CHAPTER XIII.—EXAMPLES IN LATHE WORK.

BALL TURNING.—One of the best methods of turning balls of the softer materials, such as wood, bone, or ivory, is shown in Figs. 1248 and 1249, in which are shown a blank piece of material and a tubular saw, each revolving in the direction denoted by the respective arrows. The saw is fed into the work and performs the job, cutting the ball completely off. In this case the saw requires to be revolved quicker than the work—indeed, as quickly as the nature of the material will permit, the revolving of the work serving to help the feed. Of course, the teeth of such a saw require very accurate sharpening if smooth work is to be produced, but the process is so quickly performed that it will pay to do whatever smoothing and polishing may be required at a separate operation. This method of ball cutting undoubtedly gave rise to the idea of using a single tooth, as in Fig. 1250. But when a single tooth is employed the work must revolve at the proper cutting speed, while the tooth simply advances to the feed. If the work was cut from a cylindrical blank the cutter would require to be advanced toward the work axis to put on a cut and then revolved to carry that cut over the work, when another cut may be put on, and so on until the work is completed. The diameter of ball that can be cut by one cutter is here obviously confined to that of the bore of the cutter, since it is the inside edge of the cutter that does the finishing.

This naturally suggests the employment of a single-pointed and removable tool, such as in Fig. 1251, which can be set to turn the

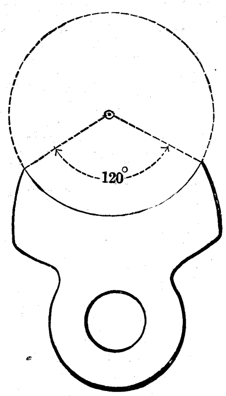

Fig. 1256.

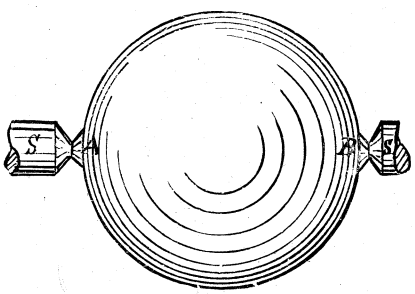

Fig. 1257.

required diameter of ball, and readily resharpened. To preserve the tool for the finishing cut several of such tools and holders may be carried in a revolving head provided to the lathe or machine, as the case may be. In any event, however, a single-pointed tool will not give the smoothness and polish of the ball cutter shown in Fig. 1252, which produces a surface like a mirror. It consists of a hardened steel tube C, whose bore is ground cylindrically true after it has been hardened. The ball B is driven in a chuck composed of equal parts of tin and lead, and the cutter is forced to the ball by hand. The ball requires to revolve at a quick speed (say 100 feet per minute for composition brass), while the cutter is slowly revolved.

A simple attachment for ball turning in an ordinary lathe is shown in Fig. 1253. It consists of a base A, carrying a plate B, which is pivoted in A; has worm-wheel teeth provided upon its circumference and a slideway at S, upon which slides a tool rest R, operated by the feed-screw handle H. The cut is put on by operating H, and the feed carried around by means of the screw at W. The base plate A may be made suitable to bolt on the tool rest, or clamped on in place of the tool, as the circumstances may permit; or in some cases it might be provided with a stem to fit in place of the dead centre. For boring the seats for balls or other curved internal surfaces the device shown in Fig 1254 may be used. It consists of a stem or socket S, fitting to the dead spindle in place of the dead centre, and upon which is pivoted a wheel W, carrying a tool T. R is a rack-bar that may be held in the lathe tool post and fed in to revolve wheel W and feed the tool to its cut. At P is a pin to maintain the rack in gear with the wheel. Obviously, a set-screw may be placed to bear against the end of the tool to move it endwise and put on the cut. An equivalent device is shown in Fig. 1255, in which the tool is pivoted direct into the stem and moved by a bar B, held in the tool post. The cut is here put on by operating the tail spindle, a plan that

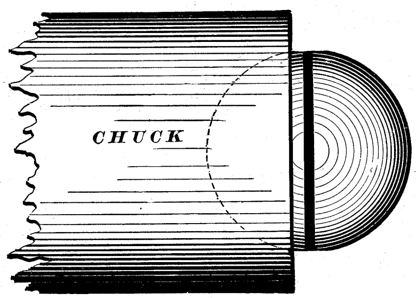

Fig. 1258.

may also be used in the device shown in Fig. 1254. The pins P upon the bar are for moving or feeding the tool to its cut. It is obvious that in all these cases the point of the tool must be out of true vertically with the axis of the work.

In turning metal balls by hand it is best to cast them with a stem at each end, as in Fig. 1257.

To rough them out to shape, a gauge or template, such as in Fig. 1256, is used, being about $\frac{1}{32}$ inch thick, which envelops about one-sixth of the ball's circumference. After the ball is roughed out as near as may be to the gauge, the stems may be nicked in, as in Fig. 1257, and broken off, the remaining bits, A, B, being carefully filed down to the template. The balls are then

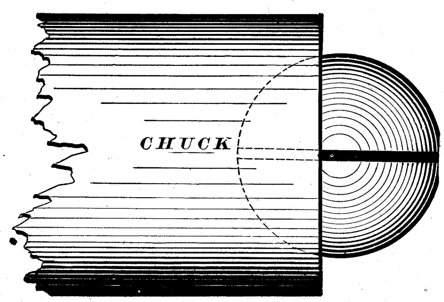

Fig. 1259.

finished by chucking them in a chuck such as shown in Fig. 1258,* and a narrow band, shown in black in the figure, is scraped, bringing the ball to the proper diameter. The ball is then reversed in the chuck, as in Fig. 1259, and scraped by hand until the turning marks cross those denoted by the black band. The ball is then reversed, so that the remaining part of the black band that is within the chuck in Fig. 1259 may be scraped down, and when by successive chuckings of this kind the lightest of scrape marks cross and recross each other when the ball is reversed, it may be finished by the ball cutter, applied as shown in Fig 1252.

* From *The American Machinist.*

and finally ground to its seat with the red-burnt sand from the foundry, which is better than flour emery or other coarser cutting grinding material.

CUTTING CAMS IN THE LATHE.—Fig. 1260 represents an end view of cam to be produced, having four depressions alike in form and depth, and arranged equidistant round the circumference, which is concentric to the central bore. The body of a cam is first turned up true, and one of the depressions is filed in it to the required form and curvature. On its end face there is then drilled the four holes, A, B, C, D, Fig. 1261, these being equidistant from the bore E. A similar piece is then turned up in the lathe, and in its end is fitted a pin of a diameter to fit the holes A, B, &c., it being an equal distance from bore E. These two pieces are then placed together, or rather side by side, on an arbor or mandrel, with the pin of the one fitting into one of the holes, as A. Two tool posts are then placed in position, one carrying a dull-pointed tool or tracer, and the other a cutting tool. The dull-pointed tracer is set to bear against the cam shown in Fig. 1262, while the cutting tool is set to take a cut off the blank cam piece. The cross feed screw of the lathe is disengaged, and a weight W, Fig. 1262, attached to the slider to pull the tracer into contact with the cam F. As a result, the slide rest is caused to advance to and recede from the line of lathe centres when the cam depression passes the tracer point, the weight W maintaining contact between the two. Successive cuts are taken until the tool cuts a depression of the required depth. To produce a second cam groove, the piece is moved on the mandrel so that the pin will fall into a second hole (as, say, B, Fig. 1261), when, by a repetition of the lathe operation, another groove is turned. The whole four grooves being produced by the same means, they must necessarily be alike in form, the depths being equal, provided a finishing cut were taken over each without moving the cutting tool.

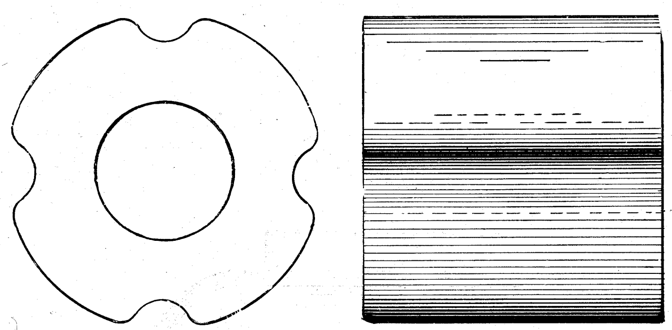

Fig. 1260.

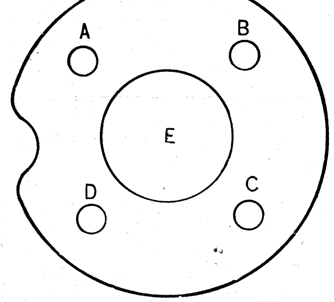

Fig. 1261.

It will be observed that this can be done in any lathe having a slide rest, and that the grooves cut in one piece will be an exact duplicate of that in the other, or guide groove, save such variation as may occur from the thickness of the tracer point, which may be allowed for in forming the guide or originating groove. From the wear, however, of the tracer point, and from having to move the cutting tool to take successive depths of cut, this method would be undesirable for continuous use, though it would serve excellently for producing a single cam. An arrangement for continuous use is shown in Fig 1263, applied to a lathe having a feed spindle at its back, with a cam G upon it. This cam G may be supposed to have been produced by the method already described. A tracer point H, or a small roller, may be attached to the end of the slide-rest and held against G by the weight W, which may be within the lathe shears if they have no cross girts, as in the case of weighted lathes. The slide-rest may be arranged to have an end motion slightly exceeding the motion, caused by the cam, of the tracer H. Change gears may then be used to cause the cam G to make one rotation per lathe rotation, cutting four recesses in the work; or by varying the rotations of G per lathe rotation, the number of recesses cut by the tool T may be varied. Successive depths of cut may then be put on by operating the feed screw in the ordinary manner. In this arrangement the depth and form of groove cut upon the work will correspond to the form of groove upon the cam-roller G; or each groove upon G being of a different character, those cut on the work will correspond. The wear on the cross slide will, in this case, be considerable, however, in consequence of the continuous motion of the tool-carrying slider, and to prevent this another arrangement may be used, it being shown in Fig. 1264 as applied to a weighted and elevating slide rest. The elevating part of the slide rest is here pivoted to the lathe carriage at I, the weight W preventing play (from the wear) at I. A bracket J is shown fast to the elevating slide of the rest, carrying a roller meeting the actuating cam G. In this arrangement the cut may be put on by the feed screw traversing the slider in the usual manner, or the elevating screw K may be operated, causing the roller at the end of J to gradually descend as each cut is put on into more continuous contact with G as the latter rotates. The form of groove cut by the tool does not, in this case, correspond to the form on G, because the tool lifts and falls in the arc of a circle of which pivot I is the centre of motion, and its radius from I being less than the radius of G, its motion is less. But in

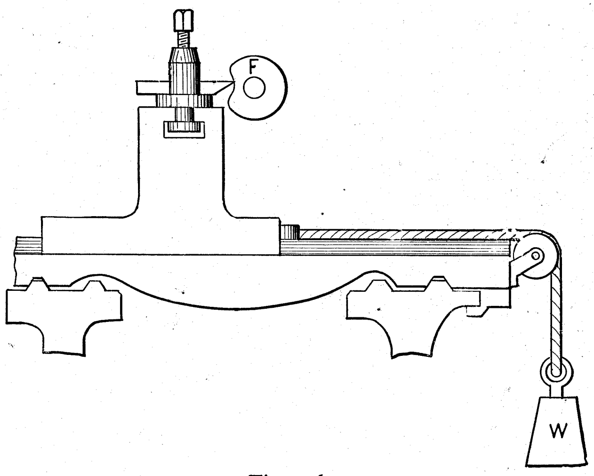

Fig. 1262.

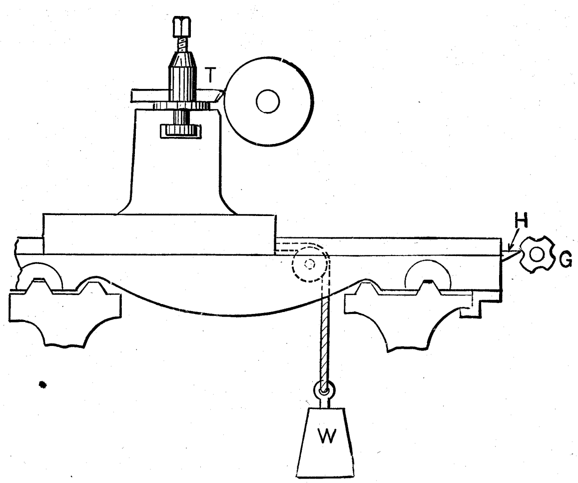

Fig. 1263.

addition to this the direction of its motion is not that of advancing and receding directly toward and away from the line of lathe centres, and the cam action is reduced by both these causes.

