CHAPTER VI.—THE LATHE.

THE lathe may be justly termed the most important of all metal-cutting machine tools. Not only on account of the rapidity of its execution which is due to its cutting continuously while many others cut intermittently, but also because of the great variety of the duty it will perform to advantage. In the general operations of the lathe, drilling, boring, reaming, and other processes corresponding to those performed by the drilling machine, are executed, while many operations usually performed by the planing machine, or planer as it is sometimes termed, may be so efficiently performed by the lathe that it sometimes becomes a matter of consideration whether the lathe or the planer is the best machine to use for the purpose.

The forms of cutting tools employed in the planer, drilling machine, shaping machine, and boring machine, are all to be found among lathe tools, while the work-holding devices employed on lathe work include, substantially, very nearly all those employed on all other machines and, in addition, a great many that are peculiar to itself. In former times, and in England even at the present day, an efficient turner (as a lathe operator is termed),

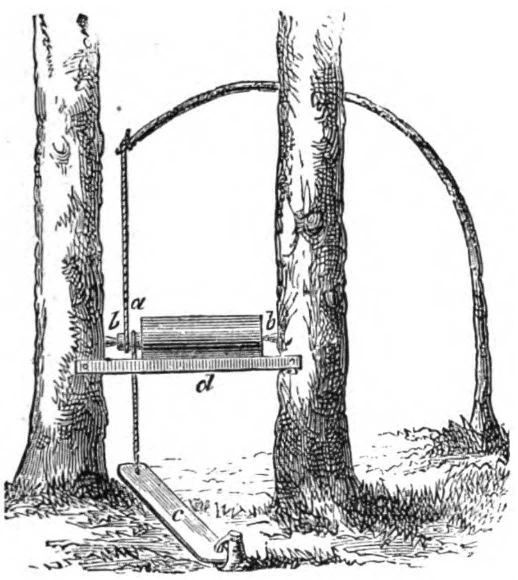


Fig. 448.

or lathe hand, is deemed capable of skilfully operating a planer, boring machine, screw-cutting machine, drilling machine, or any of the ordinary machine tools, whereas those who have learned to operate any or all of those machine tools would prove altogether inefficient if put to operate a lathe.

In almost all the mechanic arts the lathe in some form or other is to be found, varying in weight from the jewellers' lathe of a few pounds to the pulley or fly-wheel lathe of the engine builder, weighing many tons.

The lathe is the oldest of machine tools and exists in a greater variety of forms than any other machine tool. Fig. 448 represents a lathe of primitive construction actually in use at the present day, and concerning which the "Engineering" of London (England), says, "At the Vienna Exhibition there were exhibited wood, glasses, bottles, vases, &c., made by the Hucules, the remnant of an old Asiatic nation which had settled at the time of the general migration of nations in the remotest parts of Galicia, in the dense forests of the Carpathian Mountains. The lathe they are using has been employed by them from time immemorial. They make the cones *b*,*b* (of maple) serve as centres, one being fixed and the other movable (longitudinally). They rough out the work with a hatchet, making one end *a* cylindrical, to receive the rope for giving rotary motion. The cross-bar *d* is fastened to the trees so as to form a rest for the cutting tool, which consists of a chisel." C, of course, is the treadle, the lathe or pole being a sapling.

In other forms of ancient lathes a wooden frame was made to receive the work-centres, and one of these centres was carried in a block capable of adjustment along the frame to suit different lengths of work. In place of a sapling a pole or lath was employed, and from this lath is probably derived the term lathe.

It is obvious, however, that with such a lathe no cutting operation can be performed while the work is rotating backwards, and further, that during the period of rest of the cutting tool it is liable to move and not meet the cut properly when the direction of work rotation is reversed and cutting recommences, hence the operation is crude in the extreme, being merely mentioned as a curiosity.

The various forms in which the lathe appears in ordinary machine shop manipulation may be classified as follows:—

The *foot lathe*, signifying that the lathe is driven by foot.

The *hand lathe*, denoting that the cutting tools must be held in the hands, there being no tool-carrying or feeding device on the lathe.

The *single-geared lathe*, signifying that it has no gear-wheels to reduce the speed of rotation of the live spindle from that of the cone.

The *back-geared lathe*, in which gear-wheels at the back of the headstock are employed to reduce the speed of the lathe.

The *self-acting lathe*, or *engine lathe*, implying that there is a slide rest actuated automatically to traverse the tool to its cut or feed.

The *screw-cutting lathe*, which is provided with a *lead* screw, by means of which other screws may be cut.

The *screw-cutting lathe with independent feed*, which denotes that the lathe has two feed motions, one for cutting threads and another for ordinary tool feeding; and

The *chucking lathe*, which implies that the lathe has a face plate of larger diameter than usual, and that the bed is somewhat short, so as to adapt it mainly to work held by being chucked, that is to say, held by other means than between the lathe centres.

There are other special applications of the lathe, as the boring lathe, the grinding lathe, the lathe for irregular forms, &c., &c.

This classification, however, merely indicates the nature of the lathe with reference to the individual feature indicated in the title; thus, although a foot lathe is one run by foot, yet it may be a single or double gear (back-geared) lathe, or a hand or self-acting lathe, with lead screw and independent feed motion.

Again, a hand lathe may have a hand slide rest, and in that case it may also be a back-geared lathe, and a back-geared lathe may have a hand slide rest or a self-acting feed motion or motions.

Fig. 449 represents a simple form of foot lathe. The office of the shears or bed is to support the headstock and tailstock or tailblock, and to hold them so that the axes of their respective spindles shall be in line in whatever position the tailstock may be placed along the bed. The duty of the headstock is to carry the live spindle, which is driven by the cone, the latter being connected by the belt to the wheel upon the crank shaft driven by the crank hook and the treadle, which are pivoted by eyes W to the rod X, the operation of the treadle motion being obvious. The work is shown to be carried between the live centre, which is fitted to the live spindle, and the dead centre fitting into the tail spindle, and as it has an arm at the end, it is shown to be driven by a pin fixed in the face plate, this being the simplest method of holding and driving work. The lathe is shown provided with a hand tool rest, and in this case the cutting tools are supported upon the top of the tool rest N, whose height may be adjusted to bring the tool edge to the required height on the work by operating the set screw S, which secures the stem of N in the bore of the rest.

To maintain the axes of the live and dead spindles in line, they are fitted to a slide or guideway on the shears, the headstock being fixed in position, while the tailstock is adjustable along the shears to suit the length of the work.

To lock the tailstock in its adjusted position along the shears, it has a bolt projecting down through the plate C, which bolt receives the hand nut D. To secure the hand rest in position at any point along the shears, it sets upon a plate A and receives a bolt whose head fits into a T-shaped groove, and which, after passing through the plate P receives the nut N, by which the rest is secured to the shears.

To adjust the end fit of the live spindle a bracket K receives an adjusting screw L, whose coned end has a seat in the end J of the live spindle, M being a check nut to secure L in its adjusted position.

The sizes of lathes are designated in three ways, as follows:— First by the *swing* of the lathe and the total length of the bed, the term *swing* meaning the largest diameter of work that the lathe is capable of revolving or swinging. The second is by the *height of the centres* (from the nearest corner of the bed) and the length of the shears. The height of the centres is obviously equal to half the swing of the lathe, hence, for example, a lathe of 28-inch swing is the same size as one of 14-inch centres. The third method is by the swing or height of centres and by the greatest length of work that can be held between the lathe centres, which is equal to the length of the bed less the lengths of the head and tailstock together.

The effective size of a lathe, however, may be measured in yet another way, because since the hand rest or slide rest, as the case may be, rests upon the shears or bed, therefore the full diameter of work that the lathe will swing on the face plate cannot be held between the centres on account of the height of the body of the hand rest or slide rest above the shears.

Fig. 450 shows a hand lathe by F. E. Reed, of Worcester, Massachusetts, the mechanism of the head and tail stock being shown by dotted lines. The live spindle is hollow, so that if the work is to be made from a piece of rod and held in any of the forms of chucks to be hereafter described, it may be passed through the spindle, which saves cutting the rod into short lengths. The front bearing of the headstock has two brasses or boxes, A and B, set together by a cap C.

The rear bearing has also a bearing box, the lower half D being threaded to receive an adjustment screw F and check nut G to adjust the end fit of the spindle in its bearings. In place of grooved steps for the belt the cone has flat ones to receive a flat belt.

The tail spindle is shown, in Fig. 451, to be operated by a screw H, having journal bearing at I, and threaded into a nut fast in the tail spindle at J. To hold the tail spindle firmly the end of the tail stock is split, and the hand screw K may be screwed up to close the split and cause the bore at L to clasp the tail spindle at that end.

To lock the tail stock to the shears the bolt M receives the lever N at one end and at the other passes through the plate or clamp O, and receives the nut P, so that the tail stock is gripped to or released from the shears by operating N in the necessary direction. The hand rest, Fig. 452, has a wheel W in place of a nut, which dispenses with the use of a wrench.

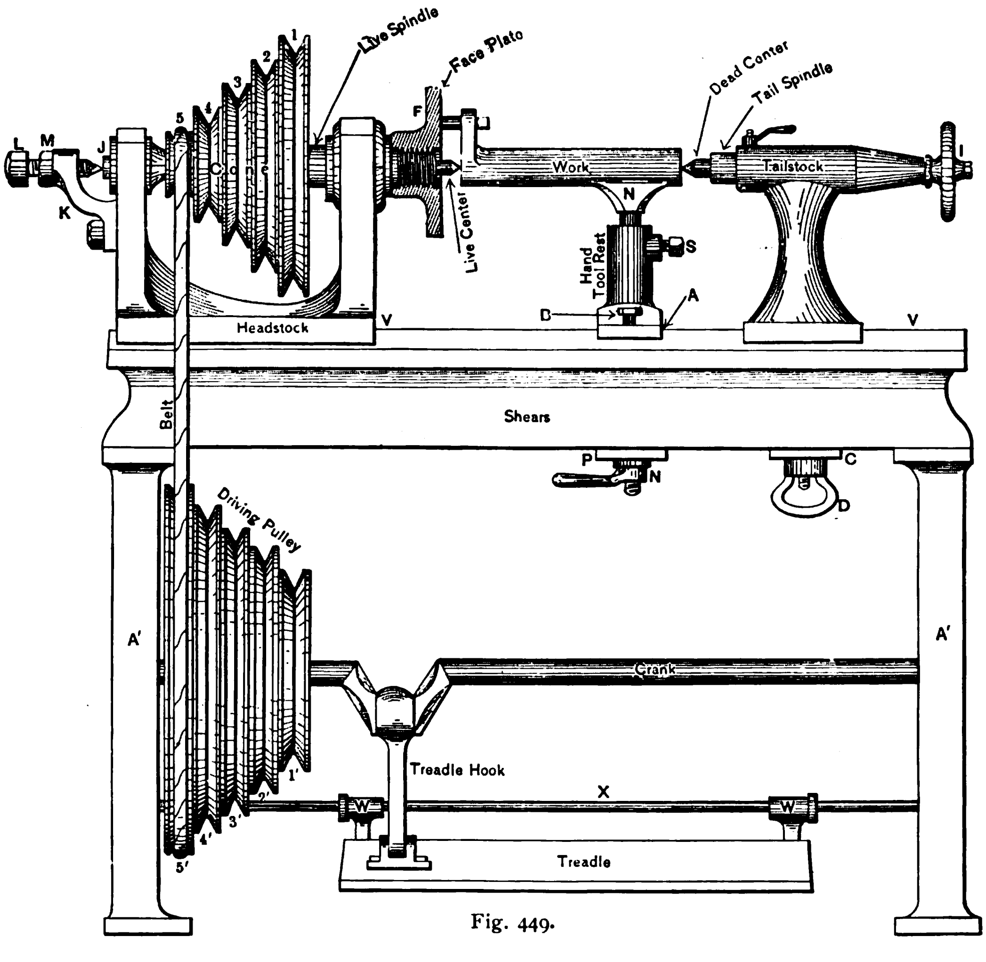


Fig. 449.

What are termed bench lathes are those having very short legs, so that they may for convenience be mounted on a bench or fastened to a second frame, as shown in Fig. 453.

It is obvious that when work is turned by hand tools, the parallelism of the work depends upon the amount of metal cut off at every part of its length, which to obtain work of straight outline, whether parallel or taper, involves a great deal of testing and considerable skill, and to obviate these disadvantages various methods of carrying and accurately guiding tools are employed. The simplest of these methods is by means of a slide rest, such as shown in Fig. 454.

The tool T is carried in the tool post P, being secured therein by the set screw shown, which at the same time locks the tool post to the upper slider. This upper slider fits closely to the cross slide, and has a nut projecting down into the slot shown in the same, and enveloping the cross feed screw, whose handle is shown at C, so that operating C traverses the upper slider on the

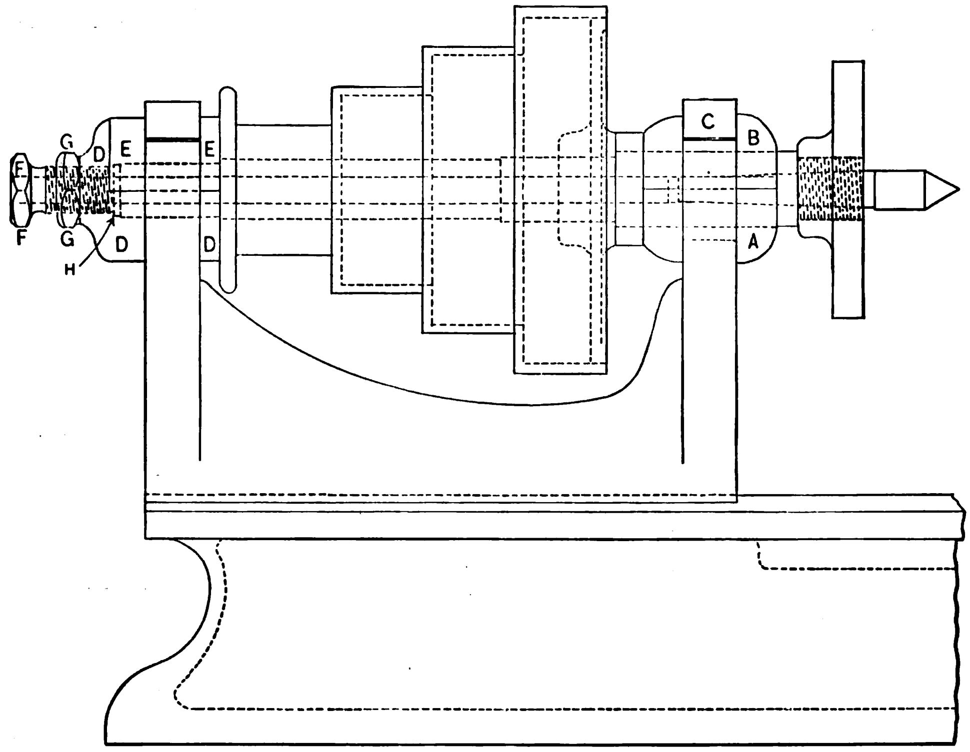


Fig. 450.

cross slide and regulates the depth to which the tool enters the work, or in other words, the depth of cut.

The cross slide is formed on the top of the lower slider, which has beneath a nut for the feed screw, whose handle is shown at A, hence rotating A will cause the lower slider to traverse along

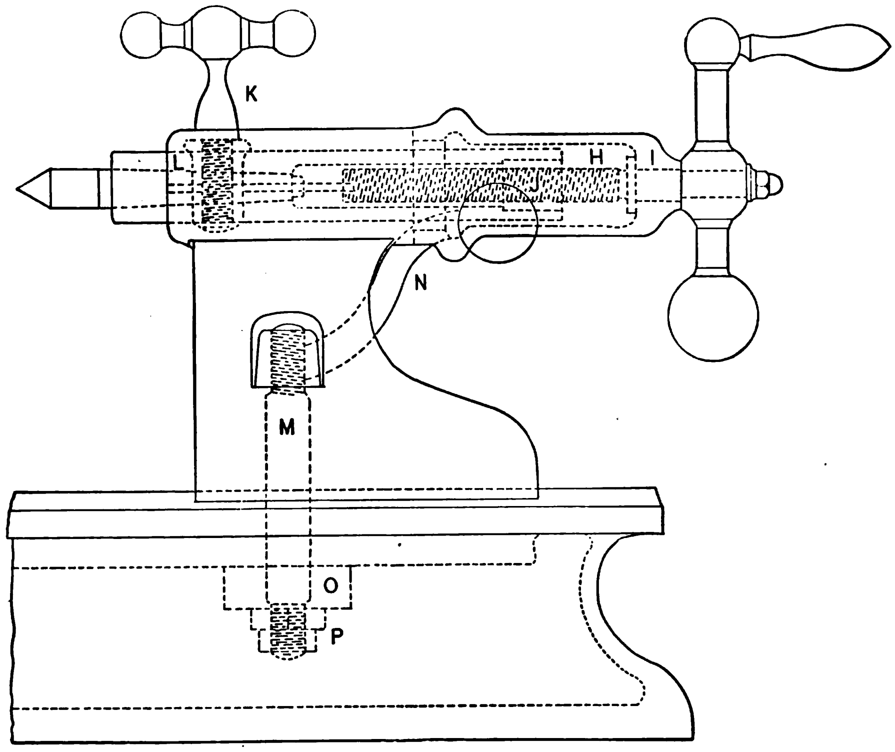


Fig. 451.

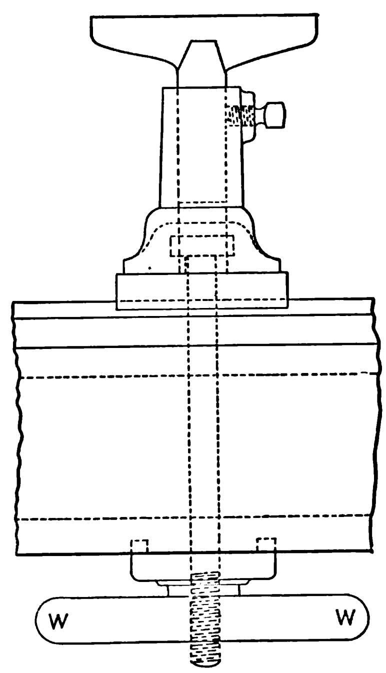


Fig. 452.

the lower slide and carry the tool along the work to its cut. To maintain the fit of the sliders to the slides a slip of metal is inserted, as at *e* and at *c*, and these are set up by screws as at *f,f* and *b,b*.

The lower or feed traverse slide is pivoted to its base B, so that it may be swung horizontally upon the same, and is provided with means to secure it in its adjusted position, which is necessary to enable it to turn taper as well as parallel work. To set this lower slide to a given degree of angle it may be marked with a line and the edge of base B may be divided into degrees as shown at D.

When a piece of work is rotated between the lathe centres its axis of rotation may be represented by an imaginary straight line and the lower slides must, to obtain parallel work, be set parallel to this straight line, while for taper work the slide rest must be set at an angle to it. Now, in the form of slide rest shown in figure the cross slide is carried by the lower or feed traverse slide, hence setting the lower slide out of parallel with the work axis sets the cross slide out of a right angle to the work axis, with the result that when a taper piece of work is turned that has a collar or flange on it, the face of that collar or flange will be turned not at a right angle to the work axis, as it should be, but at a right angle to the surface of the cone. Thus in Fig. 455, A, A,

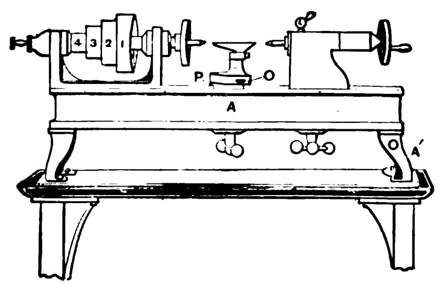


Fig. 453.

represents the axis of a piece of work, and the slide nut having been set parallel to the work axis, the face C will be at a right angle to the surface B or axis A, but with the slide nut set at an angle to turn the cone D, the cross slide will be at an angle to A, A, hence the face E will be under cut as shown, and at a right angle to the surface D instead of to A A.

This may be obviated by letting the cross slide be the lower one, as in the English form of slide rest shown in Fig. 458, in which the

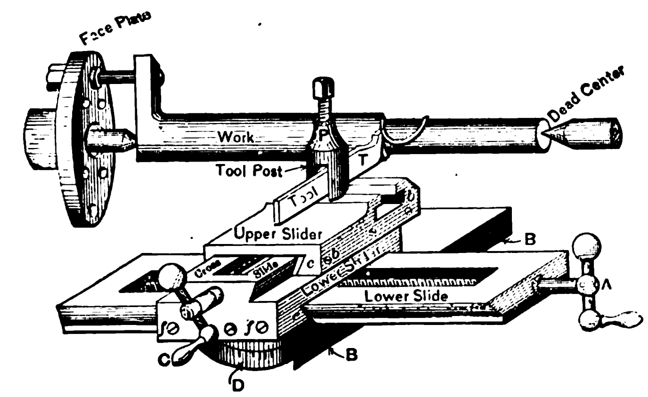


Fig. 454.

upper slide is pivoted at its centre to the cross slide, and may be swung at an angle thereto, and secured in its adjusted position by the bolt shown. The projection at the bottom of the lower slider fits between the shears of the lathe and holds the lower slider parallel with the line of lathe centres, which causes the slide rest to cut all faces at a right angle to the work axis, whether the feed traverse slide be set to turn parallel or taper. In either case, however, there is nothing to serve as a guide to set the feed traverse slide parallel to the work axis, and this must therefore be

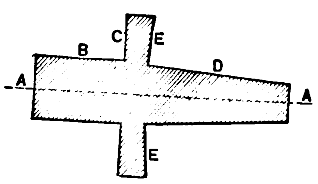


Fig. 455.

done as near as may be by the eye, and by taking a cut and testing the parallelism.

The rest may be set approximately true by bringing the operator's eye into such a position that the edge of the slide rest comes into line with the edge of the lathe shears, because that edge is parallel to the line of lathe centres, and therefore to the work axis.

In improved forms of slide rests for small lathes the screw for the longitudinal tool feed is in some cases placed beneath the front edge of the lower slide, as in Warner & Swasey's slide rest, shown in Fig. 456.

This possesses two advantages: First, that it keeps the screw clear of the tool cuttings, and prevents it from undue wear; and secondly, it brings the feed handle further away from the tail stock of the lathe, which is a great advantage on short work. Sometimes the screw is placed in the middle and the nut carried on the lower slider, as in Fig. 457.

Fig. 458 represents a form of slide rest for heavy facing and bor-

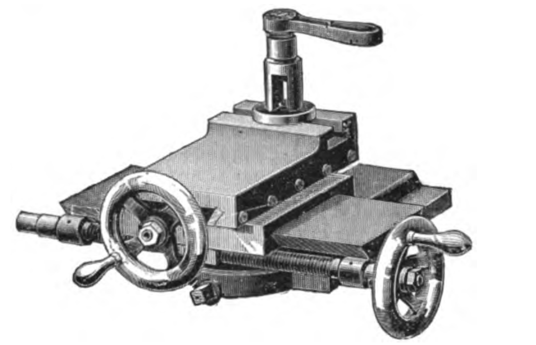


Fig. 456.

ing work, the end face A coming flush so that the tool does not overhang its base of support, and is carried firmly, which is of great importance in that class of work.

The gib *e*, Fig. 454, is sometimes placed on the front side of the slider, as in the figure, and at others on the back; when it is placed in the front the strain of the cut causes it to be compressed

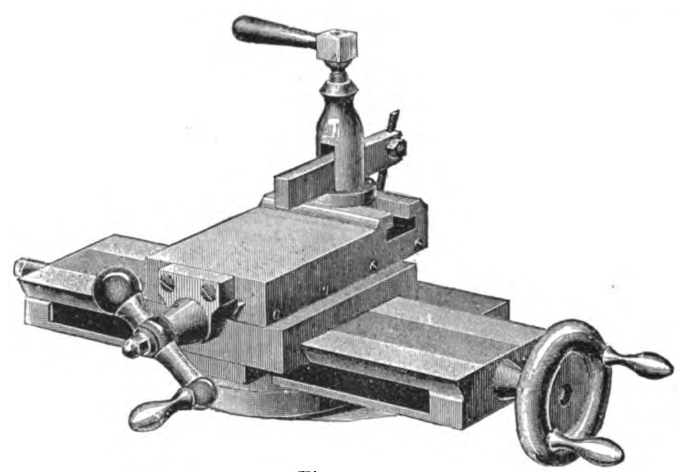


Fig. 457.

against the slide, and there is a strain placed upon the screws *f* which lifts them up, whereas, if placed on the other side the screws are relieved of strain, save such as is caused by the setting of the gib up.

On the other hand, the screws are easier to get at for adjustment if placed in front. When the screws *b* of the upper gib *c* (Fig. 454)

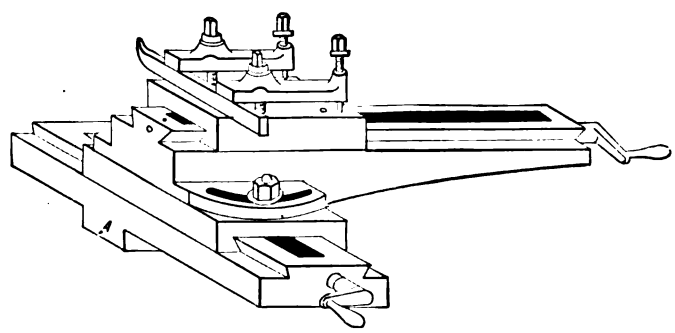


Fig. 458.

are on the right-hand side, as in that figure, there is considerable strain on the screws when a boring tool is used to stand far out, as for boring deep holes. On the other hand, however, the screws can be readily got at in this position, and may therefore be screwed up tightly to lock up the upper slider firmly to the cross slide, which will be a greater advantage in boring and also in facing operations. But the screws must not, in this case, have simple saw slot heads, such as shown on a larger scale in Fig. 459, but should have square heads to receive a wrench, and if these four screws are used, the two end ones may be set to adjust the sliding fit of the slider, while the two middle ones may be used to set the slider form on its slide when either facing or boring. The corners of the gibs as well as those of the slider and slide may, with advantage, be rounded so that they may not become bruised or burred, and, furthermore, the slider is strengthened, and hence less liable to spring under the pressure of a heavy cut.

A slide rest for turning spherical work is shown in Fig. 460.

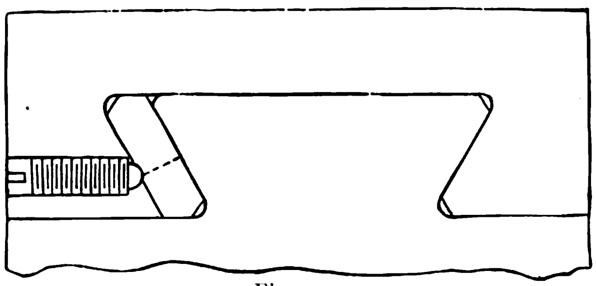


Fig. 459.

A is the lower slide way on which is traversed the slide B, upon which is fitted the piece C, pivoted by the bolt D; there is provided upon C a half-circle rack, shown at E, and into this rack gears a worm-wheel having journal bearing on B, and operated by the handle F. As F is rotated, C would rotate on D as a centre of motion; hence the tool point would move in an arc of a circle whose radius would depend upon the distance of the tool point from D as denoted by J, which should be coincident with the line of centres of the lathe.

The slide G is constructed in the ordinary manner, but the way on which it slides should be short, so as not to come into contact with the work. If the base slide way A be capable of being traversed along the lathe shears S S by a separate motion, then the upper slide way and slide may be omitted, G and C being in one piece. It is to be noted in a rest of this kind, however, that the tool must be for the roughing cut set too far from D to an amount equal to about the depth of cut allowed to finish with, and for the finishing cut to the radius of the finished sphere in order to obtain a true sphere, because if B be operated so that D does not stand directly coincident with the line of lathe centres, the centre of motion, or of the circle described by the tool point, will not be coincident with the centre on which the work rotates, hence the work though running true would not be a true sphere but an oval. This oval would be longest in the direction parallel with the line of centres whenever the pivot D was past the line of centres, and an oval of largest diameter at the middle or largest diameter

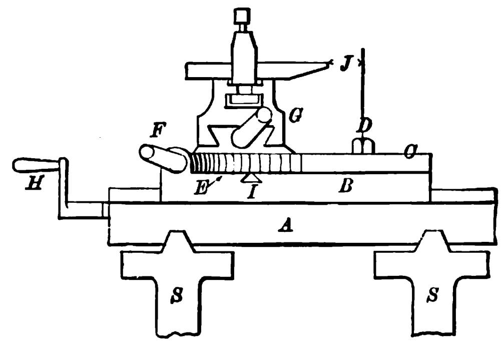


Fig. 460.

turned by the tool whenever the pivot D was on the handle H side of the line of ce. tres. To steady C it may be provided with a circular dovetail, as shown at the end I, provision being made (by set screw or otherwise) for locking C in a fixed position when using the rest for other than spherical work.

To construct such a rest for turning curves or hollows whose outline required to be an arc of a circle, the pivot D would require to be directly beneath the tool post, which must in this case occupy a fixed position. The radius of the arc would here again be determined by the distance of the tool point from the centre of rotation of the pivot, or, what would be the same thing, from that of the tool post.

Next to the hand slide-rest lathe comes the self-acting or engine lathe. This is usually provided with a feed motion for traversing the slide rest in the direction of the length of the bed, and sometimes with a self-acting cross feed; that is to say, a feed motion that will traverse to or from the line of centres and at a right angle to the same.

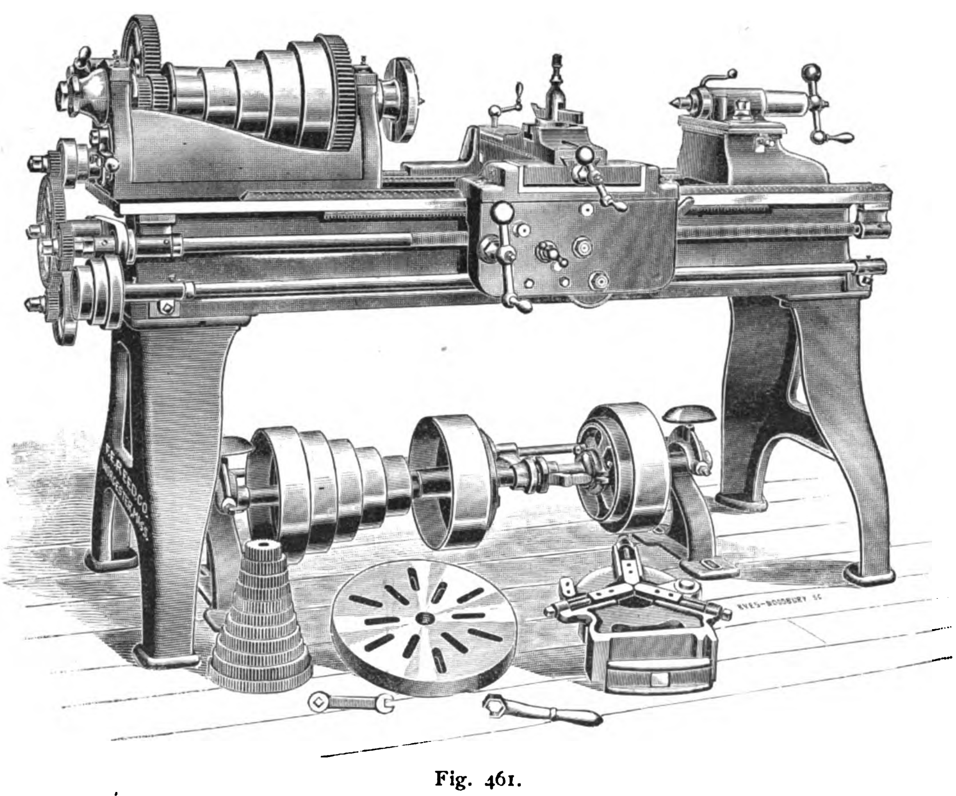


Fig. 461.

In an engine lathe the parallelism or truth of the work depends upon the parallelism of the line of centres with the shears of the lathe, and therefore upon the truth of the shears or bed, and its alignment with the cone spindle and tail spindle, while the truth of the radial faces on the turned work depends upon the tool rest moving on the cross slide at a true right angle to the line of centres.

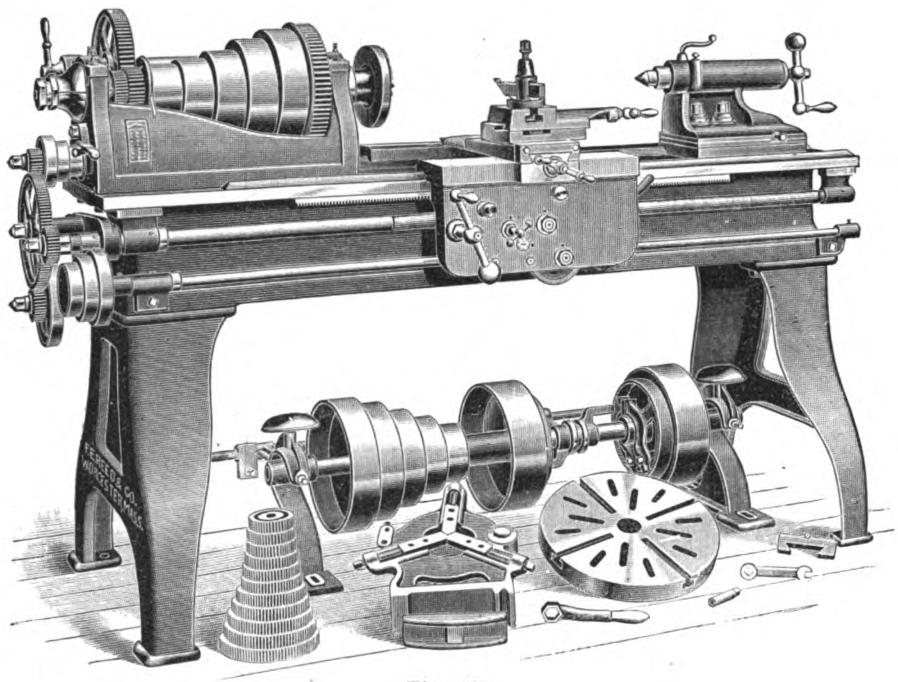


Fig. 462.

THE F. E. REED LATHE.—Figs. 461 and 462 represent a 16-inch swing engine lathe with elevating gib rest and power cross feed, being a superior example of this class of lathe, designed and constructed by the F. E. Reed Company, of Worcester Mass.; the latter figure showing the lathe with a compound instead of an elevating rest.

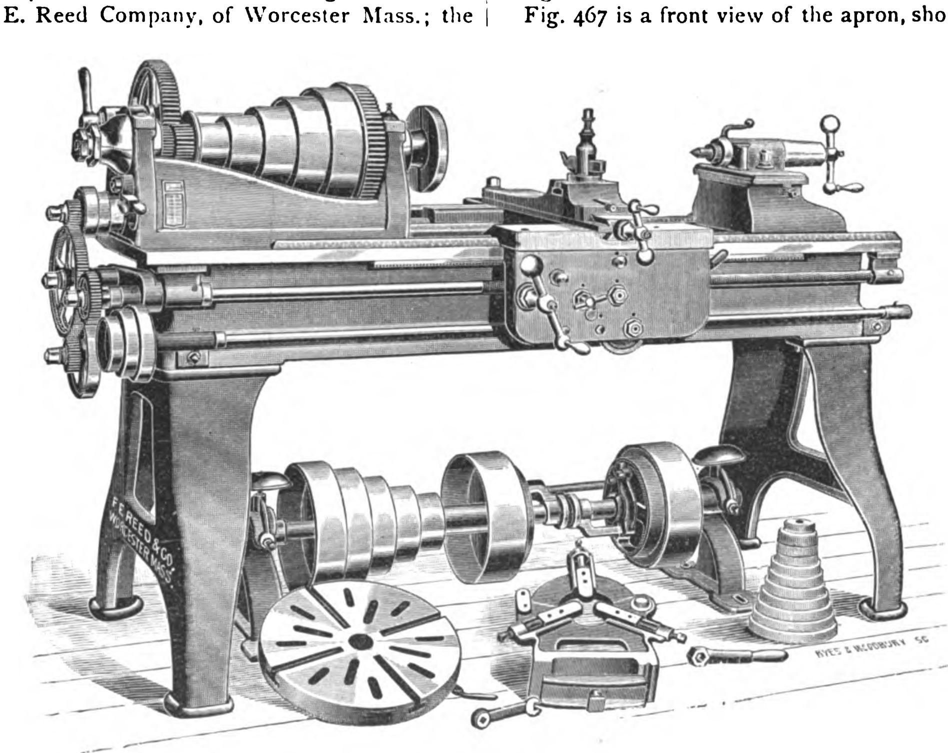


Fig. 463.

The same lathe with a taper turning attachment is shown in Figs. 463 and 464.

Spindle bearings of these lathes are shown in Figs. 465 and 466; the first showing the bearing machined; and the latter, Babbitt lined ready for service in the lathe, and it is seen that when completed nothing but Babbitt metal is in contact with the lathe spindle.

Lathes with elevating rests possess advantages for many kinds of work over other forms of rests in that they admit of quicker adjustment of the cutting tool, also of finer adjustment, and are exceedingly handy and afford exceptional advantages in getting at the work for measuring and other purposes.

Details of the construction of the important parts of this lathe are given as follows :

Fig. 467 is a front view of the apron, showing the arrangement of the gears for the longitudinal and cross feeds. For the hand, or carriage, traverse motion from the handle in Fig. 468 is given to the pinion A, Figs. 467 and 468, which drives spur gear B upon a sliding stud G, having at its end a pinion C which engages with the rack D. A spline or square key seated in G is the medium

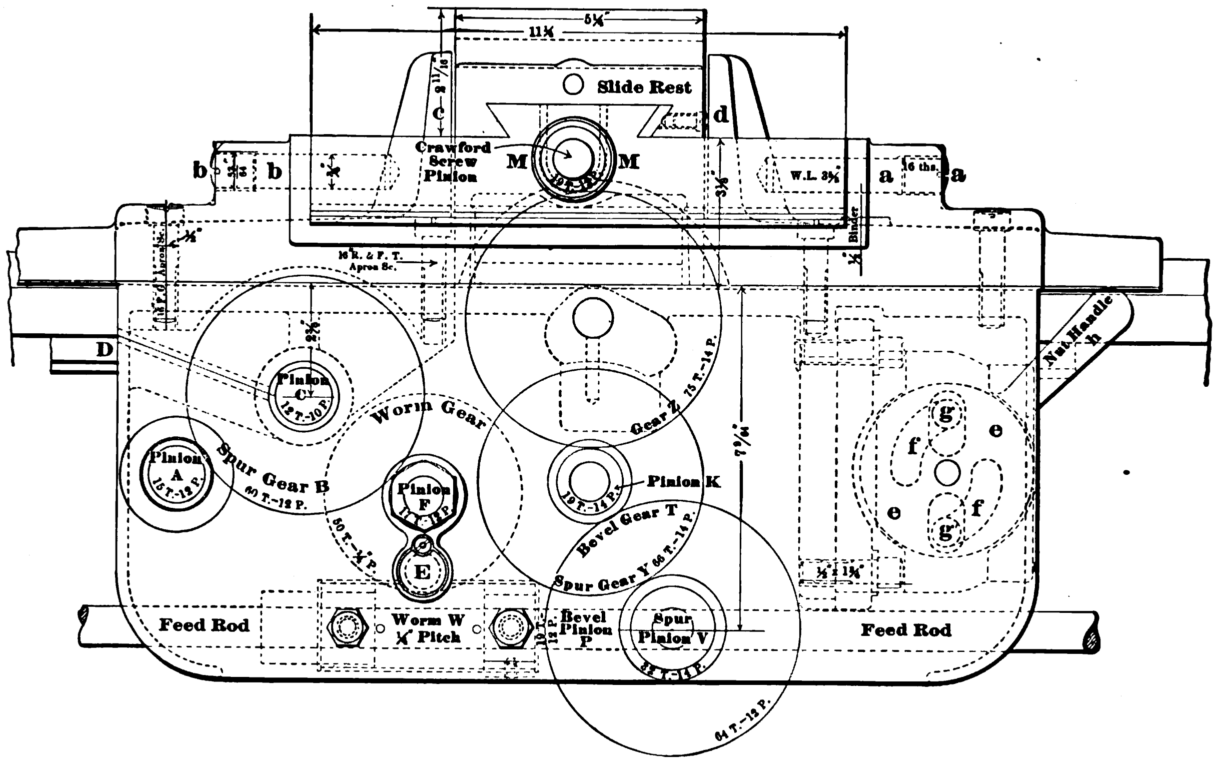


Fig. 467.

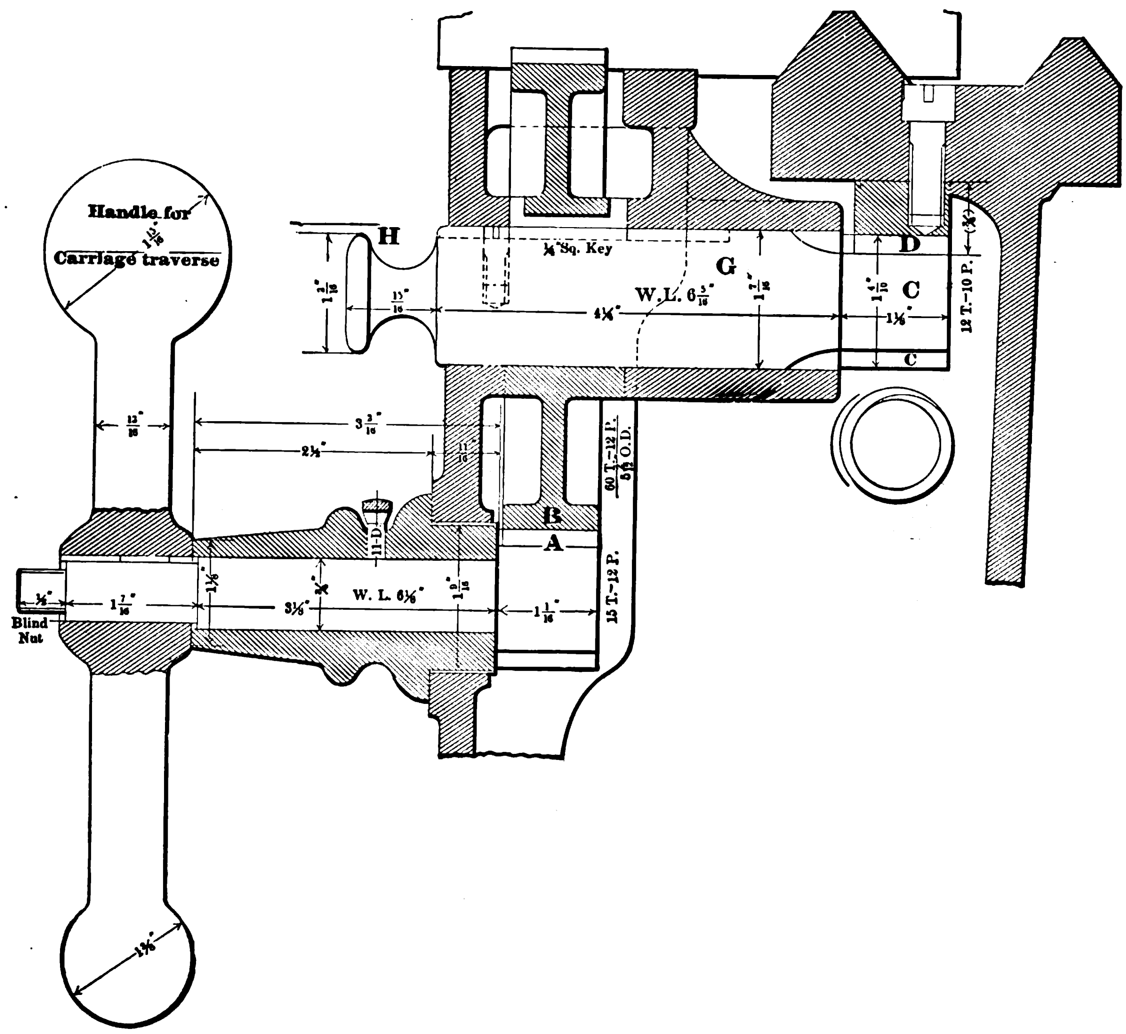


Fig. 468.

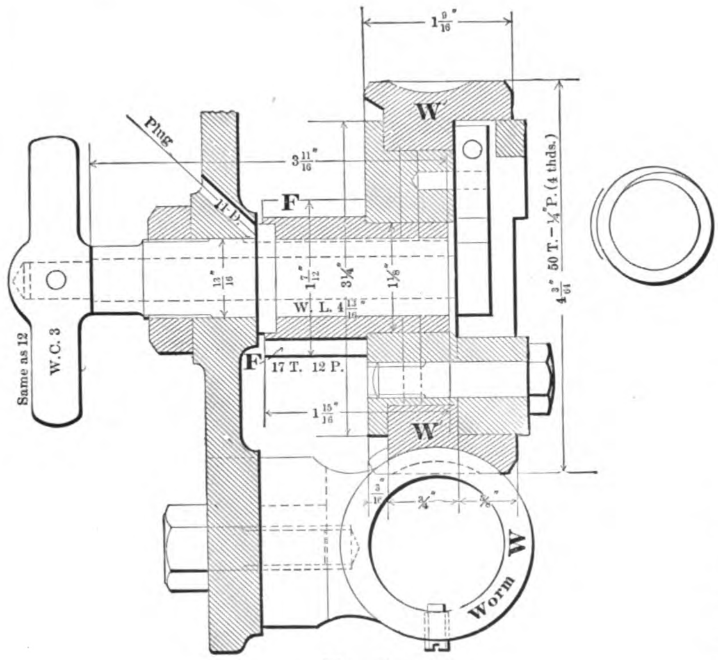


Fig. 469.

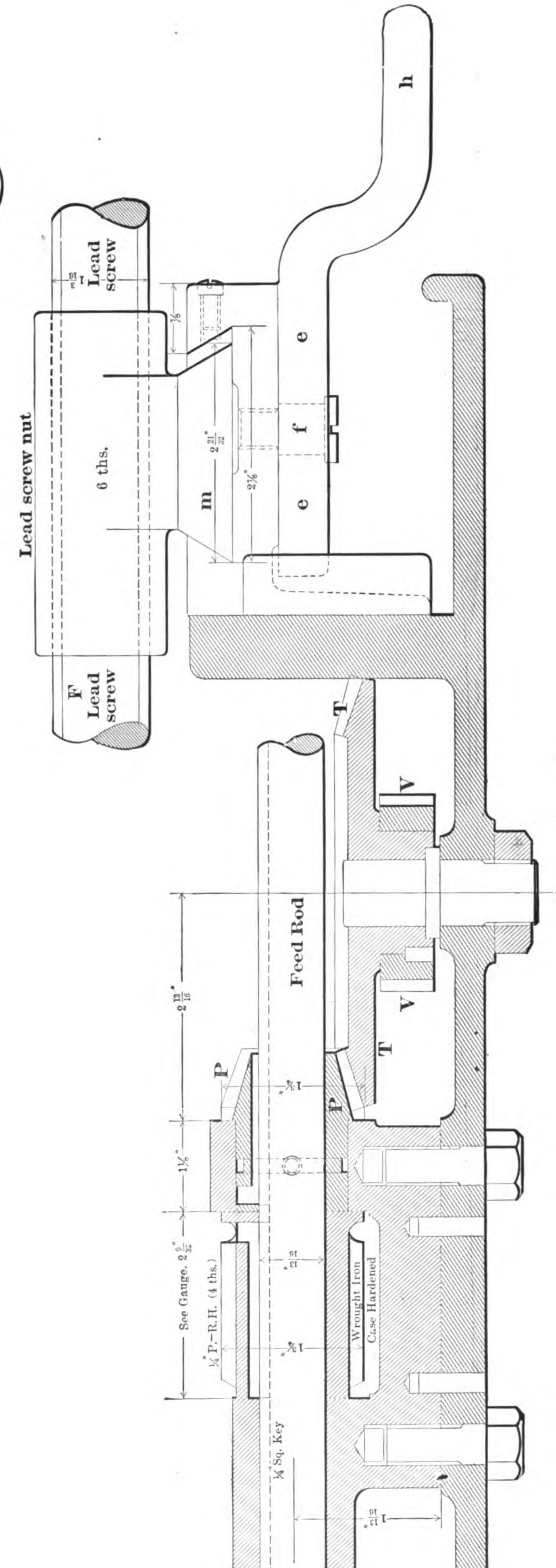


Fig. 470.

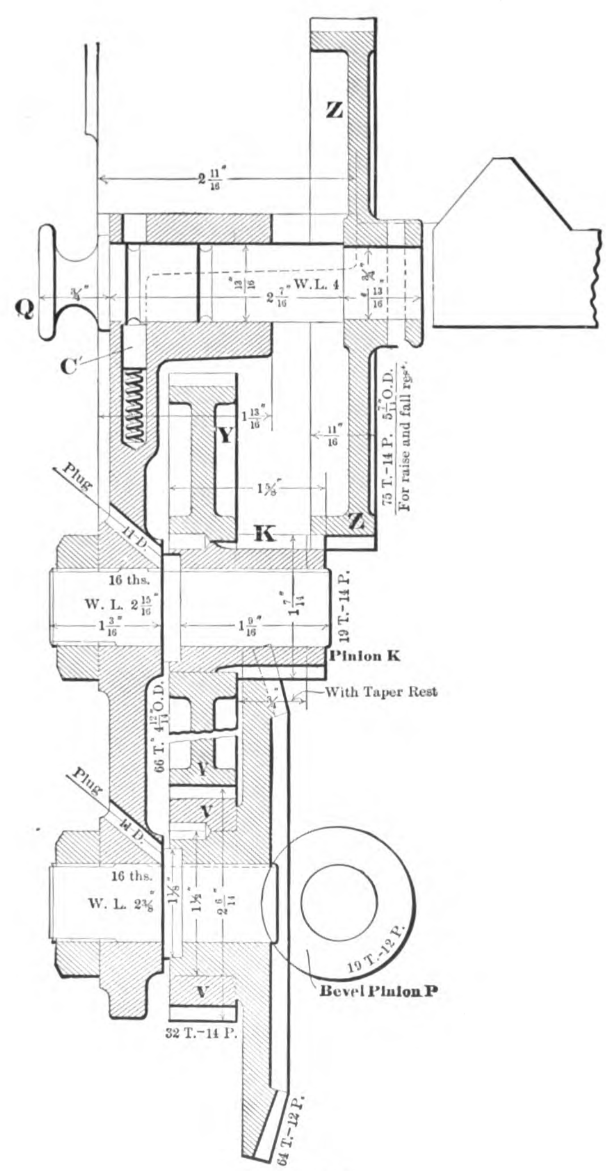


Fig. 471.

through which B drives C. By means of the knob at H, G and therefore C may be withdrawn endwise in the direction of the arrow at H, carrying the pinion C out of gear with the rack D, and the carriage traverse is thrown out of action when the lathe is used for cutting screws and the carriage is moved by means of the leading screw in connection with the open and shut nut.

The rod feed for the carriage traverse is as follows : The feed rod drives a worm W, in Figs. 467 and 469, in gear with the worm wheel W′, which in turn drives the pinion F, there being a friction-clutch motion to the worm gear for throwing into, and out of, active operation. When in operation pinion F drives spur gear B and therefore the pinion C in gear with the rack D, which completes a train of gearing for the rod feed.

The self-acting cross-feed motion is as follows : Upon the feed rod is a pinion P, Figs. 470 and 471, driving a bevel gear T, which in turn drives a spur pinion V, Figs. 467, 470, and 471. Referring now to all three of these figures, spur pinion V drives spur gear Y, which drives spur pinion K, which drives a spur wheel Z, which, as seen in Fig. 467, drives the pinion M on the cross-feed screw. On referring to Figs. 471 and 474, it will be seen that the gear Z is mounted upon a stud Q, so that it can be pulled endwise and thrown either into, or out of, gear with the cross-feed pinion M, while still remaining in gear with its driving pinion K ; and to secure it in either of these desired positions a pin with a spring beneath it, as shown at C′, Fig. 471, and at 3, Fig. 474, projects into one of two annular grooves shown in Fig. 474 by the numerals 1 and 2 provided in stud Q. As shown in the Fig. 474, Q is pushed inwards and the cross-feed motion is out of action. The method of throwing the feed-screw nut in and out of gear for screw cutting is shown in Figs. 467, 470, and 472. The nut is made in two halves, of which the top one, m, Fig. 470, is seen to operate vertically in a V-shaped slideway.

The plate e, having its handle at h, is pivoted at its centre. Each half of the nut has a projecting pin *g g′*, Fig. 472, passing into circular grooves *f f*, these grooves being eccentric to the centre of motion of *e e*, so that operating the nut handle *h* opens and closes the two halves of the feed nut upon the lead screw. A stop motion for the automatic carriage feed is provided, as in Fig. 473. A sleeve A‴ is driven by a spline in the feed rod and is carried by the apron. As the carriage traverses forward and A‴ meets A″, the latter is driven forward, compressing the spiral spring shown and causing the clutch motion at the end of the feed rod to be thrown out of gear and the feed traverse to cease.

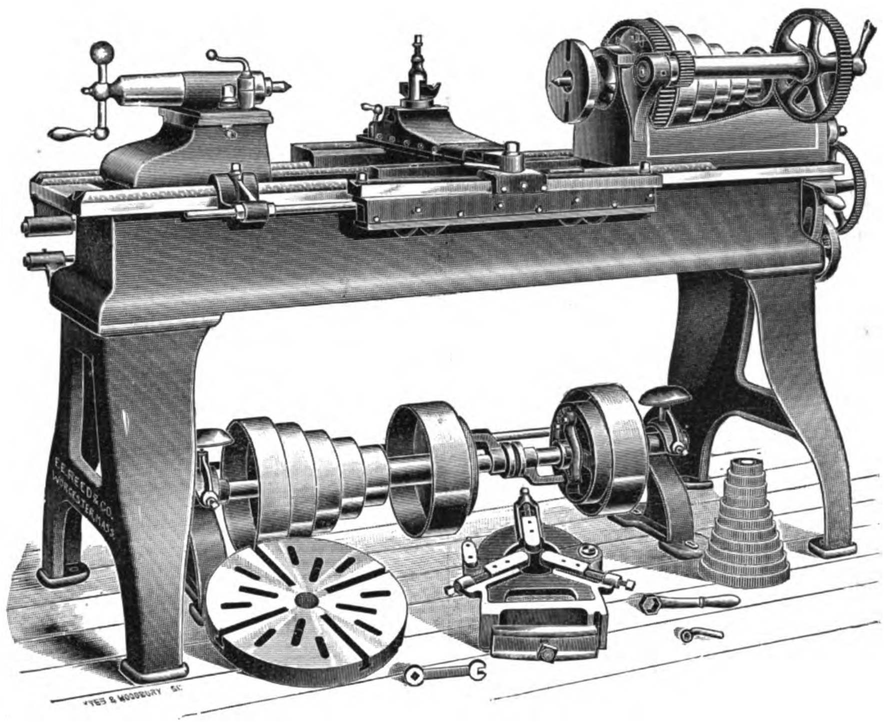


Fig. 464.

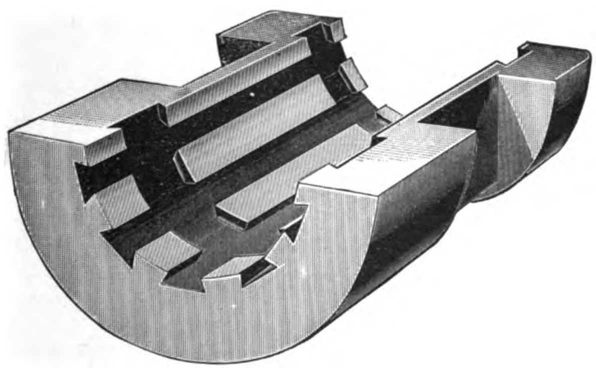


Fig. 465.

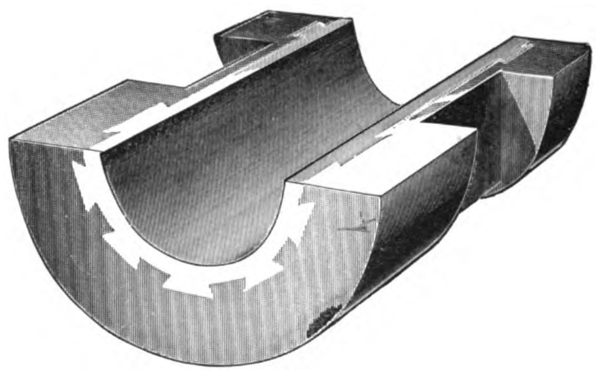


Fig. 466.

The construction of the elevating rest will be understood from Figs. 467 and 474. Referring to Fig. 467, it is pivoted upon pins at *a a*, *b b*, and threaded in the lathe carriage, to which it is accurately fitted. At the other end it is operated vertically by the elevating screw, which is seated in a ball joint provided in the lathe carriage, which is gibbed to give it a secure fit to the lathe shears ; in this manner play or lost motion at that end of the rest is avoided. The carriage, it will be seen, fits upon the outer two of the vee slides of the lathe shears, having a larger bearing area than the inside vees upon which the tailstock slides. The construction of the headstock is shown in Figs. 475 and 476. There are five steps to the belt cone, giving five changes of speed in single, and five in double or back gear, the lever being thrown in and out. End motion or play to the live spindle is taken up and the fit adjusted by a fibre corresponding washer y adjusted for compression by the threaded stud P locked in position by the nut q.

The feed motions are driven as follows: Upon the live spindle is the gear A, and beneath it, mounted upon a swinging bracket, are two gears B and C in gear with each other. This bracket swings upon having upon it the lock pin F, tongue T, which is pivoted at p and a spring S. Three taper holes G are provided as seats for the pin F when the swing frame E reaches its adjusted position.

The swing frame for carrying the change gears for screw cutting is shown in Fig. 477; it is swung from its end *a* concentric with the lead screw, and in connection with the change gear, means are provided for a wide range of rod feed receiving motion from the change gear. Immediate gear A drives pinion A", which in turn drives an extra pulley marked in the figure, "pulley for rod feed." This pulley can be belted to the pulley on the feed rod.

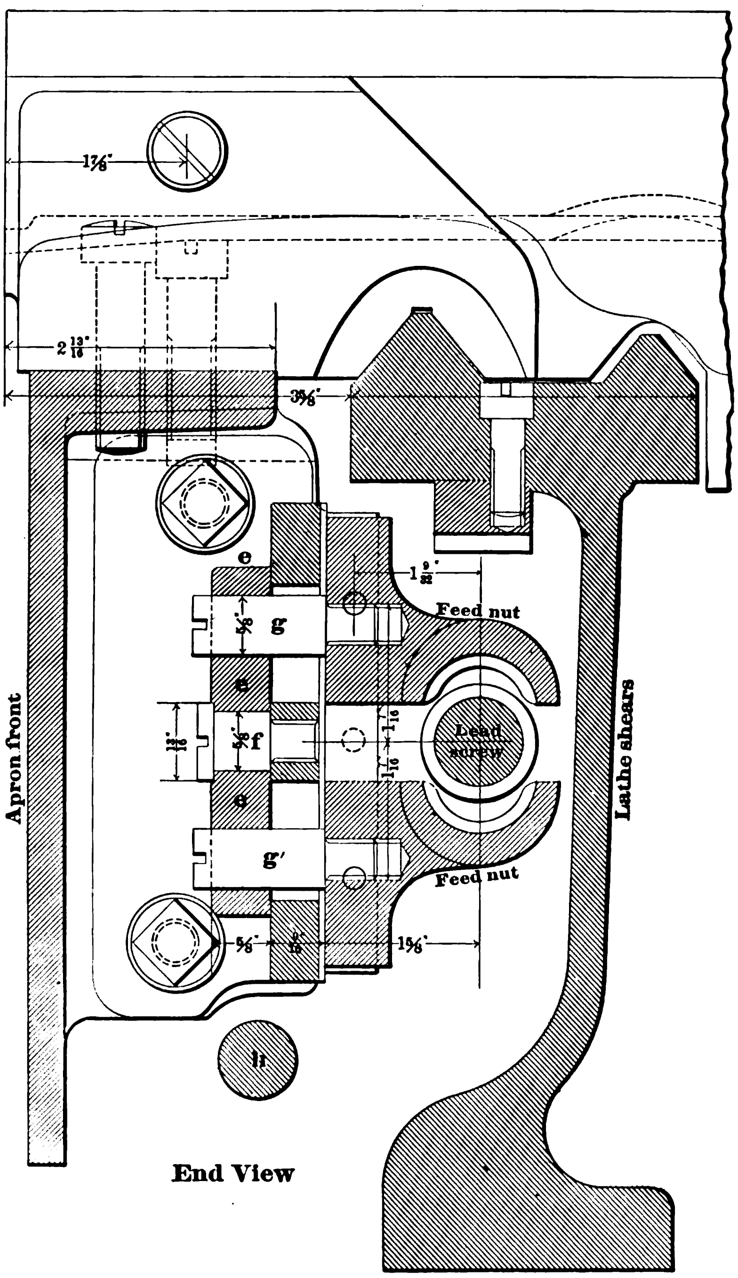


Fig. 472.

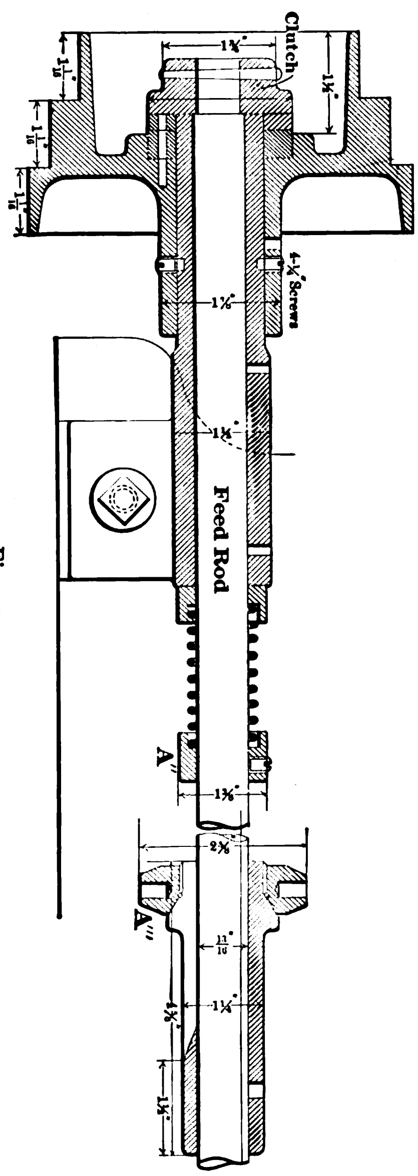


Fig. 473.

the same axis as the gear D, which is concentric with the top feed cone; gear C is in mesh with gear D as well as with gear B. Now referring to Fig. 476, suppose B is swung to the right, coming to gear with and be driven by A and transmit the motion through C to D, giving D and the top feed cone, seen in Fig. 475, motion in one direction; while if, on the other hand, the bracket be swung to the left, the gear C, Fig. 476, will come into gear with A and transmit its motion to D in an opposite direction, whereas with B and C in the central position shown in the figure they are both clear of A, therefore out of action; the construction for throwing the feed in and out of gear being as follows: E is the bracket or swinging arm upon which C and B are carried, being swung by the handle H,

The construction of the tailstock is shown in Fig. 478, and it will be seen that it is held securely to the lathe shears by two bolts passing entirely through it and having nuts of ready access at the top.

The tail spindle is securely clamped by the split at *s*, which is closed by pressure of the screw when the handle *h* is operated. The upper part *u u* has a slideway *v* in the lower part *f* and can be set over for turning taper by means of the screws *t t'*.

An ingenious and excellent construction of a taper turning attachment is that on the lathe, Fig. 479, constructed by the Flathers' Machine Tool Co., Nashua, New Hampshire, which is shown in Figs. 479, 480, 481, 482, 483.

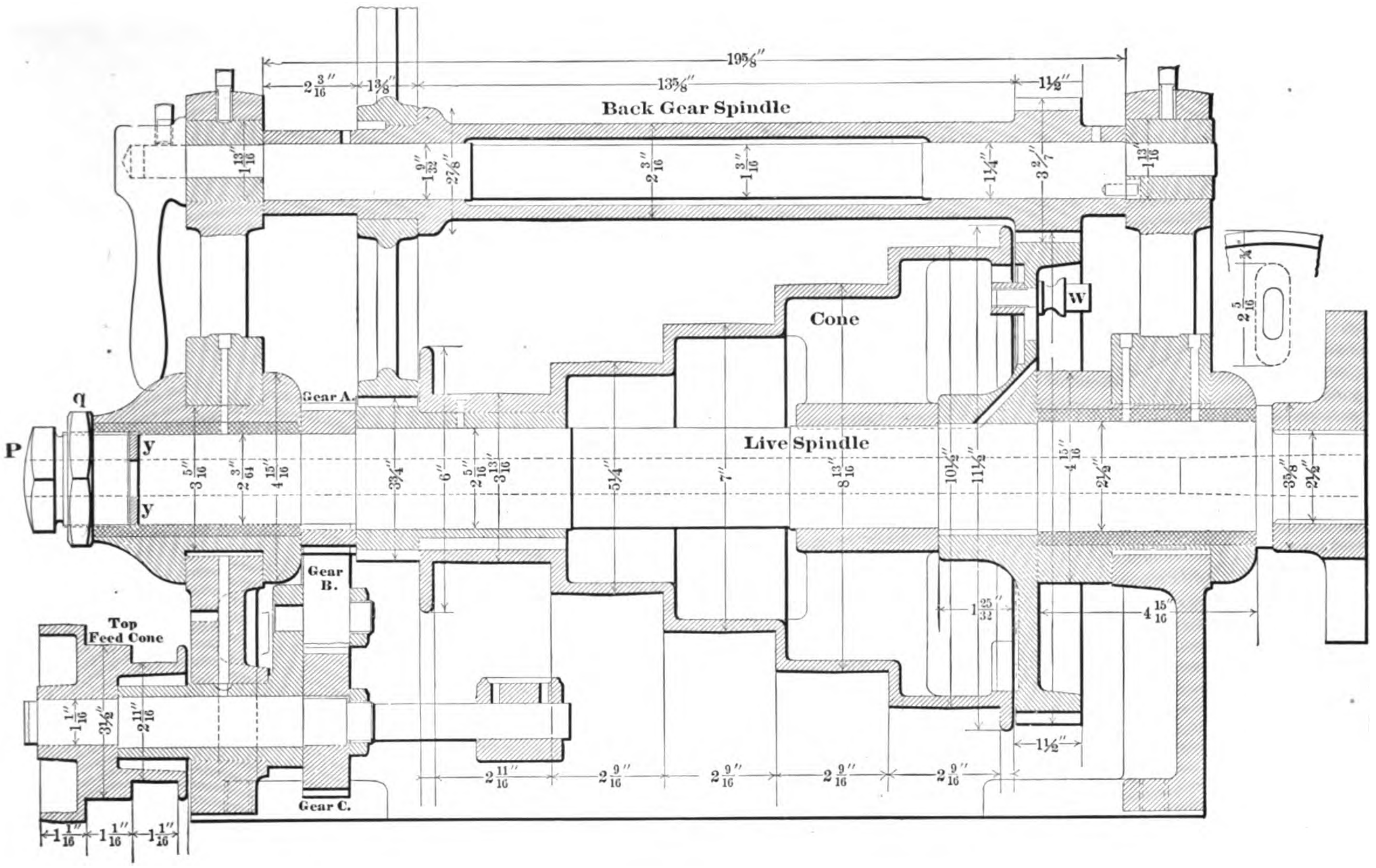


Fig. 475.

