with a brass wire for its string. The slices are then taken out into the open air, and dried upon a kind of coarse network, fastened in movable sheds four feet square, which are placed in rows in the glue maker's field. When perfectly dry and hard it is fit for sale. That is thought the best glue which swells considerably without melting by three or four days' immersion in cold water, and recovers its former dimensions and properties by drying. Glue that has got frost or that looks thick and black. should be melted over again. To know good from bad glue, the purchaser should hold it between his eye and the light, and if it appears of a strong dark colour, and free from cloudy or dark spots, the article is good.

To this account may be added some experiments on a glue made from the raspings and trimmings of ivory, the refuse pieces and shavings of the button mould makers, and other pieces of hard bone, that cannot be turned to account in entire manufacture. Six pounds of button mould shavings were put into a copper boiler with 24 quarts of cold water, and first let soak for two hours. The fire was then kindled and the liquor slowly brought to boiling, and kept at this heat for nine hours. After standing a night 14 quarts of clear gelatinous liquor were drawn off by a syphon, and 2 quarts more were obtained by pressing the residue. This was duly evaporated without addition, and when of the proper consistence was allowed to subside for half an hour, when it became firm enough to be cut into cakes, which being hung up for a fortnight in a barn, yielded about 15 ounces of solid glue, or rather less than a sixth of the weight of the bone shavings originally used. A similar experiment made with ivory turnings yielded nearly the same proportion of glue. The jelly from these clean white bones is at first very transparent and with little colour, but when concentrated by evaporation it always deepens in colour, but if well made still remains transparent. A piece of this glue put into cold water swelled, as happens with common good glue, and in 24 hours had absorbed 15 times its weight of water, but without dissolving, and by again drying in the air it returned to its original bulk and weight. It appears that at Paris there are three sorts of glue commonly sold. The best is imported from England, and is of a deep red, the next in value is the Flemish, which is whitish and transparent, and the most ordinary glue of the country is black and opaque.

In using glue, the carpenters first break it and cover it with cold water, and let it stand for about twenty-four hours, by which, as already mentioned, it swells to many times its original bulk; after which the soaked pieces are melted, without more water, over a slow fire and kept simmering for about a quarter of an hour, with frequent stirring, and are then cooled. It is now a firm jelly, of such a consistence as very readily to be cut by any instrument, but too stiff to be tremulous. When wanted to be used, it is merely warmed, which renders it sufficiently fluid to be spread over the surface of the wood with a stiff brush. Wood joined by glue requires from one to three days to be perfectly cemented, which is known by the hardness of the portion that remains on the outside of the joining, and the force of cohesion of the best glue is such that boards as thick as any commonly used in furniture carpentering will quite as readily give way to violence in any other part of the substance as at the joining. Glued boards will not set in a freezing temperature, the stiffening being owing to the evaporation of the superfluous water of the glue, which is prevented by great cold.

A variety of gelatinous cements of less firmness than common glue, and known by the general term of *size*, are made for the use of paperhangers, gilders, bookbinders, house painters in distemper, and many other trades, by boiling down in water the clippings of parchment, glove leather, fish skin, and many other kinds of skin and animal membrane. These are used either alone or mixed with vegetable tenacious substances, such as flour paste, gum-arabic and tragacanth, and the like. The preparation of these jellies is very simple, the substance used (parchment shreds for example) being merely dissolved in water by boiling, strained and evaporated to a due consistence. Eel skins and the skins of other fishes make a cement which is much valued for its transparency and tenacity.

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Amber.—Amber is principally obtained from the shores of the Baltic, but it is also found in other parts of Europe. The most esteemed is the opaque variety, resembling the colour of a lemon, and sometimes called fat amber; the transparent pieces are very brittle and vitreous. The German pipe makers, by whom it is principally used, employ thin scraping tools, and they burn a small lamp or place a little pan of burning charcoal beneath the amber to warm it slightly whilst it runs in the lathe. This prevents it from chipping out, but if it is too highly heated by friction it is apt to fly to pieces. The finer specimens of amber, which are sometimes formed into gems and ornaments, are ground on lead plates made to revolve in the lathe, any of the usual abrasive substances (sand or emery) being used. The facets are then finished by means of a whetstone, and polished with chalk mixed with water or vegetable oil. The final finish is given by means of flannel. During the polishing process the amber becomes very warm and highly electric, and if this heating goes too far it will fly in pieces. The workmen, therefore, cool it off every now and then.

Stings.—Extract the sting, which is always left behind by bees, and bathe the parts with cold water, or apply a good poultice of common clay mud. Liquid ammonia mixed either with the water or the mud, will prove of service. All liniments which require rubbing are bad, as tending to irritate the part and diffuse the poison. Above all, avoid scratching the wound.

A PERPETUAL MOTION SCHEME.

A WRITER in the "Mechanical Engineer" gives the following graphic narrative of the pursuit of the *ignis fatuus* by a clever mechanic:—

Bill Young was a man 6ft. 2in. in height, with an arm like the piston-rod of a 300-horse engine, and a thigh like its shaft. He had a clear, blue eye that looked a man square in the face when he spoke to him, and light hair that stuck up all over his head in short tufts. He worked at the vice, and when he stood up in front of it he was a sight to behold. The dumbest and least observing man in the shop could see there was a difference between him and the others. With shoulders square and chest thrown out, he drove a 16in. bastard file with those massive arms as easily as I could a 12in., and his stroke was just as vigorous and as steady at six o'clock as it was when he started. Whatever he did was well done. No man could make a closer fit or a better finish with so little fuss. Withal, he was as good natured as the day was long. No man ever went to him for advise or for consultation on a hard job that he did not give it willingly and promptly. Jealousy of others was left out of his mix when he was cast; he didn't know what the word meant. His magnificent physical proportions attracted the eye, and his temperament made everyone a friend for life.

I can see him now, as he stood many years ago, fitting up a pair of side rods; he was draw-filing them in the vice, and he had one end fast in it by the stub-end, the other being supported by usual device for that purpose. When he changed ends or sides, he would take that rod out and turn it around as easy as a boy would a cane, and it almost seemed as though he could take it by one end and brandish it like a club.

Poor Bill! he had hard luck, as I shall proceed to show. If any man who reads this thinks it is a romance, he is under a wild delusion he had better get rid of. It is a record of actual fact, so far as the facts can be told, of an episode in the life of a comrade. My object in relating it in these columns will be sufficiently obvious, I hope, to the most careless reader who reads to the end.

I was passing Bill's vice one day, when he reached out, caught me by the slack of my over-shirt, and dragged me back as easily as I would a boy—and I am no chicken myself, nor a light weight.

"Look at that," said Bill, and he pointed to a common brass door-key hanging on the wall.

"What of it?" said I.

"Do you see that key swinging back and forth as if it was alive?" said Bill.

"Yes," said I.

"Well, its been going that way ever since I hung it up there an hour ago. It's the key of my house. The old woman has gone away for a holiday, and I locked the door and brought it along. It swings just the same now as it did when it started, and it would swing that way for ever if was rightly balanced; it's too heavy on one end."

I looked at him to see if he was joking, but it was hard to say whether he was or not; he had one of those imperturbable faces which express nothing, or can be easily masked, so that it was impossible to say whether he was fooling or in earnest.

"What of it, if it has been swinging that way?" said I.

"You'll see what of it. I have got an idea that will make my fortune, and no mistake. You come along here at this time to-morrow, and I'll show you something." I laughed at him, and went on about my business.

I had forgotten all about the incident above related, but as I was going through the shop Bill called me over, and said:

"Look here!" taking down a newspaper that hung over a brass model like a double clock-hand, or a scale beam with a hole in the centre, "I hung this up over it so the boys would not see it," and he pointed to the model which was swinging away at a great rate. "That thing has been a jumping like that ever since I hung it up."

"Bill, what are you trying to get through you, anyway?"

"I want you to tell me why that thing moves without anything to drive it, and keeps going when it ought to stop?" said he.

I looked at him again; he was in dead earnest, and no mistake, so I said: "It's easy enough to see why it goes. You have it hung on a knife-edge, and it is perfectly balanced. Put your hand on the partition; it is vibrating back and forth all the while, from the shake of the lathes and planers. That is the power that keeps your model going. Take it off and put it on a frame where it can't get any external jar, and you will see that it will obey the laws of gravity, and come to a stop the same as any other insensate object, as soon as the impulse which gave it motion is spent."

"Don't you believe I can make a perpetual motion out of that?" said Bill.

"No, sir; neither you nor any other man can ever make a perpetual motion. It is a mechanical impossibility. Bill, I hope to goodness you ain't going to get struck with that idea!" said I, earnestly.

He laughed. "Well," said he, "I ain't going into it very deep, but there is an idea in that thing, and I believe I can make something out of it. I will make a small model, and if it goes all right I will make a larger one. If that is O.K., good-bye Mr. Vice."

"Bill," said I, "don't you spend a cent on it, nor a minute's time. What's the use of fooling with an impossibility?"

"That's a big word, young man. All things are possible to him who wills; didn't I hear you say that one day?"

"All things are possible that are practicable; but those that are contrary to natural laws are as far off as ever, and never will be any nearer; but I don't suppose you are in earnest," and so I left him.

A job of setting up took me out of the shop for some weeks after that, and I forgot Bill and his notions. When I returned and had a chance to look around I noticed a great change in him. He was abstracted and pre-occupied, and always in a brown study over something. He would stop in his work and stare at the wall, or away off out of the window, and was as different a man as it is possible to conceive. His very nature had changed. Once he was as sociable and even-tempered a man as you would wish to meet; now he was curt, sharp spoken, sometimes surly, and many times irritable. The men used to be afraid of him, for he was a giant in stature and strength, and if aroused there was no saying what he might not do. The boys said he had taken to drink, but no one ever smelt liquor about him, or saw the outward signs of it. He took to losing time; often he would come in at half-past nine, and sometimes quit at 12 o'clock. Such a thing was never known before. He was as regular as the clock itself. No man was more steady, and by that, and through getting the best wages in the shop, and having a good wife, he had managed to lay up, as he once told me, about $1,500, with which he intended to build him a house in a year or so. He was always tinkering and fussing away with some little trap he held in his hand and filed, and he had a lot of small gears, about an inch and a half diameter, very fine in pitch, that he used to be puzzling over. Once I caught sight of a small frame with a lot of traps on it, and then the murder was out! it flashed across me suddenly what he had said some time ago about a perpetual motion, and that was the cause of all the trouble.

I wasn't going to let an old friend and a comrade go to the dogs without a protest or a struggle, and where others held aloof from Bill and gave him the cold shoulder I forced myself on him, and put up with all his cross ways and surliness. Once in a while he would regain his old-time disposition, and then he was confidential. He knew that I was aware, by this time, of his infatuation, and he would try to get advice from me on some trouble that he had run against, but I steadily and in all cases endeavoured to discourage him from doing anything more to his machine. Sometimes he would listen to me and say that there wasn't any use in fooling with it any more, but the very next day he would be tinkering away and say, exultantly, "I have got it now. I ran her last night for three hours, and if that part of the bearings were only half finished she would be running now. I am going to put on another gear instead of a pinion and then she will start from the word go, and never stop until the world ends, or I stop her."

Seeing that his infatuation was complete I gave up remonstrating, thinking that time would effect a cure, and that when he became convinced of the hopelessness of his efforts he would rally and take his place again.

Shortly after I had to go out of the shop on another outside job, and when I returned a stranger was at Bill's vice. I asked the boys how long Bill had been gone, and they said some weeks. Inquiring what caused him to leave, they said that he had an idea that he was just on the point of discovering perpetual motion, and wanted to give his whole time to it. He had bought a small lathe, set it up in his front room, and was working night and day. No one had ever seen the machine, but from the quantity of castings he had bought and put into it the boys said it must weigh about a ton. Determined to make one more effort, I called at his house one night to see if I could not dissuade him from going further. I thought that possibly he might feel that it was indeed contrary to natural laws for such a thing as perpetual motion to exist.

When I reached the place his wife came to the door, opened it only a little way, and then, seeing me, opened it wider, and said: "Oh! Mr. Moulton, I am so glad you have come. I think Bill is out of his head. He scarcely takes time to eat or sleep, but is always at work on that dreadful machine. It don't seem to me that it is any nearer going than it was a year ago; but he is putting more time and money into it than ever before. He has drawn I don't know how much out of the bank, and keeps drawing it all the while. What to do I don't know. I wish you would tell me. He won't listen to me nor any one else. He says he is going to be rich, and have his name in all the papers, and that in a month this house won't hold the people that will come to see his wonderful machine. I have seen it lots of times, and it's a beautiful thing; but I think it will drive me crazy. Mr. Moulton, it looks to me like some awful monster. There it goes, tick-tick, tick-tick, all day long. Sometimes it runs three or four days, and then Bill begins to laugh and sing, and it seems like old times; but all of a sudden it stops, and then he is like a wild man; but he never loses heart nor hope. He says it is on account of wanting a spring here or a pin there. Then he pulls it all down and goes to working at it again.

"Mr. Moulton, that thing has swallowed up more than dollars. My husband's life and hopes have gone into it. It has changed him into iron like itself. He is as hard as it is. His children, whom he used to love so much, he cannot bear the sight of; he says they fret him. As for me—but I won't complain. Maybe, if you were to go and speak to him, you could call him back to life, for he is just as dead to it as if he was under ground. He used to have a great opinion of you, and maybe if you were to talk kindly to him you could get us out of this scrape."

The poor woman threw her apron over her head and cried in a low, pitiful way that was more than I could bear.

Suddenly the door opened and Bill came in. Seeing me sitting there in the half light, and not recognising me at first, he turned on the woman and roared out:

"I thought I told you not to let anyone in the house!"

"Bill," said I, "it's only me,—Moulton; but I will go if you don't want me here."

He looked relieved when he saw who it was, and said:

"You scared me. I thought you were a stranger sneaking around to steal my ideas, but seeing you are here, you shall see what no other man but me ever saw. Come in and have a look at her. I will trust you with anything."

I followed him, and somehow—I can't explain it —the sight of that machine affected me as only one other thing ever did in this world, and that was an automaton flute-player—a devilish thing of life size, with a face like a corpse, and motions like one galvanised. It rose to its feet, cast its sinister eyes around, raised its flute and played dirge-like tunes. It was blood curdling.

So this machine, as we stood before it, filled me with a feeling I am unable to express. It was about four feet square, and so complicated you could not see through it. The work on it was marvellous, as might have been expected from the maker of it. Every bearing was hung on centres where it could be, like lathe centres: every gear meshed perfectly, and beyond the slow, mathematical tick-tick of an escapement on it there was no sound. Something came up in my throat and choked me, and I no longer wondered at the poor wife's feelings in the presence of this concrete infatuation and delusion. I could not speak, and didn't attempt to.

"What do you think of it?" said Bill, at length.

"How long has it been running?" said I, evasively.

"Since last Tuesday," said Bill. "That is a week."

"And it is all honest?—no secret power anywhere, no coiled springs, no nigger in the fence?"

"As God is my judge, it is what you see. I think I have got her now."

Even as he spoke there was a perceptible lagging in the movement, and while we stood watching it she stopped.

Neither of us spoke.

In a moment, Bill jumped for a sledge that stood in the corner, and raised it over his head with a fearful oath.

"I'll put an end to this now and for ever," said he; but before he could strike, I grabbed his arm and stopped him.

"Wait," said I; and for this I have never ceased to blame myself.

* * * * *

Bill was so disappointed to see the machine stop when he thought that he had it perfect at last, that he was about to smash it with a heavy sledge; but just as he was going to strike, I stopped him. I did it from the instinct of a machinist. I could not bear to see all that fine work smashed up. The mere fact of its being worthless in itself had nothing to do with it. Somehow a mechanic winces when the work of his hands, or of others, is deliberately broken up before him, and I stayed Bill's hand, with some indefinite idea that perhaps a part of the machine might be good for something; a nonsensical notion enough; but impulse is not reason.

So soon as the fit passed away from Bill, he went and seated himself in a corner and leaned his head against the wall in silence. I let him alone and said nothing, for to tell the truth, I did not know what to say. If I consoled him, it might encourage him to go on with his efforts, when I came there with the intention of discouraging him.

"When in doubt do nothing," is a good motto, and I followed it. In a little while he got up and came over to the machine.

"Something must have got foul somewhere," said he, "for if it will run three days it will run thirty years. Take a look at her, Moulton, and see if you can find anything wrong."

"Bill," said I, "you must excuse me. I don't know anything about it, what your principle is, or where the machine begins or ends. I'd do more harm than good."

But before I had done speaking Bill had the lamp in his hand and was peering in among the gears and the toggle-joints, and the lazy-tongs, and every sort of mechanical movement that was ever heard of. He reached in his hand, drew his finger over the teeth of the escapement and looked at it.

"She's dry as a bone," said Bill. "No wonder she stopped. Those pallets are hardened steel, and they ought to be made of something harder. I'll send to New York and get some iridium, the mètal they point gold pens with, and try that to-morrow. Once I get that all right she will run then, and no mistake. I ain't going to give her up now, when I have got as far as this."

"Bill," said I, "are you going to work on this machine any longer?"

"Didn't you hear what I said?" he answered. "Of course I am."

"Well, now, let me tell you something," said I. "Suppose your escapement is dry; don't you see that a machine which weighs a ton, and which is supposed to have power within itself to drive itself, must be pretty nearly balanced as regards running or stopping when a little thing like that can defeat it? You are too good a mechanic not to see that, Bill."

He thought for a moment, and said slowly: "I don't know but what you are right."

"And no matter what rigs you get up," said I, continuing, "you come out at the same place you started in at."

"What's that?" said he.

"Why, your machine stands still," said I. "You may annihilate friction—almost—and balance your moving parts until a breath will start or stop them; but, Bill, the more you put in the worse you are off. Every piece you put on that machine since you began it was a mistake; for the matter of that, the whole of it is, and I want you to promise me one thing right now—that you will drop this job at once and never do another stroke on it."

He sat moody and silent, his legs stretched out in front of him, his chin sunk on his breast, and his eyes gleaming underneath his shaggy brows. I continued to exhort him, laying down the law, explaining why the machine could not work, and endeavouring by all the arguments I could summon to break up his infatuation, and I thought I had succeeded, until he broke in by saying:

"Moulton, I'll make that machine work. I can't give it up now. I have been at it too long, and I never shall hear the last of it if I stop. I'll be 'Perpetual Motion Bill' as long as I live."

"A little thing like that needn't bother you," said I. "I guess there won't be much annoyance on that score."

Somehow, while we were talking there was a curious motion to the floor, and as we walked around it seemed to spring underneath, like thin ice; but, being so absorbed in what I was saying, I hadn't noticed it until now; but I turned to Bill and said: "Have you got any shores under this floor?"

"Look at that, now!" said Bill. "She moves! She's started again! She's going! By G——! she's going!" And he made one jump for the machine in his ecstacy, for it had started into motion again, apparently of itself; but a moment after there was a sound like the ripping of a ship's sail in a hurricane, and in an instant we were all in the cellar together.

The noise was appalling, and the dust was suffocating; but, afterwhat seemed an age, Bill hallooed out to know if I was hurt, and his wife came down, pale and trembling, with a light. Nobody was hurt except the machine, and that was a wreck, complete and utter. It had fallen about seven feet, struck on one corner, and was as wholly annihilated as though it had been blown up with dynamite. The cause of the accident was easily explained. Bill had gone on adding piece after piece until the whole thing weighed over a ton, and was, of course, entirely too heavy for an ordinary dwelling-house floor. When I came in and added my weight, and Bill made his lunge, that was the last ounce it could bear, and the result was as stated.

It cured him. He never touched it again except to clear away the rubbish, and he went to work like a man to retrieve his error.

"Moulton," said he one day as I was passing through the shop, "what made that thing start up again after it had stopped?"

"Why, the settling of the floor," said I. "It threw the machine on one side, may be ever so little, but enough to get her off the centre, and start into the semblance of life, just as a battery will make a dead man twitch his muscles; but it would have soon stopped again."

This is a veritable experience, barring names, and I daresay it can be matched at this day. I hope everyone will have as lucky an exit as Bill Young had.

Now that sounds all right, seems correct, and does not offend the proprieties in any way, but part of it is untrue. The absolute facts are that Bill did not get over his disappointment, but drank himself to death in a few months after the occurrence narrated. His fate is what made me say he had hard luck, and that I regretted stopping him smashing the machine when he wanted to. If I had let him he might have recovered himself; but that starting of the machine after it had stopped always stuck to him. He could not help feeling that there was something in it after all, and he sought solace for all his woes in that false friend and worse comforter—*rum*.

* * *

Wax Finish.—Mix together with heat, white wax and spirits of turpentine to the consistency of thick paste; when cold, apply it to the work with a rag; rub on heavily so as to fill the pores of the wood; remove all wax from the surface with a wooden scraper made in the shape of a carpenter's chisel; smooth off with a bunch of soft rags by rubbing hard and quick for a few minutes; finish with a little French polish applied with a cotton pad For table tops and all large flat surfaces, allow the wax to remain on and finish with a warm iron by passing it lightly and quickly over the work until the wax is made smooth and the surface is sufficiently polished. This is not considered a desirable finish, as it is not durable and water spots it very easily.

ELECTRICAL BATTERIES FOR LIGHTING AND MOTIVE POWER.

By Frederick Walker.

BEFORE entering into the details of the construction of a powerful electrical battery for lighting, or motive power, it may be well to briefly explain the laws which govern the action of such apparatus.

Electricity is assumed to be a fluid, so subtle as to be invisible and intangible, and that it is present in every substance in nature is now a recognised fact. When we see a flash of lightning during a thunderstorm it is not the electricity that is visible, but the molecules of the atmosphere, the fine grains of dust that are floating about through the air, that are rendered incandescent by the sudden discharge, and the thunder is simply an air-wave, caused by the rapid expansion of the space traversed by the spark, and reverberating over hills and valleys, houses, and open fields, producing that continuous roll so familiar to our ears. And the electric light itself is caused by either a thread of carbon rendered incandescent in a vacuum, or fine particles of carbon passing across a space, called an "*arc*," and possessing from their great heat intense luminosity.

Presuming that electricity is present in everything that we see or touch, and yet it is only during certain conditions of the bodies that we are made aware of its existence, we have to consider what those conditions really are, and in this age of learning, where every lesson is so wrapped in abstruse language and mysterious algebraic signs, so puzzling to a novice, it is well to place them before the reader in a plain and simple manner.

Water is present in a lump of salt, sugar, or a loaf of bread; but in the ordinary state of these substances we cannot detect its presence, but upon applying heat it is immediately apparent, because we have caused it to assume a different relation with regard to the surrounding atmosphere than existed before the sugar or bread was heated. The water was in a state of equilibrium, and we, disturbing it, become aware of its existence, and the steam arising from the heated substance is a source of energy, though infinitely small.

Water lying in a puddle or pond does not look capable of driving a huge water-wheel or turbine, but raise its level, or disturb its equilibrium, and it becomes a source of energy.

So electricity is, as it were, latent, or in a state of equilibrium in all bodies, and we require, in order to obtain electrical energy, to disturb this equilibrium. There are two methods of doing this in practice, viz., by mechanical means and chemical decomposition.

The magneto and dynamo-electrical machine is the apparatus whereby the former is attained, and as a simple analogy, take the ordinary centrifugal pump, which, running at a high speed, forces water up a pipe to a higher level, from whence it will do work in descending. And, since, when we drive the dynamo by means of a steam engine, and get a certain current of electricity from the two terminals, and a centrifugal pump, driven in a similar manner, supplies a current of water, which, allowed to run through another pump, will *drive* that, and allow of machinery being driven from its pulley, we see that the analogy holds good, because, allowing a current of electricity to flow through any good dynamo will convert it, like the pump, into a motor, and it will do work.

A battery is a number ot cells, in which a difference of *potential*, as it is called, is produced by chemical means, and corresponds to a tank of water raised up a certain height, say 33ft., which would give a pressure through a pipe at the bottom of 14·9lbs., and so drive a small wheel.

The size of the tank would not make any difference to the pressure, but it would considerably influence the duration of the work.

This *potential*, or height, is called electro-motive force, and the abbreviation *E M F* is oftener used. The unit of *E M F* is a volt, and as different substances give a different potential, like different heights of the tank will give a varying pressure in the lower pipe, the cell is supposed to have an electro-motive force of so many volts, or a force capable of doing so much work.

Now a tank may be 99ft. high, and yet have such a small hole in it that the pipe taking the water down cannot deliver more than one gallon per minute, though this quantity possesses a pressure of 44·7lbs. per square inch, quite enough to drive a water motor, if the quantity were sufficient. So a cell may have sufficient electro-motive force, yet possessing so much INTERNAL RESISTANCE (corresponding to the small hole in the tank) as to prevent any quantity from passing in a given time.

Quantity of electricity is represented by the unit, the ampère, which is similar to a gallon of water flowing per second.

Resistance (still following our analogy of the tank) is proportionate to the area of the conducting pipe. To increase this at 33ft. fall of water, is to get a greater quantity at the same pressure, but if the tank be raised, so as to increased the fall, this will augment the quantity without increasing the area.

The unit of resistance is the ohm. In a cell there are usually two dissimilar metals, immersed in some solution: one of these metals has its potential or level raised; this is usually the zinc, and immediately a current flows across from it to the other metal or substance, carbon or copper, which becomes raised in potential also, and since it cannot discharge itself back through the liquid against the force that produced it, the current flows through a wire through the motor or lamp, doing the desired work on its passage, and finally reaches the zinc again, the part not immersed being of a lower potential than either carbon or immersed zinc. Zinc is the positive *element* (+) but negative pole (—) and carbon is the + pole but the — element.

The arrangement of a number of cells in *series* may be compared to a number of covered tanks, each ten feet above the other, and having the same sized outlet hole in each. Now, these coupled to each other increase the pressure in proportion to the number so connected; and so a number of cells, coupled up with the + pole of each to the — pole of the next, thus leaving one + and one — pole to attach to the work by wires, increase their *E M F* by the number so coupled up.

Suppose a number of water tanks, having holes of equal area in each, but a large pipe to convey the water to the wheel, and these tanks be all on the same level—say 10 feet—it is evident that they are all at one pressure. But if each is connected by a pipe to the descending main, it is evident that the resistance of the small hole in the first tank is no longer of consequence, for, supposing it to deliver one gallon per minute, and the number of tanks be 10, the rate of delivery will be 10 gallons per minute; and this is a fair illustration of coupling batteries in *parallel*, which is all the + poles to one leading wire, and all the — to the other. But one very large tank, pierced with ten holes, would have done the same work, and so one huge cell would give the current in ampères of a number of smaller ones coupled in parallel. A small Bunsen, or any other type of cell, the size of a thimble, will have the same *E M F* in volts as a large one of one hundred times its capacity, but the rate of discharge in ampères will increase with the size of the cell, because the internal resistance in ohms is thereby decreased. The formula for ascertaining the *E M F* of any cell is: Multiply the current in ampères by the resistance in ohms; result, *E M F* in volts.

The resistance of a cell: Divide the *E M F* in volts by the current in ampères; result, resistance in ohms.

The current delivered: Divide the *E M F* by the *total* resistance (internal and external); result, current in ampères.

The original cell, invented by Volta, was simply copper and zinc in an acid solution, which, being decomposed into its constituent gases—oxygen and hydrogen—deposited the former upon the zinc, which combining formed a salt; and the hydrogen, adhering to the copper, and being a non-conductor, prevented further action of the cell after a very short time of working.

Subsequently various substances were placed in contact with the copper, or carbon, which, having chemical affinity for hydrogen, combined with it to form water, or something equally harmless, and so enabled the cell to be *constant*, and work for a longer time without *polarisation*, as this stoppage of the current is termed.

There are many such cells that do not vary in the principles of construction, though the method by which the desired end is attained may be different. These cells are suitable for various kinds of work; for instance, my dry cell, which is a hard paste surrounding the electrods, though very efficient for such intermittent work as that required for an electric bell, is unsuitable for the constant and steady current necessary for a motor or lamp. I have not attempted to explain the whole principle of electrical action, because the object in view was to prevent the succeeding paper, which will describe the construction of a powerful battery, from being improperly understood. After the explanations, which I have endeavoured to render as plain as possible, any good text book may be perused, in order to obtain further information. I shall, however, explain some simple and necessary measuring apparatus, which, though familiar to practical electrical engineers, are not included in any text book that I am acquainted with.

Painting and Preserving Ironwork.—A good black paint for coarse ironwork may be made by mixing plumbago with hot coal-tar. Equal parts of asphaltum and resin, dissolved in common turpentine, make also a good, cheap covering for heavy ironwork. For machinery, dissolve 2lbs. of india-rubber, 4lbs. resin, and 2lbs. shellac in 5galls. of benzine. This may be used with any other paint as a vehicle. Wrought iron bridges are painted with white lead as follows: The ironwork is first made clean by scrubbing and brushing it with wire brushes; this done, all the cavities and fissures are filled up with a putty of litharge, linseed oil, varnish, and white lead; this filling being dry, brushing is repeated. Afterwards a paint is applied, consisting of 300lbs. of white lead, 10galls. of crude linseed oil, 1gall. or 2galls. of boiled linseed oil, and 1¼gal. turpentine. This paint is repeated when sufficiently dry, and finally evenly overspread with white sand. Galvanising is employed also to prevent rusting A galvanising paint consists chiefly of zinc powder and oil varnish. Rusting is further prevented by rubbing the red-hot iron with wax, tallow, pitch, or coal-tar. Rubbing with heavy petroleum is also well adapted or keeping ironwork clean.

HOW TO MAKE AN ELECTRO-MOTOR.

By Frederick Walker.

Part II.

I NOW proceed with the particulars of the winding. The three screws, with their brass ferrules, which are intended to hold the commutator in its place, should now be loosely screwed in, and the whole of the iron armature painted with shellac varnish; then, while wet, cover all the spaces between the strips with thin paper, which will stick firmly. For winding the armature No. 22 *B W G* double cotton-covered copper wire must be used, one pound being sufficient, and, if possible, this should be on a reel, as it is not only handier to wind than the ordinary coil, but has the additional advantage of affording a hold, so that each coil may be perfectly tight. This is absolutely essential, as the centrifugal force tends to bulge the coils when the motor is running rapidly, and in this case, if the wire touches the pole pieces of the field magnets, it will not only stop the motor, but rub the insulation off, and render re-winding necessary. Fig. 1 shows how the armature is to be wound, between each strip of iron, and three layers are required. Every coil must be wound the same way, *i.e.*, if the hand holding the reel passes from right to left *above* the armature, and left to right *under* it, the same direction must be observed in all three coils. When each coil is completed, all but a few turns, a piece of twine may be laid in with its ends projecting, so that when the last turns are laid it will suffice to hold the end from slipping. Also, it will be seen that, in passing the spindle, each coil is curved, and so the three cross each other, but a piece of varnished paper should be interposed to prevent them from touching. A small, soft, wood mallet should be carefully used during the work to tap down the coils, so as to ensure perfect tightness.

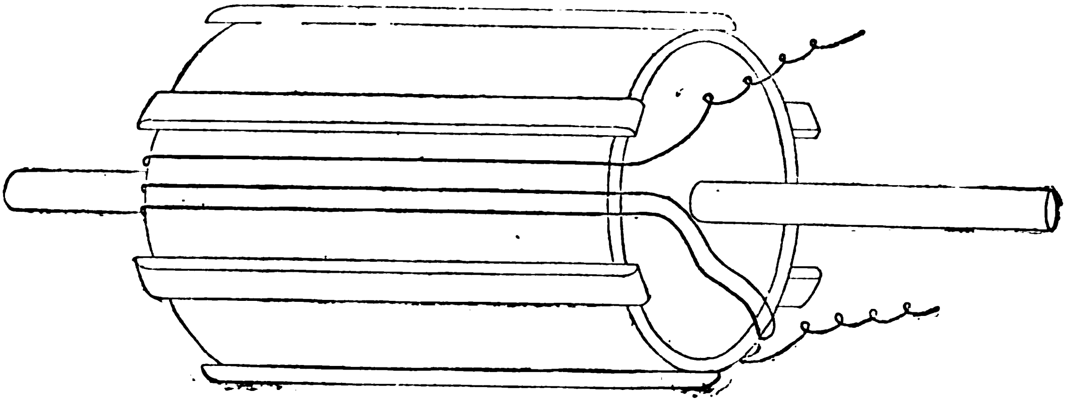

Fig. 1.—Winding the Armature.

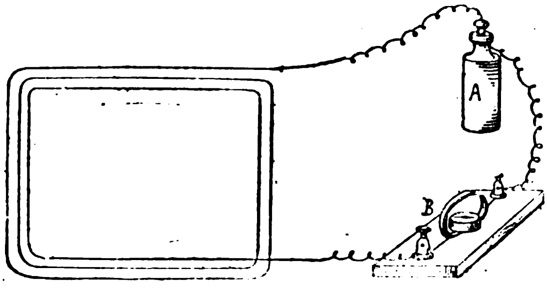

Fig. 2.—Testing the Current.

As each coil is wound, and both ends, of course, brought over so that they can, when ready, be attached to the commutator, one end should be attached to a battery; *a*, fig. 2, to the other pole of which is attached the galvanometer *b*. A piece of wire from the other terminal of the galvanometer may now be touched to the other end of the armature coil, and if the needle of the instrument is in a line with the coil of wire round it, it will at once be deflected, showing that a current is passing. Now, the wire may be touched to the spindle, and the strips on the periphery of the armature, and *no* deflection should follow, as it would show defective insulation. It is well to have the testing wires long, so that the galvanometer may be at a considerable distance from the armature, for, of course, a current passing from the battery round the coil will convert the iron into an electro magnet, which, in turn, might influence the needle. After all the coils are wound the commutator may be built, as stated in our last, and the ends of the coils soldered to the brass strips of *opposite* segments of the commutator, and the whole tightly screwed up. It might be advisable to just true the commutator up in the lathe, being very careful that no strips of metal cross the spaces, so as to, what is commonly termed, *short circuit* the coils. But if the preliminary fitting be properly and carefully carried out, there should be no occasion for trimming at all. The whole of the wire should then be well soaked in with shellac varnish, that it may be tolerably rigid when dry. Placing the armature on one side for the present, we turn to the winding of the

Field Magnets.

This will require three layers of No. 18 *B W G* double cotton-covered copper wire on each limb, previously covering with shellac and paper as before. Now fig. 3 shows the general arrangement and winding of the field magnets, and the manner in which the ends of the coils are coupled up. It will be seen that since we want the limbs arranged so that the adjacent end of each has the same polarity, the winding must have a different direction on each; for instance, suppose the hand carrying the spool of wire goes round one limb in the direction of the hands of a watch, the reverse direction must be observed while winding the opposite limb. But if, after winding, it should be discovered that a mistake has been made do not unwind again, but carry the end of coil *a* down to the lower end of *b*, and, of course, the upper end of the latter to the terminal *c*. The insulation, and also the conductivity of these coils should be tested in the same manner as those of the armature, and after well varnishing the field magnets and pole pieces may be finally coupled up, care being taken that the latter do not press upon the coils without the intervention of a piece of varnished paper. The coupling up is shown in fig. 3, the current from the battery passing from the brass terminal "*d*" round *F M* coil "*a*," then round "*b*," the end of which is connected to the brush "*e*." Thence, passing round the armature coil, whose segments happen to be opposite at the time the current travels from brush "*e*" to terminal "*c*," from which it passes to the point of lowest potential in the battery. It is immaterial to which terminal the carbon, or positive pole of the driving battery is attached, for the motor will run equally well if the current enters at "*d*" and passes through exactly the reverse way to that which we described; but since solid masses of iron, like the field magnets and pole pieces, retain a certain residue of magnetism after being disconnected from the battery, and leaving them with a polarity, it is wise to always connect the positive (+) or carbon battery wire to the same terminal.

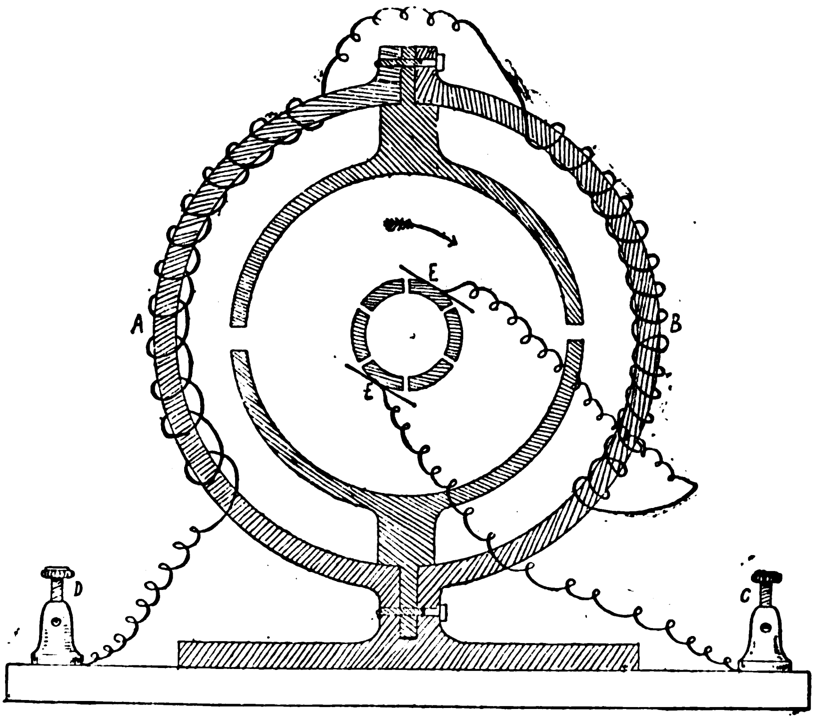

FIG. 3.—GENERAL ARRANGEMENTS OF FIELD MAGNETS.

Having placed the armature in its place, and seen that it revolves freely with the hand (it ought to spin like a gyroscope), and again made sure that there is no *short circuit*, or metallic contact between the terminals, or anywhere but the legitimate path for the current which we have shown—this may be done by connecting one terminal of the motor to one of the galvanometer, and the other of the latter to a battery of two or three cells, the remaining wire of which touch all over the *iron* of the motor; if all is right there should be no deflection, but when touching the brushes or the other terminal, the needle should swing immediately—the only remaining job is to find the angle of the brush holder at which the motor gives the best effect; this can only be done by testing with a suitable driving battery, beginning with the brushes with a slight angular advance, as shown in fig. 3, and increasing or diminishing until the maximum speed is obtained, then the brush holder should be marked so that it may be shifted any time to obtain a reduction of speed, and returned to its place without trouble. The wire upon the field magnets may be painted over with bright red shellac, and the motor screwed by its foot to a mahogany stand, into which may be fixed the terminals, the wood affording sufficient insulation for electricity of such low electro-motive force as used to drive this motor.

Now a word respecting the battery power required for this motor.