The location of pivot I is of considerable importance, since the nearer it is to the line of centres the less the action of the cam G is reduced upon the work. As this is not at first sight apparent, a few words may be said in explanation of it. It is obvious that the farther the pivot I is from the tool point the greater will be the amount of motion of the tool point, but this motion is not in a direction to produce the greatest amount of effect upon the work,

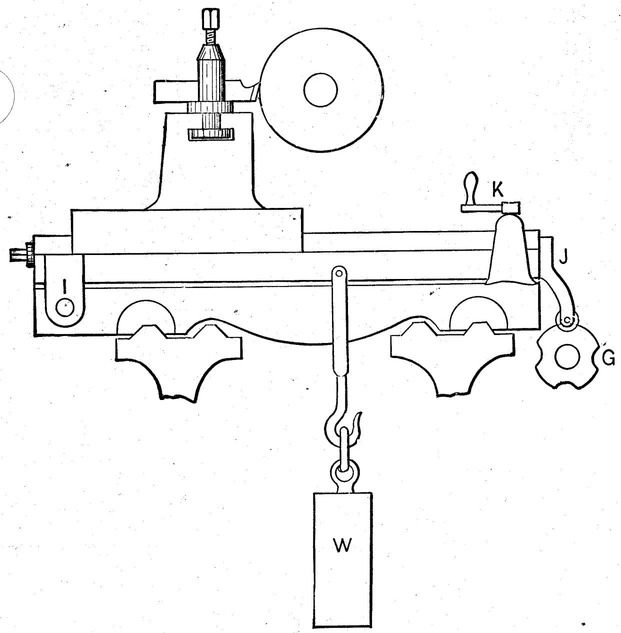

Fig. 1264.

as is demonstrated in Fig. 1265; referring to which, suppose line A B C to represent a lever pivoted at B, and that end A be lifted so that the lever assumes the position denoted by the dotted lines D and E, then the end of C will have moved from circle F to circle G, as denoted by arc H; arm C of the lever being one-half the length of arm A B, and from circle F to circle G, measured along the line H, being one-half the distance between A and the end of the line D, the difference in the diameters of circles F and G will represent the effect of the cam motion on the tool under these conditions. Now, suppose A J is a lever pivoted at K, and that end A is raised to the dotted line D, then arm J, being one-half the length of A K, will move half as much as end A, and will assume the position denoted by dotted line L, and the difference in the diameter of circles F and M will represent the cam motion upon the tool motion under these conditions. From this

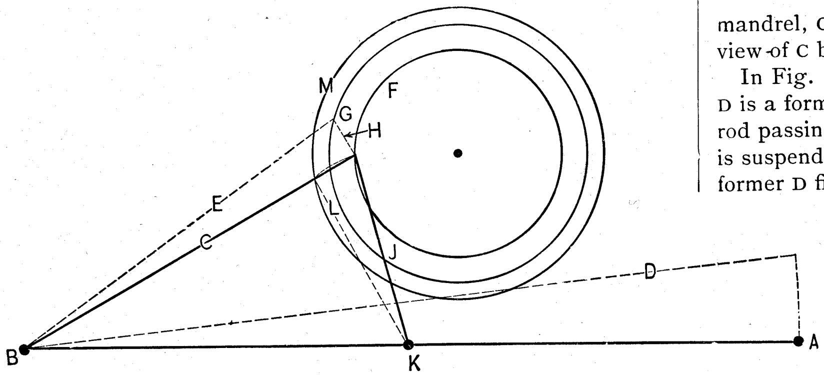

Fig. 1265.

it appears that the more nearly vertical beneath the tool point the pivoted point is, the greater the effect produced by a given amount of cam motion. On this account, as well as on account of the direction of motion, the shape of the actuating cam may be more nearly that of the form required to be produced in proportion as the pivoted centre falls directly beneath the tool point. But, on the other hand, the wear of the pivot, if directly beneath the tool point, would cause more unsteadiness to the tool; hence it is desirable that it be somewhere between points K and B, the location being so made that (B representing the pivoted point of the rest) the line B C forms an angle of 50° with the line B A. It is obvious that when the work is to be cam-grooved on a radial

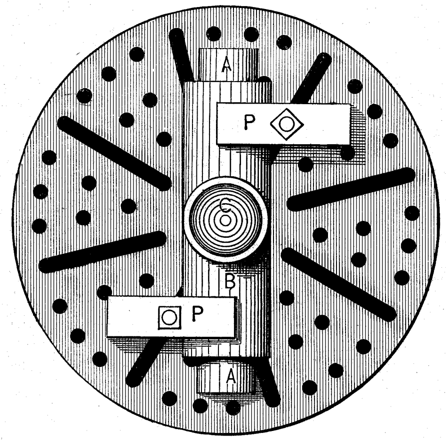

Fig. 1266

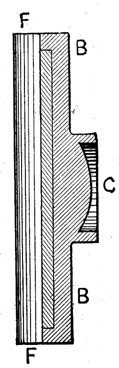

Fig. 1267.

face the pivoted design is unsuitable, and either that in Fig. 1262 or 1263 is suitable.

Similar cam motions may be given to the cross feed of a lathe: thus, the Lane and Bodley Company of Cincinnati, Ohio, employ the following method for turning the spherical surfaces of their swiveling bearings for line shafting.

The half bearing B, Fig. 1266, is chucked upon a half-round

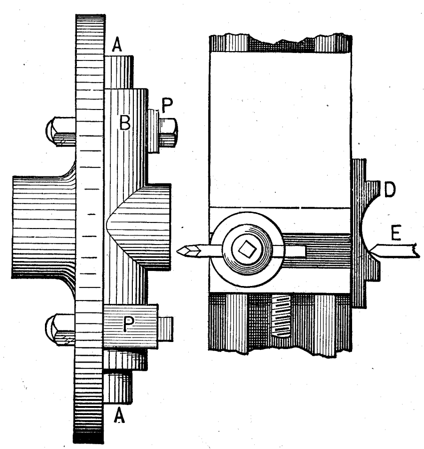

Fig. 1268.

mandrel, C being the spherical surface to be turned, a sectional view of C being shown in Fig. 1267.

In Fig. 1268 is a plan view of the chuck, work, and lathe rest; D is a former attachment bolted to the slider of the rest, and E a rod passing through the lathe block. The weight W, Fig. 1269, is suspended by a cord attached to the slide rest so as to keep the former D firmly against the end of E.

As the slider is operated, the rest is caused by E to slide upon the lathe bed, and the cutting tool forms a spherical curve corresponding to the curve on the former D. The weight W of course lifts or falls according to the direction of motion of the slider.

The cut is put on by operating handle G, thus causing E to advance.

The weight W causes any play between the slider and the cross slide to be taken up in the same direction as the tool pressure would take it up, hence the cut taken is a very smooth one. The half-round mandrel being fixed to the lathe face plate will remain true, obviating the liability of the centre of the spherical surface being out of line with the axis of the bearing-bore.

A method of producing cams without a lathe especially adopted for the purpose is shown in Figs. 1270 and 1272, which are extracted from *Mechanics*. The apparatus consists of a frame E, which fits on the cross ways of an ordinary lathe. The cross-feed screw is removed, so that E may slide backwards and forthwards freely. The frame E carries the worm-wheel A and the worm-gear B, which is operated by the crank F. The cam C to be cut is bolted on to the face of the worm-wheel, which faces the headstock of the lathe. The form for the cam, which may be made of sheet steel, or thicker material, according to the wear it is to have, is fastened to the face of the cam.

A cutter, like a fluted reamer, such as is shown in Fig. 1271, is then put in the live centre of the lathe. Care must be taken that the shank is the same size as the fluted part, and that the flutes are not cut up farther than the thickness that the cam grooves are to be cut in the blank. Having attached a cord to the back of E, pass it over a pulley H, fastened on the rear of the lathe, and

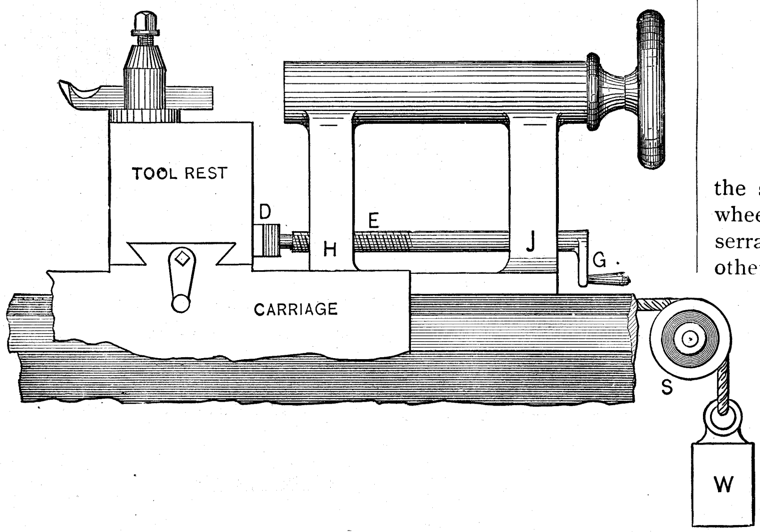

Fig. 1269.

hang on a weight G. Fig. 1272 is an edge view of the device, looking from the back of the lathe. It shows the worm A, blank C, and former D all bolted together, while the cutter I is ready in its place on a line with the centre of the worm, and just at back of the former. The machine is operated by turning the crank F,

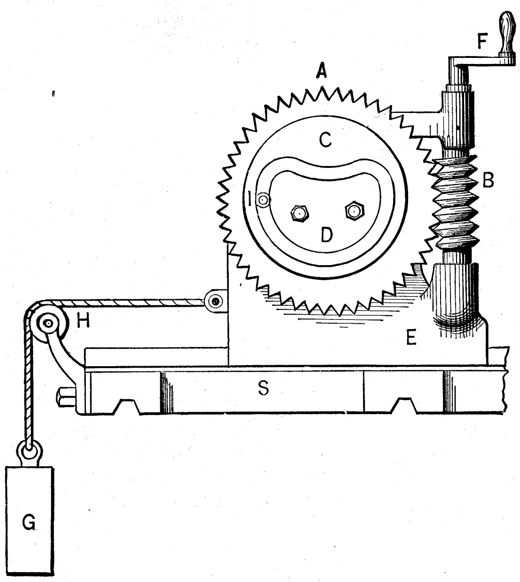

Fig. 1270.

which causes the worm A, also C and D, to revolve slowly, while the cutter I has a rather rapid rotation. The weight causes the cutter to be held firmly against the form F, and to follow its curves in and out.

Knurling or Milling Tools.—In Fig. 1273 is shown the method of using the knurling tool in the slide rest of a lathe. It represents the tool at work producing the indentations which are employed to increase the hand grip of screw heads, or of cylindrical bodies, as shown in the figure by the crossed lines. Fig. 1274 is an end view of the tool, which consists of a holder to go in

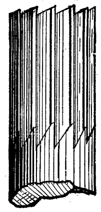

Fig. 1271.

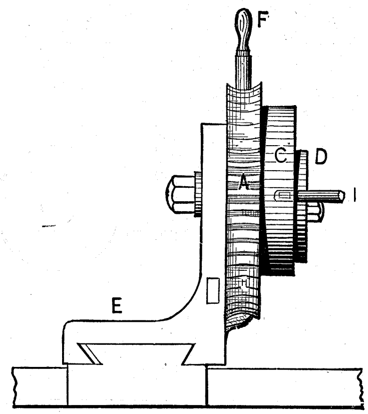

Fig. 1272.

the slide rest tool post, and carrying two small hardened steel wheels, each of which is serrated all round its circumference, the serrations of one being in an opposite direction to those of the other. The method of using the tool is shown in Fig. 1275, where it is represented operating upon a cylindrical piece of work. If the knurling is to be carried along the work to a greater length than the thickness of the knurl wheels, the lathe slide rest is slowly traversed the same as for a cutting tool.

As the knurling tool requires to be forced against the work with considerable pressure, there is induced a strain tending to force the tool directly away from the work, as denoted by the arrow in Fig. 1276, and this, in a weighted lathe, acts to raise the lathe carriage and weight. This is avoided by setting the tool at an angle, as in Fig. 1277, so that the direction of strain is below and not above the pivot on which the cross

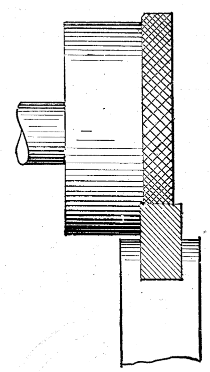

Fig. 1273.

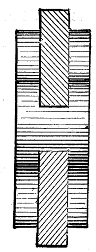

Fig. 1274.

slide rests. This is accomplished by pivoting the piece carrying the wheels to the main body of the stem, as shown in Fig. 1277.

