CHAPTER XX.—HAND DRILLING AND BORING TOOLS AND DEVICES.

HAND DRILLING AND BORING TOOLS.—The tools used for piercing holes in wood are generally termed boring tools, while those for metal are termed drilling tools when they cut the hole from the solid metal, and boring tools when they are used to enlarge an existing hole. Wood-boring tools must have their cutting edges so shaped that they sever the fibre of the wood before dislodging it, or otherwise the cutting edges wedge themselves in the fibre. This is accomplished, in cutting across the grain of the wood, in two ways: first, by severing the fibre around the walls of the hole and in a line parallel to the axial line of the boring tool, and removing it afterwards with a second cutting edge at a right angle to the axis of the boring tool; or else by employing a cutting edge that is curved in its length so as to begin to cut at the centre and operate on the walls of the hole, gradually enlarging it, as in the case of Good's auger bit (to be hereafter described), the action being to cut off successive layers from the end of the grain or fibre of the wood. Tools for very small holes or holes not above one-quarter inch in diameter usually operate on this second principle, as do also some of the larger tools, such as the nail bit or spoon bit and the German bit.

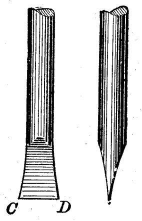

Fig. 1757.

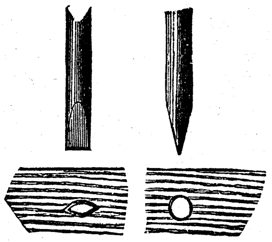

Fig. 1758.

The simplest form of wood-piercing tool is the awl or bradawl, shown in Figs. 1757 and 1758, its cutting end being tapered to a wedge shape whose width is sometimes made parallel with the stem and at others spread, as at C D in figure. It is obvious that when the end is spread the stem affords less assistance as a guide to pierce the hole straight.

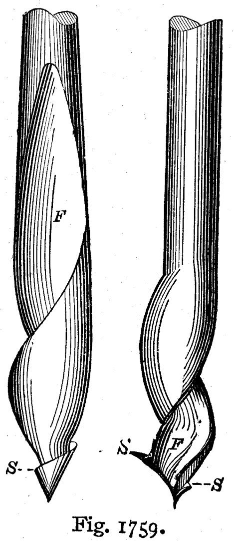

Fig. 1759.

It is obvious that the action of an awl is that of wedging and tearing rather than of cutting, especially when it is operating endways of the grain.

Thus in Fig. 1758 is shown an awl operating, on the right, across the grain, and, on the left, endwise of the same. In the former position it breaks the grain endwise, while in the latter it wedges it apart. Awls are used for holes up to about three-sixteenths of an inch in diameter.

Fig. 1759 represents the gimlet bit having a spiral flute at F and a spiral projection at S S, which, acting on the principle of a screw, pulls the bit forward and into its cut. These bits are used in sizes from $\frac{1}{16}$ inch to $\frac{1}{2}$ inch. The edge of the spiral flute or groove here does the cutting, producing a conical hole and cutting off successive layers of the fibre until the full diameter of hole is produced. The upper part of the fluted end is reduced in diameter so as to avoid its rubbing against the walls of the hole and producing friction, which would make the tool hard to drive.

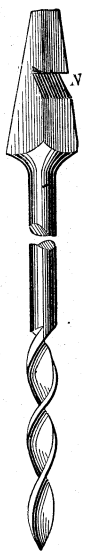

Fig. 1760.

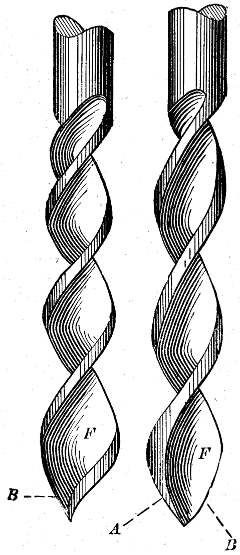

Fig. 1761.

Figs. 1760 and 1761 represent the German bit, which is used for holes from $\frac{1}{16}$ inch to $\frac{5}{8}$ inch in diameter. This, as well as all other bits or augers, have a tapered square by which they are driven with a brace, the notch shown at N being to receive the spring catch of the brace that holds them in place. The cutting edges at A and B are produced by cutting away the metal behind them.

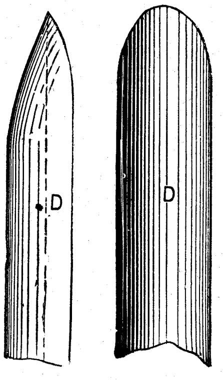

Fig. 1762.

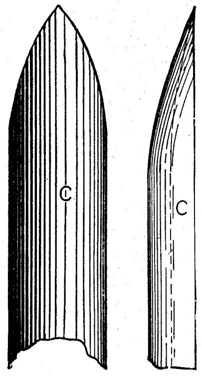

Fig. 1763.

Fig. 1762 represents the nail bit, which is used for boring across the grain of the wood. Its cutting edge severs the fibre around the walls of the hole, leaving a centre core uncut, which therefore remains in the hole unless the hole is pierced entirely through the material. If used to bore endways or parallel with the direction of the fibre or grain of the wood it wedges itself therein.

The groove of the nail bit extends to the point, as shown by the dotted line in the figure. Nail bits are used in sizes from $\frac{1}{16}$ to $\frac{3}{8}$ inch.

Fig. 1763 represents the spoon bit whose groove extends close to the point, as shown by the dotted line C.

Fig. 1764 represents the pod or nose bit, whose cutting edge extends half way across its end and therefore cuts off successive layers of the fibres, which peculiarly adapts it for boring endways of the grain, making a straight and smooth hole. It is made in sizes up to as large as four inches, and is largely used for the bores of wooden pipes and pumps, producing holes of great length, sometimes passing entirely through the length of the log.

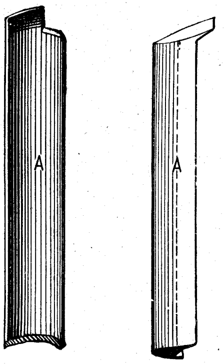

Fig. 1764.

Fig. 1765 represents the auger bit, which is provided with a conical screw S which pulls it forward into the wood. Its two wings W have cutting edges at D, D, which, being in advance of the cutting edges A,B, sever the fibre of the wood, which is afterwards cut off in layers whose thickness is equal to the pitch of the thread upon its cone S. The sides of the wings W obviously steady the auger in the hole, as do also the tops T of the twist. This tool is more suitable for boring across the grain than lengthways of it, because when boring lengthways the wings W obviously wedge themselves between the fibres of the wood.

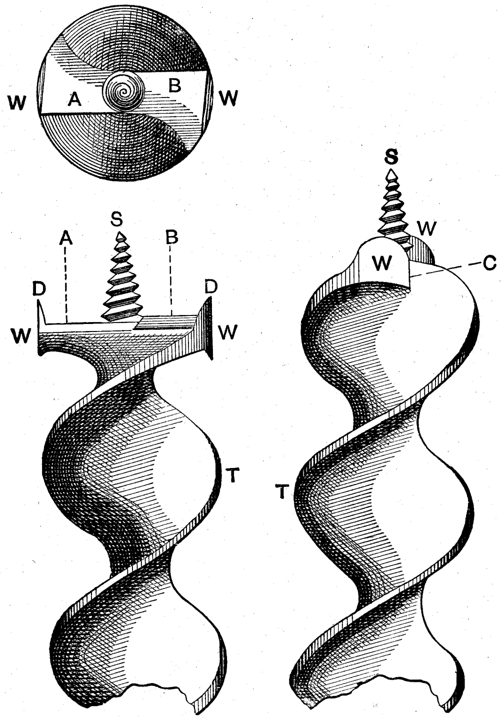

Fig. 1765.

This is obviated in Cook's auger bit, shown in Fig. 1766, in which the cutting edge is curved, so that whether used either across or with the grain the cutting edge produces a dished seat and cuts the fibre endways while removing the material in a spiral layer. The curve of the cutting edge is such that near the corners it lies more nearly parallel to the stem of the auger than at any other part, which tends to smooth the walls of the hole. This tool while very serviceable for cross grain is especially advantageous for the end grain of the wood.

