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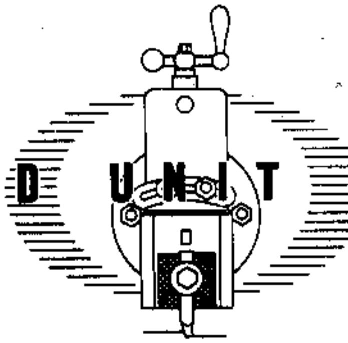
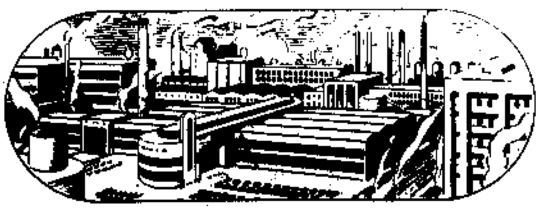


SHAPER WORK



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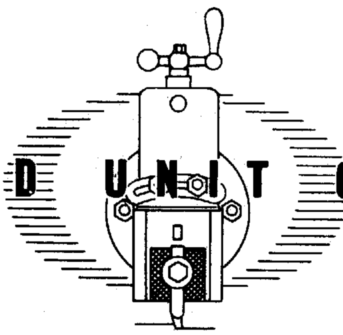

SHAPER WORK

1950

DELMAR PUBLISHERS, INC.

PRINTED IN THE UNITED STATES OF AMERICA

Preface

The production of interchangeable parts, which is the keystone of our present day manufacturing system, depends largely on the skill of the individual machine operator and of the all-round craftsman in operating machine tools and in using measuring instruments so that each machine part is held within certain prescribed limits of accuracy.

Over a period of years, careful analyses were made to determine essential occupational areas of training for machine shop practice. As a result of these studies, the following seven main divisions of the trade were defined and a series of texts were prepared to cover them: (1) Measurement, (2) Bench Work, (3) Drill Press, (4) Lathe, (5) Milling Machine, (6) Shaper Work, and (7) Heat Treatment of Metals.

Further study revealed that each operation in machine shop practice involves the teaching and learning of basic trade theory and fundamental processes. Following this line of reasoning, two types of instructional units are included in each monograph: (1) a Trade Theory Series and (2) a Fundamental Process Series. A brief description of each type follows.

TRADE THEORY SERIES

The basic trade theory and related technical information, such as principles governing machine shop operations, the derivation and application of formulas, and descriptions of machine tools and accessories, are covered in the Trade Theory Series. This technical information furnishes the student with background trade knowledge necessary to perform machine shop operations skillfully. The Trade Theory units which are directly related to the Fundamental Process units may be used as text or reference material for class, laboratory or home study.

FUNDAMENTAL PROCESS SERIES

The term Fundamental Process covers those manipulative processes which involve the use of hand and machine tools and are common to machine or bench work. The manipulative phases of an operation are described in common trade terminology and are well illustrated with line drawings. As the Fundamental Process units provide reference material for the actual performance of operations, they may be used as supplementary text material for the teaching of fundamental processes either in a school or an industrial plant.

The selected series of instructional units in each text includes those fundamental operations which are common for a specific division of the trade and which apply under all conditions. Throughout the series, the units are arranged in the natural order of dependence of one operation on the next; i.e., in a sequence which conforms to the logical order of teaching and learning difficulty. However, this arrangement may be changed to meet exacting industrial and educational training course requirements without altering the effectiveness of any one of the suggested unit courses.

* * * * *

Acknowledgement is made in footnote form throughout the text for the fine cooperation and helpful assistance given by the following manufacturers: American Tool Works Company, Cincinnati, Ohio; Armstrong Bros. Tool Co., Chicago, Illinois; Carborundum Company, Niagara Falls, N.Y.; Cincinnati Shaper Company, Cincinnati, Ohio; Gould and Eberhardt, Irvington, N.J.; Hendey Machine Company, Torrington, Conn.; Norton Company, Worcester, Mass.; Oilgear Company, Milwaukee, Wis.; "O.K." Tool Co. Inc., Shelton, Conn.; Rockford Machine Tool Company, Rockford, Illinois; Vickers, Incorporated, Detroit, Michigan; Western Machine Tool Works, Holland, Michigan; J. H. Williams and Co., Buffalo, New York.

Sincere appreciation is expressed to the Bureau of Industrial and Technical Education, The New York State Education Department for permission to reproduce this instructional material.

The Editor

Albany, New York

Machine Shop Series

This series of texts covers seven major occupational areas of Machine Shop Practice: (1) Measurement, (2) Bench Work, (3) Drill Press, (4) Lathe, (5) Milling Machine, (6) Shaper Work, and (7) Heat Treatment of Metals.

The instructional material in each book is written in simple trade terminology and illustrated through the generous use of line drawings. The range of technical information (Why-to-do) and fundamental process units (How-to-do) provides basic instruction for beginning students, apprentices and home workshop enthusiasts; and advanced reference material for skilled craftsmen, engineers, supervisory personnel and teachers.

MACHINE SHOP MEASUREMENT

A beginner's text and workbook which covers basic mathematical principles of linear, circular, and angular measurement from the standpoint of related mathematics and machine shop practice.

65 pages (7 3/4 x 10 1/4); 109 line drawings

BENCH WORK

A basic text which describes the theory of Bench Work and the operations performed with measuring, layout and bench tools.

88 pages (7 3/4 x 10 1/4); 159 line drawings; formulas; tables

DRILL PRESS WORK

An introductory text dealing with the theory and operation of drill presses; uses of accessories and holding devices; cutting speeds and feeds; drilling, reaming, countersinking, counterboring and tapping.

42 pages (7 3/4 x 10 1/4); 48 line drawings; 6 tables

LATHE WORK

A comprehensive text covering the related technical information and fundamental processes which are basic for Lathe Work held between centers and in a chuck. A partial list of topics includes: centering, mounting work; grinding tool bits; facing, straight turning; speeds and feeds; turning shoulders, chamfering, knurling, thread cutting, angle and taper turning; mandrel and chuck work; drilling, boring, reaming and tapping.

164 pages (7 3/4 x 10 1/4); 197 line drawings; formulas; tables

MILLING MACHINE WORK

An exhaustive study of modern milling machines and accessories. The instructional units cover in minute detail the theory and practice of basic and advanced milling machine operations, with emphasis on dividing head work.

298 pages (7 3/4 x 10 1/4); over 300 illustrations including phantom and cut-away sections

SHAPER WORK

A new and complete treatise on modern types of crank and hydraulic shapers. The text covers all the basic and advanced operations and related technical information required to do Shaper Work.

326 pages (7 3/4 x 10 1/4); 582 illustrations including phantom and cut-away sections

HEAT TREATMENT OF METALS

A basic text containing two sections: (I) which deals with the theory and practice of simple forging, case hardening, hardening and tempering, and (II) a series of practical laboratory and shop tests and experiments in heat treatment of common ferrous metals.

51 pages (7 3/4 x 10 1/4); well illustrated

Contents

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P Fundamental Process Series
52 Sequence of Unit

Example:

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DESCRIPTION OF *the* CRANK SHAPER

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The Shaper

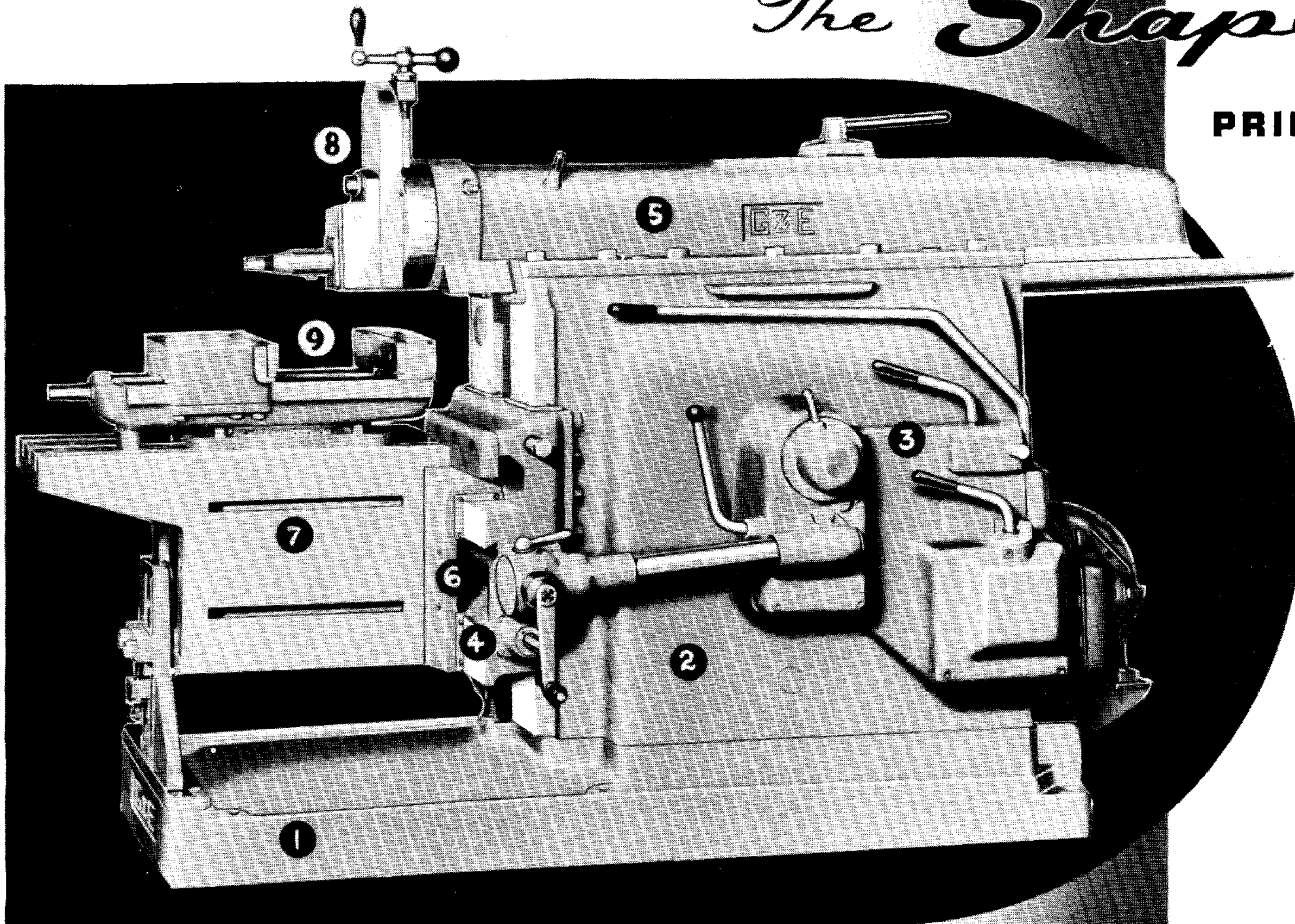


Photo by courtesy of Gould and Eberhardt

PRINCIPAL PARTS

1 – BASE

2 – COLUMN

3 – CONTROLS

4 – CROSS RAIL

5 – RAM

6 – SADDLE

7 – TABLE

8 – TOOL HEAD

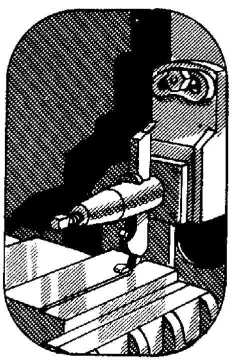
9 – VISE

SHAPER WORK

DESCRIPTION *of the* CRANK SHAPER

OBJECTIVES

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



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.

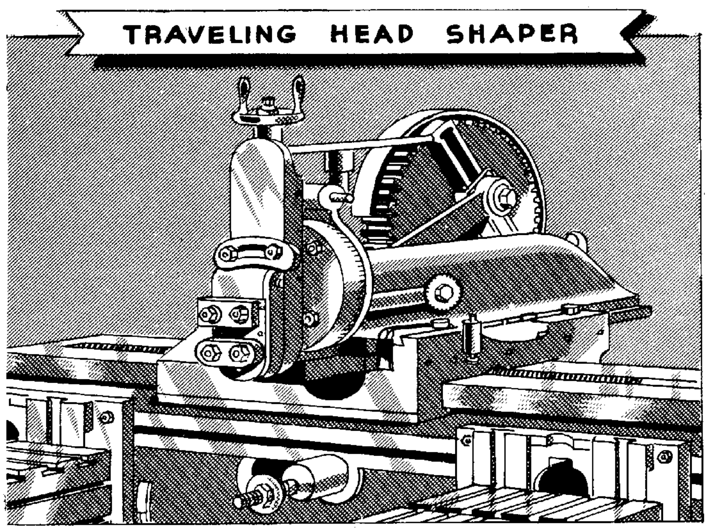
With one exception, the cutting tool, which is adjustable vertically, removes material during the forward stroke only. During the return stroke of the ram, the table and the work move toward the tool a predetermined amount as long as the automatic table feed remains engaged.

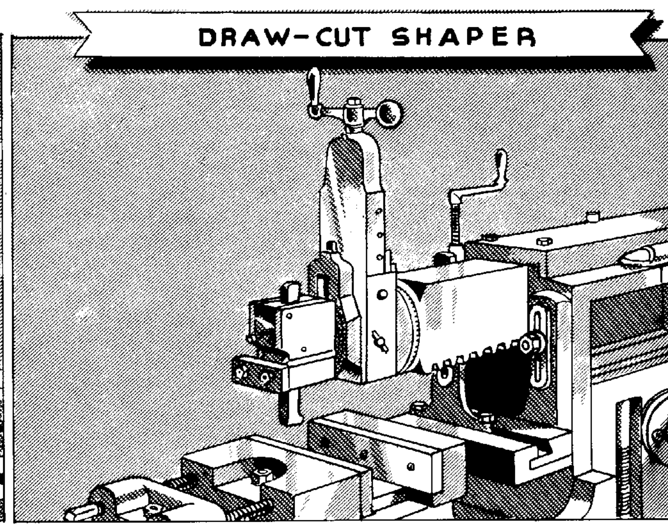
Most shapers have been designed with a vertical column or pillar which is used to support the ram, the table, and the drive and feed mechanisms. At one period in their development they were called column or pillar shapers.

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. Therefore, more specific and meaningful terms have been used in classifying their machines, terms which indicate or emphasize some characteristic features in the design of their product.

Several 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. With the draw-cut shaper, material is removed on the return stroke of the ram, instead of on the forward stroke.

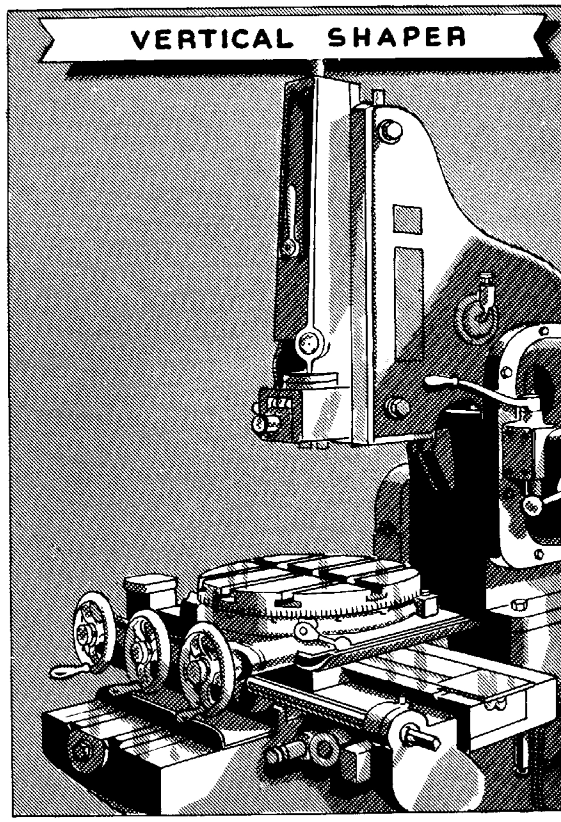




In another group of shapers, classification has been based on the type of driving mechanism utilized in their construction. For instance, shapers in which the back-and-forth movement of the ram is brought about by a crank pin in the main driving gear of the machine, have been designated crank shapers.

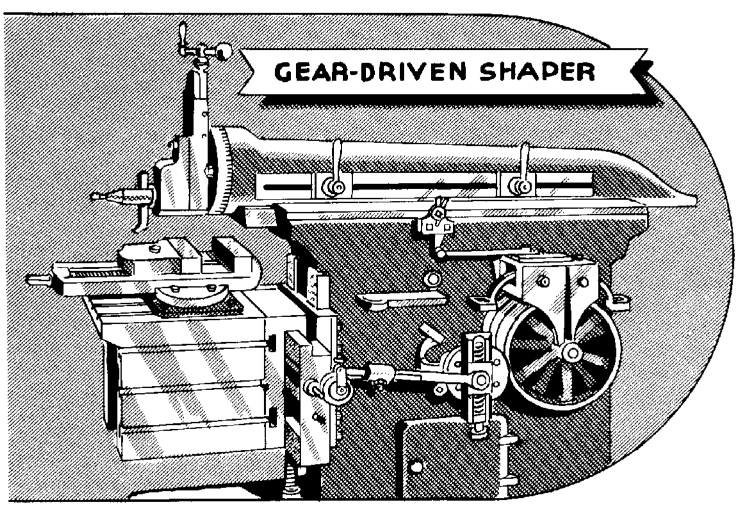
Similarly, geared shapers have been so called because a series of gears and a rack attached to the underside of the ram, move the tool over the work.

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.



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. The size of the machine also indicates the dimensions of a cube which can be held and planed in a shaper of a known size.

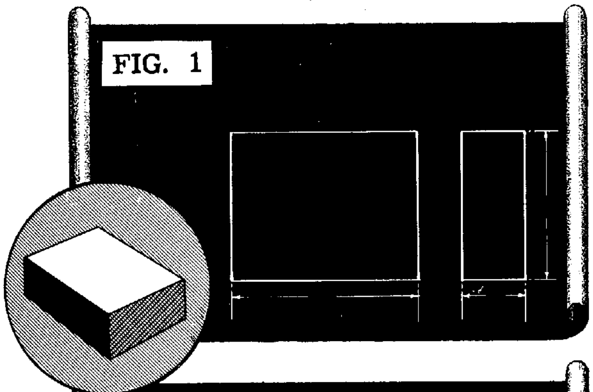
A 16-inch shaper, for example, can be adjusted for any ram stroke from 0''-16'' in length, the transverse table feed can be used to plane a surface 16 inches wide, and the vertical distance between the tool head and the worktable in its extreme lower position will be sufficient to permit planing the 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 has no facilities for angular shaping. This unit will be confined to the description of the plain crank shaper and an explanation of some of the operations which can be performed on a shaper of this type.

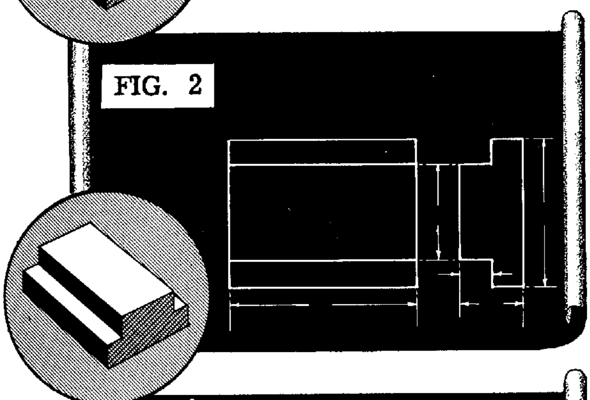
A few jobs involving operations which are typical of those frequently performed in the shaper are shown in Figures 1, 2, 3 and 4. They give some idea of the wide variety of work which may be performed by an operator who is familiar with the construction of the shaper and understands the principles of its operation.

FIG. 1



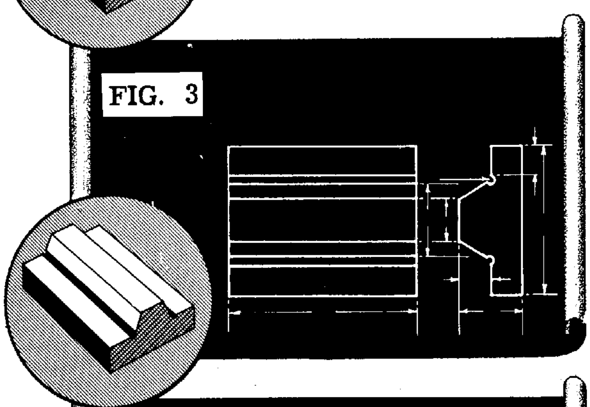
One of the simplest shaper operations is that of machining a casting to definite dimensions by taking one or more cuts from its surfaces (Fig. 1).

FIG. 2



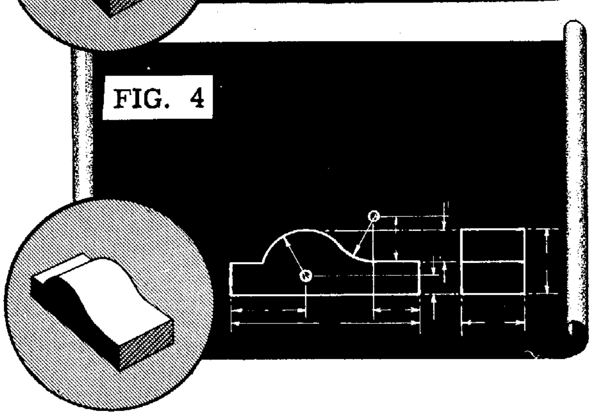
Frequently a surface can be machined to better advantage when it is placed in a vertical position and the tool fed down along a vertical surface of the work instead of across a horizontal surface of the work. Fig. 2 shows this kind of setup.

FIG. 3



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

FIG. 4



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 on the shaper.

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.

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 is 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.

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

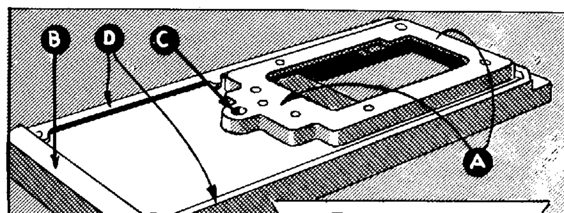


FIG. 5

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

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.

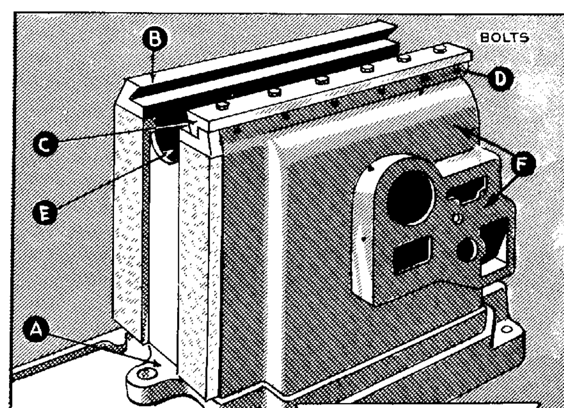


FIG. 6

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. 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 to it, 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.

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.

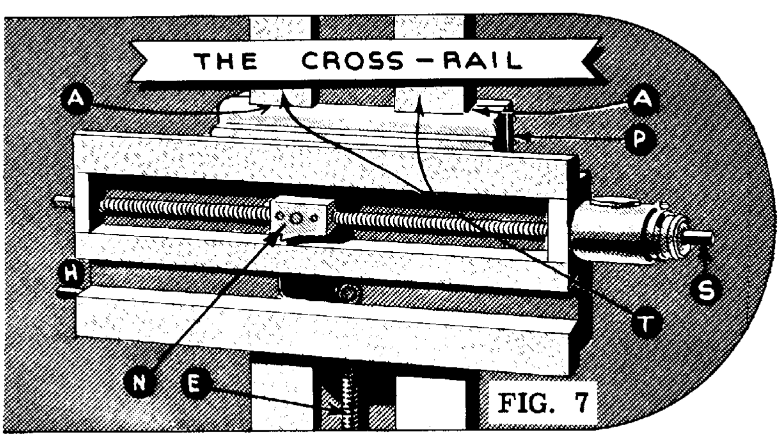


FIG. 7

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. Together with plates P, they form the bearing surfaces which permit the cross rail to be adjusted vertically 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" 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 handles, are provided on both sides of the shaper to hold the cross rail solidly to the column.

An elevating screw E controls the vertical movement of the cross rail and determines its vertical position on the column. 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, the front face of the cross rail serves in a similar capacity for the saddle. The difference is that the column face provides for vertical movement of the table, while the face of the cross rail controls horizontal movement of this part.

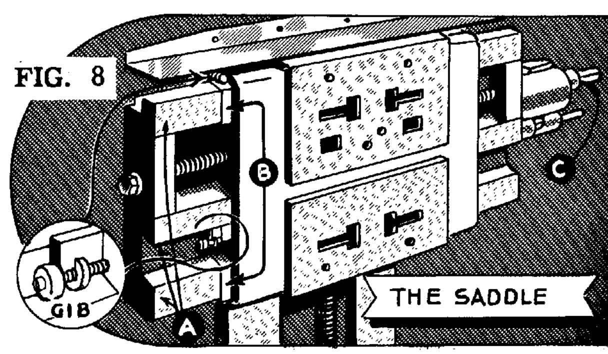
A cross-feed screw S, mounted horizontally in the cross rail, extends from end to end. By passing through a stationary nut N, attached to the rear of the saddle, it controls the sidewise movement of this part. A crank may be used on the end of the screw to feed the saddle and table by hand.

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

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.

FIG. 8



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 square box fit at the top of the rail.

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 permits 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.

THE TABLE

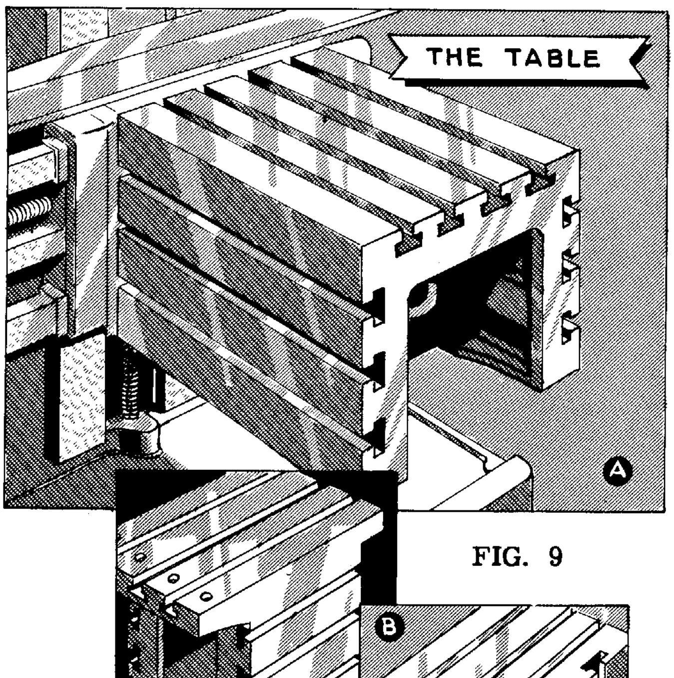


FIG. 9

The table is a rectangular shaped casting of boxlike construction with openings at the front and 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. These 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 at A, Fig. 10. With a support of the type shown at B, Fig. 10, both the front and the bottom surfaces function with the slide.

The remaining surfaces (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.

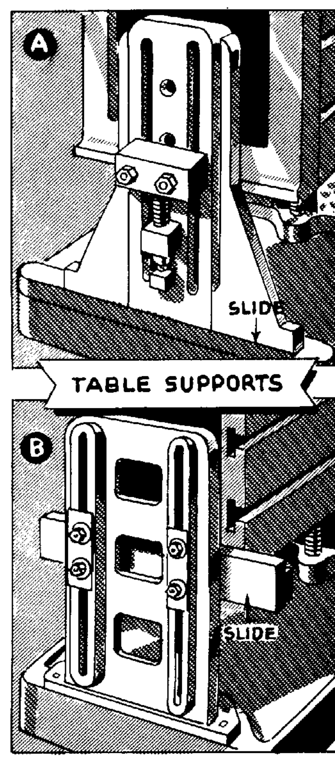
The surfaces used for holding the work have T-slots which accommodate bolts used for work-clamping purposes. The spacing and direction of these slots are not similar on all makes or models of shapers, and each manufacturer advances good reasons to justify the particular arrangement used in his product.

Two common designs prevail in regard to the direction of the T-slots. In Fig. 9A the slots on all surfaces used for clamping work run horizontally. In Fig. 9B 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 (Fig. 9C) 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.

THE TABLE SUPPORT

FIG. 10



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 either during the cutting process, or 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 (Fig. 10A) 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 another group (Fig. 10B) may be placed those which are bolted to the base of the shaper. 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. Clamping bolts securely lock the support in place.

Bearing surfaces on which the table supports slide are sometimes protected from chips, and may be lubricated by felt wipers attached to the ends of the support.

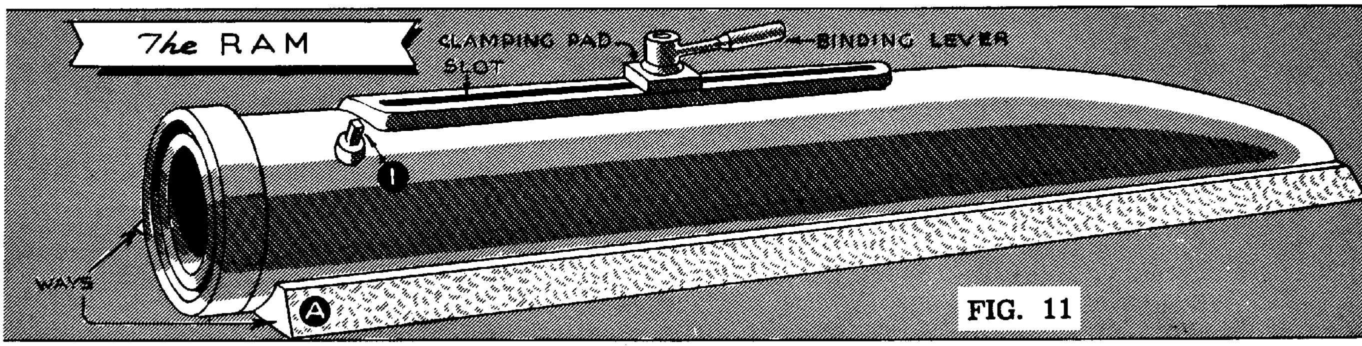


FIG. 11

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. This part supports the cutting tool and guides it over the work during the cutting process.

The V-shaped ways shown at A, in Fig. 11, 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. 12A), 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 the other. The taper gib, for example, utilizes a single screw shouldered against the large end for adjustment. The straight gib requires a series of screws spaced along its entire length in the column to accomplish the same result (Fig. 12B).

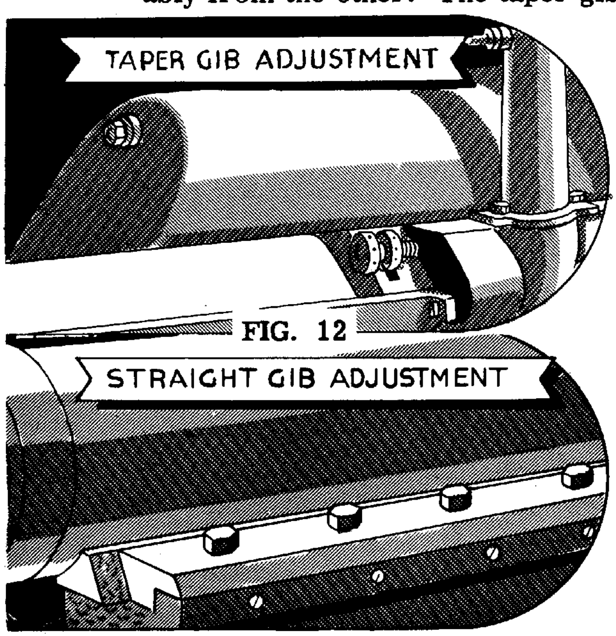
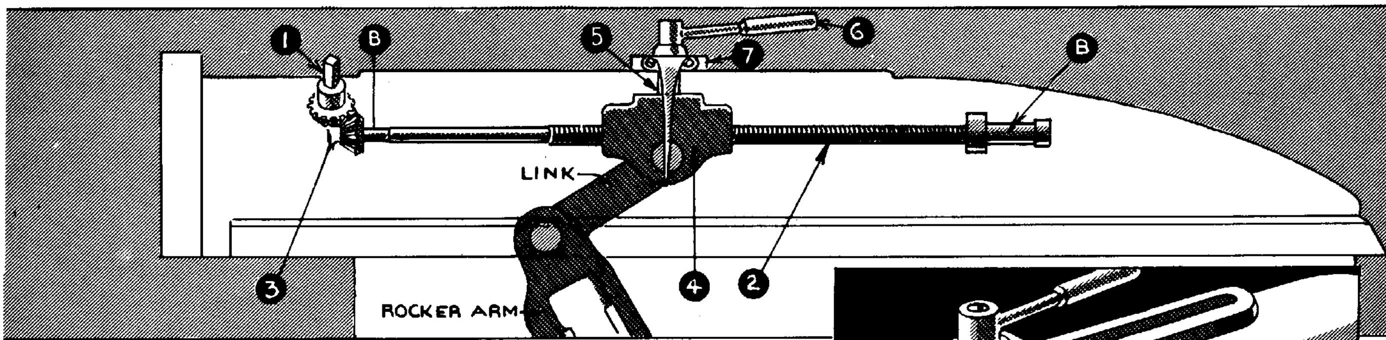


FIG. 12

To the list of parts and surfaces already covered 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) with a square end to receive a crank which is used 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 ram positioning screw (2).

Also to be included is the stationary nut (4) which aids in positioning the ram and 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. Together with clamping pad (7) these parts furnish the means whereby the ram is clamped in position.

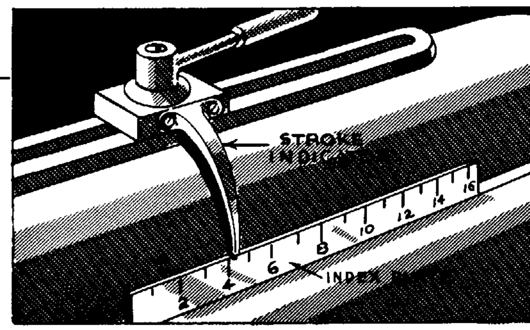
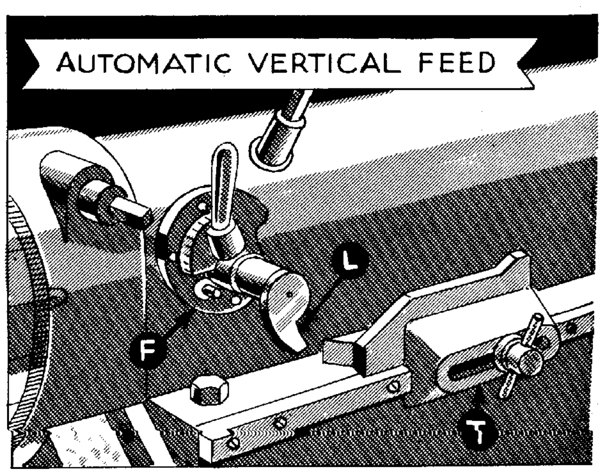


FIG. 13

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 (Fig. 13). This index plate resembles a scale in that it is marked off in inches. The largest number appearing on the index plate indicates the maximum length of stroke of the machine. For example, the number 16 indicates a 16-inch shaper.

Since the ram and the stroke indicator move as a unit (provided 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 moved as far back as it will go for its stroke.

FIG. 14



The stroke indicator and its scale have been described only because of their proximity to the ram. Their connection with the stroke-adjusting mechanism will be described in detail later.

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.

THE TOOL HEAD

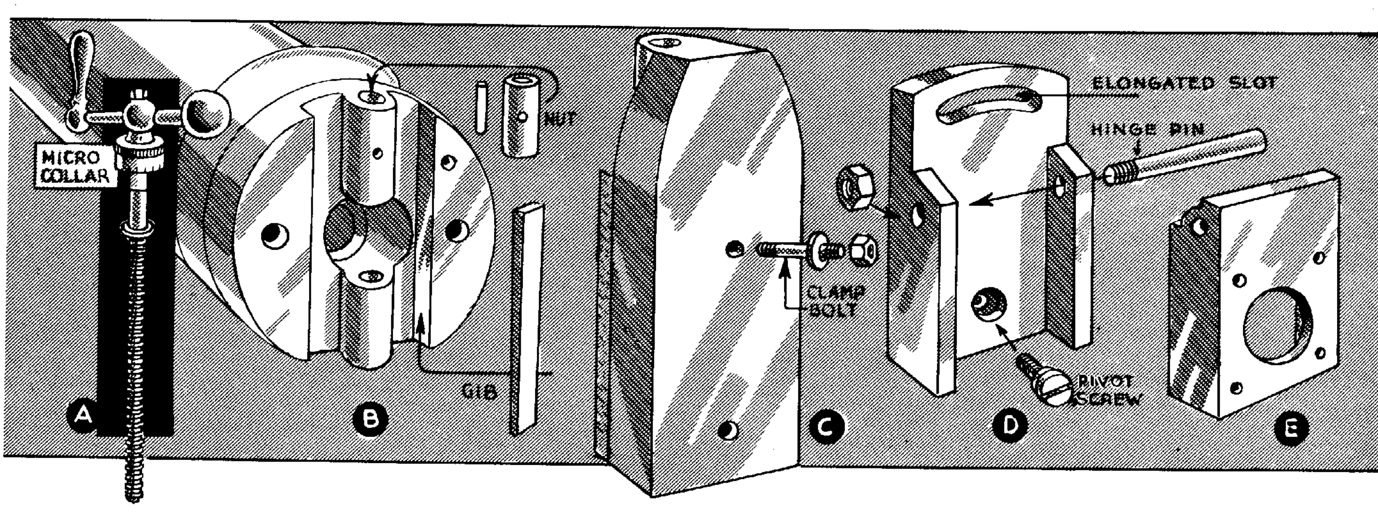
The tool head (Fig. 15) is clamped to the forward end of the ram. It consists of those parts which serve to hold the cutting tool, guide the tool vertically, and adjust it for the desired cut. Although their construction may vary somewhat in detail, all tool heads for the shaper are quite similar in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

A swivel block (B) connects the tool head to the ram. Two binder bolts extending from the circular T-slot in the face of the ram pass through holes in the swivel block and hold it in place.

Another function of the swivel block is 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 tongue or 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 in the swivel block. The direction of the cut, whether angular or vertical, will be determined by the setting of the swivel block.



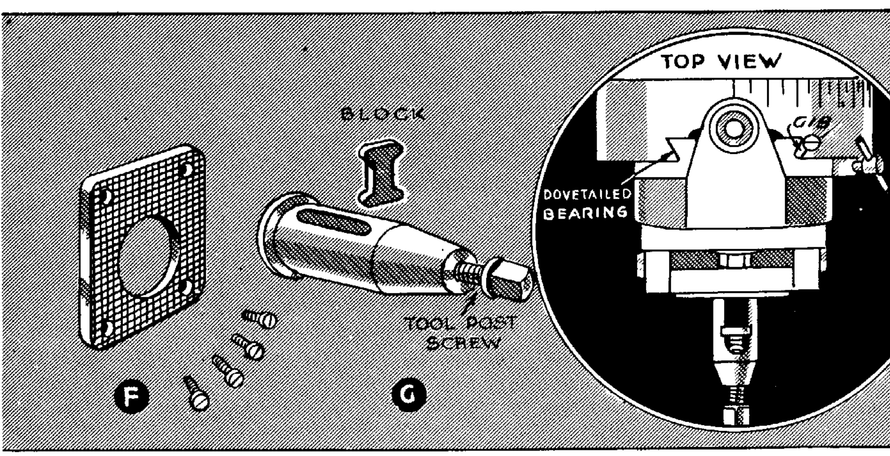
An adjustable micrometer collar on the downfeed screw, graduated in thousandths of an inch, indicates the distance through which the tool slide moves.

Most shapers come equipped with a tool-slide lock (Fig. 15) 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 marring the tool holder when pressure from the tool-post screw is applied on the tool holder.

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.



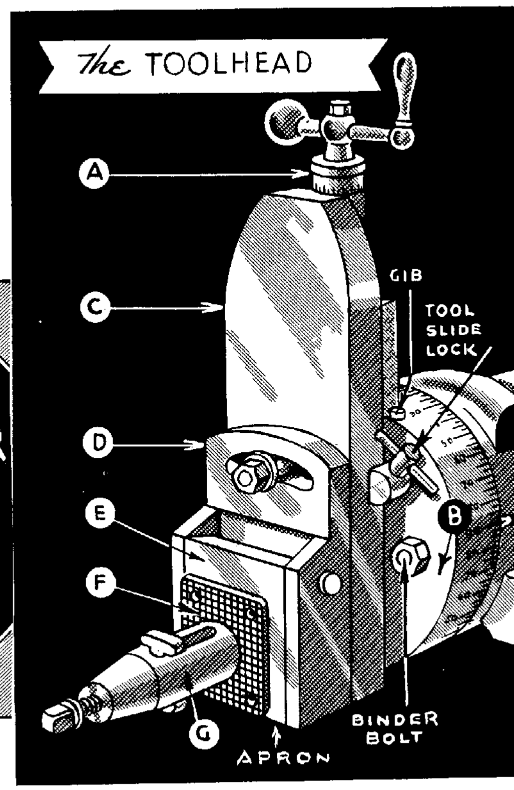


FIG. 15

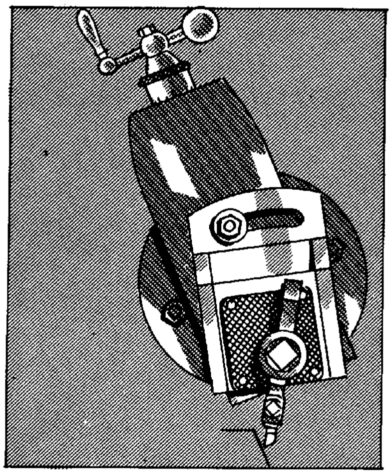


Fig. 16-A

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. This explanation covers the action of the tool block during a horizontal cut.

For a vertical or an angular cut, 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.

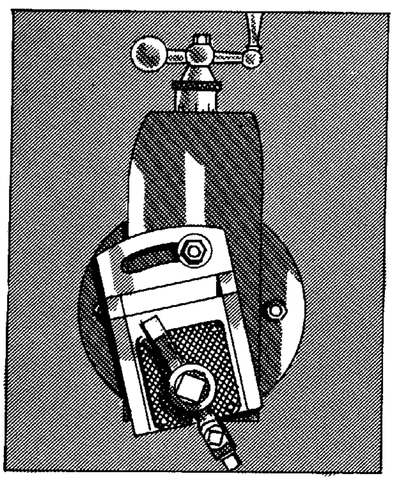


Fig. 16-B

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 changing the position of the pivot screw.

Thus, if the clapper box is swung to the right (Fig. 16A) 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 (Fig. 16B). For horizontal cuts, the clapper box is usually set vertically.

No distinction has been made between the crank-driven 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 point on, the parts for these two types of machines differ and therefore will be described separately.

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 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 compensates 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.

Since the movement of the ram on the one hand is backward and forward and that of the drive pulley 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 in several ways. Since the shaper described here has been named a crank shaper, and one way of classifying the shaper is on the basis of the driving mechanism employed, then 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.

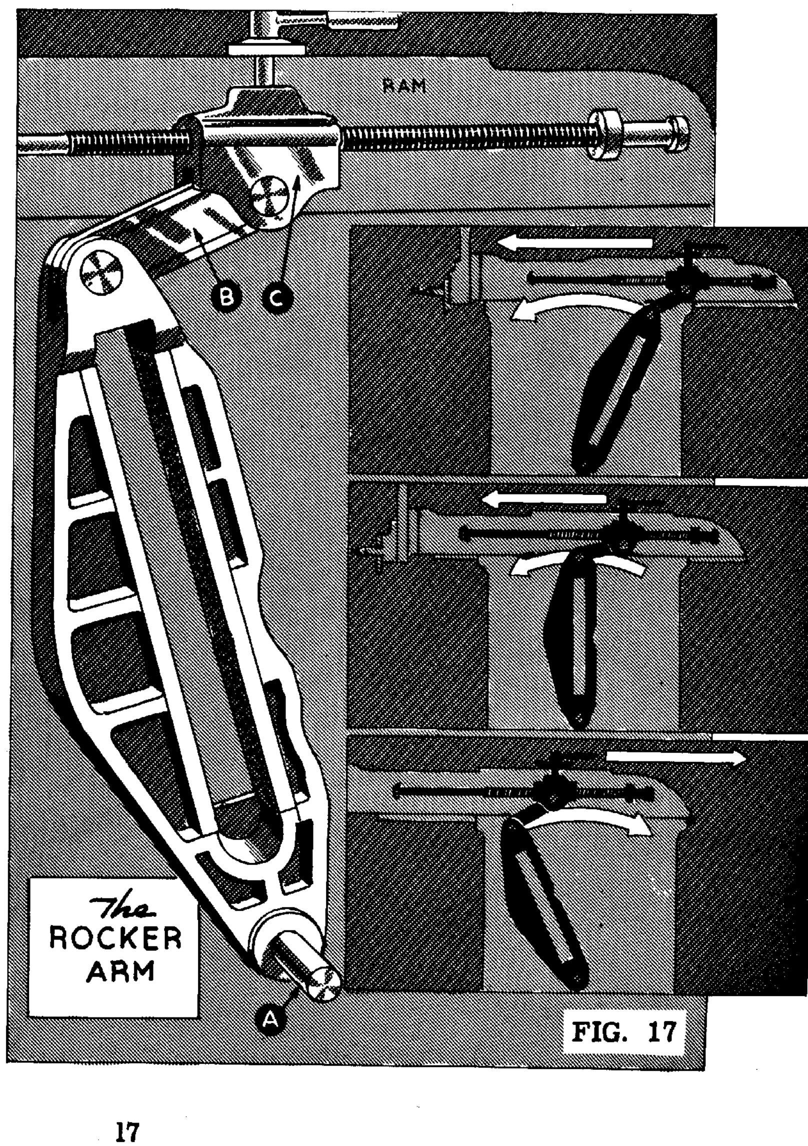


FIG. 17

Mounted within the column and directly behind the rocker arm is the main drive gear (A), Fig. 18, 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.

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 to provide 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.

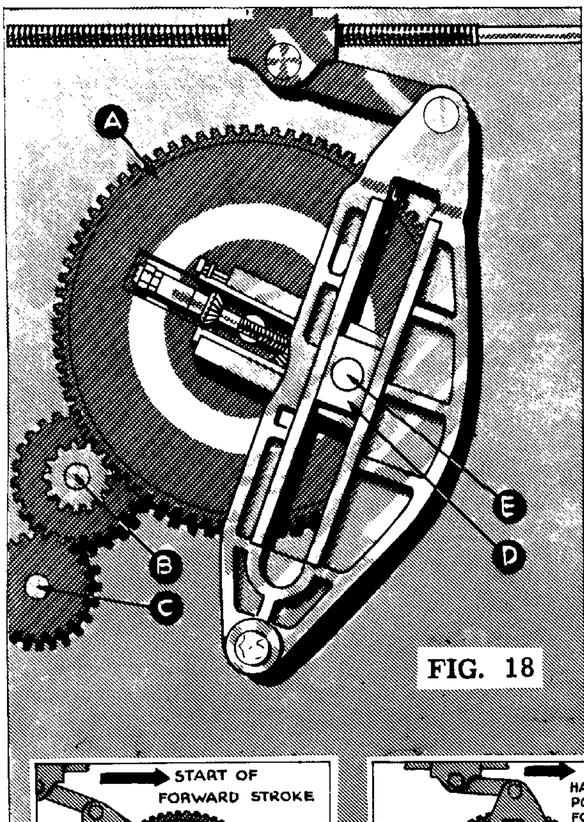
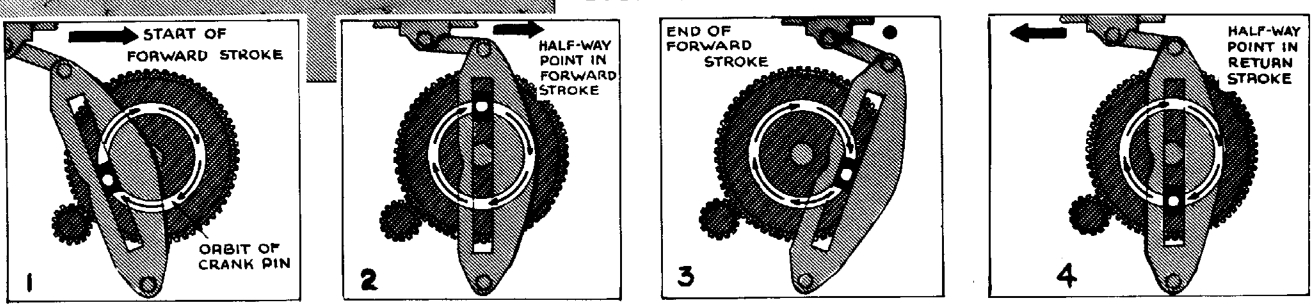


FIG. 18

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



THE QUICK RETURN

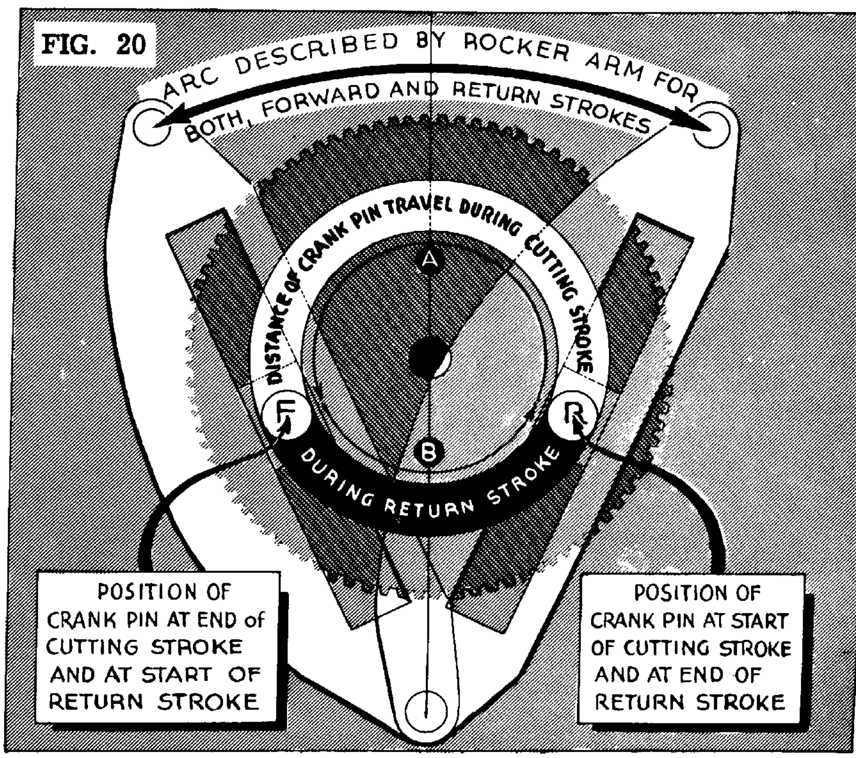
The driving mechanism of a shaper has been so designed that the return stroke of the tool is faster than the cutting stroke. The purpose is to reduce the idle time of the tool because it does not cut on its return stroke.

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 because 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 (Fig. 19).

With the bull wheel rotating at a uniform speed, the illustration shows 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 return stroke is 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.

FIG. 20



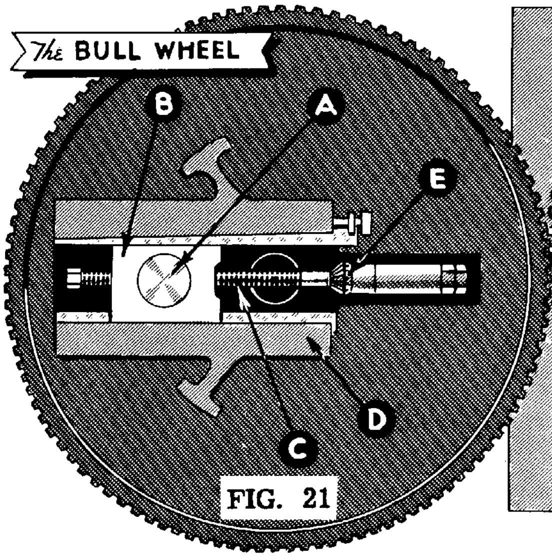


FIG. 21

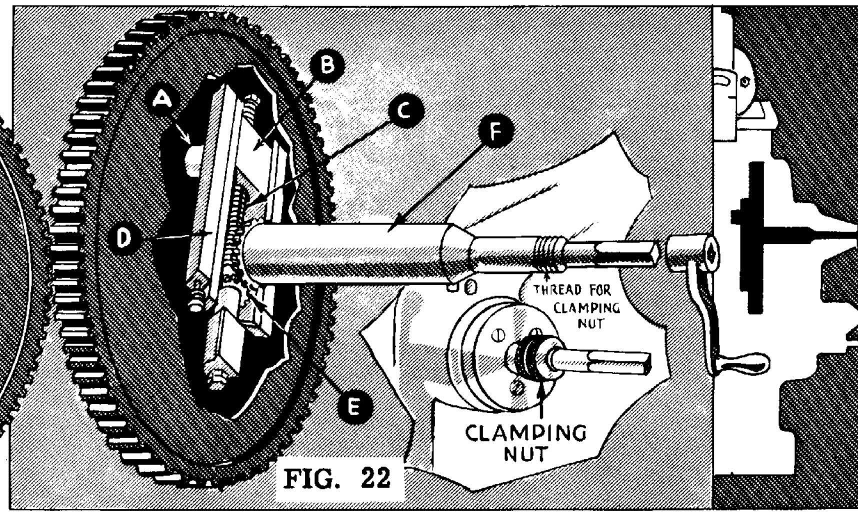
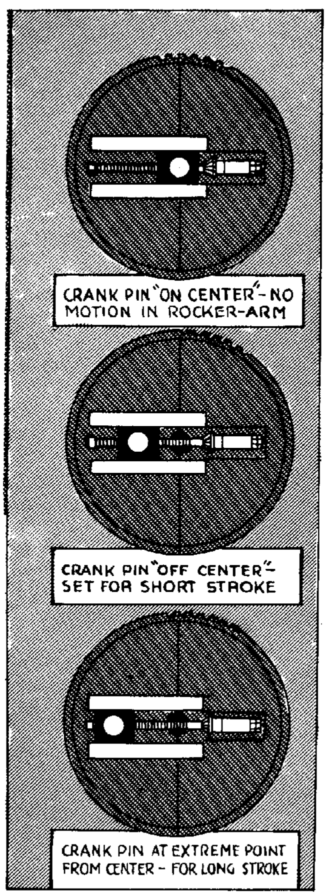


FIG. 22



THE 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. The crank pin governs the movement of the rocker arm and 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 is square 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 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 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.

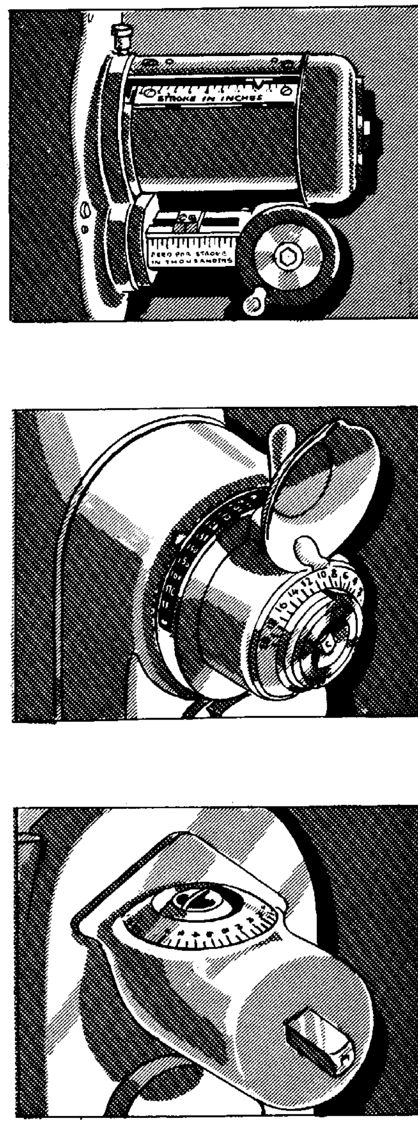


FIG. 23

THE SPEED CHANGING MECHANISM

The speed of the shaper refers to the number of cutting strokes the ram makes in a minute. It 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 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 depends 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 of a different size. The number of speed

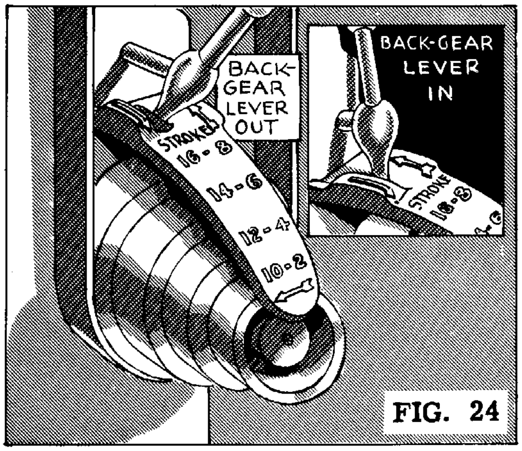


FIG. 24

changes possible is limited to the number of steps on the pulley (Fig. 24).

All but the smallest cone-driven shapers, however, have been provided with back gears inside the column, Fig. 24, 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.

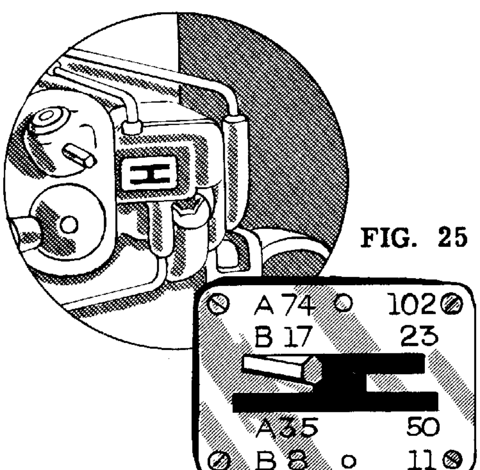


FIG. 25

A clutch is generally used 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.

THE FEED MECHANISM ON A CONE-DRIVEN SHAPER

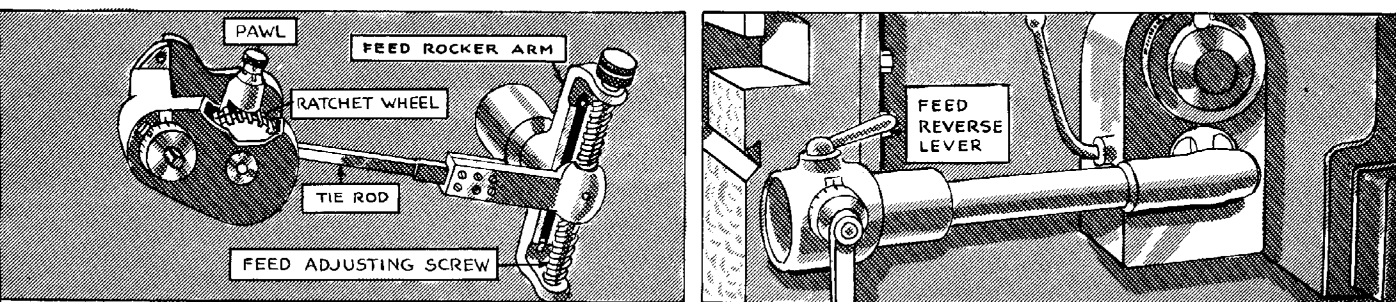
Although the feed mechanism on nearly every make of shaper differs somewhat from that on every other make, there are certain general principles underlying the construction and operation of all of them.

On most shapers the automatic feed may be applied only for moving the table horizontally on the rail. On others, 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 built so that they could be made to feed at either one end of the ram stroke or the other. Newer machines, however, are designed with the feed confined to the return stroke. On all types of shapers the feed may be disengaged or thrown out of gear and the feeding done by hand where required (Fig. 26).

The table feed screw cannot move endwise in the cross rail. The nut into which the feed screw is threaded is attached to the worktable, or saddle, and feeds the table along the cross rail when the screw is turned. The end of the feed screw has been machined square 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



On all shapers the amount of feed (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. However, there is considerable variation in automatic feed screw mechanisms.

Generally, the feed mechanism (Figs. 27 and 28) 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. This form of construction induces intermittent motion in one direction and avoids it in reverse (Fig. 29).

The ratchet wheel is either 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. As the arm oscillates (moves 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), drops into the space between the teeth on the ratchet wheel and is held there by a small spring.

The pawl (Figs. 27, 28 and 29) is made with one straight face and one beveled edge. When the arm moves 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 movement to the left, the arm moves to the right an equal distance. 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 moves to the left again.

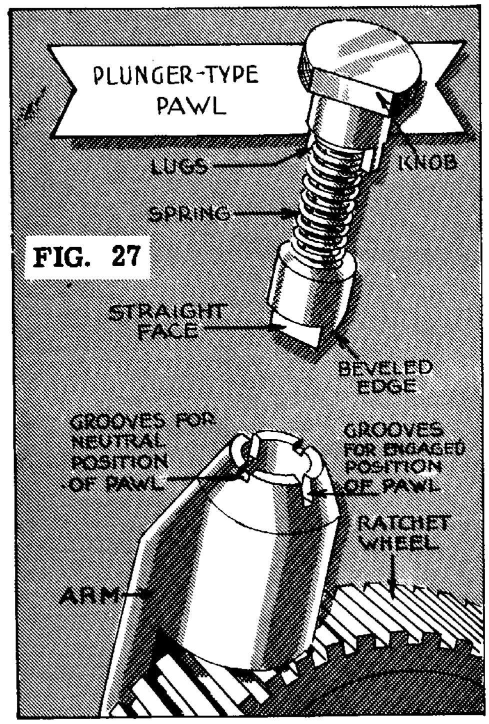


FIG. 27

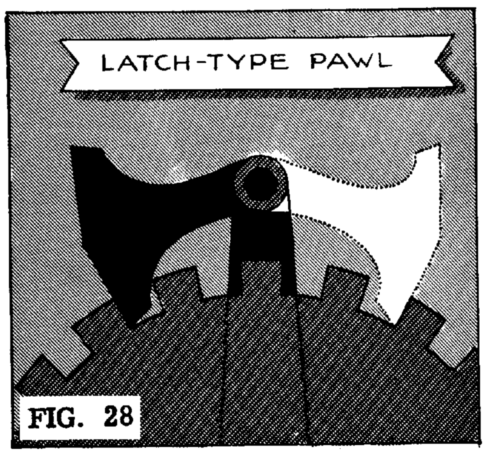
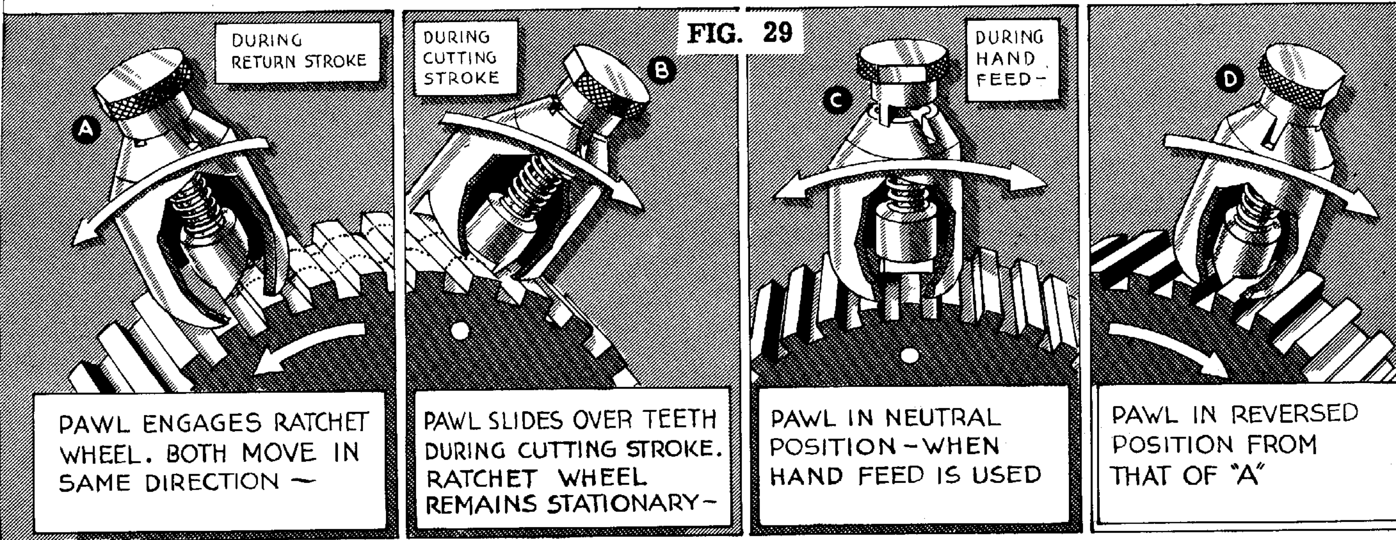


FIG. 28

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

FIG. 29



Since it is necessary 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. 29D). 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. When the pawl has been placed in the position shown by the dotted lines, the ratchet wheel will be fed in a clockwise direction.