The cells must be of a type in which the internal resistance is low, such as Grove's, Bunsen, or Trouvè's bichromate; and as electrical energy is measured by horse-power, thus—

$$\frac{\text{Electro-motive force in volts} \times \text{current in ampères} - HP}{746}$$

we have to consider the current given, and electromotive force (*E M F*) of each type of cell, in order to determine which is the most suitable, and also how many to use. The *E M F* of Bunsen's cell is about 1·9 volts, and No. 3 size gives a current of 3 ampères, so by the simple formula given above, if we take 18 cells coupled in *series* (carbon to zinc) by which the *E M F* is multiplied by the number of cells, while the available current is that of one, we get $18 \times 1{\cdot}9 = 34{\cdot}2$ volts, and $\frac{34{\cdot}2 \times 3}{746} = {\cdot}13\ H\ P$.

This is just an example of the way the number of cells and the resulting horse-power is obtained. The motor gives out on the shaft about 70 per cent. of the electrical energy of the battery, and if the connecting wires or *leads* are of sufficient thickness their resistance will be negligable.

* * *

Imitation Rosewood.—Boil one-half pound of logwood in three pints of water till it is of a very dark red; add one-half ounce of salt of tartar, Stain the work with the liquor while it is boiling hot, giving three coats; then, with a painter's graining brush, form streaks with the following liquor: Boil one-half pound of logwood chips in two quarts of water; add one ounce of pearlash, and apply hot.

CALCULATION OF WHEEL TEETH FOR WATCH WORK.

THE books written on this subject are all more or less so complicated as to almost entirely exclude them from the understanding of the general repairer. This arises from the fact that their problems and solutions are generally carried out in algebra—a study, unfortunately, that very few repairers are conversant with, as I have proved to my satisfaction by actual observation. Such being the case, and believing that a plain practical treatise on this subject was desirable, I have endeavoured in the following article to give rules combining simplicity and precision, and so arranging them that any one with a knowledge of the first four rules in arithmetic can easily comprehend and apply them.

Query.—How many revolutions will the last wheel or pinion in a train make for one turn of the first wheel, the number of wheel and pinion teeth being given?

Rule.—With the product of all the working pinion leaves multiplied together, divide the product of all the working wheel teeth multiplied together, and the quotient will be the number of turns and part of turns the last wheel or pinion will make for one of the first.

Problem.—Suppose the wheel teeth thus: 100, 80, 60, 50, and the pinions 20, 16, 10, 8. The operation would be

$$\tfrac{100}{20} \times \tfrac{80}{16} \times \tfrac{60}{10} \times \tfrac{50}{8} = \tfrac{24000000}{25600} = 937\tfrac{1}{2},$$

this number being the turns of the last wheel in this train, for one of the first wheel. The desired result may also be obtained by dividing each wheel by its working pinion separately, and multiplying all the quotients together, thus:

$$\tfrac{100}{20} = 5;\ \tfrac{80}{16} = 5;\ \tfrac{60}{10} = 6;\ \tfrac{50}{8} = 6\tfrac{1}{4};\ 5 \times 5 \times 6 \times 6\tfrac{1}{4} = 937\tfrac{1}{2}.$$

Problem Second.—Given the number of beats in an hour, the number of wheel and pinion teeth; required the number of teeth to give the escape wheel so as to obtain the given number of beats an hour. (The balance makes two beats, in most escapements, for every tooth in the escape wheel; therefore, if the latter have 20 teeth, the balance would make 40 vibrations for every revolution of the escape wheel; if the escape wheel have 15 teeth, then 30 vibrations, etc.)

Rule.—Divide one-half the number of given beats in an hour by the number of turns the escape wheel or pinion for one of the centre wheel, and the quotient will be the proper number of teeth to give the escape wheel.

Example.—Suppose the number of beats in an hour to be 16,800, and the number of wheel teeth and pinion leaves to stand thus: wheels 80, 60, 56; pinions, 8, 8, 7; by the preceding rule we find the turns of the escape wheel or pinion for one of the centre wheel to be 600. The number of beats in an hour being 16,800, the half of this would be 8,400, and this divided by 600 will give 14—the proper number of teeth for the escape wheel.

Problem Third.—How many hours a watch or clock will run before being again wound up, the number of teeth in the barrel, and the number of turns it can make before the spring runs down, together with the number of the centre pinion teeth, being given.

Rule.—Divide the number of barrel teeth by the number of centre pinion teeth, multiply the quotient by the number of turns the barrel can make, and the product will be the number of hours the watch will go before being again wound up.

Example.—Suppose the barrel to have 96 teeth, the centre pinion 8, and the number of turns the barrel can make to be 3; 96 divided by 8 gives 12—the number of turns (or hours) the centre pinion makes for one of the barrel, which multiplied by 3, the number of turns the barrel can make, will give $12 \times 3 = 36$—the number of hours it will go without again winding. If it be desired to have the watch go 30 hours, and the number of turns of the barrel to be 3, the barrel would then have to make 1 turn in 10 hours, and consequently must have ten times as many teeth as the centre pinion. If we choose to have 8 teeth for the centre pinion, the barrel must then have $10 \times 8 = 80$; if 6 teeth, then $6 \times 10 = 60$, etc., etc. When the watch or clock is desired to go a longer time, 8 days for instance, it is necessary to have an additional wheel and pinion, placed between the barrel and centre wheel. We will suppose the barrel to have 96 teeth, the additional wheel to have 80, its pinion 12, and the centre wheel pinion 10; it will be seen that the additional wheel makes but one turn in 8 hours, as $\tfrac{80}{10} = 8$, and the barrel only one turn in $\tfrac{96}{12} \times 8 = 64$ hours, so that the watch or clock, with 3½ turns of the barrel, will go 8 days. On the same principle it may be made to go a month or a year by adding one or more wheels.

Problem Fourth.—What number of teeth to give the wheels in a train consisting of wheels and pinions so that the last wheel or pinion numbers a given number of turns for one turn of the first wheel.

Rule.—The number of teeth in the pinions must first be chosen and fixed upon, these numbers multiplied together, and with this product multiply the number of turns the last wheel is to make; this will give such a number that, when divided by single factors, as 2, 3, 5, 7, etc., until the product (continuing each prime number until it no more equally divides) will give such prime numbers that can be multiplied together in sets to suit.

Example.—We will choose the number of pinions 12, 10, 8, and the number of turns the last wheel is to make (for one of the first) 200; these numbers multiplied together give $12 \times 10 \times 8 \times 200 = 192{,}000$; this divided by prime numbers gives $192{,}000 \div 2 = 96{,}000 \div 2 = 48{,}000 \div 2 = 24{,}000 \div 2 \times 12{,}000 \div 2 = 6{,}000 \div 2 = 3{,}000 \div 2 = 1{,}500 \div 2 = 750 \div 2 = 375 \div 3 = 125 \div 5 = 25 \div 5 = 5 \div 5 = 1$; these factors are now multiplied together to suit, in the following manner: $5 \times 5 \times 3 \times 2 = 150$, for the first wheel; $5 \times 2 \times 2 \times 2 = 40$, for the second; and $2 \times 2 \times 2 \times 2 \times 2 = 32$, for the third wheel, as the following proof will show: $\tfrac{150}{12} = 12\tfrac{1}{2}$, $\tfrac{40}{10} = 4$, $\tfrac{32}{8} = 4$, and these quotients multiplied together give $12\tfrac{1}{2} \times 4 \times 4 = 200$. If these numbers are thought not fitting on account of the size of the wheels, they can be arranged differently, thus: $5 \times 2 \times 2 \times 2 \times 2 = 80$; $5 \times 3 \times 2 \times 2 = 60$; $5 \times 2 \times 2 \times 2 = 40$.

Proof.—$\tfrac{80}{12} = 6\tfrac{2}{3}$, $\tfrac{60}{10} = 6$, $\tfrac{40}{8} = 5$; these multiplied together give $6\tfrac{2}{3} \times 6 \times 5 = 200$, showing the numbers to be proper.

Problem Fifth.—What number of teeth to give to the wheels in a train consisting of three wheels and pinions, when the balance is to make 16,800 vibrations an hour, or in the time the minute-hand makes one turn, and the escape-wheel has 14 teeth.

Rule.—Divide the number of beats in an hour by double the number of the escape-wheel teeth. This quotient will be the number of turns the escape-wheel will make in an hour; the numbers for the pinions are then chosen, multiplied together, and with the product multiply the former number of turns the escape-wheel makes in an hour; this product is then divided by prime numbers, and multiplied together into sets to suit.

Example.—16,800 being the number of beats given in an hour in the above problem, this, when divided by 28, double the number of escape-wheel teeth, gives 600—the number of turns the escape-wheel will make in an hour. The pinions are then chosen, which, in this case, will be 3 pinions of 8; these multiplied together, and then with the number of turns the escape-wheel makes in an hour, gives 8×8×8×600=307200; this, divided by prime numbers, shows them to be 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3, 5, 5, which can be arranged into the following sets: 5×2×2×2×2=80; 2×2×2×2×2×2=64; 5×3×2×2=60—numbers very good for practical use.

Problem Sixth.—What number to give to the teeth of wheels in a watch where the seconds hand makes one turn in a minute, or 60 turns in the time the balance makes a given number of beats in an hour.

Note.—The fourth, or seconds wheel must always make 60 turns for one of the minute, or centre wheel.

Rule.—The train is divided by 60, which will give the number of beats in a minute, and this quotient is then divided by double the number of escape wheel teeth, which will give the number of turns the escape wheel will make in a minute; from this quotient is derived the number of teeth for the seconds wheel and the escape wheel pinion. If the quotient is composed of a whole number, then the escape wheel pinion may be any number chosen; the seconds wheel must then have as many teeth as the product of the quotient multiplied by the number chosen for the escape wheel pinion; but should the quotient be a number with a fraction attached, then the number must be altered into an improper fraction—the denominator of which will be the number for the pinion, and the numerator the number for the seconds wheel. If the improper fraction be thought too high it may be reduced.

Example.—Suppose the number of beats in an hour to be 18,000, and the escape wheel to have 15 teeth; 18,000 divided by 60 gives 300 beats a minute; this quotient being divided by 30, double the number of escape wheel teeth, gives 10; this being a whole number, the escape wheel pinion may be of any number. If we choose 8 for the pinion, the seconds wheel must have 8×10=80; if 6, then 6×10=60.

Example.—The beats an hour 18,000, the escape wheel 14, what must be the number of teeth for the seconds wheel and escape wheel pinion? $\frac{18000}{60}=300$; this divided by 28, double the number of escape wheel teeth, gives $\frac{300}{28}=10\frac{20}{28}$, or $10\frac{5}{7}$; this altered into an improper fraction, gives $\frac{75}{7}$, being 7 for the escape wheel pinion, and 75 for the seconds wheel.

The calculation of wheel teeth in planetariums is far more complicated, but as this is not in the line of repairs we will not enter upon it. The preceding rules and examples are so arranged that the first three rules may be applied to any clock machinery; the last three being designed especially for watchmakers.

Grey Dye.—Expose any quantity of old iron, or what is better, the borings of gun-barrels, etc., in any convenient vessel, and from time to time sprinkle them with spirits of salt (muriatic acid), diluted in four times its quantity of water, till they are very thickly covered with rust; then to every six pounds add a gallon of water, in which has been dissolved two ounces of salt of tartar; lay the veneers in the copper and cover them with this liquid; let it boil for two or three hours till well soaked, then to every gallon of liquor add a quarter of a pound of green copperas, and keep the whole at a moderate temperatuie till the dye has sufficiently penetrated.

STEAM MACHINERY, AND THE METHODS OF OBTAINING THE PROPORTIONS OF THE SLIDE VALVE GEAR.

By A. A. Dorrington.

PART II.

VI.—Connecting Rod and Crank.

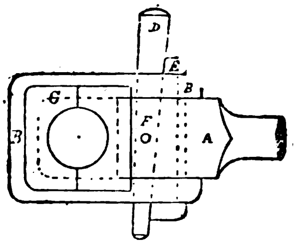

Fig. 3.—Connecting Rod.

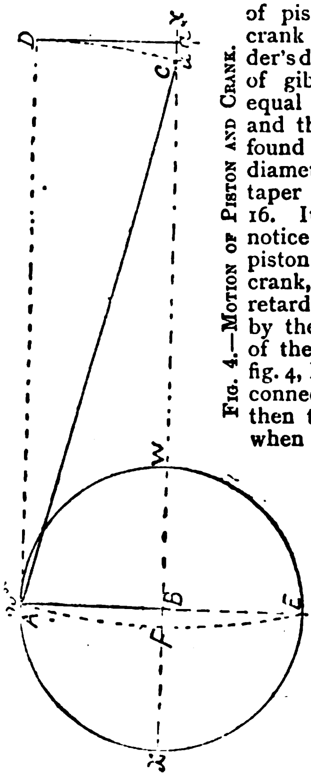

Fig. 4.—Motion of Piston and Crank.

THE length of the connecting rod varies considerably, marine screw engines being made much shorter than in other engines. A general rule is to make it twice the length of stroke, although in some cases it is made three times the length of stroke. The rod ends are made in various ways; the one most generally used is shown in fig. 3, *A* being the butt end of rod; *B* the strap; *C* steps or brasses; *D* cotter; and *E* the gib; the set screw *F* is for preventing the key from working loose. The diameter of rod at crosshead end shou'd equal the diameter of piston rod; diameter at crank end equals the cylinder's diameter × ·19; breadth of gib and cotter should equal the diameter of rod; and the thickness of key is found by multiplying the diameter of rod by ·31; the taper of key should be 1 in 16. It may be as well to notice the motion of the piston in relation to the crank, as this motion is retarded and accelerated by the varying inclination of the connecting rod. In fig. 4, let $A\ B = 1$, and the connecting rod $A\ C = 4$; then the ratio is as 4 to 1 when the crank is at right angles, or at 90° the position of the crosshead will be drawn a distance, *a*, *a*, beyond the half stroke position *D*, *D*. With *C* as a centre, and *A*, *C* as radius, describe the arc *A*, *E*; it can easily be seen that at *F* the point of intersection on the line *x*, *x* is the same distance from *B* as *C* is from the line *D*, *D*; and by placing the crank in other positions, and describing similar arcs, there will be the same irregularities, but of a less degree, as the angle of the connecting rod decreases, and which disappear at the extremities of the stroke *x* and *W*. It is evident from this that the piston is carried ahead of its proper positions throughout the forward stroke, and on the return stroke it is behind the positions due to the locations of the crank pin. The following is a table showing the angles of the crank at different positions of the stroke for both forward and return strokes, with the difference, the length of connecting rod being four times the length of crank, or twice the stroke of engine :—

Piston position of stroke	Forward Degrees.	Return Degrees.	Difference Degrees.
⅛	37⅜	46¾	9⅜
¼	54⅜	66¾	12⅜
⅓	64¼	77⅝	13⅜
⅜	68⅞	82¾	13⅞
½	82⅞	97⅛	14¼
⅝	97¼	111⅛	13⅞
⅔	102⅜	115¾	13⅜
¾	113¼	125⅝	12⅜
⅞	133¼	142⅝	9⅜

To determine the Proportions of a Wrought Iron Crank.—The diameter of the crank pin is found by multiplying the diameter of cylinder by ·16 ; and for the length multiply the diameter of cylinder by ·22. The diameter of the eye boss for crank pin should be twice the diameter of pin. The length of the boss at the shaft is usually made equal to the diameter of shaft, and for the thickness of metal round the boss = diameter of shaft × ·37. The breadth of the web at the crank pin and journal ends should be three-fourths the diameter of the respective bosses, and thickness five-eighths of width. The above proportions are very good for engines working with a steam pressure of 30lb. to 40lb. per square inch. In fixing the crank on to the shaft the main eye should be bored a shade smaller than the shaft. The key way should then be cut, and the crank slightly heated and slipped on the shaft, cold water being then poured over it, thus causing it to shrink tightly on. The key can then be driven tightly in with a few strokes of the sledge hammer. The crank pin may be done in a similar manner. Many makers simply rivet the pin, but a key makes a good strong job, and should be put in if possible. Fig. 5 is the best form of a crank.

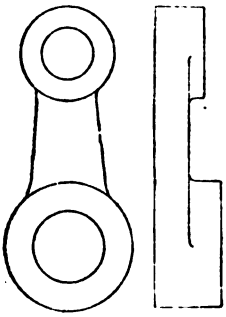

Fig. 5.—Crank.

There is also the disc crank, which is simply a round plate fixed on the shaft in the same manner as fig. 5. Another form of crank is the double or sweep crank shaft ; in this case both the crank, shaft and pin are forged together. This class of shaft (if large) is very expensive, but it has this advantage, viz., both pedestals can be fixed on the bed, thus making the engine self-contained. The double sweep shaft is used in all marine screw engines. The crank in fig. 5 requires to have a pedestal fixed from the bedplate of engine, but it is the best form of crank for the double engine.

To find the diameter of the crank shaft.—Multiply the length of the crank in inches (that is from the centre of crank pin eye to centre of shaft eye) by the total pressure on the piston, and divide this by 1,206, the cube root of the quotient equals the diameter of the shaft in the necks. To illustrate the above rule:—Suppose we require to find the diameter of a shaft in the necks (the portion of shaft that fits in the pedestals) for an engine, the diameter of cylinder being 24in., length of stroke 48in., the steam pressure being 50lbs. per square inch. Now the area of cylinder equals in round numbers 452, this, multiplied by the steam pressure 50,=22,600, the total pressure on piston, therefore 24 (length of crank) × 22,600=542,400, and this divided by 1206=449 (round numbers), the cube root=7·62, or about 7⅝ diameter. A very simple rule is to multiply the cylinder's diam. by ·33. The former rule, however, is the most reliable, as it deals with the steam pressure.

VII.—The Fly-Wheel.

When a moving power is irregular, as is the case by the piston of a steam engine, it is necessary to regulate the motion by means of a large wheel fixed on the shaft. The rim of this wheel consists of a mass of metal, and by its inertia produces an uniform motion. When the crank is at the dead points, that is, either at the bottom or top of its stroke, the wheel by its momentum continues the revolution, and carries the crank into a position where the steam exercises an influence on it. When the crank reaches a position in which the motive power is most effective, the fly-wheel absorbs a part of the power, and gives it back when the crank is where the motive power is least ; the steam being most effective at the middle of the stroke, and least at the ends.

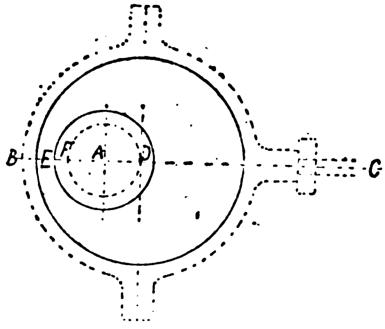

Fig. 6.—The Eccentric.

Rules for the Fly-Wheel.—The diameter is generally from 3½ to 4 times the stroke of engine. To find the weight of rim, multiply the total average pressure of steam on the piston in lbs. by the stroke in feet, and divide by this by the mean diameter of rim in feet by 45, which equals the weight of rim in cwts. The sectional area of the rim is found by multiplying the weight in cwts. by 11·45 and dividing by the mean diameter of rim in feet. Some engineers make the weight of rim = 100 lbs. for each indicated horse-power. The breadth of rim is usually made 1/24 of the diameter for large wheels and 1/12 for small wheels.

VIII.—The Eccentric.

The eccentric is a circular disc revolving in a strap or hoop, having its axis of revolution out of centre, and is used for giving a reciprocating motion to the slide valve or feed pump of an engine. The eccentric wheel or sheave has both a rotary and a reciprocating motion, its action being the same as the crank of an engine. Over this sheave is placed a loose strap which is connected to the eccentric rod, and which causes a reciprocating motion to the slide valve.

To Construct an Eccentric Wheel (fig. 6).—We will suppose that the diameter of the shaft is given with the centre *A*. Draw the line *B C*, through centre *A*, and mark off *A D* equal to half the travel of valve. From centre *D* describe a circle with a radius so as to allow sufficient thickness of metal at the *E* from the shaft *F*. This circle will represent the eccentric sheave. The dotted line shows the strap or clips. Example: An eccentric is required, the travel of valve being 6 inches, diameter of shaft 8 inches, and the thickness of metal at thin side of sheave to be 2 inches. With centre *A* and a radius of 4 inches describe shaft circle. Next set off *A*, *D* = half of valve travel = 3 inches. Make *E*, *F* = 2 inches, and from centre *D* with radius *D*, *E* describe the dotted circle which is the correct diameter of sheave.

◆

Ebony Finish.—This finish is usually applied to cherry, or other light-coloured woods having little grain. The ebony appearance is produced by the use of a stain. White shellac is the varnish usually employed, but some prefer the best rubbing-varnishes. Whatever varnish is selected, it should be as near as possible transparent, as otherwise the colour of the work will appear to be greenish or brown. Not more than three coats should be applied, as successive coats of the most transparent varnish will cause an opaque or clouded appearance. Experience and care are required to successfully rub an ebonised article, as the varnish must be rubbed almost to the wood, and if rubbed too deep a portion of the stain is removed, leaving a spot. Especial care should be used in rubbing the angles. Instead of staining the wood and applying successive coats of transparent rubbing-varnish, a black varnish (or more properly speaking, a lacquer) is often laid upon the surface of the wood. This process possesses the advantage of being very speedy, not occupying more time than ordinary spirit-varnishing, but on the other hand, the rapid hardening of the gum prevents the varnish from entering into and becoming fixed in the pores, so that it lies in a thin, hard, but very brittle coating upon the surface, and is very readily broken and scaled off, leaving spots of the original colour of the wood, that cannot be properly repaired. Shellac varnish is generally used for this finish and is prepared by adding to it drop-black or perfectly pure lamp-black, containing no grease or other foreign substance, sufficient to make it perfectly black. Apply one more coating of this to the work, and finish by adding the necessary number of coats of brown shellac, and rubbing in the usual way. This finish is employed when it is desired to engrave or carve a design through ebonised work, thus making the natural colour of the wood appear in contrast to the black.

Strychnine.—When this poison has been absorbed and conveyed into the blood there is no known antidote to its action. But if spasms have not already set in so as to close the jaws, we should, by the stomach-pump or by emetics, endeavour to remove the poison. In a case in which six grains of strychnine were taken, the life of the person appears to have been saved by the early use of the stomach-pump. It has been supposed that emetics would not act in these cases, but this is an error based on imperfect observation. In one case a man took three grains of strychnine, dissolved in rectified spirits and diluted sulphuric acid. He went to bed and slept for about an hour and a half, when he awoke in a spasm, uttering loud cries, which alarmed the household Free vomiting was brought on by the use of emetics, and this, combined with other treatment, led to his recovery. The first step, therefore, in every case, should be to induce vomiting.

A HORSE POWER—WHAT IT IS, AND HOW IT IS ESTIMATED.

THE term "horse power" originated with James Watt, who had to supply engines to take the place of horses, and do their work. It was, therefore, necessary to state the power of the engine in terms of horse power, or, in other words, that it would do the work of so many horses. To do this it was necessary to determine in some way how much a horse could do, and to fix upon some standard as a unit of power by which to measure the capabilities of a horse and, by comparison, that of an engine. The unit adopted by Watt was the raising of 33,000lb. 1ft., or 1lb. 33,000ft. in one minute. That is, it was estimated that a horse working continually for a certain number of hours per day would raise that weight against gravity that distance each minute during the day. It is not necessary to go into details as to the manner or the means used to accomplish the work: all that need be understood is that there was this amount of work done. It might be winding coals or other material out of a pit, or pumping water out of a mine. In either case there would be a given weight of material raised a given distance in a given time.

Let us examine this more in detail. There are three distinct elements in this unit of power—viz., weight, distance, and time. They might be called mass, space, and time, or mass and velocity, for velocity includes space and time, but it is preferable to use such terms as ordinary men understand and are more familiar with. I will therefore use the terms weight, distance, and time. Two of these, weight and distance, may relatively vary, but the third, time, must remain constant. For instance, as has been said, it amounts to the same thing whether we say 33,000lb. raised 1ft., or 1lb. raised 33,000ft. per minute, for the weight, multiplied by the distance, is the same in both cases. Thus, 33,000lb. x 1ft. = 33,000ft. x 1lb. In like manner, 3,300lb. x 10ft. = 33,000; or in other words, it amounts to the same if we raise 3,300lb. 10ft., as to raise 33,000lb. 1ft. Again, the result is the same if we raise 330lb. 100ft., or 33lb. 1,000ft., for the product of the weights and distances is the same in all cases. From the above, then, it is evident that the weight and distance may vary to any extent so long as their product equals 33,000; and that whether 33,000lb. be raised 1ft., or 3,300lb. be raised 10ft., or 330lb. be raised 100ft., etc., etc., in one minute, the power of one horse is exerted in the operation.

The matter will perhaps be better understood if explained on the principle of the lever. It will certainly serve as an introduction to its application to, and connection with, the steam engine.

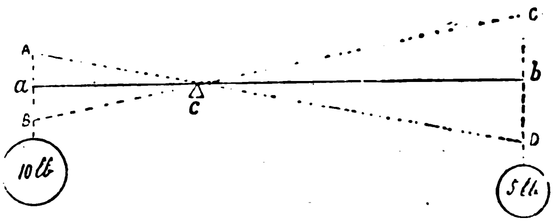

Fig. 1.

Let *a b*, fig. 1, represent a lever resting on the fulcrum, *c*. Let *a c* = 1, and *b c* = 2, then 5lb. at *b* will balance 10lb. at *a*, omitting for the present the weight of the lever. If *a c* = 1, and *b c* = 33,000, then 1lb. at *b* will balance 33,000lb. at *a*, omitting as before the weight of the lever. Now if, while in this state of equilibrium, a little force is applied either at *a* or *b*, to overcome the resistance of the atmosphere and the friction of the fulcrum, *a* will ascend while *b* descends, and *vice versâ*, and the ratio of the distance travelled or the space passed through by *a*, as compared with *b*, will be in the ratio of *a c* to *b c*—that is, 1 to 33,000; and as *b* travels the longer distance, *C D* in the same time as *a* travels the shorter distance, *A B*, it follows that *b* travels 33,000 times faster than *a*—that is, the velocity at *a* is 33,000 times *b*. Let us suppose it possible to construct and fix a lever with the short arm, *a c* = 1ft., and the long arm, *b c* = 33,000ft., with 1lb. at *b*, and 33,000lb. at *a*, and motion communicated thereto as before; then 1 lb. at *b* will travel 33,000ft. while 33,000lb. at *a* will travel 1ft. And if we suppose further that this is done in one minute then we shall have the work of one horse exerted at each end of the lever. For, as we have seen, 33,000lb. running through 1ft., or 1lb. running through 33,000ft. in one minute, equals one horse-power.

Now if, instead of moving the lever the whole length of its travel at one stroke, we move it one-tenth or one-hundredth of its travel at each stroke, then to obtain the same result we shall have to take ten strokes in one case and one hundred strokes per minute. In both cases, however, the same amount of work is done, and so it would be whatever the length of the lever, provided the distance travelled multiplied by the number of strokes per minute = 33,000ft.

Let us now apply these principles to the steam engine, and in the first place to the pumping of water, as it is simple and direct in its action.

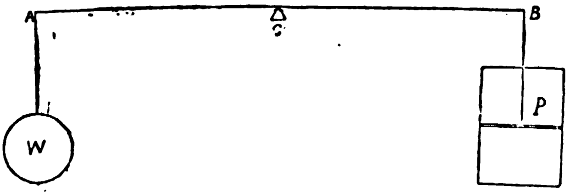

FIG. 2.

In fig. 2 the lever, *A B*, represents the beam of a pumping engine working on the centre, *C*, *A C* and *B C* being equal. *W* = the weight of water to be raised, *P* the pressure on the piston, the length of stroke = 10ft., and, for the sake of simplicity, the number of strokes per minute = 33. By the number of strokes in this case is meant down strokes of the piston only, the arrangements of the engine being such as to require no steam or pressure for the up stroke. Now let us assume the weight of water to be raised 33,000lb. at the rate of 1ft. per minute. What pressure of steam will be required on the piston? According to the above data we have a stroke of 10ft., and the number of strokes per minute, 33; therefore, we have 10 x 33 = 330 as the speed of piston, or the distance travelled per minute; and as the distance travelled multiplied by the weight, or in this case the total pressure on the piston, is to equal 33,000, therefore $\frac{33000}{330}$ = 100lb. In this example no allusion has been made to the size of the piston or the pressure per inch. These will be treated of presently. The weight of levers and rods, with the friction of the parts, have all been left out of the calculation, as they in the present state of the enquiry would complicate the problem unnecessarily.

Let us, in the second place, take the case of winding or raising coals or other material from a mine. This case, though more complicated in the arrangement, is equally simple in principle, for, although it involves the change of rectilinear motion in circular and *vice versâ*, these changes do not in the least affect the method of calculation. As the mechanica arrangement is so well understood, I will pass on to that with which we are now more immediately concerned. All that we have to consider in this case is the relative distance travelled, and the weight moved by *P* and *W* (fig. 3), for as we have seen the product of the weight and distance for any given time must in all cases equal each other. Now it is evident that for each revolution of the crank, *a*, the weight, *W*, is raised a distance equal to the circumference of the barrel, *b*; therefore the weight, *W*, multiplied by the circumference of *b*, = twice the length of the stroke of the piston multiplied by the total pressure on the piston, omitting, as before, all reference to weight and friction of apparatus.

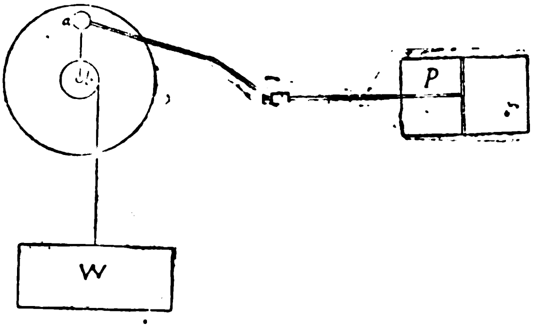

FIG. 3.

To illustrate this more fully, I give two or three examples, beginning with an extreme case.

Let us suppose the weight, *W* (fig. 3), = 33,000lb., and to be raised 1ft. per minute, and the machinery so arranged that the crank must make 33,000 revolutions in order to effect this. Let the stroke of the piston = 6in., which for each revolution of the crank will give us 1ft. travel per minute; therefore, with a total pressure of 1lb. on the piston, making 33,000 revolutions per minute, the weight, *W*, will be raised 1ft., the engine developing 1-horse power.

Again, if we suppose the machinery to be so arranged that to raise the weight, *W*, 1ft. per minute, the crank must make 3,300 revolutions, the length of stroke being the same as before, then with a total pressure of 10lb. on the piston the same amount of power would be exerted, for 3,300 x 10 = 33,000; and so on for other speeds and pressures.

Now the reader will be able to understand the reason why, as well as the rule for, calculating the power of a steam engine; which rule may be variously expressed, according to circumstances. The briefest form is the following:—Multiply the total pressure on the piston by its velocity per minute, and divide by 33,000. Deduct 20 per cent. for friction. But as this paper is intended for the uninitiated, it well be better to explain the terms a little more fully. The total pressure on the piston means the pressure per square inch multiplied by the area of the piston in square inches. The area of the piston is found by squaring the diameter in inches, and multiplying by ·7854.

Ex.—The diameter of cylinder = 20 in., and the pressure per square in. = 30lb. What is the total pressure on the piston?

20^2 x ·7854 x 30 = 9424·8 lb.

The velocity of the piston is found by multiplying twice the length of stroke in feet by the number of revolutions per minute.

Ex.—The stroke of a piston = 3·5ft., and the number of revolutions per minute = 50. What is the velocity?

3·5 x 2 x 50 = 350ft.

Having explained the terms of the rule, it is easy to find from the above data the horse-power.

Ex.—What is the horse-power of an engine, cylinder diameter = 20in., pressure per square in on the piston = 30lb., length of stroke 3·5ft., and number of revolutions = 50?

$$\frac{20^2 \times \cdot7854 \times 30 \quad 3\cdot5 \quad 2 \times 50}{33000} = 99\cdot9,$$

or nearly 100 horse-power.

This is the total power exerted by the engine, but as there is a considerable amount of power absorbed by friction, it is usual to allow 20 per cent. off this, which will reduce the effective power available for work to 80. Well-made engines do not require so large an allowance, but it is well to be on the safe side.

In the above calculation the pressure of steam on the piston, not the pressure on the boiler, is taken, for in passing from the boiler to the cylinder, especially if the distance be great and the pipes exposed, the pressure falls. To ascertain the exact pressure an indicator must be used.

The foregoing calculations apply to non-condensing engines only. When the engine is a condensing one the vacuum must be added to the pressure on the piston. Thus, supposing the pressure of the steam to be 30lb. and the vacuum 12, the total available pressure would be 42lb. per square inch. In the absence of an indicator the vacuum may be taken by a vacuum gauge; but the only correct way is to obtain it in the same way as the steam, by taking an indicator card, or diagram.

* * *

Gold-Size for Burnish-Gilding.—Grind a lump of tobacco-pipe clay into a very stiff paste with thin size; add a small quantity of ruddle and fine black lead ground very fine, and temper the whole with a small piece of tallow. When ready to use, reduce with parchment-size until it will just flow from the brush.

Staining Oak.—According to Neidling, a beautiful orange-yellow tone, much admired in a chest at the Vienna Exhibition, may be imparted to oak wood by rubbing it in a warm room with a certain mixture until it acquires a dull polish, and then coating it after an hour with thin polish, and repeating the coating of polish to improve the depth and brilliancy of the tone. The ingredients for the rubbing mixture are about three ounces of tallow, three-fourths of an ounce of wax, add one pint of oil of turpentine, mixed by heating together and stirring.

Cleaning Silver.—Silver being a comparatively soft metal, should never be rubbed with polishing powders capable of cutting or grinding, as the delicate surface, especially if engraved or ornamented, will be sure to have the delicate lines and work injured. In cleaning silver there are but two things that ever require to be removed—dirt and the sulphuret of silver. The latter appears as a coating on all silver articles exposed to the air, and especially on silver spoons, etc., which have come in contact with sulphur or the yolk of eggs. Sulphuret or sulphide of silver is soluble in several salts, especially cyanide of potassium, hyposulphite of soda, and several salts of ammonia. Therefore, to clean silver which has been blackened with sulphur, the best plan is to dissolve off the sulphide by means of some of the chemicals named. For the ordinary purposes of cleansing silver the best material is a thin paste of alcohol, 2 parts; ammonia, 1 part; and whiting enough to make a liquid like cream. This should be smeared or painted over the silver and allowed to stand until dry. If then brushed off with a very fine brush the silver will appear clear and bright. The alcohol and ammonia dissolve all dirt and sulphide, which are then absorbed by the whiting and removed with it. Where really good whiting, that is to say, an article that is soft or free from grit, cannot be procured, starch may be used.

METAL CASTING.

PART IV.

Cores Continued.—The Pattern that makes its own Core.—The Grooved Pulley Wheel and the Three Methods of Coring and Producing the Groove.—The Last of "Common" Casting.—Schiller's Song of the Bell.

ANOTHER kind of pattern "makes its own core." Still sticking to our old illustration—the engine union—*A*, in our next figure, will represent a section of a union nut. To make a pattern deliver its own core, the hollow should be made slightly larger at the bottom than at the top, to allow the sand to drop out easily. It is used as a core mould, rammed tightly full of sand, a rather deep scratch made on the bottom of the core; when the pattern is upside down in the mould the sand, on being rammed into the opposite side, makes a reverse of that scratch, and acts as the pins do on the mould itself, and is the means of steadying the self-made core in its proper position.

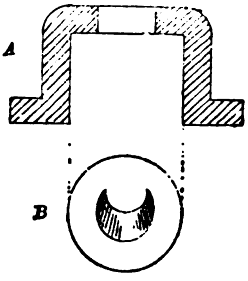

FIG. 13.

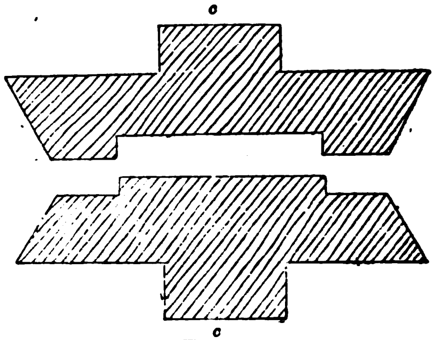

FIG. 14.

B is the bottom of the core made by *A*; the scratch alluded to is shown by the mark in the circle.

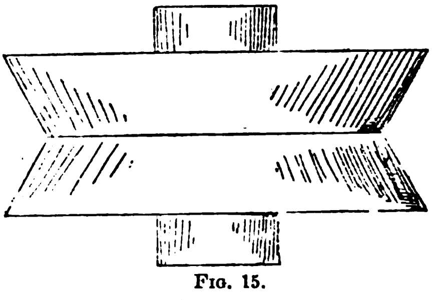

FIG. 15.

The last sample of coring, to which I shall draw your attention, is that of a grooved pulley-wheel

There are three ways of doing this; fig. 14 will explain one of them.

This is a pattern of a pulley made in two parts and making its own core, or partially so doing. The hollow in the upper half fits on the projection in the lower half. C are the hubs.

Fig. 15 gives the complete wheel. The hollow is the part that receives the sand. The pattern being in two pieces enables the caster to lift half on each side.

Another way is shown by fig. 16. Here the wheel is made with a "stay" round it. Its use is precisely the same as that described in an earlier part. The upper part shows the pattern, a section of which is shown below on the right. The sectional form of the casting is shown on the left. The lower part of the fig. shows the ring core in the sand; the method of producing this core is shown in the next illustration.

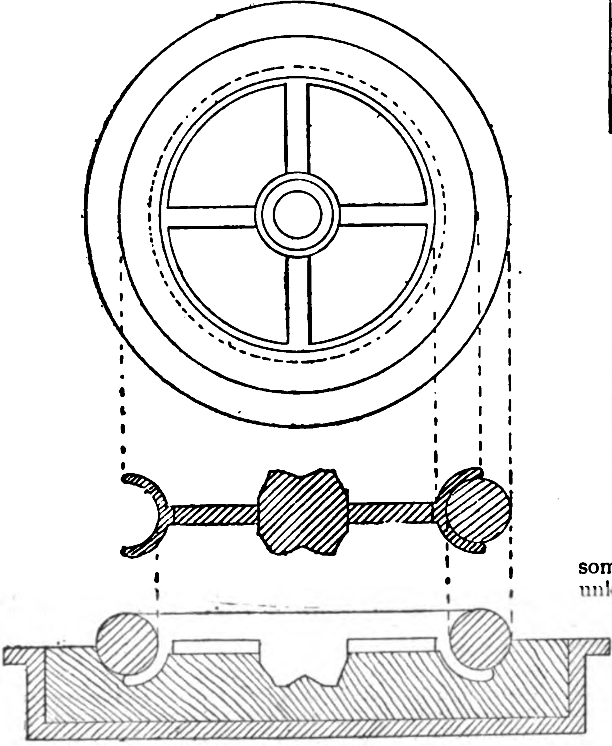

Fig. 16.

Fig. 17 shows half the mould for producing the core for the wheel. Sand is pressed into the cavity, and a ring of wire, for strengthening purposes, laid upon it; the opposite side is then filled, some paste applied and the two halves pressed together, and the core-moulding is proceeded with in the usual way. The upper illustration shows the face of the mould; the lower shows a section of half. The projecting claws show pieces which go through corresponding holes in the opposite side, the object of which is to keep the mould from shifting.