In the smaller sizes of auger bits the twist of the spiral is made coarser, as in Fig. 1767, which is necessary to provide sufficient strength to the tool. For the larger sizes the width of the top of the flute (T, Fig. 1765), or the land, as it is termed, is made narrow, as in Fig. 1768, for holes not requiring to be very exact in their straightness, while for holes requiring to be straight and smooth they are made wider, as at D, in Fig. 1769, and the wings A,B in the figure extend farther up the flutes so as to steady the tool in the walls of the hole and make them smoother. It is obvious that the conical screw requires to force or wedge itself into the wood, which in thin work is apt to split the wood, especially when it is provided with a double thread as it usually is (the top of one thread meeting the cutting edge A in Fig. 1765, while the top of the other thread meets cutting edge B).

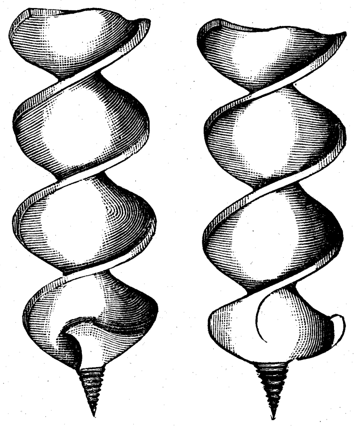
Fig. 1766.

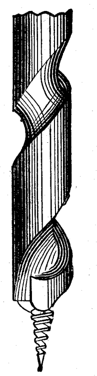
Fig. 1767.

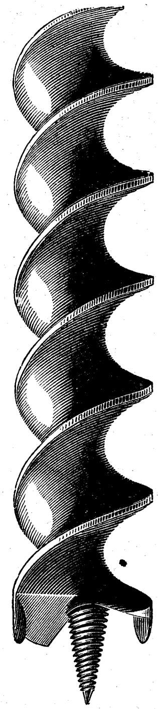
Fig. 1768.

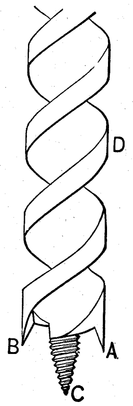

Fig. 1769.

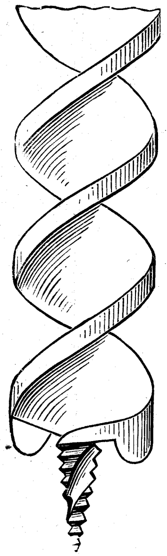
Fig. 1770.

In boring end-grain wood, or in other words lengthways of the grain of the wood, the thread is very apt to strip or pull out of the wood and clog the screw of the auger; especially is this the case in hard woods. This may be to a great extent avoided by cutting a spiral flute or groove along the thread, as in Fig. 1770, which enables the screw to cut its way into the wood on first starting, acts to obviate the stripping and affords an easy means of cleaning. The groove also enables the screw to cut its way through knots and enables the auger to bore straight.

In boring holes that are parallel with the grain or fibre of the wood, much more pressure is required to keep the auger up to its cut and to prevent the thread cut by the auger point from pulling or stripping out of the wood, in which case it clogs the thread of the auger point and is very difficult to clean it out, especially in the case of hard woods.

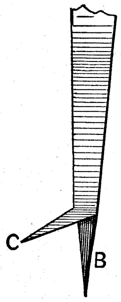

Fig. 1771.

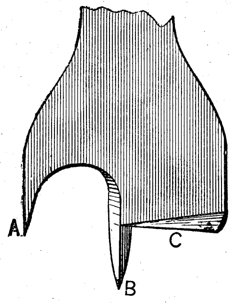

Fig. 1772.

Furthermore, after the thread has once stripped it is quite difficult to force the auger to start its cut again. To obviate these difficulties the screw is fluted as shown. It is obvious also that this flute by imparting a certain amount of cutting action, and thereby lessening the wedging action of the screw, enables it to bore, without splitting it, thinner work than the ordinary auger. But it will split very thin work nevertheless; hence for such work as well as for holes in any kind of wood, when the hole does not require to be more than about twice as deep as that diameter, the centre bit shown in Figs. 1771 and 1772 is employed, being an excellent tool either for boring with the grain or across it.

Fig. 1773.

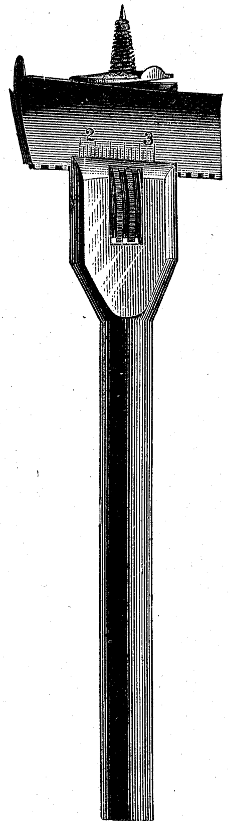

Fig. 1774.

The centre B is triangular and therefore cuts its way into the work, and the spur or wing A extends lower than the cutting edge C, which on account of its angle cuts very keenly.

Fig. 1773 represents the twist drill which is used by the wood-worker for drilling iron, its end being squared to fit the carpenter's brace.

Fig. 1774 represents an extension bit, being adjustable for diameter by reason of having its cutting edge upon a piece that can be moved endways in the holder or stem. This piece is ruled with lines on its face so that it may be set to the required size. Its upper edge is serrated with notches into which a dish screw or worm meshes, so that by revolving the worm the bit piece is moved farther out on the spur or wing side or end, it being obvious that the spur must meet the walls of the hole. A better form of extension bit for the end grain of wood is shown in Fig. 1775, the cutting edge being a curve to adapt it to severing the fibre in end-grained wood, as was explained with reference to Good's auger bit.

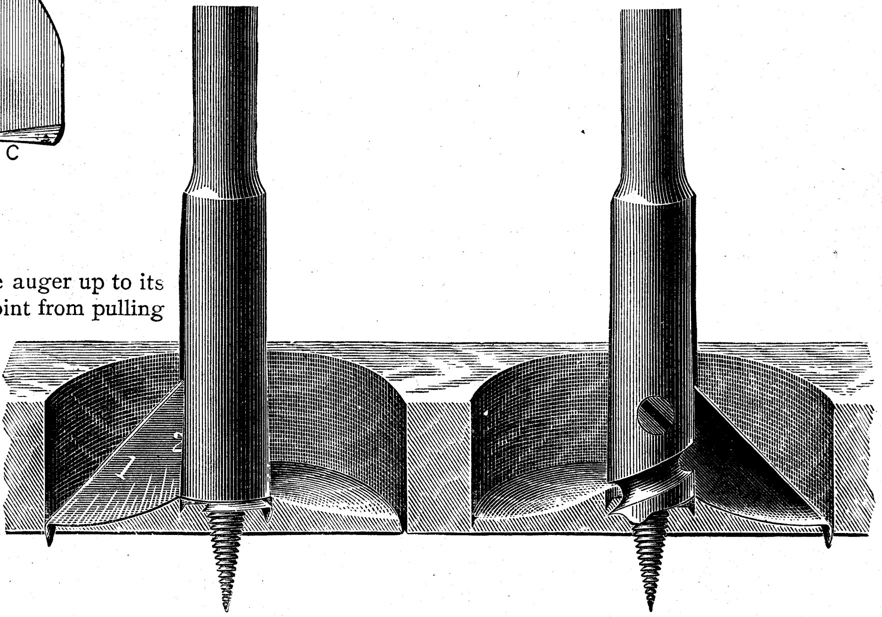

Fig. 1775.

Fig. 1776 represents a drill for stone work, whose edge is made curved to steady it. This tool is caused to cut by hammer blows, being slightly revolved upon its axis after each blow, hence the curved shape of its cutting edge causes it to sink a dish-shaped recess in the work which holds that end steady. The end of the tool is spread because the corners are subject to rapid wear, especially when used upon hard stone, and the sides of the drill would bend or jam in the walls of the hole in the absence of the clearance caused by the spread. To prevent undue abrasion water is used.