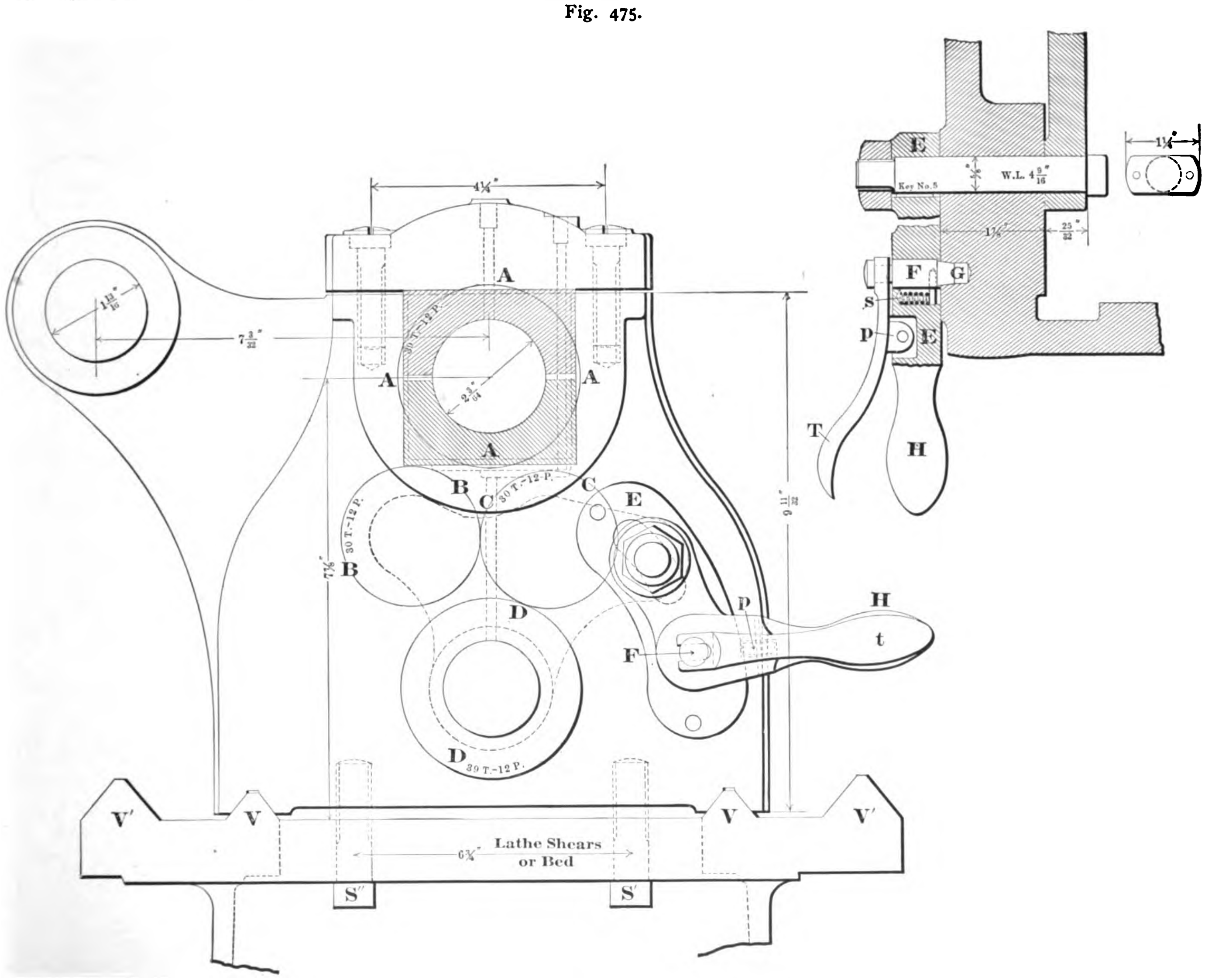


Fig. 476.

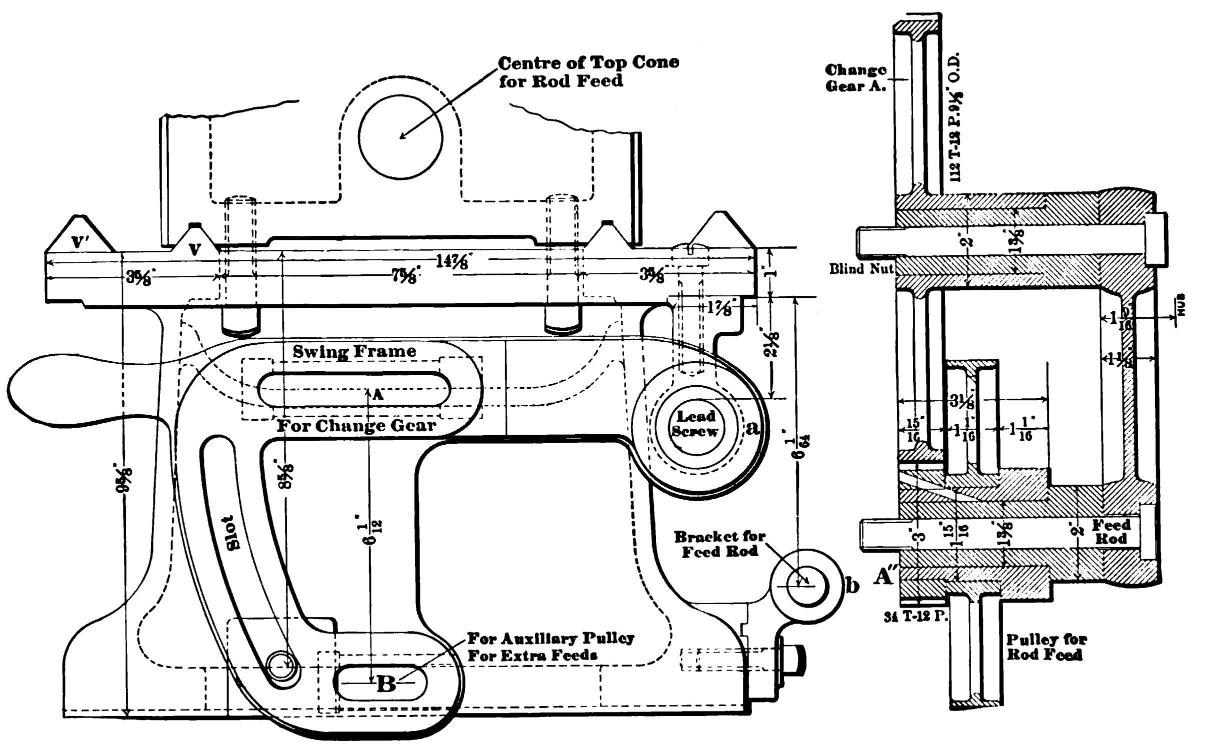


Fig. 477.

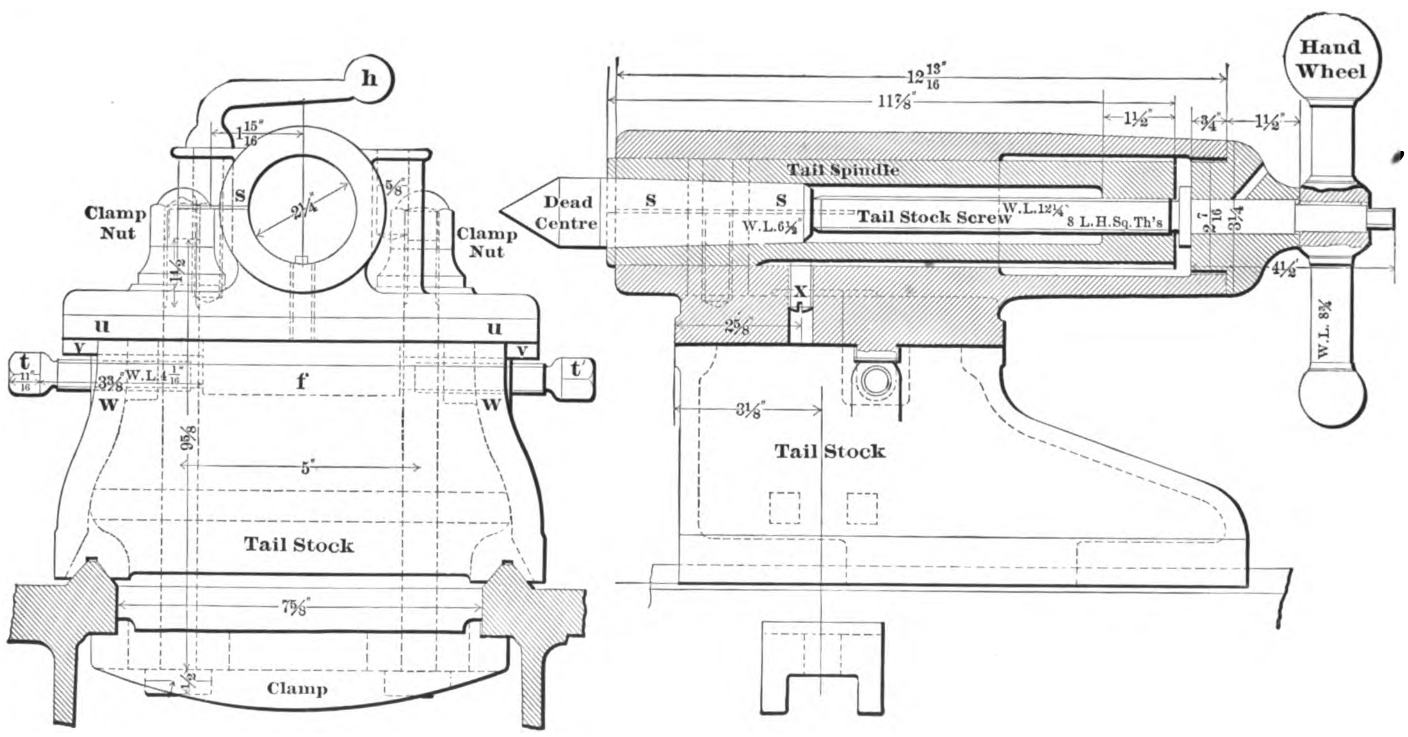


Fig. 478.

The cross-feed screw enters a sleeve at the handle end, as shown in Fig. 483, and is splined to receive feather in the sleeve. This permits the cross-feed screw to move endwise in the sleeve and the slide rest to move from the line of lathe centres without moving the cross-feed screw handle, which can be used to put on the required depth of cut in the usual way.

The cross-feed screw when attached to slide *b* on the guide bar *a*, Fig. 480, acts merely as a rod causing the slide rest, as it traverses along the lathe shears, to move in a line parallel to the guide bar *a*, thus turning the work to a taper corresponding to the angle at which the bar is set.

At P P, Fig. 483, a pinion is provided, being solid with the sleeve and serving to rotate the cross-feed screw when the automatic cross feed is put in action by the gearing in the lathe apron. The cross-feed screw passes through its nut in the usual manner and is journalled at the back end in a sliding block which fits over the dovetailed cross slide—as shown in Fig. 481—and slides freely upon it except when clamped to it, which can be done by tightening a screw. On the under side of this sliding block is a lug—a sliding fitted in a slot provided in the end *c* of the cross slide, Fig. 480—and it is in this lug that the cross-feed screw is held by a collar on the inside of its journal and a nut and washer at its back end, which is seen in Fig. 481.

The lug is upon the piece *d*, Fig. 481, secured by a bolt *e* to the guide *b* and obviously released from it by the removal of *e*. The taper turning guide bar *a* is pivoted in the centre of its length and is adjusted to stand at the angle required for the taper to be turned by a graduated disk shown at *f*, Fig. 481, and in plan in Fig. 482, being secured to its adjusted position by the screw at *g*.

In the original patent for taper turning attachments obtained by Dwight Slate, of Hartford, Conn., the brackets for carrying the attachment were secured to the back of the lathe shears, and in order to enable the turning of a taper at different points in the work length it was necessary to provide a slideway along the back of the lathe shears so that the brackets and taper bar would be adjusted along it to the required position. In a patent granted, however, to John D. Hazlett and Louis F. Lord, of Meadville, Penn., the said brackets are carried by the back of the lathe carriage itself and therefore require no adjustment other than that required to set the bar at the angle necessary for the taper to be turned. The following is from the specification of the said patent:

Our invention is a taper attachment for engine lathes and includes a slip-block connected to the tool-holder and guides to make said holder move laterally of the bed to form the taper; and the novelty in the invention, broadly speaking, lies in the means for supporting the slip-block and guide, the said support being carried by the moving carriage and always bearing the same relation to the slip-block and the point of strain.

In the drawings, Plate VII.-E, Fig. 1 is a plan view. Fig. 2 is a transverse section with the tool-holder in dotted lines. Fig. 3 is a side view of the slip-block, its guide, and the support therefor. Fig. 3*a* is a similar view with the parts in another position. Fig. 4 is a section on line *x x* of Fig 1. Fig. 5 is a vertical transverse section on line *z z* of Fig. 3*a*.

In the drawings, the bed A, the carriage B, and the tool-holder C are of ordinary construction, the carriage having transverse guideways 1, along which the tool-holder moves in forming the taper. The tool-holder is operated by a bar 2, connected with a slip-block 5, and the lateral position of the slip-block in relation to the bed and the work is determined by an adjustable guide having a dovetailed rib 6, the inclined position of which corresponds to the incline of the taper to be formed, and as the carriage moves the slip-block travels along the inclined guide and through the connection 2 moves the tool-block laterally. The guide 6 is held against longitudinal movement upon a plate 7 by a screw 12, which acts as a pivot, and a screw 17 passing through a curved slot 16 in the guide by which the adjustment is effected. The plate 7 has a dovetailed channel in its under side, and into this fits a dovetail rib on the bar 8, which supports all the parts just described—that is, the plate 7, the guide 6, and the slip-block. This support 8 is carried by brackets 9 at each end secured to the moving carriage and equally distant from the block 5, with which the support and brackets move and always bear the same relation. The plate 7 and the guide 6 are held against longitudinal movement by a bar 3, secured at one end to a bracket 4, fastened to the bed, and at the other end connected to the screw 12, which

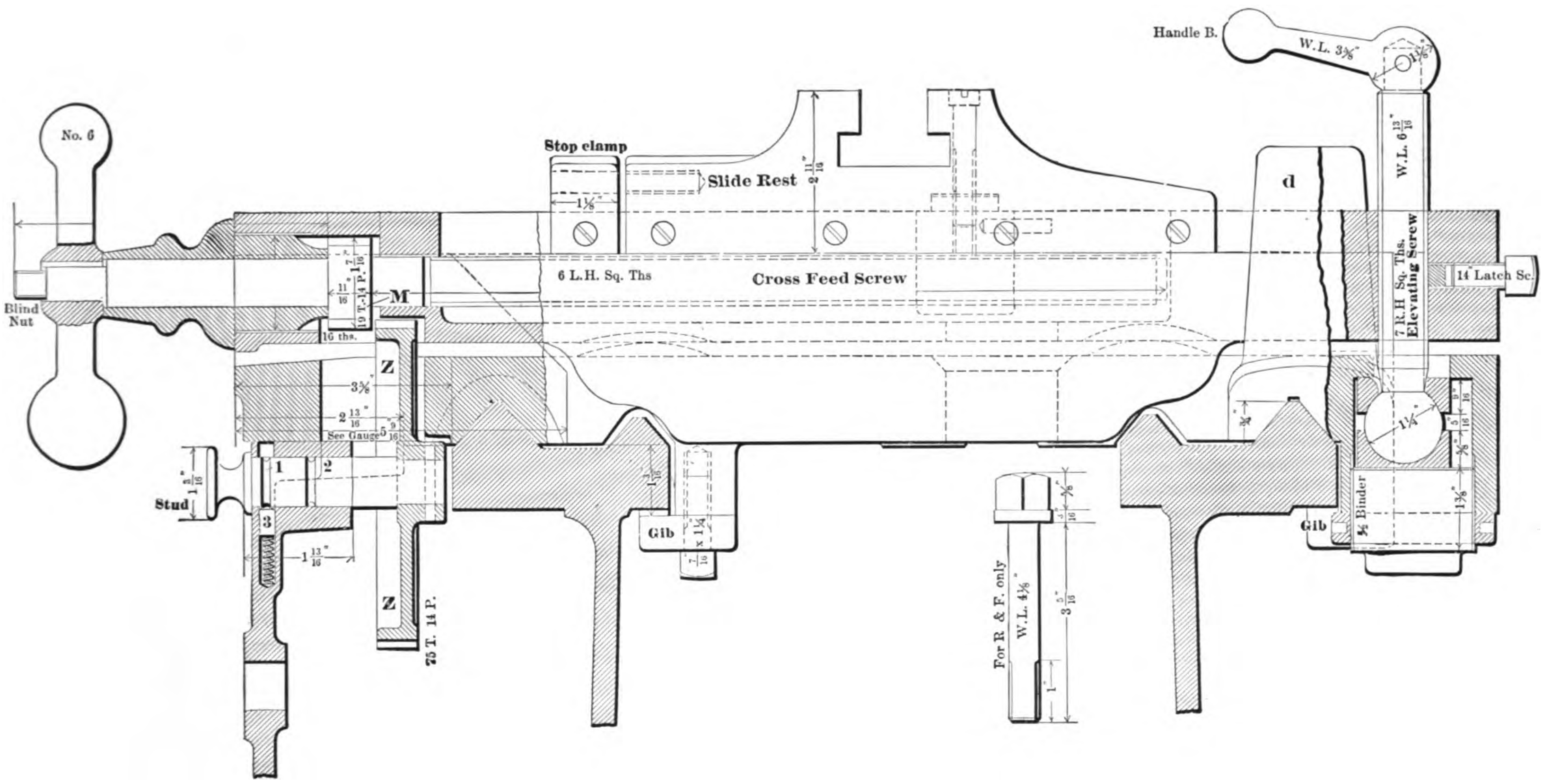


Fig. 474.

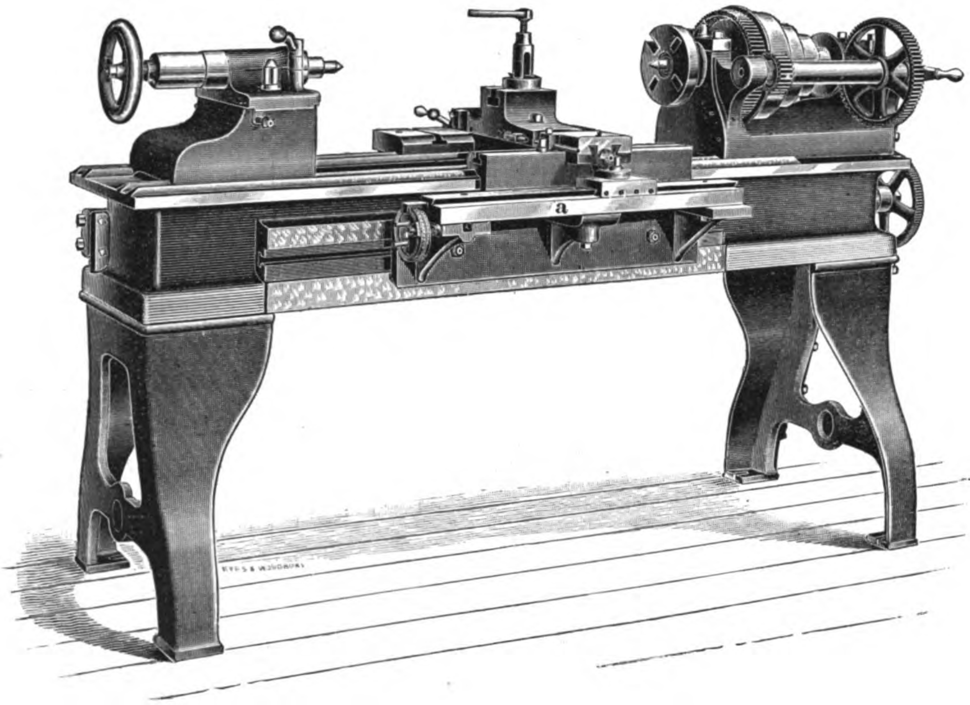


Fig. 479.

connects the guide and plate 7. A channel 10 is formed in the dovetail rib of the support 8 to receive the bar 3.

When the carriage moves, the guide-plate and the plate 7 remain stationary, while the slip-block and support 8 move

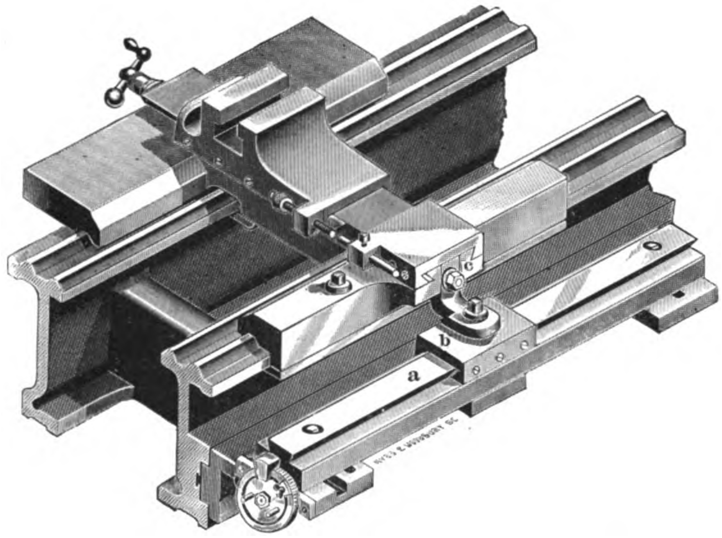


Fig. 480.

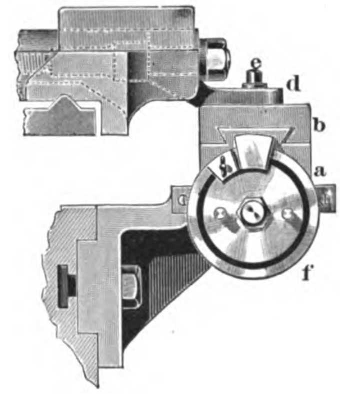


Fig. 481.

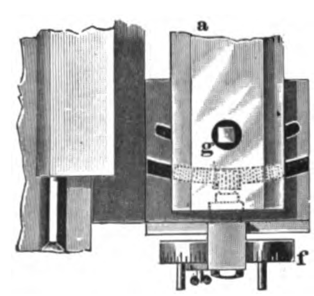


Fig. 482.

together with the brackets 9, the bar 2, and the tool-holder. As the support 8 moves in the dovetail channel of the plate 7, it acts as a bearing for the plate 7, and retains said plate in proper position in alignment with the bed to secure perfect action of the parts. The bar 2 is adjustably connected with the tool-holder to vary the position of the same for different work.

By reason of the supporting plate 8, which sustains the plate 7 and the guide 6 on the carriage, no adjustment of these parts is necessary to suit different lengths of material operated upon, as the brackets and plate move with the carriage and thus bear at all times the same relation to the point of work. In machines now in use the supporting brackets are connected to the bed and they must be adjusted opposite the point of work, and when the length of the material to be turned is changed the adjustment of the brackets is required on the bed.

THE LE BLOND ENGINE LATHES.—These lathes, Figs. 484 to 491*a*, are made of hammered steel hollowed spindles; the head-stock feed rod and lead screw bearings being of phosphor bronze. Screw-cutting stocks are provided, graduated to the $\frac{1}{1000}$ part of an inch and can be set at zero in any position. The longitudinal and cross feeds are automatic. The apron gear is so arranged that the rod feed and screw feed cannot be put into action at the same time. Tailstocks are arranged to set over for turning

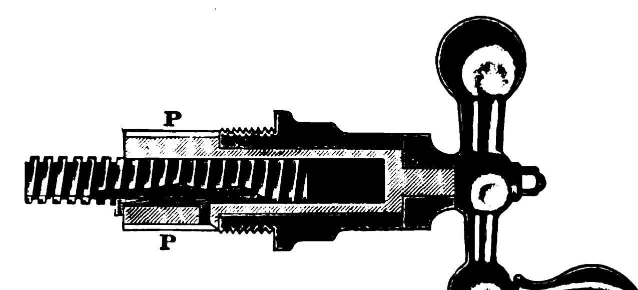


Fig. 483.

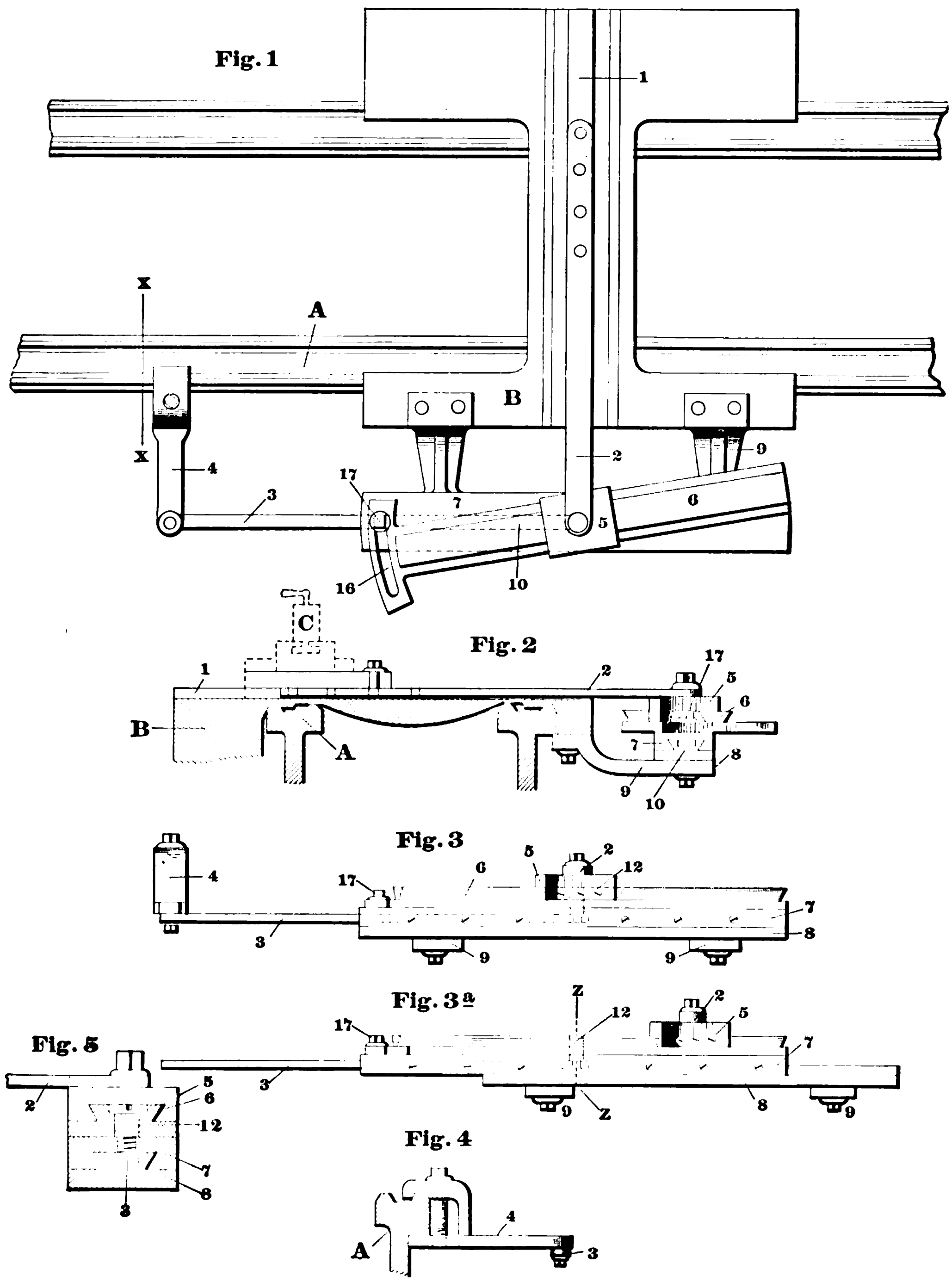


Fig. 1
Fig. 2
Fig. 3
Fig. 3a
Fig. 4
Fig. 5
A
B
C
X
Z

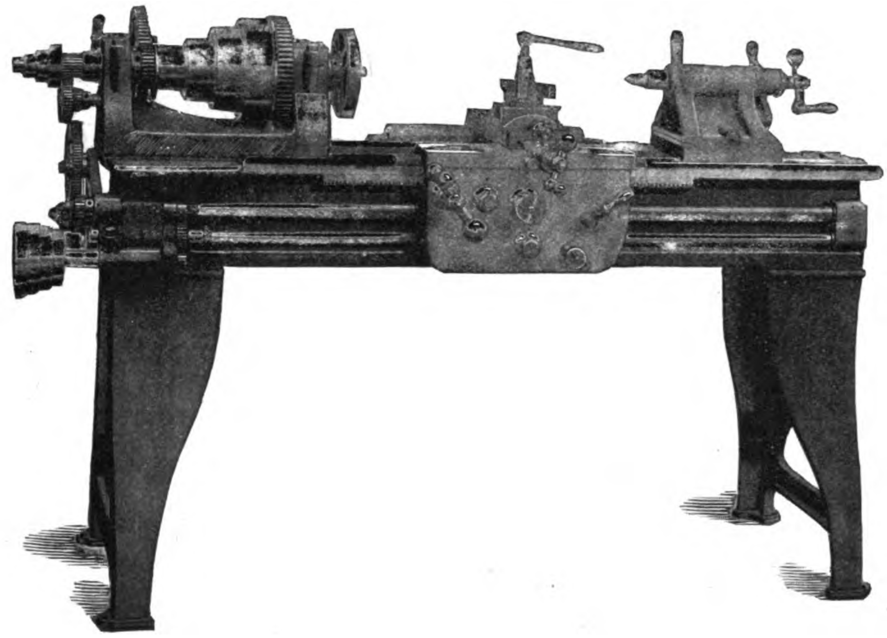


Fig. 484.

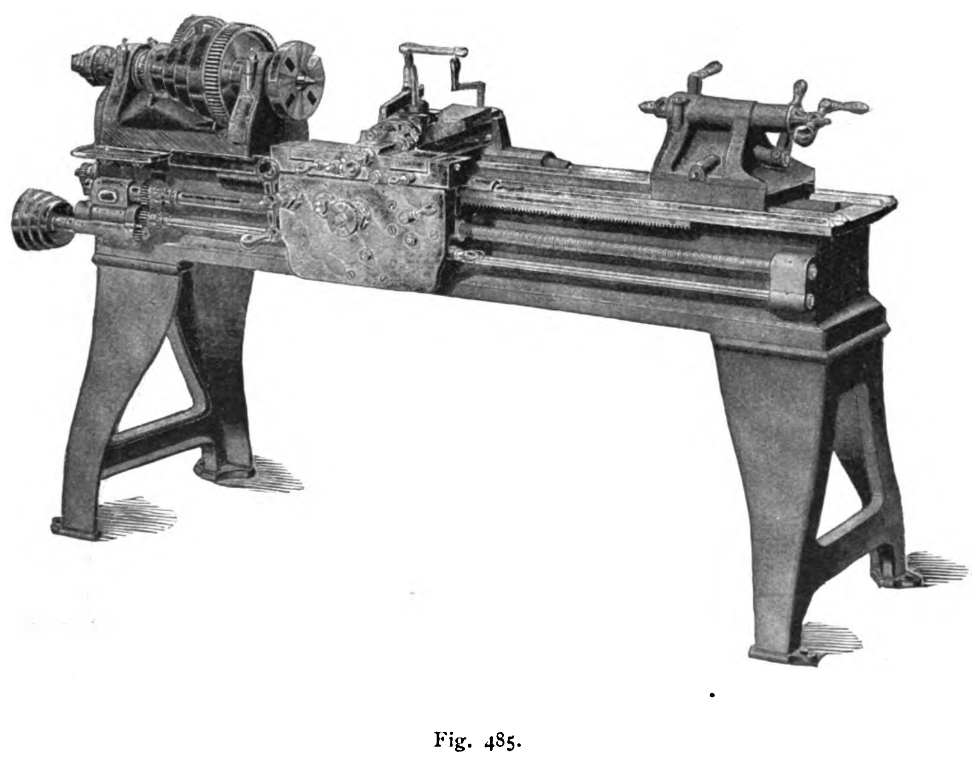


Fig. 485.

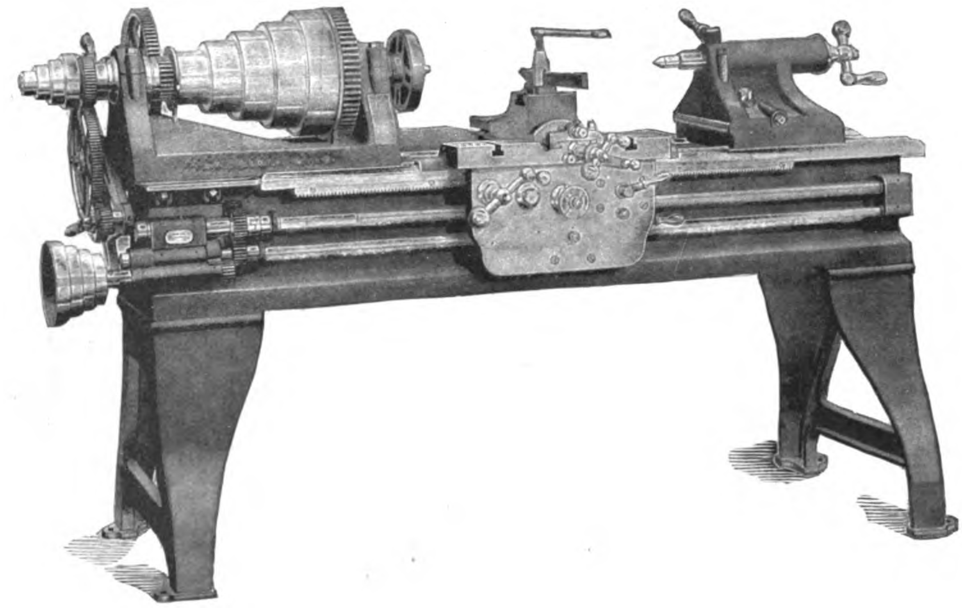


Fig. 486.

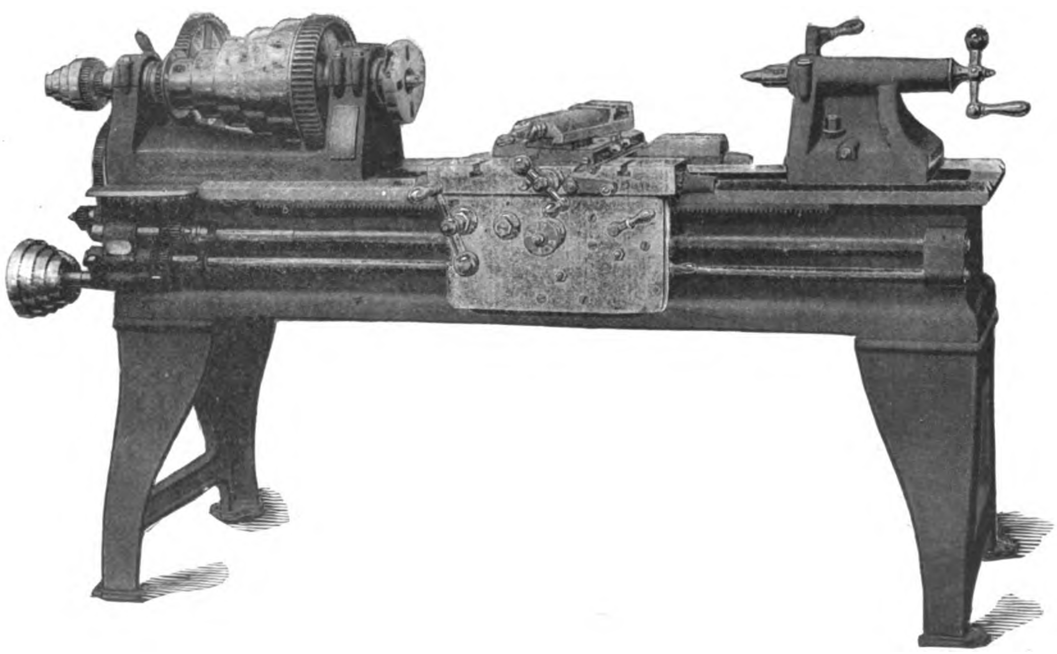


Fig. 487.

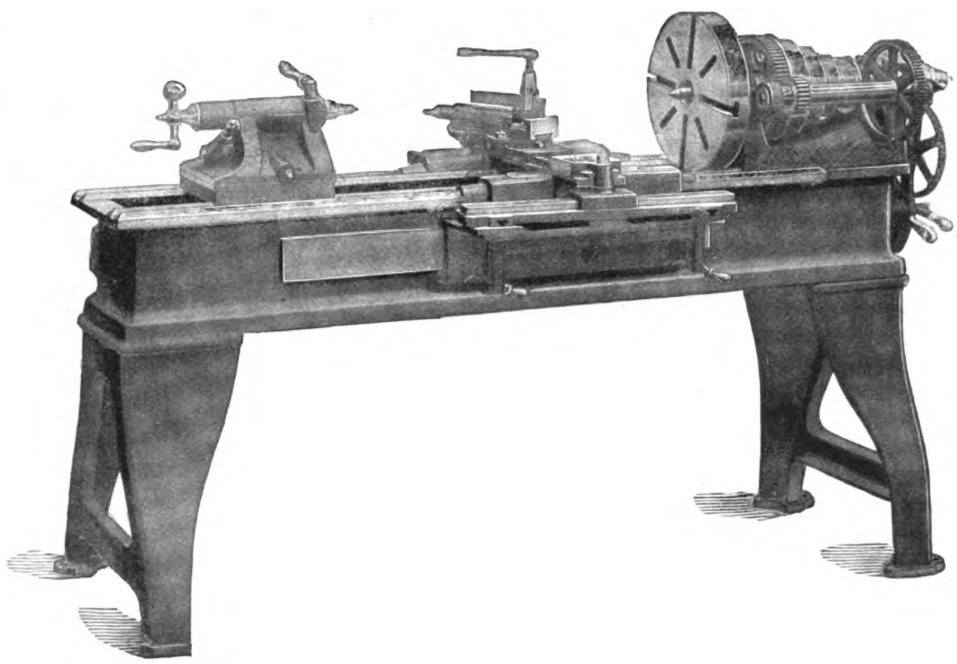


Fig. 488.

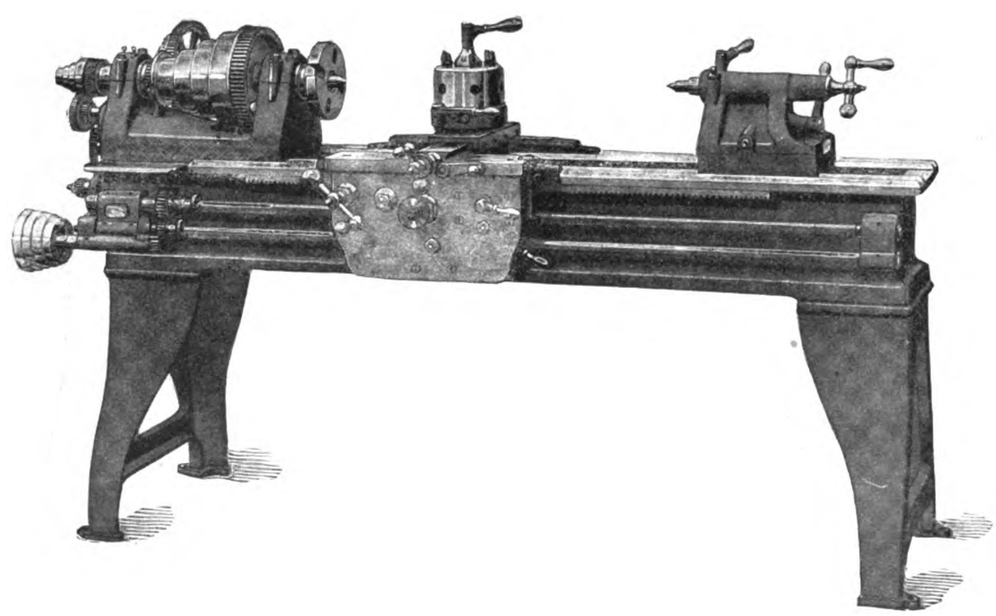


Fig. 489.

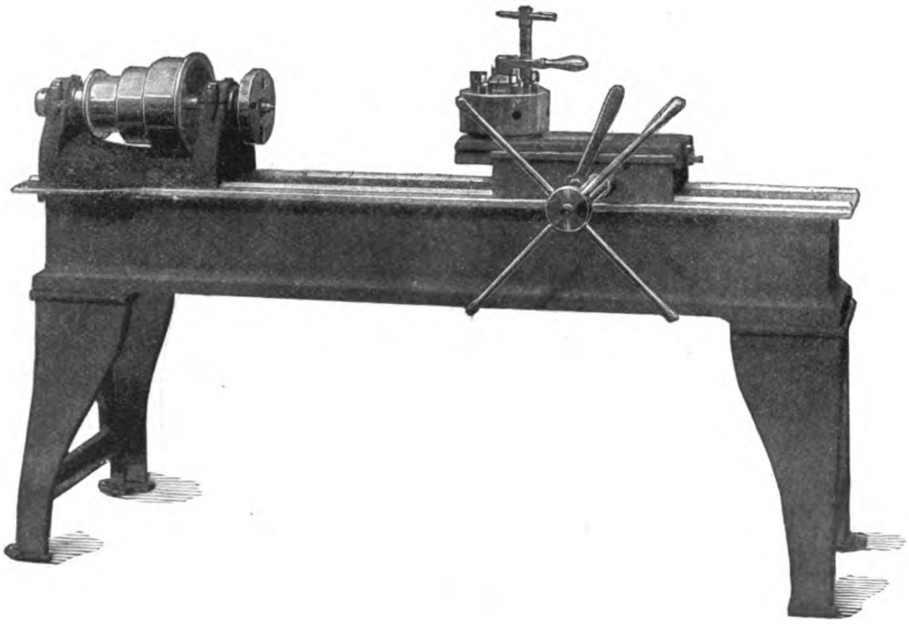


Fig. 490.

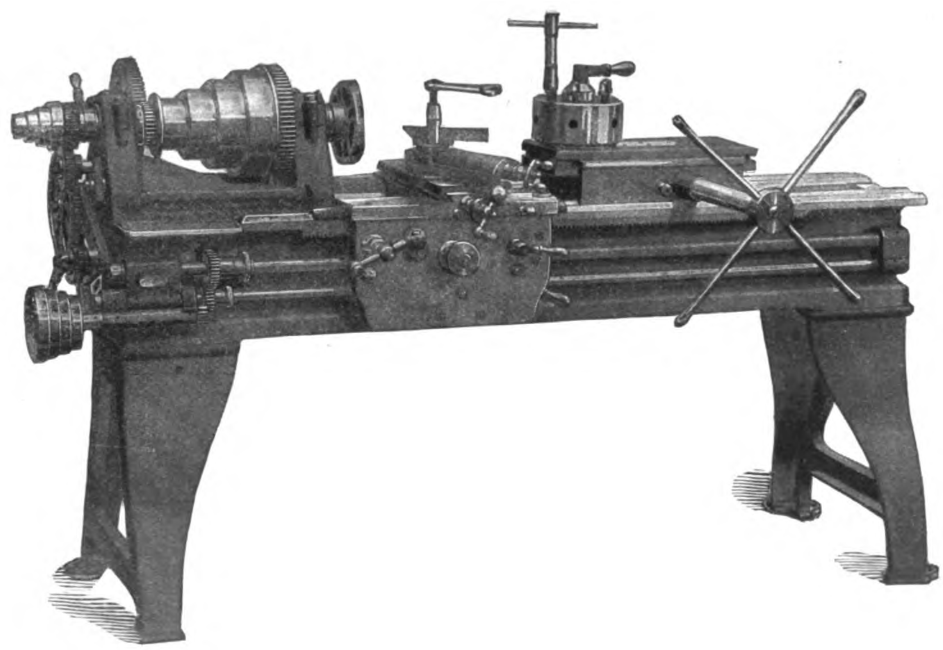


Fig. 491.

tapers if required and are graduated. All the feed motions are reversible in the apron. The feed cones are on swinging brackets and act as belt tighteners for the feed belts. All these lathes are fitted with a dial on the lead screw so that threads can be cut without either stopping the lathe or reversing the motion of the lead screw. Fig. 484 represents a 12-inch lathe, cutting threads from 5 to 40 per inch. Fig. 485 has a range of threads from 5 to 48 per inch; the hole through its spindle being $\frac{13}{16}$ inch. This lathe has an elevating slide rest. Fig. 486 has a swing of 16 inches and cuts threads from 3 to 24 per inch; the hole through the spindle being $1\frac{1}{16}$ inch. The tailstock sets over to turn tapers and is graduated. A compound rest is also provided. Threads cut are from 2 to 20 per inch. Fig. 488 shows the lathe with a taper turning attachment carried on brackets, which is carried by a slide on the back of the bed and is therefore adjustable along it. Fig. 489 shows the lathe with a turret on the carriage which is so constructed that the turret can be removed and the lathe used in the ordinary manner. Fig. 487 shows the lathe arranged as a plain chucking lathe. The end thrust of the live spindle is taken up with ball bearings, while the hole through the spindle is large enough to work stock from the bar of as large a diameter as the lathe is intended to drive. Fig. 491*a* shows the turret turned upside down to expose its construction.

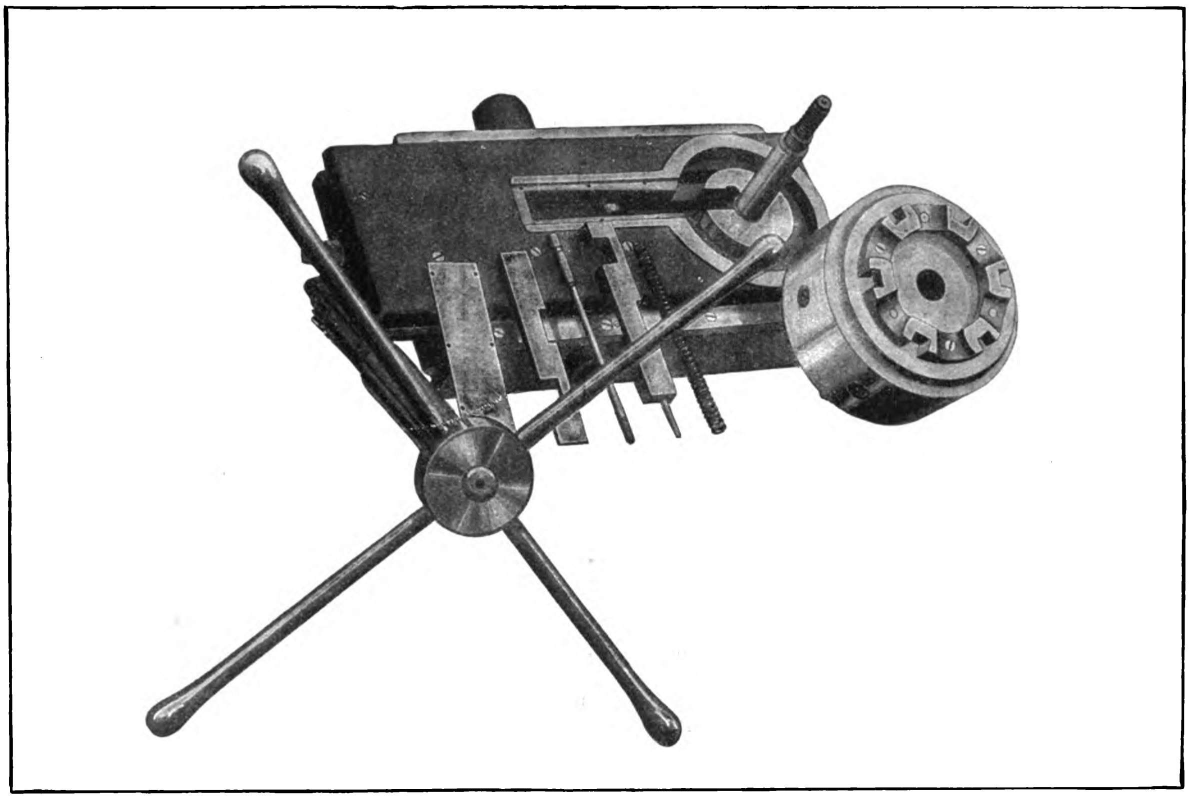


Fig. 491*a*.

Fig. 492 represents an 18-inch engine (or self-acting) lathe designed by and containing the patented improvements of S. W. Putnam, of the Putnam Tool Company, of Fitchburg, Massachusetts. The lathe has an elevating slide rest, self-acting feed traverse, and self-acting cross feed, both feeds being operative in either direction. It has also a feed rod for the ordinary tool feeding and a lead screw for screw-cutting purposes.

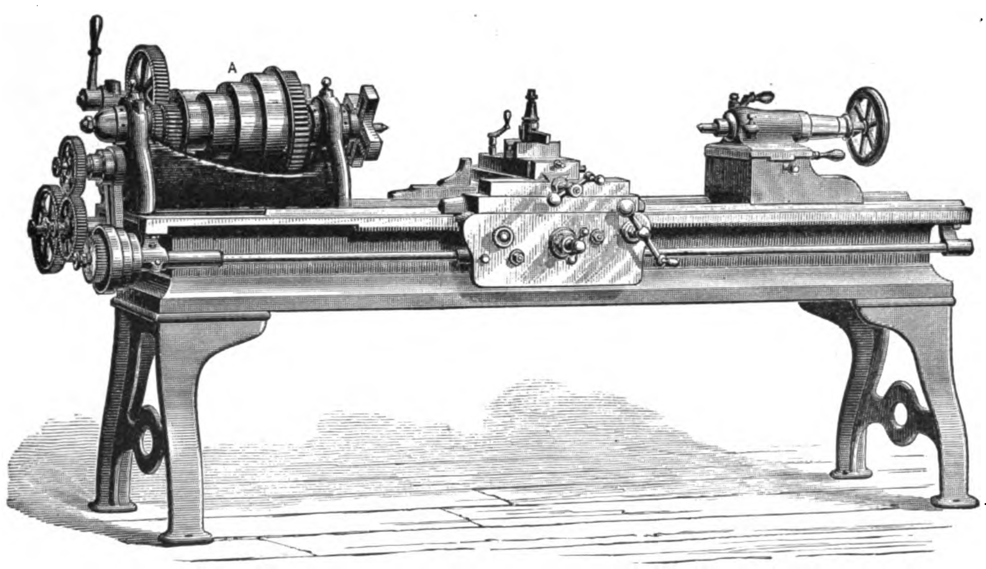


Fig. 492.

Fig. 493 represents a cross-sectional view of the shears beneath the headstock; A A are the shears or bed, having the raised Vs marked V′ and V on which the headstock and tailstock rest, and V″ and V‴ on which the carriage slides. A and A are the shears connected at intervals by cross girts or webs B to stiffen them. C C are the bolts to secure the headstock to the shears. D is a bracket bolted to A' and affording at E journal bearing for the spindle that operates the independent feed spindle. E is split at *f* and a piece of soft wood or similar compressible material is inserted in the split. The bolt F is operated to close the split, and, therefore, to adjust the bore E to properly fit the journal of the feed spindle, and as similar means are provided in various parts of the lathe to adjust the fits of journals and bearings the advantages of the system may here be pointed out. First, then, the fit of the bearing may be adjusted by simply operating the screw, and, therefore, without either disconnecting the parts or performing any fitting operation, as by filing. Secondly, the presence of the wood prevents the ingress of dust, &c., which would cause the bearings and journals to abrade; and, thirdly, the compression of the wood causes a resistance and pressure on the adjusting screw thread, which pressure serves to lock it and prevent it from loosening back of itself, as such screws are otherwise apt to do.

As the pressure of the tool cut falls mainly on the front side of the carriage, and as the weight of the carriage itself is greatest on that side, the wear is greatest; this is counteracted by forming the front V, marked V''' in figure, at a less acute angle, which gives it more wearing area and causes the rest to lower less under a given amount of wear.

The rib A'' which is introduced to strengthen the shears against torsional strains, extends the full length of the shears.

Fig. 494 is a sectional side elevation of the headstock; A A' represents the headstock carrying the bearing boxes B and B',

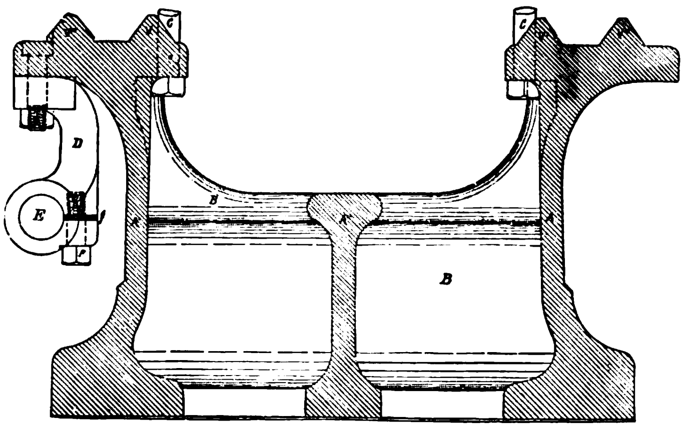


Fig. 493.

which are capable of bore closure so as to be made to accurately fit the spindle S by the construction of the front bearing B, being more clearly shown in Fig; 495; B is of composition brass, its external diameter being coned to fit the taper hole in the head; it is split through longitudinally, and is threaded at each end to receive the ring nuts C and C'. If C be loosened from contact with the radial face of A, then C' may be screwed up, drawing B through the coned hole in A, and, therefore, causing its bore to close upon S.

At the other end of S, Fig. 496, C'' is a ring nut for drawing the journal box B' through *a'* to adjust the bore of B' to fit the journal of S, space to admit the passage of B' being provided at *e*. D is a box nut serving to withdraw B' or to secure it firmly in its adjusted position, and also to carry the end adjusting step E. F is a check nut to lock E in its adjusted position.

The method of preventing end motion to S is more clearly shown in Fig. 496, in which *h* is a steel washer enveloping S, having contact with the radial face of B' and secured in its adjusted position by the check nuts *g*, hence it prevents S from moving forward to the right. *f* is a disk of raw hide let into E; the latter is threaded in D and is squared at the end within F to admit of the application of a wrench, hence E may be screwed in until it causes contact between the face of *f* and the end of S, thus preventing its motion to the left. By this construction the whole adjustment laterally of S is made with the short length from *h* to *f*, hence any difference of expansion (under varying temperature) between the spindle and the head A A', or between the boxes and the spindle S, has no effect towards impairing the end fit of S in its bearings.

The method of adjusting the bearings to the spindle is as follows:—C'' and C' are slackened back by means of a "spanner wrench" inserted in the holes provided for that purpose. C and D

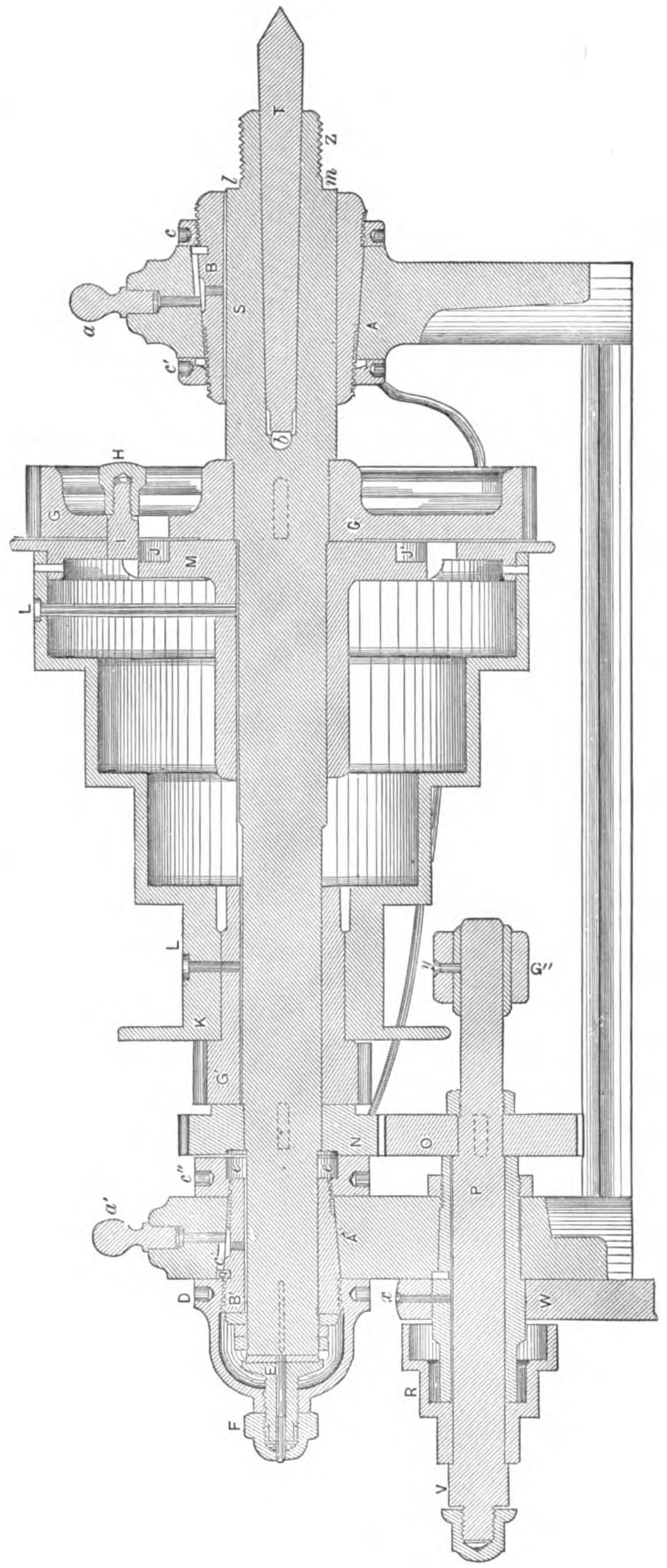


Fig. 494.

are then screwed up, withdrawing B and B' respectively, and leaving the journal fit too easy. C' is then screwed up until B is closed upon the spindle sufficiently that the belt being loose on the cone pulley, the latter moved by the hand placed upon the smallest step of the cone can just detect that there is contact between the bore of B and the spindle, then, while still moving the cone, turn C′ back very slowly and a very little, the object being to relieve the bore of B from pressure against S. C may then be screwed up, firmly locking B in its adjusted position. C″ may then be operated to adjust B′ in a similar manner, and D screwed up to lock it in its adjusted position. Before, however, screwing up D it is better to remove F and release E from pressure against *f*, adjusting the end pressure of E after D has been screwed home against A′.

To prevent B and B′ from rotating in the head when the ring nuts are operated, each is provided with a pin, *q*, grooves *c* and *c*′ permitting of the lateral movement of B and B′ for adjustment. The boxes B, B′ admit of being rotated in their sockets in A and A′ so as to assume different positions, the pins *q* and *q*′ being removable from one to another of a series of holes in the boxes B, B′ when it is desired to partly rotate those boxes. The tops of the boxes are provided with oil holes, and the oil ways shown at *r*, *s* being the oil groove through the head and *a* simply a stopper to prevent the ingress of dust, &c.

The thread on S at Z, Fig. 494, is to receive and drive the face plates, chucks, &c., which are bored and threaded to fit over Z. To cause the radial faces of such face plates or chucks to run true, there is provided the plain cylindrical part *l*, to which the bore in the hub of the face plate or chuck is an accurate fit when the radial face of that hub meets the radial face *m*.

Referring again to Fig. 494, G′ is the pinion to drive the back gear while G receives motion from the back-gear pinion. The object of the back gear is to reduce the speed of rotation of S and to enable it to drive a heavier cut, which is accomplished as follows :—G′ is secured within the end K of the cone and is free to rotate with the cone upon S; at the other end the cone is secured to M, which is free to rotate upon S so far as its bore is concerned. G is fixed upon S and hence rotates at all times with it; but G may be locked to or released from M as follows :—

In G is a radial slot through which passes a bolt I provided with a cap nut H, in M is an annular groove J. When I is lifted its head passes into a recess in M, then H is screwed

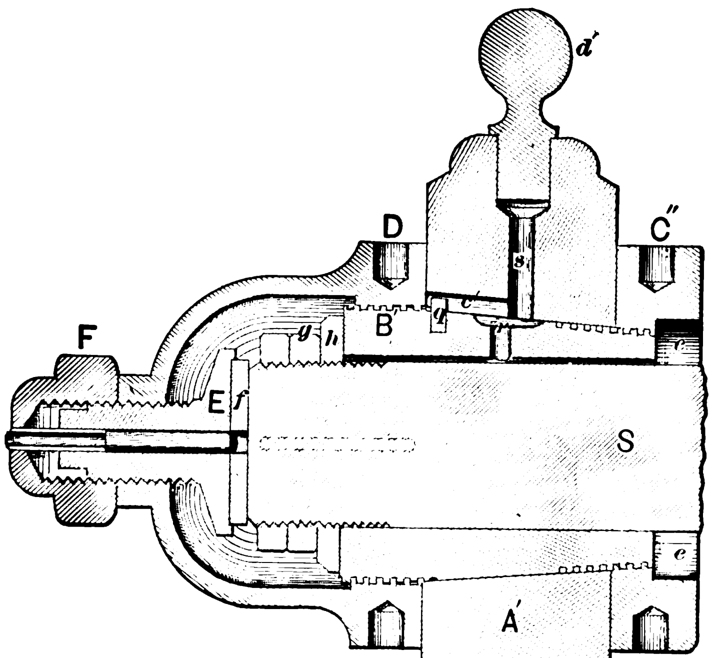


Fig. 496.

up and G is locked to M. This is the position of I when the back gear is not in use, the motion of the cone being communicated to S through I. But if H be loosened and I be moved inwards towards S, the head of I passes into the annular groove J, and the cone is free to rotate upon S while the latter and G remain stationary unless the back gear is put into operation. In this latter case the pinion G′ rotating with the cone drives the large gear of the back gear and the small pinion of the

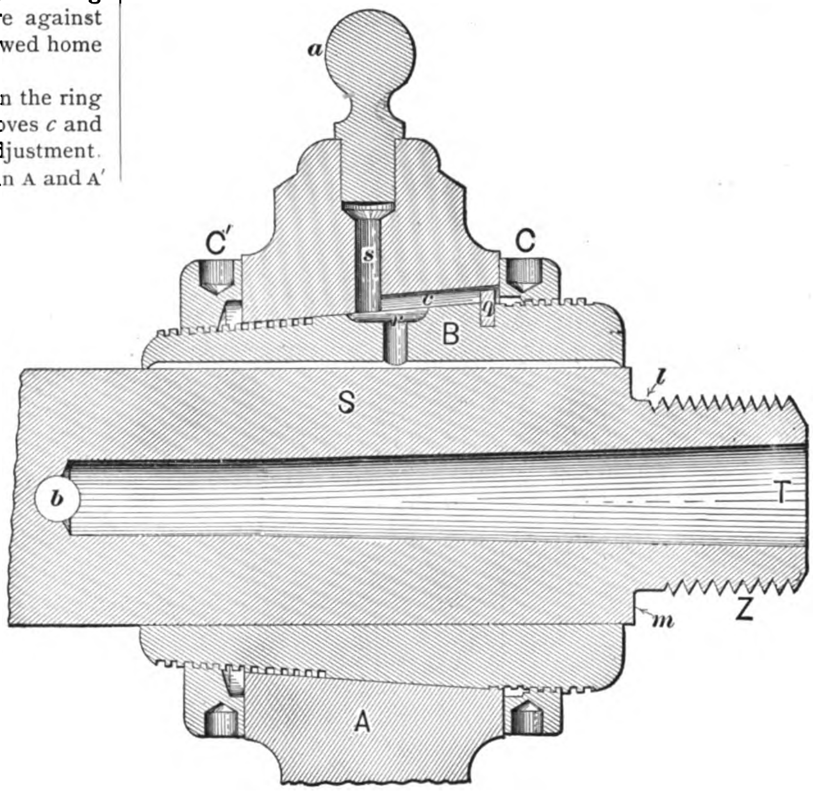


Fig. 495.

latter drives G, whose speed of rotation is reduced by reason of the relative proportions of the gear wheels.