The third way of moulding a wheel will be understood when the instructions for false coring are read, the pattern being made in one piece, and looking like fig. 15.

Were I to go into other forms of common casting, I should only worry the student without informing him anything. The intelligent tyro will be continually met by difficulties which his own observations will teach means of surmounting.

Before proceeding to fine or ornamental casting, let me call my readers' attention to Schiller's "Song of the Bell." The author of that sonorous poem must have frequented foundries for the purpose of getting the knowledge with which it abounds. Hear some selections from him through an (to me) unknown translator.

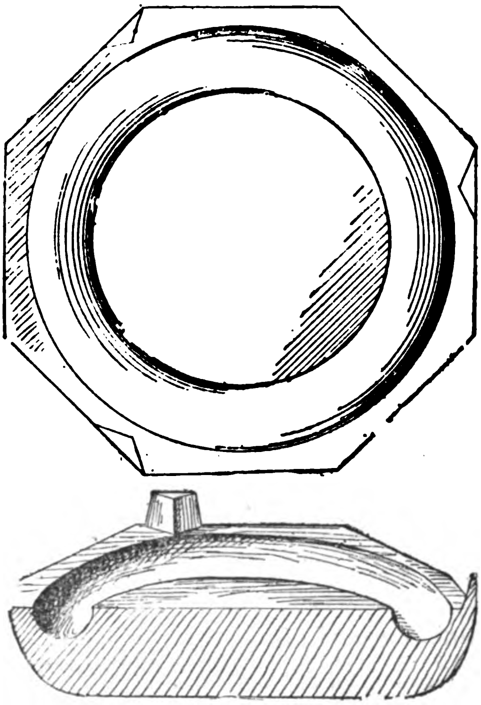

Fig. 17.

" Firmly bas'd in kneaded clay,
See the mould accomplished stands;
Our minster bell we cast to-day,
Comrades forth with ready hands!
From each labouring brow
Heavy drops must flow;
Though the master's praise weclaim,
Higher blessing is our aim.

" Bring the red fir's crackling bough,
Dry and withered should it be,
Thus the flame we kindle now,
Clear and steady we may see;
Mark the copper's glow,
Bring the tin and now
Cast therein its molten ore,
So the stream shall mingled pour.

" The glowing masses yield, and mark
How briskly springs the vivid spark!
With ashen salts we purge the mass,
That freely to the mould it pass;
Nor let vile drops appear,
To mar the accents clear.
Our metal should be sound and pure,
So will its tones be true and sure.

" How darkly red the metal burns!
Plunge we this staff awhile below,
When clogged with ore it, glazed, returns,
The mixture will be ripe to flow.
Now, friends, your test apply,
See that ye surely try
If each ingredient mingled there
Its meet proportion duly bear.

" Now may the striving ore be freed;
The rending outlet we prepare;
Our mould received the metal well,
We poured within its hollow clay;
Yet dare we not the hazards tell,

Ere it be given to the day.
The brittle frame might fail,
The stubborn ore prevail;
Even when we hope to crown our toil,
Destruction may be near the while.

* * * * *

"Rest from your weary toil,
Till the seething ore subside;

* * * * * *

Now we break the outward mould,
And, rescued from its pris'ning cell,
Our eager eyes shall then behold
The fashioned figure of the bell.

"God hath blessed our skilful care!
Rising like a star of gold.
See the form proportioned fair,
Glances through the severed mould.
O'er its burnished side,
Sportive sunbeams glide;
The sculptured motto witness bears,
To crown with praise the master's cares.

"Now your strength and art combine
Raise the bell from out its clay.

* * * * *

Gently, gently lift!
It rises! Firm and swift
Evermore of peace to tell,
Sacred be the minster bell"

Having reached a good place to break off, I will reserve what remarks I may have on fine and figure casting for the New Year.

◆

Filler for Rosewood.—6lbs. bolted English whiting, 2lbs. calcined plaster, 1lb. rose pink, 2oz. Venetian red, ¼lb. Vandyke brown, ¼lb. brandon red, 1 gallon boiled linseed oil, ½ gallon spirits turpentine, 1 quart black japan. Mix well, apply with brush, rub in with excelsior or tow, and clean off with rags.

Embossed Gilding for Illuminating.—Gilding of figures and letters on paper and for the embellishment of manuscripts, is performed with shell gold tempered with gum water; or the characters may be drawn with a milky solution of gum ammanacum made in water, and gold leaf applied upon them when almost dry; they may again be sufficiently moistened for receiving the gold by breathing on them. Letters raised from the surface, if paper or parchment in the manner of embossed work, such as are seen on ancient manuscripts, may be formed either by friction on a proper body with a solid piece of gold, or by leaf gold. The former method is practised by tempering pulverizer's crystal with strong gum water, and with this paste forming the letters; when they are dry they are rubbed with a piece of solid gold as in polishing, and the letters will appear as if gilt with burnished gold. The letters are formed with an embossed figure, either of the separate letters or of whole words cut in steel, and each letter of these stamps when they are used is oiled evenly with a feather. Then fill these concave letters with the above paste, and strike the stamps in a perpendicular direction on the paper or vellum laid on sheets of soft paper. When the embossed letters are formed with leaf gold, the following or a similar composition must be used: Thicken beaten whites of eggs with as much vermilion as is necessary to give them the consistence of paste; use the stamps as before, and when the letters are dry moisten them by a small pencil with strong gum water, and when this is almost dry cover the letters with leaf gold, pressing it close to every part of them with cotton-wool; when dry, burnish.

TOOL-ROOM SYSTEMS.

CHORDAL writes to the "American Machinist"—I have often spoken in these letters about tool-room systems. I may have spoken admiringly of many of the complete tool-rooms which I have seen; I may have ridiculed the concern which operated without a tool-room, but I do not suppose that there is anyone better aware than myself of the existence of vast numbers of shops in which not a single man has ever seen a tool-room, or heard any intelligent description of a tool-room. If such a man should get a description of a tool-room, and especially of a complete and perfect one, it would be all the discouragement which he would need.

I went through a tool-room in a certain shop, and if I should put on paper a memorandum of the elegant things which I saw, of the perfect and accurate system employed, of the rare ingenuity displayed in the construction and arrangement of tools, of the rigid accountability to which the men were held, and of the large sums of money expended in the maintenance of the feature, no man now without a tool-room would ever think of starting late in life with this grand affair as a model in view. The picture of the perfect tool-room would be a picture of the perfect hopelessness of the man without the tool-room.

I can put my own general idea of the value of a tool-room in a few words. To wit: That there is not a machine-shop in the country so small, or so poor, or so mean, that it cannot afford the luxury. A tooll room is not an expense; it is an element of economy from the word go. It doesn't involve more labour; it saves labour. It doesn't take up room; it saves room.

Most people in thinking of tool-rooms have their minds drawn at once toward measuring machines, and standard inches, and millionth parts of standard inches, and Verniers and micrometers, and expansion reamers, and all such as that. The fact is that there is no real reasonable association between a tool-room, and the extra fine measurements. That the employment of one may be an outgrowth of the other is true, but that an improvement in the accuracy of operations in a concern is to precede the inauguration or the installation of a tool-room, I most respectfully deny.

There is an old saying "a place for everything, and everything in its place." But it is not enough. The place must not only exist, but its place of existence must be known. The knowledge that there is a place for something, and that that something is in its place, is a precious small satisfaction to me if I do not know where to go to look for the place. The place should be in a manner self-indexing; otherwise we have an orderly kind of a disorder, which is the worst kind of a disorder known.

In my tramping days I struck a boarding house where one of the boarders, a boiler maker, used a barrel for a trunk. You can imagine what sort of a receptacle it was, and in what order the contents were. The owner of this elegant trunk, if twitted on the subject, fell back upon this old saying. He said the place for all his things was in that barrel, and all of his things were in that barrel, therefore was the saying fulfilled.

The word tool-room suggests by its very sound a setting apart of valuable space for tools; it suggests thee mploying of a man in charge; it suggests an entirely new way of doing things; it suggests the stocking of a room with tools; it suggests no end of expenditure; it suggests a something which it would take years to inaugurate in an ordinary shop.

If a great good involves too much trouble or expense, we are apt to put off the enjoyment of it, while a small beginning in a good way may lead to, in the end, the perfect thing. It is my purpose to show that it is possible, in a machine shop, to start a tool-room in ten minutes, and without ten cents' expense. I propose that, while this is a mere start, it is the real thing after all; that the thing once started will be so satisfactory that it will never be stopped; that the full benefits of a tool-room will be felt from the start, and that no expenditures on account of a tool-room will become a burden not compensated for by the savings of a tool-room. I will illustrate the matter by giving the tool-room history of a certain shop, and hope I will not be asked to point out the location of the concern.

Hugh Cowen was a Scotchman, with a shop working about seventy-five men on every imaginable kind of machine shop work. His shop was just like any other ordinary every-day shop; he had no tool-room, and did not know what a tool-room was; but I will describe his general tool arrangements. As to drills, there were lots of them around each drilling machine—flat drills and twist drills, odd counter-bores, pin drills, and flue cutters, and all such things as that. No two drill presses would receive the same drill. There were square shank drills, and taper shank drills, and parallel shank drills. If a man wanted to drill a three-quarter's hole, he tried to find a three-quarter's drill; if he found one, all right; if he found one a trifle too big he ground it down; if he found one a trifle too small, he used it, unless it was a great deal too small; if entirely too small, he took it to the blacksmith's shop and had it spread. If he wanted an extra long drill, he unhesitatingly had it blacksmithed out of some long inch drill, or something like that. When he had done with the drill, he left it in the drill press. When the next man came he took it out of the drill press and threw it on the floor. Briefly, there was an unorganised and unsuitable and expensive lot of drills kept in stock upon the floor. As to taps, four or five vicemen had, by some hocus-pocus, got possession of certain odd taps, and by the exercise of the usual generosity and meanness, and bulldozing and pilfering, there managed to be a fair interchange of the use of these taps. If a new tap was wanted, the foreman had one made by any lathesman who was thought capable of making a tap, and that lathesman would make a thing which might be a magnificent tap or it might not, depending largely upon the lathesman himself, upon the humour he was in, upon the lathe he worked at, upon the piece of steel he made it out of, and upon the length of time he had in which to make it. A nice five-eighths plug tap represented ten hours' labour, and stood a fair chance of being ruined at any stage between the cutting off of the steel and the first twist it got in a hole. There was no regularity about the sizes of the taps, and in fitting work around the shop it was very important to know just exactly what tap had been used in the hole Bolt cutter taps were made large, as is the common and pernicious custom. Some of the plug taps would be made as large as the bolt taps, and some of the bolt taps would be made as small as the plug taps. If a tap got broken, no provision was made for replacing it until the instant need occurred, and no new tap replaced an old one as long as the old one could be forced into a hole. As to reamers, there were but two in the shop. What they had been made for no one knew and no one cared. There were punching machines in the shop, and you could only count with certainty upon the existence of the punching tool actually in the machine. There were two or three friendless little drill-chucks kicking around the shop, and one or two of the men in the shop knew where to lay their hands on some little twist drills. The dogs were of the cur variety, full-blooded curs at that, and the breed running down. Boring bars were made occasionally to be used in a lathe or in a drilling machine. They went on the floor, and a few months' knocking around put them in bad shape. The mandrels consisted of a miscellaneous lot of chunks of bar iron piled around under the lathes, and almost anywhere, in fact. A man wanting a mandrel, took the job with him, and went on a general skirmish after something that would fit. If he found something to fit, he would use it if he could—and I will say right here that it is a pretty hard sort of a mandrel, pretty badly bent and a good deal too tight, or a good deal too loose, if a man can't make it go if he sets his mind on it. There were three or four ratchet-drilling arrangements around the shop in the usual bad order of public property, and if you wanted one of them the shortest process of getting it was to commence at one end of the shop, and keep your eyes open and ask questions and keep on until you found it. To find drills to fit it involved simply more questions and more skirmishing, or the simple act of getting a new one made—most always the latter. Bolt-cutter dies, together with the miscellaneous taps and dies in which no one claimed a proprietary personal interest, were kept in a certain drawer where about everything else was kept that could be said to have an actual place in the shop. While this drawer was the place for everything, there was no certainty of finding the thing there, and very often you would not even find the drawer there. It may have been carried off to the light; it may be turned upside down on the floor. The hack-saw could always be found without trouble; it hung on a certain nail, and it was very seldom that a man using it failed to hang it back. Inexplicable mystery attaching to the hack-saw! There used to be a brace in the shop—a regular carpenter's brace; nobody knows what has become of the brace; ditto a certain hand vice; ditto a pair of cutting pliers; ditto lots of things. Tools and material for repairing belts had a place in the foreman's little lock-up desk.

Hugh Cowen was not an old man to detect the weaknesses in his own concern. He made a tour of the country and visited all of the fine and systematic shops, and went into elegant tool-rooms, etc., knowing full well that they were not for him, and then he came back home and stuck a little notice up in the shop, reading as follows: "I respectfully request that all taps in the shop be delivered to John Morris before noon to-morrow. They can be got from him whenever wanted, and must be returned to him. Comply with this request or expect a discharge.—HUGH COWEN."

John Morris was one of the vicemen in the shop—no more a tool maker than he was a pattern maker, but Hugh Cowen did not care for that. He went to him and said, "I have ordered all the taps in the shop to be brought to you, and I want you to take care of them."

The next day the window-sill at John Morris's vice bench was piled full of taps, and it was simply astonishing to find how many taps, and what a variety of them, there was in this shop. In a week Hugh Cowen scratched out the word "taps" and inserted the word "drills" in the notice aforesaid, and he gave John Morris instructions, further, simply to take care of them. It looked a good deal cleaner on the floor around the drill presses, and in two days, without anybody understanding why it should be so, it was found that if a man wanted a five-eighth drill for a certain drill press, John Morris had that drill. It was not only there, but it was a five-eighth drill, as close as the accuracy of the shop called for. If John Morris did not have the drill he would agree to have it in the course of twenty minutes, and he did have it. In the course of a week or two the ratchet drills were hung on pegs on the wall alongside John Morris's vice, and John Morris came into possession of all the tools to fit them. In some unaccountable way the sockets in all these ratchet affairs became uniform. I suppose John Morris must have chipped and filed them out so that they were all alike, which made the drills available all around. John Morris might have done this years ago, but it was not his business; but somehow or other he had made it his business now, and that without a suggestion. He was simply clothed with responsibility. Pretty soon the foreman orders an overhauling of the drill-press spindles, and they become all alike, and the sockets and all such things as that would fit anything in the shop. I wonder what made the foreman think of that, or rather, why he did not think of it years before, five, ten, fifteen, twenty years before?

It soon turned out that there was always a five-eighth tap in the possession of John Morris, and if a new one was needed, it was John Morris who reported it, and for some reason unknown, this tap was at once made, and always by the same lathesman, who became the expert in the matter of tap making. He devoted a little attention to the nice annealing of steel and so on, and he got so that he could make a fair sort of a tap in a reasonable length of time, and his five-eighth taps were all alike—that is, they were "his" five-eighths, which might differ from Tom Smith's five-eighths, but that did not make any difference so long as one man made all the taps.

Hugh Cowen found out one day that he could take five dollars of his tap money, and buy about twenty dollars' worth of taps, and get good taps for his money. That settled tap making in Hugh Cowen's shop. I do not know just what led him into finding out just what his taps cost him home-made, but suspect that his tool-room, which after all consisted of a bit of paper stuck on a post, had something to do with it.

It will take a picture or two, and more than a sentence or two, to tell what was the result of this sudden notion on Hugh Cowen's part, but I will add here that after two years' time I consider that Hugh Cowen's tool-room, as it has grown from a trifling start, above indicated, is now the equal in its relation to his shop, and in its relation to the past condition of his tool arrangements, to the tool-room in any shop in the land.

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Oil-Size for Oil-Gilding.—Grind calcined red-ochre with the best and oldest drying-oil. When desired for use, add sufficient oil of turpentine to make it work freely.

Clarifying Shellac Solutions.—Much trouble is generally experienced in obtaining clear solutions of shellac. If a mixture of 1 part shellac with 7 parts of alcohol of 90 per cent. is heated to a suitable temperature, it quickly clears, but as quickly becomes turbid again on cooling. The only practical method of freeing the solution from what some writers call "wax," and others "fatty acid," which is present in shellac in the proportion of 1 to 5 per cent., and is the cause of the turbidity, has hitherto been the tedious process of repeated filtration. M. Peltz recommends the following method: Shellac 1 part is dissolved in alcohol 8 parts, and allowed to stand for a few hours. Powdered chalk is then added in quantity equal to half the weight of shellac in the solution, and the latter is heated to 60° R. The greater portion of the solution clears rapidly, and the remainder may be clarified by once filtering. Carbonate of magnesia and sulphate of baryta were tried in the same way, but were not found equally efficacious.

SMITHING AND FORGING

By J. L. Lowe, Brentford.

CHAPTER V.—Drills and Drilling.

FROM the painful grinding with stone or shell of the Polynesian Islander in order to get a hole through a hard substance to the steam-driven drill, whistling as it revolves from sheer content at its ability to cut out and quickly remove the hardest steel, and because it is well supplied with a suitable lubricant is doubtless a good step. So, also, is the distance between the No. 10 needle drilled truly up its centre to be utilised as a watch staff to the Morse twist drill, 3in. diameter, with 36in. of cutting-length, and which will take a four-horse engine to drive it properly through tough wrought iron.

Between such tools as those mentioned above hundreds of sizes, and nearly as many shapes and forms, are used. There are very few good amateur workmen but have tried experiments in new forms, either through discontent with those they had or because they considered that they knew how to improve them. There are three considerations which affect the working of drills. First, the metal they are to act on; second, the speed with which they are to revolve; third, the pressure to which they will be subject. The calculation of the ratio of shape to speed and pressure—of speed to shape and pressure—of pressure to speed and shape—of pressure to shape and speed, can be done mathematically, and would doubtless bear a near proportion to a truthful result, but would be useless for the production of large quantities of work unless in the hands of workmen who were practically acquainted with the weak points of drills and drilling.

That we may not have our article considered as *boring* instead of drilling, we will at once proceed to illustrate the simplest and one of the oldest of drills, viz., the fiddle bow drill. The shank should be of steel, enlarged at the end which receives the drill, and filed half way through, about the same distance from the end; the depth of the hole should be ½in., the drills made from wire to fit the hole, filed half way through at the end, forming a step,

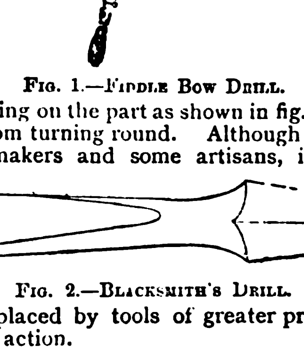

Fig. 1.—Fiddle Bow Drill.

which, resting on the part as shown in fig. 1, prevents the drill from turning round. Although still in use by watchmakers and some artisans, it is being

Fig. 2.—Blacksmith's Drill.

rapidly displaced by tools of greater precision and rapidity of action.

The drill in common use by smiths is illustrated fig. 2), and is used in a crank brace either under a press or a post drill, the pressure in the first case being obtained by weighting a compound lever (fig. 3), or by a screw actuated by a wheel or shifting handle (fig. 4).

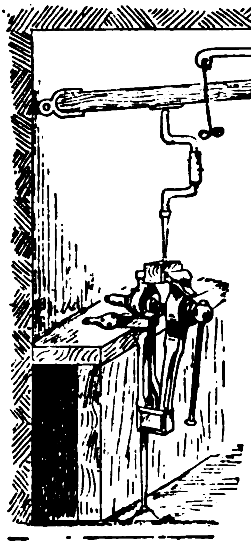

Fig. 3.—Lever Drill Press.

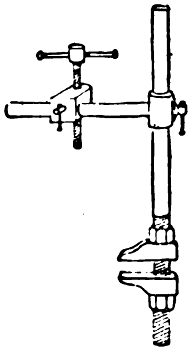

Fig. 4.—Drilling Post for a Bench.

Drills of the same pattern as fig. 2, but formed on a lighter model, are used in the hand brace, and, if well shaped, work quickly and fairly well (see fig. 5). A most useful form of drill for large holes, called a pin drill, is shown on fig. 6. A hole the size of the pin is first made with a small drill; the pin of the large drill fitting this forms a centre on which it revolves, removing the metal enclosed in its circumference easily and rapidly.

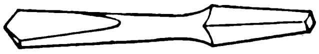

Fig. 5.—Brace Drill.

Fig. 6.—Pin Drill.

The twist drill referred to in the first part of this paper is an unique invention of American origin, and which demands a chapter to itself; its capabilities are immense. It may be regarded as a tool which has revolutionised the art of drilling, but, as it requires very peculiar manipulation in using as well as grinding, its description must be deferred to a future chapter.

Boring, an analogue of drilling, consists in enlarging apertures already formed in metal, and as cylinders and other engineering work up to 12ft. in diameter have been truly bored, and as the instruments used are various and complicated, their consideration must also be left over for Volume II.

MODEL YACHTS.

PART VI.

(For Illustration see Supplement.)

BEFORE concluding our list of typical rigs, we may mention a rather unique specimen, the "sliding gunter." It resembles the cutter minus the gaff, the after leech of mainsail extending in a straight line from the boom to topmast head. The mast, which may have more rake than that of the cutter, stands only an inch or so above the hounds, thus dispensing with all topmast rigging. The sliding topmast is merely a light spar (fitted on the *after* side of lower mast), the heel extending some 3in. below the hounds, and carries two hoops which slide freely on the lower mast. The upper part of the sail is sewn to the topmast, while the lower part travels on the mast by the usual brass rings. A movable brass pin, fitted immediately below the lower hoop, supports the topmast, and is removed to "dip" the sail.

A handier adaptation of the rig is this:—Make a "pole" mast exactly like that of the cutter, and fit the brass rings to the lower part of the sail (below hounds), leaving the upper part free. Set the sail by a halyard led through an eyelet at the topmast head, controlled from deck. Having here a standing topmast, the usual topmast stays must be fitted.

The former rig is the sliding gunter proper; the latter modification, though practically the same, is really a cutter with jib-headed trysail. In both cases the forestaysail and jib remain the same as those of the cutter, but the topmast staysail is unnecessary. Such a rig is simplicity itself, and presents a smart, rakish appearance when afloat, but cannot hold its own in competition with the rigs already described. On the whole the fastest type is the cutter rig, after which follow the yawl, schooner (plate 6), schooner (plate 5), lugger, sliding gunter, and lateen. Of course such comparison can only refer to general sailing. On some courses the lateen may lead splendidly, while on others the same boat is at a disadvantage. The direction of a vessel's course by that of the wind may be "reaching," "running," or "beating." "Reaching" (sometimes called sailing *on* a wind) indicates a course at about right angles to it. "Running" is sailing *with* the wind; that is, in the same direction. In "beating," a vessel actually approaches the wind, though indirectly. The reverse of running, a beating course is the most difficult to traverse, especially for models. Most of them can run, many can even reach well, comparatively few can beat properly. The successful boat is that which accomplishes all three. This we may call the criterion of model-yacht sailing, by which good, bad, and indifferent must be gauged. On a long running or reaching course, for instance, the tremendous lateen will drive a boat at a great speed, but the craft becomes slower as the head is turned to windward. The lugger is seen at her best on the same courses, though she goes to windward better. The drawback of both rigs consists in part of the sail standing before the mast—an advantage in running and reaching, but the reverse in beating. Further, the sail cannot possibly stand so flat as when the fore leech is attached to the mast, similar to the trysail of a cutter or schooner.

The foregoing will give the reader a fair idea as to the requirements of a sailing model. Briefly, we must have a good hull, good rigging, and good handling.

Hints on the relative proportions of the principal dimensions were given in a previous chapter. The beginner must exercise caution before exaggerating any dimensions with a view to greater results. Much the same may be said with reference to the midship section and general form. Occasionally may be seen a model cut away below water to such an extent that the hull appears to consist mainly of deck and keel; another seems all deck and little keel, or the reverse. One builder considers a hollow fore-end, with a full stern, gives the best results; while another advocates a bluff entrance and hollow delivery. The safest plan is to avoid all such extremes, and seek rather to improve the general balance of the various parts.

In the rigging of models—even more than the hull—similarity to a "real" ship should be observed only so far as it affects the general disposition. Details should be simplified wherever possible. For instance, a "hook and eye" connection is much preferable to a belaying pin, besides being more reliable. Very many persons entertain the idea that, given two hulls identical in dimensions and form, but differently rigged, the faster boat is that which carries most sail. Within reasonable limits this may be correct, but beyond, every square inch is a loss instead of a gain. The hull itself may be perfect, but an excessive spread of canvas will spoil all. Ships experience only light weather compared to models, and attempts to over-rig the latter invariably produce the same effect. Should the weight of keel be increased, matters are worse than before; the craft exhibits a strong tendency to bury herself, and ploughs a random passage with the fore-end and half of the deck under water. If a boat fails to give satisfaction under a rational suit of sails, certainly nothing can be gained by adding inch after inch to the spars and crowding them with outrageous sails. Experimental alteration in various parts of the rigging is the only way by which the difficulty can be met. The position of the mast is most important in cutters: shifting it even half an inch further forward or aft will proportionately affect the boat's performances. The experiment is easily tried, and is certainly worth the trial. Much may be gained by varying the lengths of single spars, narrowing the head or foot of a sail, or carrying the bowsprit a trifle further in or out, each having its own effect. The whole rig may be re-arranged, or even a different rig applied to the same hull; the latter often the most successful plan of all. A hint here with reference to all types alike. Most models under three feet in length, especially those with little beam, may be vastly improved by arranging a longer and lower disposition of the sails. The advantage to be derived from such an arrangement is at once apparent. The same area, or even greater, may be presented to the wind, but the centre of effort being lower, the average sailing inclination becomes less, and the resistance offered by the leeside being reduced, the result is an increase of speed. Others having great beam carry loftier rigging with comparative ease, provided the upper portions of the trysail, etc., are cut rather narrow.

Reef-points, the use of which is to shorten sail, are of doubtful utility in a sailing model. The best plan is to have one or even two spare suits of sails; the first (or "storm sails," for use in strong winds) being all smaller than those in ordinary use; the second suit (for light winds) larger, and of the lightest possible material throughout. By using sails of one suit with sails from another, the craft may be manipulated with wonderful facility.

Another item in the rigging may or may not be adopted by the model-yacht builder—namely, deadeyes and blocks, both of which have a pleasing effect in any rig. True, the whole purpose of deadeyes is accomplished by the "friction clutch" already described, while the small brass eyelets prove perfect substitutes for blocks, without the risk of fouling. The choice we leave to the builder himself, who, should he decide in favour of blocks, etc., may obtain them, together with other model fittings, at Stevens', 22, Aldgate, London. The small brass screws, rigging cord, etc., may be had at most ironmongers' establishments.

The final painting and varnishing of the hull, deck, and spars, is not the least important feature in the work, for though it sometimes improves an indifferent model, it frequently disfigures a good one.

Our imaginary boat has as yet received nothing further than varnishing. Turn her bottom upwards as before, and give a preparatory coat of any colour that may be at hand. If an uniform colour is intended, it may be applied as soon as the first is quite dry, and afterwards varnished. It will more probably be desirable to have the top sides black, and the bottom some other colour. That being so, the bottom should receive one or two coats, carried up to within say an inch of the deck, and be allowed to dry perfectly hard. We now require to mark a level line along each side at about 1½in. below the deck amidships. The simplest method is this:—Prop the boat upright on any smooth surface, say a bare table top, or a large drawing board. The gauge may consist of a block of wood, dressed on the lower side, and carrying an adjustable metal point. Set it to correspond with the mark on the boat's sides, then try it at the stem and stern, either of which may be elevated if necessary, in order to obtain a better line. Then carefully guide the gauge block along by the side, scratching a steady continuous line all fore and aft, both sides of the boat. Now turn her bottom upwards once more, and with a small brush (black paint) carefully follow the gauged line throughout its length; after which the remainder of the topsides may be finished with a larger brush. When the second coat of black has had time to dry, proceed to add her ladyship's title—whatever that may be—on each bow, not forgetting the name and port across the stern, with any other decorations, such as painted mouldings, imitation carving, etc., after which it only remains to varnish over all.

While speaking of names, decorations, etc., a word may be said in favour of flags. Those hoisted at the gaff or on a separate flagstaff must be omitted, as one would foul booms and rigging, while the other would soon be swept overboard; but the signal halyards, from deck to masthead, may be hooked to the same deck plate as the topmast backstay, and passed through a brass eyelet or small block at the "truck." Silk flags are obtainable at the model "dockyards."

"Finally, my brethren," about sailing a model yacht. It is not sufficient that the yacht itself be taken, though some improvident individuals take no more. Accidents *will* happen, even to the most perfect yacht, managed by the most intelligent yachtsman, and so simple a thing as a broken stay assumes an awkward aspect when it happens that the captain has not provided himself with material to replace it. His luggage should therefore include at least the following additional items:—Pliers, small pricker, cord, *ball* of string, and a few spare 8-shaped eyelets for the rigging. Arrived at the scene of action, notice the direction of the wind, and try a good "reaching" course first of all. Place the boat in the water, with the head turned slightly to windward, but don't push, because as the sails fill she will glide away naturally. So much for *leaving* port. When she is approaching the shore don't let her "ground" if it can possibly be prevented, but turn the bow up to ***windward*** and then let go, when the boat will gradually "fall away," and move off in safety. Should she betray an inclination to go to windward, ease off the mainsail a little and tighten the gibs; if to leeward, the reverse. The spare sails may be tried singly, or the whole suit together according to the wind. Always handle a model with great care, especially while placing in and taking out of the water; and if you have any respect for the craft, don't allow strange spectators to assist.

It sometimes happens, on summer evenings, for instance, that the wind falls off quite suddenly, leaving the boat off in mid-ocean. Out with the ball of string, tie a small pebble or weight to the end, and (with plenty of slack line) pitch the weight, rocket fashion, well over the model, taking care not to hit it; then gently—very gently—haul the wanderer in and—go home.

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SOME LATHES USED IN WATCH WORK.

(For Illustrations see Supplements.)

THE application of the lathe to watch work is of comparatively recent date. The last ten years has seen the development of the application, but, previously, the lathe, as the term is now understood, was but little used in general watch work, though, for special purposes, the tool has been employed since the early days of horology.

The accompanying illustrations show three lathes with various attachments, from which much useful information may be inferred. For many purposes, and especially for light work, amateur mechanics will find watchmakers' lathes particularly useful. The tools are somewhat costly, being made with great accuracy and of first-rate material, though small in comparison with mechanics' lathes generally.

The Boley lathe will first have our attention. This is a German production, and the following particulars will be interesting. Fig. 1 shows the lathe which may be termed an improved form of the ordinary turnbench. It has a triangular bed in place of the ordinary rectangular bar, with the advantage, it is claimed, of greater strength. The centres are placed in V grooves, instead of through round holes, as in ordinary turns. By this arrangement the necessity of using material which accurately fits the holes is obviated. The centres are fastened by means of eccentrics, turned by a lever handle, which actuate the straps shown in the illustration. The work is shown mounted between centres, a small pulley, running on the dead centre, turning the work, which has a carrier fixed to it, as in engineering work. The small grooved roller, shown towards the right, is to take a turn of the driving band, and so relieve the work of pressure.

Fig. 2 shows the lathe fitted with an attachment similar to an ordinary boring collar. The engraving needs no explanation. The lathe is here shown mounted on a small pedestal, so as to make it independent of the vice jaws. The pedestal is fitted so that the lathe may be raised or lowered and turned angularly.

Fig. 3 shows the lathe fitted with an universal head, thereby converting it into an ordinary watchmakers' "mandrel." A compound slide-rest is also shown on the bar, thus making a very complete tool. The hand-rest and back poppet are shown detached.

Fig. 4 shows the lathe fitted with an ordinary mandrel, to which various chucks may be fitted. The driving pulley runs on the dead centre, and drives the mandrel by means of the carrier attached to it. Various chucks, of the usual American pattern, are shown lying below the lathe.

The sheet of illustrations shows many simple arrangements by which the turnbench is modified into the lathe.

The Whitcomb lathe, manufactured by the American Watch Tool Company, is shown on another sheet. It is claimed for this lathe that it embraces all the improvements suggested by the experience of the best watch repairers in America. All its lines have been studied to combine beauty with strength and convenience. Its size and proportions secure solidity which prevents vibration. The production of the Whitcomb lathe has increased from 25 lathes in 1874 to 285 in 1881. The lathe is made in three sizes. No. 1 has the bed 7⅝in. long, and swings 3⅛in. No. 1½ has the bed 9¾in., and swings nearly 4in. No. 2 has the bed 11⅝in., and swings 4¾in. These dimensions are only approximate, as the lathes are made to metric measurements.

Each lathe has a plain tailstock and hand-rest, as shown in fig. 1; the cost varies with the size. Also, two distinct qualities are made, a *soft* and a *hard* lathe. The price of the 1½ lathe is, for the former, about £8, and for the latter about £12. For the plain lathe

Fig. 2 shows a new style of foot wheel recommended for use with this lathe. It has a rocking motion to the stirrup, and its general construction may be inferred from the cut.

Fig. 3 shows the patent universal head, which every watchmaker will easily identify. Near the centre are shown three taper peep holes, through which the action of the pumping centre may be observed. This is a decided advantage. The method of operating the clamps is similar to that adopted in Swiss mandrels, though some improvements are claimed for it.

Fig. 4 shows a slide-rest. It has three slides, as shown, and possesses several features characteristic of American machinery.

Fig. 5 is a wheel-cutting arrangement attached to the lower plate of a slide-rest. It is designed for cutting all kinds of wheels and pinions used in key or stem-winding watches.

Fig. 6 is an attachment used for setting jewels. It may be made with callipers to measure the jewels and turn a recess to fit.

Fig. 7 is a pivot polishing fixture used for grinding or polishing conical or straight pivots. It is also useful for snailing and drilling. The base is graduated so that the spindle may be set at any required angle.

Fig. 8 is an improved filing fixture. The guides for the file are hardened rollers, which may be adjusted for height by a screw and milled nut seen in the illustration.

Fig. 9 is a screw tailstock, made much heavier than the one shown in fig. 1, and useful for heavy drilling.

The Moseley lathe is shown on another supplement. Mr. C. S. Moseley has been connected with the manufacture of watches by machinery from its infancy in America, and was the first to bring into use the split or spring chuck, in its present form; was also the original superintendent, and for five years designing and consulting engineer of the Elgin National Watch Company, of Elgin, Ill. He originated and perfected our many appliances for producing these tools; and with his experience and counsel we feel confident of pleasing in character, style, and perfection.

The Moseley lathe is made in three sizes and two qualities. The No. 1 *hard* lathe, illustrated (fig. 1), has a bed 9¾in. long, and swings 3½in., and costs £10. By a peculiar arrangement of the slots and jaws of the universal face plate (fig. 2) a 20-size movement may be chucked so as to be operated upon at any part.

In the hard lathes the head and tailstock, spindles and their bushings, are of the finest-tempered *steel*, ground to size and shape by special machinery.

The outside surface of entire lathe is highly polished and nickel-plated, cone pulleys of hard rubber with four speed changes, and indexed with 60 holes, that a circle may be divided in 60, 30, 20, 15, 12, 10, 6, 5, 4, 3, or 2 equal divisions.

The bearings on all lathes have *oil holes* and *oil chambers* in the bushings, covered by shields which exclude chips and dust and protect the operator from flying oil. An opening in the shield allows the bearing to be lubricated, and by a partial revolution closes the opening, confining the oil where it is needed, without the usual cup and its cover which is continually being misplaced.

The headstock is fastened to the bed by a bolt at each end in combination with wedges and screw, which makes it very secure and easily attached or detached. The tailstock is fitted with hardened sliding spindle and bushings; rear end mounted with hard rubber knob, and taper hole in front for centres, drill chucks, etc.

The screw for binding T in rest is tapped in a steel ring, which can be set in any position, thus accommodating all workmen and all work.

The sliding shoe has an arrangement by which it is held down on the bed to prevent chips and dust from collecting under, at the same time allowing it to move perfectly free.

The lathes are fastened to bench by a heavy wood screw, leaving all clear below, or by bolt and thumb nut beneath the bench.

The many calls for something at less cost has induced us to make a lathe without hardened bearings—same perfection in all working parts. They are in style nearly the same as just described, the live or head spindle running in anti-friction metal bearings, steel work soft, except mouth of live spindle and the tailstock spindle. The pulley indexed; 24 holes.

By the use of a new and expensive machine all head and tailstocks and all other fixtures are made interchangeable, every centre of exactly same height from bed, and perfectly central. No matter which way they may be placed upon the bed, they will always line correctly, thus obviating the necessity of purchasing a complete outfit at once, and permit of making additions at convenience.

Fig. 2 shows the universal face plate, which may be screwed into the mandrel the same as any other chuck.

Fig. 3 shows a pivot polisher. It will do all kinds of pivots, besides spotting, snailing, and drilling. It is fastened to the bed as a slide-rest, and has graduated angular and vertical adjustments. The illustration shows the attachment half-size, and the following directions for its use will be read with interest. After the pivot is turned to a proper shape, put on the polisher; the spindle being parallel with the lathe-bed, and the lap to the rear. Use a cast-iron lap first, one having square corners for square shoulders, or one with round corners for conical shoulders. The lap itself must be perfectly true and uniformly smooth. Fine oilstone powder and oil, or No. 1 crocus, should be used with the iron laps. When the pivot is ground to shape, carefully clean it and remove the iron lap. Polish with a boxwood lap and No. 4 crocus.

Fig. 4 shows a wheel and pinion cutter, with three spindles. Each spindle, with its cutter, has separate adjustments, and is held in position by a pawl.

Fig. 5 shows a half open tailstock. The upper half is cut away so that spindles may be laid in place, instead of being passed through. This is very convenient when a number of spindles are to be used for drilling, tapping, counterboring, chamfering, etc.

Fig. 6 is a traverse spindle tailstock useful for straight drilling.

Fig. 7 is a swing rest, similar to the jewelling rest, but it has no calliper. It is very useful in cutting a recess, and the cutter swings away from the work to allow examination or the use of a hand-tool.

Fig. 8 shows a section of the bed of the form adopted in the Moseley lathe. It has central guiding surfaces, which are more correct in principle than to spread the guides to the outside.

Fig. 9 shows a filing attachment to be held in the hand-rest in place of the T. It is adjusted vertically by means of a finely-threaded screw, fitted with a milled nut, as shown. The guides are hardened steel and fixed in their places: being round they may be turned over if worn by use. This attachment is useful in filing squares on arbors held between the lathe centres.

Fig. 10 shows a wheel cutter similar to fig. 4, but fitted with one spindle only.

Fig. 11 shows a screw tailstock, useful for heavy work.

Fig. 12 shows a jewelling-rest, having a lateral screw and swing calliper. As it registers and cuts recesses to correspond with various jewels, etc., that may be callipered, this rest is in constant use in watch factories.

The foregoing brief particulars of the various lathes and lathe appliances used in watch work will interest many readers. There are many most ingenious contrivances employed in the watch trade which might be adapted by other trades to advantage. Amateur mechanics who use lathes for light work will not fail to see, in the illustrations we publish herewith, many valuable and suggestive contrivances.