Normally, the plunger-type pawl (Fig. 29) is held in the spaces on the ratchet wheel by a coil spring. When the pawl is in the position shown, (Fig. 29 at A and B) 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 (Fig. 29D), 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, the automatic feed will not operate, although the pawl arm continues to oscillate (Fig. 29C).

To position the pawl properly (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 to it. 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.

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 the automatic feed will not operate. (Refer to Fig. 29C).

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 brings about 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; one is gear-driven (Fig. 20), 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 mechanism 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, or away from the center to increase the feed.

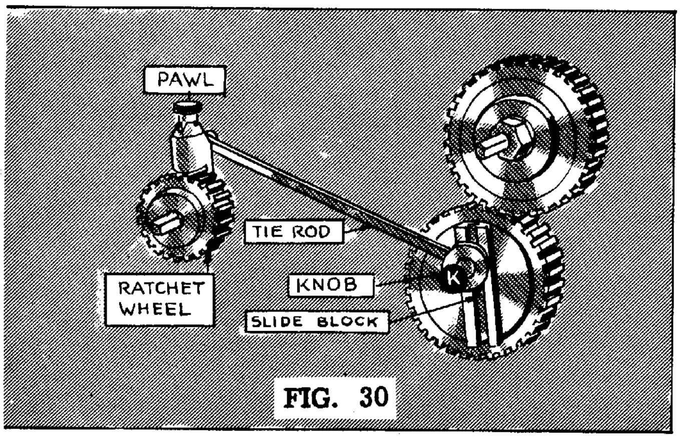


FIG. 30

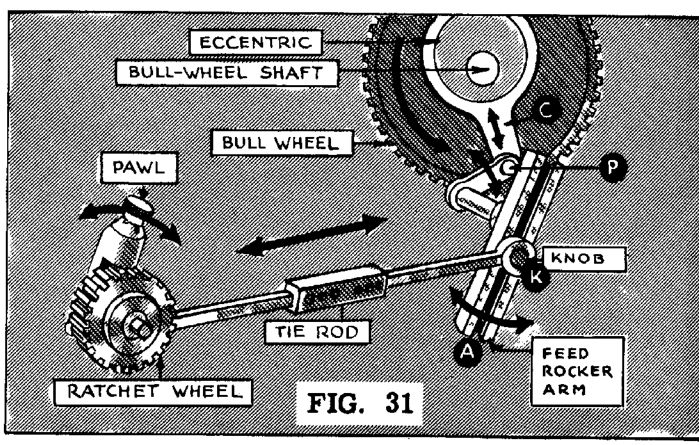


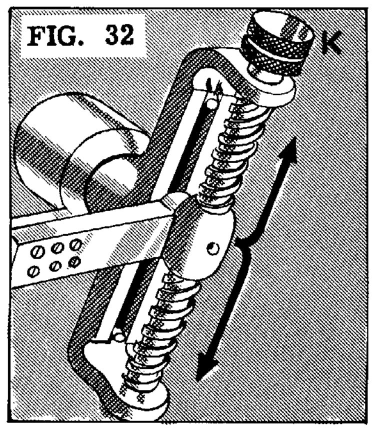
FIG. 31

The disc turns continuously in one direction only. Two connecting gears are 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. 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.

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.

FIG. 32



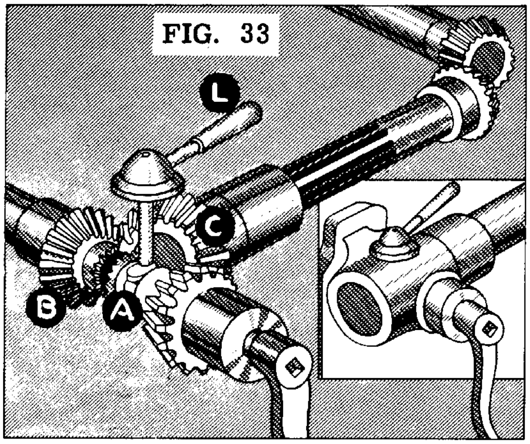
A screw, threaded into one end of the tie rod, has been added to the rocker arm in Fig. 32. This type construction permits the amount of feed to be changed by simply turning the knob (K) to move the end of the tie rod toward or away from the center of the rocker arm.

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 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 already explained. The pawl, however, cannot be reversed because there is no need 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).

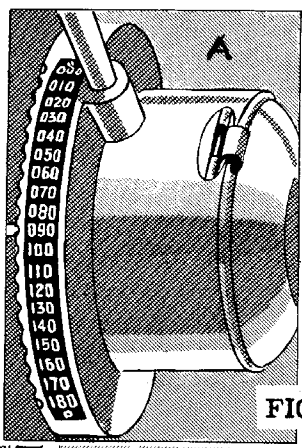
FIG. 33



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.

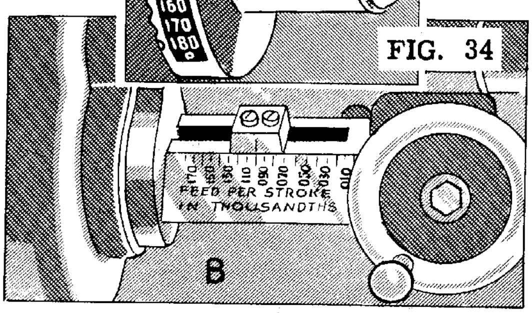
Although the bevel gears rotate intermittently as long as the machine remains in operation, the feed screw is caused to rotate only when the clutch has been shifted to the right or to the left and its inter-locking teeth have been brought into engagement with those on the end of one or the other of the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

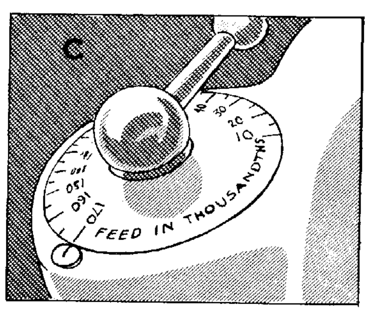
Lever (L) provides control of the automatic table feed. Its position, whether center, right, or left, indicates not only the position of the clutch but also the direction in which the automatic feed will move the table. In other words, the shaper is said to have directional feed control because the table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

FIG. 34





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 marked position to the next on the dial. Movement in one direction increases 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.

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.

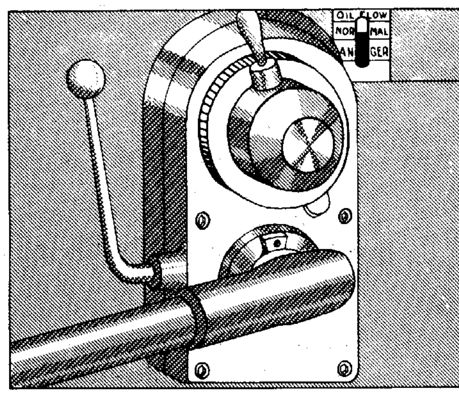


FIG. 35

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 hand crank (Fig. 35).

When the shaper includes rapid power traverse as a regular part of its mechanism, this unit is built into the machine. This feature 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).

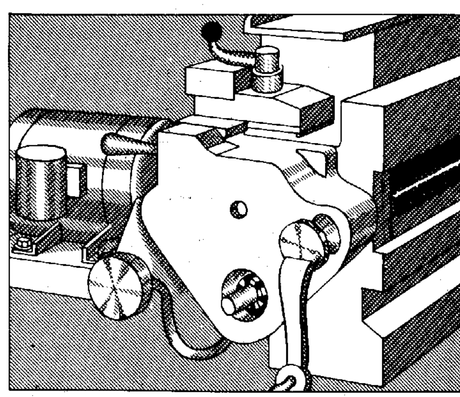


FIG. 36

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 located usually on the operator's side of the machine. Its direction is controlled by the levers used for engaging the automatic feed or by push buttons.

THE OILING SYSTEM

Changes and improved designs in shaper construction have been made not only to the machine but also to the mechanisms used to deliver an adequate supply of lubricating oil at all times to the parts most likely to be affected by wear.

The transition from simple cone-driven shapers to modern motor-driven machine tools has been accompanied by a gradual change in the method employed to supply its working parts with oil. The shaper requiring hand lubrication throughout has gradually developed into one in which many of the bearing surfaces are now automatically oiled.

This has changed oiling from a routine job of the operator to one performed regularly by a controlled pressure lubricating system. It 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 (Fig. 37). 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.

Because there are variations in the design of the different makes of shapers, it is impossible to describe exactly or locate precisely all the points which require oil to be supplied by one method or another. However, parts on different makes of shapers 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 unit has not been described.

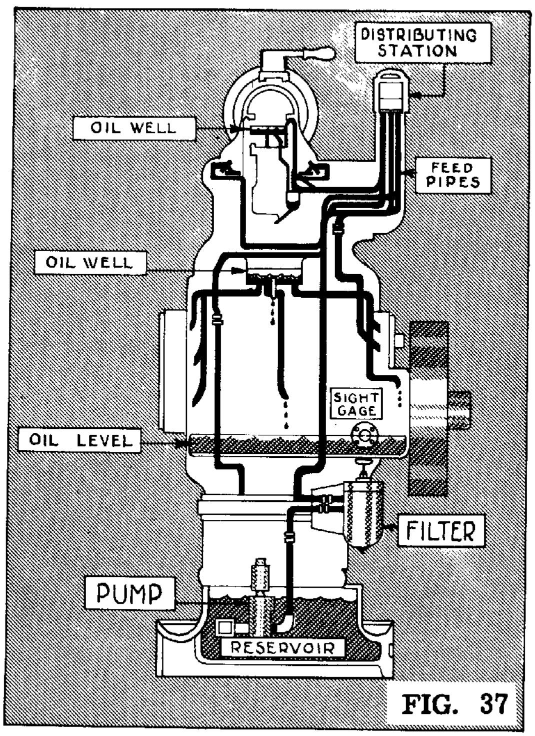


FIG. 37

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 to exclude dust and grit. The reservoir, regardless of its location, is usually equipped with a sight gage to show the oil level within (Fig. 37).

A pump, usually of the geared or plunger type and driven from the constant-speed drive, pumps oil from the reservoir. It forces the oil through tubes which lead directly to points requiring 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).

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

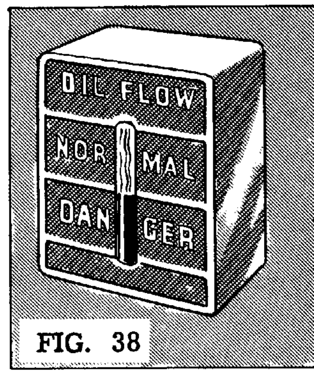


FIG. 38

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.

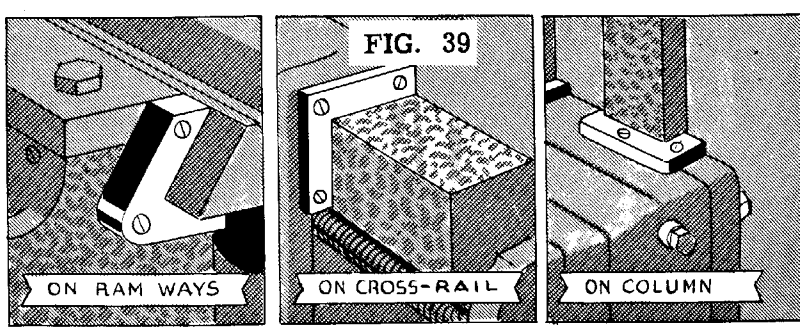
As an additional precaution against the entrance of foreign material into the lubricating system, the oil may be drawn through a screened enclosure in the reservoir before entering the pump. On leaving the pump, it may again be passed through a filter.

Four pressure lines lead directly from the pump or the distributing station (if one has been included in the system) and terminate at reservoirs located at four corners of the ram way guides. The guide ways for the crank block and other moving parts in the rocker arm, and usually the cross-rail unit, are lubricated in a similar 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 surfaces 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 to lubricate the machine.

A number of devices are used to bring oil to (and simultaneously to exclude dust and grit from) bearings which have not been connected with a circulating oiling system.

FIG. 39



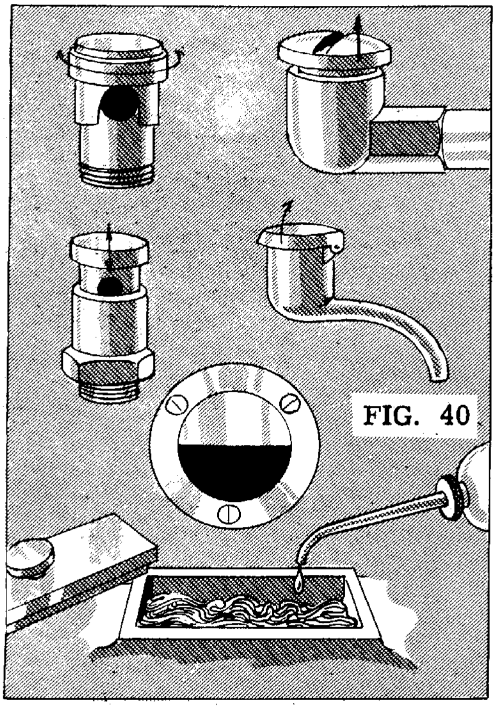


FIG. 40

These bearings therefore must be lubricated by the operator.

The bearings requiring this form of lubrication are most numerous on the older shapers which were not provided with automatic oiling for any of their parts. These bearings include those surfaces and units within and about the column which are automatically oiled in the modern shaper.

Usually several types and sizes of oilers (Fig. 40) are used on a shaper for oiling and protecting its bearings. Their selection is governed by such pertinent factors as the location and function of a particular bearing and the amount of oil it requires.

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 semi-automatic oilers which provide metered lubrication within the limited capacity of the oiler.

DESCRIPTION OF *the* HYDRAULIC SHAPER

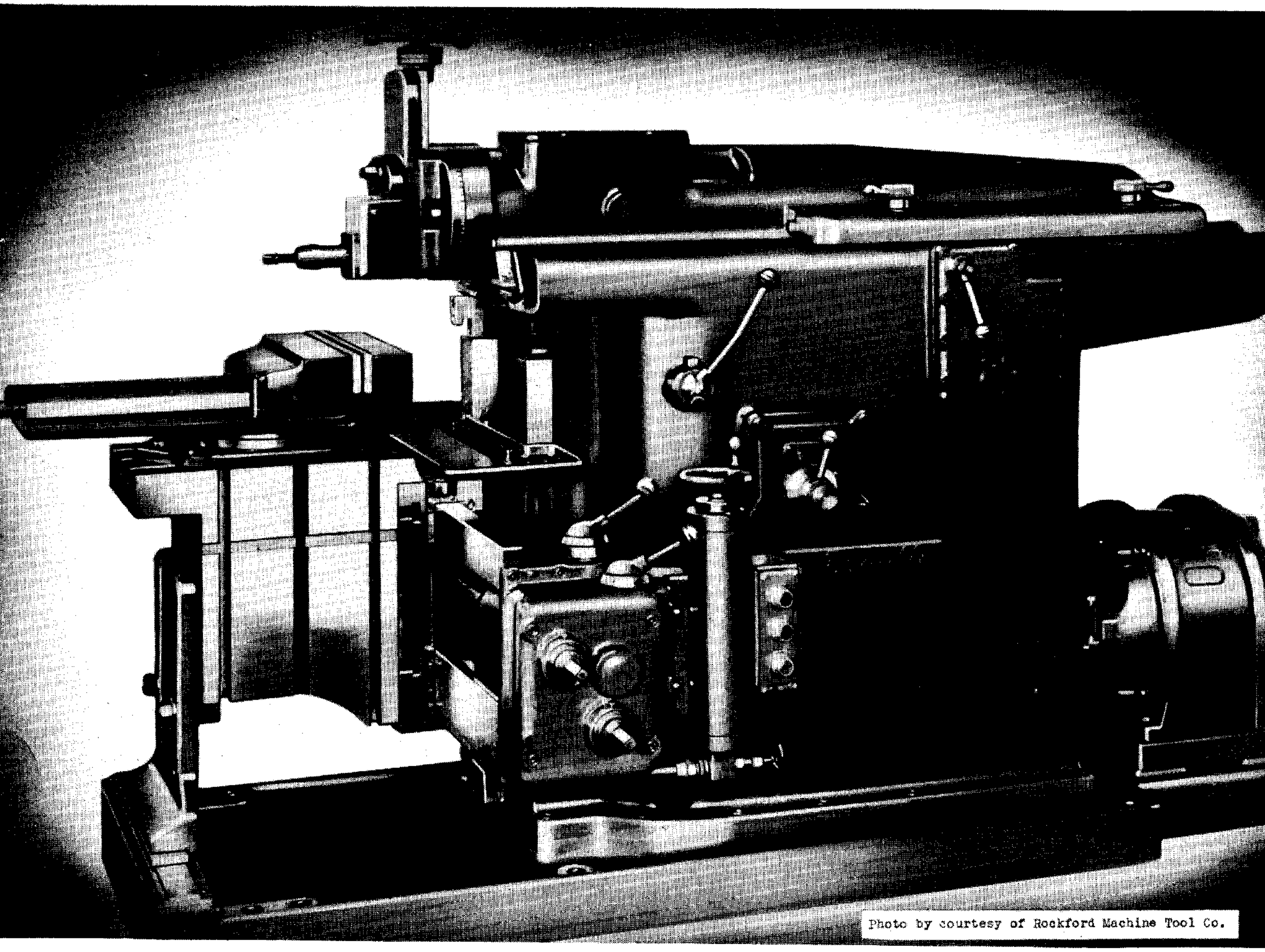


Photo by courtesy of Rockford Machine Tool Co.

UNIT T 52 (A)

Part II Pages 33 - 46

DESCRIPTION *of the* HYDRAULIC SHAPER

OBJECTIVES OF UNIT

1. To point out how the hydraulic shaper differs from the crank shaper.

2. To describe parts and units which are common to the hydraulic shaper and its hydraulic system.

3. To indicate the function of parts and units on the hydraulic shaper.

INTRODUCTORY INFORMATION

Crank shapers and hydraulic shapers differ very little in their outward appearance and in their general construction. The main difference lies in the means used to move the ram backward and forward. The mechanism for actuating the ram on the crank shaper has been described. That used on the hydraulic shaper, which operates on an entirely different principle, will be covered in this unit. Its operation is based on Pascal's law which, in brief, states that a fluid confined to a pipe or other enclosure will transmit applied pressure equally in all directions and to every surface to which it extends.

In the hydraulic shaper the ram receives its reciprocating motion from a piston which is moved backward and forward in a cylinder under the ram by a flow of oil from an electrically driven pump. The oil, under pressure, acts alternately against opposite ends of the piston. This causes the ram to reciprocate because it is connected with the piston.

Several valves, each designed for a specific purpose, form a part of the hydraulic system used to operate and control the shaper. One valve, manually operated, starts and stops the shaper. Another, mechanically operated, regulates the length of the ram stroke. A third one, whose operation is entirely automatic, controls the volume and regulates the

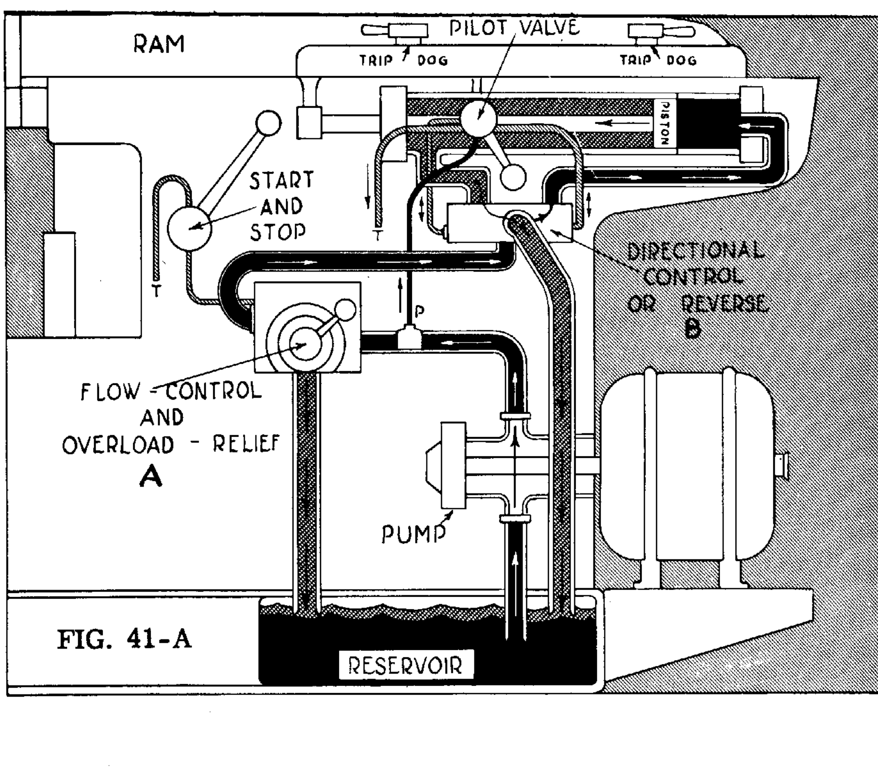


FIG. 41-A

pressure of the oil admitted to the hydraulic system. A fourth valve not only automatically directs the flow of oil to alternate ends of the ram cylinder, but also directs it back to the reservoir. Moreover, both the ram and the automatic feeding mechanisms operate hydraulically on shapers equipped with this type of driving unit.

THE HYDRAULIC UNIT

The hydraulic unit employed to drive a machine tool is usually supplied by a manufacturer who specializes in this type of equipment and adapts it to the requirements of a particular machine. The unit includes a high-pressure pump (usually electrically driven) for circulating the fluid, and valves for controlling its pressure, volume, and direction of flow.

The hydraulic unit also includes pipes and fittings which connect these parts and make of them a complete circuit. In this circuit the fluid is drawn from the reservoir, directed to the cylinder under pressure, and then returned to its original source after it spends its energy on the piston for such time as is required for the ram to complete its forward or return stroke.

Figure 41 shows by diagram how a simple hydraulic circuit functions on a shaper. All pipes carrying fluid under high pressure to the piston are shown in black. Those pipes which return the fluid to the reservoir are shaded. The arrows indicate the direction of the liquid flow. The illustration (Fig. 41A) indicates the course of the fluid during the forward stroke of the ram. The fluid drawn from the tank by the pump, passes through the combination flow-control and relief valve (A) and on to the directional valve (B). From here, for the forward stroke of the ram, it is directed to the right-hand end of the cylinder, causing the piston and the ram connected to it to move forward. At the same time as the piston moves to the left, it expels fluid from the head-end of the cylinder and returns it to the supply tank by way of the directional control valve.

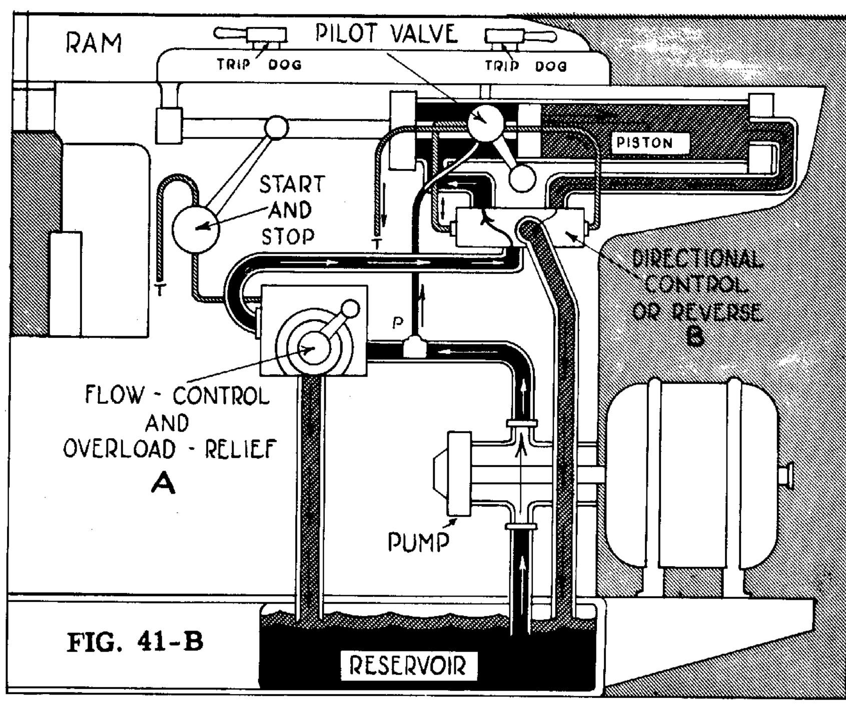


FIG. 41-B

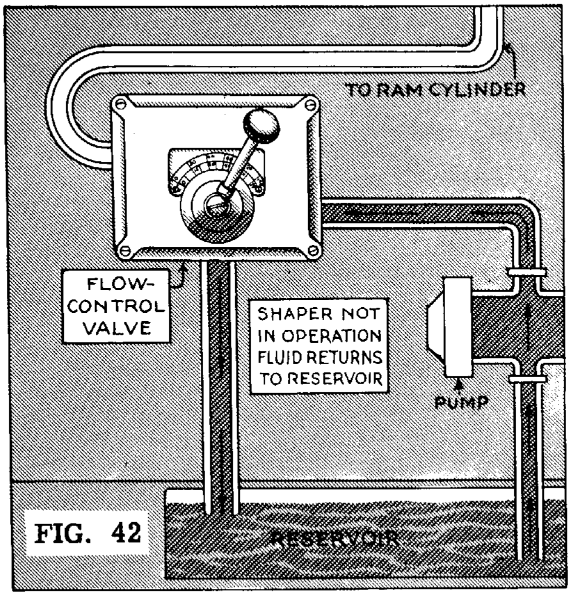


FIG. 42

Similarly, in Fig. 41 (B) the pipes shown in black depict the course of the fluid during the return stroke of the ram. By means of the directional control valve, the fluid under high pressure has been directed, not to the right-hand end of the cylinder as before, but to the left-hand end. This reverses the direction of the piston travel and causes the ram to move back. As it is forced back, the piston ejects the fluid from this end of the cylinder, causing it to return to the tank.

When the shaper is stopped for one reason or another, the pump (which is usually of the constant-delivery type) continues to pump the usual volume of oil. Since the oil is not utilized to drive the shaper, it must be disposed of in another manner. This is a function of the flow-control valve (Fig. 42) which operates automatically in conjunction with the start-and-stop lever. This valve opens wide, and the oil returns directly to the reservoir instead of going to the ram cylinder as it does when the machine is in operation.

Briefly, this explains how the hydraulic unit functions. The manner in which the individual parts or units perform their functions will be explained in greater detail under their own headings.

DESCRIPTION OF THE PUMPS

The pump, whether driven electrically or by means of a belt, is usually operated at a constant speed. This speed makes it possible to deliver the fluid in sufficient volume and at a high enough pressure to exceed slightly the maximum demands which may be imposed upon it by the machine of which it has become a part.

Three types of pumps are commonly used for this purpose. They are: the gear pump, the vane pump, and the plunger pump, illustrated in Figures 42 to 46. Each type is made in varying sizes to fit specific working conditions.

The gear pump and the vane pump are known as constant-delivery pumps. As the name indicates, they will deliver a specified amount of fluid at a constant pressure as long as their speeds remain constant.

Since the output of these pumps, regulated by their speeds, has been calculated to equal or exceed slightly the maximum amount of fluid they will be called upon to deliver during heavy operations and at high machine speeds, it follows that for lighter operations and slower speeds these pumps will deliver considerably more fluid than is actually required. When this condition arises, a relief valve connected to the hydraulic system automatically diverts the excess fluid to the reservoir instead of to a pipe leading to the machine drive.

In contrast with the constant-delivery pumps, the plunger pump of the design shown in Fig. 46 permits the amount of fluid delivered to the hydraulic system to be varied. This is accomplished, not by changing its speed of rotation or by diverting part of its output by means of a relief valve, but rather by regulating the amount of reciprocating movement imparted to its plungers.

A brief description of each type pump follows. In design and construction they vary considerably, but each will perform creditably if used under conditions for which it has been designed.

THE GEARED PUMP

This is a type of rotary pump which employs gears with intermeshing teeth for pumping the fluid. The construction of this pump is simple, its only moving parts being the gears. Although spur gears have been used successfully in these pumps, gears with helical teeth result in quieter operation, especially when rotating at the faster speeds required to maintain high pressure in the hydraulic system.

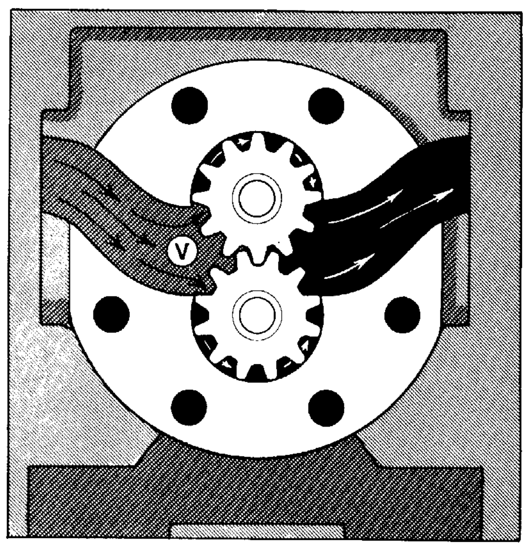
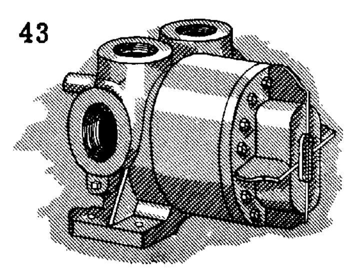


FIG. 43



In operation, the gears revolving in the direction indicated by the arrows (Fig. 43) create a partial vacuum in the space marked (V) in the gear case. With this suction, the atmospheric pressure in the oil reservoir forces the fluid into the pump chamber through the intake.

As the revolving gears pass the intake, the fluid fills the spaces between the teeth. The fluid, confined between the outer pump casting and the spaces between the gear teeth, is then carried to the opposite side of the pump chamber and ejected at the outlet. The volume of fluid pumped and the pressure at which it enters the hydraulic system, depend largely on the speed of the gears.

Pumps of this design perform very satisfactorily when connected directly to an electric motor. When the pump speed resulting from this type of drive is too fast, a speed-reduction unit may be used between the motor and the pump.

THE VANE PUMP

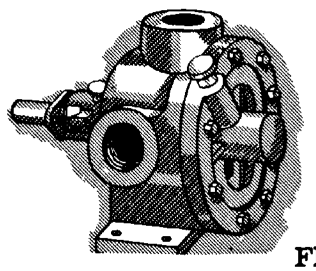
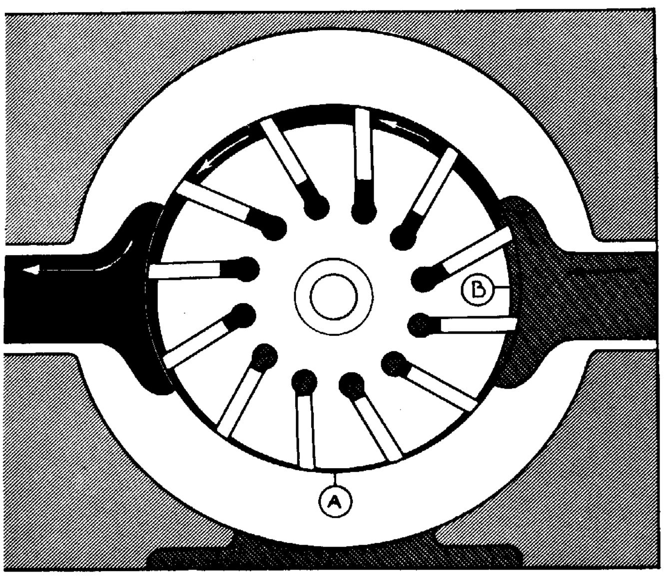


FIG. 44



The vane pump is also a rotary pump of the constant-delivery type with the exception that instead of gears it employs a rotor equipped with vanes for pumping the fluid. Its principle of operation is quite similar to that of the geared pump in that the vanes create a partial vacuum in the pump chamber. Similarly, the spaces between the vanes, like those between the teeth in the geared pump, confine the fluid and cause it to be carried from the intake to the exhaust port for ejection into the hydraulic system.

The vane pump utilizes a rotor with slots in its outer edge. Into these slots have been fitted vanes which slide (radially) toward or away from the center of the rotor during its rotation.

The radial movement of the vanes which combined with the rotary motion of the rotor is responsible for the functioning of the pump, may be induced by various forms of pump construction. In Fig. 44, for example, the pump chamber is round and the shaft and rotor have been located off center for this purpose. The centrifugal force set up by the revolving rotor and the pressure of the fluid within the pump chamber cause the vanes to slide outward in their slots and hug the surface of the pump chamber. Since the rotor is off center and practically touches the pump body at point (A), Fig. 44, the vanes are forced into their slots when they are carried past this point. Then, continuing its rotation in a counterclockwise direction from (A) each vane gradually emerges from its slot and in so doing enlarges the space (B) directly behind and thereby creates a suction in this part of the pump chamber.

The intake port has been located at this place in the pump chamber also. The fluid, having been forced into the space between vanes by atmospheric pressure, is then carried around the pump chamber by the vanes and expelled through the exhaust port.

The exhaust port is located opposite the intake port and in that section of the pump chamber in which the action of the vane in its slot is the reverse of its action at the intake port. For instance, instead of moving out in its slot, the vane now begins to move in. This movement, combined with its rotary movement toward point (A), causes the space between the pump chamber and the rotor in which the fluid has been trapped to become smaller gradually. This leaves the fluid no alternative but to enter the exhaust port.

Fig. 45 illustrates a type of pump used with a hydraulic shaper. This is another form of vane-pump construction wherein the rotor is located centrally in the pump chamber instead of off center. The radial movement of the vanes in their slots is controlled by the contour of the ring. Instead of being round, the ring opening has been elongated at points (O) to form two opposing pumping chambers.

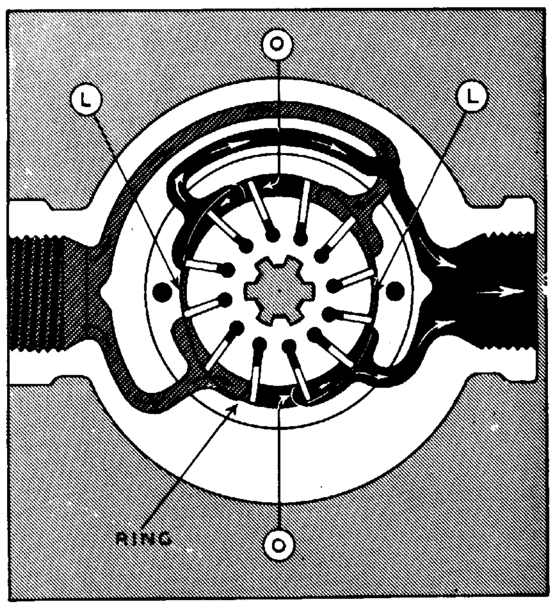
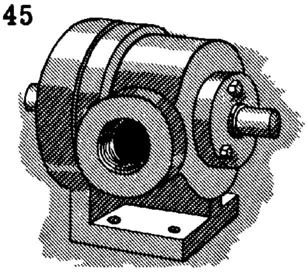


FIG. 45



The shape of the ring opening causes the vanes to function twice for each turn of the rotor. The vanes are forced into the slots at (L). Centrifugal force and pressure back of the vanes immediately move them out again and keep them in contact with the ring after they pass these points.

The intake and discharge of fluid occur through ports in side-valve plate bushings located on each side of the pump chamber. The valve openings connect with two intake and two exhaust ports, one of each being required for each pump chamber.

These pumps function well when directly connected to an electric motor. They rely on valves to control the volume of the fluid which is delivered to the ram cylinder when the entire output of the pump, calculated to meet the maximum demand, is not required. The alternate method of changing the speed of the pump as more or less fluid is required is usually impracticable.

THE PLUNGER PUMP

Functioning of the plunger pump shown in Fig. 46 is dependent upon the reciprocating (in-and-out) movement of the plungers or pistons in their cylinders. Although pumps of this type are also made in constant-delivery models, one whose output may be increased or decreased or stopped entirely while the pump is in motion, will be described. Pumps of this kind are known as variable-displacement pumps.

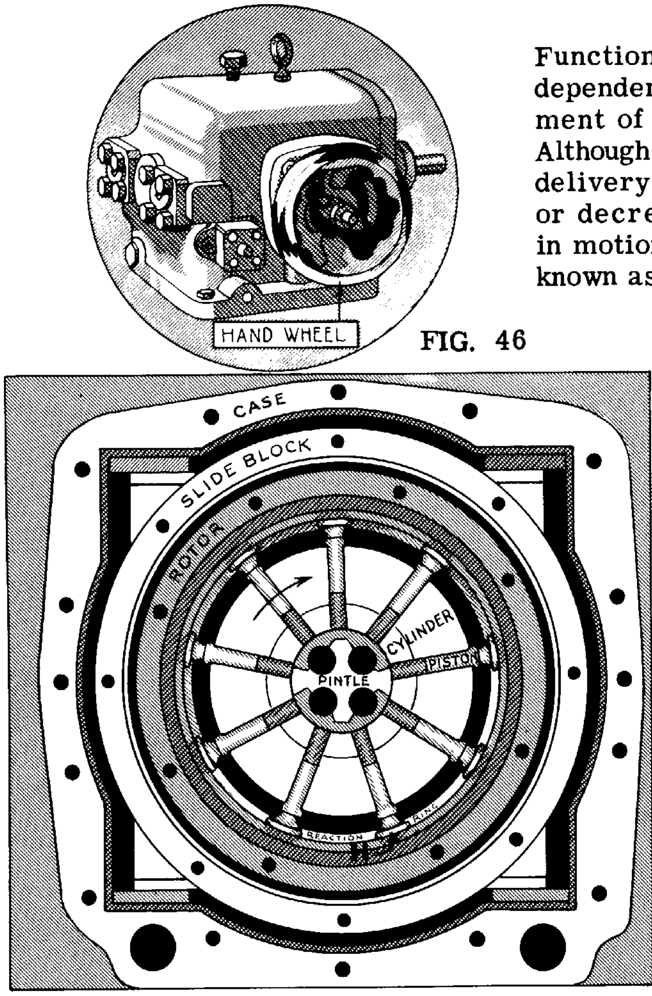


FIG. 46

Fig. 46 shows the interior of such a pump and indicates the relationship one part bears to another when the pump is in neutral, that is, when the pump, even though it is in motion, delivers no fluid. In this position all parts are centrally located around the shaft or "pintle".

From the center shaft on out, the parts include: the cylinder which revolves on the stationary pintle; the pistons which revolve with the cylinder; the reaction ring which forms an integral part of the rotor and revolves as a unit; and the slide block, which may be moved to the left or to the right within the pump casing.

With the pump in motion and the parts in the position shown in Fig. 46, the cylinder revolves about the stationary pintle and carries the pistons around with it.

As a result of the centrifugal force set up by the rapidly revolving cylinder, the pistons move out radially and are forced into continuous contact with the reaction ring. At the same time, the reaction ring and the rotor are caused to revolve also.

Inasmuch as the reaction ring comes in contact with the piston on one side of its conical head only (see Fig. 46 at H), each piston is given a slow partial rotation in its bore in one direction during one half of the revolution of the cylinder and a partial turn in the opposite direction during the other half revolution.

In addition to the movements already imparted to the pistons, rotary by the cylinder and oscillating by the reaction ring, the pistons must be given a reciprocating (in-and-out) movement in their cylinders if the pump is to deliver fluid.

In the pump illustrated, this is accomplished by moving the unit comprised of the slide block, rotor, and reaction ring from its position on center as shown in Fig. 46 to its position to the left of center as shown in Fig. 47 or, to any intermediate position between these settings. The hand wheel in Fig. 46 controls the movement of the slide block sideways.

Since the shaft or pintle is immovably located in the center of the pump casing, shifting the slide block to the left or to the right brings the reaction ring closer to the cylinder on one side and creates a proportionately larger opening on the opposite side. Then as the cylinder revolves, the pistons move out during one part of a revolution and are forced into their cylinders during the other part.

During their rotation in the lower half of the revolution, the pistons (1 to 4 in Fig. 47) move out of their cylinders progressively farther, create a suction, and draw fluid into their cylinders as they pass over the openings in the underside of the pintle. This fluid, coming from the intake, is shaded in Fig. 47. Arrows indicate the direction of its flow.

During their rotation in the upper half of the revolution, the pistons (5 to 9 in Fig. 47) are forced into their cylinders gradually by the reaction ring and discharge the fluid as they pass over openings in the upper surface of the pintle. The fluid being discharged (shown in black) is under high pressure.

The amount of fluid which a pump of this type delivers is governed by the distance the reaction ring has been moved off center. This determines the distance each piston moves in its cylinder and thus controls the amount of fluid which is admitted to each cylinder.

If the slide block and rotor unit are moved to the right in the pump case, the function of the pistons during each half revolution of the cylinder is reversed. The pistons (5 to 9) passing over the opening in the upper surface of the pintle, draw in fluid. Those (1 to 4) passing over the openings in the lower surface of the pintle, discharge fluid.

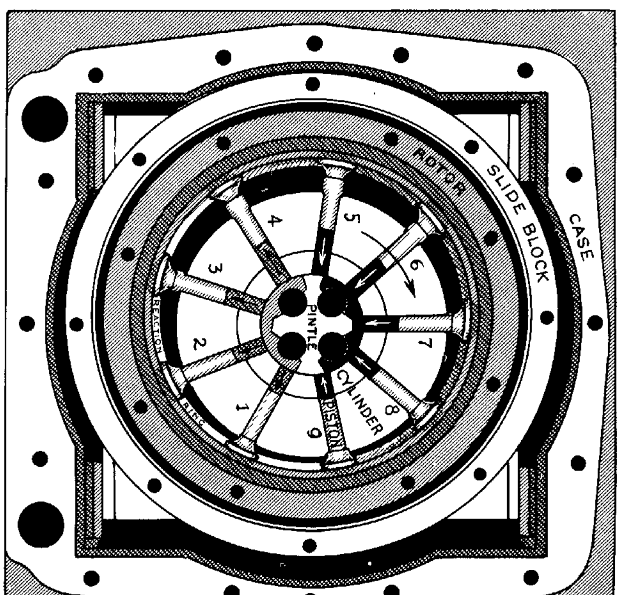
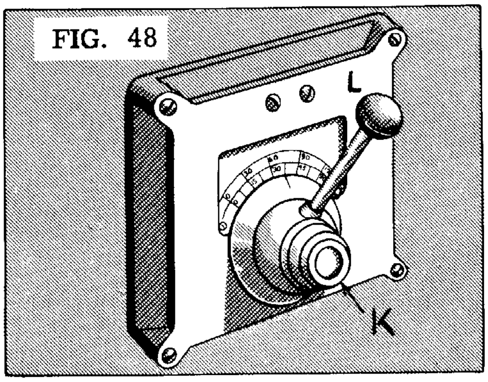


FIG. 47

DESCRIPTION OF THE VALVES

Several valves employed to control the direction of the oil and to regulate its pressure and volume after it leaves the pump are described below. The valves have previously been named and their approximate positions in a hydraulic system for a shaper have been illustrated. These valves are of the plunger or piston type.

FIG. 48



THE FLOW-CONTROL AND OVERLOAD-RELIEF VALVE

This is the first valve through which the fluid passes after it leaves the pump. It performs a dual function. First, as a relief valve, it protects the hydraulic system from overloads by limiting the maximum system pressure. For the machine shown, a working pressure of eight hundred pounds per square inch has been recommended and the valve has been adjusted to open when the pressure developed in the system reaches this figure.

Second, as an automatic flow-control valve, it automatically selects from the fluid coming from the pump that portion which will be allowed to enter the hydraulic system. The excess fluid will be by-passed and returned to the reservoir directly.

In this shaper the speed-control dial (Fig. 48) has been made a part of the volume-control valve because the speed of the machine depends upon the volume of fluid permitted to act on the piston under the ram.

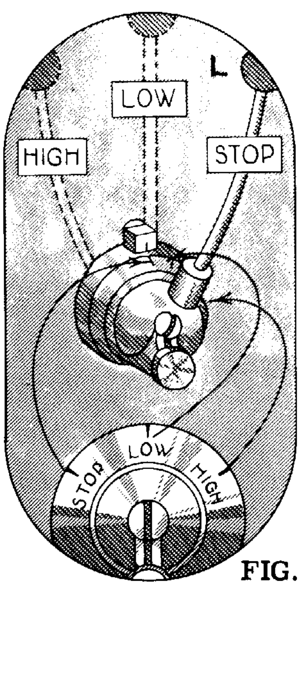


FIG. 49

Lever (L) in Figure 49 controls the volume adjustment of this valve. Its position in relation to the speed-control chart determines and indicates the cutting speed in feet per minute of the ram. Movement of the lever to the left reduces the volume of oil permitted to pass to the ram cylinder and results in a corresponding decrease in ram speed. Conversely, movement of the lever to the right increases the speed of the ram by increasing the flow of oil to its cylinder.

This valve operates to control the pressure and also to regulate the volume by by-passing and diverting excess fluid from the port it would normally enter if needed, to another port which returns it to the reservoir.

THE START-AND-STOP VALVE

The start-and-stop valve (Fig. 49) is operated by lever (L) which controls both starting and stopping of the shaper. The location of the start-and-stop valve on the shaper and the position it occupies in the hydraulic system have been illustrated on the hydraulic shaper. This valve, manipulated by lever (L) in Figure 49 exercises control over the shaper by actuating and working in conjunction with the flow-control and overload-relief valve to which it is connected with pipes.

With lever (L) in its "Stop" position, pressure on one side of the otherwise balanced control piston (within the flow-control valve) is dropped to atmospheric pressure by allowing fluid to flow back through the start-and-stop valve and on to the tank. This causes the overload-relief valve to open wide and allows the entire pump delivery to discharge back to the reservoir at low pressure. Shifting of lever (L) to an operating position stops the escape of fluid through the valve to which it is connected.

With lever (L) in one of its operating positions -- either "Low" or "High", the flow-control valve, instead of diverting fluid, directs it to the ram cylinder in amounts automatically controlled by the position of the speed-control lever on its adjacent speed-control dial.

THE DIRECTIONAL-CONTROL OR REVERSE VALVE

The directional-control valve (Fig. 50) has been placed between the flow-control valve and the ram cylinder for the purpose of changing the direction of the flow of oil from one end of the ram cylinder to the other in order for the ram to reciprocate. This valve receives fluid from the flow-control valve where its volume (as determined by the position of the speed-control lever) and its pressure have been regulated automatically.

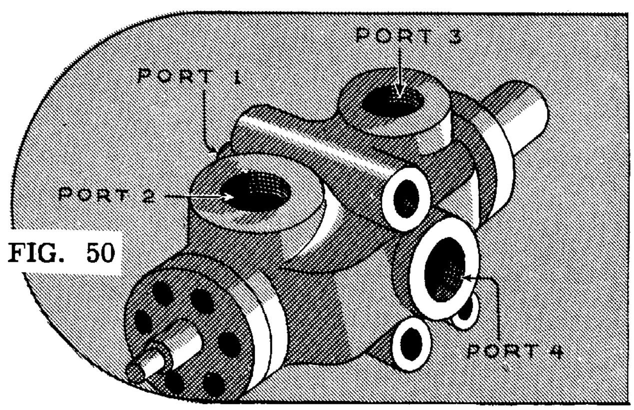


FIG. 50

This valve (Fig. 50), known as a four-way valve, has four threaded openings or ports which are connected with various members of the hydraulic system with pipes. Port 1 at the rear, used as an intake port only, admits oil from the pump. Port 4, used as an exhaust only, emits oil and returns it to the reservoir. Ports 2 and 3, connected to the left and right-hand ends of the ram cylinder, respectively, serve in both capacities. For example, when port 2 serves as an intake port and port 3 as an exhaust (Fig. 51), the ram moves to the left. When the functions of these ports become reversed, then the ram moves to the right.

In Figure 52 the piston within the valve has been moved to the left. In this position the space between its lands forms a connection between the intake (port 1) and port (2) which now becomes an exhaust port. Oil entering the valve chamber under high pressure through port (1) now leaves the valve through port (2), enters the ram cylinder from the left and causes the ram to move to the right.

Furthermore, port (3) now becomes an intake port, receiving oil forced from the right-hand end of the ram cylinder and directing it through channels (C) and (D) to exhaust port (4) to be returned to the reservoir. This indicates the course of the oil through the valve during the return stroke of the ram.

This valve, like most valves used in a hydraulic system, is of the piston or plunger type. Although different makes of valves vary in construction, all of them function in much the same manner as the one described. In the valve shown in Fig. 51 a sliding piston of circular cross section controls the passage of oil from the intake to a selected exhaust port by routing it through inter-connected channels or grooves within the valve chamber.

The piston, instead of being of one diameter throughout its entire length, has been reduced somewhat in its center section to permit a connection between adjacent ports and channels, lands (L_1) and (L_2) serving to block channels to which fluid should not be admitted. For example, in Fig. 51, the piston has been moved to the right within the valve chamber. With the piston in this position, oil under pressure enters the valve chamber through channels connected with port (1) in the rear, passes through the space between the lands of the piston, goes on to the opening leading to port (3), and then passes through pipes to the right-hand end of the ram cylinder, causing the ram to move to the left.

Meanwhile, oil draining from the left-hand end of the ram cylinder enters the valve at port (2). Because of land L_1 on the piston, oil must pass through channels (A) and (B), and then to port (4) which is connected with the reservoir. The oil follows this course during the cutting stroke of the ram.

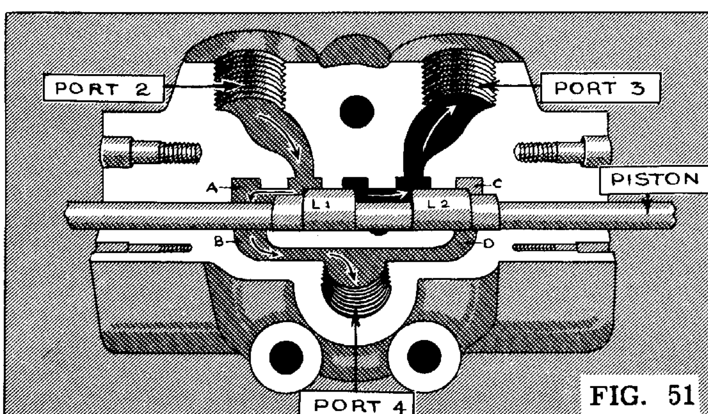


FIG. 51

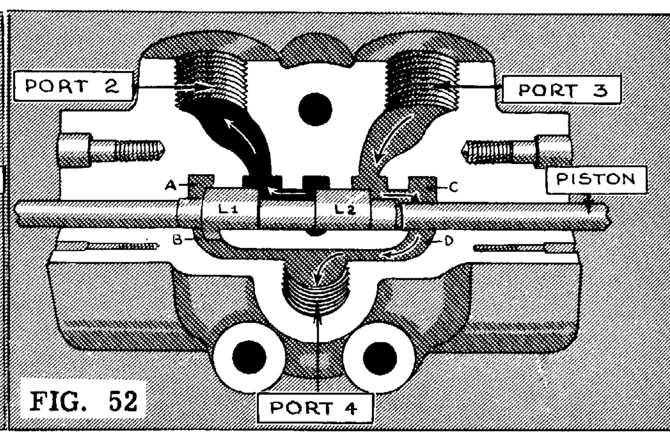


FIG. 52

THE PILOT VALVE

The pilot valve (Fig. 53) is located under the ram. It is actually a small valve used to actuate the larger reverse valve which controls the movement of the ram. Although it may be operated manually by shifting lever (L) whenever the ram travel must be reversed quickly, it is usually operated mechanically by the two trip dogs on the ram. These govern both the length of the stroke and its position relative to the work.

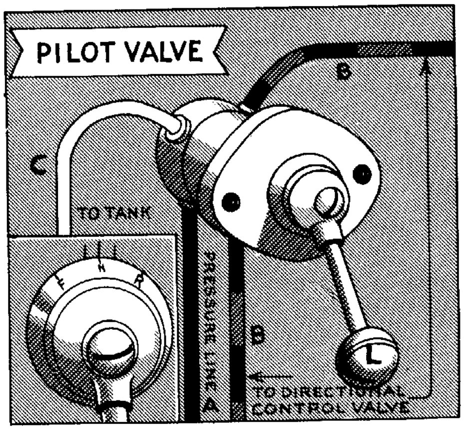


FIG. 53

As they move back and forth with the ram, the trip dogs give a partial rotation to a projection on the pilot valve at alternate ends of the ram stroke. This action releases a comparatively small amount of oil from one side or the other of the piston in the reverse-valve chamber, causing the pressure to drop automatically. As a result of the unequal pressure on one side, the piston is forced to change its position relative to the valve ports which connect with the ram cylinder.

The pilot valve (Fig. 53) exercises its control over the reverse valve by means of four small pipes which connect it with the hydraulic system. One leads to the high-pressure line (A), one each to the right and left ends (B) of the reverse valve to permit dropping the pressure on one side or the other of its piston, and one (C) to the reservoir to carry of the small amount of oil released from the reverse valve.

When the shaper is in operation, fluid whose pressure has been regulated by the setting of the relief valve and whose volume has been determined by the position of the speed-control lever, passes from the pump to the directional-control valve.

Oil under high pressure leaves the directional-control valve, enters one end of the ram cylinder and exerts its pressure on the ram piston until the pilot valve, actuated by one of the trip dogs, causes a reversal of the flow of oil through the directional-control valve and a corresponding reversal in ram movement. Oil which has spent its energy is discharged from the ram cylinder under low pressure and returned to the reservoir to be circulated again.

DESCRIPTION OF THE POWER CROSS FEED

The power cross feed moves the table intermittently in a horizontal direction at the beginning of each ram stroke. In the hydraulic shaper a piston-type valve, operated by hydraulic pressure, actuates the feed mechanism. This in turn causes the cross-feed screw to make a partial revolution for each stroke of the ram.

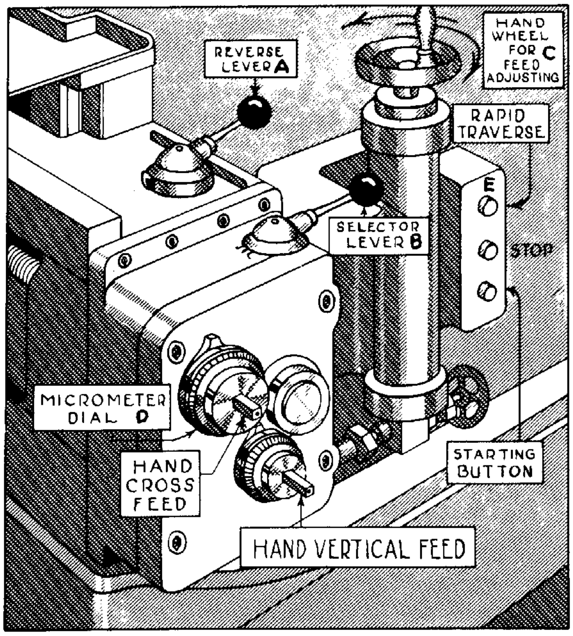


FIG. 54

Levers (A) and (B), Fig. 54, control both the automatic cross and vertical feeds. The beveled edge on lever (B), called the selector, bears the words "Cross" and "Vertical". They refer to the feed which may be selected by moving lever (B) in one direction or the other from its "Off" position.

The beveled edge of lever (A), known as the directional-control lever, bears the words "Forward" and "Reverse". These refer to the direction of the cross feed for the table. Lever (A) also bears the words "Up" and "Down". These refer to the vertical power traverse of the cross rail on the column.

The handwheel (C) is turned to obtain the amount of feed desired for each stroke of the ram. The amount of cross feed obtained may be read on the micrometer dial (D) on the cross-feed screw.

DESCRIPTION OF POWER RAPID TRAVERSE

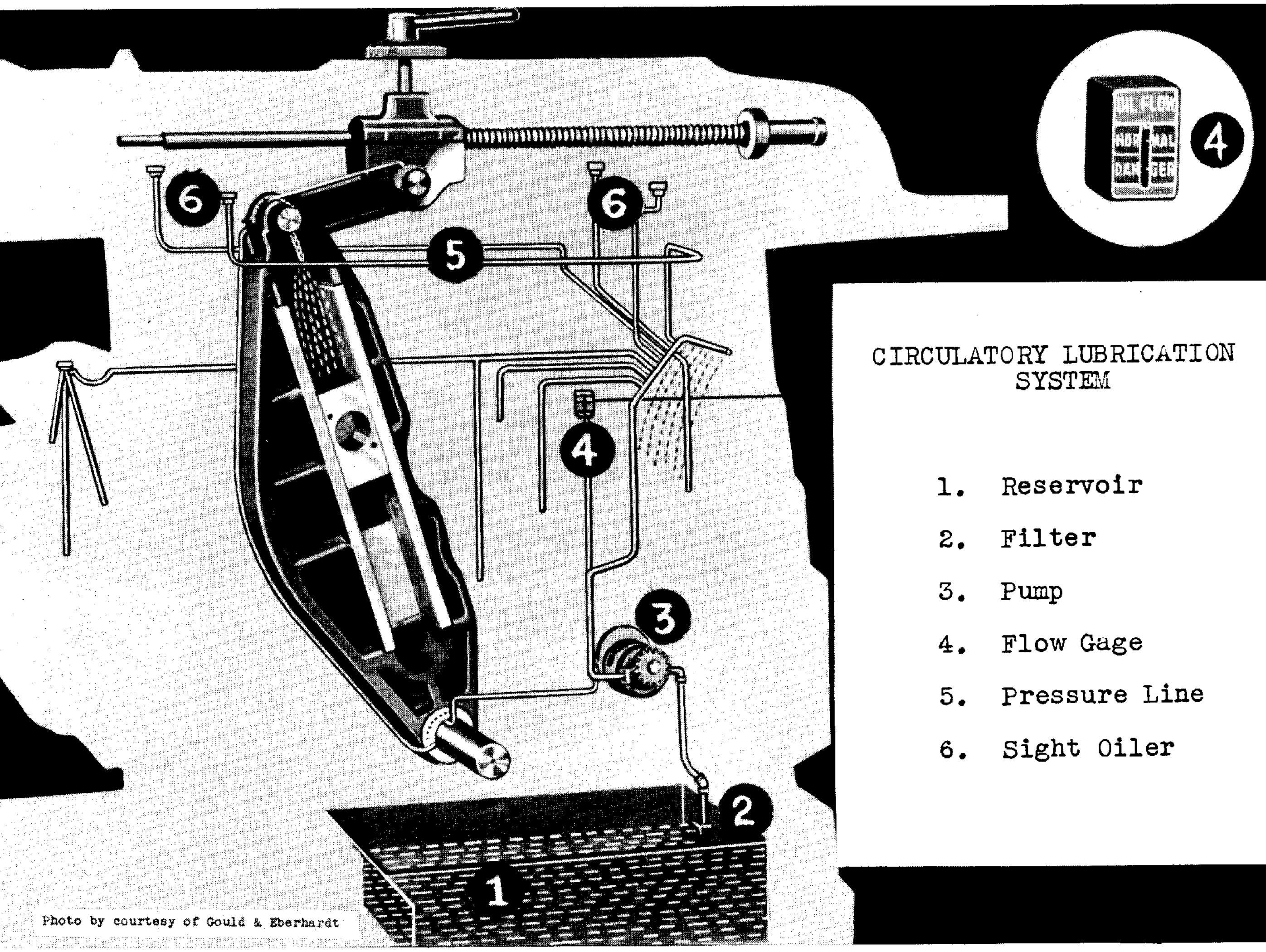
An electric motor mounted on the back of the cross rail on the operator's side of the shaper, furnishes the power for rapid traverse of the table.

The operation of the rapid traverse mechanism is much the same as the operation of the regular feed. The one important exception is that in addition to the cross power traverse, vertical power traverse is also available. In other words, the reverse lever (A) in Fig. 54 determines the direction (toward or away from the operator) of the horizontal traverse. It also determines the direction (up or down) of the vertical traverse. The position of selector lever (B) determines whether the movement of the table is to be horizontal or vertical, depending on whether the word "Cross" or "Vertical" on the hub of the lever is moved to the reference mark.

Push button (E) controls the motor for power rapid traverse. The table will continue to traverse in the direction previously set while the push button is pushed in. Traverse will stop immediately when pressure on the button is released.

When a change in the direction of the rapid traverse is desired, the traverse motor must be stopped before the reverse lever is shifted to the direction desired. This latter precaution must be carefully observed. Otherwise, the reverse clutch may be damaged.

HOW TO OIL THE SHAPER



CIRCULATORY LUBRICATION SYSTEM

1. Reservoir
2. Filter
3. Pump
4. Flow Gage
5. Pressure Line
6. Sight Oiler

Photo by courtesy of Gould & Eberhardt

UNIT P 52 (A)

Part I Pages 47 - 54

HOW TO OIL THE SHAPER

OBJECTIVES OF UNIT

1. To point out the reasons for oiling a shaper.
2. To show how and when to oil a shaper.
3. To explain how to maintain a circulating oiling system.

INTRODUCTORY INFORMATION

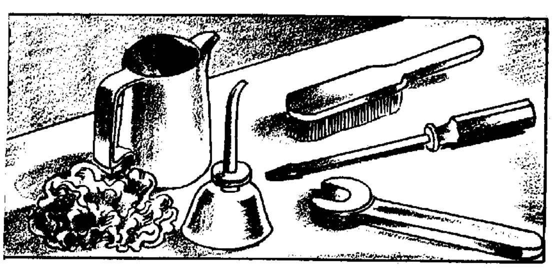
The manufacturer of machine tool equipment goes to considerable length to design and build smooth and nearly frictionless surfaces on all working parts of the shaper. The parts are fitted together with such exactness that they will function smoothly and make possible the production of accurate work when the shaper is operated in a skillful manner.