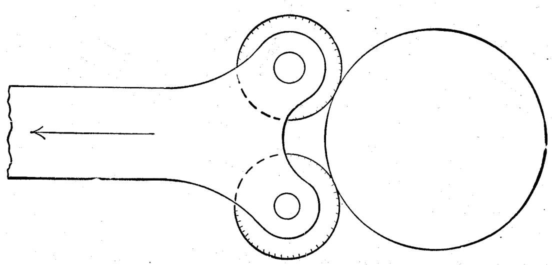

Fig. 1275.

For use by hand the knurling or milling tool is fitted to a holder and handle, as in Fig. 1278, and the hand tool rest is placed some little distance from the work so that the knurl can pass over it, and below the centre of the work.

Knurls for screw heads are made convex, concave, or parallel, to fit the heads of the screws, and may be indented with various patterns.

WINDING SPIRAL SPRINGS IN THE LATHE.—Spiral springs whose coils are close, and which therefore act on distension only,

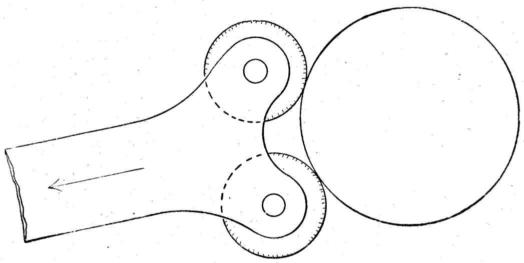

Fig. 1276.

may be wound by simply starting the first coil true, and keeping the wire as it winds on the mandrel close to that already wound thereon.

Spiral springs with open coils may be best wound as shown in Fig. 1279, in which is shown a mandrel held between the lathe

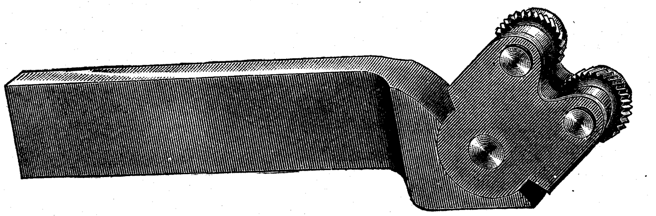

Fig. 1277.

centres and driven by a dog that also grips one end of the wire W, of which the spring is to be made. The wire is passed through two blocks B, which, by means of the set-screw in the lathe tool post, place a friction on it sufficient to place it under a slight tension which keeps it straight. The change gears of the lathe are arranged as they would be to cut a screw of a pitch equal to

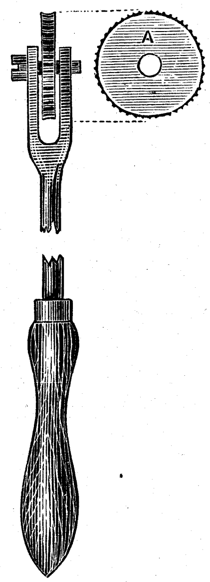

Fig. 1278.

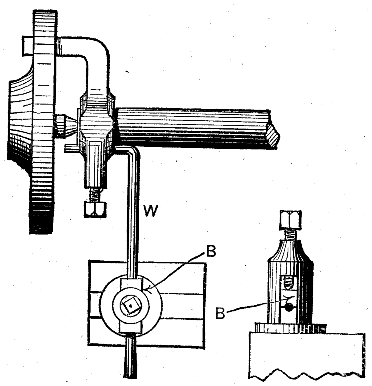

Fig. 1279.

the thickness of the wire added to the space there is to be between the coils of the spring. The first turn of the lathe should wind a coil straight round the mandrel when the self-acting feed motion is put in operation and the winding proceeds, and when the spring is sufficiently long, the feed motion is disconnected, and the last coil is allowed to wind straight round the mandrel, thus giving each end of the spring a flat or level end.

If the wire is of brass it will be necessary to close it upon the mandrel with blows from a lead mallet to prevent it from uncoiling on the mandrel when the end is released, which it will do to some extent in any event.

If it is of steel it may be necessary to heat the coil red-hot to prevent its uncoiling, and in the coiling it will, if of stout wire, require to be bent against the mandrel during winding with a piece of steel placed in the tool post, as in Fig. 1280, in which A

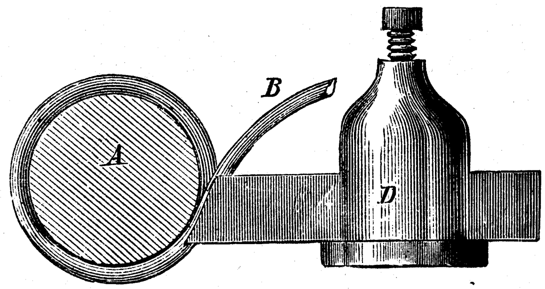

Fig. 1280.

represents the mandrel, B the spring wire, and D the lathe tool post.

In the absence of a lathe with a self-acting feed motion, the mandrel may have a spiral groove in it and the piece of steel or other hard metal shown in figure must be used, the feed screw of the slide rest being removed so that the wire can feed itself along as the mandrel rotates. Near one end of the mandrel a

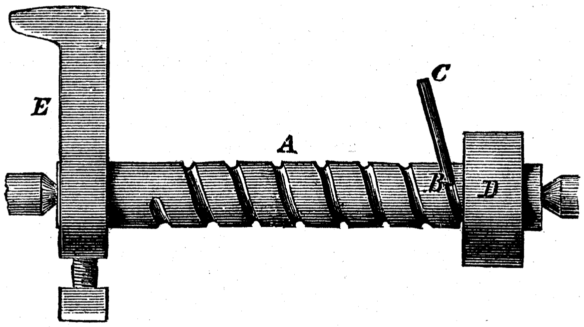

Fig. 1281.

small hole is drilled through, there being sufficient space between the hole and the end of the mandrel to admit of a loose washer being placed thereon; the bore of this washer requires to be rather larger in diameter than the outside diameter of the spring, when wound upon the mandrel, and also requires to be provided with a keyway and key. The washer D (Fig. 1281), is slipped over the mandrel, the end of the wire C is inserted in the hole B

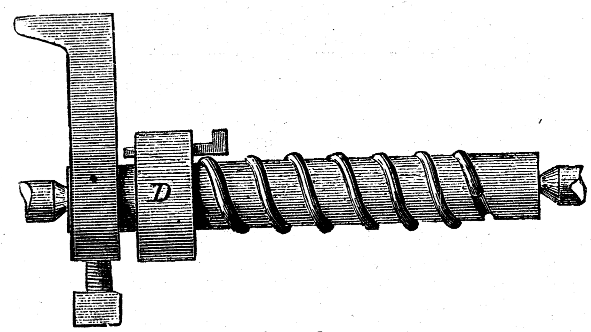

Fig. 1282.

and the spring being wound, the washer is passed up to the end, and the key driven home as in Fig. 1282; when the wire is cut off and the mandrel may be taken from the lathe with the spring closely wound round it to be hammered if of brass, and heated if of steel. The hammering should be done over the whole circumference, not promiscuously, but beginning at one end and following along the wire with the blows delivered not more than $\frac{1}{4}$ of an inch apart; for unless we do this we cannot maintain any definite relation between the size of the mandrel and the size of the spring.

When a grooved mandrel is used, its diameter should be slightly less than the required diameter of spring, as when released the coils expand in diameter.

If it is not essential that the coils be exactly true, take a plain mandrel, such as shown in Fig. 1283, and a hook, such as shown at A, fasten the end of the wire either round the lathe dog, or in a hole in the mandrel as before, and wind one full coil of the spring upon the mandrel, then force this coil open until the hook end of A can be inserted between it and over the mandrel, the other end hanging down between the lathe shears, which will

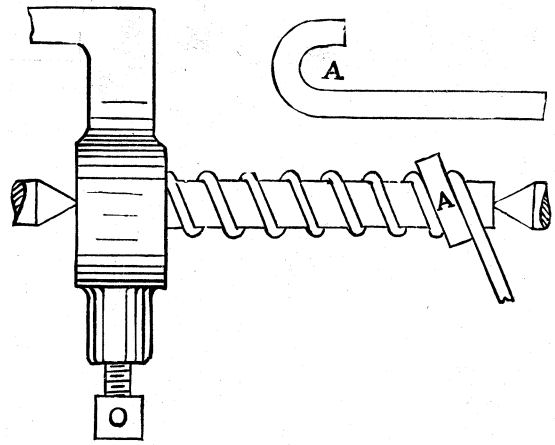

Fig. 1283.

prevent it from rotating, starting the lathe while holding the unwound end of the wire against the hook with a slight pressure, and the winding will proceed as shown in the figure, the thickness of A regulating the width apart of the coils. It is obvious that if the coil is to be a right-handed one and is started at the carrier end, the lathe must revolve backwards.

Spiral springs for railroad cars are wound while red-hot in special spring-winding lathes and with special appliances.

TOOLS FOR HAND TURNING.—Many of the tools formerly used in hand turning have become entirely obsolete, because they were suitable for larger work than any to which hand turning is now applied; hence, reference to such tools will be omitted, and only such hand tools will be treated of as are applicable to foot lathes and wood turning, their purposes being those for which hand tools are now used.

To the learner, practice with hand tools is especially advantageous, inasmuch as the strain due to the cut is felt by the

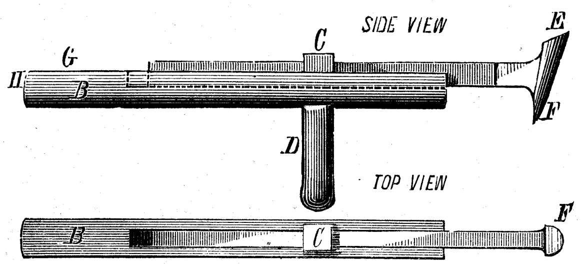

Fig. 1284.

operator; hence, the effects of alterations in the shape of the tools, its height or position with relation to the work, and also the resistance of the metal to severance, are more readily understood and appreciated than is the case where the tool is held in a slide rest or other mechanical device. If under certain conditions the hand tool does not operate to advantage, these conditions may be varied by a simple movement of the hands, altering the height of the tool to the work, the angle of the cutting edges to the work, or the rate of feed, as the case may be, and instantly perceiving the effects; whereas with tools held by mechanical means, such alterations would involve the expenditure of considerable time in loosening, packing, and fastening the tool, and adjusting it to position.

Small work that is turned by hand may, under exceptionally expert manipulation, be made as interchangeable and more accurate in dimensions than it could be turned by tools operated in special machines. That is to say, it is possible to turn by hand a number of similar small pieces that will be when finished as true, more nearly corresponding in dimensions, and have a finer finish, than it is practicable to obtain with tools operated or guided by parts of a machine. This occurs because of the wear of the cutting tools, which upon small work may be compensated for in the hand manipulation in cases where it could not be in machine manipulation. But with ordinary skill, and under ordinary conditions, the liability to error in hand work induces greater variation in the work than is due to the wear of the tool cutting edges in special machine work; hence, the practical result is that work made by special machinery is more uniform and true to size and shape than that made by hand, while also the quantity turned out by special machines is very much greater.

The most desirable form of tool for taking a heavy hand cut is the heel tool shown in Fig. 1284, which, it may be remarked, is at present but little used on account of the greater expedition of tools held in slide rests. It consists of a steel bar, about $\frac{3}{8}$ or $\frac{1}{2}$ inch square, forged with a heel at F, so that it may firmly grip the hand rest, and having a cutting edge at E. This bar is about 8 inches long, and is held in a groove in a wooden stock by a strap passing over it, and having a stem which passes down through the handle D, in which is fixed a nut, so that by screwing up or unscrewing D the bar is gripped or released, as the case may be, in a groove in the stock. In use, the end H of the stock is held firmly against the operator's shoulder, the left hand grasps the stock and presses the tool firmly down upon the face of the hand rest, while with the right the handle D is moved laterally, causing

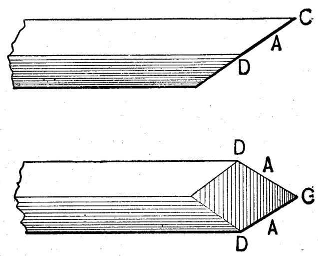

Fig. 1285.

the tool to move to its cut. The depth of the cut is put on and regulated by elevating the end H of the stock. The heel F is placed close enough to the work to keep E F nearly vertical, for if it inclines too much in any direction the tool gets beyond the operator's control. The position of the heel F is moved from time to time along the hand rest to carry the cut along.

A cut of $\frac{1}{8}$ inch deep, that is, reducing the work diameter $\frac{1}{4}$ inch, may readily be taken with this tool, which, however, requires skilful handling to prevent it from digging into the work.

The shorter the distance from the face E to the heel F the more easily the tool can be controlled; hence, as F serves simply as a sharp and gripping fulcrum it need not project much from the body of the steel; indeed, in many cases it is omitted altogether, the bottom of the steel bar being slightly hollowed out instead. No oil or water is required with the heel tool.