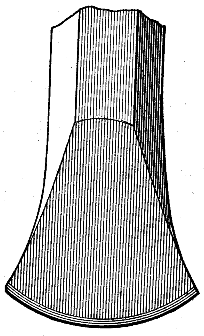

Fig. 1776.

In soft stones the hammer blows must be delivered lightly or the cutting edge will produce corrugations in the seat or bottom of the hole, and falling into the same recesses when revolved after each blow the chipping action is impaired and finally ceases. To prevent this the cutting edge is sometimes curved in its length so that the indentations cross each other as the drill is revolved, which greatly increases the capacity of the drill, but is harder to forge and to grind.

The simplest hand-drilling device employed for metal is the fiddle bow drill shown in Fig. 1777. It consists of an elastic bow B, having a cord C, which passes around the reel R, at one end of which is the drill D, and at the other a stem having a conical or centre point fitting into a conical recess in a curved breast-plate. The operator presses against this plate to force the drill to cut, and by moving the bow back and forth the cord revolves the drill.

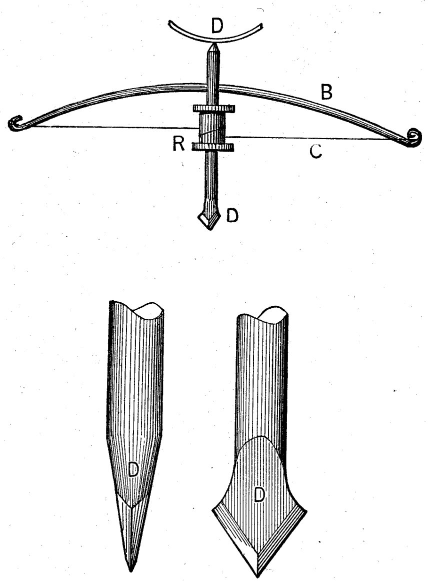

Fig. 1777.

As the direction of drill revolution is reversed at each passage of the bow, its cutting edges must be formed so as to cut when revolved in either direction, the shape necessary to accomplish this being shown in the enlarged side and edge views at the foot of the engraving. It is obvious that a device of this kind is suitable for small holes only, as, say, those having a diameter of one-eighth inch or less. But for these sizes it is an excellent tool, since it is light and very sensitive to the drill pressure, and the operator can regulate the amount of pressure to suit the resistance offered to the drill, and therefore prevent the drill from breakage by reason of excessive feed. In place of the breast-plate the bow drill may be used with a frame, such as in Fig. 1778. the frame being gripped in a vice and having a pin or screw A. If a pin be used, its weight may give the feed, or it may be pressed down by the fingers, while if a screw is used it must be revolved occasionally to put on the feed.

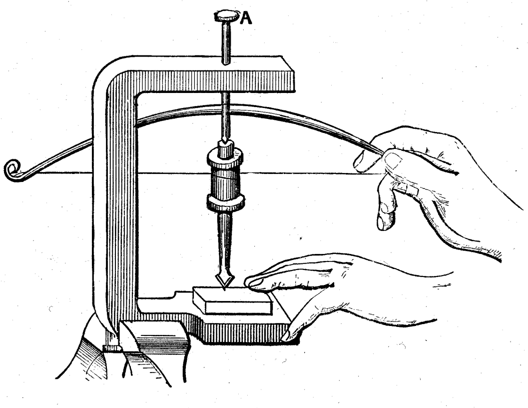

Fig. 1778.

Fig. 1779 represents a hand-drilling device in which the cord passes around a drum containing a coiled spring which winds up the cord, the latter passing around the drill spindle, so that pulling the cord revolves the spindle and the drill, the drum and spiral spring revolving the drill backwards.

Fig. 1780 represents a drilling device in which the drill is carried in a chuck on the end of the spindle which has right and left spiral grooves in it, and is provided with a barrel-shaped nut, which when operated up and down the spindle causes it to revolve back and forth.

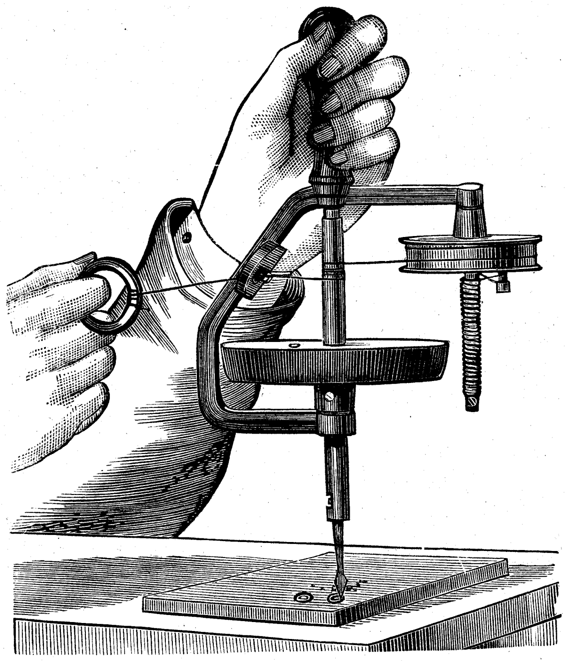

Fig. 1779.

The nut or slide carries at one hand a right-hand, and at the other a left-hand nut fitting into the spindle grooves, and cut like a ratchet on their faces. Between these is a sleeve, also ratchet cut, but sufficiently short that when one nut engages, the other is released, with the result that the drill is revolved in one continuous direction instead of back and forth, and can therefore be shaped as an ordinary flat drill instead of as was shown in Fig. 1777. The drill is fed to its cut by hand pressure on the handle or knob at the top.

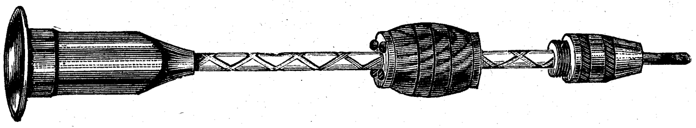

Fig. 1780.

Fig. 1781 represents Backus' brace for driving bits, augers, &c., the construction of the chuck being shown in Fig. 1782. The two tongues are held at their inner ends by springs and are coned at their outer ends, there being a corresponding cone in the threaded sleeve, so that screwing up this sleeve firmly grips the tool shank and thus holds it true, independent of the squared end which fits into the inner tongue that drives it.

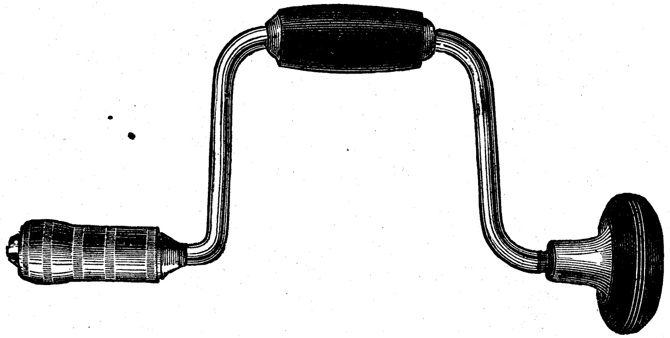

Fig. 1781.

In another form this brace is supplied with a ratchet between the chuck and the cranked handle, as shown in Fig. 1783, the construction of the ratchet being shown in Fig. 1784. The ring is provided on its inner edge with three notches, so that by pulling it back and setting it in the required notch the ratchet will operate the chuck in either direction or lock it for use as an ordinary brace. The ratchet enables the tool to be used in a corner in which there would be no room to turn the crank a full revolution. This end may, however, be better accomplished by means of the Backus' patent angular wrench shown in Fig. 1785, which consists of a frame carrying a ball-and-socket joint between it and the chuck, as shown.

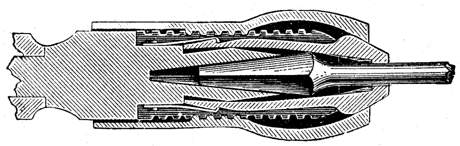
Fig. 1782.