Smooth surfaces which move over one another will not remain in this condition very long if they are not separated with a film of lubricating oil. Neither will the ease of movement between surfaces be continued in the absence of lubrication. Instead the surfaces will wear rapidly and become scored, and the effort required to operate the shaper will be increased considerably.

Therefore, it is necessary to keep a film of oil constantly on both flat and round bearing surfaces. To accomplish this, various methods have been used. Some of these are entirely manual; others are partially manual and partially automatic.

Regular care and attention must be given whichever method is used. The presence of an oiler alone is no assurance that the bearing to which it leads will receive oil. It may be empty or clogged, and either of these conditions alone will result in a dry bearing.

To lubricate a machine properly, the operator must be aware that every revolving shaft has a bearing which must receive oil, and that flat surfaces moving over one another must be lubricated also. When starting work on a shaper, the operator should locate all the bearing surfaces. If the bearings are hand oiled, he must determine the location of the oil holes for these bearings and make certain that they are kept well oiled at all times. If they are automatically oiled, continuous circulation of oil must be maintained. The entire circulatory oil



system must receive regular attention to assure its functioning in an efficient manner.

Pressure and hand oiling systems are seldom used exclusively for all parts of the shaper. They are frequently supplemented by cascade oiling of the transmission gears and splash oiling of some parts within the column.

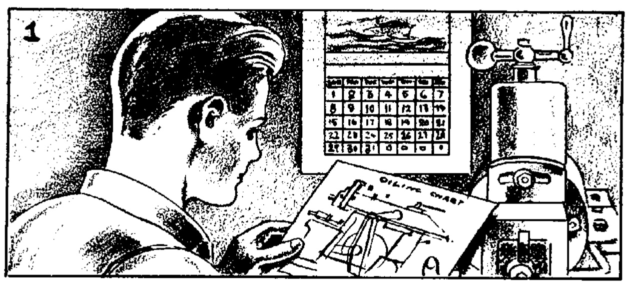
TOOLS AND EQUIPMENT

Shaper	Wiping Cloth	Brush
Oil Cans	Screw Driver	Wrenches

PROCEDURE

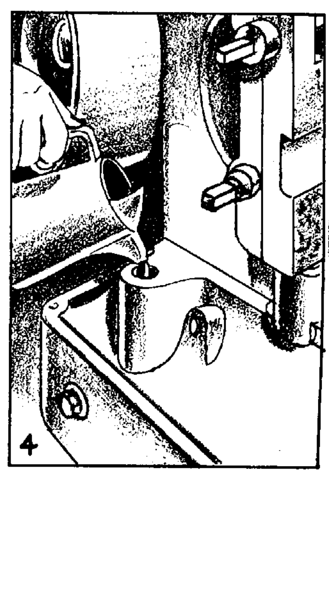
1. Follow the specific directions given on the lubrication chart supplied by the shaper manufacturer, if it is available. This will assure each bearing surface the regular application of the correct quantity and quality of lubricant.

2. Follow the directions given hereafter if a lubrication chart is not available, so that the shaper will be lubricated with equal assurance, regardless of the method (manual or automatic) used to lubricate the machine.



3. Determine oiling procedures to follow on those types of construction which have neither been included on the manufacturer's chart or in the procedures below, on the basis of information previously covered and the statements which follow.

   NOTE: Although relieved of some of his oiling duties when the shaper has an automatic oiling system, the operator's duties do not diminish. He assumes responsibilities for the maintenance of the system.



4. Give the circulatory oiling system the following routine daily checkup.

   a. Check the oil level in the reservoir by the sight gage. If a gage has not been used, check the level by removing the fill and level plug in the reservoir.

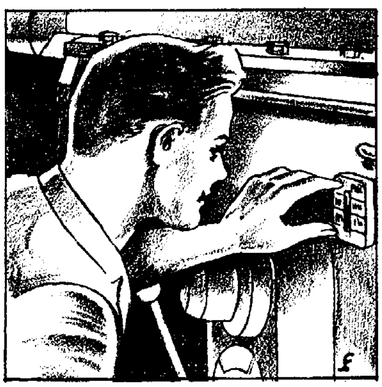
b. Clean the area around the plug before removing in order to prevent the entrance of foreign material to the reservoir.

c. Add, if needed, enough clean oil of a viscosity recommended by the manufacturer to maintain the proper oil level in the reservoir according to the line on the sight-gage glass. If the gage has been omitted from the system, fill the reservoir to the bottom of the plug.

d. Tighten the plug securely to avoid oil leakage. Immediately wipe up oil spilled on the machine to prevent its flowing onto the floor or collecting dust.

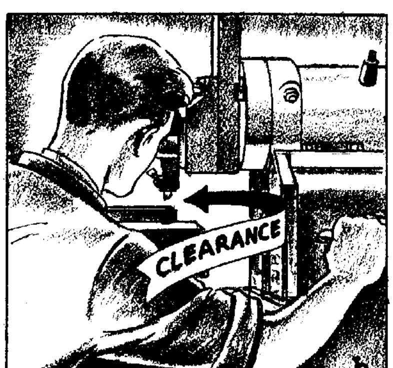
e. Check the operation of the pump and the circulation of oil by starting the main drive motor with the starting clutch disengaged.

NOTE: Because of differences in construction, it may be necessary on some shapers to engage the clutch in order to set the pump in operation. With this type construction, the speed-change lever should be in neutral so the ram will not be set in motion.



f. Allow the motor to run while checking the flow of oil through the flow gage and in every sight oiler on the machine.

g. Stop the motor if for any reason oil is not visible in the flow gage or the sight oilers, and report this condition immediately.



h. Start the machine, only after it has been set for a slow ram speed and the ram has been checked to see that the tool will clear (not strike) the work in the machine. This is done for the purpose of distributing oil uniformly over the working surfaces before beginning actual machining operations.

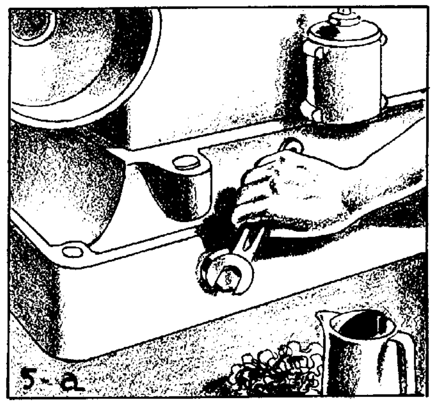
CAUTION If this is the operator's first experience with the shaper, or if he is doubtful of the speed and ram setting, he should seek assistance before setting the machine in motion.

i. Keep the faces of gages and oilers clean and in good repair. Replace those which become damaged.

5. Follow the directions given below for changing the oil in a circulatory system.

NOTE: The lubricating oil must be changed oftener than indicated below if the shaper operates in surroundings which are unusually dusty, or if the shaper is used for very severe machining operations.

a. Drain the oil from the reservoir at least twice yearly and more frequently if discoloration or thinning out makes this advisable.



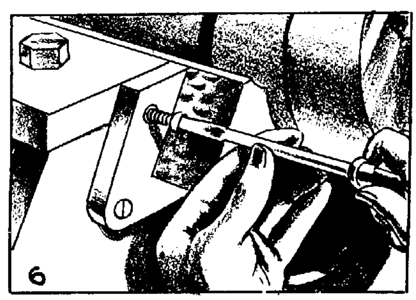
b. Examine the condition of the filter (if one has been used) and clean it if necessary.

NOTE: It is a good practice to service the filter whenever the oil in the reservoir has been changed. This may require nothing more than turning a handle to clean the filter plates. In other types it may require the replacement of a felt pad which has become loaded with foreign materials removed from the oil. Although the use of a filter may extend the interval between oil changes, it will not eliminate the need for changes altogether. Discoloration from dirt, and thinning out from extended use, still make periodic changes a requirement of good lubrication.

c. Remove all sediment which has been removed from the oil and has accumulated in the reservoir. Then, flush the reservoir with kerosene.

d. Securely close the opening used for draining the reservoir so that oil can not leak from this opening.

e. Fill the reservoir to the proper level with clean oil of the viscosity recommended by the shaper manufacturer. S.A.E. 30 refers to a medium grade of oil.



6. Examine occasionally the felt wipers used on the machine. If they have become loaded with dirt and metal particles, wash them in gasoline and allow to dry thoroughly before replacing.

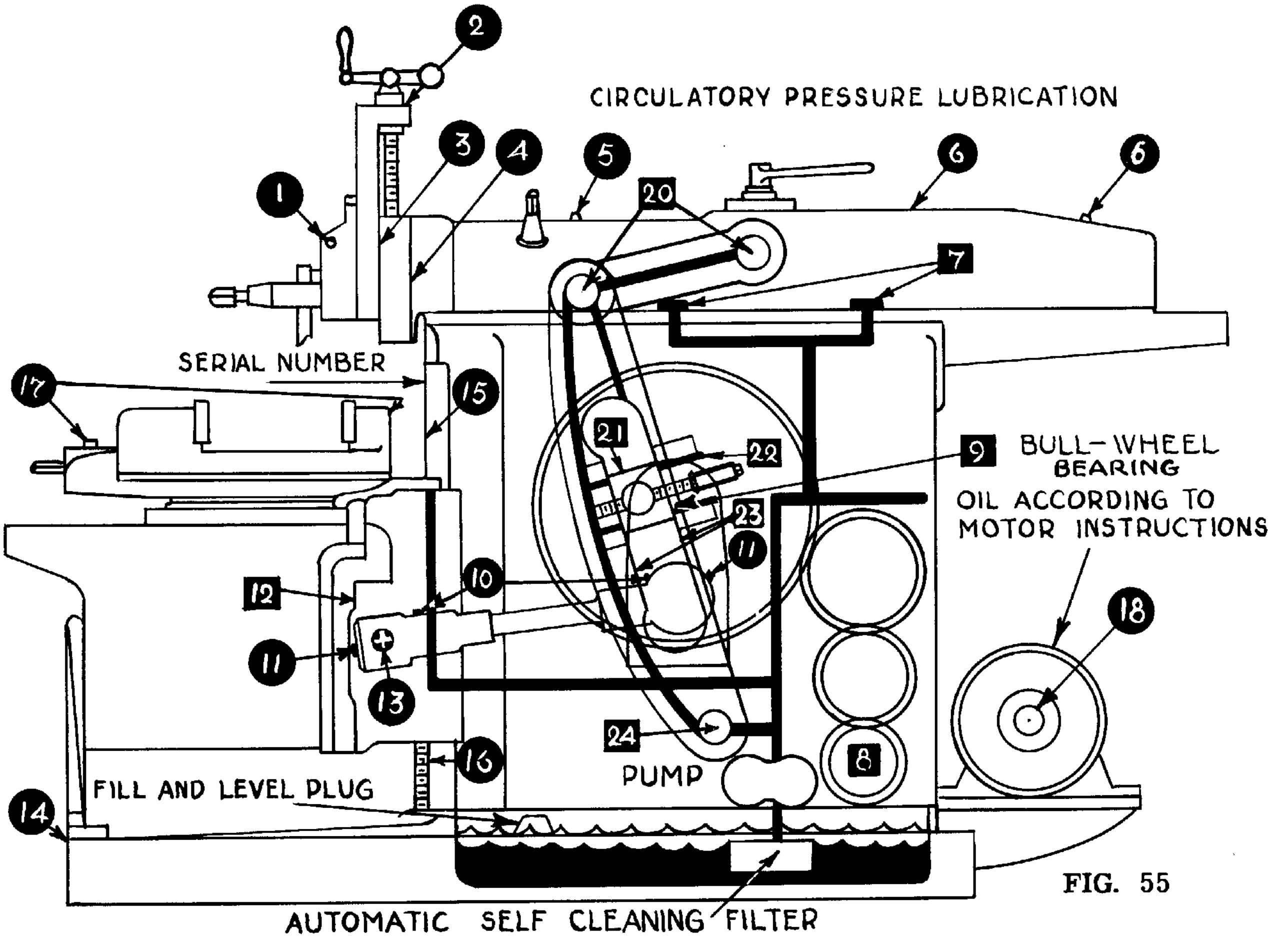


FIG. 55

NOTE: All places on a shaper which must be lubricated in one way or another have been located and numbered on the oiling chart shown above. In addition, corresponding numbers precede the directions for oiling these places. The numbers for those places which are usually oiled automatically are enclosed in a square instead of a circle.

CAUTION Do not oil any part of the shaper while it is in motion. As an extra precaution against accidents, do not have the main drive motor in operation.

1. Apply a drop or two of oil to the oil hole leading to the hinge pin and to the sides of the tool block which it supports.

2. Oil the down-feed screw and the bearing in the top of the tool slide in which it turns.

3. Raise the tool slide and wipe its dovetailed surfaces clean. Then apply a small amount of oil and distribute it evenly over the surfaces with the fingers.

4. Apply a small quantity of oil to the back face of the swivel block when it becomes necessary to change its position.

5. Lubricate the front bearing of the ram-adjusting screw.

6. Oil the ram-adjusting screw (through the slot) and its rear bearing.

7. Oil the guide ways on both sides of the ram. If felt wipers have not been provided for this purpose, first wipe the guides with a clean cloth.

8. Lubricate the main drive-shaft bearings on both sides of the column.

9. Fill the oiler for the bull-wheel bearing. Since this is a large bearing, it is frequently equipped with a sight oiler which provides metered lubrication.

10. Oil the bearings on both ends of the feed shaft.

11. Supply a small amount of soft grease to the feed reverse gears within the front end of the gear case, and to the feed mechanism in the rear case.

12. Wipe the top, front, and bottom surfaces on one end of the cross rail. Apply oil to the cross rail and distribute it with the fingers. Then turn the handcrank to move the saddle to the end just oiled and repeat the cleaning and the oiling for the other end of the cross rail.

13. Lubricate the threads on the cross-feed screw and its bearing in each end of the cross rail in which it turns.

14. Wipe chips and dirt from the surface on which the table support slides. Then apply oil to this surface.

15. Thoroughly clean the vertical bearing surfaces on the column. Then apply a small amount of oil and spread it uniformly with the fingers before raising or lowering the cross rail.

16. Clean and oil the elevating screw. If the elevating screw rotates in a bearing in the base of the machine, apply a few drops here too.

17. Apply a few drops of oil to the front and rear vise-screw bearings and to the vise screws.

18. Maintain the oil at the correct level in the wells which supply oil to the sleeve-type motor bearings, or inject a small amount of soft grease less often if the bearings are of the ball or roller type.

19. Oil the places where the gear shift and clutch levers emerge from the transmission and column. (These places are not shown in Fig. 55.)

CAUTION The following parts are within the column and may be oiled only through an opening in the left side of the column. A door or a removable hand-hole cover is usually provided for this opening. Although it is necessary to have the machine shut off during oiling, it is imperative now that not only the machine but also the motor be shut off if accidents are to be prevented. In a shaper with a circulating system, these parts would be automatically oiled.

20. Oil the pins in the links which connect the rocker arm with the nut on the ram-adjusting screw.

21. Saturate with oil the felt pad which is usually placed in the pocket of the slide block. The purpose of the felt pad is to keep the crank pin lubricated.

22. Place a few drops of oil on the parts which comprise the stroke-adjusting assembly: the screw, gears, and slide on the bull-wheel.

23. Spread oil uniformly over the slide-block bearing surfaces in the rocker-arm slot.

24. Oil the rocker-arm shaft on which the arm pivots.

CAUTION Replace the hand-hole cover for the opening to the column as soon as the oiling within has been completed.

SAFETY PRECAUTIONS FOR OILING THE SHAPER

- Do not oil the shaper when it is in operation.
- Do not fool around the machine while it is being oiled.
- Avoid leaning against the machine; it may result in accidental starting.
- Wipe all excess oil from surfaces near oiling places on the machine and wipe up any oil spilled on the floor.
- Remove oily waste to a covered receptacle to eliminate a fire hazard.
- Use an oil can with a bent spout and place it where it can cause no personal injury.

HOW TO OPERATE AND CARE FOR THE SHAPER

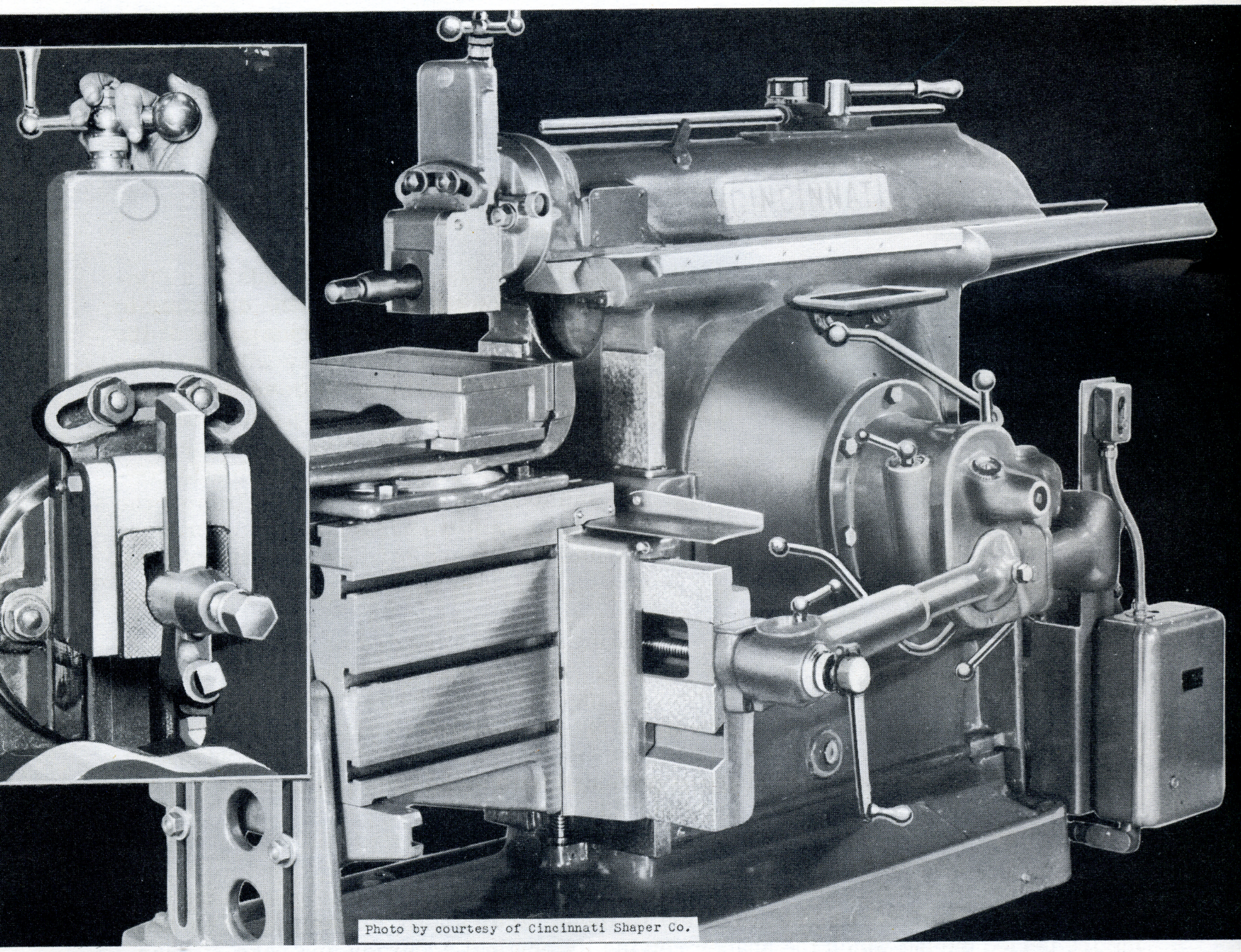


Photo by courtesy of Cincinnati Shaper Co.

UNIT P 52 (A)

Part II Pages 55 - 74

HOW TO OPERATE and CARE for the SHAPER

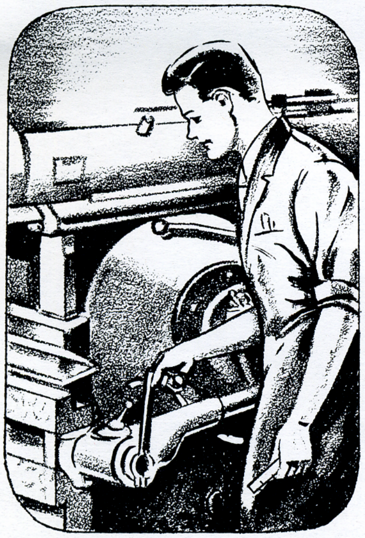
OBJECTIVES OF UNIT

1. To show how to care for the shaper and its accessories.

2. To become familiar with the operating mechanisms on the shaper.

3. To show how to use the controls on the shaper.

INTRODUCTORY INFORMATION



Skillful operation of the shaper depends to a considerable extent upon the ability of the operator to control the movements of the various parts of the machine with certainty. Familiarity with the controls plays an important part in developing this ability. For this reason and for personal and machine safety, it is important for the operator to become familiar with both the hand and the automatic controls. He must know exactly what action of the mechanism will result when each button is pressed and the various levers and handles are manipulated.

The operating units are located on the right side of the shaper. They are accessible to the operator without his moving from the usual operating position. The operating units include levers for: starting and stopping the shaper, changing the speed and the position of the ram, and controlling the direction of the feeds. On shapers provided with rapid power traverse, a lever or a push button is provided for engaging this mechanism.

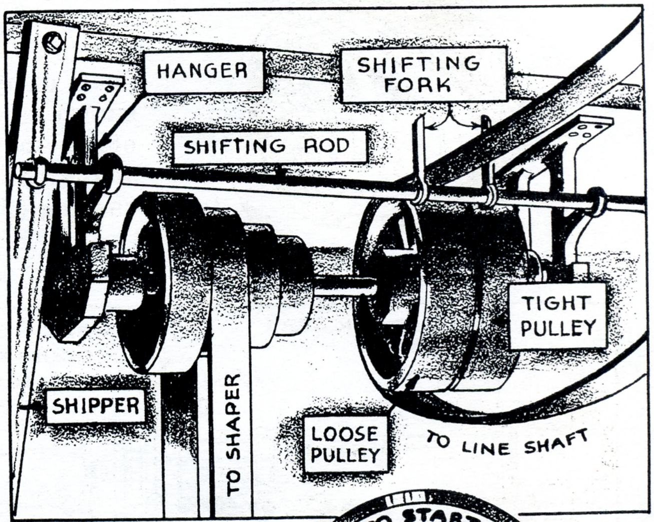
Closely associated with the skillful operation of the shaper are its proper use and care. Experience proves that attention to these factors aids materially in extending the period during which the shaper retains its original accuracy and ease of operation. Procedures which assure these results are described in this unit.

EQUIPMENT

Crank or Hydraulic Shaper

PROCEDURE

HOW TO START AND STOP THE CRANK SHAPER



Several common types of drives are used on the shaper. The particular type of drive determines the method used for starting and stopping the machine.

The cone-driven shaper, for example, usually receives its power from an overhead countershaft equipped with two identical pulleys (Fig. 56 at A). One is known as a tight pulley, since it is keyed to the countershaft and is used to drive the upper cone pulley. The other, known as a loose pulley, revolves without turning the countershaft. The loose pulley serves only to retain the belt when the shaper is not in operation.

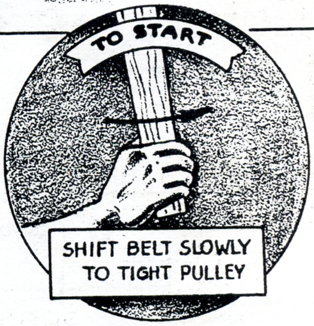


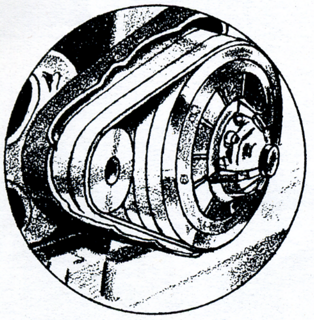
FIG. 56

To start the machine (Fig. 56 at B), the belt is shifted from the loose pulley onto the tight pulley by a fork. The movement of this fork is controlled by means of the shipper handle which extends down from the countershaft to a position within reach of the operator. The shipper handle should be moved slowly to allow the belt to shift onto the tight pulley gradually to bring the machine up to speed.

To stop the shaper (Fig. 56 at C), the belt is again shifted to the loose pulley. The width of the drive pulley on the line shaft must be equivalent to the combined width of the tight and loose pulleys. The belt utilizes one side of the face on the drive pulley when it is guided onto the loose pulley and the other side when it is guided onto the tight pulley.

Hurried starting of the shaper should be avoided, for it produces two undesirable results: (1) belt slippage and (2) the noise which invariably accompanies it. Both can be avoided by starting the shaper without undue haste.

Such deliberation in shifting is unnecessary when the machine is being stopped. At this time the belt is simply guided onto the loose pulley. In contrast, when the machine is being started, parts having considerable weight must be set in motion, and this cannot be done instantly.



Instead of a cone pulley, some shapers employ a single step pulley for driving the machine. This single pulley may be driven from a line shaft, or from a counter-shaft directly above the shaper. In an arrangement known as direct drive, the shaper is driven by a constant-speed electric motor which is usually located at the rear of the shaper on an extension of the base casting (Fig. 57 at A).

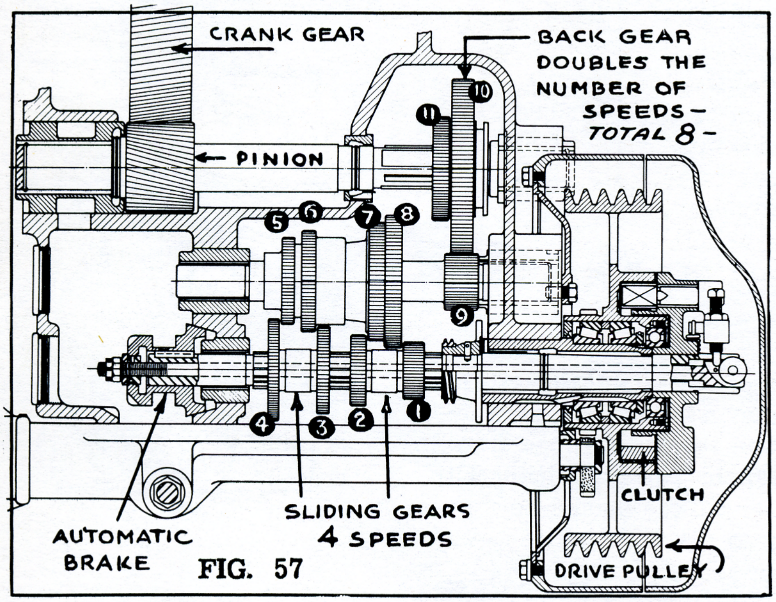


FIG. 57

Motion is transmitted by gears from the single drive pulley to the mechanism which actuates the ram (Fig. 57 at B). The number of different combinations in which these gears can be arranged within the gear box by means of an external lever, determines the number of speed changes possible for the series.

A clutch on the main drive shaft permits starting and stopping the shaper independently of the motor. This is accomplished by a short movement of a lever which extends from the clutch to a place easily accessible from the operator's usual position.

Shifting the clutch lever in one direction engages the clutch and starts the shaper. Shifting it in the opposite direction disengages the clutch and stops the ram at any part of its stroke (Refer to Fig. 57).

Most shapers using a single-pulley drive are provided with a brake. This brake is located on the main drive shaft and on the end opposite the clutch, to permit almost instantaneous stopping.

On some shapers, application of the brake is automatic. This occurs coincidentally with the disengagement of the clutch. On others, the brake is applied by a slight pull on the clutch lever after the clutch has been disengaged.

HOW TO START AND STOP THE HYDRAULIC SHAPER

A single lever is mounted on the right side of the column for controlling both the starting and stopping of the shaper. Another lever, which is interconnected with the one on the right side, permits control of the machine from the left side when this is necessary. Before either of these levers can function for starting, it is necessary to start the electric motor which operates the pump for the hydraulic system.

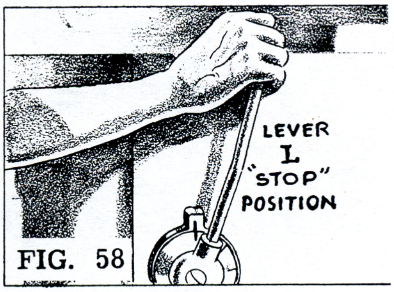


FIG. 58

In addition to "Stop" which appears at the index line when the machine is at rest, the words "Low" and "High" also appear on the hub of the starting lever. They refer to the series of low speeds and high speeds indicated on the speed-index plate which are possible when the lever is shifted to one of the positions designated on its hub.

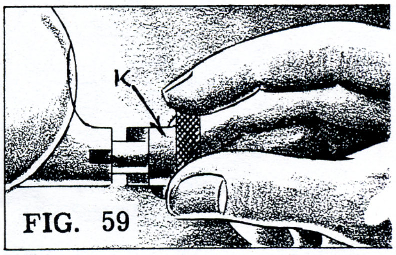


FIG. 59

Moving lever (L) to the left so that it assumes an approximately vertical position, places the word "Low" adjacent to the reference line and starts the ram moving in the low-speed range.

Movement of the lever beyond this point is limited by a spring pin which is attached to knob (K) (Fig. 59) and engaged in a slot under the hub of the lever. A light pull on knob (K) together with a turn of approximately 180°, withholds the spring pin from the slot which limits its movement. Consequently, the starting lever can now be moved farther to the left and the word "High" placed adjacent to the reference mark. This puts the ram into the high-speed range of movement. To stop the ram, this lever is shifted toward the rear of the machine to a position where "Stop" appears opposite the reference mark. To stop the electric motor which drives the hydraulic pump, it is necessary merely to push its control button.

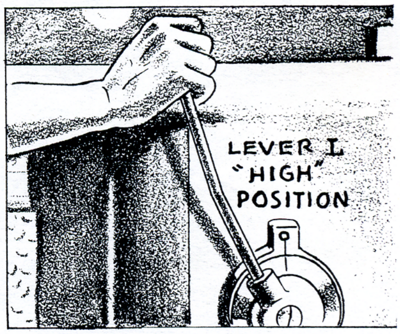
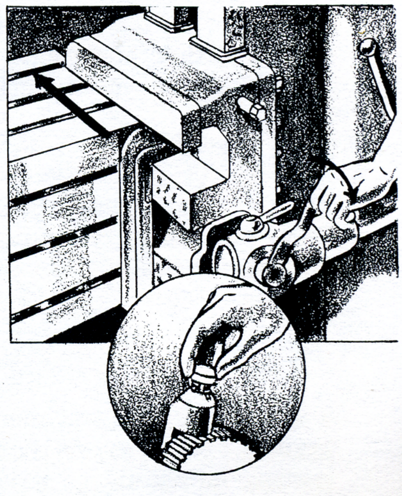


FIG. 60

HOW TO CONTROL MOVEMENT OF THE TABLE ON THE CRANK SHAPER



Crosswise movement (horizontal) of the table in either direction over the cross rail is obtained by turning the hand crank on the end of the cross-feed screw in one direction or another. Clockwise rotation of the crank handle moves the table away from the operator. Conversely, counterclockwise rotation moves the table toward the operator.

Automatic movement of the table (automatic feed) in a crosswise direction is controlled by a lever or a knob located on the cross-rail unit. The feed is engaged, disengaged, and reversed by changing the position of the knob or lever.

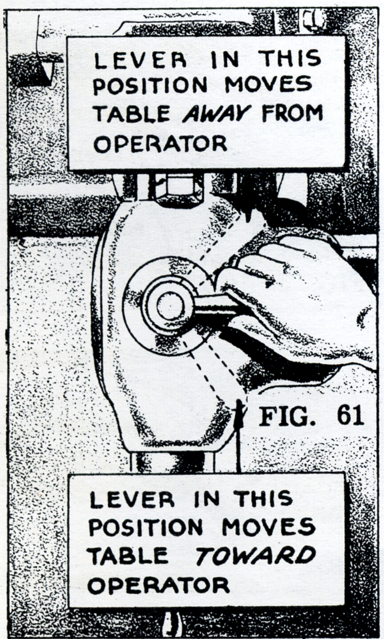


FIG. 61

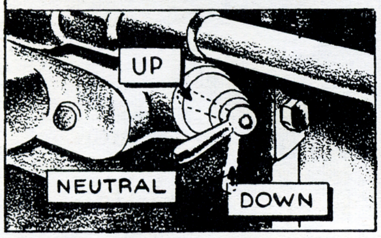


FIG. 62

On the modern shaper which uses a bevel-gear reverse mechanism, the table moves in the direction in which the feed lever has been moved (Fig. 61). Setting this lever away from the machine, feeds the table toward the operator. Setting the lever in the opposite direction, feeds the table away from the operator. The feed is disengaged by setting the lever in the midway position. The shaper is said to have directional control when the table feeds in the direction in which the feed lever has been moved.

The amount of feed per stroke (the distance the table moves over for each stroke of the ram) may be regulated on all shapers. The location of the mechanism used for regulating the amount of feed is in approximately the same position on each machine.

Vertical movement of the table (up or down on the face of the column) is secured by turning the elevating shaft in one direction or another by turning the hand crank. The elevating shaft protrudes from one side or the other of the cross rail, just below the cross-feed screw.

HOW TO CONTROL MOVEMENT OF THE TABLE ON THE HYDRAULIC SHAPER

The table on the hydraulic shaper, like the one on the crank shaper, may be fed by hand in either horizontal direction by turning the hand crank on the end of the cross-feed screw in one direction or the other.

The cross rail may also be moved by hand in either vertical direction. To raise or lower the table, place the hand crank on the elevating shaft and turn it in whichever direction will produce the desired vertical movement of the cross rail on the column.

A somewhat different method is used for engaging the automatic cross feed on the hydraulic shaper from those used for this purpose on any of the crank shapers whose feeding mechanisms have been described.

The location of the feed levers on the hydraulic shaper and their placement for engaging and disengaging the cross feed, have been illustrated. Detailed instructions for applying the feed and for regulating the amount of feed per stroke, are covered later.

HOW TO OPERATE THE RAPID POWER TRAVERSE ON THE CRANK SHAPER

The rapid power traverse mechanism is controlled by a lever on the operator's side of the shaper (when the rapid power traverse unit is built-in and forms an integral part of the feed mechanism) (Fig. 63). When the rapid traverse unit functions independently of the regular feed mechanism (Fig. 64) it is usually operated by an individual electric motor and controlled by push buttons.

On the built-in type, the same lever that engages and controls the direction of the table during feed, also controls the direction of the power rapid traverse.

On some shapers the direction of the power rapid traverse is opposite to that of the feed set. When a unit which functions in this manner is engaged, it serves as a quick return. It moves the table over rapidly after a cut has been completed, and places the work in readiness for another cut.

On other shapers, instead of functioning as a quick return, the rapid power traverse functions in the same direction when engaged as does the feed -- in the direction in which the feed lever has been moved. In both types, however, the direction is reversed by reversing the position of the feed lever.

To operate the built-in type of power rapid traverse, engage the cross feed by shifting the feed lever in the desired direction. Then pull out on the rapid traverse lever and hold it in this position while the table moves over the required distance. Release the lever to stop the rapid movement of the table. Release of the control lever automatically disconnects the rapid power traverse and reinstates the regular feed which becomes operative immediately (Fig. 63).

FIG. 63

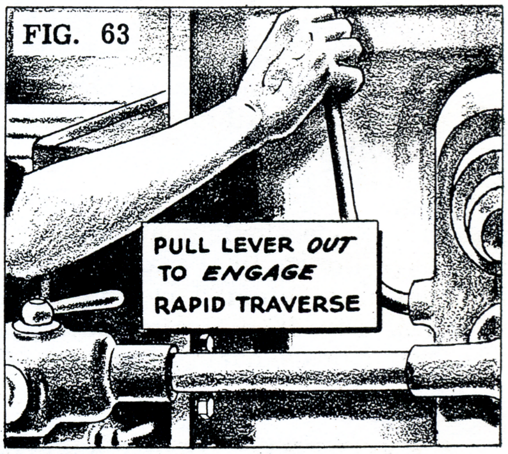
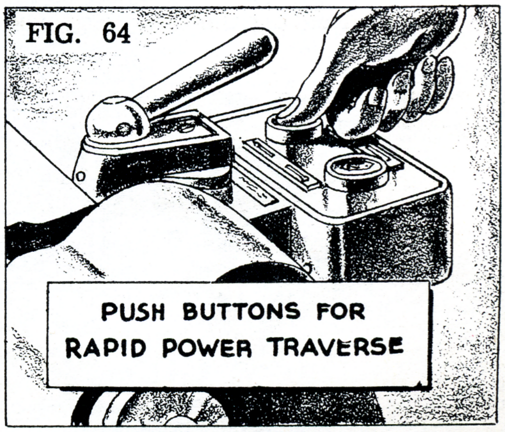


FIG. 64



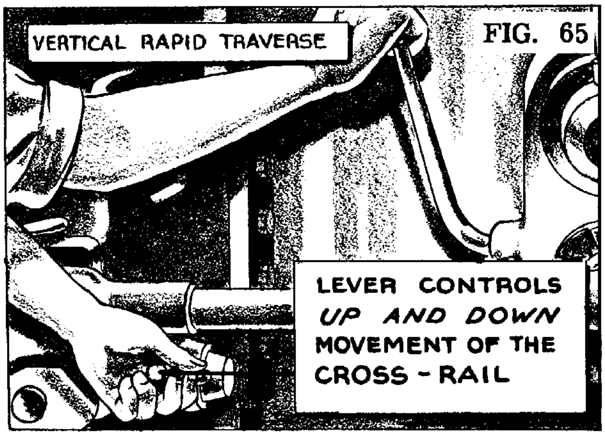


FIG. 65

A somewhat different procedure is necessary when the shaper is equipped with an independent unit for the rapid power traverse. This unit is usually connected to the left-hand end of the cross-feed screw through a worm and worm wheel. Inasmuch as the direction of rotation of the driving motor may be reversed, movement of the table on the rail may be in either direction.

The control is through a "Forward" and a "Reverse" push button conveniently located at the operating end of the cross rail. The table may be traversed in either direction by simply pushing the button for the forward or for the reverse movement. This unit may be operated while the machine is at rest.

In addition to horizontal power rapid traverse of the table, power rapid vertical traverse of the rail on the column is also available to elevate or lower the work table rapidly.

The same single control lever used for the horizontal traverse is also used to engage the vertical traverse. The direction of the vertical traverse, whether up or down, is selected and indicated by another directional control lever located at the rail (Fig. 65). A safety device is usually incorporated in the feed mechanism to prevent damage during operation of the rapid traverse.

CAUTION Before using power rapid vertical traverse on either the crank or the hydraulic shaper, be sure all clamps and nuts are loosened. After adjusting the table and work for height, tighten the table and rail support.

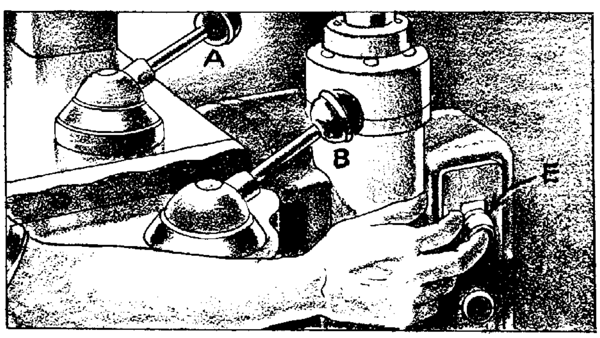


FIG. 66

HOW TO OPERATE RAPID POWER TRAVERSE ON THE HYDRAULIC SHAPER

Rapid power traverse on the hydraulic shaper is not actuated by pressure of the fluid in the hydraulic system. Instead, it is driven by an electric motor mounted on the back of the cross rail on the operator's side of the shaper. The motor, and consequently the rapid traverse, operates under the control of push button (E).

Except for the additional requirement -- that of depressing button (E) -- operation of rapid traversing in a horizontal direction is the same as the operation of the regular cross feed which will be explained later in more detail.

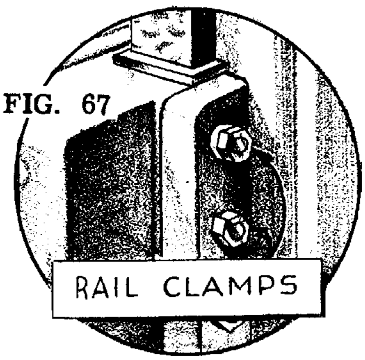
In addition to the cross power traverse, vertical power traverse is also available on this shaper for raising and lowering the table. The operation of vertical traverse is also controlled by push button (E). However, its operation in this direction requires a change in the position of the selector lever (B). In addition, it may require a change in the position of the directional control lever (A).

For vertical traverse, the selector lever (B) is moved in a counterclockwise direction. Its movement in this direction brings the word "Vertical" on its hub to the reference line, and indicates that subsequent movement of the table will be either up or down.

The directional control lever (A) is then moved in one direction or the other from its "Off" position. The word "Up" on its hub should register with the reference mark if the table is to be raised. The word "Down" should register opposite the register mark if the table is to be lowered.

CAUTION Before depressing the push button which controls the operation of the rapid vertical traverse, make certain that the clamps for holding the rail to the column, and also the clamps or bolts which hold the table support to the table, have been loosened (Fig. 67).

FIG. 67



After the rail has been raised or lowered as desired, the rail and table support in position.

HOW TO CONTROL MOVEMENT OF THE RAM ON THE CRANK SHAPER

As is the case with all other controls indicated so far, those which have to do with the length of the ram stroke, placement of the stroke with relation to the cut, and speed of the ram, are also located on the right side of the shaper. This location makes them readily accessible from the operator's usual position.

For example, the stroke may be increased or decreased by placing a hand crank on the stroke-adjusting shaft (Fig. 68) and by turning it in one direction or the other, as required. A stroke-indicator dial, or a scale adjacent to the ram, indicates when this setting has been made correctly.

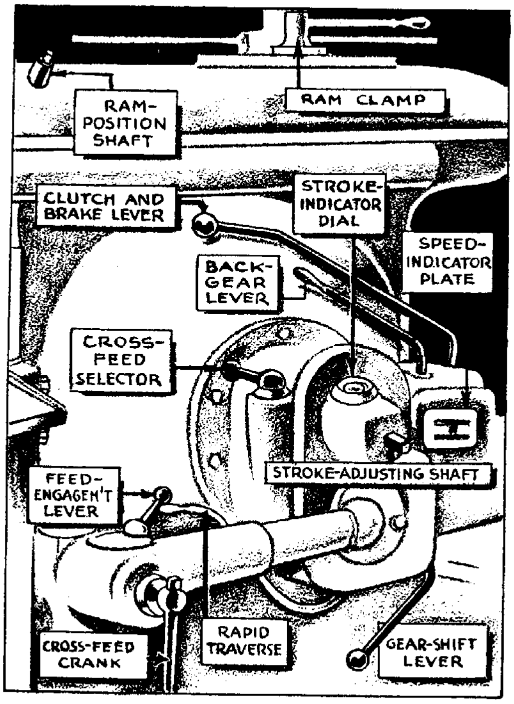
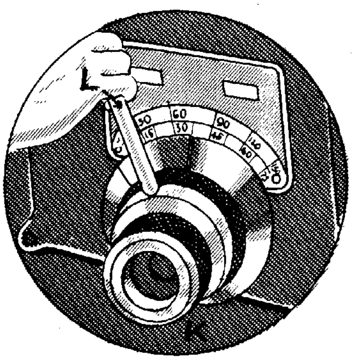


FIG. 68

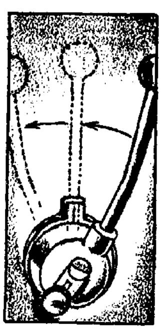
After first loosening the ram clamp, the stroke may be located over the cut by turning the ram-positioning shaft with a hand crank. The direction in which the shaft must be turned will be determined by the direction in which the ram must be moved, whether forward or backward from its present position.

Any of the eight ram speeds indicated as strokes per minute on the speed-indicator plate are made available by locating the gear-shift lever and the back-gear lever in their designated positions. Four of these speeds are obtained by moving the gear-shift lever when the back-gear lever occupies one of its positions. Four different speeds are obtained by moving the back-gear lever to its alternate position.



HOW TO CONTROL MOVEMENT OF THE RAM ON THE HYDRAULIC SHAPER

The controls provided on the hydraulic shaper for regulating the speed of the ram, the length of the ram stroke, and the position of the stroke with relation to the cut, differ considerably from the controls provided for regulating similar ram movements on the crank shaper.



Instead of being specified as strokes per minute, the speed of the ram on the hydraulic shaper is indicated as the cutting speed in feet per minute on the speed-index plate attached to the flow-control valve. Also, in contrast with the crank shaper whose cutting speed increases or decreases whenever the stroke is made longer or shorter, the cutting speed of the hydraulic shaper is not affected by changes in the length of the stroke. Therefore, once the cutting speed has been determined in feet per minute, this speed may be set without computing by simply loosening knob (K) and then moving lever (L) to any number on the speed plate, or to any intermediate position.

Furthermore, either the "High" or the "Low" series of speeds on the speed plate may be selected by shifting the starting lever to the position which brings either the word "High" or "Low" on its hub line with its reference mark. Thus, instead of the usual eight speeds provided on a crank shaper, an infinite number of speeds within the limits prescribed on the speed plate become available on the hydraulic shaper.

FIG. 69

Both the length of the stroke and its correct placement over the work are controlled by the two knobs located over the slot in the ram (Fig. 69). These knobs are actually clamping nuts screwed onto the upper ends of threaded studs which extend downward and terminate in flat rectangular members under the ram slot.

These rectangular members are, in effect, trip dogs placed at opposite ends of the ram stroke and clamped in the desired position by means of the knurled knobs (Fig. 69). The trip dogs alternately engage with fingers located one above the other on the upper end of a vertical shaft connected with the pilot valve. Each time one of the rectangular members (trip dogs) engages a finger, the shaft attached to the finger makes a partial rotation and actuates the pilot valve, causing it to reverse the direction of the ram movement.

Since the knobs and the rectangular members,to which they are connected by means of studs, can be moved in the ram slot, they may be spaced and located to suit any job whose length is within the capacity of the shaper.

HOW TO CONTROL MOVEMENT OF THE TOOL SLIDE

Movement of the tool slide, together with the cutting tool, is controlled by the handle attached to the down-feed screw located within the slide. The slide is lowered by rotating the handle in a clockwise direction, and raised by turning it in the opposite direction (Fig. 70).

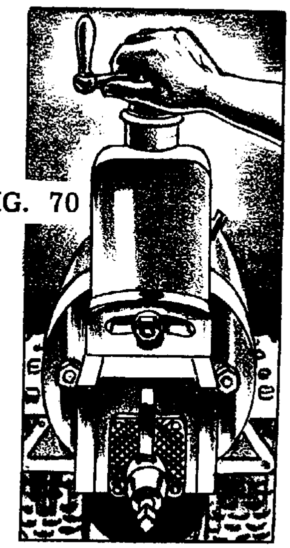


FIG. 70

The extent of its vertical and angular movement -- about 7'' on a 16-inch shaper -- is limited by the length of the slide and down-feed screw. For convenience in making accurate adjustments of the slide and the tool, the feed screw has been fitted with a micrometer collar graduated in thousandths of an inch.

A graduated column, similar in function, is provided on the cross-feed screw and sometimes on the elevating shaft as well. Together they provide micrometer adjustment of both the tool and the work. When the dial is clamped in place, it becomes an integral part

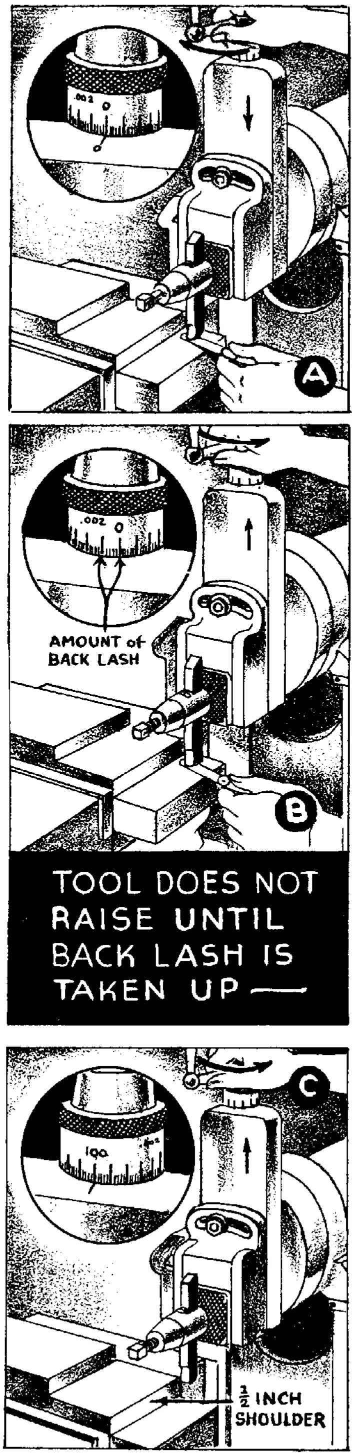


FIG. 71

of the screw on which it is mounted and accurately measures movement of both the screw and the part of the machine which it is intended to move.

The number of graduations on the collar is directly related to the lead of the screw (the distance a screw advances in one revolution). For example, if the down-feed screw has five threads per inch, one revolution of the screw advances the tool slide 1/5 of an inch or .200''. If the circumference of the graduated collar is divided into two hundred equal spaces, then the distance between lines on the collar represents 1/200 of a revolution (.200'') or one one-thousandth of an inch (.001'').

HOW TO TAKE UP "BACK LASH"

Whenever a graduated dial is used on the shaper for making accurate adjustments of the tool or the work, all "back lash" or "lost motion" must be taken out of the screw before the dial is set to a definite position. Back lash in a screw refers to the lost motion between the threads of the screw and the threads in the nut through which the screw turns. Back lash is present in a small degree even in new machines, and to a greater extent in older machines because of increased wear.

Before using the micrometer dial for setting the tool for a certain cut, back lash must be taken out of the down-feed screw. One way to make certain that all back lash has been taken out is to first give the handle about a half turn in a direction opposite the proposed adjustment before setting the tool to the surface from which the depth of cut is to be measured with the graduated collar or dial. (Refer to Fig. 71 at (A).)

For subsequent cuts in the same direction, back lash will be of no further consequence. However, when the movement of the tool is reversed from a downward direction to an upward direction, the back lash must be taken up again before the tool will move up when the screw is turned. (Refer to Fig. 71 at (B).)

The amount of back lash in the screw can be measured, when its direction is reversed. At this time the screw makes a partial turn before the tool slide is moved in the opposite direction by the screw. This partial turn may be measured by noting the readings on the graduated collar before reversing the screw, and again at the instant the tool slide moves in its reversed direction.

HOW TO CARE FOR THE SHAPER AND ITS ACCESSORIES

Care of the shaper and its accessories requires the performance of certain tasks before the machine is set in motion and others of equal importance after the job has been completed.

In addition, care of the shaper and its accessories requires the observance of specific precautions during the setting up of the job and the tool. Finally, the operator must adhere to accepted procedures during performance of the job, and avoid other practices which may result in damage to the machine and involve the safety of the operator and fellow workers.

A tradesman's standing among his fellow workers and their appraisal of his ability are determined, to a large extent, by the care and judgment used on the machines and tools with which he works.

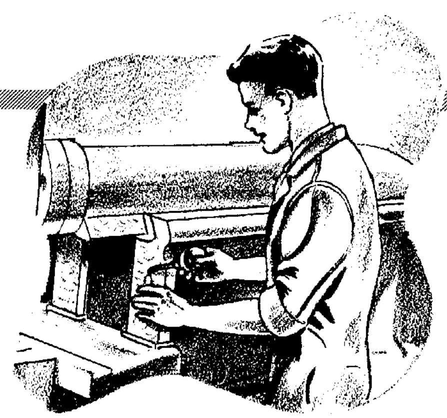
An efficient worker operates machines with care. He also handles tools in a manner which will continue their usefulness over a long period, and he returns them to their proper places when the job is completed. He knows accuracy is impossible with tools damaged by rough usage and haphazard piling about the machine.

He disposes of chips before they become a hindrance to his work, and he judiciously lubricates his machine in a routine manner at such regular intervals as dictated by the speed of the machine and the type of work performed.

He assumes that other workmen, like himself, prefer to start a job with a clean machine and, therefore, he makes certain that it is clean and in good working order when he leaves it.

Every setup of the job and the machine includes the numbered steps below. Procedures recognized by skilled tradesmen as being helpful in turning out good work and in reducing machine wear and damage to a minimum, are recommended under each step.

1 LUBRICATING THE SHAPER



a. Read the Description of the Oiling System previously covered. This description begins on page 29.

b. Follow the instructions given in the section How to Oil the Shaper (starting with page 47) which apply to the type shaper in use.

2 MOUNTING THE WORK-HOLDING DEVICE

a. Remove all burrs, chips, and dirt from the surface of the machine table in order to provide a flat, clean surface on which to place the work-holding device.

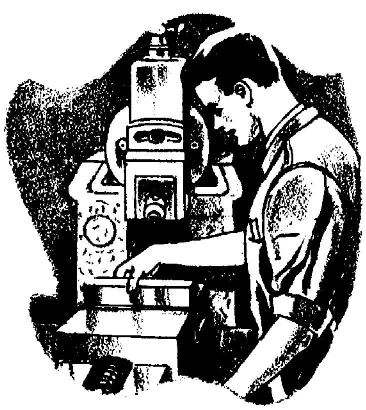
b. Clean the bottom of the vise or other work-holding device thoroughly before it is placed on the machine table. This precaution will prevent pitting and scarring of the table and the bottom of the vise caused by chips between these surfaces.

c. Ask for help in lifting heavy machine vises or fixtures whenever it is necessary to place them in position, or to remove them. Dropping these accessories may damage both the machine and the holding device. More important, dropping may cause personal injury.

Place a washer under each nut used for clamping a vise, a fixture, or the work itself, to the machine table. Make certain that the nut has not been drawn down to the end of the threaded portion on the bolt. If this occurs, the part which it is intended to clamp will still be free to move, although the force applied to the nut would tend to indicate that the part has been clamped securely to the table.

3 MOUNTING THE WORK

a. Clamp all work in the shaper securely, using whichever method is most appropriate for holding the job on hand. It is dangerous to have the work move even a small amount during the cut. Work which is forced out of the holding device by pressure of the cutting tool is almost certain to damage the shaper before the machine can be brought to a standstill.



b. Place a cardboard between the vise jaws and a rough casting. This same protection should be given the table and a casting if it is clamped to the table instead of in a vise or in a fixture. Cardboard will protect these machine surfaces from the irregularities which are usually present on unmachined castings.

CAUTION Refrain from hammering the handle of the shaper vise to secure the work in the vise. The handle is usually long enough to apply enough pressure to hold the work without the aid of a hammer. Hammering may set up burrs which will injure the operator's hands.

c. Place all the work held in a vise as far down in the jaws as practicable without having the tool cut into the vise jaws. If a job is to be clamped to the machine table, keep it as low as possible. This procedure makes the setup rigid and reduces the vibration to a minimum during the cut.

d. Use the shortest bolts possible for clamping work so as to avoid interference between the ram and the bolts. This applies especially to the bolts nearest to the ram.

e. Avoid marring the machine table by using only wood or burr-free metal blocking for supporting the outer ends of the clamps used to hold work to the table.

f. Use parallels (and store them also) in a manner which will prevent their dropping on hard material for this will raise a burr. Their use in this condition will result in inaccurate work. When a parallel becomes burred despite all precautions that were taken to prevent this condition, remove the burr with a flat smooth file if the parallel is soft. If the parallel has been hardened, use an oil stone for this purpose.

4 MOUNTING THE TOOL

a. Clamp the tool holder in the tool post with as little overhang as practicable. This eliminates unnecessary strain which would be placed on the tool head if a cut were made with the tool holder extending below the tool block farther than required.

b. Place the tool holder in a vertical position so that if it is forced over by the pressure of the cut, the tool will swing in an arc away from the work instead of into the work as would be the case if the tool holder were set toward the cut.

c. Clamp the tool holder securely in the tool post to prevent its working loose during the cut.

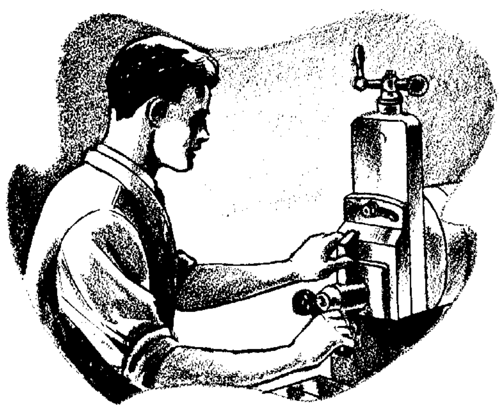
d. Use only sharp cutting tools. Dull cutting tools require considerably more power to remove a given amount of metal than do sharp tools. Furthermore, a dull tool creates much more heat than does a sharp tool, and produces an inferior finish on the work.

e. Clamp the cutting tool securely in its holder and as short as practicable. These two practices ('d' and 'e') will prevent tool breakage and its attendant hazards to the operator and the machine. Clamping the tool as suggested conforms to the practice of keeping the setup rigid.

f. Make certain that the clapper block is functioning correctly: (1) that it lifts slightly on the return stroke of the ram; and (2) it assumes its position against the back of the clapper box immediately under pressure of the cut.

g. Adjust the tool holder and the tool only when the machine is at a standstill. These adjustments become extremely hazardous if made when the shaper is in motion.

5 ADJUSTING THE WORK AND THE TOOL



a. Before turning a handcrank, shifting a lever, or pushing a control button, determine definitely just what shaper action will result. Manipulating any part of the shaper without knowing what motion will occur, in what direction and how fast, may result in serious personal injury and damage to the machine.

b. Thoroughly clean, and then oil, the flat bearing surfaces on the cross rail used to guide the table horizontally. Give the same care to the bearing surfaces on the front of the column, used to guide the table vertically. This care should be given these surfaces each time the table is moved.

c. Remove all tools and accessories from the base of the machine to avoid jamming when the cross rail is lowered. Tools placed on other parts of the shaper and no longer needed for the job should also be removed. This is especially important as these tools might become dislodged through vibration and thus interfere with the movement of the parts being fed automatically. Considerable damage to the feed mechanism usually results if movement of a part is forcibly stopped while the shaper is in operation and the automatic feed is still engaged.

d. Previous to making adjustments of such parts as the cross rail, loosen the clamps which lock these parts rigidly in place during the cut. It is equally important that these clamps be tightened after the adjustment has been made and that all other parts not used to feed the work or the tool be clamped securely.

e. To assure a more rigid machine setup, adjust the table vertically so that the space between the work and the bottom of the ram is no greater than the safety of the operator requires. A space of approximately two inches is considered sufficient for this purpose.

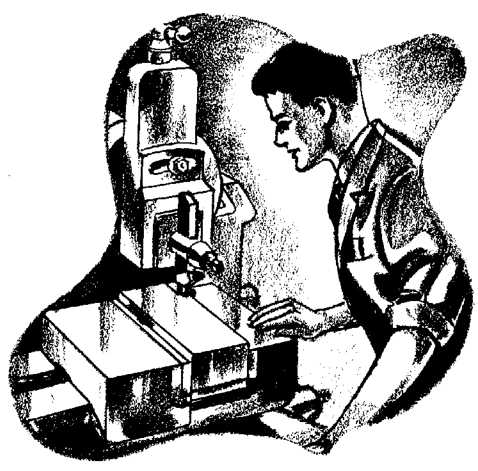
Whenever the distance between the ram and the work is increased appreciably, the tool slide must be extended beyond the tool head a correspondingly greater distance. In this extended position the tool slide is not well supported, and, as a result of this lack of support, is likely to be broken if the tool should get caught in the cut or if the slide should strike the column at the end of the return stroke.

f. Avoid gear clashing when the speed is being set. Make all speed changes with the clutch disengaged.

g. Whenever the construction of the shaper permits, pull the belt or turn the hand wheel to give the ram one complete stroke by hand, before turning on the power. Since this is impossible on many shapers equipped with individual motor drive, the clutch should be engaged cautiously while the ram makes a complete stroke. This procedure is recommended to permit detection of any interference between the ram and the work.

h. Before engaging the rapid power traverse, make certain there will be no interference between the tool and the work. Also, in order to avoid jamming these parts, ascertain whether or not the table can be fed over the required distance before reaching the limit of its travel on the cross rail.

6 TAKING THE CUT



a. Set a cutting speed which is commensurate with the length of stroke and at the same time takes into consideration the material being cut and the cutting material in the tool.

b. Set the tool so that it clears (passes over without cutting) the highest part of the job before engaging the clutch. After the machine has been set in motion, feed the tool down toward the work carefully.

c. Lock the tool slide in place after the depth of cut has been established so as to keep it from moving during the cut.

d. Before engaging the automatic feed, determine the rate of feed for which the machine has been adjusted.

e. Whenever the automatic feed operates at the beginning of the cutting stroke, instead of preferably during the return stroke, adjust the length and the position of the stroke so that the tool will run beyond the back end of the work a somewhat greater distance than usual. This will allow the feeding of the table to be completed before the tool engages the cut. The feed mechanism should not be forced to feed the work after the tool begins to cut, for it was not designed to withstand the heavy pressure required to force the tool into the metal.

f. Feed the work to the tool slowly by hand. Then, when the cut is of the desired depth, engage the automatic feed.

g. Remain at the machine while the cut is in progress in order to maintain control at all times.

h. Brush chips from the work in a direction which will prevent their entering the working parts of the shaper.

i. After completing angular shaping, set the tool head back to the vertical position and tighten it in place. This is a precautionary measure recommended to prevent the tool head from striking the column during the return stroke. This hazardous condition develops when the stroke is lengthened and the head is left in the angular position.

7 DISASSEMBLING THE SETUP

a. Clean the work-holding device of all chips and oil.

b. Remove any special holding device or fixture from the machine and return it to its proper storage space.

NOTE: The vise is usually left on the machine table and bolted securely in place. Leaving the vise in place with the bolts loose may result in serious injury, for the vise is sure to move when work is secured.

c. Return all tool holders not usually used on the shaper to the tool crib, or storage cabinet if one is provided.

d. Brush all chips from the machine. Then wipe machine with waste or cleaning cloths.

e. Return all straps and bolts to their proper places in a clean condition. Assemble the bolts, nuts and washers.

f. Carefully return parallels to their storage space to avoid burring.

