PLANING MACHINES

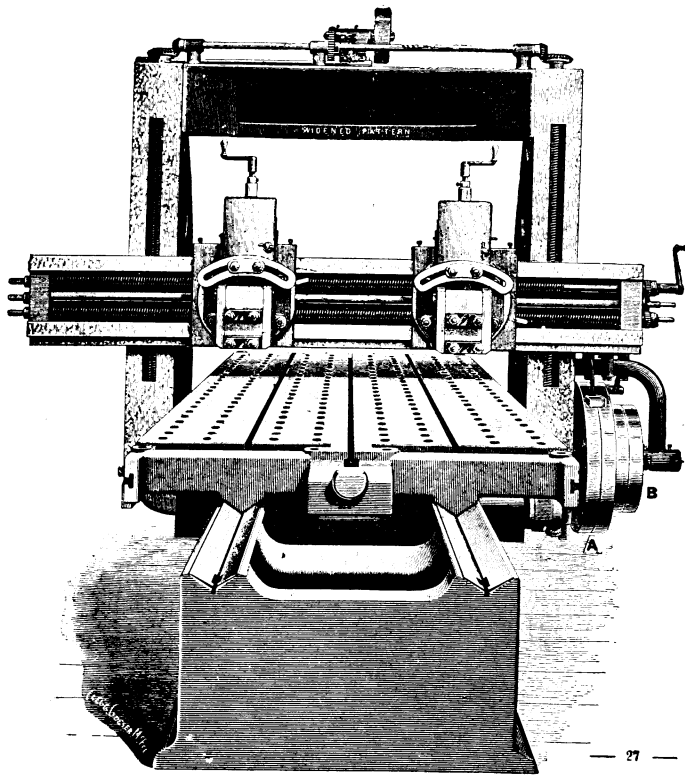


Fig. 138.

PLANING OPERATIONS.

The operation of planing constitutes straight-line cutting by means of a planer, a shaper, a slotting machine or a key-way cutter, with a steel cutting tool. In the planer, the piece to be planed is given a straight-line motion to a stationary tool; while in the shaper and slotting machine, the work is stationary and the cutting tool is given a straight-line motion over the surface of the former. The planer is a very important tool to the engine-builder, as well as others, being instrumental in the production of engine and lathe beds, slides, parallel pieces, etc.

The work to be planed is securely fixed to the table of the machine, and is moved backwards and forwards by means of suitable gear, the cutting tool being held in the tool box, mounted upon the cross-slide.

The devices feeding the cutting tool, and regulating the traverse of the table in planing machines, are of different forms; the general practice is 1, the employment of two driving belts, one for the forward and the other for the backward movement of the table; 2, the feeds are actuated by independent frictional devices, the tappets on the carriage being employed only to shift the belts; 3, narrow driving belts moving at a high speed to facilitate shifting on the pulleys.

Also, the rack and pinion movement is employed in nearly all planers to give the traverse to the table.

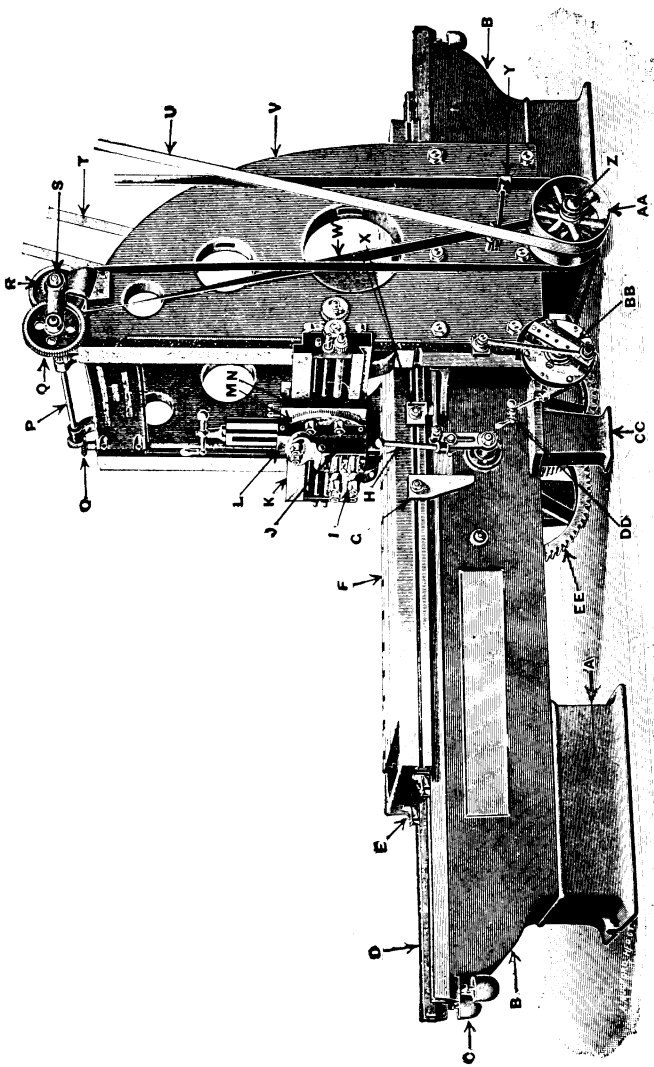


Fig. 139.

PLANING OPERATIONS.

