MACHINERY'S ENCYCLOPEDIA

A WORK OF REFERENCE COVERING PRACTICAL MATHEMATICS AND MECHANICS, MACHINE DESIGN, MACHINE CONSTRUCTION AND OPERATION, ELECTRICAL, GAS, HYDRAULIC, AND STEAM POWER MACHINERY, METALLURGY, AND KINDRED SUBJECTS IN THE ENGINEERING FIELD

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IN COLLABORATION WITH MANY PROMINENT MECHANICAL AND ELECTRICAL ENGINEERS

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paper, cloth, stone, cement, etc., and sprayed coatings can either be polished, treated with chemicals to form various patina effects, or allowed to form a natural patina, thus securing protection of the material from atmospheric action.

Detachable Coatings. — The detachable coatings form an interesting part of the application of the process. It has been found that, if the Schoop spray be turned upon a smooth, greased surface of reasonable hardness, the "bombarding fog" of metal particles will remain upon the surface without impacting, and will copy the surface to its finest line or detail. On cooling and tapping this "reverse," it detaches readily, and by using it as a mold and repeating the treatment with a film of grease, a detachable copy of the original object, a coin, medal, or any relief subject can be obtained in any metal. C.L.L.

SCRAPING MACHINE PARTS. In metal working, slight errors in plane or curved surfaces are often corrected by the use of hand scrapers; scraping is also employed to produce ornamental effects on exposed surfaces. When correcting errors, the part to be scraped is ordinarily applied to whatever surface it is being fitted; the bearing marks or "high spots" are then noted and removed by scraping. By repeatedly obtaining these bearing marks and then removing them, a more evenly distributed bearing is secured. In this way, bearing boxes are often fitted to their shafts after having been bored. Small flat surfaces are scraped to make them more accurate, the method being to first apply the work to a standard surface plate, note the bearing marks and, if there is unevenness, correct the error by scraping. When fitting two flat parts together, it is common practice to first scrape one member to secure as true a surface as possible, and then use it as a standard while fitting the other part. In order to make the bearing marks show clearly, some kind of red or black marking material is generally used. A thin coating is applied to the bearing shaft, surface plate, or whatever surface the work is to be scraped to fit. The work is then rubbed over this surface and the marking material shows just where the high spots are. It is important to keep the marking material in a covered box in order to exclude all grit or chips. The scraper should be made "glass hard" and be given a fine edge by the use of an oilstone.

Marking Materials Used when Scraping. — The materials commonly used to show the bearing marks are oil mixed with lampblack, Prussian blue, or red lead. Lampblack mixed with lard oil is good for marking metal surfaces for rough-scraping. Prussian blue paste in tubes is smooth and convenient to use, but a small amount of lard oil mixed with the paste improves it. Red lead mixed with mineral machine oil to the consistency of putty is a good mixture for general scraping operations. Lard oil can be used instead of mineral machine oil when the mixture is applied to the surface plate, but, on account of its smeary nature, it is undesirable to apply it to work on which a dull red-lead surface is required which shows the high spots black and shiny when rubbed with the surface plate.

Mixing Red Lead. — The mixing of red lead requires patience, as the lead and oil do not unite readily, and considerable pounding, stirring, and kneading are required. The mixture should be worked until it is smooth. When the compound is kept in a receptacle, it may be allowed to dry out and then be used like shoe or stove polish, mixing in as much machine oil as is required at the time.

Application of Red Lead. — For rough-scraping, apply red lead generously to the surface with a rag, using machine oil to assist in spreading. When an even coating has been spread, place the surface plate on the surface to be scraped, rub a little, and remove. The high spots will be clearly defined by the red markings. This is the best way to show the bearing spots. When the spotting shows fairly uniform all over, the process should be reversed, applying the red lead and oil to the work in a somewhat drier form, with the object of attaining a dull red coating which, when rubbed with a clean surface plate, will make a good background for the polished black high spots. The amount of red lead should be gradually reduced and a little gasoline should be mixed with it to act as a drier, finally using just enough red lead to dull the surface without coloring it. This procedure will show the true high spots. They will be small, but no false bearing will appear, which is likely to happen if the surface plate is kept colored. Venetian red is finer than red lead and is sometimes preferred for very accurate work.