In this case it is obvious that since the pulley rotates upon the spindle it requires lubrication, which is accomplished through the oil hole tubes L.

The means of giving motion to the feed spindle and lead screw are as follows :—N, Fig. 494, is a pinion fast upon S and operating the gear O, which is fast upon the spindle P, having journal bearing in a stem in A′ and also at G″. P drives the three-stepped cone R, which is connected by belt to a similar cone fast upon the independent feed spindle. The seat for the driving gear of the change wheels for the lead screw is on P at V. To provide ample bearing surface for P in A′ the bush or sleeve shown is employed, but this sleeve also serves to pivot the swing frame W which carries the studs for the change wheels that go between the wheel on V and that on the lead screw; *x y* are simply oil holes to lubricate P in its bearings.

To provide a wider range of tool feed than that obtainable by the steps on the feed cones, as R, they are provided at their ends with seats for change wheels, the swing frame W carrying the intermediate wheels for transmitting motion from V to a similar seat on the cone on the feed spindle.

Fig. 497 represents the tailstock (or tailblock as it is sometimes termed), shown in section. A represents the base which slides upon the raised Vs on the bed and carries the upper part B, in which slides the tail spindle C, which is operated longitudinally by the tail screw D, having journal bearing in E, and threaded through the nut F which is fast in C. The hand wheel G is for rotating D, whose thread operating in the nut F, causes C to slide within B in a direction determined by the direction of rotation of G. To lock C in its adjusted position the handled nut H is employed in connection with the bolt I, which is shown in dotted lines; C is split as shown by the dotted lines at *f*; J is the dead centre fitting accurately into a conical hole in C. When it is required to remove J from C the wheel G is operated to withdraw C entirely within B, and the end *d* of D meets the end *e* of J and forces J from the coned hole in C.

The method of securing the tailstock to the shears or releasing it from the same is as follows. A vertical prolongation of B affords at B″ a bearing surface for the nut-handle L and washer M. K is a bolt threaded into L passing through M, B″ and N, the latter of which it carries. N spans the shears beneath the two Vs on which the tailstock slides. Moving or rather partly

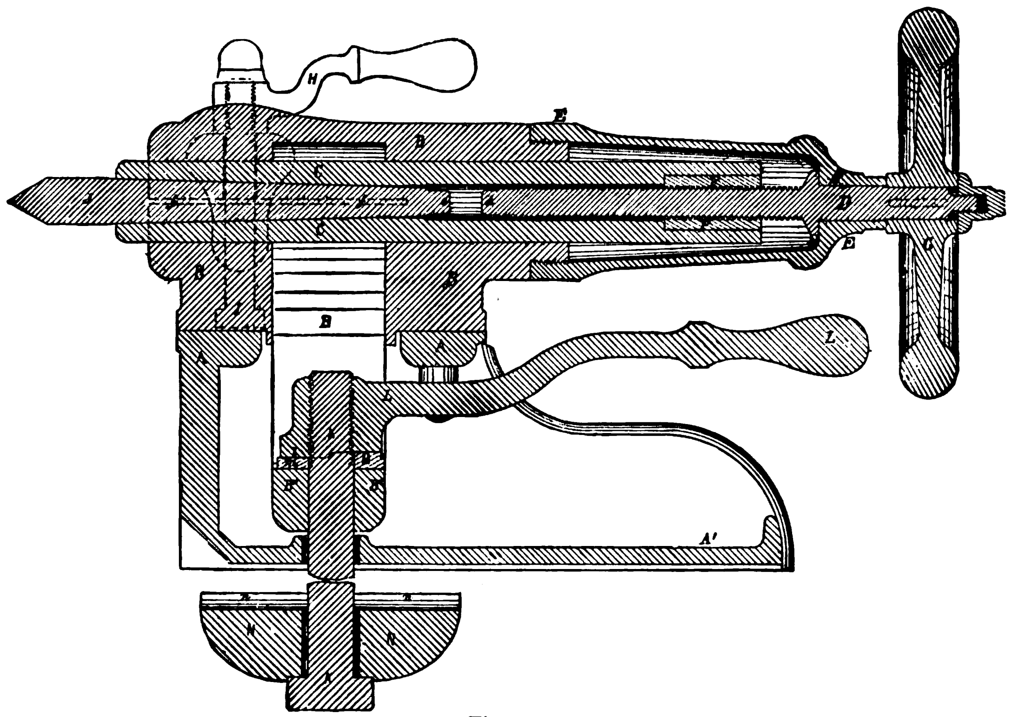


Fig. 497.

rotating the handle L in the necessary direction lifts K and causes N to rise, and grip the shears beneath, while the pressure of M on B″ causes B to grip A and the latter to grip the raised Vs on the shears. If L be rotated in the opposite direction it will cause N to fall, leaving A free to slide along the shears. To prevent N from partly rotating when free, its ends are shaped to fit loosely between the shears as shown at *n*.

To give to N sufficient rise and fall to enable it to grip or fall entirely free from the shears with the small amount of rotary motion which the handle-lever L is enabled from its position to have, the following device is provided. M is a washer interposed between L and B″. This washer has upon it steps of different thickness as shown at M and *m*, the two thicknesses being formed by an incline as shown. The face of L has, as shown, similar steps; now as shown in the cut the step *l* on lever L meets the steps *m* of the washer, the handle having receded to the limit of its motion. The bolt K then has fallen to the amount due to unscrewing the threaded or nut end of L, and also to the amount of the difference of thickness at M and at *m* of the washer, the plate N being clear of the lathe-shears. But suppose the handle L be pulled towards the operator, then the surface *l* passing from a thin section on to a thick one as M of the washer, will lift the bolt K, causing N to meet the under surface of the shears, and then the motion of L continuing the pressure of the thread will bind or lock N to the bed.

The surface A′ in Fig. 497 affords a shelf or table whereon tools, &c., may be placed instead of lying on the lathe bed, where they may cause or receive damage.

Fig. 498 represents an end view of the tailstock viewed from the dead centre end, the same letters of reference applying to like parts that are shown in Fig. 497. The split at *f* is here shown to be filled with a piece of soft wood which prevents the ingress of dust, &c. At *d* is a cup or receptacle for oil, *e* being a stopper, having attached to it a wire pin flattened and of barb shape at the end, the object being to cause the wire to withdraw from the cup a drop of oil to lubricate the dead centre and centre in the work. The proximity of *e* to the dead centre makes this a great convenience, while the device uses much less oil than would be used by an oil can.

The method of setting over the upper part B to enable the turning of the diameter of work conical or taper instead of parallel is shown in figure: P and P′ are square-headed screws threaded into the walls of A and meeting at their ends the surface of B′. In A there is at *a* a wide groove or way, and on B there is at *b* a projection fitting into the way *a* so as to guide B when it slides across A, as it will when P is unscrewed in A and P′ is screwed into A. This operation is termed setting over the tailstock, and its effect is as follows:—Suppose it be required to turn a piece of work of smaller diameter at the end which runs on the dead centre, then, by operating the screw P towards the front of the lathe (or to the left as shown in the cut) and screwing P′

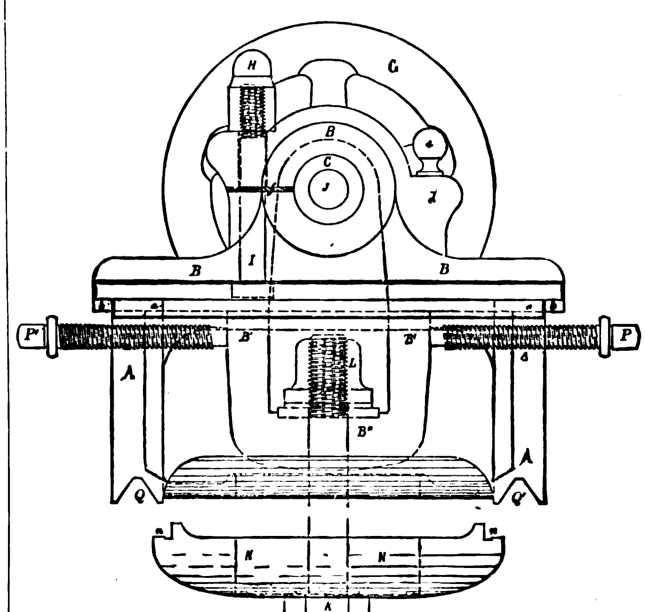


Fig. 498.

farther into A, the end of P′ will meet the surface of B′, causing B′ to move over, and the centre of the dead centre J (which is the axis of rotation of the work at that end) will be nearer to the point of the cutting tool. Or suppose the work requires to be turned a taper having its largest diameter at the end running on the dead centre, then P′ would be unscrewed and P screwed farther into A, carrying B farther towards the back of the lathe.

The **V** grooves Q and Q′ fit upon the inner raised **V**s shown at V, V′ in Fig. 499.

Fig. 499 is a side view of the slide rest for holding and traversing the cutting tool. A represents the carriage resting upon the raised **V**s marked V″ and V‴ and prevented from lifting by its own weight, and in front also by the gib *a* secured to A by the bolt *b* and having contact at *c* with the shears. A carries at *d* a pivot for the cross slide B and at *e* a ball pivot for the cross slide elevating screw C. This screw is threaded through the end of B so that by operating it that end of B may be raised or lowered to adjust the height of the cutting tool point to suit the work. To steady B there is provided (in addition to the pivots at *d*) on A two lugs *f*, between the vertical surfaces of which B is a close working fit. The upper surface of B is provided with a **V**-slide way *g*, to which is fitted the tool rest D (the construction being more clearly shown in Fig. 500).

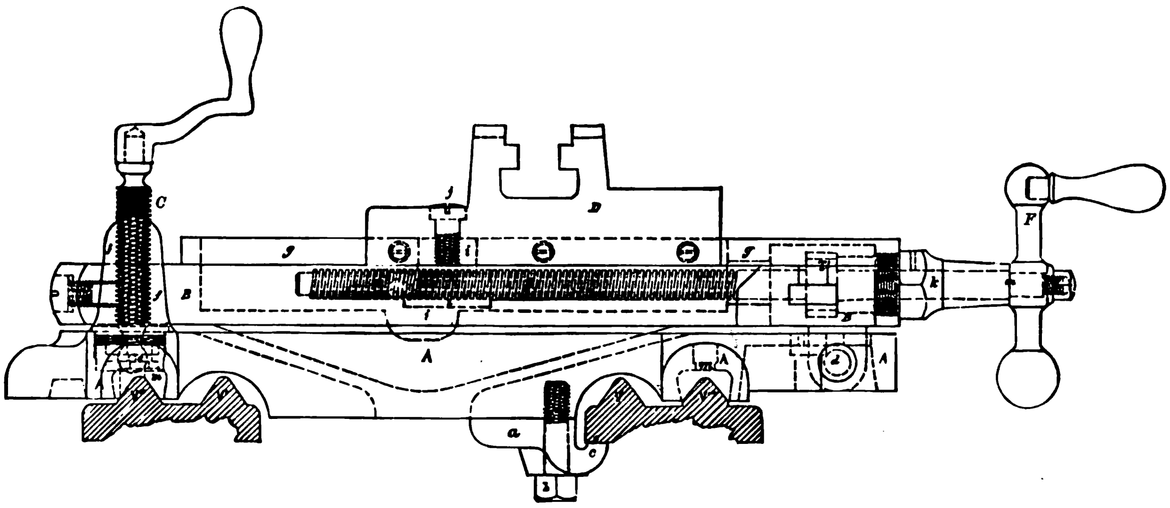


Fig. 499.

The means for traversing D along the slide *g* on B is as follows :—

A nut *i* is secured to D by the screw bolt *j*, and threaded through the nut *i* is the cross-feed screw E, which has journal bearing in the piece *k*, which is screwed into the end face of B; there is a collar on E which meets the inner end of *k*, and the handle F being secured by nut to that end of E its radial face forms a shoulder at *m* which with the collar prevents any end motion of E, so that when F is rotated E rotates and winds through the nut *i* which moves D along B.

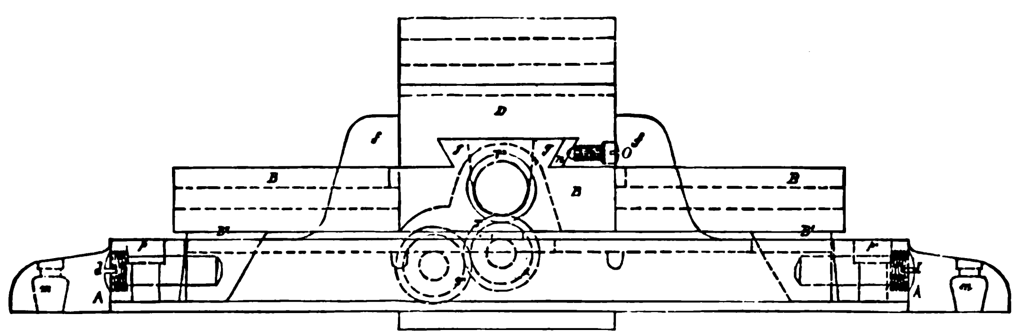


Fig. 500.

An end view of A, B, and D is shown in Fig. 500, in which the letters of reference correspond to those in Fig. 499. B′ and B″ are the projections that pass into A and receive the pivoting screws *d* and *d*. To adjust the fit and take up any wear that may ensue on the slide *g*, on B and on the corresponding surface on D, the piece *n* is provided, being set up by the adjusting screws O.

To adjust the fit and take up the wear at the pivots *d* they are made slightly taper, fitting into correspondingly taper holes in B.

The dotted circle T′, represents a pinion fast upon the cross-feed screw (E, Fig. 499); the similar circles T and S″ also represent pinions, the three composing a part of the method of providing an automatic or self-acting cross feed or cross traverse to D by rotating it through a gear-wheel motion derived from the rotation of the independent feed spindle, as is described with reference to Fig. 501.

m in Fig. 500 represents a cavity or pocket to receive wool, cotton or other elastic or fibrous material to be saturated with oil and thus lubricate the raised **V**s while keeping dirt from passing between the rest and the **V**s. The shape of these pockets is such as to enable them to hold the cotton with a slight degree of pressure against the slides, thus insuring contact between them.

The mechanical devices for giving to the carriage a self-acting traverse in either direction along the bed, so as to feed the tool automatically to its cut, and for giving to the tool rest (D, Fig. 499) traverse motion so as to feed the tool to or from the line of centres along the cross slide, are shown in Fig. 501, which presents two views of the feed table or apron. The lower view supposes the feed table to be detached from the carriage and turned around so as to present a side elevation of the mechanism. The upper view is a plan of the same with two pinions (N and N′), omitted. A represents the part of the lathe carriage shown at A in Fig. 500. It has two bolts *p* and *p*′, which secure the apron G, Fig. 501, to A. At H is the independent feed spindle or feed rod operated by belt from the cone pulley R, Fig. 494, or by a gear on stud P at V. H is carried in bearings fixed to each end of the lathe shears or bed, both of these bearings being seen in Fig. 492. H is also provided with a bearing fixed on the feed apron as seen in Fig. 501, and is splined as shown at *h*. At I is a bracket fast upon the apron G and affording journal bearing to J, which is a bevel pinion having a hub which has journal bearing in the bracket I. The fit of the bearing to the journal is here again adjusted by a split in the bearing with a screw passing through the split and threaded in the lower half (similar to the construction of D in Fig. 493); J is bored to receive H, and is driven by means of a feather projecting into the spline *h*. When therefore, the carriage A is moved it carries with it the apron G, and this carries the bracket I holding the bevel pinion J, which is in gear with the bevel-wheel K, and therefore operates it when H has rotary motion. At the back of K, and in one piece with it, is a pinion K′, both being carried upon the stud L; pivoted upon this same stud is a plate lever M, carrying two pinions N and N′ in gear together, but N only is in gear with K′, hence K′ drives N and N drives N′. Now in the position shown neither N or N′ is in gear with the gear-wheel O, but either of them may be placed in gear with it by means of the following construction:—

At the upper end of M there is provided a handle stud M′ passing through the slot M″ in G. Screwing up this stud locks M fast by binding it against the surface of G. Suppose, then, M′ to be unscrewed, then if it be moved to the right in the slot M″, N will be brought into gear with O and the motion will be transmitted in the direction of the arrows, and screwing up N would retain the gear in that position. But suppose that instead of moving M′ to the right it be moved to the left, then N′ will be brought into gear with O and the direction of rotation of O will be reversed.

lathe and a section of which is shown in the cut, the whole feed table or apron will be made to traverse along the lathe shears.

The direction in which this traverse will take place depends upon the adjusted position of M′ in M″, or in other words upon whether N or N′ be the pinion placed in gear with O. As shown in the cut neither of them is in gear, and motion from H would be communicated to N and N′ and would there cease; but if M′ be raised in the slot M″, N would drive O, and supposing P′ to be held to O, the motion of all the gears would be as denoted by the arrows, and the lathe carriage A would traverse along the lathe bed in the direction of arrow Q″. But if N′ be made to drive O all the motions would be in the opposite directions. The self-acting feed motion thus described is obviously employed to feed the cutting tool, being too slow in its operation for use to simply move the carriage from one part of the lathe bed to another; means for this purpose or for feeding the carriage and cutting tool by hand

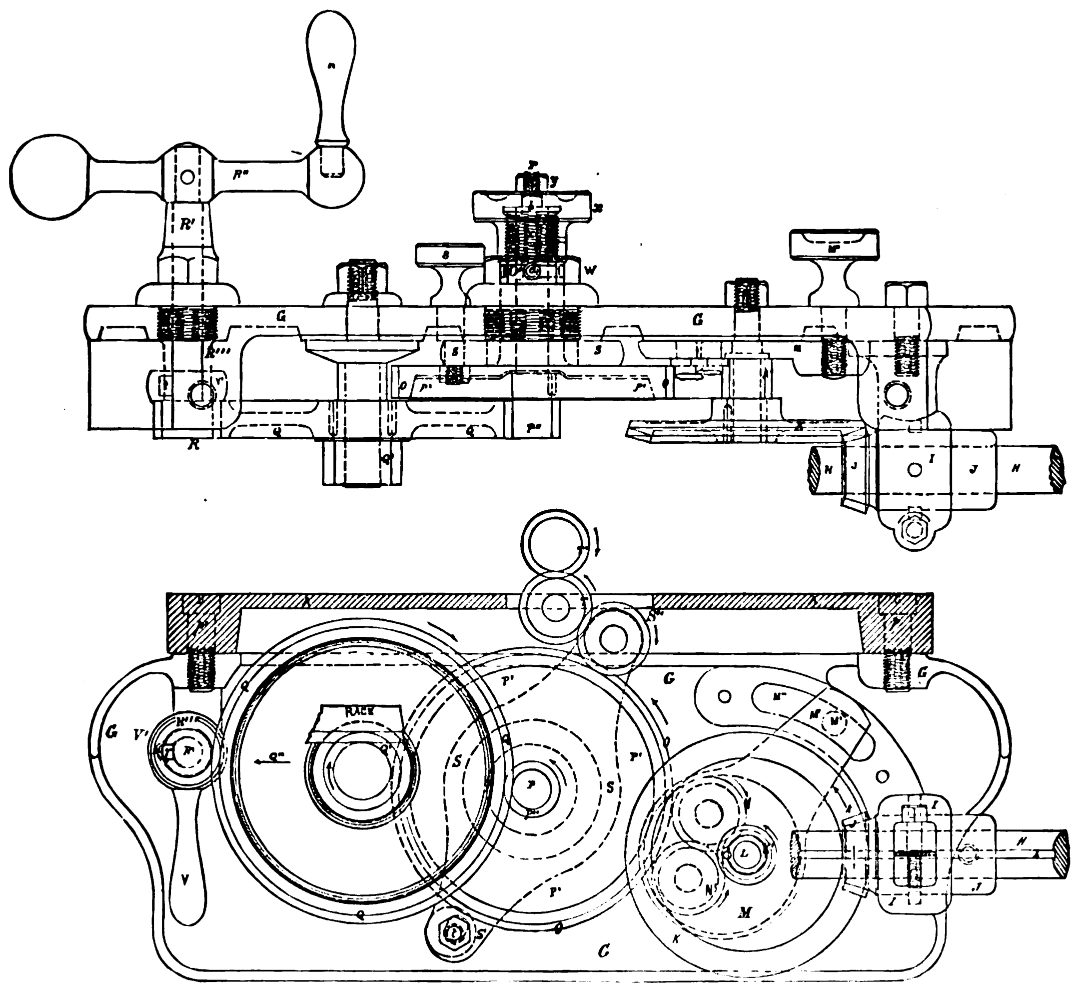


Fig. 501.

Thus, then, O may be made to remain stationary or to rotate in either direction according to the position of M′ in the slot M″, and this position may be regulated at will.

The gear O contains in its radial face a conical recess, and upon the same stud or pin (P) upon which O is pivoted, there is fixed the disk P′, which is in one piece with the pinion P″; the edge of P′ is coned to fit the recess in the wheel O, so that if the stud P is operated to force the disk P′ into the coned recess in O the motion of wheel O will be communicated to disk P′, by reason of the friction between their two coned surfaces. Or if P be operated to force the coned edge of the disk out of contact with the coned bore or recess in gear O, then O will rotate while P′ and P″ will remain stationary. Suppose the coned surfaces to be brought (by operating x) into contact and P′ to rotate with O, then P″ being in gear with wheel Q will cause it to rotate. Now Q is fast to the pinion Q′, hence it will also rotate, and being in contact with the rack which is fixed along the shears of the

are provided as follows:—R is a pinion in gear with Q and fast upon the stud R′, which is operated by the handle R″. The motion of R″ passes from R to Q and Q′ which is in gear with the rack. But Q′ being in gear with P″ the latter also rotates, motion ceasing at this point because the cone on P′ is not in contact with the coned recess in O. When, however, P′ and O are in contact and in motion, that motion is transmitted to R″, which cannot then be operated by hand.

It is often necessary when operating the cross feed to lock the carriage upon the lathe bed so that it shall not move and alter the depth of the tool-cut on the radial face of the work. One method of doing this is to throw off the belt that operates the feed spindle H, place N in gear with O and P′ in contact with O, so that the transverse feed motion will be in action, and then pull by hand the cone pulley driving H, thus feeding the tool to its necessary depth of cut. The objection to this method, however, is that when the operator is at the end of the lathe, operating the feed cone by hand he cannot see the tool and can but guess how deep a cut he has put on. To overcome this difficulty a brake is provided to the pinion R as follows :—

The brake whose handle is shown at V has a hub V′ enveloping the hub R″ which affords journal bearing to the stud R′. In the bore of this hub V′ is an eccentric groove, and in R″ is a pin projecting into the eccentric groove and meeting at its other end the surface of the stud R′. When, therefore, V is swung in the required direction (to the left as presented in the cut), the cam groove in V′ forces *r* inwards, gripping it and preventing it from moving, and hence the movement of R which also locks Q and Q′.

It remains now to describe the method of giving rotary motion to the cross-feed screw E (Fig. 499) so as to enable it to self-act in either direction. S is a lever pivoted upon the hub of O and carrying at one end the pinion S″, while at the other end is a stud S′ passing through a slot in G. The pinion S″ is in gear with O and would therefore receive rotary motion from it and communicate such motion to pinion T, which in turn imparts rotary motion to T′. Now T′ is fast upon the cross-feed screw as shown in Fig. 499 and the cross-feed screw E in that figure would by reason of the nut *i* in figure cause the tool rest D to traverse along the cross-slide in a direction depending upon the direction of motion of T′, which may be governed as follows :—

If S′ be moved to the left S″ will be out of gear with T and the cross-feed screw may be operated by the handle (F, Fig. 499). If S′ be in the position shown in cut and M″ also in the position there shown (Fig. 501), operating the feed screw by its handle would cause its pinion T′ to operate T, S″, and O ; hence S′ should always be placed to disconnect S″ from T when the cross-feed screw is to be operated by hand, and S′ operated to connect them only when the self-acting cross feed is to operate. In this way when the cross feed is operated by hand T′ and T will be the only gears having motion. It has been shown that the direction of motion of O is governed by the position of M′, or in other words, is governed by which of the two pinions N or N′ operates, and as O drives S″ its motion, and therefore that of T′, is reversible by operating M′.

The construction of S′ is as follows :—Within the apron as shown in the side elevation it consists of what may be described as a crank, its pin being at *t*; in the feed table is a slot through which the shaft of the crank passes ; *s* is a handle for operating the crank. By rotating *s* the end S′ of S is caused to swing, the crank journal moving in the slot to accommodate the motion and permit S to swing on its centre.

The device for forcing the cone disk P′ into contact with or releasing it from O is as follows :—The stud P is fast at the other end in P′ and has a collar at *b*; the face of this collar forms one

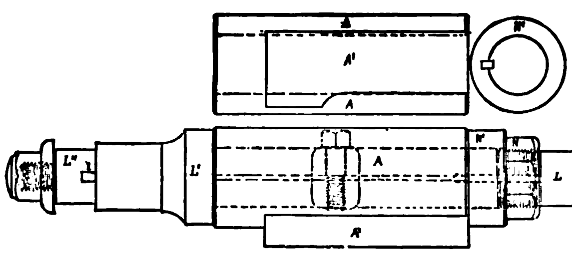


Fig. 502.

radial face, and the nut W affords the other radial face, preventing end motion to *x* without moving P endwise. If *x* be rotated its thread at *x*′ causes it to move laterally, carrying P with it, and P being fast to P′ also moves it laterally. P′ is maintained from end motion by a groove at O′ in which the end of a screw *a* projects, *a* screwing through W and into the groove O′.

The lead screw of a lathe is a screw for operating the lathe carriage when it is desired to cut threads upon the work. It is carried parallel to the lathe shears after the same manner as the independent feed spindle, and is operated by the change wheels shown in Fig. 492 at the end of the lathe. These wheels are termed change wheels on account of their requiring to be changed for every varying pitch of thread to be cut, so that their relative diameters, or, what is the same thing, their relative number of teeth, shall be such as to give to the lead screw the speed of rotation per lathe revolution necessary to cut upon the work a thread or screw of the required pitch.

The construction of the bearings which carry the lead screw in the S. W. Putnam's improved lathe is shown in Fig. 502, in which A represents the bearing box for the headstock end of the lathe, having the foot A′ as a base to bolt it to the lathe shears. L represents the lead screw, having on one side of A the collar L′ and on the other the nut and washer N and N′. The seat for the change wheel that operates the lead screw is at L″, the stop pin *l* fitting into a recess in the change wheel so as to form a driving pin to the lead screw. The washer N′ is provided with a feather fitting into a recess into L so that it shall rotate with L and shall

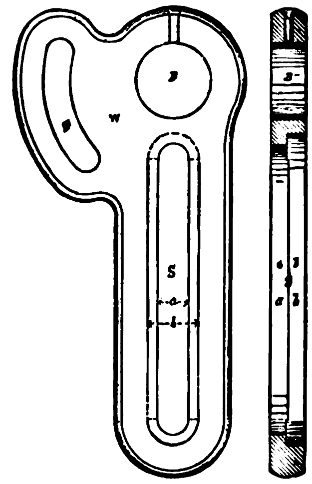


Fig. 503.

prevent the nut N from loosening back as it would be otherwise apt to do. End motion to L is therefore prevented by the radial faces of L′ and N′.

At the other end of the lathe there are no collars on the lead screw, hence when it expands or contracts, which it will do throughout its whole length under variations of atmospheric temperature, it is free to pass through the bearing and will not be deflected, bent, or under any tension, as would be the case if there were collars at the ends of both bearings. The amount of this variation under given temperatures depends upon the difference in the coefficients of expansion for the metal of which the lead screw and the lathe shears are composed, the shears being of cast iron while lead screws are sometimes of wrought iron and sometimes of steel.

The bearings at both ends are split, with soft wood placed in the split and a screw to close the split and adjust the bearing bore to fit the journal, in the manner already described with reference to other parts of this lathe.

The construction of the swing frame for carrying the change wheels that go between the driving stud V, Fig. 494, and that on the seat L″, Fig. 502, are as follows :—

Fig. 503 represents the change wheel swing frame, an edge view of which is partly shown at W in Fig. 494. S is a slot narrower at *a* than at *b*. Into this slot fit the studs for carrying the change wheels.

By enabling a feed traverse in either direction the lathe carriage may be traversed back (for screw-cutting operations) without the aid of an extra overhead pulley to reverse the direction of rotation of the lathe, but in long screws it is an advantage to have such extra overhead pulley and to so proportion it as to make the lathe rotate quicker backwards than forward, so as to save time in running the carriage back.

The mechanical devices for transmitting motion from the lead screw to the carriage are shown in Fig. 504, representing a view from the end and one from the back of the lathe. B is a frame or casting bolted by the bolt *b* to the carriage A of the lathe. C is a disk having a handle C′ and having rotary motion from its centre. Instead of being pivoted at its centre, however, it is guided in its rotary motion by fitting at *d d* into a cylindrical recess provided in B to receive it. C contains two slots D and D′ running entirely through it. These slots are not concentric but eccentric to the centre of motion of C. Through these slots there pass two stud bolts E and E′ shown by dotted lines in Fig. 504, and these bolts perform two services: first by reason of the nuts F and F′ they hold C to its place in B, and next they screw into and operate the two halves G and G′ of a nut.

Suppose, now, that the handle C′ be operated or moved towards

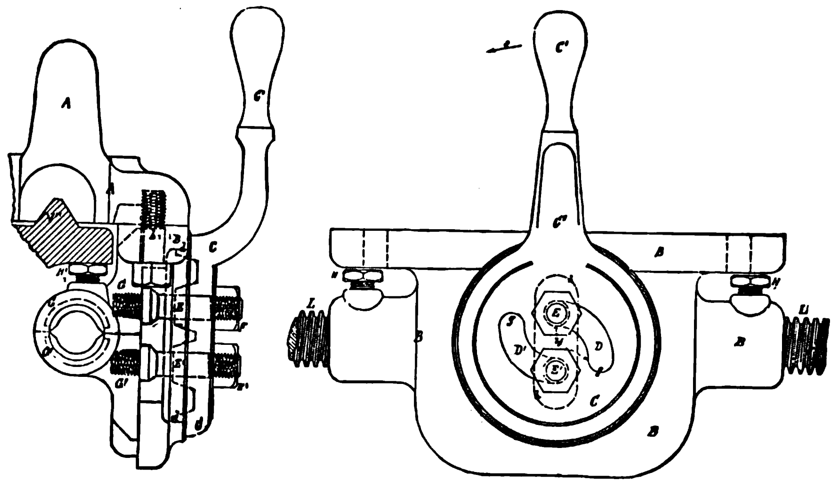


Fig. 504.

arrow *e*, then the dot at *f* being the centre of its motion and the slots D and D′ gradually receding from *f* as their ends *g* are approached they will cause E to move vertically upward and E′ to move vertically downward, a slot in B (which slot is denoted by the dotted lines *h*) guiding them and permitting this vertical movement.

Since E and E′ carry the two halves of the nut which envelops the lead screw L it is obvious that operating C′ will either close or

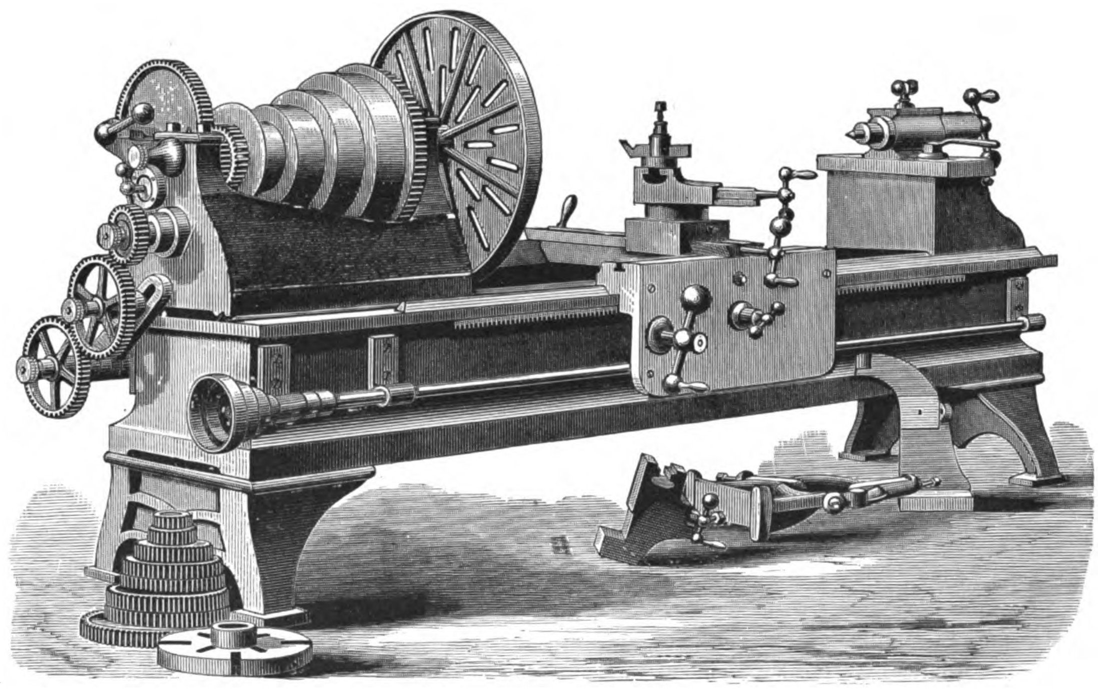


Fig. 505.

release the half nuts from L according to which direction it (C′) is moved in.

The screws H and H′ screw tightly into B, and the radial faces of their heads are made to have a fair and full bearing against the underside of the shears, so that they serve as back gibs to hold the carriage to the shears and may be operated to adjust the fit or to lock the carriage to the bed if occasion may require. This lathe is made with a simple tool rest as shown in the engravings or with a compound slide rest. In some sizes the rest is held to the carriage by a weight upon a principle to be hereafter described. The bed is made (as is usual) of any length to suit the purposes for which the lathe is to be used.

The next addition to the lathe as it appears in the United States is that of a compound slide rest.

Fig. 505 represents a 28-inch swing lathe by the Ames Manufacturing Company, of Chicopee, Massachusetts. It is provided with the usual self-acting feed motion and also with a compound slide rest. The swing frame for the studs carrying the change wheels for screw cutting here swings upon the end of the lead screw, the same spindle that carries the driving cone for the independent feed rod which is in front of the lathe, also carries the driving gear for the change wheels used for screw cutting.

The construction of the compound rest is shown in Figs. 506 and 507. N is the nut for the cross-feed screw (not shown in the cut) and is carried in the slide A. A and the piece L above it are virtually in one, since the latter is made separate for convenience of construction and then secured to it firmly by screws. B is made separate from C also for convenience of construction and fixed to it by screws; L is provided with a conical circular recess into which the foot B of C fits. E is a segment of a circle operated by the set screw F to either grip or release B. The bolt D simply serves as a pivot for piece B C: at its foot C is circular and is divided off into the degrees of a circle to facilitate setting it to any designated angle.

If, then, F be unscrewed, C may be rotated and set to the required angle, in which position screwing up F will lock it through the medium of E. G is the feed nut for the upper slider H, which operates along a slide way provided on C, the upper feed screw having journal bearing at C′. I is the tool post, having a stepped washer J, by means of which the height of the tool K may be regulated to suit the work.

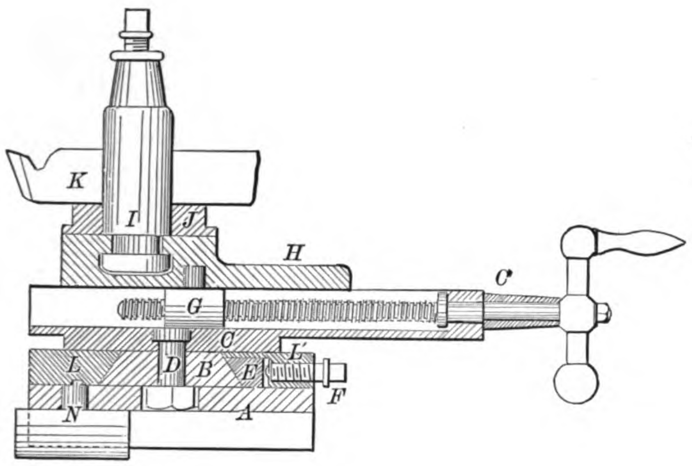


Fig. 506.

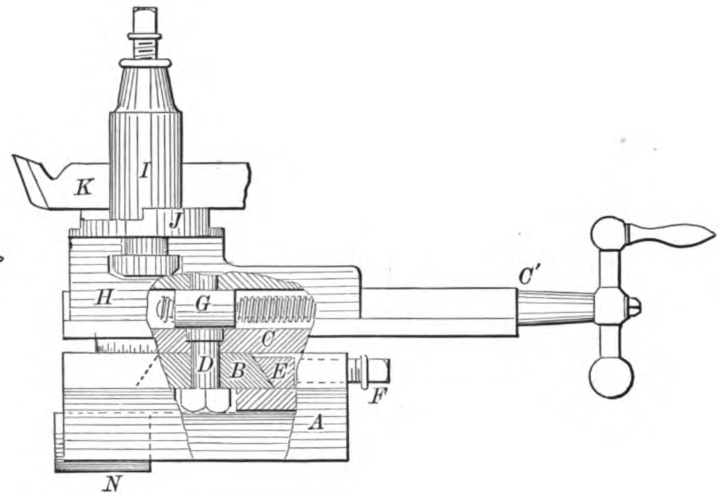


Fig. 507.

Suppose, now, that it be required to turn a shaft having a parallel and a taper part; then the carriage may be traversed to turn the parallel part, and the compound slide C may be set to turn the taper part, while the lower feed screw operating in N may be used to turn radial faces.

The object of making A and L in two pieces is to enable the boring and insertion of B, which is done as follows:—The front end of L as L′ is planed out, leaving in it a groove equal in diameter and depth to the diameter and depth of B, so that B may be inserted laterally along this groove to its place in L. The segment E is then inserted and a piece is then fitted in at L′ and held fast to A by screws. It is into this piece that the set screw F is threaded.

Various forms of construction are designed for compound rests, but the object in all is to provide an upper sliding piece carrying the tool holder, such sliding piece being capable of being so set and firmly fixed that it will feed the tool at an angle to the line of the lathe centres.

Another and valuable feature of the compound rest is that it affords an excellent method of putting on a very fine cut or of accurately setting the depth of cut to turn to an exact diameter; this is accomplished by setting the upper slide at a slight angle to the line of centres and feeding the tool to the depth of cut by means of the screw operating the upper slide. In this way the amount of feed screw handle motion is increased in proportion to the amount to which the tool point moves towards the line of lathe centres, hence a delicate adjustment of depth of cut may be more easily made.

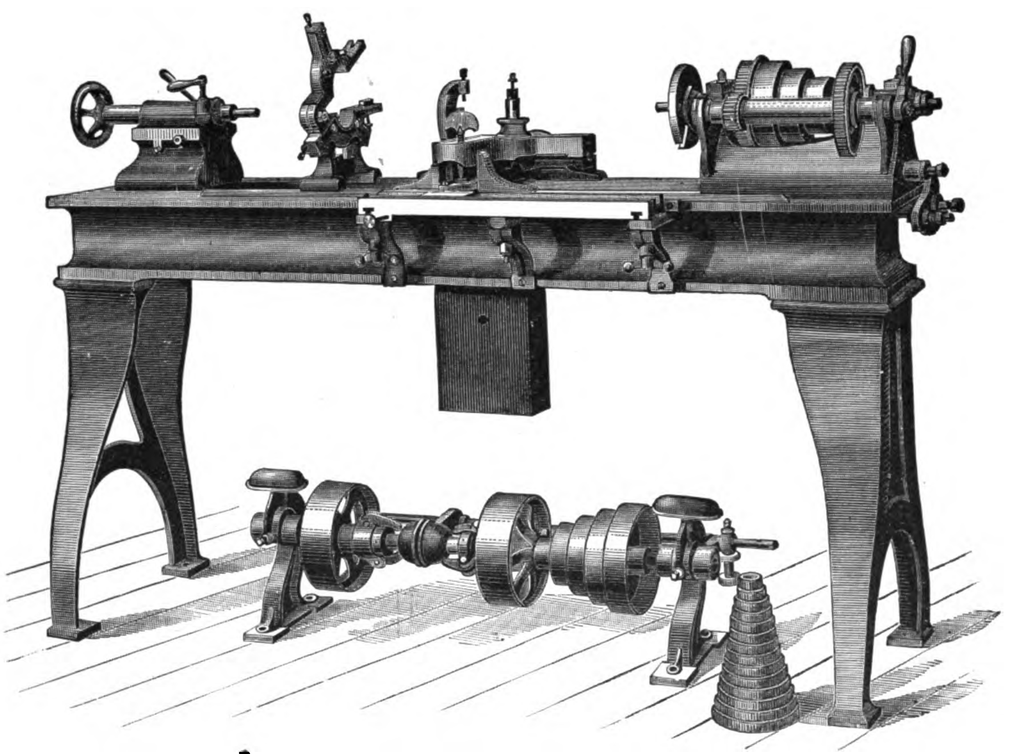


Fig 508.

Suppose, for example, that a cut be started and that it is not quite sufficiently deep, then, while the carriage traverse is still proceeding, the compound rest may be operated to increase the cut depth, or if it be started to have too deep a cut the compound rest may be operated to withdraw the tool and lessen its depth of cut. Or it may be used to feed the tool in sharp corners when the feed traverse is thrown out, or to turn the tops of collars or flanges when the tailstock is set over to turn a taper.

It is obvious, however, that comparatively short tapers only can be conveniently turned by a compound slide rest; but most tapers, however, are short.

To turn long tapers the tailstock of the lathe is set over as described with reference to the Putnam lathe, but for boring deep

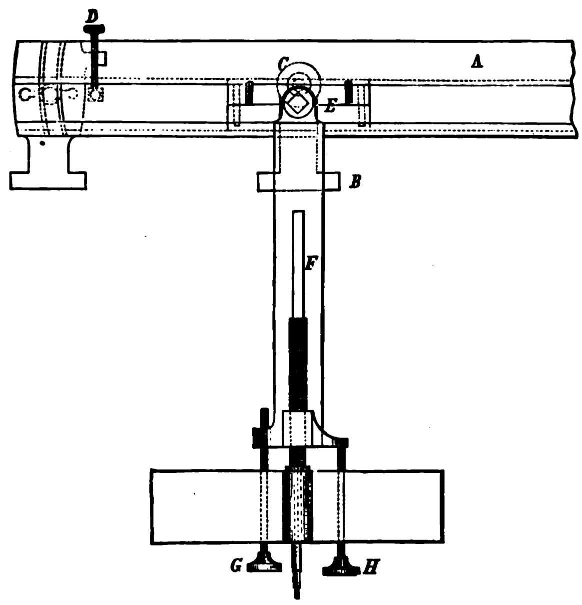


Fig. 509.

holes the slide rest must either be a compound one or a taper turning former or attachment must be employed.

When, however, the tailstock is set over, the centres in the work are apt to wear out of true and move their location (the causes of which will be hereafter explained).

In addition to this, however, the employment of a taper turning attachment enables the boring of taper holes without the use of a compound slide rest, thus increasing the capacity of the lathe not having a simple or single rest.

In Fig. 508 is shown a back view of a Pratt and Whitney weighted lathe having a Slate's taper turning attachment, the construction of which is as follows:—Upon the back of the lathe shears are three brackets having their upper surfaces parallel with and in the same plane as the surface of the lathe shears. Pivoted to the middle bracket is a bar which has at each end a projection or lug fitting into grooves provided in the end brackets, these grooves being arcs of a circle whose centre is the axis of the pivot in the middle bracket.

The end brackets are provided with handled nuts upon bolts, by which means the bar may be fixed at any adjusted angle to the lathe shears. Upon the upper surface of the bar is a groove or way in which slides a sliding block or die, so that this die in traversing the groove will move in a straight line but at an angle to the lathe bed corresponding to the angle at which the bar may be adjusted. The slide rest upon being connected by a bar or rod to the die or sliding block is therefore made to travel at the same angle to the lathe bed or line of centres as that to which the bar is set. The method of accomplishing this in the lathe, shown in Fig. 508, is as follows:—

In Fig. 509 A is the bar pivoted at C upon the centre bracket B; E is the sliding block pivoted to the nut bar F. This nut bar carries the cross-feed nut, which in turn carries the feed screw and hence the tool rest. When the nut bar is attached to the sliding block to turn a taper it is free to move endways upon the lower part of the carriage in which it slides, but when the taper attachment is not in use the bar is fastened to the lower part of the carriage by a set screw.

The screw at D is provided to enable an accurate adjustment for the angle of the bar A. G and H are screws simply serving to adjust the diameter to which the tool will turn after the manner shown in Fig. 588, G being for external and H for internal work.

When the lathe has a bed of sufficient length to require it, a slide is provided to receive the brackets, which may be adjusted to any required position along the slide, as shown in Fig. 510. This is a gibbed instead of a weighted lathe, and the method of attaching the sliding block to the lathe rest is as follows:—

A separate rod is pivoted to the sliding block. This rod carries at its other end a small cross head which affords general bearing to the end of the cross-feed screw, which has a collar on one side of the cross head and a fixed washer on the other, to prevent any end motion of the said screw.

The cross-feed nut is attached to the traversing cross slide. The other or handle end of the cross-feed screw has simple journal bearing in the slide rest, but no radial faces to prevent end motion, so that one may from the rod attached to the sliding-block traverse the cross-feed slide, which will carry with it the feed screw. As a result, the line of motion of the tool rest is governed by the sliding die, but the diameter to which the tool will turn is determined by the feed screw in the usual manner. When it is not required to use the taper attachment, the rod or spindle is detached from the sliding die and is locked by a clamp, when the rest may be operated in the usual manner.

Fig. 511 represents a slide rest for turning shafting in which two cutting tools are employed simultaneously, that at the

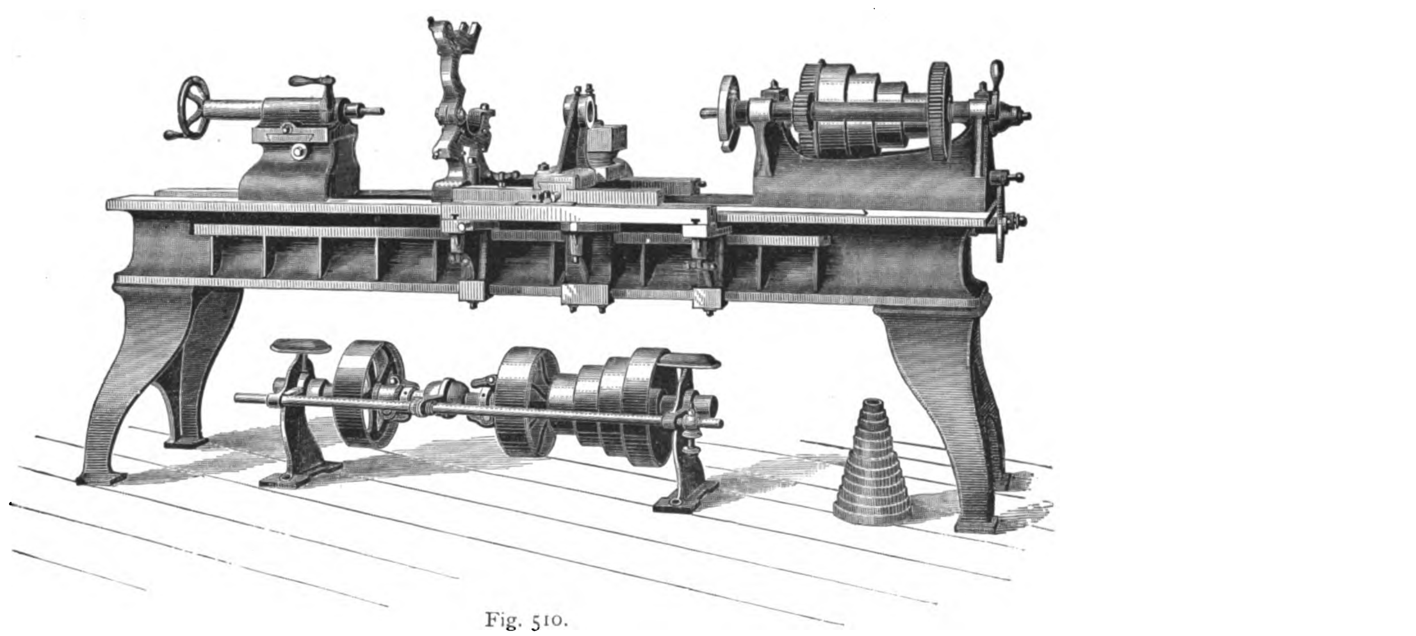


Fig. 510.

back of the rest being turned upside down, as shown in the figure.

The lower cross feed screw is right and left handed, so as to operate both tool rests, while each rest has in addition an independent feed screw.

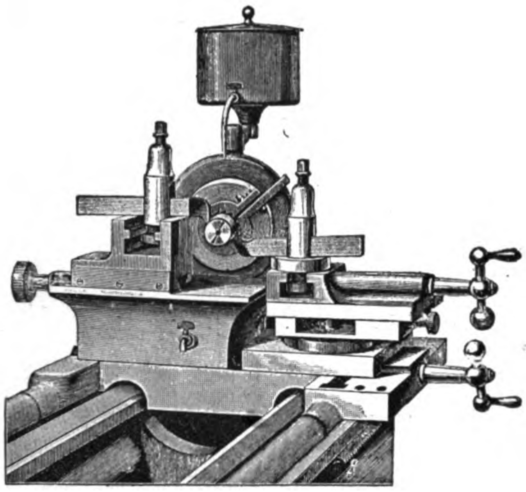


Fig. 511.

Fig. 512 represents the New Haven Manufacturing Company's three tool slide rest, for turning shafting. It is provided with a follower rest, in front of which are two cutting tools for the roughing cuts, and behind which is a third tool for the finishing cut. The follower rest receives bushes, bored to the requisite diameter, to leave a finishing cut. The first tool takes the preliminary roughing cut; the second tool turns the shaft down to fit the bush or collar in the follower rest; and, as stated, the last tool finishes the work.

Fig. 513 represents a 44-inch swing lathe, showing an extra and detachable slide rest, bolted on one side of the carriage and intended for turning work of too large a diameter to swing over the slide rest. By means of this extra rest the cutting tool can be held close in the rest, instead of requiring to stand out from the tool-post to a distance equal to the width of the work. The ordinary tool post is placed in this extra rest.

When it is desired to bolt work on the lathe carriage and rotate the cutting tools, as in the case of using boring bars, the cross slide is sunk into instead of standing above the top surface of the carriage so as to leave a flat surface to bolt the work to, and T-shaped slots are provided in the carriage, to receive bolts for fastening the work to the carriage, an example of this kind being shown in Fig. 514.

Fig. 515 represents a self-acting slide or engine lathe by William Sellers and Co., of Philadelphia. These lathes are made in various sizes from 12 inches up to 48 inches swing on the same general design, possessing the following features:— The beds or shears are made with flat tops, the carriage being gibbed to the edges of the shears, these edges being at a right angle to the top face of the bed. The dead centre spindle is locked at each end of its bearing in the tailstock, thus securing it firmly in line with the live spindle. The ordinary tool feed is operated by a feed rod in front of the lathe, and this rod is operated by a disc feed, which may be altered without stopping the lathe so as to vary the rate of tool feed; and an index is provided whereby the operator may at once set the discs to give the required rate of feed. The lead screw for screw cutting is

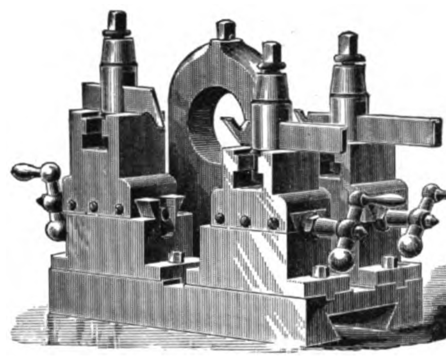


Fig. 512.

placed in a trough running inside the lathe bed, so that it is nearer to the cutting tool than if placed outside that bed, while it is entirely protected from the lathe cuttings and from dirt or dust; and the feed-driving mechanism is so arranged that both may be in gear with the live spindle, and either the rod feed or screw-cutting feed may be put into action instantly, while putting one into action throws the other out, and thus avoid the breakage that occurs when both may be put into action at the same time. The direction of the turning feed is determined by the motion of a lever conveniently placed on the lathe carriage, and the feed may be stopped or started in either direction instantly. The mechanism for putting the cross feed in action is so constructed (in those lathes having a self-acting cross feed) that the cross feed cannot be in action at the same time as the turning feed or carriage traverse by rod feed.

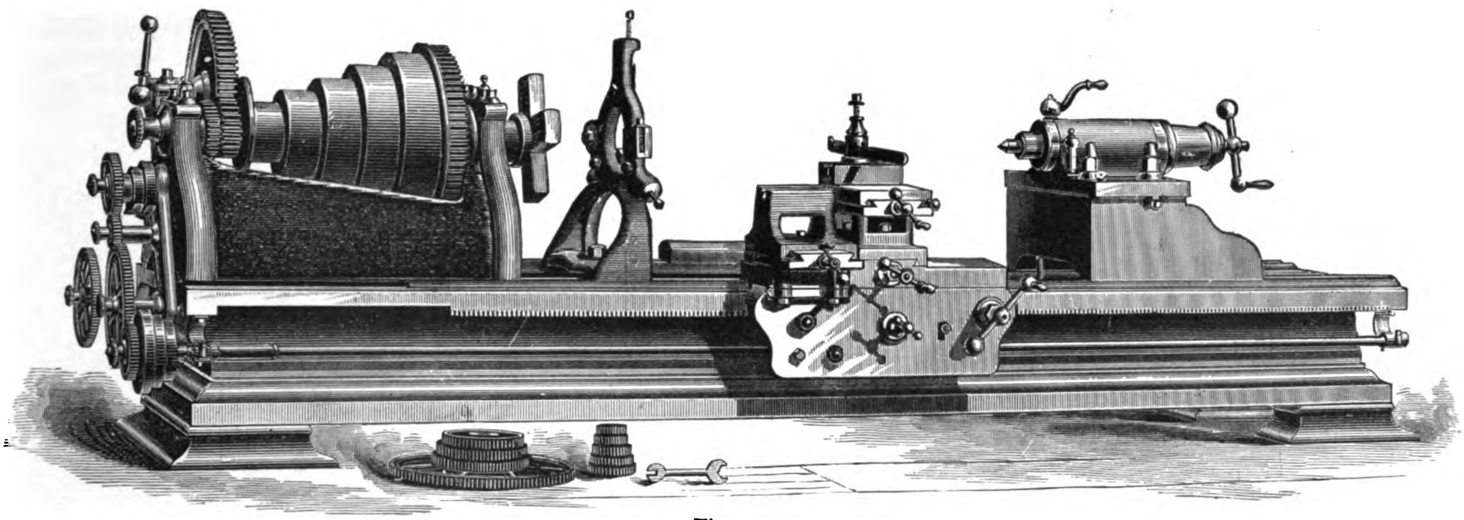


Fig. 513.

Lathes of 12 and 16 inches swing are back-geared, affording six changes of speed, and the lathe tool has a vertical adjustment on a single slide rest. Lathes of 20 inches swing are back-geared with eight changes of speed. Lathes of 25 inches and up to 48 inches swing inclusive are triple-geared, affording fifteen changes of speed, having a uniformly progressive variation at each change.

The construction of the live head or headstock for a 36-inch lathe is shown in the sectional side view in Fig. 516, and in the top view in Fig. 517, and it will be seen that there are five changes of speed on the cone, five with the ordinary back-gear, and five additional ones obtained by means of an extra pinion on the end of the back-gear spindle, and gearing with the teeth on the circumference of the face plate, the ordinary pinion of the back-gear moving on the back-gear spindle so as to be out of the way and clear the large gear on the cone spindle when the wheel of the extra back-gear pinion is in use, as shown in Fig. 517.

The front bearing of the live spindle is made of large diameter to give rigidity, and the usual collar for the face plate to screw against is thus dispensed with. End motion to the live spindle is prevented by a collar of hardened steel, this collar being fast on the live spindle and abutting on one side against the end face of the back bearing and on the other against a hardened steel thrust collar.

All these parts are enclosed in a tight cast-iron tail-block, which serves as an oil well to insure constant and perfect lubrication. The surfaces which confine the revolving collar back and front are so adjusted as to allow perfect freedom of rotary motion to the spindle and collar, but no perceptible end motion. The securing of the live spindle endwise is thus confined to the thickness of the steel collar only, and this is so enclosed in a large mass of cast iron as to insure uniformity of temperature in all its parts, hence there is no liability for the live spindle to stick or jam in its bearings, while the expansion of the live spindle endways from this collar (if it expands more than the lathe head) is allowed for in freedom of end motion through the front journal, which is a little longer than the bearing it runs in. In turning work held between the lathe centres the end thrust is taken against the hardened steel collar on the live spindle, and the hardened steel collar at the back of it, while in turning work chucked to the face plate the spindle is held in place endways by the confinement of the steel collar on the spindle between the steel collar behind it and the back end of the back bearing. With this arrangement of the spindle the change from turning between the lathe centres and turning chucked work requires no thought or attention to be given to any adjustment of the live spindle to accommodate it for the changed condition of end pressure between turning between the centres and turning chucked work, as is the case in ordinary lathes.

The double-geared lathes, as those of 12, 16 and 20 inches swing, are provided with face plates that unscrew from the live spindle to afford convenience for changing from one size of face plate to another, and all such lathes have their front live spindle journal made of sufficiently enlarged diameter above that of the screw, to afford a shoulder for the face plate to abut against. The nose of the live spindle is not threaded along its entire length, but a portion next to the shoulder is made truly cylindrical but without any thread upon it, and to this unthreaded part the face plate accurately fits so that it is held true thereby, and the screw may fit somewhat loosely so that all the friction acts to hold the

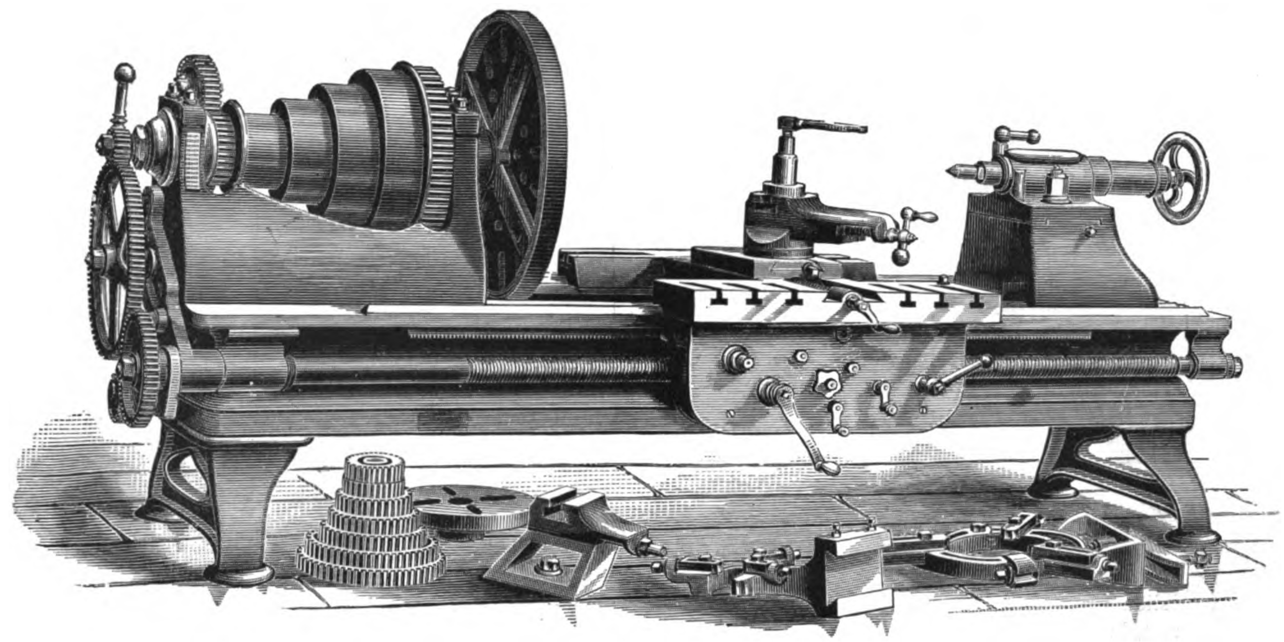


Fig. 514.

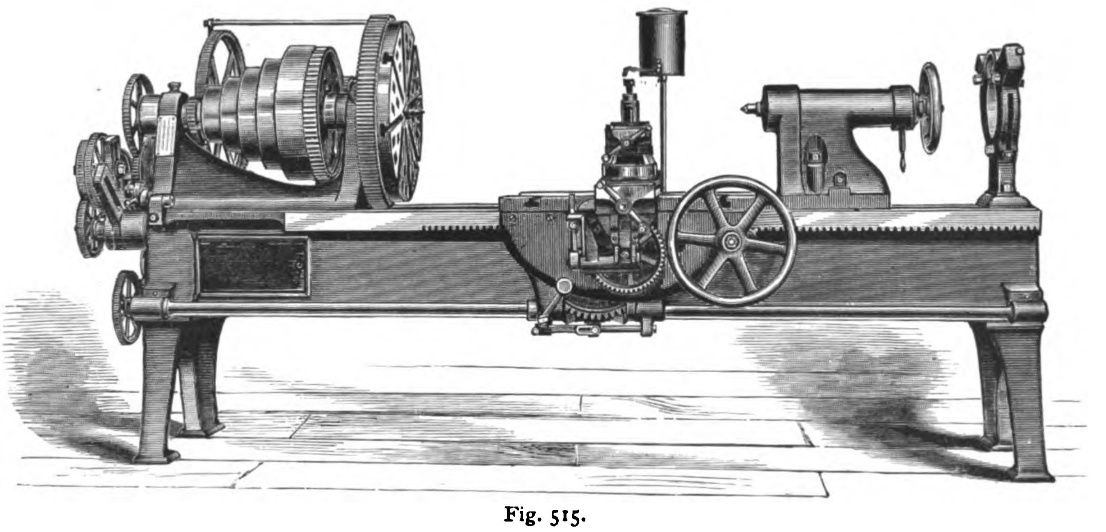


Fig. 515.

face plate true and hard up against the trued face of the spindle journal. Face plates fitted in this way may be taken off and replaced as often as need be, with the assurance that they will be true when in place unless the surfaces have been abused in their fitting parts.

The construction of the tailstock or poppet-head, as it is sometimes termed, is shown in Figs. 518, 519, and 520. To hold it in line with the live spindle it is fitted between the inner edges of the bed, and it will be seen that one of the bed flanges (that on the left of the figure) is provided on its under side with a V, and the clamp is provided with a corresponding V, so that in tightening up the bolt that secures the tailstock to the bed the tailstock is drawn up to the edge of the shears, and therefore truly in line with the live spindle, while when this bolt is released the tailstock is quite free to be moved to its required position in the length of the bed. As a result of this form of design there is no wear between the clamp and the underneath V, and the tailstock need not fit tightly between the edges of the bed, hence wear between these surfaces is also avoided, while the tailstock is firmly clamped against one edge of the bed as soon as the clamp is tightened up by the bolt on that side.

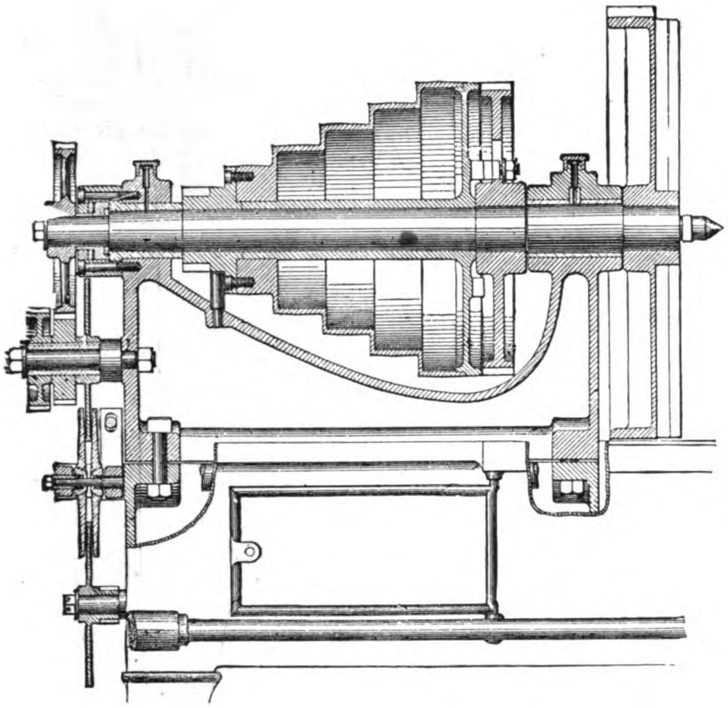


Fig. 516.

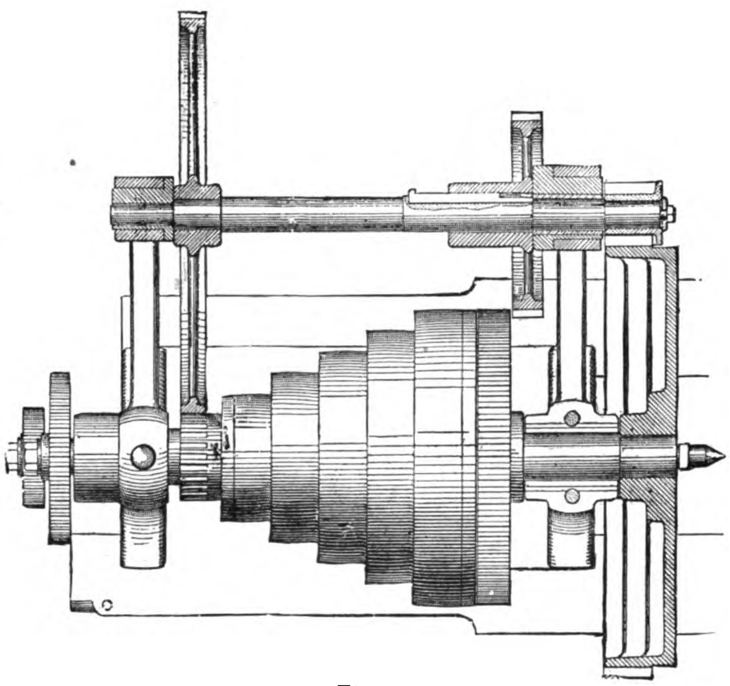


Fig. 517.