Fig. 139 shows a heavy planer designed to plane 10 feet long, 34 inches high and 34 inches wide. The cabinets *A* support the bed *B*, which has parallel, V-shaped grooves *D*, on its upper side. Drip cups, to receive the overflow oil from these grooves, are shown at *C*. The table *F* is moved by rack and gear; on its under side are parallel V-shaped strips, which are fitted to slide smoothly in the similarly-shaped grooves *D*, on the bed; the wipers *E* contain felt to filter the oil entering the grooves, and also tend to keep them clean.

The long dog *G* strikes the rocker arm *H*, which has a removable arm for hand use; this rocker arm, through a system of mechanism, shifts the driving belts, reversing the motion of the table; *N* is the back or short dog; the cutter-head is on the cross-bar and consists of the tool-post *I*, where the cutting tool is clamped; *J* is the clapper or tool box, fastened to the vertical slide, or feed regulator, *L*, and swivels to any angle, being attached to the shoe *M*, which slides on the cross-bar *K*, thus giving the cross-feed or "advance" of the tool.

The down-feed or depth of cut is regulated by the handle shown over slide *L*. The head-lift bevel pinion *O* raises or lowers the cross-bar *K*, being geared to head-lift shaft *P*, on which is the spur-wheel *Q*, geared into pinion *S*, operated by the pulley *R* and belt *W*, driven from the pulley shaft *Z*.

The front post, or housings, *V*, are of box-form in section, and are bolted to the sides of the bed, being connected at the top by a substantial box-shaped cross-girt. The pulley-shaft *Z* is driven by two driving belts; the

forward, or cutting belt, *T*, and the backward, or return belt, *U*; the belts being moved on the fast and loose pulleys by belt shifter *V*. The backing pulleys *A A* are shown in the illustration; the forward, or cutting motion pulleys, are on the other side of the bed.

The friction box *B B* revolves through an angle which is varied by turning the worm shaft *D D*, which moves a segment having stop-lugs, so placed that the lugs on the back of the friction box strike them, thereby actuating the cross-feed. *E E* is the center gear which meshes with the table-rack.

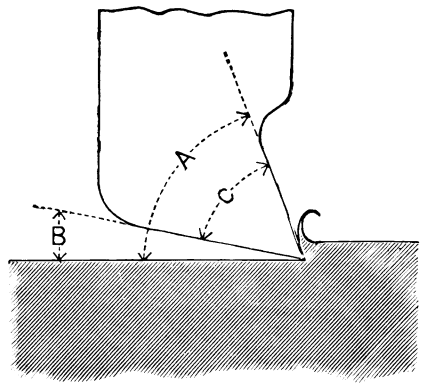


Fig. 140.

Planing machines run at a linear velocity of 15 to 20 feet per minute. The depth of cut depends on the material. The average cutting speeds for the various metals are as follows: Brass, 30 feet; gun metal, 25; cast iron, 15 to 20; wrought iron, 16; steel, 12. For general work the cross-feed, or advance of the tool should be from 12 to 14 cuts per inch for roughing cuts. The finishing cuts should be done with a broad tool, advancing from one-fourth to three-eighths of an inch with each cut.

PLANING OPERATIONS.

The tools used in planing are very similar in form to lathe-turning tools—a front tool used for roughing, a side tool for edge work, and a spring tool for flat work or surfacing. In fig. 140, *A* is the cutting angle, *B* the angle of relief or clearance, and *C* the tool angle.

The "cutting angle" for cast iron is 70°, for wrought iron, 65°, for brass, 80°, according to the table below.

TABLE.

	Cast Iron.	Wrought Iron.	Brass.
Cutting angle.....	70°	65°	80°
Clearance.....	3°	4°	3°
Tool angle.....	67°	61°	77°

One cutter head is shown in fig. 139, but it is quite common to have two cutter heads or clapper boxes, as shown in front view fig. 138, on the cross-bar, and in large machines there are, in addition, "side-heads," one on each housing, making four. All these heads will swivel to any angle.

Fig. 141 shows the arrangement of the cutter or cross-bar head which moves on the cross-bar parallel with the work table or platen.*

A is the tool-post-apron, sometimes called the clapper-box, being hinged so that the tool can lift upon the return or backward stroke; this prevents the tool edge rubbing on the work; *B* is the swivel apron; *C* the "slider" which carries the apron; *D* is the swing frame or swivel head; *E* is the saddle which slides on the cross-bar.

* *Platen* is a very old word meaning a covering plate; the more modern definition for this is "table."

PLANING MACHINES.

The cross-bar heads are operated by self-acting mechanisms both in the cross and angular feeding, the side-heads being fitted with vertical self-acting feed motions.

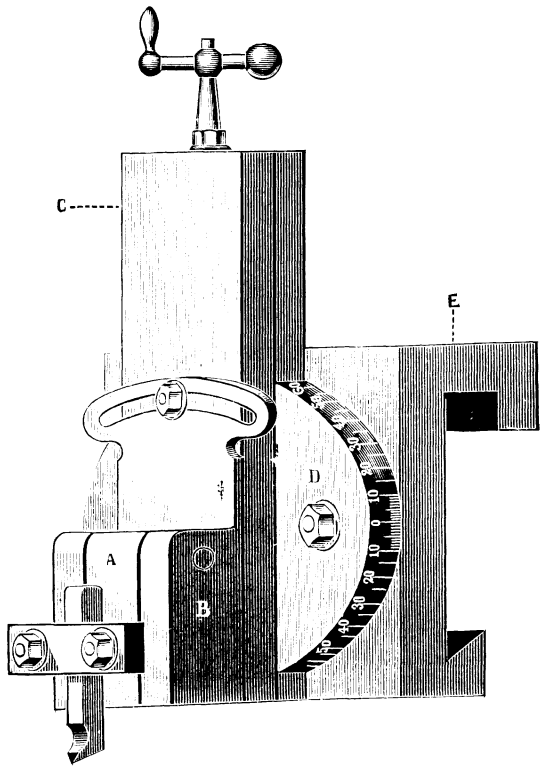


Fig. 141.