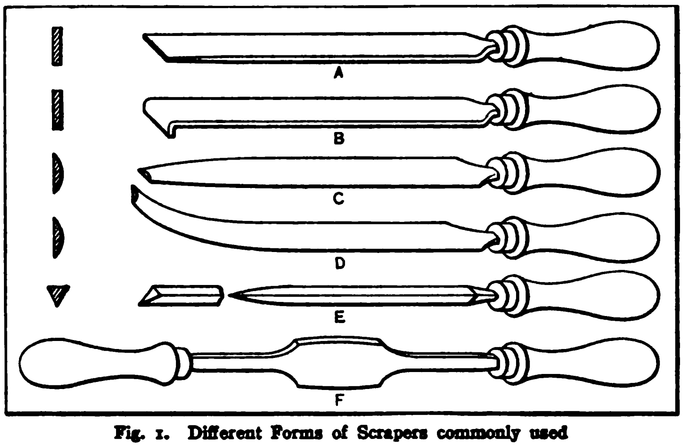

Fig. 1. Different Forms of Scrapers commonly used

Different Forms of Scrapers. — In Fig. 1, the different forms of scrapers commonly used are shown. The flat scraper *A* is almost invariably used for plane surfaces. For ordinary purposes, the scraper blade is about $\frac{3}{16}$ inch thick, from 1 to $1\frac{1}{4}$ inch wide, and is drawn out at the point to a thickness of about $\frac{1}{16}$ inch. The cutting end is as hard as possible and is rounded slightly, in grinding, so that the outer corners will not score the surface being scraped. The grinding should be done, preferably, on a wet grindstone, the edge being finished with an oilstone. When using a scraper of this form, it is generally held at an angle of about 30 degrees. The hook scraper *B* is also used on flat surfaces. It is preferred by some workmen for obtaining a fine, smooth surface and can be used, occasionally, in narrow spaces where there would not be room enough for a straight, flat scraper. Straight and curved scrapers of the "half-round" type are shown at *C* and *D*. These are used for scraping bearings, etc., the sides forming the cutting edges. The curved type *D* is more convenient to use on large half-bearings, as it is held at an angle and the scraping is done by the curved edge. The "three-cornered" or "three-square" scraper shown at E is also used to some extent on curved surfaces. When the end is beveled, as shown in the detail view to the left, this form of scraper is convenient for producing sharp corners or for "relieving" them slightly.

The two-handled scraper shown at F is an excellent form for scraping bearing boxes and all curved surfaces which are so located that this type can be used. This style of scraper is much superior to the forms shown at C and D, especially for large work. The straight or curved half-round type works very well on soft bearing metals such as babbitt metal, but on brass or bronze, it cuts slowly and, as soon as the edge is slightly dulled, considerable downward pressure is necessary. The type F requires very much less effort on the part of the workman, and it will cut rapidly. As there are two handles instead of a single handle at one end, the blade can be pressed against the work with little exertion. This form of scraper is largely used in railroad shops, for the heavy scraping required on driving-wheel boxes and in fitting the large connecting-rod brasses now in use. The sides are sometimes ground slightly concave to give the cutting edges "rake," by holding them against the face of the grinding wheel.

Distribution of Bearing Marks. — When correcting errors on flat or curved surfaces by hand scraping, it is desirable to obtain an evenly spotted bearing with as little scraping as possible. When the part to be scraped is first applied to the surface plate, or to a journal in the case of a bearing, three or four "high" spots may be indicated by the marking material. The time required to reduce these high spots and obtain a bearing that is distributed over the entire surface depends largely upon the way the scraping is started. If the first bearing marks indicate a decided rise in the surface, much time can be saved by scraping larger areas than are covered by the bearing marks; this is especially true of large shaft and engine bearings, etc. An experienced workman will not only remove the heavy marks, but also reduce a larger area; then, when the bearing is again tested, the marks will generally be distributed somewhat. If the heavy marks which usually appear at first are simply removed by light scraping, these "point bearings" are gradually enlarged, but a much longer time will be required to distribute them.

The number of times the bearing must be applied to the journal for testing is important, especially when the box or bearing is large and not easily handled. The time required to distribute the bearing marks evenly depends largely upon one's judgment in "reading" these marks. In the early stages of the scraping operation, the marks should be used partly as a guide for showing the high areas, and, instead of merely scraping the marked spot, the surface surrounding it should also be reduced, unless it is evident that the unevenness is local. The idea should be to obtain first a few large but generally distributed marks; then an evenly and finely spotted surface can be produced quite easily.