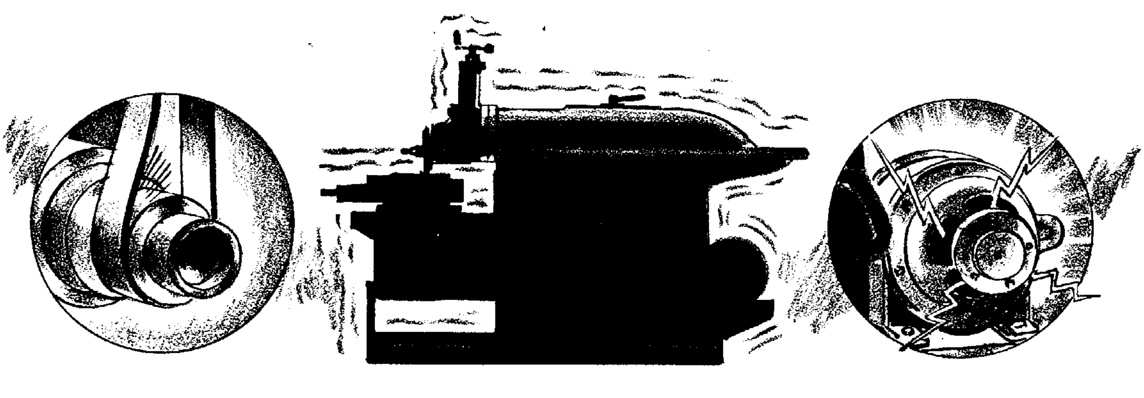
8 MAINTAINING THE SHAPER IN A GOOD OPERATING CONDITION

Under this heading have been listed some of the measures which should be observed for the correct functioning of the shaper and its driving mechanism. Because of daily working on the shaper, the operator should detect immediately conditions about the machine which contribute to inefficient operation and to inaccurate performance. Since the operator's regular duties may not include correction of these faulty conditions, it is his duty to report them to the individual responsible for maintaining the machine in proper adjustment and in good repair. The following are some of the procedures that should be used.

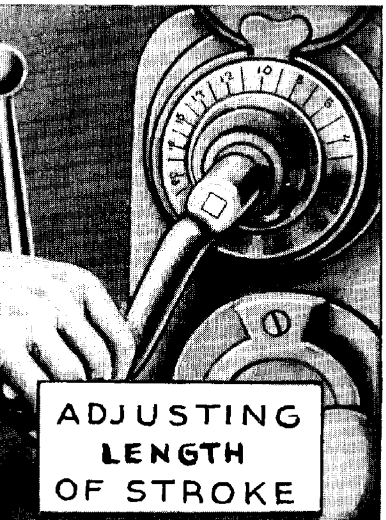
a. Adjust the tension on the belt when necessary in order to prevent excessive slippage on the pulley and to assure maximum power when it is needed.

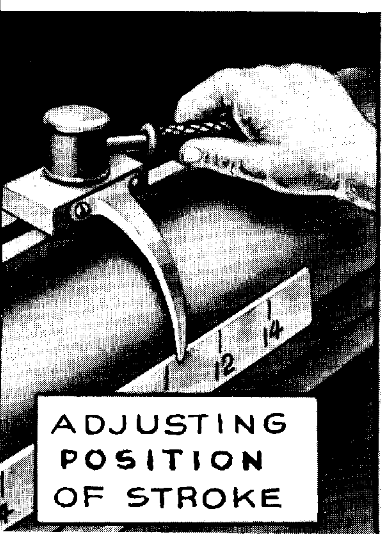
b. Make adjustments on the machine to compensate for wear and permit production of accurate work.

c. Give timely service to electric motors and their controls in order to forestall their breakdown.



HOW TO ADJUST THE SHAPER





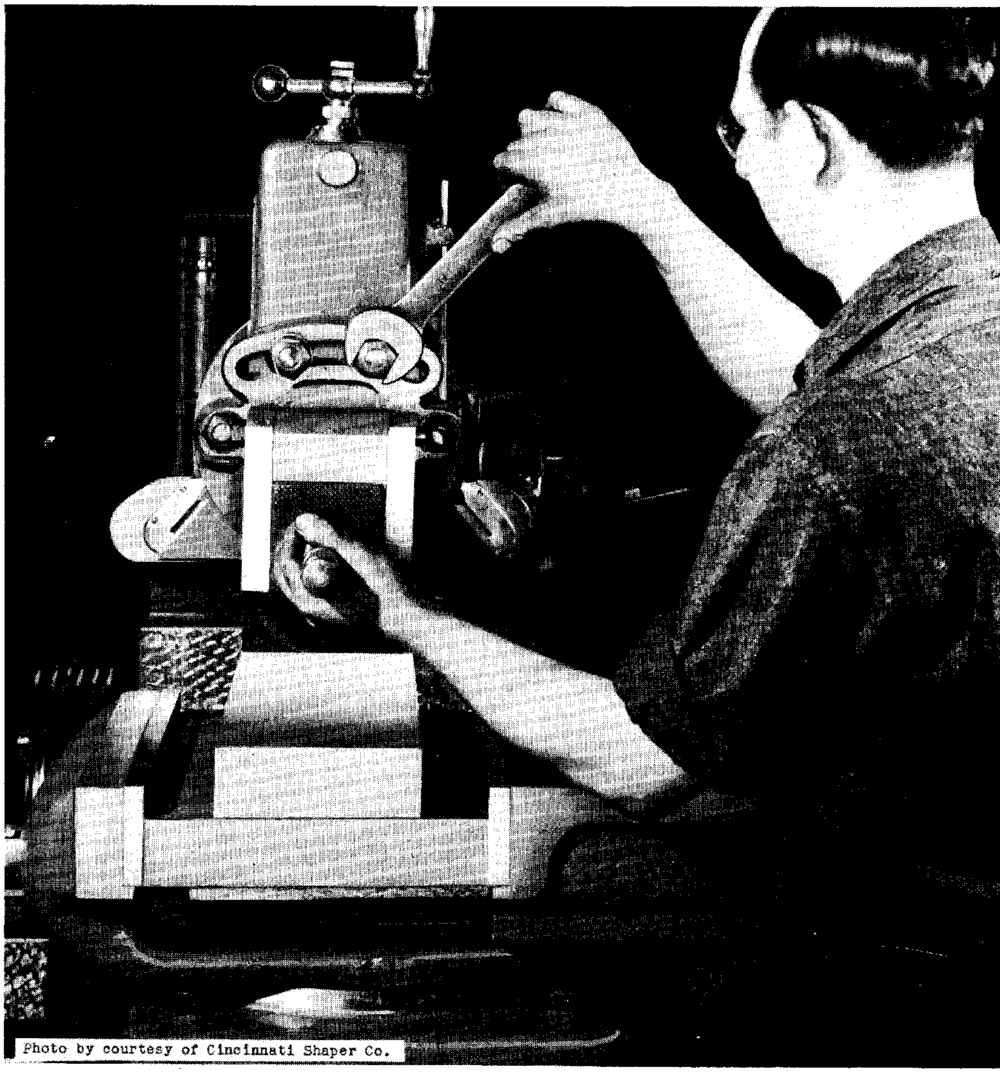


Photo by courtesy of Cincinnati Shaper Co.

UNIT P 52 (A)

Part III Pages 75 - 96

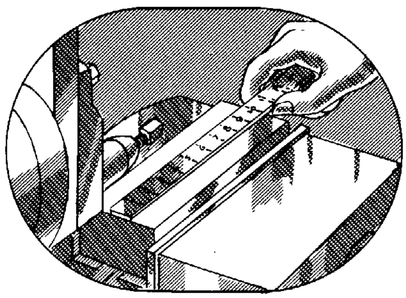
HOW TO ADJUST THE SHAPER

OBJECTIVES OF UNIT

1. To point out the machine adjustments which should be made prior to actual machining operations.

2. To show how to make machine adjustments on both the crank and hydraulic shapers.

3. To explain how job specifications influence machine adjustments.



INTRODUCTORY INFORMATION

Certain definite machine adjustments must be made, or at least must be given consideration, for every job performed in the shaper. If the machine is to be set up rigidly and the work performed without an undue amount of lost motion and lost time, the machine must be adjusted to meet the requirements of the job.

Since two jobs are seldom exactly alike in all respects, several machine adjustments may be required in order to have the machine operate efficiently. For example, considerable variation in the height of the work requires that the table be adjusted vertically for rigidity in the setup. For economy of time, the length of stroke should be adjusted to the minimum required for each job. For the same reason, the speed of the shaper should very closely approach that recommended for machining the material in the job with the particular cutting medium in use.

The type of cut, whether for roughing or finishing, influences the amount of feed used. An adjustment of the feed mechanism is necessary to change from one type of cut to another.

Most of these adjustments should be made after the job has been secured in the machine vise or other holding device. They should be made in the sequence suggested. Most important of all, for the safety of both the operator and the machine, adjustments should be made prior to starting.

Whenever practices for adjusting the hydraulic shaper differ from those given for making a like adjustment on the crank shaper, the sequence of steps to follow is given for adjusting both types of shapers. The steps for adjusting the hydraulic shaper, however, have been placed in a separate section.

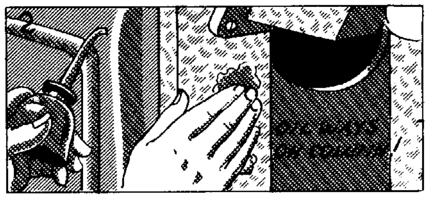
TOOLS AND EQUIPMENT

Shaper	Wrenches of correct size	Tool holder
Scale	Oil can for machine oil	Tool bit

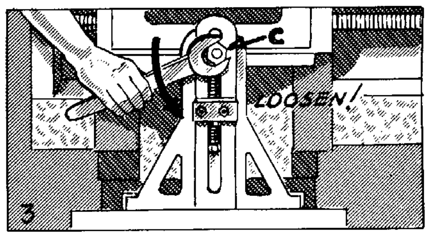
PROCEDURE

HOW TO ADJUST THE CROSS RAIL

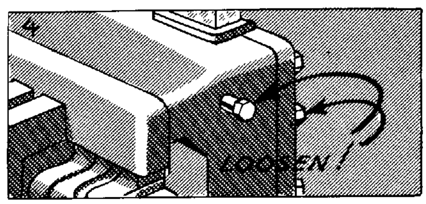
1. Wipe all chips and dirt from the front faces of the column. When the vertical position of the table must be changed, the cross rail is moved up or down on these bearing surfaces.



2. Apply a small quantity of oil to the clean bearing surfaces of the column. Distribute the oil evenly with the fingers (Illustration 2).

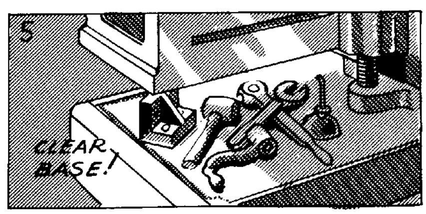


3. Loosen the table support clamps (C) which fasten this support to the table (Illustration 3).

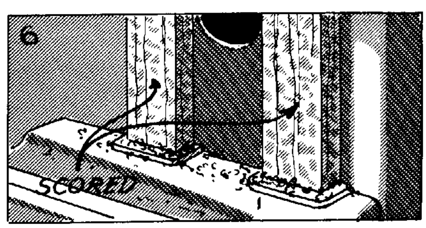


4. Loosen the clamping nuts, or the clamping levers -- on both sides of the column -- which lock the cross rail rigidly to the column (Illustration 4). On some makes of shapers the clamps for both sides may be manipulated from the operator's side.

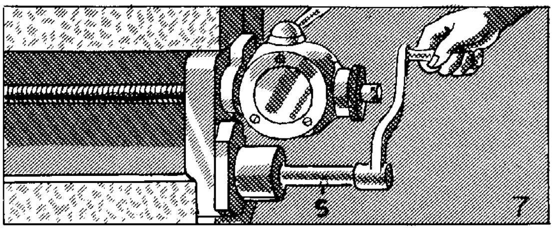
   NOTE: Do not loosen the other strap bolts as they are adjusted to hold the rail with sufficient friction so as to slide on the column.

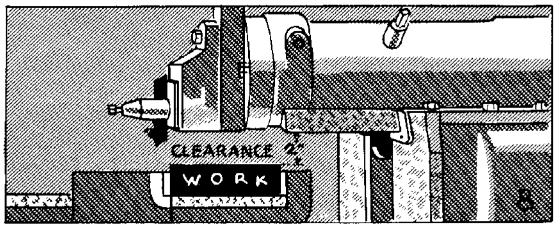


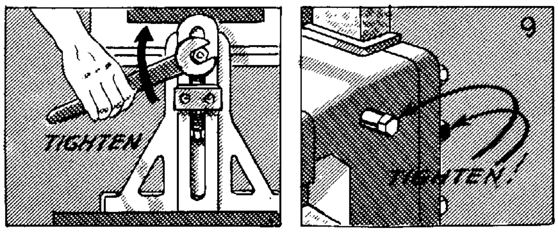
5. Avoid possible damage to the machine from tools and work pieces placed on the base of the shaper by removing them before changing the position of the rail (Illustration 5).

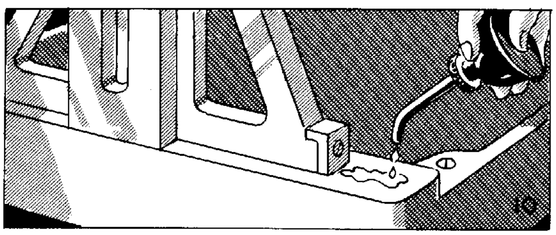


6. Make certain that chips and dust do not become lodged between the column and the cross rail. Foreign material between their surfaces will cause misalignment of these parts and also may cause scoring of their faces if these parts are moved when chips are present (Illustration 6).









7. Place a crank on shaft (S) which is connected with the elevating screw through bevel gears within the rail (Illustration 7).

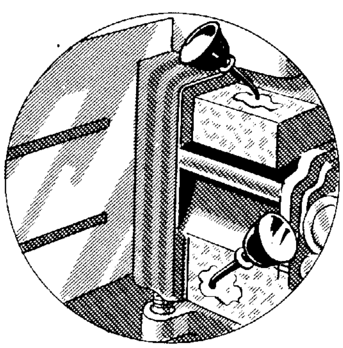
8. Turn this crank in a clockwise direction to lower the table and counterclockwise to raise the table. In either case, whether the table is raised or lowered, the underside of the ram should clear the work by no less than two inches for the safety of the operator (Illustration 8).

9. Tighten the clamps used for locking both sides of the cross rail rigidly in place on the column (Illustration 9).

10. See that the slide for the table support is clean. Apply a few drops of oil thereto, and then tighten the table support clamps, making sure that the support rests on its sliding surface (Illustration 10).

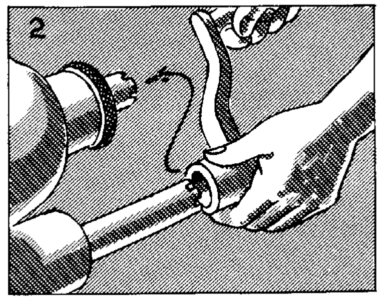
NOTE: The rail clamps should always be tightened before the table support is adjusted. With the rail clamps loose, the table sags somewhat because of its weight. Thus, if the support is adjusted and clamped with the rail clamps loose, their subsequent tightening will raise the support slightly from its slide and result in table deflection under pressure of cut.

HOW TO ADJUST THE TABLE HORIZONTALLY



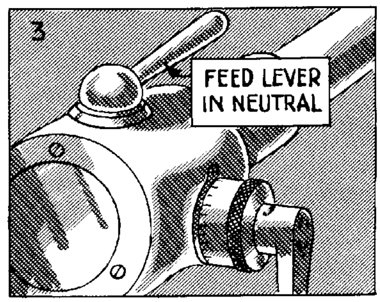
1. Examine the bearing surfaces of the cross rail over which the saddle and the table move. If these surfaces are found to lack oil, apply a few drops. If the oil on these surfaces is found to be dirty and laden with grit, wipe to remove grit and dirt before oiling.

NOTE: Considerable pressure is exerted on the faces of the cross rail because of the overhang of the table. In addition, these faces are continually exposed to dust and chips. As a result of these conditions, the cross rail will wear out of shape rapidly and will make accurate work difficult unless the bearing surfaces are kept clean and well oiled at all times. On modern shapers, felt wipers impregnated with oil help to clean the surface and to apply oil.



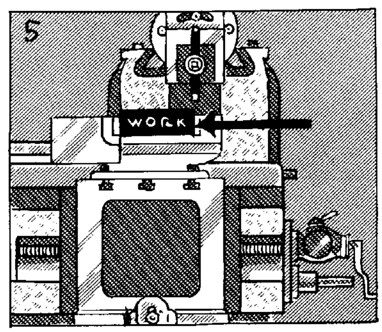
2. Remove the handcrank from the elevating shaft and place it on the end of the cross-feed screw. (Illustration 2).

   NOTE: In a machine equipped with rapid power traverse, the cross-feed screw, instead of being squared on the end to receive the crank, usually has clutch teeth of one form or another. This design eliminates the hazard of a rapidly revolving crank, for although it remains on the screw, the crank does not revolve with it when the automatic feed is applied. For hand feeding, the crank which is held out of engagement by a spring is pushed in to mesh the teeth on the crank with those on the screw.



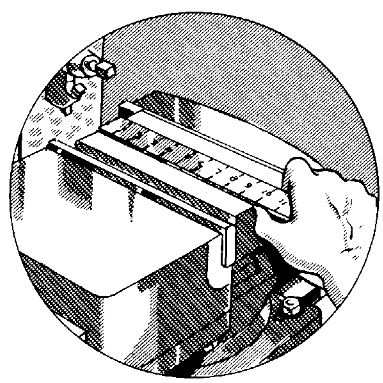
3. Make certain that the feed knob or the feed lever, whichever construction is used, is in neutral, a position in which the automatic feed is disengaged. (Illustration 3).

4. Rotate the crank on the cross-feed screw in a clockwise direction to move the table away from the operator and counterclockwise to move the table toward the operator.

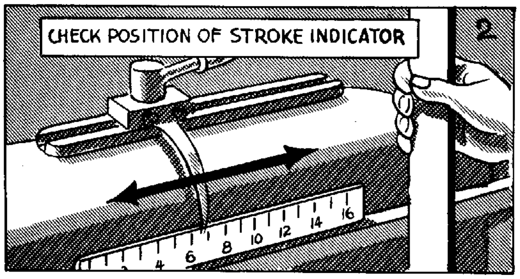


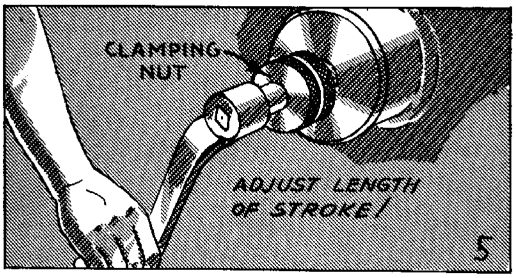
5. Move the table over until one edge of the surface to be planed is approximately central with the ram. (Illustration 5).

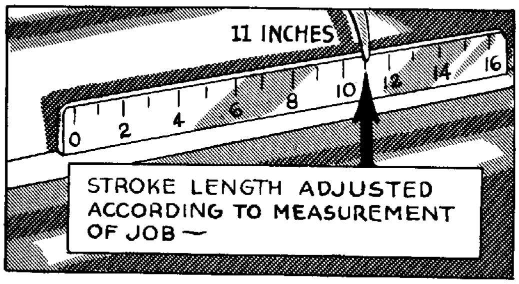
HOW TO ADJUST THE STROKE ON SHAPERS WITH A SCALE ADJACENT TO THE RAM



1. Measure the length of the surface which is to be planed to determine the length of stroke for which the shaper must be adjusted. Then add one inch to this dimension to provide for clearance of the cutting tool at both ends of the job.







2. Pull the belt by hand, or turn the handwheel if the shaper is motor-driven,before adjusting the stroke, and stop when the stroke indicator, moving with the ram, ceases to move along the stationary scale (Illustration 2). The highest number reached indicates the present stroke-length and determines whether or not an adjustment is needed.

3. Loosen the clamping nut on the outer end of the stroke-adjusting shaft.

4. Place the proper crank on the square end of the stroke-adjusting shaft.

5. Turn the crank (Illustration 5) in one direction or the other (depending on whether the stroke is to be made shorter or longer) until the stroke indicator is over the number on the stationary scale which corresponds with the length of ram stroke required. This number should be the one derived in the first step.

6. Tighten the clamping nut on the stroke-adjusting shaft, so that the length of ram stroke will not change during the operation of the shaper.

7. Remove the crank from the stroke-adjusting shaft.

HOW TO ADJUST THE STROKE ON A SHAPER WITH A DIRECT-READING STROKE INDICATOR

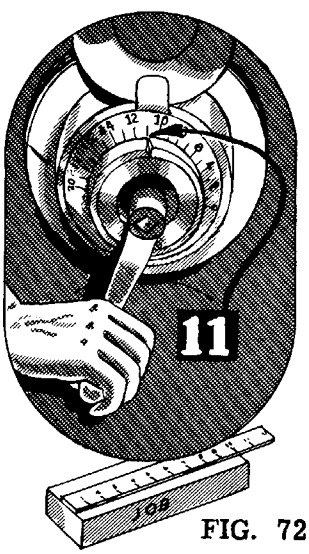


FIG. 72

1. Measure the length of the surface which is to be shaped (Fig. 72) and add one inch to this measurement in order that the ram stroke will permit the tool to travel beyond the back and front ends of the work.

2. Place the proper crank on the square end of the stroke-adjusting shaft (Fig. 72).

3. Turn the crank, together with the dial, until the number coinciding with the indicator corresponds with the required length of stroke in inches.

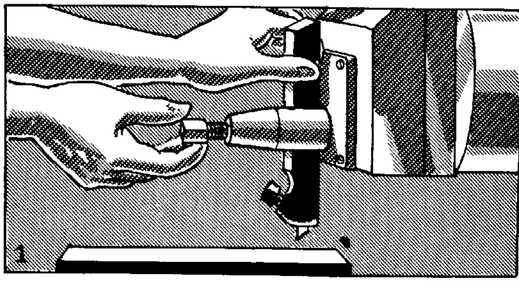
4. Remove the crank from the stroke-adjusting shaft.

NOTE: The two actions, unlocking the stroke-adjusting shaft before setting the ram stroke and again locking it after the setting has been made,take place when the crank is inserted and removed.

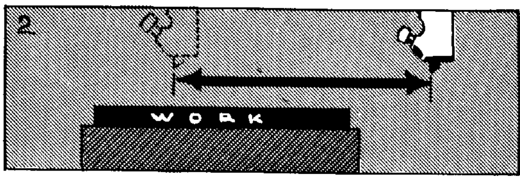
FOR ADJUSTMENT OF THE STROKE ON THE HYDRAULIC SHAPER REFER TO PAGE 92.

HOW TO ADJUST THE POSITION OF THE RAM

1. Place the tool holder, together with the cutting tool, in the tool post and clamp it in the approximate position it will occupy during the cutting process (Illustration 1).

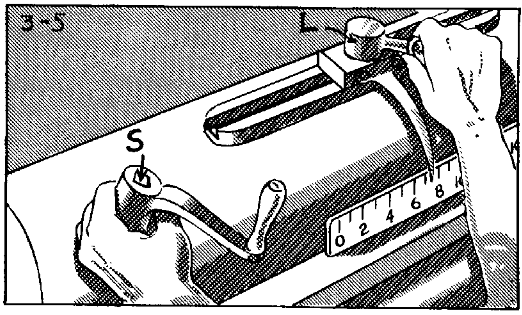


2. Determine whether or not the stroke will cover the work by stopping the ram, after moving it to its extreme forward position. Pull the belt, turn the handwheel, or use whatever other means appropriate for the shaper being used (Illustration 2).



3. Loosen the clamping block by turning the binding lever (L) in a counterclockwise direction (Illustration 3-5).

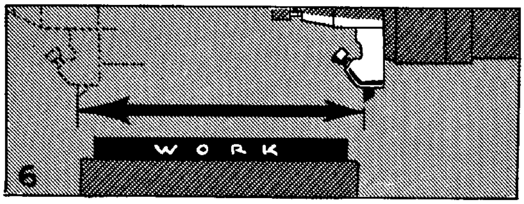
4. Place a crank on the square end of the ram-adjusting shaft (S) (Illustration 3-5). Then adjust the ram until the cutting tool extends about one-fourth inch beyond the front edge of the surface to be planed.



5. Remove the crank and turn the binding lever clockwise to clamp the ram securely in position.

6. Pull the belt by hand, or use whichever method is most appropriate to the shaper, and move the ram to the extreme end of its return stroke (Illustration 6). When the ram occupies this position, the cutting tool should extend about one-half inch beyond the work.

If the feed operates at the beginning of the stroke instead of during the return stroke, slightly more clearance and a longer stroke must be provided.



HOW TO ADJUST THE SPEED OF THE RAM

Eight different ram speeds, indicated as strokes per minute, are usually provided on the shaper. The speeds are available in two series of four each: a direct series for the faster speeds and shorter ram strokes, and a series through the back gears for the slower speeds and longer ram strokes. Thus, two speeds are possible for each position of the gear-shift lever on the shaper with a geared transmission, and also for each step of the cone pulley on a belt-driven shaper (one speed with the back gears "in" and another with the back gears "out").

It is desirable to adjust the speed of the shaper and to regulate the number of strokes per minute, so that the cutting speed of the tool in feet per minute closely approximates the established rate at which each different material can be machined most economically. In other words, for cutting similar material, the shaper must make twice as many strokes for a cut 6" long as it does for a cut 12" long, if the cutting speed is to be at the same rate for both cuts (refer to illustration below).

If a uniform cutting speed is to be maintained, the number of ram strokes per minute must be reduced when the stroke is lengthened and increased when the stroke is shortened.

Most modern shapers have a speed chart attached. From this chart the operator can determine, without calculations, how many strokes of a given length the ram must make per minute for the tool to cut at a desired cutting speed.

To operate a shaper which is not equipped with this convenient speed chart, it becomes necessary to calculate the correct ram speed required for different stroke lengths and materials.

Since each make of shaper employs a somewhat different method for setting the speed of the ram, it will be impossible to explain all of them. However, steps will be given for adjusting the ram speed on several common types. Familiarity with the methods explained, together with a study of a particular one which differs from these, should enable the operator to set the speed on any shaper without difficulty.

HOW TO USE A SPEED CHART TO ADJUST THE SPEED ON A CONE-DRIVEN SHAPER

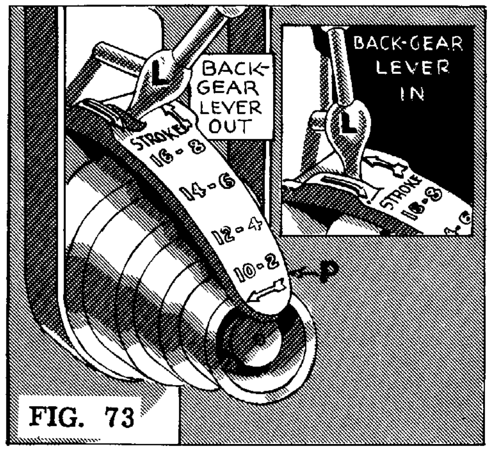
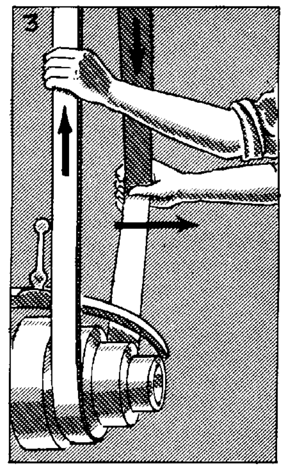


FIG. 73

1. Pull the belt until the stroke indicator reaches the largest number on the stroke-index plate in order to determine the length of stroke for which the ram has been adjusted.

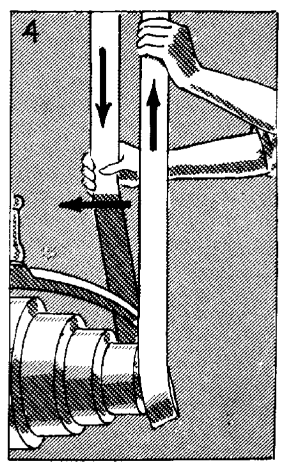
2. Refer to plate (P) above the cone pulley (Fig. 73). From the numbers appearing on this plate, choose the one which most nearly corresponds with the length of the stroke. The location of this number on plate (P) determines the position of the belt.

   NOTE: For strokes of an odd number of inches in length, such as 7, 9 and 11, which do not appear on plate (P), the position of the belt should be on the next larger or smaller step of the pulley. The step selected will depend on whether or not the material being cut can be machined at a cutting speed that is higher or lower than average.



3. Remove the belt from its step on the lower cone pulley, pulling down on one side of the belt as well as out. It is the downward pull which sets the belt in motion and makes its removal easier (Illustration 3).

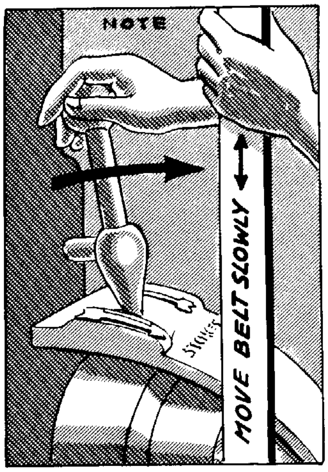
4. Shift the belt to the desired step on the upper cone pulley. Then run the belt onto the corresponding step on the lower cone pulley.



CAUTION Do not start the shaper when it is necessary to shift the belt. Unlike most other cone-driven machines, the outer end of the pulley on the shaper is frequently unsupported, and there is nothing to prevent the belt from leaving the pulley entirely. Closeness to a moving belt may cause serious personal injury.

5. Observe in which column on plate (P) the number corresponding to the stroke length appears. Note the direction in which the arrow at the head of this column points. (Refer to Fig. 73).

6. Move the back-gear lever (L) in the direction indicated by the arrow at the head of the column in which the stroke length appears. Move it toward the column for strokes eight inches or less in length, and out from the column for strokes from ten to sixteen inches in length.



NOTE: If the teeth on the back gears are in such a relative position that they cannot be engaged readily, do not use force. Instead, pull the belt slowly to change this relationship so the gears will slide into mesh easily. (Refer to illustration.)

7. Close the door on the belt guard when the speed setting has been completed.

NOTE: When the foregoing instructions have been followed, the ram will make the number of cutting strokes per minute of the length indicated. This will result in a cutting speed in feet per minute which is approximately correct.

HOW TO ADJUST THE SPEED ON CONE-DRIVEN SHAPERS WITHOUT A SPEED CHART

Many cone-driven shapers lack speed charts and plates such as are provided on the modern shaper to help the operator determine the correct cutting speed. The operator of a shaper of this type must either calculate the speed, using as a basis the figures representing such factors as the length of stroke, or he must depend upon his own judgment. If it is reliable, he gives consideration to the same factors used when calculations are made, but with experience as the basis instead of figures

If the shaper has the usual four-step cone pulley and back gears such as shown in Fig. 73, but without plate (P), some general rules may be formulated to operate the shaper at a safe and approximately correct speed. Minor increases and decreases can then be made from the approximate speed when differences in materials and unusual cutting conditions warrant such changes.

Proceed as follows to determine which step of the cone pulley to use for machining work requiring any stroke length within the capacity of the shaper.

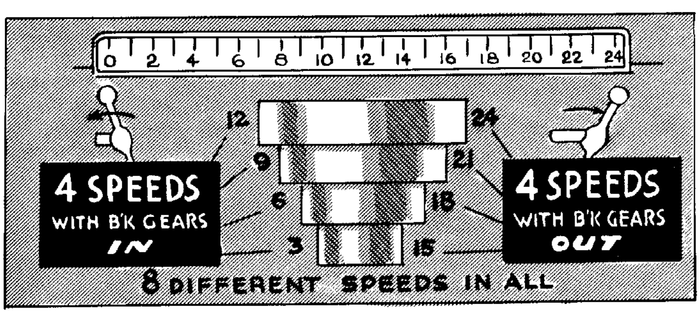


FIG. 74

1. Divide the maximum stroke length given on the index plate by the number of different speeds available on the shaper (Fig. 74).

2. Let the result of the division be the stroke-length in inches for which the smallest step on the cone pulley will be used in direct speed (without back gears).

3. Increase by the amount derived in step 1 the length of stroke for which each succeeding, and larger, step of the pulley will be used.

4. Continue to increase by the same amount, the stroke-length for which each step of the pulley is to be used in the backgear series of speeds. Begin with the smaller step of the cone pulley.

A formula for these calculations could be written:

$$I = \frac{A}{N}$$

in which

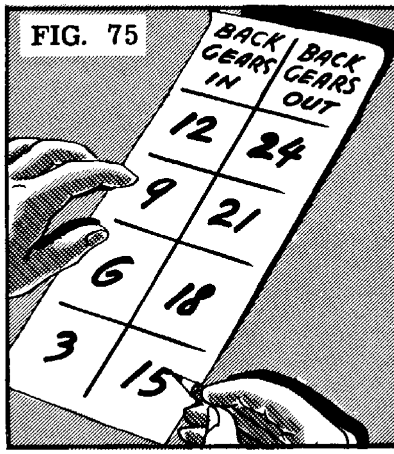
I = Maximum stroke-length to be used with small pulley
I = Amount of increased stroke-length for larger pulleys
A = Maximum stroke-length for which the shaper can be used
N = Number of different speeds available on the shaper

Proceed as follows, to make a speed chart for a 24-inch back-geared shaper having a four-step pulley:

FORMULA: $I = \frac{A}{N}$, or, by substitution, $I = \frac{24''}{8} = 3''$.

Thus, the smallest step is used for ram strokes not exceeding three inches in length. The second and succeeding steps are used for strokes six inches, nine inches, and twelve inches in length, respectively. If this procedure is carried through, the series of back-gear speeds will begin with fifteen inches for the small step and continue to eighteen inches, twenty-one inches, and twenty-four inches for the progressively larger steps. The chart in Fig. 75 shows how the numbers should be arranged for a 24-inch shaper with eight speeds.

FIG. 75



HOW TO ADJUST THE SPEED OF THE RAM ON A GEAR-DRIVEN SHAPER

To adjust the ram speed on a gear-driven shaper, follow the instructions given in the operator's manual supplied by the manufacturer. If it is available, this manual contains specific directions on how to proceed. In the absence of a manual, the careful operator proceeds cautiously when adjusting the speed on a shaper which he has not previously operated. He examines the speed-adjusting mechanism thoroughly to determine wherein it resembles one with which he is familiar. This investigation will disclose familiar parts which, in turn, will lead to a prompt understanding of the remainder of the mechanism.

Direction for adjusting the speed (number of strokes per minute) on several common makes of shapers will be presented.

A. TO ADJUST THE SPEED ON A HENDEY SHAPER

1. Examine the speed plate shown in Fig. 76. Note that the factors needed to determine the speed of the shaper have been included on it.

   a. The Length of Stroke in Inches is given in a vertical column on the left side of the plate.

   b. The number of Strokes per Minute is represented by the figures in the upper row and divided into two series of speeds, one series attainable with the Back Gears In, the other with the Back Gears Out.

   c. The Approximate Cutting Speeds in Feet Per minute which result from the various combinations of stroke lengths and ram speeds are also given.

2. Observe the numbers on the stroke plate, and note that they correspond with those in the upper horizontal row of the speed plate.

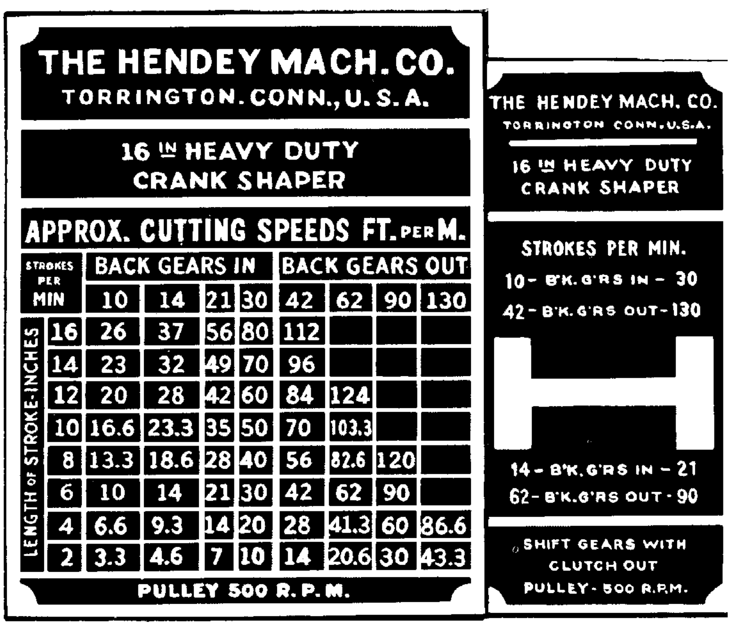


FIG. 76

3. Determine the cutting speed in feet per minute at which the kind of material in the job should be machined.

4. Consult the stroke-index dial and determine from it the length of the stroke for which the ram has been adjusted.

5. Locate in the first column (Fig. 76) on the left side of the speed plate the number which corresponds with the length of the ram stroke as indicated on the stroke-index dial.

6. Locate in one of the vertical rows to the right of this number the figure corresponding with that of the cutting speed selected in step 3.

7. Read the number appearing at the top of this column. This represents the number of strokes per minute for the ram.

8. Observe the precautions which appear on the stroke plate for the shifting of the gears.

9. Select from the numbers on the stroke plate the one which most nearly approximates the number of strokes per minute noted in step 7.

10. Move lever (I) into the slot, or place it in the position opposite which this number appears. (Refer to Fig. 78).

11. Shift the back-gear lever (B) to its position marked "In" (for slower speeds) if the number of strokes per minute for which the shaper is to be adjusted appears in the left section of the speed chart. Shift the lever to the position marked "Out" if the number appears in the right section. The position which the back-gear lever should occupy during various speeds is indicated on the stroke chart alone.

For example, to adjust the speed (number of strokes per minute) for taking a roughing cut with a high speed tool on a cast-iron job requiring a 12-inch ram stroke, proceed in the following order. Refer to Fig. 77.

1. Find the cutting speed in feet per minute for a roughing cut on cast-iron by referring to a chart of allowable cutting speeds. The speed recommended will be 60 feet per minute

2. Find number (12), which is the length of stroke required, in the first column on the left side of the speed chart (Fig. 77).

3. Move to the right in the row opposite number (12) and stop at number (60), which represents the cutting speed in feet per minute as previously determined.

4. Move up in the column above number (60) to number (30) which appears at the top and indicates the number of ram strokes per minute.

5. Shift lever (L) to the position under number (30) on the stroke chart.

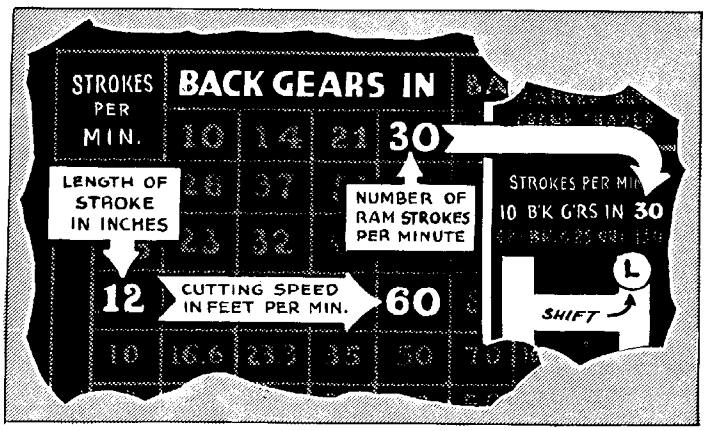


FIG. 77

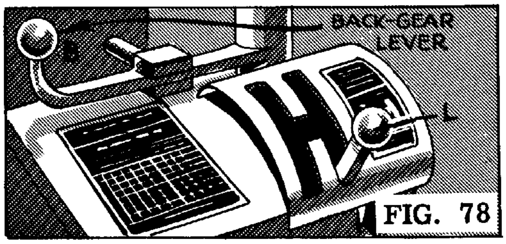


FIG. 78

6. Shift back-gear lever (B) to the position marked "In", as noted on both charts for a ram speed of 30 strokes per minute. (Refer to Fig. 78.)

B. TO ADJUST THE SPEED OF A CINCINNATI SHAPER

1. Determine the cutting speed in feet per minute which is recommended for shaping the kind of material in the job. (Refer to the table of Allowable Cutting Speeds on page 308).

2. Determine from the stroke-index dial the length of stroke for which the shaper has been adjusted.

NOTE: The cutting speeds which result from various combinations of stroke lengths and ram speeds — two factors which determine the cutting speed of the shaper tool — are frequently supplied on a speed chart attached to the shaper, as shown in Fig. 76. In other cases, the manufacturer supplies a table of cutting speeds in an operator's manual. The table shown in Fig. 79 has been reproduced to use in adjusting the speed of the shaper.

3. Locate in the upper row of the table the number which corresponds with the length of the ram stroke. (Refer to Fig. 79).

4. Find in the column below this number the number which most nearly corresponds with that of the cutting speed in feet per minute.

5. Move to the extreme left column in the same row in which the cutting speed has been located. The number appearing at this point represents the strokes per minute for which the shaper is to be adjusted.

6. Select from the numbers on the stroke plate, the one which corresponds exactly with the required number of strokes per minute.

CAUTION Do not shift gears when the clutch is engaged.

7. Shift the speed indicator by means of lever (L) to the slot adjacent to the selected number.

8. Shift back-gear lever (B) to position "A or B", the choice depending upon which of these letters precedes the speed selected.

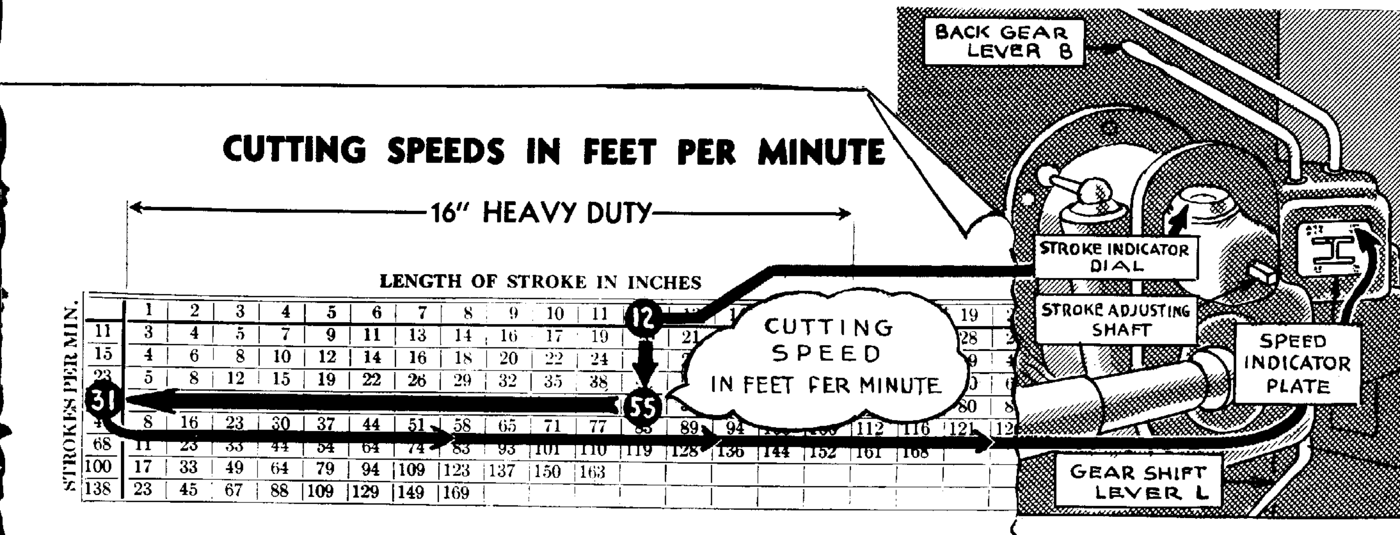


FIG. 79

If the speed of this shaper is to be adjusted for the same job used in the previous example, proceed as follows and refer to Fig. 79.

1. Find the cutting speed for a roughing cut on cast iron using a high speed tool. The speed recommended is 60 feet per minute.

2. Find number (12) (which is the length of stroke required) in the upper row in the table of cutting speeds. (Refer to Fig. 79).

3. Move down in the column under number (12) and stop at number (55), since this is the number which comes nearest to the recommended cutting speed of 60 feet per minute for roughing cast iron.

4. Move to the extreme left in the row opposite number (55). Number (31), appearing at the intersection of this row and the left-hand column, indicates the number of ram strokes for which the shaper is to be adjusted to get the approximately correct cutting speed.

5. Shift the speed indicator by means of lever (L) to the slot in the stroke plate under number (31).

6. Shift back-gear lever (B) to its position marked "B".

FOR ADJUSTMENT OF THE SPEED
ON THE HYDRAULIC SHAPER,
REFER TO PAGE 94.

HOW TO ADJUST THE AUTOMATIC FEED ON A CONE-DRIVEN SHAPER

1. Read the description of the feed mechanism used on this type of shaper.

2. Determine in thousandths of an inch the approximate amount of feed most desirable for the job. Give consideration to the factors which influence the selection of the proper amount of feed.

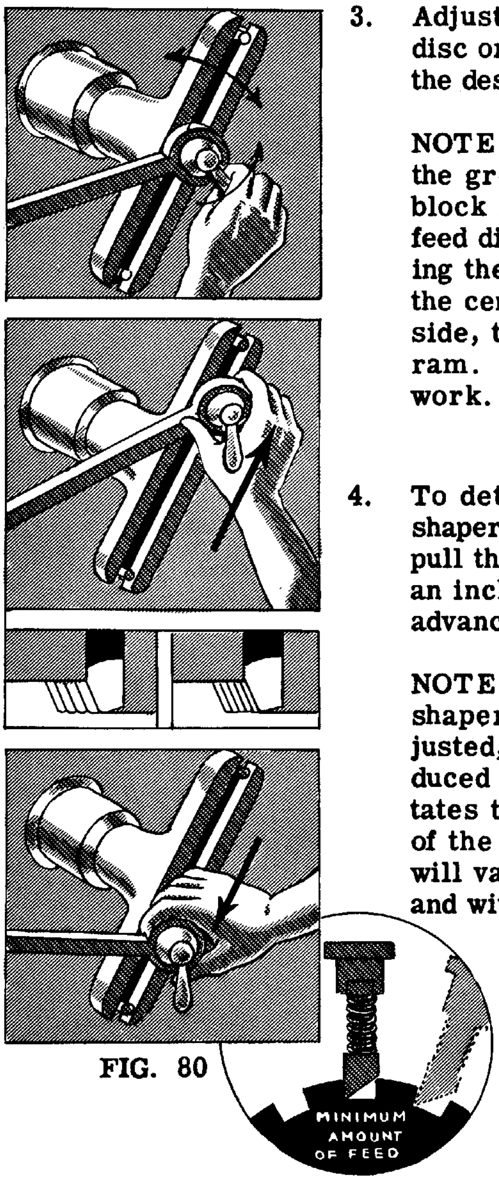


FIG. 80

3. Adjust the slide block out from the center of the feed disc or feed rocker arm, a distance estimated to produce the desired amount of feed.

   NOTE: The farther from center the block is moved, the greater becomes the amount of feed. If the slide block is moved out from the center of one side of the feed disc or feed rocker arm, the feed will operate during the cutting stroke. If the block is moved out from the center of the feed-regulating device on the opposite side, the feed will operate on the return stroke of the ram. This latter adjustment is preferable for most work. Refer to Fig. 80.

4. To determine the amount of table feed for which the shaper has been adjusted, apply the automatic feed; then pull the belt by hand and note how many thousandths of an inch the micrometer dial on the cross-feed screw advances for each stroke of the ram.

   NOTE: The minimum amount of feed for which any shaper using this type of feed mechanism can be adjusted, is established by the amount of movement produced in the cross-feed screw when the feed pawl rotates the ratchet wheel only one tooth for each stroke of the ram. This amount, in thousandths of an inch, will vary with the number of teeth on the ratchet wheel and with the lead of the thread on the cross-feed screw.

5. Continue to make additional adjustments of the slide block in its feed-regulating device, if the first estimated setting does not result in the desired amount of feed.

HOW TO ADJUST THE AUTOMATIC FEED ON A SHAPER USING A DIRECT-READING FEED DIAL

1. Read the description of the automatic type of feed mechanism.

2. Determine, in thousandths of an inch, the amount of feed which will be desirable for the job. Base the amount of feed selected on influencing factors as: depth of cut, finish desired and material to be shaped

3. Select from the numbers on the feed dial, the one which most nearly corresponds with the selected feed in thousandths. Then move this number on the dial to the index line, using whatever method is provided on the shaper for this purpose.

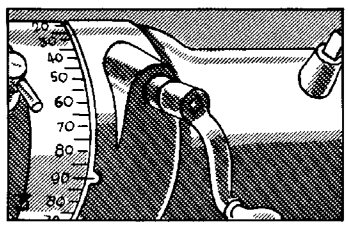
HOW TO ADJUST THE TOOL HEAD

FOR ADJUSTMENT OF THE AUTOMATIC FEED ON THE HYDRAULIC SHAPER REFER TO PAGE 95.

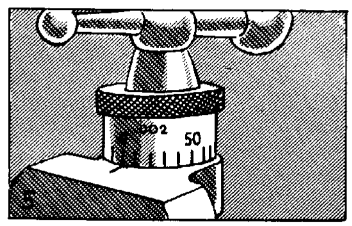
1. Reread and review the description of the tool head.

2. Loosen the binder bolts or other clamping devices (which hold the swivel block to the end of the ram) if the position of the tool head must be changed.

3. Set the tool head to the position required for taking the type of cut specified. For vertical and horizontal cuts, set the head in a vertical position with the 90° mark on the swivel block opposite the index mark on the ram. See illustration (3). For angular work, place opposite the index line on the ram whichever graduation on the swivel block will produce the desired angular cut.

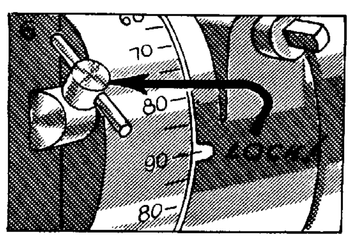


4. Clamp the tool head in the selected position. Recheck setting to make certain that the position has not changed during the clamping process.



5. Adjust the cutting tool so that it just barely clears the high point of the job by means of the ball crank on the down-feed screw.

6. Set the zero on the micrometer dial on the down-feed screw to its index line (Illustration 5), so that the depth of cut may be accurately determined. Then, to prevent movement of the tool slide during the cut, tighten the screw on the tool-slide lock. Refer to Illustration 6.



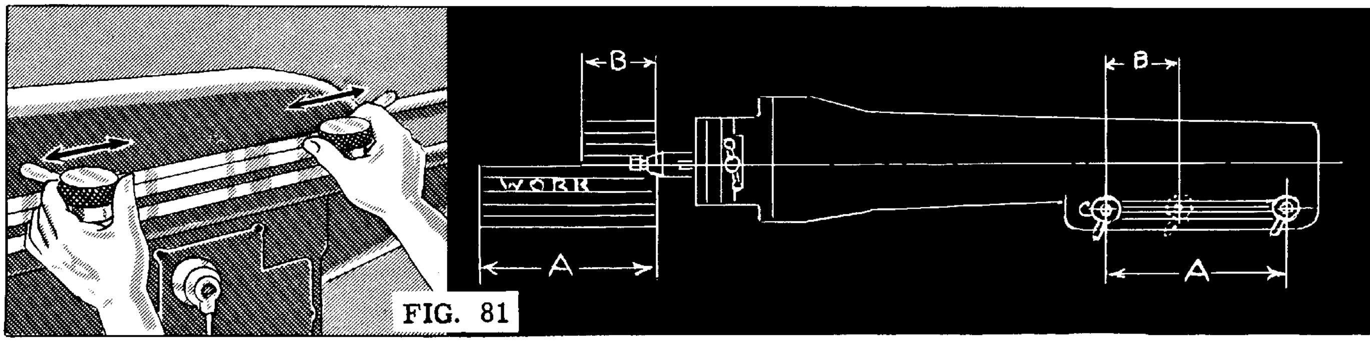
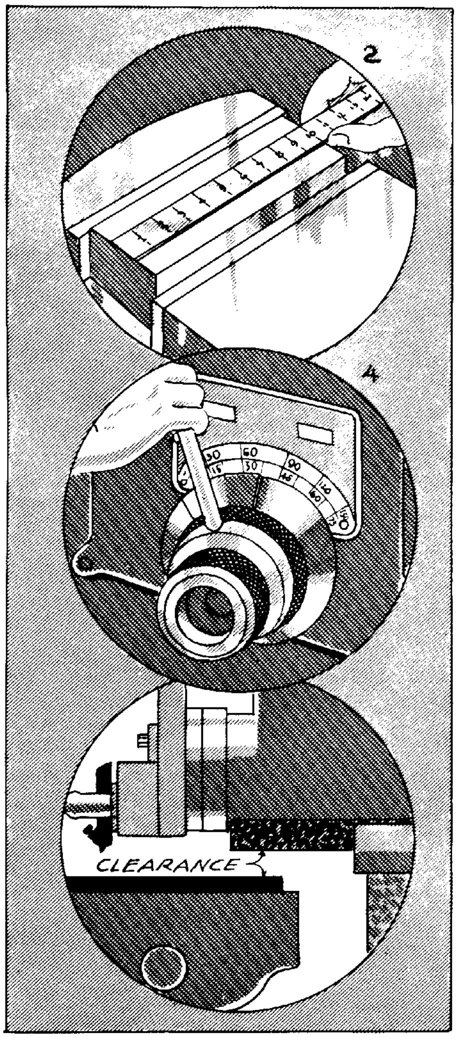


FIG. 81



HOW TO ADJUST THE STROKE AND THE POSITION OF THE RAM ON A HYDRAULIC SHAPER

1. Reread the description of the Pilot Valve on page 45.

   NOTE: Both the stroke-length and its position relative to the work may be adjusted simultaneously. This is possible because both of these adjustments are controlled by the trip dogs on the ram. The position of the trip dog at the front determines how far the ram may travel toward the rear of the shaper. Likewise, the position of the trip dog at the rear determines how far the ram may move forward. The trip dogs actuate the pilot valve which in turn causes the ram to reverse its direction of travel.

2. Measure the length of the surface to be planed after the work has been located in the shaper (Illustration 2).

3. Turn the knobs on the trip dogs to loosen. Then locate them about equidistant from the ends of the ram slot a distance approximately the length of the job. Refer to Fig. 81. This is done to make a trial adjustment.

4. Set the speed-control lever for one of the slower speeds on the shaper while the length and position of the stroke are being adjusted.

CAUTION Make certain that neither the cutting tool nor the ram

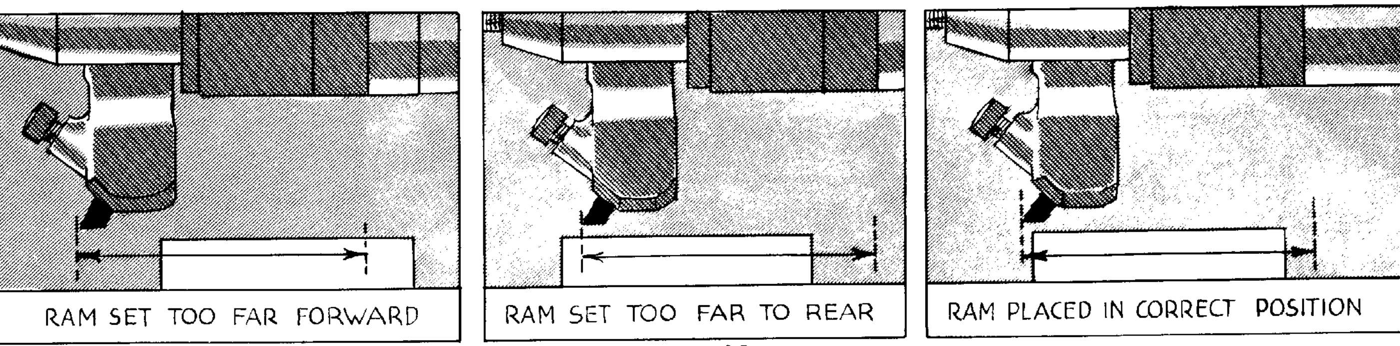


FIG. 82

will strike the work when the shaper is set in motion.

5. See that the control lever is in its "Stop" position before starting the motor which operates the pump for the hydraulic system.

6. Start the shaper cautiously. Run the ram to its forward position. Then stop the machine and note whether or not it is necessary to make a further adjustment of the trip dog which controls this end of the ram stroke.

7. If the cutting tool has run beyond the forward end of the work more than one-fourth of an inch (the desired clearance at this end), the rear trip dog has been improperly placed See Fig. 82. To correct this condition, move the rear trip dog forward a distance equivalent to the distance which the tool has overrun the job in excess of the usual quarter-inch allowance.

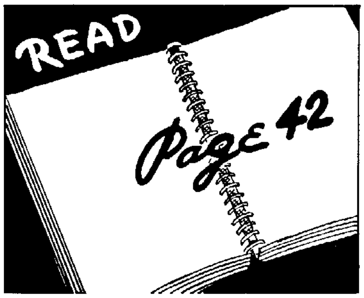
8. Move the rear trip dog back if the cutting tool falls short of clearing the front end of the job.

9. Make further adjustments of the rear trip dog if the first trial does not produce the result desired.

10. Start the shaper again and allow the ram to run to its rear position. Then stop the shaper.

11. Observe the position of the cutting tool with relation to this end of the work. If the tool passes beyond the work more than three-fourths of an inch, move the front trip dog back a distance equivalent to the excess in length of the stroke. Conversely, if the cutting tool does not travel back sufficiently to clear the work by the required distances, move the front trip dog forward a distance equivalent to the deficiency in stroke length. Refer to Figs. 81 and 82.

HOW TO ADJUST THE SPEED ON THE RAM OF A HYDRAULIC SHAPER



1. Review the description of the flow-control, overload-relief and start-and-stop valve on page 42.

2. Determine the cutting speed in feet per minute recommended for machining the kind of material in the job with the particular cutting material in the tool. (Refer to Chart of Allowable Cutting Speeds - Feet Per Minute on page 308).

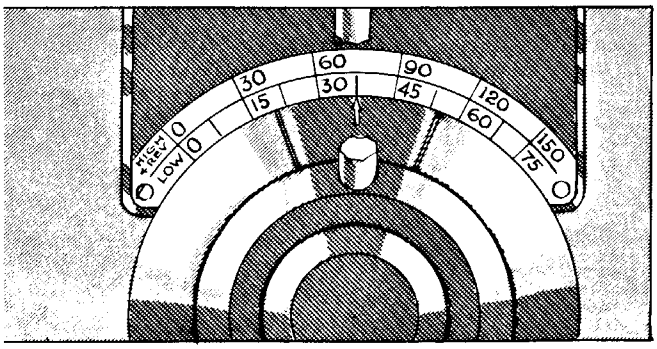
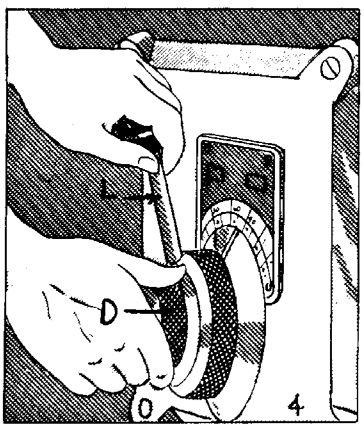


FIG. 83

3. Select from the speed-index plate on the shaper, the number which most nearly approximates that of the computed cutting speed in feet per minute. (Fig. 83).

4. Loosen the knurled locking disc when it is necessary to change the cutting speed of the tool. (See illustration 4).

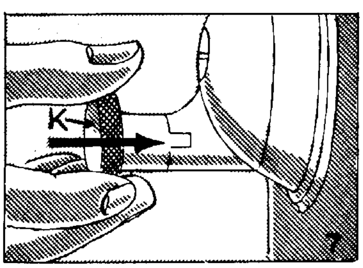
5. Move lever (L) in the direction necessary to place the adjacent index line under the desired cutting speed in feet per minute on the index plate. (Refer to Fig. 83).



6. Lock lever (L) in position by tightening the knurled locking disc (D).

7. Push in knob (K) on the starting lever for the series of slower speeds and for heavy cuts. Then, when the entire setup has been completed and the shaper is ready to be set in motion, move the starting lever to its "Low" position. (Illustration 7).

NOTE: When the starting lever occupies this "Low" position, any of the cutting speeds in the lower arc on the speed dial become available. It is necessary only to move the index line adjacent to lever (L) to any position desired in order to secure an infinite number of speed changes on this type of shaper. Obviously, the speeds in the upper arc are available when the starting lever is in its "High" position.



8. Pull out knob (K) on the starting lever (Illustration 7) and then turn it through 180° when one of the speeds

in the faster series has been selected and when light cuts are to be made. Then move the starting lever to its "High" position, after the job setting has been completed and the machine adjustments have been made. Fig. 84.

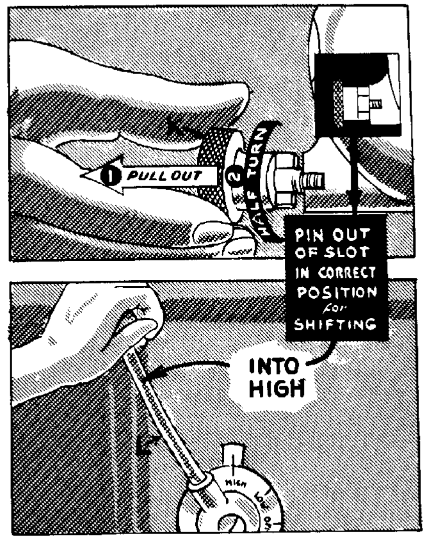


FIG. 84

NOTE: The cutting speed of the tool in the hydraulic shaper, when once adjusted on its speed-index plate, remains constant even though the length of the stroke may be made shorter or longer. This is in contrast with the crank shaper in which the cutting speed changes whenever the stroke-length changes. This latter design, therefore, requires that the number of strokes per minute, and their length as well, be known in order that the cutting speed may be calculated.

HOW TO ADJUST THE CROSS FEED ON A HYDRAULIC SHAPER

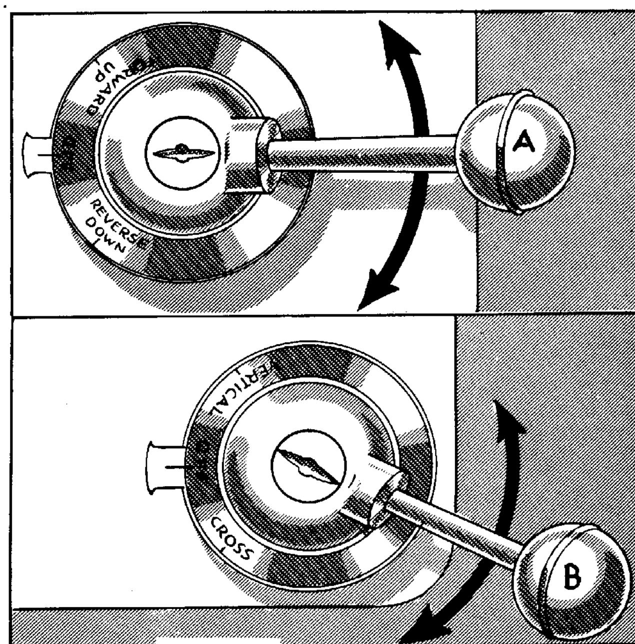


FIG. 85

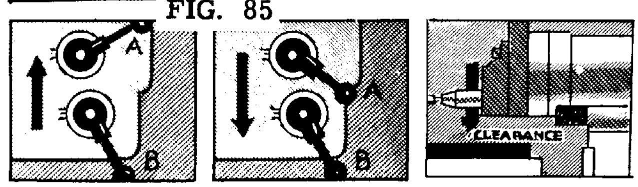
1. Determine the amount of feed to be used. Base the estimate on the factors which affect the amount of feed which can be used.

2. Move selector lever (B) toward the operator, bringing the word "Cross" on its hub to the index line. Fig. 85.

3. Move the directional-reverse lever (A) in the direction in which the work is to feed: toward the operator for movement of the work in this direction; toward the column for feeding in the opposite direction. (Refer to Fig. 85).