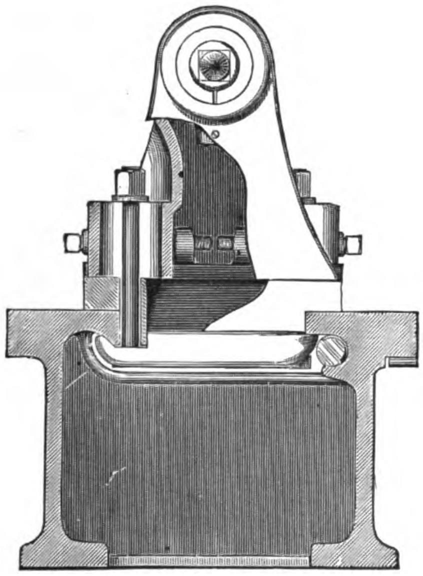


Fig. 518.

Fig. 520 shows the method of locking the tailstock spindle and of preventing its lateral motion in the bearing in the tailstock. At the front or dead centre end of this bearing there is between the spindle a sleeve enveloping the spindle, and coned at its outer end, fitting into a corresponding cone in the bore of the tailstock. Its bore is a fit to the dead spindle, and it is split through on the lower side. Its inner end is threaded to a sleeve that is within the headstock, and whose end is coned to fit a corresponding cone at the inner end of the bore of the tailstock.

To this second sleeve the line shown standing vertically on the left of the hand wheel is attached, so that operating this handle revolves the second sleeve and the two sleeves screw together, their coned ends abutting in their correspondingly coned seats in the tailstock bore, and thus causing the first-mentioned and split sleeve to close upon the dead centre spindle and yet be locked to the tailstock.

As the bore of the tailstock is exactly in line with the live spindle, it follows that the dead spindle will be locked also in line with it.

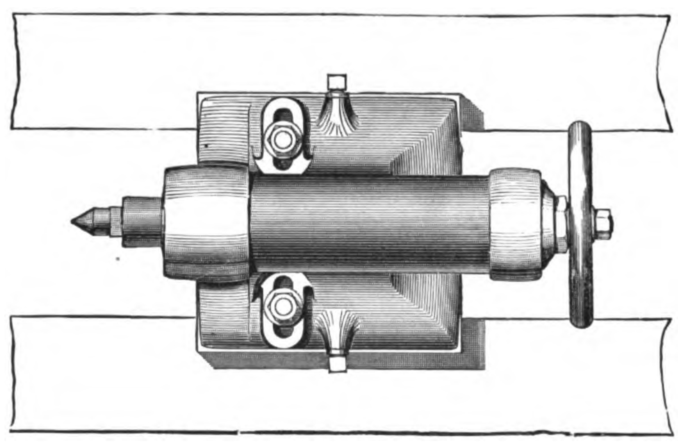


Fig. 519.

Figs. 521 and 522 represent sectional views of the carriage and slide rest of these lathes of a size over 16 inches swing. On the feed rod there are two bevel pinions P, one on each side of the bevel-wheel A, and by a clutch movement either of these wheels may be placed in gear with bevel-wheel A.

The clutch motion is operated by a lever which, when swung over to the right, causes the bevel pinion on the right to engage with the bevel-wheel A, and the carriage feeds to the right, while with the lever swung over to the left the carriage feeds to the left.

On the inclined shaft is a worm, or, as the makers term it, a spiral pinion of several teeth which gears into a straight toothed spur gear-wheel, giving a smooth and rolling tooth contact, and therefore producing an even and uniform feed motion.

This spur gear is fast on a shaft C, which is capable of end motion and is provided on each of its side faces with an annular toothed clutch. On each side of this spur-wheel is a clutch, one of which connects with the train of gears for the turning feed, and the other with the cross-feed gear B.

When the shaft (whose end is shown at C, and to which the spur gear referred to is fast) is pulled endways outwards from the lathe bed, its front annular clutch engages with the clutch that sets the cross-feed gear B in motion, and B engages with a pinion which forms the nut of the cross-feed screw.

When shaft C is moved endways inwards its other annular clutch engages the clutch on that side of it, and the turning feed is put into operation. The method of operating shaft C endways is as follows :—

In a horizontal bearing D is a shaft at whose end is a weighted lever L, and on the end of this shaft is a crank pin shown engaging a sleeve E which affords journal bearing to the outer end of shaft C, so that operating the weighted lever L operates E, and therefore shaft C with the spur gear receiving motion from the worm. A simple catch confines lever L to either of its required limits of motion, and allows the free motion of the operating lever to start or stop either the longitudinal or the cross feed, either of which is started or stopped by this lever, but no mistake can occur as to which feed is operated, because the catch above mentioned requires to be shifted to permit the feed to be operated.

The lower end of the bell crank F engages with the sleeve E, so that when the shaft C is operated outwards the horizontal arm of bell crank F is depressed and the spur pinion of the cross-feed nut is free to revolve, being driven by the cross-feed motion. When the lever F is moved towards the lathe bed (which occurs when the stop or catch is set to allow the longitudinal feed to be used) the nut of the cross feed is locked fast by the horizontal arm of the bell crank F. This device makes the whole action from one direction of feed to another automatic, and the attention of the workman is not needed for any complicated adjustment of parts preparatory to a change from one feed to the other.

At H is a hand wheel for hand feeding, the pinion R meshing into the rack that extends along the front of the lathe bed; back of the hand wheel and at H' a clamp is provided whereby the saddle or carriage may be locked to the lathe bed when the cross feed is being used, thus obviating the use of a separate clamp on the bed.

The top slide of the compound rest is long and its guideway is short, the nut being in the stationary piece G, and it will be observed that by this arrangement at no time does the bearing surfaces of the slides become exposed to the action of chips or dirt.

Fig. 523 is a sectional view of the carriage and slide rest as arranged for 12 and 16-inch lathes when not provided with a self-acting cross feed. In this case end motion to shaft C is given by lever H, which is held in its adjusted position by the tongue T. In this lathe the screw-cutting and the turning feed cannot be put into gear at the same time.

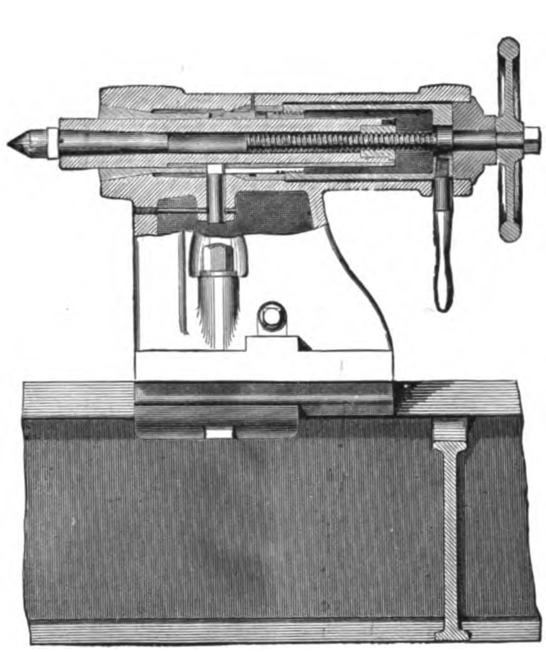


Fig. 520.

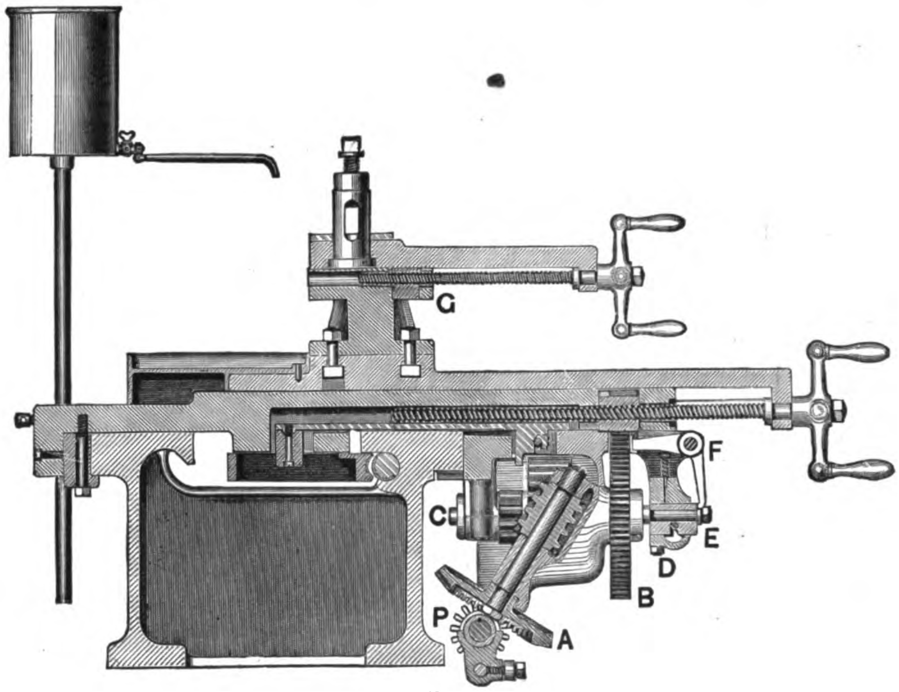


Fig. 521.

The tool nut is arranged to enable the tool to be adjusted for height after it is fastened in the tool post by pivoting it to the cross slide, a spring S forcing it upwards at its outer end, thus holding the tool point down and in the direction in which the pressure of the cut forces it, thus preventing the wear of the pivot from letting the tool move when it first meets the cut. The nut N is operated to adjust the tool height, and at the same time enables the depth of cut to be adjusted very minutely. A trough catches the water, cuttings, &c., and thus protects the slides and slideways from undue wear.

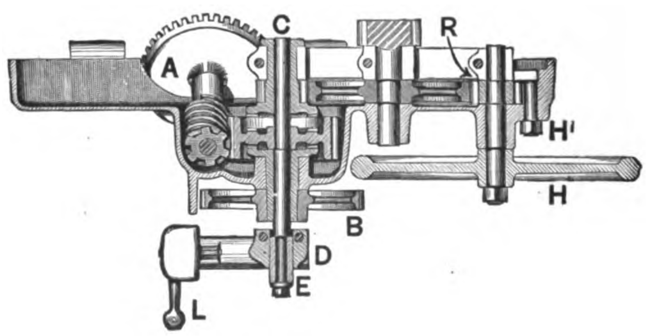


Fig. 522.

In all these lathes the feeding mechanism is so arranged that there are no overhanging or suspended shaft pins or spindles, each of such parts having a bearing at each end and not depending on the face surface of a collar or pin, as is common in many lathes. Furthermore, in these lathes the handle for the hand carriage feed moves to the right when the carriage moves to the right; the cross-feed screw (and the upper screw also in compound slide rests) has a left-hand thread, so that the nut being fixed the slides move in the same direction as though the nut moved as in ordinary lathes. The tailstock or poppet-head screw is a right hand because the nut moves in this case. The object of employing right-hand screws in some cases, and left-hand ones in others, is that it comes most natural in operating a screw to move it from right to left to unscrew, and from left to right to screw up a piece, this being the action of a right-hand screw, left-hand screws being comparatively rarely used in mechanism, save when to attain the object above referred to.

Fig. 524 represents the Niles Tool Works car axle lathe, forming an example in which the work is driven from the middle of its length, leaving both ends free to be operated upon simultaneously by separate slide rests.

The work being driven from its centre enables it to rotate upon two dead centres, possessing the advantage that both being locked fast there is no liberty for the work to move, as is the case when an ordinary lathe having one live or running spindle is used, because in that case the live spindle must be held less firmly and rigidly than a dead centre, so as to avoid undue wear in the live spindle bearings; furthermore, the liability of the workman to neglect to properly adjust the bearings to take up the wear is avoided in the case of two dead centres, and no error can occur because of either of the centres running out of true, as may be the case with a rotating centre.

The cone pulley and back gear are here placed at the head of the lathe driving a shaft which runs between the lathe shears and drives a pinion which gears with the gear on the work driving head shown to stand on the middle of the shears. This head is hollow so that the axle passes through it. On the face of this gear is a Clement's equalizing driver constructed upon the principle of that shown hereafter in Fig. 756.

The means for giving motion to the feed screw and for enabling a quick change from the coarse roughing feed to a finer finishing feed to the cutting tool without requiring to change the gears or alter their positions, is shown in Fig. 525. *a* and *b* are two separate pinions bored a working fit to the end of the driving shaft S, but pierced in the bore with a recess and having four notches or featherways *h*. The end of the driving shaft S is pierced or bored to receive the handled pin *i*, and contains four slots to receive the four feathers *j* which are fast in *i*. In the position shown in the figure these feathers engage with neither *a* nor *b*, hence the driving shaft would remain motionless, but it is obvious that if pin *i* be pushed in the feathers would engage *b* and therefore drive it; or if *i* were pulled outwards the feathers would engage *a* and drive it, because *a* and *b* are separate pinions with a space or annular recess between them sufficient in dimensions to receive the feathers. The difference in the rate of feed is obviously obtained through the difference in diameters of the pair of wheels *a*, *c* and the pair *d*, *b*, the lathe giving to the lead screw the slowest motion and, therefore, the finest feed.

The means for throwing the carriage in and out of feed gear with the feed screw and of providing a hand feed for operating the tool in corners or for quickly traversing the carriage, is shown in Fig. 526, in which S represents the feed screw and B a bracket

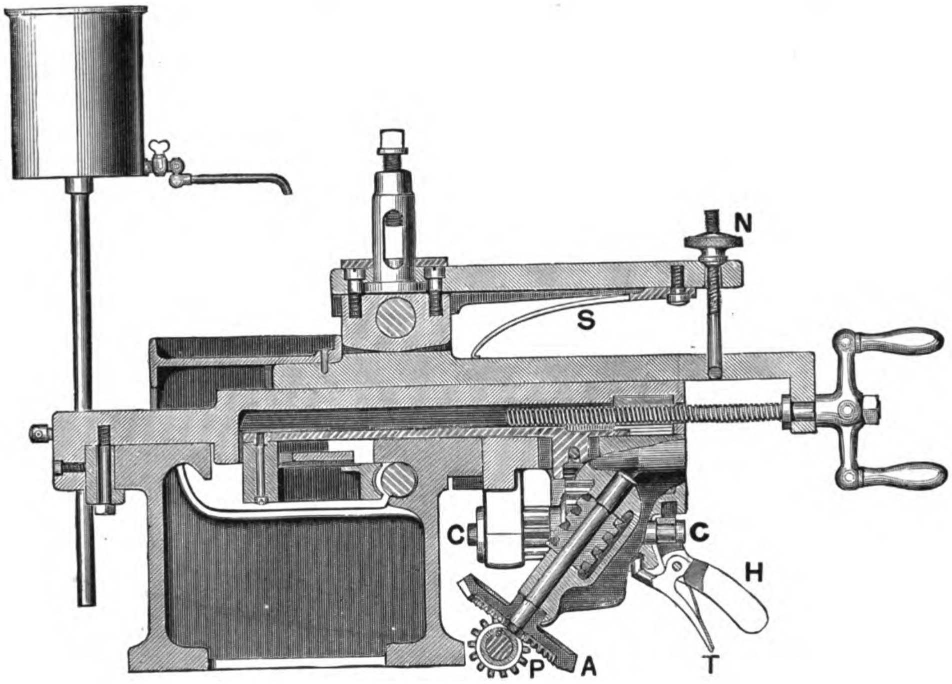


Fig. 523.

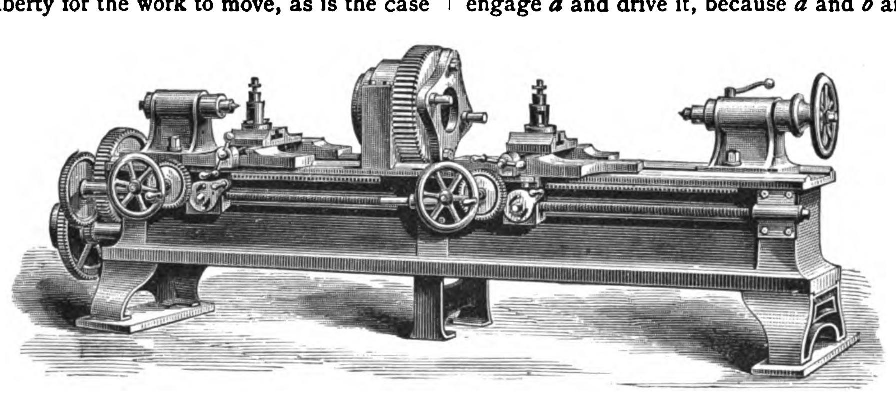


Fig. 524.

or casting bolted to the carriage and carrying the hand wheel and feed mechanism shown in the general cut figure.

B provides a slide way denoted by the dotted lines at *b*, for the two halves N and N′ of the feed nut. It also carries a pivot pin shown at *p* in the front elevation, which screws into B as denoted

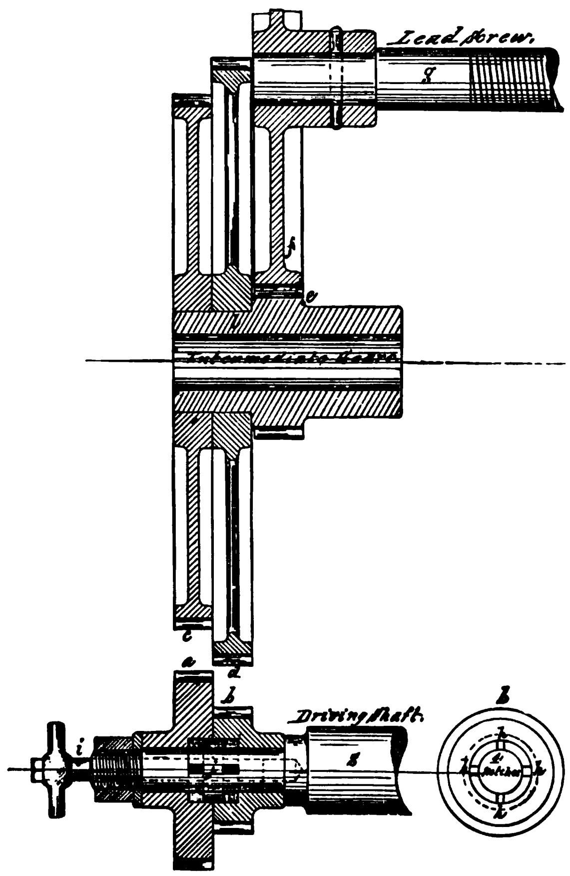


Fig. 525.

by *p*′ in the end view; upon this pivot operates the piece D, having the handle *d*. In D are two cam grooves *a a*; two pins *n*, which are fast in the two half-nuts N N′, pass through slots *c c* in B, and into the cam grooves *a a* respectively.

As shown in the cut the handle *d* of D is at its lowest point, and the half-nuts N′ and N are in gear upon the feed screw; but

Fig. 527, which is taken from *The American Machinist*, represents an English self-acting lathe capable of swinging work of 12 inches diameter over the top of the lathe shears, which are provided with a removable piece beneath the live centre, which when removed leaves a gap, increasing the capacity of the lathe swing. The gears for reversing the direction of feed screw motion are here placed at the end of the live head or headstock, the screw being used for feeding as well as for screw cutting.

Fig. 528 represents a pattern-maker's lathe, by the Putnam Tool Co., of Fitchburg, Massachusetts. This lathe is provided with convenient means of feeding the tool to its cut by mechanism instead of by hand, as is usually done by pattern-makers, and this improvement saves considerable time, because the necessity of frequently testing the straightness of the work is avoided.

It is provided with an iron extension shears, the upper shears sliding in V-ways provided in the lower one. The hand-wheel is connected with a shaft and pinion, which works in a rack, and is used for the purpose of changing the position of the upper bed, which is secured in its adjusted position by means of the tie bolts and nuts, as shown on the front of the lower shears. This enables the gap in the lower shears to be left open to receive work of large diameter, and has the advantage that the gap need be opened no more than is necessary to receive the required length of work. The slide-rest is operated by a worm set at an angle, so as to operate with a rolling rather than a sliding motion of the teeth, and the handle for operating the worm-shaft is balanced. The carriage is gibbed to the bed. The largest and smallest steps of the cone pulley are of iron, the intermediate steps being of wood, and a brake is provided to enable the lathe to be stopped quickly. This is an excellent improvement, because much time is often lost in stopping the lathe while running at a high velocity, or when work of large diameter is being turned. The lathe will swing work of 50 inches within the gap, and the upper shears will move sufficiently to take in 4 additional feet between the centres.

In the general view of the lathe, Fig. 528, the slide-rest is shown provided with a T-rest for hand tools, but as this sets in a clip or split bore, it may readily be removed and replaced by a screw tool, poppet for holding a gauge, or other necessary tool. To enable the facing of work when the gap is used, the extra attachment shown in Figs. 529 and 530 is employed. It consists of an arm or bar A, bolted to the upper shears S by a bolt B, and clamp C, in the usual manner, and is provided with the usual slideway and feed-screw *f* for operating the lower slide T, which carries a hollow stem D; over D fits a hub K, upon the upper slide E, which hub is split and has a bolt at F, by means of which the upper slide may

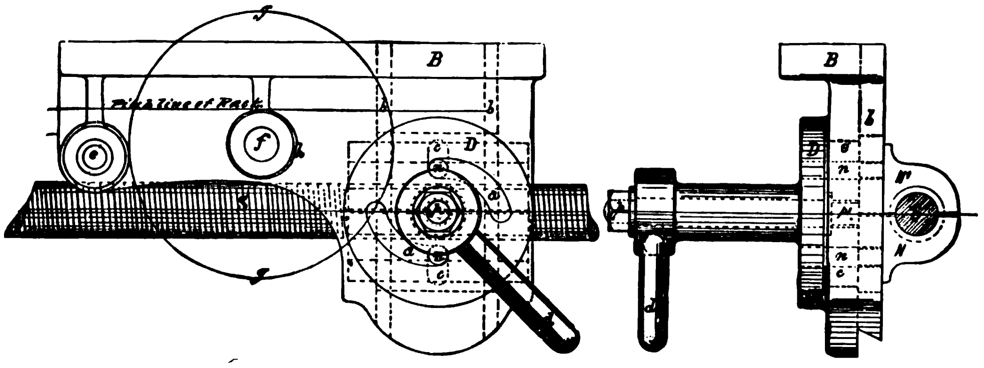


Fig. 526.

suppose *d* be raised, then the grooves *a a* would force their respective pins *n* up the slots *c*, and these pins *n* being each fast to a half of the nut, the two half-nuts would be opened clear of the feed screw, and the carriage would cease to be fed.

The hand-feed or guide-carriage traverse motion is accomplished as follows:—B provides at *e* journal bearing to a stud on which is the hand wheel shown in the general cut; attached to this hand wheel is a pinion operating a large gear (also seen in general cut) whose pitch line is seen at *g*, in figure. The stud carrying *g* has journal bearing at *f*, and carries a pinion whose pitch circle is at *h* and which gears with the rack.

be clamped to its adjusted angle or position. The upper slider H receives the tool post, which is parallel and fits in a split hub, so that when relieved it may be rapidly raised or lowered to adjust the height of the tool.

The construction of the brake for the cone pulley is shown in Figs. 531 and 532, in which P represents the pulley rim, L the brake lever, S a wooden shoe, and W a counter-weight. The lever is pivoted at G to a lug R, provided on the live headstock, and the brake obviously operates on the lowest part of the cone flange; hence the lever handle is depressed to put the brake in action.

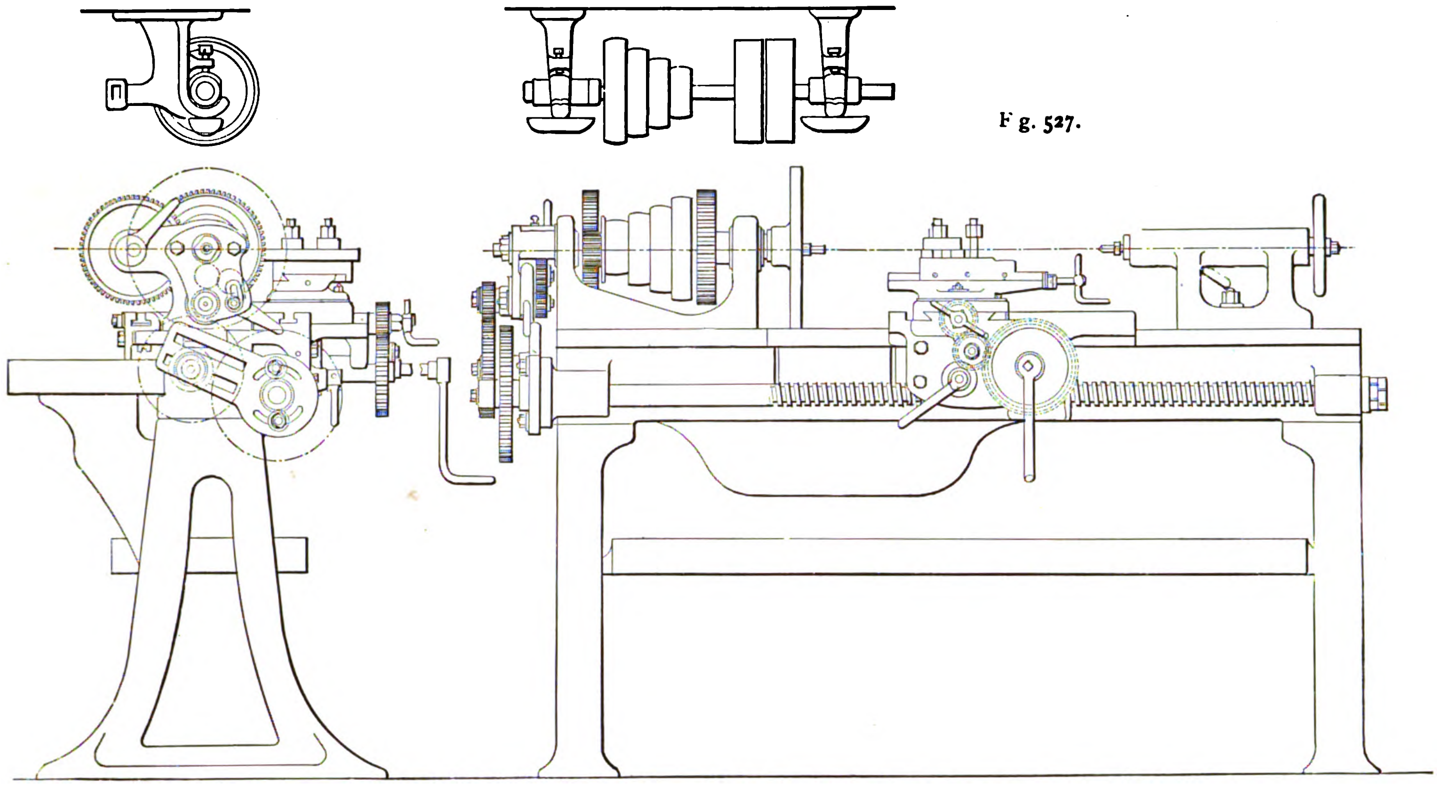


Fig. 527.

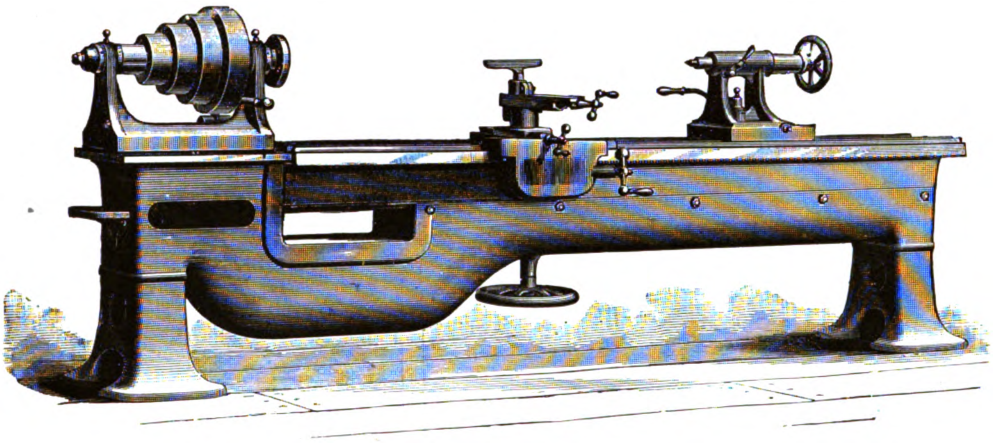


Fig. 528.

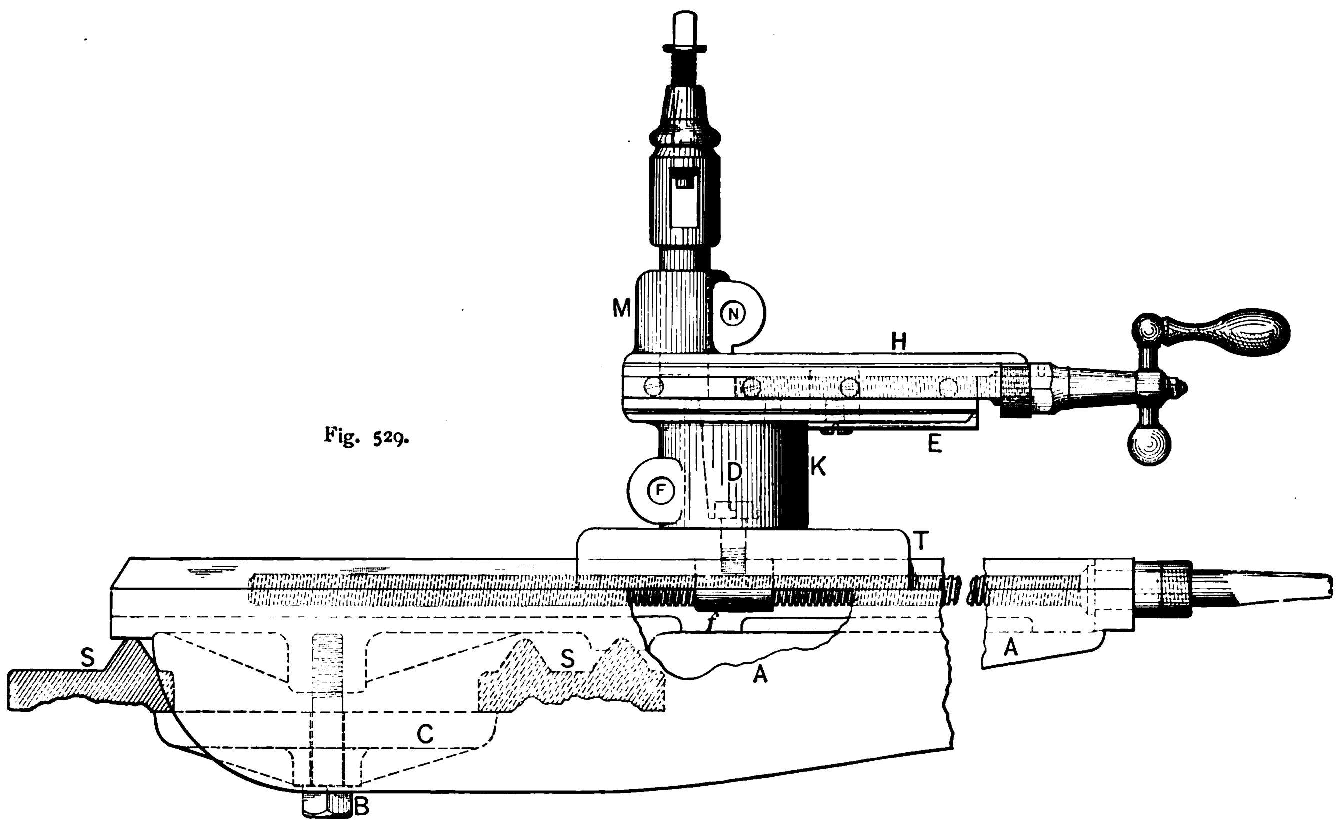


Fig. 529.

The construction of the front and back bearings for the live spindle is the same as that shown in Figs. 495 and 496.

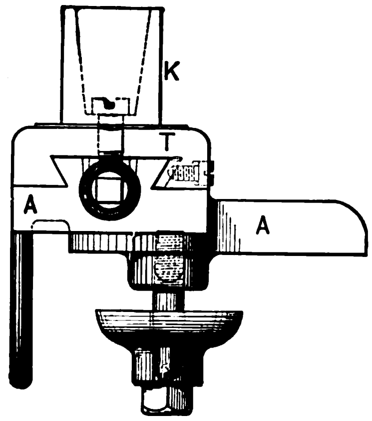


Fig. 530.

Wood turners sometimes have their lathes so made that the headstock can be turned end for end on the lathe shears, so that the face plate may project beyond the bed, enabling it to turn work of large diameter. A better method than this is to provide the projecting end of the lathe with a screw to receive the face plate as shown in Fig. 533, which represents a lathe constructed by Walker Brothers of Philadelphia. At the end of the lathe is shown a hand rest upon a frame that can be moved about the floor to accommodate the location, requiring to be turned upon the work.

For very large work, wood-workers sometimes improvise a facing lathe, as shown in Fig. 534, in which A is a headstock bolted to the upright B; C is the cone pulley, and E a face plate built up of wood, and fastened to an iron face plate by bolts. The legs A, of the tripod hand rest, Fig. 535, are weighted by means of the weights B.

In Fig. 536 is shown a chucking lathe, especially adapted for boring and facing discs, wheels, &c. The live spindle is driven by a worm-wheel, provided around the circumference of the face plate. The driving worm (which runs in a cup of oil) is on a driving shaft, running across the lathe and standing parallel with the face of the face plate. This shaft is driven by a pulley as shown, changes of speed being effected by having a cone pulley on the counter-shaft and one on the line of shafting.

This lathe is provided with two compound slide rests. One of which may be used for boring, while the other is employed for facing purposes. These rests are adjustable for location across the bed of the lathe by means of bolts in slots, running entirely across the lathe bed.

These slide rests are given a self-acting motion by the following arrangement of parts: at the back of the live spindle is an eccentric rod, operating a connecting rod, which is attached at its lower end to the arm of a shaft running beneath the bed, and parallel to the lathe spindle. This shaft passes beyond the bed where it carries a bevel gear-wheel, which meshes with a bevel gear-wheel upon a cross shaft. This cross shaft carries three arms, one at each end and inside its journal bearings in the bed, and one beneath and at a right angle to the other two. These receive oscillating motion by reason of the eccentric connecting rod, &c.

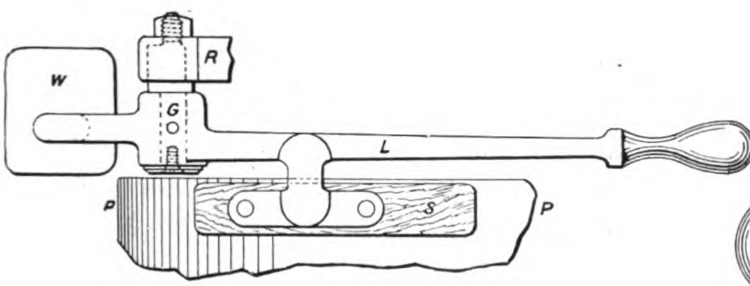


Fig. 531.

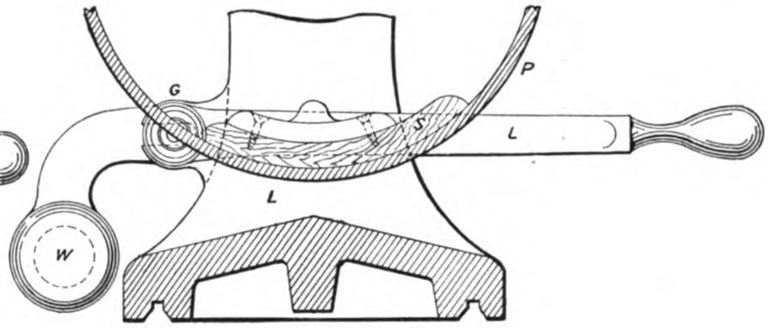


Fig. 532.

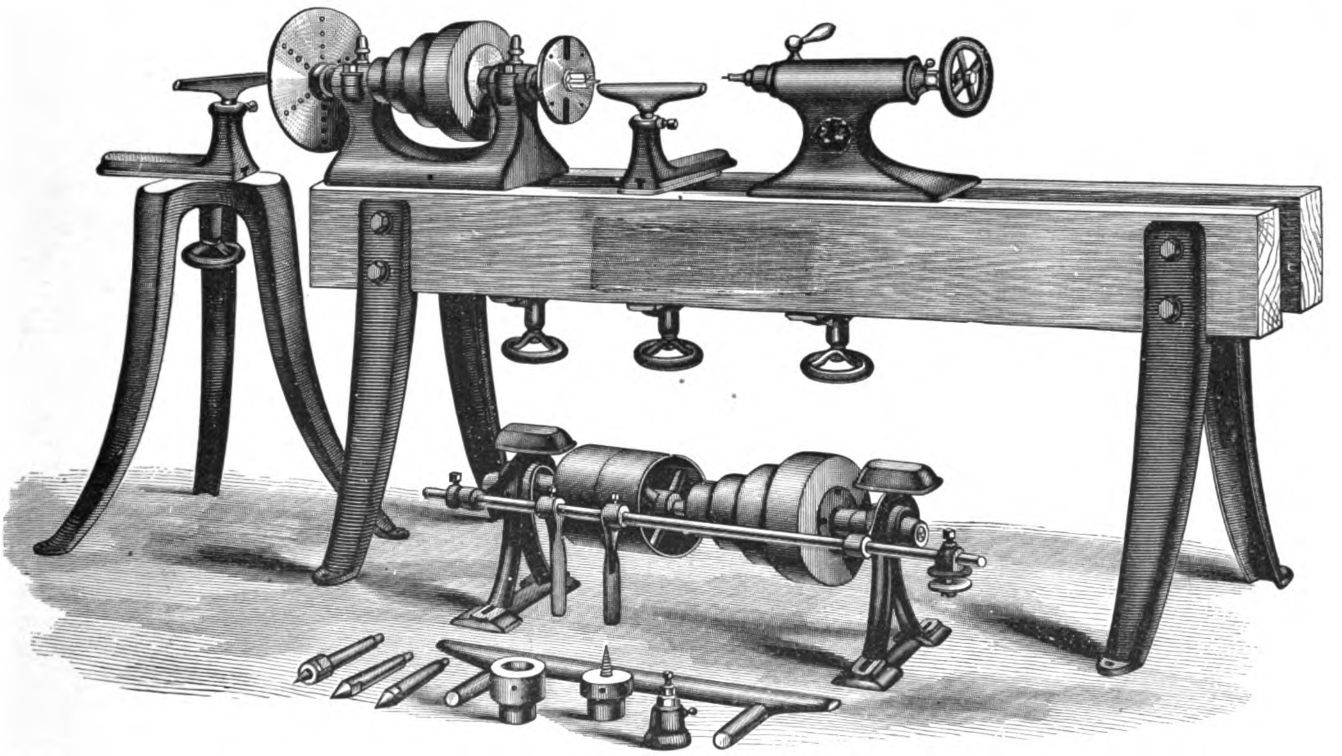


Fig. 533.

For each compound rest there are provided two handles as usual, and in addition an L lever, one arm of the latter being provided with a series of holes, while the other carries a weight.

The L lever carries a pawl which operates a ratchet wheel, placed on the handle end of the slide rest cross feed screw. If then a

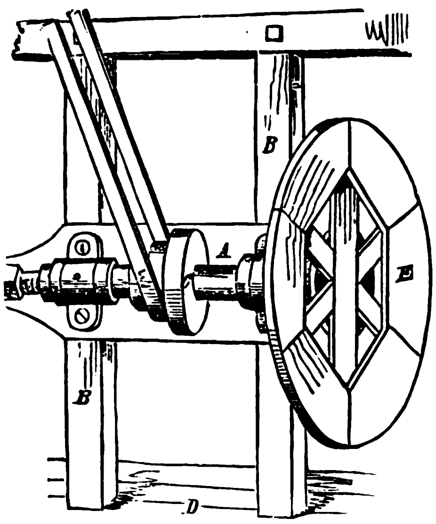


Fig. 534.

chain be attached to one of the holes of the L lever, and to the oscillating arm, the motion in one direction of the latter will be imparted to the L lever (when the chain is pulled). On the return motion of the oscillating arm, the chain hangs loose, and the weight on the L lever causes that lever arm to fall, taking up the slack of the chain, the feed taking place (when the pawl is made to engage with the ratchet wheel) during the motion of the oscillating arm from right to left, or while pulling the chain.

The rate of feed is varied by attaching the chain to different holes in the L lever.

To operate the rests in a line parallel to the lathe spindle, a similar L lever is attached by chain to the third oscillating arm, which is placed on the cross shaft, mid-way of the bed, or between the two slide rests. It is obvious then that with an L lever attachment on each feed screw, both slides of each rest may be simultaneously operated, while either one may be stopped either by detaching the chain or removing the L lever.

For operating the rests by hand, the usual feed-screw handles are used.

Fig. 537 represents a 90-inch swing lathe by the Ames Manufacturing Company of Chicopee, Massachusetts.

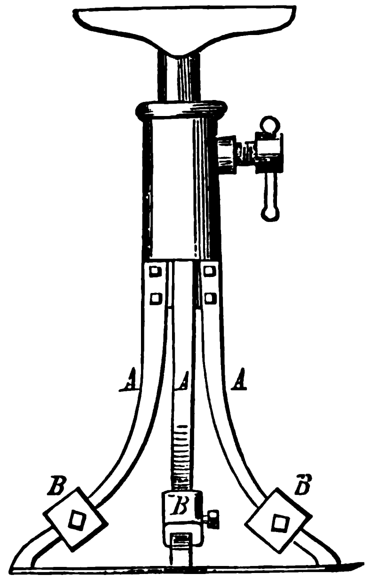


Fig. 535.

The distinguishing feature of this lathe is that the tailstock spindle is made square, to better enable it to bear the strain due to carrying cutting tools in place of the dead centre; and by means of a pulley instead of a simple hand wheel for operating the tail spindle, that spindle may be operated from an overhead countershaft, and a tool may be put in to cut key-ways in pulleys, wheels, &c., chucked on the face plate (which of course remains stationary during the operation), thus dispensing with the necessity of cutting out such key-ways by hammer, chisel, and file, in wheel bores too large and heavy to be operated upon in a slotting machine.

On account of the weight of the tailstock it is fitted with rollers, which may be operated to lift it from the bed when it is to be moved along the lathe bed.

Fig. 538 represents a 50-inch swing lathe by the New Haven

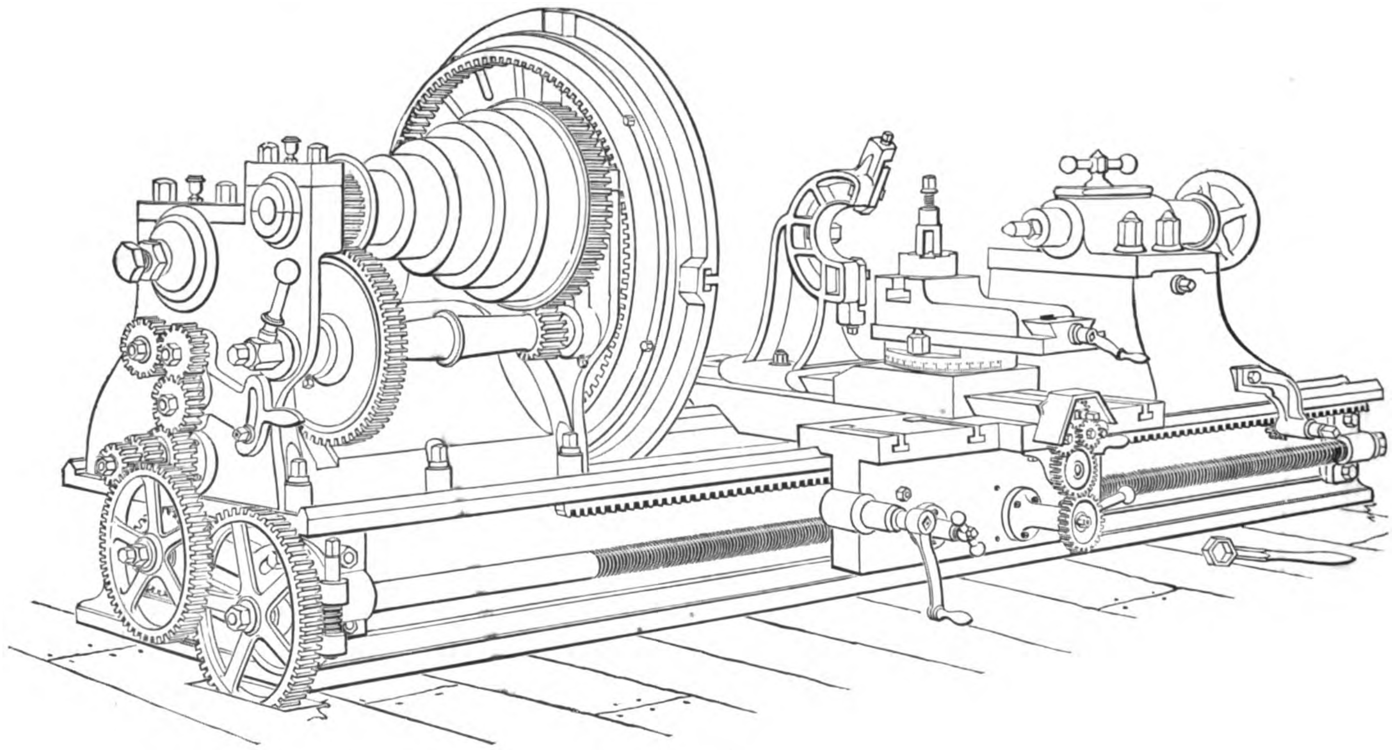


Fig. 538.

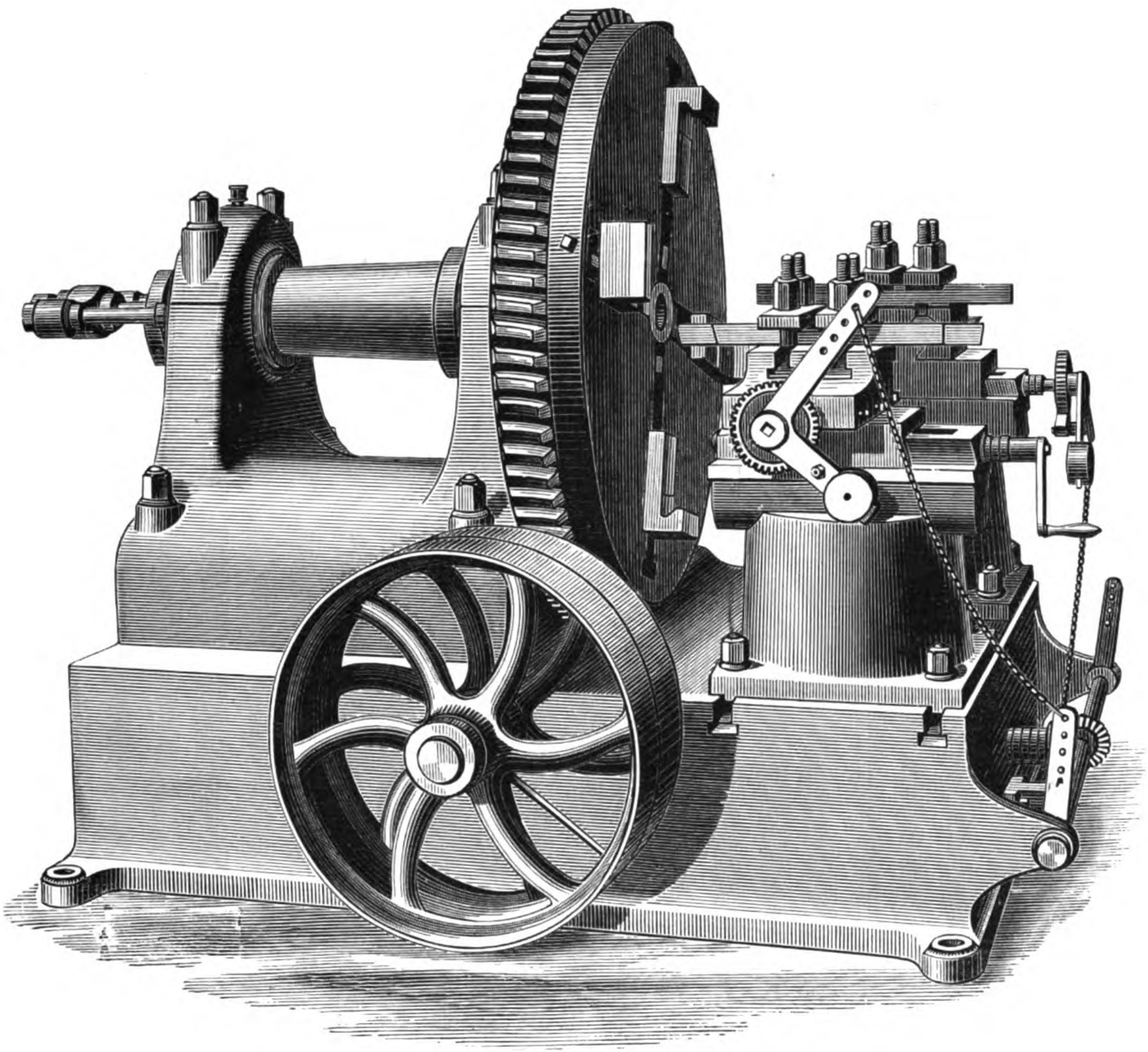


Fig. 536.

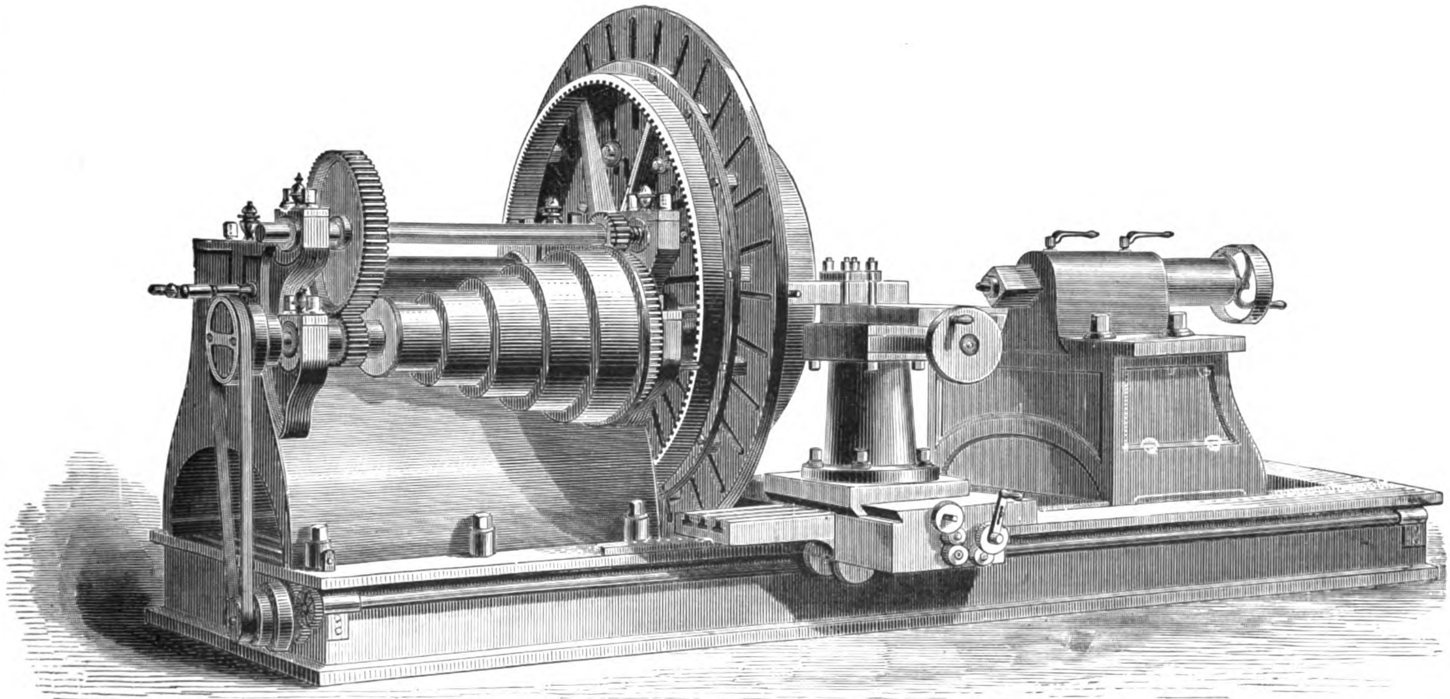


Fig. 537.

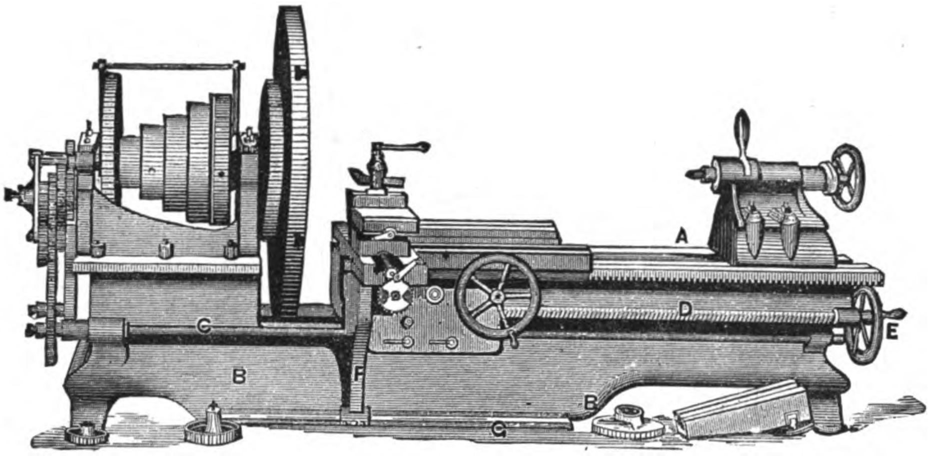


Fig. 540.

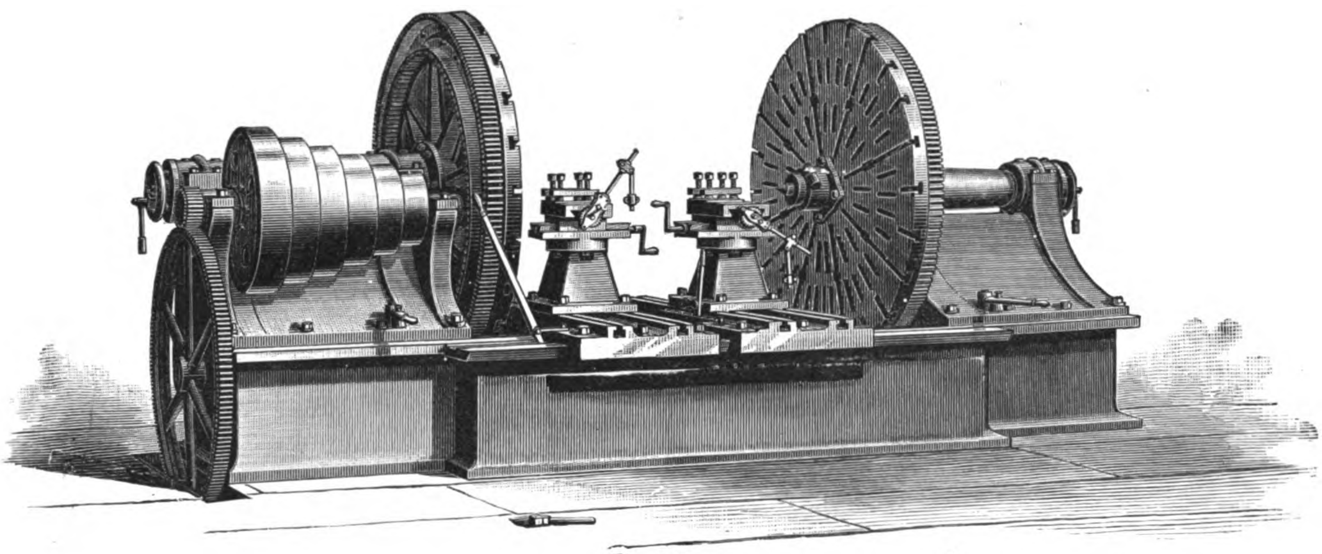


Fig. 541.

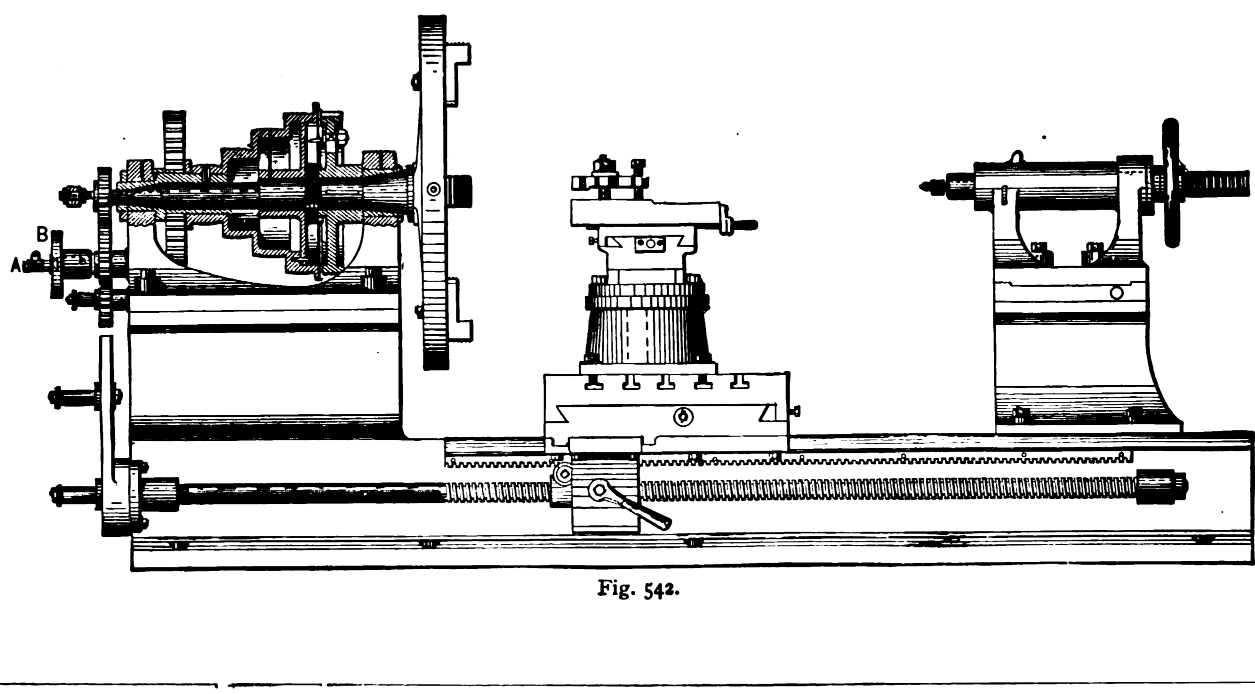


Fig. 542.

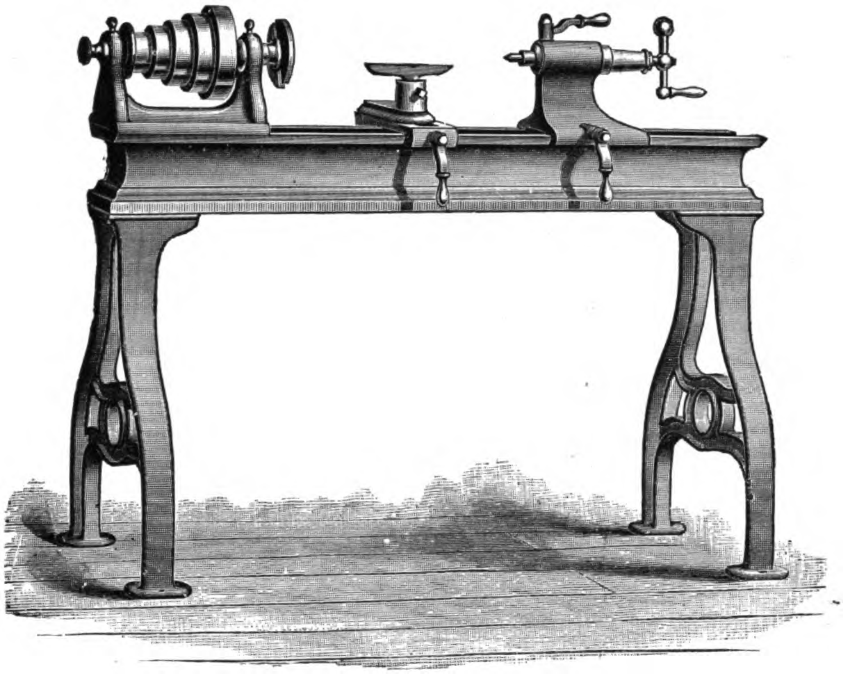


Fig. 543.

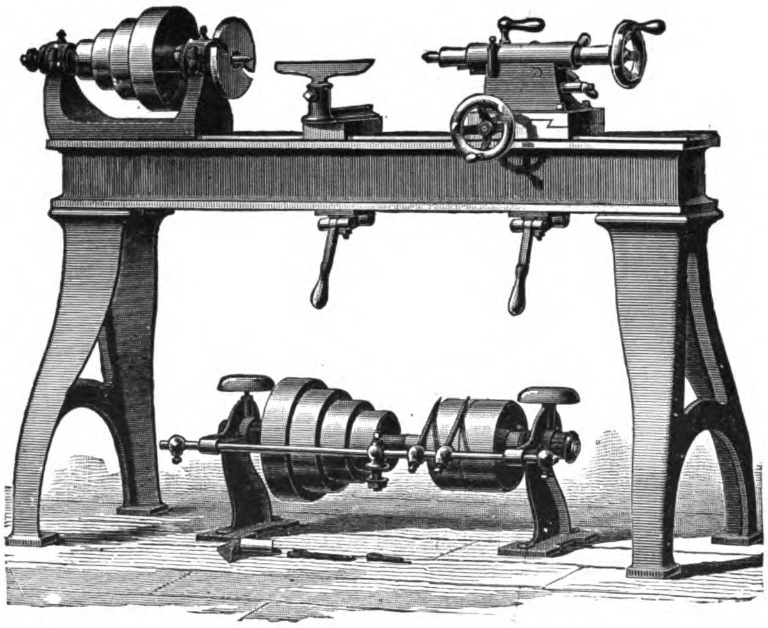


Fig. 544.

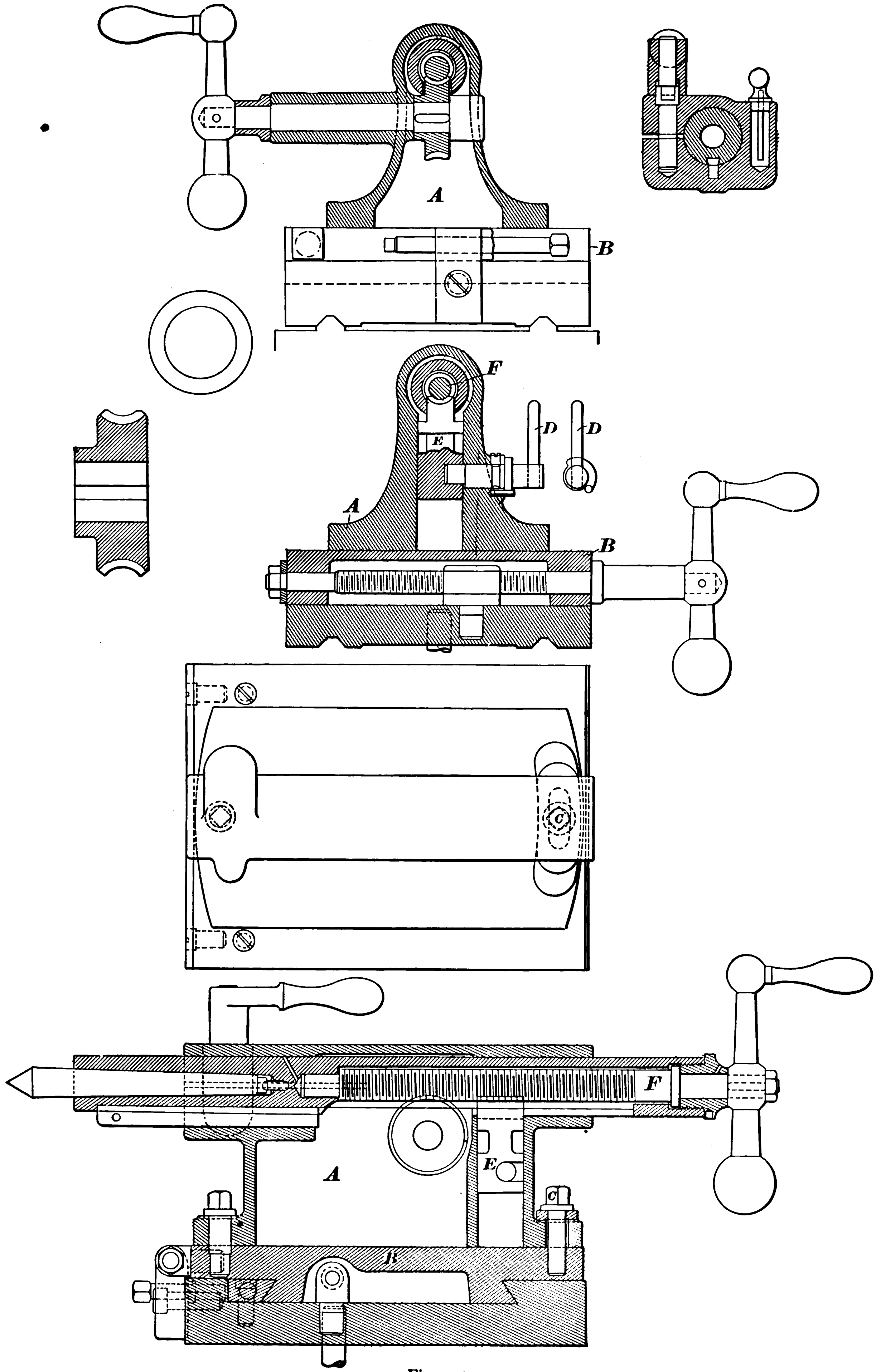


Fig. 545.