The proper distribution of the bearing marks on the finished surface depends somewhat on the class of work. For flat surfaces which must be very accurate, all the marks should be approximately the same size and evenly distributed. In locomotive work, the bearing marks on driving-wheel boxes should indicate a heavier bearing in the "crown," or top of the box, than on the sides. Split bearing boxes such as are used for engine connecting-rods should also be scraped in this way. If the heaviest bearing were left at the sides, a slight heating of the journal would be more likely to greatly increase the friction and cause excessive heating. When doing such fine work as scraping surface plates, the bearing marks on the finished work should be evenly distributed, of about the same size, and cover at least 60 per cent of the total area.

Scraping Ornamental Surfaces. — The scraping of ornamental surfaces is commonly known either as "frosting," "snow-flaking" or under the general name of "spotting," and consists in using the scraper in such a way as to obtain a fairly symmetrical series of spots upon the surface to be ornamented. These ornamental surfaces are of two kinds: one is formed of small square spots arranged in checkerboard fashion, although somewhat irregular, whereas the other has a series of crescent-shaped marks arranged in parallel rows. The former marking is usually termed "snow-flaking" and the latter, "frosting." To produce the snow-flaking effect, an end-cutting scraping tool is pushed straight ahead to produce square-shaped marks at even intervals and in parallel rows. Similar spots are then made to fill the intervening spaces by pushing the scraper at right angles to the first direction of movement. Frosting is accomplished by giving the scraping tool a peculiar twist as the cut is made. This is not easy to do, and difficult to describe. Surfaces that are ornamented in this manner may often be very carefully hand-scraped in order to secure an accurate plane surface prior to the ornamental scraping, or they may be left as finished by the machine. Ornamenting a surface that has been hand-scraped is done to give a regularity to the marks left by the tool. When a surface is ornamented without previous scraping to correct errors, it may be done wholly as an ornamentation or, as is sometimes the case, to deceive those who are apt to consider such a finish a proof of careful fitting.

Auxiliary Scraping Appliances. — There are a number of elements entering into the cost of scraping operations other than that of scraping proper, and often it is the lack of attention to these factors that accounts for much lost time. This is particularly the case in such laborious operations as "straightening out." This operation consists in moving the sliding machine member with the packing set up tightly over the fixed member, in order to find the bearing on the packing, and finally to locate the high spots. It is obvious that the packing must be adjusted to make the sliding member pull hard, otherwise it would be impossible to detect any variation in pressure due to inequalities in the machining. Even on comparatively light work, this pulling and pushing, if done directly by hand, involves more labor than is required in the actual operation of scraping. The principal point to be observed is that a workman has a certain amount of physical endurance, and, if the greater part of his energy is concentrated on the productive operation of scraping, a material increase in production will result; because of this fact, it becomes of extreme importance that means be provided for making the task of pulling easier. The classifications of work determining the selection of a proper type of pulling device are:

1. Planer slides, lathe rest slides, and work of a similar character; these are usually pulled directly by hand. For this work a rack and pinion operated by a ratchet wrench is the most convenient type of pulling device; the tight and loose places in the work are easily detected.

2. Boring mill rams, shaper rams, milling machine tables, and similar work which is comparatively short and too heavy to be pulled by a ratchet wrench. The type of device suitable for this class of work is a rack and pinion operated by power. By driving the pinion through a frictional device, the slipping of the driven friction member indicates the high spots in the work.

3. Planer cross-rails, lathe beds, and work having large dimensions, and where the pull required is long. For this class of work, the pulling device takes the form of a power-driven wire-rope drum. A tension indicator interposed between the work and the wire rope indicates any variation in pulling force required to move the work.

Hand-operated Devices for Obtaining Bearing Marks. — Concrete examples of the conditions stated in Class 1 are illustrated in Figs. 2 and 3. The upper view *A*, Fig. 2, shows the application to a planer slide and swivel of a rack and pinion operated by a ratchet wrench. In this case, the clamping bolt hole *a* in the swivel is made use of as a bearing for the pinion. A lug is cast on the slide at *b* to