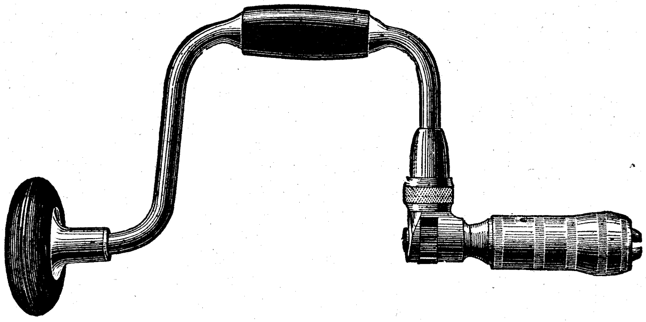
Fig. 1783.

Figs. 1786 and 1787 represent the brace arranged to have a gear-wheel connected or disconnected at will, the object of this addition being to enable a quick speed to the chuck when the same is advantageous.

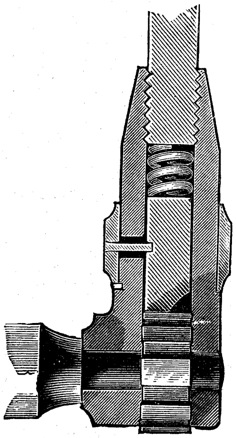
Fig. 1784.

For drilling small holes in metal, the breast drill shown in Fig. 1788 is employed. It consists of a spindle having journal bearing in a breast-plate at the head, and in a frame carrying a bevel gear-wheel engaging with two gear-pinions that are fast upon the spindle, this frame and the bevel gear-wheel being steadied by the handle shown on the right. At the lower end of the spindle is a chuck for holding and driving the drill, which is obviously operated by revolving the handled crank which is fast upon the large bevel gear. The feed is put on by pressing the body against the breast-plate.

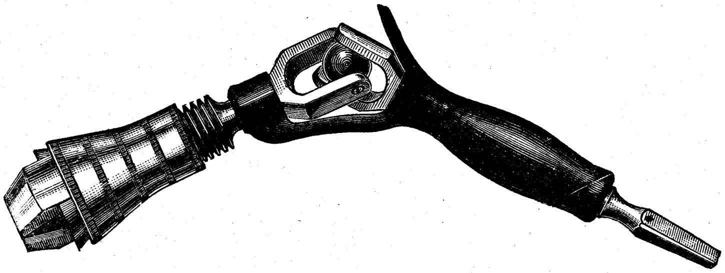
Fig. 1785.

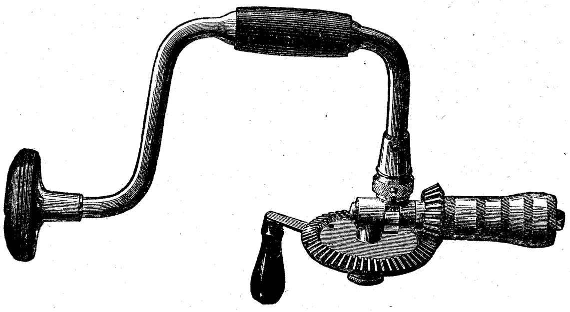
Fig. 1786.

It is obvious that but one bevel pinion would serve, but it is found that if one only is used the spindle is apt to wear so as to run out of true, and the bore of the gear-wheel rapidly enlarges from the strain falling on one side only. To avoid this the spindle is driven by two pinions, one on each side of the driving gear as in figure.

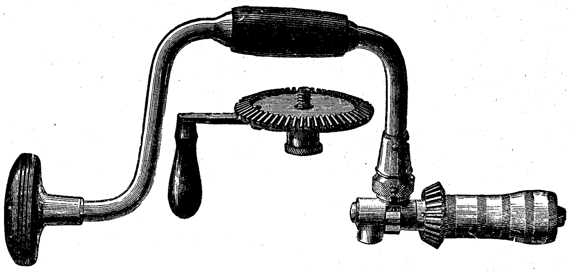
Fig. 1787.

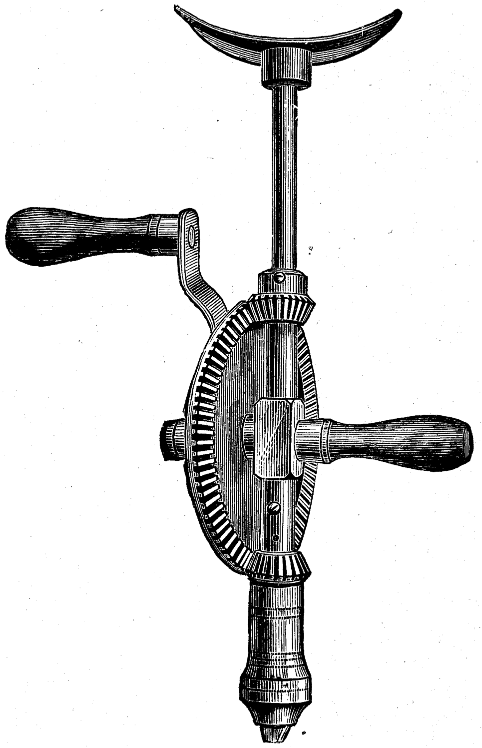
Fig. 1788.

Breast-drills do not possess enough driving power to capacitate them for drills of above about quarter inch in diameter, for which various forms of drill cranks are employed.

Fig. 1789 represents a drill crank which receives the drill at A, and is threaded at B to receive a feed screw C, which is pointed at D; at E is a loose tube or sleeve that prevents the crank from rubbing in the operator's hands when it is revolved.

To use such a drill crank a frame A, Fig. 1790, is employed, being held in a vice and having at T a table whereon the work W may be rested. The feed is put on by unscrewing the screw S in this figure against the upper jaws of A; holes of about half inch and less in diameter may be drilled with this device.

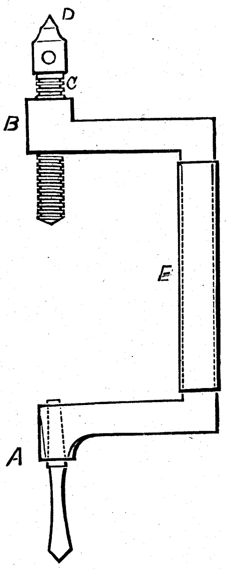

Fig. 1789.

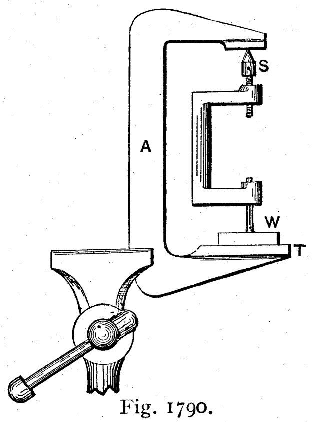

Fig. 1790.

A very old but a very excellent device for hand drilling when no drilling machine is at hand is the drilling frame shown in Fig. 1791, which consists of two upright posts A, and two B, placed side by side with space enough between them to receive and guide the fulcrum lever and the lifting lever. The fulcrum lever is pivoted at C, and has an iron plate at E, and suspends a weight at its end which serves to put on the feed. The lifting lever is pivoted at D, and at F hooks on to the fulcrum lever. At its other end is a rope and eye G, and it is obvious that the effect of the weight upon the fulcrum lever is offset by any pressure applied to G, so that by applying the operator's foot at G the weight of drill feed may be regulated to suit the size of hole and strength of drill being used. The work is rested on a bench, and a drill crank or other device such as a ratchet brace may be used to drive the drill. This drill frame is capable of drilling holes up to about two inches in diameter, but it possesses the fault that the upper end of the brace or drilling device moves as the drill passes into the work in an arc H of a circle, of which the pin C is the centre. The posts A are provided with numerous holes for the pin C, so that the fulcrum lever may be raised or lowered at that end to suit the height of the work above the work bench. Another objection to this device is, it takes up a good deal of shop room.

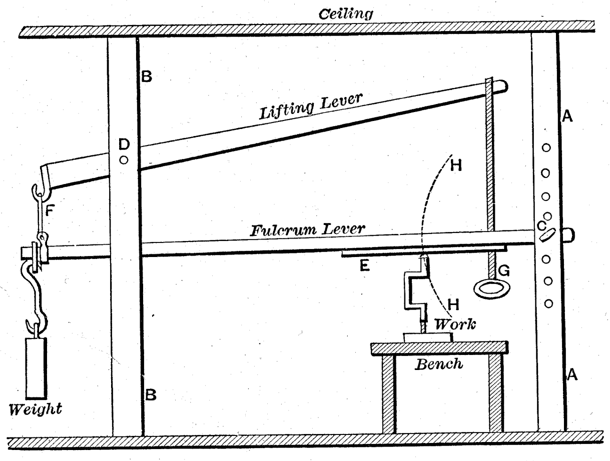

Fig. 1791.