4. Close off the feed entirely by turning the handwheel (C), shown in Fig. 86, to the right (clockwise).

5. Start the shaper with lever (L), (Fig. 84), after making certain that both the tool and the ram will clear all parts of the job.



6. Open the feed by slowly turning handwheel (C) to the left (counterclockwise) continuing the rotation of the handwheel until the graduated dial (D) on the cross-feed screw moves the desired number of thousandths for each cutting stroke.

7. Disengage the feed by moving reverse lever (A) in one direction or the other and aligning the word "Off" on its hub with the index line as shown in Fig. 85.

HOW TO ADJUST THE VERTICAL FEED ON THE HYDRAULIC SHAPER

1. Determine the rate of feed to be used. Consider those factors which affect the rate of feed.

2. Move selector lever (B) toward the column of the shaper, thus bringing the word "Vertical" on its hub opposite the index line. (Refer to Fig. 85).

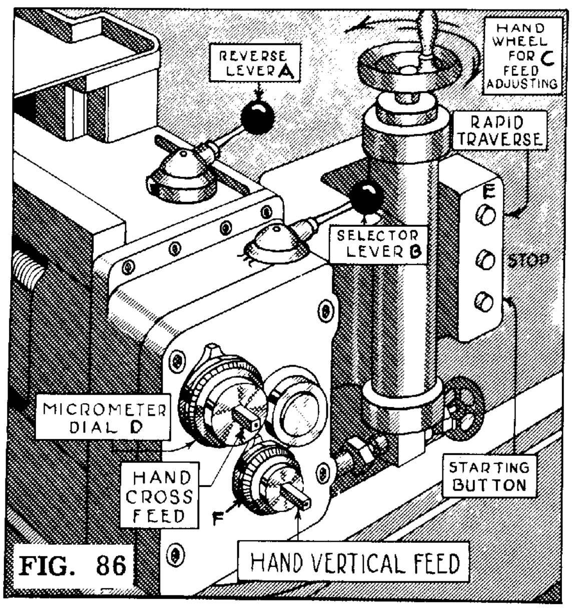


FIG. 86

3. Move the directional-reverse lever (A) in one direction or the other so that either the word "Up" or "Down" appears opposite the index line, depending upon which vertical movement is desired (Fig. 87).

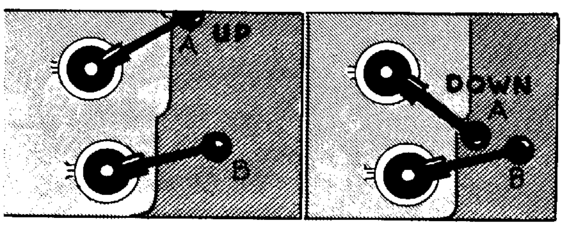
4. Repeat step No. 4 on page ninety-five.

5. Repeat step No. 5 on page ninety-five.

6. Open the feed by slowly turning the handwheel (C) to the left (counterclockwise) continuing the rotation of the handwheel until the graduated dial (F) on the elevating shaft moves the desired number of thousandths per stroke.

7. Repeat number seven above.

FIG. 87



NOTE: The rapid power traverse unit (which functions in connection with the feed mechanism) has been described on page 46. Its operation has been explained in How to Cperate Rapid Power Traverse on the Hydraulic Shaper on page 62.

DESCRIPTION OF WORK-HOLDING DEVICES

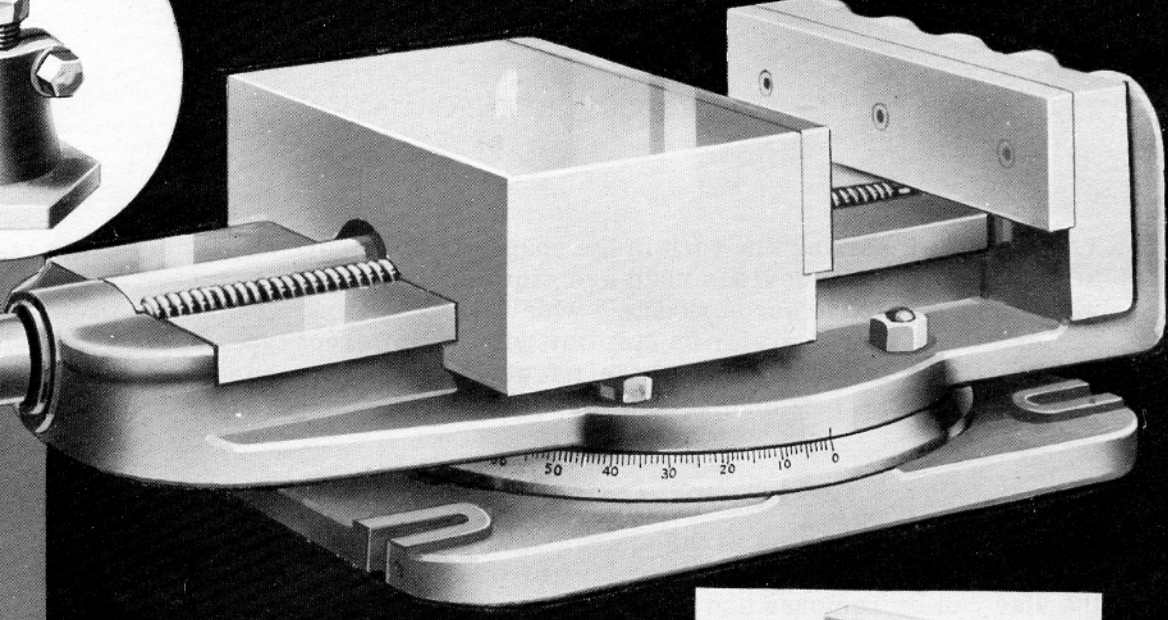
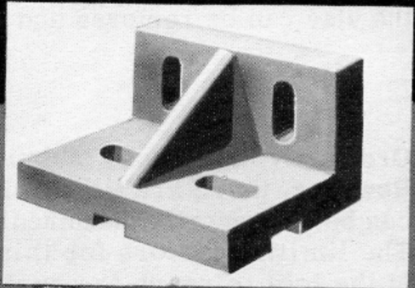


Photo by courtesy of Western Machine Tool Works



UNIT T 52 (B)

Part II Pages 97 - 116

DESCRIPTION of WORK HOLDING DEVICES

OBJECTIVES OF UNIT

1. To point out the principal types of shaper vises.
2. To describe other types of holding devices.
3. To discuss some of the factors to consider in selecting work holding devices.

INTRODUCTORY INFORMATION

The manner of holding the work in the shaper is an important part of shaper operation. Although the devices used are simple, they can be arranged in numerous ways and combined to accommodate a wide variety of work. It is, therefore, essential that the shaper operator be familiar with the different types of holding devices and be acquainted with some of their features so that he can intelligently select the most suitable method of holding the work.

Most small work is held in the shaper vise which is bolted to the top of the work table. If the work is too large, or for any other reason cannot be held in the vise, the vise can be removed and the work secured to the top or side of the table.

Ordinarily, the shaper table is large enough to support the whole area of the work. However, there are times when large pieces that extend beyond the shaper table can be conveniently machined if the overhanging portion is given additional support. The limiting factors for this procedure are the length of the stroke, the ability of the tool to reach the surface to be finished, and the advisability of using the shaper for the work to be machined.

Sometimes, what appears to be a very complex set-up can be made comparatively simple by using a holding device called a “fixture”. These fixtures sometimes consist of simple arrangements of standard holding devices to accommodate special classes of work.

DESCRIPTION OF WORK-HOLDING DEVICES

THE SHAPER VISE

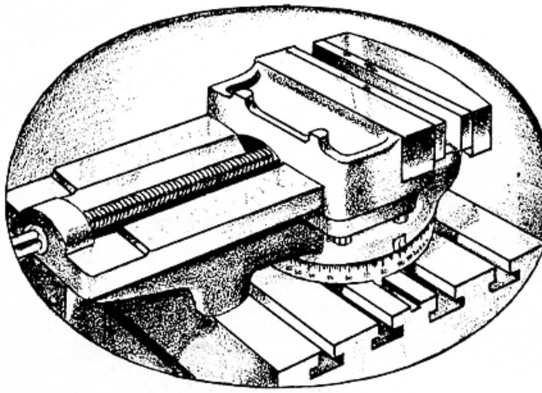


FIG. 88

The principal parts of the vise (Fig. 88) are the base, body, fixed jaw, movable jaw, screw, handle (or wrench), and the plates which are attached to the face of the jaws.

The bases of the vises (Figs. 89, 91, and 92) are bolted to the table by either three or four bolts. The number of bolts used depend on the design of the base. The base is graduated through an arc of 180° with a zero (0) position on the left side, a zero (0) position on the right side, and with a 90° mark in the front, midway between the two zero marks (Fig. 89). On the underside of the base are provided square keys which fit into the table slots and which square the base on the shaper table.

The body of the vise is a semi-steel casting which fits on the base of the vise (Fig. 89). The heads of the bolts, which are free to slide, are held in a circular groove in the underside of the body. When the vise is being assembled, the bolts pass through holes in the base and holes in the table as shown in Fig. 90. Washers and nuts are placed on the bolts which extend into the openings and, when tightened, secure the vise and base to the table. When the nuts have been loosened, the vise can be swiveled to form any angle with the direction of the stroke. The pilot in the base provides a central point about which the body of the vise swivels (Fig. 89).

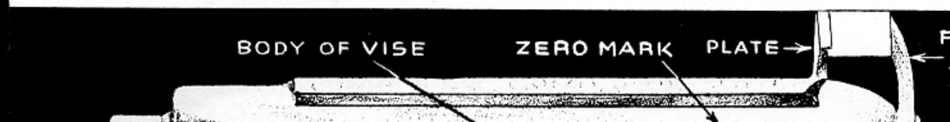


FIG. 89

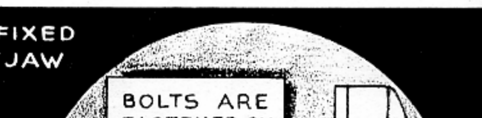


FIG. 90

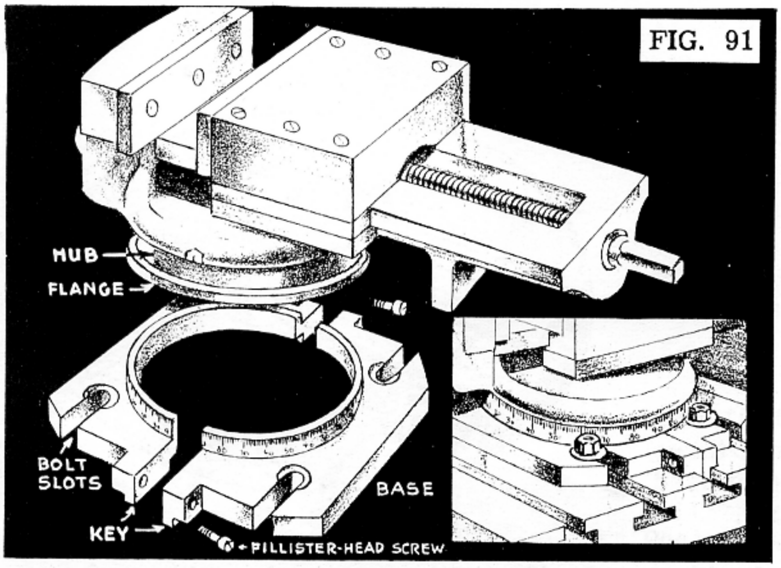


FIG. 91

In the design shown in Fig. 91, the base acts as a clamping ring for the body. It is split so that it can be assembled on the projection called the hub (Fig. 91) which is on the underside of the vise body. Two fillister-head screws hold together the two halves of the clamping ring, or base. The vise may be swiveled to any angle horizontally. When the nuts which hold the base to the table are tightened, they exert a downward pull on the flange of the hub and hold the vise securely in position.

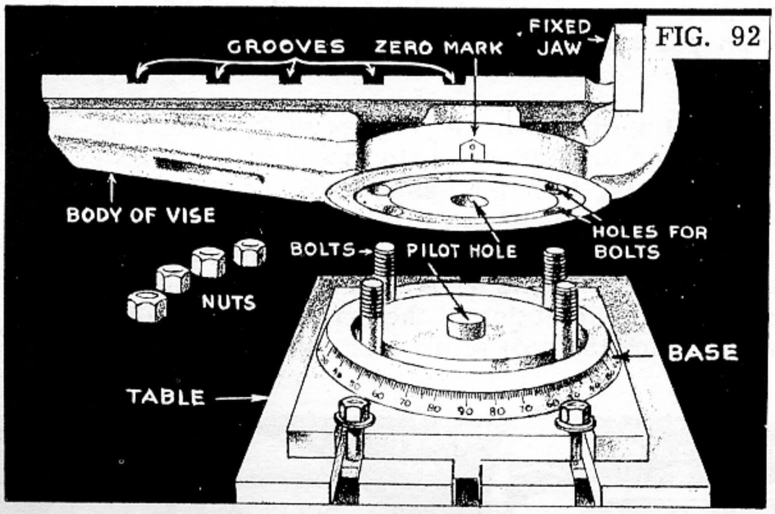


FIG. 92

The base illustrated in Fig. 92 is bolted to the table of the shaper and is held independently of the vise body. The base is made with a circular T-slot to receive the heads of four T-bolts. The bolts project above the base and are made long enough to pass through the flange on the bottom of the vise and to hold a washer and a nut (Fig. 93). When the nuts are loosened, the vise may be swiveled horizontally to any desired angle. The vise is securely clamped to the base when the nuts are tightened.

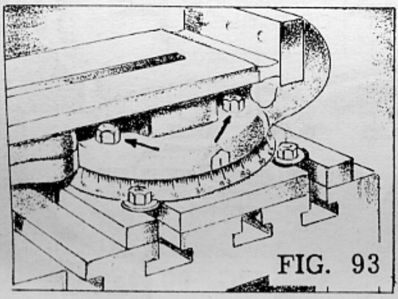


FIG. 93

The vise (Fig. 89) has bosses which are cast on the underside of the vise body. The bosses provide additional support when wide pieces are held between the jaws or when the vise is used with the jaws at right angles (90°) to the direction of the cut. When the vise is in this position and the work is held vertically, the jaws should be offset to permit the ends of bars to be machined (Fig. 94).

The solid, or fixed jaw, (Fig. 96) is an integral part of the vise body and is machined square with the surfaces upon which slides the movable jaw (Figs. 95 and 96). Both the fixed and the movable jaws are usually faced with either annealed or hardened and ground steel plates. Although hardened and ground plates hold their accuracy better and their surfaces are not easily damaged, annealed plates have a slightly greater gripping power. The plates may be removed by taking out the screws which attach them to the jaws. This becomes necessary only if the plates need to be reground or machined.

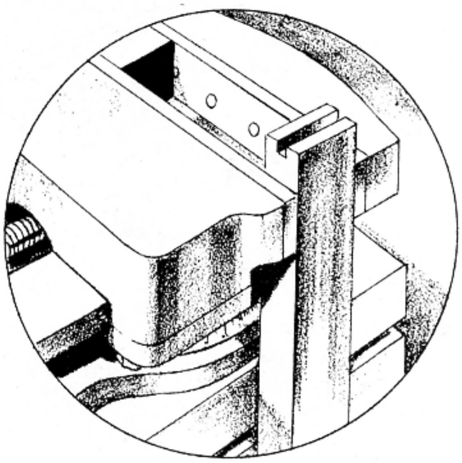


FIG. 94

Movable vise jaws are operated by either single or double screws. The movable jaw (Fig. 95) is operated by a single screw and is provided with guides to hold it square. The straps are bolted to the underside of the block and are adjusted to allow the movable jaw to slide without tendency to lift excessively.

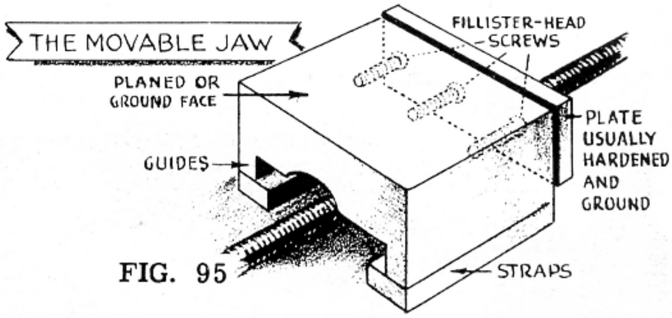


FIG. 95

The vise screw passes through a nut which is attached to the bottom of the movable jaw. Two bearings, one at each end of the casting, support the screw (Fig. 96). A large washer is placed on one end of the screw to receive the pull caused by the tension on the screw when the vise has been tightened. The lock nuts or adjustable collars hold the washer in place and provide for necessary adjustment. The movable jaw of the single-screw vise has a flat top which may be used as a surface plate for use with measuring instruments.

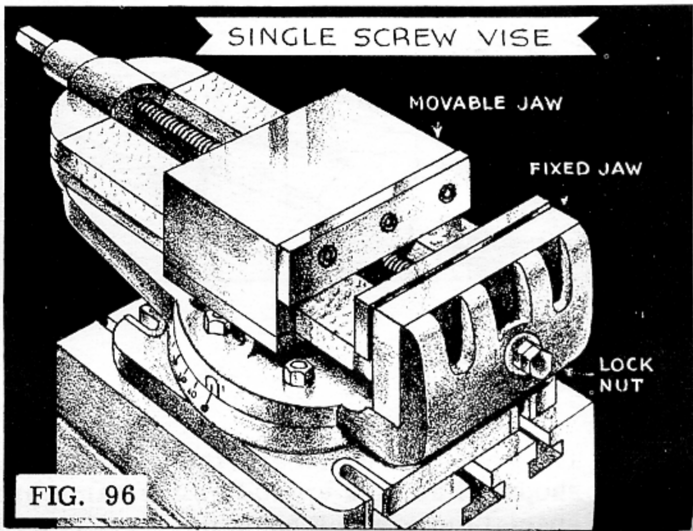


FIG. 96

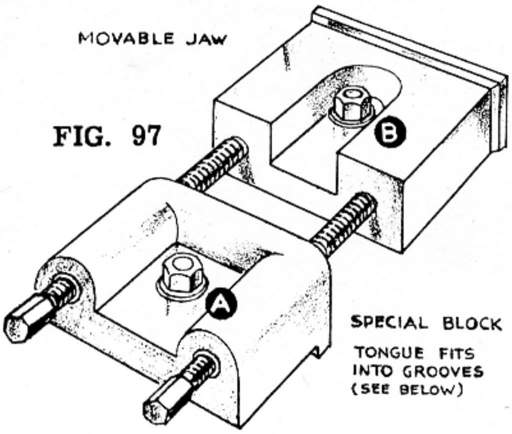


FIG. 97

A vise also may be equipped with double screws (Fig. 97). The movable jaw of this vise is made without guides. In addition to holding straight work, it will hold work with a slight taper. When the nut (B) has been loosened, the movable jaw can be moved forward by hand until it is against the work. The jaw is forced against the object by two set-up screws which are held in a special block and can be adjusted to suit the position of the movable jaw.

When the nut (A), (Fig. 98) has been loosened, the special block may be raised so that the tongue on the underside may be lifted clear of the groove. The block may then be moved to any position in which the tongue and groove coincide and in which the adjustment is enough to allow the screws to force the movable jaw against the work. When the nut (A) has been tightened, pressure can be applied to the movable jaw by tightening the two set-up screws. Finally, the nut (B) must be tightened to hold the movable jaw firmly against the surface of the vise body.

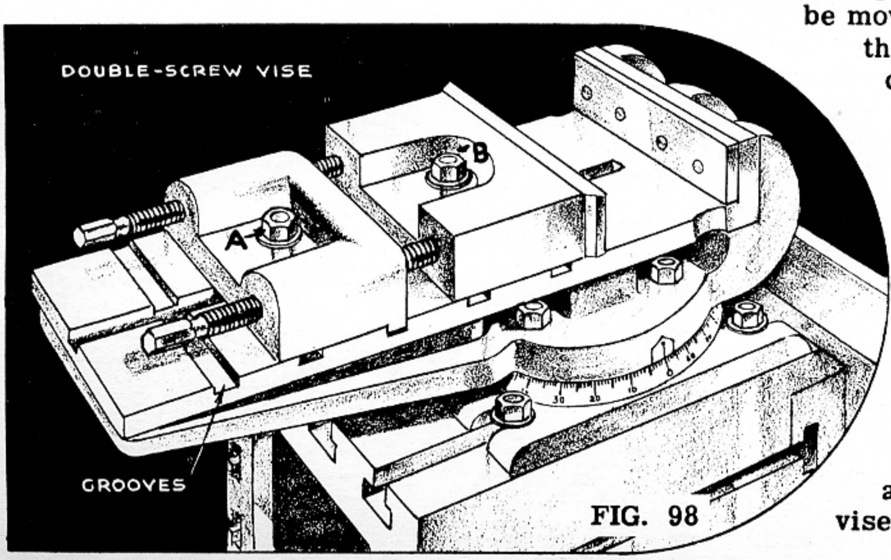
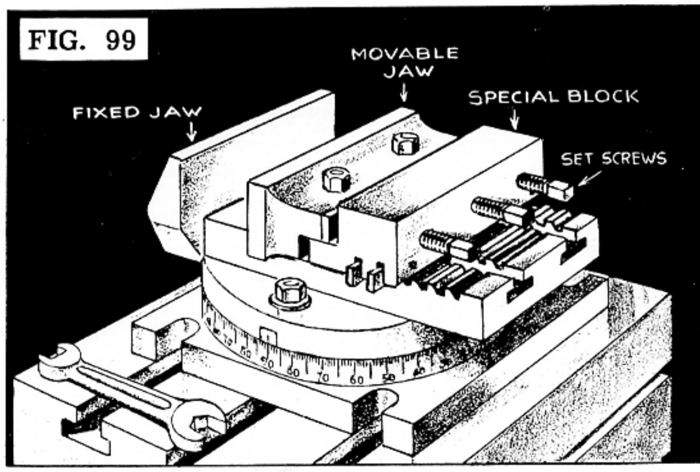


FIG. 98

The shaper and planer vise illustrated in Fig. 99 is frequently found in machine shops. The vise embodies the same principle as the double-screw vise, but the special block which holds the set screws is furnished with two plates instead of the tongue and groove used in the previous design shown in Fig. 98. In addition, the block has a ledge upon which rests the undercut surface of the movable jaw. Three smaller set screws take the place of the two heavier screws with which double-screw vises are equipped. The jaws of this vise are not faced with steel plates.

FIG. 99



The selection of either the single- or double-screw vise will depend upon the nature of the work. The preference for the single-screw vise is based upon the fact that the single-screw type is simpler and quicker to operate. On the other hand, the double-screw vise has the advantage of being able to hold work with a slight taper and to hold the movable jaw very securely against the work.

For tapered and irregularly shaped pieces, a vise (Fig. 100), with a swiveling movable jaw may be used. The jaw is pivoted on a central stud which allows the jaw to align itself against the side of the object. Two bolts are used to clamp the jaw in position. It should be observed that the screw draws the swiveling jaw to the work instead of forcing the jaw forward. Whenever the vise is to be used to hold regularly shaped pieces with parallel sides, the swiveling jaw must be set in line with the fixed jaw. This is accomplished by using a dowel pin which is provided for locating the swiveling jaw in proper alignment with the fixed jaw.

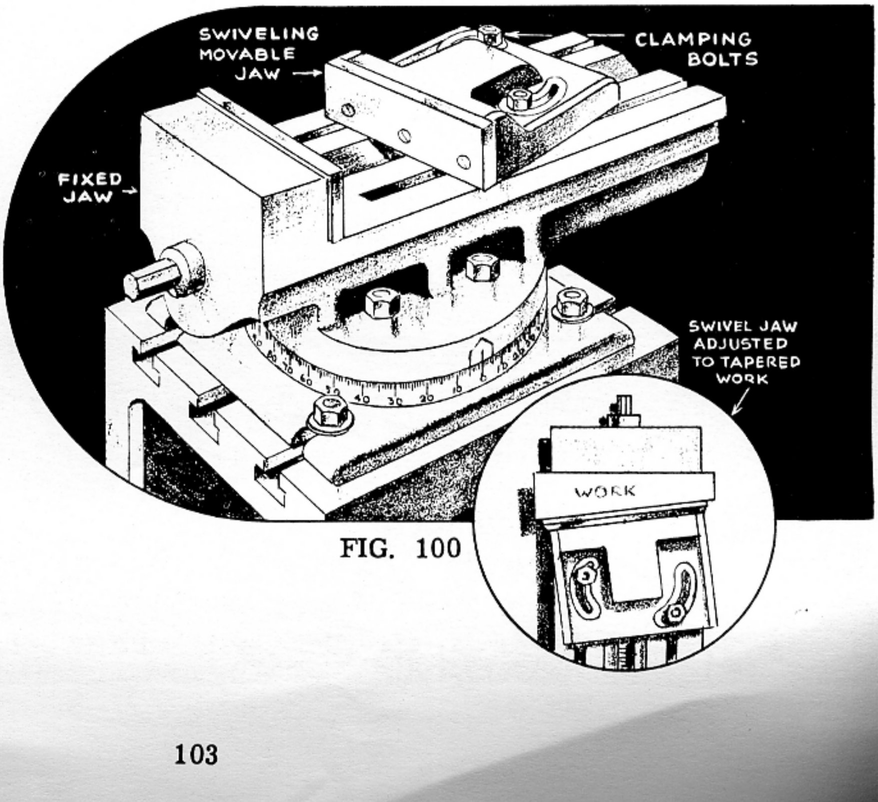


FIG. 100

Manufacturers of shapers supply a vise as part of the regular equipment of the machine. The decision, as to type of vise to be furnished, rests with the purchaser.

PARALLELS

It is not always practicable to place the work between the jaws of the vise or to lay the work directly on the table without some supporting piece underneath. Sometimes projections on the underside of the work require that the piece be raised to clear the projections. Or, it may be necessary to raise the work a definite amount to simplify the machining operations.

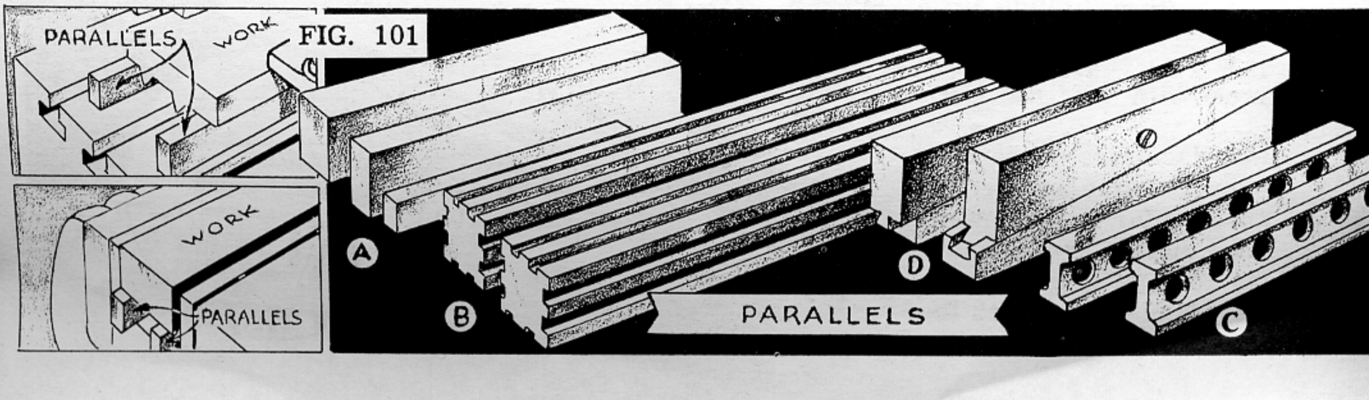
These supporting pieces are called parallels (Fig. 101). They are square or rectangular bars (A) made in pairs of either cast iron or steel. Frequently, parallels are made by cutting off two pieces from a square or rectangular bar of cold drawn steel, or they may be accurately machined to any desired size.

For general shaper work, the larger parallels are often made of cast iron and have grooves cut the entire length of their surfaces as shown at (B). The purpose of this is to lighten the parallels somewhat and present less area to be cleaned and to be kept free of burrs. Another method of lightening parallels is to undercut the sides and cut holes in the webs as illustrated at (C). When extreme accuracy is required, the parallels are made of steel which is hardened, seasoned, and ground.

There is no definite standard as to how high, wide, or long a parallel must be. Opinions vary as to what are the most suitable sizes to have available for use with the shaper. Manufacturers usually sell parallels in sets which are designed so that when used singly or in combinations they will give a wide range of sizes. For general shaper work, parallels should range progressively from about 1/8" high, 1/4" wide, and 6" long, up to about 3" high, 1-1/2" wide, and 12" long. To suit special purposes, however, it is often more economical and more practicable to make or purchase a set of parallels instead of using available parallels in combination.

Occasionally, adjustable parallels (D) can be used conveniently to support the work in the shaper vise. As the parallels can be set and locked to micrometer measurement, any height from 3/8" to 2-1/4" can be obtained with a set of these parallels.

FIG. 101



SHAPER BOLTS

The most convenient method of fastening work or work-holding devices to the table is by the use of T-head bolts. The square T-head bolt (Fig. 102) is ordinarily used. The heads of these bolts fit into T-slots which are cut in the shaper table. The square T-head bolts must be inserted in the end of the slot and moved along lengthwise to the desired position. The bolts cannot turn in the slot or be lifted out because of the square head and the T-slot.

For use with some setups, it is more convenient to place the bolt in the slot after the work has been placed on the table. For this reason, a cut-away T-bolt (Fig. 102) is manufactured. This bolt can be inserted into the slot and then turned. The head is made narrow enough so that it can be placed in the top of the slot, and, as the length is longer than the width, a partial turn of the bolt causes the head to catch on the side of the T-slot and thus prevents the head from further turning. Besides, the head catches on the underside of the slot and prevents the bolts from being pulled out.

For types of work in which different lengths of bolts are required, the tapped T-head bolt (Fig. 102) is frequently used. The head, or block, is tapped to receive a stud which may be made to any desired length and on which a thread is cut on both ends. The head of the bolt can be inserted into the T-slot and moved along to the desired position. The stud is then screwed into the head as far as the shoulder of the thread will permit. The shoulder will prevent further turning of the stud in the head when the nut is being tightened. The assembled bolt, likewise, is held in the slot by the head. A nut and a washer are furnished with each bolt.

Bolts, alone, are limited in their use to objects that have holes or slots to receive them. Used with clamps, bolts may be utilized for innumerable purposes.

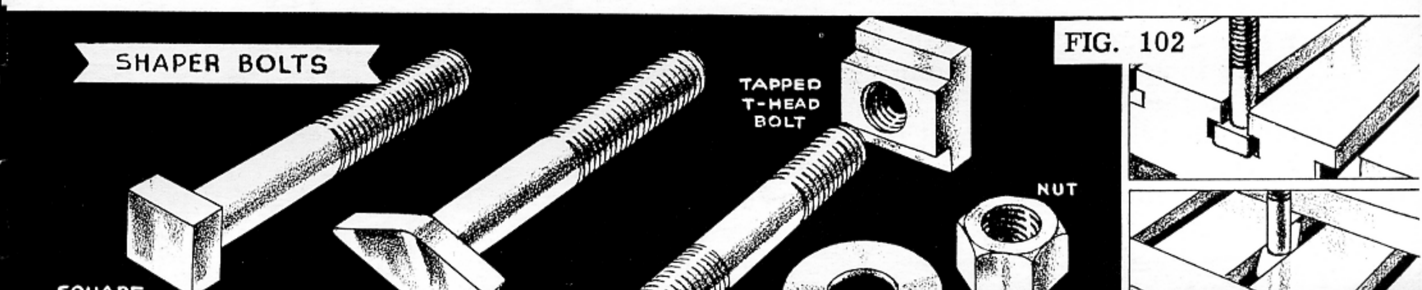


FIG. 102

STRAPS OR CLAMPS

Clamps are designed to hold objects which have a wide range of sizes and shapes. Usually, the styles purchased from the manufacturers are sufficient for most purposes. However, there are occasions when special ones must be made. As clamps are subject to severe usage, they should be made of tough steel and heat-treated.

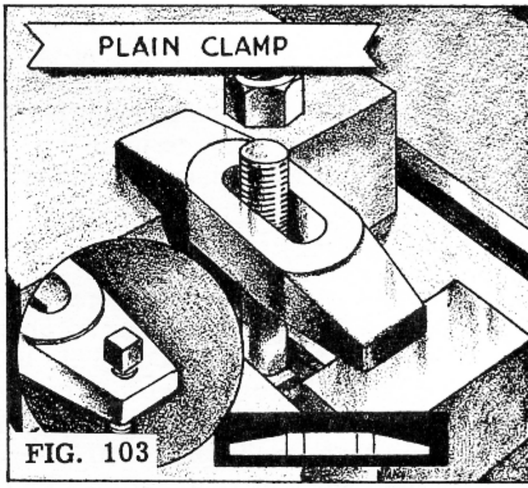


FIG. 103

The plain clamp illustrated in Fig. 103, is stiff and strong and is used for general clamping purposes. It is made with an elongated slot, or hole, through which the T-bolt passes. The bottom of the clamp is flat while the top and the sides taper. The shape of the work to be clamped must be such that the clamps can be placed in a position which will not interfere with the machining of the surfaces.

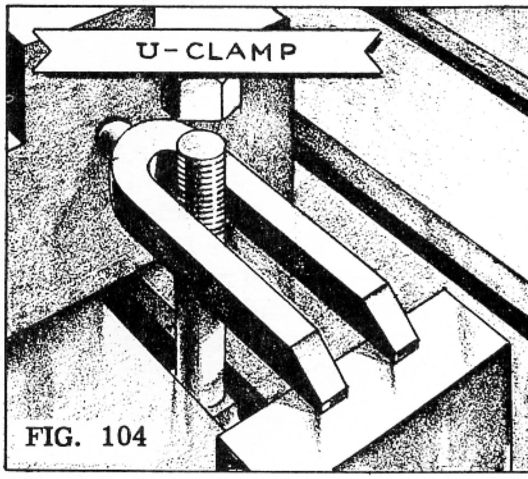


FIG. 104

An exceedingly useful clamp is the U-clamp (Fig. 104) which is made with a continuous slot, and is open at one end. The U-clamp has an advantage over the plain clamp which has a closed slot because it can be removed without taking the nut off the T-bolt. Also, the bolt can be located in the most advantageous position for clamping by pushing it along the slot in the clamp.

The disadvantage of the U-clamp is that it has a tendency to spread and bend under heavy clamping pressure. The U-clamp may be purchased with or without a finger.

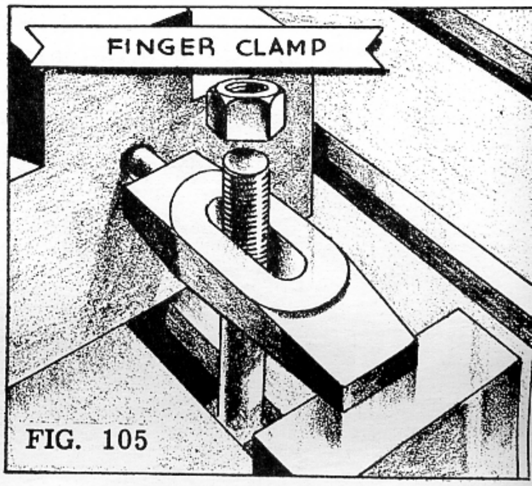


FIG. 105

When a finger clamp (Fig. 105) is used, the finger is usually supported in a drilled or cored hole in the work. This is a convenient method of holding the work without interfering with the machining operations. However, drilled holes may be objectionable so unless a cored hole is available, another type of clamp must be used.

Duplicate pieces with cored or drilled holes in their sides can be held with a double finger clamp illustrated in Fig. 106. As the double finger is a little shorter than the usual style of clamp, the work can be placed so that one bolt will clamp the two pieces.

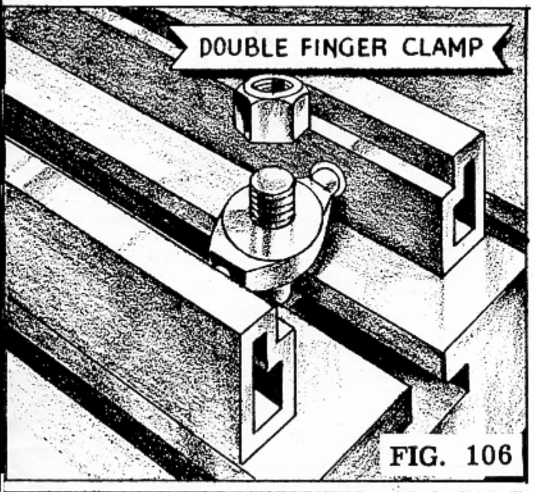


FIG. 106

A gooseneck, or offset clamp is shown in Fig. 107. The offset feature of this clamp allows the top of the clamping bolt and the nut to be below the surface to be planed.

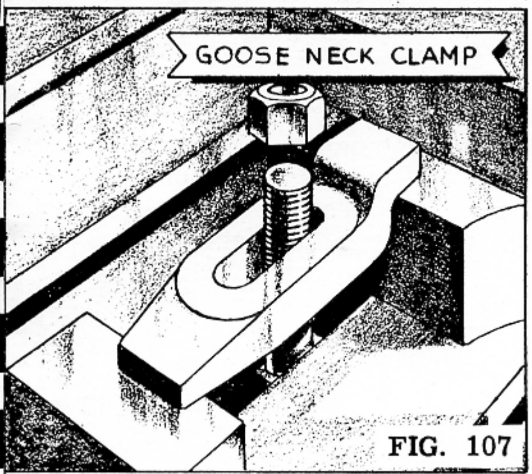


FIG. 107

The adjustable clamp shown in the insert (Fig. 103) is similar to the plain clamp, except that the adjustable clamp has a set screw in a tapped hole opposite the clamping end. This adjustable device allows the back of the clamp to be raised or lowered by turning the screw. By this means, the clamp may be quickly adjusted to the height of the clamped surface without the use of packing strips. The single-point contact of the screw may or may not be an advantage.

If the part to be clamped has a curved surface, there will be a tendency for the clamp to slide off the work. In contrast, if the clamped surface were flat but set at an angle causing the clamp to be tilted slightly sideways, then the single-point contact of the screw would be an advantage. The final decision, as to whether an adjustable clamp or a plain clamp is to be used, must be left to the judgment of the individual.

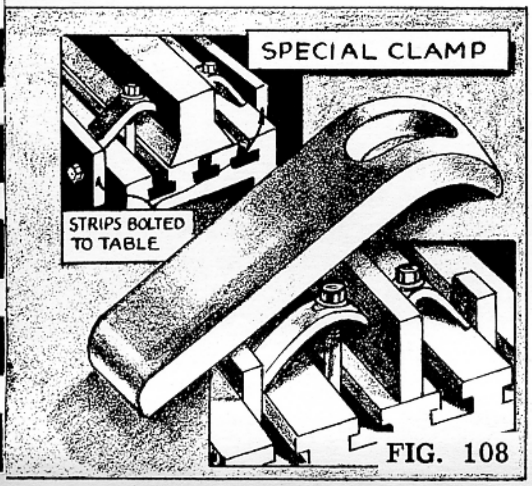


FIG. 108

The clamps previously described are usually adequate for most clamping purposes. Occasionally, a special clamp is preferred, such as the one illustrated in Fig. 108. The clamps are placed between stops inserted in the table slots and the work to be clamped. When the nuts on the bolts are tightened, the work is forced downward on the table. It should be noticed that four slots in the table are required for this set-up; whereas most shaper tables are provided with three slots. This deficiency can be overcome if a strip is clamped on both sides of the table and allowed to project above the top of the table about one inch in order to take the thrust of the clamps. (See Fig. 108).

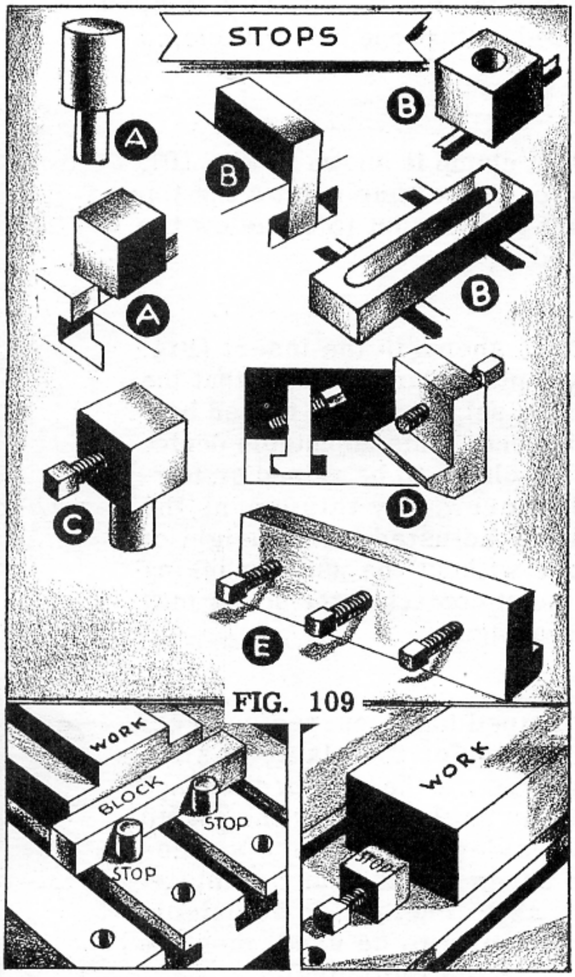
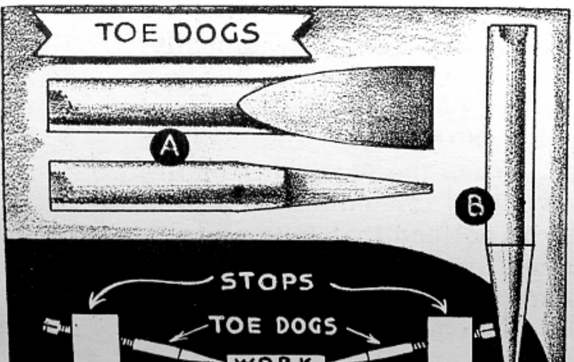


FIG. 109

STOPS

Stop pins (Fig. 109) are used to prevent movement of the work on the table. They can be placed at the ends or along the sides of the work in order to take the thrust of the tool, or they can be used to hold the work to the table. For locating the stops in relation to the work, the table is provided with holes in addition to the T-slots. Plain stops, as shown at (A) may be round or square pieces of steel turned down at one end to fit the table slots or the reamed holes in the table. Often, stop pins are plain blocks (B) which can be inserted into the table slots. They may also have holes drilled or slots cut through the center so that they can be held to the table with bolts. Others, (D) are provided with steps which catch on the underside of the T-slots. These are inserted in the ends of the T-slot and then pushed along to the required position. The stops, illustrated at (C), (D) and (E) are tapped to hold set screws which can be tightened directly against the work or can be used in connection with toe dogs (Fig. 110). The screws are set either straight or at an angle. Those set straight take the thrust of the tool; ones inclined at an angle are used to exert a downward pressure when the work is being held.

FIG. 110



TOE DOGS

A similar method of holding work is employed when thin material is held on the table with toe dogs (Fig. 110). The dogs are forged from round stock with either a flat end as shown at (A) or a pointed end as shown at (B). At the opposite end, a counterbored hole receives the end of a screw, which is used to force the toe dog against the work. The narrow edge or the point of the dog, whichever is used, allows clearance for the tool when thin metal is being planed. The slight angle at which the dog is set holds the work securely to the table.

HOLD-DOWNS

Hold-downs (Fig. 111) are thin, wedge-shaped pieces of hardened and ground steel used principally to hold work in the vise. The larger edge, which is placed against the vise jaws, is ground at an angle of 92° with the underside. The thin contact edge is left square with the bottom, or, is rounded slightly. When the job and the hold-downs have been placed in position, and the jaws of the vise are tightened, the hold-downs are tilted slightly to a position which forces the work down on the supporting surface.

This method is used to hold flat work (Fig. 111) which cannot be held conveniently by other methods. It is especially suitable for holding thin metal and on jobs when a small amount is to be removed from the surface. With this arrangement, the work can be held securely without distortion. At the same time, there is ample room for manipulating the shaper tool.

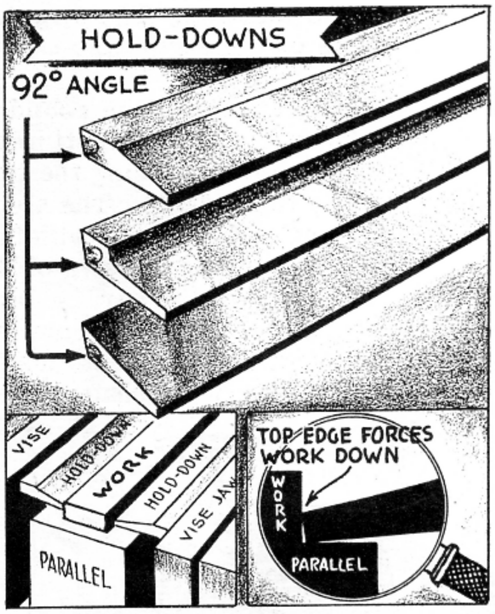


FIG. 111

ALIGNING STRIPS, OR BARS

Aligning strips (Fig. 112) are placed on the shaper table as a guide to setting the work parallel, at 90°, or at an angle to the direction of the stroke. They may be used also as stops against which the end of the material may be placed when duplicate lengths are being cut off from a piece of stock. Aligning strips can be plain bars, as illustrated at (A) and (B). They may both be held to the table with clamps and bolts and, in the case of (B), with bolts which pass through the slot. These strips may be located and set in any desired position on the table. They should be securely braced with stops to prevent their shifting if the work is held against the strips with set screws.

The two styles of aligning strips illustrated at (C) and (D) are provided with tongues which fit into the table slots. This limits the use of these strips to being set parallel with the travel of the tool as shown in the inserts (E) and (F). The tongues, however, make possible a quick and easy alignment of the strips

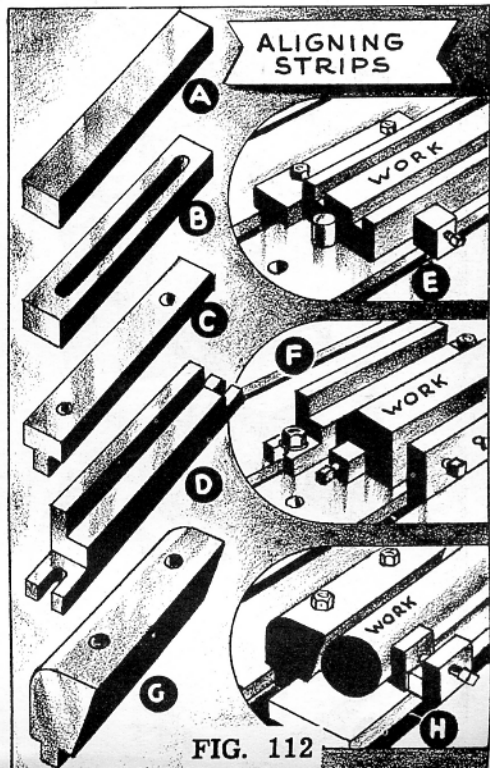


FIG. 112

parallel with the direction of the cut. In addition, the tongues prevent the strips from shifting. The aligning strip shown at (F) may be reversed so that the high side of the strip also can be placed against the work. Refer to Fig. 112.

To locate and align round shafting on the shaper table, the angular aligning strip shown at (G) is sometimes used. The strip is aligned parallel with the direction of the cut by placing the tongue of the strip in the table slot (H). Bolts secure the strip to the table. The sloping face of the aligning bar is made so that it will form an angle of about 80° with the top of the table. When the round shaft is forced against the bar by the screws of the stops, the shaft will in turn be forced downwards by the slope of the bar. A binding piece is inserted between the screw and the shaft to protect the shaft from the end of the screw and to present a flat surface for the point of contact. See Insert (H) in Fig. 112. As the center of the screw is above the center of the shaft, the packing block is placed at the bottom of the binding piece.

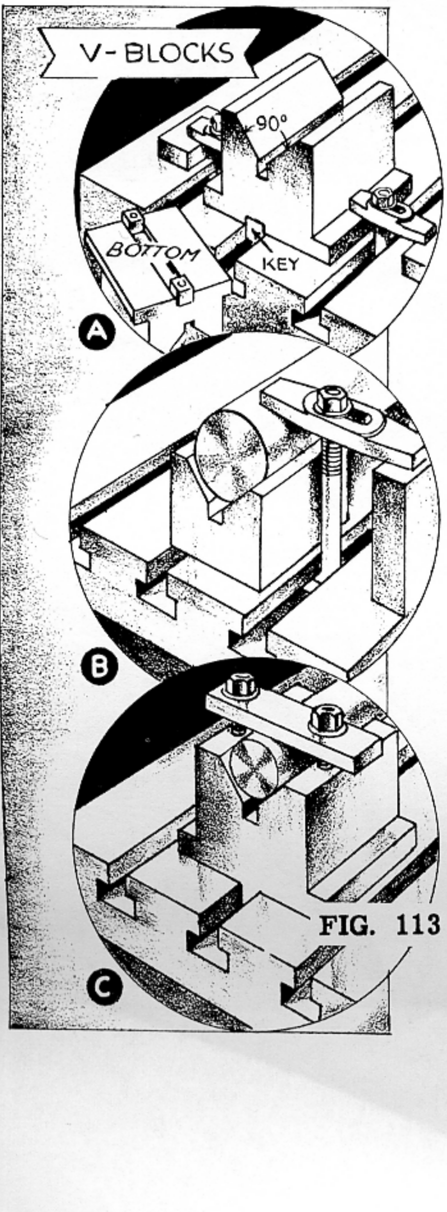


FIG. 113

V-BLOCKS

In addition to the method of placing shafts and round pieces directly on the shaper table, round work may be held in rectangular blocks with 90° V-shaped openings cut in one or more of their sides. Shafts are usually many times longer in proportion to their diameters. For this reason,two blocks are ordinarily used to support the work. As the openings resemble a "V", they are called V-blocks (Fig. 113).

Although styles of V-blocks vary considerably, the two most practical styles are those illustrated at (A) and (B). The one illustrated at (A) has a flange on the base. This flange is used to support clamps when the block is clamped to the shaper table. On the underside of the block is a rectangular groove which is cut the entire length of the V-block and into which square blocks, or tongues, are inserted. These are held in place with screws. The tongues project below the under surface of the V-block so that when the V-block is placed on the table the tongues fit into the table slot and align the V-block parallel with the direction of the cut. Although this is an advantage, it limits the position of the V-block to placing it central with the table slots. Because of the spacing of the slots on the table, the clamping bolts cannot always be placed near enough to the work that they are intended to clamp.

For this reason,the tongues can be removed from the underside of the V-block so that they can be placed nearer to the clamping bolts. Although it is a simple matter to remove the tongue, it saves time to have available V-blocks without tongues, as illustrated at (B). With this style, the flange also has been omitted so that the V-block can be placed as close to the clamping bolt as possible. Time and care, however, are required to align or set this style of V-block in the desired position.

Occasionally, special V-blocks such as those illustrated at (C) can be used. This type of V-block has the advantage of having tongues so that it can be aligned quickly and accurately with the direction of the stroke. It is provided also with flanges which permit it to be clamped to the table. In addition, it carries its own clamping device to hold the work in position. This eliminates the need of shifting the V-block so that the clamping bolts can be placed near the work.

ANGLE PLATE

Work and odd-shaped castings which must be held at right angles to a finished surface can be held by clamping the finished surface to an L-shaped device called an angle plate (Fig. 114). These angle plates are made either of steel or cast iron and are accurately machined to an angle of 90°. Usually, angle plates for shapers are made of cast iron with a rib in the center to support the two sides. Some angle plates have elongated holes through which bolts pass to hold the work to the angle plate and to bolt the angle plate to the table.

On the underside of the base of the angle plate (B) are cut two rectangular slots at 90° to each other. Into these slots tongues or keys may be fitted and held in position with screws. The tongues may be placed in either one of the slots, depending on whether the angle plate is to be placed parallel or at 90° with the direction of the cut.

The bolt slots in the base are cut parallel with the length of the angle plate so that when the tongues are located in the T-slot, as illustrated at (A), the holes will extend over to the adjacent T-slots.

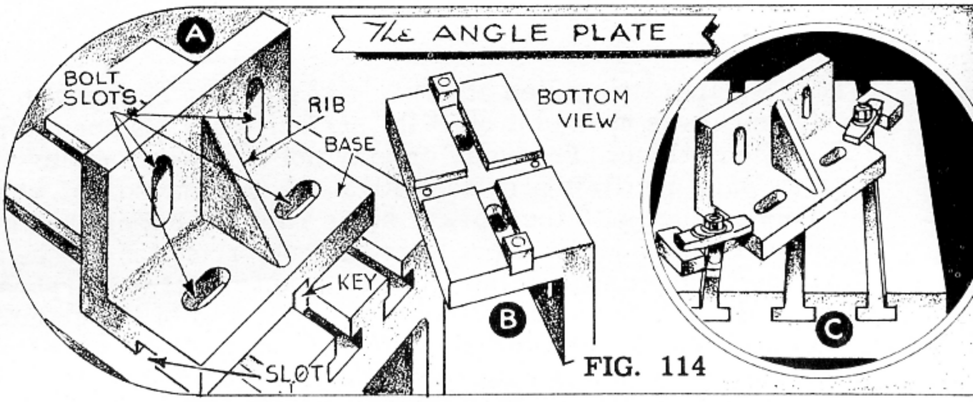


FIG. 114

Whenever it is necessary to set the angle plate on the shaper table at an angle with the direction of the cut, the tongues may be removed entirely from the rectangular slots. To avoid changing and removing the keys, an angle plate (C) with a plain base may be used. Refer to Fig. 114. Also, because of the position of the angle plate on the table, it may not be possible to use the bolt holes in the base. If this should be the case, the angle plate must be fastened to the table with clamps. Stops also may be necessary to prevent the plate from shifting. Often by rearranging the set-up or by shifting the angle plate slightly on the table, one of the bolt slots may be utilized to hold one side of the plate. Clamps may then be used to secure the remaining portion. Bolts which pass through slots or bolt holes have a greater gripping power because of their direct gripping action as compared with the lever action of the clamp. Bolts should be used whenever practical when two surfaces are being clamped together.

C-CLAMPS

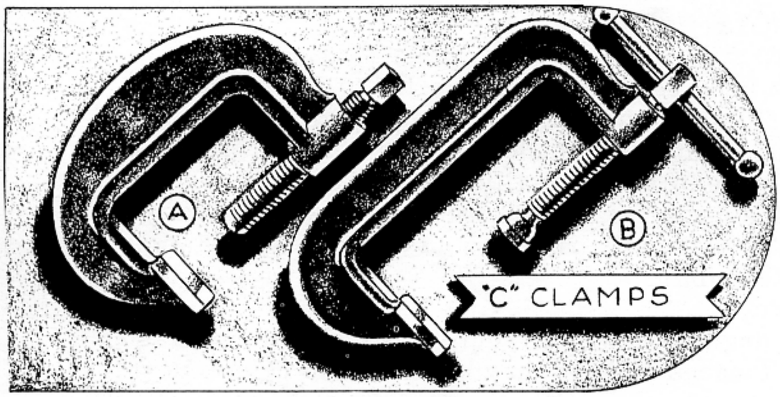


FIG. 115

There are times when clamps and bolts cannot conveniently be employed to hold parts together, and for this reason other clamping devices have been designed which may be substituted. One of these devices is the "C-Clamp" illustrated in Fig. 115. As the name implies, the clamp is shaped like the letter (C). The clamp should be made of tough steel and heat treated after forging to increase its strength and to reduce any tendency to spring. The parts to be held together are clamped between the pad and the end of the screw. When pressure is applied by turning the screw, the pieces are held tightly together.

The C-clamp illustrated at (A) is a heavy-duty clamp with a plain screw. Unless some means is used to protect the surface being clamped, the end of the screw will mar the surface. This may or may not be objectionable. To overcome this, the screw in clamp (B) is provided with a swiveled end so that when the end of the screw makes contact with the work it stops rotating but allows the screw to continue to turn and apply additional pressure. Added protection for the surface being clamped may be obtained by placing a piece of soft metal or cardboard under the swiveled end of the screw and another piece on the pad of the clamp. The swiveled end of the screw has an additional feature in that it allows the swiveled end of the screw to align itself against a tapered or an irregular surface.

The styles of clamps vary considerably. For light clamping purposes, the one illustrated at (B) can be used. For use when considerable clamping pressure is required, the heavy-duty clamp illustrated at (A) is preferable. Special styles may be purchased as desired.

When the size of the clamp is being designated, the distance between the end of the screw and the pad of a fully opened C-clamp is called the capacity. The distance from the center of the screw to the inside edge of the C-clamp is termed the throat. Ordinarily, C-clamps are made with the narrow throats because there is less strain on the clamp when the distance from the screw to the back of the clamp is short. Should it be necessary that the screw applying the clamping pressure be at some distance from the edge of the clamped surface, then a C-clamp with a deep throat must be used. C-clamps are quickly and easily adjusted, and are convenient and handy when used in the correct situation.

MACHINIST'S CLAMPS

Another style of clamp that is used considerably is the machinist's, or parallel, clamp (Fig. 116). This clamp is especially suitable when the pieces to be held together are parallel and have a machined finish.

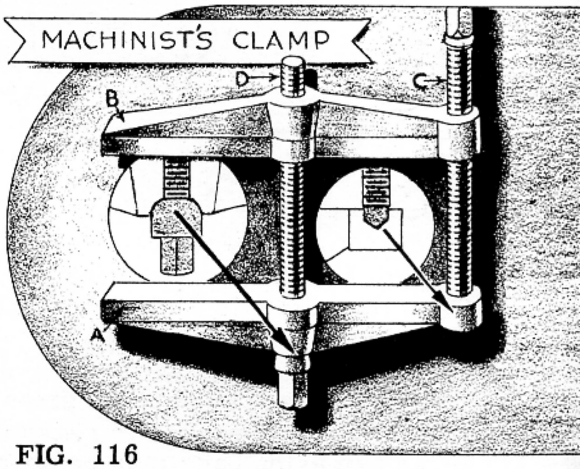


FIG. 116

The machinist's clamp consists of two screws and two jaws which embody the same principle of gripping as do the clamps and bolts. The exception is that the machinist's clamp is self-contained and needs no additional support. Screw (C) takes the place of a supporting block and can be adjusted to suit the width of the surfaces to be clamped. Similarily, screw (D) is substituted for the clamping bolt which is used to apply the clamping pressure. The shoulder of the center screw (D) has been made convex to rest on a concave seat which iscut in the outer side of the jaw (A). This construction allows the jaws to tilt slightly. The end of the screw (C) is turned down to fit loosely into a blind hole that is drilled in the face of the jaw and toward the end.

The jaws are made of tough, drop-forged steel. Together with the screws they are heat treated to increase their strength. Both holes in the jaw (B) are threaded. The holes in the jaw (A) are plain. When the clamp is adjusted properly, it holds very securely. If a strip of soft metal or cardboard is placed between the jaws and the clamped surface, the jaws of the clamp will not mar the work. The machinist's clamp is light, handy, and convenient, but not strong.

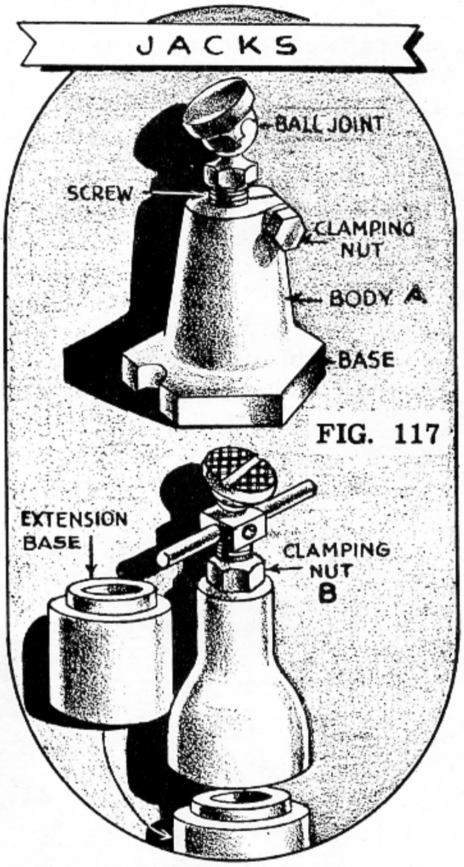


FIG. 117

JACKS

In spite of all the clamping devices and methods of holding work on the shaper table, it is not always possible to level work or to support overhanging pieces properly without the aid of a jack (Fig. 117). A jack can be easily slipped under the work, the screw adjusted to the height of the supported surface, and then the screw locked in position, so that it does not jar loose.

The body of the jack (A) is threaded to receive the screw which may be raised or lowered by turning. The screw has a ball joint at the top, which allows the end to swivel and to bear evenly against the surface of the work.

Without some form of locking device, the screw of the jack would be jarred loose by the vibration of the machine. To overcome this, the body of the jack is split at the upper end so that when the clamping nut is tightened the threaded portion of the screw is gripped and held securely. This, however, is not the only type of locking device. Sometimes an extra nut is placed on the screw near the top of the jack as illustrated at (B). After the top of the screw has been set to the height of the supported surface, this extra nut is given a partial turn clockwise. Thus the screw is locked tightly by being drawn against the thread in the body of the jack.

Jacks are made in various sizes to accommodate different heights of work. If a jack is not high enough to reach the work, a small jack may be placed on a block, or an extension base may be used (Fig. 117).

When a bolt and clamp are used to hold an overhanging surface, a jack placed underneath the work makes a very suitable support. Jacks, then, are a very convenient means of leveling, bracing, and supporting work. A set of jacks should always be available, especially when a large variety of work must be set up on the shaper table.

SHIMS AND WEDGES

Whenever a rough casting or uneven work is to be secured directly to the shaper table, the uneven surfaces must be supported to prevent rocking. It is especially important to have a solid foundation under the part to be clamped. This support will prevent any spring or distortion due to the pressure of the clamps (Fig. 118). As these spaces are usually small, thin strips of metal called "shims", wood, cardboard, or paper, are used as packing.

Sometimes it is more practical to use a wedge, which is a piece of steel thinner at one end than at the other (See Fig. 118). The thin end of the wedge can be inserted into the space (Fig. 118) and then tapped slightly to make a solid base. When work must be leveled on the table, the wedge is often preferred because the low spot can be easily raised by inserting a wedge at the proper place and tapping or driving it in as may be required. Although wedges and shims can be made of almost any material, they are usually made of metal.

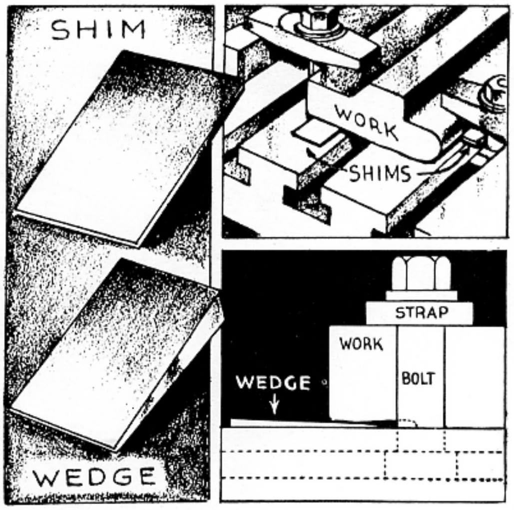


FIG. 118

PACKING AND STEP BLOCKS

Square or rectangular blocks (Fig. 119) are used to support straps, or clamps, at the end opposite the work. As the clamp must be level to obtain maximum gripping power, blocks are made in various sizes so that they can be used singly or in combination and in such a manner that the height of the supporting surface is the same as that of the work. Although packing blocks are made of metal, wood blocks are often substituted.