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SPECIMENS OF PRIZE TURNERY.

(For Illustrations see Supplement.)

THE worshipful company of Turners held their thirteenth annual exhibition at the Mansion House on the 23rd, 24th, and 25th of October, and the prizes were distributed on Friday, the 26th.

Of the exhibits generally there is little to be said. They were neither particularly numerous nor exceptionally good. Considering the value of the prizes, many of which are in cash, the collection of work was by no means creditable. Evidently all the expert workmen have not yet been induced to send in specimens of their handicraft for competition at this annual exhibition. Year after year the same names appear in the list of prize winners, and the circle of turners who have been attracted to compete is a very small one. Without desiring to say one word in disparagement of the handiwork of those who did exhibit, yet for the credit of turners we wish the specimens had been more numerous and the competition keener.

We give a sheet of illustrations showing some of the objects which obtained the I., II., IV., V., VI., VIII., X., and XI. prizes for turning in wood. We shall give particulars of these and illustrations of others at the earliest opportunity.

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Owing to want of space, letters signed F. A. M., G. C. Clarke, Geo. F. Jackson, and Jas. Cowan have been unavoidably held over.

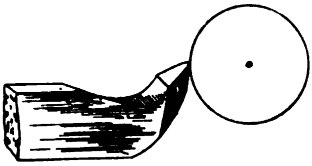


FIG. 1.

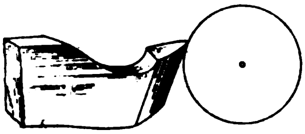


FIG. 2.

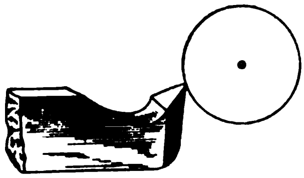


FIG. 3.

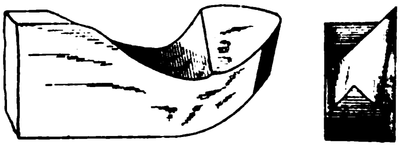
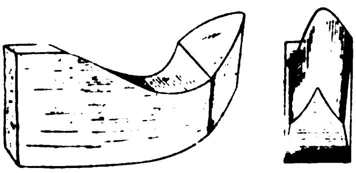


FIG. 4.



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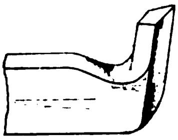

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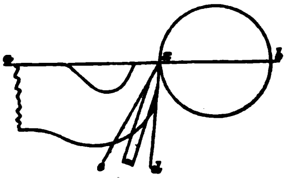

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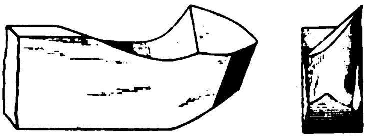

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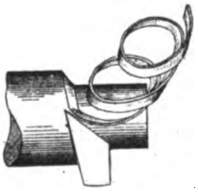

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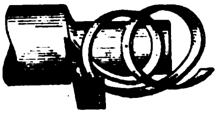


FIG. 10.

SLIDE-REST TOOLS FOR METAL TURNING.

AMATEUR MECHANICS.

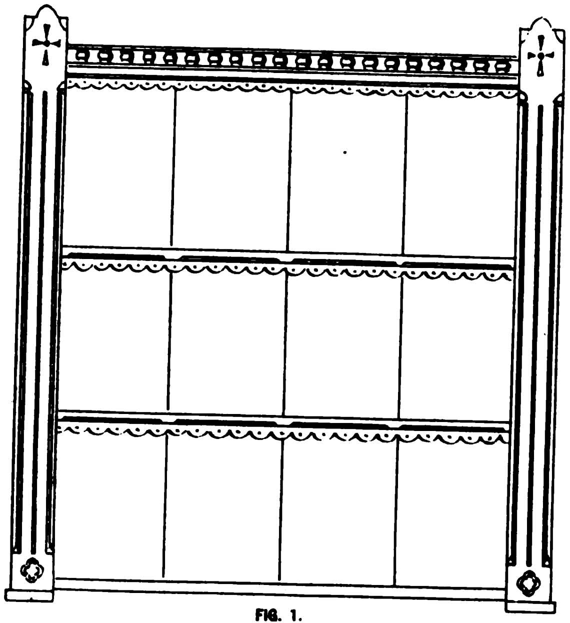
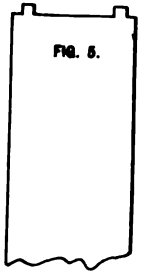


FIG. 1.



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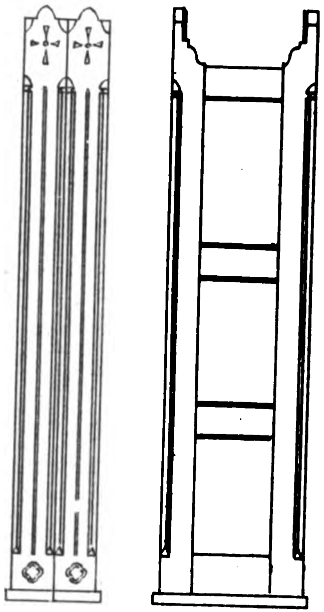


FIG. 2.

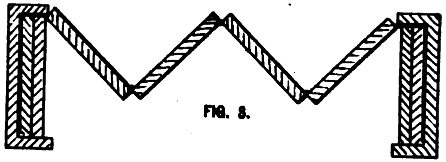


FIG. 3.

FIG. 4.

Whiteman & Bass Photo-Litho. London

A PORTABLE BOOKCASE.

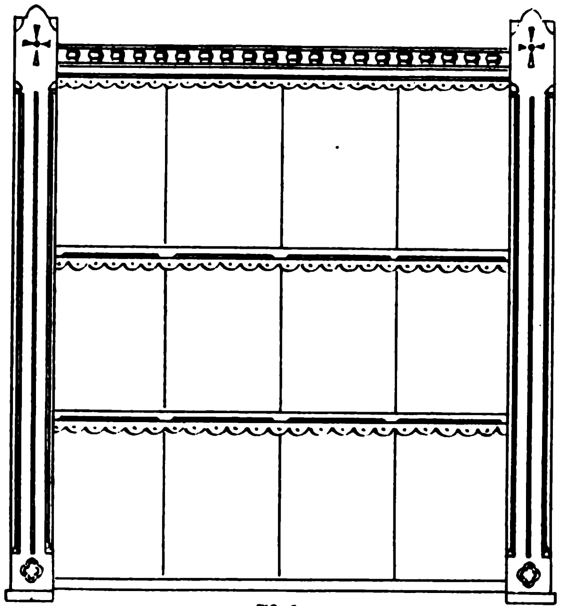


FIG. 1.

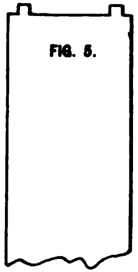


FIG. 5.

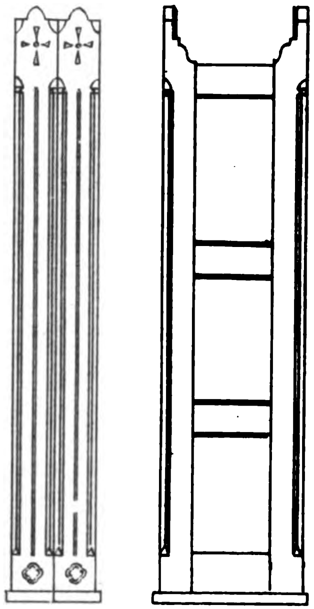


FIG. 2.

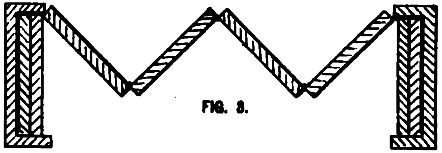


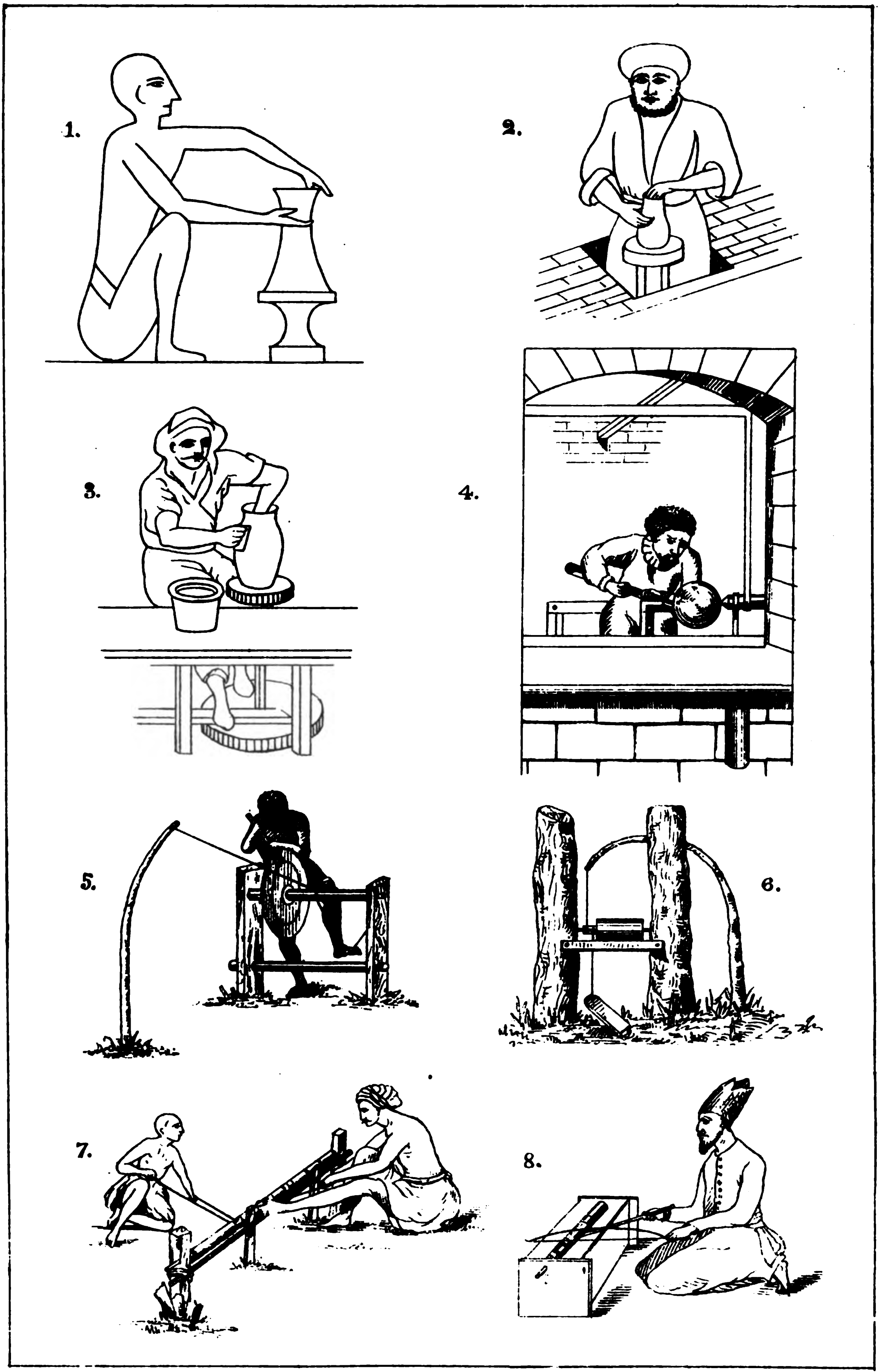
FIG. 3.

FIG. 4.

Whiteman & Bass *Photo-Litho*, London.

A PORTABLE BOOKCASE.

AMATEUR MECHANICS.



Whiteman & Bass Photo Litho London

THE ART OF TURNING.

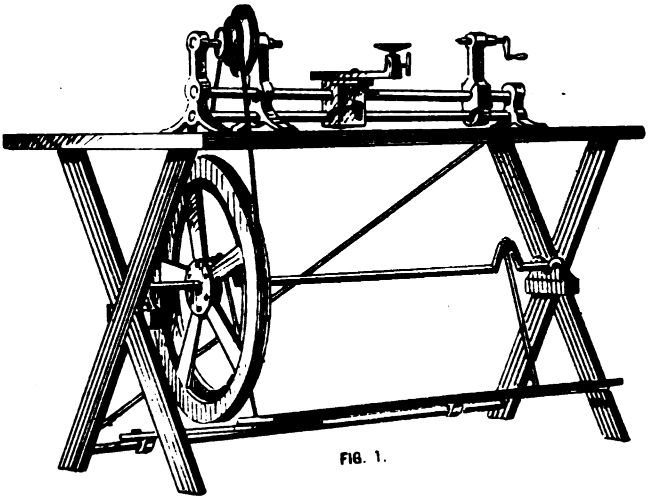


FIG. 1.

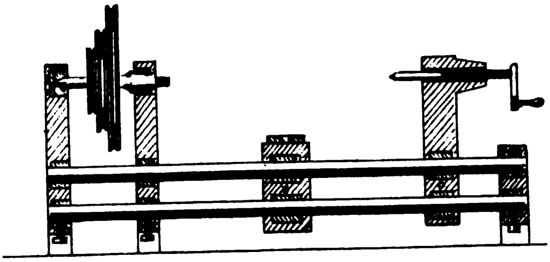


FIG. 2.

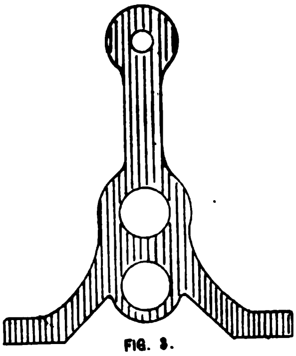


FIG. 3.

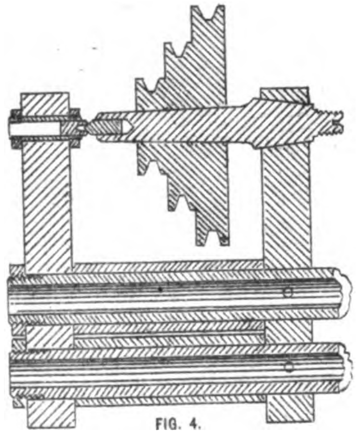


FIG. 4.

Whiteman & Bass *Photo-Litho* London

AN INEXPENSIVE LATHE.

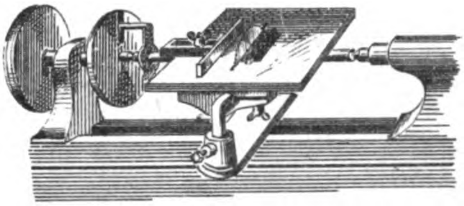


FIG. 1.

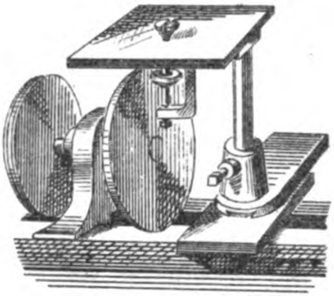


FIG. 2.

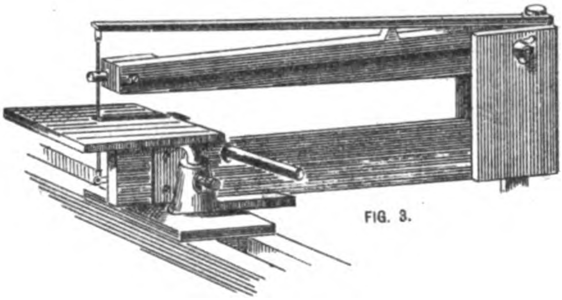


FIG. 3.

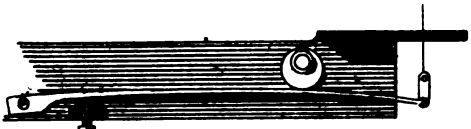


FIG. 4.

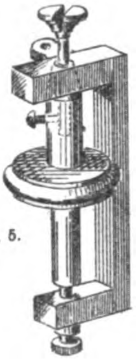
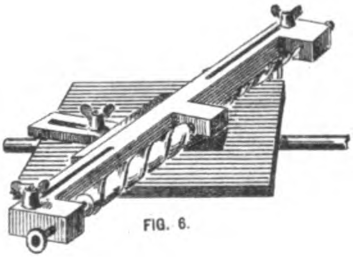


FIG. 5.



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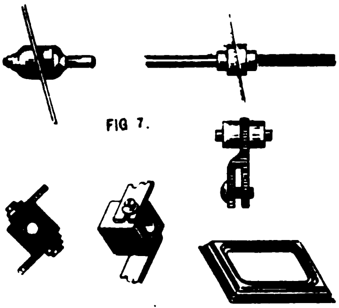
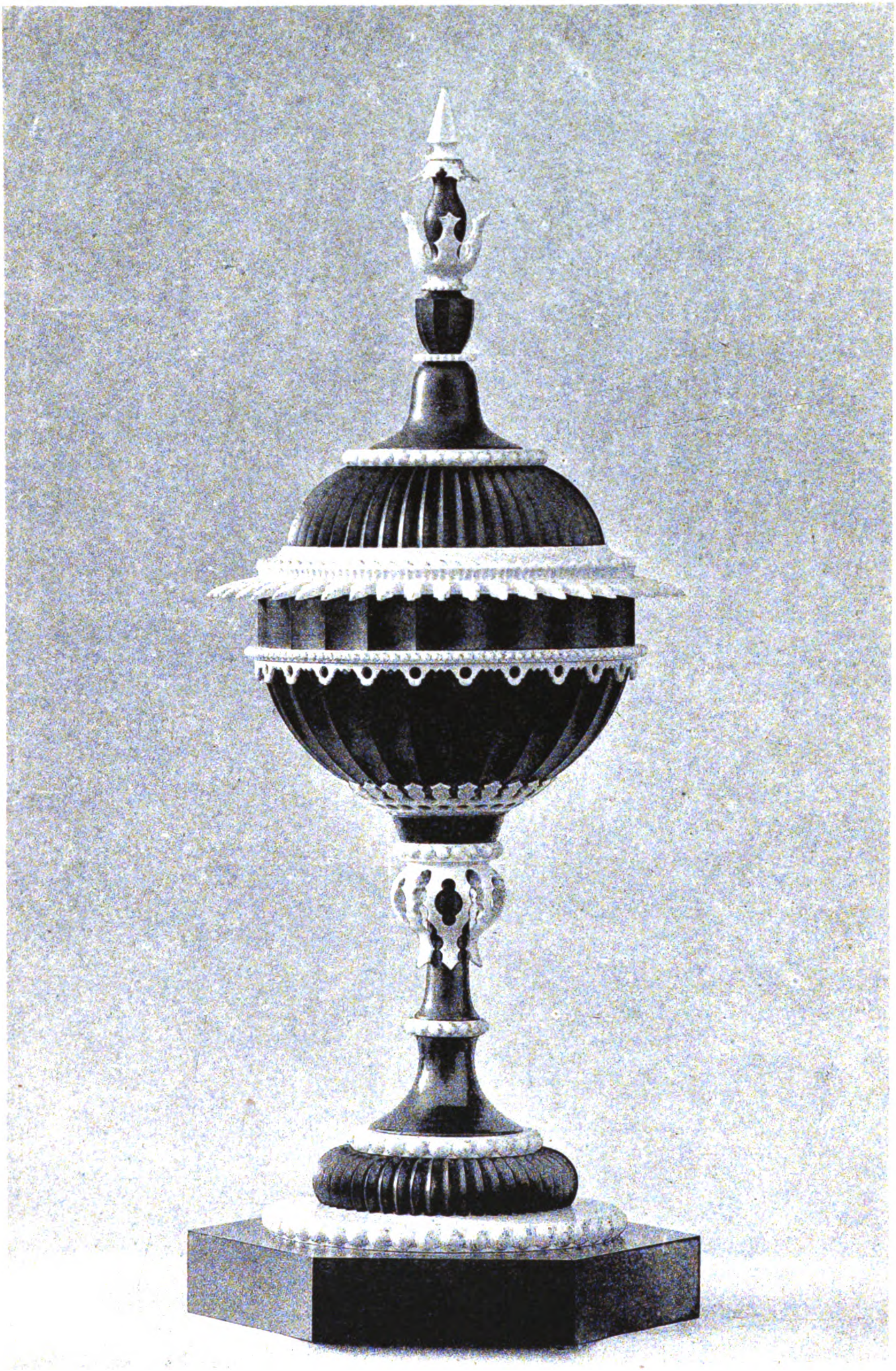


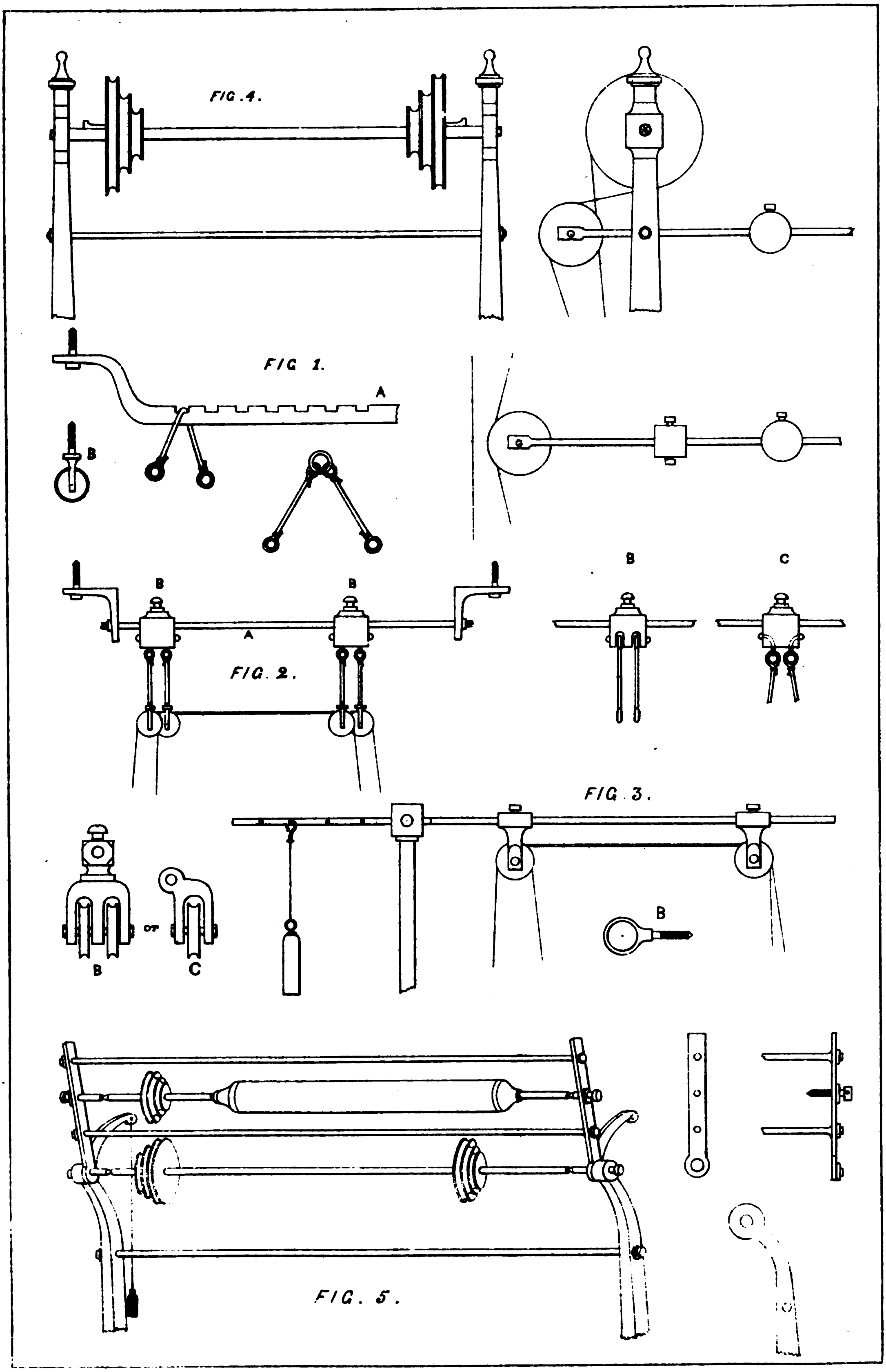
FIG 7.

Whiteman & Bass Photo-Litho London

WOODWORKING ATTACHMENT FOR LATHE.



ORNAMENTAL TURNERY._ CUP IN BLACK WOOD & IVORY.



Whiteman & Bass Photo-Litho London

LATHE OVERHEADS.

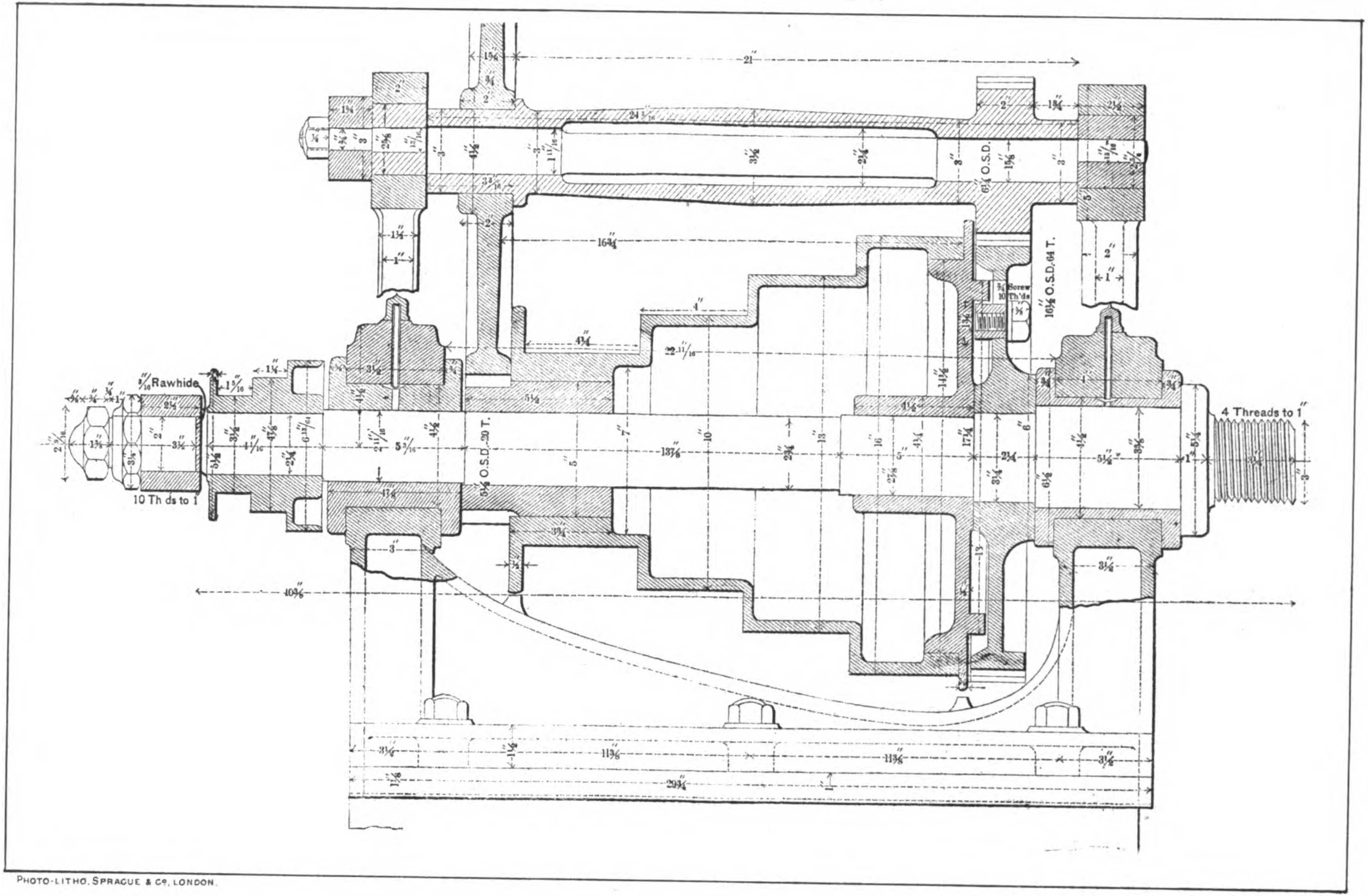
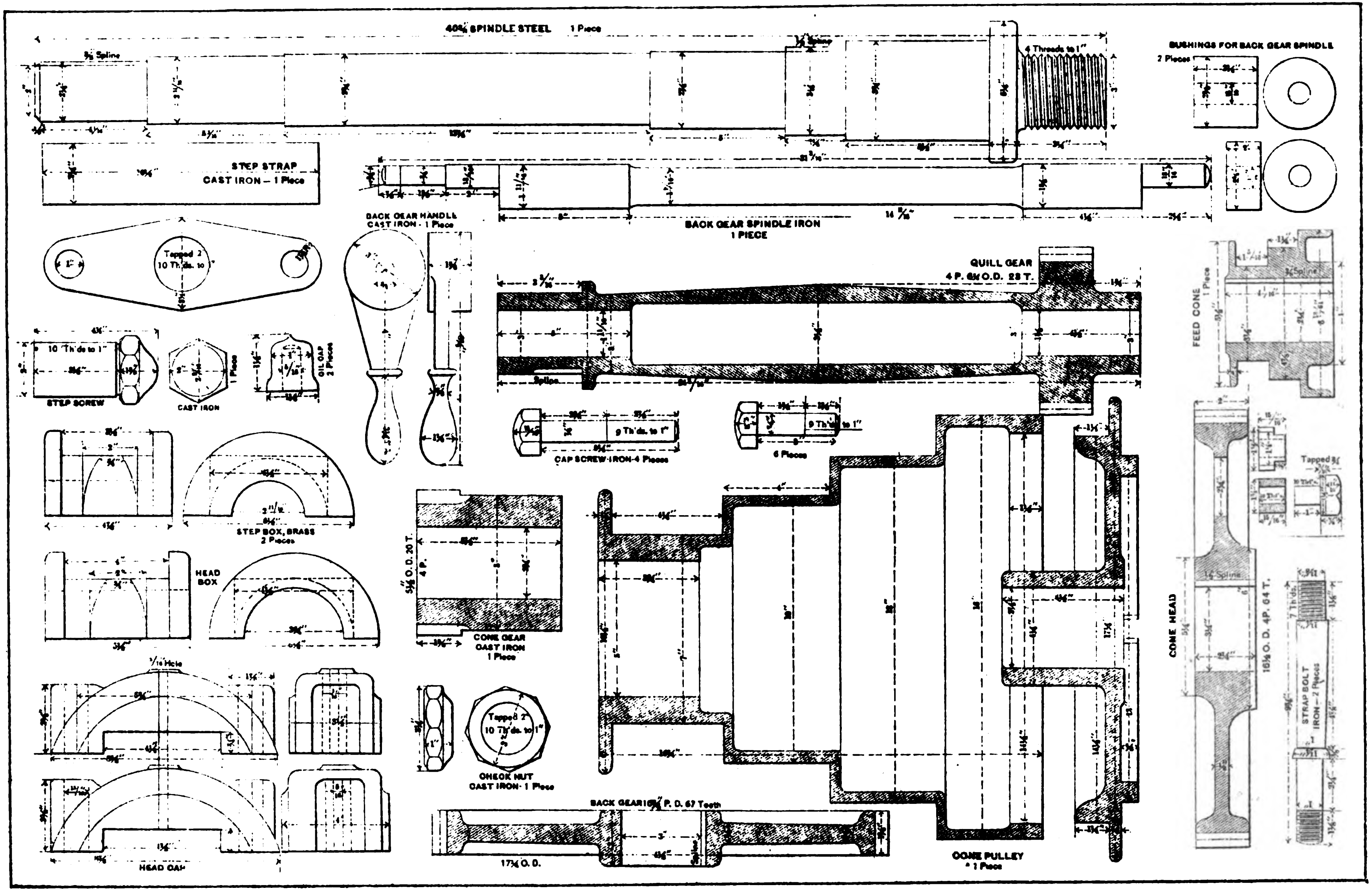


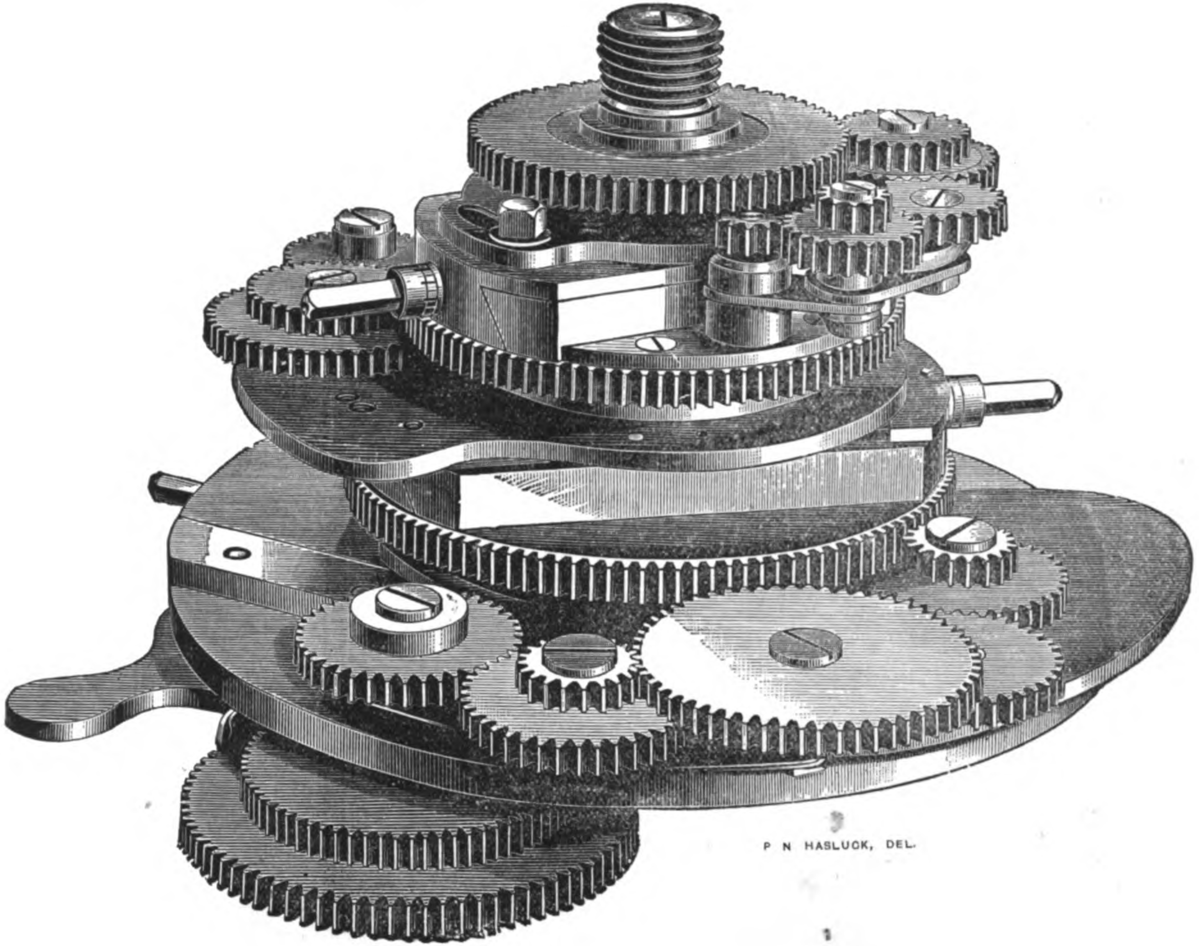
PHOTO-LITHO. SPRAGUE & Cº. LONDON.

TWELVE-INCH AMERICAN LATHE HEADSTOCK.



Waterman & Bass Photo-Litho London

AMERICAN LATHE HEADSTOCK_DETAILS.



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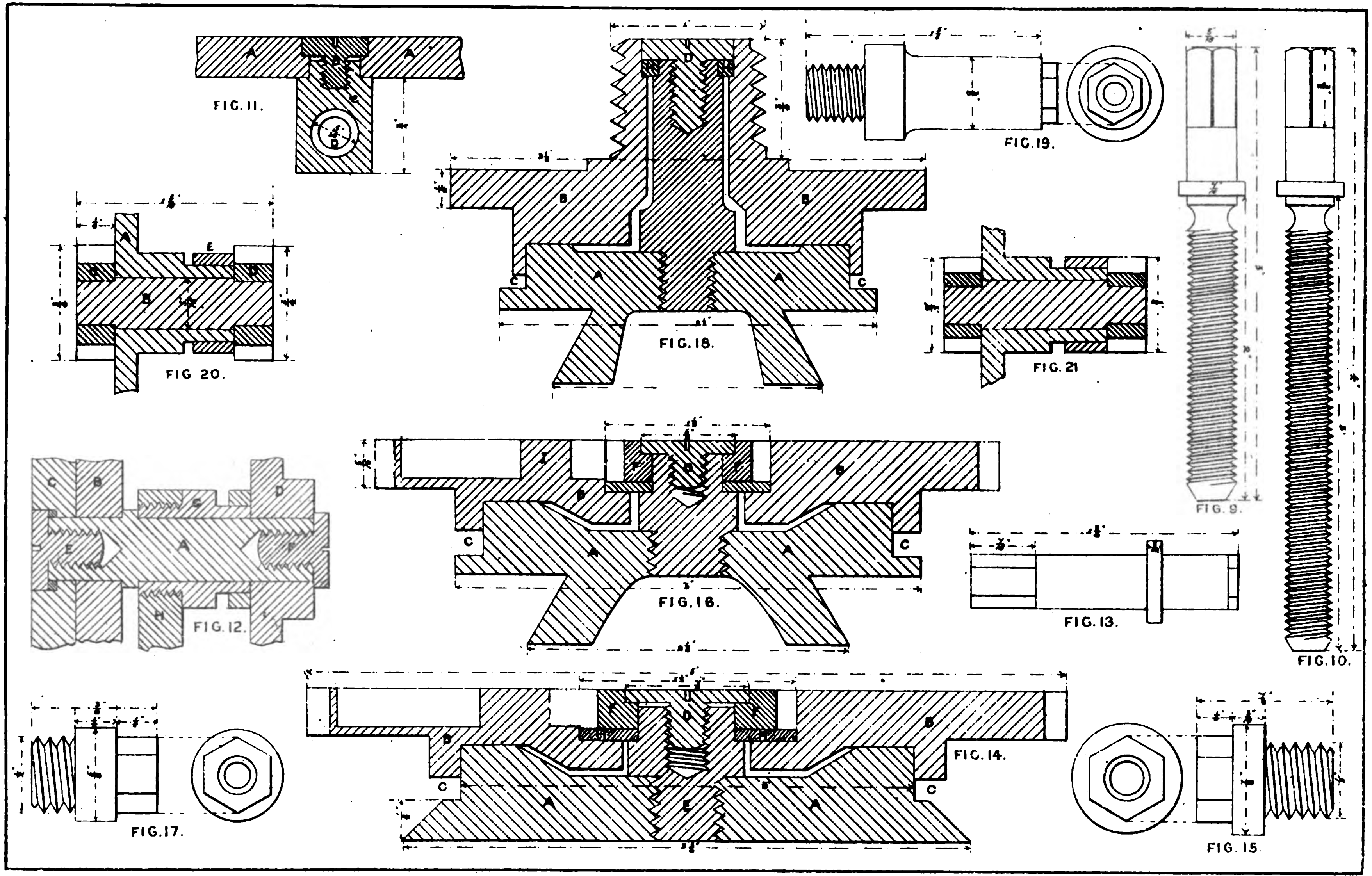
PLANT'S GEOMETRIC CHUCK.—PERSPECTIVE ELEVATION.

