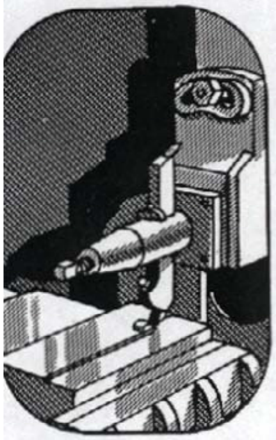
OBJECTIVES OF UNIT

1. To explain how metal is removed in the shaper.
2. To point out several types of metal shapers.
3. To name and describe the main parts of a mechanically driven crank shaper.
4. To indicate the functions of these parts.

INTRODUCTORY INFORMATION



The shaper is a machine tool used to machine a flat surface which may be in a horizontal, a vertical, or an angular plane. In addition, the shaper is used to machine odd and irregular shapes which would be difficult to produce on other machines.

The work is held on an adjustable worktable or, if its size and shape permit, in a vise which in turn is bolted to the table.

A single-point cutting tool attached to a rigid arm called the ram moves over the work with a reciprocating (alternate forward and backward) motion. The length of the ram stroke and the number of strokes per minute may be varied as the length of the work and its composition change.

With one exception, the cutting tool, which is adjustable vertically, removes material during the forward stroke only. During the return stroke of the ram, the table and the work move toward the tool a predetermined amount as long as the automatic table feed remains engaged.

Most shapers have been designed with a vertical column or pillar which is used to support the ram, the table, and the drive and feed mechanisms, and therefore at one period in their development were called column or pillar shapers.

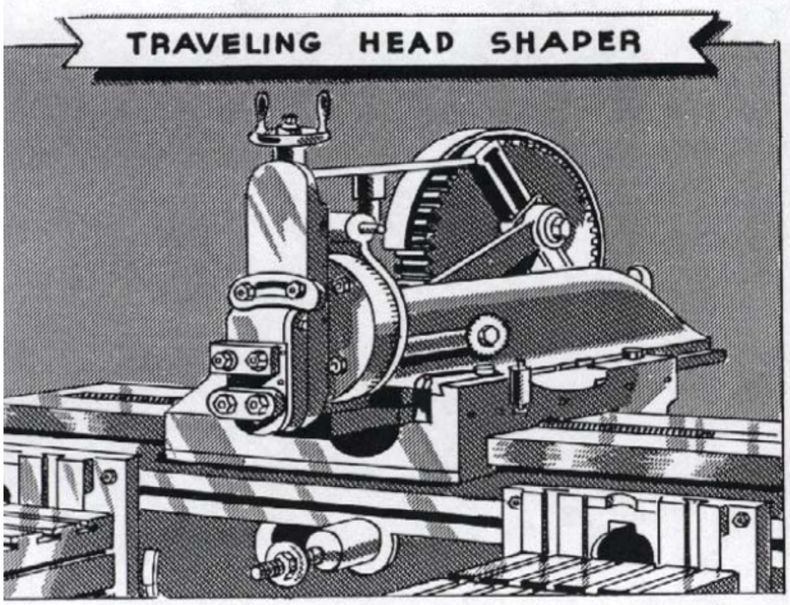
However, since the column-type of design has become so generally used in shaper construction, manufacturers have assumed that this fact has become commonly known in the machine industry and therefore have used instead more specific and meaningful terms in classifying their machines, terms which indicate or emphasize some characteristic features in the design of their product.

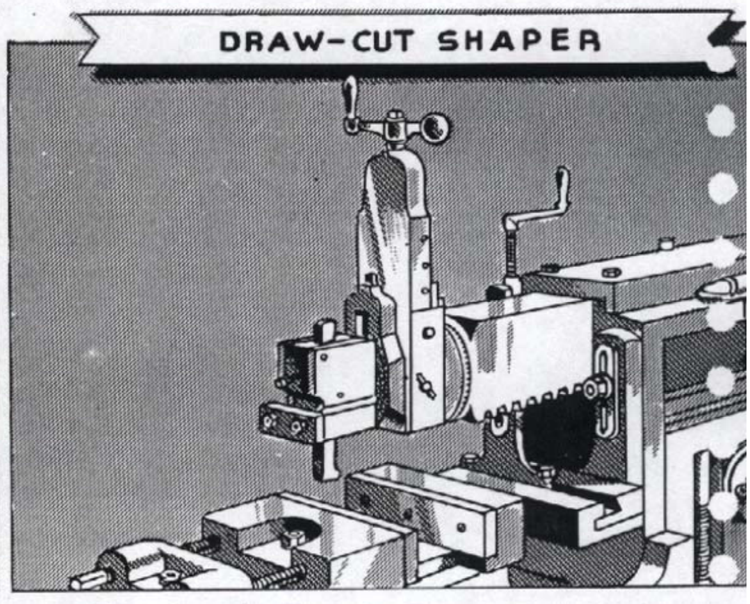
Several more or less commonly used types of shapers are manufactured. Each class has been designed to perform a definite class of shaper work with the greatest possible effectiveness.

Among the less common designs are the traveling-head shaper and the draw-cut shaper. The classification of these machines has been influenced by the action of the machine during its operation. For example, in the traveling-head machine, contrary to general procedure, the ram and the tool, instead of the work, move when the automatic feed has been engaged, and, in the draw-cut shaper, material is removed on the return stroke of the ram, instead of on the forward stroke as is the case with other types of shapers.

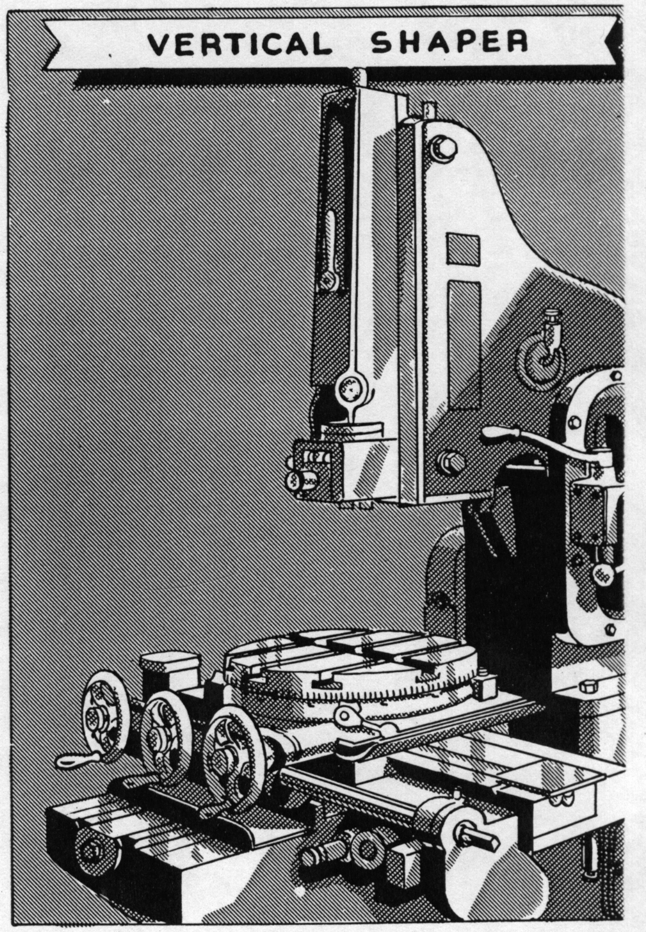
In another group of shapers, classification has been based on the type of driving mechanism utilized in their construction. For instance, shapers in which the back-and-forth movement of the ram is brought about by a crank pin in the main driving gear of the machine, have been designated crank shapers.

Similarly, geared shapers have been so called because a series of gears and a rack attached to the underside of the ram, move the tool over the work.



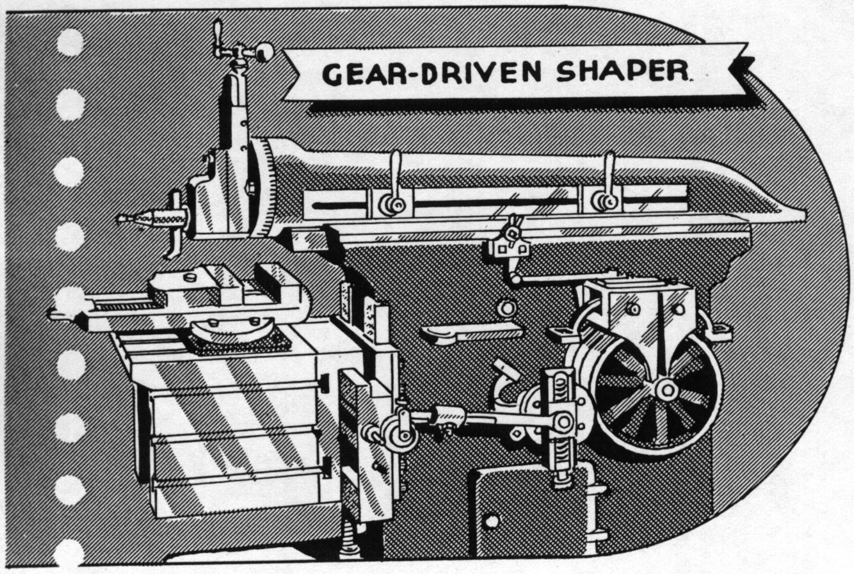


In the vertical shaper, still another constructional feature of its design is responsible for its name. In machines of this type, the tool moves in a vertical direction in contrast to the usual horizontal movement of the ram on the other types of shapers mentioned.



The size of a shaper is designated by the maximum length of its stroke given in inches. This length of stroke may range from 6 inches on a bench-type shaper to 36 inches on a heavy-duty machine, and indicates, in addition to the size of the machine, the dimensions of a cube which can be held and planed in a shaper of a known size.

A 16-inch shaper, for example, can be adjusted for any ram stroke from 0"-16" in length, the transverse table feed can be used to plane a surface 16 inches wide, and the vertical distance between the tool head and the worktable in its extreme lower position will be sufficient to permit planing the upper surface of a 16-inch cube resting on the table.



The crank shaper of the vertical-column construction is the type most commonly used in machine shops and tool rooms. Shapers in this classification are manufactured in universal models on which the table may be adjusted to angular positions, and also in plain models on which the table, however, has no facilities for angular shaping. This monograph will be confined to the description of the plain crank shaper and to an explanation of some of the operations which can be performed on a shaper of this type.

A few jobs involving operations which are typical of those frequently performed in the shaper have been illustrated on this page. They give some idea of the wide variety of work which may be performed by an operator who is familiar with the construction of the shaper and who understands the principles of its operation.

One of the simplest shaper operations is that of machining a casting to definite dimensions by removing one or more cuts from its surfaces, the surfaces to be placed horizontally during the cut and the job to be held in the vise as indicated in Fig. 1.

Frequently a surface can be machined to better advantage when it is placed in a vertical position and the tool fed down along a vertical surface of the work instead of across a horizontal surface of the work. Fig. 2 shows this kind of setup.

Shaping the work at an angle other than 90° from the machine table closely resembles vertical cutting, but such a machining process involves adjustment of the tool head to a position corresponding to the angle required on the work. This setup has been illustrated in Fig. 3.

Both lateral movement of the table and vertical movement of the tool are required when it becomes necessary to shape an irregular layout such as the one shown in Fig. 4.

The cutting of slots, keyways, and dovetails are other operations which can readily be performed in the shaper.

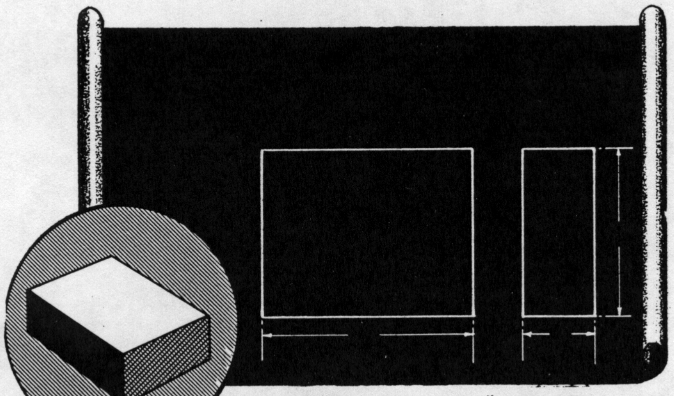


FIG.1

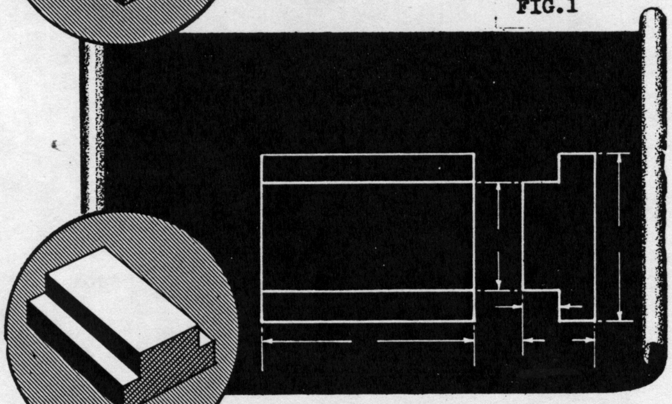


FIG.2

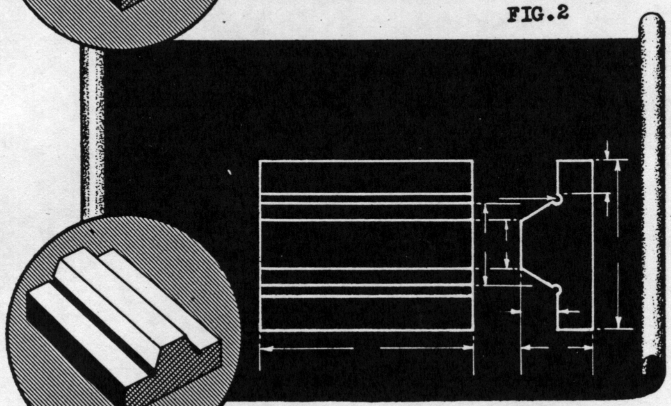


FIG.3

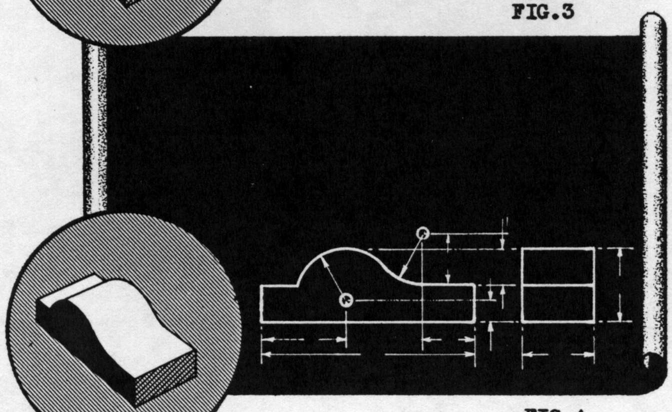


FIG.4

The bottom of the column rests on surface A of the base casting. The upper surface forms the guide ways for the ram. Either one or both of the V-shaped guide ways B may be cast as an integral part of the column, but different methods for taking up wear between these surfaces and the ram must be provided for each form of construction.