To suit the various heights to which the end of the clamp must be supported, the step block (Fig. 119) with its series of raised surfaces is an exceedingly handy piece of equipment. Although it is difficult, in all cases, to foretell at what height the clamp must be supported, the slight variation between the height of the selected step and the height of the work can be eliminated by putting a thin packing strip between the clamp and the step to be used.

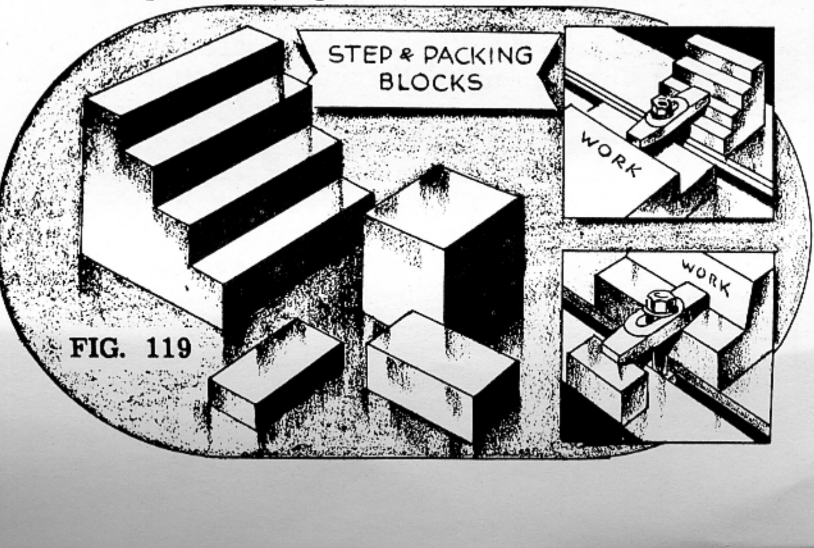


FIG. 119

FIXTURES

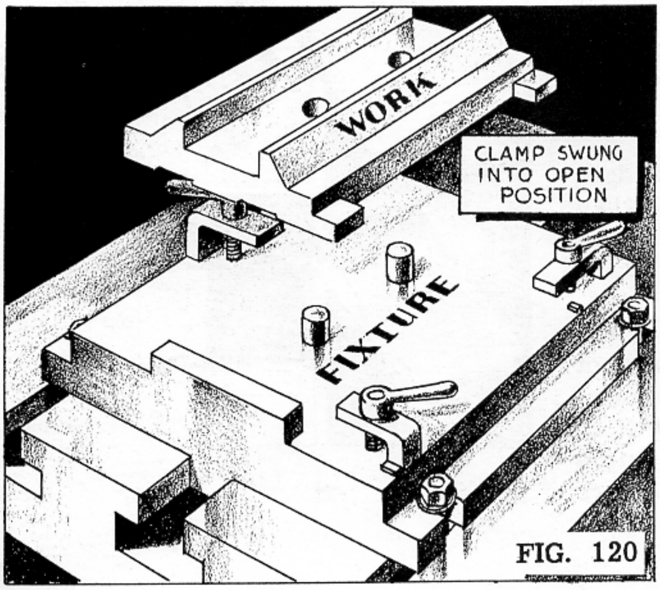


FIG. 120

A fixture (Fig. 120) is a special device designed to hold irregularly shaped jobs which cannot be held by the usual methods, and to hold pieces which are required in large quantities.

Both the fixture and the tool are moved during shaper-machining operations. For this reason a fixture for shaper work is used principally as a holding device. The larger fixtures are usually fastened to the table; the smaller ones are often held in the vise.

A good fixture is made so that the work is located accurately, secured quickly and firmly, and released easily.

Whether or not a fixture should be used depends upon many factors. If there are a large number of pieces to be made and if the cost per piece can be reduced by using a fixture, one may be justified. Odd shaped pieces that are awkward to handle and require considerable time to set up may often be easily and quickly clamped in a fixture. On the other hand, to make a fixture for one or two pieces, even if the pieces are difficult to hold by the usual methods, may not warrant the cost.

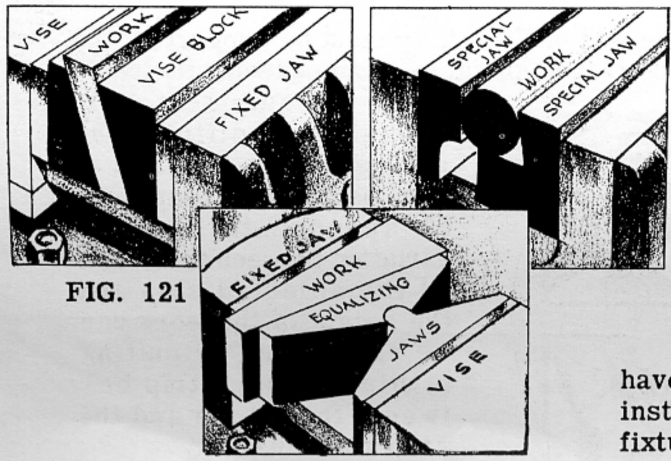


FIG. 121

SPECIAL VISE JAWS

Special vise jaws and shaped vise blocks, although not ordinarily classified as fixtures, have a great many possibilities for holding work which would be difficult to hold in any other way. Only three simple examples are given in Fig. 121. However, it should be remembered that these holding devices have a great many adaptations and in many instances can be used instead of expensive fixtures.

HOW TO MOUNT WORK-HOLDING DEVICES

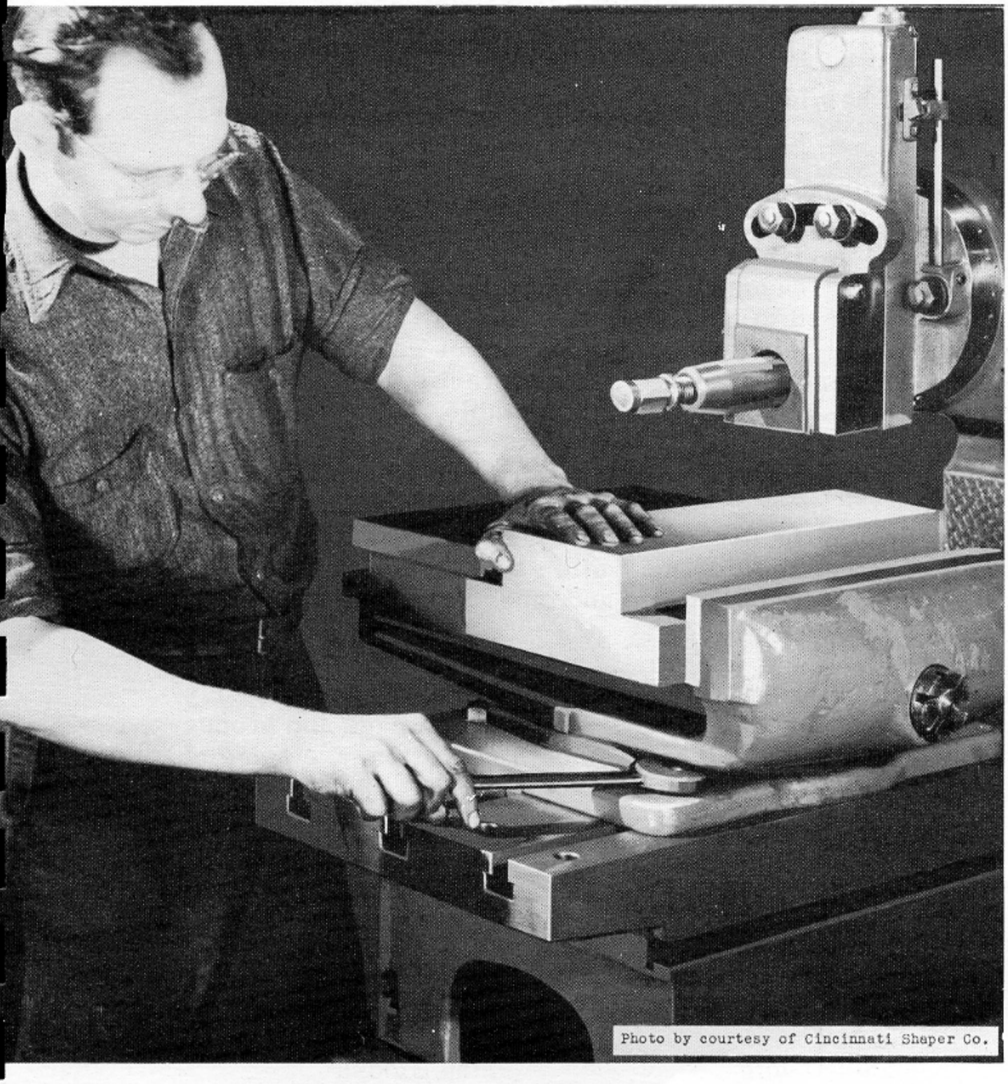
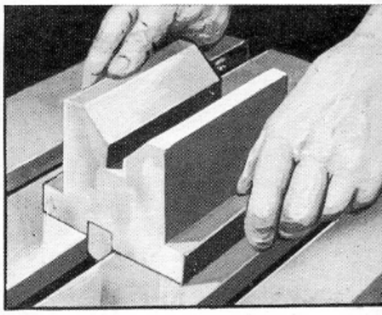
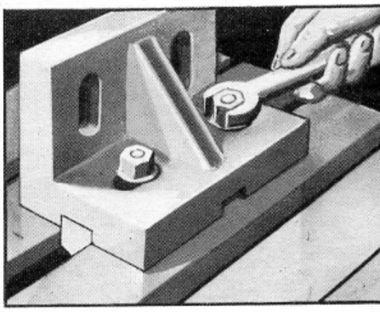


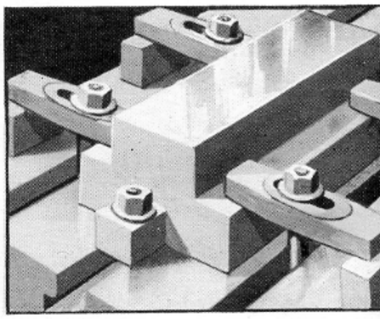
Photo by courtesy of Cincinnati Shaper Co.



MOUNTING V-BLOC



MOUNTING ANGLE-PLA



MOUNTING WORK ON TAB

UNIT P 52 (B)

Part III Pages 117 - 150

HOW TO MOUNT WORK-HOLDING DEVICES

OBJECTIVES OF UNIT

1. To show how to mount and dismount the shaper vise.
2. To tell how to set the vise parallel, at 90°, and at an angle with the direction of the stroke.
3. To illustrate how to use other work-holding devices.

INTRODUCTORY INFORMATION

Of all the work-holding devices, the vise is the most extensively used. It is heavy and awkward to handle and for this reason it should not be taken off the table unless some other method is to be used to hold the work. If more than one shaper is available, and if the shapers are being used for a variety of work, it is sometimes convenient to keep one shaper for vise work. This practice saves the time and labor required to mount and dismount the vise on the table.

In addition to vises, there are many types of holding devices ranging from the simple clamp to more specialized devices designed to meet the requirements of a special piece of work. Although the devices illustrated in this section are of standard design, the experienced operator may often be able to suggest slight modifications which would save considerable time and labor when the job is being set up.

Finally, it is important that all work-holding devices be carefully and properly stored when not in use. Proper storage of the parts to prevent damage and proper cleaning and oiling to prevent rust and to insure smooth operation, are some of the essential routine duties of the good mechanic.

TOOLS AND EQUIPMENT

Shaper	Necessary Wrenches	Angle Plate
Parallels	Slot Cleaner	Mill File
C-clamps	Lead Mallet	Packing Strips
Stops	Cleaning Cloth	Step Blocks
Toe Dogs	T-head Bolts	Wedge and Shims
Hold-downs	Magnifying Glass	Special Vise Jaws
V-blocks	Shaper Vise	Square and Protractor
Jack	Assorted Clamps	Tissue Paper
Fixtures	Machinist's Clamps	Indicator
Brush	Aligning Strips	Oil Can

HOW TO MOUNT A SHAPER VISE WITH A DETACHED BASE ON THE SHAPER TABLE

PROCEDURE

FIG. 122

1. Reread the description of the vise with detachable base. Note that the base is separate from the vise body and three bolts are used to hold the vise and the base to the shaper table.

2. Clean the table.

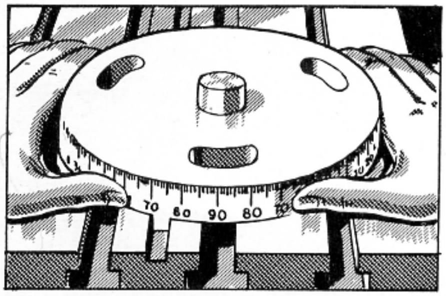
3. Draw the slot cleaner (Fig. 122) through the entire length of the table so that all dirt and chips are removed.

4. Brush off the chips from the table top before and after cleaning the chips from the slots (Fig. 122).

5. Wipe the table top clean with a cloth or wiping rag.

6. Inspect the surface of the table for burrs. If burrs are present, remove them with a file. Use care when burrs are being removed so that the table is not damaged by excessive filing or scraping the surface.

FIG. 123



7. Clean thoroughly the base of the vise. Be sure that all chips are removed from the slots to prevent them from getting between the underside of the base and the table top (Fig. 123).

8. Place the base on the table with the graduations toward the front (Fig. 123).

9. Align the key attached to the base with the key slot in the table and lower the case.

10. Clean thoroughly the body and the base of the vise (Fig. 124).

    NOTE: If preferred, a bar can be tightly held between the vise jaws so that this end of the vise can be held securely when it is being lowered onto the base.

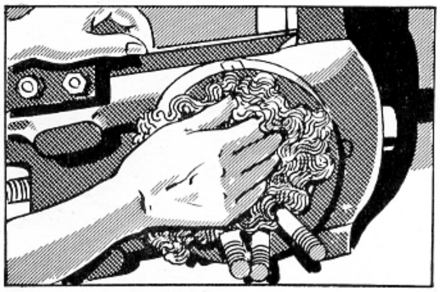


FIG. 124

CAUTION Two or three persons may be needed to mount the vise on the base to prevent personal injury through strain and also to avoid damage to the vise.

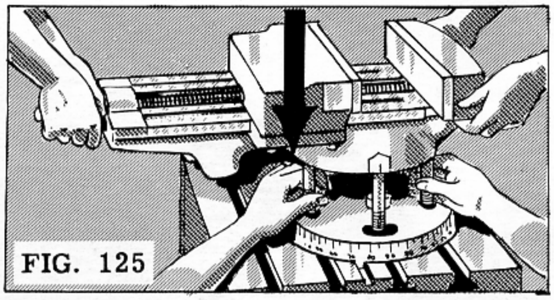


FIG. 125

11. Hold the body of the vise above the base and place the bolts around the T-slot so that they are aligned with the slots in the base (Fig. 125).

12. Lower the vise carefully to the base. Be sure that the pilot upon which the vise swings enters the recess in the vise body.

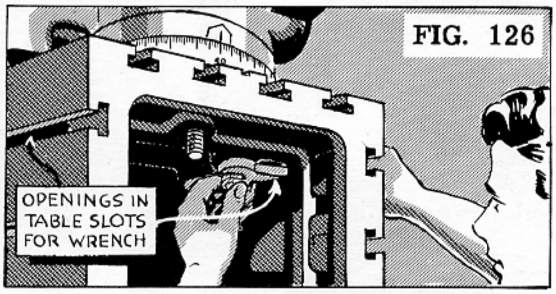


FIG. 126

CAUTION Arrange the bolts approximately in position before lowering the vise. The final adjustments must then be made with a rod. Under no circumstances must the fingers be placed between the vise and the base at this time.

13. Place a washer and a nut on each of the three bolts as they protrude through the table. Screw the nuts on just far enough to hold the vise and the base to the table (Fig. 126).

14. Rotate the vise until the zero mark on the vise coincides with the desired graduation on the base, and tighten the nuts securely.

HOW TO MOUNT A SHAPER VISE WITH A CLAMP-RING BASE

1. Reread the description of the shaper vise with a clamp-ring base illustrated on page 100, Fig. 91. Note that the base acts as a clamping ring. In the illustration, the base is shown separated from the vise in order to make clear the construction and method of clamping. However, the base is not removed when the vise is mounted on or taken off the table.

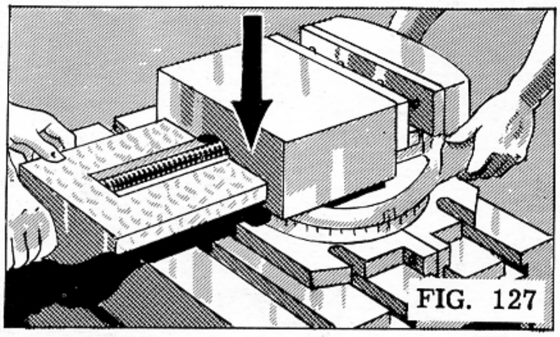


FIG. 127

2. Clean the table and the base of the vise. Remove burrs.

3. Place the vise, with base attached, on the table with the graduations toward the front (Fig. 127).

4. Align the key attached to the base with the selected T-slot. Then lower the base and the vise to the table.

5. Place a bolt in each end of the two table slots which correspond to the bolt slots in the base of the vise (Fig. 128). Be sure that the two back bolts can be placed in the table slots after the base is placed on the table.

6. Move the bolts along to enter the slots in the vise base.

7. Place a washer and a nut on each of the bolts and screw them on just far enough to hold the vise in place (Fig. 128).

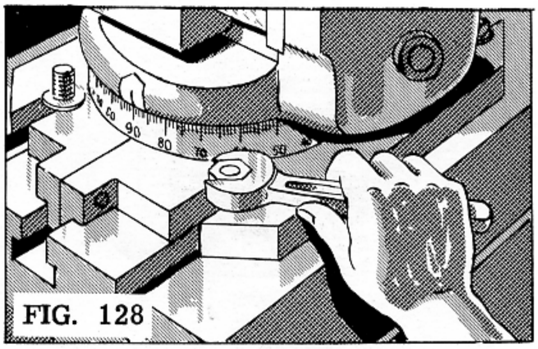


FIG. 128

8. Move the vise around to the desired position and tighten the four bolts. The vise and the base will then be secured to the table and will not shift under the heaviness of cuts.

HOW TO MOUNT A SHAPER VISE WITH AN INDEPENDENT BASE

1. Reread the description of the shaper vise with independent base. Note that the base is clamped to the table independently of the vise. The base is not detached, though, when the vise is mounted on or taken off the table.

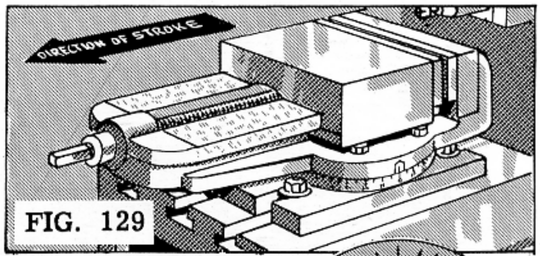
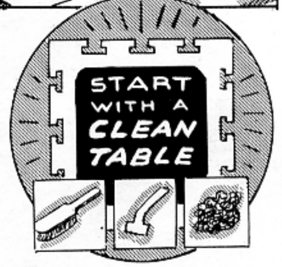


FIG. 129

2. Clean the table and vise base and remove burrs.



3. Place the bolts in the table slots before lowering the vise to the table, provided the base has bolt holes instead of slots. If the base has slots instead of bolt holes, the bolts may be moved into place later.

4. Allow the bolts to enter the bolt holes in the base. Then lower the vise and the base to the table.

5. Place a washer and a nut on each bolt and tighten the four nuts (Fig. 130). These will hold the base to the table.

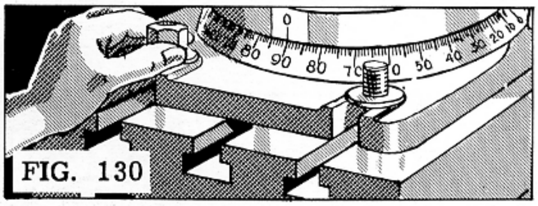


FIG. 130

6. Rotate the vise until the zero mark on the vise coincides with the desired graduation on the base (Fig. 131).

7. Tighten the four nuts on the vise. These will secure the vise in position on the base (Fig. 131).

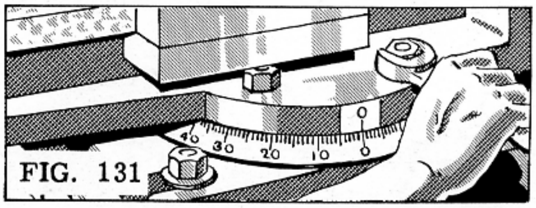


FIG. 131

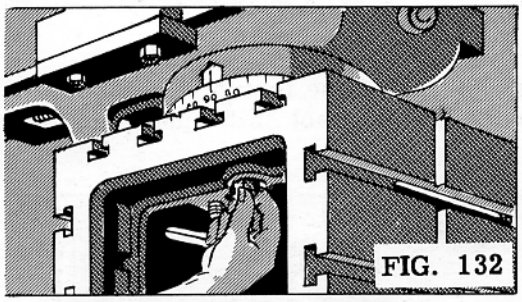


FIG. 132

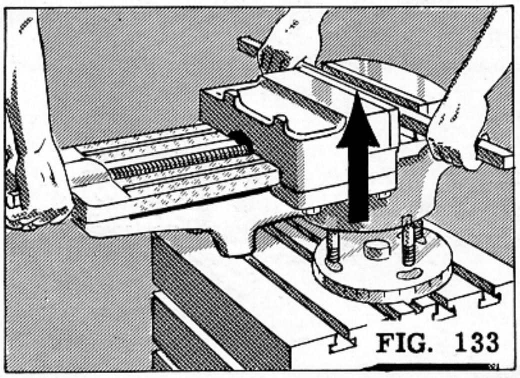


FIG. 133

HOW TO DISMOUNT A SHAPER VISE WITH A DETACHED BASE

1. Brush off all chips from the vise and the table.

2. Loosen and take off the three nuts and washers from the clamping bolts which pass through the table and project from the underside (Fig. 132).

   NOTE: A bar can be gripped between the vise jaws in order to provide handles for lifting the vise more conveniently (Fig. 133).

3. Lift the vise so that the bolts clear the base and place it on a bench or a suitable tool stand (Fig. 133).

4. Remove the base from the table (Fig. 134).

5. Clean around the vise screw and other parts that were inaccessible before the vise was taken off the table (Fig. 135).

6. Wipe the parts with an oily cloth to prevent rusting.

7. Assemble the vise and the base and put the nuts and washers on the bolts (Fig. 136).

8. Place the vise on a stand near the machine or store it in an appropriate and safe place to prevent damage or injury to the surface of the jaws or to other parts of the vise.


FIG. 134


FIG. 135

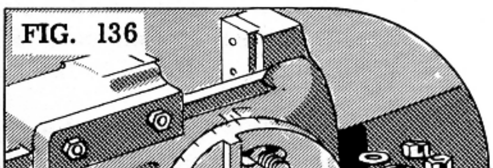
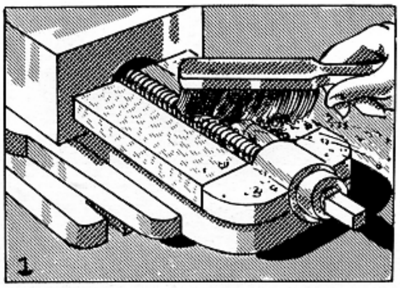


FIG. 136

HOW TO DISMOUNT A SHAPER VISE WITH AN ATTACHED BASE

Although some vises have detachable bases, other vises are attached to the base with a clamp ring or with four T-head bolts, which are held in a circular T-slot in the base (page 100). In each case, the vise is not removed from its base when it is being mounted on or taken off the shaper table.

1. Brush off all chips from the vise and table as shown in Illustration 1.
2. Wipe the vise with a cloth. If a coolant has been used, the vise should be dried with waste or rags.
3. Remove the four nuts which hold the base to the table (Fig. 137).
4. Lift the vise with the base attached. Remove it from the table and place it on a bench or a tool stand large enough to hold the vise (Fig. 138).
5. Clean around the vise screw and other parts that were inaccessible before the vise was taken off the table.
6. Wipe the parts with an oily cloth to prevent rusting.
7. Place the vise on a stand near the machine, or store the vise in an appropriate and safe place to prevent injury to the surface of the jaws or to the other parts of the vise.
8. Remove and clean the T-bolts and place them, with nuts and washers replaced, with the vise.



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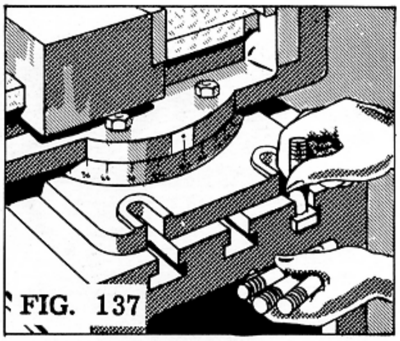


FIG. 137

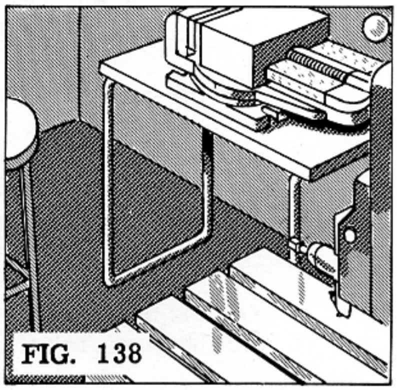
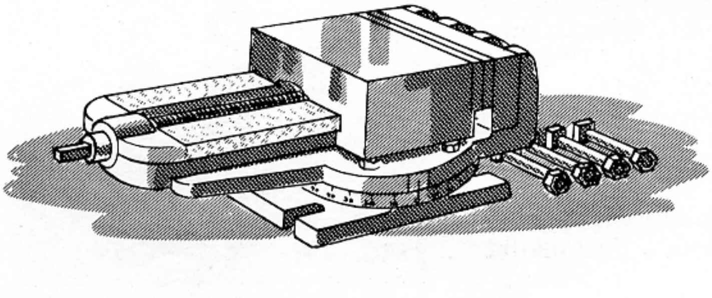


FIG. 138



HOW TO SET THE SHAPER VISE WITH THE AID OF THE GRADUATIONS ON THE BASE

FIG. 139

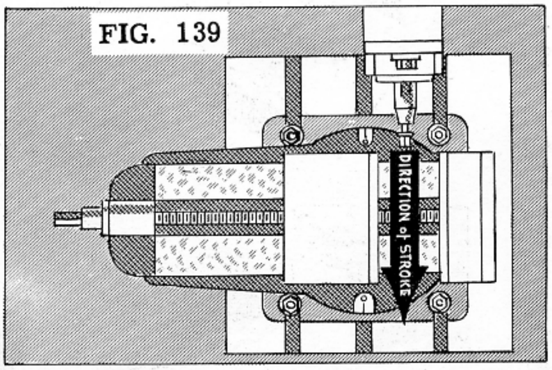
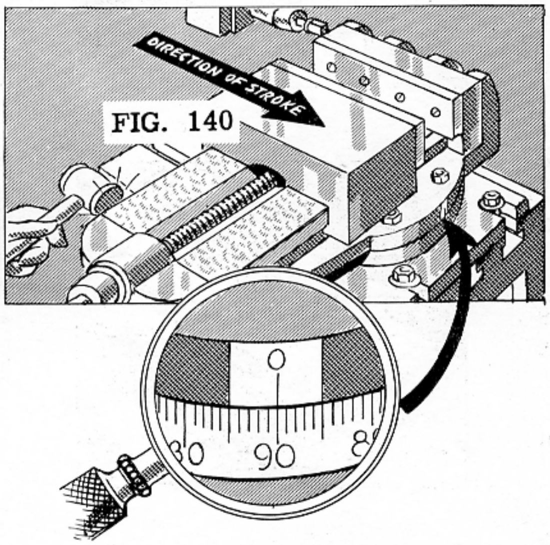


FIG. 140



A. PARALLEL WITH THE DIRECTION OF THE STROKE

1. Loosen the clamping nuts on the bolts just enough so that the vise will swivel on the base.

2. Note whether the bolts hold the vise independently to the base or whether the vise and the base are clamped to the table as a unit.

3. Set the zero mark on the vise with the 90° graduation on the base (Fig. 140).

4. Tighten the nuts on the clamping bolts just enough to hold the vise in place.

5. Tap the vise lightly into position with a lead mallet if it is necessary to adjust the setting. Use a magnifying glass to magnify any slight variation in the position of the matching lines, thereby making it possible to adjust the markings more accurately (Fig. 140).

6. Tighten the clamping nuts securely after the vise has been finally checked and set.

B. AT RIGHT ANGLES (90°) TO THE DIRECTION OF THE CUT

1. Loosen the clamping bolts.

2. Move the vise around until the handle of the vise is toward the front and the two zero marks on the vise coincide with the zero graduations on both sides of the base (Fig. 141).

3. Tighten the nuts on the clamping bolts just enough to hold the vise in position.

4. Examine the setting. If an adjustment must be made, tap the vise into position with a lead mallet.

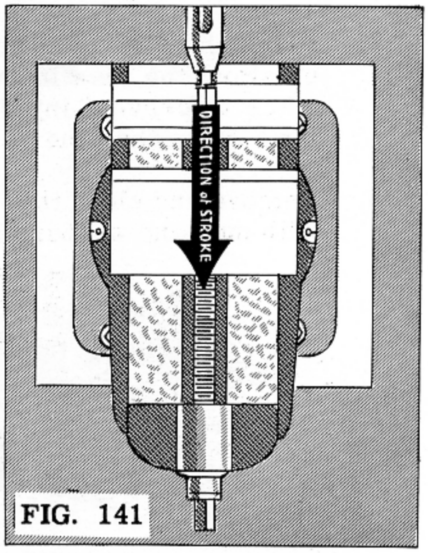


FIG. 141

5. Use a magnifying glass to accurately check the setting.

6. Tighten the clamping nuts securely after the vise has been finally checked and set.

C. AT AN ANGLE TO THE DIRECTION OF THE STROKE

1. Determine the angle at which the vise must be set.

2. Note that the zero position is the one in which the vise jaws are set 90^{o} to the direction of the stroke (Fig. 142).

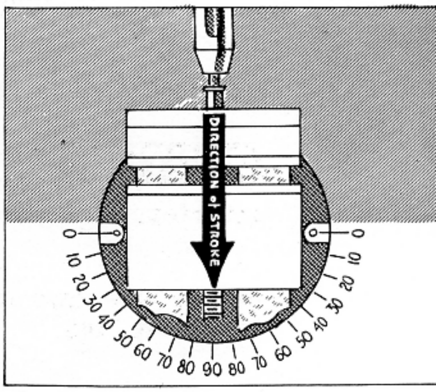


FIG. 142

3. Loosen the clamping nuts and move the vise around from the zero position until the zero mark on the vise coincides with the desired degree on the base (Fig. 143).

4. Tighten the nuts on the clamping bolts just enough to prevent the vise from moving.

5. Check the setting. If it is necessary to make an adjustment, lightly tap the vise into position with a lead mallet. Use a magnifying glass when the setting is being checked accurately.

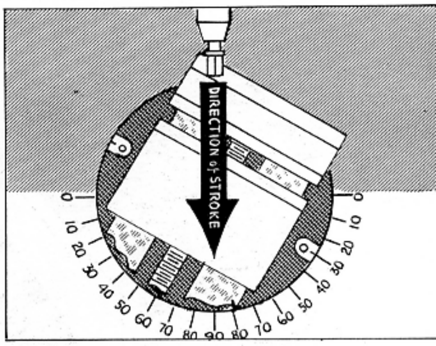


FIG. 143

6. Tighten the clamping nuts securely after the vise has been finally checked and set.

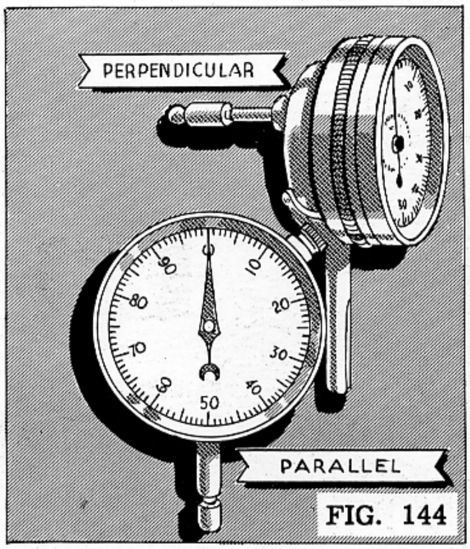


FIG. 144

HOW TO SET THE VISE WITH AN INDICATOR

NOTE: The setting of the vise with the graduations on the base is usually accurate enough for most purposes. When extreme accuracy is essential, other methods must be employed. A very simple and accurate gage for this purpose is the dial indicator, which should always be available in a well-equipped machine shop.

Dial indicators (Fig. 144) are graduated to read either to one-thousandth part of an inch (1/1000") or to one ten-thousandth part of an inch (1/10,000") with the operator estimating the value when the pointer is not exactly on the line representing the basic dimension. Four practices for setting the vise with an indicator are given.

HOW TO SET THE BOTTOM OF THE VISE PARALLEL WITH THE TABLE WITH AN INDICATOR

1. Follow the steps previously covered for mounting the vise.

CAUTION Be sure that dirt does not get between the vise and the table surfaces. A very small particle between the surfaces will interfere with the parallelism of the vise with the table.

2. Set the vise jaws approximately parallel with the direction of the stroke. Refer to Fig. 145.

3. Open the vise to its full capacity.

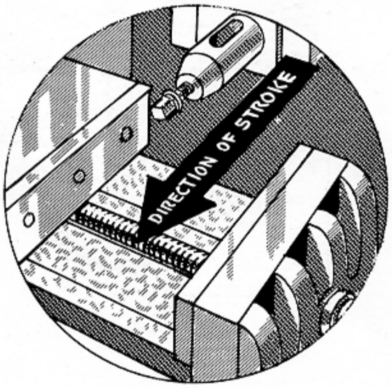


FIG. 145

4. Examine the work seat of the vise for burrs. Carefully remove any that may be present.

5. Clean the surface thoroughly.

6. Select two test parallels high enough to project above the top of the vise jaws and long enough to extend two or three inches beyond the width of the vise (Fig. 146).

   NOTE: If parallels are not available, the indicated readings may be taken directly from the work seat of the vise.

7. Clean the parallels and lay them carefully on the work surface of the vise. Place one against each of the vise jaws.

FIG. 146

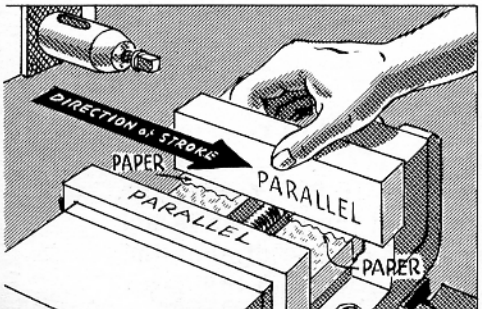


FIG. 147

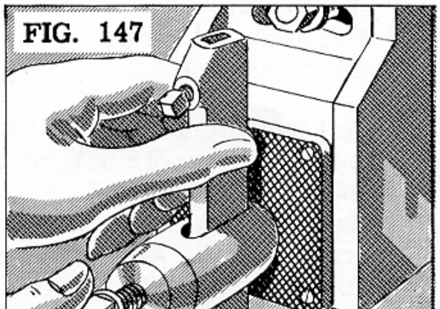
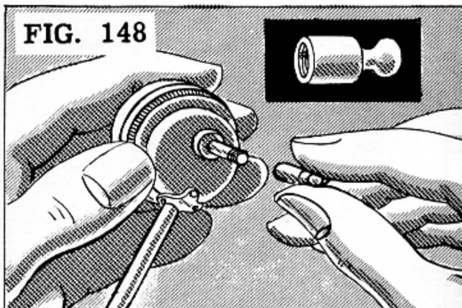


FIG. 148



8. Arrange the parallels against the face of the vise jaws so that they both project evenly beyond the sides of the vise. Some mechanics prefer to place a piece of tissue paper under the ends of each parallel to insure good contact and to prevent slipping (Fig. 146).

9. Select an indicator with the contact shaft perpendicular with the dial (Fig. 144). The dial faces upward and can be conveniently read from the operating position.

   NOTE: Dial indicators are made with two types of contact shafts, one parallel and the other perpendicular to the face of the dial. Figures 149 and 152 illustrate the arrangement for both types of indicators.

10. Reverse the position of the tool holder in the tool post (Fig. 147). This will provide a more convenient surface upon which to place the clamp because the tool end which contains the set screw and the tool has an irregular surface.

11. Attach a small, ball-type contact point to the end of the indicator contact spindle (Fig. 148). This point is simply screwed onto the end of the contact spindle. When necessary, the point can be removed quite easily.

12. Assemble the indicator, the gage-holding rod, the swivel or sleeve, and the clamp (Fig. 150).

13. Clamp the assembled unit to the end of the tool holder with the dial facing upward (Fig. 151).

14. Manipulate the down-feed crank and the cross-feed table control handle until the contact point is about one-half inch above one of the parallels.

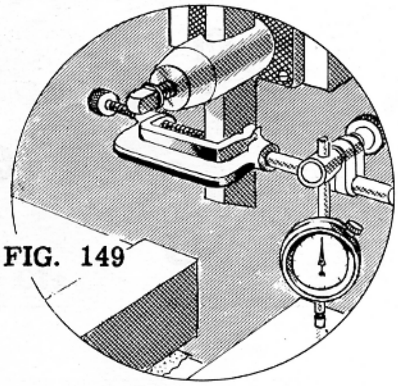


FIG. 149

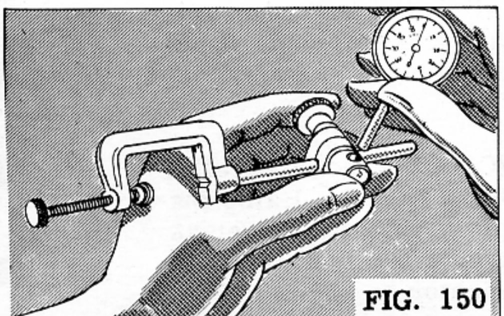


FIG. 150

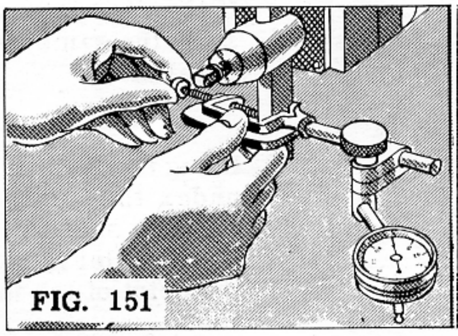


FIG. 151

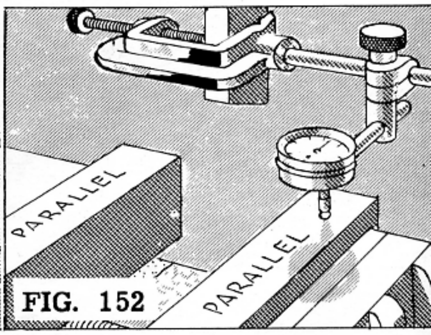


FIG. 152

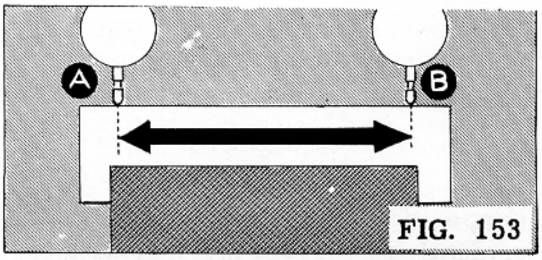


FIG. 153

15. Set the machine so that the length of the stroke is about one inch shorter than the length of the parallels (Fig. 153).

16. Position the ram so that the contact point travels within one-half inch of both ends of the parallels (Fig. 153).

CAUTION If the ram with the attached indicator cannot be operated by hand, use a slow speed to move the indicator back and forth over the parallel. Great care must be exercised that the point of the indicator is not allowed to travel beyond the surface of the parallel.

If this should happen, the point would drop below the level of the surface and would damage the indicator when the return stroke is made. This is also the reason for having both parallels project evenly beyond the sides of the vise. In other words, both parallels must be set in the same relation to the position of the stroke when the testing operation is in progress. Otherwise, there is the possibility of the indicator traveling beyond the surface of one of them.

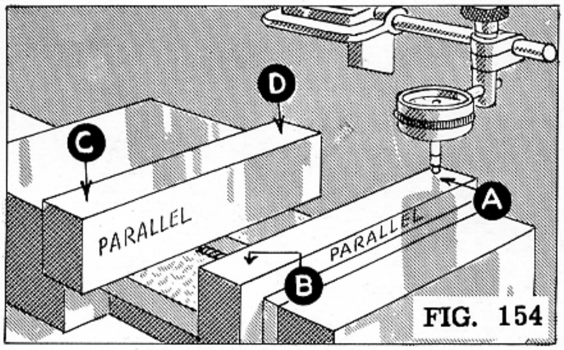


FIG. 154

17. Move the ram so that it is at the beginning of the stroke. Move the table so that one end of the parallel is under the contact point of the indicator as shown at (A) in Fig. 154.

18. Lower the indicator until the pointer registers about ten one-thousandths of an inch on the dial. This will show that the indicator point is making contact with the parallel.

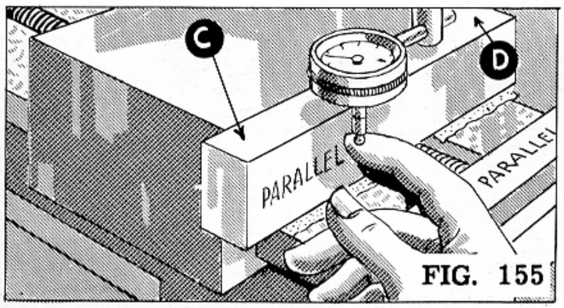


FIG. 155

19. Note the measurement on the dial. Then, move the ram to the forward position (B). If the vise is parallel, the indicator will show the same reading at both ends of the parallel.

20. Bring the surface (C) of the second parallel under the indicator. NOTE: Raise the contact shaft slightly with the finger as the parallel is moved directly underneath the point of the indicator as shown in Fig. 155.

21. Release the contact shaft and allow the contact point to rest on the parallel. The reading at (C) should be the same as the readings at (A) and (B).

22. Draw the ram again to the beginning of the stroke (Fig. 156). If the reading at (D) corresponds with all the others, the vise is parallel.

    NOTE: If (B) and (C) are low, adjust the table support and tighten the table gibs. This may be all that is necessary to bring these points into alignment.

    NOTE: If (A), (B), (C), or (D) is low, loosen the clamping nuts and place a proper shim underneath the lowest point of the base.

    CAUTION Make certain that there are no particles of dirt underneath the base of the vise.

23. Tighten the nuts and recheck the setting at all four points by following the same steps.

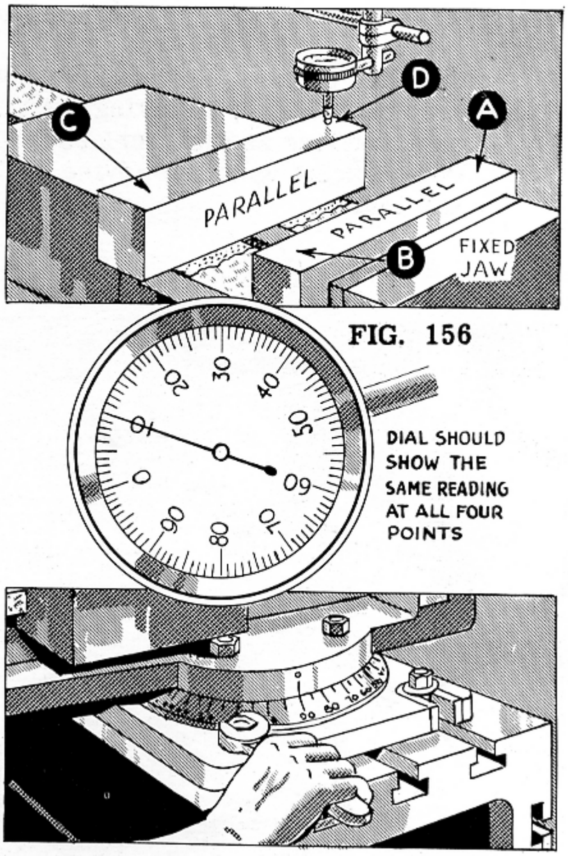


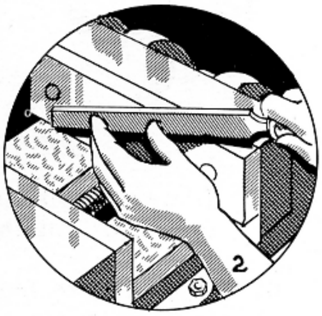
FIG. 156

HOW TO TEST THE FIXED JAW FOR SQUARENESS WITH AN INDICATOR

1. Mount vise on table.

   CAUTION Be sure that the undersurface of the base and the table surface are clean.

2. Examine the face of the fixed jaw. Carefully remove any burrs with a smooth or mill file or abrasive stone.



3. Clean the vise jaws thoroughly.

   CAUTION Care should be exercised to see that chips do not get between the jaws of the vise and the work. They may cause injury to the jaws and the work when the vise is tightened. Furthermore, the jaws should be protected from rough work by a strip of soft metal or cardboard placed between the work and the faced surfaces. With proper care the accuracy of the vise can be preserved for an indefinite period of time.

NOTE: Some vises have removable plates attached to the jaws. These plates may be removed by taking out the fillister head screws. They can then be placed on a machine and the surfaces refaced or reground. This, however, is not usually done, except upon the advise of the person responsible for the maintenance of the machine.

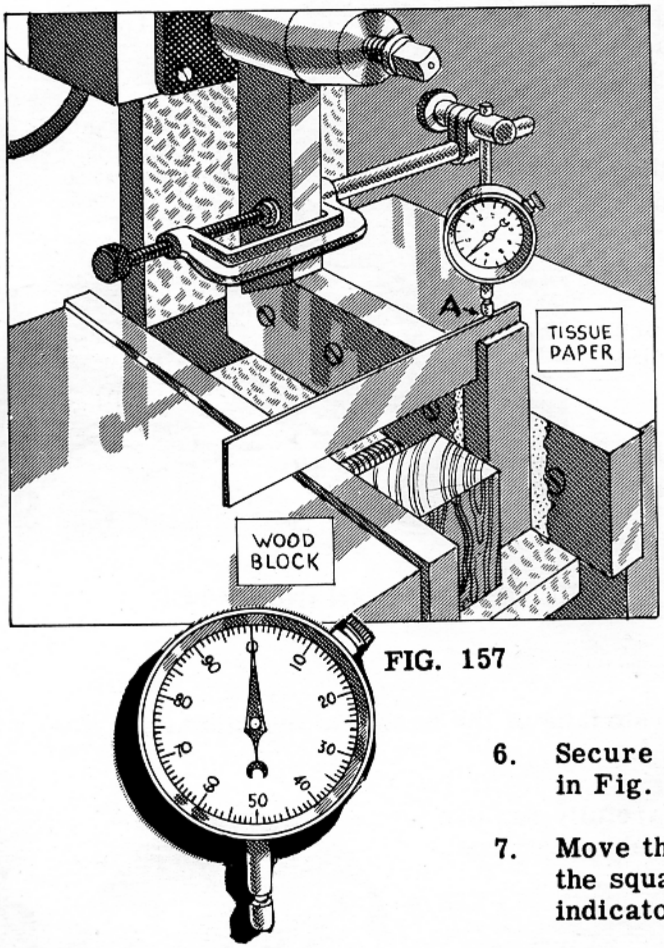


FIG. 157

4. Place a piece of paper against the fixed jaw of the vise. Next to the paper in a vertical position, place the beam of the square as illustrated in Fig. 157.

CAUTION The square is a precision tool and must be handled with great care if the accuracy is to be preserved. Every precaution should be taken against nicking the surface or the edges. Dropping a square may permanently destroy its accuracy, thereby rendering it useless. Squares should be kept in a box or case when not in use.

5. Place a block of clean wood between the beam of the square and the movable jaw (Fig. 157). Then, tighten the vise sufficiently to hold the square in this position.

6. Secure the indicator to the tool holder as shown in Fig. 157.

7. Move the ram and the table to bring the blade of the square directly under the contact point of the indicator as at (A) in Fig. 157.

8. Lower the indicator with the down-feed crank until the contact point of the indicator touches the edge of the blade.

9. Continue to lower the indicator until the finger of the dial registers about ten one-thousandths of an inch, assuming that the divisions on the dial are in terms of .001".

10. Observe the reading and move the table to the right in order to bring the blade of the square under the contact point as at (B), Fig. 158.

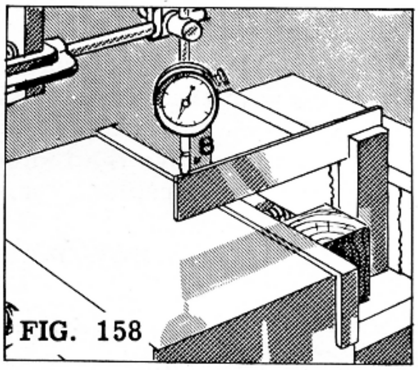
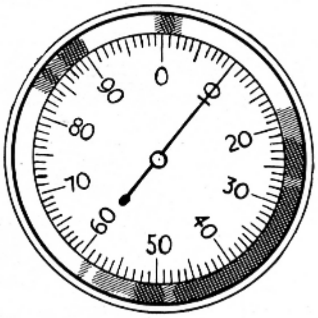


FIG. 158

11. Observe the position of the pointer. If the readings are the same at both ends of the blade, the face of the fixed jaw is square.

12. Test at each end of the jaw in the same manner.

NOTE: When the pointer does not register the same at both ends of the blade, it will be necessary to shim between the back of the plate and the machined surface of the vise. If the test shows that the face is more than a few thousandths out of square, the plate should be reground. Too much shimming may warp the plate when the screws which hold it to the vise are tightened.

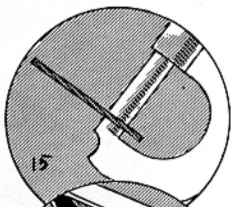


13. Observe the difference in the readings indicated at each end of the blade and determine the direction in which the blade must be shimmed to correct the inaccuracy.

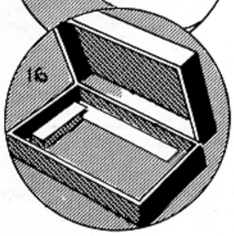
14. Estimate the thickness of the shim.

NOTE: The thickness of the shim should be the same as the error noted on the indicator if the length of the blade and the height of the plate are the same.

NOTE: The thickness will be only half of the indicated error if the blade is twice as long as the height of the plate.



15. Measure the shim with a micrometer as shown in Illustration 15.



16. Remove the square from the vise and carefully place it in a safe place.

17. Take out the fillister-head screws. Remove the plate. Clean the machined surface of the vise and the back of the plate. If the reading indicated that the blade is high at (B), place the shim between the upper surfaces of the two faces. If it is low at (B), place the shim between the lower surfaces.

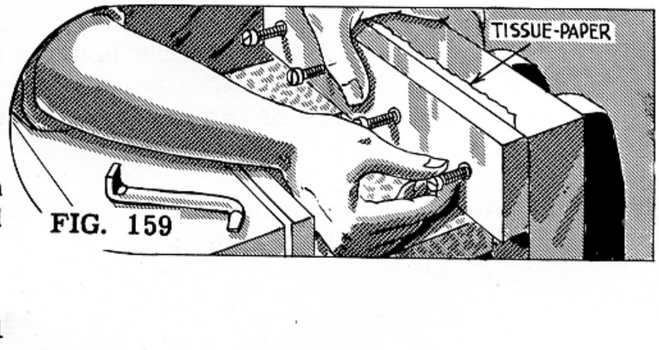


FIG. 159

18. Hold the plate and the shim in place with the hand and insert the fillister-head screws (Fig. 159).

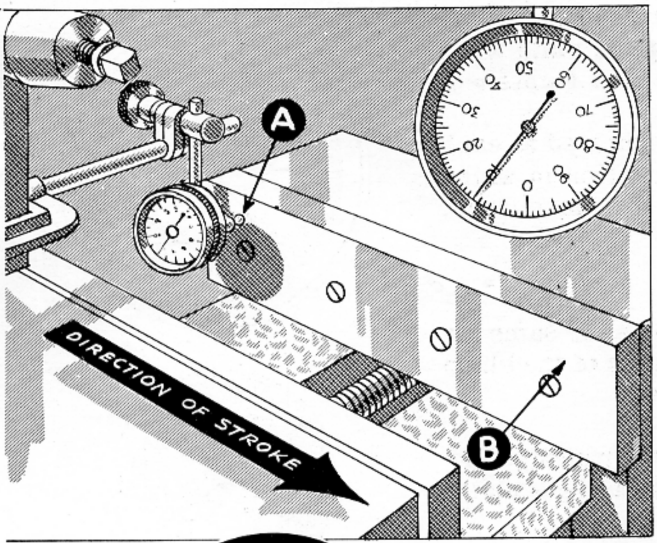
19. Tighten the screws so that the plate is held securely.

20. Place the square in the vise and repeat the testing procedure until the face of the jaw is square.

21. Remove the indicator from the machine, the square from the vise, and carefully replace them in their boxes.

HOW TO SET THE VISE PARALLEL WITH THE DIRECTION OF THE STROKE WITH AN INDICATOR

1. Mount the vise on the shaper table if necessary.



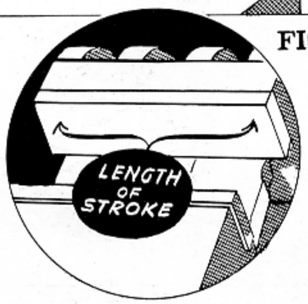


FIG. 160

2. Loosen the clamping nuts and set the vise so that the jaws are parallel with the direction of the cut. The vise handle should be on the left to facilitate operation of the shaper. The zero mark on the vise should coincide with the 90° graduation on the base.

3. Tighten the nuts on the clamping bolts lightly. The nuts should be tight enough to prevent the vise from swiveling, yet loose enough to allow the vise to be moved by a tap with the hand or a lead or composition mallet.

4. Clamp the assembled indicator in the tool post or to the shank of the tool holder (Fig. 160).

5. Observe that the indicator has a contact shaft perpendicular to the face of the dial. When a vertical surface is being tested, this style of indicator can be read more conveniently than an indicator with a contact shaft parallel with the face of the dial.

6. Arrange the indicator with the contact point toward, but not touching, the face of the fixed jaw (Fig. 160).

7. Set the stroke of the machine for one inch less than the length of the fixed jaw.

8. Adjust the position of the ram to allow the contact point to travel within one-half inch of both ends of the jaw.

9. Move the ram to the beginning of the stroke as illustrated at (A), Fig. 160.

10. Move the table until the face of the vise jaw presses against the contact point of the indicator. The finger of the indicator should register about ten one-thousandths of an inch to insure good contact between the face of the jaw and the contact point.

11. Note the measurement on the dial. Then move the ram to the forward position (B), Fig. 161.

12. Observe the readings on the dial when the indicator is at each end of the jaw. The difference, if any, between the dial settings should be divided by two. The result is the distance the vise must be swiveled.

13. Tap the vise lightly to move it the necessary distance in a direction away from the higher setting (Fig. 161).

14. Tighten the clamping nuts securely and recheck the setting. When the indicator reading is exactly the same at both ends of the jaw, the vise is set parallel with the stroke.

15. Remove the indicator from the machine and carefully replace the parts in its case or holder.

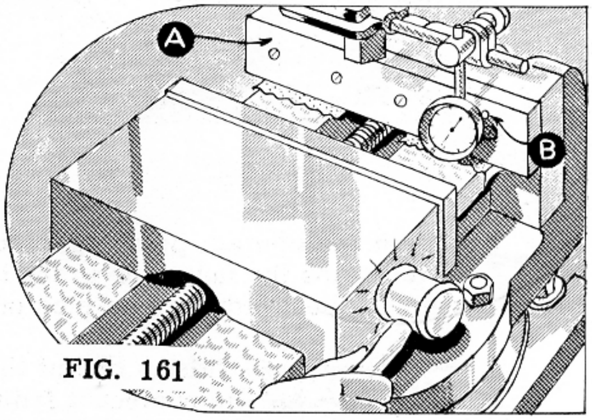


FIG. 161

HOW TO SET THE VISE AT 90° TO THE DIRECTION OF THE STROKE WITH AN INDICATOR

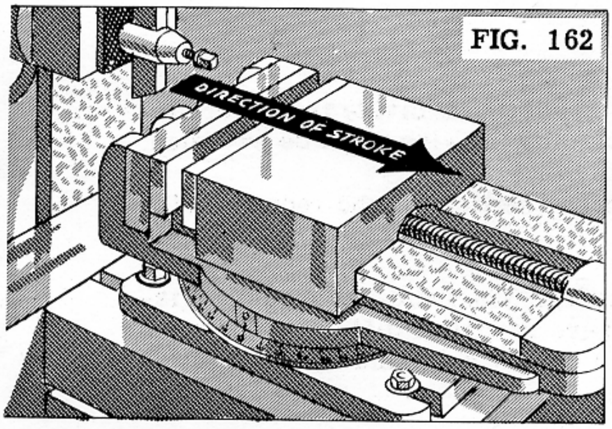


FIG. 162

1. Mount the vise on the table if it is necessary to do so.

2. Loosen the clamping nuts and set the jaws at 90° to the direction of the stroke (Fig. 162). The vise handle will then be toward the front and the zero marks on the vise will coincide with the zero marks on the base.

3. Tighten the nuts lightly on the clamping bolts. The nuts should be tight enough to prevent the vise from swiveling, yet loose enough to allow the vise to move by giving it a tap by hand or with a lead mallet.

4. Clamp the assembled indicator in the tool post (Fig. 163) or to the shank of the tool holder.

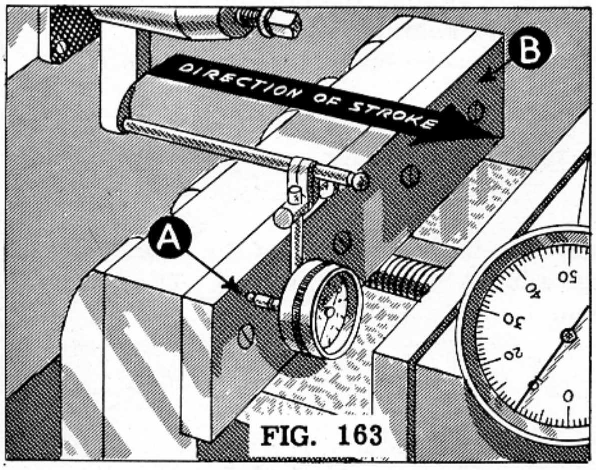


FIG. 163

5. Observe that the indicator has a contact shaft perpendicular to the face of the dial. When a vertical surface is being tested, this style of indicator is more conveniently read than an indicator with a contact shaft parallel with the face of the dial.

6. Arrange the indicator near the end of the jaw with the contact point forward, but not touching, the face of the fixed jaw (Fig. 163).

   NOTE: The contact point is pressed against the face of the jaw either by moving the ram in slightly or by adjusting the clamp which holds the indicator to the tool holder.

7. Adjust the contact point against the face of the jaw by means of the clamp which holds the indicator to the tool holder. Have the pointer register about ten one-thousandths of an inch on the dial as shown at (A), Fig. 163.

CAUTION This is one of the safest methods of adjusting the indicator to protect it from damage. The adjustment can be made by moving the ram. However, this should not be attempted unless the action of the ram can be controlled by hand.

8. Note the reading on the dial. With the table hand feed, move the vise so that the indicator is in position (B).

9. Observe the reading at (B).

10. Subtract the lower reading from the higher reading and divide the difference by two. The answer is the amount in thousandths the vise must be swiveled.

11. Tap the vise in a direction away from the higher setting for the required distance.

12. Tighten the clamping nuts and recheck the setting. The indicator should register the same at both ends of the jaw. If there is still a difference between the two readings, the clamping nuts should be loosened and the adjustment continued until the setting is correct.

13. Remove the indicator from the machine. Carefully replace the indicator parts in the case.

HOW TO USE THE SHAPER BOLTS

1. Reread the descriptions of various types of shaper bolts.
2. Insert a T-slot cleaner in the end of the table slot near the apron and draw the cleaner outwards. Repeat this step a few times to clean out all the chips.
3. Brush off the chips that may accumulate around the top of the slots and the surface of the table as a result of cleaning out the slots.

THE SQUARE T-HEAD BOLT

Insert the T-head in the end of the table slot and push the bolt along to the required position.

THE CUTAWAY T-HEAD BOLT

Drop the head of the bolt into the table slot and turn the head.

THE TAPPED T-HEAD BOLT

1. Insert the tapped head into the end of the table slot and move it along into position.
2. Select a stud that will project far enough above the surface of the work to hold a clamp (if necessary), a washer, and a nut.

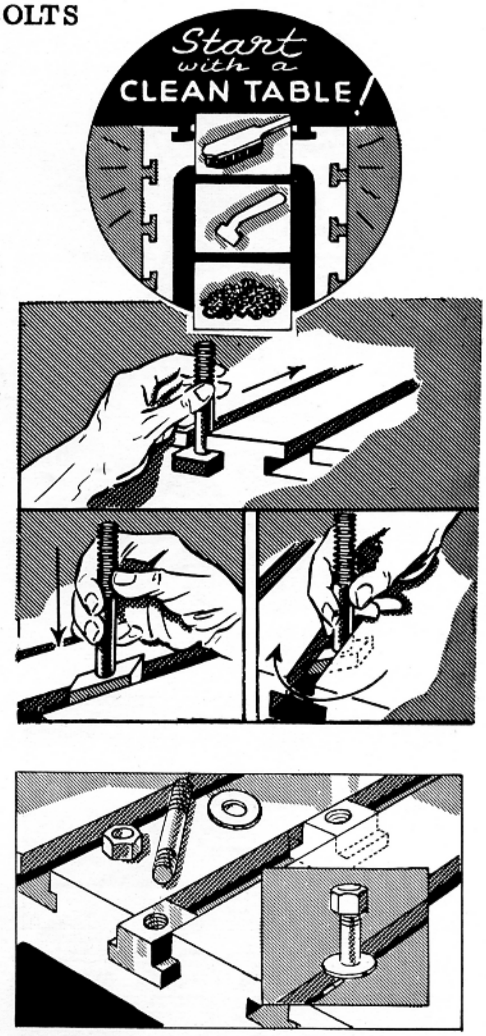
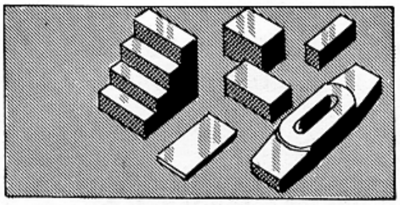


FIG. 164

HOW TO USE CLAMPS, PACKING BLOCKS AND STEP BLOCKS



1. Reread the different types of clamps, packing blocks, and step blocks.
2. Select a plain clamp and a block equal to the height of the surface to be clamped. If blocks of the exact height are not available, a strip should be placed between the top of the block and the underside of the clamp.