Manufacturing Company of New Haven, Connecticut. The compound rest is here provided with automatic feed so that it may be set at an angle to bore tapers with a uniform feed. The tailstock is provided with a bracket, carrying a pinion in gear with the hand-feed rack, so as to move the tailstock along the bed by means of the pinion. The feed screw is splined to give an independent feed, and the swing frame is operated by a worm as shown.

Gap Lathe or Break Lathe.

The gap lathe is one in which the bed is provided with a gap beneath the face plate, so as to enable that plate or the chucks to swing work of larger diameter, an example being given in Fig. 539.

It is obvious, however, that the existence of the gap deprives the slide rest of support on one side, when it is used close to the face plate. This is obviated in some forms of gap lathes by fitting into the gap a short piece of bed that may be taken out when the use of the gap is required.

the face plates are provided with spur teeth, so that both are driven by pinions, which by being capable of moving endways into or out of gear, enable either face plate to be used singly, if required, as for boring purposes.

The slide rests are operated by ratchet arms for the self feed, these arms being operated by an overhead shaft, with arms and chains.

Fig. 542 represents a chucking lathe adapted more especially for boring purposes. Thus the cone pulley is of small diameter and the parts are light, so that the lathe is more handy than would be the case with a heavier built lathe, while at the same time it is sufficiently rigid for large work that is comparatively light.

The compound rest is upon a pedestal that can be bolted in any required position on the lower cross slide, and is made self-acting for the feed traverse by the change wheels and feed screw, while the self-acting cross-feed is operated by a ratchet handle, actuated by a chain from an overhead reciprocating lever ; the latter being actuated from the crank-pin at A, which is adjustable in a slot in the crank-disk B. A lathe of this kind is very suitable for brass work of unusually large diameter, because in such work the cuts

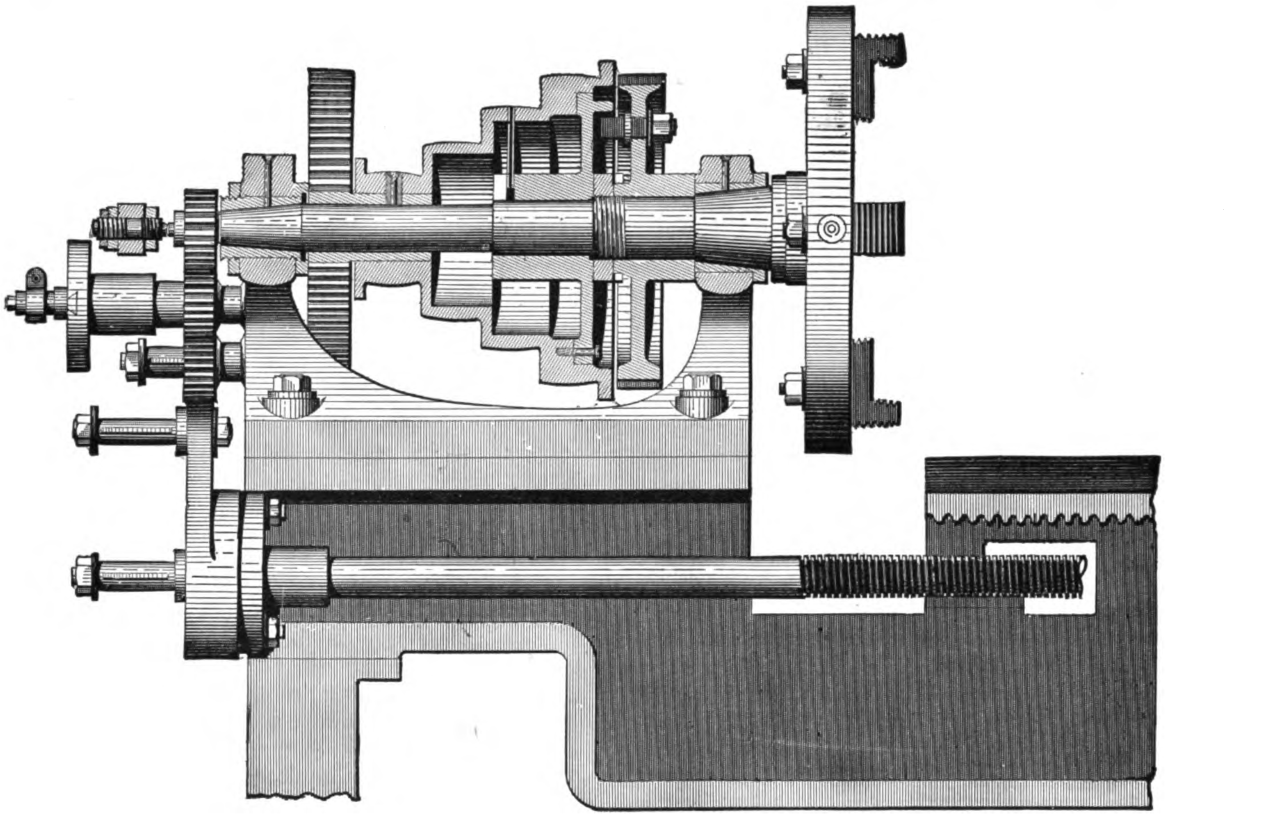


Fig. 539.

The gap lathe has not found favor in the United States, the same result being more frequently obtained by means of the extension lathe, which possesses the advantages of the gap lathe, while at the same time enabling the width of the gap to be varied to suit the length of the work. Fig. 540 (Plate X) represents an extension lathe by Edwin Harrington and Son, of Philadelphia. There are two beds A and B, the former sliding upon the latter when operated by the hand-wheel E, which is upon the end of a screw that passes between the two beds, has journal bearing in the upper bed, and engages a nut in the lower one, so that as the screw is operated the wheel moves longitudinally with the upper bed. C is the feed rod which communicates motion to the feeding screw D, which has journal bearing on the upper bed and therefore travels with it when it is moved or adjusted longitudinally. The cross slide has sufficient length to enable the slide rest to face work of the full diameter that will swing in the gap, and to support the slide rest when moved outwards to the full limit, it is provided with a piece F, which slides at its base upon the guideway or slide G.

Fig. 541 represents a double face plate lathe such as is used for turning the wheels for locomotives. The circumferences of both

and feeds are light, and the cutting feed is quick, hence a heavy construction is not essential.

Examples of various kinds of lathes are given as follows:

Fig. 543 (Plate XI.) represents a thirteen-inch swing hand and drilling lathe, in which the guides or **V**s for the tailstock and for the hand rest are on the edge of the bed, the top surface of which is flat, and their holding and releasing devices are in front.

Fig. 544 represents Warner and Swazey's set-over lathe, a type extensively used by brass workers. In this lathe the foot block is intended to carry the cutting tool in place of the dead centre, and for this purpose it is provided with a cross slide and quick and slow motions to the spindle.

An improved form of this foot block is shown in Fig. 545 (Plate XII.). In this the upper part A is pivoted at the forward end to the set-over slide B, allowing the spindle to be swung out of line for boring taper holes. A binder screw C at the back end clamps it securely in position.

Quick and slow motions to the spindle are provided for as in the plain set-over, the change from one to the other being effected by the lever D on the front side. This lever D, by the motion of an eccentric, raises or lowers the nut E into or out of mesh with the screw F.

These lathes are provided with foot blocks having either round or square spindles.

Fig. 546 (Plate XIII.) represents a lathe for dressing the hexagons of globe valves and having the cutting spindles so as to operate simultaneously on two opposite sides of the hexagon. The work spindle is mounted on a chuck having the necessary index or division device.

Fig. 547 (Plate XIII.) represents Warner & Swazey's double-head lathe for turning the keys of cocks, etc. The tool consists of two complete machines mounted on the same bed, so that one man can easily attend to both.

One of the special features of this machine is the automatic feed and its connection with the tool slide, the method of its connection being such that the tool slide can be fed automatically either parallel to, or at any angle with, the line of centres. This is accomplished as shown in Fig. 548 (Plate XIV.). The tool slide A is connected with the sliding rack B by the stud C. The lower end of this stud C fits into a block D sliding in a rectangular slot planed cross-ways in the top of the rack B.

The guide F for the tool post slide A, which swivels at the line E E and is held by clamp screws, can thus be set at any desired angle without destroying the connection between the slide and the rack. The rack B gears into the pinion G, which is fixed on the same shaft with a worm wheel H. This worm wheel is driven by the worm I, which forms part of the shaft J.

The other end of the shaft J is connected with a reversing mechanism consisting of a clutch K, actuated by the lever L and connecting the bevel gear M (which is fastened to the shaft J) with the cone shaft N, either directly or through the other two bevel gears X and P, thus giving motion in each direction. When the lever L is vertical, as shown in the figure, the clutch is disconnected from both gears and the tool remains stationary.

In turning a key the feed can be arranged so as to make the tool take a single cut across the key and then stop, or so as to take a cut in one direction, then reverse and return to the starting point, and then stop. The latter way is usually preferable, as on the return the tool will take a light finishing cut.

The method of imparting either of these motions is as follows: Attached to the rack B is a rod R, carrying three adjustable stops. Two of these, S and T, are plain collars held by set screws, and when these alone are used to act on the clutch lever L, the tool takes a single cut, its progress being arrested at the end of that cut by one of the stops pushing the clutch lever into its vertical position. The third stop U contains a short spiral spring, and when it is used the stop T is left loose on the shaft, merely forming a washer between the spring and the lever.

The operation is as follows: With the tool at the tail block end of its travel a key is placed in the lathe and the feed started by pulling the upper end of the clutch lever towards the carriage. The tool is then fed towards the head, taking the first or roughing cut over the key.

This movement of the tool continues until the stop T comes in contact with the clutch lever. The first result is to compress the spring in the stop U. As soon as this has taken place the beveled end of the stop U comes in contact with and presses down the latch V, thus releasing the clutch lever and allowing the spring to force the lever over and reverse the direction of the feed. The tool then travels back, taking a light finishing cut, as spoken of before. Finally the stop S acts on the clutch lever, bringing it into its central position and stopping the feed with the tool in its original position, ready for another key.

In actual practice the time consumed in the foregoing operations in one machine is sufficient to enable the man in charge to remove the finished key from the other machine, insert a new one, and start the feed.

Thus the two machines not only do the work with practically no waste of time, but by means of the automatic feed and the fine screw adjustment to the swivel slide, the finished product is far superior to that turned out by the slide rest method, requiring less grinding of the key to fit the cock.

THE HENDEY-NORTON LATHE.—Fig. 549, Plate XV., represents the Hendey-Norton screw-cutting engine lathe. Fig. 550, Plate XV., being an outline view, showing the gears for screw cutting arranged in a line beneath the headstock, as may be more clearly seen in Fig. 551.

Fig. 552, Plate XVI., shows the arrangement of the gearing and clutch for reversing the travel of the carriage both for feeding and screw cutting. Fig. 552*a* in the same plate shows the construction of the gearing in the apron as used on the small size of lathe, which has no power cross feed. Fig. 1, Plate XVI.-A, gives examples of screw-cutting work done on this lathe.

The notable feature in this lathe is the facility and exactitude with which threads may be cut without requiring to arrange the change gears, which consist of a train of gears mounted in the form of a cone directly on the screw of the lathe, and secured thereto by one spline, the whole being enclosed in a case which forms the cover for the gears, and the bearings at either end for the screw. In the lower part of this box is arranged a driving shaft with bearings parallel to the screw. The shaft has a spline the full length of the inner side of the box, and has sliding upon it the driving, or stud gear. This gear bears the proper relation to all the gears in the cone, to cut the regular list of threads from 6 to 20, its position relative to the gears in the cone being controlled by the handle shown, the inner end of which is a forked casting with bearings on either side of the gear, and in an upper extension of the same fork are the bearings for an intermediate gear which is thrown in or out of the various gears of the cone by means of the handle as shown. The index plate on the front has notches of sufficient depth to receive and guide the handle and gear in perfect line with the cone gear wanted, the thread which the combination will cut being stamped above each notch. The latch for holding the handle and gear in place is arranged to secure the handle, both in and out, entering the upper hole when in, and the upper part of the notch for handle when out. This prevents any possibility of the handle being thrown out from the motion of the shaft or gears when running, and also holds the handle in position where last used, which would otherwise fall to the lower end of the slot. Thus far the device is described as only cutting the twelve regular threads from 6 to 20—which include all the ordinary threads in daily use—and is accomplished without change, aside from the movement of the lever from one notch to the other.

The lathes here shown have but two changes; cutting from 1½ threads per inch to 80 threads per inch, and have one extra gear to cut 11½ threads per inch for steam pipe, so often called for; yet should occasion arise to cut any special thread not provided for, this arrangement does not interfere with the making and using of any special gear, the same as in any ordinary lathe.

In Plate XVII., Fig. 1 represents a Forming Monitor Lathe, and Fig. 2 a detail of the forming tool. This machine embodies a departure from the old method of turning irregular shapes. Its operation is extremely simple, and the quality of the work turned out is such that it has rapidly taken the place of all other methods.

The forming tool slide is the most important feature. In the one shown in the cut the tool is fed forward by means of a rack and pinion, passing under the piece at the proper distance to give it its right diameter. At the beginning of the return stroke the tool, by the motion of a double eccentric, drops slightly, thus preventing all dragging across the finished work. Means are provided for adjusting the tool in all directions.

The several figures in Plate XVIII. represent a patented forming tool-slide of later type for this same machine. In this form the tool, instead of lying horizontal and passing under the work, stands nearly vertical and passes up and down back of it. The holder A is planed at slight angle on the back side, giving clearance to the tool as it passes by the work.

Motion to the tool slide is obtained by means of the rack B and pinion C and the lever D. Just before the return stroke a slight turn of the hand wheel E carries the tool back and prevents marring the finished work.

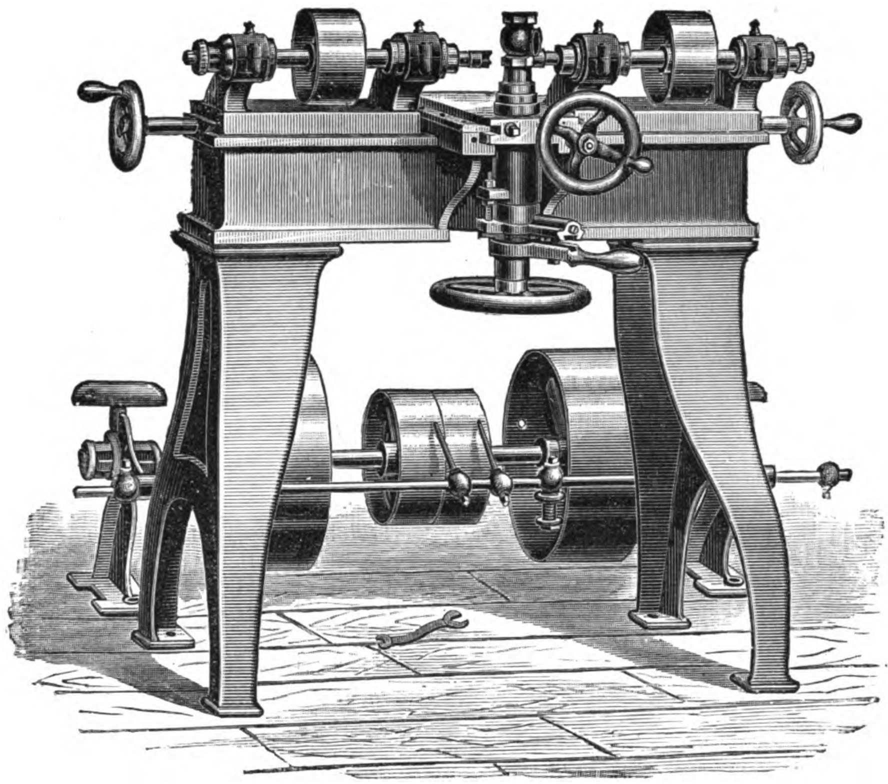


Fig. 546.

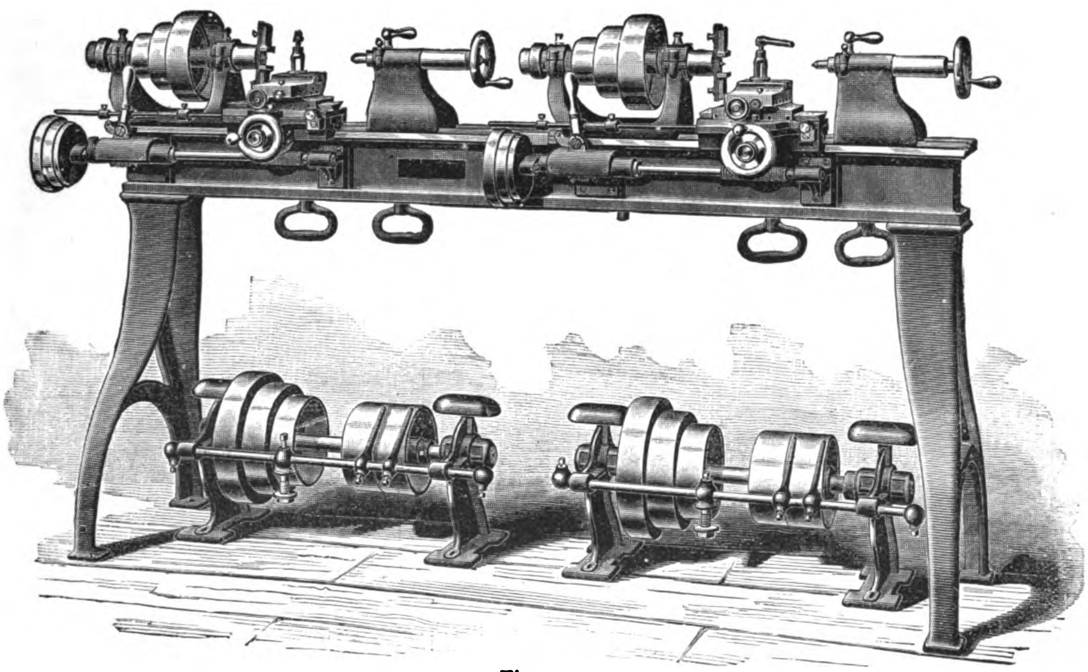


Fig. 547.

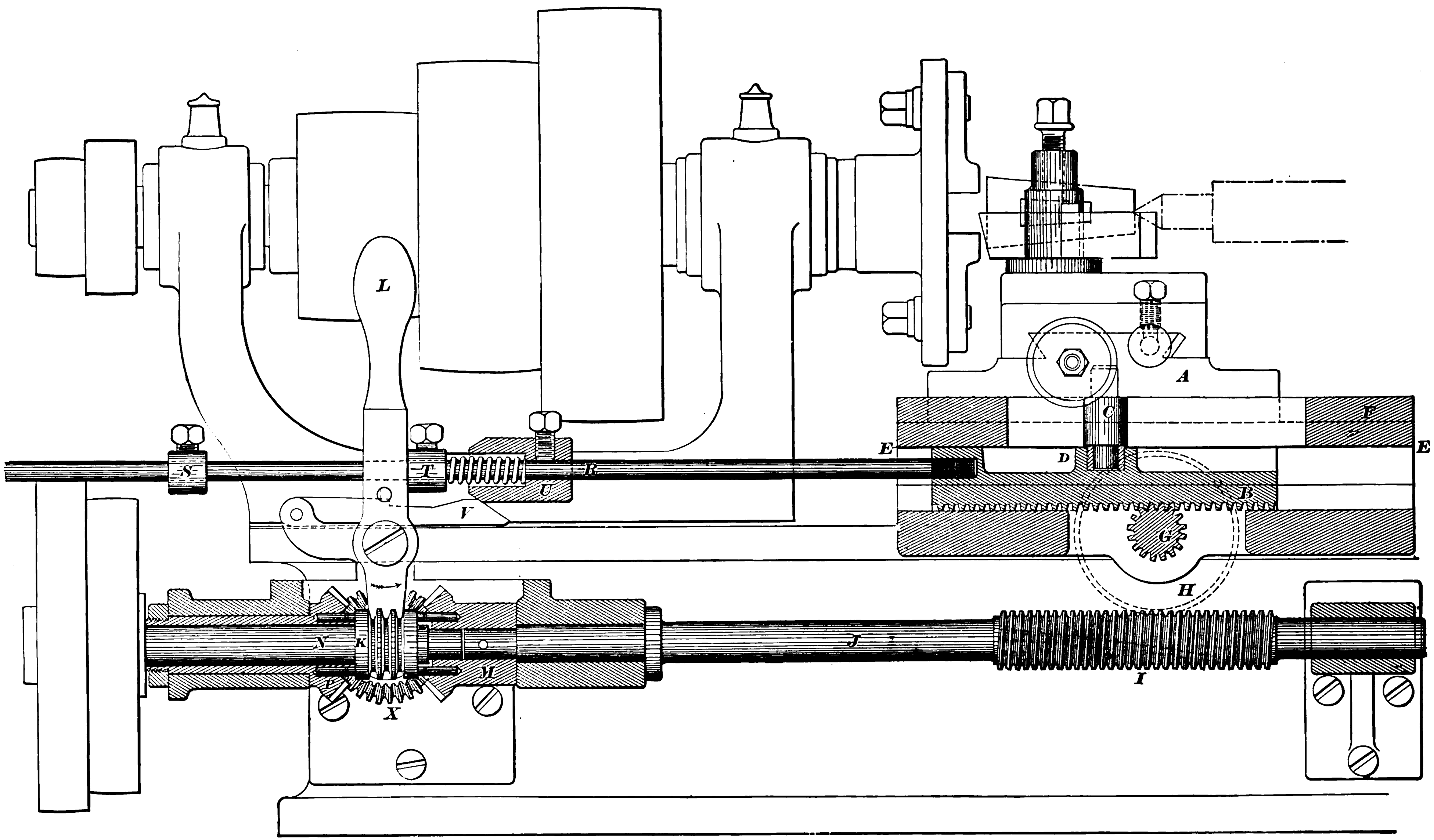
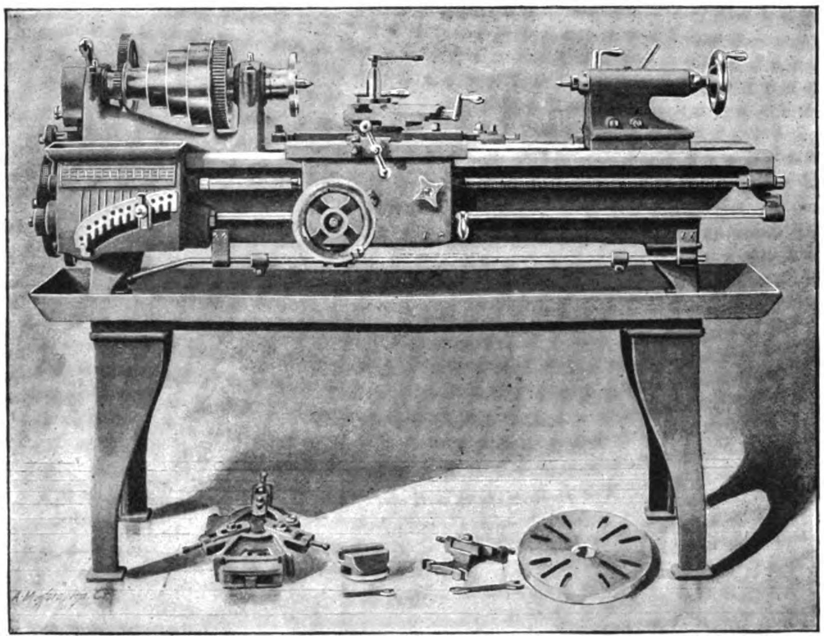


Fig. 548.



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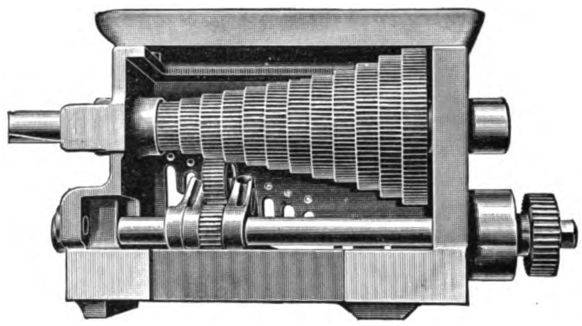

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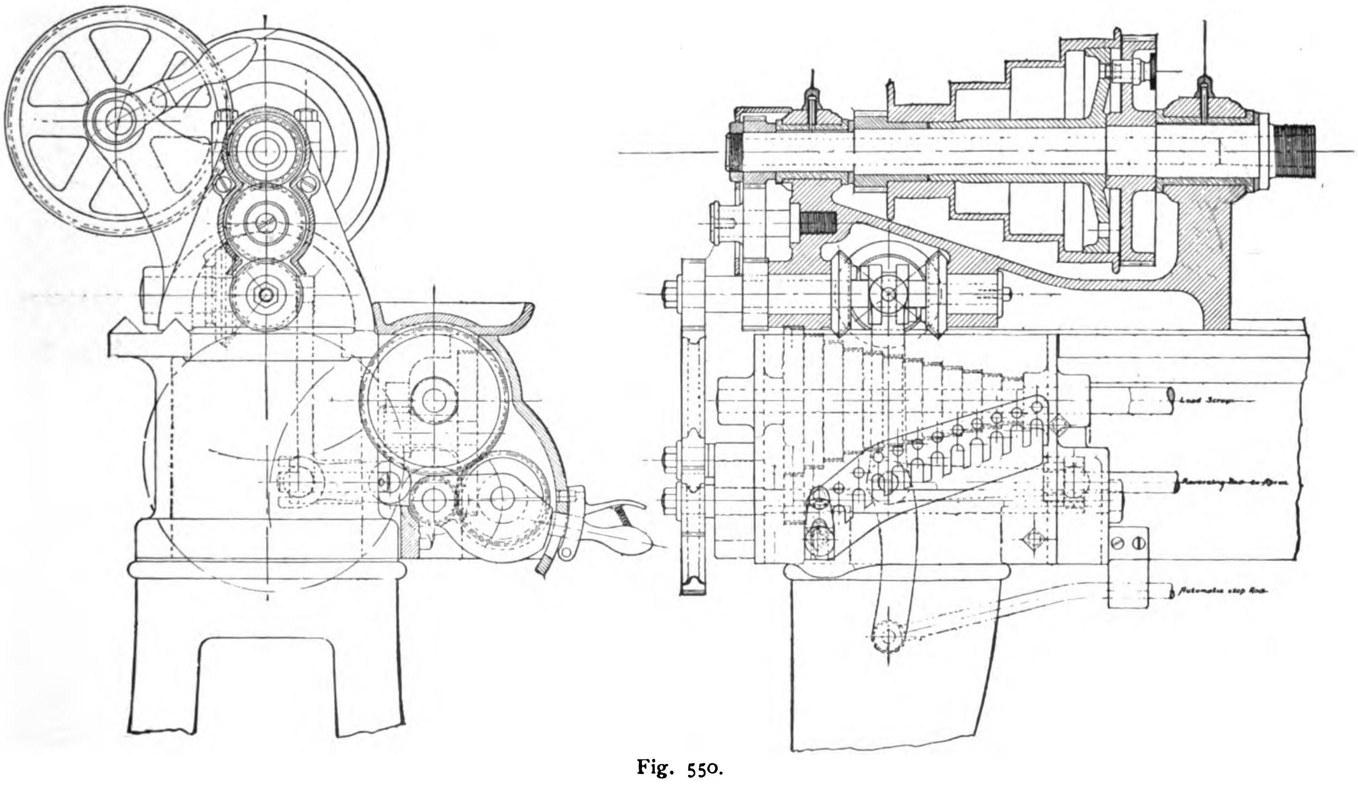


Fig. 550.

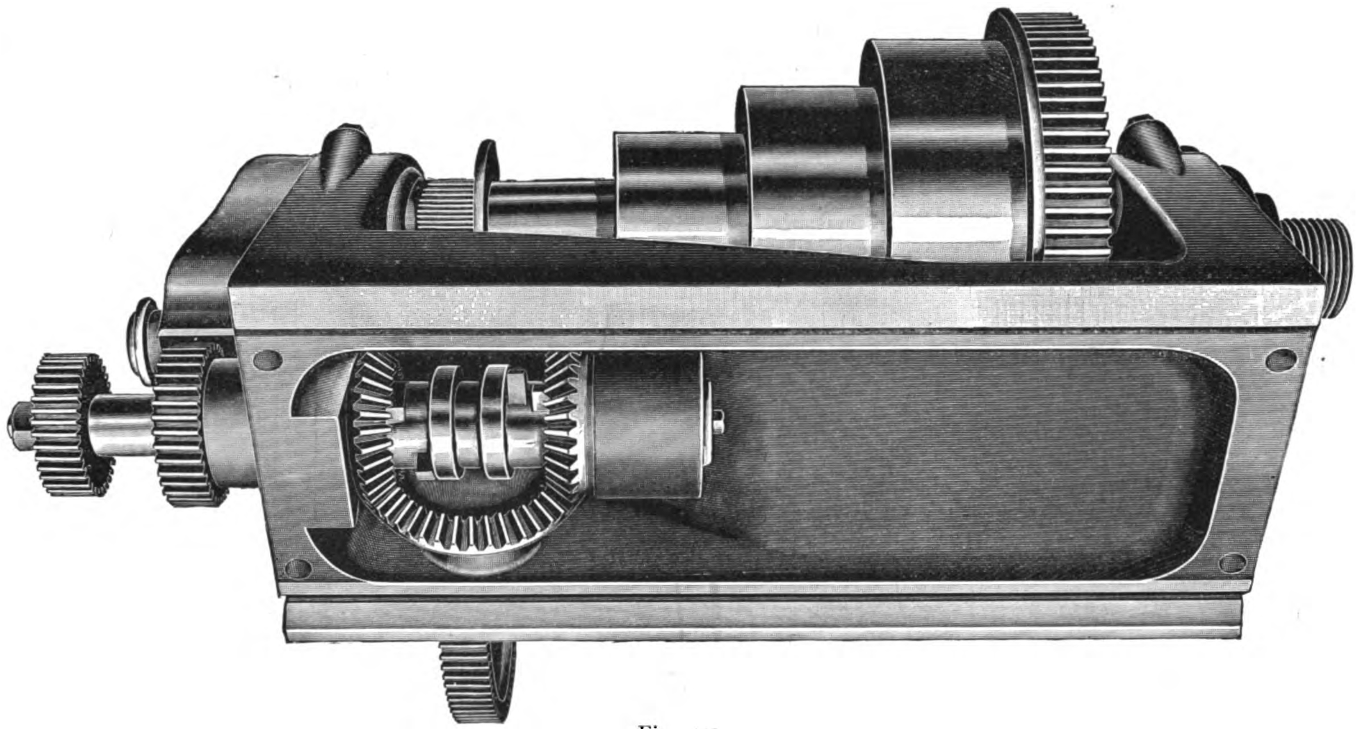


Fig. 552.

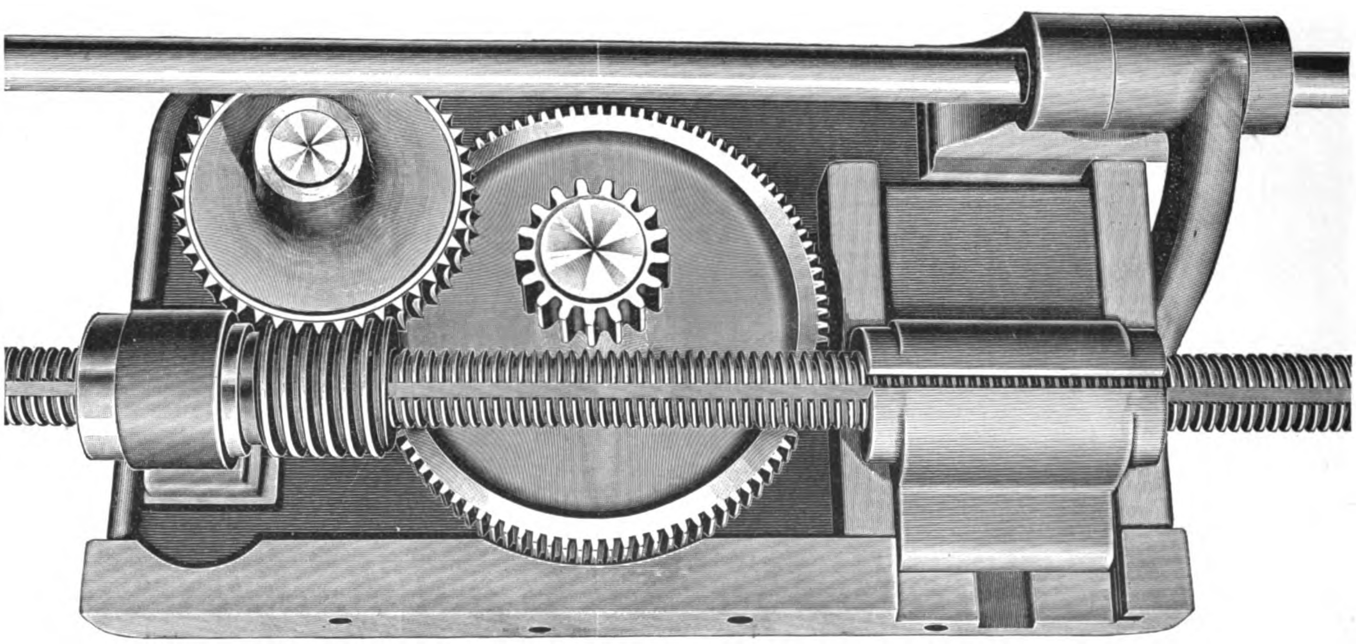


Fig. 552*a*.

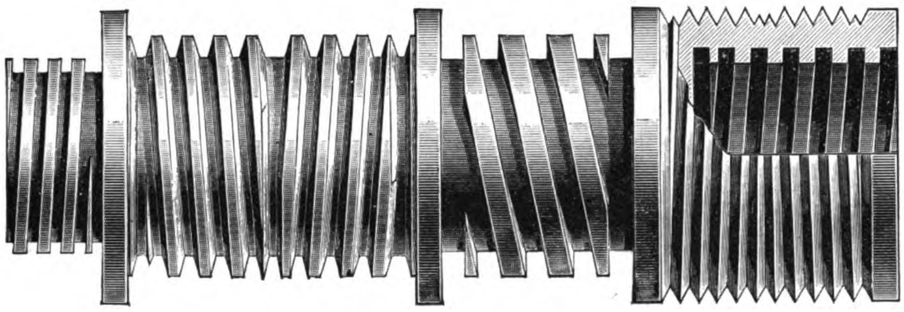


Fig. 1.

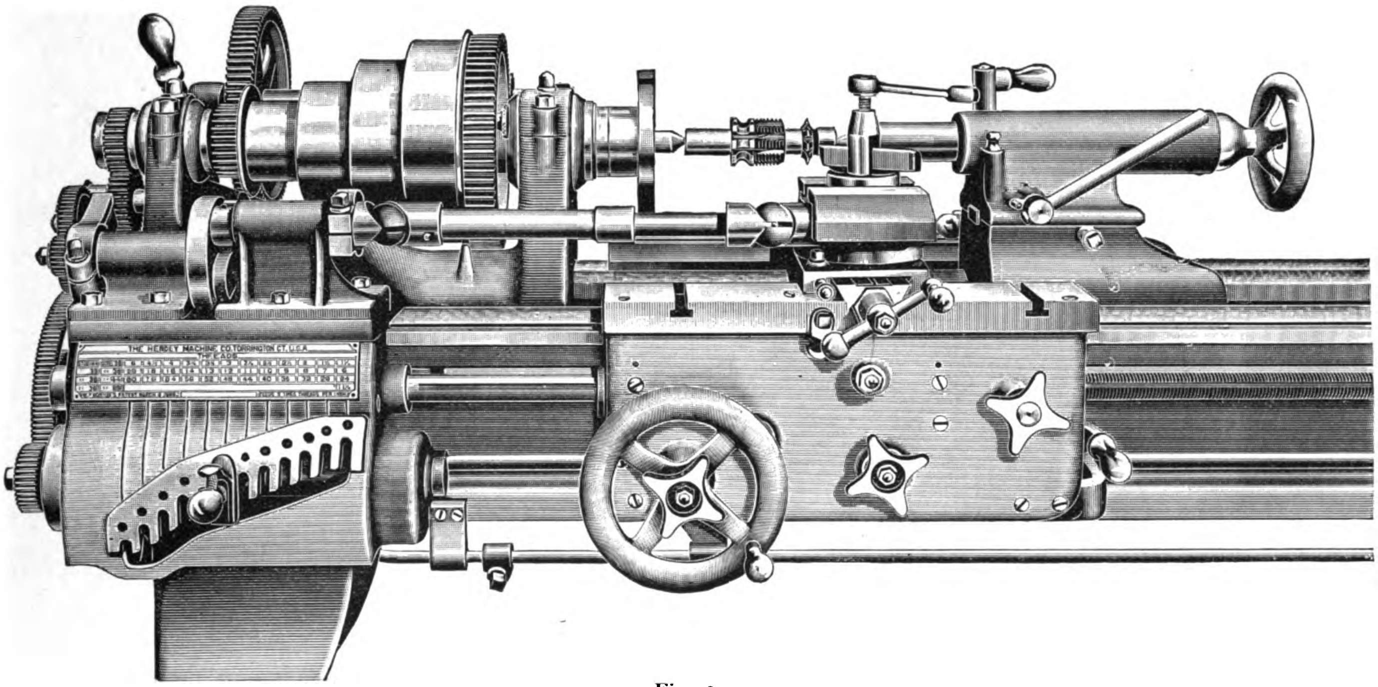
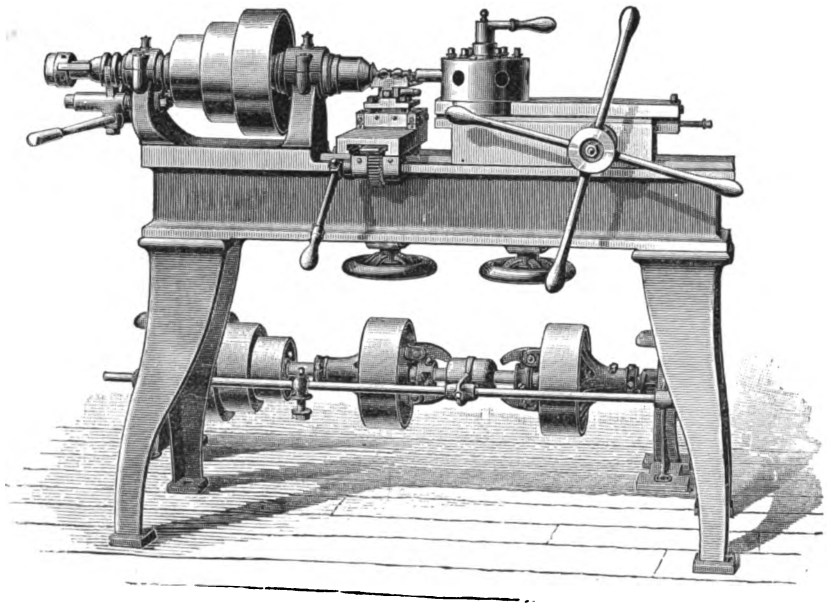


Fig. 2.



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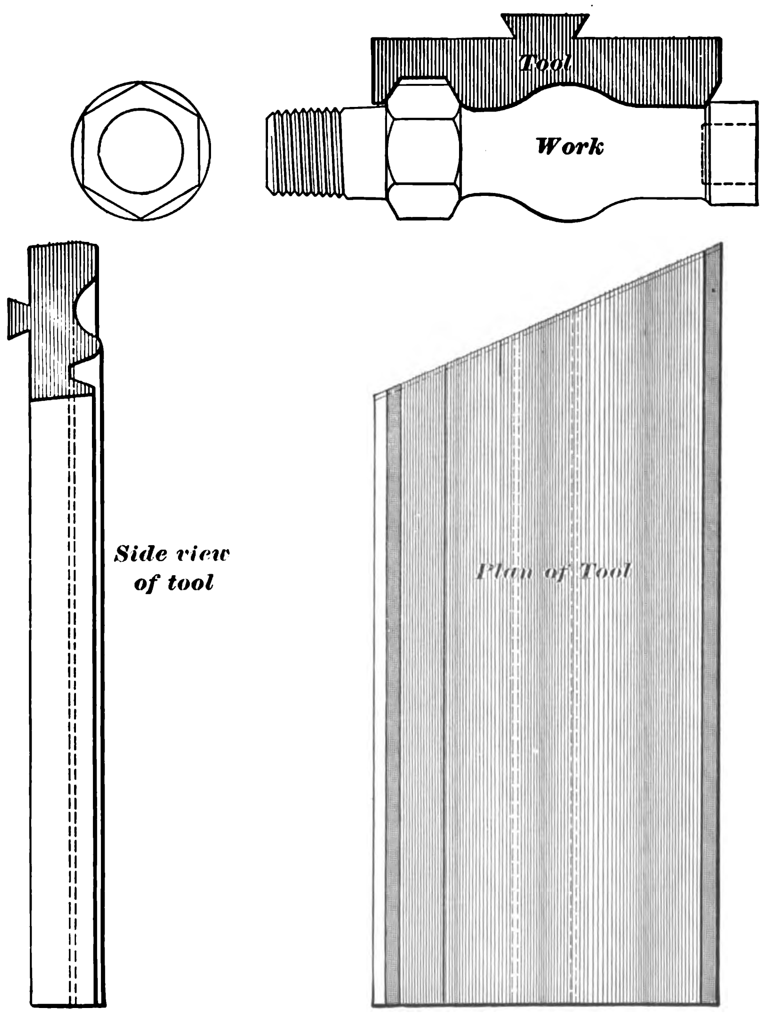

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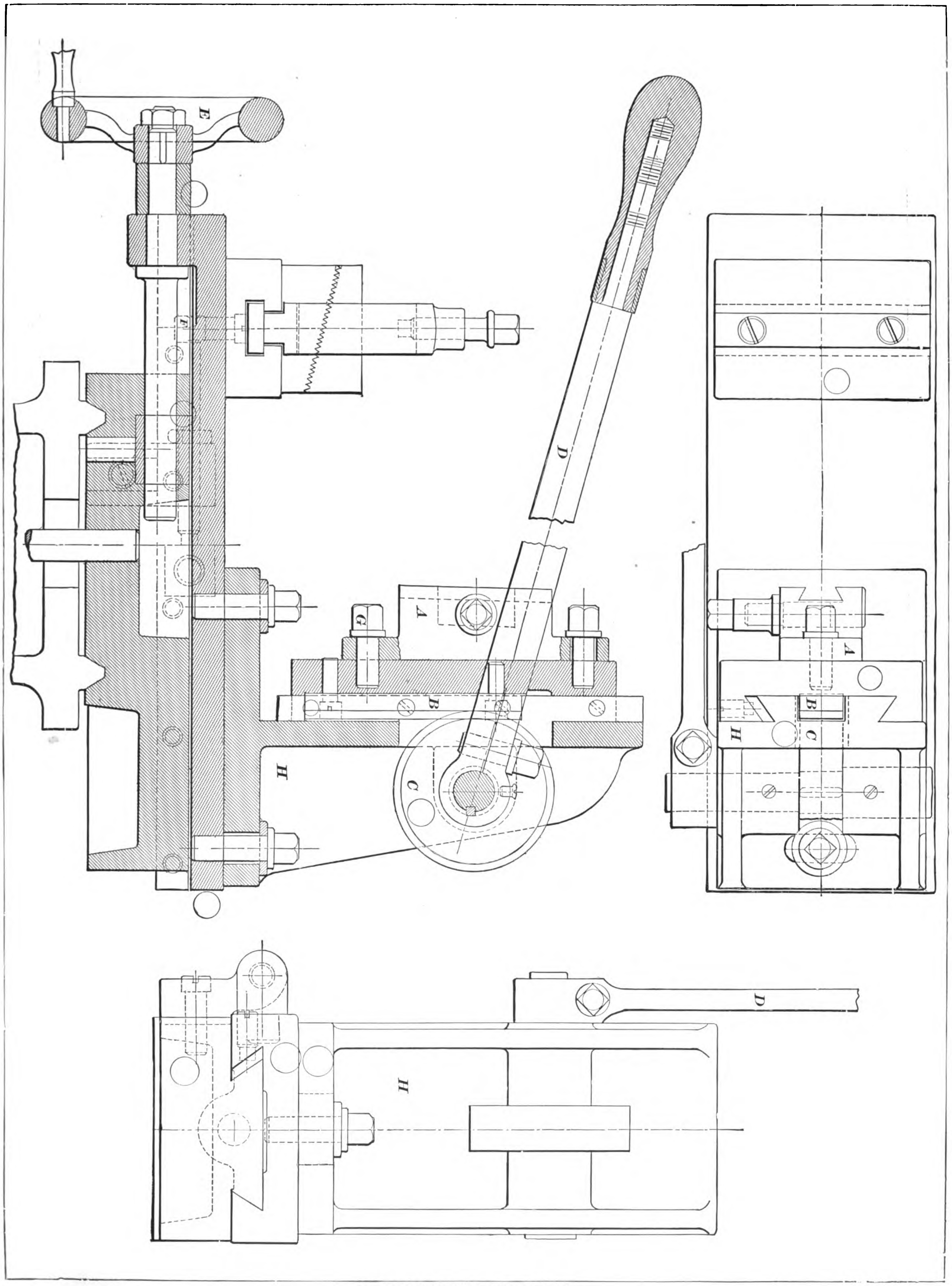
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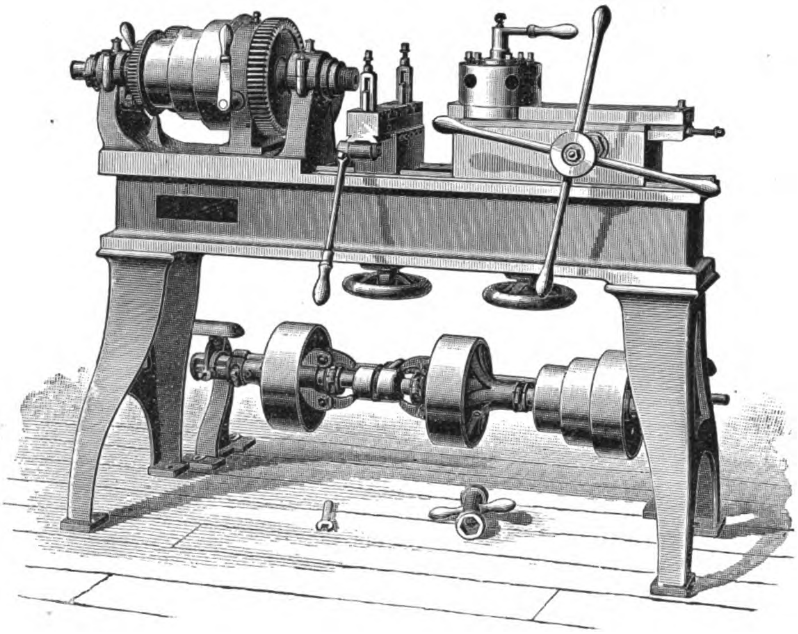

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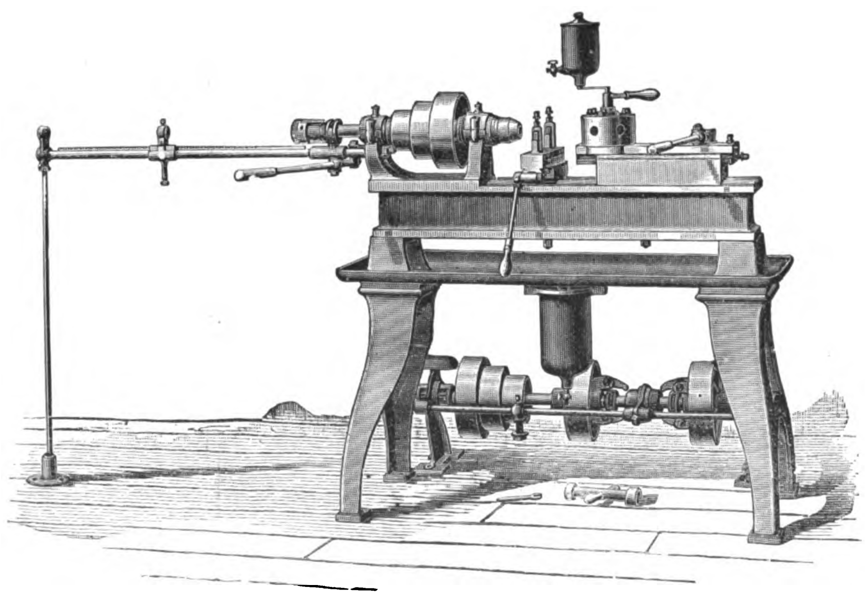
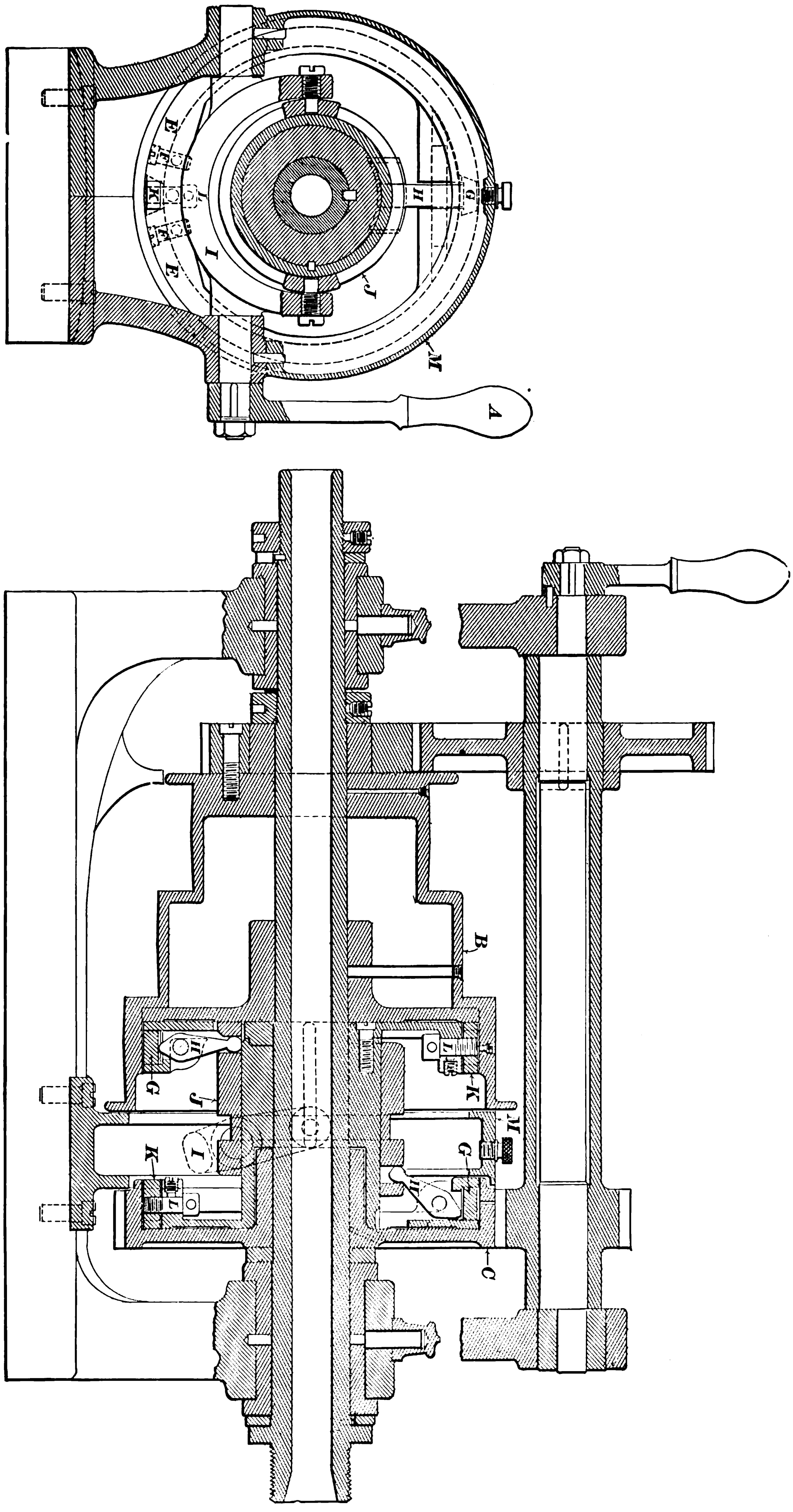


Fig. 2.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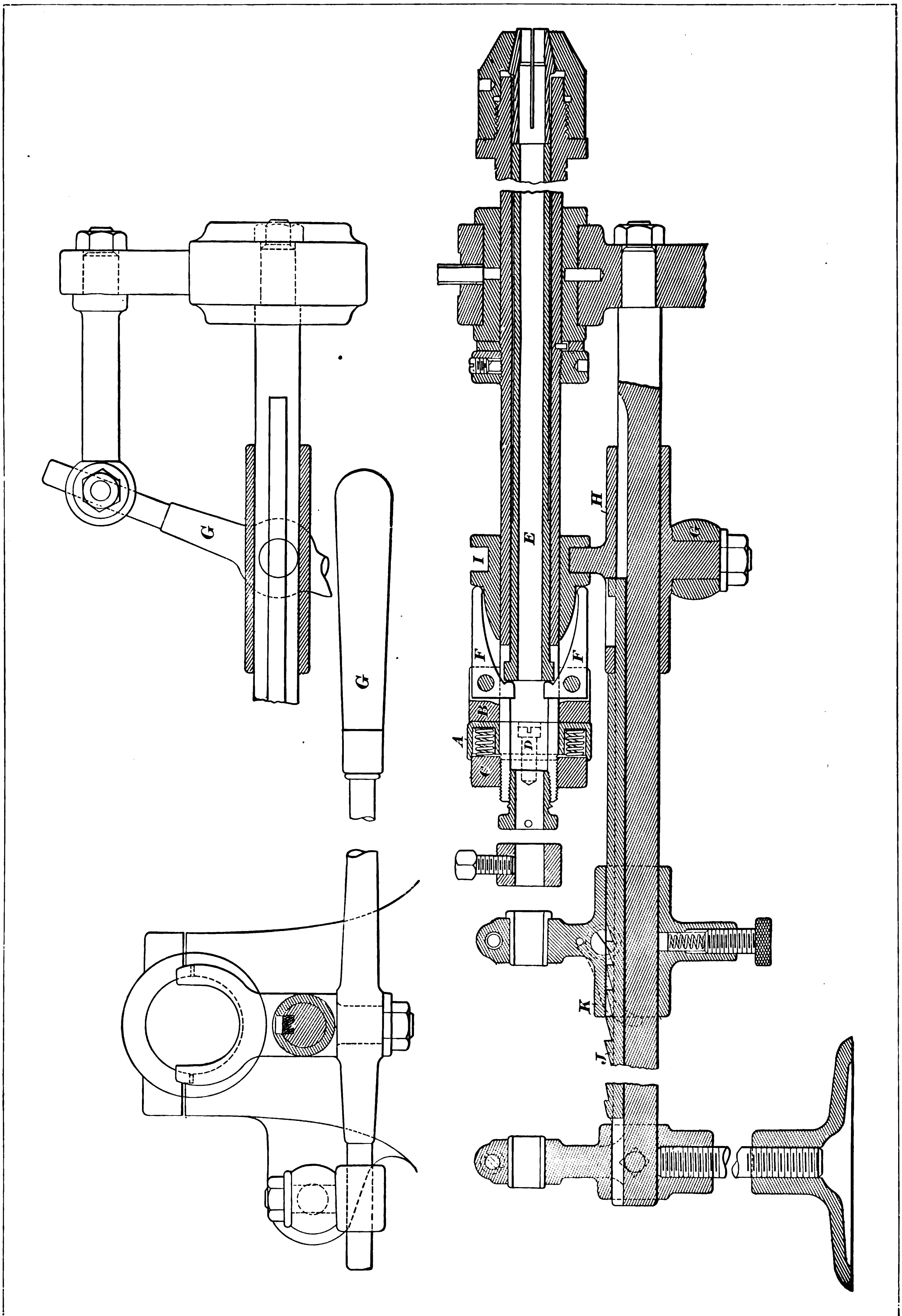
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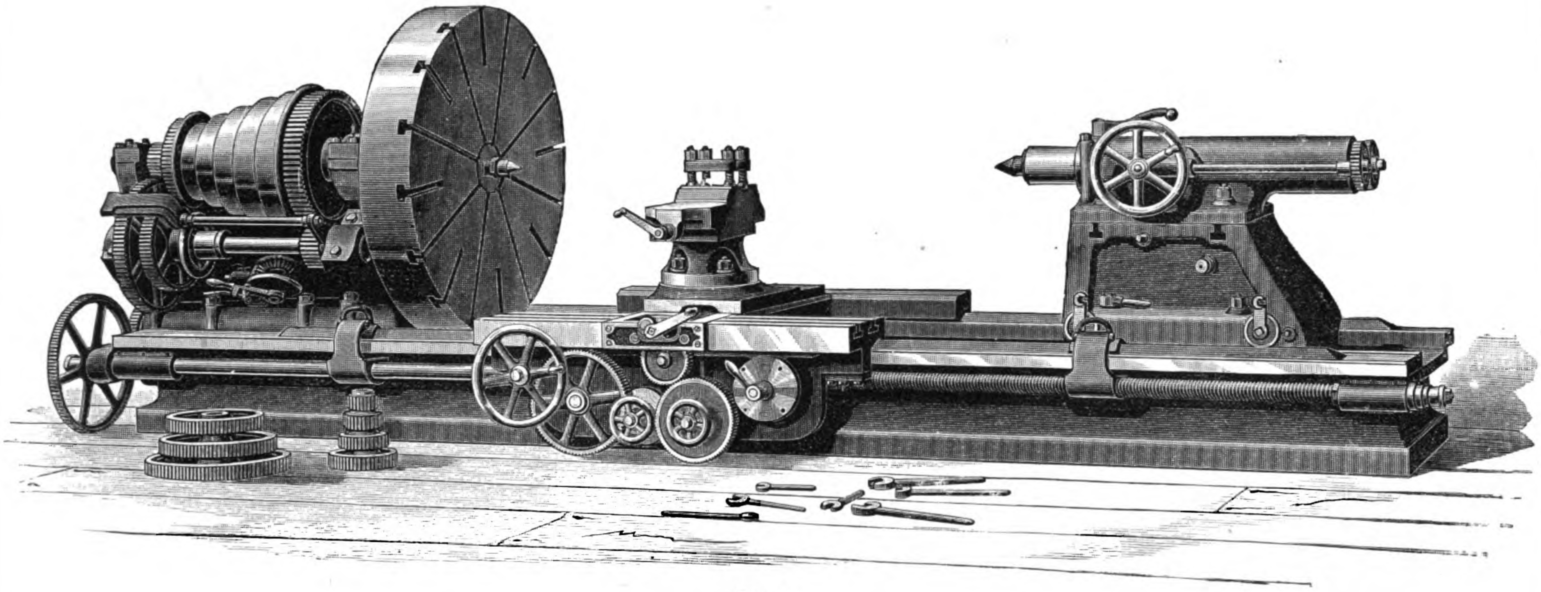


Fig. 1.

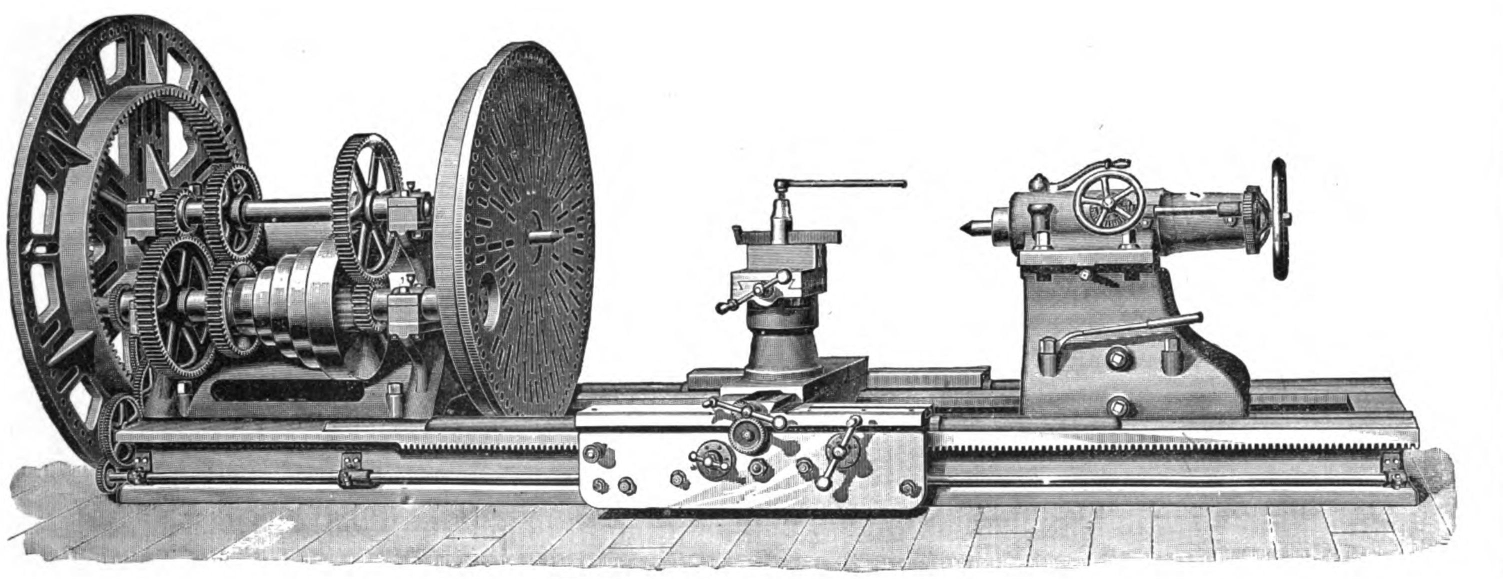
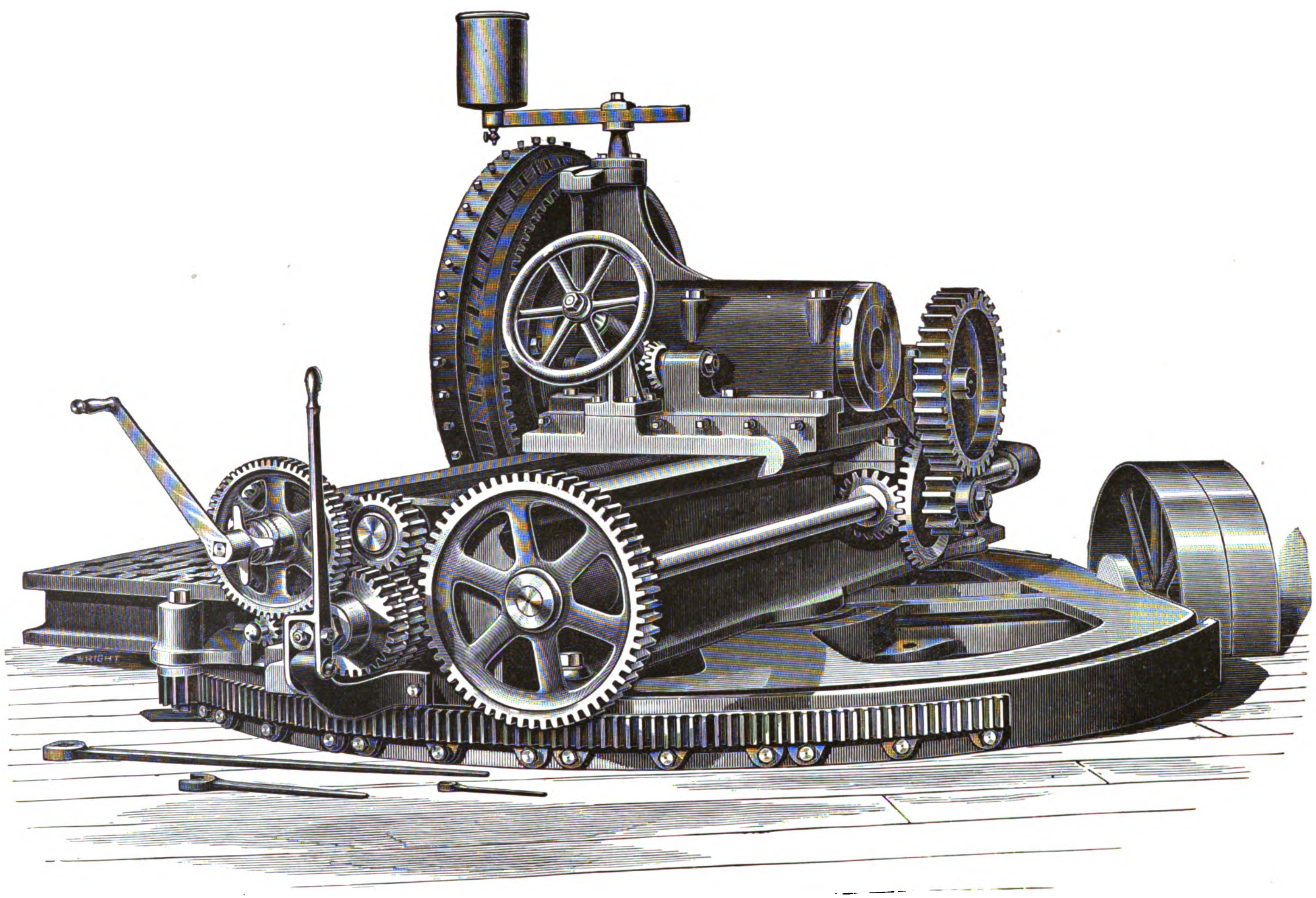


Fig. 2.