The hand rest should be so adjusted for height that the cutting edge of the tool stands slightly above the horizontal level of the work, a rule which obtains with all hand tools used upon wrought iron and steel.

The graver is the most useful of all hand turning tools, since it is applicable to all metals, and for finishing as well as roughing out the work. It is formed by a square piece of steel whose end is ground at an angle, as shown in the top and the bottom view, Fig. 1285, A A being the cutting edges, C C the points, and D D the heels.

It is held in a wooden handle, which should be long enough to grasp in both hands, so that the tool may be held firmly. For cutting off a maximum of metal in roughing out the work the graver is held as in Fig. 1286, the heel being pressed down firmly upon the tool rest. The cut is carried along the work by revolving the handle upon its axis, and from the right towards the left, at the same time that the handle is moved bodily from the left towards the right. By this combination of the two movements, if properly performed, the point of the graver will move in a line parallel to the centres of the lathe, because, while the twisting of the graver handle causes the graver point to move away from the centre of the diameter of the work, the moving of the handle bodily from left to right causes the point of the graver to approach

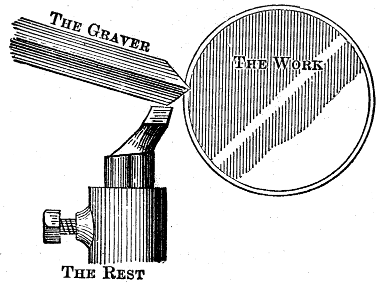

Fig. 1286.

the centre of that diameter; hence the one movement counteracts the other, producing a parallel movement, and at the same time enables the graver point to follow up the cut, using the heel as a pivotal fulcrum, and hence obviating the necessity of an inconveniently frequent moving of the heel of the tool along the rest. The most desirable range of these two movements will be very readily observed by the operator, because an excess in either of them destroys the efficacy of the heel of the graver as a fulcrum,

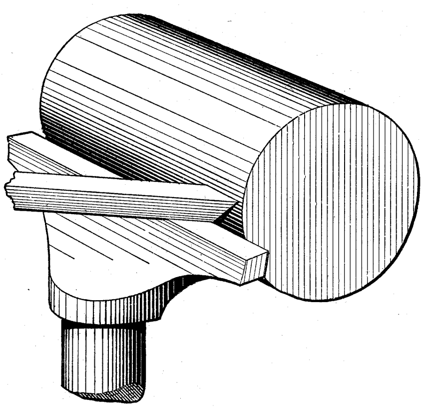

Fig. 1287.

and gives it less power to cut, and the operator has less control over the tool.

For finishing or smoothing the work the graver is held as in Fig. 1287, the edge being brought parallel to the work surface. For brass work the top faces of the graver should be slightly bevelled in the direction shown in Fig. 1288.

The graver cuts most efficiently with the work revolving at a fast speed, or, say, at about 60 feet per minute, and for finishing wrought iron or steel requires an application of water.

To finish work that has been operated upon by a heel tool or

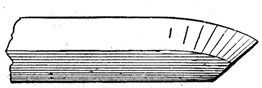

Fig. 1288.

by a graver, the finishing tool shown in Fig. 1289 may be employed. It is usually made about $\frac{5}{8}$ or $\frac{3}{4}$ inch wide, as the graver is employed for shorter work. It is ground so as not to let the extreme corners cut, and is used at a slow speed with water. The edge of this tool is sometimes oilstoned, causing it to cut with a clean polish. The tool is held level, brought up to the work, and a cut put on by elevating the handle end. To carry the cut forward, the tool is moved along the hand rest to nearly the amount of its width, and is brought to its cut by elevating the handle as before. When the work has been finished as near as may be with this tool, it may be finished by fine filing, the lathe running at its quickest speed; or the file may be used to show the high spots while using the finishing tool.

For facing the ends of work the tool shown in Fig. 1290, or that shown in Fig. 1291, may be used, either of them being made from an old three-cornered file. The cutting edge at A, Fig. 1290,

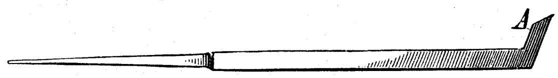

Fig. 1289.

should be slightly curved, as shown, The point of the tool is usually brought to cut at the smallest diameter of the work, with the handle end of the tool somewhat elevated. As the cut is carried outwards the handle end of the tool is depressed, and the point correspondingly elevated. It may be used dry or with water, but the latter is necessary for finishing purposes.

Another form of this tool is shown in Fig. 1291. It has two

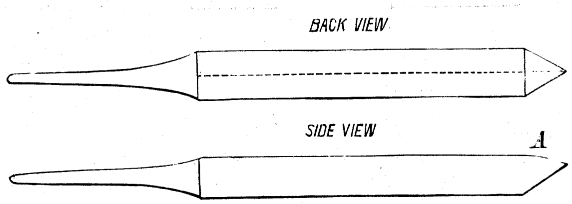

Fig. 1290.

cutting edges A A, one of which rests on the hand rest while the other is cutting, the tool being shown in position for cutting a right and a left-hand face, the face nearest to the work being shown in the lower view. This face should be placed against the radial face of the work, and the cut put on by turning the upper edge over towards the work while pressing the tool firmly to the lathe rest.

For cutting out a round corner the tool shown in Fig. 1292,

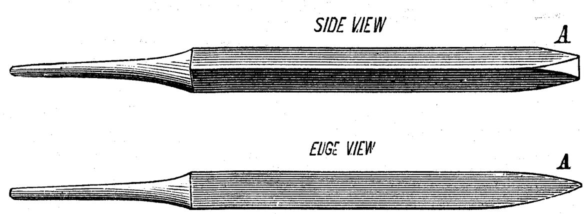

Fig. 1291.

employed either for roughing or smoothing purposes (water being used with it for the latter), the heel causes it to grip the hand rest firmly, and acts as a pivotal fulcrum from which the tool may be swept right and left round the curve, or a portion of it.

This tool, as in the case of all tools used upon wrought iron or steel, should not cut all round its edge simultaneously, as in that case, unless indeed it is a very narrow tool, the force placed upon it by the cut will be too great to enable the operator to hold and

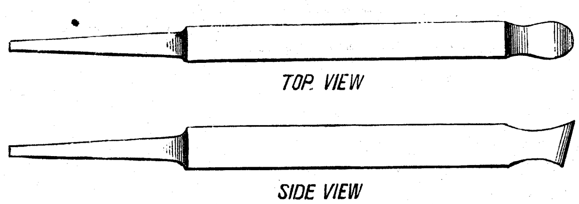

Fig. 1292.

control it; hence the cut should be carried first on one side and then on the other, and then at the point, or else the handle end should be moved laterally, so that the point sweeps round the work. It should be brought to its cut by placing its heel close to the work, and elevating the handle end until the cutting edge meets the work.

The point or nose of the tool may obviously be made straight or square, as it is termed, to suit the work, the top rake being omitted for brass work.

In using this tool for cutting a groove it is better (if it be a deep groove, and imperative if it be a broad one, especially if the work be slight and apt to spring) to use a grooving tool narrower in width than the groove it is to cut, the process being shown in Fig. 1293, in which W represents a piece of work requiring the two grooves at A and B cut in it. For a narrow groove as A the tool is made about half as wide as the groove, and a cut is taken first on one side as at C, and then on the other as at D. For a wider

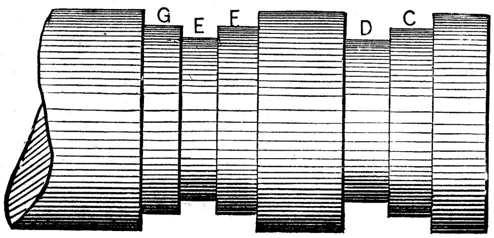

Fig. 1293.

groove three or more cuts may be made, as at E, F, G. In all cases the tool while sinking the groove is allowed to cut on the end face only; but when the groove is cut to depth, the side edges of the tool may be used to finish the sides of the groove, but the side and end edge must not cut simultaneously, or the tool will be liable to rip into the work.

HAND TOOLS FOR BRASS WORK.—In addition to the graver as a roughing-out tool for brass work, we have the tool shown in Fig. 1294, the cutting edge being at the rounded end A. It is held firmly to the rest, which is not placed close to the work (as in

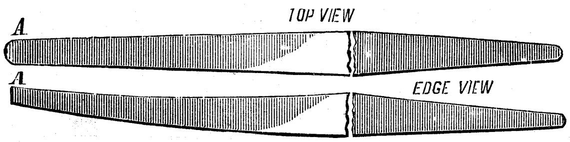

Fig. 1294.

the case of other tools), so as to give the tool a wide range of movement, and hence permit of the cut being carried farther along without moving its position on the rest. It may be used upon either internal or external work.

For finishing brass work, tools termed scrapers are employed.

Fig. 1295 represents a flat scraper, the two end edges A and the side edges along the bevel forming the cutting edges.

In this tool the thickness of the end A is of importance, since if it be too thin it will jar or chatter. This is especially liable to occur when a broad scraper is used, having a great length of

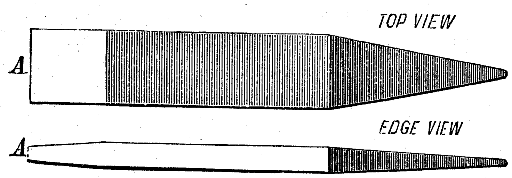

Fig. 1295.

cutting edge in operation. This may be obviated to some extent by inclining the scraper as in Fig. 1296, which has the same effect as giving the top face negative rake, causing the tool to scrape rather than cut. The dividing line between the cutting and scraping action of a tool is found in the depth of the cut, and the presentation of the tool to the work, as well as in the shape of the tool. Suppose, for example, that we have in Fig. 1297, a piece of work W and a tool S, and the cut being light will be a scraping one. Now suppose that the relative positions of the size of the work and of the tool remain the same, but that the cut be deepened as in Fig. 1298, and the scraping action is converted into that class of severing known as shearing, or we may reduce the depth of cut as in Fig. 1299, and the action will become a cutting one.

But let the depth of cut be what it may, the tool will cut and not scrape whenever the angle of its front face is more than 90° to the line of tool motion if the tool moves, or of work motion if the work

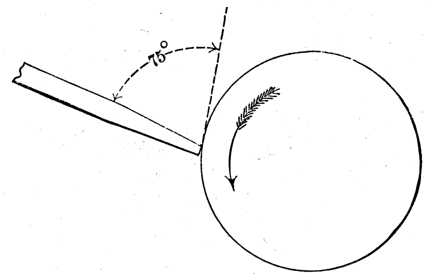

Fig. 1296.

moves to the cut. In Fig. 1300, for example, the tool is in position to cut the angle of the front face, being 110° to the direction of tool motion.

We may consider this question from another stand-point, however, inasmuch as that the tool action is a cutting one whenever the pressure of the cut is in a direction to force the tool deeper

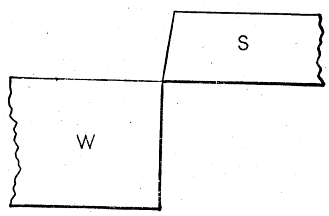

Fig. 1297.

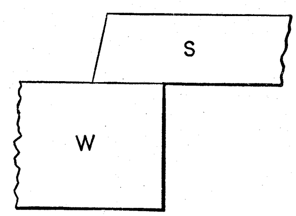

Fig. 1298.

into the work, and a scraping one whenever this pressure tends to force the tool away from the work, assuming of course that the tool has no front rake, and that the cut is light or a "mere scrape," as workmen say. This is illustrated in Fig. 1301, the tool at A acting to cut, and at B to scrape, and the pressure of the cut upon A acting to force the tool into the work as denoted by

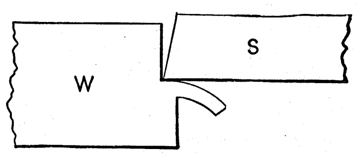

Fig. 1299.

the arrow D, while that upon B acts to force it in the direction of arrow C, or away from the work.

In addition to these distinctions between a cutting and a scraping action we have another, inasmuch as that if a tool is pulled or dragged to its cut its action partakes of a scraping one, no

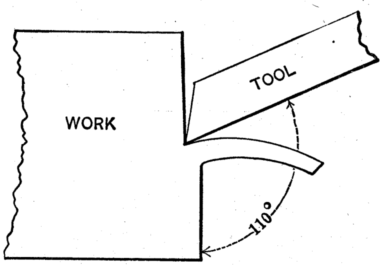

Fig. 1300.

matter at what angle its front face may stand with relation to the work.

The end face of a flat scraper should be at a right angle to the body of the tool, so that both edges may be equally keen, for if otherwise, as in Fig. 1302, one edge as A will be keener than the other and will be liable to jar or chatter.

The flat scraper can be applied to all surfaces having a straight outline, whether the work is parallel or taper, providing that there is no obstruction to prevent its application to the work.