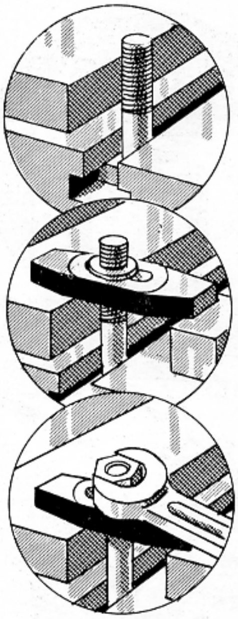


FIG. 165

3. Insert a square T-head bolt in the table slot.

4. Place the clamp over the bolt. Support one end of the clamp on the work and the other on the block. Check to see that the clamp is level and that the bolt is placed near the clamped surface. See Fig. 166 for the correct method of clamping.

NOTE: Because of the location of the table slots and the size and shape of the work, it is not always possible to place the bolt in a position of maximum gripping power. The arrangement emphasized in Figure 166 should be duplicated whenever practicable.

5. Place a washer and a nut on the bolt and tighten the nut with a wrench.

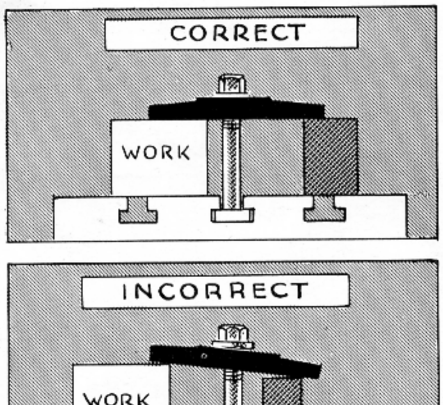


FIG. 166

CORRECT

1. Bolt near the work. Greatest pressure is exerted on the work.

2. Clamp level. Full area of the fâce of the clamp bearing on the work gives maximum gripping power.

INCORRECT

1. Bolt near the block. Greatest pressure is exerted on the block and not on the work. Corner of the work only is held, providing minimum gripping power.

2. Clamp not level. Clamp has tendency to tip the work. Tightening the nut has tendency to bend the bolt.

INCORRECT

1. Bolt midway between the work and the block. Pressure evenly distributed when greatest pressure needed on the work.

2. Clamp not level. Point of clamp only gripping the work. Tightening the nut has tendency to bend the bolt.

HOW TO USE ALIGNING STRIPS OR ALIGNING BARS

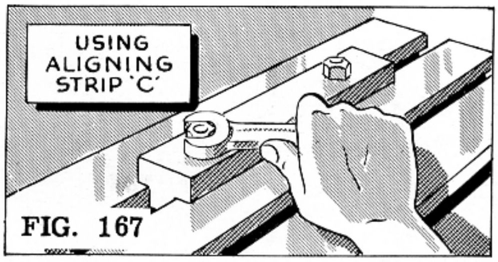


FIG. 167

A. EDGE OF THE STRIP PARALLEL WITH THE DIRECTION OF THE STROKE

1. Determine the types of aligning strips that may be required for the job on hand.

2. Clean the table and with a file or abrasive stone remove any burrs which may be on the table surface.

3. Select two strips similar to the ones illustrated in Figures 167 and 168. On the undersurface of each of these there is a tongue which, when placed in the table slot, aligns the strip with the direction of the stroke.

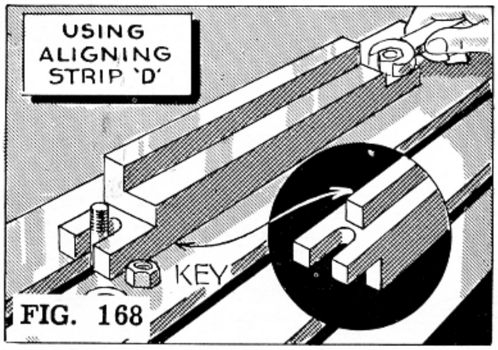


FIG. 168

4. Place two T-head bolts in the table slot.

5. Clean the bottom surface of the strip and with a fine file remove any burrs which may be on the base or the sides. If the strip illustrated in Fig. 167 is used, take the nuts and washers off the bolts.

6. Place the strip over the bolts and onto the table with the tongues in the table slot. If the strip shown in Fig. 168 is used, it is placed directly on the table and aligned with the tongue in the same manner as the previous strip.

7. Place the washers and the nuts on the bolts. In the case of Fig. 168, move the bolts into the open lug slots, and tighten the nuts securely. The alignment of the strip can be tested with an indicator if this should be necessary.

B. EDGE OF THE STRIP 90° TO THE DIRECTION OF THE STROKE

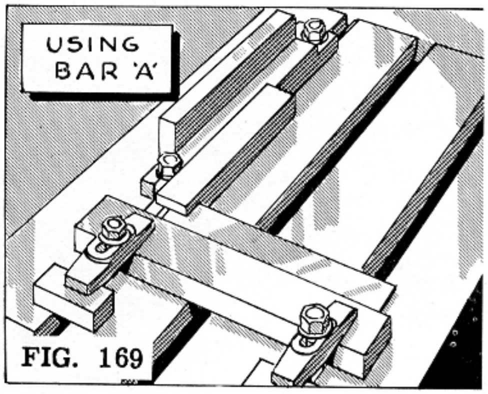


FIG. 169

NOTE: Either of the aligning bars, or strips, shown in Figures 169 and 170 may be used for this purpose. If the one at Fig. 169 is selected, it is held to the table with bolts which pass through the slot. The strip is secured to the table with clamps.

1. Insert the necessary number of bolts in the table slots.

2. Thoroughly clean the aligning strip with a clean cloth and remove all burrs with a fine file or abrasive stone.

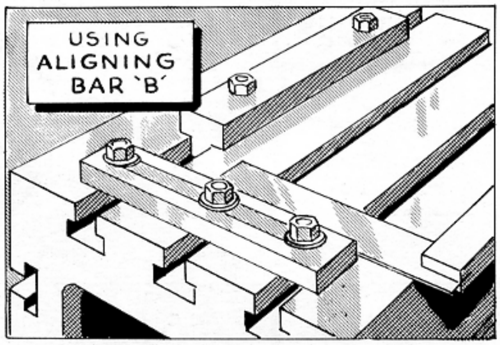


FIG. 170

3. Place the strip on the table in the required position. In the case of Fig. 169, clamps must be used.

4. Use either a solid square (Fig. 170), or a combination square to set the new aligning strip at 90° with the one previously located, or at 90° with the edge of the table.

CAUTION Provision must be made to protect the edges and surfaces of a square from damage by keeping the square in a case, or by laying it on a cloth in a safe place when it is not in use.

5. Place the beam of the square against the first aligning bar and adjust the second aligning strip parallel with and against the blade of the square (Fig. 169).

6. Tighten the nuts lightly to hold the strip in place.

7. Test again for squareness. First, lay two pieces of tissue paper over the strip. Then, with the beam of the square pressed against the first bar, move the square forward until the blade grips the two pieces of tissue paper.

8. Adjust the aligning strip by tapping it with a lead or composition mallet until the force required to withdraw the two pieces of paper is the same.

9. Tighten the nuts down securely when the proper adjustment has been made. The strip may be set also by placing the beam of the square against the edge of the table (Fig. 170) and aligning the strip parallel with the blade of the square. If a more accurate setting is required, an indicator can be used.

10. Clean and return all tools promptly when all necessary adjustments have been made.

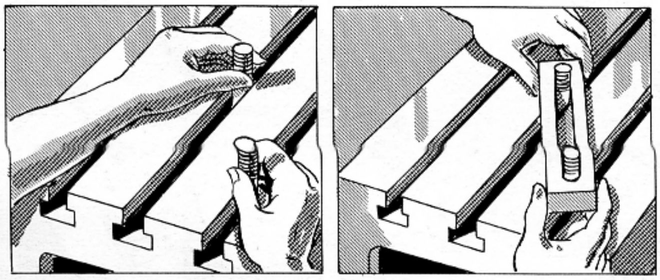


FIG. 171

C. EDGE OF THE STRIP AT AN ANGLE ON THE TABLE

1. Select one of the strips with an elongated slot. If the type strip shown in Fig. 171 is used, the slot through which the bolts pass may be utilized even when the strip is placed at an angle on the table.

2. Clean the top surface and the edge of the table. Remove any burrs which may be present.

3. Place the bolts in the table slots.

4. Clean the aligning strip and be sure that it is free of burrs.

5. Place the strip over the bolts and set it approximately at the desired angle.

6. Set the protractor to the correct angle.

7. Press the base of the protractor against the edge of the table (Fig. 172). With the blade extending over the top of the table, adjust the strip against and parallel with the blade of the protractor (Fig. 172).

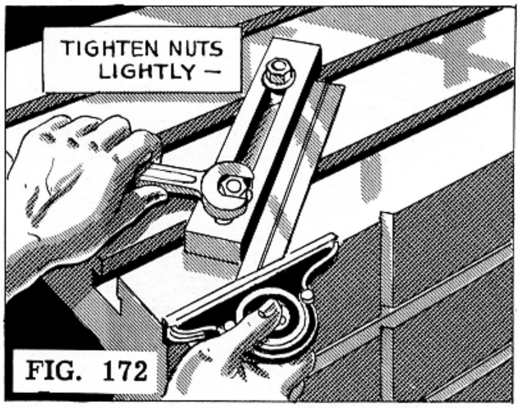


FIG. 172

8. Tighten the nuts just enough to hold the strip in position.

9. Place two pieces of tissue paper over the strip. Press the protractor against the edge of the table, and move it forward until the blade grips the two pieces of paper (Fig. 173).

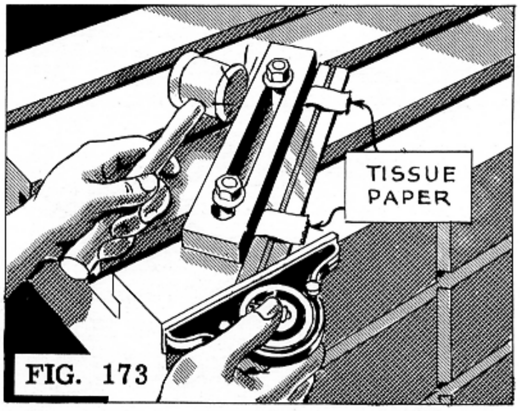


FIG. 173

10. Adjust the parallel, if necessary, by tapping it lightly with a lead mallet until the force required to withdraw the two pieces of tissue paper is the same.

11. Tighten the nuts down securely when the setting is correct.

NOTE: If an aligning strip already has been set parallel with the stroke, the second strip may be set at an angle with the one located on the table. In this case, the protractor is substituted for the square, and the strip is set at an angle.

HOW TO USE STOPS

1. Determine the type stop needed for the job on hand.

2. Clean out the table slots and brush the surface of the table.

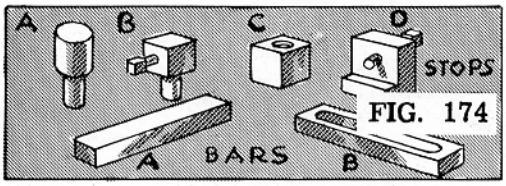


FIG. 174

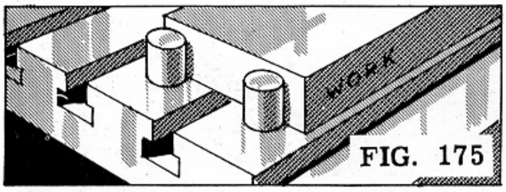


FIG. 175

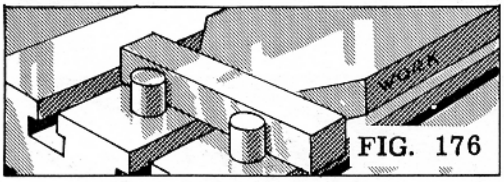


FIG. 176

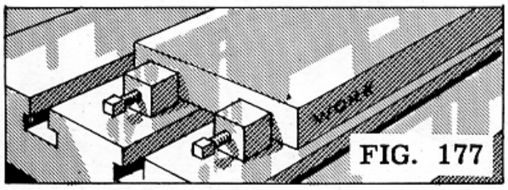


FIG. 177

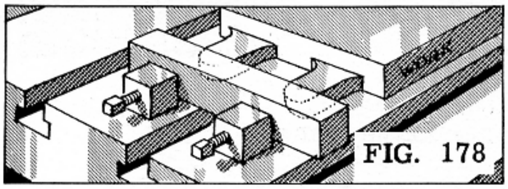


FIG. 178

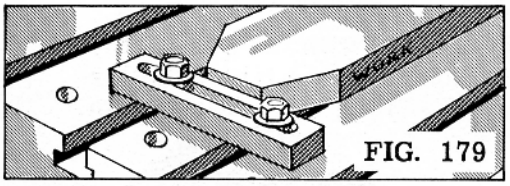


FIG. 179

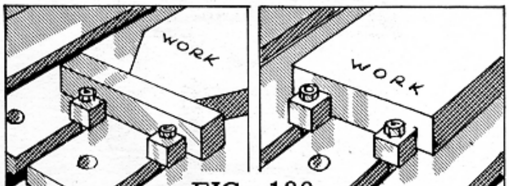


FIG. 180

3. Select two stops from each of the types illustrated in Figure 174 at (A), (B), (C), and (D); a bar A, and a bar B.

4. Clean the two stops (A), and place them in the round holes located near the front of the table (Fig. 175).

5. Locate the finished edge of the work against the two stops.

6. Insert a bar between the stops and the contacting surface of the work if the width of the work is too narrow to catch against the two stops (Fig. 176). For an unfinished or an uneven surface, the stops (B) (Fig. 174) are more practical because the screws can be adjusted.

7. Place the two stops, type (B), in the holes in the table (Fig. 177). Then, after the work has been located in relation to the stops, the screws can be adjusted to compensate for any unevenness of the edge.

   NOTE: Sometimes the unevenness of the contacting surface, especially in castings, takes the form of lugs or other projections. In this case, place a bar between the stops and the projections on the casting (Fig. 178), and adjust the screws to suit. When it is impractical to use the holes on the table to hold stops, the slots can be utilized for this purpose.

8. Put a T-bolt in each of the selected table slots and place the bar over the bolts (Fig. 179).

9. Provide a washer and a nut for each bolt. Adjust the stop to the work. Then, tighten the nuts securely. Individual stops (C) may also be used with or without a bar (Fig. 180).

   NOTE: Stops are often used to hold the work by the pressure of the screws. The screws may either force the work against an aligning strip or hold the piece between two sets of stops as described in the following steps.

a. Arrange the work, and aligning strip, on the table in their proper relation.

b. Select three stops with screws set at an angle. The slight angular set of the screws, which is between 5° and 10°, will force the work against the aligning strip and the work to the table (Fig. 181).

c. Insert the stops in the end of the table slots and move them along to the desired position.

d. Tighten the screws against the piece to be held. At the same time tap the work lightly with a lead mallet to seat the work on the table.

e. Note that the work can be held between individual stops or by those arranged in sets. The screws may be parallel with the surface of the table instead of set at an angle (Fig. 182). To compensate for different widths of work, strips of various widths can be used with any of the stops and slots.

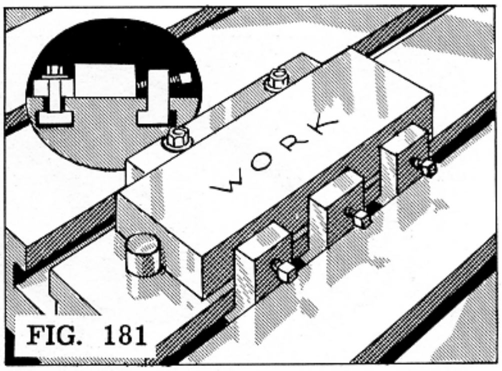


FIG. 181

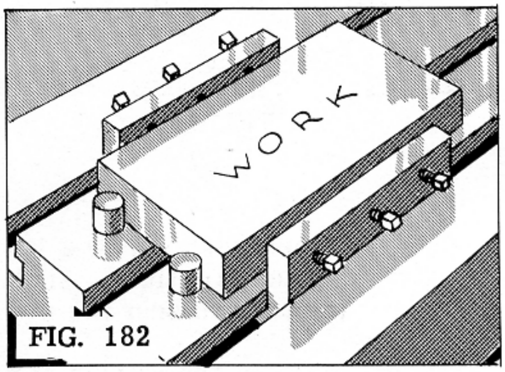


FIG. 182

HOW TO USE TOE DOGS

1. Read the description of toe dogs and stops.

2. Wipe the table surface and clean out the table slots.

3. Arrange the work on the table.

4. Put two round stops in the reamed holes at the front of the table (Fig. 183). This will prevent shifting caused by the cutting action of the tool.

5. Place two stops in each of the selected table slots (Fig. 183). The number of stops will depend upon the length of the piece. At least two sets should be used unless the piece is so short that there is room for only one set.

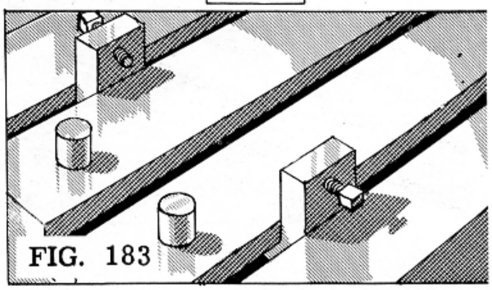


FIG. 183

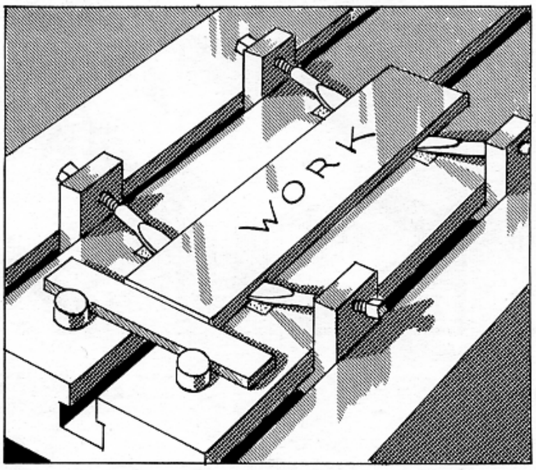


FIG. 184

6. Select four toe dogs with flat ends, two for each side of the work.

7. Place the toe dogs in turn against the sides of the work. Support the flat ends upon shims and the opposite ends against the screws of the stops (Fig. 184). Shims are not always used. When they are employed, the table surface is protected and the contact edges of the toe dogs are steadied.

8. Arrange the toe dogs so that they are set at about the same angle as that of the screws. If the toe dogs are inclined at too great an angle, the pressure of the screws will force the outer end of the dogs upward. When this happens, the pressure against the work will be released.

9. Adjust each screw a little at a time. Continue in order until all screws are sufficiently tight. At the same time, tap the work lightly with a lead mallet in order to seat the work onto the table.

NOTE: The amount of pressure to exert against the screws will depend upon the thickness and construction of the work (its resistance to distortion) and upon the holding power required to overcome the cutting action of the tool. This is largely a matter of experience and judgment.

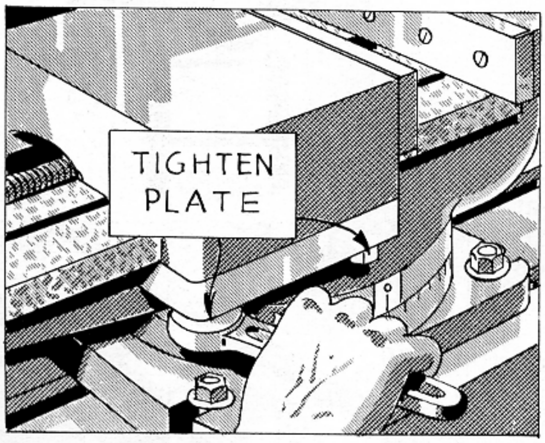


FIG. 185

HOW TO USE HOLD-DOWNS

1. Reread the description of hold-downs.

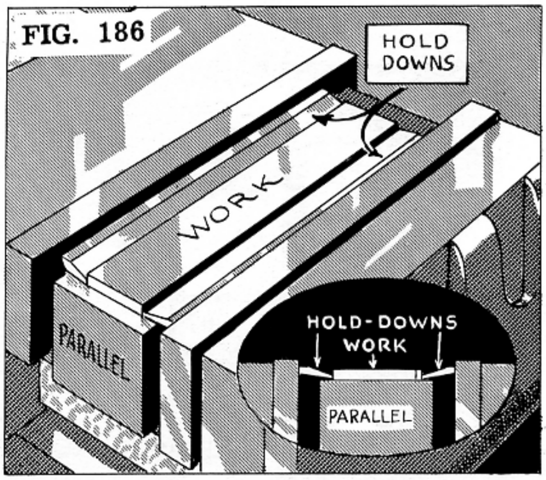
2. Note that the same principle will be employed to grip the work with hold-downs as was used with toe dogs. In this case, the work will be held between the vise jaws instead of on the table.

3. Mount the vise on the shaper table.

4. Tighten the plate underneath the movable jaw to prevent excessive lifting

of the jaw when the vise is tightened. This should be done only when necessary and when an adjustment is provided for this purpose (Fig. 185).

FIG. 186



5. Open the vise wide enough to place the work and the hold-downs between the two jaws (Fig. 186).

6. Select a parallel bar which will raise the work as high as possible in the vise and at the same time allow the hold-downs to be held between the jaws (Fig. 186).

7. Check the vise and all contacting surfaces to be sure they are clean. If the work has a finished surface, place four pieces of tissue paper on the parallel so that the four corners of the work will rest upon the tissue paper.

8. Place the work upon the parallel with one hold-down on each side (Fig. 186).

9. Tighten the vise jaws to grip the hold-downs lightly against the work.

CAUTION The amount of force that may be exerted against the work will depend upon the ability of the material to resist distortion. The cut must also be regulated accordingly. Otherwise, the cutting action of the tool will push the work forward and out of the vise.

10. Increase the pressure of the jaws against the hold-downs. At the same time, seat the work on the parallels by tapping lightly with a lead mallet.

CAUTION If a heavy blow is struck with the mallet, the work will rebound and will not seat on the parallel.

11. Test the work for being seated by trying to pull out the tissue paper. All four pieces of tissue paper will hold securely when the work is properly seated on the parallels.

HOW TO USE V-BLOCKS

A. 'V'-BLOCKS PARALLEL WITH THE DIRECTION OF THE STROKE

1. Reread the description of 'V'-blocks (page 110).

2. Wipe the table surface and clean out the table slots.

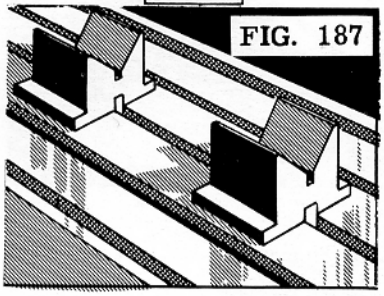


FIG. 187

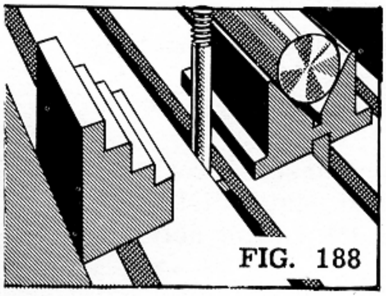


FIG. 188

3. Clean the bottom of the V-blocks with a file. Remove any burrs from the surface of the V-blocks and the table with a fine cut file or abrasive stone.

4. Place the V-blocks on the table with the tongues in the selected slot. The tongues will align the V-blocks with the table slot (Fig. 187).

5. Support the work in the V-blocks (Fig. 189).

6. Insert two T-bolts into the table slot and move them along into position.

7. Select two flat clamps and place them over the bolts.

8. Insert a piece of copper, cardboard, or soft metal strip between the finished surfaces of the work and the clamps (Fig. 189).

9. Check the clamp to be certain it is level and that the bolt is as near as possible to the clamped surface.

10. Tighten securely the nuts on the bolts.

11. Place a suitable stop against the forward edge of the V-block to take the thrust of the tool.

ALTERNATE METHOD

As an alternate method of holding the shaft, the V-blocks illustrated in Fig. 190 can be used. These V-blocks are essentially handy when a number of duplicate pieces have to be held.

a. Use care in checking the table and work for burrs and cleanliness when mounting the blocks on the table.

b. Place the V-blocks on the table with the tongue in the table slot.

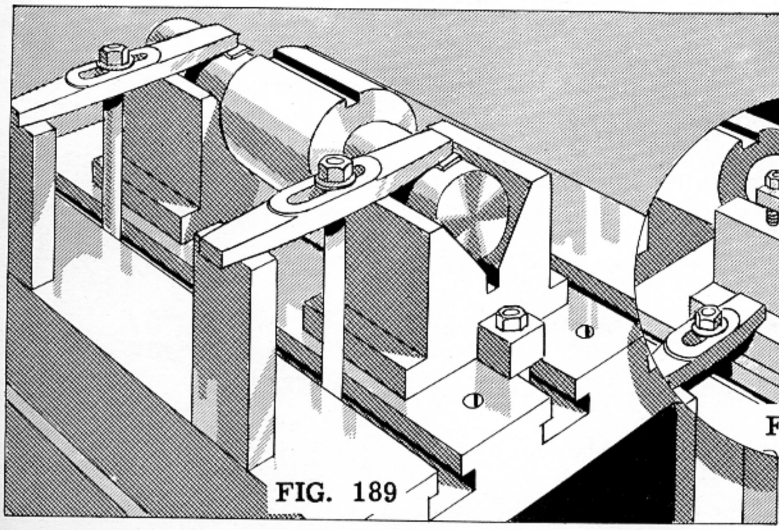


FIG. 189

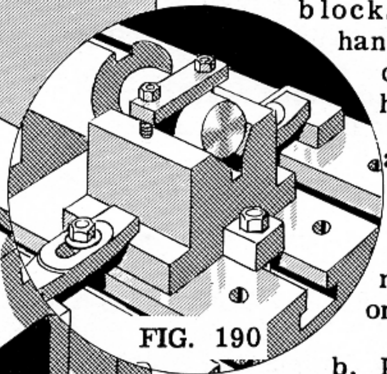


FIG. 190

c. Strap the V-block to the table and fasten a stop forward and against the front of the block to receive the thrust of the tool (Fig. 190).

d. Place the work in the V-block; put the clamp over the bolts; and then put on the washers and the nuts. Be sure that a protecting strip of soft metal or cardboard is between the finished surface of the work and the clamp.

e. Hold the clamp level and turn the nuts to tighten the clamp with the fingers.

f. Alternately tighten each of the nuts with a wrench. Tighten a little at a time until enough pressure is applied to hold the work securely.

B. 'V'-BLOCKS 90° TO THE DIRECTION OF THE STROKE

1. Check the work table and V-blocks to see that they are clean and free of burrs.

2. Align the V-blocks with each other by placing the work or a test bar in the V-shaped openings.

3. Place a square on the table in a vertical position with the blade touching the shaft as shown in Fig. 191 at (A).

4. Hold a combination square so that the blade lies flat on the table surface and the head rests against the front edge of the table.

5. Adjust the combination square so that the end of the blade touches the edge of the first square (Fig. 191).

6. Arrange the squares in the same manner at the opposite end of the shaft as shown at (B) in Fig. 191.

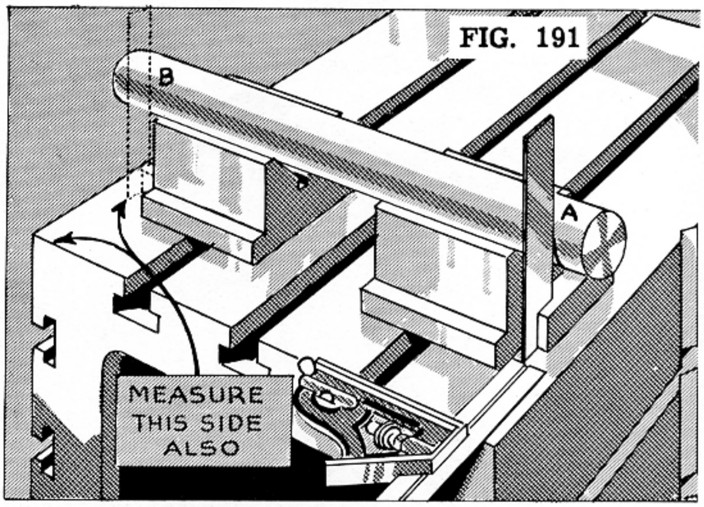


FIG. 191

7. Move or lightly tap the V-block until the edge of the first square is the same distance from the front edge of the table as it was when the square was in position A.

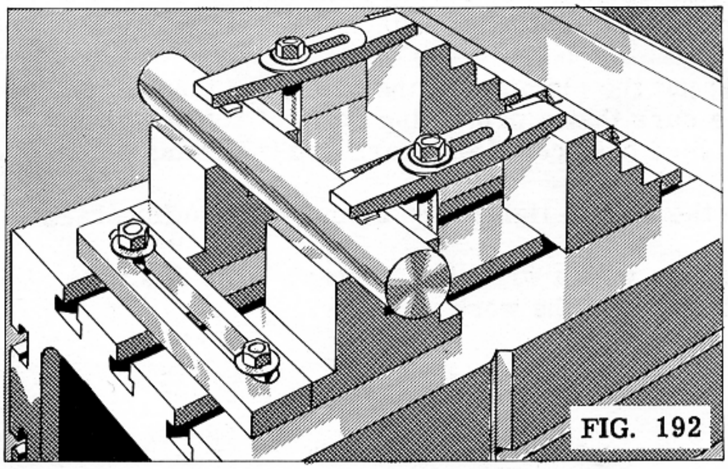


FIG. 192

8. Bolt a bar stop to the table and against the forward edges of the V-blocks (Fig. 192). This will hold the V-blocks in alignment and, in addition, will act as a stop to take the thrust of the tool.

9. Clamp the round portion of the work with two flat clamps. Use soft metal or cardboard shims between the finished surfaces of the work and the undersides of the clamps to protect the finished surfaces.

10. Recheck the alignment. Make any necessary adjustments. Then tighten the nuts down securely.

HOW TO USE ANGLE PLATES, C-CLAMPS AND JACKS

A. ANGLE PLATE AT 90° WITH DIRECTION OF STROKE

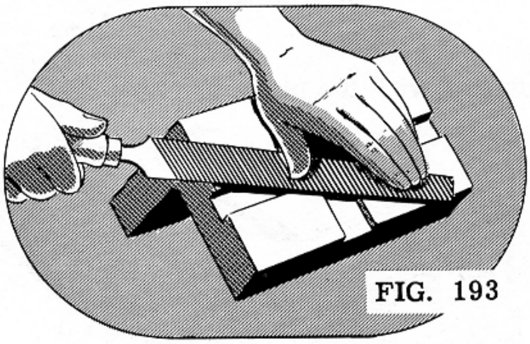


FIG. 193

1. Reread description of angle plates, pages 111 and 112.

2. Wipe the table surface and clean out the table slots.

3. Clean the angle plate. Remove with a fine file or flat abrasive stone any burrs on the faces of the angle plate and the surface of the table.

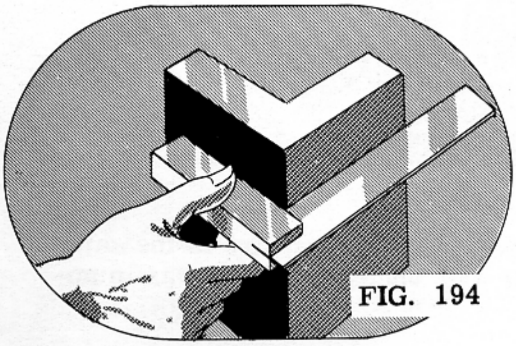


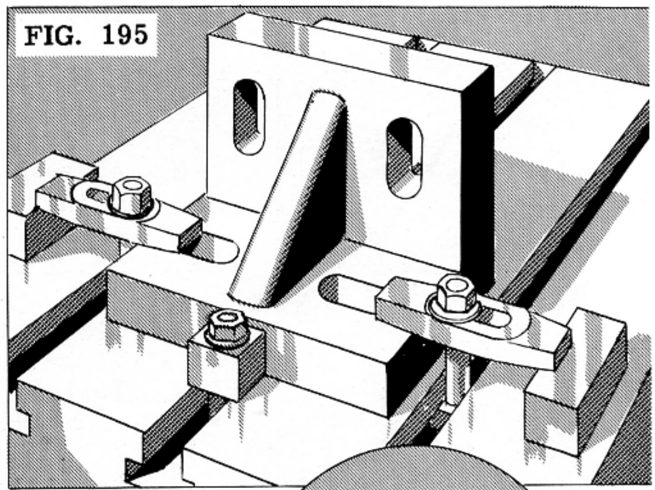
FIG. 194

4. Test the two sides of the angle plate for squareness with a precision square. It must be assumed that the square is kept in the tool room or some other safe place, and checked periodically for accuracy.

5. Place the angle plate on the table with the tongues aligned with the central slot of the table.

6. Place clamps on each side of base and secure the angle plate to the table (Fig. 195).

7. Bolt a stop to the table close against the forward edge of the angle plate (Fig. 195). This will prevent any movement due to the thrust of the tool.



NOTE: Aligning the plate by means of the tongues in the table slot will be accurate enough in most cases. The angle plate, however, may be tested with an indicator in a manner similar to that used for checking the accuracy of vise jaws. The plate may also be tested for squareness with the table by using a solid square (Fig. 196) as follows:

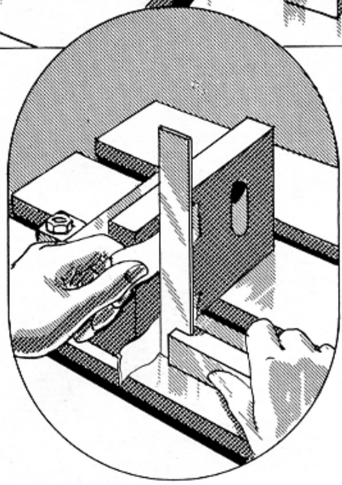


FIG. 196

a. Clean the surface of the table, the face of the angle plate, and the beam of the square.

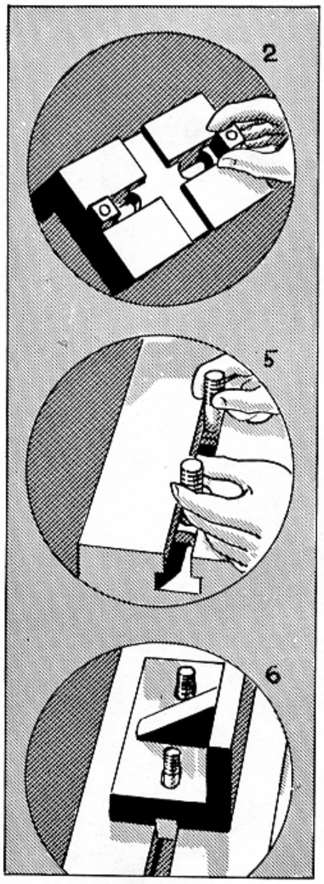
b. Place the beam of the square on the table and bring the blade against the face of the angle plate.

c. Test the face for squareness. Check whether or not the blade of the square is parallel with the face of the angle plate. A more positive method is to use tissue paper between the surfaces to be tested.

d. Insert two pieces of tissue paper between the angle plate and the blade of the square (Fig. 196).

e. Press the beam of the square downward on the table and forward against the angle plate.

f. Withdraw the two pieces of tissue paper. When the force required to remove them is the same, the angle plate will be square with the table. Otherwise, paper or thin metal shims must be placed under the lower side of the base to square the vertical surface of the angle plate with the table. The angle plate may also be removed and the faces reground. Whichever procedure is followed, the test should be repeated in squaring the angle plate with the table.



B. ANGLE PLATE PARALLEL WITH THE DIRECTION OF THE STROKE

1. Reread the description of clamps and jacks. (Refer to pages 112 and 114).

2. Arrange the tongues on the base of the angle plate so that when the tongues are aligned with the table slots,the angle plate will be parallel with the direction of the stroke. (See Illustration 2.)

3. Clean the table and angle plate and remove burrs.

4. Test the plate for squareness with a solid square (Fig. 194).

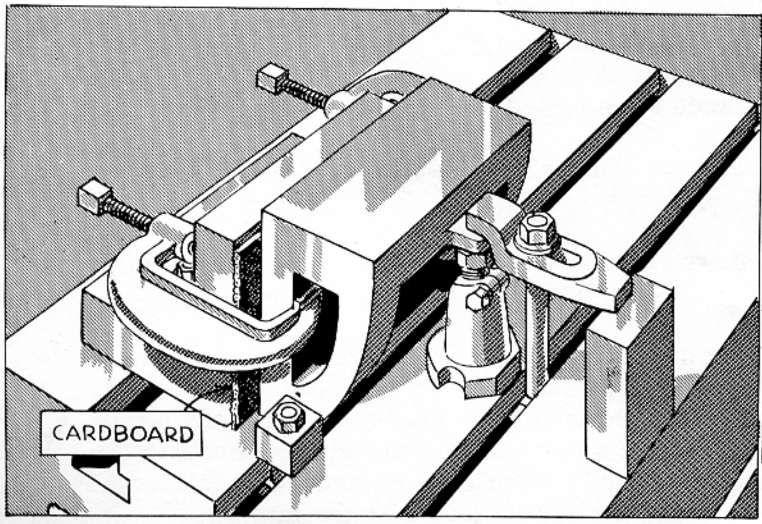
5. Insert two T-head bolts in the table slot. (Refer to Illustration 5.

6. Place the angle plate over the bolts and align the tongues with the table slot (Illustration 6).

7. Bolt the angle plate to the table (Illustration 7).

8. Clean the side of the work and the face of the angle plate. (Refer to drawing 8).

9. Place a piece of cardboard between the face of the angle plate and the surface of the work (Illustration 9), if the material being held has a rough surface. This will protect the finished face of the angle plate (Fig. 197).



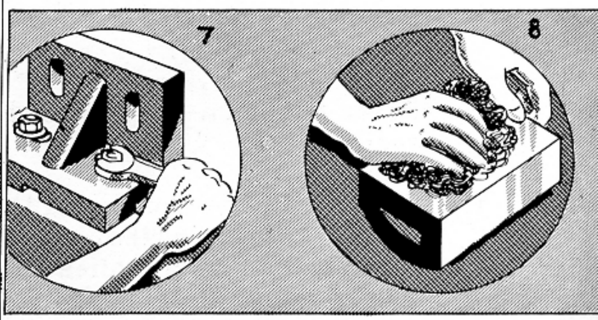


FIG. 197

10. Use two C-clamps to hold the work to the plate.

11. Place one piece of soft metal between the C-clamp screw and the work and another piece of soft metal between the pad of the C-clamp and the work. These soft metal pieces will protect the surfaces from being marred by the screw or the pad of the C-clamp. If the surfaces to be held are rough or will not be damaged by marks, the metal packing may be left out.

12. Tighten the C-clamp securely by turning the square-head of the clamping screw with a wrench.

13. Place a stop against the front edge of the angle plate to take the thrust of the tool (Fig. 197).

14. Select a jack of suitable size. The length of the threaded part of the screw that is held in the jack base should be at least equal to the diameter of the screw (see illustration at 14).

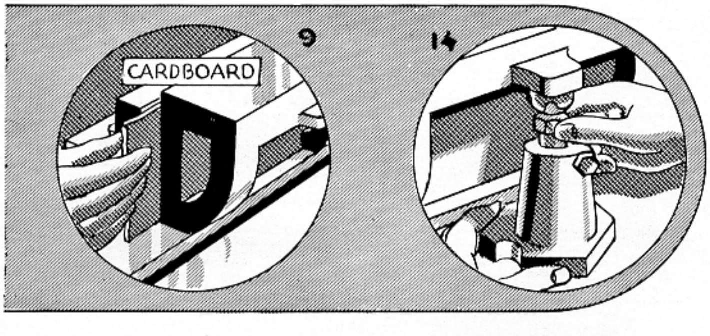
15. Clean the base of the jack.

16. Place the jack under the unsupported portion of the material. A piece of cardboard should be used under the base of the jack to prevent its slipping or marring the table surface.

17. Adjust the jack screw until the swivel top touches the material to be supported and there is a slight tension when the screw is turned.

18. Arrange a clamp so that the work will be clamped directly above the part supported by the jack.

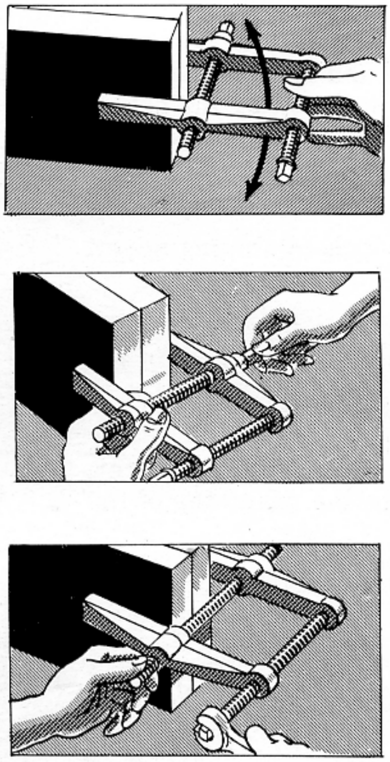
19. Place a piece of cardboard or soft metal under the clamp if it is necessary to protect the finished surface.



20. Tighten the nut on the T-head bolt.

NOTE: The angle plate should be tested for parallelism with the direction of the stroke and for squareness with the table.

HOW TO USE MACHINIST'S OR PARALLEL CLAMPS



1. Reread the description of machinist's clamps. Parallel clamps are often used instead of C-clamps to hold parts together. Parallel clamps are usually used in pairs.

2. Open the jaws of the clamp a distance equal to the combined thickness of the work.

3. Place the clamp over the work to be held. If protecting strips are necessary, cardboard or soft metal should be placed between the jaws of the clamp and the finished surfaces.

4. Tighten the front screw with the fingers until the clamp grips the work and the jaws of the clamp are parallel (Fig. 198).

5. Tighten the back screw securely by using a wrench or round rod which has been inserted into the head of the screw.

FIG. 198

NOTE: If the clamp is holding firmly with maximum gripping power and both jaws are in contact along the entire surface that is being held, the clamp will not move. Figure 199 illustrates both correct and incorrect methods of adjusting the clamp.

CORRECT: Jaws are adjusted parallel with surface being clamped. This insures maximum holding power. Clamp will not move up and down.

INCORRECT: Jaws are not parallel with surface being clamped. Jaws are holding with minimum gripping power. Jaws open at the front or back and hold at one point only. Clamps move up and down.

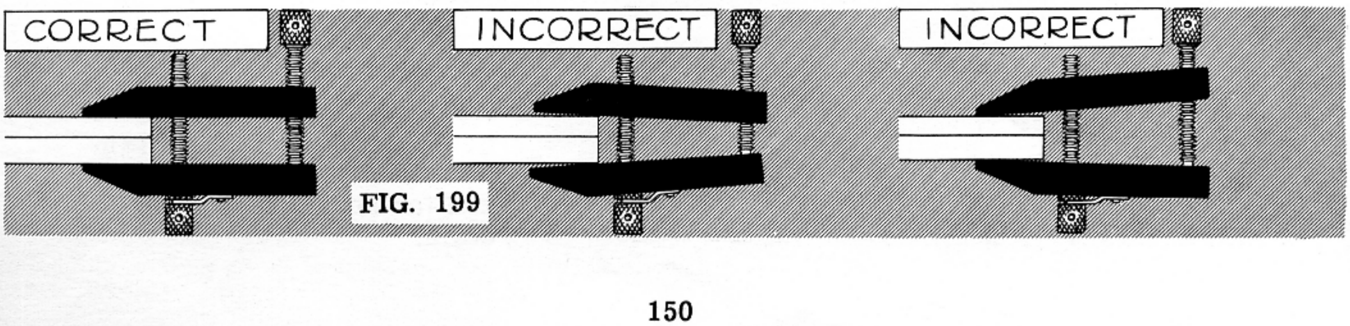
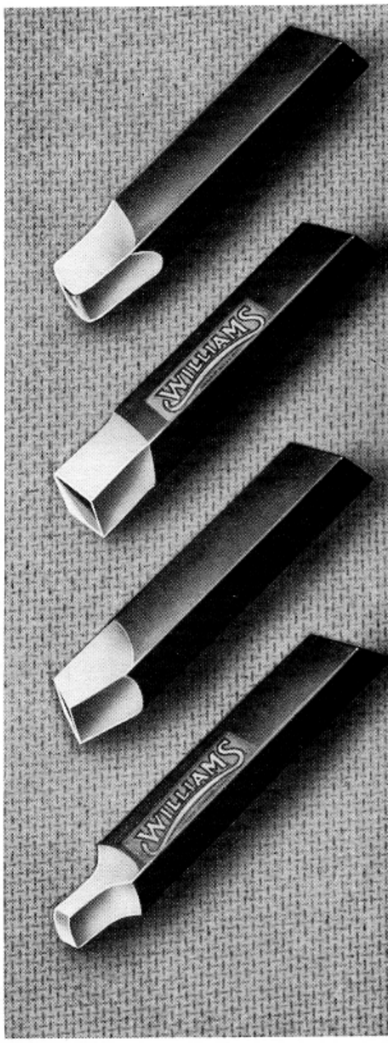
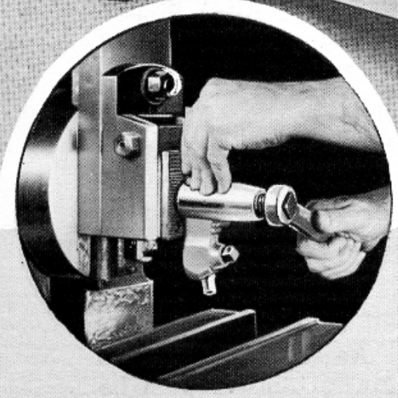


FIG. 199

DESCRIPTION OF SHAPER TOOL HOLDERS AND SHAPER TOOLS

Photo by courtesy of J. H. Williams & Co.





UNIT T 52 (C)

Parts I and II   Pages 151 - 166

DESCRIPTION of SHAPER TOOL HOLDERS

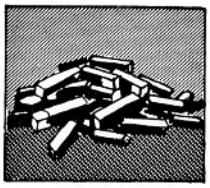
OBJECTIVES OF UNIT

1. To become familiar with the terminology used with tool holders.

2. To describe the various types of tool holders used for shaper work.

3. To become familiar with manufacturer's designations of tool-holder styles.

INTRODUCTORY INFORMATION



The use of tool holders instead of solid forged tools in the machine-tool industry was principally a matter of economy. The first attempts to hold tools in holders, although ingenious, allowed the tool to slip under heavy cuts and often lacked the rigidity so necessary for general use.

With the introduction of more expensive steels for cutting tools, much money was invested in the production of costly forged tools, as considerable time was required to forge, grind, and shape these tools. In addition, waste was unavoidable, for when the tools became too short to be held in the machine, they were discarded and eventually scrapped.

Gradually, as design improvements in tool holders were made, the use of these devices was extended. As a result of improved design, tools are securely and solidly held in tool holders, grinding has been reduced to a minimum, forging is unnecessary, and much waste has been eliminated. Although proportionately larger and stronger tool holders are designed for the larger machines, solid tools are still extensively used in the heavy machine-tool industries.

In addition to standard tool holders, there are those which can be purchased in sets. The sets contain a number of standard tools or bits which fit into a special holder. A set of these cutters is adequate for the usual shaper operations. Extra cutters usually may be purchased, and special ones can be made to order.

The American Society of Mechanical Engineers has adopted a set of definitions which apply to all single-point tools, including tool holders. As these definitions have not been adopted by all users and manufacturers, special attention must be given to how the terms are applied in each case.

DESCRIPTION OF TOOL HOLDERS

SIZE AND STYLE

To the shaper operator, the size of the tool holder used depends principally upon the size of the shank wihch will fit into the tool post of the machine. It is also necessary for the operator to decide whether or not the tool holder should be straight or offset, right-hand or left-hand; and to select the style of holder to suit the shape of the tool.

The straight-shank tool holder (Fig. 200) holds the tool parallel with the sides of the tool holder in contrast to the bent style (Fig. 201) which holds the tool at an angle with the slides. These tool holders also may be left or right (Fig. 201) depending upon the inclination of the tool either to the left or to the right of the work.

According to the American Standards as issued by the American Society of Mechanical Engineers and published in the American Machinists' Handbook, "A bent tool has the point bent to the left or right (Fig. 201) to make its operation more convenient. These tools are called left-bent tools if the point is bent to the left when looking at the tool from the point end with the face upward and the shank pointing away, and vice versa."

As a tool holder can be classified as a tool shank, this definition can be applied to a tool holder. Conventional usage, however, has not yet entirely adopted the definition, and for this reason four examples of two leading tool-holder manufacturers' products are shown in Fig. 202.

It should be noticed also that the term offset, instead of bent, is used to describe these holders.

The tool holder shown at (A) is designated as a right-hand offset tool holder; the one illustrated at (B) is a left-hand offset. The tool holder shown at (C) which holds a side-cutting tool is also a left-hand offset holder, although it is bent in the direction opposite to that of (B).

FIG. 200

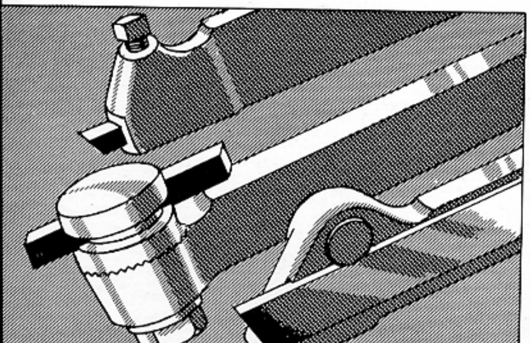


FIG. 201

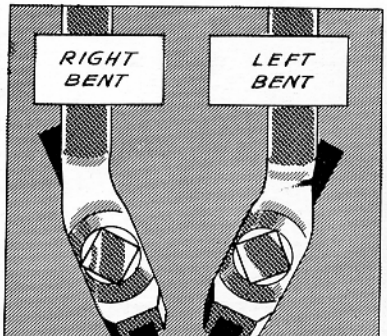
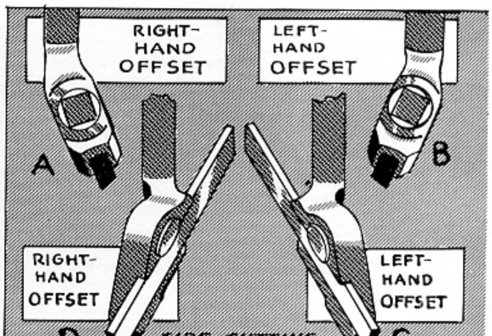


FIG. 202



Notwithstanding that the tool holder is "bent" to the opposite side compared with the one portrayed at (B), the tool which it holds will cut on the same side of the work. The tool holder shown at (D) is correspondingly a right-hand offset side-cutting tool holder.

The style of tool holder is also influenced by the cross-sectional shape of the tool (Fig. 200). It is understood that the tool is selected first to suit the style of cut, the nature of the material, and the kind of work.

Tool holders are designated by a manufacturers' number, usually with a letter placed either before or after the number. In other instances, a letter may be placed both before and after the number. The letter (S), (R) or (L) after the number indicates that the holder is straight, right-hand, or left-hand. The letter before the number frequently is the manufacturer's identification of the style of cutter. For example, a designation T-2-S would indicate that the tool holder is to be used to hold a 3/8" square tool bit and has a 5/8" x 1-1/2" x 8" straight shank. This would fit in a tool post with a maximum tool capacity of 7/8" x 1-1/2".

TYPES OF TOOL HOLDERS

Tool holders may be classified according to the method of holding the tool in relation to the shank of the holder: (1) those which hold the tool parallel (horizontal) with the shank of the holder; (2) those which incline the tool at a slight angle with the shank; and (3) those which incline the tool at a steep angle with the shank.

Each of the three holders illustrated in Figure 200 is designed to hold the tool parallel with the shank of the tool holder. The tool to be used in these three tool holders is ground to the required shape and with the necessary clearances. Unless the tool is held parallel, the angle at which the point of the tool is presented to the work will be changed and the clearances also will vary.

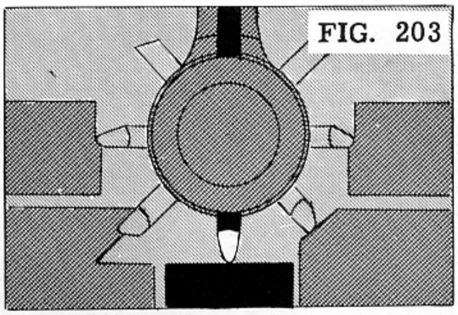


FIG. 203

An exceedingly handy holding device is the shaper-and-planer tool holder shown in Fig. 203. The tool is held parallel with the shank, but may be set at almost any angle to cut on the right- or left-hand side of the work. The tool holder may be held in the shaper in the conventional manner (Fig. 204) with the cutting edge ahead of the supporting surface, or the tool holder may be turned around to act as a gooseneck tool with the cutting edge behind the fulcrum (Fig. 205). In the former case, the tool has a tendency to spring into the work when cutting, whereas the spring of the tool is away from the work when it is held in the latter position.

As the tool is held parallel with the shank of the tool holder, the clearances and angles are easily determined and ground without having to take into consideration the inclined angle of the tool (Fig. 206).

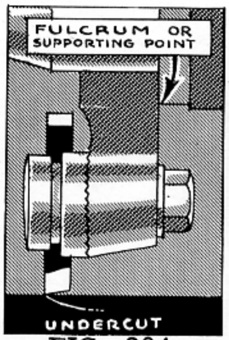


FIG. 204

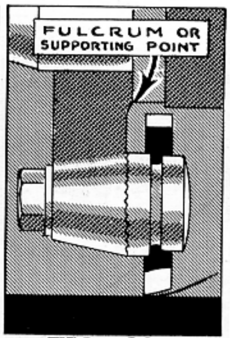


FIG. 205

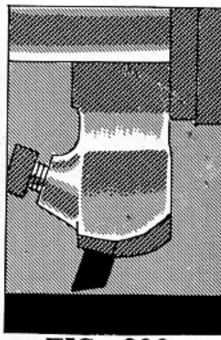


FIG. 206

In the second group of holders the tool is inclined at a slight angle. The slight angle at which the tool is held, called the tool-holder angle, should be such that it will eliminate, as much as possible, grinding the top of the tool. For shaper work, a satisfactory tool-holder angle is 15° (Fig. 206). The tool grinding in this case gives the tool both front and side clearance.

The remaining two examples in this classification (Fig. 207) incline the tool at a steep angle which should correspond to the most satisfactory clearance angle for the front of the tool. This type of tool holder, however, while not extensively used for general shaper work, has some merit when used to hold formed tools. The tool in this case can be ground on the top without changing the contour of the tool if the top surface is always ground at the same angle.

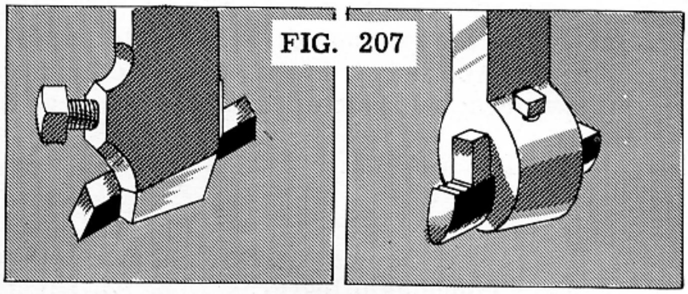


FIG. 207

CLAMPING METHODS

Two principal methods are used to clamp the tool in the shaper tool holder: first, a direct clamping action caused by the pressure of a screw; second, a wedging action produced either by a cam or by a drawbolt.

An example of the first method is shown in Figures 208 and 209. A tool is inserted in a rectangular or square hole in the front of the holder and is forced down by the direct pressure of the screw.

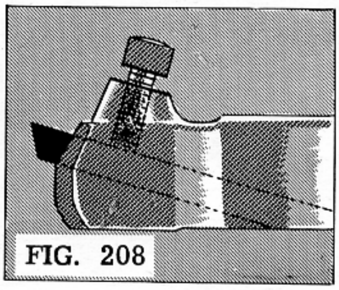


FIG. 208

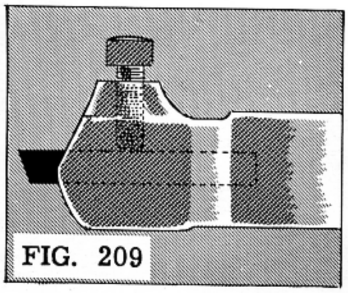


FIG. 209

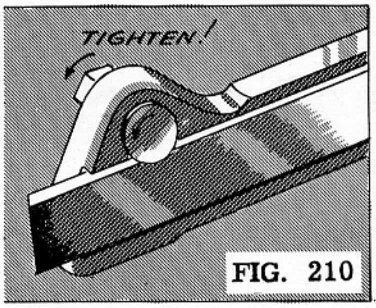


FIG. 210

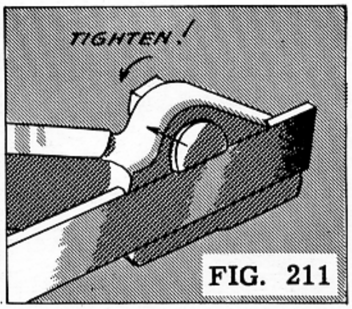


FIG. 211

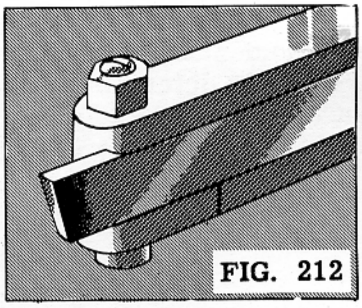


FIG. 212

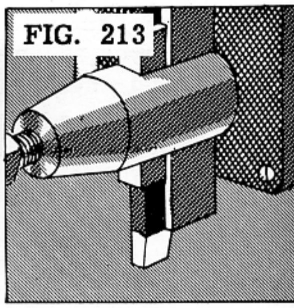


FIG. 213

In the second case, the tool is wedged against the bottom ledge of the tool holder by a cam action (Fig. 210). As the cam is turned with a wrench it presses downward against the tool in such a direction that, as the cutting action of the tool tends to force the tool into the tool holder, it wedges tighter as the pressure increases. The tool can be easily released by turning the cam in the direction opposite to that indicated by the arrow.

The drawbolt is another adaptation of the wedging action which also can be used very effectively with flat tools (Fig. 211). The cutter is placed in a slot in the side of the tool holder and is held in position with a tapered-head bolt with a flat side. As the bolt is drawn in, the tapered surface forces the bolt downwards and the pressure of the flat side of the head on the tool holds it in place.

Fig. 212 and Fig. 213 illustrate two other methods of holding the tool in the tool holder.

There are also on the market patented sets of tools and tool holders which have many convenient features. The set illustrated in Fig. 214 is made especially for shaper work.

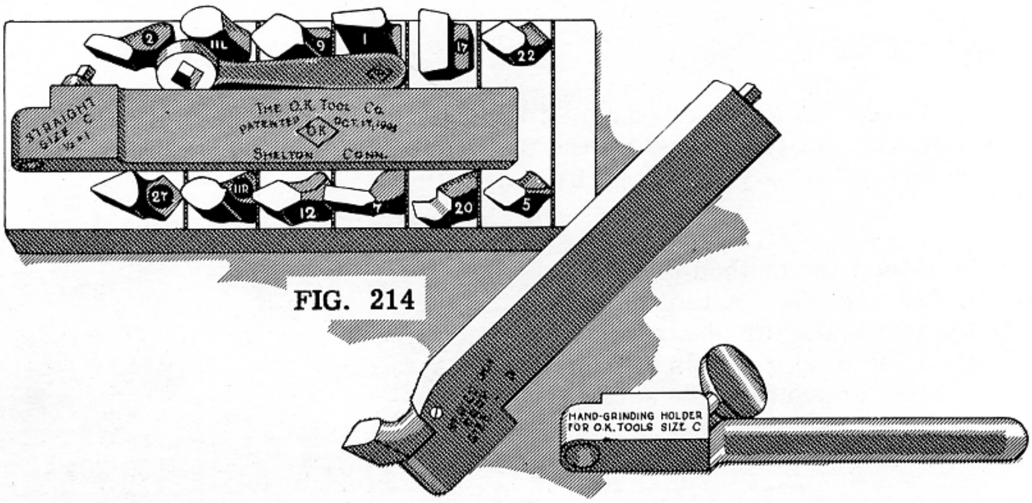


FIG. 214

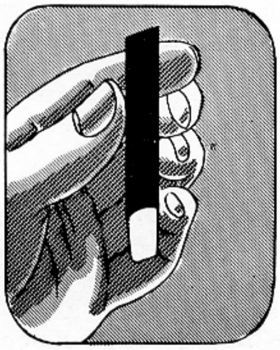
DESCRIPTION of SHAPER TOOLS

OBJECTIVES OF UNIT

1. To understand the terminology used with cutting tools.

2. To become familiar with various shapes of tools.

3. To visualize and understand the angles of clearance, the angles of rake, and the lip angle of the tool.



INTRODUCTORY INFORMATION

Tools used in the shaper may be forged or ground to shape from solid steel bars or they may be smaller pieces of steel which are held and clamped in a tool holder.

The shape of the tool varies considerably with the character of the work. To give examples of the various shapes of tools for every purpose and at the same time to satisfy every individual mechanic's preference for form would be extremely difficult. In addition, the terms applied to single-point tools and tool holders are not entirely consistent. Although attempts have been made to standardize these terms, conventional usage so far has frustrated attempts to apply them in every case.

There are certain principles, however, which the beginner must understand before he can use and grind cutting tools intelligently. For example, a tool may cut well for general work, but may not be satisfactory for sustained, heavy-duty production cuts.

The same caution should be observed in this unit regarding terminology as was followed with tool holders. The terms adopted by the American Standards Association have not been accepted by all users and manufacturers. Therefore, some explanation may be necessary when standard terms differ from those in conventional use.

It should be understood that changes of this character take time and often require considerable expense on the part of manufacturers. Eventually, the terms and processes which are best for the industry as a whole will finally be adopted.

CUTTING TOOL TERMINOLOGY

The shaper tool, or cutter, is in most cases a piece of high-grade steel which is shaped, hardened and ground to a cutting edge. It is securely held in the tool head of the shaper and made to pass across the work to take a series of cuts.

The tools may be forged from steel bars or they may be smaller pieces of steel inserted in a tool holder. The cutters are usually square or rectangular in shape, except in cases where tools are made in sets to fit special types of tool holders.

The shape or form of the tool depends chiefly upon the shape of the cut. It may also be influenced by the kind of finish required and the kind of material to be machined. The rake, the cutting angle, and the clearances, on the other hand, depend principally upon the nature of the material. All of the foregoing considerations are governed by certain basic underlying principles which have been determined as a result of experimentation and observation.

A discussion of cutting tools is better understood if some of the terms used to describe them are defined. The following American Standards' definitions apply to some of the more common terms used in connection with single-point cutting tools.

POINT - The point is all that part of the tool which is shaped to produce the cutting edges and face (Fig. 215).

SHANK - The shank is that part of the tool on one end of which the point is formed or the tip or bit is supported. The shank in turn is supported in the tool post of the machine (Fig. 215).