Ratchet braces are employed to drill holes that are of too large a bore to be drilled by tread drills, and that cannot be conveniently taken to a drilling machine.

In Fig. 1792 is represented a self-feeding ratchet brace. A is the body of the brace, having a taper square hole in its end to receive the square shank of the drill. L is a lever pivoted upon A, and having a pawl or catch B, which acts upon ratchet teeth provided upon A. When the lever L is moved backward the pawl B being pivoted rides over the ratchet teeth, but when L is pulled forward B engages the ratchet teeth and rotates A and therefore the drill. At F is a screw threaded into A, its pointed end abutting against some firm piece, so that unscrewing F forces the drill forward and into its cut. These features are essential to all forms of ratchet braces, but the peculiar feature of this brace consists in its exceedingly simple self-feeding devices, the feed screw F requiring in ordinary braces to be operated by hand when the drill requires to be fed.

The construction and operation of the self-feeding device is as follows: The feed screw F is provided with a feather way or spline and with a feed collar C, operated by the pawl E. The feed-collar C has at D a groove, into which a flange on pawl E fits, and on its side face there is a groove receiving an annular ring on the face of lever L, these two keeping it in place. The pawl E is a double one, and may be tripped to operate C in opposite directions to feed or release the drill, as the case may be, or it may be placed in hind position to throw the feed off—all these operations being easily performed while the lever L is in motion. Collar C is in effect a double ratchet, since its circumference is provided with two sets of notches, one at *g* and the other at *h*. Each set is equally spaced around the circumference, but one set or circle is coarser spaced than the other, while both are finer spaced than is the ratchet operated by pawl B. Suppose, now, that the lever L is at the end of a back stroke, and pawl E will fall into one of the notches on side *g* of the feed-ratchet, and when lever L is moved on its forward stroke it will operate the feed ratchet and move it forward, A standing still until such time as pawl B meets a tooth of the ratchet on A. The feed screw F is provided with a left-hand thread, and the feed ratchet has a feather projecting into the spline in the feed screw; hence moving the feed ratchet at the beginning of the forward motion of L and before A is operated, puts a feed on, and the amount of this feed depends upon how much finer the notches into which pawl E falls are than those into which B falls. The feed takes place, be it noted, at the beginning of the lever stroke, and ceases so soon as pawl B operates A and the drill begins to cut.

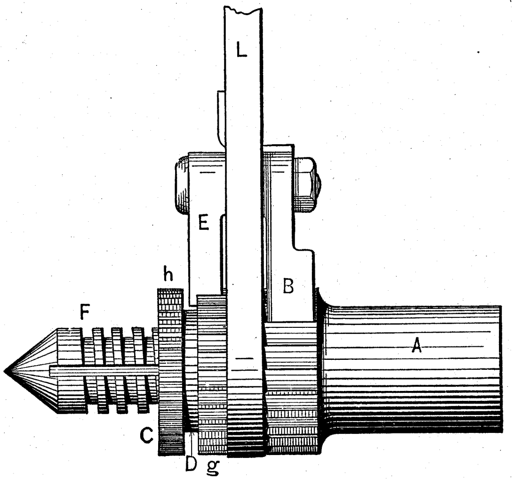

Fig. 1792.

As shown in the figure, the feed collar is set for large drills (which will stand a coarser feed than small ones), because the notches are finer spaced at *g* than at *h*. For small drills and finer feeds the collar is slipped off the screw and reversed so that side *h* will fall under E, it being obvious that the finer the notches are spaced the more feed is put on per stroke. The spacings are made to suit very moderate feeds, both for large and small drills, because the operator can increase the feed at any stroke quite independently of the spacings on the feed ratchet. All he has to do is to give the lever handle a short stroke and more feed is put on; if still more feed is wanted, another short stroke may be made, and so on, the least possible amount of feed being put on when the longest strokes are made. In any event, however, there will be a certain amount of average feed per stroke if equal length of strokes is taken, the spacing being made to suit such ordinary variations of stroke as are met with in every-day practice. When it is desired to stop feeding altogether, or to release the drill entirely from the cut, all that is necessary is to trip the feed-pawl E (without stopping the lever motion), and it will operate the feed screw in the opposite direction sufficiently to release the drill in a single backward stroke of the lever. The range of feed that is obtainable with a single feed ratchet is sufficient for all practical purposes, although it is obvious that if any special purpose should require it, a special feed ratchet may be made to suit either an unusually fine or coarse rate of feed. The feed screw is not provided with either a squared head or with the usual pin holes, because the feed ratchet is so readily operated that these, with their accompanying wrench or pin, are unnecessary.

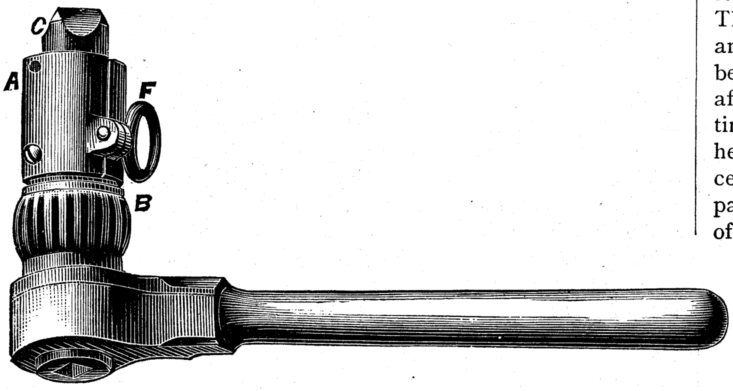

Fig. 1793.

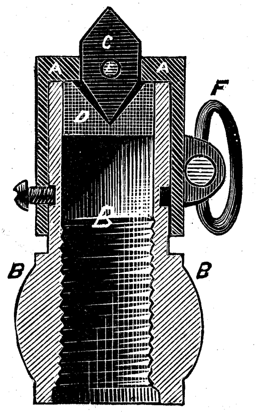

Fig. 1794.

Figs. 1793 and 1794 represent a self-feeding ratchet brace for hand drilling in which the feed is obtained as follows: The inside or feed sleeve B, which screws upon the drill spindle, is fitted with a friction or outer sleeve A, in the head of which is secured a steel chisel-shaped pin C, the lower end of which is pointed and rests upon a hardened steel bearing D, fixed in the head of the inner sleeve B. This sleeve, with its bearing D, revolves upon the point of the pin C, and within the friction sleeve A. Having thus described its construction, we will now describe the operation of the self-feeding device. The head of the pin C being chisel-shaped, prevents the pin and the outer sleeve A from revolving. If the thumb or friction screw F is unscrewed, it will permit the inner sleeve B to rotate freely upon the bearing of pin C, and within the friction sleeve A. As the screw F is tightened, the friction upon the inner sleeve B is increased, causing it to remain stationary, and consequently causing the screw on the drill spindle to feed the drill until the friction on the drill becomes greater than the friction on the sleeve B. This then commences to rotate again within the outer sleeve A, and continues until the chip which the drill has commenced to cut is finished, when the same operation is repeated, thus giving a continuous feed, capable of being instantly adjusted to feed fast or slow as desired, by tightening or loosening the friction screw F, thereby causing a greater or less friction upon the inside or feed sleeve B.

To afford a fulcrum or point of resistance for the chisel-piece C, or the pointed centre used in the common forms of ratchet brace feed screws, various supporting arms, or stands are employed. Thus Fig. 1795* represents a boiler shell *a*, to which is attached an angle frame or knee *b*, carrying the angle piece *c* (which may be adjusted for vertical height on *b* by means of the bolt shown) affording a fulcrum for the feed sleeve *d*. This sleeve is sometimes made hexagonal on its outside to receive a wrench or to be held by the hand when feeding, or it may have holes near its centre end to receive a small pin or piece of wire; *e* is a chain to pass around the boiler to secure *b* to it, which is done by means of the device at *f*.