AMATEUR MECHANICS.



Whiteman & Bass Photo Litho London

PLANT'S GEOMETRIC CHUCK — DETAILS IN SECTION.

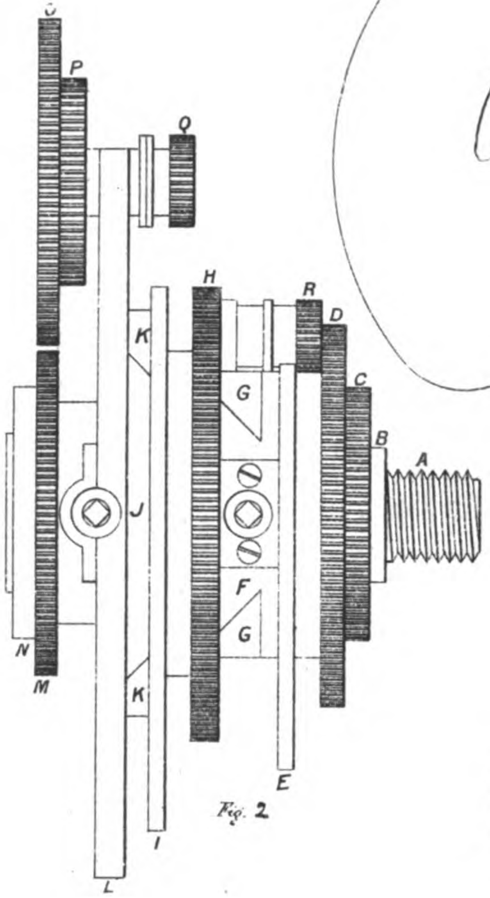


Fig. 2

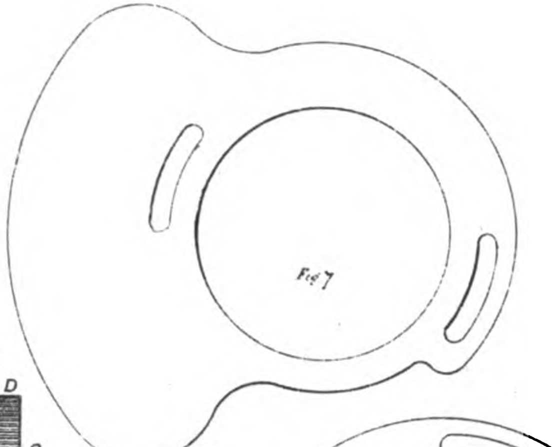


Fig 7

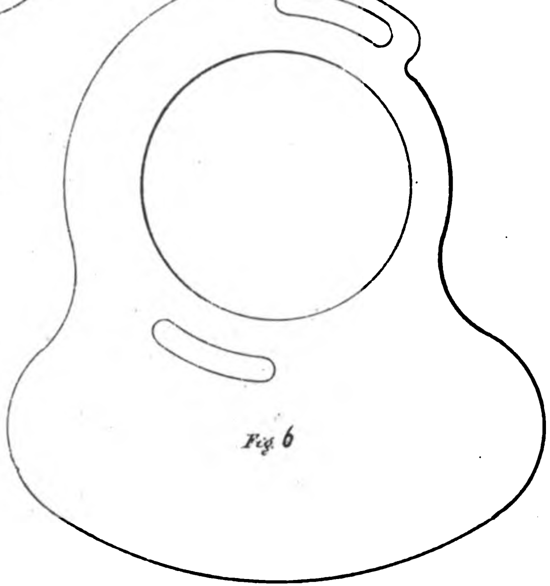


Fig 6

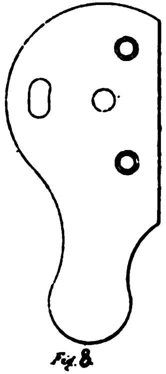


Fig. 8

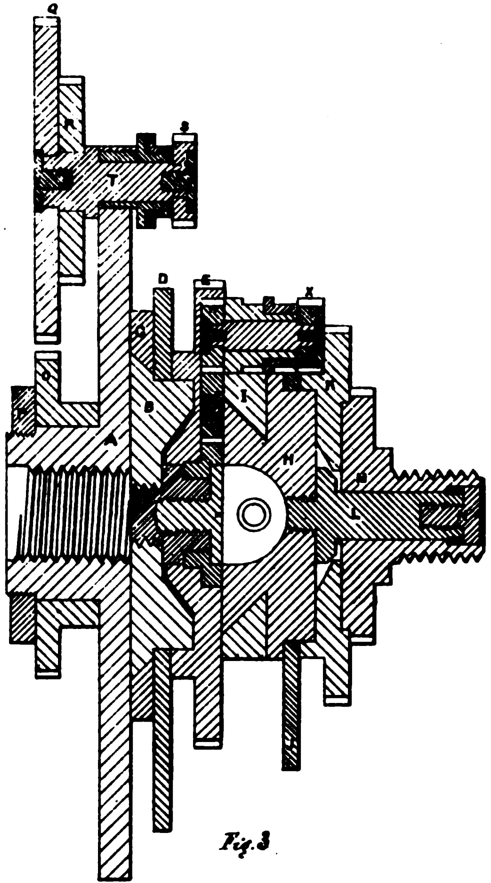


Fig. 3

Whiteman & Bass Photo-Litho. London

PLANT'S GEOMETRIC CHUCK: SECTION AND ELEVATION OF TWO PART CHUCK, &c.

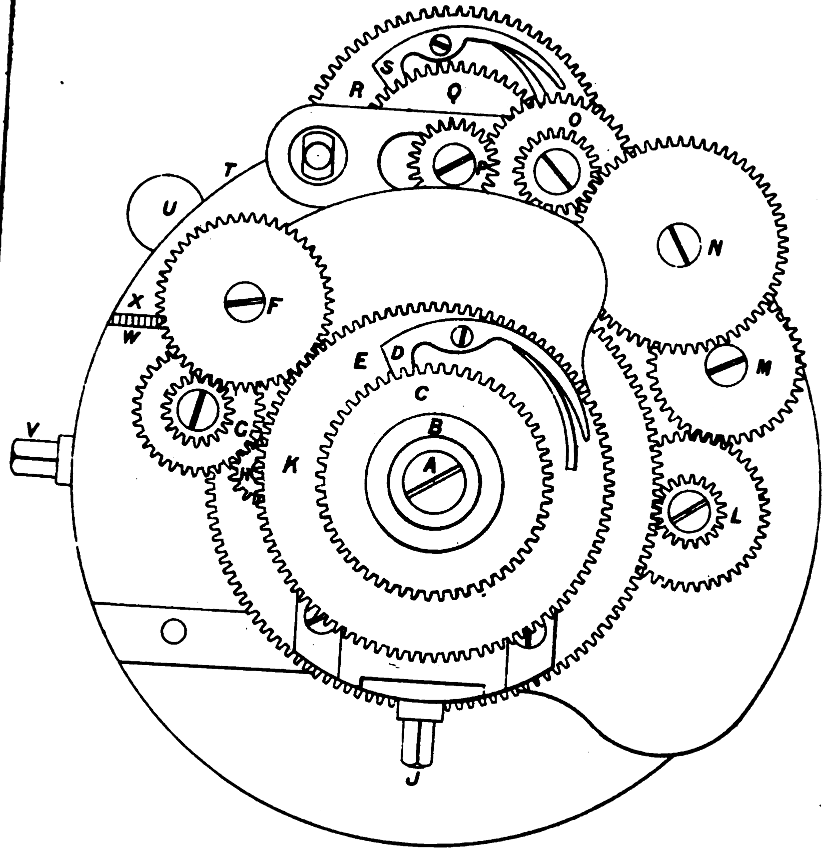


FIG. 4.

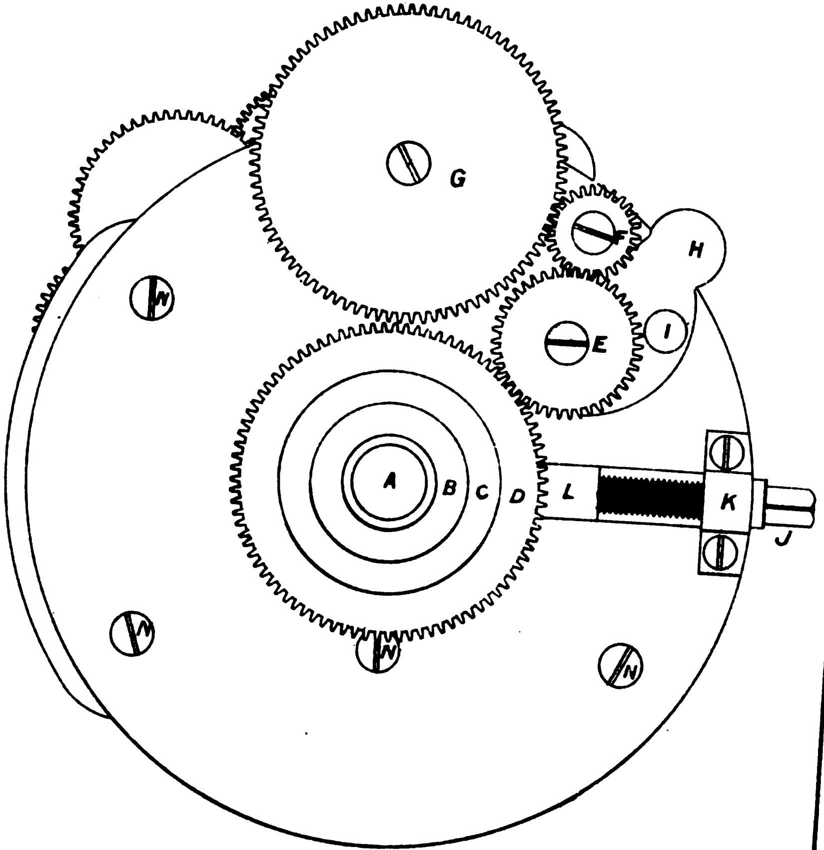


FIG. 5.

Whiteman &Bass Photo-Litho. London

PLANT'S GEOMETRIC CHUCK: FRONT & BACK OF TWO PART CHUCK.

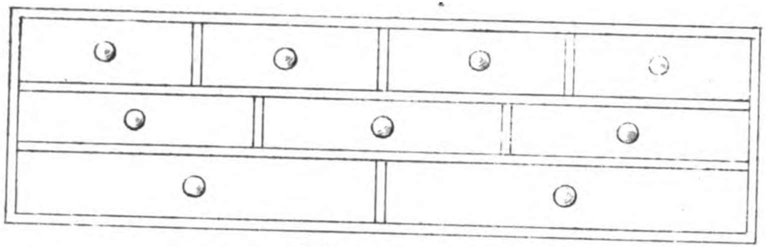


Fig 3.

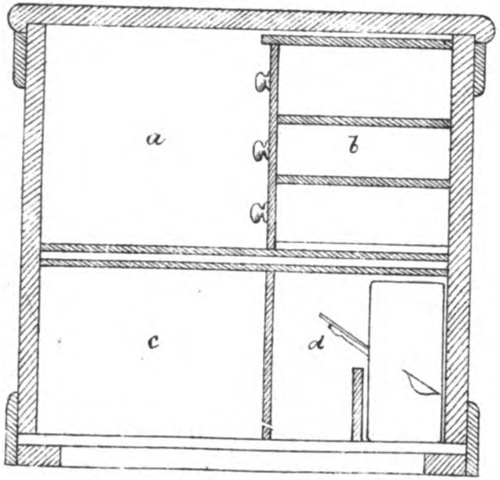


Fig 2.

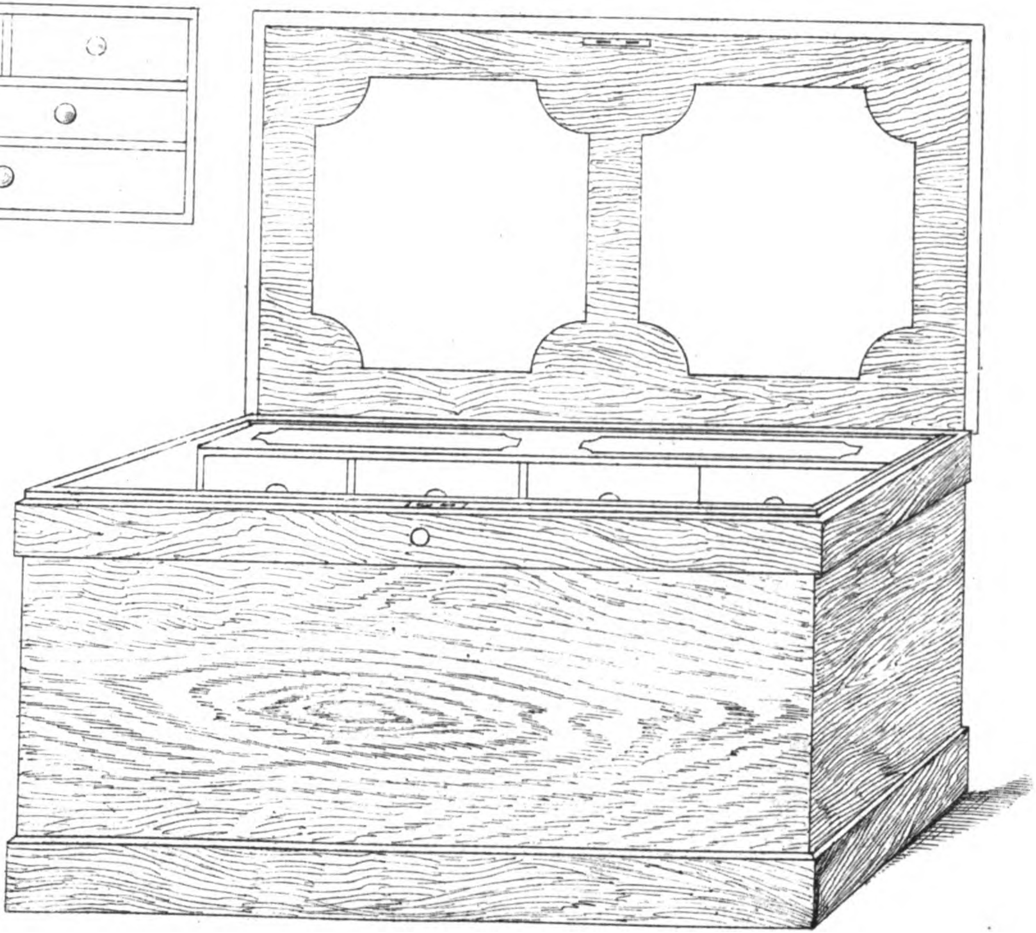


Fig 1.

PHOTO-LITHO. SPRAGUE & Cº. LONDON.

A CABINET MAKER'S TOOL CHEST.

AMATEUR MECHANICS.

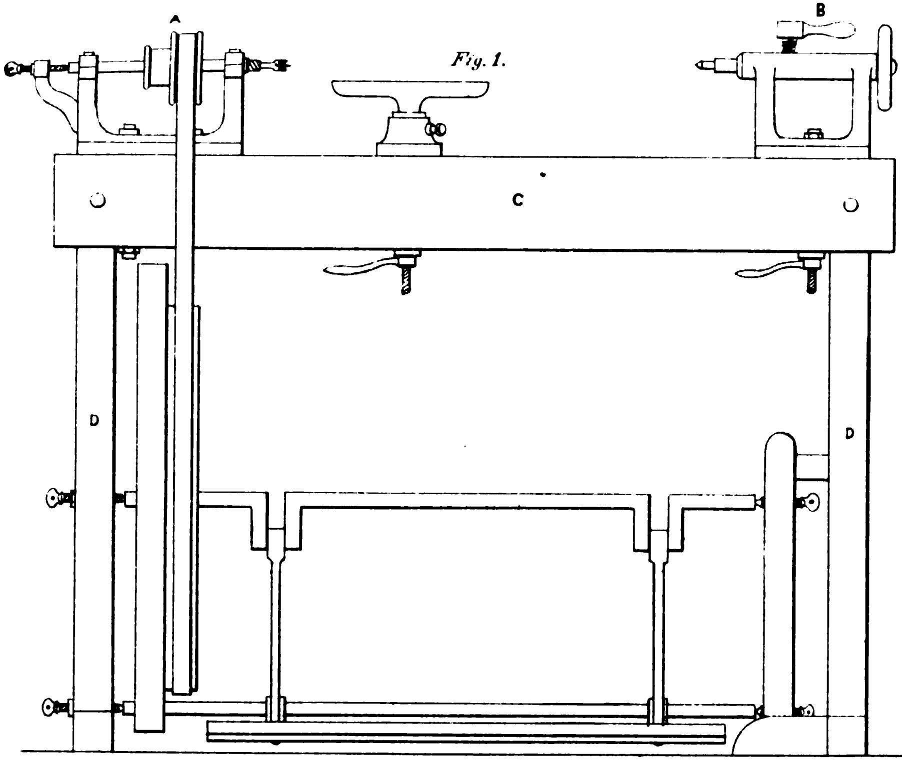


Fig. 1.

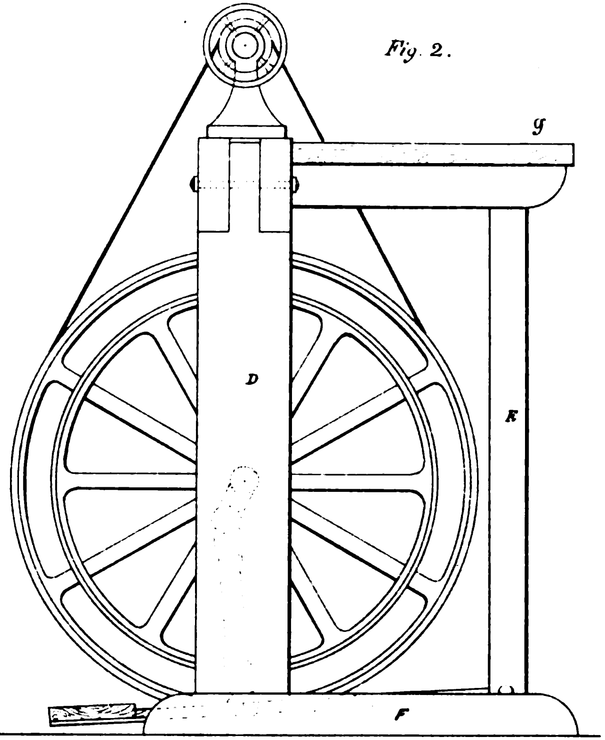


Fig. 2.

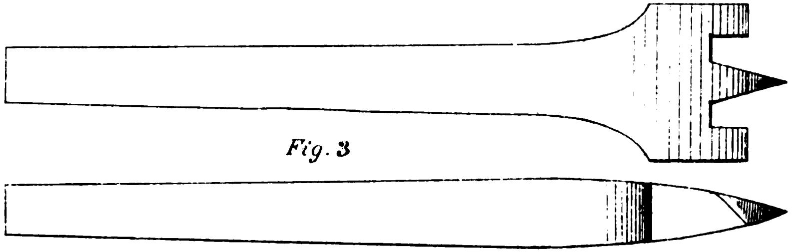


Fig. 3

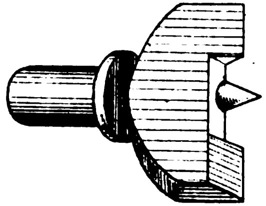
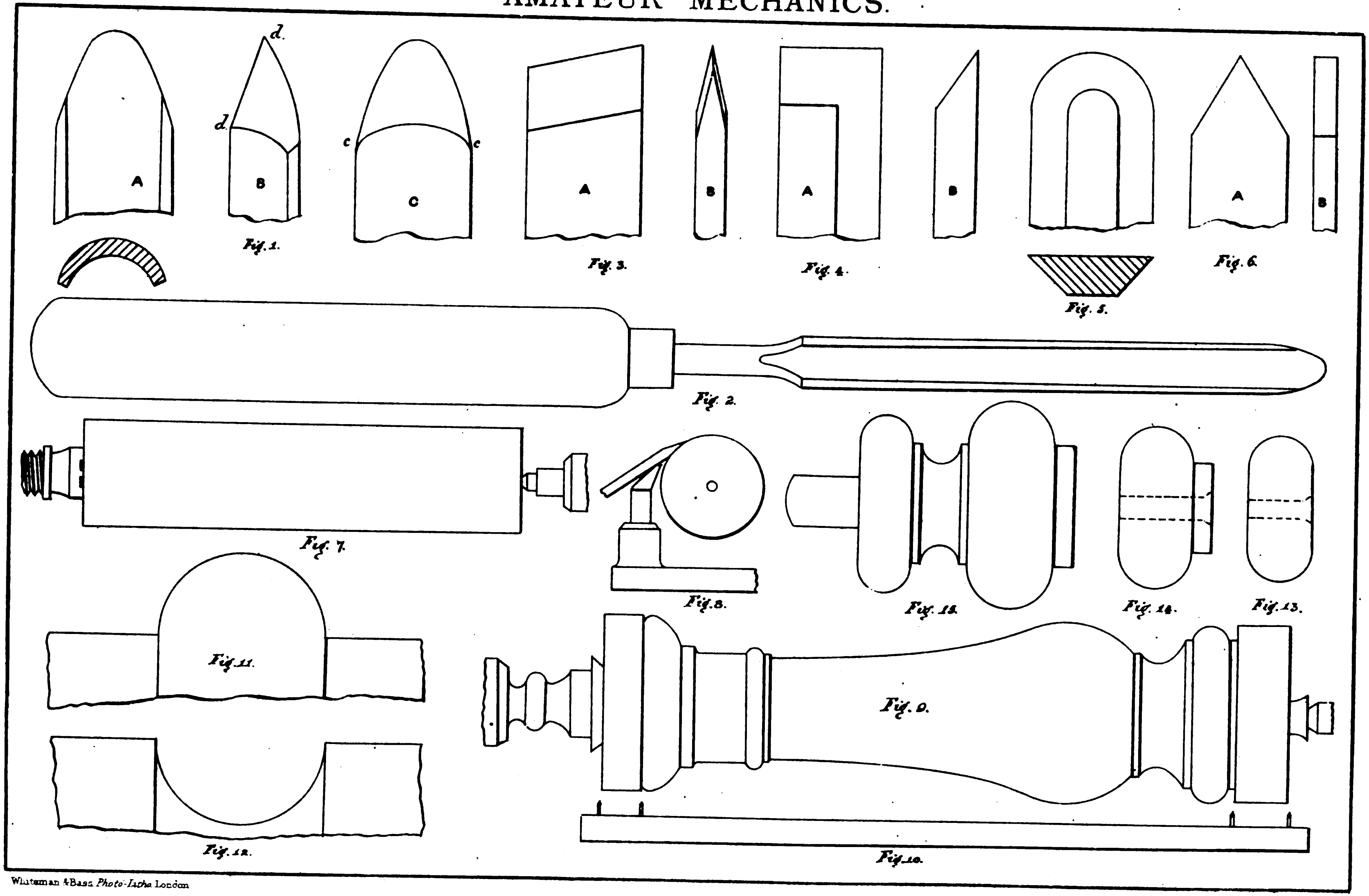


Fig. 4.

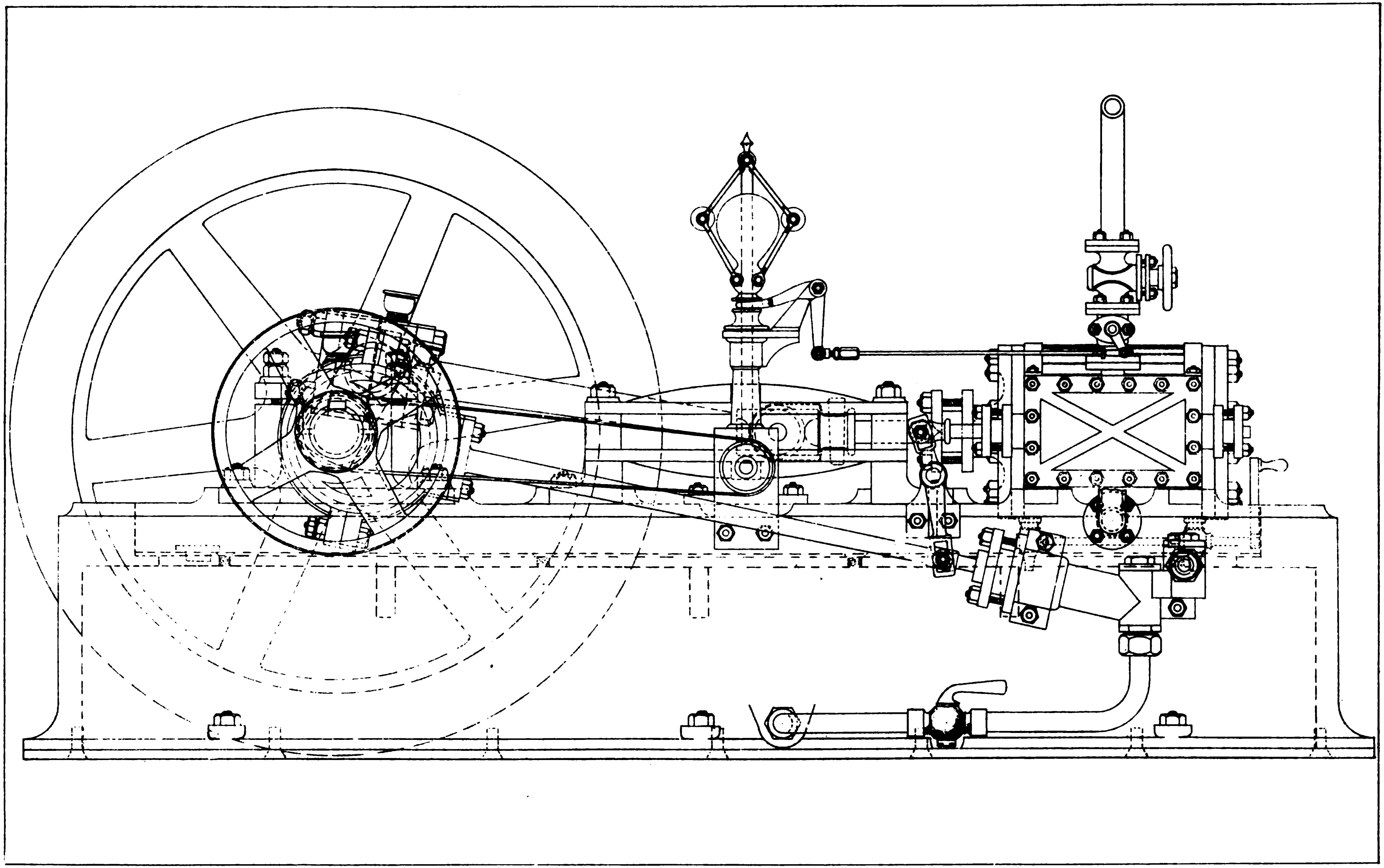
Sprague & Cº 22, Martins Lane Cannon St. E.C.

WOOD TURNER'S LATHE.



Whiteman & Bass Photo-Litho London

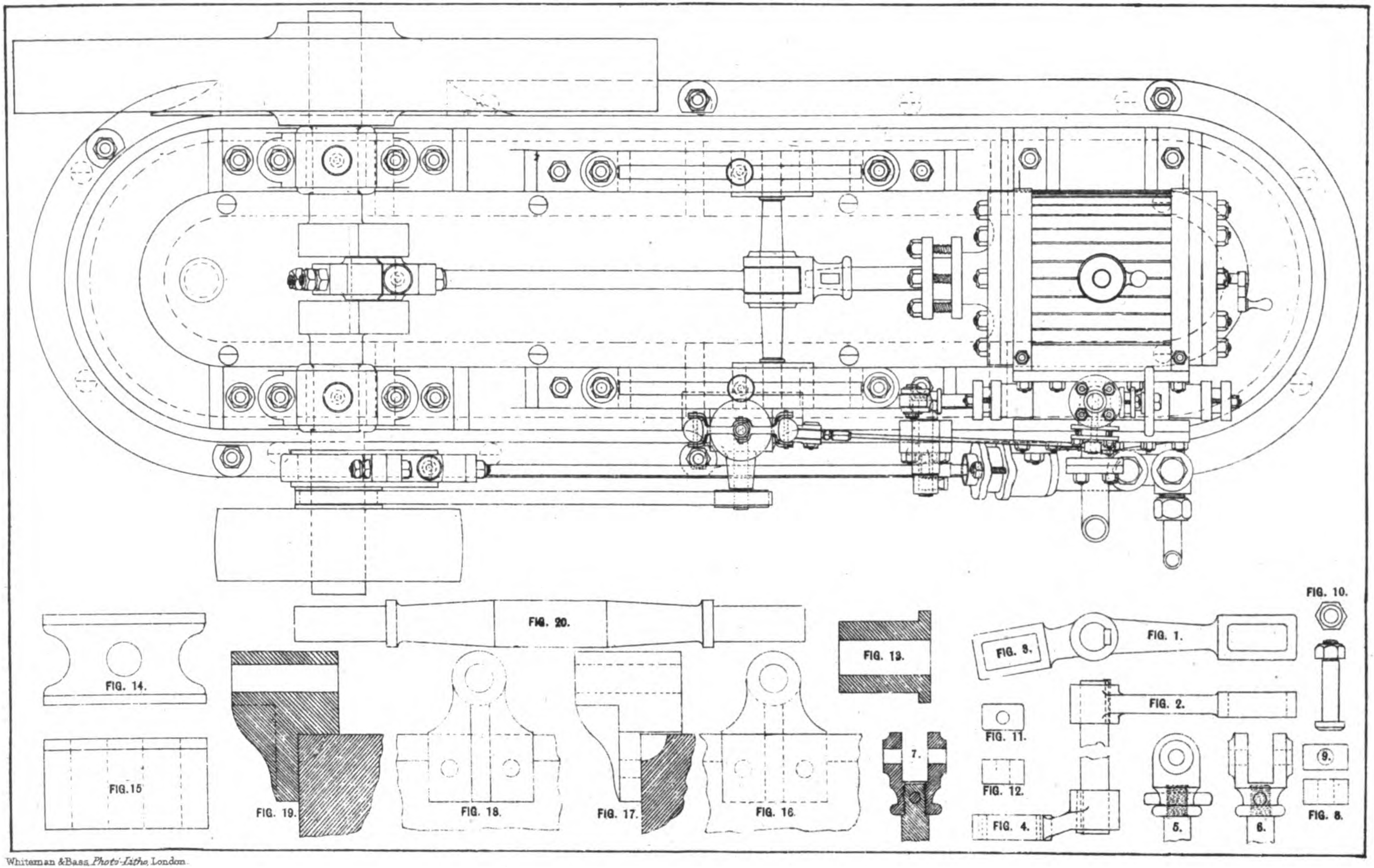
THE AMATEUR WOOD TURNER — GOUGES, CHISELS AND WORK.



Whiteman & Bass Photo-Litho London

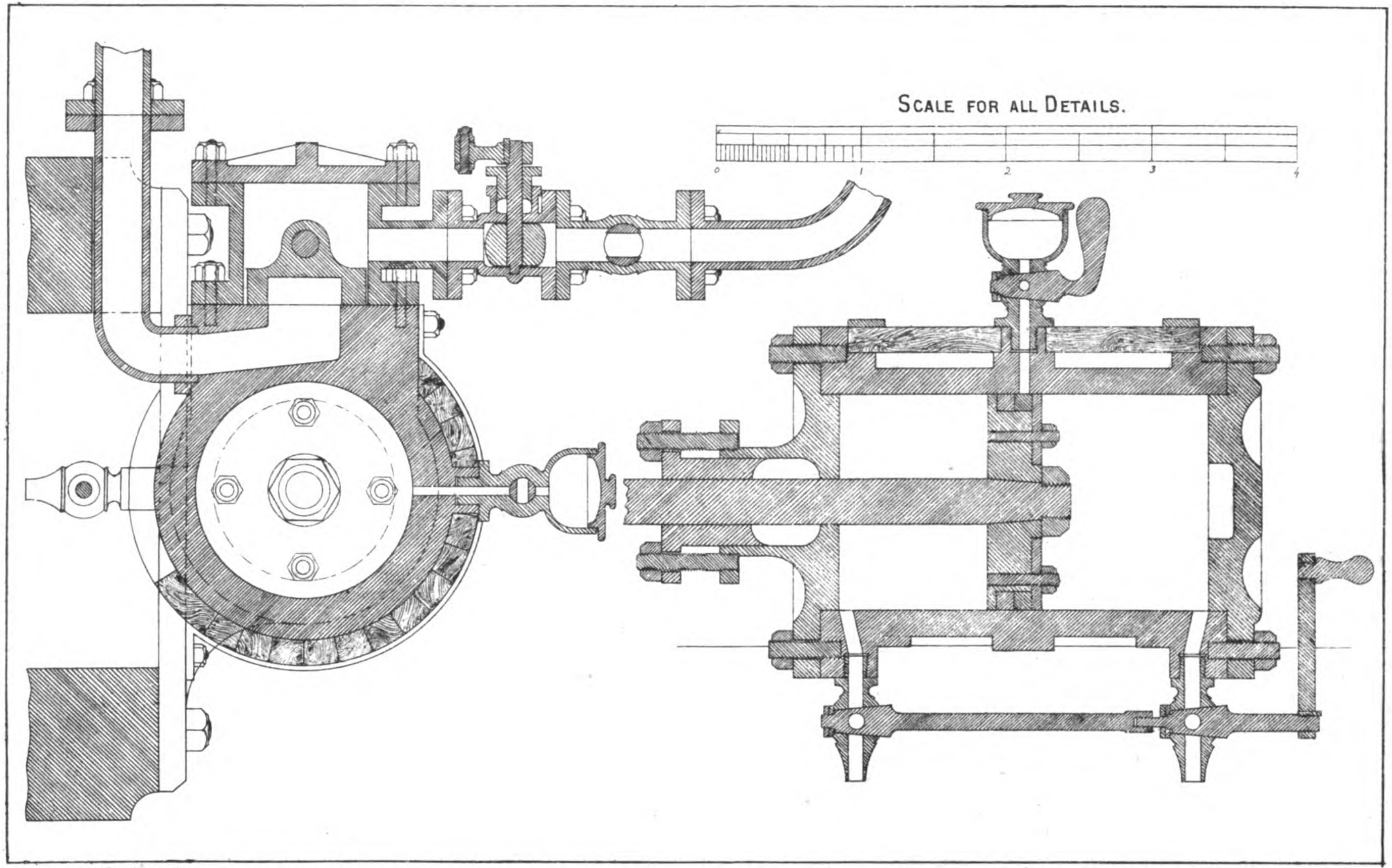
MODEL HORIZONTAL STEAM ENGINE — ELEVATION.

AMATEUR MECHANICS.



Whiteman & Bass *Photo-Litho*, London.

MODEL HORIZONTAL STEAM ENGINE: PLAN & DETAILS.



Whiteman & Bass Photo-Litho, London.

MODEL HORIZONTAL STEAM ENGINE.—SECTIONS OF CYLINDER.

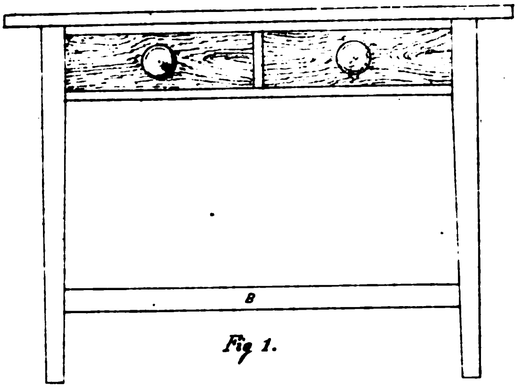


Fig 1.

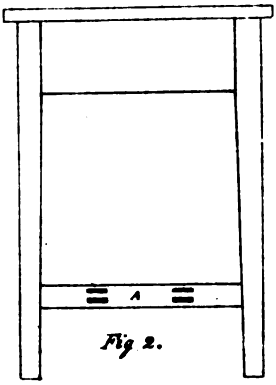


Fig 2.

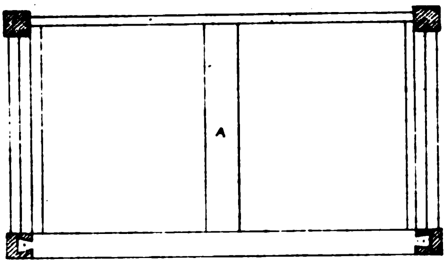


Fig 7.

Fig 8.

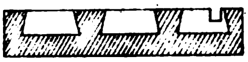


Fig 9.

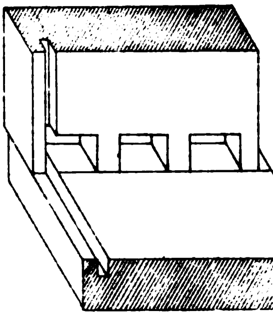


Fig 10.

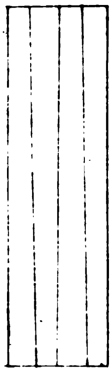


Fig 3.

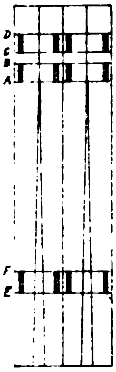


Fig 4.

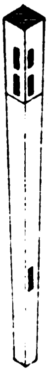


Fig 5.

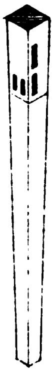


Fig 6.

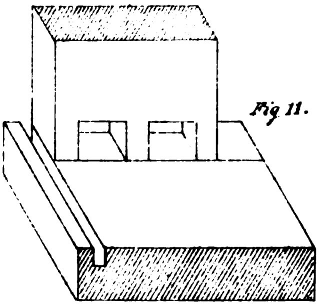


Fig 11.

Fig 12.

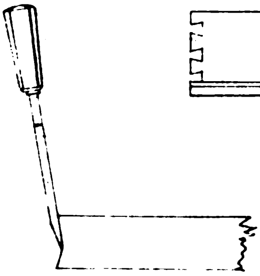


Fig 13.

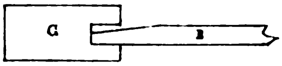


Fig 14.