Planing machine tables are provided with bolt-holes and T-slots or grooves on the surface for fixing the work, which is usually bolted direct to the table. This cannot always be done, on account of the shape of the work.

PLANING OPERATIONS.

Fig. 142 shows an open-side planer; this tool is adapted to accommodate work when bolted to the table, of a greater width than the ordinary planer; the cross-vail or beam is a right-angle casting having a vertical leg with

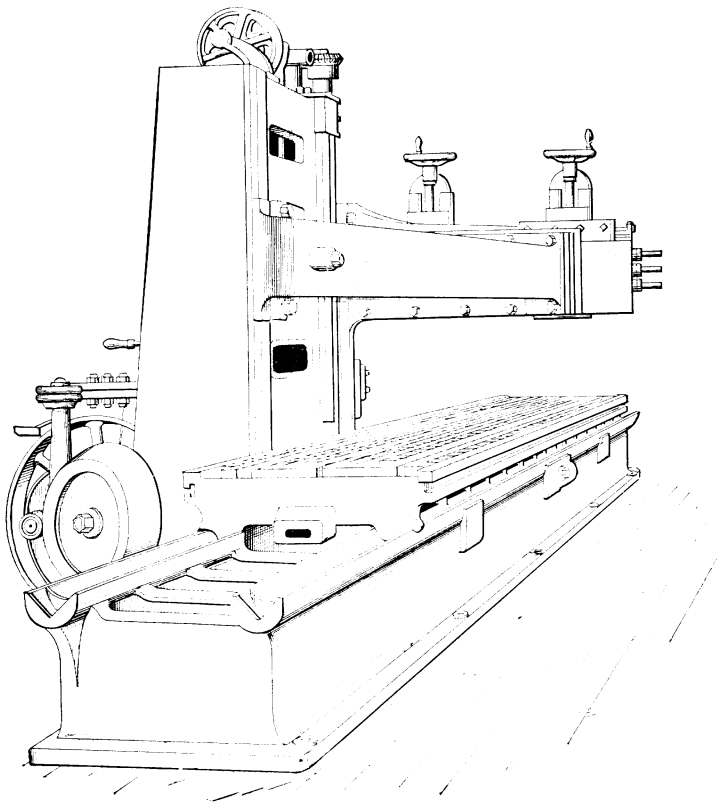


Fig. 142.

a very long bearing on the front face of the post; the horizontal arm is supported at the back by a heavy brace bolted securely to it, this arrangement insuring stiffness and stability; the brace has a sliding bearing on the side

and at the rear of the post, being rigidly clamped to it when set in position for planing. The beam and brace are raised and lowered by power.

Fig. 143 shows a swivel chuck which is sometimes

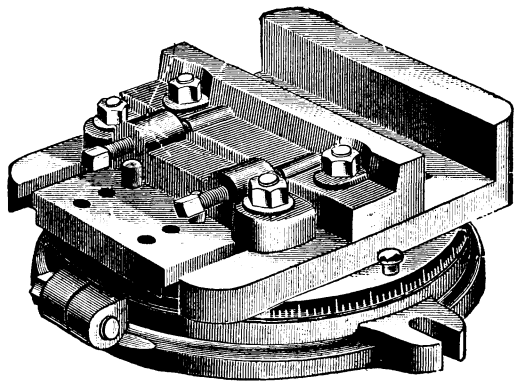


Fig. 143.

used; it is bolted on the table and travels with it, the work being held between the jaws as in a vise. Frequently work has to be held as on a lathe; for this purpose two

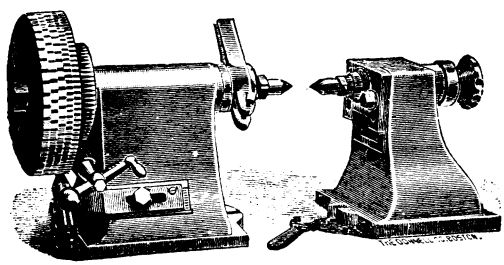
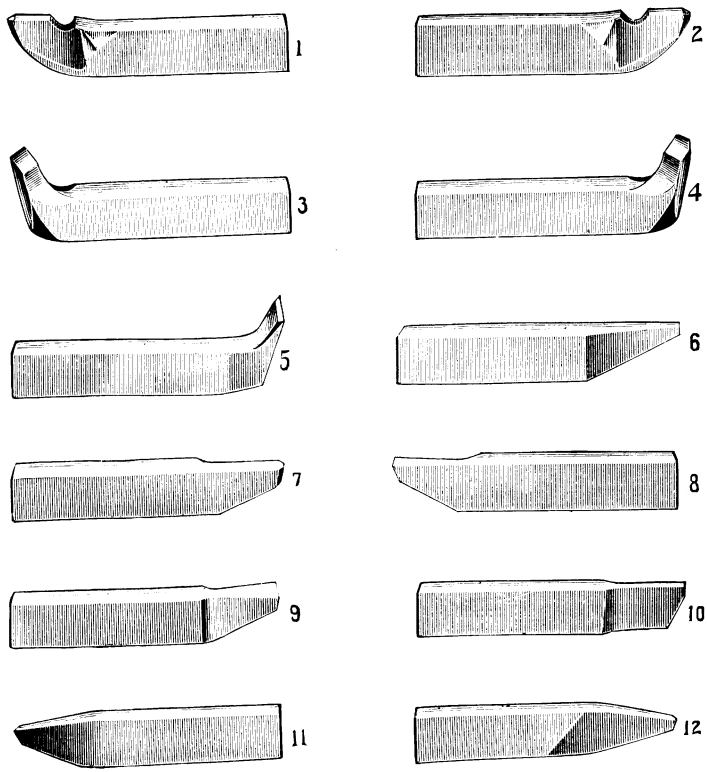