For many purposes a simple stand having an upright cylindrical bar carrying an arm that may be set at any height and set to its required position on the bar by a set-screw is sufficient, the base of the stand being secured to the work by a clamp or other convenient device.

Fig. 1796 represents a flexible shaft for drilling holes inaccessible to a drilling machine, and in situations or under conditions under which a ratchet brace would otherwise require to be used. It consists of a shaft so constructed as to be capable of transmitting rotary motion though the shaft be bent to any curve or angle. A round belt driven from a line shaft rotates the grooved pulley, and the shaft transmits the rotary motion to bevel-wheels contained in a portable drilling frame, the fulcrum for the feed being afforded by a drilling post after the manner employed in ratchet drilling. The shaft is built up of several layers of wire (as shown in the view to the left), the number of layers depending upon the size and strength of shaft required, wound one upon the other helically. The layers are put on in groups of three to eight wires, parallel to each other, each successive layer containing groups of varying numbers of wires, thus giving a different pitch to the helices for each layer, the direction of each twist or helix being the reverse of the one upon which it is wound. When the shaft is laid up in this manner, the wires at each end for a short distance are brazed solidly together, and to these solidified ends the piercers are secured for the attachment of the pulley and tool which it is to drive.

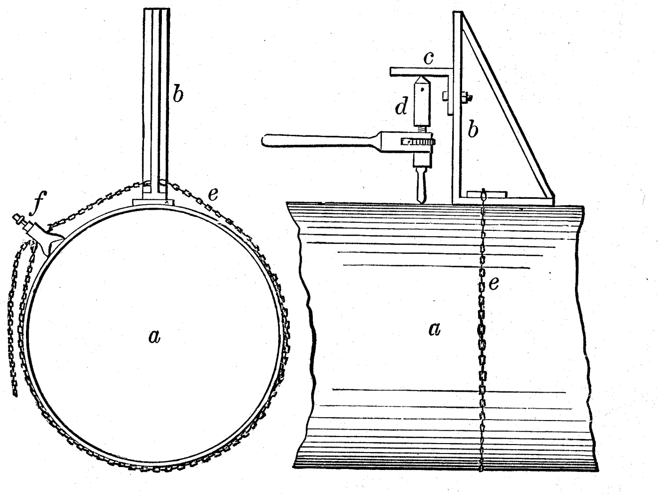

Fig. 1795.

This construction, it will be readily seen, produces a shaft which will have considerable transverse elasticity, while it must necessarily offer great resistance to torsional strain, the reversed

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* From *The American Machinist.*

helices forming a kind of helical trussing, which effectually braces it against torsion. The case within which it turns is simply an elastic tube of leather or other suitable material, within which is wound a single helix of wire fitting its inside tightly, the inside diameter of the helix being a little greater than the outside diameter of the shaft, and wound in a contrary direction to the outer helices of the shaft. This forms a continuous bearing for the shaft; or at least serves as a bearing at the points of contact between the shaft and case which are brought about in the various bending of the whole when in use.

In order to give to the instrument all the transverse elasticity possible, that end of the shaft carrying the pulley is made with a feather so that it may slide endways in the pulley, while the latter is secured to the case, the case, however, not rotating with it. It will be readily seen that this is a necessary precaution, inasmuch as in the varying curves given to the instrument in use a difference will occur in the relative lengths of the shaft and tube.

It might be supposed that the friction of the shaft within the tube would be so considerable as to militate against the success of the apparatus; but in practice, and under test for the determination of this, it has been found that the friction generated by running it when bent at a right angle does not exceed that when used in a straight line more than 15 per cent. of the latter.

In the running of it in a bent position, not only will there be friction between the shaft and tube, but there must also be some little motion of the layers of wire one upon another in the shaft itself; and to provide against the wear and friction which would otherwise occur in this way, provision is made for not only oiling the bearings at the ends, but also for confining a small quantity of oil within the tube, by which all motion of the wires upon one another, or the shaft upon the interior of the tube, is made easy by its being well lubricated.

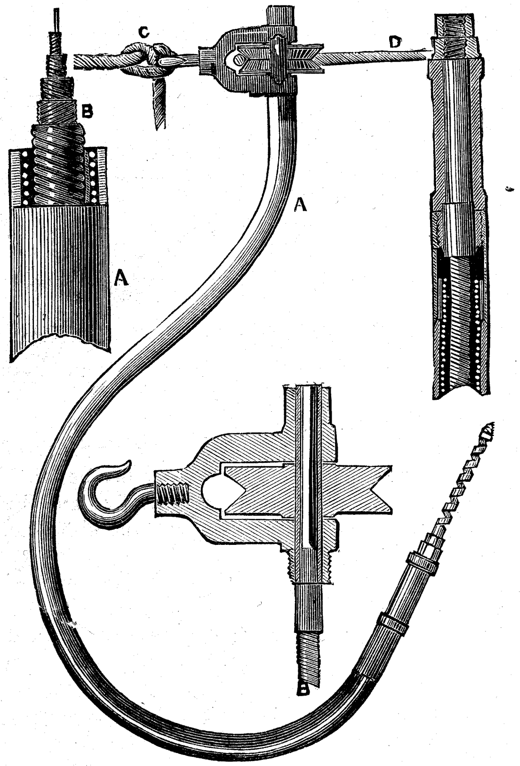

Fig. 1796.

In the figure the shaft is shown complete with a wood-boring auger in place at the shaft end. Shafts of similar but very light construction are employed by dentists for driving their dental drills and plugging tools, many of them having ingenious mechanical movements derived from the rotary motion of the shaft.

In Fig. 1797 is represented a drilling device in position for drilling a hole from the inside of a steam boiler. A represents a base piece made with a journal stud b. This base piece is provided with radial arms a, with threaded ends and nuts made with conical projecting ends, as shown at a^2. One of these pieces is used at each end of the machine when convenient, their use for centring and holding the frame being apparent. When not convenient to use two of them, one end of the frame is sustained as shown in the engraving, or in some other manner that may suggest itself. The casting B is made in two pieces, and is provided with a bearing for the pin b, and holds the ends of the rods C C. The actuating shaft G carries the bevel-wheel g, more clearly seen in the figure at side, which drives the drill spindle, whose ends are of different lengths, for convenience in reaching to different distances. The cross-head E may be slid along as required on the rods, and the revolving frame and drill turned around to different positions.

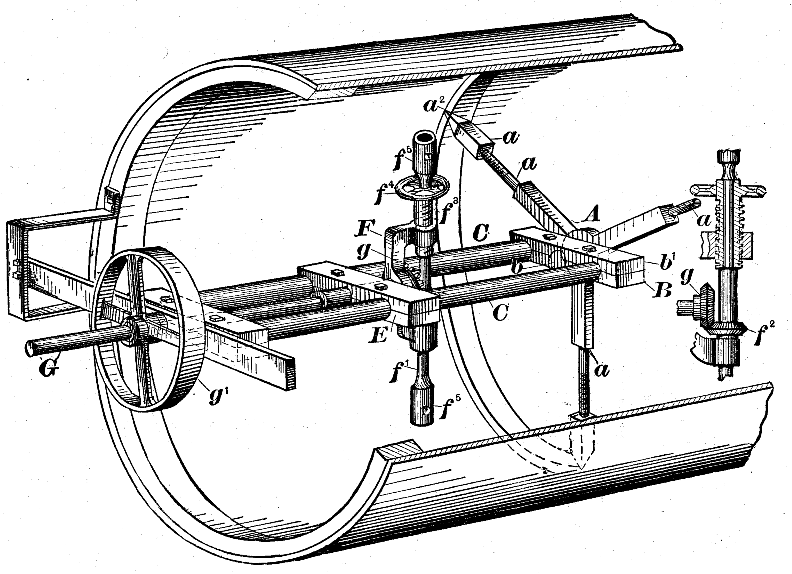

Fig. 1797.

Fig. 1798 represents a small hand drilling machine to be fastened to a work bench. A suitable frame affords journal bearing to the upright spindle, upon which is a bevel-gear G, which is driven by a gear upon the same shaft as the wheel W. The spindle is threaded at S and is fed by the hand wheel F, which is threaded upon the screw S and has journal bearing in the cap C.