When both ram ways form a permanent part of the column, a taper gib inserted between the ram and its ways provides a means of adjustment between these parts. Where only one ram way has been cast to the column, the second guide C is bolted thereto, thus permitting its position to be changed with a series of screws D when it becomes desirable to alter the adjustment between the ram and its ways. (Refer to page 12.)

The front vertical face of the column has been accurately planed at right angles to the ram ways on the top. This face and the T-ways adjacent thereto on both sides, keep the cross rail in its proper horizontal relationship with the ram when the cross rail must be moved vertically on the face of the column.

The convex wall F on the right side of the shaper column provides space internally for the main driving gear and externally supports the stroke-adjusting mechanism and the table feed unit.

A large opening in the left side of the column allows access to its interior for repairs and adjustments. A cover over this opening excludes foreign material and prevents accidental contact with the moving parts enclosed in the column.

Another opening located at the top of the column and in the center of the front face is called the throat E. When a shaping operation is to be performed near the end of a long piece of work, it may be extended into this opening in the column. A guard keeps chips from the throat when it is not in use.

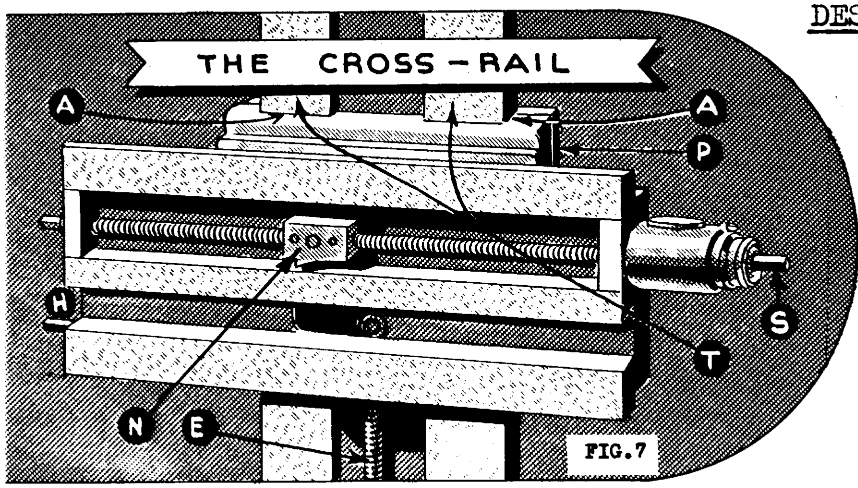


FIG.7

DESCRIPTION OF THE CROSS RAIL

The cross rail is a relatively long casting located across the front of the column. Its function is to permit vertical and horizontal movement of the table.

Opening A fits around the front and sides of the vertical surfaces on the column, and, together with plates P, forms the bearing surfaces which permit the cross rail to be adjusted vertically to provide for jobs which may vary considerably in height.

Plates P are bolted to the back of the cross rail and extend behind the T-shaped ways T which form part of the column face.

The gib between the side of the column and the cross rail keeps these parts in adjustment sideways. Hexagon-head bolts, or often handles, are provided on both sides of the shaper to bind the cross rail to the column immovably.

An elevating screw E controls the vertical movement of the cross rail and determines its position on the column. When it becomes necessary to change the height of the cross rail, motion, applied by means of a crank at the squared end of the horizontal shaft H, is transmitted through bevel gears within the rail to the elevating screw or to a nut mounted thereon.

Just as the front face of the column furnishes the bearing surface for the cross rail so, in turn, the front face of the cross rail serves in a similar capacity for the saddle, but with this difference: the column face provides for vertical movement of the table, whereas the face of the cross rail controls horizontal movement of this part.

A cross-feed screw S, mounted horizontally in the cross rail, extends from end to end, and, by passing through a stationary nut N, attached to the rear of the saddle, controls the sidewise movement of this part. A crank may be used on the end of the screw to feed the saddle, together with the table, by hand.

A metal guard (not shown) protects the bearing surfaces of the cross rail from damage, and bronze retainers with felt inserts or wipers remove dirt and fine particles of metal from its working surfaces while adjustment is being made.

DESCRIPTION OF THE SADDLE

The saddle, or apron, which is a comparatively thin, flat casting located between the cross rail on one side and the worktable on the other, forms the connecting link between these parts.

The rear of the saddle fits the horizontal guide ways A on the cross rail. These guide ways generally consist of a dovetail fit at the bottom and a

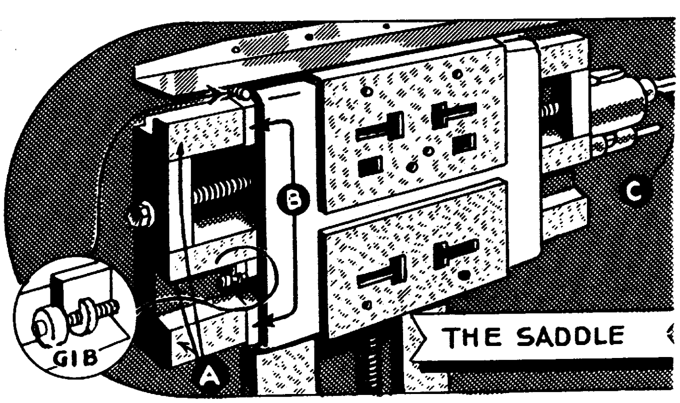


FIG.8

DESCRIPTION OF THE SHAPER

The parts of the shaper will be described in the order in which these parts or units might be brought together for assembly of the machine.

DESCRIPTION OF THE BASE

The base, which rests directly on the shop floor, is a casting which serves as a foundation for the entire machine. After being leveled, the machine may be fastened securely with foundation bolts inserted through holes provided for this purpose near the outer edge of the base.

The portion of the base beneath the column is utilized as an oil reservoir when the machine has been equipped with a pressure-lubricating system; that portion of the base not so used is hollow underneath and braced with internal ribs spaced at intervals designed to strengthen the casting.

The only places which have been machined on the base casting are surface A, to which the column will be bolted, pad B, which forms a flat bearing surface for the table support, and hole C, which centers the lower end of the table elevating screw. All other surfaces are unfinished.

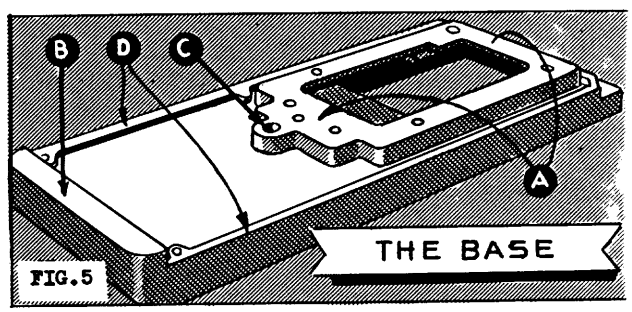


FIG.5

A rim D surrounds the base. This retains excess oil which drips from the machine and prevents the oil from reaching the shop floor.

On some motor-driven machines an extension to the rear of the base casting provides space for the motor; on others, however, the motor is attached to the column or to a separate casting which is bolted to the base.

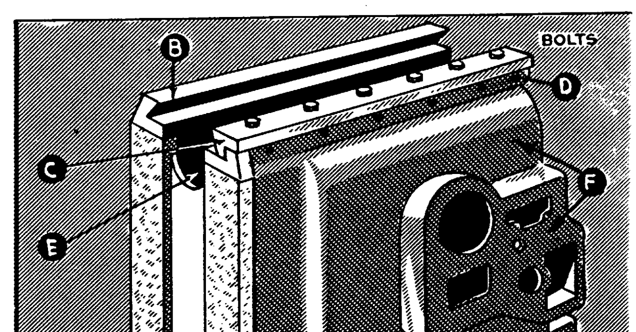


FIG.6

DESCRIPTION OF THE COLUMN

The column or frame, as it is also called, is a hollow casting shaped like a box with openings at the top and bottom. In addition to enclosing the mechanism which drives the ram, it also houses a unit which actuates the automatic feed, and, in the mechanically driven shaper, another unit which permits adjustment of the ram stroke. Heavy internal ribs keep the column permanently rigid and accurate. Its external surfaces support both the table which holds the work and the ram which holds the cutting tool.

square box fit at the top of the rail, and, since an accurate fit must be maintained between these members, taper gibs using end screws for adjustment are supplied in both of these places.

Interaction of a stationary nut attached to the rear face of the saddle and a cross-feed screw mounted in the rail permit horizontal movement of the saddle on the guide ways of the cross rail. A graduated collar C on the cross-feed screw permits micrometer adjustment of the saddle and table in a horizontal direction. Felt wipers B assist in maintaining these parts in good working condition by cleaning and lubricating their bearing surfaces.

T-slots, which extend either partially or entirely across the front face of the saddle, accommodate bolts used to clamp the table to this member, thus making a single unit of these parts. Usually, when the T-slots extend only partially across the saddle, another slot is placed in its face for the alignment of fixtures which may be substituted for the table.

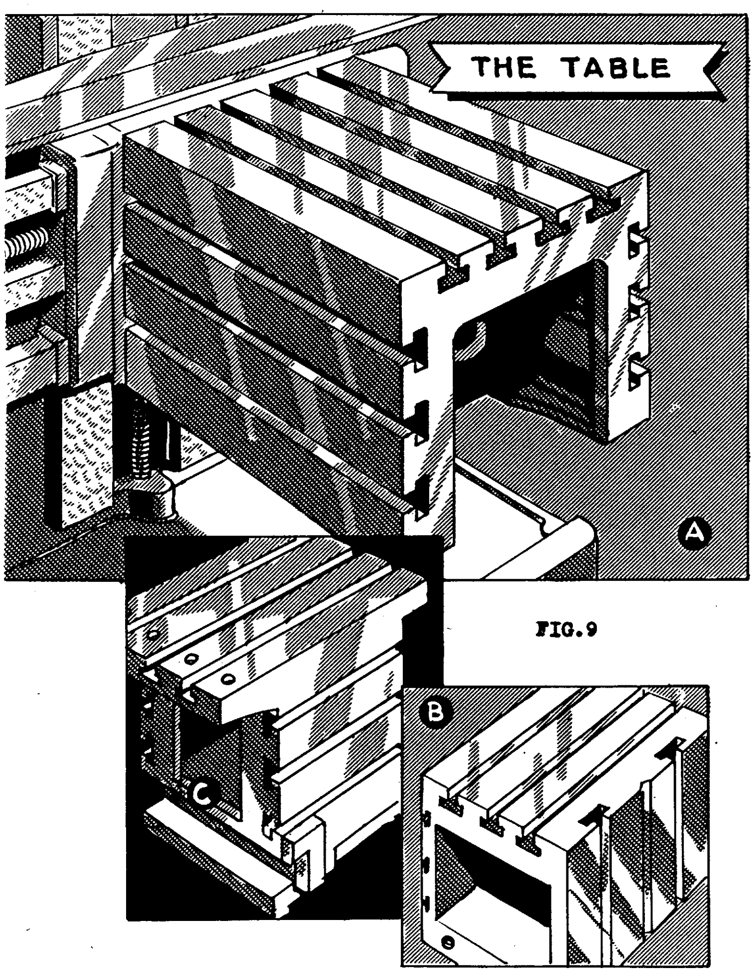


FIG.9

DESCRIPTION OF THE TABLE

The table is a rectangularly shaped casting of boxlike construction with openings at the front and at the bottom. All of its surfaces have been machined accurately. The need for such accuracy must be apparent since each face serves in one of two capacities — either for locating the table in relation to other parts of the shaper or for locating and holding the work or work-holding device during the machining process.

The rear face of the table is clamped to the front face of the saddle by means of bolts which are supplemented by dowels or a key to maintain, permanently, the relationship between these parts.

The front face is used as a clamping surface for a table support as shown in A, Fig. 10. With a support of the type shown in B, Fig. 10, both the front and the bottom surfaces function with the slide.

The remaining surfaces, that is, the top and the two sides, are used for locating and holding work directly, or for locating and holding a vise or fixture which, in turn, grips the work.

The surfaces used for holding the work have T-slots which accommodate bolts used for work-clamping purposes. The spacing and the direction of these slots, however, are not similar in all makes or models of shapers, and each manufacturer advances good reasons to justify the particular arrangement used in his product.

Two common designs prevail in regard to the direction of the T-slots. In one A, the slots on all surfaces used for clamping work run horizontally; in another B, the slots on the top and on the left side run horizontally, but those on the right side run vertically. Also, tables with vertical T-slots generally have a vertical V-shaped groove for quickly aligning and clamping shafting to the table in an upright position.

Another variation in table design C includes holes provided in its clamping surfaces for use with table stops, and the extension of the upper working surface at both the front and rear. This design provides places for clamping the table to the saddle at the top in addition to the usual bolts in its front face.