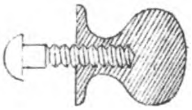
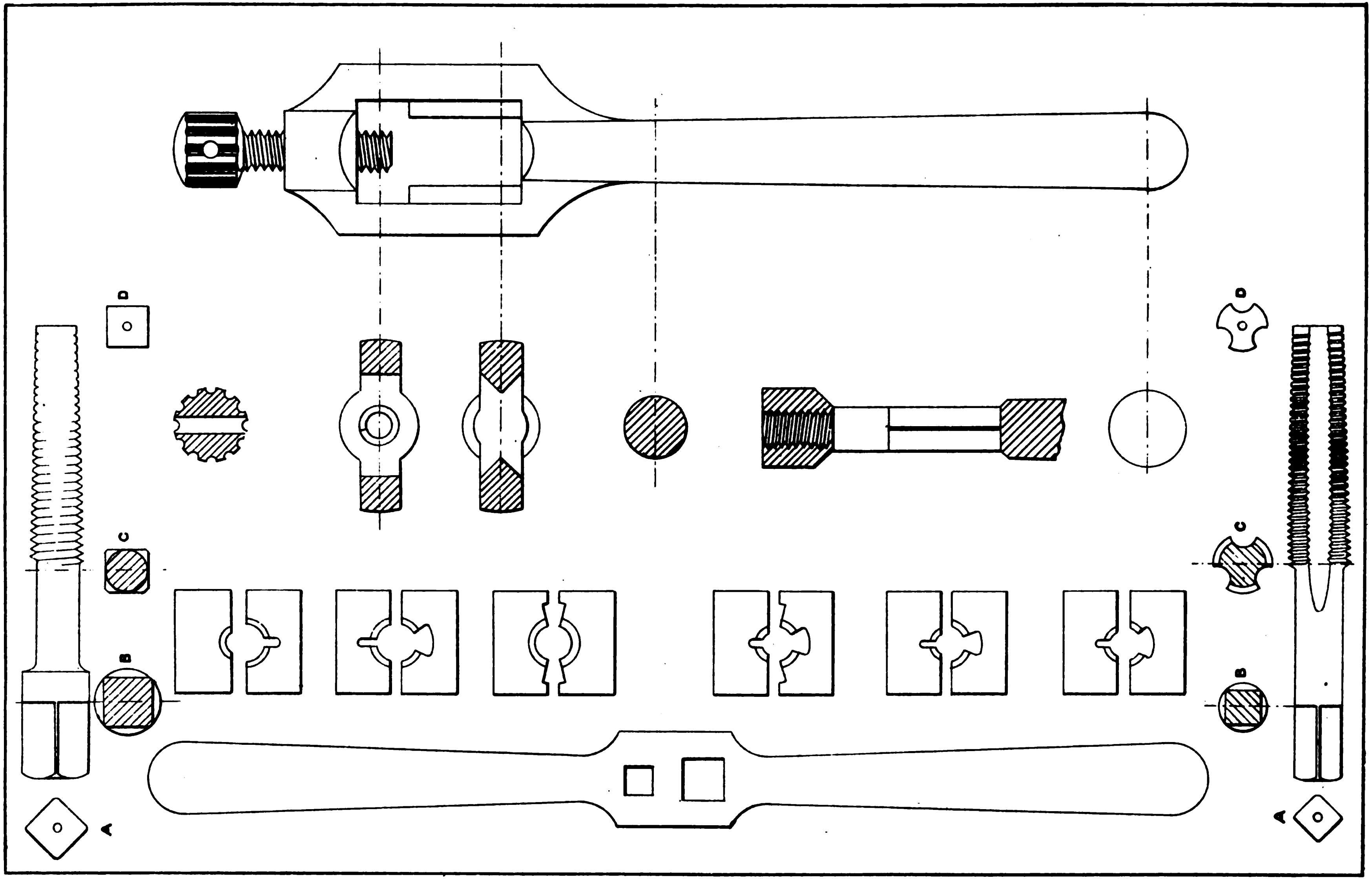


Fig 15.

PHOTO-LITHO. SPRAGUE & Co. LONDON.

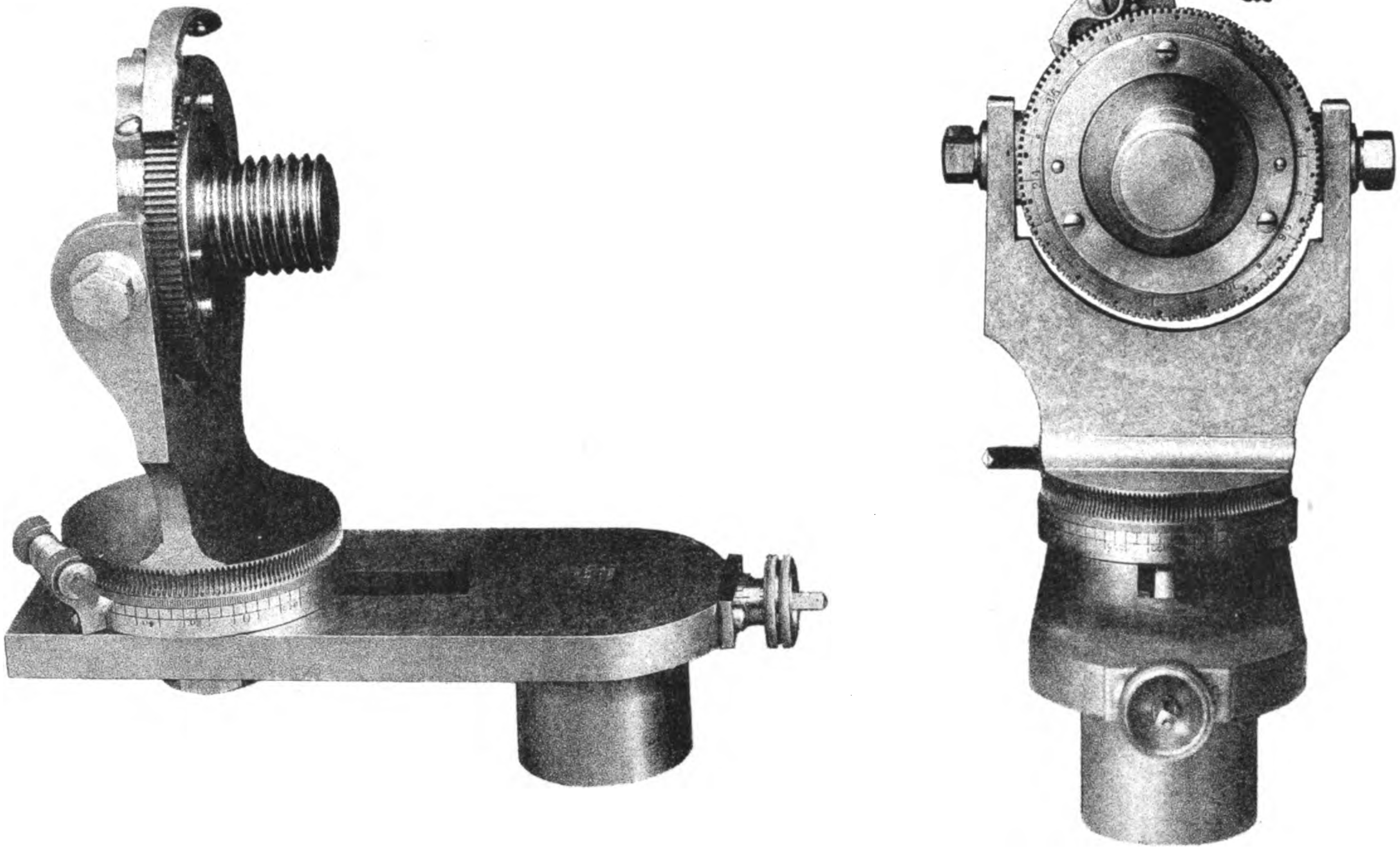
A KITCHEN TABLE.

AMATEUR MECHANICS.



Whiteman & Bass Photo Litho London

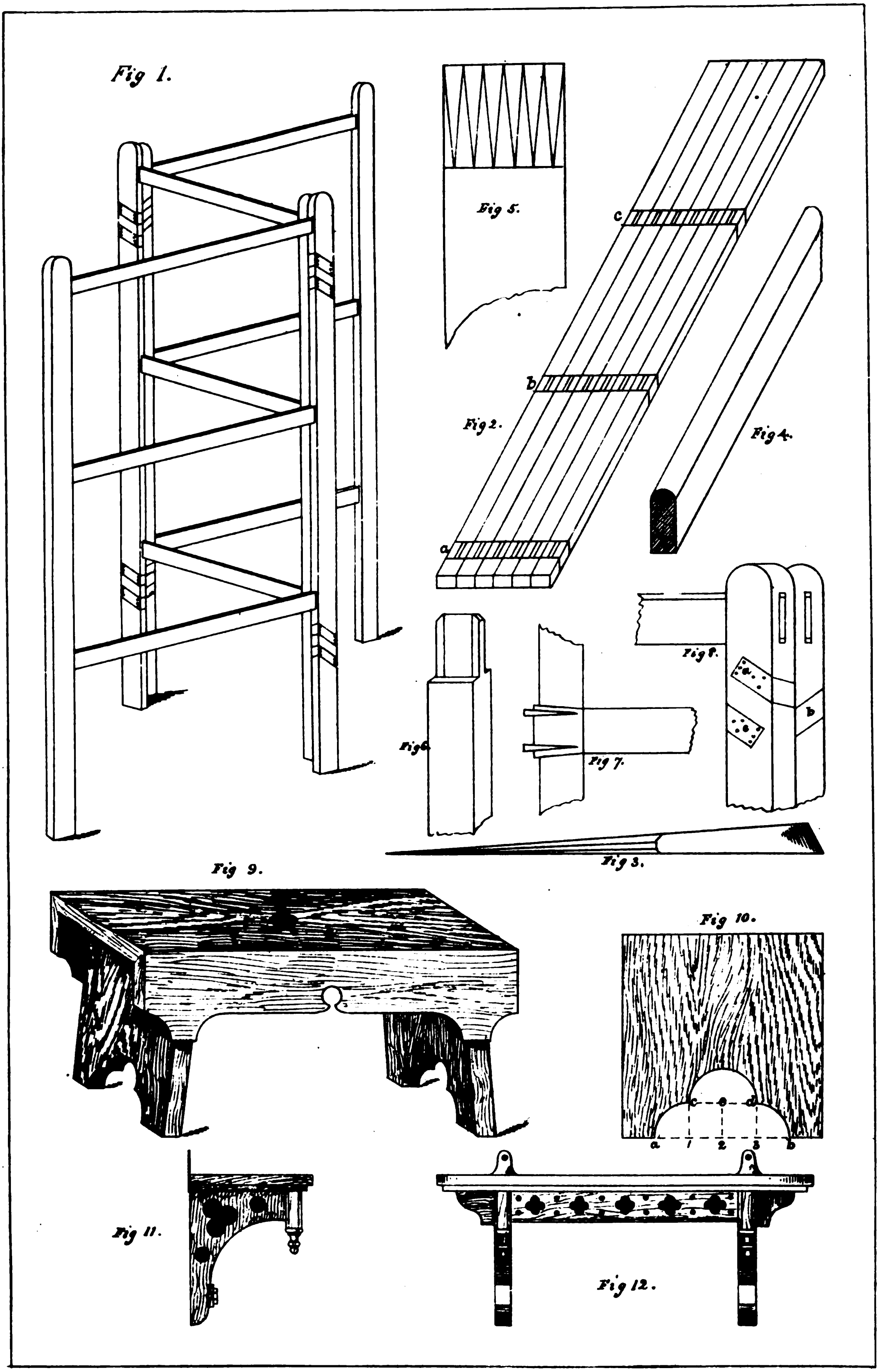
SCREWING APPARATUS.



"INK-PHOTO". SPRAGUE & Cº. LONDON.

FROM A PHOTO BY THE MANCHESTER PHOTOTYPE Cº

UNIVERSAL DOME CHUCK.



Whiteman & Bass Photo-Litho London

CLOTHES HORSE, BUFFET STOOL AND BRACKET.

Fig. 1.—Eccentric Cam, Eccentric Cutter 4 turns cut, Slide Rest 12.

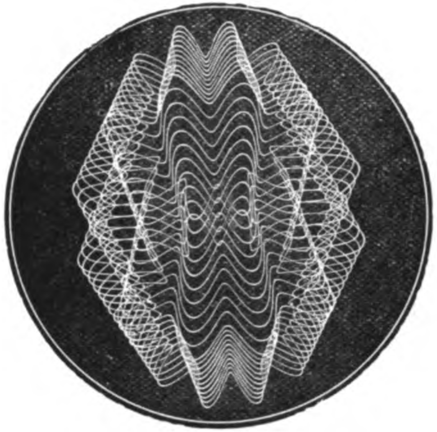


Fig 2.—Eccentric Chuck.

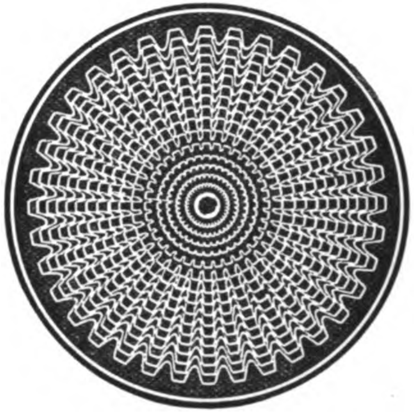


Fig 3.—Stop used on Slide Rest to shorten the stroke at each cut.

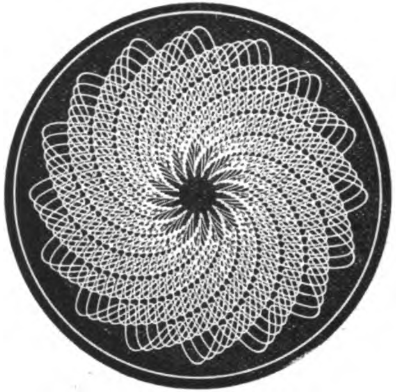


Fig. 4.—Twisted by Dividing Wheel on Chuck.

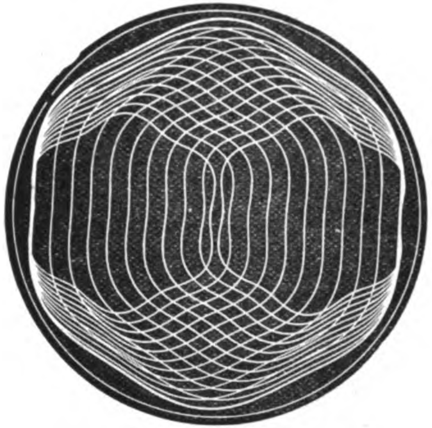


Fig. 5.—Eccentric Chuck, cuts at 48 and 96.

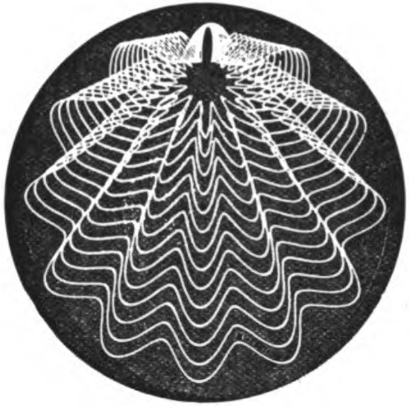
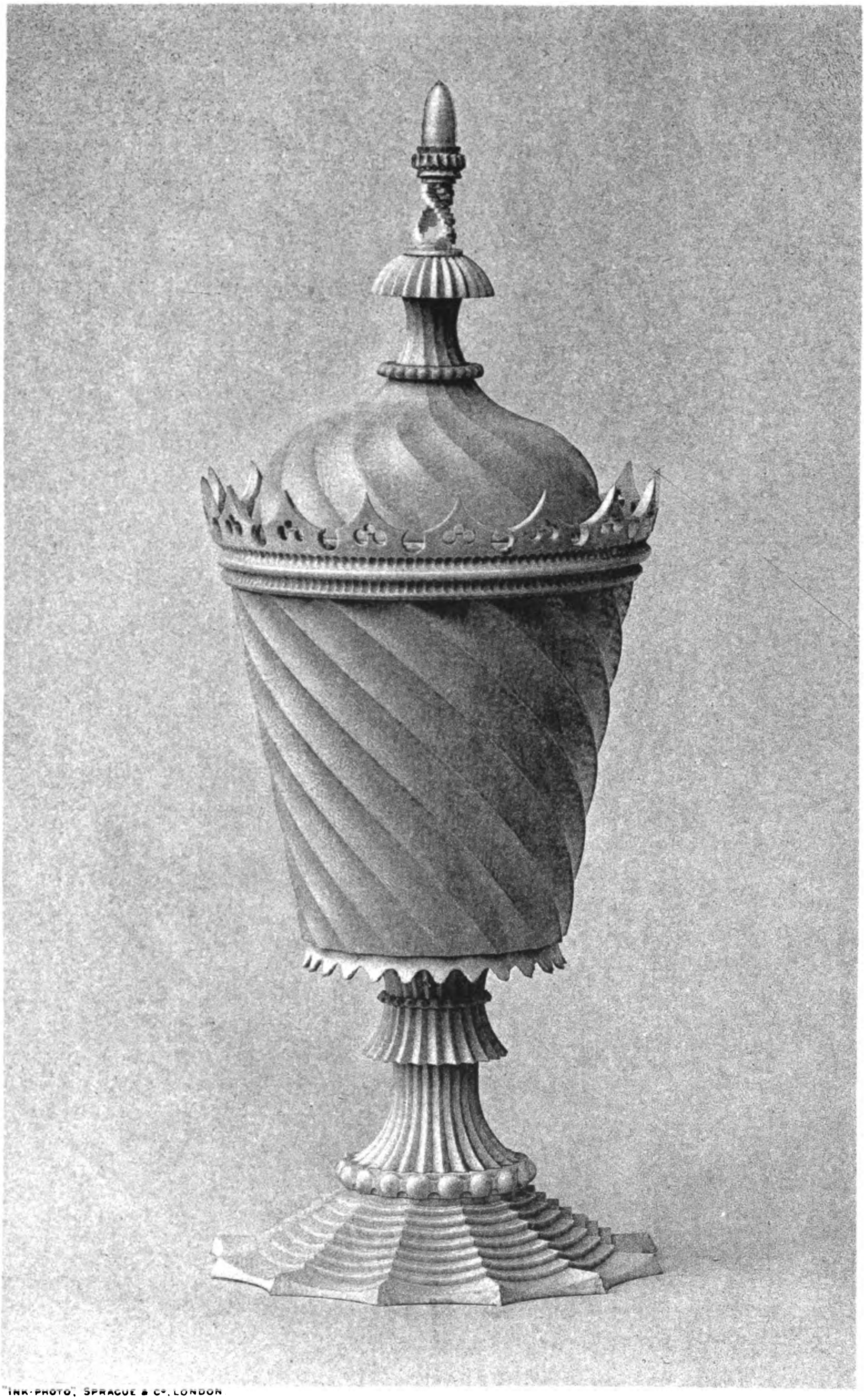
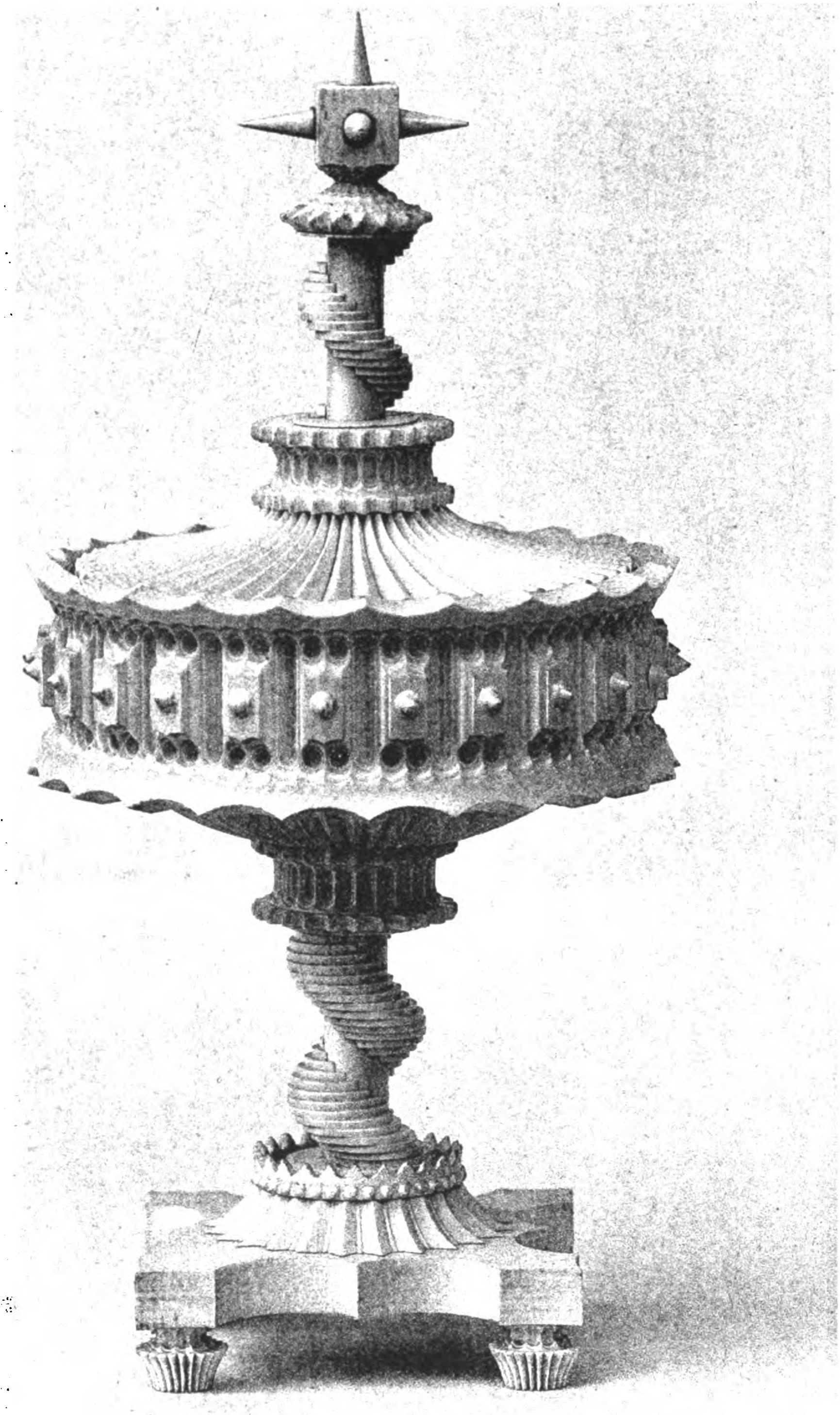


Fig 6.—Oval Cam, Eccentric Chuck, producing shell pattern.

GEOMETRIC FIGURES CUT BY CAPT. DAWSON'S SLIDE-REST.



SPIRAL FLUTED IVORY CUP & COVER.



"INK-PHOTO", SPRAGUE & Cº. LONDON

SPECIMEN OF ORNAMENTAL TURNERY IN IVORY.

Swivel Tool-holders.

Fig. 1.

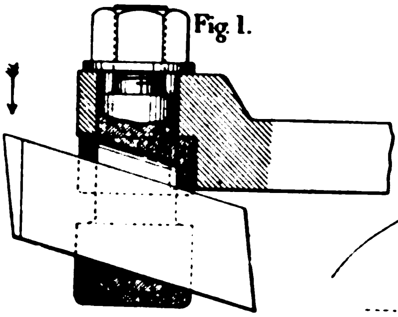


Fig. 7.

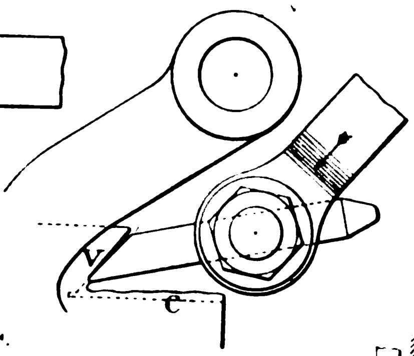


Fig. 9A.
Scale 1 to 8.

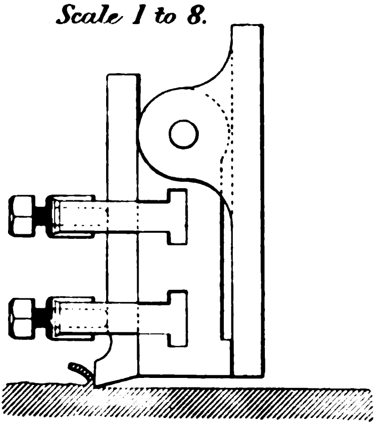


Fig. 2.

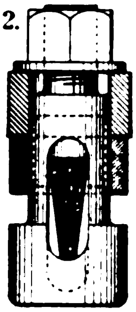


Fig. 4.

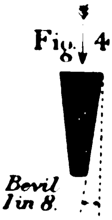


Fig. 9.

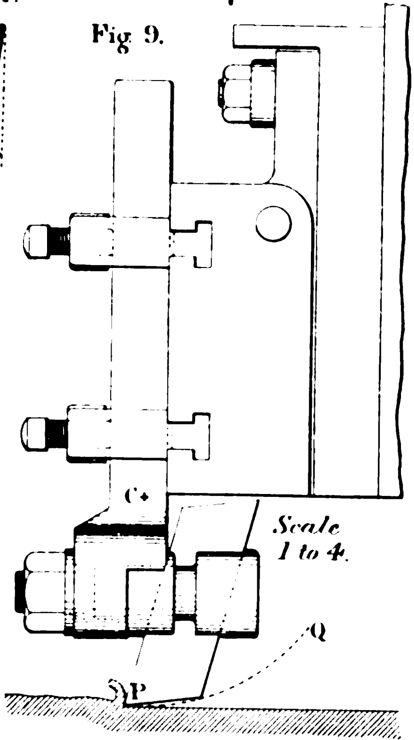


Fig. 9B.
Scale 1 to 8.

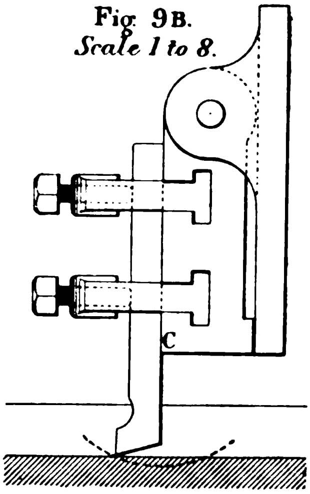


Fig. 3.

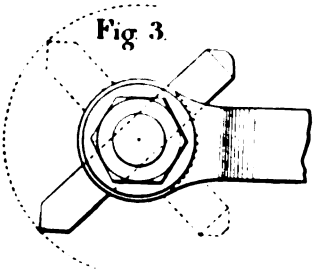
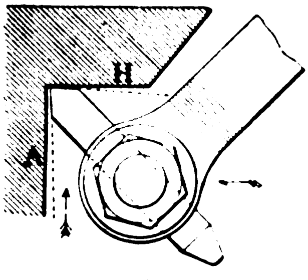


Fig. 5.



Tool-holder for Planing Machines.

Fig. 6.

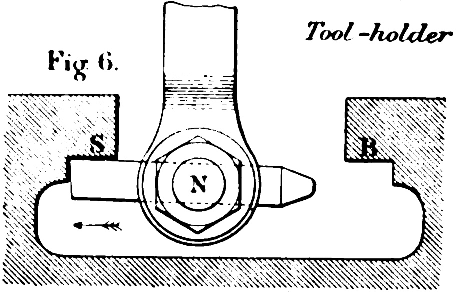


Fig. 10.

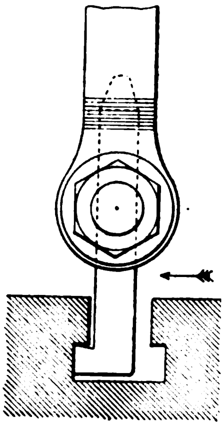


Fig. 8.

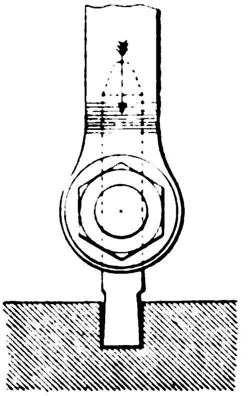
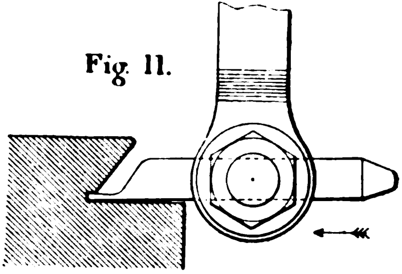


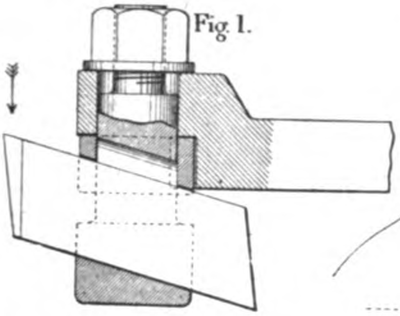
Fig. 11.



CUTTING METALS.—Figs. 1 to 11.

AMATEUR MECHANICS.

Fig. 1.



Swivel Tool-holders.

Fig. 7.

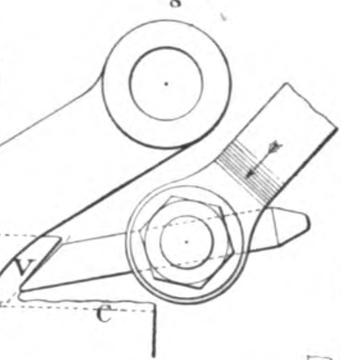


Fig. 9A.
Scale 1 to 8.

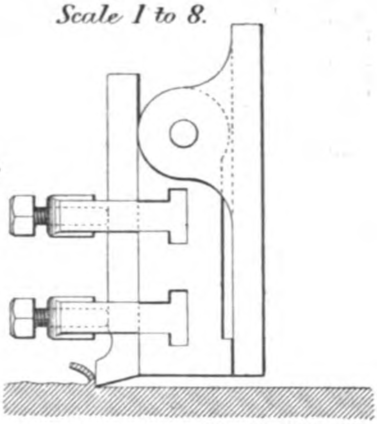


Fig. 2.

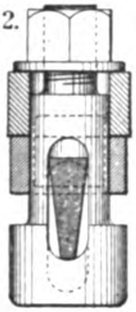


Fig. 4.

Fig. 9.

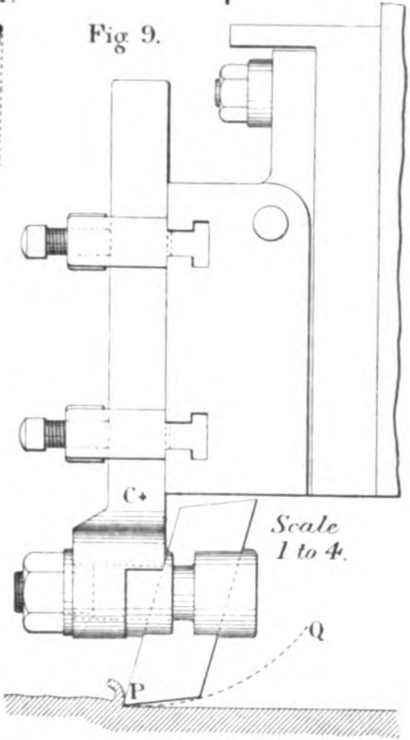


Fig. 3.

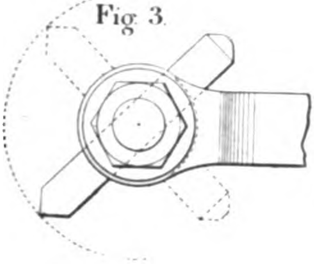


Fig. 9B.
Scale 1 to 8.

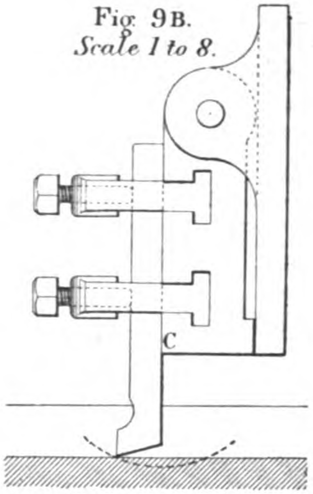
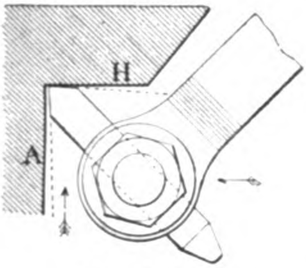


Fig. 5.



Tool-holder for Planing Machines.

Fig. 6.

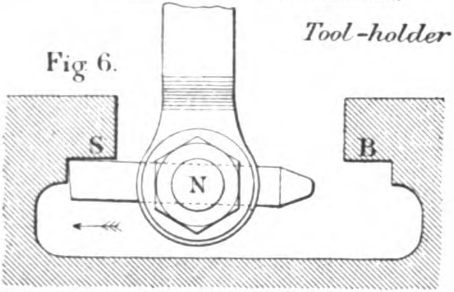


Fig. 10.

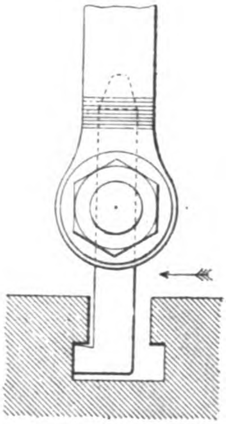


Fig. 8.

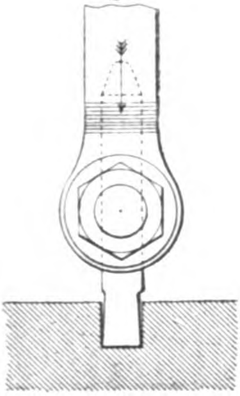
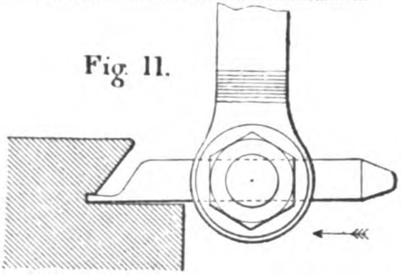


Fig. 11.



CUTTING METALS.—Figs. 1 to 11.

Tool-holder for Screw-cutting Lathes

Fig. 12.

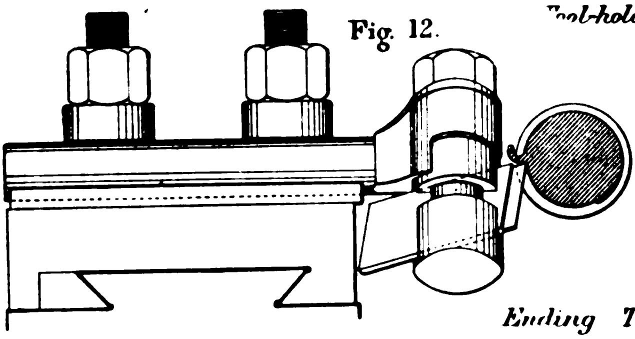
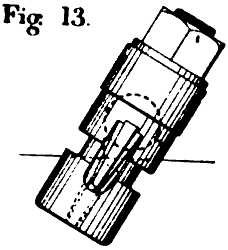


Fig. 13.



Ending Tool-holder.

Fig. 16.

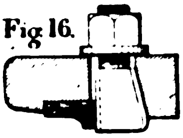


Fig. 15.

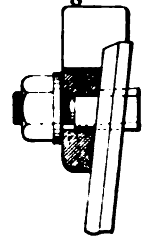


Fig. 14.

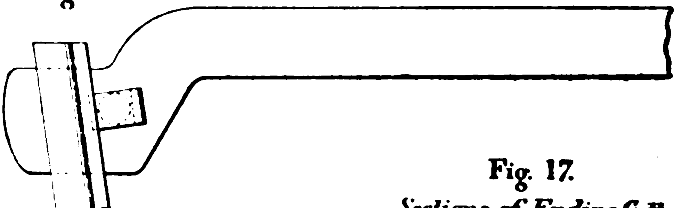


Fig. 17.

Sections of Ending Cutters.

Scale 1 to 2.

Parting Tool-holder.

Fig. 19.

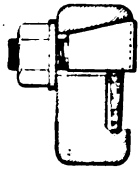


Fig. 18.

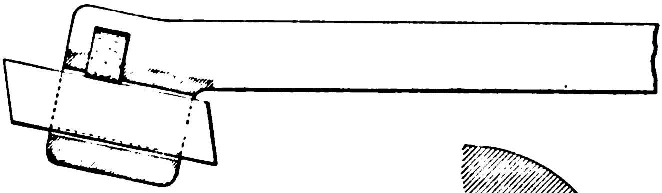


Fig. 20.

Scale 1 to 4.

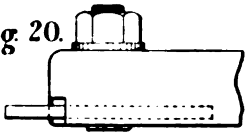
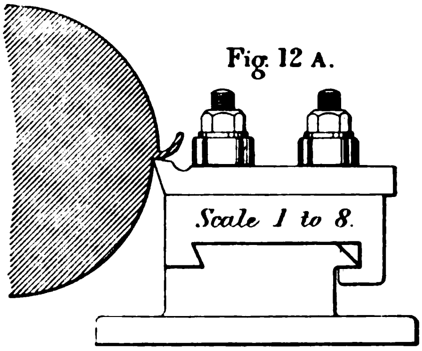


Fig. 12 A.



Scale 1 to 8.

Fig. 22. *Angle Gauge for Swivel Cutters.*

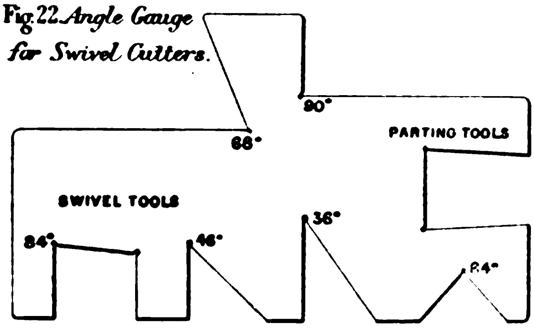


Fig. 23. *Angle Gauge for Round Cutters.*

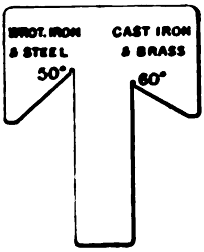
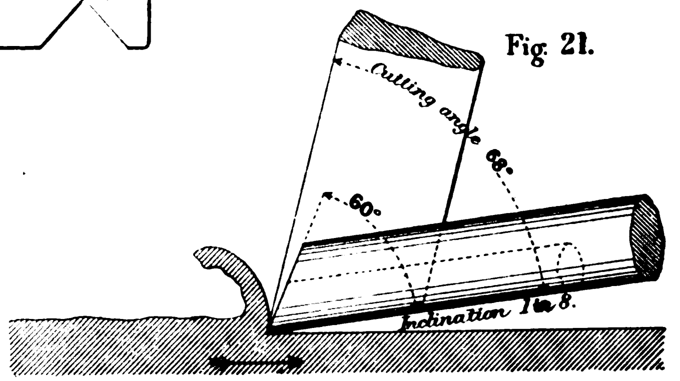


Fig. 21.



CUTTING METALS.—Figs. 12 to 23.

Fig. 24.

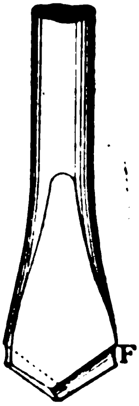


Fig. 25.

Drills.

Fig. 26.