SURFACING LATHE WITH CUTTER FACE PLATE.



This same hand-wheel serves to adjust the tool to the diameter to be formed, the slide being brought against an adjustable stop-screw F at each operation.

Clearance is given the tool sideways, when forming shoulder pieces, by swiveling the tool block A on the lower screw G, while the knee H itself can be set around to compensate for the shear of the tool. It will readily be seen that this form of slide not only admits of easier and more rigid adjustment, but its capacity is much greater than it is possible to obtain with the horizontal one.

An automatic chuck is provided with these machines, which is worked by a lever at the left end of the head. By means of this the pieces to be formed can be placed in position, rigidly gripped, finished and removed without stopping the machine. In operation the work requiring the tools in the turret is first done, after which the forming tool is drawn past the part to be formed, thus completing the piece.

Fig. 1 (Plate XIX.) represents an improved type of the Monitor or Turret Lathe that is especially convenient where two speeds are required to complete a piece of work, as it obviates the necessity of stopping the machine to throw in the back gears. By a simple movement of the lever A (Plate XX.), at the side of the cone, the speeds can be varied in the ratio of four to one, thus giving the proper changes for the different diameters in the piece being turned, and also between the boring and tapping. Its construction can be readily followed by reference to Plate XX.

This represents a longitudinal section through the head and also a cross section through the clutch mechanism. In this form of head both the cone B and the head gear C run loose on the spindle. Between the two is the driver D keyed fast to the spindle. This driver consists of a hub carrying a head at each end, the one at the gear end being cast on, while the one at the cone is screwed on, to admit of assembling the parts.

In the periphery of each of these heads is turned a rectangular groove, and in these grooves fit rings E, E. These rings are made in halves, each half being fastened at one end to the head by the screws F. The other ends of the rings are beveled, and between them fits the wedge G.

Motion is imparted to this wedge by the toggle H, and this in turn is actuated by the lever A through the fork I and sleeve J. Thus, when the lever A is thrown towards the head gear the wedge in the head gear ring is thrown out, the ring expanded and the gear is clutched to the spindle. When the lever is thrown toward the cone the head gear is first released, and then the wedge in the cone ring is thrown out, the ring expanded and the cone clutched, as in the case of the head gear. When the lever is vertical both the head gear and the cone are free, and the spindle remains stationary.

An excellent feature of this clutch is the means provided for taking up wear and adjusting the rings. Between the fixed ends of the rings E, E (Plate XX.), and opposite the actuating wedge G, is a second wedge K, similar to the other except that it is reversed, the small end being toward the centre. Into this wedge is tapped the adjusting screw L, which can be easily worked from the outside when the shield M is removed. The wedge K also serves another purpose. It is made long enough to pass through the ring and across the flanges of the head on either side. The ends of the wedge where it passes through the flanges being squared, it thus serves as a key or driver for the rings, taking all side strain from the screws.

These frictions have shown themselves in practice to be both effective and durable, and the principle involved in the style of head itself is such that it readily commends itself to manufacturers.

Fig. 2 (Plate XIX.) represents a screw machine with wire feed for automatically feeding the stock without stopping the machine. It embodies several improvements, which are clearly shown in Plate XXI. One of these is the spring collar A, interposed between the finger-holder B and the backing nut C. The objection to this form of wire feed chuck hitherto has been that, while holding securely stock that is drawn exactly to gauge, it required constant adjustment for rough stock or where there was any variation in the finished rod. This difficulty has been entirely obviated by the use of the spring collar. This consists essentially of a steel collar carrying in the face, next to the backing nut C, a nest of spiral springs. It is held to the nut C by the screws D, and these also serve to increase or diminish the force of the springs, as occasion may require.

The collar is adjusted so that the pressure against the plunger E is sufficient to hold the work securely, while at the same time it allows the spring chuck to adapt itself to any variations in the diameter of the rod. It has been found perfectly feasible, by the use of this collar, not only to hold finished rods of varying diameters, but also rough rods, and even castings of various kinds. Its adoption has made easy the finishing of many varieties of work hitherto deemed impracticable for automatic wire feeds.

The fingers are operated by the fork H and the wedge I. This fork is actuated by the lever G, which also feeds the wire forward, after the chuck has been opened, by means of the ratchet J and the dog K.

A forge lathe is a lathe of great strength in all its parts, so as to enable it to take very heavy cuts on larger rough forgings, it being found cheaper to cut out the work, as it were, rather than to forge it down to size when the forging is massive.

A lathe of this description is shown in Fig. 1 (Plate XXII.), which represents a sixty-inch lathe constructed by the Niles' Tool Works.

The lathe swings sixty inches over the ways and forty-six inches over the carriage. The cone is mounted on an independent spindle, with a steel pinion geared into an internal gear on the back of the face plate. It has five steps for a belt four and one-half inches wide, and has two sets of back gears, providing fifteen changes of speed to the face plate. The main spindle is ten inches in diameter at the front end, and the bearing is fifteen inches long. The face-plate is bolted fast to the spindle.

The carriage is sixty-eight inches long, and is gibbed both front and back with longitudinal, cross, and angular feed. The tool is held by four clamps and studs. The tool-rests can be removed at will, and then the carriage presents a large, flat surface, on which work may be bolted for boring.

The foot-stock is held to the bed by four bolts, and it is also provided with a strong pawl, which engages with a rack cast in the bed. This pawl is raised or lowered by means of the hand knob seen at the side of the foot-stock, and, when engaged, makes a positive lock for the foot-stock.

The foot-stock has four rollers, mounted on eccentric studs with clamps. By turning the studs a quarter-turn and clamping the straps shown in the illustration (and which are connected to these studs), the rollers are brought into engagement with the bed, and the entire foot-stock is raised slightly from the ways, and can be readily adjusted to any desired position.

The upper side of the foot-stock is also held by four bolts. This arrangement allows the foot-stock to be set over for taper work without unclamping from the bed, and is very convenient when working with heavy pieces. The foot-stock screw is geared at the back end, and arranged to be operated by the hand-wheel shown at the front in the illustration.

The lathe is also provided with heavy, steady and follower rests, and the steady rest has an opening of extra size to admit large shafts. Adjustable hinged supports for the lead screw are also provided, which are arranged to slide upon the ways. These can be removed from the bed at will, or adjusted to suit the convenience of the operator.

When the diameter of lathe work exceeds about ten feet it is usual for the lower part of the work to pass below the floor: what is known as a pit lathe being employed in connection with a pillar or movable compound slide rest, sometimes operated by a star feed, or a pawl and ratchet feed operated from overhead by a chain.

Fig. 2 (Plate XXII.) represents the triple geared Putnam Lathe, with a back face plate for a pit lathe.

SURFACING LATHE WITH CUTTER FACE PLATE.—In Plate XXIII. is represented a surfacing lathe, designed and constructed by Messrs. Bement, Miles & Co., of Philadelphia, Pa.

This class of lathe is sometimes designated as a rotary planing machine; it may more properly be termed, however, a surfacing lathe, since it has the chuck, live spindle, and feed motions characteristic of a lathe. In place of slide rests and the ordinary cutting tools, a large number of tools are inserted around the circumference of what may be termed the lathe face plate, which is mounted upon a carriage operating along a slideway upon the bed, which is mounted upon a plate forming a quadrant of a circle, upon the centre of which the lathe bed is pivoted, so that the face plate can be set at any required angle within 90 degrees. The work is firmly bolted to a fixed table provided in the front of the face plate.

This class of lathe will surface work with great rapidity and effectiveness.

A chucking lathe is one having a swing that is large in comparison with the length of the lathe bed or shears.

A simple form of chucking lathe is shown in Fig. 1 (Plate XXIV.), there being no tailstock or back head. The compound rest is moved along the bed or shears by means of the screw at the right-hand end. The compound rest has an automatic feed of eight inches and automatic cross feeds. Both these feeds are reversible.

Fig. 2 (Plate XXIV.) is a chucking machine or lathe by the Pratt & Whitney Company.

In place of having a gap in the bed to give capacity for the necessary amount of swing, the turret slide block is made high enough to give the required swing, which gives a maximum of swing for the full length of work the lathes will take in.

The machine has an automatic feed, which is automatically tripped at any desired point, and is also provided with a special rapid feed for reaming. The head is provided with an internal friction clutch which is worked by the lever to the left of the main cone gear, and this clutch enables the back gear to be thrown in or out without stopping the machine.

A rack and pinion motion is provided for moving the foot-stock or turret-slide block on the bed, and adjusting it, this being worked by the handle shown at the side of the block. The turret is revolved automatically by the movement of the slide, the same as a screw machine.

The spindle has a hole entirely through it, and the machine is furnished with drawback collet mechanism, when desired, or other modifications are made adapting it to special requirements.

Double Axle Lathe.—An improved form of double axle lathe, designed and constructed by Messrs. Bement, Miles & Co., of Philadelphia, Pa., is illustrated in Plate XXV. The bed is provided with two slides with flat surfaces, such slides being generally preferred to vee slides in lathes of this class.

Each slide is provided with a separate rest and tool post, which may be operated separately by hand, or conjointly by the feed motion. The dead centre is fast in its tailstock. The ordinary headstock is here replaced by a tailstock having a firm tail-spindle locking device. The axle passes through the driving head, and is driven on a dead centre at each end.

This ensures the production of true work, and gives a rigidity which enables the carrying of very heavy cuts. A rotary pump furnishes a water supply to a central tank, from which, by suitable pipe service, a liberal supply of water can be furnished to each cutting tool, keeping it cool, and enabling the tools to work at a high rate in feet per minute.

Fig. 1 (Plate XXVI.) is a simple form of gap lathe, constructed by the Fitchburg Machine Works. The upper bed slides longitudinally to open the gap to the required distance or width. The guideways are upon the outer edges of the shears, and the tailstock or back head is rigidly constructed to enable it to feed drills, boring bits, etc.

Upon the shears of this lathe there is shown a drill-holding rest, but it is obvious that this can be replaced by a compound slide rest.

An example of a modern gap lathe is shown in the Bridgeport Machine Tool Works lathe, Fig. 2 (Plate XXVI.).

This lathe is provided with a sliding bed that may be secured to the lower bed at any required point, to suit the width of the work. When the upper bed is moved to come close up to the face plate and is secured there, the slide rest has a firm foundation to support it, without any opening beneath it, as in the ordinary gap or break lathe, as it is sometimes termed.

This lathe is provided with a friction clutch motion, which enables the speed to be changed from single gear to back gear without stopping the lathe.

The feed is obtained from a splined screw receiving motion from the gear wheels shown at each end of the lathe, the rod connecting them being at the back.

The form of tool rest employed is that shown in Figs. from 608 to 611, on pages from 174 to 176.

Fig. 1 (Plate XXVII.) represents a horizontal chucking machine, by the Brown & Sharpe Manufacturing Company, and having an automatic feed to the turret with eight changes of feed. The back gears are beneath the spindle cone and entirely enclosed. They run continuously, and are engaged or disengaged by a friction clutch whose construction is shown in Figs. 2 and 3. Fig. 3 gives a sectional view of the head stock.

Fast upon the cone spindle and between the cone C and the gear D is a flange piece X, carrying the small levers *r*, *r'*, which, through the medium of the pins shown, operate the wedges S, S; S', S', which open out a ring which is in two halves, as shown at R, R, in Fig. 3. *d* is a sleeve, a sliding fit endways upon *x*, and having a recess *c* for receiving a clutch ring, *a* representing the clutch lever which is upon the shaft *b*. The sleeve *d* carries the pieces *e*, and in the position the parts occupy in the figure, *e* does not bear upon either the levers *r* nor the levers *r'*, and the cone would revolve, without revolving the cone spindle.

But suppose lever *a* be operated to the left and ring *d* will be moved to the left, forcing inwards the end of levers *r*, *r*, which would force outwards the tongues S', S', and cause the two half rings to grip the bore of the cone at *m*, and drive it by friction, thus giving the cone spindle the belt or single gear speed.

Now suppose that instead of moving *d* to the left, it be moved to the right, and the pieces *e*, *e*, will engage with the levers *r'*, *r'*, forcing outward the pieces S, S (see Fig. 3), and causing the two halves of the ring R to grip the bore of the gear D and drive it by friction.

The springs *s* (Fig. 3) are merely to withdraw the two halves of the friction ring R when the levers *r'*, *r'*, are released from contact with pieces *e*, *e*.

A combination turret lathe, constructed by the Bridgeport Machine Tool Works, is illustrated in Figs. 1 and 2 of Plate XXVIII.

This machine has a hollow spindle, having a chuck at each end, and hence is capacitated for the operations usually performed by a screw machine, having a 2½-inch hole through the spindle, which has a chuck fitted at each end; a three-stepped cone for 4" belt, the largest step 14 inches in diameter, with back gears proportioned 4½ to 1, and a 6-hole turret, with automatic or hand feed.

The back gears are thrown in or out of action by means of a friction clutch, which is operated by the lever shown on top of the main bearing, and by means of which the machine may be stopped, or the back gear thrown in or out without stopping.

The holes in the turret are 2½" diameter, and the turret is hexagonal in shape, the object being to provide flat surfaces to which tool holders or other devices may be bolted, as is sometimes preferred.

The turret slide has a motion of 14" in the block, with an adjustable trip for the automatic feed.

The feed mechanism is clearly shown in Fig. 2. The turret revolves automatically, as it is drawn back or not, as may be desired, the change being made by simply pushing in a small pin in front of the shoe.

Instead of the usual block with cut-off slide, a regular lathe carriage is provided, having an automatic feed along the bed, and an automatic cross-feed. An adjustable stop is provided, with which the carriage may be brought into contact when it is desired to bring it to the same position for a certain length upon each piece, and it may also be clamped in any desired position upon the ways, when the cross-feed is to be used.

There are also adjustable stops for limiting the motion of the cross-slide in either direction. The cross-slide carries two tool blocks, which may be adjusted to any desired distance from each other. The motion of the feeds is reversed by means of the bevel gears and double-ended clutch, shown in front under the cone pulley. The clutch is operated by the handle above.

An unusual feature for machines of this class is seen in the provision made for turning tapers, which is done by means of a Slate taper attachment, shown by the rear view, Fig. 2, which also

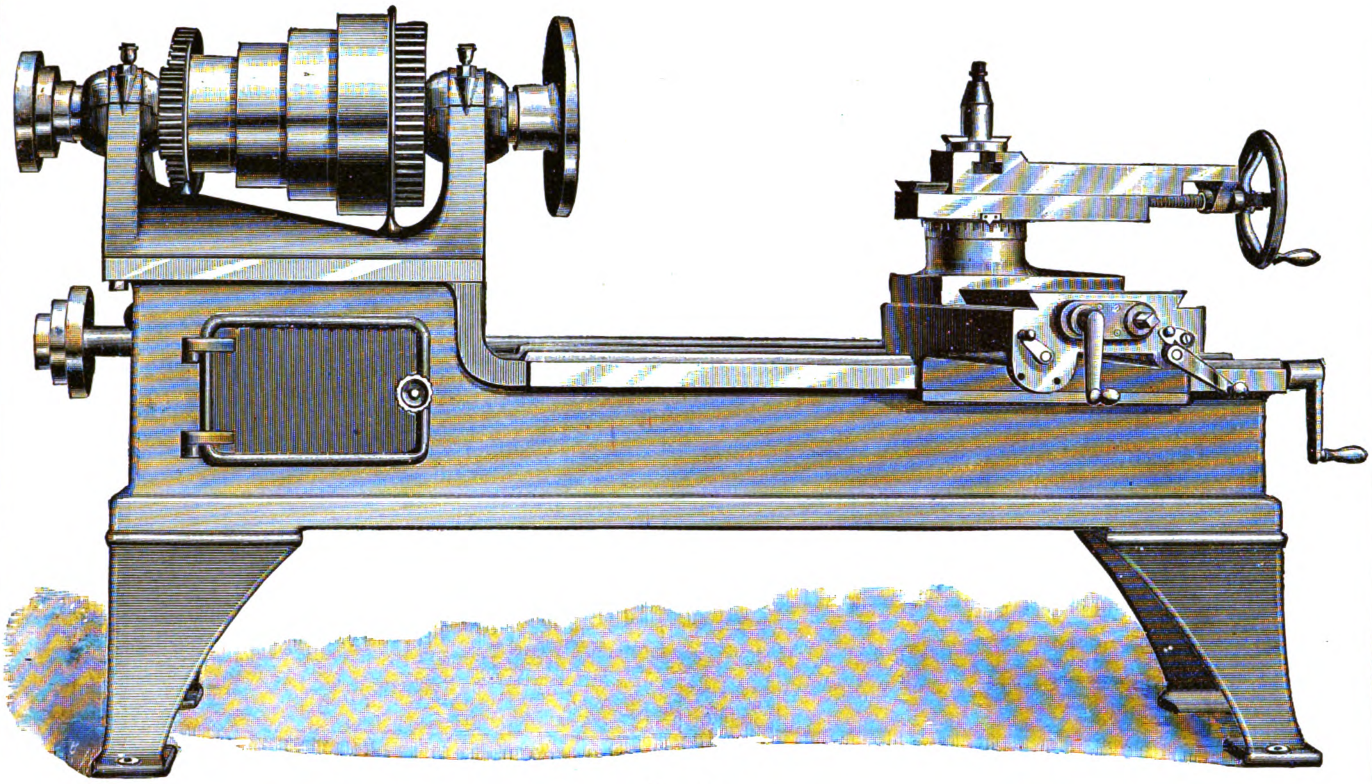


Fig. 1.

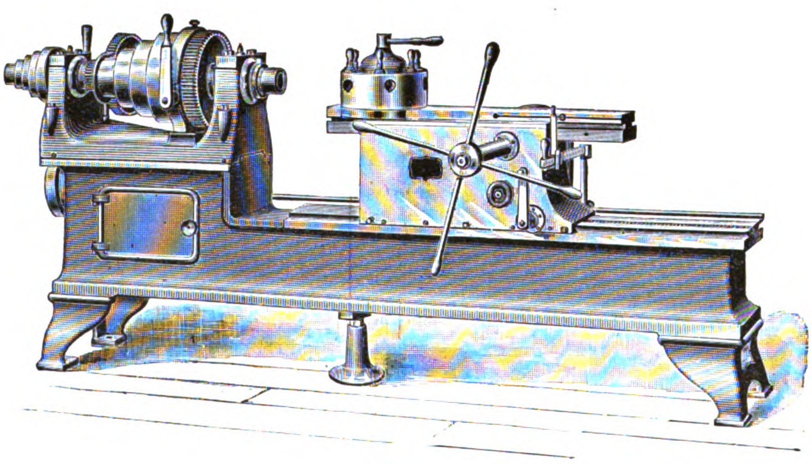
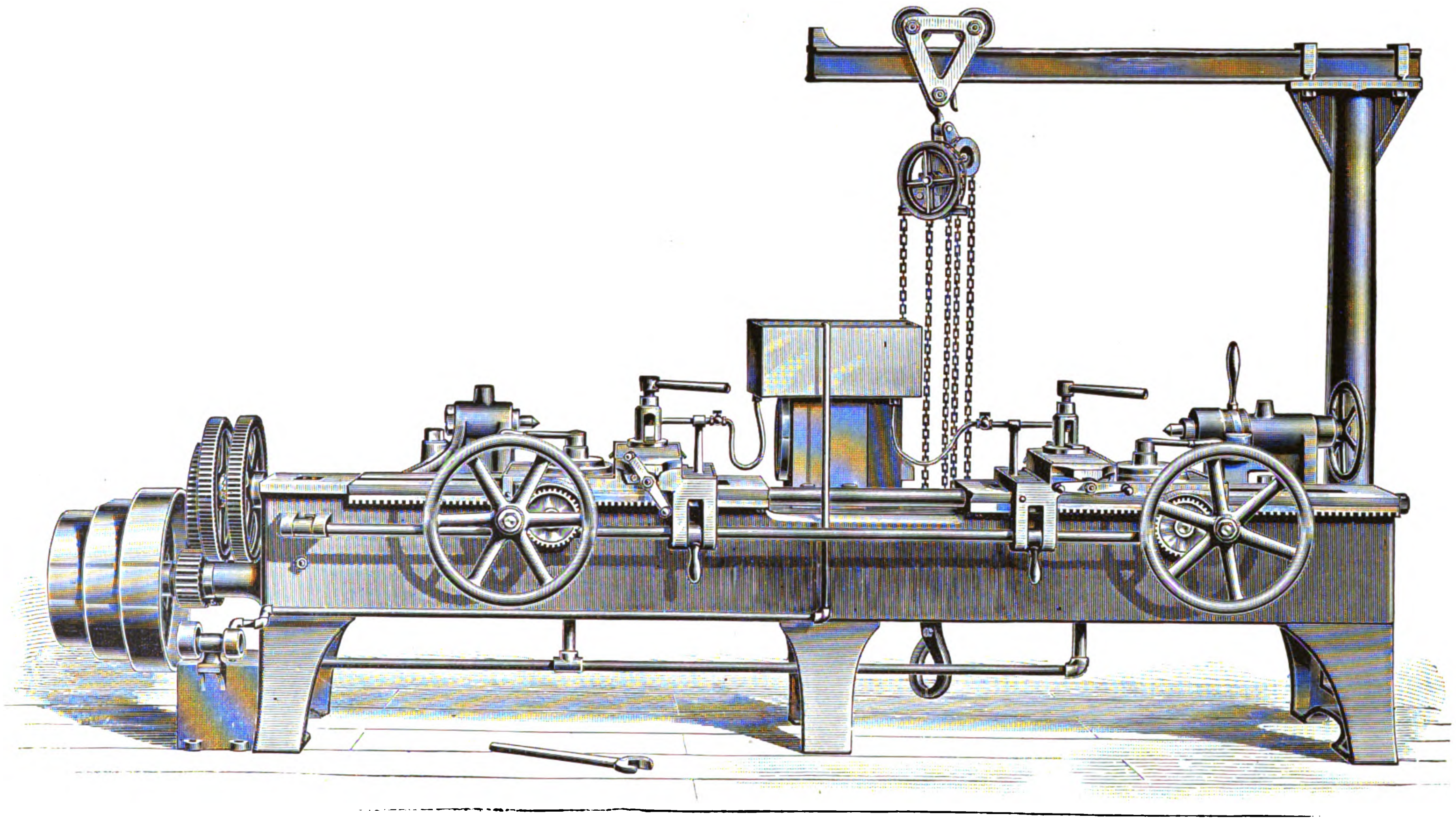
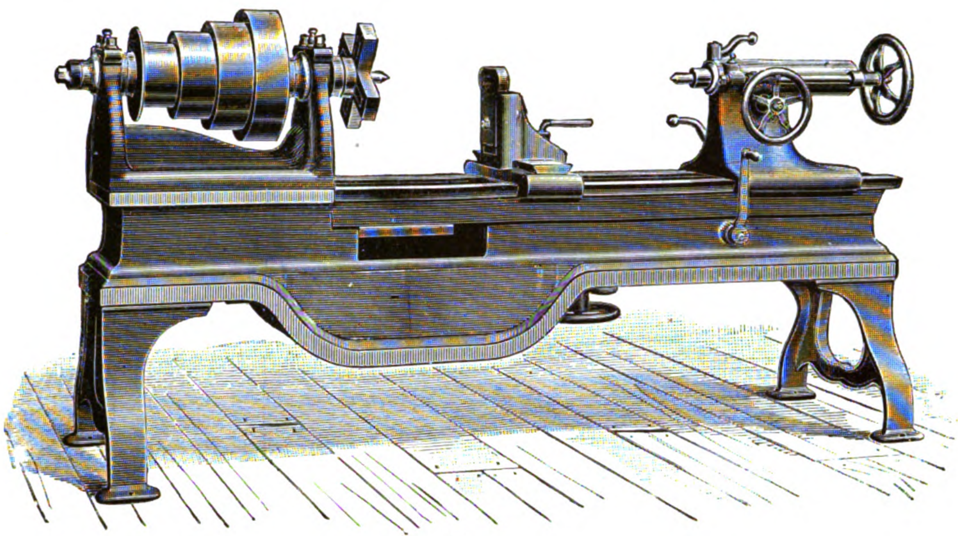


Fig. 2.





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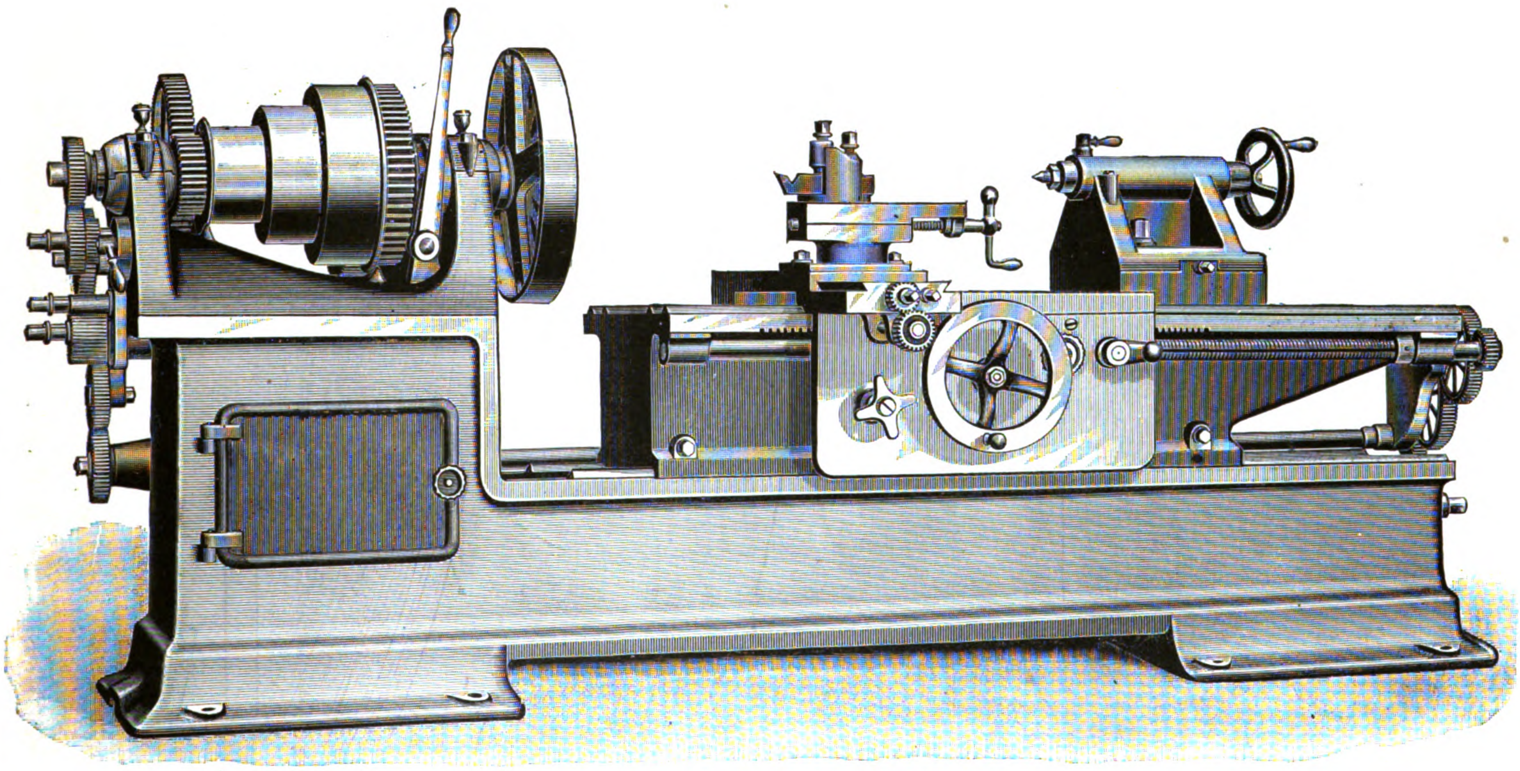

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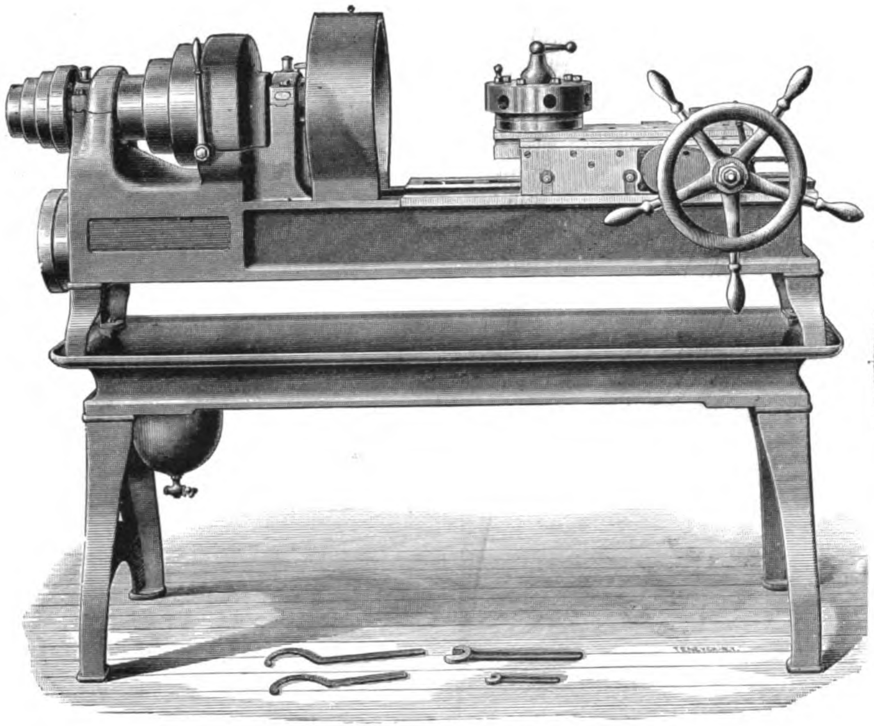

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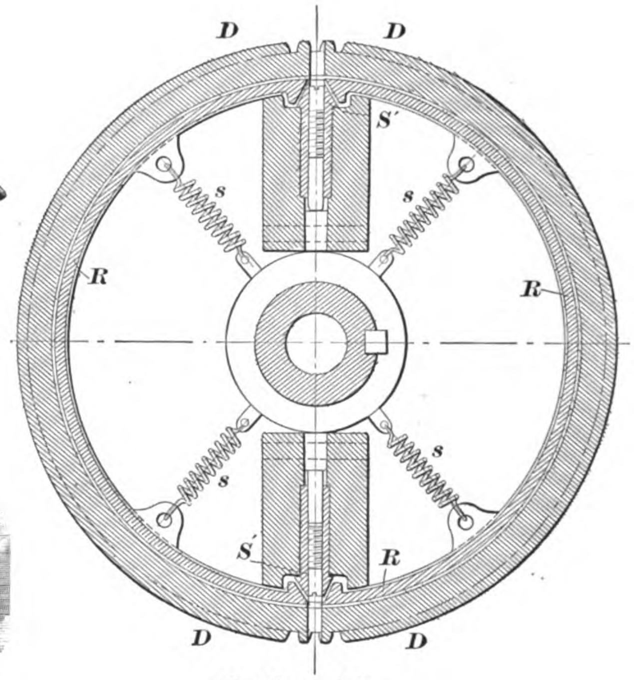
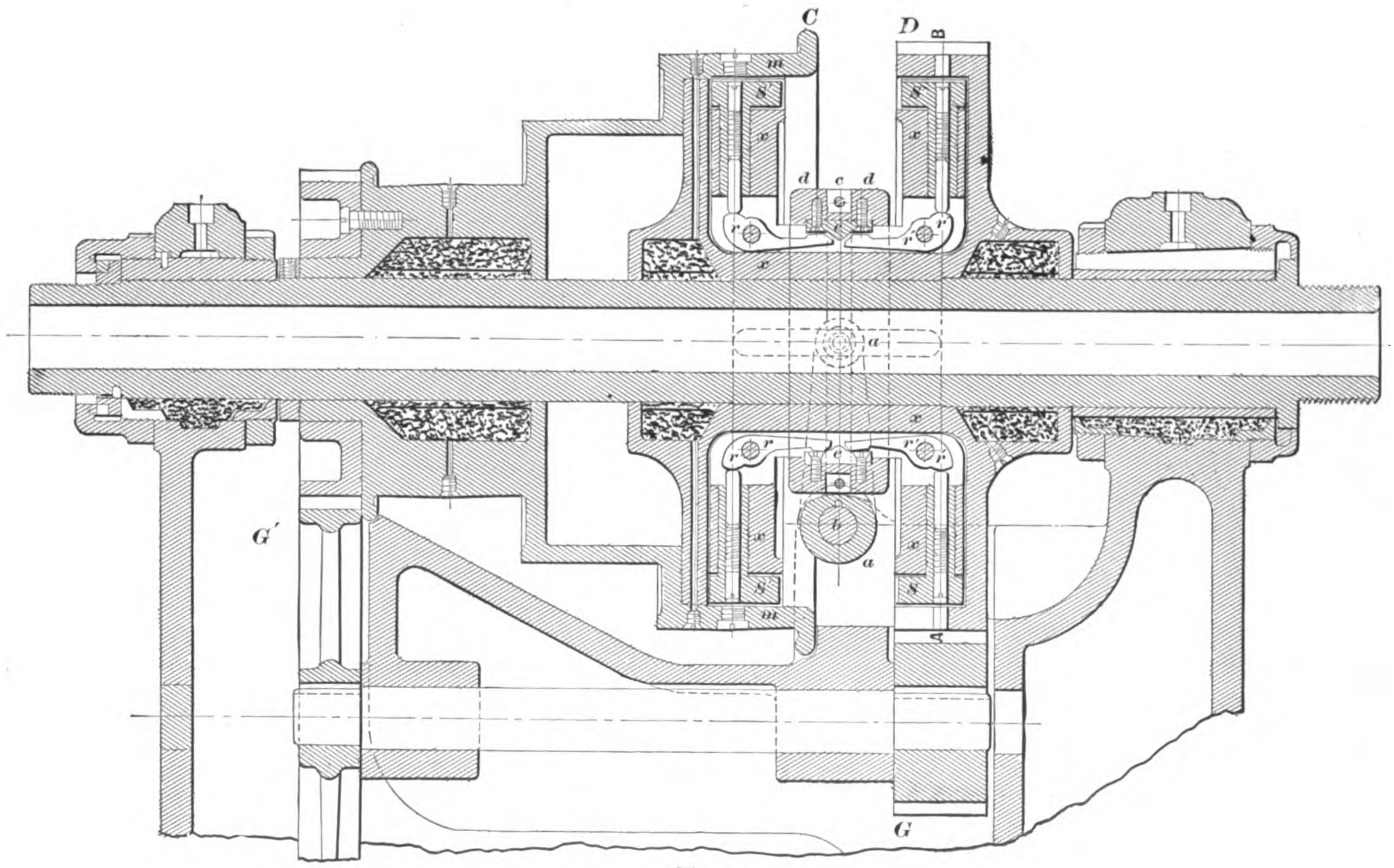


Section A B.

Fig. 3.



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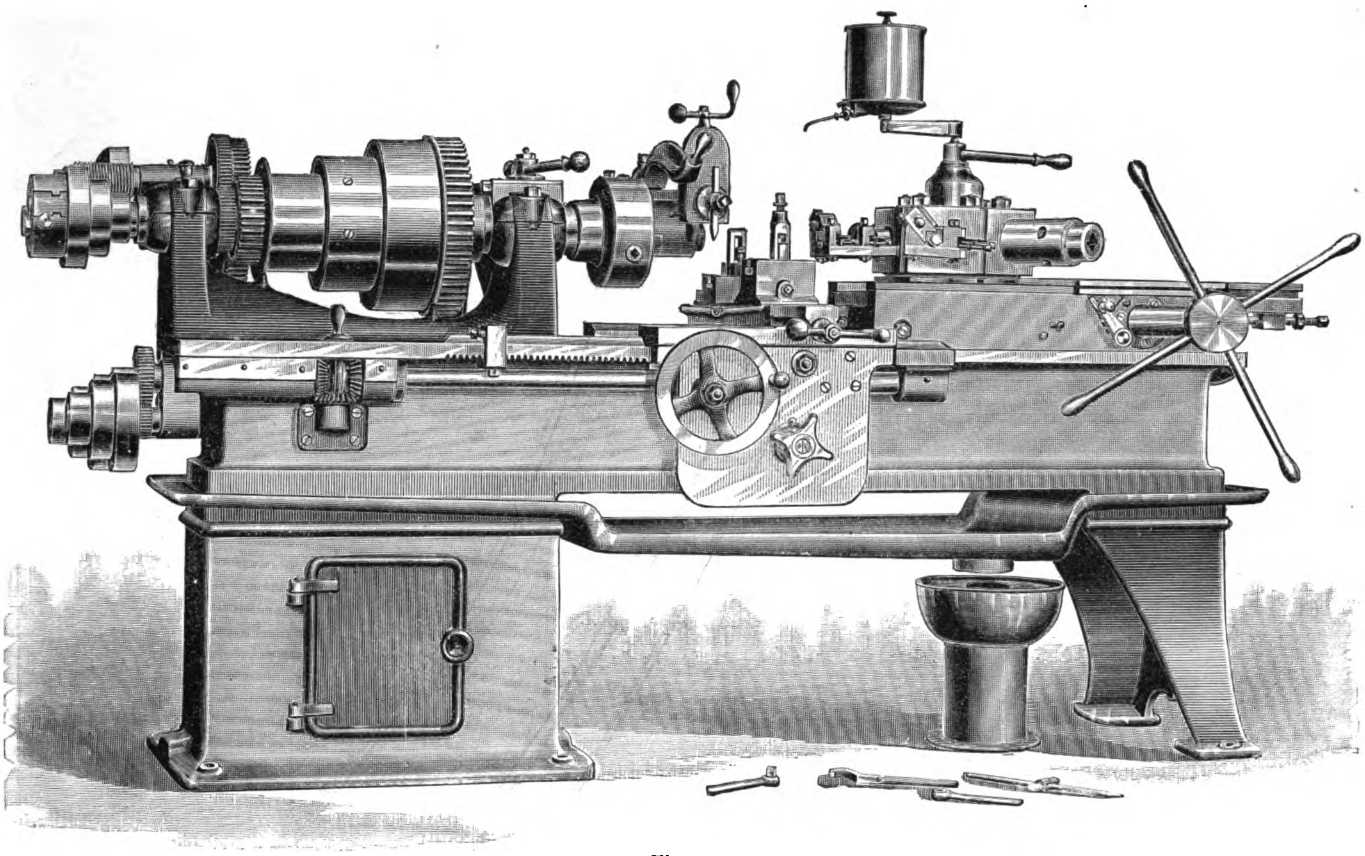

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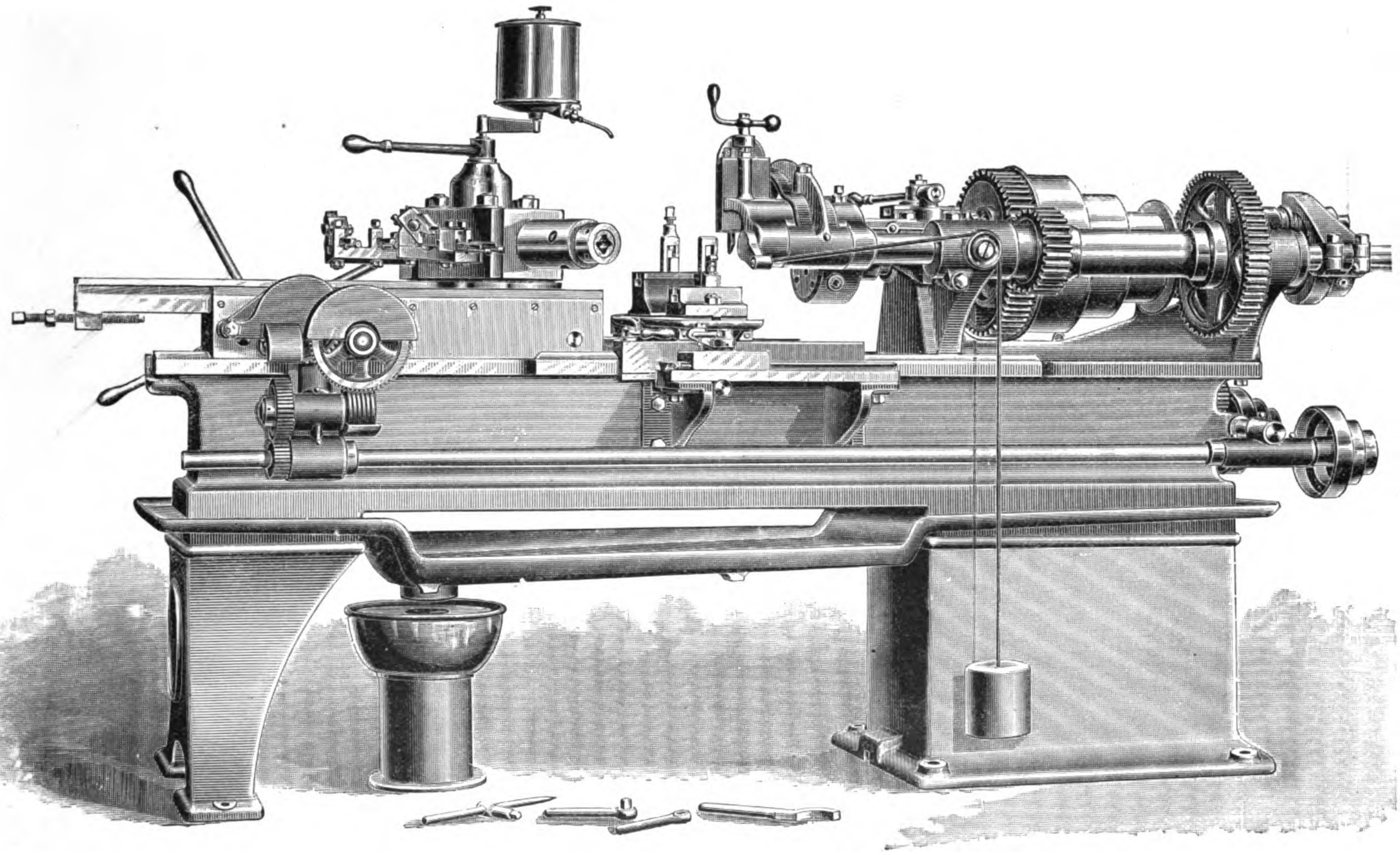

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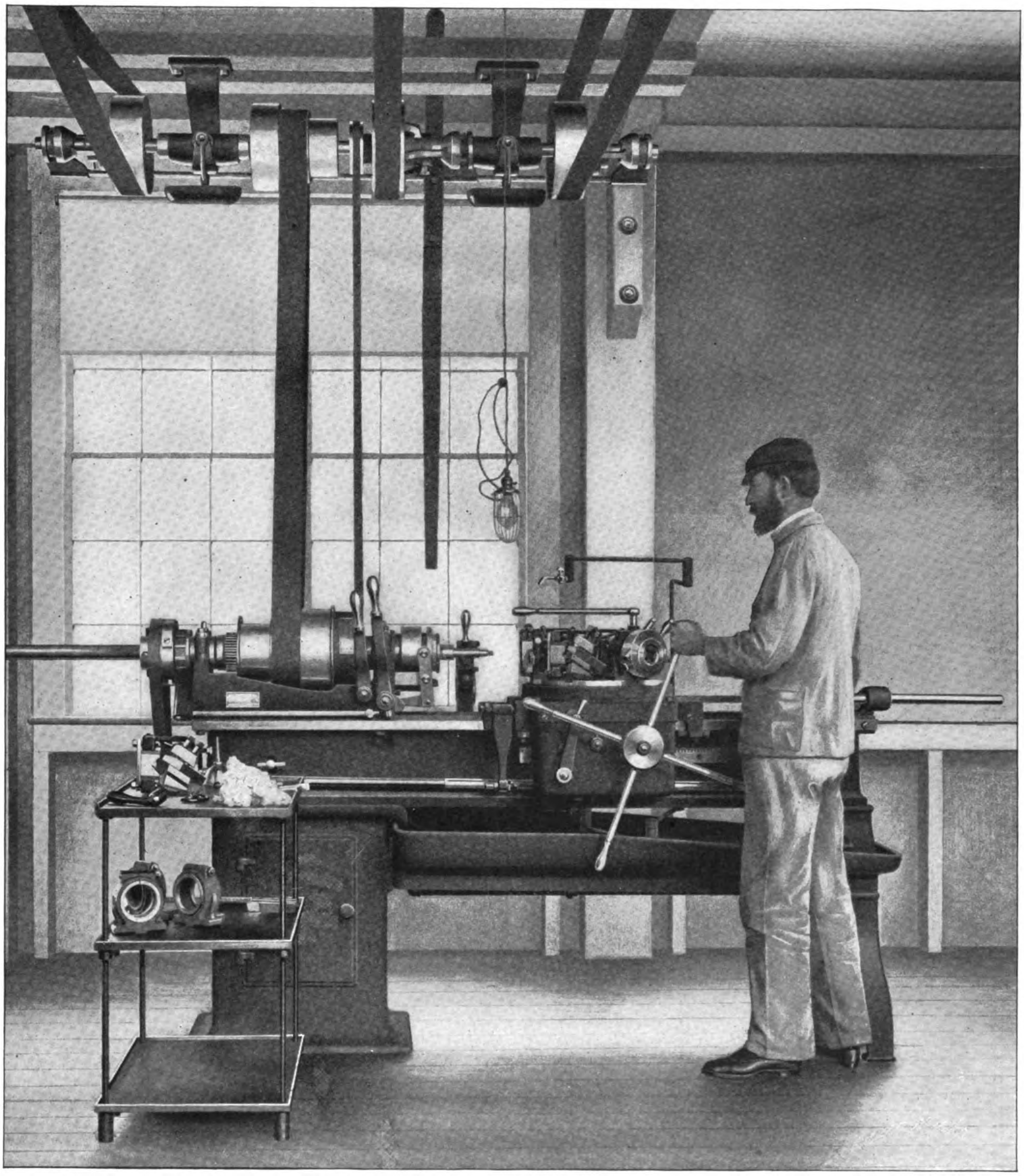

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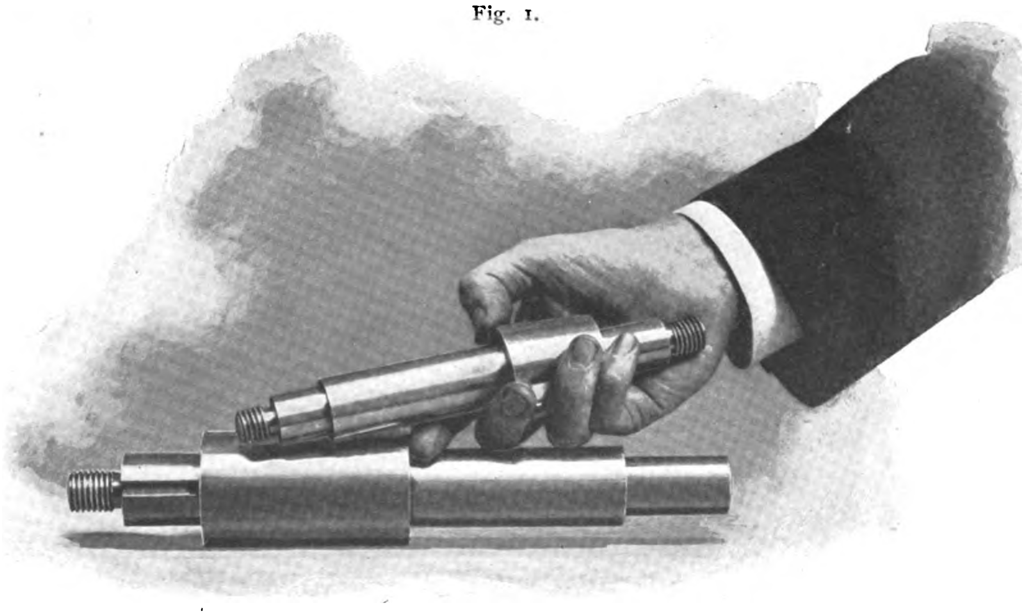


Fig. 2.

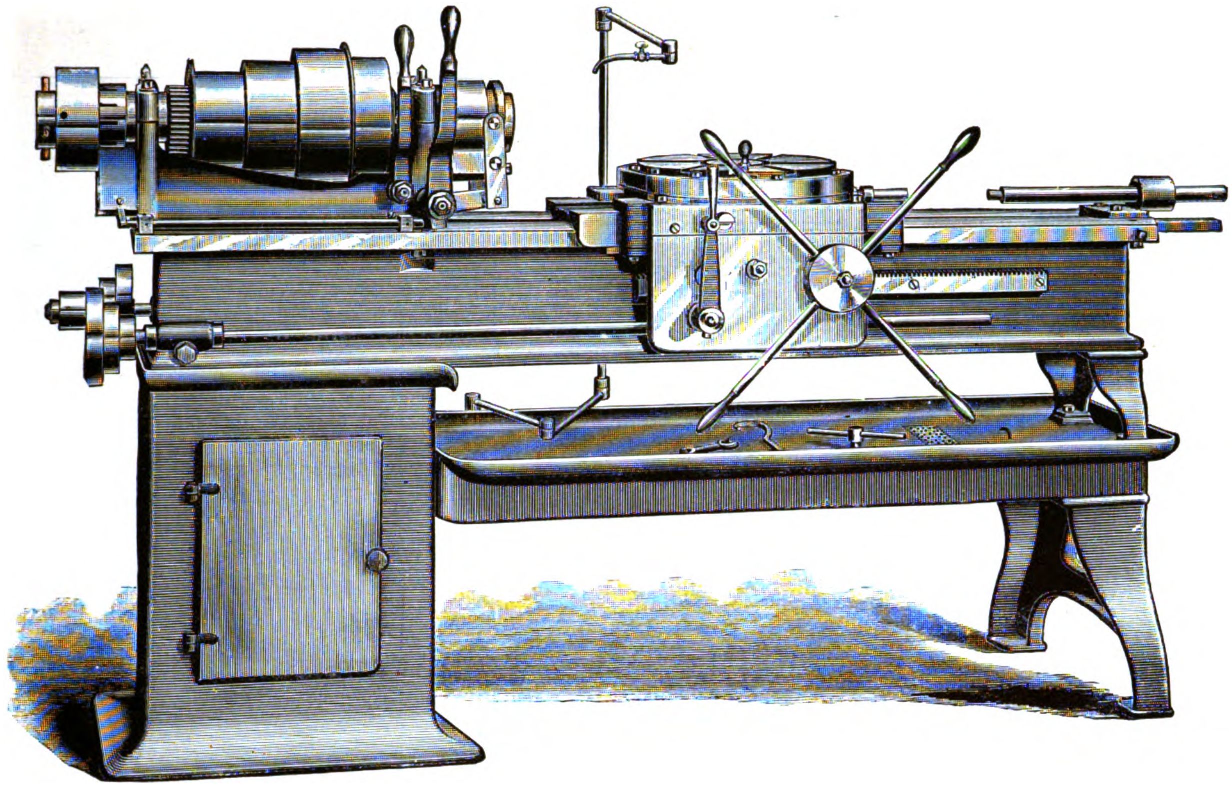


Fig. 3.—The 2 x 24 Flat Turret Lathe.—Front View.

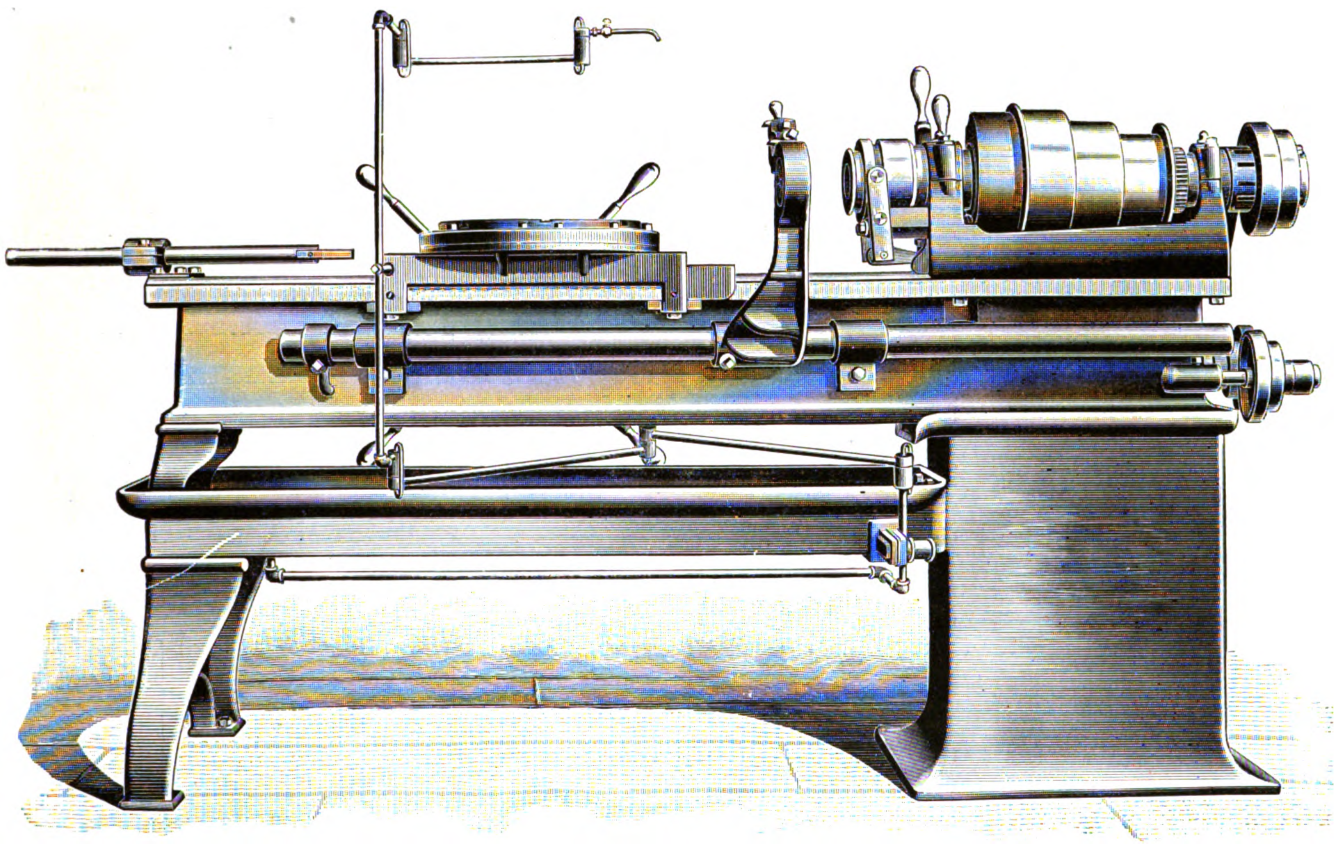


Fig. 4.—The 2 x 24 Flat Turret Lathe.—Back View.

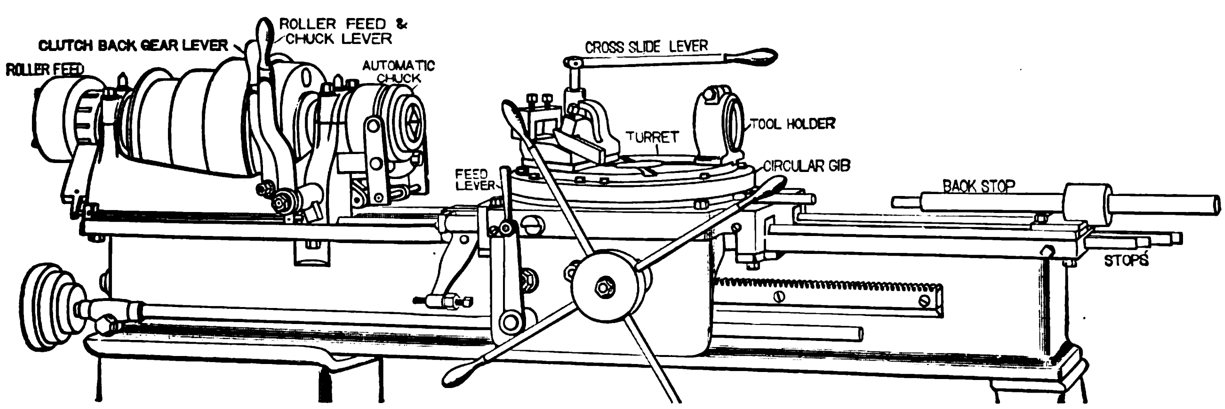


Fig. 5.

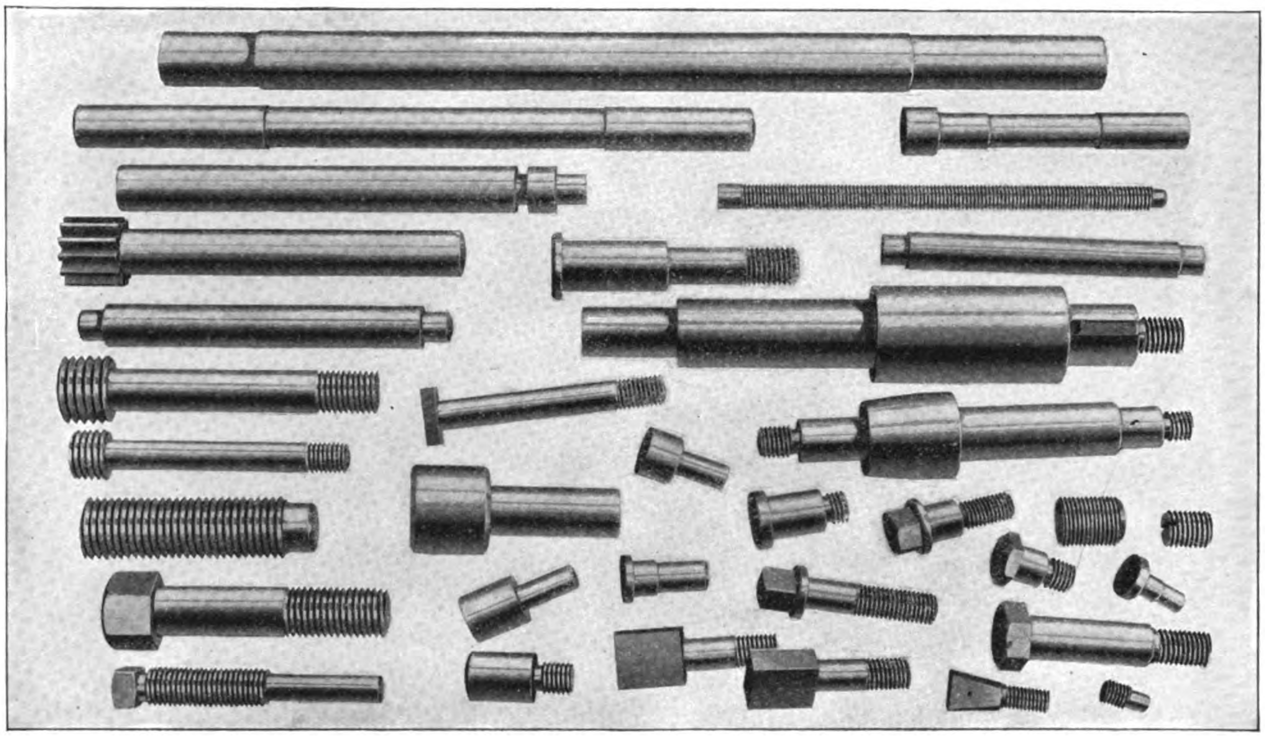


Fig. 1.

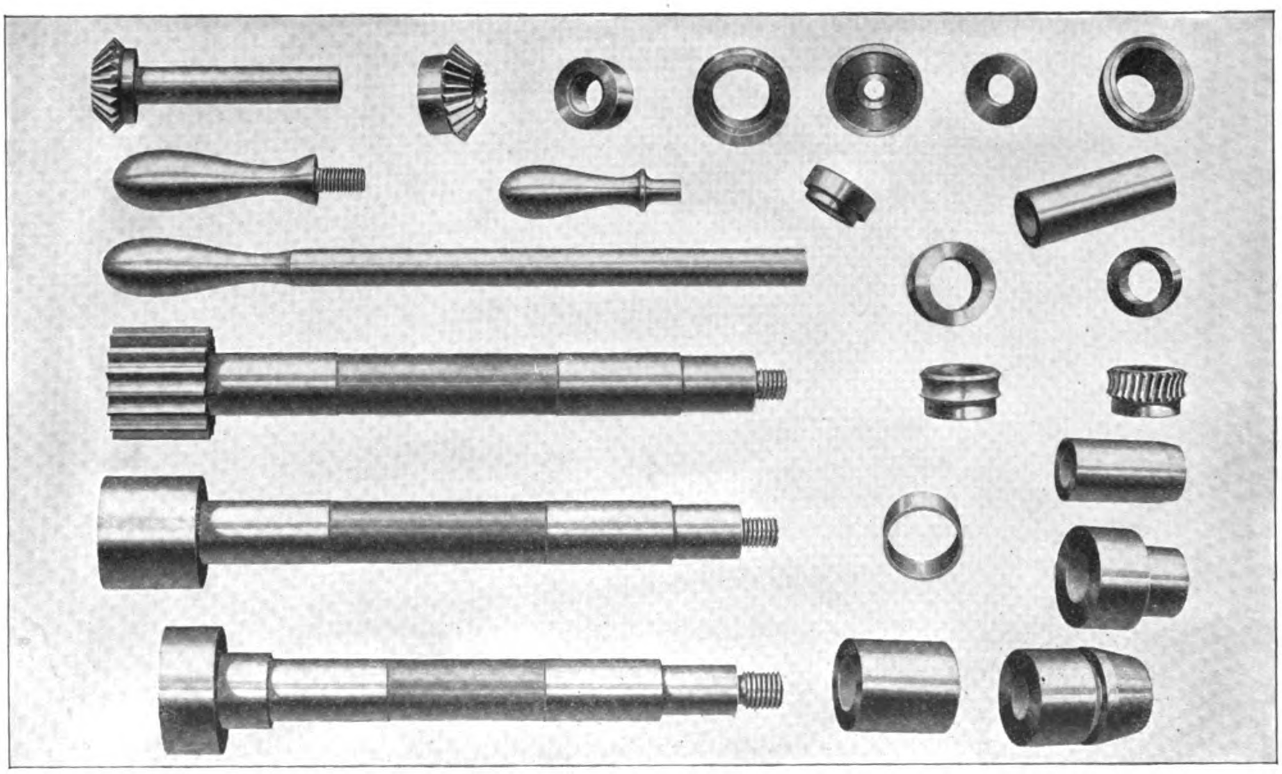


Fig. 2.

shows the arrangement of the chasing bar, which is, perhaps, the most novel feature of the machine.

Into the brackets which support the back gear are fixed two sleeves or thimbles, which project inside the bracket, each toward the other. They enter the ends of the back gear quill, which is enlarged for the purpose, the two forming the bearings for the back gear. Through these sleeves passes the chasing bar. The stud, upon which is placed the chasing hob, runs at half the speed of the main spindle, which gives an opportunity for the employment of coarse, and, consequently, durable threads, which are made of the buttress or ratchet form. The arm which carries the nut is adjustable upon the bar, and is clamped by the two bolts, as shown.

To the other end of the chasing bar are fitted two castings, one of which is the hand lever for operating the bar, to which it is keyed fast. The other piece has two bearings upon the bar, one each side of the lever, under which it passes, and is provided at one side with the chasing tool slide rest. This piece is not keyed fast to the chasing bar, but is made to turn freely upon it, being, however, secured to the hand lever by the single bolt seen passing down through a boss in the centre of the lever. The bolt passes freely through the lever, and is tapped into the lower casting. Around the body of this bolt is a spiral spring, which tends to force the two pieces apart; and when the bolt is slacked it does so to any extent desired.

Underneath the lower casting is a guide bar, upon the upper edge of which it may be made to rest, and which may be inclined either way to any desired amount. Supposing the bolt to be slacked and the spring to have the two pieces separated a short distance, the bar may be swung over by the lever, until the piece carrying the tool rest is in contact with the guide bar. A further depression of the lever does not lower the tool, but compresses the spring, and, at the same time, brings the nut into contact with the hob; then, as the bar moves along, the spring extends and keeps the lower piece down upon the guide, which, as above said, may be set at any desired inclination.

A turret machine, or what is termed by its makers, the Jones & Lamson Machine Company, a 2-by-24 flat turret lathe—meaning that the machine will operate upon work 2 inches in diameter and 24 inches long—is shown in the following illustrations:

Figs. 1, Plate XXVIII.-A., and 3, 4, and 5, Plate XXIX., are various views of the lathe, whose method of operation differs from other machines of its class in that the first cut taken over long, slender work begins at the chuck end, where the work is held stiffly, the feed traversing towards the free end of the work; and to accomplish this purpose the tools are provided with a quick opening and closing movement.

The construction differs principally in the use of a revolving tool holder in the form of a turntable, and is commonly called a flat turret, instead of an ordinary cylindrical turret, and this permits a quicker starting and stopping than is attainable in a large high turret. This plate is held down by a gib at the outer edge, and it is provided with an indexing mechanism, which will turn it automatically to 3, 4, 5, or 6, placed according to the number of tools used.