Fig. 144.

"planer centers" are used, as shown in fig. 144. These are bolted on the table; one of these is shown with a "dividing index."

PLANING MACHINE TOOLS.

The following illustrations show the tools in general use in planing machines. The name of each tool is given below in Note.



Figs. 145–156.

NOTE.—No. 1, Left-hand Side Tool; No. 2, Right-hand Side Tool; No. 3, Left-hand Diamond-point Tool; No. 4, Right-hand Diamond-point Tool; No. 5, Broad-nose, or Stocking Tool; No. 6, Scaling Tool; No. 7, Right-hand Siding Tool; No. 8, Left-hand Siding Tool; No. 9, Finishing Tool, for corners; No. 10, Cutting-off Tool; No. 11, Left-hand Bevel Tool; No. 12, Right-hand Bevel Tool.

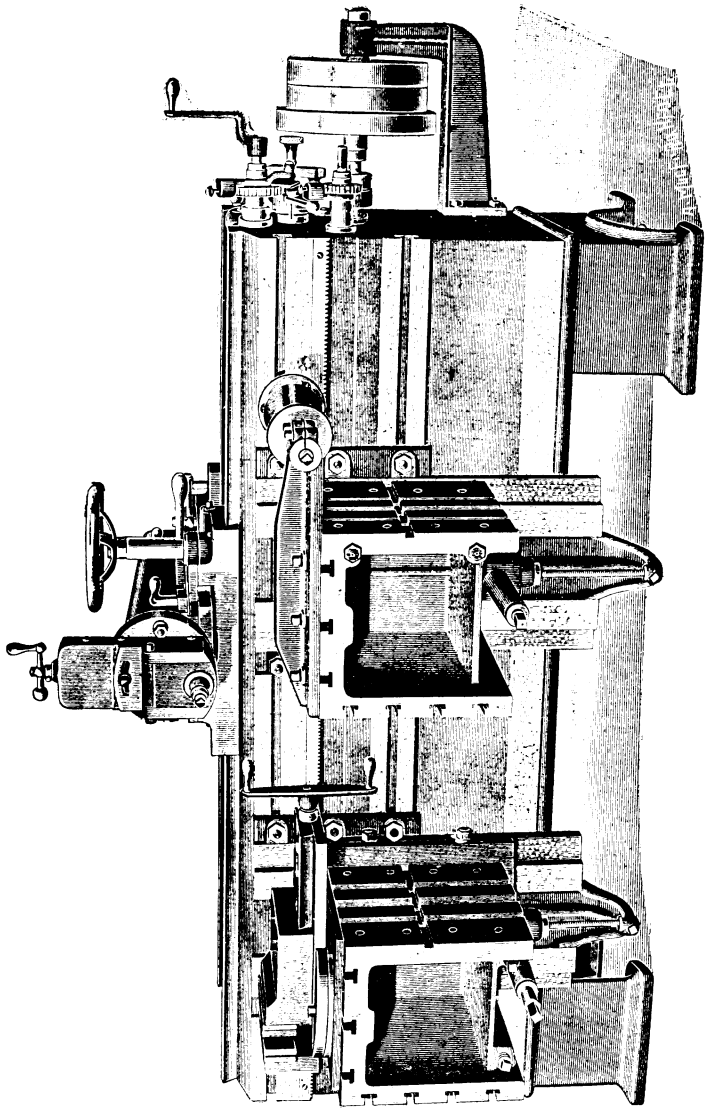


Fig. 157.

SHAPING MACHINES.

The shaper, or shaping machine, is a straight-line cutter of the planer class; they perform a large variety of operations formerly executed by hand-chipping and filing.

In this machine the work is held stationary, the tool being given a reciprocating cutting motion.

The feed-motion of shaping machines may be communicated either to the cutting-tool or to the work; when the feed is given to the cutting-tool the machine is described as *a traveling-head* shaper; such an arrangement is shown in fig. 157.

More generally—and in all small shapers—the feed is communicated to the work-table, as shown in fig. 158, the ram or tool-head having no side travel, the feed motion being given to the table carrying the work.

The shaper is a useful and handy tool, and is made in a variety of forms for special purposes, the work ranging from key grooves in shafting to planing valves and steam ports in engine cylinders.