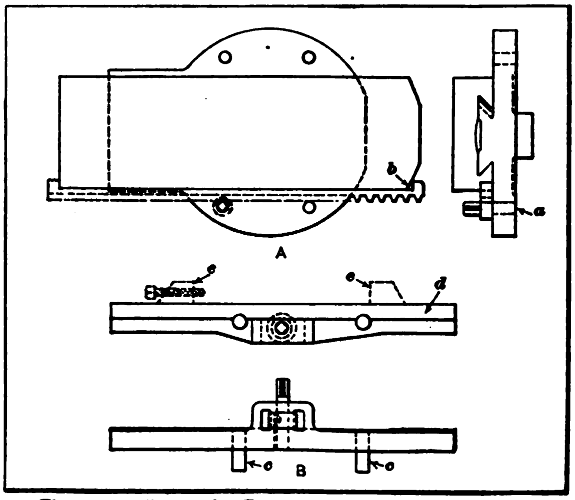

Fig. 2. Appliances for Traversing Planer Tool-slide when Testing Bearing Surfaces

provide a square seat for the projection on the rack. The rack is a loose fit endwise on the slide and is easily removed. When the design of the swivel is such that the clamping bolt hole *a* is too near the slide to be used as a bearing for the pinion, the device shown at *B* is substituted. The pins *c* fit into the holes in the swivel and hold the device from moving. The surface *d* supports the rack and keeps it in place when the slide is in the extreme positions. The lugs *e*, indicated by the dotted lines, show how the device can be attached to a swivel in which the clamping bolt holes are not available for supporting the device.

The special bench represented in Fig. 4, while not strictly a pulling device, is shown because it is very useful for holding slides and swivels and work of a similar character during the operations of pulling and scraping. The top half of the bench, shown tilted, is for holding the swivel on an angle, the object being to easily keep the slide against the fitting angle of the swivel while finding the bearing before the packing is fitted. When the packing is being fitted, and during the operation of "straightening out," this swinging top *A* is kept level. The magnetic chuck *B* provides a very convenient means for holding the packing while it is being scraped. A drawer *C* is used for keeping the scrapers, oilstone, etc. The bench is made of wood and iron and bound at the corners.

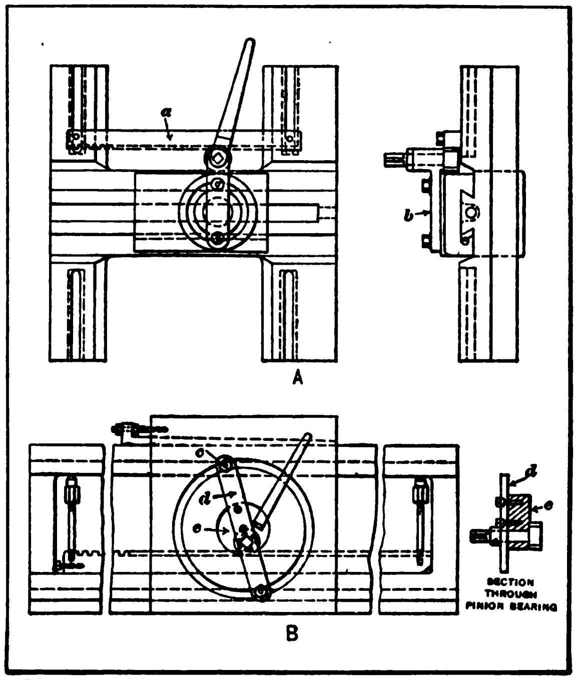

Fig. 3. Rack-and-pinion Traversing Devices applied to Lathe Cross-slide and Planer Saddle

Sketch *A*, Fig. 3, clearly indicates the method of attaching a rack and pinion to the cross-slide of a lathe carriage. The rack *a* is bolted to the rest by means of T-slots. The pinion bearing casting *b* extends across the top of the slide and is clamped by two bolts in the circular T-slot. The rack is set parallel with the ways of the rest by placing the slide, with the pinion clamped to it, in one extreme position and clamping the adjacent end of the rack in proper mesh with the pinion; then the operation is repeated with the slide in the other extreme position.