Thus, in Fig. 1303 we have a piece of work taper at *a* and C,

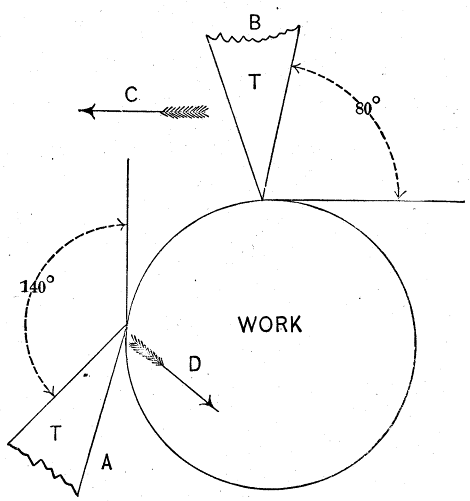

Fig. 1301.

parallel at *e*, and with a collar at *d*, the scraper S being shown applied to each of these sections, and it is obvious that it cannot be applied to section *a* because the collar *d* is in the way. This

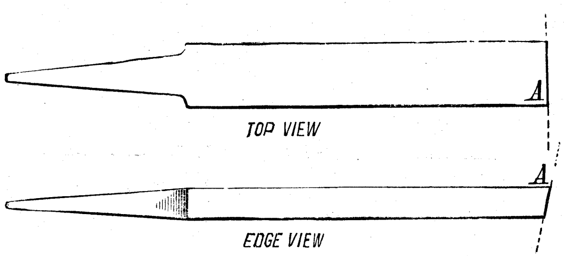

Fig. 1302.

is remedied by grinding the scraper as in Fig. 1304, enabling it to be applied to the work as in Fig. 1305. Another example of the use of a bevelled scraper is shown in Fig. 1306, the scraper S

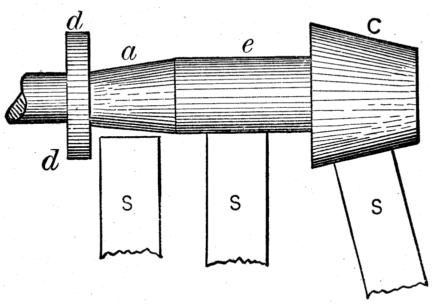

Fig. 1303.

having its cutting edge parallel to the work and well clear of the arm H.

The round-nosed scraper is used for rounding out hollow corners, or may be made to conform to any required curve or shape. It

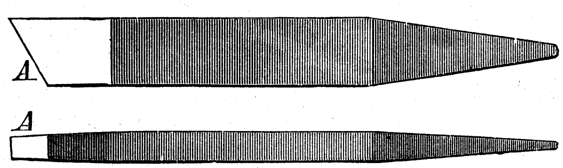

Fig. 1304.

is limited in capacity, however, by an element that affects all scraping tools, that if too great a length of cutting edge is brought into action at one time, chattering will ensue, and to prevent this the scraper is only made of the exact curvature of the work when it is very narrow, as at S in Fig. 1307.

For broad curves it is made of more curvature, so as to limit the length of cutting edge, as is shown in the same figure at S′, and is swept round the work so as to carry the cut around the curve.

There are, however, other means employed to prevent chattering,

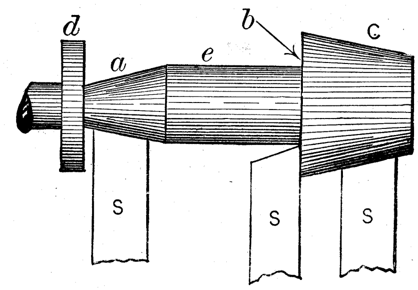

Fig. 1305.

and as these affect the flat scraper as well as the round-nosed one, they may as well be explained with reference to the flat one.

First, then, a thin scraper is liable to chatter, especially if used upon slight work. But the narrower the face on the end of the scraper, the easier it is to resharpen it on the oilstone, because there is less area to oilstone. A fair thickness is about $\frac{1}{20}$ inch;

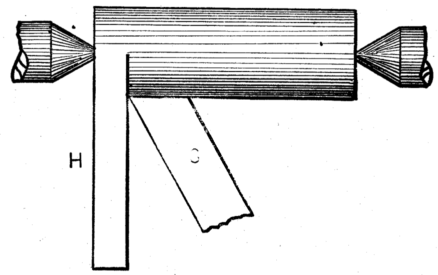

Fig. 1306.

but if the scraper was no thicker than this throughout its whole length, it would chatter violently, and it is for this reason that it is thinned at its cutting end only. Chattering is prevented in small and slight work by holding the scraper as in Fig. 1308, applying it to the top of the work; and to reduce the acting length of cutting edge, so as to still further avoid chattering, it is some-

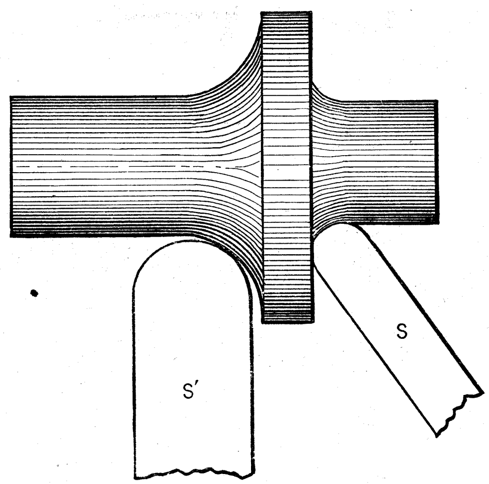

Fig. 1307.

times held at an angle as in the top view in Fig. 1309, S being the scraper and R the tool rest.

When the scraper is applied to side faces, or in other cases in which a great length of cutting edge is brought into action, a piece of leather laid beneath the scraper deadens the vibration and avoids chattering.

It is obvious that the scraper may be given any required shape to meet the work, Fig. 1310 representing a scraper of this kind; but it must in this case be fed endways only to its cut, if the work is to be cut to fit the scraper.

In Fig. 1311 is shown a half-round scraper, which is shown in

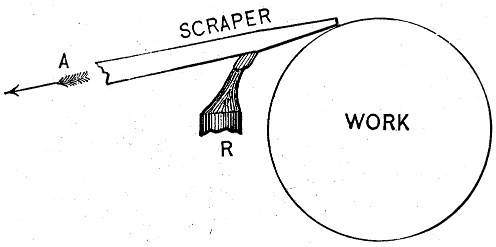

Fig. 1308.

Fig. 1312 in position to scrape out a bore or hole. This tool is made by grinding the flat face and the two edges of a worn-out half-round smooth file, and is used to ease out bores that fit too tightly. The cutting edges are carefully oilstoned, and the work revolved at a very quick feed.

When a number of small pieces of duplicate form are to be

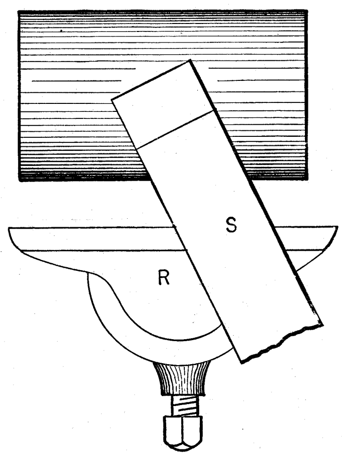

Fig. 1309.

turned by hand, a great deal of measuring may be saved and the work very much expedited by means of the device shown in Fig. 1313. It consists of a tool stock or holder, the middle of which, denoted by A, is square, and contains three or four square slots,

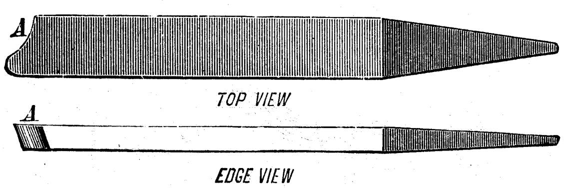

Fig. 1310.

with a set-screw to each slot to hold different turning tools. Each end of the stock is turned parallel, as denoted by B, C. In Figs. 1313 and 1314, D, E, and F are the tools, and G, H, are the set-screws.

Fig. 1315 represents top and side view of a plate, of which there

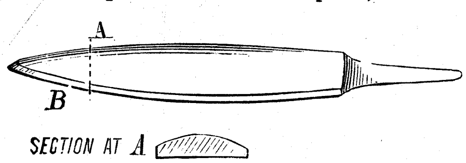

Fig. 1311.

must be two, one to fasten on the headstock and one on the tailstock of the lathe, as shown in Fig. 1316. In Fig. 1317 the manner of using the tool is shown, similar letters of reference denoting similar parts in all the figures.

The plates P P are bolted by screws to the headblock H and the tailstock T of the lathe. The tool holder is placed so that the cylindrical ends B, C, rest on the ends of these plates, and in the angles P′ P′. The cutting tool D is sustained, as shown, upon the lathe rest R. In use the operator holds the stock A in his hands in the most convenient manner, using the tool E as a handle when there is a tool in the position of E. The cutting point of the tool is pressed up to the work W, and the feed is carried along by

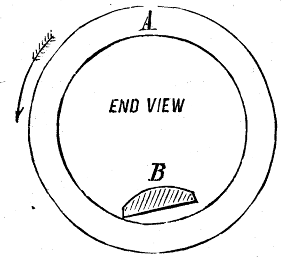

Fig. 1312.

hand. It is obvious, however, that when the perimeters of A B meet the shoulders O O, Fig. 1315, of the plates P P, the tool cannot approach any nearer to the diametrical centre of the work; hence the diameter to which the tool will turn is determined by the distance of the shoulder O of the plate P from the centre of the lathe centres, as shown in Fig. 1316 by the line L. In carrying the cut along it is also obvious that the lateral travel of the stock

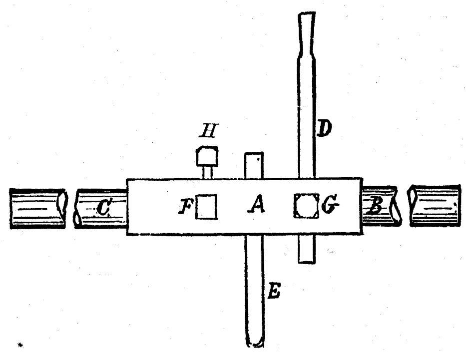

Fig. 1313.

or holder must end when the end of the square part A comes against the side face of either of the plates. In the engraving we have shown the tool D cutting a groove in the work W, while the shoulder of the holder is against the plate fastened to the lathe tailstock T; and so long as the operator, in each case, keeps the shoulder against that plate, the grooves upon each piece of work will be cut in the same position, for it will be observed that the

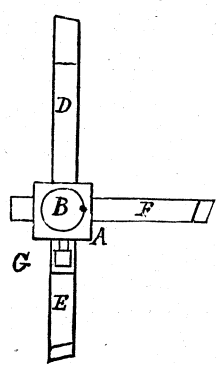

Fig. 1314.

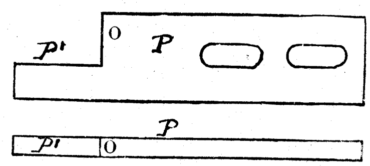

Fig. 1315.

position in the length of the work performed by each tool is determined by the distance of the cutting part of each tool from the end of the square part A of the tool holder. All that is necessary, then, is to adjust each tool so that it projects the proper distance to turn the requisite diameter and stands the required distance from the shoulders of the square to cut to the desired length, and when once set error cannot occur.

This plain description of the device, however, does not convey an adequate idea of its importance. Suppose, for example, that it is required to turn a number of duplicate pieces, each with a certain taper: all that is necessary is to adjust the plates P in their distances from the lathe centres. If the large end of the

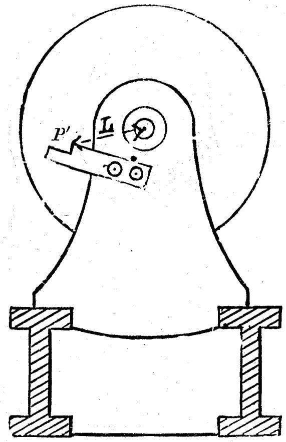

Fig. 1316.

taper on the work is required to stand nearest the lathe headstock A, the plate P on the headstock must be moved until its shoulder O is farther from the lathe centre. If, however, the work requires to be made parallel, the plates P must be set the same distance for the axial line of the centres. If it be desired to have

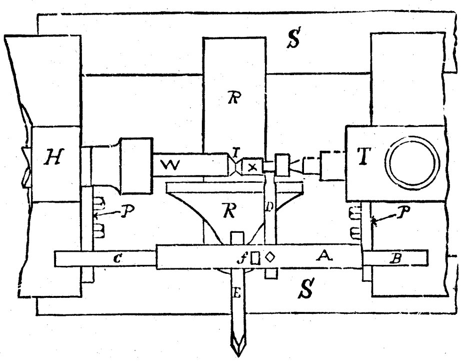

Fig. 1317.

a parallel and a taper in proximity upon the same piece of work, the tool must have one of its cylindrical ends taper and use it upon the taper part of the work.