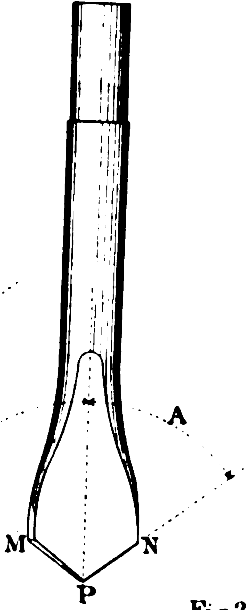


Fig. 27.

Fig. 27A.

Fig. 29.

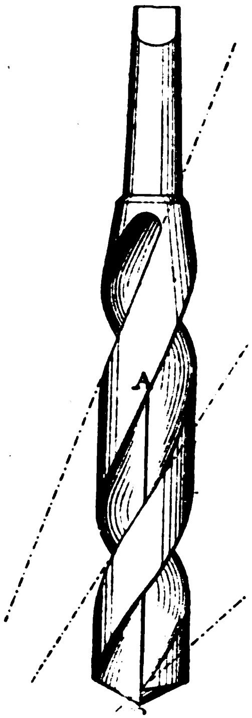


Fig. 30.

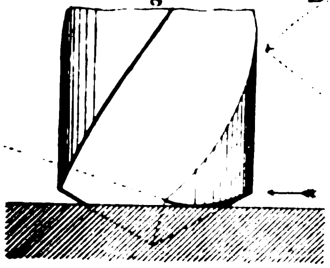


Fig. 28A.

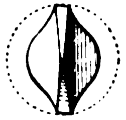


Fig. 28.

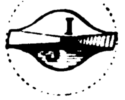


Fig. 33.

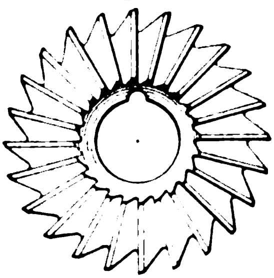


Fig. 31.

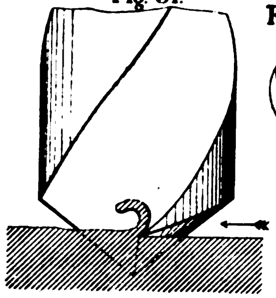


Fig. 29A.

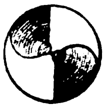


Fig. 32.

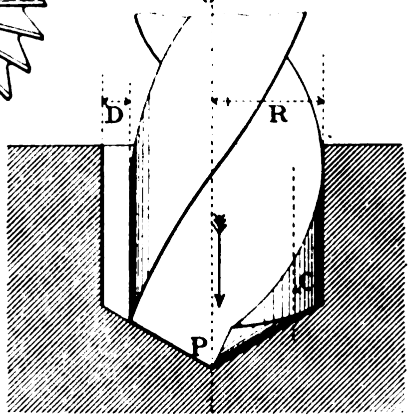


Fig. 34.

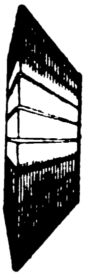


Fig. 35.

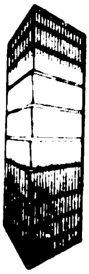


Fig. 39.

Method of Grinding Cutters.

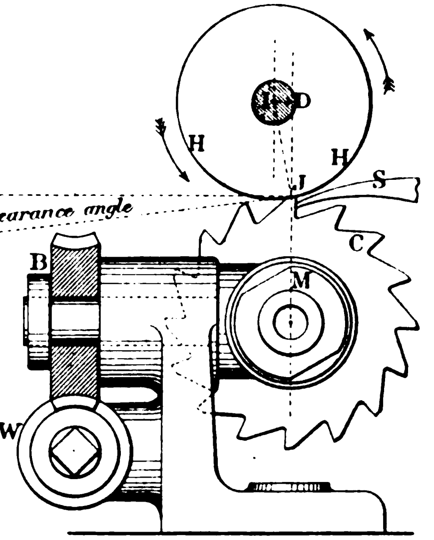


Fig. 36.

Fig. 37.

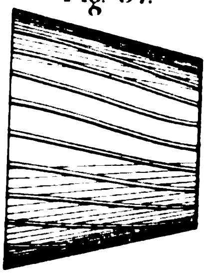
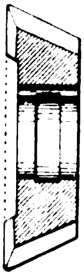


Fig. 38.



CUTTING METALS.—Figs. 24 to 39.

Fig. 40.

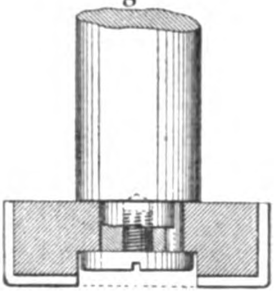


Fig. 41.

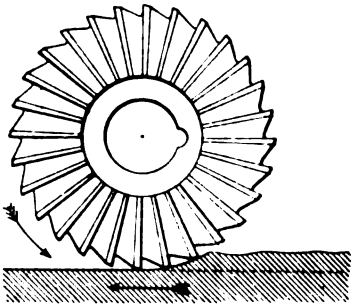


Fig. 42.

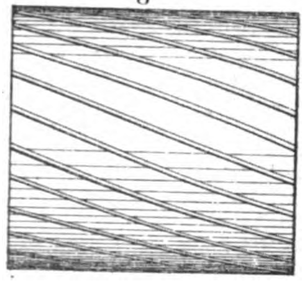


Fig. 47. *French Milling Cutter. Scale 1 to 2.*

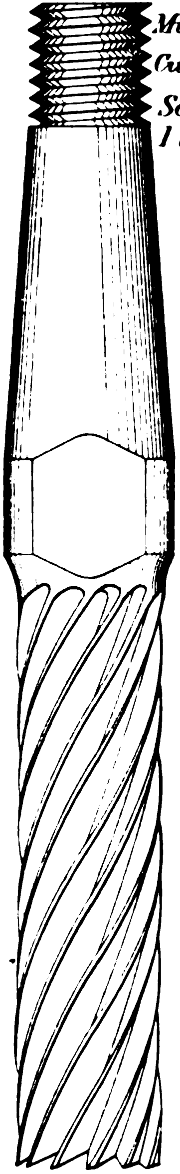


Fig. 46. *Grooved Milling Cutter.*

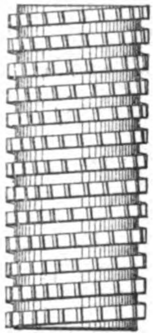
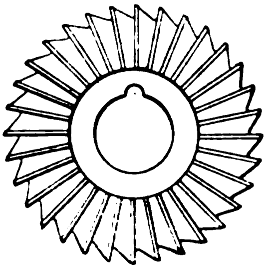


Fig. 43.



Milling Cutters

Fig. 44.

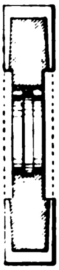


Fig. 45.

Fig. 50. *Elevation.*

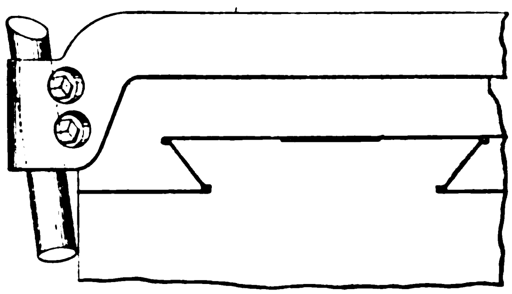
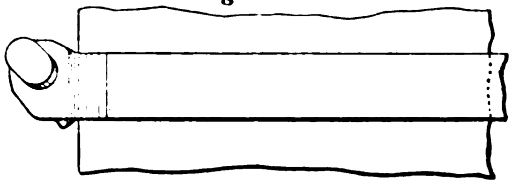


Fig. 51. *Plan.*



Tool-holders with slight overhang

Fig. 52. *Plan.*

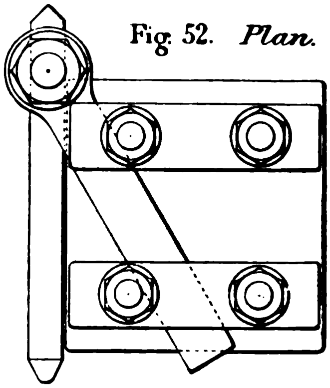


Fig. 49. *Section of Flute, French Cutter. Full size.*

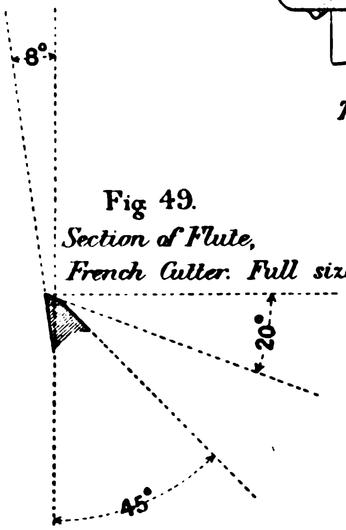
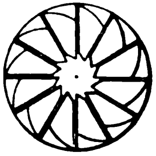
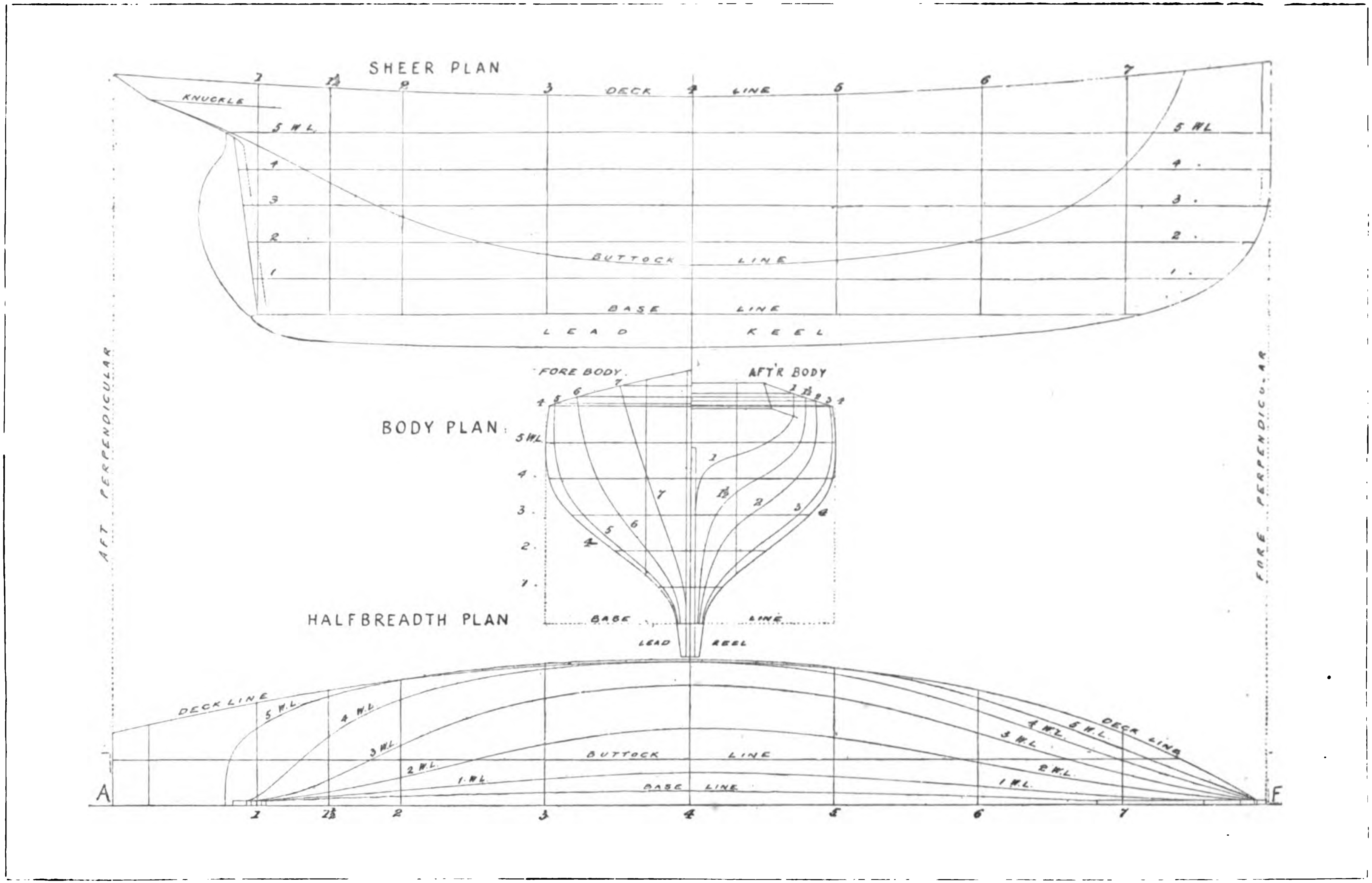


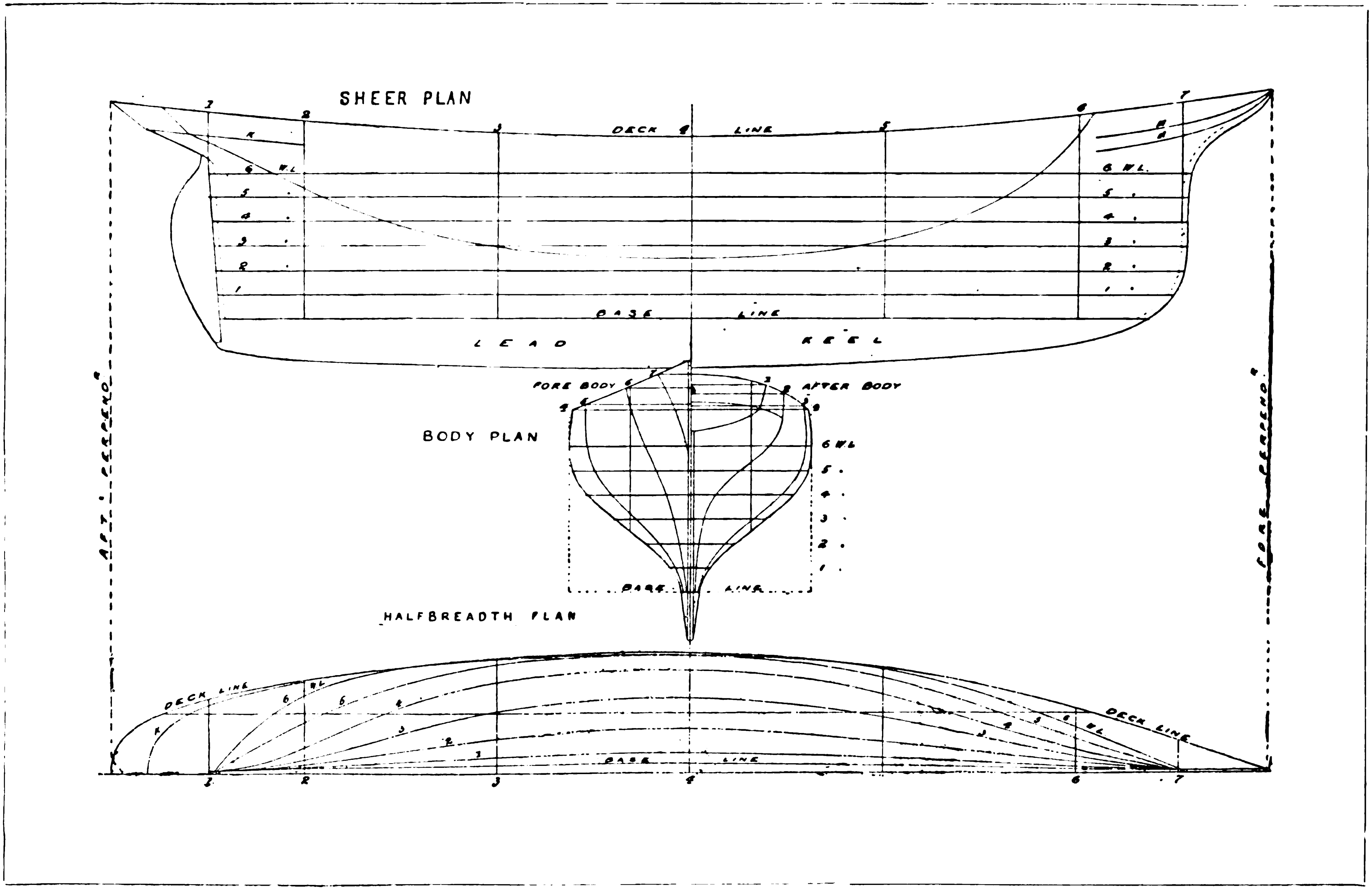
Fig. 48.



CUTTING METALS.—Figs. 40 to 52.



MODEL YACHTS.—PLATE I.



MODEL YACHTS.—Plate II.

Fig. 1 BLOCK METHOD

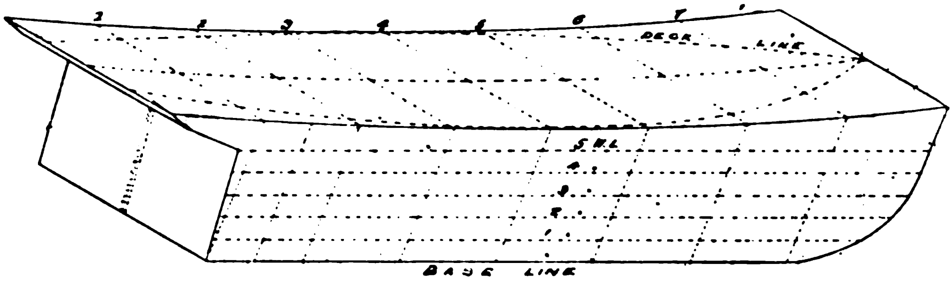


FIG. 2. BREAD AND BUTTER METHOD.

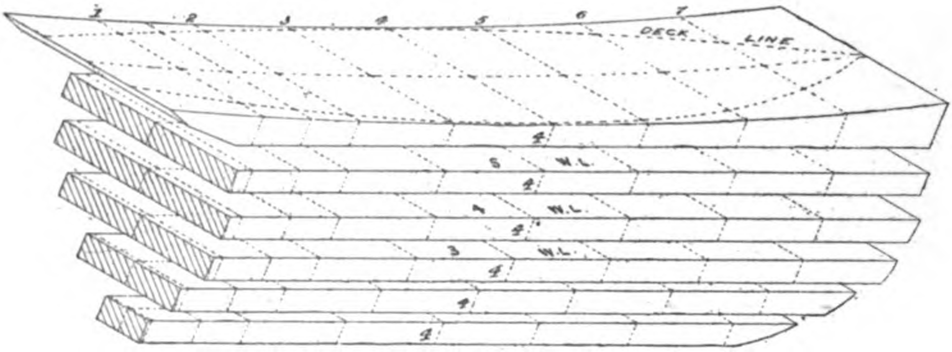


FIG. 4.

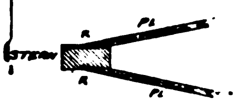


FIG. 5.

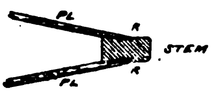


FIG. 3. WOOD-BUILT METHOD

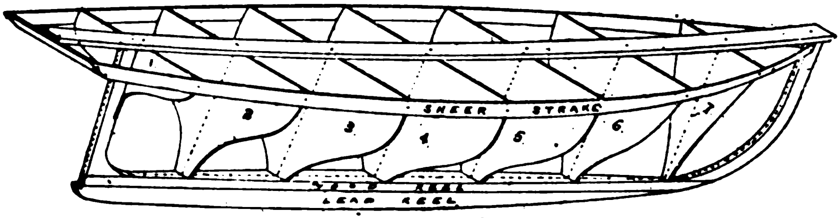


FIG. 6 WOOD-BUILT

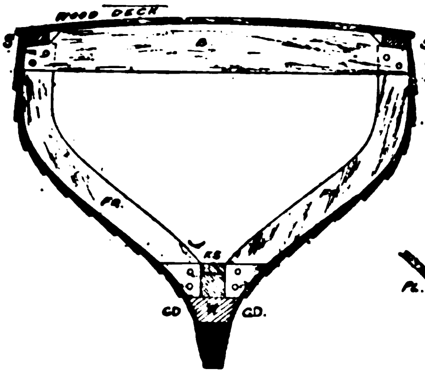


FIG. 7 TIN-BUILT

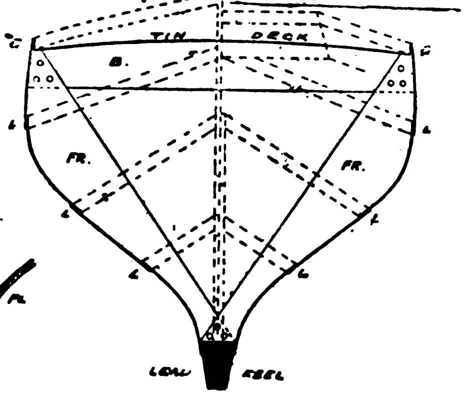
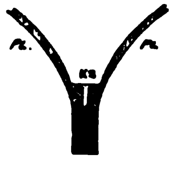


FIG. 8



MODEL YACHTS.—PLATE III.

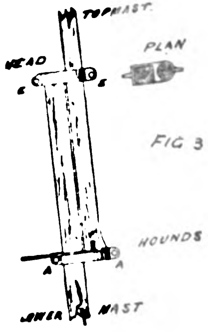


FIG 3

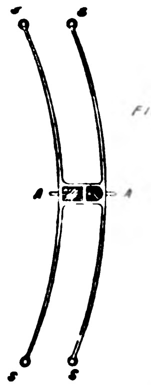


FIG 4

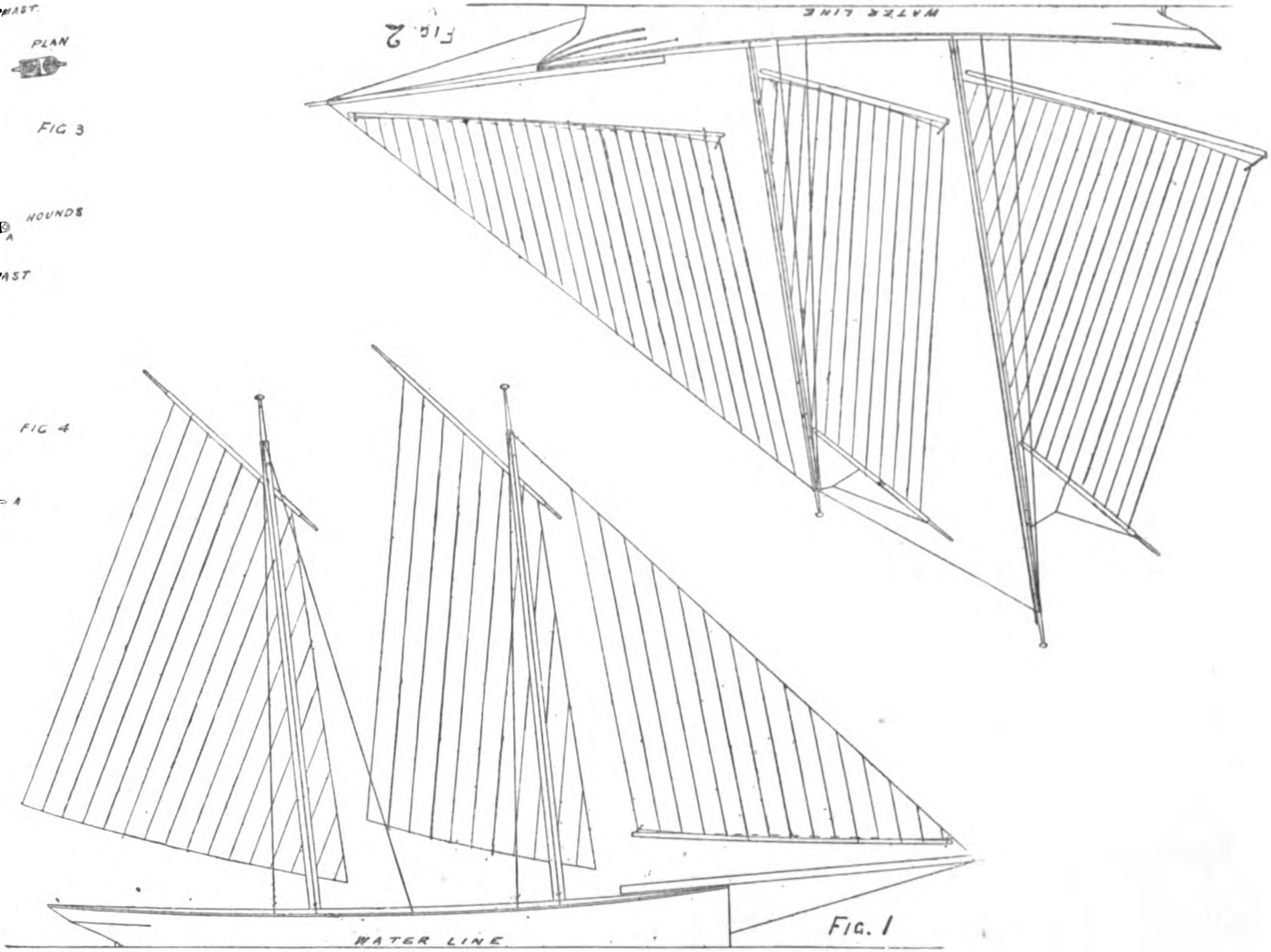
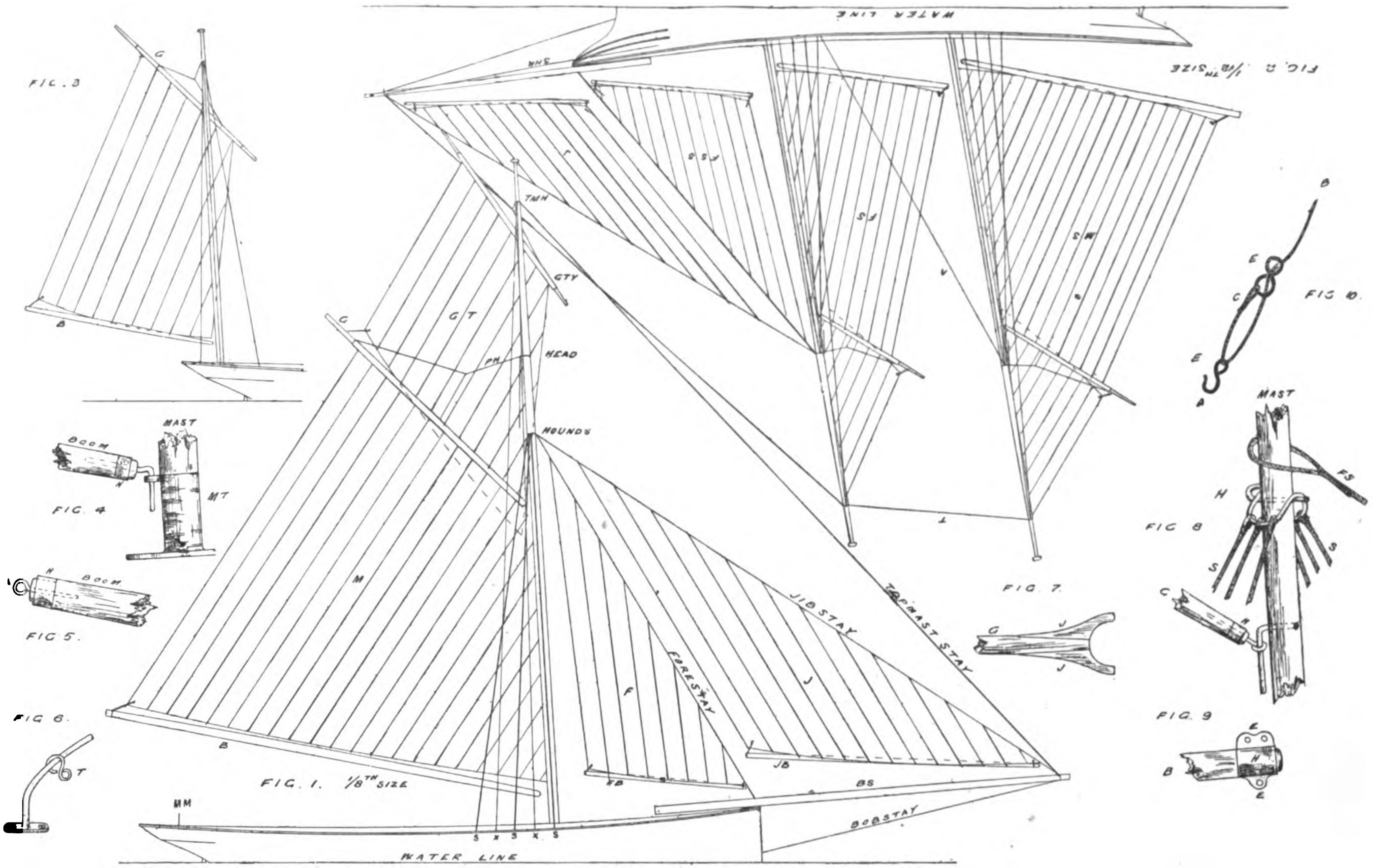


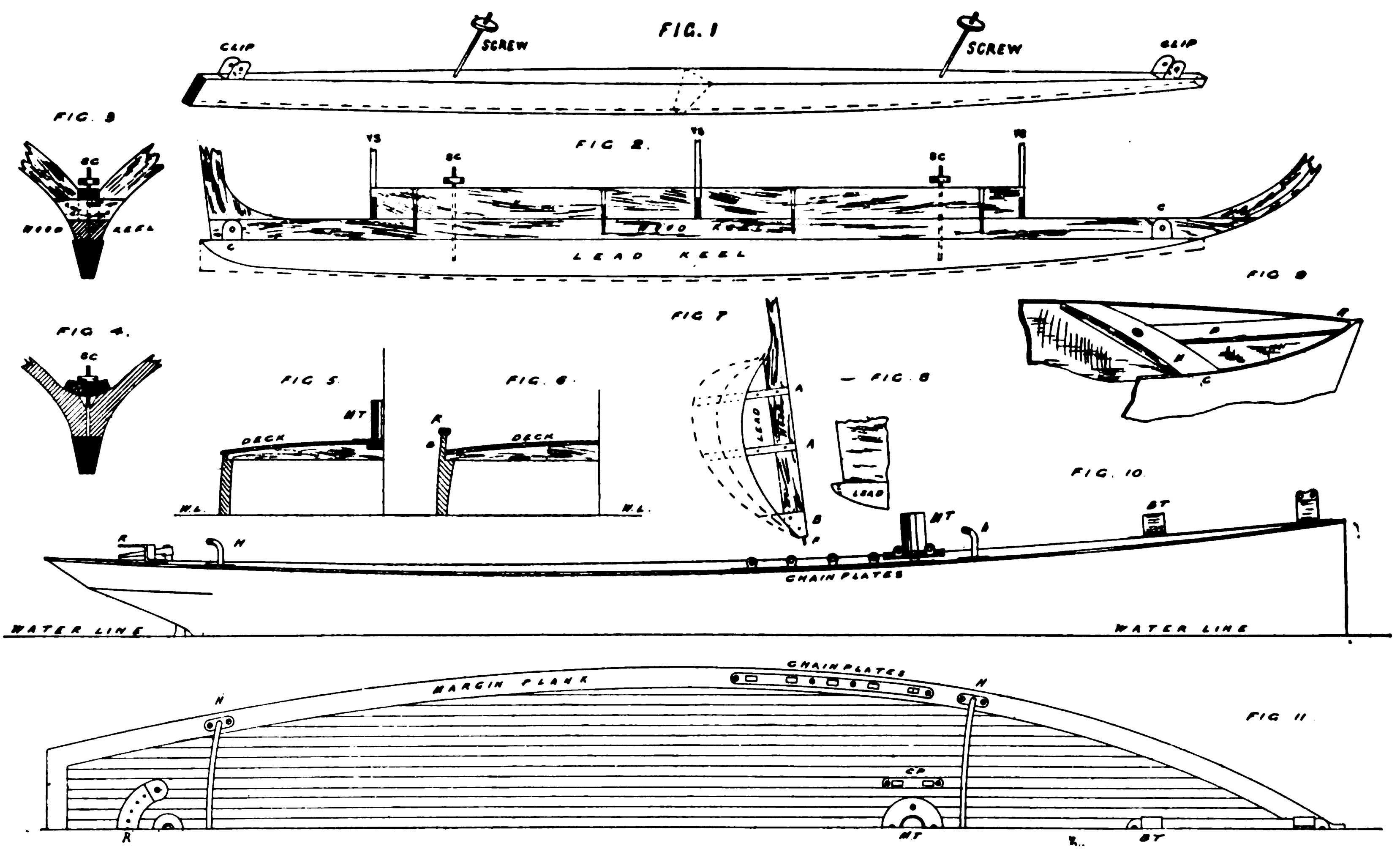
FIG. 2

FIG. 1

MODEL YACHTS.—PLATE IV.

AMATEUR MECHANICS.

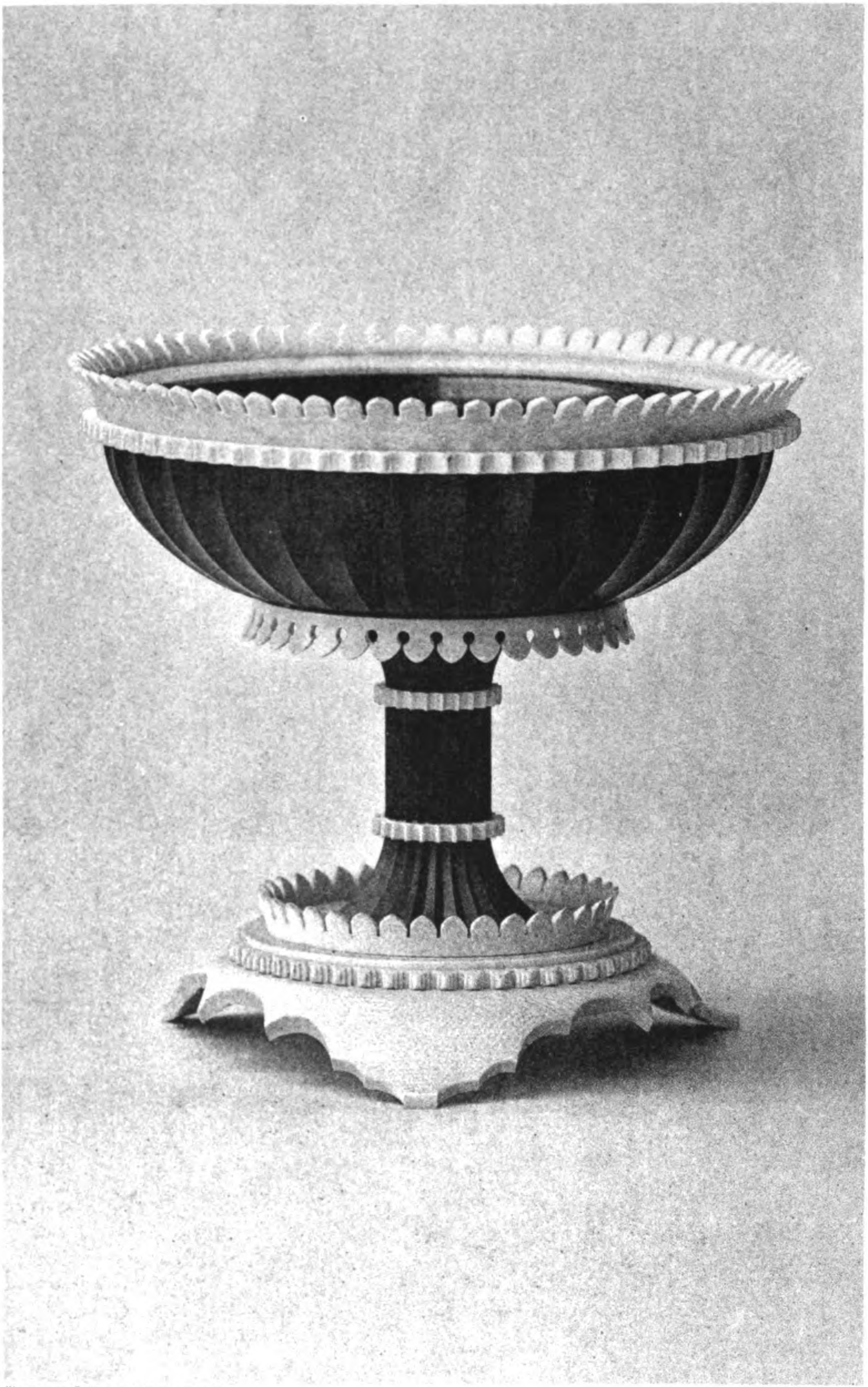




MODEL YACHTS.—PLATE VI.

INK-PHOTO, SPRAGUE & Co. LONDON

FLUTED IVORY VASE.



"INK-PHOTO", SPRAGUE & Cº LONDON

TAZZA IN BLACK WOOD AND IVORY.

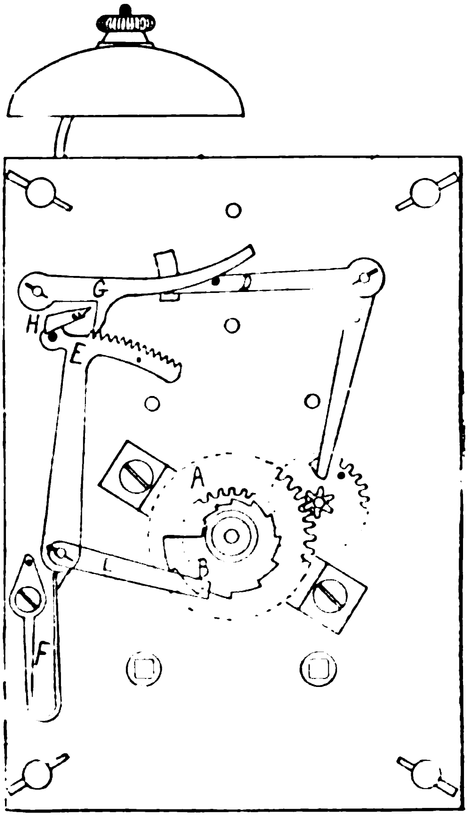


Fig. 1.—Back Plate of Eight Day English Clock.

Fig. 6.—Chamfering Tool with wheel.

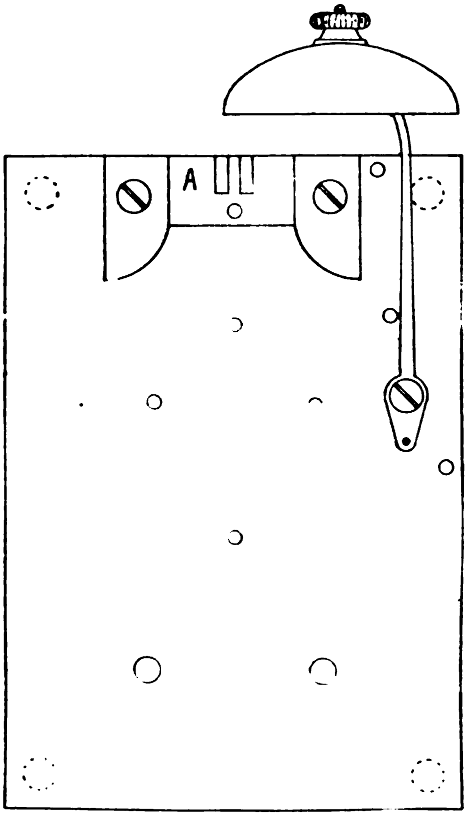


Fig. 2.—Front or Top Plate of Eight Day English Clock (dial removed).