The method of attaching a rack and pinion to a small planer cross-rail and saddle is shown at *B*, Fig. 3. It is practicable to apply this method for pulling the saddles

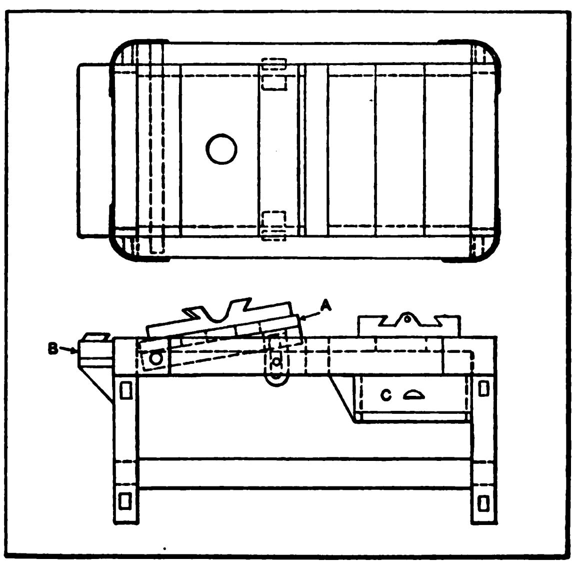

Fig. 4. Bench for Holding Slides and Swivels

of cross-rails up to sizes of 48 inches. Referring to the illustration, the rack rests on the rough inside surface of the cross-rail, and is held in position by a screw, studs, and nuts, as indicated. The adjustment of the pinion into proper mesh with the rack is accomplished by making the pinion bearing *e* in the form of an eccentric bushing fitting into the hole in the saddle. The eccentric bushing is clamped by the strap *d* and bolts *c*.

Power-operated Machines for Obtaining Bearing Marks. — The principles embodied in the design of the pulling machine illustrated in Fig. 5 are applicable to the work mentioned in Class 2 in the foregoing. This machine is made for pulling boring mill rams; the simplicity of the design is immediately apparent from a study of the three views shown. The top and end views show a right-hand ram and swivel in position on the table of the machine. This table is supported on three legs to avoid any tendency to rock, and the design is adapted to hold either right- or left-hand swivels.