In Fig. 1317 the tool D is shown cutting a square groove. The tool at *f* serves to turn the parallel part X, and the tool E would cut the V-shaped groove I.

All kinds of irregular work may be turned by varying the

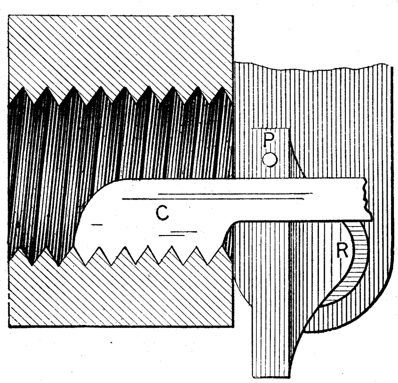

Fig. 1318.

parallelism and form of the cylindrical ends B C; but in this event the shoulders O O, Fig 1315, should be made V-shaped and hardened to prevent them from rapid wear.

SCREW CUTTING WITH HAND TOOLS.—Screw threads are cut by hand in the lathe with chasers, of which there are two kinds, the outside and the inside chaser. In Fig. 1319 is shown an outside, or male, and in Fig. 1318 an inside, or female chaser. The width of a chaser should be sufficient to give at least four teeth, and for the finer thread pitches it is better to have six or eight teeth, the number increasing as the pitch is finer, and the length of the work will permit. The leading tooth should be a

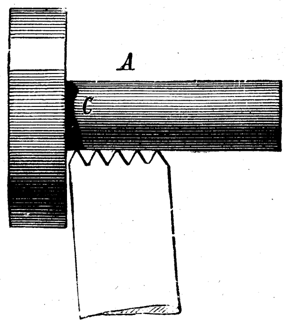

Fig. 1319.

full one, or otherwise it will break off, and if in cutting up the chaser a half or less than a full tooth is formed it should be ground off. The tooth points should not be in a plane at a right angle to the chaser length, but slightly diagonal thereto, as in Fig. 1319, so that the front edge of the chaser will clear a bolt head or shoulder, and permit the leading tooth to pass clear up to the head without fear of the front edge of the steel meeting the shoulder.

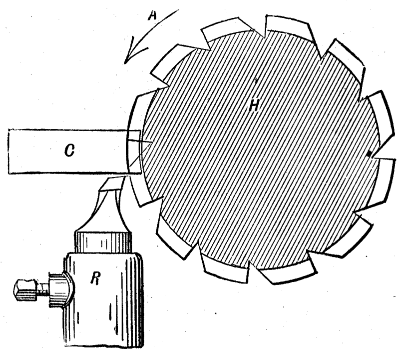

Fig. 1320.

The method of producing a chaser from a hob is shown in Fig. 1320, in which H is a hob, which is a piece of steel threaded and serrated, as shown, to give cutting edges to act, as the hob rotates, upon the chaser C. If the chaser is cut while held in a constant horizontal plane, its teeth will have the same curvature as the hob, or, in other words, they will fit its circumference. Suppose

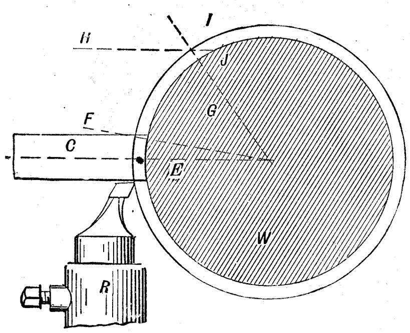

Fig. 1321.

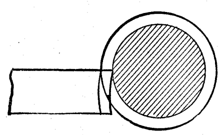

Fig. 1322.

that the chaser, being cut up by the hob and then hardened, is applied to a piece of work of the same diameter as the hob and held in the same vertical plane, as in Fig. 1320, it is obvious that, there being no clearance, the teeth cannot cut. Or, suppose it be applied to a piece of work of smaller diameter, as in Fig. 1334, it cannot cut unless its position be lowered, as in Fig. 1322, or else it must be elevated, as in Fig. 1323. In either case the angle of the thread cut will be different from the angle of the sides of the chaser teeth, and the thread will be of improper depth. Thus, on referring to Fig. 1321, it will be seen that the chaser C has a tooth depth corresponding to that on the work W along the horizontal dotted line E only, because the true depth of thread on the work is its depth measured along a radial line, as line F or G, and the chaser teeth are, at the cutting edge, of a different angle. This becomes more apparent if we suppose the chaser thickness to be extended up to the dotted line H, and compare that part of

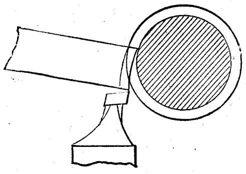

Fig. 1323.

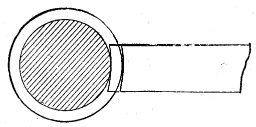

Fig. 1324.

its length that lies within the two circles I J, representing the top and bottom of the thread, with the length of radial line G, that lies within these circles. If, then, the chaser be lowered, to enable it to act, it will cut a thread whose sides will be of more acute angle than are the sides of the chaser teeth or of the hob from which it was cut. The same effect is caused by using a chaser upon a larger diameter of work than that of the hob from which the chaser was cut, because the increased curvature of the chaser teeth acts to give the teeth less contact with the work, as

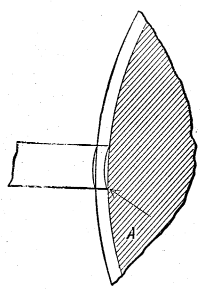

Fig. 1325.

is shown in Fig. 1325, for the teeth cannot cut without either the lower corners A of the teeth being forced into the metal, or else the chaser being tilted to relieve them of contact. To obviate these difficulties and enable a chaser to be used upon various diameters of work, it is, while being cut up by the hob, moved continuously up and down, as denoted in Fig. 1326, by A and B, which represent two positions of the chaser. The amount of this movement is sufficient to make the chaser teeth more straight in their lengths, and to give them a certain amount of clearance, an

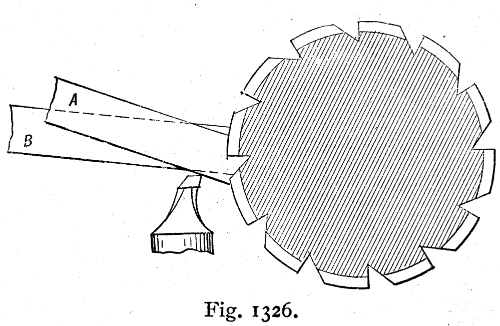

Fig. 1326.

example of the form of chaser thus produced being shown in Fig. 1327, applied to two different diameters of work, as denoted by the circle A and segment of a circle B, C representing the chaser.

To obtain the most correct results with such a chaser, it must be applied to the work in such a way that it has as little clearance as will barely enable it to cut, because it follows from what has been said with reference to single-pointed threading tools that to whatever amount the chaser has clearance, a corresponding error of thread angle and depth is induced. In hand use, therefore, it does not matter at what height the chaser is applied so long as it is elevated sufficiently to barely enable it to cut.

After the chaser is cut on the hob, its edges, as at C, and the corner, as at D, in Fig. 1328, should be rounded off, so that they

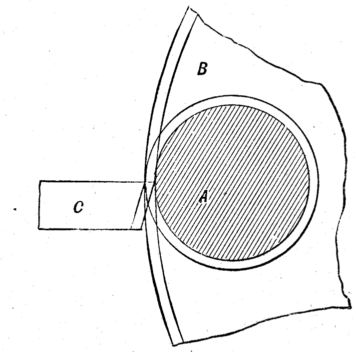

Fig. 1327.

may not catch in any burr which the heel of the hand tools may leave on the surface of the hand rest.

For roughing out the threads on wrought iron or steel the top face should be hollowed out, as shown in Fig. 1328, which will enable the chaser to cut very freely. For use on cast iron the top face should be straight, as shown in Fig. 1328 at A, while for use on

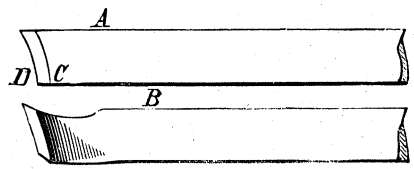

Fig. 1328.

soft metal, as brass, the top face must be ground off, as shown in Fig. 1329.

The Pratt and Whitney Co. cut up chasers by the following method: In place of a hob, a milling cutter is made, having concentric rings instead of a thread. The cutters are revolved on a milling machine in the ordinary manner. The chaser is fastened in a chuck fixed on the milling machine table, and stands at an

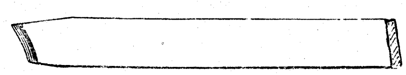

Fig. 1329.

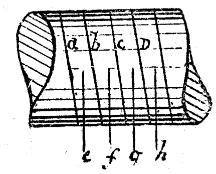

Fig. 1330.

angle of 15°. It is traversed beneath the milling cutter, and thus cut up with teeth whose lengths are at a right angle to the top and bottom faces of the chaser; hence the planes of the length of the teeth are not in the same plane as that of the grooves of the thread to be cut. Thus, let *a*, *b*, *c*, and *d*, Fig. 1330,

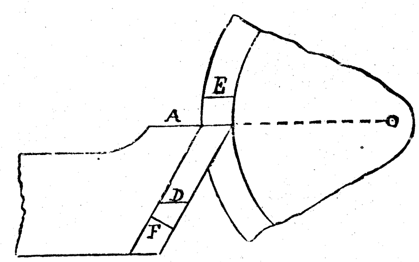

Fig. 1331.

represent the planes of the thread on the work, and *e*, *f*, *g*, *h*, will be the planes of the lengths of the chaser teeth.

The chaser, however, is given 15° of bottom rake or clearance, and this causes the sides of the chaser teeth to clear the sides of the thread.

Now, suppose the top face A, Fig. 1331, of the chaser to be parallel with the face of the tool steel, and to lie truly horizontal and in the same plane as the centre of the work. This clearance will cause the thread cut by the chaser to be deeper than the natural depth of the chaser teeth. Thus, in Fig. 1331 is shown a chaser (with increased clearance to illustrate the point desired), the natural depth of whose thread is represented by the line F, but it is shown on the section of work that the thread cut by the tool will be of the depth of the line D, which is greater than

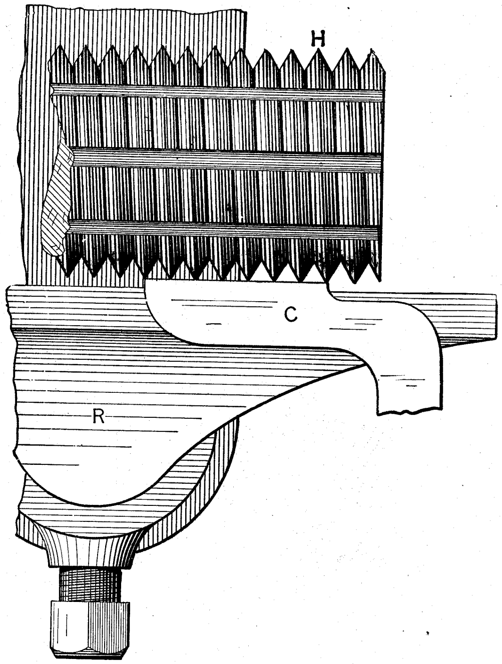

Fig. 1332.

the length or depth of F, as may be more clearly observed by making a line E, which, being parallel to A, is equal in length to D, but longer than F. Hence, the clearance causes the chaser under these conditions to cut a thread of the same pitch, but deeper than the grooves of the hub, and this would alter the angles of the thread. This, however, is taken into account in forming the angles of the thread upon the milling cutter, and, therefore, of the chaser, which are such that with the tool set level with the

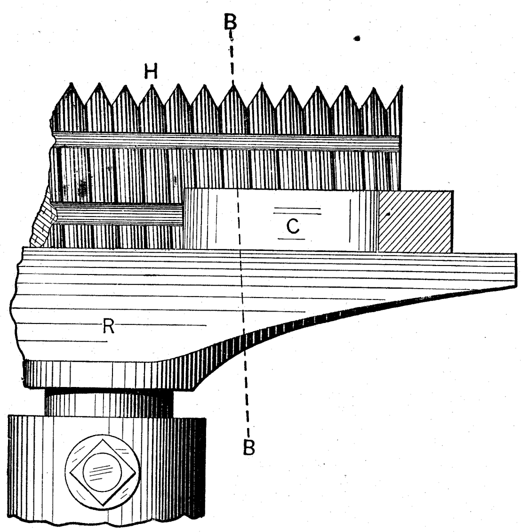

Fig. 1333.

work centre, the thread cut will be of correct angle, notwithstanding the clearance given to the teeth.