DESCRIPTION OF THE TABLE SUPPORT

The table support extends from the worktable to the base of the machine. Its purpose is to support the outer end of the table and thereby prevent deflection which might occur during the cutting process, or deflection which might be induced by the unsupported weight of the table itself.

Despite wide variations in detail, designs of table supports readily lend themselves to placement into one or the other of two general groups. Into one group A, may be placed all supports which are bolted to the table and slide over a planed bearing surface of the base extension when the table moves horizontally. Into the other group B, may be placed those which are bolted to the base of the shaper, a group in which the sliding action takes place at the bottom of the table instead of on the base of the machine.

Elongated slots permit adjustment of the table support vertically to suit the table and cross-rail positions, and clamping bolts securely lock the support in place.

Bearing surfaces on which the table supports slide are sometimes protected from chips, and simultaneously lubricated by the felt wipers attached to the ends of the support. (Refer to Fig. 39, page 31.)

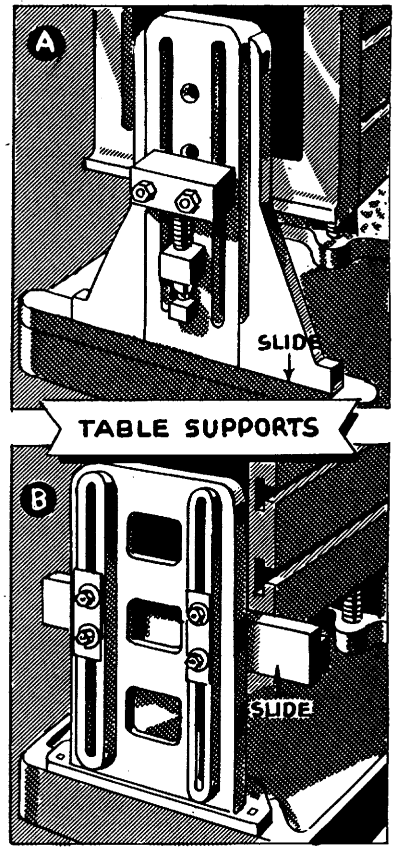


FIG.10

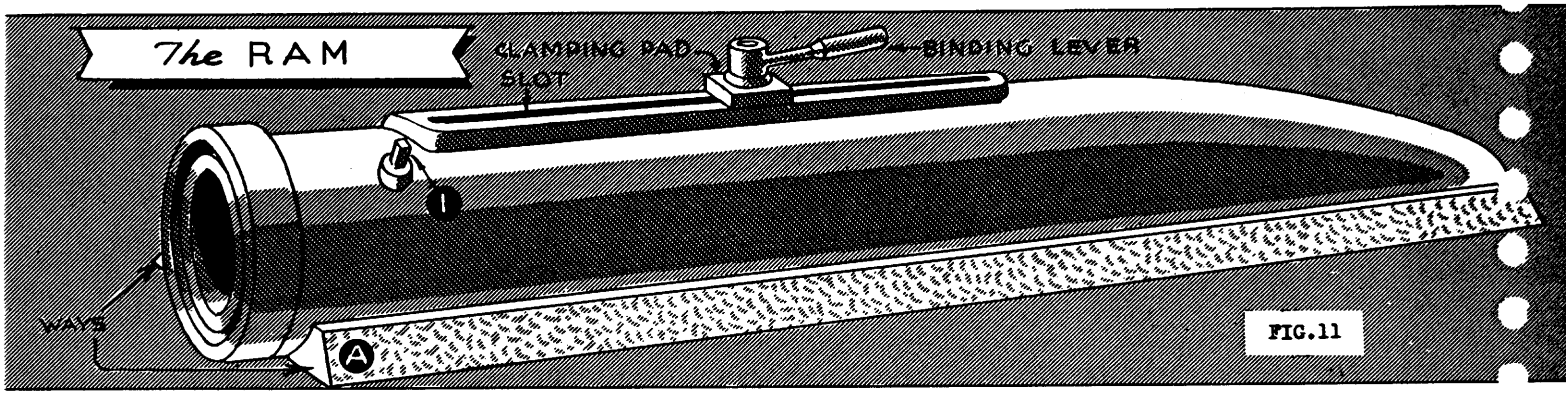


FIG.11

DESCRIPTION OF THE RAM

The ram is the long and rather narrow member of the shaper, designed to move back and forth horizontally in the uppermost section of the column. It is the part which supports the cutting tool and also guides it over the work during the cutting process.

The V-shaped ways A extend along the entire length of the ram, and, together with the ram ways in the column, form its guiding surfaces.

A gib, either tapered or straight (Fig. 12), is provided to take up wear which may occur between these moving parts. No difficulty should be encountered in determining which type gib has been used, since the means of adjusting one differs noticeably from that used for adjusting the other. The taper gib, for example, utilizes a single screw shouldered against the large end for adjustment, whereas the straight gib requires a series of screws spaced along its entire length in the column to accomplish the same result (Fig. 12).

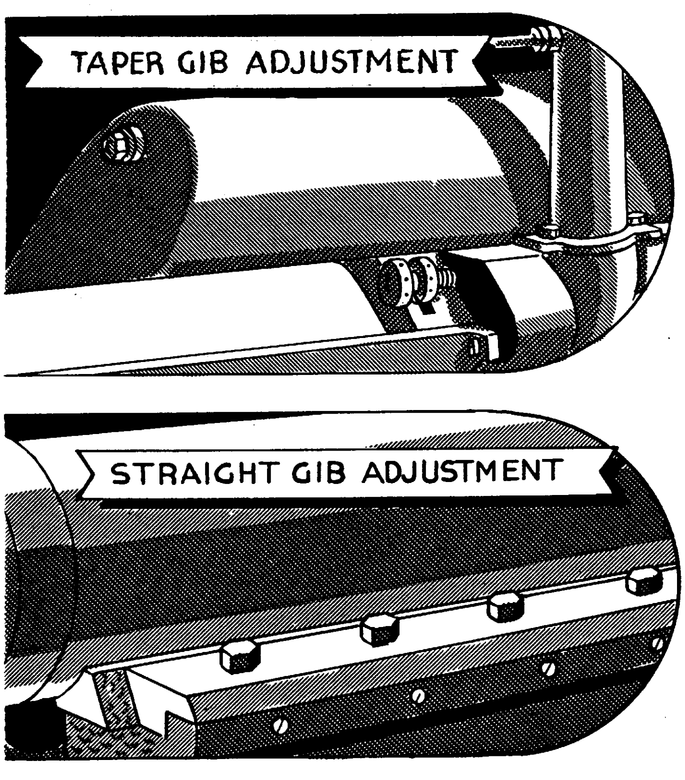
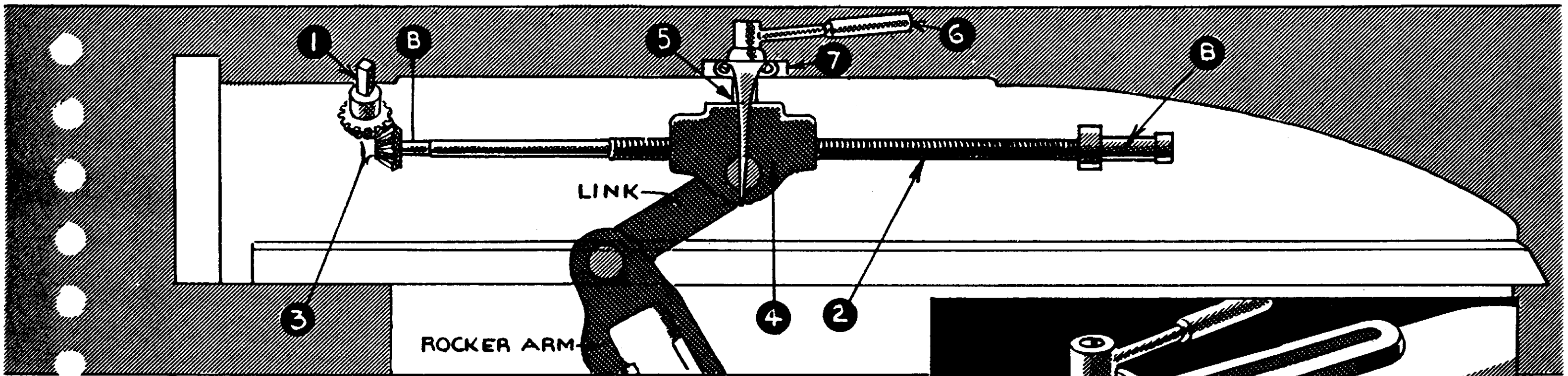


FIG.12

To the list of parts and surfaces already alluded to must be added the parts which aid in placing the ram stroke over the surface to be planed (Fig. 13). These parts include shaft 1 whose outer end has been squared to receive a crank for use when the ram is being placed, horizontal screw 2 which extends almost the entire length inside the ram and is supported in bearings at B, and bevel gears 3 which connect the shaft and the screw 2.

Also to be included is the stationary nut 4 which aids in placing the ram, and assists in clamping it in position as well. The nut is linked to the rocker arm below, fits the thread on screw 2,



and extends up to the inner surface of the ram. Stud 5, which is free to slide in the elongated slot in the ram, extends up from the nut, within, to the binding lever 6 on top of the ram, and, together with clamping pad 7, these parts furnish the means whereby the ram is clamped in position.

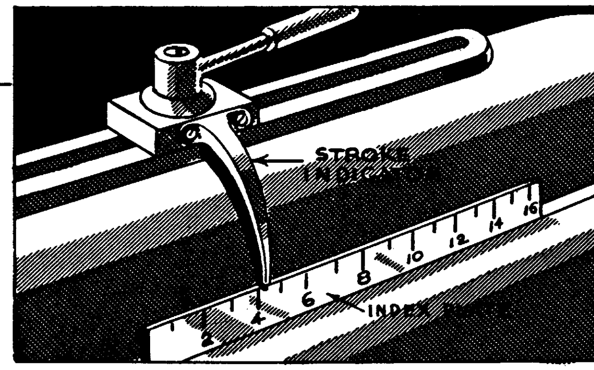


FIG.13

Many shapers of older design use a stroke indicator which attaches to the clamping pad on the ram and extends down to a stationary index plate on the column. This index plate resembles a scale in that it is marked off in inches, the largest number appearing on the index plate coinciding with the maximum length of stroke attainable on the machine, such as number 16 for a 16-inch shaper, etc.

Since the ram and the stroke indicator move as a unit, providing the binding lever has been tightened, the length of ram stroke in inches will be the same as the number on the scale to which the indicator points when the ram has reached the rear end of its stroke.

A description of the stroke indicator and its scale has been included here only because of their proximity to the ram. Their connection with the stroke-adjusting mechanism has been described on page 20.

In addition, some shapers have an automatic vertical feed F for the tool head (Fig. 14). On shapers so equipped, the feed mechanism is attached to the right side of the ram directly behind the head. Motion is transmitted to the feed screw in the head by feed lever L which is actuated as the ram moves back and forth by an adjustable tappet T on the column.

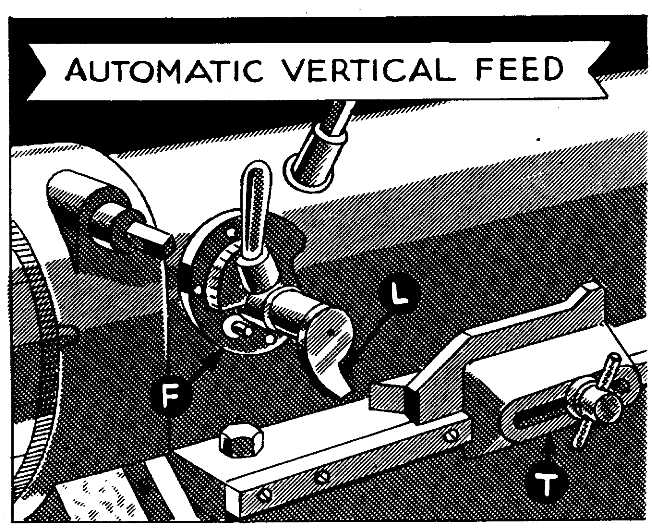


FIG.14

DESCRIPTION OF THE TOOL HEAD

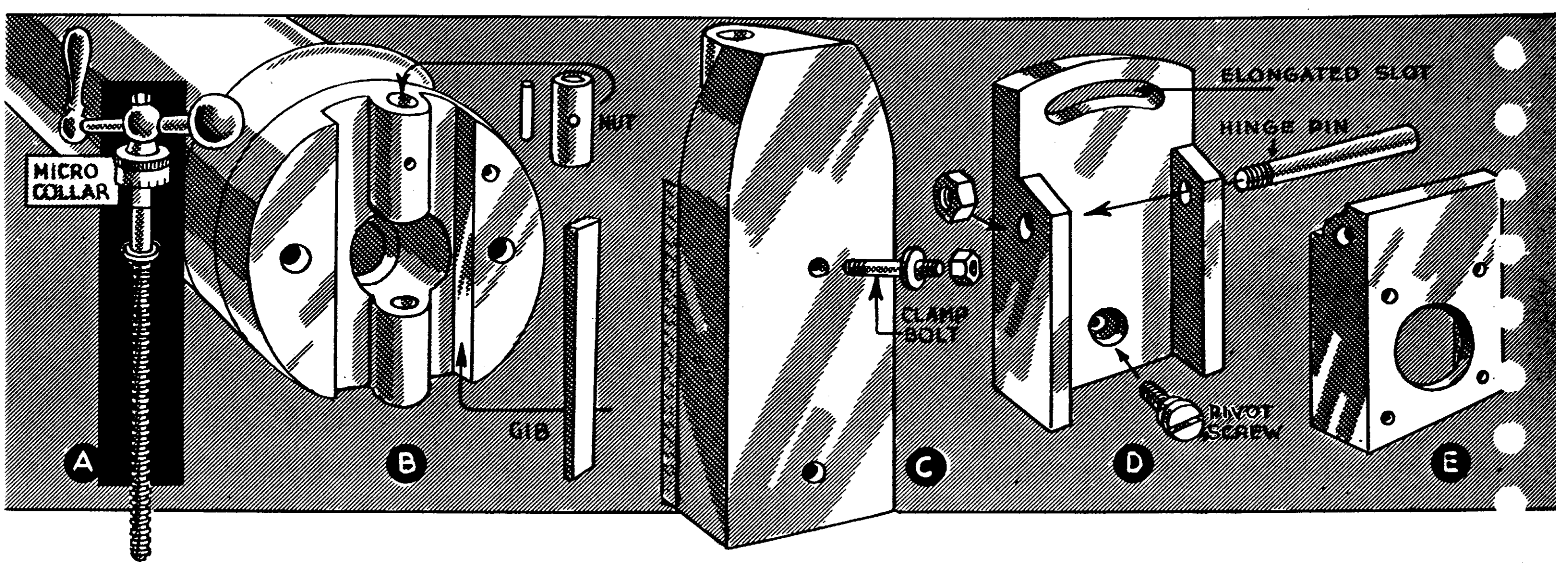
The tool head is clamped to the forward end of the ram. It comprises the parts which serve to hold the cutting tool and also those parts which guide the tool vertically and adjust it for the desired cut. Although their construction may vary somewhat in detail, all tool heads for the shaper are quite similar in appearance and in function, since each is an assembly of parts somewhat similar in design to those described herewith. (Refer to Fig. 15.)