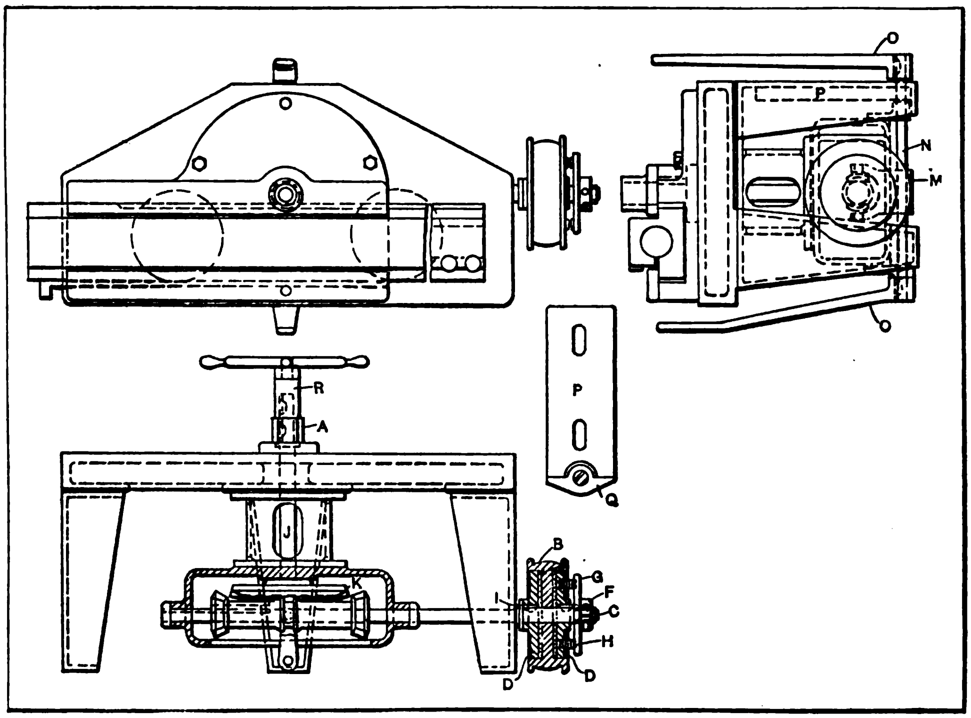

Fig. 5. Machine for Imparting Motion to Boring Mill Rams while Scraping

The machine illustrated is belt-driven, although a motor drive could be easily substituted. The mechanism for driving the pinion *A*, which meshes with the teeth of the ram, is shown by the lower view. Referring to the sectional view of the friction pulley, the driving member is the flanged pulley casting *B*, having a solid web. This member is a running fit on the shaft *C* and friction disks *D*. The friction disks are the driven members, and are keyed to the shaft *C*. Between these disks and the pulley casting are two leather washers. The amount of friction required is adjusted by means of the split nut *F* which moves the spring disk member *G* (keyed to the shaft) and compresses the twelve springs *H*. This regulates the pressure on the friction disks, leather washers, and pulley; the thrust is taken by the nut *F* and collar *I* on the shaft. The leather washers are prepared by soaking in oil for twenty-four hours. This preparation, together with the action of the springs, provides a very uniform and positive slippage of the driven members when the load is excessive. A motion in either direction is imparted to the pinion shaft *J* by the bevel gear *K* and the double bevel pinion drive. The bevel pinion is shifted by operating levers *O*. The detail sketch of the weight *P* shows its action on the double rocker arm *Q*, which is pinned to the lever shaft *N*. This device keeps the double bevel pinion in a central position when the hand levers are not operated.

In operation, the swivel is centered by its hole fitting the hub cast on the table, and clamped by bolts as indicated. When the packing and gibs are being fitted, the handwheel is left off the machine, and the ram only moved back and forth for a short distance near the center of its travel. After the operation of "straightening out" the ram is completed, the handwheel is used to pull the ram by hand (once or twice) to make sure the ram pulls evenly from end to end of its travel. The friction is so adjusted that it will just pull the ram when the packing and gibs are set to a rather tight running fit. The high spots in the ram are indicated by the friction slipping. The machine is geared to move the ram at a rate of about 15 feet per minute. A modification of this machine may be used for pulling any work of comparatively short dimensions, by coupling the sliding work member to a rack supported in suitable guides and driven by a mechanism similar to that shown.

Power-driven Wire-rope Pulling Device. — The type of pulling machine illustrated in Fig. 6 is particularly adapted to the work mentioned in Class 3. The general features of the machine comprise a heavy cast-iron base carrying the motor, wire-rope drum, and driving mechanism. Bolted to the base are two upright steel bars *A*, which are made rigid by the braces as indicated. These bars support the wire-rope idler sheaves *B* and *C* and the electric conductor cord drum *D*. The holes in the bars *A* are used for carrying the wire-rope sheaves at a height to suit the work, it being desirable to have the rope attached to the gage measuring the pull as nearly level as possible. The machine is self-contained as far as the application of power is concerned. The spur pinion on the motor-shaft meshes with the gear on the worm-shaft. Between the bearings for this shaft is the worm; this worm drives a worm-gear on a cross-shaft. On the cross-shaft are also a sliding clutch and wire-rope drum. This drum has clutch teeth cast on one end and is driven by the sliding clutch. The lever *E* is for operating the sliding clutch. The

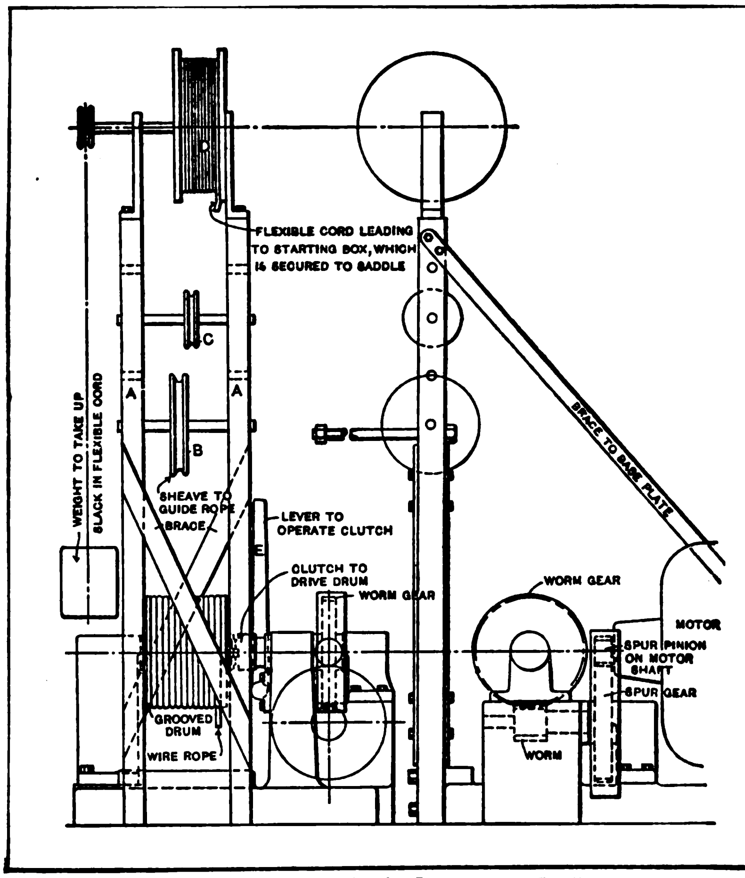

Fig. 6. Pulling Device for Large Planer Saddles

advantage of this clutch is to facilitate the attaching of the wire rope with its tension indicator to the work.