Fig. 157 shows a usual type of traveling-head shaper; the tool-head is carried in a saddle having variable self-acting feed in either direction; it has also a rapid movement along the bed by hand through a rack and pinion, or in some cases it is operated by a powerful square-cut screw; the tool has ratchet down-feed motion; it can be swiveled and will act at an angle; two tables are provided,

NOTE—Shaping machines are generally run at a tool speed of 12 to 20 feet per minute.

each having a hand movement along the bed, and also a vertical adjustment by screws; one table has, generally, a horizontal surface for clamping work, the other being provided with horizontal and vertical slotted surfaces for clamping the work in any desired position.

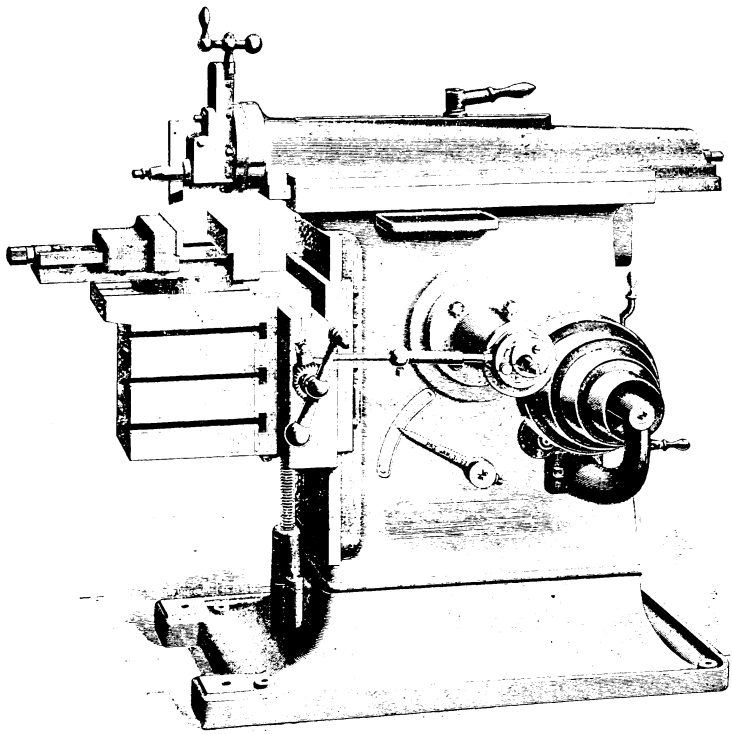


Fig. 158.

For forming teeth in spur-wheels cut out of solid blanks, shapers of special design are made, of which an example is given in fig. 159—it is the "Fellows' Gear Shaper."

SHAPING MACHINES.

A, *B*, *C*, are change gears; *D*, the "module" or pitch gear, the number of teeth of which must have a fixed ratio with the teeth of the cutter; *E*, feed trip; *F*, lower index; *G*, apron; *H*, chip pan; *I*, work arbor; *J*, cutter; *K*, cutter

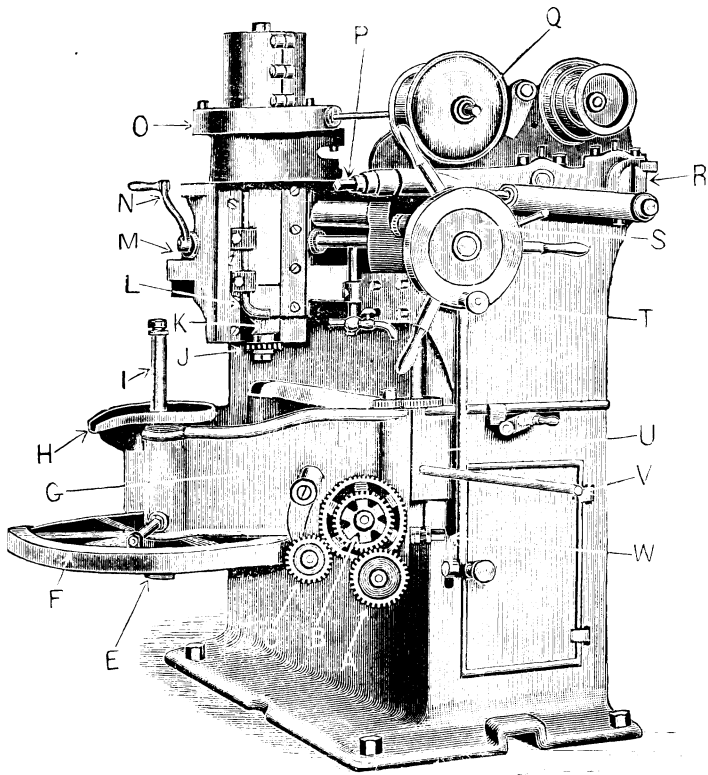


Fig. 159.

slide; *L*, work support; *M*, saddle binder; *N*, saddle adjustment; *O*, upper index; *P*, adjustment for the position of cutter; *Q*, to rotate cutter; *R*, driving crank; *S*, pilot wheel; *T*, locking pin; *U*, apron lever; *V*, detachable lever; *W*, worm adjustment.

PLANING OPERATIONS.

The Fellows Gear Shaper goes back to first principles and generates its tooth form from flat and circular surfaces which can be made absolutely true and can be proven to be so.

The work is done automatically, by a circular cutter of the correct pitch.