A swivel block B connects the tool head to the ram, using for this purpose two binder bolts which extend from the annular T-slot in the face of the ram and pass through holes in the swivel block.

Another function has been assigned to the swivel block, that of allowing the tool head to be adjusted for making vertical and angular cuts with the aid of the tool slide C.

A circular projection on the rear of the swivel block extends into a recess in the ram, and not only centers these parts with each other, but also allows the tool head to be set vertically or swung at an angle when the binder bolts have been loosened. The perimeter of the swivel block has been graduated in degrees for convenience in making angular settings on the tool head.

The front face of the swivel block includes a dovetailed opening which receives a dovetailed projection on the tool slide, and also a taper gib for keeping these parts properly adjusted. With the aid of the stationary nut and the ball crank on the end of the downfeed screw A, the tool slide may be moved a considerable distance in the swivel block. The direction of the cut, whether angular or vertical, will be determined by the setting of the swivel block.



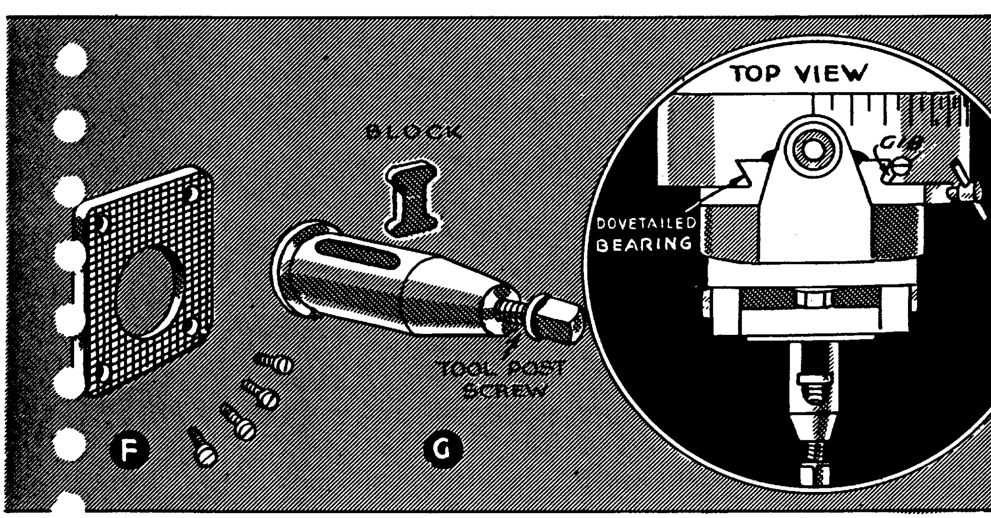
An adjustable micrometer collar, graduated in thousandths of an inch, indicates the distance through which the tool slide moves when movement of the handle turns the down-feed screw in the stationary nut..

Most shapers come equipped with a tool-slide lock for holding the tool slide in a fixed position for horizontal shaping.

Also included among the parts comprising the tool head is a group called the apron. It consists of a clapper box D, a clapper block E, a serrated plate F, a tool post G, a hinge pin, and a pivot screw.

The cutting tool is held in the tool post securely between the tool-post screw and the tool block. The serrations on the plate attached to the tool block prevent the tool from slipping during the cutting process. A block is placed ahead of the tool-post screw to prevent indentations which are likely to occur on the tool holder when pressure from the tool-post screw is applied in the same place repeatedly.

Since the shaper tool cuts on the forward stroke only, the apron has been so constructed that it supports the tool rigidly during this stroke and allows it to lift slightly and also to swing clear of the work entirely, if necessary, during the return stroke. This construction prevents severe rubbing and subsequent damage to the cutting edge of the tool.



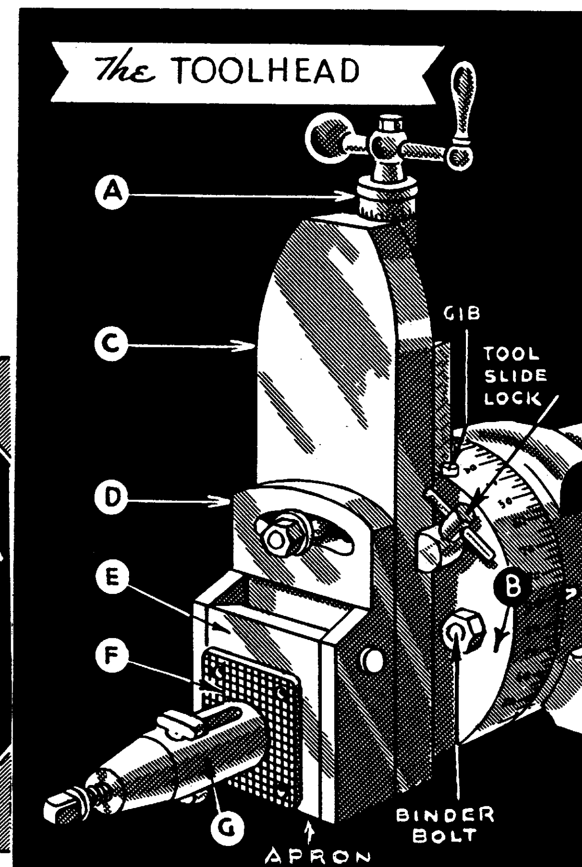


FIG.15

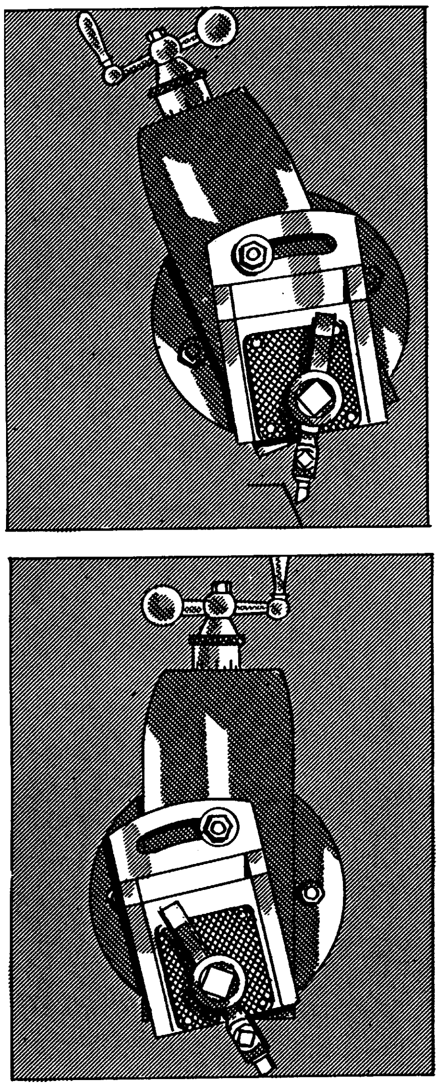


FIG.16

The clapper block E, or tool block, as it is also called, fits snugly against the sides and the back of the clapper box D. It is held in place by the hinge pin which, by means of its taper, has been so finely adjusted that the tool block will not move perceptibly during the cutting stroke, although it will lift readily on the return stroke for reasons which have been previously stated. This explanation describes the action of the tool block during a horizontal cut.

For a vertical or an angular cut, however, lifting of the tool is not sufficient; it must also swing clear of the work on the return stroke to avoid interference.

The clapper box has been designed to meet this additional requirement, that of swinging the tool out from the work on the return stroke when it is cutting in a vertical or an angular plane. It accomplishes its assignment in the following manner.

The clapper box is attached to the tool slide by means of a pivot screw and a clamping bolt. When the clamping bolt has been loosened, the clapper box may be swung through a small arc in either direction within the limits of its elongated slot without altering the position of the pivot screw.

Thus, if the clapper box is swung to the right, the cutting tool will lift and also swing away from a right-hand vertical surface and vice versa for a left-hand setting of the clapper box. For horizontal cuts, the clapper box is usually set vertically.

The use of the apron has been further explained on pages 186 and 187.

To this point, no distinction has been made between the crank-driven shaper and the hydraulically driven shaper. Since the parts described thus far have been common to both types of machines, this was not required.

From this place forward, however, the parts for these two types of machines differ and therefore will be described under separate headings — the description of the crank shaper continuing from here on, and that of the hydraulic shaper beginning on page 33.

DESCRIPTION OF THE DRIVING MECHANISMS FOR A CRANK SHAPER

The member which actuates the ram, that is, the part which controls the back-and-forth movement of the ram, is called the rocker arm. This casting is hinged at its lower end by means of a rocker-arm shaft A (Fig. 17) located near the base of the column. The upper end of the rocker arm connects with the ram by means of a link B and a clamp block C, the link compensating for changes which occur in the vertical length of the rocker arm as its upper end swings through an arc centered at the rocker-arm shaft. An explanation of the function of the clamp block has been included with the description of the ram on page 13.

Since the movement of the ram on the one hand is backward and forward and since that of the drive pulley on the other hand is circular, it must be apparent that a change of movement, from circular to reciprocating, has been effected within the machine.

This change in movement could be accomplished by several means, but since the shaper described here has been named a crank shaper, and if we apply what we have previously learned — that one way of classifying the shaper is on the basis of the driving mechanism employed — then we must conclude that a crank pin has been used for actuating the rocker arm.

Fig. 18 illustrates how the crank-type drive mechanism, functioning through the rocker arm and its connecting parts, causes the ram to reciprocate.

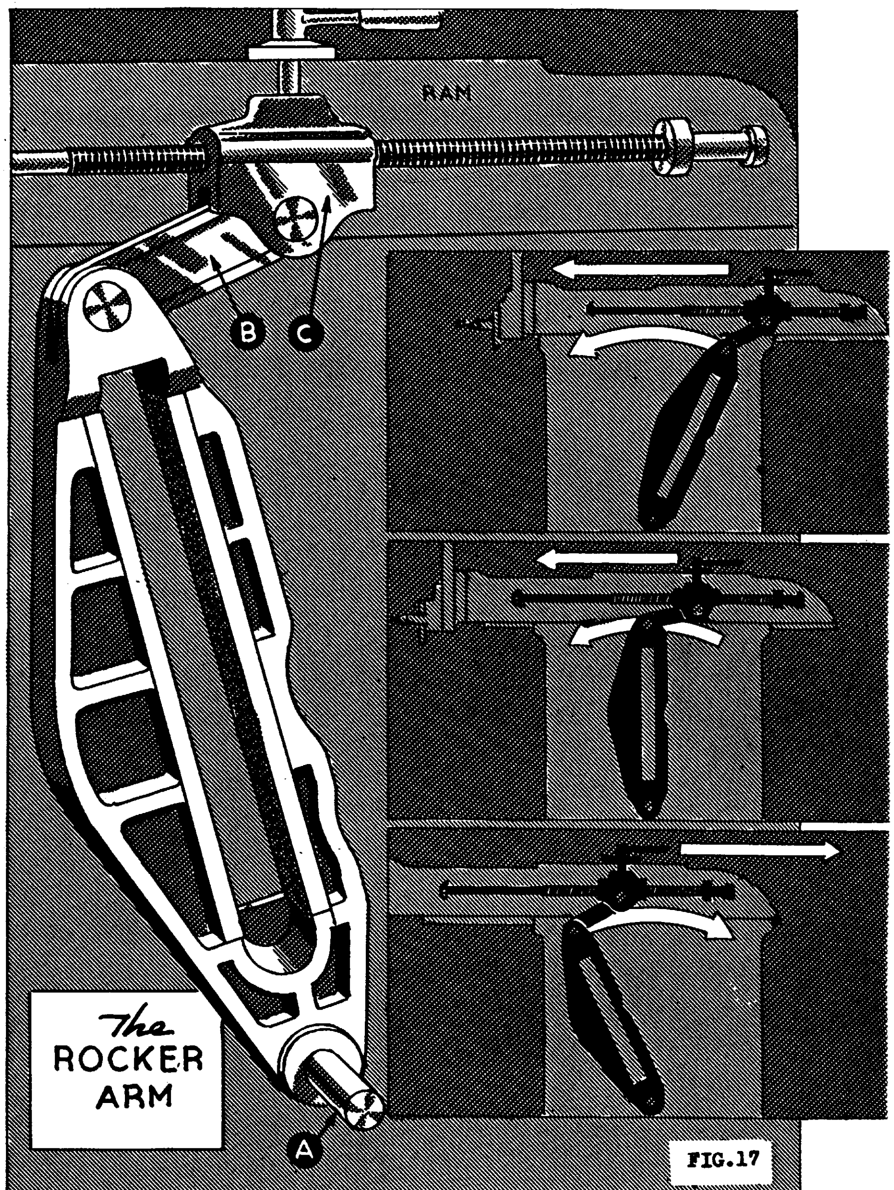


FIG.17

Mounted within the column and directly behind the rocker arm is the main drive gear A, also called the bull wheel. This gear revolves on its hub which extends into a bearing mounted in the column wall. It is driven by pinion B and is connected through gearing with shaft C on which the drive pulley has been mounted. Whether the bull wheel revolves fast or slow is determined by the speed for which the machine has been set. The mechanism for changing speeds has been explained on page 21.