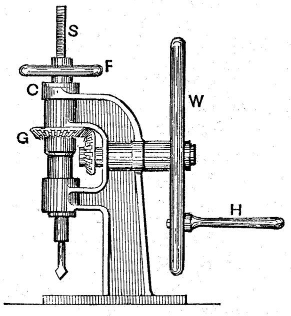

Fig. 1798.

Fig. 1799 represents a hand drilling machine for fixture against a post, the larger wheel serving as a fly-wheel and the smaller one being to feed with.

SLOTTING MACHINE.—In the slotting machine the cutting tools are carried in a ram or slide that operates vertically, and the work table lies horizontal and beneath the ram.

Fig. 1800 represents a slotting machine, and Fig. 1801 is a sectional view of the same machine.

The cone spindle shaft has a pinion which drives a spur-wheel upon an horizontal shaft above. Upon the inside face of this spur gear is a cam groove for operating the feed motions, at the other end of the shaft is a Whitworth quick-return motion, such as has already been described with reference to shaping machines. The connecting rod from the quick-return motion attaches to the ram, which operates on a guide passing through a way provided at the upper end of the main frame, and bolting to the front face of the main body of the frame. The object of this arrangement is that by adjusting the height of this guide to suit the height of the work, the ram will be guided as close to the top of the work as the height of the latter will permit; whereas when the guide for the ram is fixed in position on the frame the ram passes as far through the guide when doing this as it does when doing thick work, and is therefore less closely guided than is necessary so far as the work is concerned.

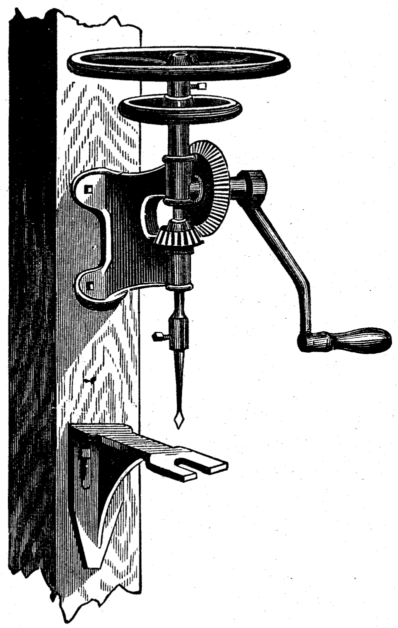

Fig. 1799.

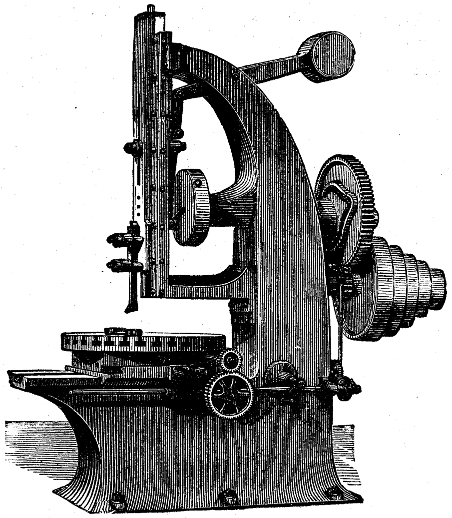

Fig. 1800.

The ram, or slotting bar as it is sometimes termed, is counterbalanced by the weighted lever shown, so that the ram is always held up, and there is no jump when the tool post meets the work, because the tool motion is always taken up by the lever.

The work is held upon a circular table capable of being revolved upon its axis to feed the work to the cut. This table is carried upon a compound slide having two horizontal motions, one at a right angle to the other. The lower of these is operated by a rod running through the centre of the machine, as seen in the sectional view in Fig. 1801. The upper is operated through the larger of the two gear-wheels, seen at the side of the machine in the general view of the machine in Fig. 1800. The upper and smaller of these wheels operates a worm, which engages with worm-teeth cut on the periphery of the circular table to rotate the latter. Either or all of these feed motions may be put in simultaneous action, or all may be thrown out and the feeds operated by hand.

As the tool is in many cases rigid on the ram or bar of a slotting machine, it is preferable that the feed should occur while the tool is at the top of its stroke and before it meets the work, so that it may not rub on the return stroke, and thus become rapidly dulled.

Fig. 1802 represents a slotting machine in which the guideway for the slotting bar or ram is fixed in position, and the feed motions are entirely on the outside of the machine. In this case the worm-gear pinion is on the side of the machine not seen in the engraving.

The cutting tools for slotting machines are carried in one of these ways: first, bolted direct to the slotting bar or ram, in which case they stand vertically; secondly, in a box that is bolted to the end of the ram and standing horizontally; and thirdly, held in a tool bar, in which case the tool may stand either horizontally or vertically.

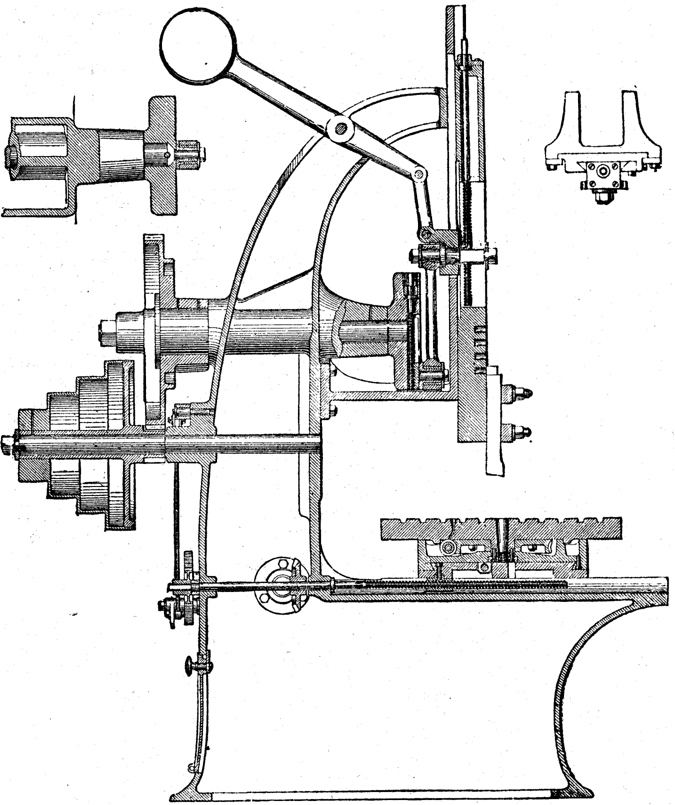

Fig. 1801.

Fig. 1803 shows a tool B secured in a hole provided in a stout bar A by the set-screw C. The tool in this case being rigidly held the cutting edge is apt to rub against the work during the upward stroke and become rapidly dulled. To avoid this, various devices have been employed, but before describing them it will be well to point out that the shape of the tool has an important bearing upon this point.

In Fig. 1804, for example, is a tool T bolted to the box B at the end of the slide S. W is a piece of work having the cut C taken off it. Now suppose that A is the centre of motion or fulcrum from which the spring of the tool takes place (and there is sure to be a little spring under a heavy cut), then the point of the tool will spring in the direction of the arrow E, and will cut deeper to the amount of its spring; but during the up stroke the tool being released from pressure will not spring, and therefore will partly