In order to enable the cutting of an inside chaser from a hub, it requires to be bent as in Fig. 1332, in which H is the hub, R the lathe rest, and C the chaser. After the chaser is cut, it has to be straightened out, as shown in Fig. 1318, in which is represented a washer being threaded and shown in section; C is the chaser and R

the lathe rest, while P is a pin sometimes let into the lathe rest to act as a fulcrum for the back of the chaser to force it to its cut, the handle end of the chaser being pressed inwards.

When an inside chaser is cut from a hub (which is the usual method) or male thread, its teeth slant the same as does the male thread on the side of the hub on which it is cut, and in an opposite direction to that of the thread on the other side of the hub. Thus, in Fig. 1333, H is the hub, C the chaser, and R the lathe rest. The slope of the chaser-teeth is shown by the dotted line B. Now, the slant of the thread on the half circumference of the hub not shown or seen in the cut will be in an opposite direction, and in turning the chaser over from the position in which it is cut (Fig. 1333) to the position in which it is used (Fig. 1334), and applying it from a male to a female thread, we reverse the direction with

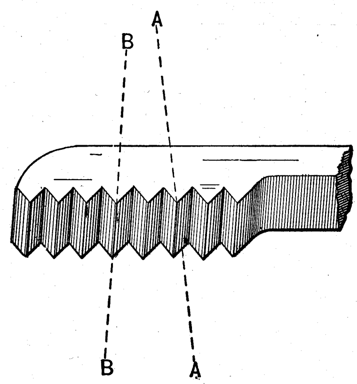

Fig. 1334.

relation to the work in which the chaser-teeth slant; or, in other words, whereas the teeth of the chaser should lie as shown in Fig. 1334 at A A, they actually lie as denoted in that figure by the dotted line B B. As a consequence, the chaser has to be tilted over enough to cause the sides of the chaser-teeth to clear the sides of the thread being cut, which, as they lie at opposite angles, is sufficient to cause the female thread cut by the chaser to be perceptibly shallower than the chaser-teeth, for reasons which have been explained with reference to Fig. 1321. It may be noted however, that an inside chaser cannot well be used with rake, hence the tilting in this case makes the thread shallower instead of deeper.

To obviate these difficulties the hub for cutting a right-hand inside chaser should have a left-hand thread upon it, and *per*

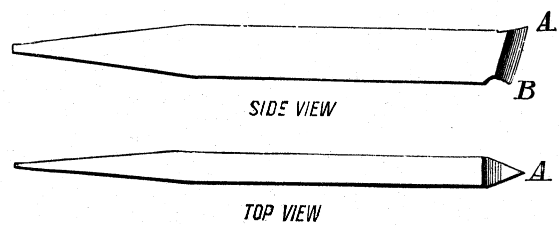

Fig. 1335.

contra, an inside chaser for cutting a left-hand thread should be cut from a hub having a right-hand thread.

The method of starting an outside thread upon wrought iron or steel to cut it up with a chaser is as follows :—

The work is turned up to the required diameter, and the V-tool shown in Fig. 1335 is applied; the lathe is run at a quick speed, and the heel of the tool is pressed firmly to the face of the lathe rest, the handle of the tool must be revolved from right to left at the same time as it is moved laterally from the left to the right, the movement being similar to that already described for the graver, save that it must be performed more rapidly. It is in fact the relative quickness with which these combined movements are performed which will determine the pitch of the thread. The appearance of the work after striking the thread will be as shown in Fig. 1336, A being the work, and B a fine groove cut upon it by the V-tool.

The reason for running the lathe at a comparatively fast speed is that the tool is then less likely to be checked in its movement by a seam or hard place in the metal of the bolt, and that, even if the metal is soft and uniform in its texture, it is easier to move the tool at a regular speed than it would be if the lathe ran comparatively slowly.

If the tool is moved irregularly or becomes checked in its forward movement, the thread will become waved or "drunken"—that is, it will not move forward at a uniform speed; * and if the thread is drunken when it is started, the chaser will not only fail to rectify it, but, if the drunken part occurs in a part of the iron either harder or softer than the rest of the metal, the thread will become

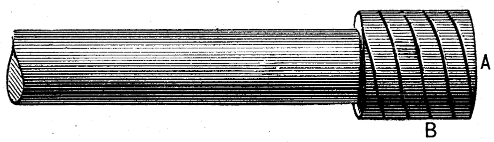

Fig. 1336.

more drunken as the chaser proceeds. It is preferable, therefore, if the thread is not started truly, to try again, and, if there is not sufficient metal to permit of the starting groove first struck being turned out, to make another farther along the bolt. It takes much time and patience to learn to strike the requisite pitch at the first trial; and it is therefore requisite for a beginner to leave the end of the work larger in diameter than the required finished size, as shown in Fig. 1336, so as to have sufficient metal to turn out the groove cut by the V-tool at the first trial cut, and try again.

If the thread is to be cut on brass the V-tool must not have any top rake. Some turners start threads upon brass by placing the chaser itself against the end of the work and sweeping it rapidly from left to right (for a right-hand thread), thus obviating the use of the V-tool.

In all cases the work should be rounded off at the end to prevent the chaser-teeth from catching.

In applying the chaser to the groove cut by the V-tool the leading tooth should be held just clear of the work at first, and only be brought to touch the work after the rear teeth have found and are traversing in the groove. By this means the chaser will carry the thread forward more readily and true. The thread must be carried forward but a short distance at each passage of the chaser, gradually deepening the thread while carrying it forward.

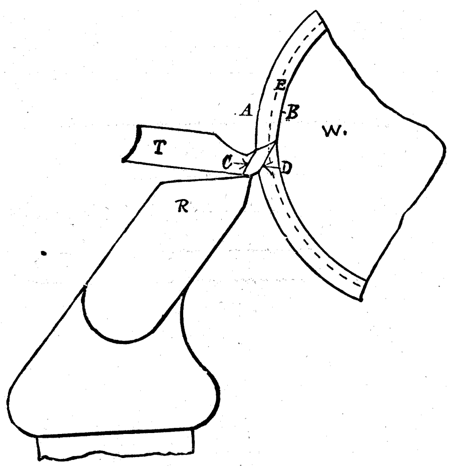

Fig. 1337.

To start an inside thread the corner of the hole at its entrance should be rounded off and the back teeth of the chaser placed to touch the bore while the front teeth are clear. The lathe is to be run at a quick speed, and the chaser moved forward at as near the proper speed as can be judged. When the chaser is moved at the proper speed, the rear teeth will fall into the fine grooves cut by the advance ones, and start a thread, while otherwise promiscuous grooves only will be cut. It is an easy matter, however, to start a double thread with an inside chaser; hence, when the thread is started the lathe should be stopped and the thread examined.

* See Fig. 253, Plate II., Vol. I.

The chaser should be placed with its top face straight above the horizontal level of the work and held quite horizontal, and the handle end then elevated just sufficient to give the teeth clearance enough to enable them to cut; otherwise, with a chaser having top rake, the thread cut will be too deep, and its sides will be of improper angle one to the other.

Thus, in Fig. 1337, W represents a piece of work, R the lathe rest, and T the chaser. The depth of the thread cut in this case will be from the circle A to the circle B; whereas the depth of the chaser teeth, and therefore the proper depth for the thread, is from C to D. Thus tilting the handle end of the chaser too much has caused the chaser teeth to cut a thread too deep. If on brass work the chaser has its top face ground off as in figure, tilting the handle too much will cause the thread cut to be too shallow, and in both cases the error in thread depth induces a corresponding error in the angles of the sides of the thread one to the other and relative to the axial line of the bolt or work.

If the chaser teeth are held at an angle to the work surface, the thread cut will be of finer pitch than the chaser, and the angles of the sides of the thread on the work will not be the same as those of the teeth. It is permissible, however, during the early cuts taken with a hand chaser to give the chaser a slight

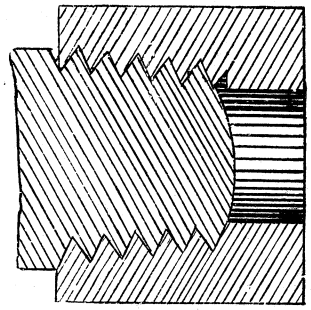

Fig. 1338.

degree of such angle, because it diminishes the length of cutting edge, and causes the chaser to cut more freely, especially when the pitch of the thread is coarse and the chaser is becoming dull.

In the case of a taper thread the same rule, that the thread may be roughed out with the chaser teeth at an angle to the surface lengthways of the work, but must be finished with the teeth parallel to the surface, holds good.

Thus, in Fig. 1338 is a taper plug fitting in a ring having a threaded taper bore, the threads matching, and having the thread sides in both cases at an equal angle to the surface, lengthways of the work, though the tops and bottoms of the thread are not parallel with the axial line of the work.

WOOD TURNING TOOLS.—Wood turning in the ordinary lathe is generally performed by hand tools, and of these the principal is the gouge, which in skillful hands may be used to finish as well as to rough out the work (although there are other more useful finishing tools to be hereafter described).

It is used mainly, however, to rough out the work and to round out corners and sweeps. The proper form for this tool is shown in Fig. 1339, the bevel on the end of the back or convex side being carried well round at the corners, so as to bring those corners up to a full sharp cutting edge on the convex or front side.

The proper way to hold a gouge is shown in Fig. 1340, in which the cut taken by the tool is being carried from right to left, the face plate of the lathe being on the left side, so that by holding it in the manner shown the body and arms are as much as possible out of the way of the face plate, which is a great consideration in short work. But if the cut is to be carried from left to right, the relative position of the hands may be changed.

When the work runs very much out of true, or has corners upon it, as in the case of square wood, the forefinger may be placed under the hand rest, and the thumb laid in the trough of the gouge, pressing the latter firmly against the lathe rest to prevent the tool edge from entering the work too far, or, in other words, to regulate the depth of the cut, and prevent its becoming so great as to force the tool from the hands or break it, as is sometimes the case under such circumstances. When the gouge is thus held, its point of rest upon the lathe rest may be used as a fulcrum, the tool handle being moved laterally to feed it to the cut, which is a very easy and safe plan for learners to adopt, until practice gives them confidence. The main point in the use of the gouge is the plane in which the trough shall lie. Suppose,

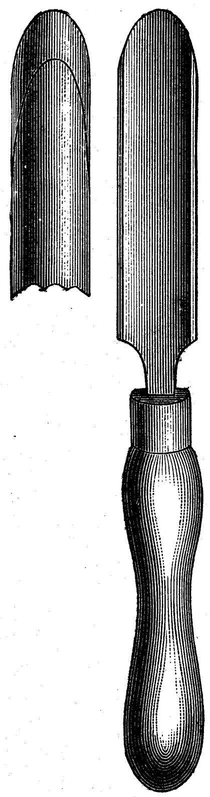

Fig. 1339.

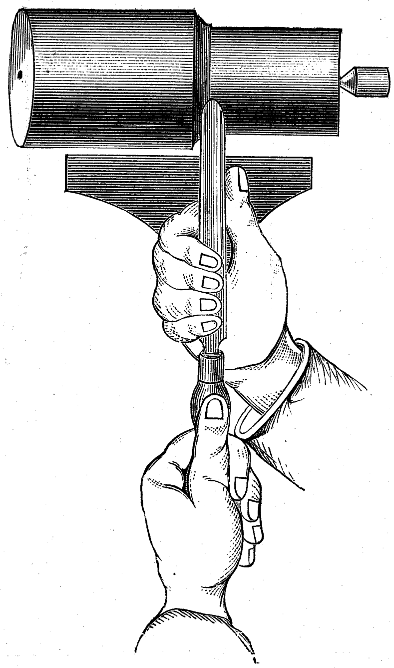

Fig. 1340.

for example, that in Fig, 1341 is shown a piece of work with three separate gouge cuts being taken along it, that on the right being carried in the direction of the arrow. Now the gouge merely acts as a wedge, and the whole of the pressure placed by the cut on the trough side or face of the gouge is tending to force the gouge in the direction of the arrow, and therefore forward into its cut, and this it does, ripping along the work and often throwing it out of the lathe. To avoid this the gouge is canted, so that when cutting from right to left it lies as shown at B, in which case the pressure of the cut tends rather to force the gouge back from the cut, rendering a slight pressure necessary to feed it forward. The gouge trough should lie nearly horizontal lengthwise, the cutting edge being slightly elevated. The gouge should never (for turning work) be ground in the trough (as the concave side is termed), and should always be oilstoned, the trough being stoned with a slip of stone lying flat along the trough, the back being rotated upon

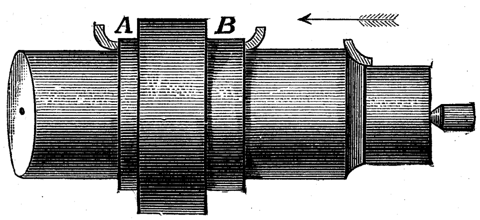

Fig. 1341.

a piece of flat stone, and held with the ground surface flat on the surface of the stone, and so pressed to it as to give most pressure at and near the cutting edge.