A large locking pin E, Fig. 2, Plate XXXI.-A., is located directly under the work, and insures a perfect return of the plate to its correct position.

The carriage is gibbed at the outside securely to the bed, and it rides on two 90-degree V's of large area, as seen in Fig. 5, Plate XXXIII.

The cutting tools are bolted to the top of the plate, or table, and as it revolves, each tool is brought in line with its work. From this construction, it will be seen that overhang of the tools and of the turret slide is eliminated.

The turning tools are provided with backward rests; these rests may be set to precede or to follow the cutter. The first chip over rough work must be taken with the cutter in advance of the rest, but after the work is turned true the rest may precede the cutter.

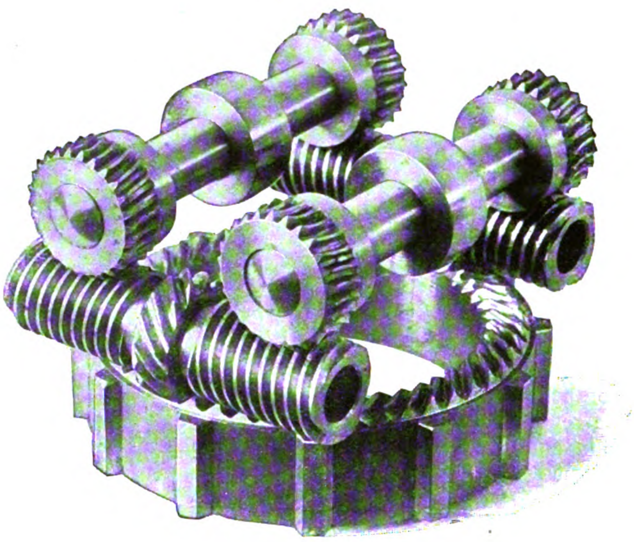
Long, slender work cannot be turned true by beginning at the end, on account of its springing away from the tool before the rest reaches it; for this reason the first cut is started at a point near the chuck and runs toward the end away from the chuck.

The cutter, which is held rigidly in a pivoted block, is fed into the work by a lever, the ball end of which appears directly over the turner, Fig. 1, Plate XXXV. At the left of each turner is seen the latch, which is held in position by its two adjusting screws. This latch controls the position of the back rests. The lever serves as a means for feeding the tool when the cut is started near the chuck; after sufficient length has been turned the back rest is pushed into position by the latch. This may be done while the lathe is running and after the feed has been thrown in, but it must be done before the tool has reached a part of the work that springs away from the tool.

In most cases, one cut taken as above will produce a straight surface that runs true, but in some extreme cases it may be necessary to take a second cut in the same way.

After the stock has been turned true, the back rest is set in advance of the tool, and the cut is taken from the end toward the chuck. When the work is short, all cuts may be taken from the end and toward the chuck with the cutter in advance.

The spindle, Fig. 1, Plate XXXI., of the machine is hollow, and is provided with automatic chuck at one end, and a revolving roller feed at the other. The chuck shown in Figs. 1, 2, and 3, Plate XXXIII., grips the rough bar of work, which passes through the roller feed and spindle. The roller feed pushes the stock through the spindle and chuck when the chuck is opened. One



lever operates the chuck and the roller feed at the same time, and may be operated while the lathe is running.

The automatic chuck consists of a main body *g*, Figs. 2, and 7, Plate XXXIII., which is screwed on to the spindle, and adapted to receive conical shaped jaws *d*. These jaws are forced into the tapering hole in the main body by an inside lip on sleeve *c*, Figs. 3 and 8, Plate XXXIII., which passes over the body part. This sleeve is given a slight longitudinal motion which forcibly draws the jaws into the body. The means for giving this sleeve this slight but positive motion consists of struts *a*, which pivot in the main body, and swing against the collar *b* on the sleeve *c*. These struts are caused to swing in against said sleeve by an outer sleeve *e*, Fig. 6. This outer sleeve is bell-mouthed and is forced over the loose ends of the struts, and as it forces them to swing in, they strike against the collar on the inner sleeve, and thus the inner sleeve is given that slight but positive longitudinal motion which forces the collar jaws into the tapering hole and consequently on to the work.

The lever for operating the outer sleeve is connected to the sleeve by a toggle joint which gives great leverage. The chuck receives a bar as large as can be passed through the spindle, and the jaws can be used on square, round, or hexagon bars.

When the chuck is used for holding hexagon bars, one of the four sections is removed, and the remaining three are separated by spacing pieces so that they take bearing on the flat surface of the bar at three equi-distant places.

The jaws can be removed and exchanged without removing the sleeve, the adjusting collar being screwed back as far as it will go, and the jaws removed in sections.

On the spindle at the outer end the revolving roller feed is mounted. This feed is operated by the same lever that operates the chuck. When the chuck is opened, the feed is set in motion, and it causes the bar of stock to pass through the chuck until it strikes a swinging stop which is pivoted to the carriage at the front of the turret, which determines the length of the piece. This swinging stop is shown in position in Fig. 4, Plate XXIX., and swung down out of operating position in Fig. 5, Plate XXIX. It is used when the turret is at its extreme backward point of travel, hence it does not use one of the forward stops of the turret, which it leaves free for other tools. Motion is given to the rolls by gearing, which consists of an idler gear on the spindle, which might be called a face tangent, since it is not a scroll. This gear drives two tangent pinions of 16 pitch, 15 teeth, and 4⅛ (screw) pitch. The face tangent has 50 teeth, and is loose on the spindle. When the chuck is opened the gear is stopped by a pin engaging with ratchet teeth on its periphery. This gives motion to the tangent pinions, which in turn drive two worms; these worms drive the worm wheels which are on the shafts that carry the rolls, and the rolls bear upon the bar of work and push it through the spindle and chuck.

The efficiency of this feed is the more pronounced in proportion as the bar from which the work is made is heavier, in which case feeds actuated by a weight cause the bar to strike too heavy a blow, while the ratchet feeds, requiring an extra tube to pass through the lathe spindle, obviously reduce its work-holding capacity.

The back gear is under the cone spindle, runs free, and is not keyed as usual.

The large gear and cone on the spindle of the lathe are connected by friction clutches, which are operated by a sliding sleeve and struts similar to those used in the automatic chuck above described.

An auxiliary back gear, commonly called triple back gear, lies directly below the regular back gear. It is operated by a handle projecting out through a hole in the bed directly below the small step of the cone.

The regular gear gives the cone a ratio of about 4 to 1 to the spindle, and the triple gear, when used, increases that ratio to 16 to 1.

The clutch back gear lever, shown in Fig. 5, Plate XXIX., is connected to sliding sleeve *m* by drum *m'* and crank *m''*, Fig. 1, Plate XXXI.

Collar *l* is keyed to the spindle, also secured against end motion by screw points. Struts *l'* enter slots in collar *l*, and project out into notches cut in friction collars *k* and *n'*. These friction collars are thus rotatively connected to the spindle.

Sliding sleeve *m*, as shown in the drawing, is over to the extreme left, and has forced friction collar *n'* into the taper seat of cone *n*, thus locking the cone to the spindle. Forcing the sliding sleeve *m* to the other extreme would connect the gear to the spindle and release the cone.

Means for operating the triple gear consist of an eccentric casting having a cam surface engaging in the sliding clutch sleeve P'. By turning casting P''', the eccentricity of the triple-gear bearing to the main bearing of the casting at *r* and *r'* draws the gears *q* and *q'* out of their mating gears, and the cam surface engaging sliding collar P causes the clutch teeth of P' to engage with the clutch teeth of *o*; and since *o* and *o'* are keyed together, this operation connects the large back gear rotatively to the shaft P.

The spindle boxes are of the round pattern. The top half of each box is held by a cap which is fitted over two hollow posts which are firmly driven into the main casting; these posts hold the cap against side and end thrust, so that the top half of the box is practically as firm as the lower. The cap bolts pass through these posts and tap into the main casting.

The mechanism for turning the turret, and locking it at the different positions, is shown in Fig. 1, Plate XXXI.-A., in which A represents the turret; B the pinion, which is connected to the turret by a ratchet which permits it to revolve freely on the hub of the turret in one direction. C represents a rack engaging with the pinion; E is the locking pin. It is drawn by lever D. This lever is depressed by the dog C' on the end of rack C, and shows the pin withdrawn.

While the carriage is being moved to the back end of its travel, a projection H, Fig. 2, Plate XXXI.-A., on the bed arrests the motion of the rack, and as long as the carriage continues to move back, the rack is forced in. At the beginning of the rack's stroke the pin E is drawn. The pinion begins to turn as soon as the rack is moved, but since the pawls engaging the ratchet teeth are some distance back from the tooth at first, there is distance enough allowed to fully draw the locking pin before the ratchet teeth come in contact with the engaging pawls. As soon as the teeth and pawls meet, the motion of the pinion is communicated to the turret, and it is caused to revolve.

When the locking pin is drawn, a latch hooks over the lever that draws it, and holds the lever down; thus it prevents the pin returning. This latch is disengaged by projections on the turret at the proper time. These projections are adjustable screws, which may be removed from contact with the latch, and thus permit the turret's turning beyond any unused position.

The power feed for the turret carriage is thrown out of gear at any desired point for each position of the turret. For instance, if one of the tools on the turret must travel the whole length of a piece 15 inches long, and another has a cut of only 2 inches, and so on, each tool will travel the length of its own cut only, and not the length of the longest cut. The mechanism for accomplishing the above result is contained in the carriage, and in the top of the bed.

Six adjustable stops N are located in the top of the bed. These stops are flat bars, and each has a notch on the top edge near the inner end. Six pawls F are pivoted to the carriage directly above the stops. These pawls are free on the pivot, and when not held up fall down on to the tops of the stops.

Each pawl is provided with a finger *f*, which bears on the periphery of the turret. Now in this periphery there are six notches which are so located that, when the turret is in a certain position, a certain notch will be opposite a certain finger, so that each position of the turret has a separate stop.

The positions of the turret are marked 1, 2, 3, etc., and the stops are also marked in the same way.

The connection of these stops to the power feed trip R is through stud P, which is mounted on a sliding bar G. This bar is so connected to the stud P that its motion oscillates the stud. Turning this stud disengages the feed lever. It will be seen that when the forward motion of the pawl is arrested by the engaging with the notched stop bar, the slide bar G is also arrested; and as the feed still carries forward the carriage, the oscillating stud is moved enough to turn its edge away from R, which releases the feed worm from its gear.

The carriage slides on two Vs as usual, but only one V controls it against side thrust. Four steel shoes, *a* and *b*, Fig. 5, Plate XXXIII., form the bearing of the carriage E on the Vs. The shoes *a*, that take bearing on the front V, are clamped securely to the carriage saddle, while the shoes *b*, on the back V, are loose laterally, as the saddle casting rests on the top, and does not touch the sides. The front shoes are clamped against a flat surface that is perpendicular to that on which the back shoe gets its bearing. Screws *c*, of fine pitch and large diameter, take the down thrust on the tops of the shoes on the turret Vs. These screws serve as an adjustment or compensation for the twist existing in saddle E casting.

On account of the unevenness of floors of workshops, the bed is mounted on a three-point bearing. (See Plate XXXIV.)

This bearing reduces the deflection, and eliminates a variation of the deflection in addition to serving the primary purpose of a tripod bearing, and of preventing the twisting of the bed caused by the unevenness of the floor. The head end of the bed bears on rocking points on the top of the pedestal leg. At this end the bed has two bearings, one on each side, and, as shown, these points are not at the extreme end of the bed, but are at a point nearly under the front end of the head. This shortens the dis-

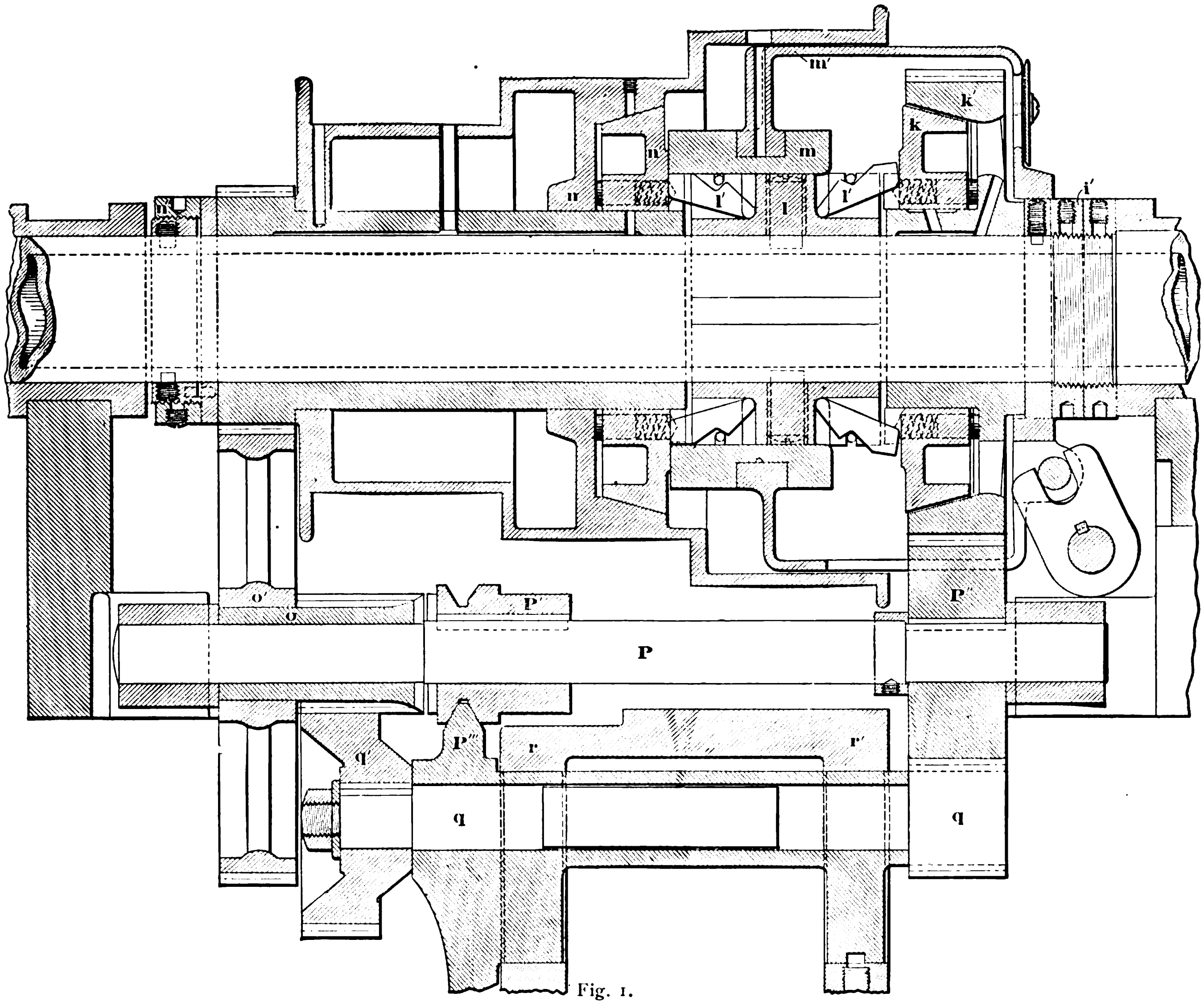


Fig. 1.

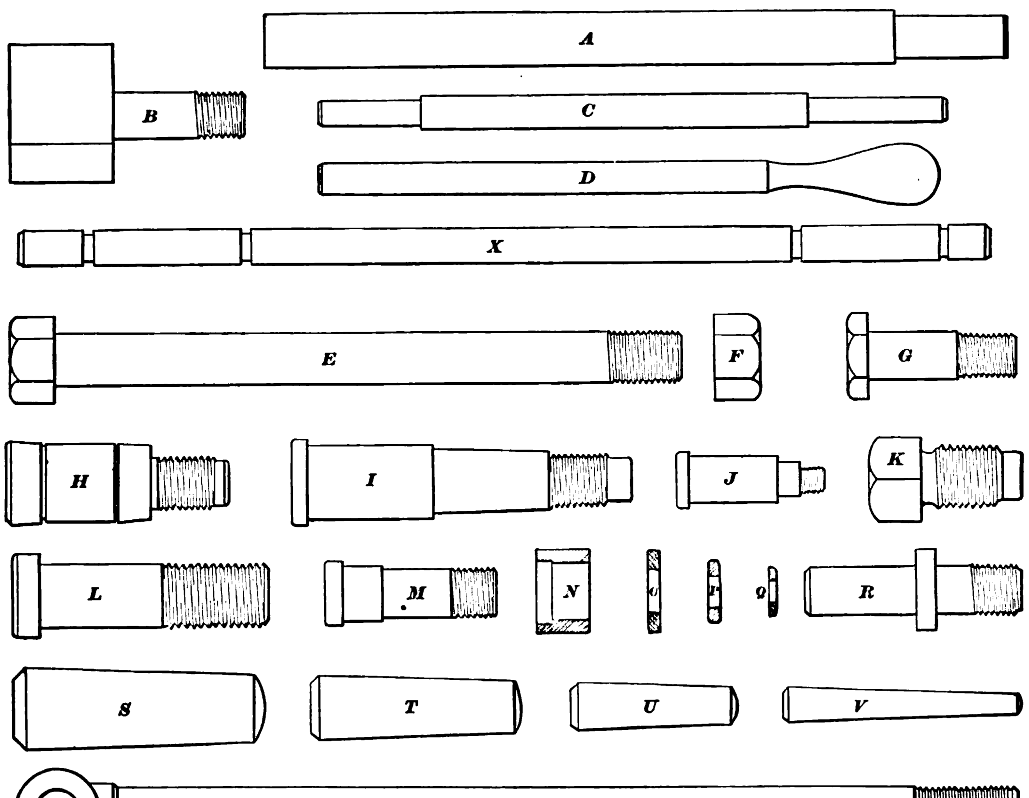


Fig. 2.

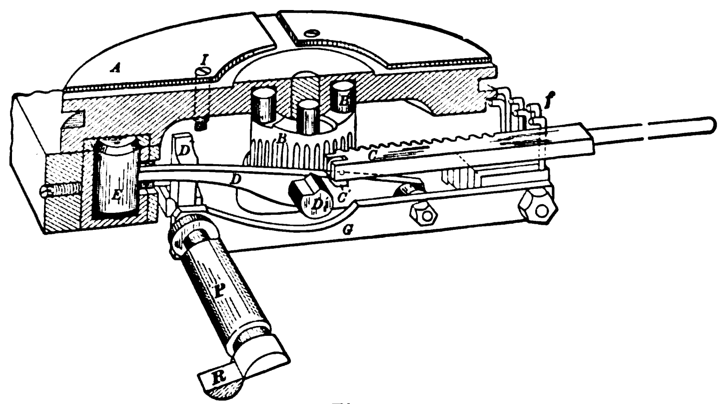

A
I
B
D
E
C
D'
G
f
P
R

Fig. 1.

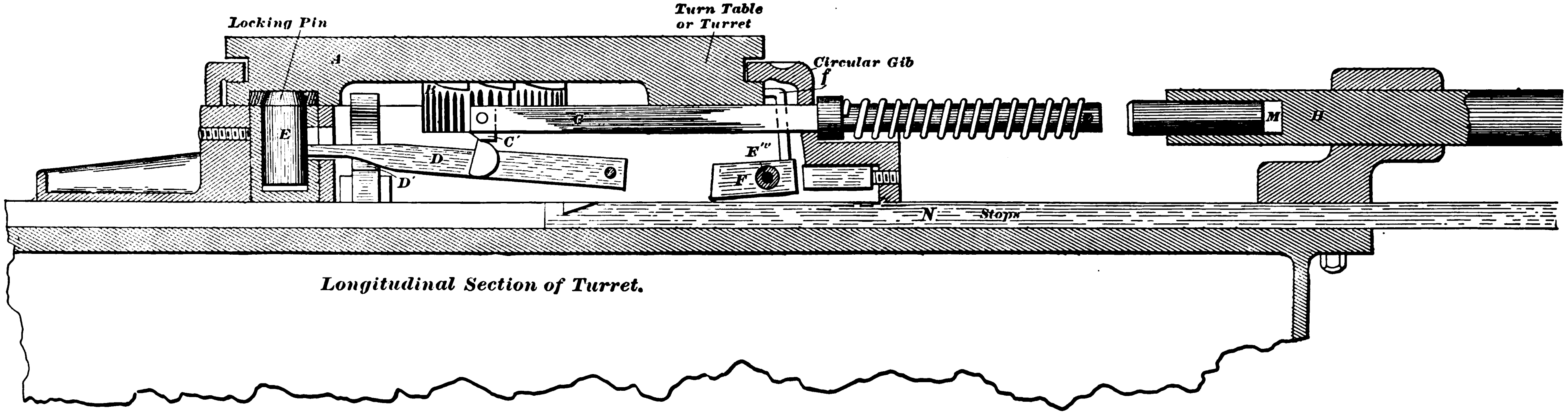
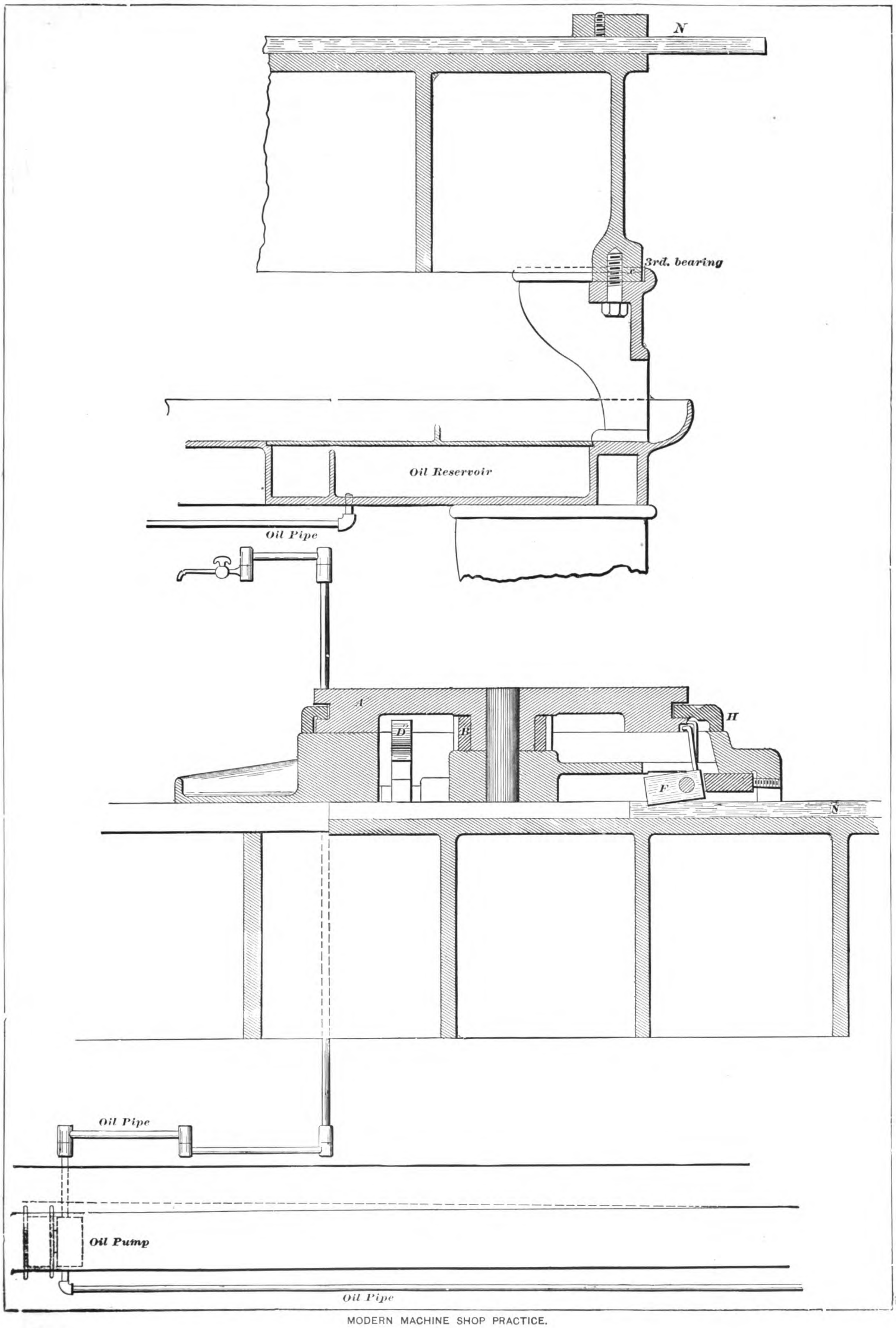

Locking Pin
Turn Table
or Turret
Circular Gib
f
A
E
G
C'
D
D'
F''
F
M
H
N
Stops
Longitudinal Section of Turret.

Fig. 2.


N
3rd. bearing
Oil Reservoir
Oil Pipe
A
D
B
H
F
N
Oil Pipe
Oil Pump
Oil Pipe

DETAILS OF FLAT TURRET LATHE.

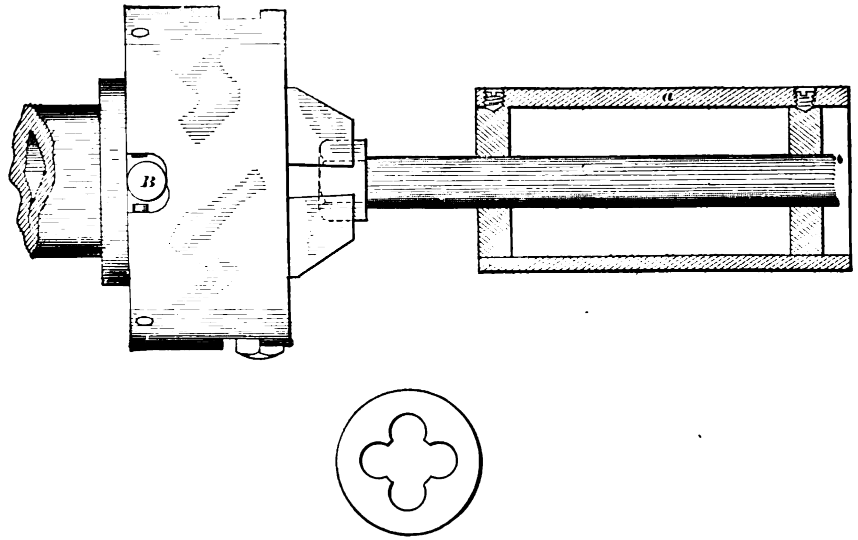


Fig. 1.

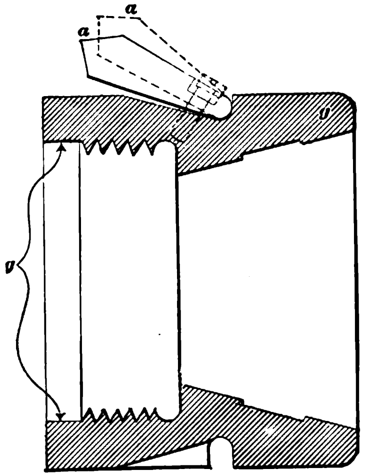


Fig. 2.

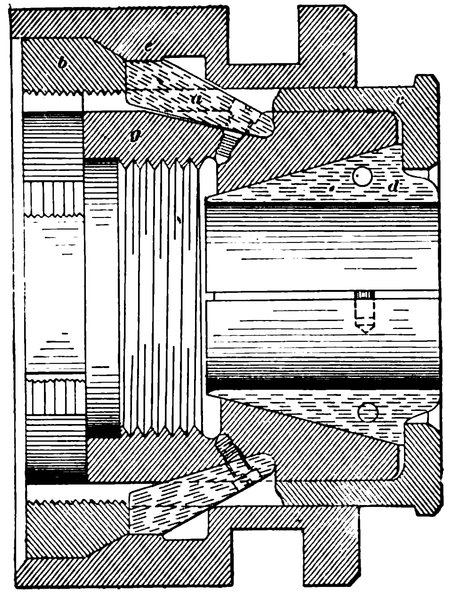


Fig. 3.

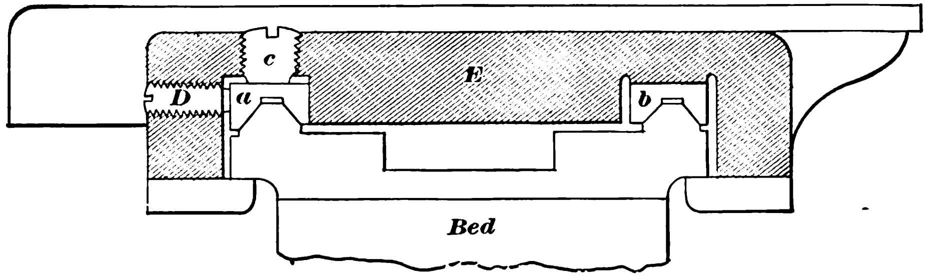


Fig. 5.

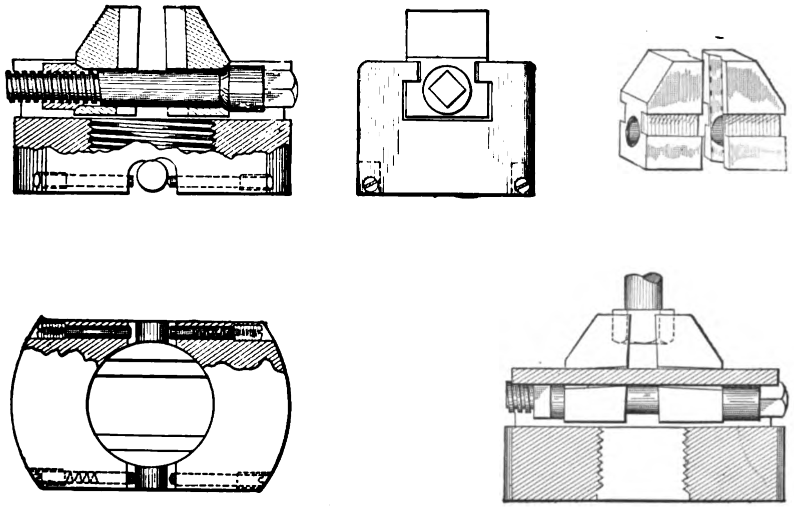


Fig. 4.

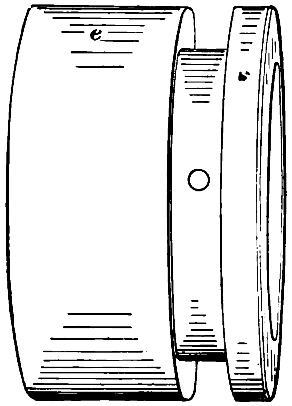


Fig. 6.

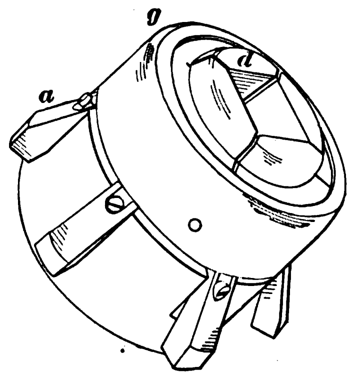


Fig 7.

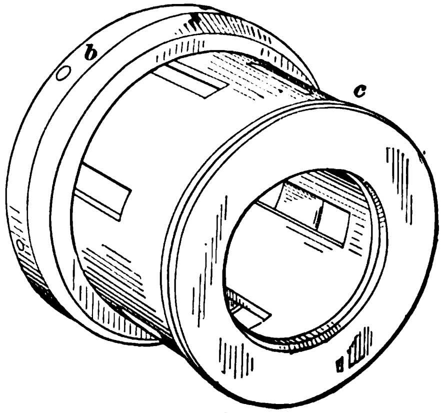
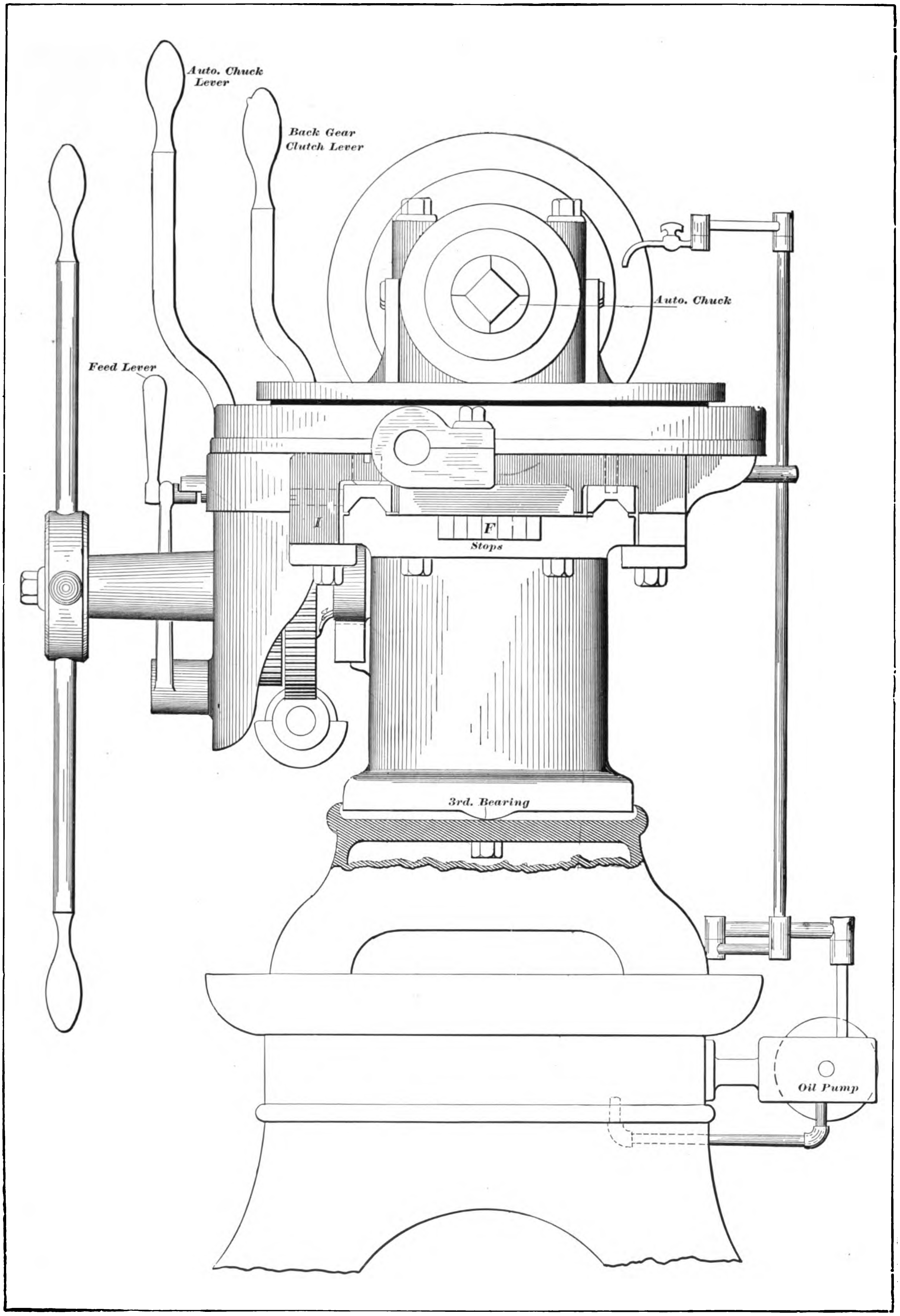


Fig. 8.


Auto. Chuck Lever
Back Gear Clutch Lever
Auto. Chuck
Feed Lever
I
F
Stops
3rd. Bearing
Oil Pump

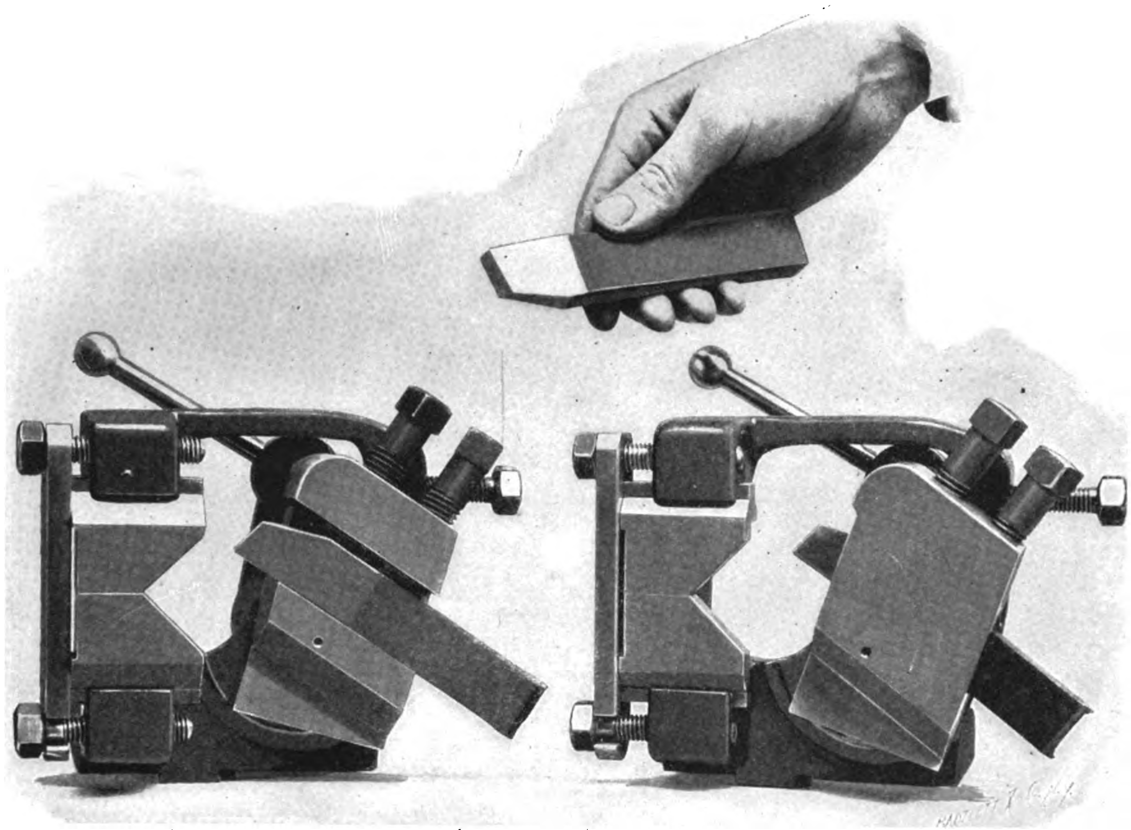


Fig. 1. TURNERS AND CUTTERS. Fig. 2.

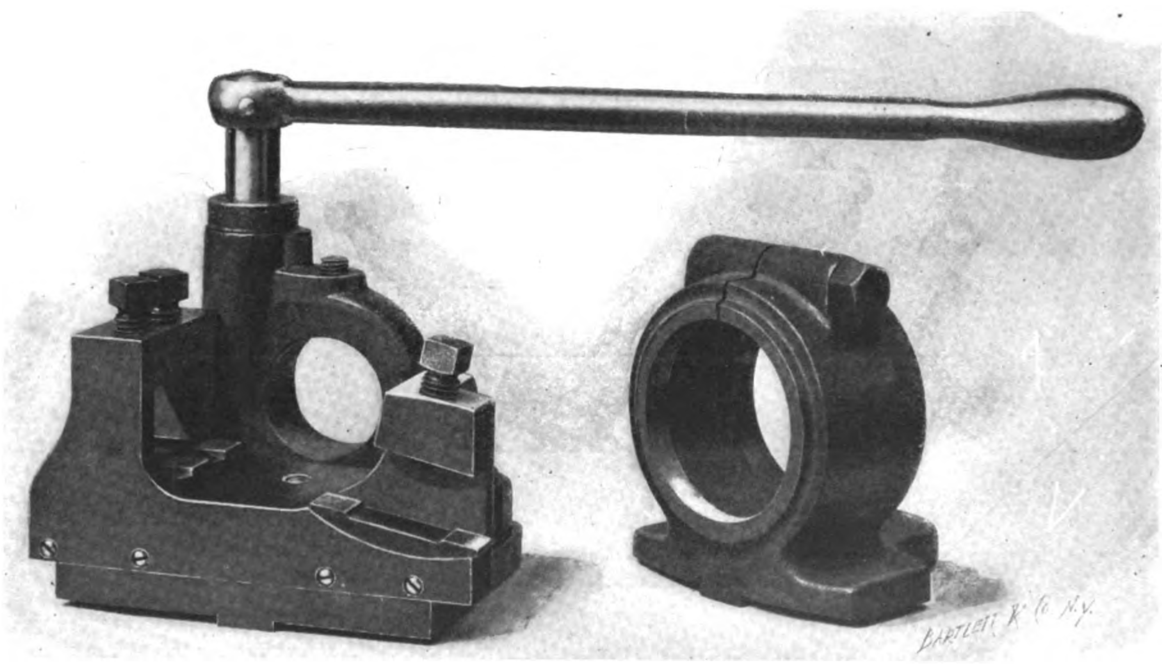


Fig. 3.—Cross Slide. Fig. 4.—Tool Holder.

tance between supports, and at the same time puts some of the bed and head where it will counteract the deflection instead of increasing it.

The third point of bearing is on the top of the short leg, a trifle one side of the centre, to compensate for the extra weight of the front of the carriage.

Another reason for connecting the pedestal leg to the bed as shown, is to prevent its varying the deflection of the bed; for if it were bolted rigidly to the bed, and it should happen to stand on an uneven floor that would give strongest bearing at a point farthest from the third leg, there would be an excessive deflection coming from increased distance between supports, and the additional weight of head and pedestal; while, on the other hand, if it obtains a strong inside bearing point, the weight of pedestal and head, as well as part of the bed, would be outside of the support, and would give a very different result.

All pieces of work shown on Plate XXX. can be produced on this class of machine from the rough bar, or forging, in much less time than by the regular engine lathe.

All the work shown, Figs. A to V, Plate XXXI., is made with only one chucking, and finished, except a small nib, which can be neatly removed with a fine file. This nib is left by the cut-off tool, and is very small when proper care is taken at the final severing of the piece from the bar.

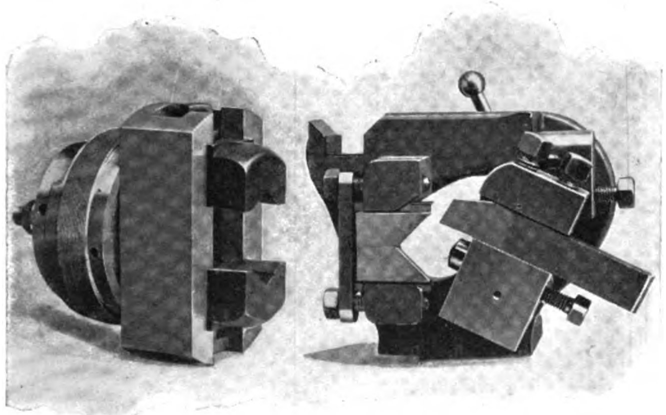


Fig. 552*b*.

Pieces B and W, Plate XXXI., are made from forgings. Piece E, if made in great numbers, can be cheaply produced from the forging; but if a very few are to be made, and machine forgings are not available, it can be quickly made from the rough bar.

All other pieces shown in Plate XXXI. are made from the continuous bar of rough stock. Drawn and rolled finished stock can be used and held true by the automatic chuck.

The pieces S, T, U, and V are made by using the taper turner. F represents a finished nut made from the bar. O, P, and Q represent finished washers made from continuous bar.

Necking can be done on slender work, as shown by piece X. This is accomplished by use of the turning tool, Fig. 552*b*. The back rest supports the stock, and the ball lever feeds the tool in to the correct depth. It may also be done by use of cross slide, Fig. 3, Plate XXXV., by inserting a bushing in the upright part, which is bored in true alignment with the spindle for this purpose.

The taper turner, Fig. 1, Plate XXXV., is used for turning long taper or irregular forms, such as handles, taper pins, and locomotive frame bolts. The cutter is held in a rocking tool holder, which is held in contact with a pattern or template bar by spring pressure. As the tool is fed over the work the pattern is held motionless. For turning short pieces of taper and irregular work under two or three inches long, it is preferable to use a broad tool, the cutting edge of which has been shaped to produce the desired form.

Figures 1 and 4, in Plate XXXIII., represent a chuck of special design, which has for its object, first, to provide a quick means for chucking irregular pieces of work, and particularly a kind of work in which the part gripped is of uncertain eccentricity to the part that extends beyond and is to be operated upon; second, to provide means for preventing the unscrewing of the chuck from the spindle when in use.

As shown in Fig. 1, the chuck is being used for holding bolt forgings. These forgings must be "trued up" by the body, letting the head run out as much as necessary. The bolt is first placed in the centring sleeve *a*, which is held by the turret; then the chuck is opened, and the turret run up till the bolt head passes into the chuck jaws. These jaws are loose in their slideways, and able to slide to any position to suit the bolt head when the bolt body is held true.

A screw draws the jaws together, and when the pressure is brought on it, tips the jaws in their slideways, and thus causes them to bind on the guides sufficiently to withstand all side thrusts of any cutting tool.

The back of the chuck is cut so as to form a taper pocket when screwed on the spindle. In this pocket a roll is placed, which is held in contact with the taper seat in the chuck and the collar of the spindle, and thus forms a "roll ratchet." A screw on the other side prevents its operating when the chuck is to be removed.

SCREW-CUTTING MACHINE.—The screw-cutting dies used in the flat turret lathe are the patent of James Hartness. The construction of the chasers is peculiar, inasmuch as the teeth at the front of the chaser have a cutting clearance, while the teeth at the back of the chaser have no clearance, but, instead, ride on the thread and control the lead. This gives the cutting teeth an ideal cutting clearance on each side of each tooth, and relieves these teeth of the labor of feeding to the die forward, and keeps the thread pitch true.

So accurate is the lead-controlling feature that regular dies for market seldom have an error in lead greater than one sixty-fourth in eighteen inches, which is less than one quarter the average error in standard taps, and less than one-half the error in ninety per cent. of engine lathes.

The construction of the chaser, of dies, and of the holders is thus described in the patent:

Heretofore, it has been found well-nigh impossible to secure perfect uniformity in any considerable length of screw cutting by the use of a die, for while the thread may not vary to any appreciable extent throughout, say, one inch of the thread, yet at the end of, say, six inches it is seldom found of the correct pitch, and will vary as much as a sixty-fourth, which is a serious defect. For this reason it has heretofore been found necessary to resort to the engine lathe for chasing a thread with an assured perfect lead.

It has been the practice in making chasers for screw-cutting dies to give the chaser the same clearance throughout its length, in some cases giving a greater clearance at the back portion of the chaser, and, in some cases, providing for no contact whatever of the back portion of the chaser with the work. Such formations give opportunity for variance in the pitch of the thread, because the lead of the die is not absolutely controlled. By my invention I propose to control the lead by having the back portion of the chaser (*i.e.*, that portion back of the teeth which do the actual cutting) serve as a nut, closely embracing the work and fitting the thread with a line contact extending back into the body of the die, and no contact at the front edge thereof, or along the line of the points of these back teeth. This involves a novel formation of the chaser, to be hereinafter specifically described with reference to the accompanying drawings.

Another object of my invention is to make provision for changing the lead of the die to secure different effects in the thread cutting, and this involves a peculiar relation between the chasers and their controlling means, which will hereinafter be specifically described.

Still another object of the invention is to provide for quickly changing the diametrical adjustment of the die to adapt it for roughing out or for finishing work.

The invention also aims to improve the general construction of the die.

With the above ends in view the invention consists in a number of novel constructions and combinations of parts which will be found recited in the appended claims.

The drawings which accompany and form part of this specification illustrate an embodiment of the invention.

Fig. 1, Plate XXXVI., shows a face view of the die partially broken away and sectionalized. Figs. 2, 3, and 4 show sections on lines 2,2, 3,3, and 4,4, of Fig. 1.

Fig. 9 shows a face view of a chaser for use when provision is made in the die for changing the lead, dotted lines being here used to demonstrate the effect. Fig. 10 is a rear end view of the die, illustrating certain modifications in the construction of the anti-friction spline between the die shank and the main holder.

Fig. 11 shows a section taken on line 15 of Fig. 3. Fig. 12 shows a top plan view of a piece of work with a chaser cutter over it, together with a broken-line illustration of a milling cutter by which the form of chaser shown in Figs. 6 and 7 is produced. Fig. 13 shows the same parts in end elevation.

In general construction, the die closely resembles that shown in my former patent, and a brief enumeration of the principal members of the die will suffice, without setting forth the details of construction described in said patent.

The letter *a* designates the main holder ; *b* and *c*, the two members of the die body, *b* being what I have hereinbefore referred to as the "shank" ; *e*, the chaser cutters ; *f*, the cam engaging said cutters, and by its rotary movement opening and closing the same ; *f'*, the cylindrical cam holder adjustably connected with the cam, and rotatable on the member *c* of the die body ; and *g*, the spring-pressed collar connected with the cam holder, and employed for automatic opening purposes.

In order to minimize friction between the shank *b* and the holder *a* under working strain, these parts are rotatively connected together by means of rolling splines, either in the form of balls or rollers.

In Fig. 4, the two parts mentioned are shown as formed at opposite sides, with confronting longitudinal grooves *z* and *z'* semicircular in cross-section, and balls z^2 occupy these grooves, and are confined by pins z^3, entered through the holder *a*.

Disk-like rollers *y y'* (see Fig. 10) may be employed instead of the balls, with substantially the same effect, the grooves in the shank and holder being correspondingly formed. The roller *y* is shown as set in with its axis in a plane embracing a diametrical line of the die, and the grooves in which it runs are rectangular in cross-section. This roller will take a thrust in either direction, and hence is adapted to both right and left-hand dies. The roller *y'* is shown set in angularly and engaging grooves triangular in cross-section. This roller is thus adapted to take a thrust in one direction only.

It will be readily recognized that any of the forms of connection above described intervening between the holder and shank, constitute an anti-friction spline minimizing friction in longitudinal movement of the shank in the holder under working strain.

Instead of the bayonet form of connection between the spring-pressed ring *g* and the cam holder *f'* shown in my former patent, I now use knurl-headed taper-pointed screws *x*, entered through the cam holder and engaging sockets in the ring ; and instead of the pivoted latch of said former patent I employ a sliding bolt *w*, fitted through a handle *w'*, which is screwed into the cam holder. A spiral spring w^2 surrounds a reduced part of the said bolt, and exerts itself to produce locking engagement between the latter and the die body. The bolt is likewise rotatable, and is cut out in opposite sides at its inner end, as shown at w^3 and w^4, Fig. 11, one cut extending nearer to the longitudinal centre of the bolt than the other. The locking engagement of the bolt with the die body is in these cut-out places, and to change the adjustment of the die it is only necessary to turn the bolt half-way around. Thus the die can be quickly changed from finishing to roughing out adjustment, and *vice versa*, by varying its cutting diameter.

The same co-action is had between the sliding bolt and the automatic opening devices, as between the pivoted latch of my former patent and these devices.

There is a slight difference in form of the ball-headed block *m*, in that it is grooved longitudinally, as shown at *m'* in Fig. 3, to receive the tappet piece or releasing pin *n*, said groove having an inclined or curving base to act to thrust the pin against the bolt *w*, when the die body member *c* moves outward longitudinally.

The bolt is locked in its different positions of rotary adjustment by the engagement of a pin w^5, fastened in the end of the handle *w'* with any one of a series of sockets w^6 in a knob w^7 on the bolt.

Of course there may be more than two cut-out places in the bolt, and as many adjustments may be provided for in this way as required, the principal advantages derived being a saving of time in changing from one adjustment to another.

Another change to be noted over the construction shown in my former patent is that the flange f^4 of the cam holder, instead of being integral with the holder, is a separate ring screwing into said holder. This has to do with the object above stated of changing the lead of the die, for by adjusting this ring the cam which confines the chaser in its socket is caused to move in or out, and its control of the chaser is thus affected. The chaser can be held perfectly square in its seat by screwing the ring up tight, or by loosening said ring the chaser can be allowed to cant under working strain, there being allowed sufficient lateral looseness between the cam and chaser for this purpose. The object of this adjustment is to provide means for varying the depth to which the heel or leading part of the chaser shall enter the thread of the work. Now by cutting the teeth of the chaser at an angle greater than the correct leading angle, the tendency of the chaser will be to lead at the angle of its milling. In Fig. 12 the line *u u* indicates the angle at which the chaser has been milled, and the line *u' u'* indicates the correct leading angle. Now by furnishing a means for varying the pressure of the heel of the die into its work, it may be caused to lead slower, or to lead up to the angle of its natural clearance (indicated by line *u u*).

The object first stated, namely, that of making the lead positively uniform, may be accomplished in a variety of ways. Figs. 7, 12, and 13 illustrate a novel formation of chaser for the purpose, and it may be well to first state that this chaser is produced by the milling process rather than by the use of a helical tap, as commonly practised in making chasers. In using a milling tool whose teeth pass around its circumference in true circles instead of helically (which is the kind of tool proposed to use), I work said tool on an angle to the chaser to correspond with the lead. This very act of establishing an angular relation between the milling tool and the chaser blank effects the peculiarity desired in the formation of the acting face of the chaser when the latter is moved radially into engagement with the mill; viz., the cutting of the said acting face on different angles at different points in its length, which will be best understood by reference to Figs. 12 and 13. The axis of the milling cutter (indicated by the line *y y* in these figures) at different points bears different relations to the face of the chaser, so that the circles of the milling teeth vary throughout the longitudinal extent of the chaser. Take the point designated t^5 in Fig. 13 (this being the forward end of the axis of the mill), and the circle described thereabout and indicated by the broken line t^6 will be found to traverse the face of the chaser so as to create in the milling action a cutting edge at the front side u^2 of the chaser at the point *u*, for that point in the plane of the front side of the chaser is the lowest point traversed by the circle of the milling tool. The highest point is at the back side of the chaser at *u'*, and thereby a full clearance is obtained. On the other hand, when the back end of the chaser is considered, the centre t^7, about which the milling tool at this part revolves, has changed in its relation to the face of the chaser as compared with the milling centre at the front, so that the highest point traversed is now at the front side of the chaser, as indicated at u^5, and the lowest point is at the back side, as indicated at u^4. A line embracing the points of intersection of the various circles of the milling teeth (as the point u^6, Fig. 13) will follow a line contact between the chaser and the work, and that line contact will extend from the point of the last tooth to cut back into the chaser to the point u^6. This peculiarity of the acting face of the die may be stated in this wise, that the edges of the several teeth lie in different intersecting planes on different angles to the front side of the die, so that the amount of clearance decreases from the front end of the die to the back end while the points of the teeth recede from cutting

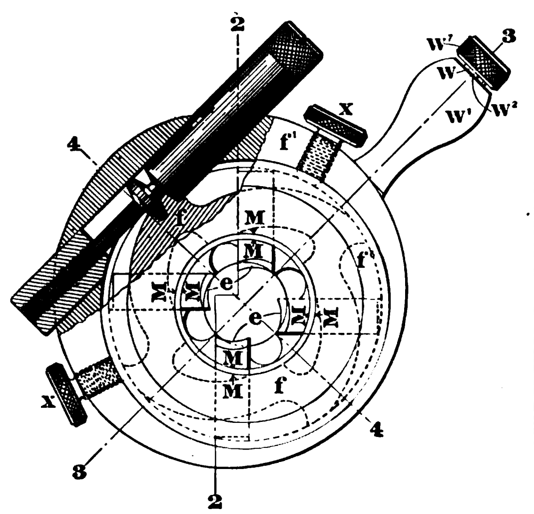


Fig. 1.

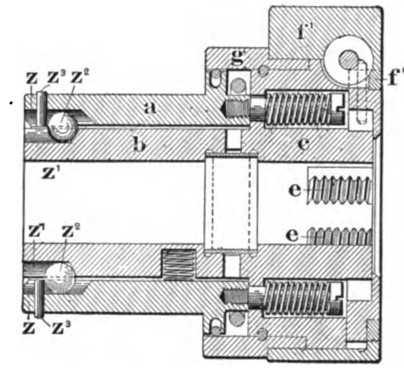
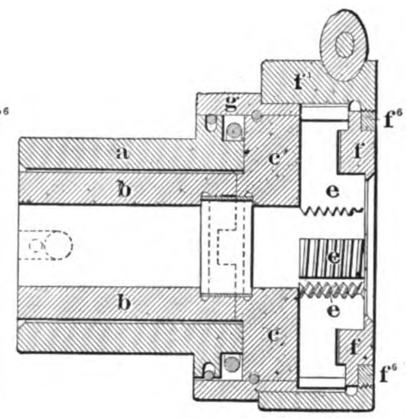


Fig. 4.



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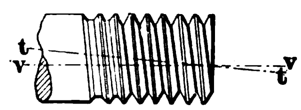
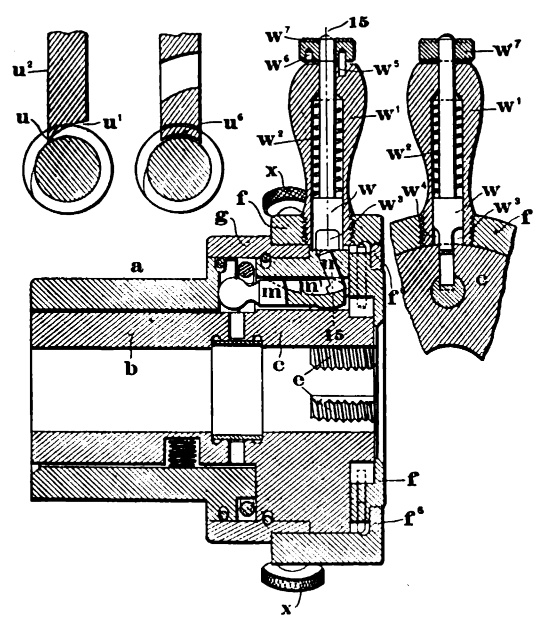


Fig. 8.

Fig. 6. Fig. 7. Fig. 3. Fig. 11.



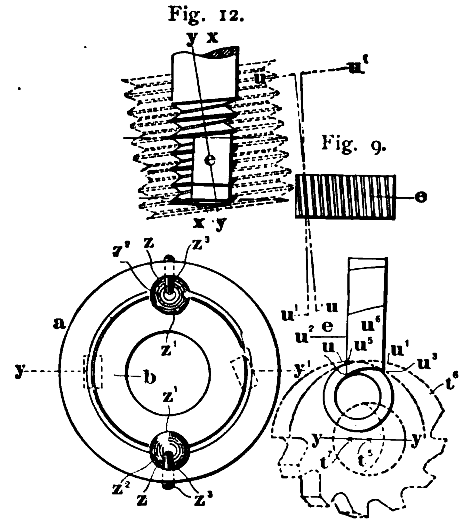


Fig. 12. Fig. 9. Fig. 10. Fig. 13.

J. E. REINECKER LATHE.

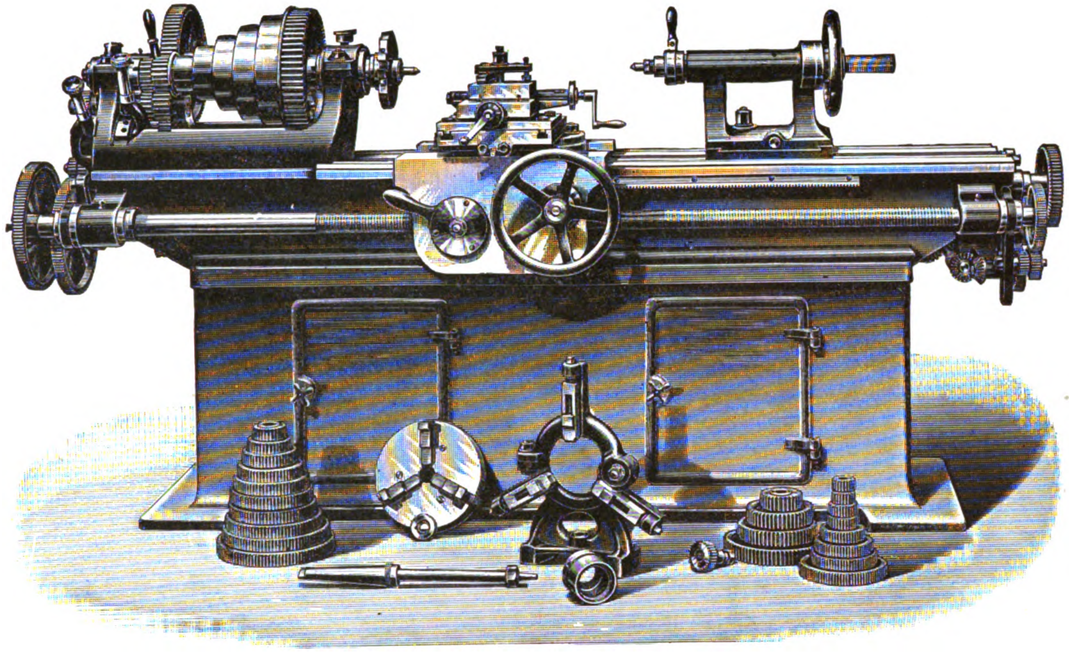
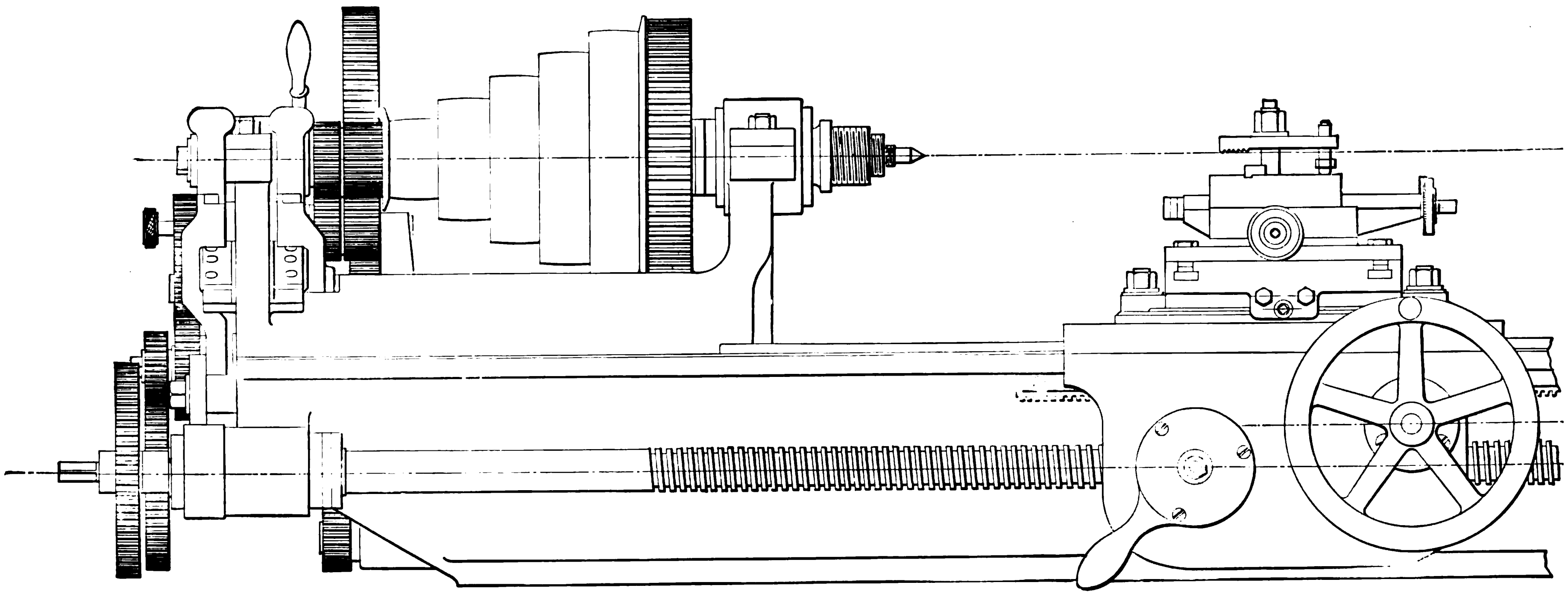


Fig. 1.