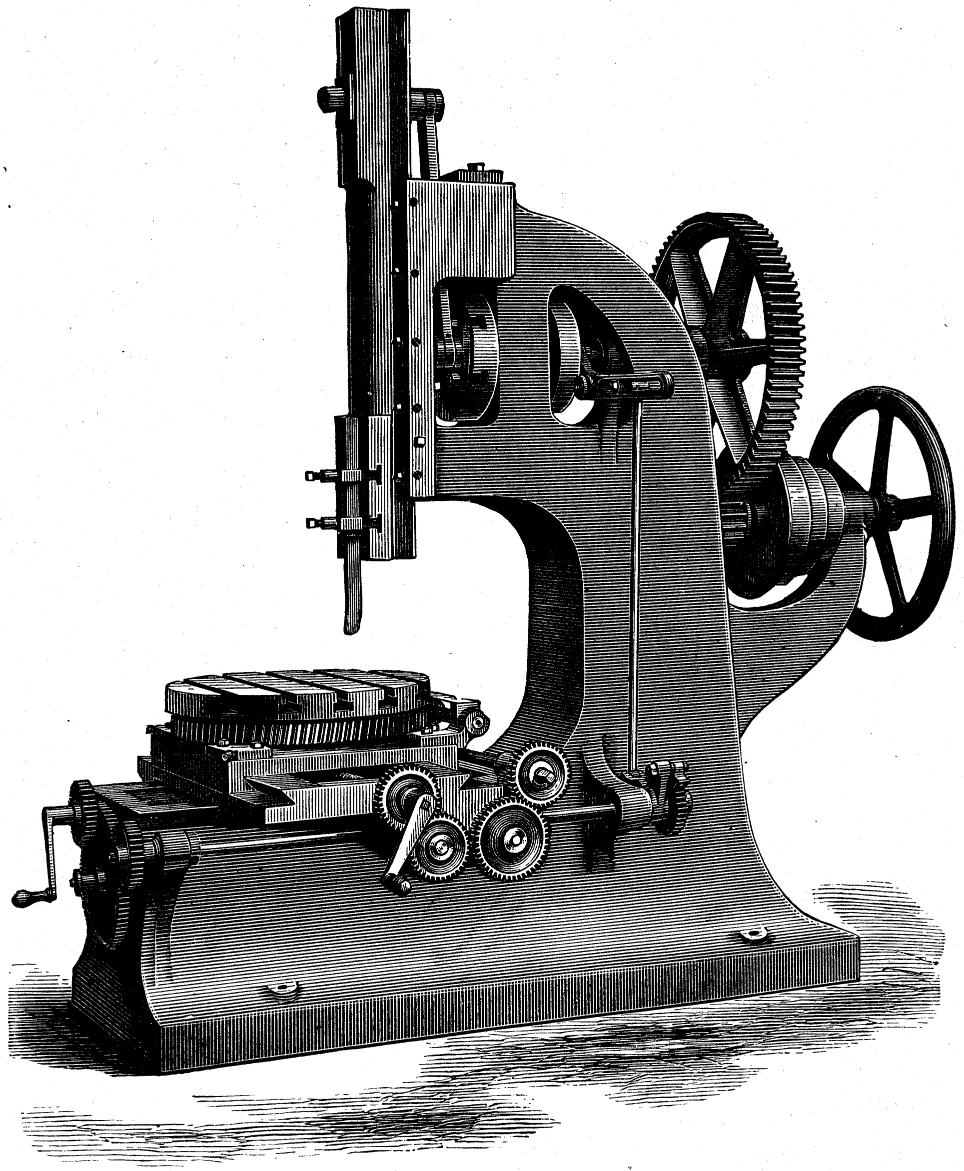

Fig. 1802.

or quite clear the cut according to the amount of the spring. This desirable action may be increased by giving the face of the tool which meets the cutting a slight degree of side rake, as shown in Fig. 1805, in which S is the slide, T the tool, B the box, and F the direction of the tool spring, which takes place in this case from the pressure of the cutting in its resistance to being bent out of the straight line.

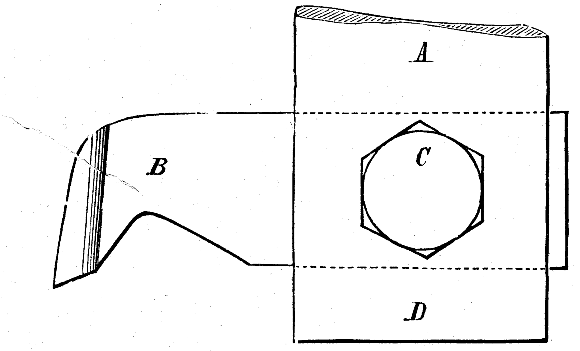

Fig. 1803.

In Fig. 1806 is a device for obviating to some extent this defect. A A is the tool box or bar containing a tool-holding piece pivoted at C, the tool being secured therein by the set-screw E B. A spiral spring sustains the weight of the pivoted piece and of the tool. During the down stroke the spiral spring holds the pivoted piece against the box or bar A, while during the up stroke the pivoted piece allows the tool to swing from the pivot C as denoted

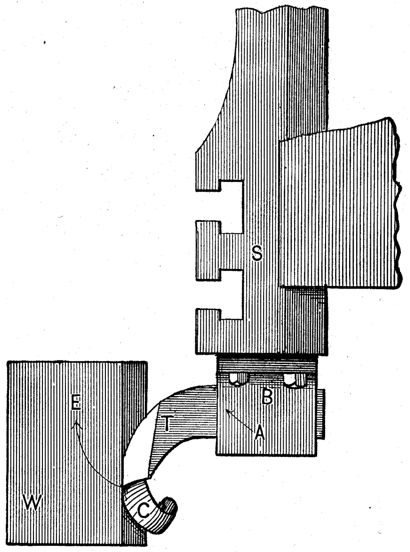

Fig 1804.

by the arrow D. In this case the friction on the tool edge is that due to overcoming the resistance of the spring only.

In round-nose tools that are slight, and which from having a maximum length of cutting edge are very subject to spring, additional strength may be given the tool by swelling it out at the back, as denoted by the dotted line B in Fig. 1807.

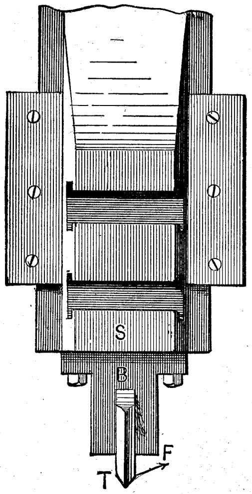

Fig. 1805.

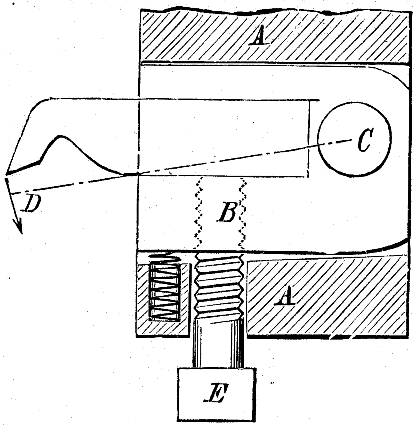

Fig. 1806.

Excessively heavy cuts may be taken by the form of tool shown in Fig. 1808, in which A is the tool, B the tool box, and C the work, the depth of cut being from D to E, which may be made 2$\frac{1}{3}$ inches if necessary. The face F of the tool is ground at an angle in the direction of I, so that the tool shall take its cut gradually, and that the whole length of the tool cutting edge shall not strike the cut at the same instant, which would cause a sudden strain liable to break either the tool or some part of the machine itself.

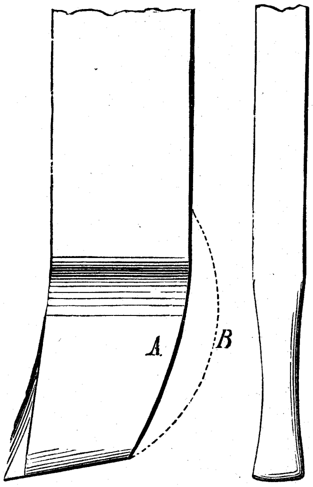

Fig. 1807.

So likewise the tool will leave its cut gradually and not with a jump. As shown in the cut, but a small part of the cutting edge would first meet the work, exerting for an instant of time only enough pressure and resistance to bring all the working parts of the machine up to a bearing, and as the tool descends (as denoted by the arrow G), the strain would increase until the whole length of tool cutting edge was in operation. For such heavy duty as this the tool is tempered down to a purple to give it strength.

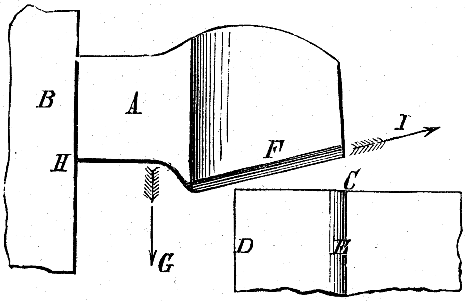

Fig. 1808.