For finishing flat surfaces, the chisel shown in Fig. 1342 is employed. It should be short, as shown. It should be held to the work in a horizontal position, or it is apt to dig or rip into the work, especially when it is used upon soft wood. Some expert workmen hold it at an angle for finishing purposes, which makes it cut very freely and clean, but increases the liability to dig into the work; hence learners should hold it as shown.

Another excellent finishing tool is the skew-chisel, Fig. 1343, so

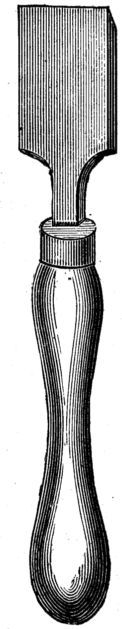

Fig. 1342.

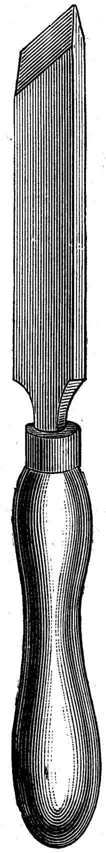

Fig. 1343.

called because its cutting edge is at an angle, or askew with the body of the tool. This tool will cut very clean, leaving a polish on the work. It also has the advantage that the body of the tool may be kept out of the way of flanges or radial faces when turning

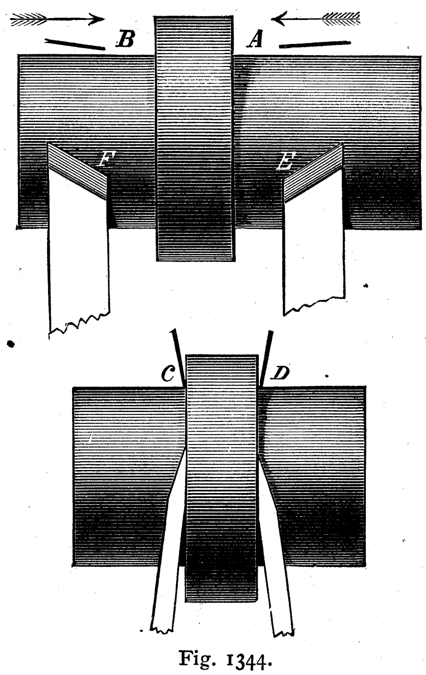

Fig. 1344.

cylindrical work, or may, by turning it on edge, be used to finish radial faces. It is shown in Fig. 1343 by itself, and in Fig. 1344 turning up a stem. It is held so that the middle of the edge does the cutting, and this tends to keep it from digging into the work. The bevels forming the cutting edge require to be very smoothly oilstoned.

The whole secret of the skillful and successful use of this valuable tool lies in giving it the proper inclination to the work. It is shown in Fig. 1344, at E, in the proper position for taking a cut from right to left, and at F in position for taking a cut from left to right. The face of the tool lying on the work must be tilted over, for E as denoted by line A, and for F as denoted by the line B, the tilt being only sufficient to permit the edge to cut. If tilted too much it will dig into the work; if not tilted, the edge will not meet the work, and therefore cannot cut. For cutting down the ends of the work, or down a side face, it must be tilted very slightly, as denoted in figure by C D, the amount of the tilt regulating the

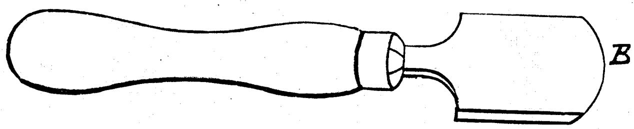

Fig. 1345.

depth of the cut, so that when the cutting edge of the tool has entered the wood to the requisite depth, the flat face of the tool will prevent the edge from entering any deeper. In cutting down a radial face the acute corner of the tool leads the cut, whereas in in plain cylindrical work the obtuse is better to lead.

For cutting down the ends, for getting into small square corners, and especially for small work, the skew chisel is more handy than the ordinary chisel, and leaves less work for the sand-paper to do. Beginners will do well to practise upon black walnut, or any wood that is not too soft, roughly preparing it with an axe to something near a round shape.

For finishing hollow curves the tool shown in Fig. 1345 is employed, the cutting edge being at B; the degree of the curve determines the width of the tool, and, for internal work the tool is usually made long and without a handle.

The tool shown in Fig. 1346 is employed in place of the gouge in cases where the broad cutting edge of the latter would cause tremulousness. It may be used upon internal or external work, being usually about two feet long. For boring purposes, the tools

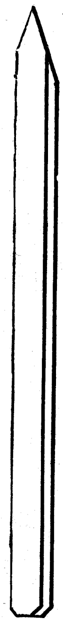

Fig. 1346.

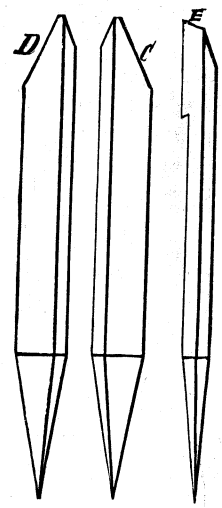

Fig. 1347.

shown in Fig. 1347 are employed, the cutting edges being from the respective points along the edges C, D, respectively. But when the bore is too small to admit of the application of tools having their cutting edges on the side, the tool shown in Fig. 1347 at E is employed, which has its cutting edge on the end.

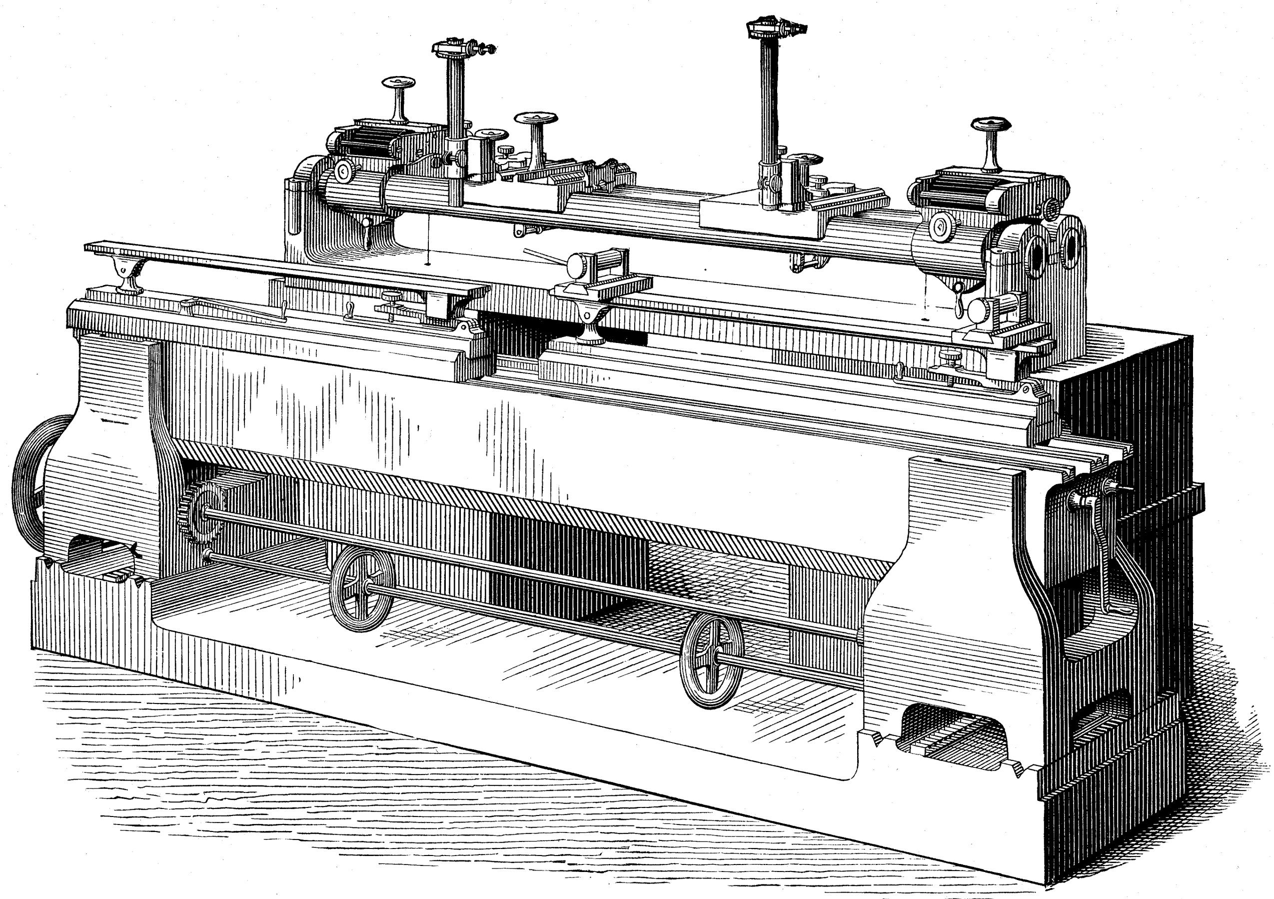

Fig. 1348.

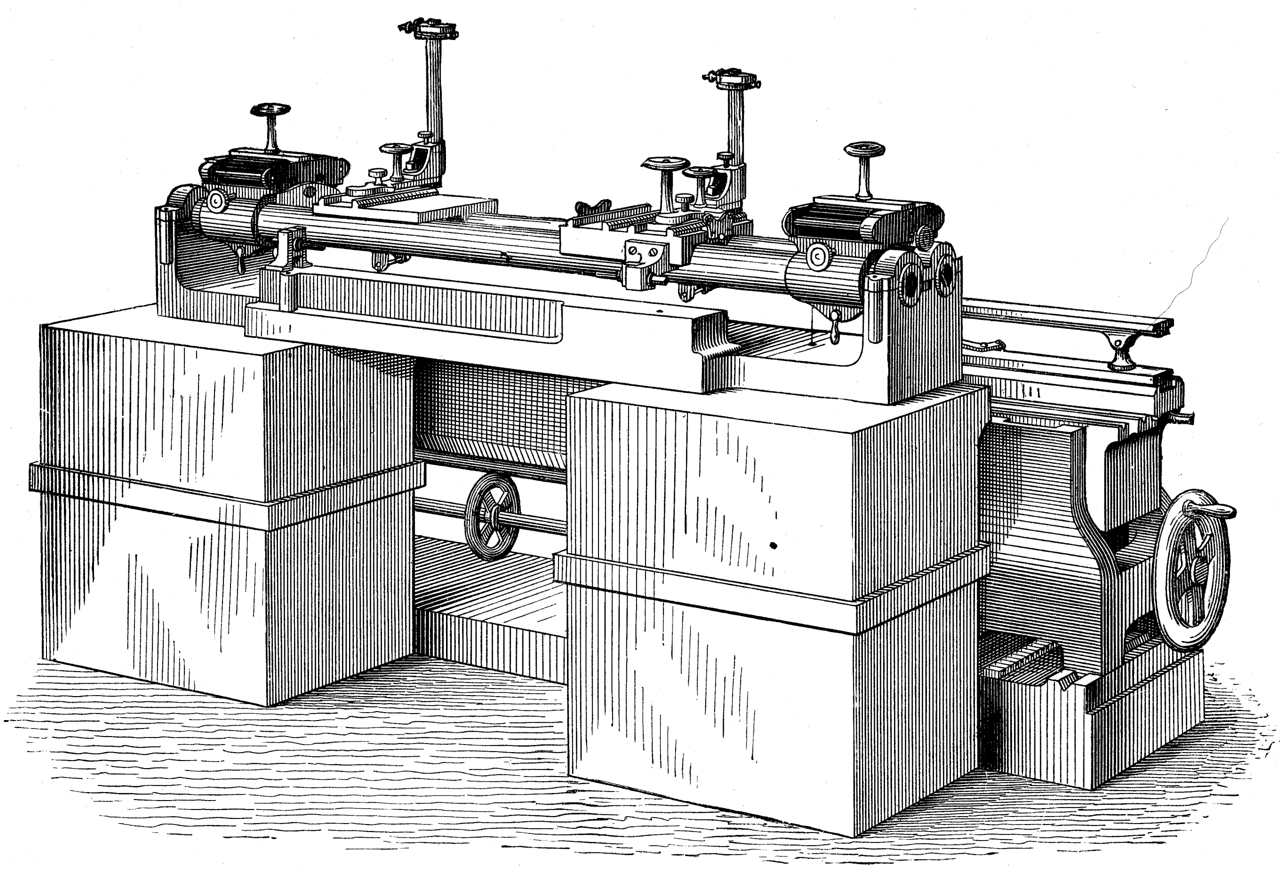

Fig. 1349.