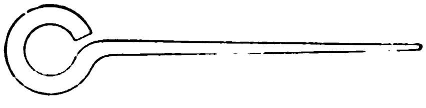


Fig. 3. -Examining Pin.

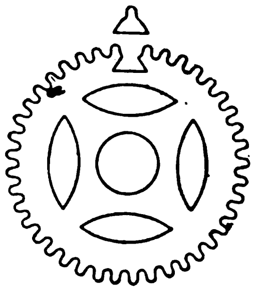


Fig. 4.—Replacing Broken Tooth.

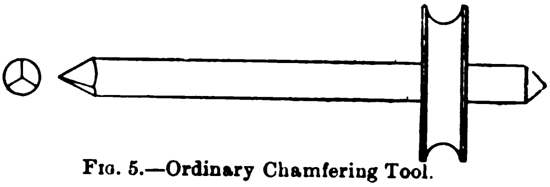


Fig. 5.—Ordinary Chamfering Tool.

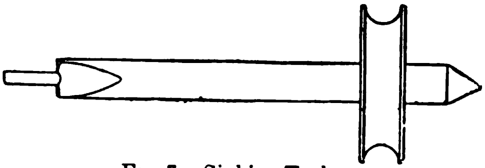


Fig. 7.—Sinking Tool.

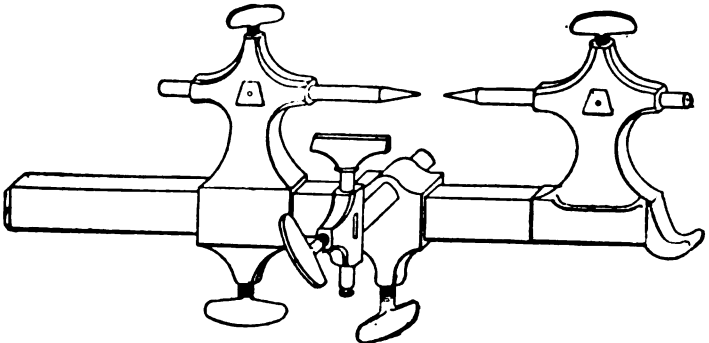


Fig. 8.—Turns.

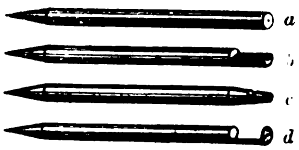


Fig. 9.—Centres of Turns

HOW TO REPAIR CLOCKS.—Figs. 1 to 9.

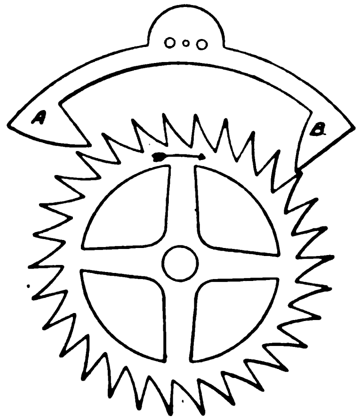


Fig. 10.—Escape Wheel and Pallets.

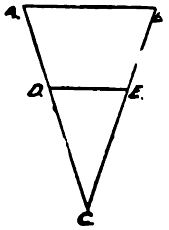


Fig. 11.—Proportion of Rack Tail and Rack.

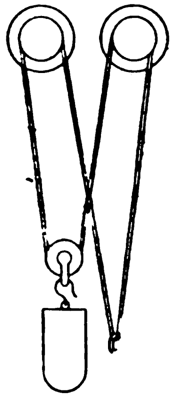


Fig. 12.—Endless Chain of Old English Clock.

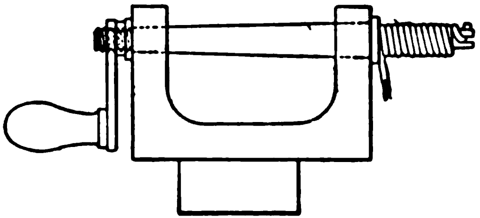
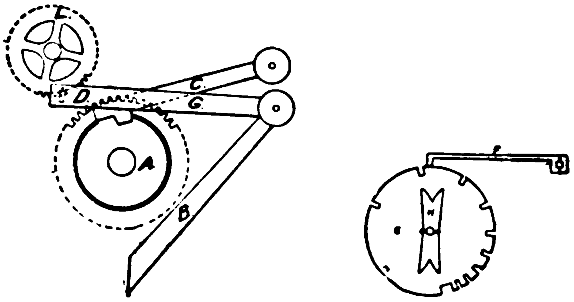


Fig. 13.—Tool for Making Clock Chain.



Figs. 14 & 15.—Locking Plate Mechanism.

Fig. 16.—Fastening Cat-gut to Barrel.

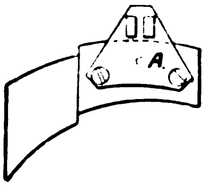


Fig. 18.—Arrangement for Spring Suspension.

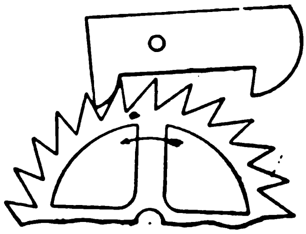


Fig. 17.—Escapement of Drum Timepiece.

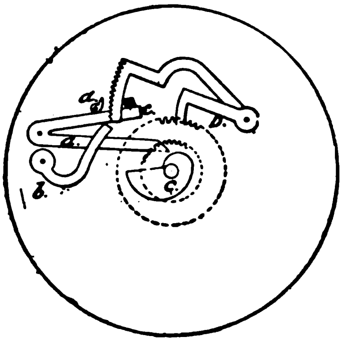


Fig. 19.—Rack Striking Arrangement of French Clocks.

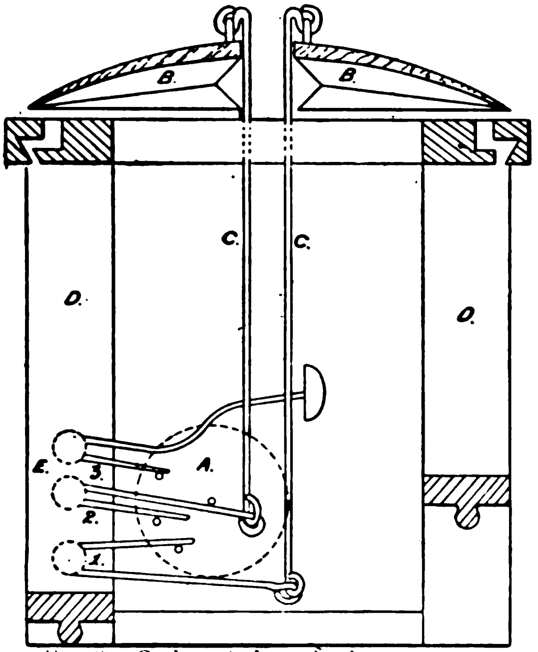


Fig. 20.—Cuckoo Clock, musical arrangement.

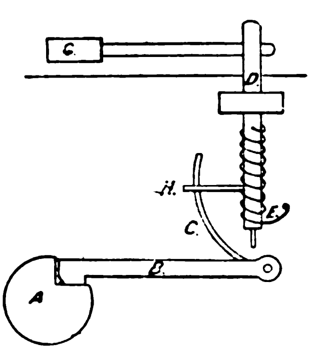


Fig. 21.—Cuckoo Clock, details.

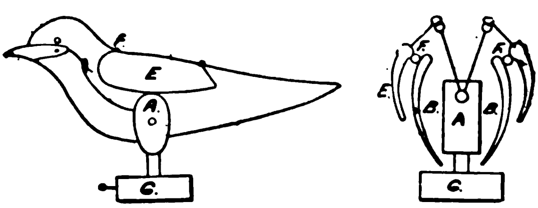


Fig. 22.—Mechanism of Cuckoo.

HOW TO REPAIR CLOCKS.—Figs. 10 to 22.

AMATEUR MECHANICS.

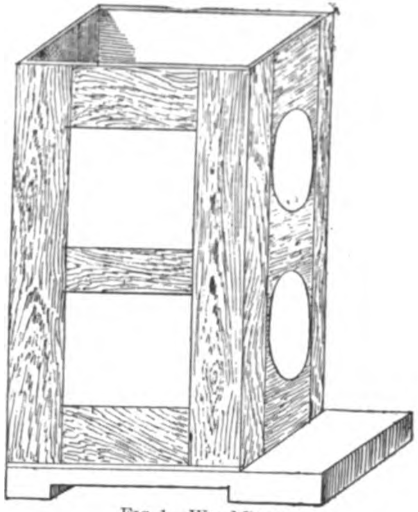


FIG. 1.—Wood Body

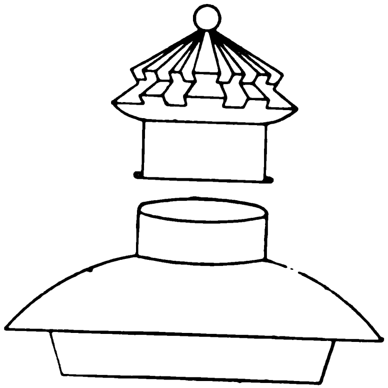


FIG. 11.—Hood and Cap.

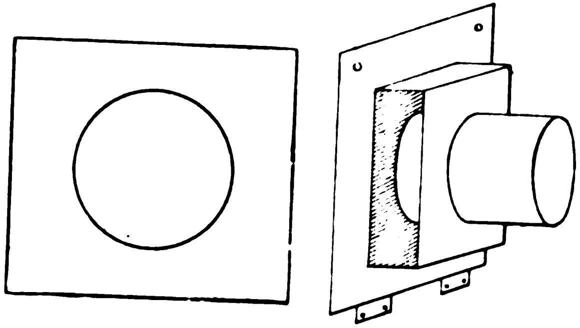


FIG. 9.—Slide Stage.

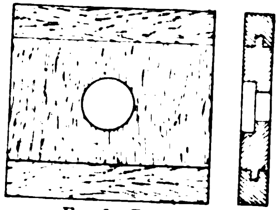


FIG. 8.—Doors.

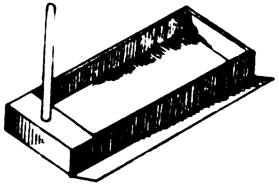


FIG. 7.—Tray.

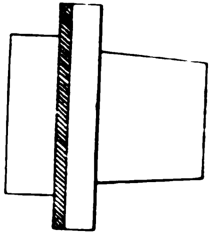


FIG. 10.—Slide Stage.

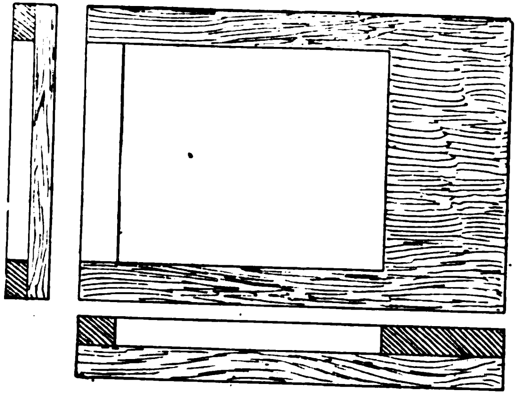


FIG. 2.—Bottom

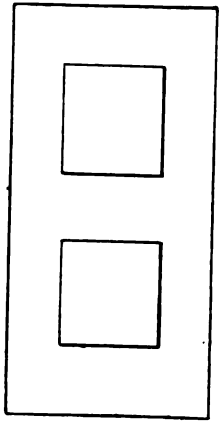


FIG. 3.—Side.

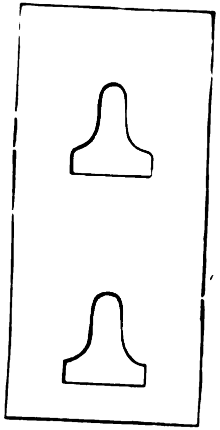


FIG 4.—Back

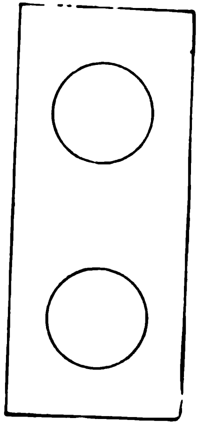


FIG. 5.—Front.

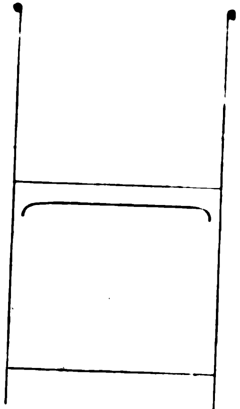


FIG. 6.—Section.

HOW TO MAKE A BI-UNIAL MAGIC LANTERN.

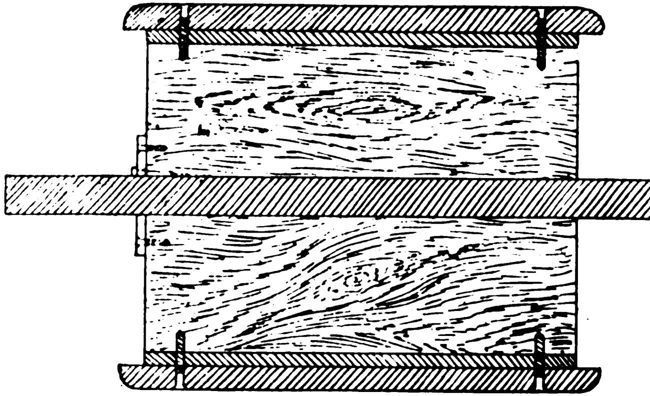


FIG. 1.—Section of Armature.

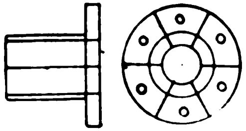


FIG. 2 *b*.—Commutator.

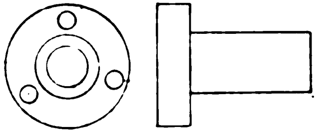
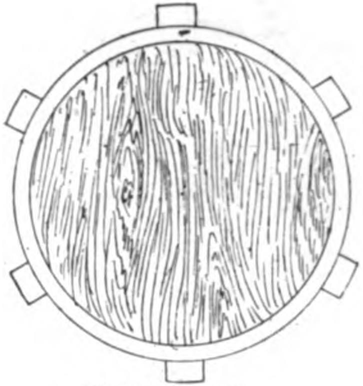


FIG. 2 *a*.—Commutator.


End of Elevation.

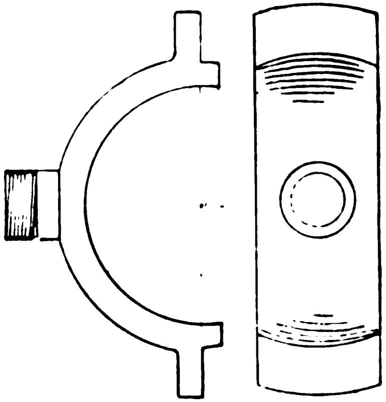


FIG. 4 *a*.

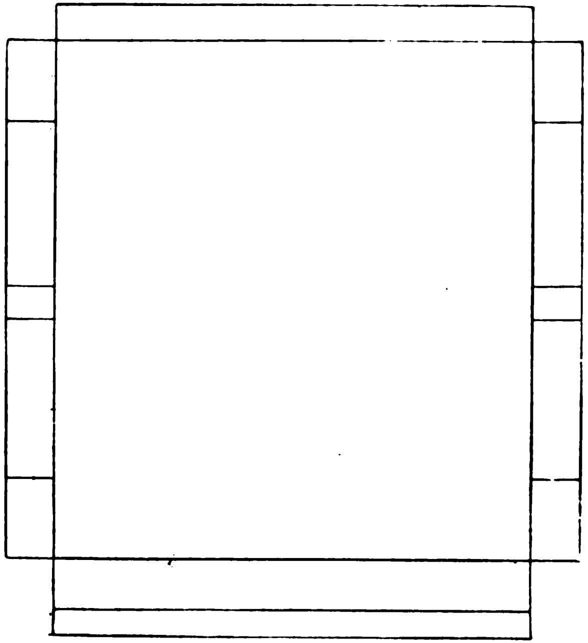
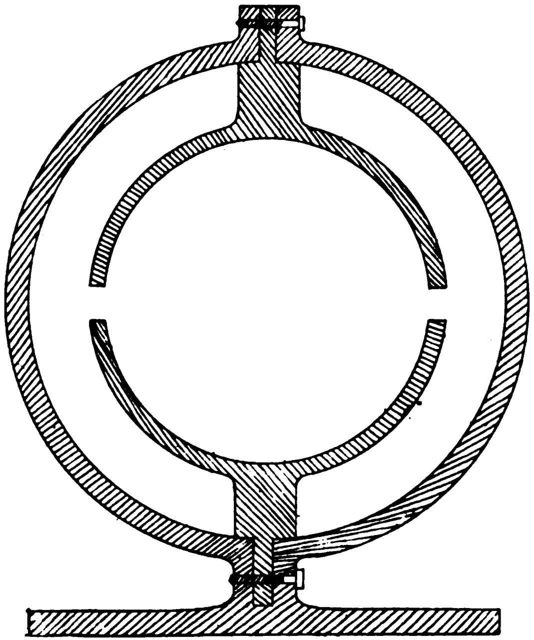


FIG. 3.—Field Magnets.


Section.

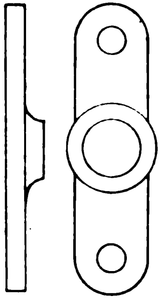


FIG. 5.

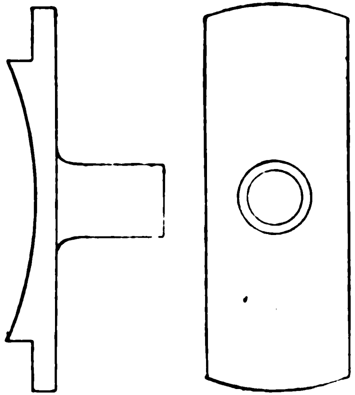
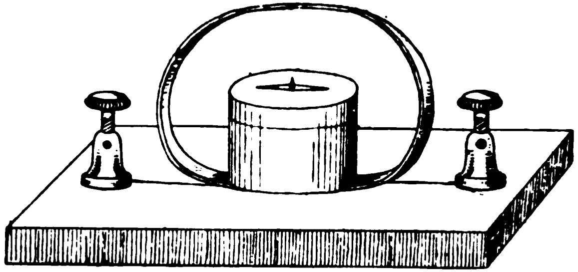


FIG. 4 *b*.


Galvanometer.

HOW TO MAKE AN ELECTRO-MOTOR.

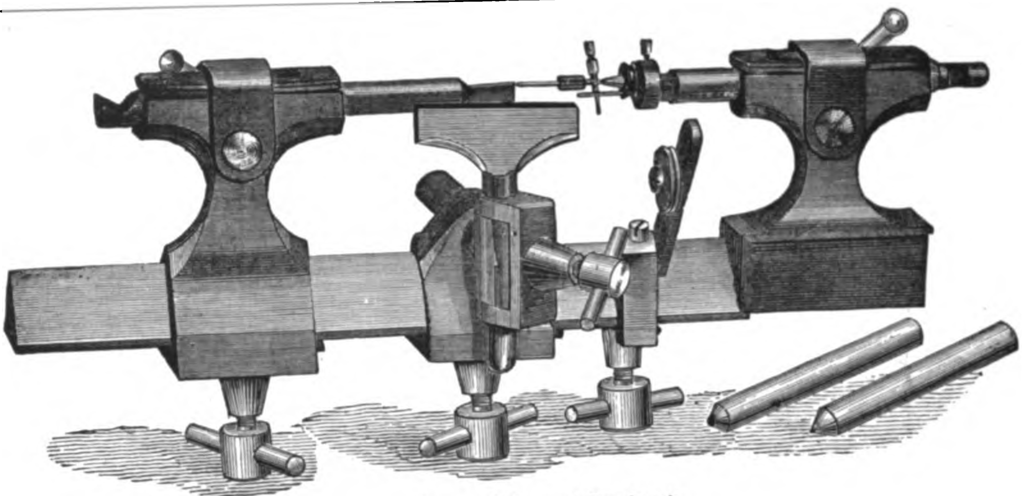


FIG. 1.—Improved Form of Turnbench.

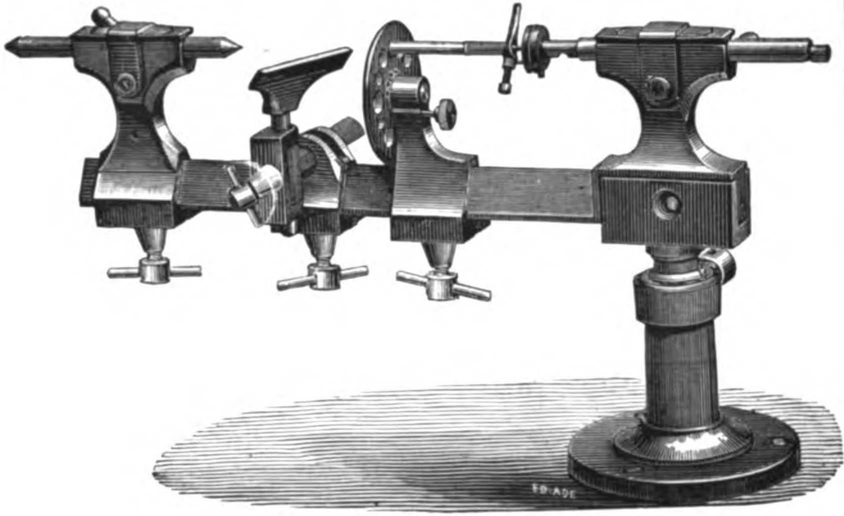


FIG. 2.—Turnbench fitted with Boring Collar.

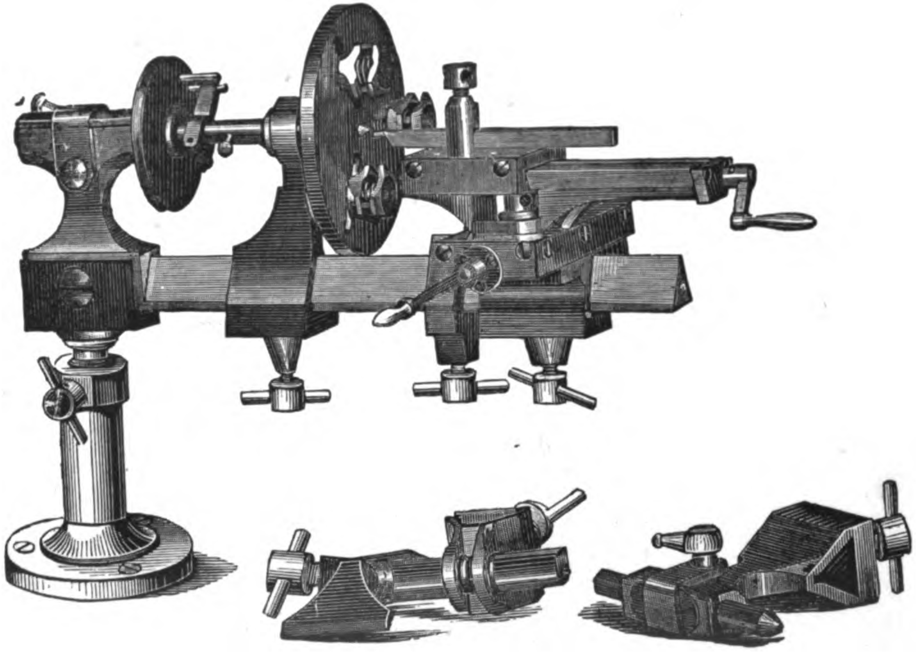


FIG. 3.—Turnbench fitted with Watchmaker's Headstock.

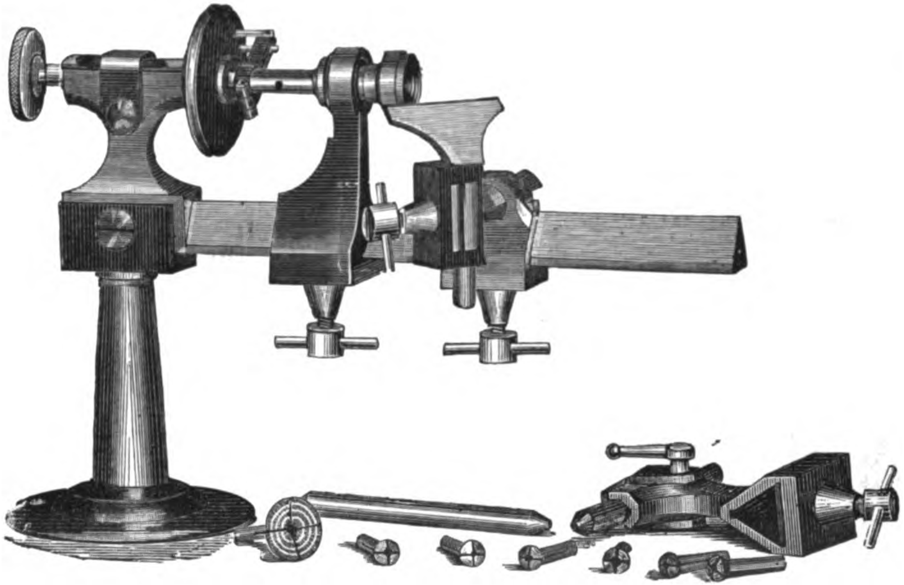


FIG. 4.—Turnbench fitted with Collar Poppet.

AMATEUR MECHANICS.

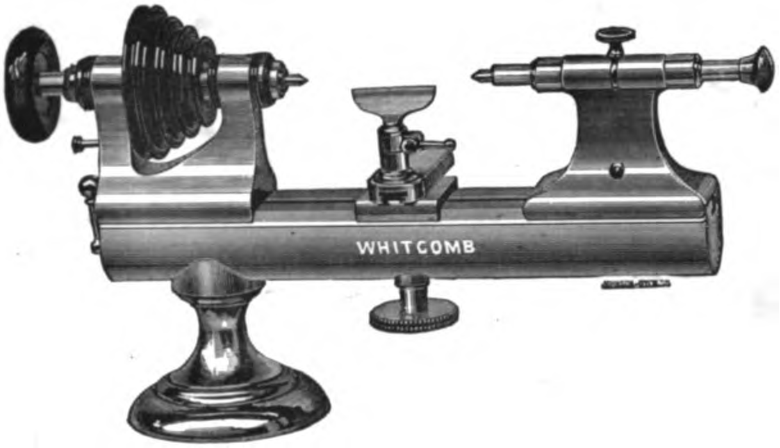


Fig. 1.—The Whitcombe Lathe.

Fig. 2.—Foot Wheel.

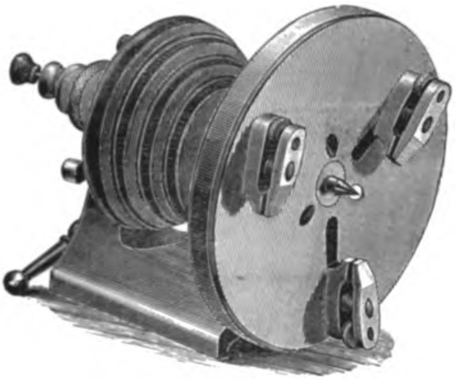


Fig. 3.—Patent Universal Head.

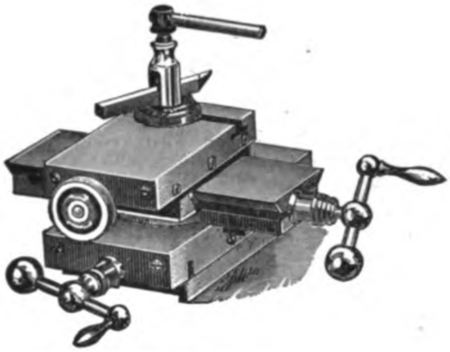


Fig. 4.—Slide-Rest.

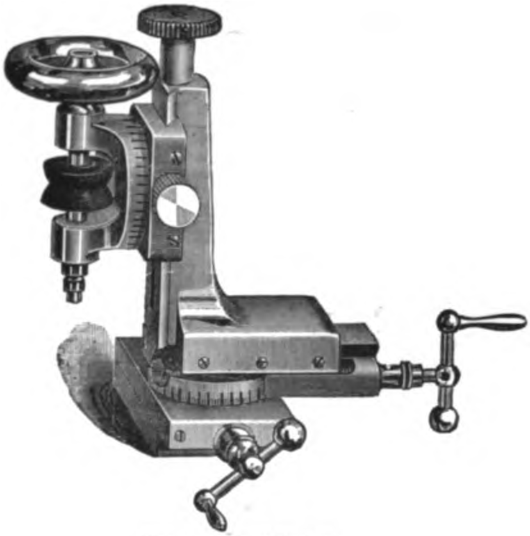


Fig. 5.—Wheel Cutter.

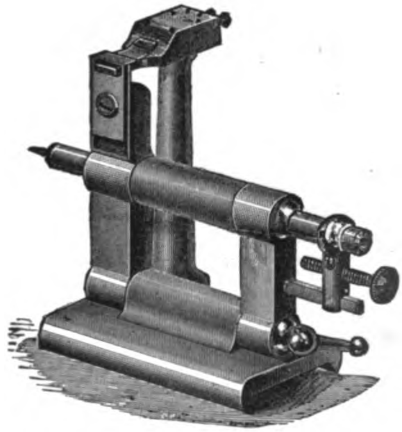


Fig. 6.—Jewelling Rest.

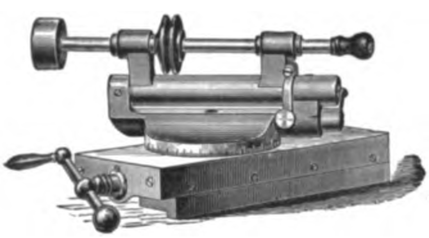


Fig. 7.—Pivot Polisher.

Fig. 8.—Filing Attachment.

Fig. 9.—Screw Tailstock.

THE WHITCOMB LATHE.

AMATEUR MECHANICS.

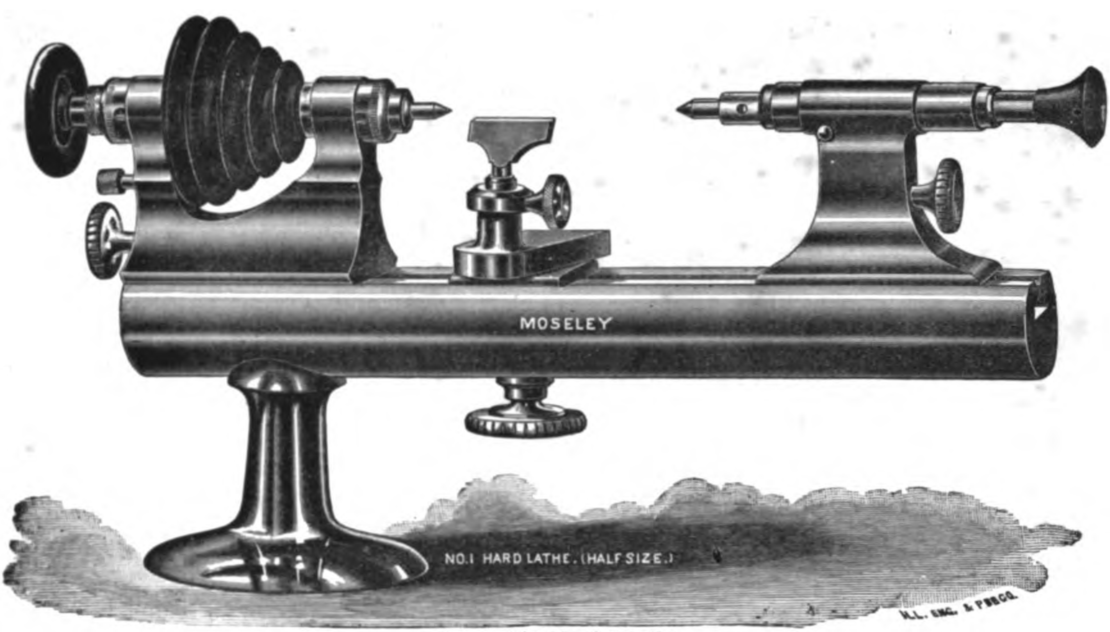


FIG. 1.—The Moseley Lathe.

FIG. 2.—Universal Face Plate.

FIG. 3.—Pivot Polisher.

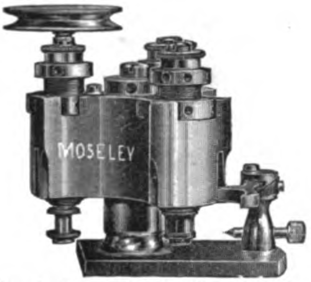


FIG. 4.—Three Spindle Wheel Cutter.

FIG. 5.—Half Open Tailstock.

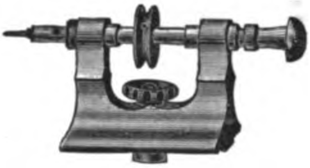


FIG. 6.—Traverse Spindle Tailstock.

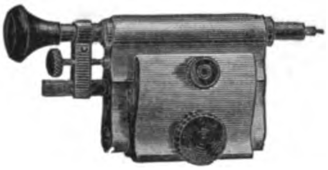


FIG. 7.—Swing Rest

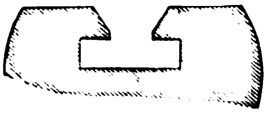


FIG. 8.—Section of Bed.

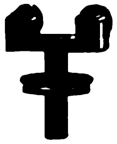


FIG. 9.—Filing Attachment.

FIG. 10.—Single Spindle Wheel Cutter.

FIG. 11.—Screw Tailstock.

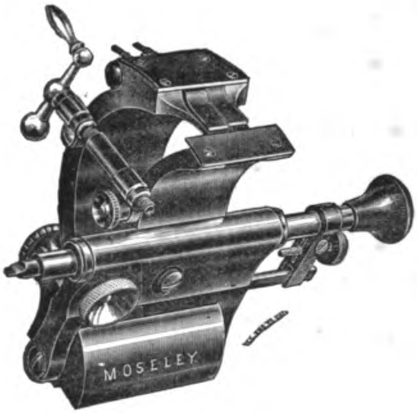


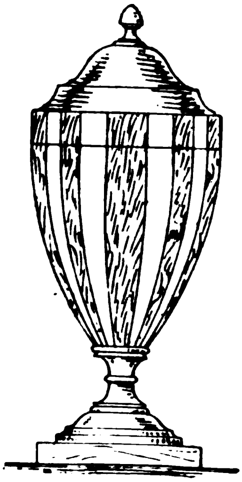
FIG. 12.—Jewelling Rest.

THE MOSELEY LATHE.

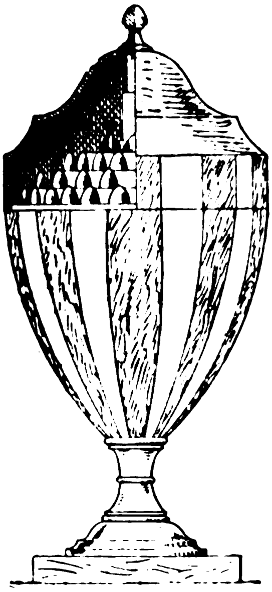
AMATEUR MECHANICS.

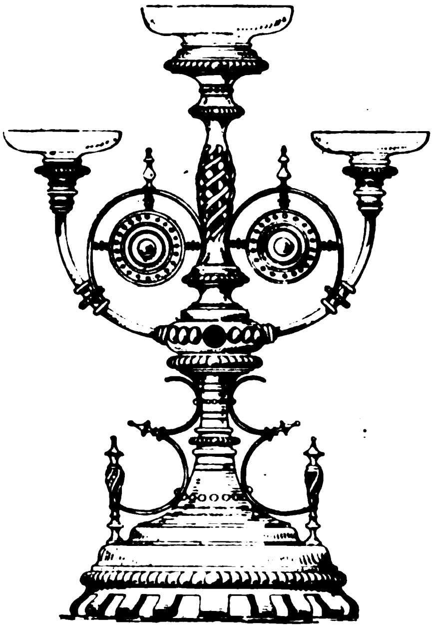

Fourth Prize.

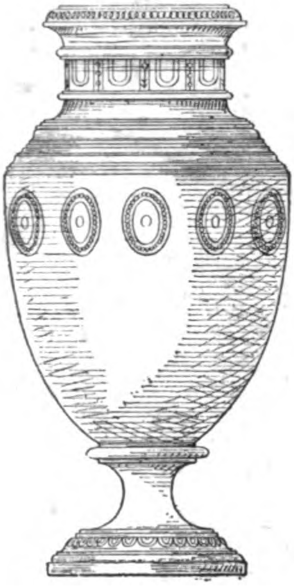

First Prize.

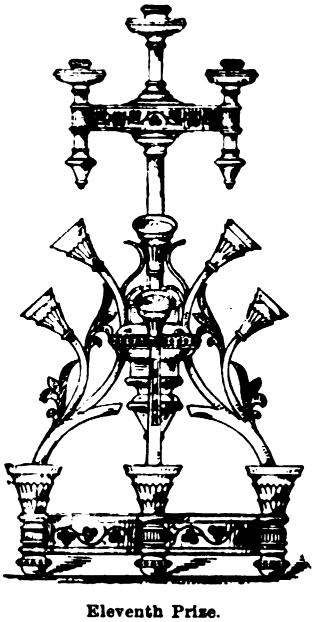

Tenth Prize.

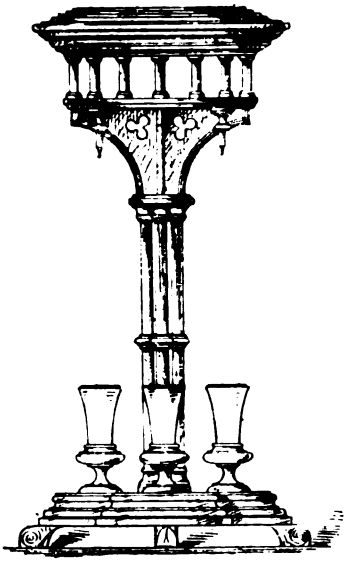

Eighth Prize.

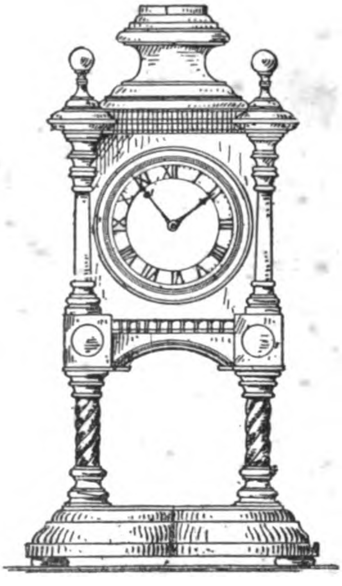

Tenth Prize.


Fourth Prize.


Second Prize.


Eleventh Prize.


Sixth Prize.


Fifth Prize.

SPECIMENS OF PRIZE TURNERY FROM THE MANSION HOUSE EXHIBITION.

Historical
[illegible]