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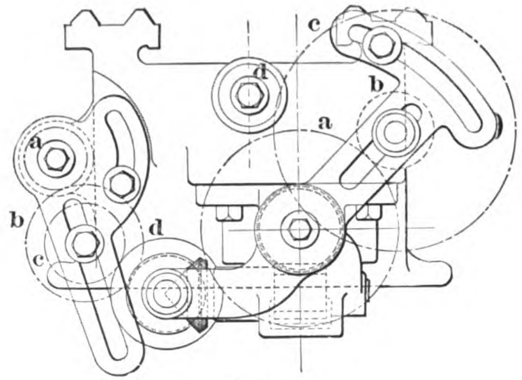

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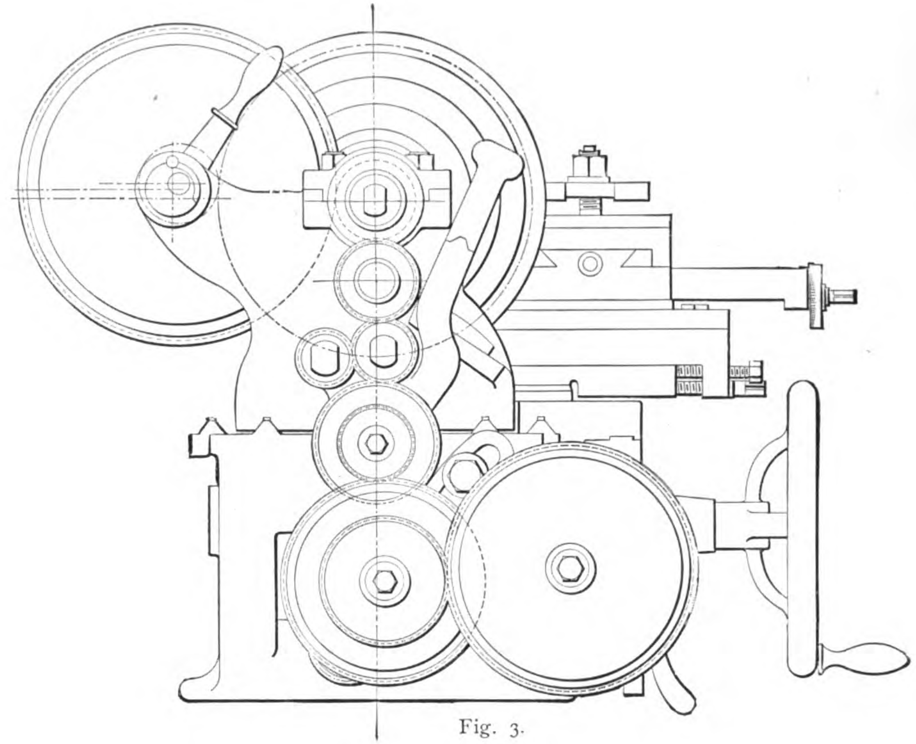

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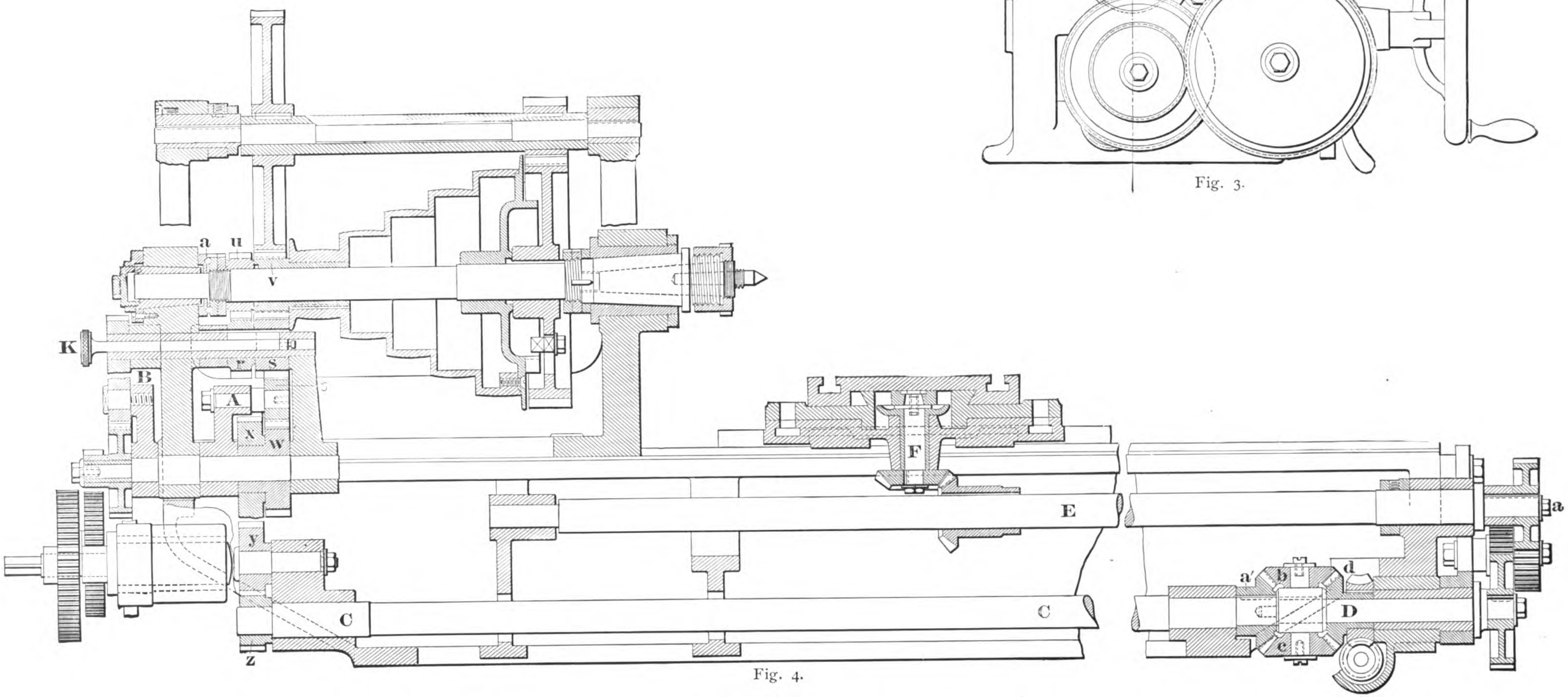

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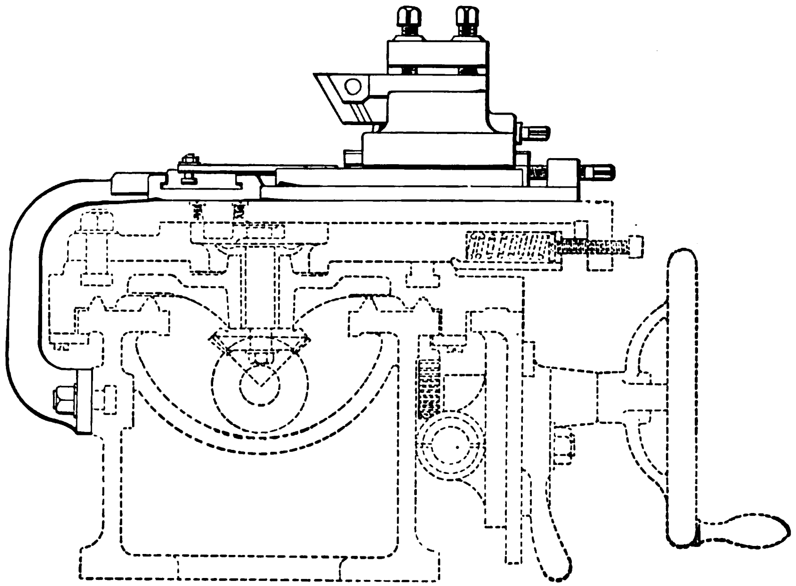
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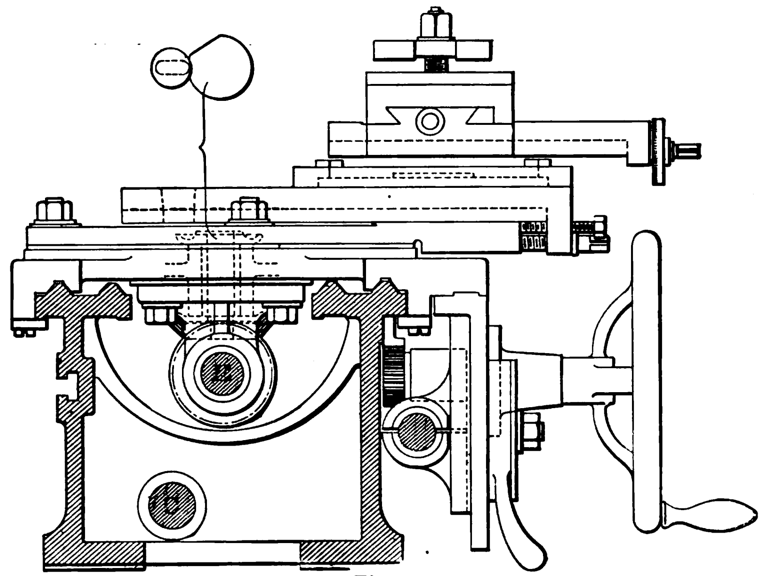
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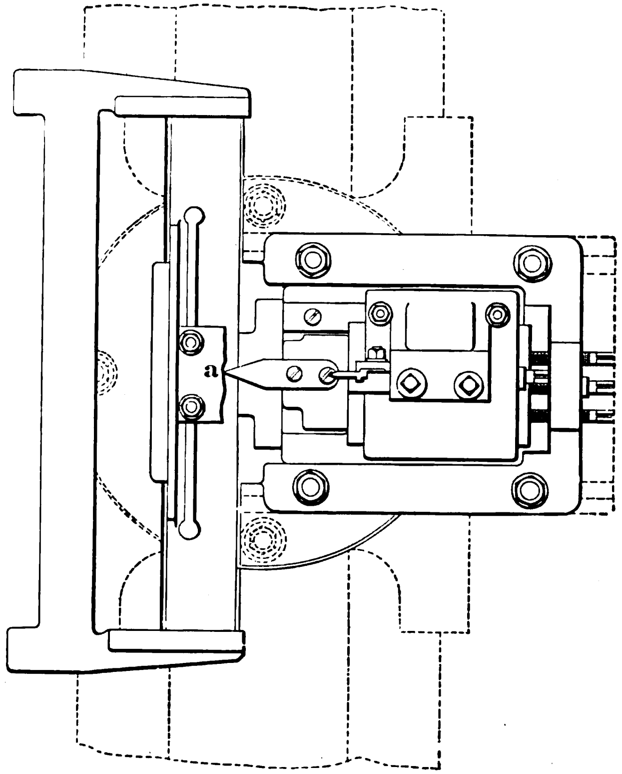
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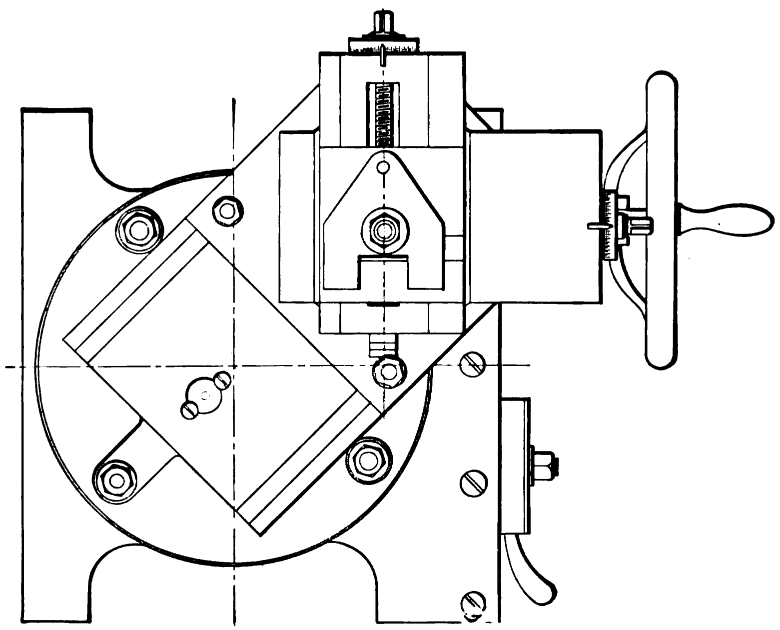


Fig. 8.

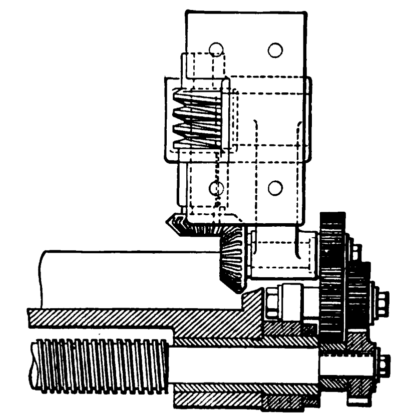


Fig. 7.

position, the line of contact between the die and the work at the rear portion of the die being in the body of the die and not at the points of the teeth, as heretofore. The idea is to get a free cutting edge at the front end of the chaser, as shown at u in Fig. 6, with a full clearance back of the same, as shown at u'; but in passing back through the chaser, the clearance decreases and the line of contact of the chaser with the work recedes from the plane of the face u^2 of the chaser while the points of the teeth at the front side u^2 leave the work. At the back of the die there is no cutting clearance (see Fig. 7), and a good leading contact is had, as shown at u^3, the teeth of the chaser occupying the thread of the work throughout the width of the chaser, but pressing closely on the work only at the middle. To make this more clear, I have shown in Fig. 8 a line v v, which indicates the plane of the face of the cutter, and a line t t, indicating the longitudinal line of contact between the work and the cutter.

The longitudinal line embracing the points of the teeth at the front side of the chaser gradually leaves the work, while the longitudinal line of contact between the chaser and the work moves back into the chaser. In other words, the points of the teeth, back of a few which do the actual cutting, have no cutting engagement with the work and cannot have under any circumstances (which is clearly illustrated in Fig. 7), there being a controlling line of contact in the body of the die, which line recedes from the plane of the front side of the die.

Chaser cutters of this character will operate on the work with a perfect lead, and the result is absolute uniformity in any length of thread.

The essential peculiarity of the chaser may be described as that of having a cutting clearance at the forward end or mouth and no such clearance at the back or heel, so that it forms a cutting tool at the entrance and a leading nut at the rear.

I believe it to be new with me to accomplish this result by a peculiar formation of the acting face of the chaser, and while I have described the peculiarity as being produced by a milling process, I do not wish to be understood as limiting myself to any particular mode of producing the necessary peculiarity of formation, for it may be accomplished in a variety of ways.

By reference to Fig. 1, the face of the cam f may be seen to be inscribed with marks M for registry with similar marks on the chasers, so that when a new set of chasers is placed in the dies a proper adjustment of the cam with relation thereto may be assured by causing the marks to register.

Lathe with Capacity for Relieving or Giving Clearance to the Cutting Edges of Tools.—This lathe, whose construction is shown in Figs. 1 to 10, Plates XXXVI.–A to XXXVI.–C, is constructed by, and is the design of, J. E. Reinecker, of Chemnitz-Coblentz, Germany.

Fig. 1, Plate XXXVI.–A, is a general view of the lathe, which is of ordinary standard pattern, the novelty consisting of some special features which in no way interfere with the use of the lathe for all ordinary work. Figs. 2 and 3 are side and end elevations; and Fig. 4 a longitudinal sectional view, showing details of the mechanism.

Referring to Fig. 4, Plate XXXVI.–B, the arrangement of spindle bearings is seen, the front bearing being taper, and the thrust taken upon a ring of steel balls a, at the forward end of the rear bearing. Just below this bearing is a stud shaft, which is fitted with a sliding key, moved by the knurled knob K outside, by means of which this stud can be driven by either one of two gears r, s, which are mounted loosely upon it near its inner end. These gears are of the same size, and r engages with a gear u keyed to the main spindle, while the other engages with the gear v on the cone pulley. Since the ratio of the back gearing is 16 to 1, it is evident that when the back gear is thrown in, threads of two different pitches can be cut, using the same arrangement of change gears, the pitch of thread cut when the key is pushed in being 16 times as great as when the key is pulled out. The drive from the cone pulley is especially useful when cutting worms or other very coarse threads. Outside the head and below this stud is placed the usual tumbling gear arrangement, by which the feed motion is reversed, so that right or left-hand threads may be cut; and translating gears are supplied, by which metric threads, or modul threads having 3.1416 mm. as a unit of measurement, may be cut.

The gear s, driven from the cone pulley, acts also as an idler, by means of which a train of gearing t, w, x, y, z, is driven, that gives motion to the shaft C, which passes through the bed, as shown, to a point near the end of the bed, where it terminates, and has keyed to it at the end the mitre gear a', which is in mesh with two other mitre gears, b and c, which are mounted to turn freely upon studs, which are fixed opposite each other in the enlarged end of the shaft D, which is called the differential shaft.

The two wheels b and c engage with a fourth mitre gear d, the motion of which is controlled by the worm wheel seen at the right of it, and visible also in Fig. 2, Plate XXXVI.–A. If the wheel d be held stationary, then the differential shaft D will make one revolution for two of the shaft C, but by giving motion to the gear d by means of the worm gearing, driven from a train of change gears attached to the end of the lead screw, as shown at Figs. 2 and 7, Plates XXXVI.–A and XXXVI.–C, the motion of the differential shaft D and of the splined shaft E can be modified; the last-named shaft being driven by the differential shaft through the medium of another train of change gears, as shown in Figs. 1, 4, and 5, Plates XXXVI.–A and XXXVI.–B. The motion of this entire train of mechanism can also be reversed by a tumbling gear arrangement under the head, controlled by the lever A, Fig. 4, Plate XXXVI.–B.

The splined shaft E drives by means of mitre gears a vertical shaft F, which is fitted to the carriage, and at the upper end of which is a cam that gives a slide the required motion to cause the tool to back off, or relieve the teeth of a milling cutter, and as this slide can be set to any desired angle, as indicated in Fig. 8, it follows that the clearance can be given at any angle, including what is called side clearance, if desired.

By means of changing the gears composing the last-named train—*i. e.*, the one connecting shafts D and E—the cam at the carriage can be given the required number of revolutions per revolution of the lathe spindle called for by the number of teeth in the cutter, and if these teeth are straight, then this train of gears is the only one that needs to be considered, except that for giving the proper rate of feed; but if the teeth are spiral, then a table shows the proper gears to use connecting the end of the lead screw with the worm shaft, by means of which the mitre gear d is given just the required motion to retard or accelerate the motion to compensate for the spiral, whether it be to the right or to the left.

When the cutter to be relieved is of irregular outline, the device, Fig. 9, Plate XXXVI.–C, is used, where a form or pattern is adjustably secured to a bar which is supported by brackets attached to the back of the lathe bed by a T-slot.

It will be noticed in Fig. 8, Plate XXXVI.–C, that the slides of the compound rest can be kept in their normal position, if desired, regardless of the angle to which the backing-off slide is set, and that they can be moved in or out upon the lower to suit circumstances.

The lathe not only produces milling cutters which can be ground on the faces of the teeth without change of form, but it will also give clearance to worm hobs, and do a large variety of similar work not within the scope of the ordinary lathe.

Gisholt's Lathes for Heavy Work.—These lathes mark an era of advance, in their capacity to take wide and heavy cuts with a multiplicity of tools, while producing smooth and true work. Referring to Figs. 1, 2, and 5, Plates XXXVI.–D and XXXVI.–E, the bed, headstock, and brackets are, to avoid vibratory strains, cast solid in one piece. The turrets are hexagonal and slide directly on the ways of the machine, while, to avoid spring, the turrets are of very large diameter. The carriage is provided with the turret tool post, each tool of which is independently adjusted for height. Both the carriage and the turret may be used in screw cutting. The cross-feed has a micrometer index reading to one thousandth of an inch. Automatic feed and dead stops, independently adjustable, are provided for each face of the turret, and independently adjustable stops are provided for each tool in the turret tool post. The feed motions permit of four changes of feed, varying as 1, 2, 4, and 8, which are instantly obtainable, either from the end of the lathe, or from the turret slide. The feed motion is also instantly reversible.

Figs. 3, and 4 give examples of the operation of these lathes in finishing cone pulleys. The pulley shown has 3½ inches bore and the three large steps are finished on the inside. The first tool employed is that for boring and facing the three largest steps. Double cutters are used in this tool, which is rigidly fastened to the turret face, and steadied on the outer end by a supporting bar which fits a bushing in the chuck. The second and third tools are the roughing and finishing boring bars, each supported, when doing their work, at the outer end in a chuck bushing. The fourth and fifth tools are the Gisholt standard facing heads, with finishing and sizing cutters for boring and facing the largest step. This completes the first operation. In the second operation, the pulley is mounted on a face plate arbor supported from bushing in chuck, the outer end running in holder as shown. A cone plate fitting the bore of the largest step, and a bushing fitting the bored hole, are placed on the arbor and the pulley pressed on them in place ; the cone plate in this case is permanent and, therefore, fastened securely in the pulley.

A driving plate with two studs is fastened to the chuck, the studs fitting holes in cone plate and acting as drivers. The regular tool post is removed and in its place is mounted the double cone pulley turning tool with the proper multiple cutters inserted, as shown, and the cross slide connected with former, or taker, attachment slide. All steps are roughed out and faced with this tool, which is then revolved so that finishing cutters are in position. The finishing cut is then taken in the same manner, and the pulley is completed.

NEW HAVEN MANUFACTURING COMPANY'S LATHE.—Fig. 554 is a front view of the New Haven Manufacturing Company's lathe with independent rod and friction feed. The arrangement of the compound rest is shown in Fig. 553*a*, while the rise and fall carriage is shown in Figs. 555 and 556. A taper turning attachment is shown in Fig. 553*a*, which is a rear view.

This lathe is provided with an automatic stop motion for the carriage, which is seen in Figs. 553 and 554, the former also showing the hollow spindle in the feed mechanism on the larger sizes of lathes.

FAY AND SCOTT'S LATHE.—Pattern makers' lathes. Fig. 557 illustrates a pattern maker's lathe in which the hollow head spindle extends through the outer end of the headstock, and is provided with a large face plate on that end for turning pulley patterns, or any work larger than the swing of the lathe. The carriage has a hand feed (by rack and pinion) the entire length of bed.

The tail spindle sets over to turn taper (on work between centres), in connection with the carriage. The cone (which is bored inside to secure perfect balance) has four changes of speed for 21¼-inch belt. The rest holder sets on a plate fitted to the ways, and is readily and securely fastened with a cam lever at the back, within easy reach of the operator.

A 41-inch pattern maker's lathe is shown in Fig. 558. The headstock swivels for turning taper work on face plate. The head spindle front bearing is 3 inches in diameter and 6 inches long, and is chucked for centres with Morse taper No. 4. The face plate is fitted to the end of the spindle with a feather, and is drawn back to the collar by a rod passing through the spindle and screwed into a collar recessed into the front of the face plate by the small hand wheel shown at the outer end of the headstock. The head cone has four steps for a 4-inch belt, the largest step being 17 inches in diameter. The carriage is fed by power from the small cone on the end of the spindle, and the direction of the feed is reversed at the apron by the knob shown near the hand wheel. The lathe has a compound rest, graduated in degrees. A follower rest is attached to the carriage by a gib, and is readily adjusted to work of any size that would require a follower rest.

A 66-inch pattern maker's gap lathe is illustrated in Fig. 559. The carriage has a compound tool block, graduated in degrees for work up to full swing of lathe with gap closed. The compound tool block on the bar at the back is for work in full swing of lathe when gap is open. The cone in the headstock has four steps for a 4-inch belt. The head spindle is 3 inches in diameter, and the front bearing 6 inches long. The countershaft has an iron cone and two friction pulleys 18 inches diameter by 4½ inches face, one of which should run 425 revolutions, and the other, to run the lathe backwards for largest work, should run 125 revolutions per minute. The face plate slips on to a feather, and is drawn back to the collar on the spindle by a rod passing through the hollow head spindle, and screwed into a nut recessed into the front of the face plate by means of the small hand wheel shown at the end of the headstock. The tool in the carriage is designed to be used on work up to 26 inches in diameter ; and on larger work, up to 66 inches in diameter, the lathe is to run backwards, using the tool on the bar shown at the back of the lathe, which is supported on a bracket attached to the bed at the front end, and, at the other end, to the carriage, which is extended for that purpose ; the projected end of the carriage being stiffened by a bracket to the under side, and gibbed to slide in a recess at the bottom of the lower bed. The tool on the carriage is used on face plate work to the full swing of the lathe. To open the gap, the top bed is moved on the lower bed by means of the screw and hand wheel shown at the end of the bed.

An 84-inch swing face plate lathe is shown in Fig. 560. The spindle is of steel. The bearings are 2¾ inches by 6 inches, and 2⅛ inches by 4 inches. The cone, which is of iron and carefully balanced, has four steps for 4-inch belt. The largest step is 17¼ inches in diameter. The face plate is 26 inches in diameter. The countershaft has an iron cone, self-oiling hangers, and two friction pulleys 18 inches diameter by 4 inches face, which should run at 110 and 425 revolutions per minute, giving eight changes of speed to accommodate work from 7 feet in diameter to the smallest that is likely to be required of the lathe. Attached to the headstock in front is a casting which supports a 2-inch shaft 8 feet long ; and to this shaft are attached two other shafts 3 feet, and to these, one 8 feet long. These shafts are all adjustable, in and out, to bring the rests into proper position for the work in hand. A rest holder is furnished, with two hand turning rests 18 inches and 26 inches long ; also a compound rest 16 inches long, with hand feed, which can be used either on the back or front side and face of the work. The compound rest, and the swivel bearings which support the shaft across the face of the work, are graduated in degrees, and allow the operation of the tool at any desired angle.

THE LODGE AND SHIPLEY ENGINE LATHE.—An example of this line of lathes is given in Figs. 1 and 2, Plate XXXVI.-I.

The lead screw is splined so that it may be used for a rod feed as well as for screw cutting.

Fig. 1 is an example, with a rise and fall of elevating rest. Fig. 2 illustrates the taper turning attachment. The carriage is gibbed to the bed its entire length. The bearing on the bed is not recessed, but has a full bearing from end to end, and the entire depth of **V** on the bed. The carriage is provided with a screw and clamp for locking it while using the cross-feed.

Both the upper and lower slides of the compound rest are fitted with taper gibs, which, besides being tapering, are tongued and grooved into the sides. The taper gibs are provided with only two screws, one front and one back, which take up the wear the entire length. The top slide has a long movement for angles, and is fitted with a screw of ten pitch. The screw is provided with an indexed micrometer divided into lines, each of which reads 2-1000th. The lower slide is provided with a micrometer divided into 64ths of an inch. When starting the cut, an exact diameter may be obtained without the use of calipers, by using the tailstock spindle as a gauge. For example, in the 18-inch lathe, secure the tool firmly in place, move it forward until the point touches the spindle ; the tool is then set to turn a diameter of two inches. If smaller diameters are wanted, move forward by the micrometer the required amount, as explained. If larger diameters are wanted, move backward in the same manner, except that, in moving backward, a half turn more than required should be made, and then brought back to the proper place, in order that lost motion may not cause confusion.

The change for screw-cutting gears is mounted on a short shaft running in substantial bearings in the bed and directly

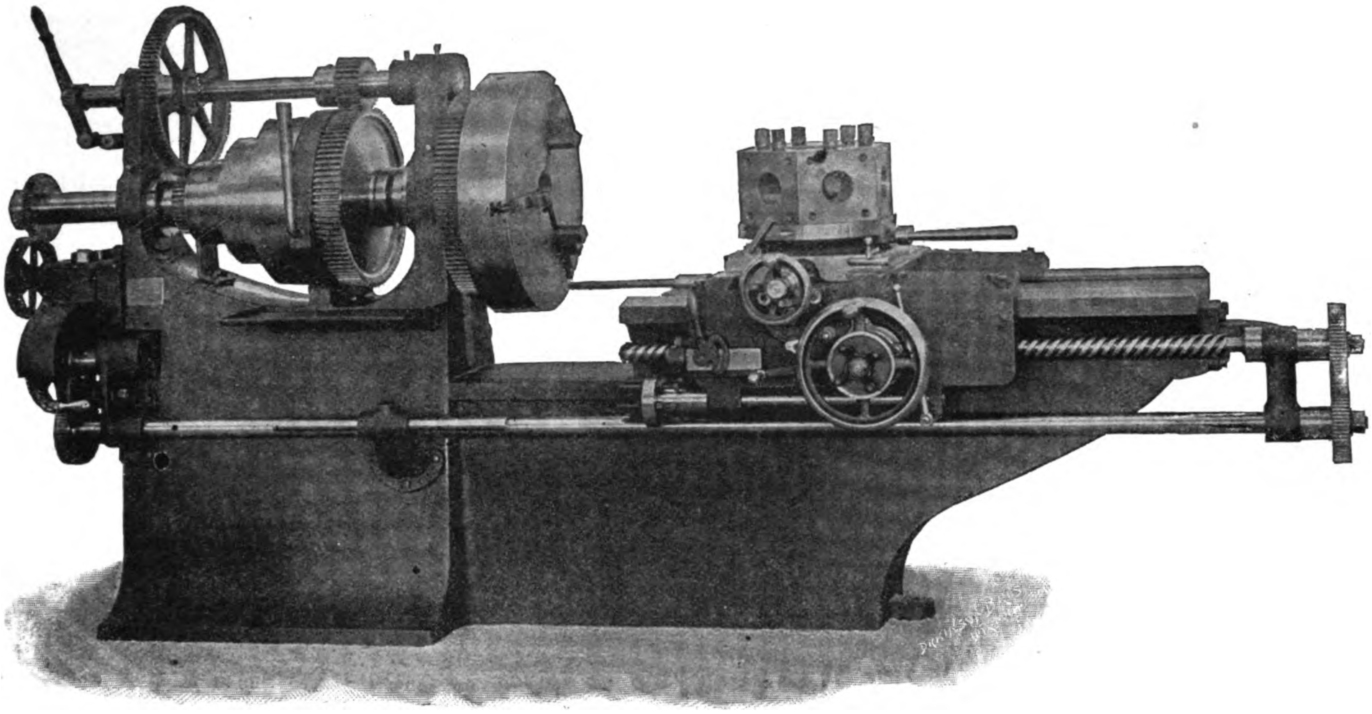
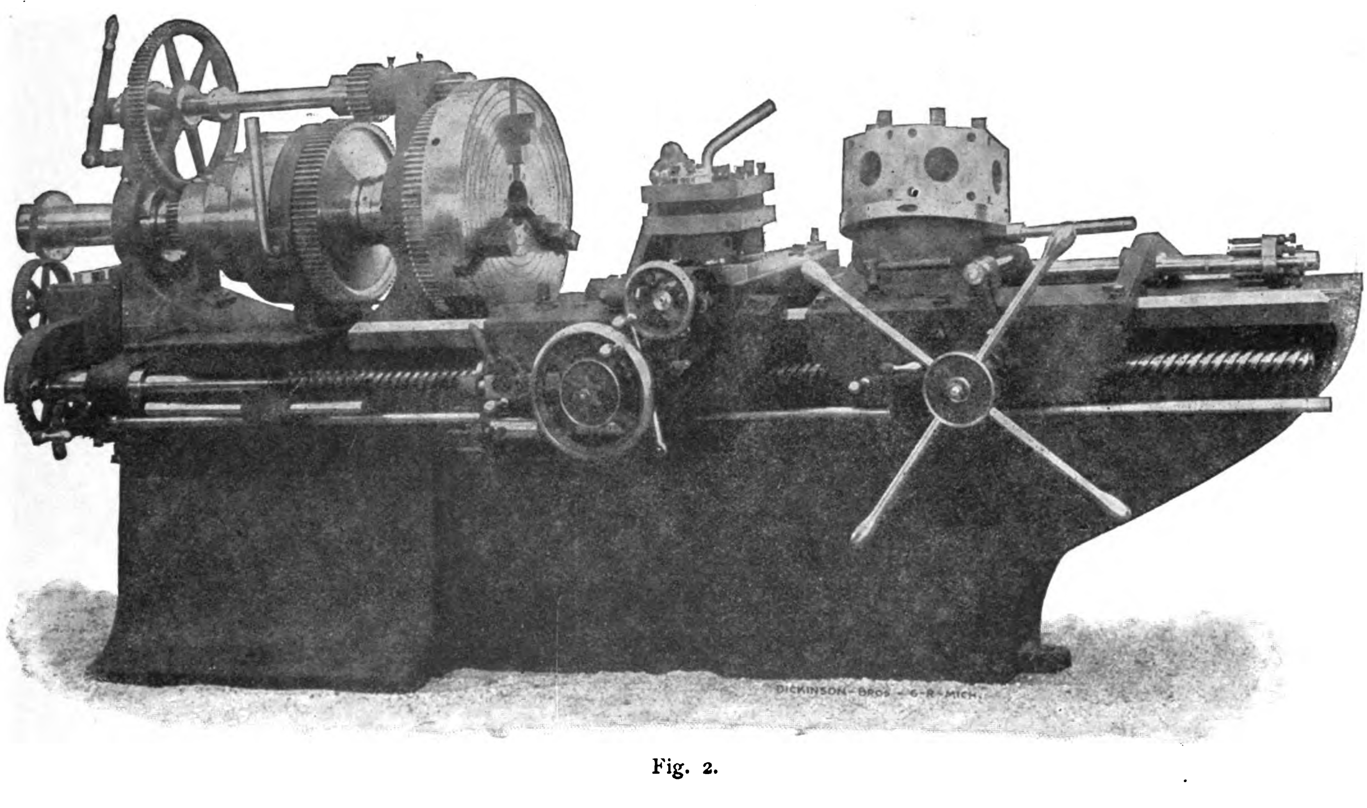


Fig. 1.



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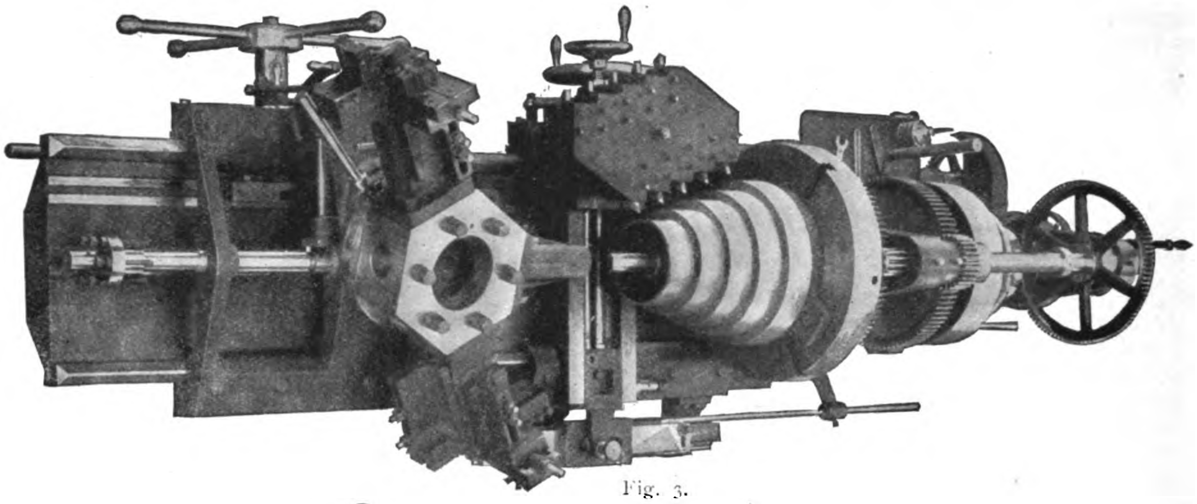

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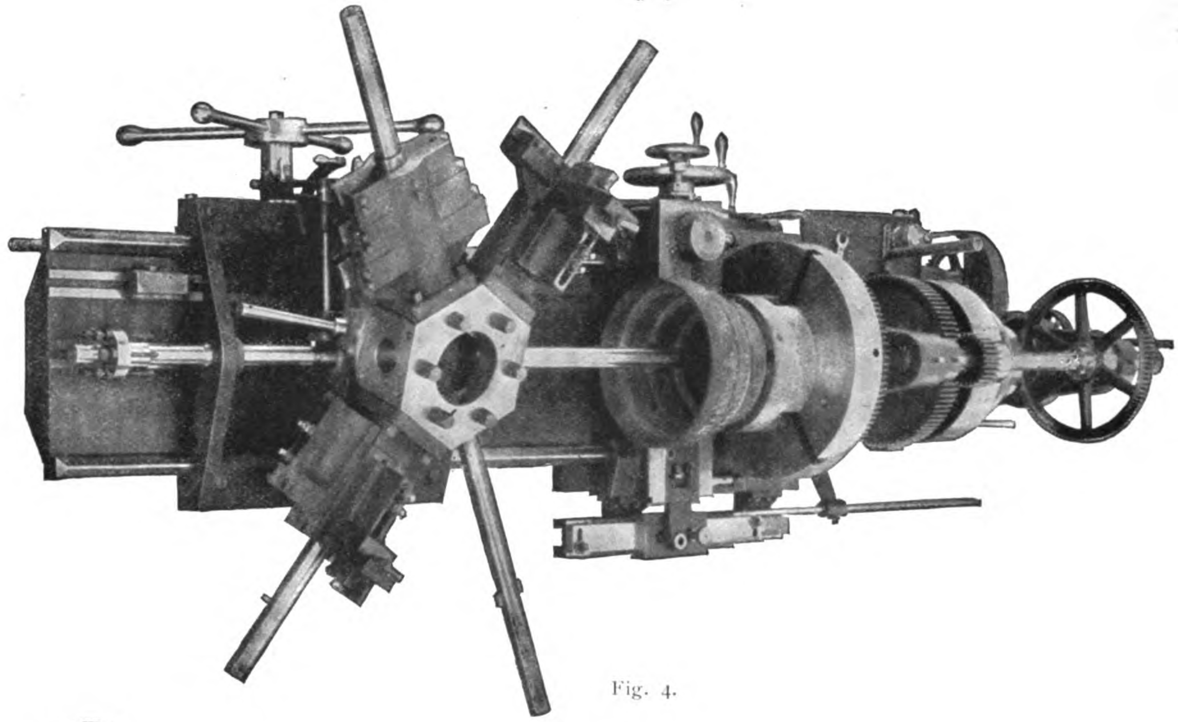
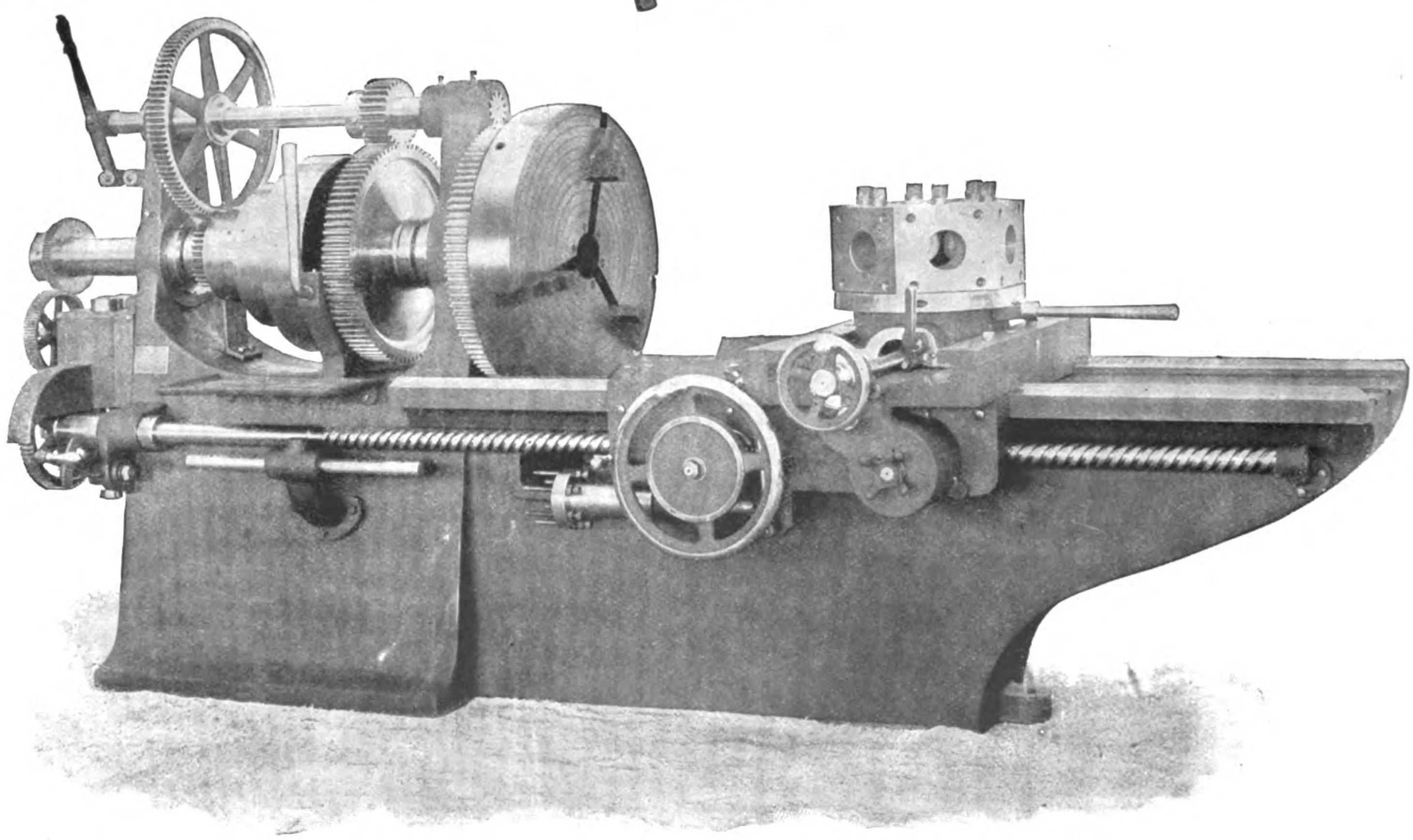


Fig. 4.



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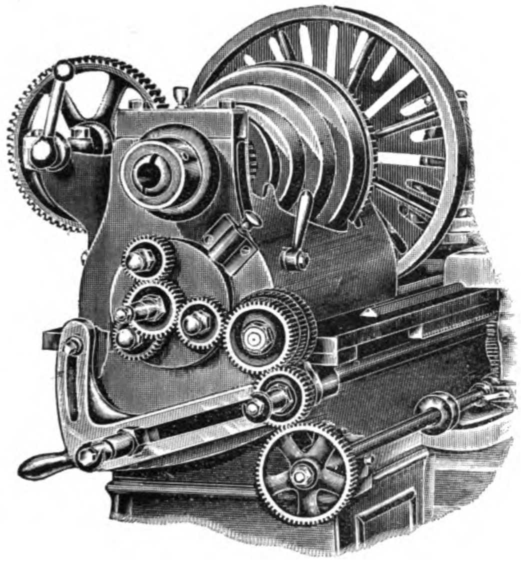


Fig. 553.

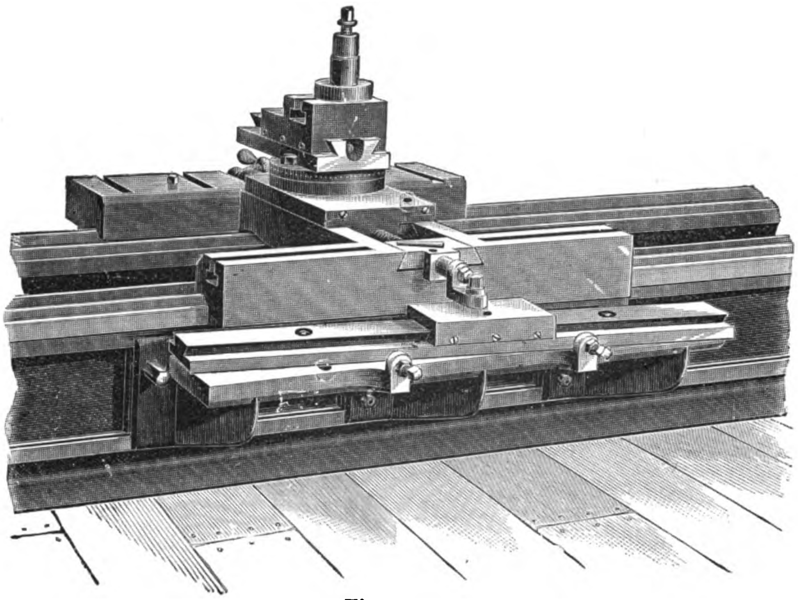


Fig. 553*a*.

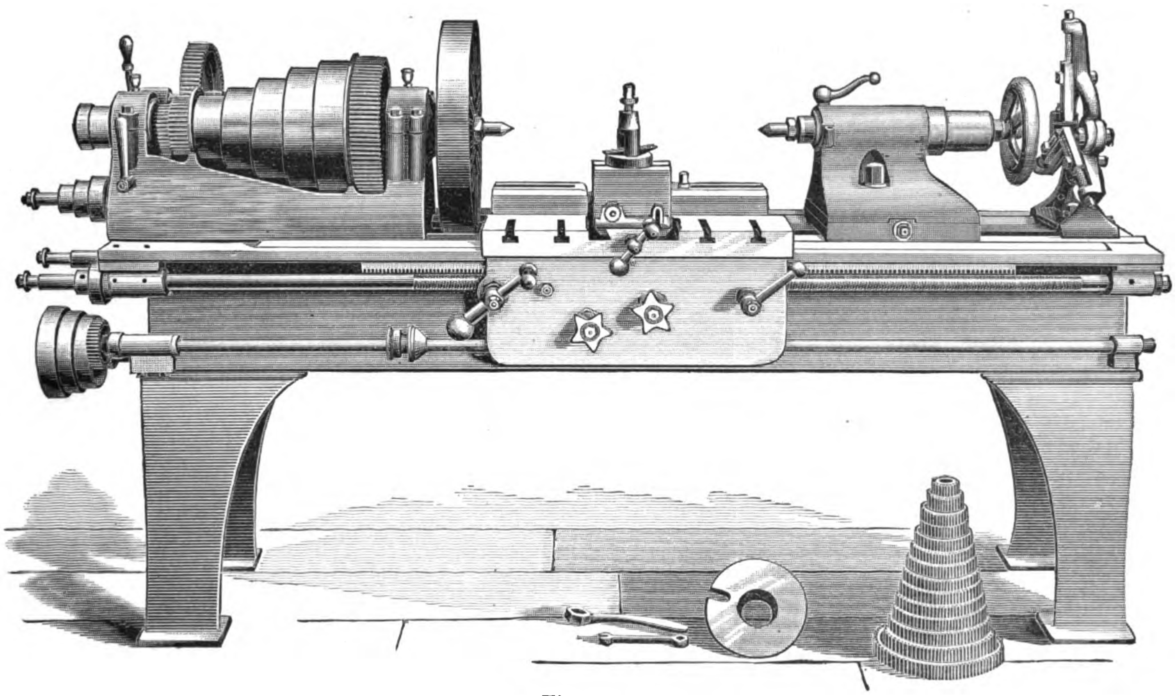


Fig. 554.

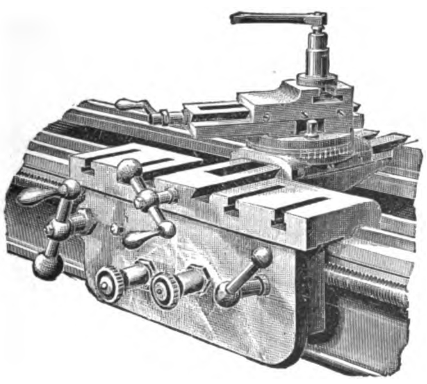


Fig. 555.

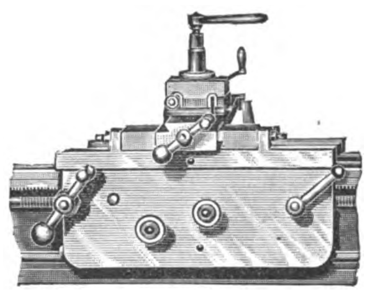
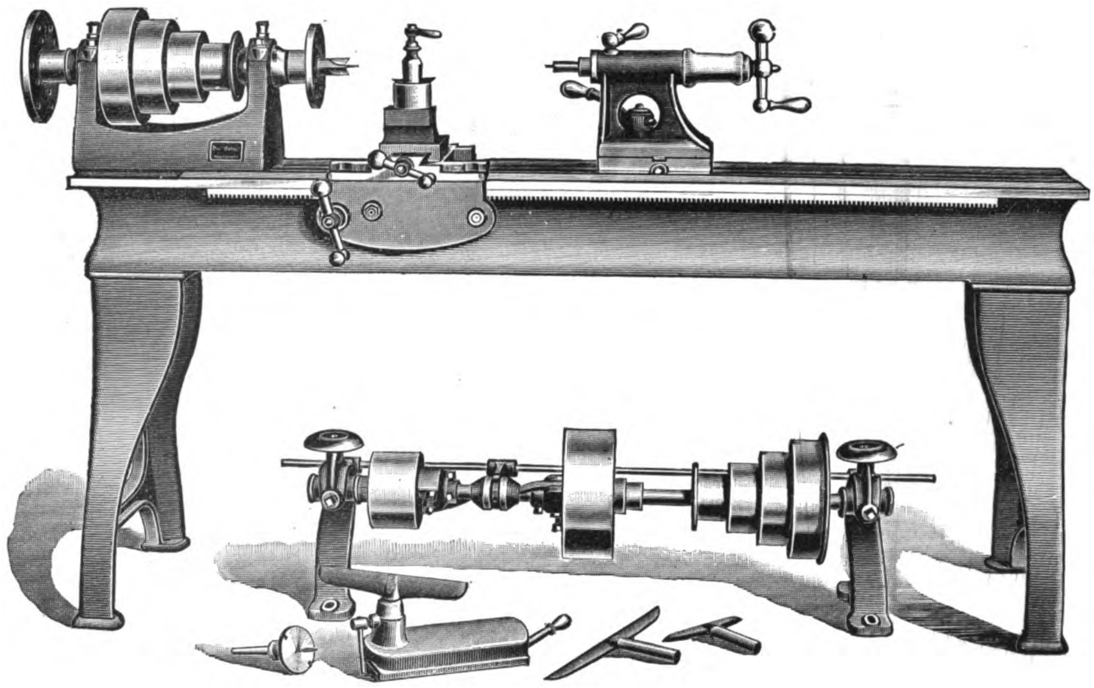


Fig. 556.



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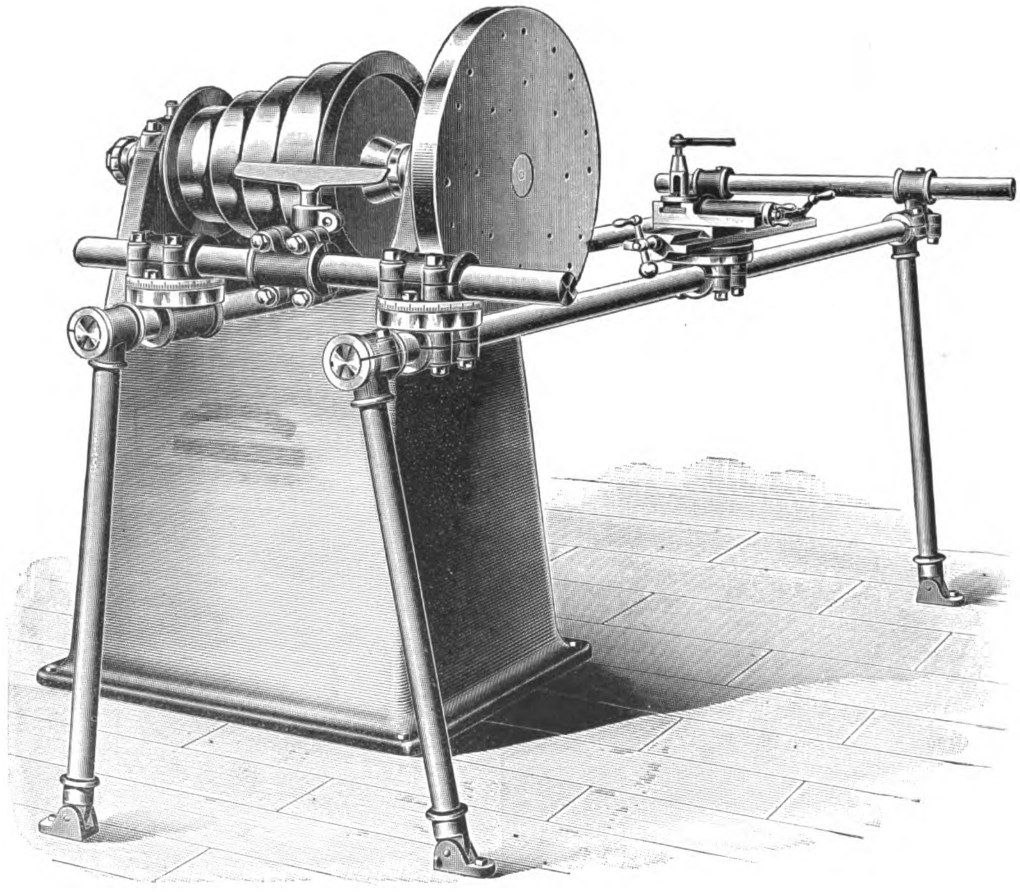
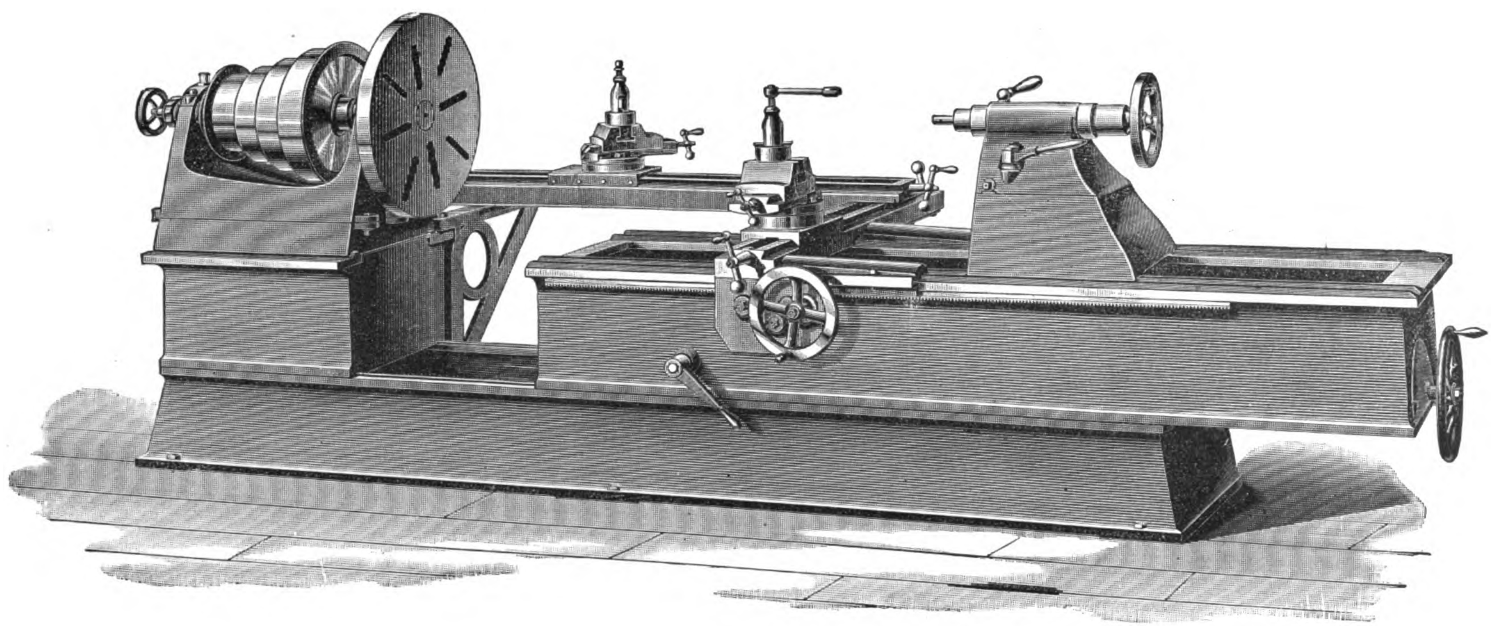


Fig. 558.



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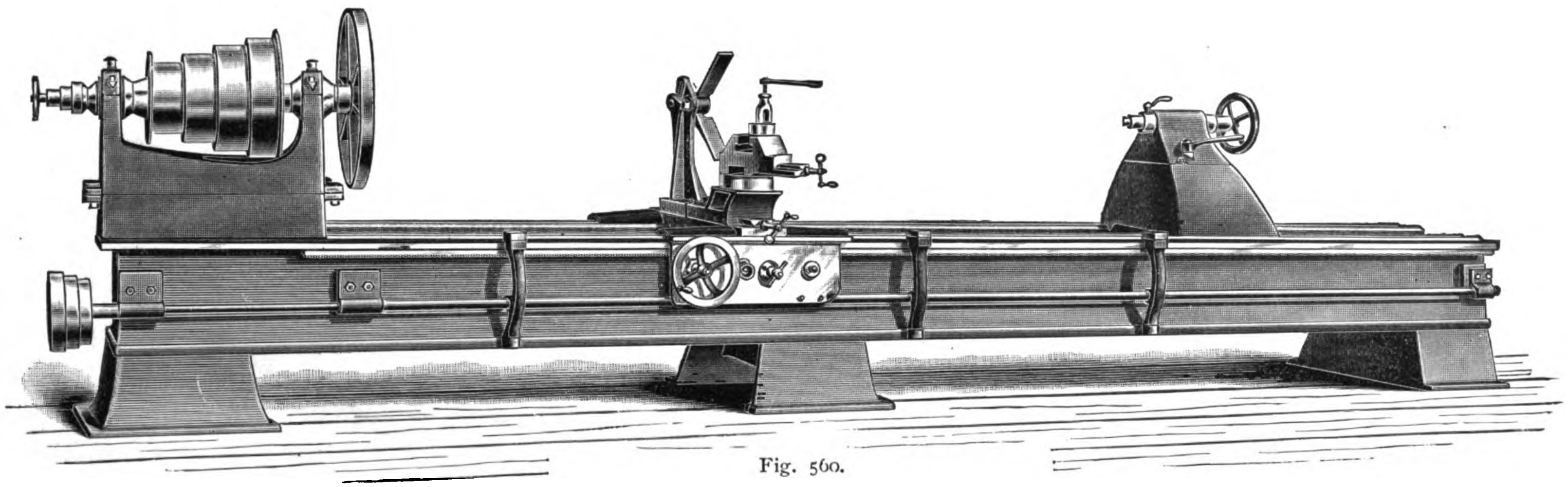
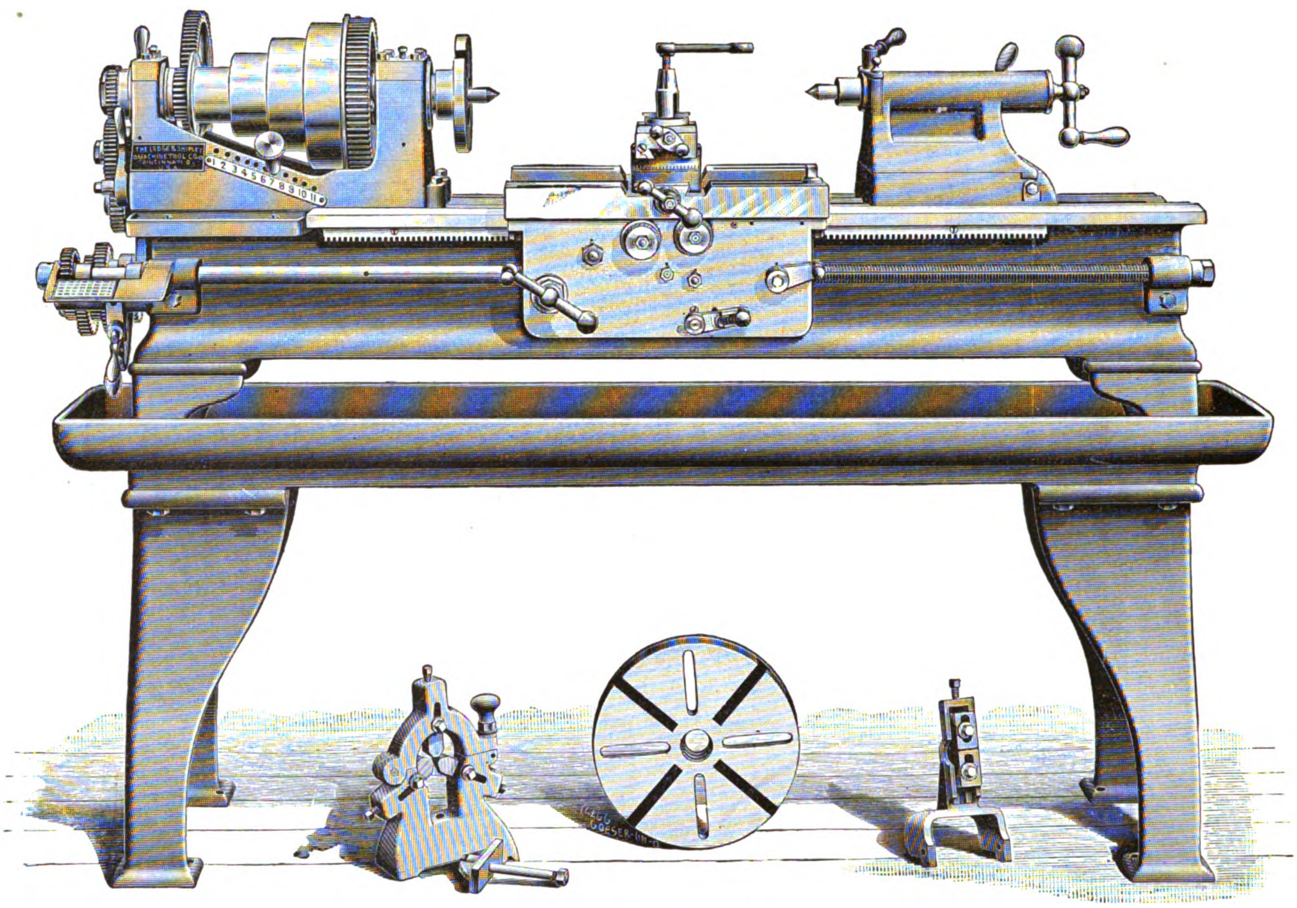


Fig. 560.



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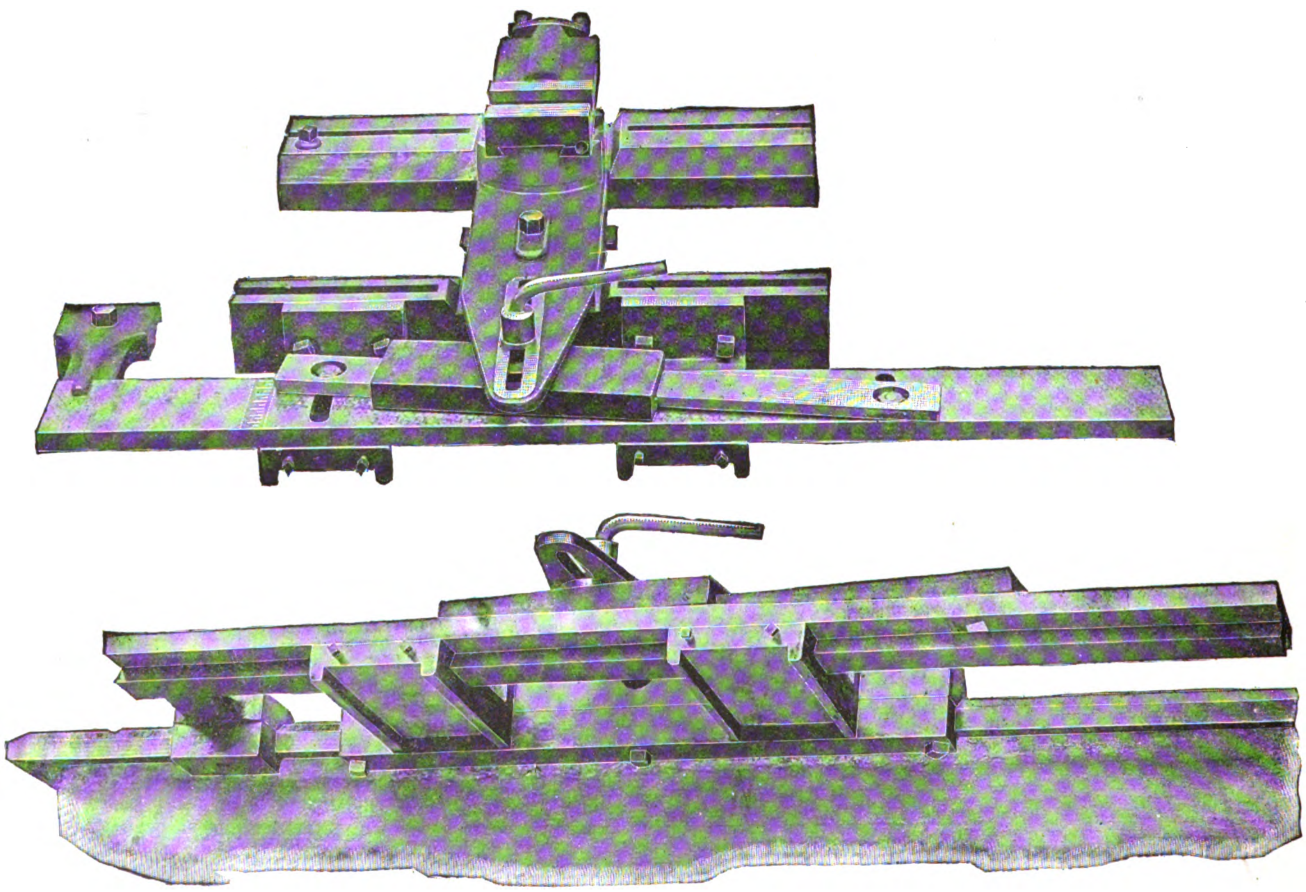

Fig. 2.

under the headstock. The knob shown in front of the head carries a gear that continually runs either right or left. This gear may be dropped into any one of the change gears instantly, and thus gives four times as many changes as there are change gears, because on the outer end of the change gear shaft are four gears, into any one of which the gear shown on the lead screw may engage.

None of the gears are removed to set the lathe for cutting different pitches of threads or for different rod feeds. A substantial and simple plate is used to change from right to left-hand screws. The index plate has the words "Threads," "Knob," on the upper line. Under the word "Threads" are the number of threads the lathe will cut; under the word "Knob" are the figures 1 to 10; thus, should the operator desire to cut any certain thread, he finds this on the index plate, engages his gear opposite to it, places the knob in the hole indicated on the plate, and starts the tool to work.

The taper attachment is changed from straight to taper by tightening or releasing one screw. When attached for taper work the sliding shoe connects directly with the tool rest and not with the screw, making its operation instantaneous. The nut is made to release and slide in a groove. The stud for the sliding shoe also engages into a groove, and to attach or detach requires nothing more or less than the releasing of one screw and tightening another, or *vice versa*.

The bracket carrying the taper attachment is bolted to and travels with the carriage, so that at whatever part of the bed the carriage may be the taper attachment can be instantly engaged.

MODERN

MACHINE-SHOP PRACTICE

OPERATION, CONSTRUCTION, AND PRINCIPLES OF

SHOP MACHINERY, STEAM ENGINES, AND ELECTRICAL MACHINERY

BY

JOSHUA ROSE, M.E.

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THIRD EDITION

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