Slide block D has been mounted on crank pin E, and together they extend from the face of the bull wheel into a slot in the rocker arm. The sliding block has been added for the reason that it provides longer and more enduring bearing surfaces in the slot than would the crank pin if the latter were used without the block. As the bull wheel revolves, the crank pin rotates in a circular path about the center of the large gear. During this rotation, the slide block turns on the crank pin and at the same time slides up and down in the slot in the rocker arm, thus causing the rocker arm to move forward during one part of a turn of the bull wheel and backward during the remainder of its revolution.

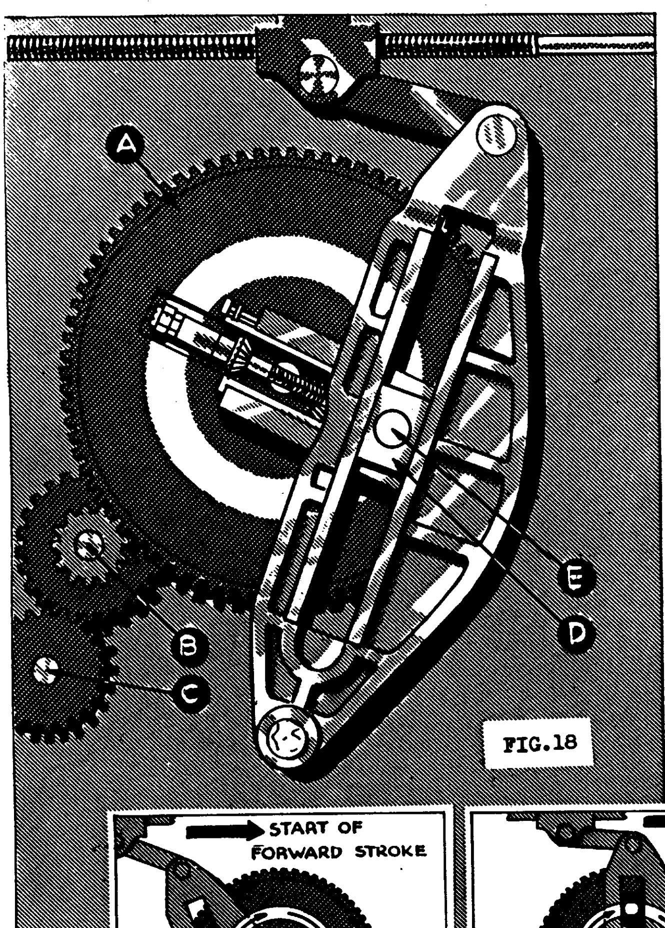


FIG.18

Fig. 19 indicates in successive order several of the relative positions occupied by the crank pin, the slide block and the rocker arm during a revolution of the bull wheel. 1 and 3 show the rocker arm in its extreme backward and forward positions, respectively; 2 shows it in the center of a forward stroke when the slide block is in its upper position; and 4 shows the rocker arm in the center of a return stroke when the slide block is in the lower end of the rocker-arm slot.

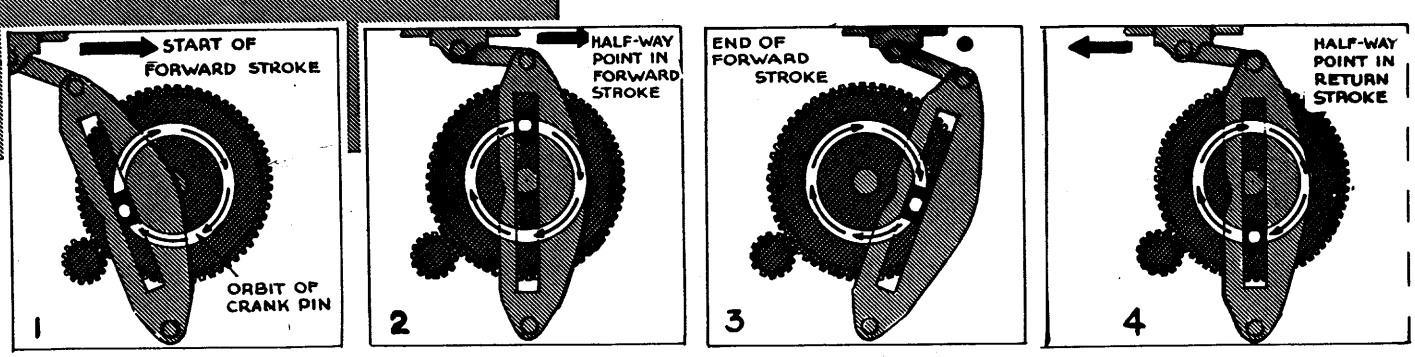


FIG.19

DESCRIPTION OF THE QUICK RETURN

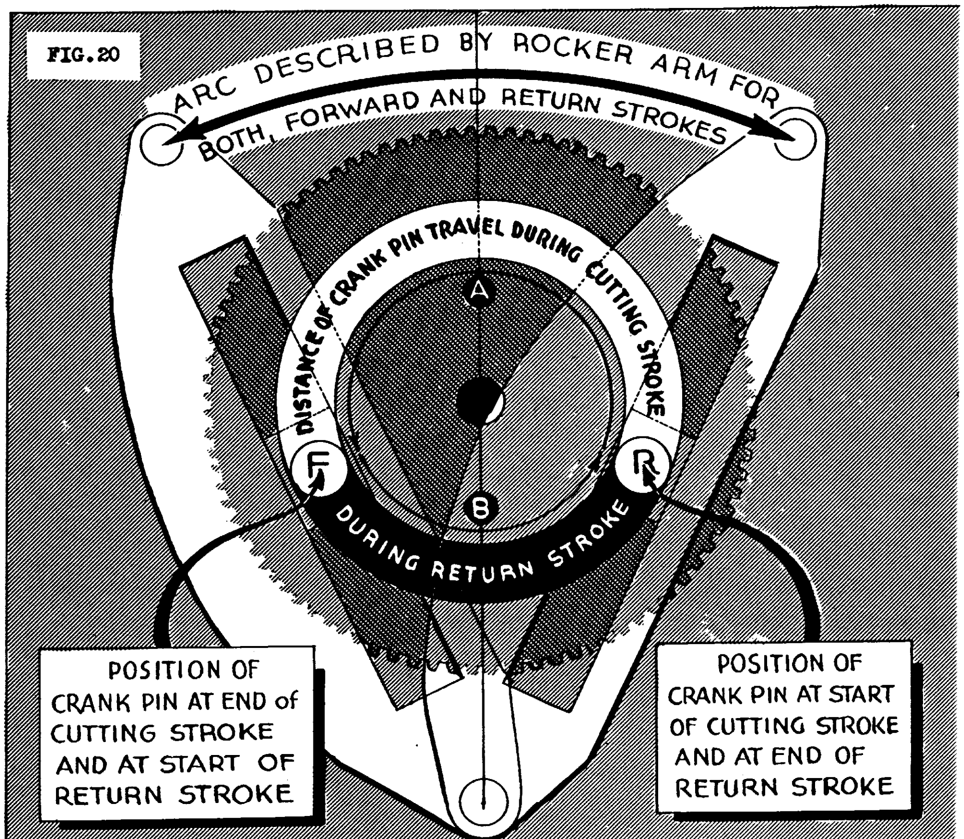
The driving mechanism of a shaper has been so designed that the return stroke of the tool is faster than the cutting stroke, the purpose being to reduce the idle time of the tool, inasmuch as it does not cut on its return stroke.

Fig. 20 illustrates how this is accomplished. The crank pin (and the slide block) occupies the position marked R when the rocker arm is in its rear position. In operation, the crank pin moves in the path and in the direction indicated by arrows passing through arc A which terminates at point F. This portion of a revolution represents the cutting stroke, and point F marks the beginning of the return stroke. The slide block has moved in the upper end of the rocker-arm slot during this stroke.

When the crank pin reaches point F, the rocker arm stops momentarily, since it is at this point that the rotation of the crank pin reverses the direction of the rocker arm and the ram begins its return stroke. This return movement occurs while the crank pin moves in the lower portion of its circular path close to the pivot of the rocker arm, indicated as arc B, and continues until the crank pin again reaches the starting point R. This marks the completion of one cycle. (Refer to Fig. 19 also.)

Since the bull wheel rotates at a uniform speed, the illustration must make it apparent that the cutting stroke requires more time than the return stroke, the ratio of the time required for the cutting stroke to that of the time required for the return stroke being the same as the ratio between the lengths of arcs A and B. This ratio is approximately 1-1/2 to 1. In other words, it takes 1-1/2 times as long to make the cutting stroke as it does to make the return stroke. Refer to Description of Speeds and Feeds, page 293.

FIG. 20



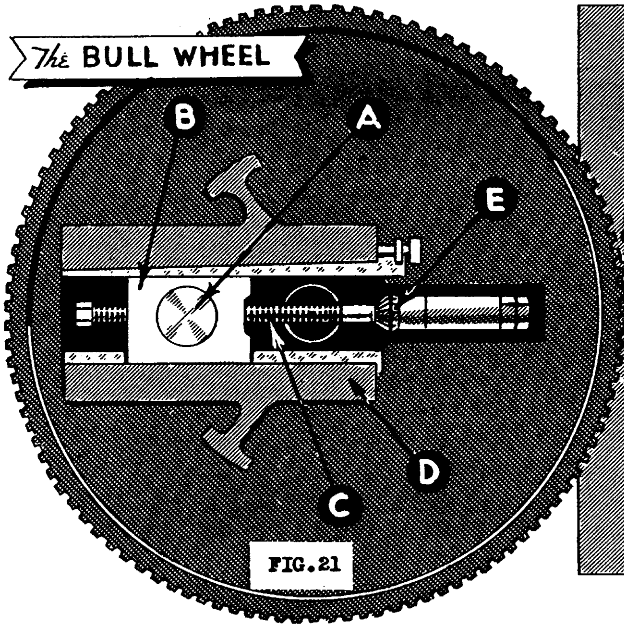


FIG.21

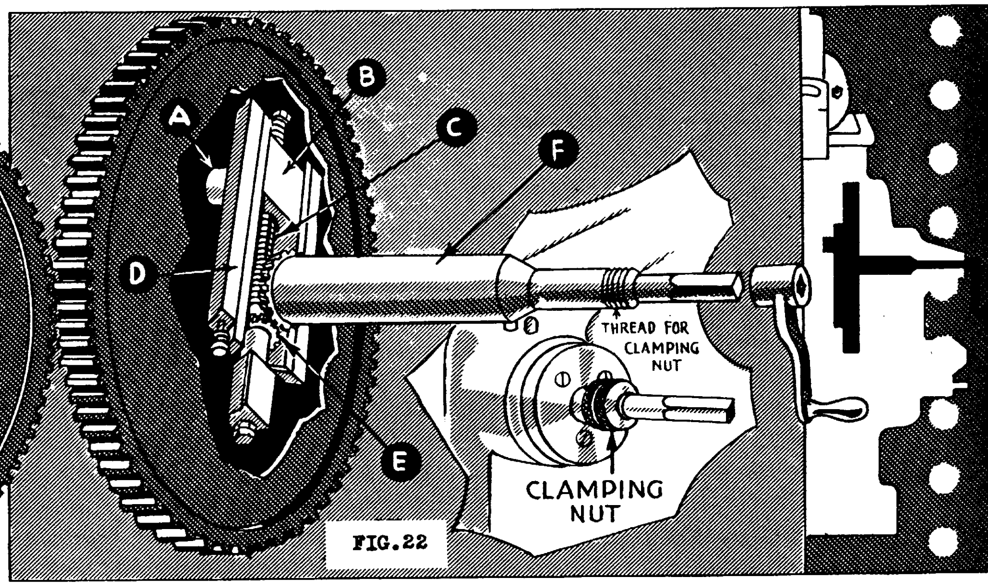
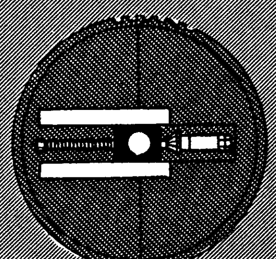
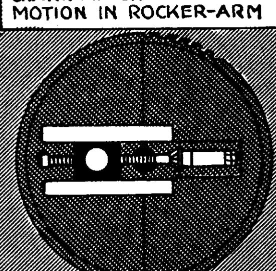


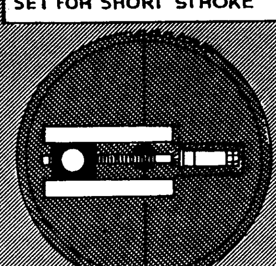
FIG.22



CRANK PIN "ON CENTER"- NO MOTION IN ROCKER-ARM



CRANK PIN "OFF CENTER"- SET FOR SHORT STROKE



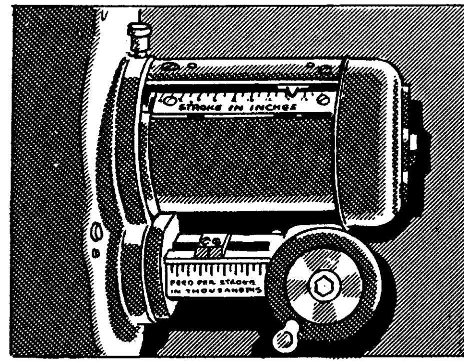
CRANK PIN AT EXTREME POINT FROM CENTER - FOR LONG STROKE

DESCRIPTION OF STROKE-ADJUSTING MECHANISM

Since the jobs performed in the shaper vary considerably in length, it would be impractical to use a machine with a single, fixed length of ram stroke. The ram stroke, therefore, has been made adjustable to facilitate shaping both long and short work. This is accomplished by moving the crank pin A (Figs. 21 and 22) toward or away from the center of the bull wheel, since the crank pin governs the movement of the rocker arm and consequently the length of the ram stroke.