The tension indicator illustrated at *A* in Fig. 7, and used in connection with the pulling machine just described, is essentially a double toggle joint. A force pulling on the wire rope, with the indicator attached to the work, compresses the spring *a* between the two short links *b*. The amount of compression is indicated by the index hand on the dial of the gage *c*. The function of the stud *d* is to limit the outward travel of the lever arms and thus reduce their movement by keeping the spring under a slight compression when there is no load, *i.e.*, there is no movement of the lever arms until the pull is sufficient to move the work. This avoids the tendency of the gage to jump or vibrate. There is no stop-pin at zero for the index hand, the return to zero being controlled by the stud *d*. It is evident that, since the relative movement of any two levers of the toggle joint is not in direct proportion to the amount of tension applied to the device, compensation should be made in the dial graduations. This refinement is not necessary, however, as the requirements simply are that the gage indicate *variations* in tension and not the *amount* of variation measured in any definite quantity.

The lower diagram *B*, Fig. 7, shows the pulling machine and tension indicator in position for pulling a planer cross-rail saddle. The cross-rail is shown lying face up on suitable iron parallels. This is the position for fitting the packings and straightening out the angle. When the top surface is being scraped, the cross-rail is turned right side up. In this case, the idler-sheave shafts are moved up in their supports so as to keep the wire ropes level. The pulling machine is not fastened to the floor; its weight and the braces keep it in position. The swivel block of the indicator is bolted to the T-slot in the saddle. When the saddle is pulled backwards, the packing is left loose. The starting box and reversing switch for the motor are on a board which is fastened to the saddle. The weight and cord attached to the sheave on the drum shaft, Fig. 6, take up the slack in the electric cable as the saddle moves forward. The rate of traverse is about 10 feet per minute.

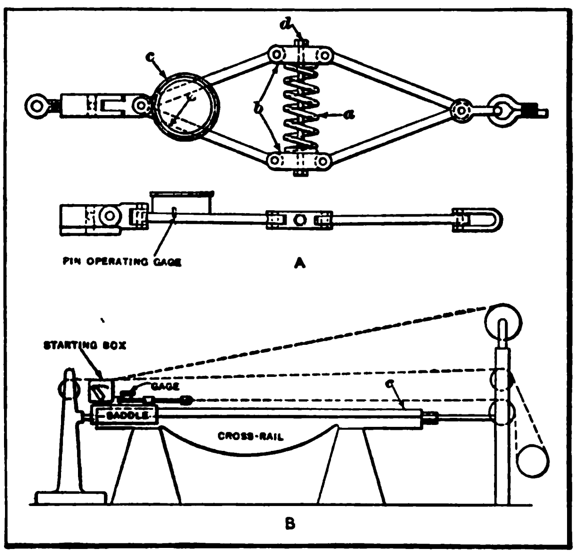

Fig. 7. (A) Indicating Mechanism for Pulling Device. (B) Pulling Machine and Tension Indicator in Position for Traversing a Planer Saddle

In operation, the saddle is moved for a short distance near the center of the cross-rail to fit the packings. During the operation of straightening out the cross-rail, the saddle is brought to the position shown at *B*, Fig. 7, the packing is adjusted and the operator starts the motor. By watching the gage, the operator marks on the cross-rail with a piece of chalk the tight places. When the surfaces being tested are parallel with those that have previously been finished, the index hand on the gage will remain fixed from end to end of the cross-rail. The packings are tightened one at a time. A. S.

SCREW. Considered as a mechanical machine element, the screw is classed as one of the "mechanical powers." In the case of the screw, the initial force, tending to turn the screw, moves through the circumference of a circle, the point of application usually being at the end of a crank or bar, at the surface of a pulley or handwheel. A screw may be defined as a cylinder around which threads are wound in successive coils or helices, equally spaced. The lead of a single-threaded screw is the distance between