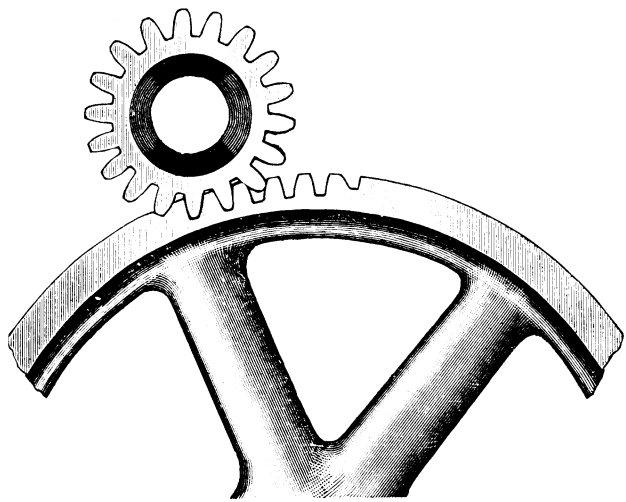


Fig. 160.

An example of the work produced is shown in fig. 160. This is effected as follows: The blank to be cut is securely fixed on the work arbor and the machine being started, the cutter reciprocating vertically on its center line is fed towards the blank, and cuts its way to the proper depth; at this point both cutter and blank begin to revolve, the cutter maintaining its reciprocating motion; this revolution of the cutter and blank is obtained by external mechanism, which insures that the movement

SHAPING MACHINES.

shall be as though the cutter and blank were two complete gears in correct mesh; fig. 161 shows a section through the centers of blank and cutter which will explain the process of cutting an external-toothed gear wheel; internal gears can be cut with equal ease and regularity.

Fig. 161 shows the action of the gear cutter, also each cut and the wedge form of the gear shaper chips.

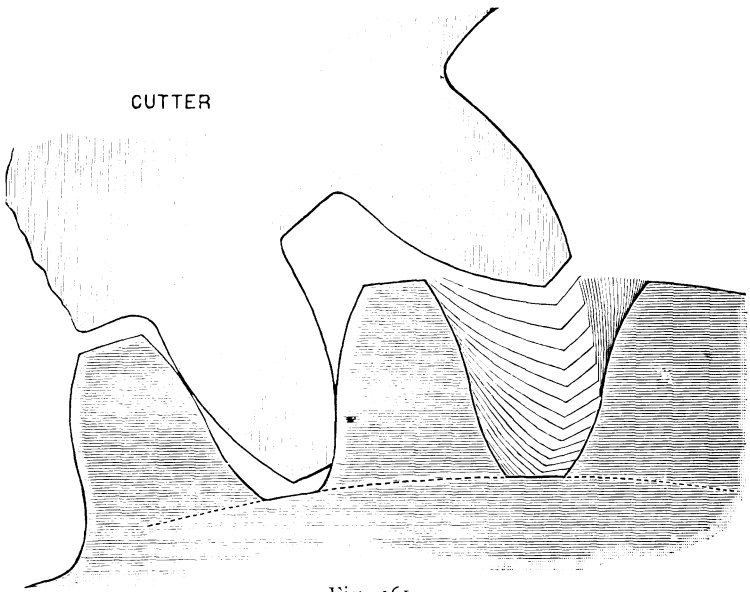


Fig. 161.

The combined result of rotary and reciprocatory motions is that the cutter teeth generate conjugate teeth in the blanks which mesh correctly with the cutter teeth and with each other.

Fig. 162 illustrates a device for setting planing or shaper tools; it consists of a body containing a spirit level, the bubble of which appears through an elongated opening

DEVICE FOR SETTING TOOLS.

formed in the top plate, attached to the body and provided at its side with linear graduations having their zero points coinciding with the zero point of the bubble. The body is provided with a downwardly extending web terminating in

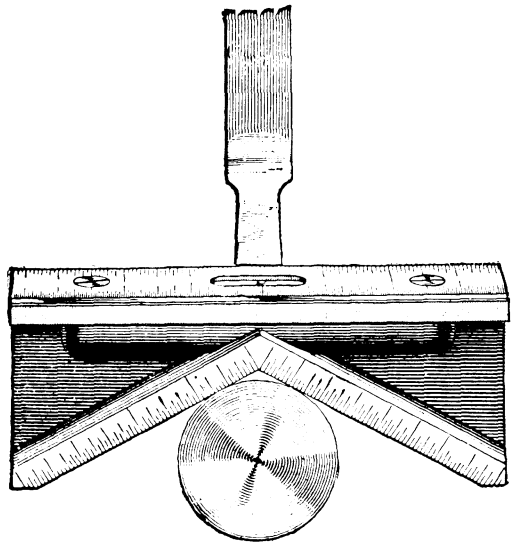


Fig. 162.

legs, extending at an angle of 150 degrees and having their apex in vertical alignment with the bubble of the spirit level. The outer faces of the legs are provided with linear graduations, reading from the apex outwardly.

NOTE.—The figure shows the instrument on the shaft and the tool in position in the tool post ready to cut a keyseat. For setting a square-nose tool in the shaper or planer, to cut a keyseat or groove, the operator places the instrument upon the shaft with the legs touching the sides of the shaft and turns the instrument until the bubble of the spirit level is at zero. The planer tool is then brought to the correct position by aid of the graduations and is set with its edge parallel with the top surface of the instrument.