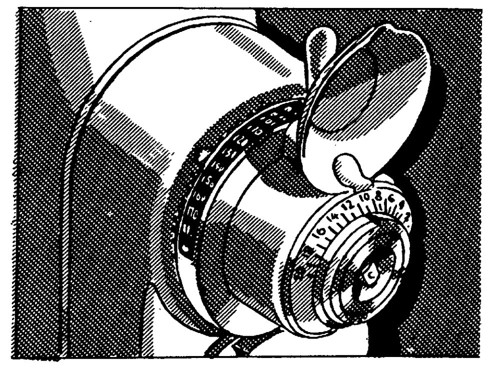
For this reason the crank pin has been mounted in a movable crank block B, threaded to receive the adjusting screw C, as shown in Fig. 21. The crank block together with the crank pin may be adjusted in the slide D on the face of the bull wheel by turning the adjusting screw C. In this way the position of the crank pin, and its relation to the center of the bull wheel, may be varied from "on center," when no ram movement occurs as the bull wheel turns, to one at the end of the slide D, a position of the crank pin which causes the ram to travel through its maximum stroke.

Since it is desirable to adjust the ram stroke from a point outside the shaper, a stroke-adjusting shaft F (Fig. 22) has been extended through the center of the bull wheel to a point where its inner end connects with the adjusting screw C through bevel gears shown at E. The outer end of this shaft, which protrudes from the column, has been squared to fit a crank used for adjusting the ram stroke.

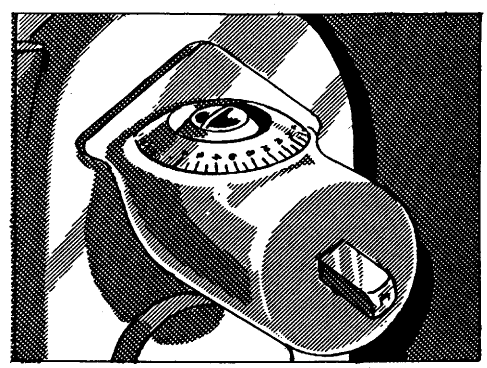


The outer end of the stroke-adjusting shaft is also provided with a means for locking it in place so that it will not turn and change the length of the stroke once it has been set. Various devices are used for this purpose, the threaded clamping nut perhaps being the most common (Fig. 22).

This nut has been displaced on many of the newer shapers, however, by a clamping device which automatically fulfills the purpose of the old-type clamping nut. The newer clamping units have been so designed that freeing of the clamping device occurs coincidentally with placing of the crank on the squared end of the stroke-adjusting shaft, and clamping takes place automatically when the crank is withdrawn from the shaft.



For additional convenience in setting the length of the ram stroke, the shaper has been equipped with an index plate and a pointer or a dial and a pointer. The pointer moves along its adjacent scale when the stroke-adjusting shaft is turned (Fig. 23). The highest number to which the pointer advances indicates in inches the length of the stroke for which the machine has been set. A type of index plate and pointer used with older designs of shapers has been described on page 13 in connection with the description of the ram.



A description of the parts necessary for placing the stroke so that the travel of the tool covers the surface to be shaped, has been included with that of the ram on page 12.

FIG.23

DESCRIPTION OF THE MECHANISM FOR CHANGING SPEEDS

The speed of the shaper is usually associated with the number of cutting strokes the ram makes in a minute, and is determined by the speed, or the number of revolutions per minute, of the driving gear or bull wheel. Variations in the length of stroke, differences in the consistency of the material being cut, and difficulties encountered in the performance of certain operations, require that the speed of the shaper be adjustable. There are several different ways in which the speed of the machine may be changed, the method used depending on the type of drive mechanism employed on the machine. The simplest among these is the cone-pulley drive. The speeds are varied by shifting the belt from one step on the pulley to another

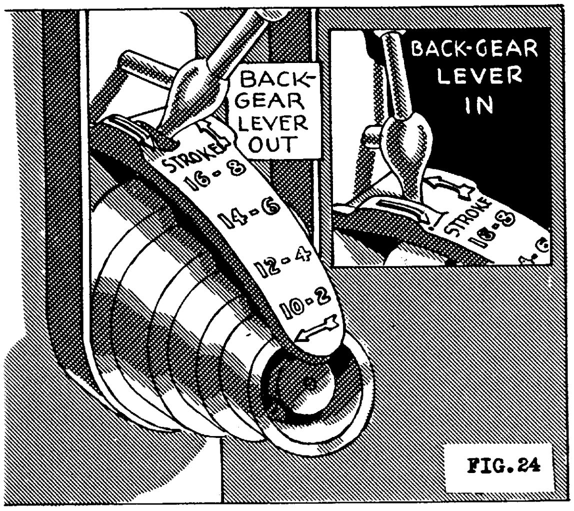


FIG.24

of a different size, the number of speed changes possible being limited to the number of steps on the pulley. (Refer to Fig. 24).

All but the smallest cone-driven shapers, however, have been provided with back gears inside the column, making an additional series of speeds available and thereby doubling the range of speeds. The back gears may be engaged and disengaged by means of a lever outside the column.

The double row of numbers on the plate above the cone pulley, when used in conjunction with the length of ram stroke, will assure an approximately correct cutting speed. Arrows on the upper end of this plate indicate the position the back-gear lever should occupy (toward or away from the column); the location of the number which corresponds with the length of the ram stroke in inches, indicates the step on the cone which the belt should occupy.

Instead of having a cone pulley, some shapers come equipped with a single constant-speed pulley and a sliding-gear transmission whereby the necessary speed changes may be obtained. In this design the gears may be placed entirely within the column or in an overhanging gear box attached to the column of the machine. The gears are placed between the drive pulley and the gearing which connects with the main drive gear.

The power may be supplied to the drive pulley on the transmission from an overhead countershaft. In another design, an individual motor, mounted at the rear of the machine and connected with the transmission either by belting or by a series of gears, may be used for this purpose.

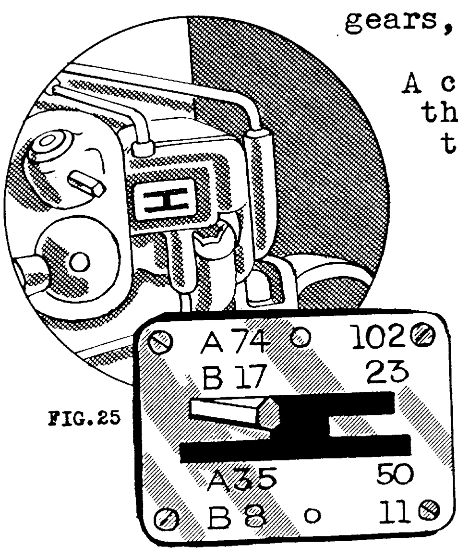


FIG.25

A clutch is generally used in connection with these drives to facilitate starting and stopping the shaper without recourse to the button used for starting and stopping the motor. Most shapers are provided with a brake for quickly stopping the ram after the clutch has been disengaged.

The different speeds are obtained by arranging the gears in the transmission in varied combinations by means of levers connected with the gears and extending to the operator's position on the right side of the column. Eight speeds are usually provided. They are available in two series of four each. An index plate (Fig. 25) attached to the gear box indicates the number of strokes per minute for each position of the handles used for shifting the gears.

DESCRIPTION OF THE FEED MECHANISM ON A CONE-DRIVEN SHAPER

Although the feed mechanism on nearly every make of shaper differs somewhat from that on every other make, there are certain general principles underlying the construction and operation of all of them. An understanding of the general principles involved, plus a knowledge of the details wherein several of the mechanisms differ, should provide a basis for analyzing variations in construction even though they have not been explained here.

On most shapers the automatic feed may be applied only for moving the table on the rail, but on some shapers both the cross-feed screw and the elevating screw are connected with the automatic feed mechanism. This design provides vertical as well as cross feeding of the table by means of power. The cross-feed mechanism operates once for each cutting stroke of the ram.

All but the more recent models of shapers were so designed that they could be made to feed at either one end of the ram stroke or the other. Newer machines, however, have been so arranged that the feed is confined to the return stroke; but on all of them the feed may be disengaged or thrown out of gear and the feeding done by hand where required (Fig. 26).

Fig. 7 illustrates the position of the table feed screw in the cross rail and shows the nut used to move the table. Since the screw cannot move endwise, it must be apparent that the nut into which the feed screw is threaded and which is attached to the worktable, or to the saddle, feeds the table along the cross rail when the screw is turned. The end of the feed screw has been squared in order that the table may be fed by hand with a crank. Furthermore, a micrometer collar has been attached to the feed screw adjacent to the square so that the table movement may be measured in thousandths of an inch.

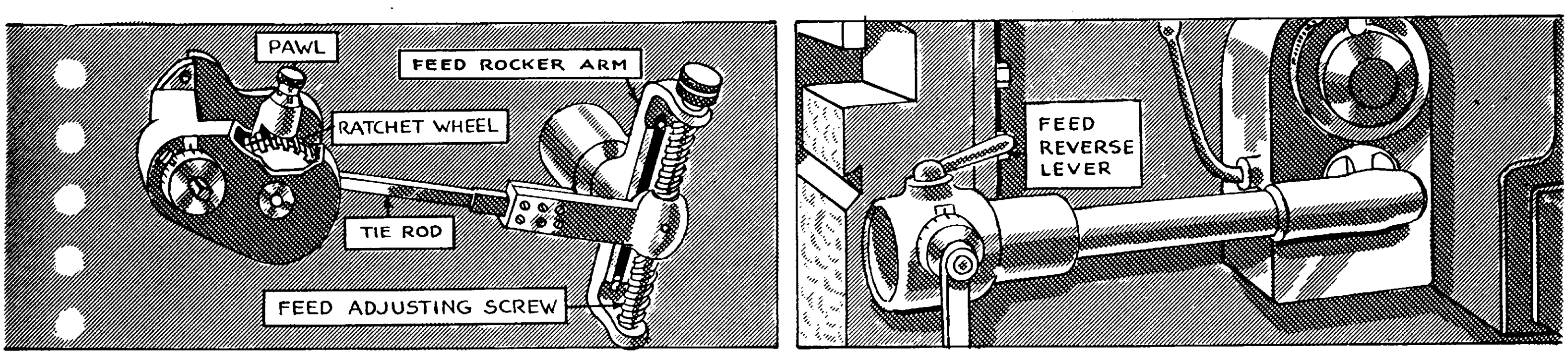


FIG.26

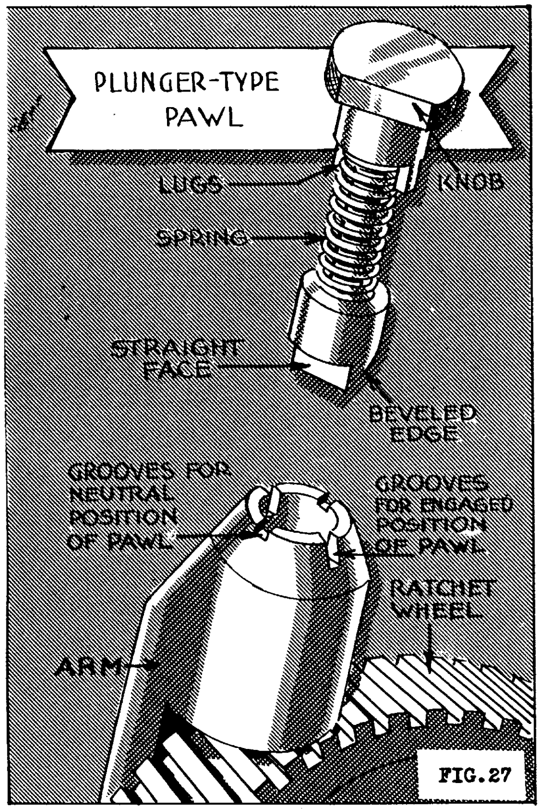


FIG.27

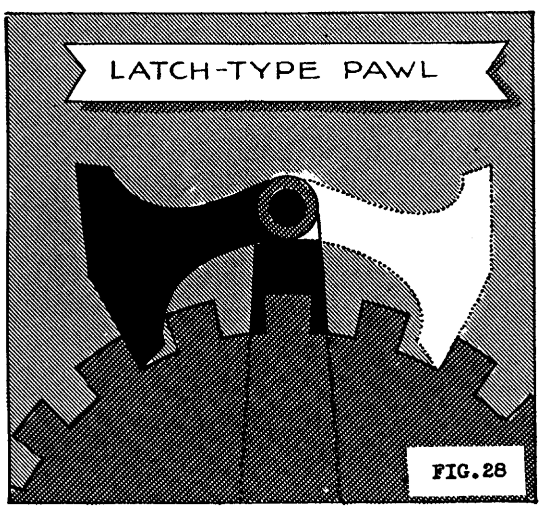


FIG.28

On all shapers the amount of feed, that is, the distance the table moves toward the tool for each stroke of the ram, is determined by the part of a revolution which the screw is caused to make by the feed mechanism, but among the means used to turn the feed screw automatically there is considerable variation.

Generally, the portion of the feed mechanism which directly causes the feed screw to make a partial turn after each stroke of the ram, includes a ratchet wheel, a pawl, and an arm which carries the pawl, a form of construction which induces intermittent motion in one direction and avoids it in reverse (Fig. 29).

The ratchet wheel is keyed to the feed screw, or it may transmit its motion to the feed screw through gears. The arm which carries the pawl fits freely on the feed screw, and, as the arm oscillates (swings backward and forward) about the screw, the plunger-type pawl which moves up and down in the arm (Fig. 27), or the latch-type pawl which pivots on the arm (Fig. 28), falls into the space between the teeth on the ratchet wheel, and is held there by a small spring.

The pawl is made with one straight face and one beveled edge. When the arm swings to the left, the straight face of the pawl meets the face of the ratchet tooth squarely, remains in the slot, and partially rotates the ratchet wheel (and the screw). After completing its swing to the left, the arm swings to the right an equal distance. But during the backward swing (to the right), the pawl is forced out of the slots because of its beveled edge, and caused to pass over one or more teeth of the ratchet wheel. The ratchet wheel itself remains stationary until the arm swings to the left again.