THE SLOTTING MACHINE.

The slotting machine may be classed as a *vertical shaper*, or planing machine: it performs straight line cutting; the tool, as in the shaper, receives the motion, the bed or table being stationary, except for feed adjustment.

There are many varieties of slotters, both light and heavy; the small machines are usually crank-driven, the larger ones have steel racks and pinions driven by a train of spur gears, with shifting belts; for slotting heavy forge work, especially cutting propeller shaft cranks out of the solid, they are built of great cutting power.

The principal features aimed at in all, are smooth running and convenient handling of the work.

The advantageous features of the slotter are, first, that the lay-out of the work is always visible, the line to be worked to being on top where the tool begins to cut, instead of where it finishes the cut as in the case of the shaper; and secondly, that there are three feeds—longitudinal, cross and circular—all with a wide range.

For the slotting of interior surfaces, and the planing of such exterior surfaces as for one reason or another cannot be done advantageously on the planer or turned in the lathe, and where the pieces are of medium or large size, the slotter is a necessity.

For cutting keyways in wheels, etc., the slotting machine has no equal and in addition nearly all descriptions of broaching work can be accomplished with it.

PLANING OPERATIONS.

Fig. 163 shows a well known form of the tool in common use for machine-shop purposes; the tool-bar can be adjusted to suit the height of the work, or any length

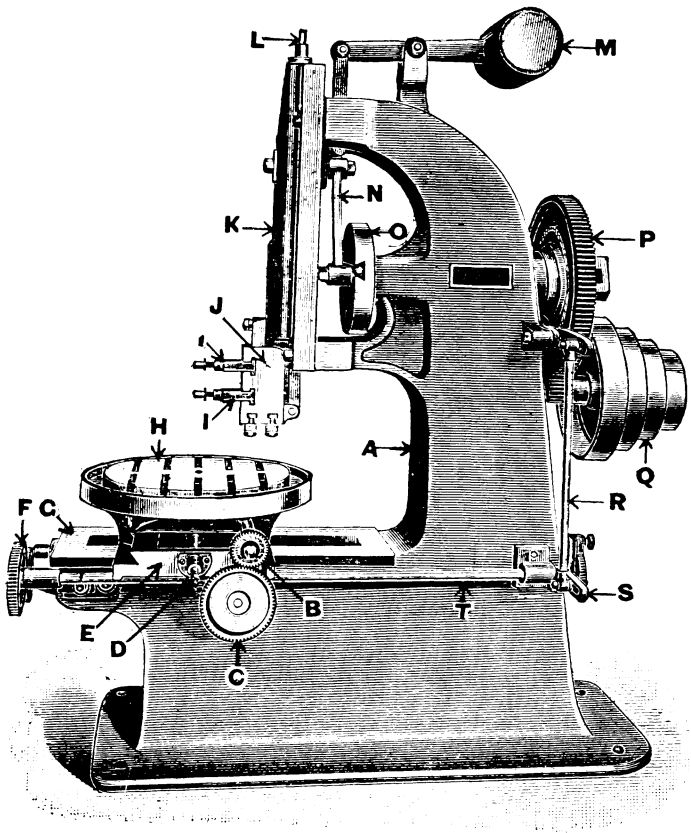


Fig. 163.

of tool used; the work-table has power feed for the longitudinal, cross and circular movement; all the feeds are moved at the top of the stroke, when the tool is clear of the work.

THE SLOTTING MACHINE.

The ram, or tool-bar, as shown in the illustration, is counter-weighted and easily regulated; the hand cranks and levers for all adjustments are placed within easy reach of the operator.

The cutting tools in slotting machines are gripped in a relief tool block, *J*, carried by the ram, *K*, moving vertically in the slides of the upright frame, *A*; the work being operated on is fixed on the work table, *H*, which lies horizontal beneath the ram; the work table is carried on a compound slide, having two horizontal motions: the lower slide or carriageway, *G*, is operated by the rod or feed-shaft, *T*, and the end main feed gear, *F*; the upper slide or saddleway, *E*, is operated in a similar manner by the main intermediate gear, *C*. *D* is the transverse adjusting screw; the small wheel, *B*, operates a worm, which engages with a worm wheel on the periphery of the circular table, *H*, to rotate it; the tool-posts, *I*, *I*, are carried in the relief tool-block or apron, *J*; the ram, *K*, may be varied according to the thickness of the work on the table by the adjusting screw, *L*, on the ram; *M* is the counterweight which balances the ram and prevents "jump" when the tool is entering or leaving the work; *N* is the connecting rod attached to the crank-plate, *O*, which gives motion to the ram; the gear, *P*, on the crank-plate shaft is driven by a pinion on the driving-cone pulley, *Q*; the feed-rod, *R*, gives motion to the feed-shaft, *T*, by means of the bell-crank, *S*.

The cutting-bar slide is made adjustable on the outside of frame, and by making the slide very heavy, no matter at what point the cutting-bar is set, it will be very rigid. To adjust the cutting-bar slide, it is only necessary

to tighten up one of the gib screws and loosen the clamping bolts, and by revolving the driving cone the slide can be adjusted in any desired position to bring it down close to the work.

The accompanying drawings (fig. 174 being a side view and fig. 175 a front view) will show the detail of the relief tool-block on all these machines.