The movement of the arm which carries the pawl has been synchronized (timed) with that of the ram; that is, the pawl, actuated by the arm, moves the ratchet wheel and the feed screw during one stroke of the ram (Fig. 29 A), preferably during the return stroke, and slides over one or more teeth in the ratchet wheel during the forward stroke of the ram (Fig. 29 B), getting ready in this way to feed the work to the tool on the next return stroke.

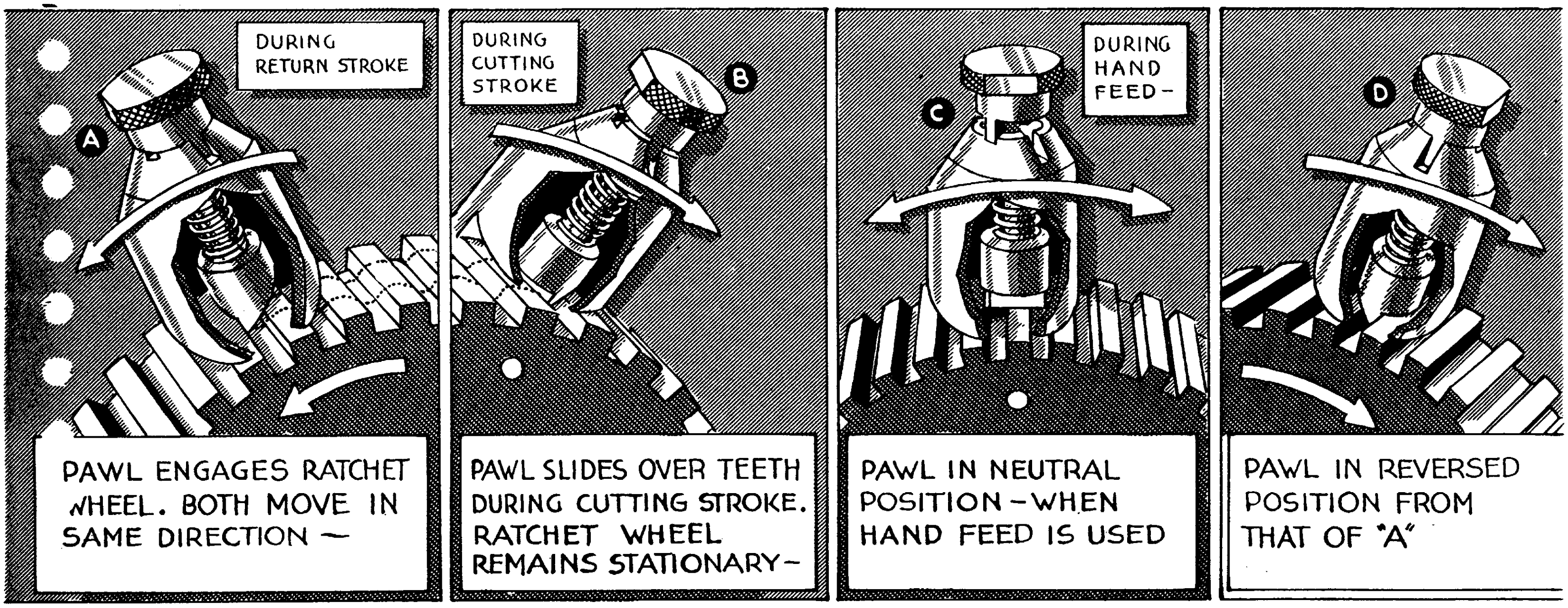


FIG.29

Since it is desirable to feed the work in either direction, the feed mechanism has been so designed that the ratchet wheel may be rotated in either direction simply by reversing the position of the pawl (Fig. 29 D). This brings the driving face (the straight face) of the pawl against the opposite sides of the teeth on the ratchet wheel, thus changing the direction of its rotation as the arm oscillates.

The latch-type shown in Fig. 28 is double-ended. When it occupies the position indicated by the solid lines, the ratchet wheel will be rotated intermittently in a counterclockwise direction, and vice versa when the pawl has been placed in the position shown by the dotted lines.

Normally, the plunger-type pawl (Fig. 29) is held in the spaces on the ratchet wheel by a coil spring and when the pawl is in the position shown, movement of the pawl carrier causes the feed screw to turn in a counterclockwise direction.

When the pawl is lifted by means of the knob and turned one-half revolution, the ratchet wheel is caused to rotate intermittently in a clockwise direction, since the driving face of the pawl engages the opposite sides of the teeth. Obviously then, if the pawl is withdrawn from engagement with the ratchet wheel and subsequently withheld therefrom, the automatic feed will not operate, although the pawl arm continues to oscillate (Fig. 29 C).

To position the pawl properly, that is, to align its driving face with the teeth on the ratchet wheel when the feed is to be engaged and also to prevent the pawl from engaging the ratchet wheel when the automatic feed is not to be used, two slots have been cut into the pawl arm on the surface adjoining the knob. Furthermore, the knob has been made with projections, or lugs, on its underside to fit these slots (Fig. 27).

The deeper of the slots is cut parallel with the teeth on the ratchet wheel; the other at right angles thereto. When the knob has been turned to the position in which its projections may enter into the deep slot, the driving face of the pawl has been aligned with the teeth and the pawl is brought into engagement with the ratchet wheel by the spring. (Refer to Fig. 29).

When the knob is lifted and turned one-fourth revolution, its projections engage the shallower slot on the pawl carrier. In this position the pawl is held out of engagement with the ratchet wheel, and consequently the feed is inoperative. (Refer to Fig. 29 C).

Obviously, the amount of feeding movement imparted to the feed screw through action of the pawl on the ratchet wheel can be varied by increasing or decreasing the oscillating movement of the pawl arm.

Any appreciable change in the length of its swing effects a corresponding change in the number of teeth over which the pawl passes during the backward movement of the arm. The ratchet wheel remains stationary and the pawl assumes the position from which it will again give the feed screw a partial turn at the moment when the direction of the arm swing is reversed.

Two mechanical devices for regulating the amount of table feed are shown herewith; one is gear-driven (Fig. 30), and the other is actuated by an eccentric (Fig. 31); both are connected with the ratchet gearing on the feed screw by a tie rod.

The device in Fig. 30 employs a slotted disc fitted with a slide block which carries a crank pin for use with the tie rod. When knob K has been loosened, the slide block may be moved toward the center of the disc to decrease the feed—away from the center to increase the feed.

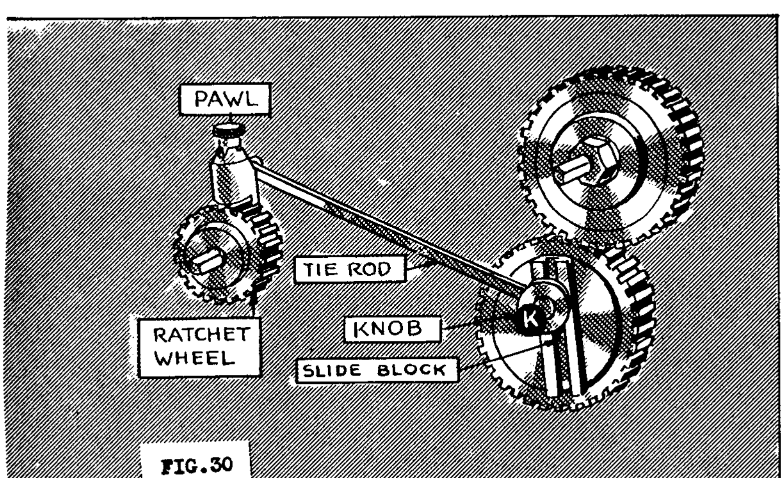


FIG.30

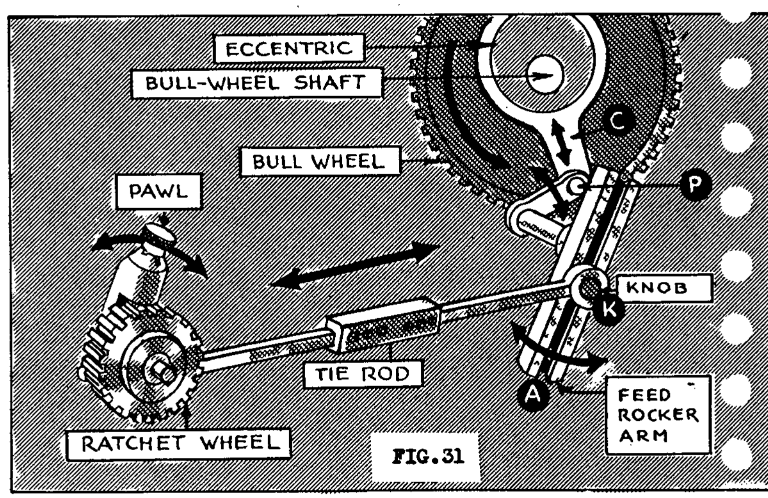


FIG.31

The disc is turned continuously in one direction only, two connecting gears being used for this purpose, one attached to the bull-wheel shaft and the other mounted directly behind the disc and on the same shaft. Since the gears are of equal size, the disc makes one revolution for each revolution of the bull wheel and causes an oscillating movement of the tie rod for each ram stroke.

In Fig. 31 only the mechanism used to impart oscillating movement to the feed rocker arm (and to the tie rod) differs from that employed for this purpose in Fig. 30; for, even though an oscillating rocker arm A, instead of a revolving disc, has been employed, the method used to vary the amount of feed remains quite similar. The amount of feed may still be increased or decreased by shifting the position of the crank pin in relation to the center of the feed rocker arm.

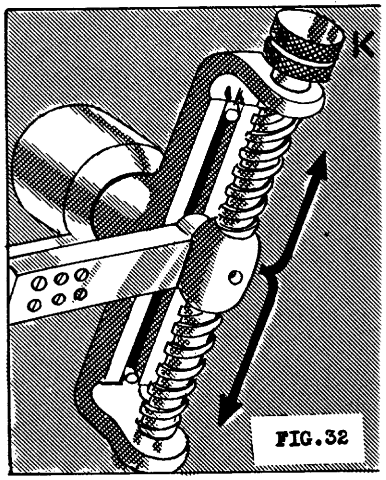


FIG.32

In Fig. 31 an eccentric revolving with the bull-wheel shaft causes the connecting rod C to move up and down once for each revolution of the main drive gear. Since the pin P extends into the lower end of the connecting rod, it too moves up and down and causes the rocker-arm shaft and the rocker arm attached to its outer end to oscillate a fixed distance. An eccentric is only one of several devices employed to cause oscillating movement of the feed rocker arm.

A screw, threaded into one end of the tie rod, has been added to the rocker arm in Fig. 32. This type of construction permits the amount of feed to be changed by simply turning the knob K to move the end of the tie rod toward or away from the center of the rocker arm.

DESCRIPTION OF THE BEVEL-GEAR FEED REVERSE

The newer shapers have been so designed that the automatic feed always operates during the return stroke of the ram. Older machines are so arranged, however, that the feed can occur during either the forward or the return stroke. On this type shaper the feed functions during the forward stroke when the slide is moved in one direction from the center of the feed rocker arm, and during the return stroke when the slide is moved in the opposite direction.

On modern shapers, a cam on the bull-wheel shaft, instead of an eccentric or gears, imparts oscillating movement to the pawl arm. The ratchet gearing used on older machines for turning the feed screw, and also for reversing its direction of rotation, has been removed from its former location at the rail and combined with the rest of the feed mechanism at the side of the column. The action of the ratchet wheel and the pawl remains quite similar to that explained on page 25. The pawl, however, cannot be reversed, there being no need for this, inasmuch as the intermittent movement from the feed mechanism is transmitted by means of a telescoping shaft to a bevel gear-reversing unit at the rail (Fig. 33).

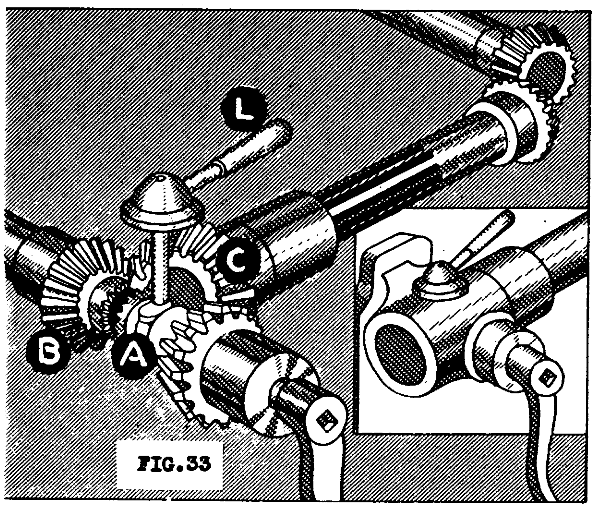
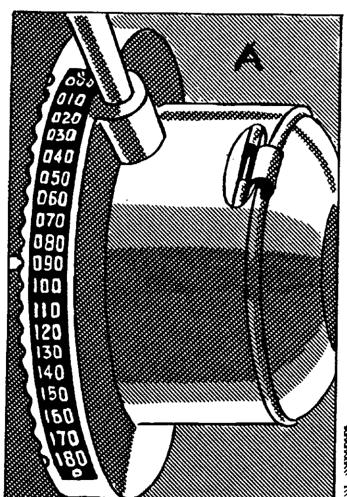


FIG.33

A reversing unit, similar to the one illustrated, has been used frequently in machine construction where rotary motion in either direction is desirable. It comprises a positive clutch A which is keyed to the outer end of the feed screw between two bevel gears B. The larger bevel gear C on the end of the telescoping shaft, rotates these gears in opposite directions.

Although the bevel gears rotate intermittently as long as the machine remains in operation, the feed screw is caused to rotate only when the clutch has been shifted to the right or to the left and its interlocking teeth have been brought into engagement with those on the end of one or the other of the bevel gears.