A is the adjustable slide attached to the main frame by the bolts *C*; *B* is the ram having slides *H*, *H*; *D* is the

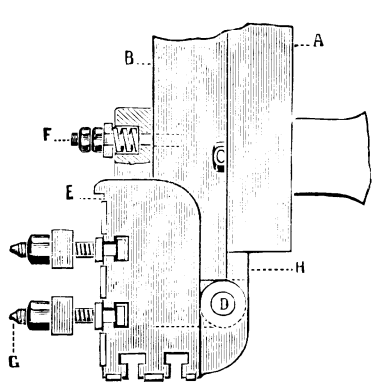


Fig. 174.

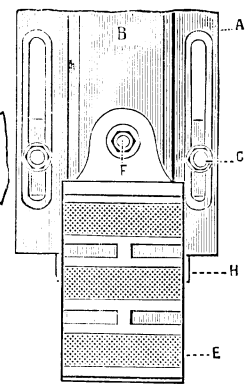


Fig. 175.

pivot or pin on which the apron or tool-box *E* hinges; *F* is the relief spring which presses the apron *E* against the ram *B* on the downward or cutting stroke of the tool, as illustrated in fig. 176; on the return or idle stroke, the relief spring yields and takes the pressure off the cutting point of the tool, which is carried in the tool posts *G*.

Fig. 177 shows a form of machine used largely in machine shops for cutting keyways up to one inch wide; it is constructed on the principle of a broacher or drift cutter,

the work being fixed to the adjustable table, *A*, by the heavy clamping, *D*. The cutter-bar, *G*, which has coarse teeth, as shown, is drawn through the work; there is a provision for automatic relief on the return stroke, which prevents the breaking of the cutter-teeth; *B* is the supporting bracket used when cutting sleeves or hubs; it has an adjusting screw, *C*, for holding the work; the clamp, *D*, is used for holding all large work such as pulleys, spur and

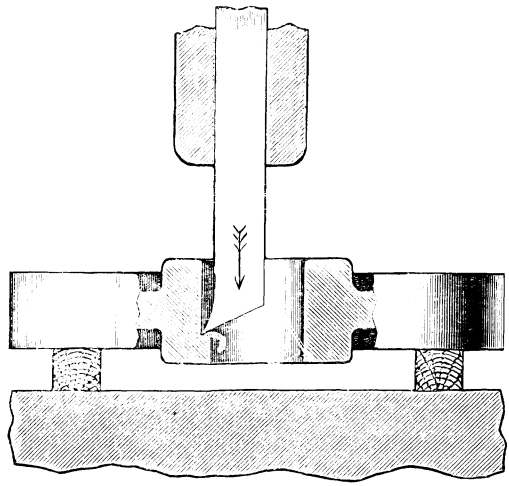


Fig. 176.

bevel gears, etc., being fixed by the screwed studs, *E*, which compress springs *Q*.

An adjustable chuck, *F*, is used for centering small work; the vertical cutter bar, *G*, is connected to the cross-head, *I*, which reciprocates in vertical guides under the table; a scale, *H*, is provided for graduating the depth of the key seat; collars or packing, *I*, regulate the height of

PLANING OPERATIONS.

the clamp, *D*; an adjustable clamp arm, *J*, is used for holding small work; it has hand feed screw; an adjusting post, *N*, and clamp screw, *M*, for attachment to the table.

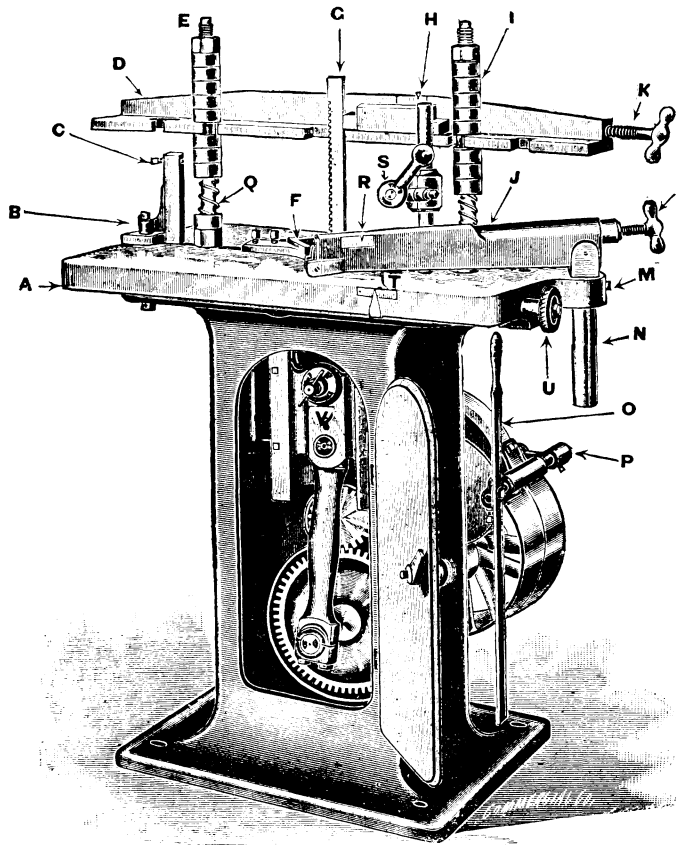


Fig. 177.

The spur gear enclosed in case, *O*, are driven by the tight and loose pulleys revolving at 175 revolutions per minute; in this machine the work is chucked by the hole or bore.