Lever L provides control of the automatic table feed. Its position, whether center, right, or left, indicates not only the position of the clutch but also the direction in which the automatic feed will move the table. In other words, the shaper is said to have directional feed control, since the table moves in the direction in which the lever has been positioned.



Feed mechanisms of the type just described usually include a direct-reading feed dial, or a scale, and a feed selector (Fig. 34). For each position of the feed selector, the dial immediately indicates the amount of feed in thousandths of an inch for each stroke of the ram.

The number of different feeds obtainable on any shaper, and their range as well, varies with the make of the machine. Usually, the amount of feed changes .010" when the feed selector is moved from one position to the next on the dial. Movement in one direction in-

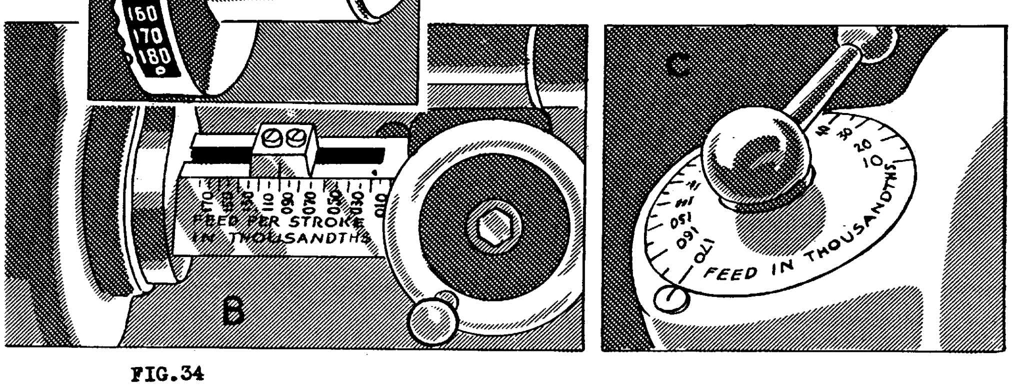


FIG.34

creases the feed, and movement in the opposite direction decreases it.

Many shapers still in use are not equipped with a direct-reading dial. On machines without this convenience, the pawl is usually adjusted so as to move the ratchet wheel one or more teeth on the return stroke of the ram, depending on the amount of feed desired. Then, even though the machine has no direct-reading feed dial, the amount of feed may be ascertained in thousandths of an inch by noting how far the micrometer collar on the feed screw rotates after each cutting stroke.

DESCRIPTION OF POWER RAPID TRAVERSE

Some shapers are equipped with power rapid traverse, designed to move the table automatically in either direction on the cross rail and at a fixed rate which is several times that of the most rapid feed indicated on the feed dial. In addition, some machines are so designed that this mechanism may be used to move the cross rail up and down on the column.

Its purpose is to bring the work into the proper relationship with the tool as rapidly as possible, using power supplied to the machine instead of using a handcrank (Fig. 35).

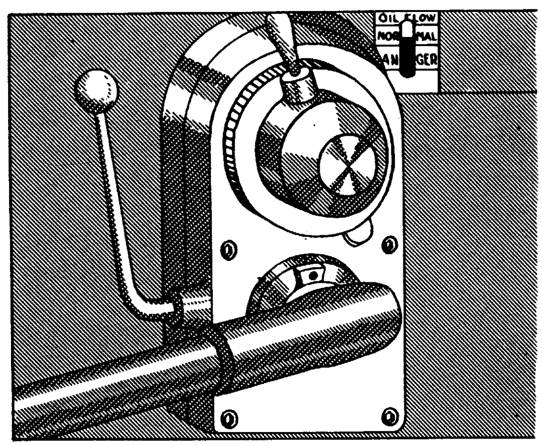


FIG.35

When the shaper includes rapid power traverse as a regular part of its mechanism, this unit has been built into the machine. This feature, however, has sometimes been added to the shaper without materially changing its former design. Under these circumstances, the rapid power traverse usually is comprised of an individual motor attached to a unit which engages the feed screw and turns it rapidly (Fig. 36).

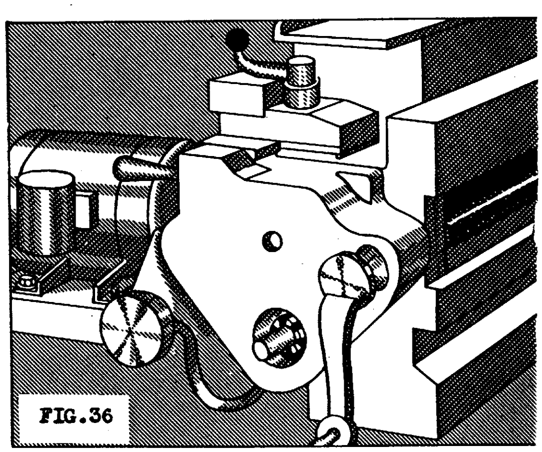


FIG.36

Both types of quick traverse operate independently of the rest of the shaper. This supplementary power unit is put into operation by a lever or a button, usually on the operator's side of the machine. Its direction is controlled by the levers used regularly for engaging the automatic feed or by push buttons.

DESCRIPTION OF THE OILING SYSTEM

Changes and improved designs in shaper construction have been extended not only to the machine itself, but also to the means used to assure an adequate supply of lubricating oil at all times to the parts most likely to be affected by the greatest amount of wear.

Transition of the shaper from a simple cone-driven machine to the modern motor-driven machine tool has been accompanied by a gradual change also in the method employed to supply its working parts with oil, so that from a shaper requiring hand lubrication throughout, it has gradually evolved to one in which many of the bearing surfaces are now automatically oiled. (Refer to page 52.)

This has changed oiling from a function performed more or less regularly by the operator to one performed in a consistent manner by a pressure-lubricating system, and has resulted in placing emphasis on maintaining the oiling system in proper working order rather than on the actual application of the lubricant to the machine part.

Nearly all modern shapers employ a complete circulating pressure system for automatically and continuously supplying oil to each of the important moving parts. Since it would be impractical to extend tubes to all places requiring oil, the more accessible parts and places which do not require a continual supply must still be oiled by the operator (Fig. 37).

Because there are variations in the design of the different makes of shapers, it is impossible to describe exactly or locate precisely all the various points which require oil to be supplied by one method or another. Parts on different makes of shapers, however, which perform the same function, seldom differ to the extent that all similarity disappears. For this reason the operator should be able to recognize the part and lubricate it properly even though the identical one has not been described.

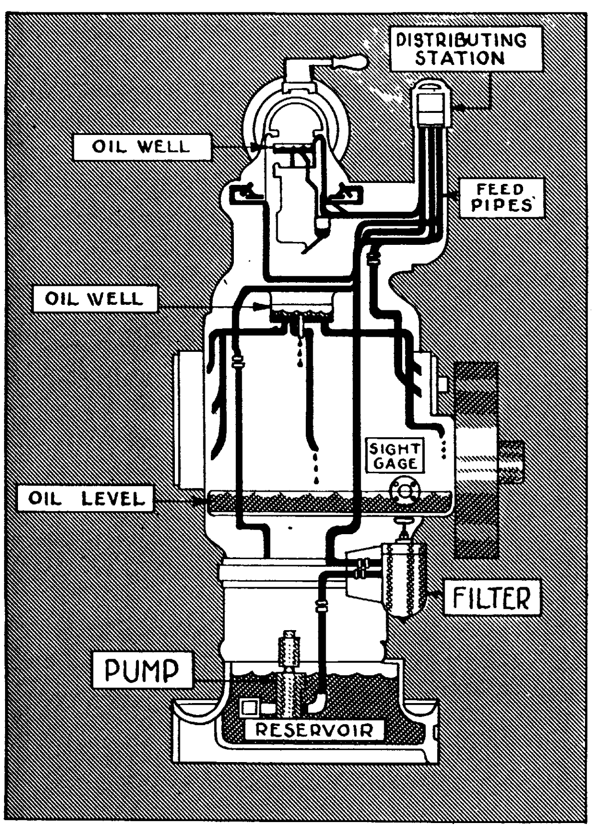


FIG.37

Either a gear chamber in the column or a space in the base of the machine under the column acts as an oil reservoir. The spaces used for this purpose are practically air-tight, and, consequently, dust and grit are almost entirely excluded therefrom. The reservoir, regardless of its location, is usually equipped with a sight gage to show the oil level within.

A pump, usually of the geared or plunger type, and driven from the constant-speed drive, pumps oil from the reservoir and forces it through tubes which lead directly to the points which require lubrication. Some lubricating systems include a glass-covered flow gage wherein a continuous thin stream of oil remains visible while the pump continues to circulate oil through the system (Fig. 38).

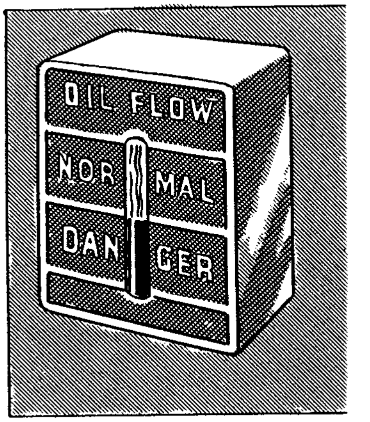


FIG.38

In a variation of the system described above, the pump, instead of forcing oil to bearings directly, pumps oil to a sight-feed distributing station located on the top of the column. This acts as a central distributing point from which the oil feeds to individual tubes leading to the important parts of the shaper, including the bull-wheel bearing, the drive pinion, the feed mechanism, the ram bearings, the rocker-arm assembly, the transmission, and the cross rail (Fig. 37).

From the distributing station in which the continuous circulation from the reservoir may be constantly observed, the oil flows to the various parts of the machine and then returns to the reservoir. In order that foreign material picked up in its circulation may settle out before it passes to the supply reservoir, the oil may be returned to an adjoining settling tank, rather than directly to the reservoir.

As an additional precaution against the entrance of foreign material into the lubricating system, the oil may be drawn through a screened enclosure in the reservoir before entering the pump, and then passed through a filter on leaving it.

Four pressure lines lead from the pump directly, or from the distributing station (if one has been included in the system), and terminate at reservoirs located at four corners of the ramway guides. (Refer to page 52). The guide ways for the crank block and other moving parts in the rocker arm, and usually the cross-rail unit also, are lubricated in a si .ilar manner. The flat and round bearing surfaces have deep oil grooves for distributing oil uniformly. Some of these bearing surfaces have been fitted with wipers for retaining oil and for protecting the s''rfaces from dust and grit (Fig. 39).

The lubrication system for a hydraulic shaper does not require a separate pump. It is usually connected with the hydraulic system which operates the machine, and utilizes oil from this source for lubricating the machine also.

A wide variety of devices is used to convey oil to, and simultaneously to exclude dust and grit from, bearings which have not been connected with a circulating oiling system.

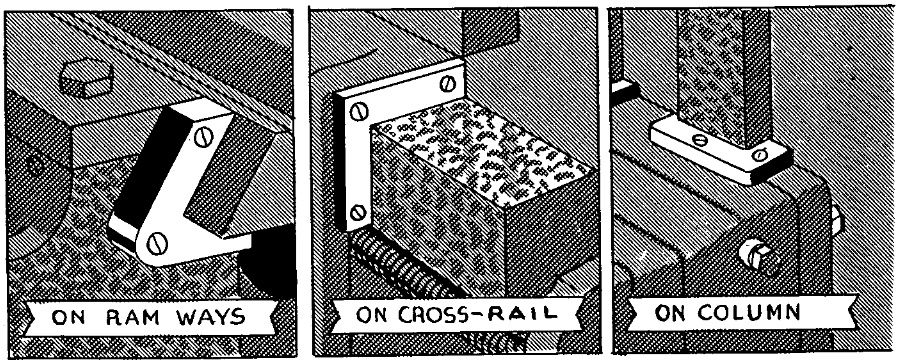


FIG.39

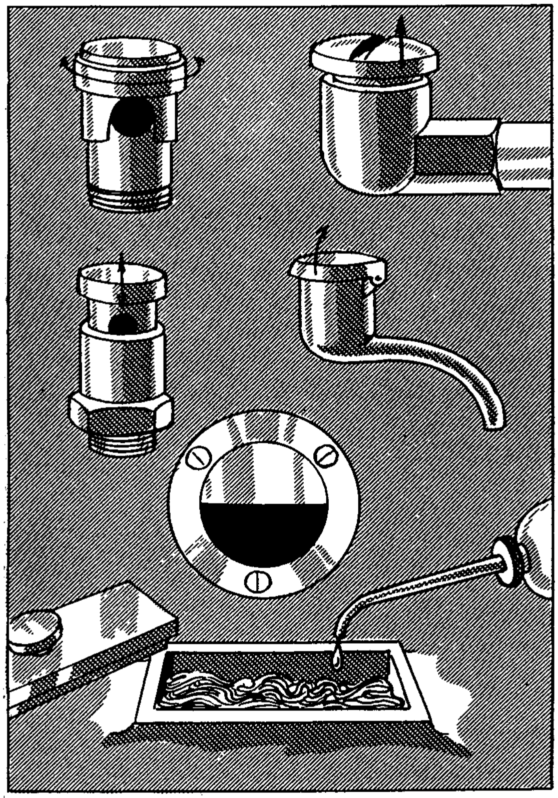


FIG.4^

These bearings therefore must be lubricated by the operator.

The bearings requiring this form of lubrication obviously will be most numerous on the older shapers which were not provided with automatic oiling for any of their parts. Among these bearings will be included those within and about the column, which are automatically oiled in the modern shaper

Usually several types and sizes of oilers will be employed on a shaper for oiling and protecting its bearings, their selection being governed by such pertinent factors as the location of a particular bearing, the amount of oil it requires, etc.

The devices used in connection with machine lubrication have ranged all the way from wooden plugs whittled to fit the holes and intended to exclude chips, to semiautomatic oilers which provide metered lubrication within the limited capacity of the oiler. Several types used more or less commonly on the shaper have been illustrated in Fig. 40.

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