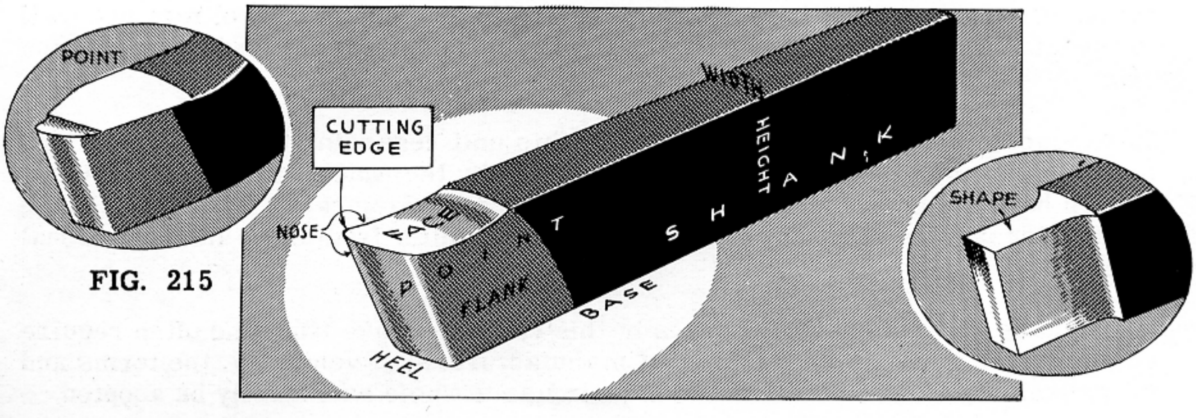


FIG. 215

FACE -The face is that surface on which the chip rolls or flows as it is cut from the work (Fig. 215).

CUTTING EDGE -The cutting edge is that portion of the face edge along which the chip is separated from the work. The cutting edge consists usually of the side-cutting edge, the nose radius and the end-cutting edge (Fig. 215).

SHAPE -The shape of the tool is the contour of the face when viewed in a direction at right angles to the base (Fig. 215).

WORKING ANGLES -The working angles are those angles between tool and work which depend not only on the shape of the tool, but also on its position with respect to the work.

CUTTING ANGLES - The cutting angle is the angle between the face of the tool and a tangent to the machined surface at the point of action. It equals 90^{o}, minus the true-rake angle (Fig. 216).

LIP ANGLE -The lip angle is the included angle of the tool between the face and the ground flank measured in a plane at right angles to the cutting edge. When measured in a plane perpendicular to the cutting edge at the end of the tool, it is called the end lip angle. When measured at the point of chip flow, it is called the true lip angle (Fig. 217).

BACK-RAKE ANGLE -The back-rake angle (Fig. 218) is the angle between the face of a tool and a line parallel to the base of the shank or holder. The angle is positive if the face slopes downward from the point toward the shank, and is negative if the face slopes upward toward the shank (Fig. 218).

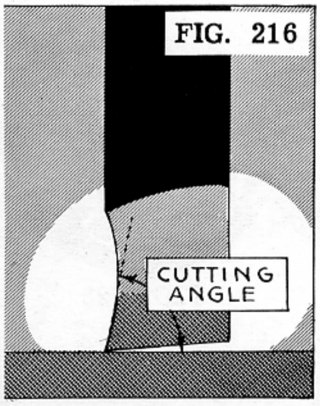


FIG. 216

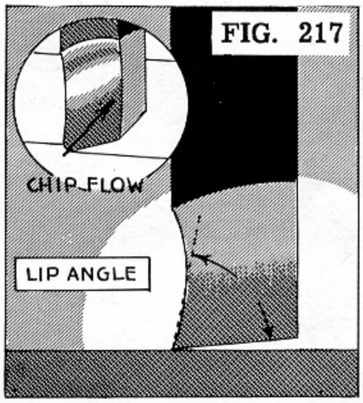


FIG. 217

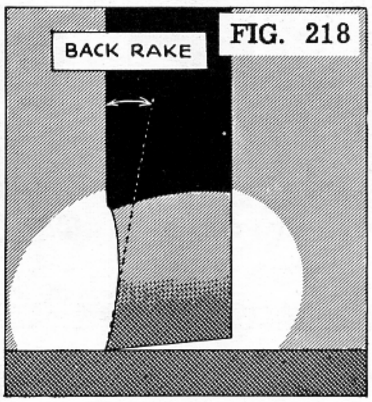


FIG. 218

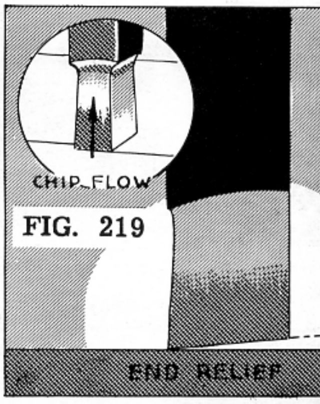


FIG. 219

END-RELIEF ANGLE -The end-relief angle is the angle between the portion of the end flank immediately below the cutting edge and a line drawn through that cutting edge perpendicular to the base. It is measured in a plane parallel to the center line of the point (Fig. 219).

SIDE-RELIEF ANGLE -The side-relief angle is the angle between the portion of the flank immediately below the cutting edge and a line drawn through this cutting edge perpendicular to the base. It is measured in a plane at right angles to the center line of the point (Fig. 220).

SIDE-RAKE ANGLE -The side-rake angle is the angle between the face of a tool and a line parallel to the base. It is measured in a plane at right angles to the base, and at right angles to the center line of the point (Fig. 220).

TRUE-RAKE ANGLE - The true-rake angle (or "top-rake"), under actual cutting conditions, is the actual slope of the tool face toward the base from the active cutting edge in the direction of chip flow. It is a combination of the back-rake and side-rake angles and varies with the setting of the tool and with the feed and depth of cut (Fig. 221).

RIGHT-CUT TOOL -A right-cut single-point tool is one which, when viewed from the point end of the tool, with the face up, has the cutting edge on the right side (Fig. 223).

LEFT-CUT TOOL - A left-cut tool has the cutting edge on the left when looking at the point end with the face upward (Fig. 222).

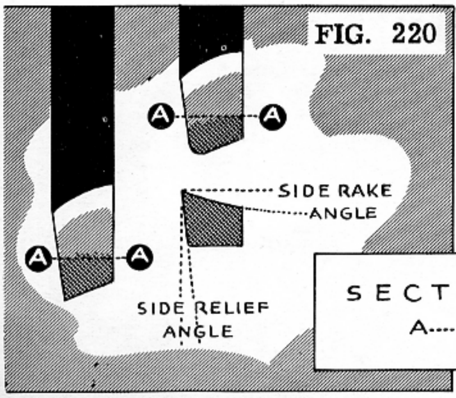


FIG. 220

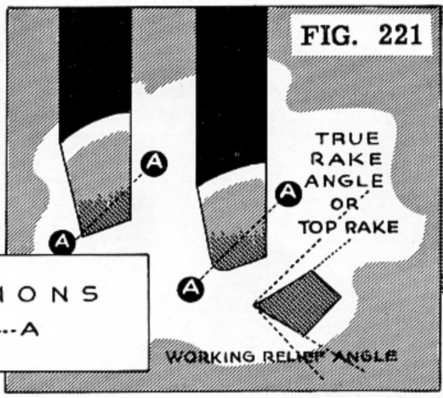


FIG. 221

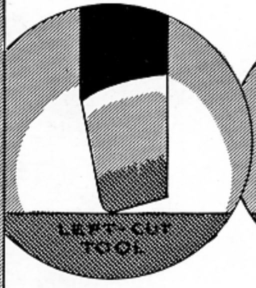


FIG. 222

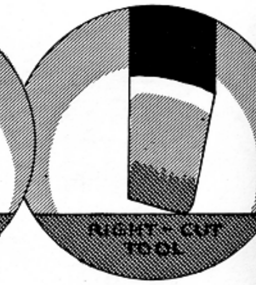


FIG. 223

BENT TOOL -A bent tool has the point bent to the left or right to make its operation more convenient. These tools are called left-bent tools if the point is bent to the left when looking at the tool from the point end with the face upward and the shank pointing away, and vice versa (Fig. 224).

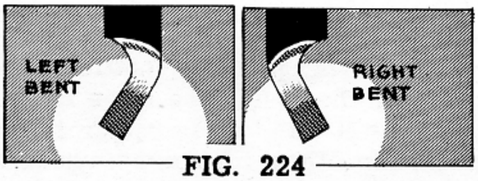


FIG. 224

SIDE-CUTTING-EDGE ANGLE -The side-cutting edge angle is the angle between the straight side-cutting edge and the side of the tool shank. In the case of a bent tool, this angle is measured from the straight portion of the shank (Fig. 225).

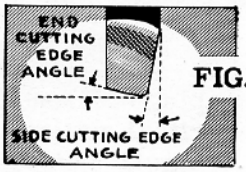


FIG. 225

END-CUTTING-EDGE ANGLE -The end-cutting edge angle is the angle between the cutting edge on the end of the tool and a line at right angles to the side edge of the straight portion of the tool shank (Fig. 225).

THE SHAPE OR FORM OF THE TOOL AS VIEWED FROM THE TOP

The shape of the tool may be curved, flat or its sides may converge to a sharp point. The form of the tool will depend principally upon the surface being machined. For example, a tool with a curved surface could not be used to produce a rectangular slot or to produce a sharp corner. In contrast, a tool with a sharp corner would not be recommended for a curved surface or for roughing a flat surface.

Usually, there is a difference between the roughing and the finishing tool. In addition, a tool may be offset, or bent to the right or to the left and may feed either in a right-hand or left-hand direction.

A tool with a rounded nose may be used to rough out both steel and cast-iron surfaces, and with slight modification may be used to produce a finish cut. Frequently, the shear-cut tool (Fig. 226) is preferred for finishing steel; whereas, a tool with a flat end shaped as in Fig. 227 is extensively used to finish cast iron.

The three tools illustrated in Fig. 228 should give satisfactory results when used in the shaper to produce flat horizontal surfaces.

The tool shown at (A) is recommended for roughing cut.

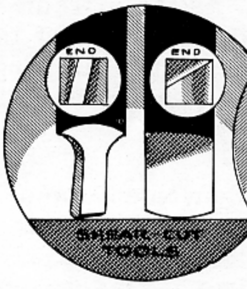


FIG. 226

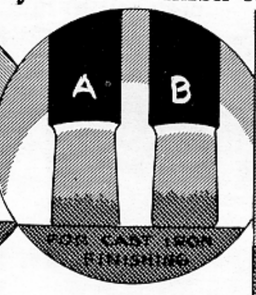
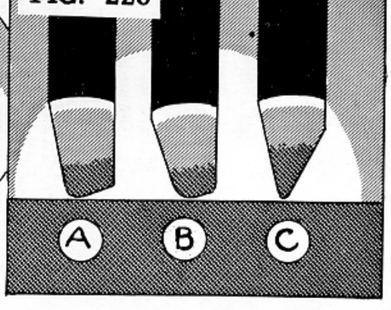


FIG. 227

FIG. 228



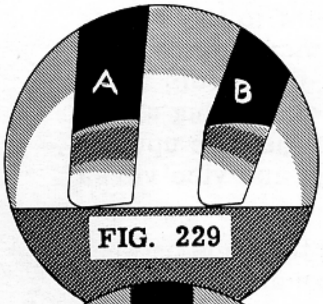


FIG. 229

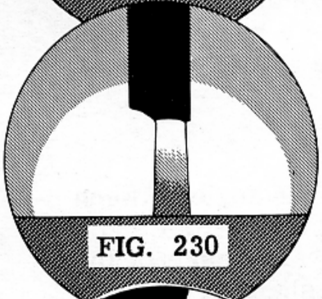


FIG. 230

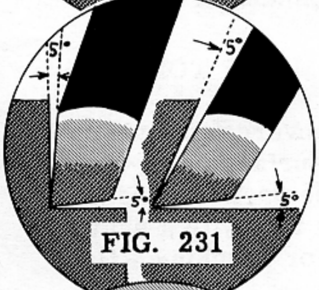


FIG. 231


FIG. 232

It has a side-cutting edge angle of 8°, an end-cutting edge angle of 15°, and a 1/16" radius on the nose of the tool. The slight variation of the round-nosed tool shown at (B) is preferred by many for roughing cuts. It has a side-cutting edge angle of 20° and a large radius on the nose. The large radius on the nose is often objectionable if this tool is used for fine cuts, roughing out radii, and in other instances where a broad surface on the tool is likely to produce chatter. This may be overcome by using a tool with a small radius as illustrated at (C).

Similar in shape to the tool for shaping horizontal surfaces is the roughing tool for down or vertical cutting (Fig. 229). The tool is ground to an angle of about 85° with a small radius on the nose. The side-cutting edge should be parallel with the side of the tool (A) or may be offset slightly (B) to give clearance for the tool holder.

For finishing cast iron, the tool (A) (Fig. 227) is extensively used and will give excellent results. The corners of the tool may be sharp or they may be rounded slightly as in (B).

Whenever it is desired to finish the surfaces of steel, the shear-cut tool (Fig. 226), when used with a little coolant, will produce a smooth, bright finish.

In addition to being used to finish cast iron, the square-nosed tool (Fig. 230) can be used to cut slots and to cut-off material. The tool is ground considerably narrower when used to cut-off material, and made to the desired width for cutting slots.

A tool that is used to finish square or acute angular corners is ground as in Fig. 231. This tool is ground at an angle from 5° to 10° less than the angle of the corner which it is intended to cut. As the extreme point of this tool will break down easily, it is not suitable for roughing cuts. For roughing, the nose of the tool should be rounded (Fig. 232).

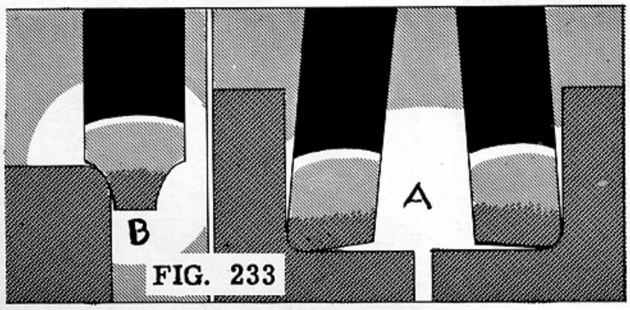


FIG. 233

Convenient tools for rounding the edge or for cutting the radius of a corner are called radius tools (Fig. 233). These tools are made in two styles to suit either an inside or an outside radius. The inside radius tool (A),

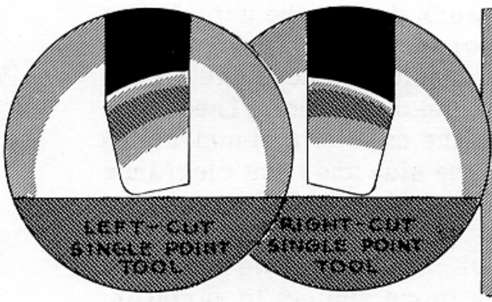


FIG. 234 FIG. 235

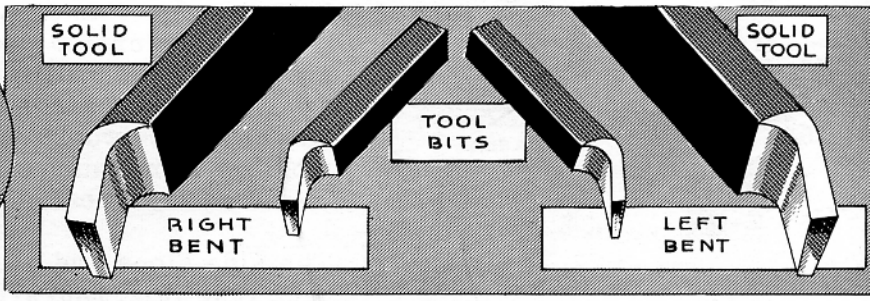


FIG. 236

should be ground at an angle of about 85° to give enough clearance for the sides when the inside radius is being cut. Frequently this radius can be cut out with the nose of the round-nosed roughing tool. The corners of the outside radius tool (B), also should be given a slight relief to prevent it from cutting into the adjoining flat surfaces.

As it is necessary at times to shape both sides of a job without taking the work out of the vise or the machine, tools are made to cut on the right-hand or left-hand side of the work. These tools are referred to as: right-hand, left-hand, right-cut or left-cut tools.

According to the American Standards Association definition, "A right-cut single-point tool is one which, when viewed from the point end of the tool, with the face up, has the cutting edge on the right side" (Fig. 234). "A left-cut tool has the cutting edge on the left when looking at the point end with the face upward" (Fig. 235).

Here again, terminology and use of shaper tools are not entirely consistent with these definitions. Some manufacturers still prefer to designate these in the opposite manner.

The same situation exists with the bent tools. In American Standards terminology, right and left single-point tools are designated as in Fig. 236. At the same time, some users still favor the old method of naming them oppositely. However, the important characteristics such as clearance, rake, cutting angles, and shapes are fairly well established for the shaper operator.

CLEARANCE, RAKE AND LIP ANGLE

The purpose of clearance, both on the side and the end of the shaper tool, is to allow the cutting edge to do the cutting and the back of the cutting edge to clear the work.

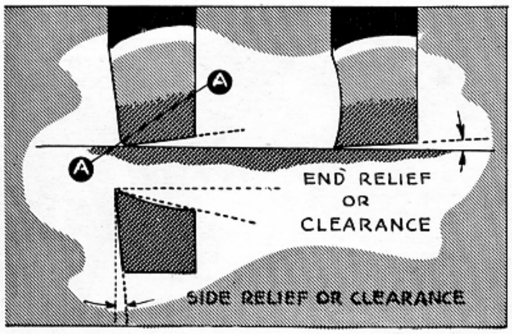


FIG. 237

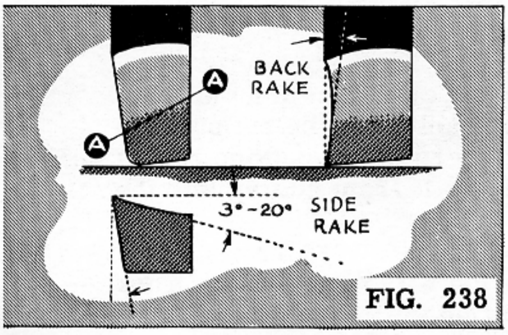


FIG. 238

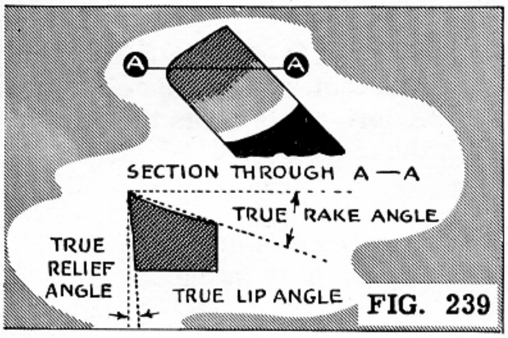


FIG. 239

TOOL WITH NEGATIVE RAKE

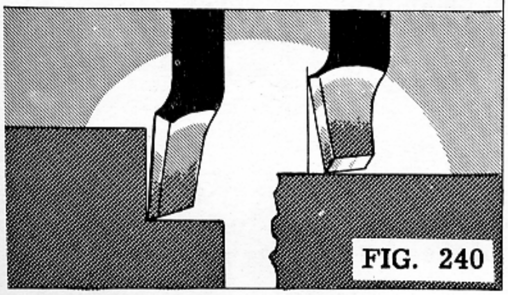


FIG. 240

It should be realized that the shaper tool does not feed sideways into the work during the actual cutting. Therefore, a clearance of 2^{o} to 6^{o} with an average of 4^{o} is usually considered adequate clearance for the side and the end of the tool. The effective clearance would, in the case of a round-nosed tool, be a combination of the side and front clearance measured at the nose of the tool (Fig. 237).

The side slope and back slope, or side rake and back rake (Fig. 238) are more subject to variation than the front and side clearances. It is the amount of side and back rake which has the greatest influence upon the true lip angle of the tool (Fig. 239).

Theoretically, the rake should be ground on the tool to reduce the amount of power required for cutting and to reduce the wear resulting from the enormous pressure required to have the metal chip flow off the work. On the other hand, the least possible rake should be given in order to support the cutting edge and prevent it from wearing and crumbling away.

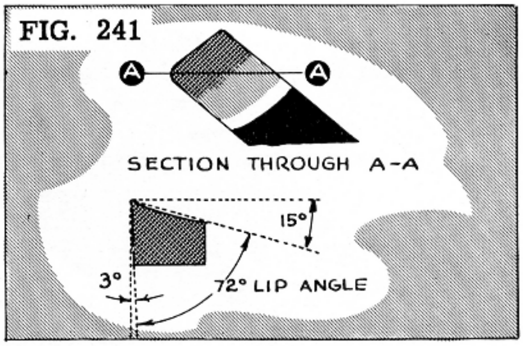
Thus, there are two opposite requirements: one which requires the edge to be as sharp as possible; the other tends to avoid a sharp cutting edge. The amount of rake must be determined then as a compromise between the above two opposite requirements. The tool should be sharp to cut with maximum efficiency, blunt enough to support the cutting edge, and still be able to produce the desired finish on various metals.

With the foregoing principle in mind, no set rake is satisfactory for all metals and under all conditions. Some very satisfactory results have been obtained with the following rake angles: for steel, a side rake of 10^{o} to 20^{o} and a back rake of 2^{o} to 8^{o}; for cast iron, a side rake of 3^{o} to 10^{o} and a back rake of 0^{o} to 3^{o}.

Occasionally, a side-cutting tool may be given a negative rake (Fig. 240). As the tool moves forward, it first strikes the work above the extreme point, softening the blow slightly and reducing the tendency to break off the tip of the tool.

The lip angle of the tool is influenced by the amount of rake and the clearance of the tool. For instance, if a tool has 3° clearance on the side and a side slope of 15°, the lip angle at that point will be 72° (Fig. 241).

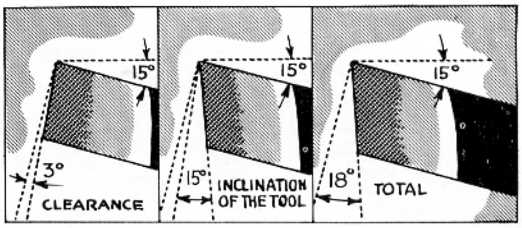
FIG. 241



These tools are ground to be used with a tool holder which holds the tool parallel with the shank (Fig. 245).

Often the only type of tool holder available is one which will hold the tool at a 15° angle of inclination. This angle must be taken into consideration when the tool is ground. If the tool is inclined 15° in the tool holder and a 3° relief angle (front clearance) is required, 15° plus 3°, or an 18° relief angle must be ground on the end of the tool in order to compensate for the 15° slope and to give 3° clearance (Fig. 242).

FIG. 242



The same procedure must be followed in regard to the back rake of the tool. Since the tool is set at 15°, the back slope will also be 15°. With a 3° relief, a lip angle of 72° must be ground (Fig. 243). If for cutting cast iron a back relief of 2° were required, then the cutter would be ground on the tip to a lip angle of 85° (Fig. 244).

FIG. 243

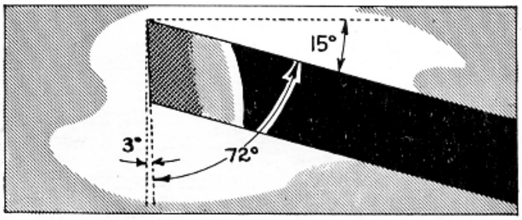
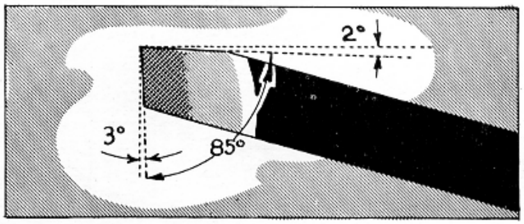


FIG. 244



The side relief and the side rake are also affected by the 15° inclination, but not in the same proportion as are the end relief and the back relief.

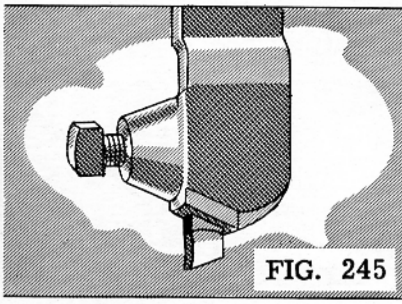


FIG. 245

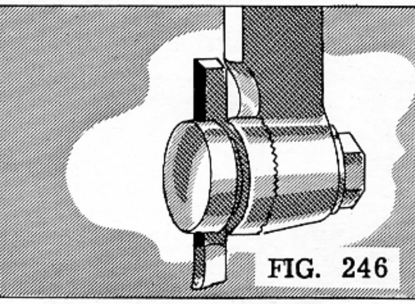


FIG. 246

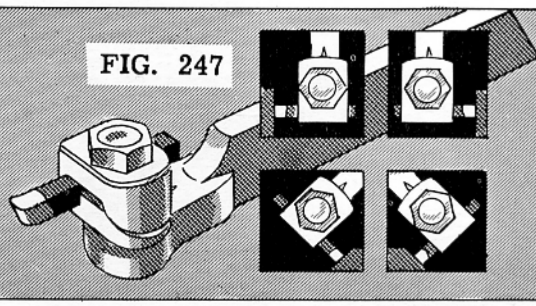
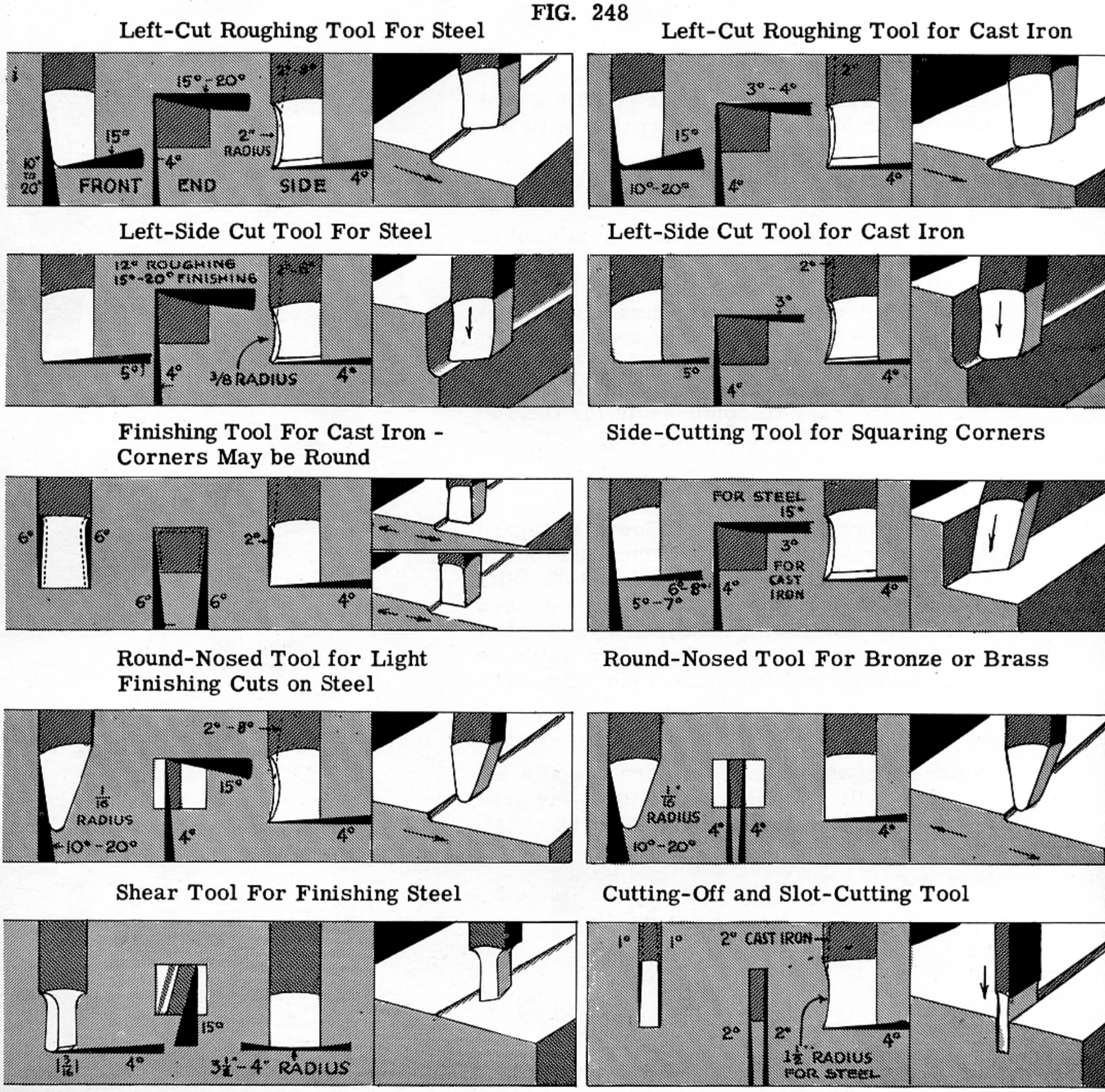


FIG. 247

The tools as illustrated on this page conform to the terminology of the American Standards Association. The indicated cutting angles and the clearance are to be used when the tool is held parallel with the shank of the holder.

FIG. 248



HOW TO SET UP SHAPER TOOLS

Photo by courtesy of J. H. Williams & Co.

UNIT P 52 (C)

Part I Pages 167 - 172

HOW TO SET UP SHAPER TOOLS

OBJECTIVES OF UNIT

1. To tell how the tool head is set up to receive shaper tools.

2. To show how the tool and tool holder are selected and set.

3. To illustrate typical tool set-ups.

INTRODUCTORY INFORMATION

An important element in tool setting is one of rigidity. The tool head is provided with adjustments to help eliminate vibration and at the same time allow for the movement of the tool. To minimize vibration or chatter, the head should be properly adjusted. In addition, the tool must be supported properly. The tool slide and tool should not be allowed to overhang or project beyond the point of support any more than is absolutely necessary. The tool also must be held short in the tool holder. There are times, however, when overhang is unavoidable. In these cases, light cuts should be taken and care should be observed when the tool is being fed into the work.

Another important consideration is to set the tool or holder so that the tool swings away from the work. The importance of such a setting is evident when a flat surface is being roughed out. If the tool is held in a vertical position and the side pressure of the cut causes the tool or holder to move, the tool will swing away from the surface being machined. On the other hand, if the tool or tool holder is pointed toward the cut and the side pressure of the cut causes the tool or holder to move, the tool will "dig in." Here again, there are exceptions to this rule. If it is necessary to point the tool toward the cut, the tool must be watched carefully to see that it does not shift and dig into the work.

Finally, the tool may be set ahead or behind the point of support. In many cases, the tool can be set ahead of the point of support. For finishing cuts, the tool may be set behind the supporting surface, the double purpose being to eliminate chatter and to produce a smoother finish.

TOOLS AND EQUIPMENT

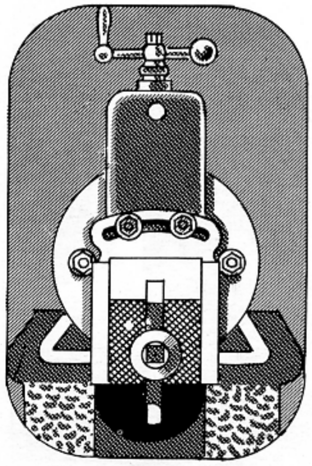
Shear tool
Cleaning cloth
Tools for serrating
Available tool holders
Tools for cutting slots

Tools for cutting contours
Shaper and necessary wrenches
Tools for combined and vertical cuts
Tools for side cutting and chamfering
Tools for horizontal and vertical cuts

HOW TO USE SHAPER TOOLS

PROCEDURE

PREPARATION OF THE TOOL HEAD

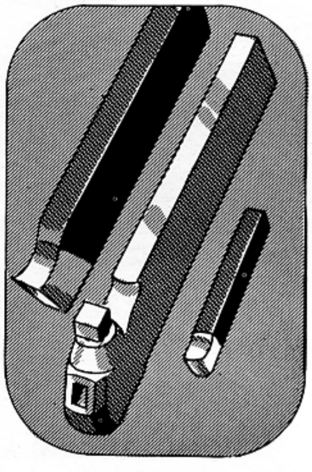


1. Check the tool head assembly to become familiar with it.
2. Clean and oil the head daily.
3. Examine the clapper box and make sure that dirt, burrs, or chips do not prevent the block from working freely.
4. Check the back of the block and the base of the clapper box to be sure that no chips are lodged between the two parts. Chips would prevent the block from seating properly.
5. Move the block outward and upward with the hand and allow it to drop back into place.
6. Examine the block to see that it seats solidly on its base.
7. Turn the down-feed crank to move the tool slide up and down.

   NOTE: The gib on the tool slide should be adjusted so that the down-feed crank offers resistance to turning when the tool slide is moved downwards.

   CAUTION Experience, care and judgment are necessary when adjusting the gib. The regulating should be done by a qualified person.

SELECTION OF THE TOOL OR TOOL HOLDER



1. Read the description of tools and tool holders on pages 153 and 158.
2. Decide whether a solid forged tool or a tool holder must be used. The type selected should be determined by the job to be machined and the available supply of tools and tool holders.
3. See whether the tool is held parallel with the shank of the tool holder or is inclined at an angle if a tool holder is used.

4. Check the clearance and the rake of the tool to see that they fit the manner in which the tool is held in relation to the shank of the tool holder. Remember that the inclination of the tool affects both the clearance and the rake.

5. Choose from the special set, if one is available, a tool to suit the character of the work. These tools are ground with the correct clearance and rake, and the cutter can be changed easily to meet the requirements of the job.

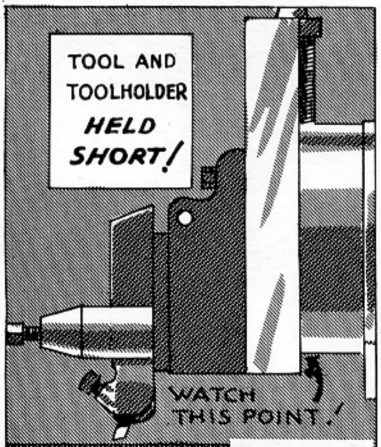


FIG. 249

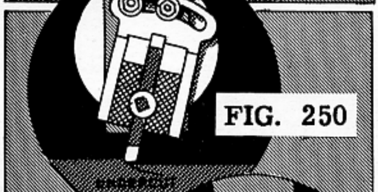


FIG. 250

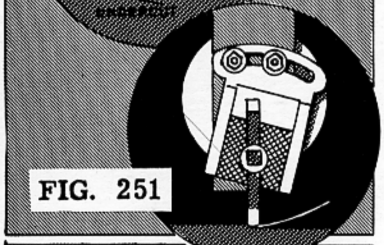


FIG. 251

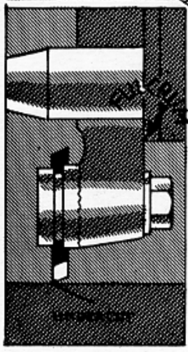


FIG. 252

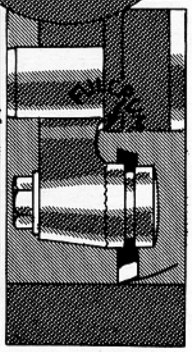


FIG. 253

SETTING THE TOOL OR TOOL HOLDER IN THE TOOL POST

1. Adjust the tool slide with the down-feed crank so that when additional cuts are taken, the tool slide will not project or overhang more than one inch below the head of the ram (Fig. 249).

   NOTE: Sometimes it is necessary to move the slide beyond the limit of one inch for some cutting operations. If this is necessary, light cuts should be taken and care should be exercised. Otherwise, the tool slide may be broken.

2. Move the clapper box to the right (Fig. 251) if the tool is cutting on the right-hand side of the work. This will allow the tool to move clear of the work and will prevent unnecessary wear on the cutting edge of the tool.

3. Move the clapper box to the left if the tool is cutting on the left-hand side of the work.

4. Set the clapper box in a vertical position for cutting off, for cutting slots and for making similar cuts.

5. Move the head either to the right or to the left for angular cuts.

   NOTE: The adjustment of the clapper box to the right or left will depend upon the direction of the cut, whether the cut is on the right or left side of the work, and the direction in which the head is swiveled. These adjustments are fully explained in the following steps.

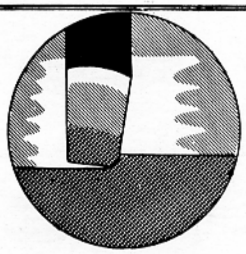
6. Hold the tool short in the tool holder (Fig. 249).

7. Place the tool holder or tool in the tool post with the smallest possible amount of overhang (Fig. 249). The reasons for this are to secure the tool rigidly, to prevent chatter in the tool and to prevent undue strain on the tool slide.

8. Place any one of the tools in the shaper tool post in the conventional manner (Fig. 252). Notice that the cutting edge of the tool is ahead of the support or fulcrum.

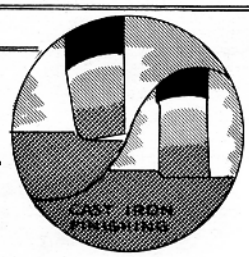
9. Reverse the tool holder as illustrated in Figure 253 if a gooseneck tool is desired. This has the cutting edge behind the support to allow the tool to swing away from the work when it is under heavy cutting pressure.

HORIZONTAL CUTS

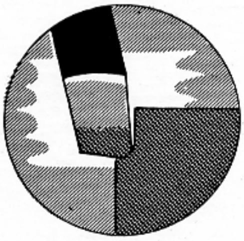


1. Tool head vertical.
2. Clapper box vertical or over to the left.
3. Tool or tool holder held vertically.

1. Tool head vertical.
2. Clapper box vertical or over to the right.
3. Tool or tool holder held vertically.

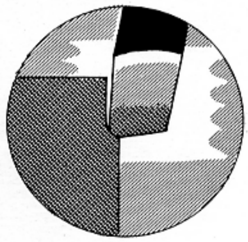


VERTICAL CUTS

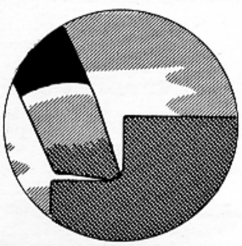


1. Tool head vertical.
2. Clapper box over to the left.
3. Tool holder inclined to give about 5° clearance on the side.

1. Tool head vertical.
2. Clapper box over to the right.
3. Tool holder inclined to give about 5° clearance on the side.

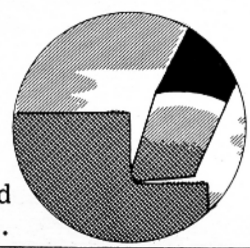


COMBINED CUTS

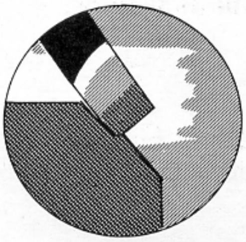


1. Tool head vertical.
2. Clapper box over to the left.
3. Tool set to have about 5° clearance with the vertical and the horizontal sides.

1. Tool head vertical.
2. Clapper box over to the right.
3. Tool set to have about 5° clearance with the vertical and the horizontal sides.

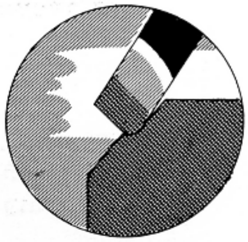


ANGULAR CUTS

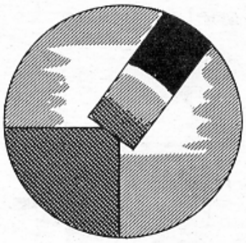


1. Tool head set to the left.
2. Clapper box over to the right.
3. Tool set to have about 5° clearance with the angle of the cut.

1. Tool head set to the right.
2. Clapper box over to the left.
3. Tool set to have about 5° clearance with the angle of the cut.

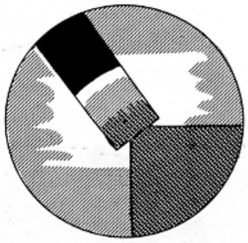


CHAMFERS

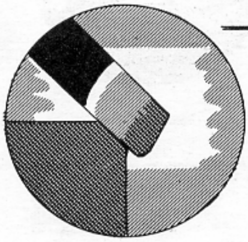


1. Tool head set to the right.
2. Clapper box parallel with the head.
3. Tool edge set approximately with a gage, or with a protractor.

1. Tool head set to the left.
2. Clapper box parallel with the head.
3. Tool edge set approximately with a gage, or with a protractor.

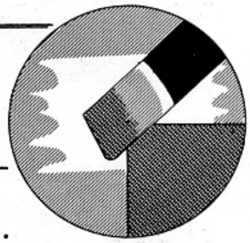


CHAMFERS

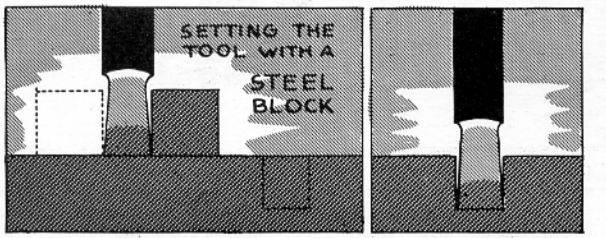


1. Tool head vertical.
2. Clapper box to the right.
3. Tool edge set approximately with a gage, or with a protractor.

1. Tool head vertical.
2. Clapper box to the left.
3. Tool edge set approximately with a gage, or with a protractor.

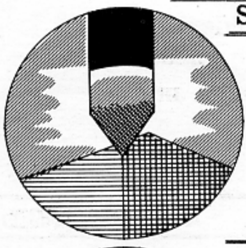


SLOTS



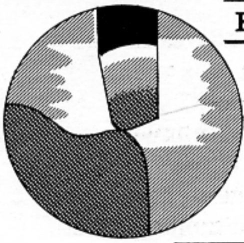
1. Tool head vertical.
2. Clapper box vertical.
3. Tool set with a horizontal surface and side of the tool set with a steel block or a small square.

SERRATIONS



1. Tool head vertical.
2. Clapper box vertical.
3. Tool vertical.

FORM CUTS



1. Tool head vertical.
2. Clapper box vertical.
3. Tool vertical.

DESCRIPTION OF HORIZONTAL, VERTICAL AND COMBINED CUTS

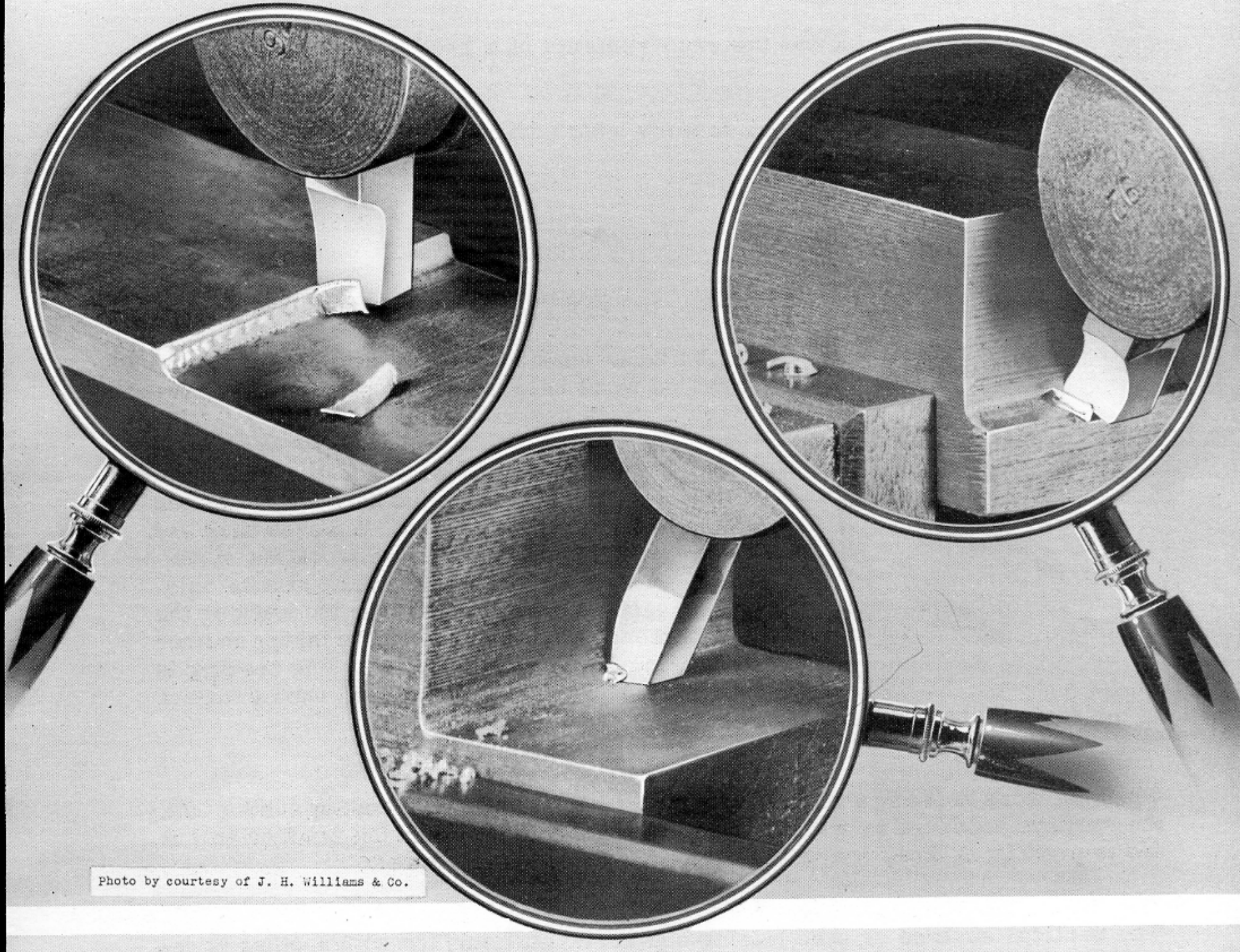


Photo by courtesy of J. H. Williams & Co.

UNIT T 53 (A)

Part II Pages 173 - 188

DESCRIPTION *of* HORIZONTAL, VERTICAL *and* COMBINED CUTS

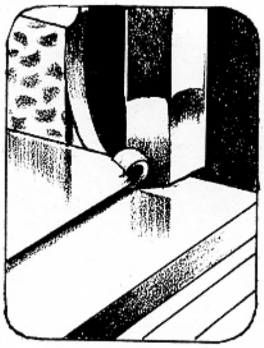
OBJECTIVES OF UNIT

1. To describe horizontal, vertical and shoulder cuts.

2. To point out the requirements of a good set-up.

3. To discuss the factors which affect surface finish.

INTRODUCTORY INFORMATION



Most shaper work consists of machining flat surfaces on work held in one or another of the devices already described.

A single-point tool, so called because it has one cutting edge, does the cutting. It moves back and forth over the work with a reciprocating movement, cutting during the forward stroke only. During each return stroke, either the work or the tool is moved (fed) preparatory to taking another cut during the forward stroke. The feeding is continued automatically, or by hand, until a surface of the desired size or shape has been machined.

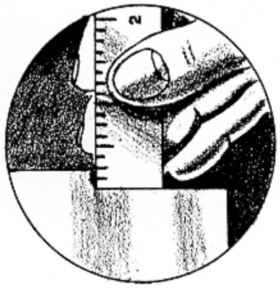
When the work is fed in a horizontal direction under the reciprocating cutting tool, the surface produced is a horizontal flat surface. But when the work or tool is fed in a vertical direction, a vertical flat surface is produced.

The vertical surface or step joining one horizontal surface with another is referred to as a shoulder. Both horizontal and vertical shaping are required to form a shoulder when the distance separating the horizontal surfaces is considerable.

The surface finish attained depends on such factors as the shape of the tool, the depth of cut, the rate of feed and the material being machined.

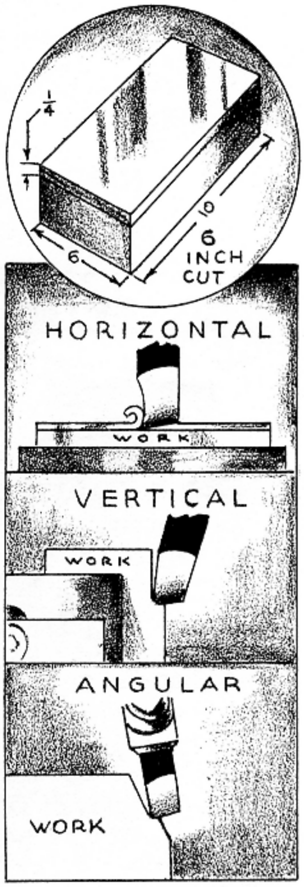
DEFINITION OF CUTS

In the subsequent description of shaper operations, the word "cut" is used frequently. As the following examples will indicate, the same meaning is not attached to this word in each instance.



The most common usage of the word has reference to the thickness of metal which the tool removes from the surface of the work and indicates the depth of the shoulder which is made by the tool when it is cutting the metal. For example, when a 1/4-inch cut is to be made, 1/4" of metal is removed from the surface, and the thickness of the work is reduced a corresponding amount. During the cut, the tool forms a shoulder one-fourth inch deep as indicated by a measurement taken from the finished surface to the uncut surface of the work.

The term "cut" is used in another sense in calculating the time required to machine a given area. In this instance, "cut", refers to the width of the surface from which the metal is removed, for the work is usually placed in the shaper lengthwise.



Now, with the feed per stroke known, the width of the surface determines the number of strokes required to take a cut across the surface. For example, if one-fourth inch of metal is removed from a surface 6" wide and 10" long, and the work is placed in the machine lengthwise, the width of the surface would be referred to as a 6-inch cut, for the tool would be required to feed a total of 6" to finish the surface. The number of strokes required to machine the surface depends upon the rate of feed.

The word "cut" is used in still another sense to designate the plane of the surface from which the metal is removed. For example, when the surface requiring machining lies flat, and the work is fed under the tool in a horizontal direction, the tool is said to take a horizontal cut.

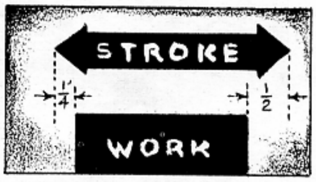
The same procedure is followed in referring to metal removed from a surface located in a vertical or an angular plane (Refer to illustrations at right). Thus, when the tool is fed down or the work is fed up at right angles to the top of the table, the cut is said to be a vertical cut. When the tool head is swiveled from its 90° location, and the tool is subsequently fed to the work by means of the down-feed screw, the result is an angular cut.

THE HORIZONTAL CUT

A horizontal surface is produced by a series of cuts made with a single-point cutting tool during the forward stroke of the shaper ram and the feeding of the work in a horizontal direction during each return stroke. Alternate cutting and feeding are continued until a surface of the desired width has been machined, the feeding being either automatically or manually controlled. During the cutting process, the work is clamped rigidly in a vise, in a fixture or to the surface of the table. The work is fed as the table moves on the cross rail when the cross-feed screw is turned.

With the exception of unusual conditions which require that the feeding mechanism operate at the beginning of the cutting stroke instead of during the return stroke, the length of stroke should be set only about an inch longer than the work. Approximately one-half inch of this extra length should come at the beginning of the stroke in order that the clapper block may seat properly before the tool engages the next cut. The remaining one-half inch should come at the end of this stroke.

PLACEMENT OF THE STROKE



When the feed has been adjusted to operate at the beginning of the stroke, the tool must be allowed to run beyond the back end of the work a somewhat greater distance than usual. The stroke too must be made correspondingly longer. The additional space is required at the beginning of the stroke under these conditions in order that all feeding of the table will have been completed before the tool engages the metal. Otherwise, the feed mechanism will be subjected to the heavy pressure needed to force the tool into the metal. The feed mechanism never was designed to withstand such heavy pressures.

Although it is essential that the ram stroke be somewhat longer than the work so that the cutting tool clears both ends of the work, the tool is idle (non-cutting) as it passes through this extra clearance space.

For economy of time, it is important that the stroke-length be held to the minimum required for proper functioning of the tool. The work should be placed in the shaper to reduce the non-cutting or waste time of the tool to a minimum. Despite the desire to save time, the stroke should not be shortened to the extent that the feed mechanism is caused to operate after the tool has entered the cut.

PLACEMENT OF THE WORK

Since it is necessary for the tool to overrun the work (whether the stroke used is long or short) the job should be placed in the shaper in the position requiring the fewest strokes, for less time will then be wasted. Thus, when a surface may be planed either crosswise with a short stroke or lengthwise with a longer stroke, the longer one should be selected.

For example, a job which can be machined by placing it either lengthwise or crosswise is shown in Figure 254. If this job is placed in the shaper crosswise, the non-cutting area traveled by the tool will be twice as great as that which the tool would travel if the job were placed in the machine lengthwise. The non-cutting area for the crosswise cut is represented in grey. The lengthwise cut is represented in black.

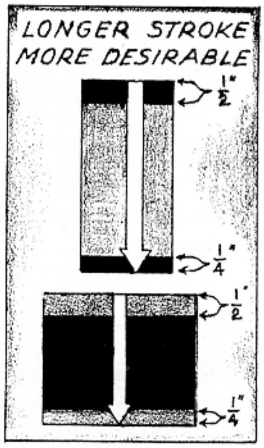


FIG. 254

The work held in the vise should be gripped by its longer sides and the vise jaws should be set parallel with the ram as shown in Figure 255. Narrow work should not be held in the vise as illustrated in Figure 256 because it is likely to bend or turn under the cutting pressure.

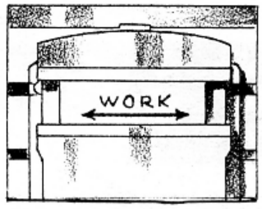


FIG. 255

All work, however, cannot be planed with a lengthwise stroke. It is often expedient when extremely heavy cuts are being taken and when the work has only a small gripping surface, to set the vise jaws at right angles to the ram and to use a shorter crosswise stroke. With this arrangement the work is less likely to slip in the vise because the thrust of the tool during the cut is taken up by the vise jaw.

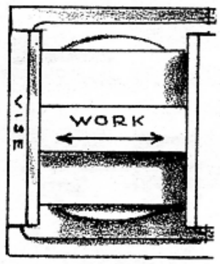


FIG. 256

TOOLS FOR THE HORIZONTAL CUT

Tools of various shapes and tools for various cuts and materials have been described and illustrated in the section entitled, DESCRIPTION OF SHAPER TOOL HOLDERS AND SHAPER TOOLS, beginning on page 151.

For horizontal cuts when the surface finish is of minor importance, a round-nosed roughing tool illustrated in the above section will prove very satisfactory. When the selection is made, both the material in the job and the direction of the feed must be taken into consideration. The material to be cut influences the top- and side-rake angles of the tool. The direction of the feed determines whether a tool having its cutting edge on the right side, or on the left-side will be used.

The cutting edge should be on the side from which the work approaches the tool during the cut. For example, a round-nose tool with cutting edge on the left side of the tool should be used for roughing out a horizontal surface of cast iron when the work is fed to the tool from the left side.

Either a solid forged tool ground to the recommended shape, or a tool bit ground to a similar shape and held in a suitable tool holder, can be used. For extremely heavy cuts, the solid tool is preferred.

REQUISITES OF A GOOD SET-UP

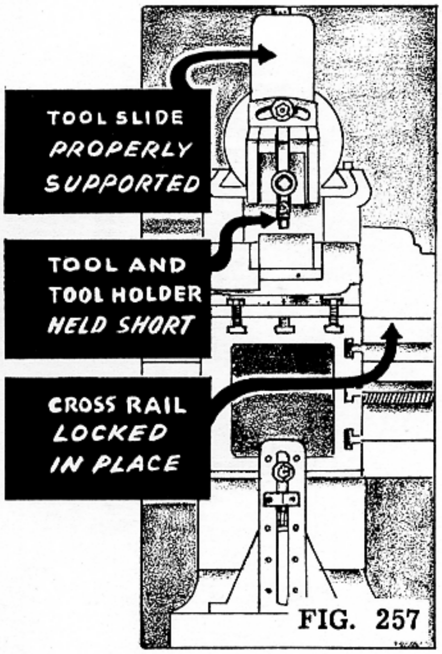


FIG. 257

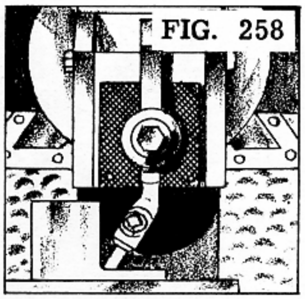


FIG. 258

Rigidity of machine and cutting tool is essential for taking heavy cuts and to produce accurate work in the shaper. A rigid set-up requires proper placement of cross rail on the column, correct placement of the cutting tool, and the position of the tool slide on the head (Fig. 257).

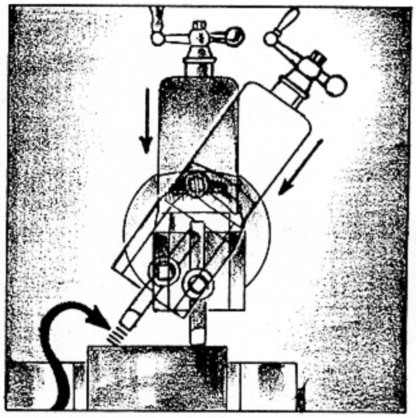
Whenever practical, move the cross rail up on the column so that the surface to be planed is about two inches below the ram. The bolts which clamp the rail to the column and also the table support must be loosened before the rail is adjusted. After the rail has been located, these bolts should be tightened again.

If a tool bit is used, it should extend from its holder only far enough to allow the cut to be made without interference between the work and the tool holder. The tool holder or forged tool should be clamped in the tool post with its cutting end fairly close to the tool head so that it will be well supported.

The tool slide should also be kept well up on the tool head where it too will be properly supported. Allowing the slide to extend more than 1-1/2 inches beyond the head is considered hazardous since it is likely to break from the pressure of a heavy cut. If both the rail and the tool are located as discussed, it will be practically impossible to move the slide too far down on the head during the cut.

When the surface to be planed cannot be raised so that it is close to the ram, the extra space should be provided for in the setting of the tool. In such cases, the tool should be extended from the tool post, rather than the tool slide from the head. Refer to Figure 258.

When a cut is taken from a horizontal surface, the tool head, clapper box, and cutting tool are usually placed in a vertical position, perpendicular to the surface to be planed.



ADDITIONAL DISTANCE SLIDE MUST TRAVEL TO REACH SURFACE —

FIG. 259

The only reason for setting the head vertically, with the 90° graduation on the swivel block in line with the zero on the ram, is that with the head in this position, vertical movement of the tool coincides exactly with that registered on the graduated micrometer dial located on the down-feed screw.

On the other hand, if the head is set at an angle other than 90°, the actual vertical movement of the tool will be somewhat less than the distance indicated on the graduated dial. This is due to the fact that the tool is moved toward the work in an angular instead of in a vertical direction when the down-feed handle is turned (Fig. 259).

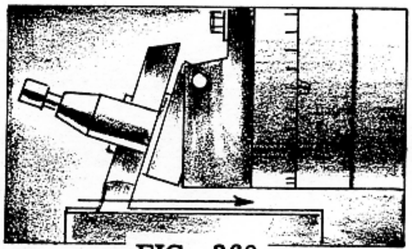
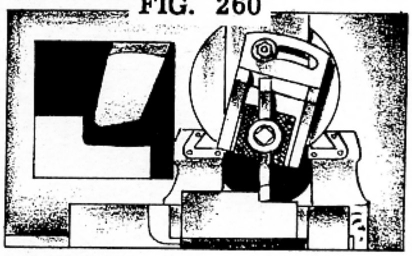
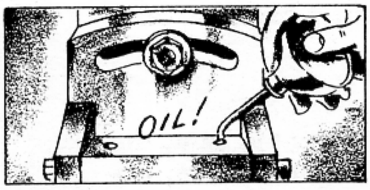


FIG. 260



POSITION OF THE CLAPPER BOX

The function of the clapper box is to permit the tool to lift during its return stroke. This action prevents severe rubbing of the tool on the metal and the consequent dulling of its cutting edge. The clapper box is usually set square with the head during horizontal cuts, although for heavy cuts it may be desirable to swing its upper end away from the cut in order to relieve the tool from excessive drag. When the clapper box is swiveled, the tool not only lifts but also swings out from the work during the return stroke.



If the clapper block is to function as intended, it must be maintained in good operating condition by keeping it clean, properly adjusted, and well oiled. The lubrication will assure the block's lifting freely during the return stroke. Cleanliness and careful adjustment of the taper pin on which it hinges, will assure proper seating of the block during the cutting stroke.

PLACEMENT OF THE TOOL HOLDER AND THE TOOL

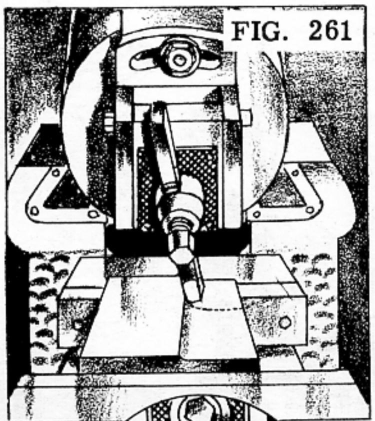


FIG. 261

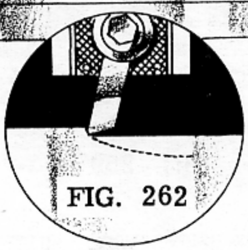


FIG. 262

The cutting tool should be clamped securely in the tool post in a vertical position approximately square with the surface to be planed. During heavy cuts when the pressure of the cut on the tool is likely to move the tool sidewise, the tool should be set at a slight angle away from the work. If, by any chance, the tool moves, it will be in a direction away from the work as shown by the arc in Figure 261. If the tool is pointed toward the work and the cutting pressure moves it sidewise, its movement will be in the direction indicated by the arc in Figure 262. The cut will become deeper and, if unobserved, this downward movement of the tool may result in planing below the finish line and thus cause the work to be spoiled. When the tool must be pointed into the cut, it must be watched very closely in order to detect immediately any change in the position of the tool and holder which might occur. The farther the tool extends from the tool post, the greater the chance of moving because the pressure on its end increases in proportion to the distance it extends from the tool post. For most work, a solid tool need not extend more than 1-1/2 inches below the tool block.

DIRECTION OF THE FEED

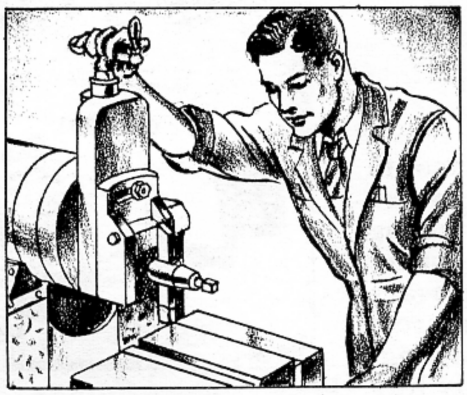


FIG. 263

During the operation of the shaper, the operator usually stands at the right-front side of the machine (Fig. 263). From this position, most levers, controls and handles for setting up the job and the machine, and subsequently operating the shaper during the cut, are readily accessible to the operator.

The logical place to start the cut is from the right side of the work, the side nearest the operator. From his usual place, the operator is then able to observe the depth of the cut and the cutting action of the tool during the cut. A tool with its cutting edge on the left side must be used for cuts started on the right side of the work. The tool is set to the depth of cut desired by means of the down-feed handle. This depth of cut is indicated in thousandths of an inch on the down-feed micrometer dial (Fig. 263).

The work is fed along the cross rail to the tool by hand until the cut has been started and its correct depth has been established. Only then is the power cross feed engaged (Fig. 264).

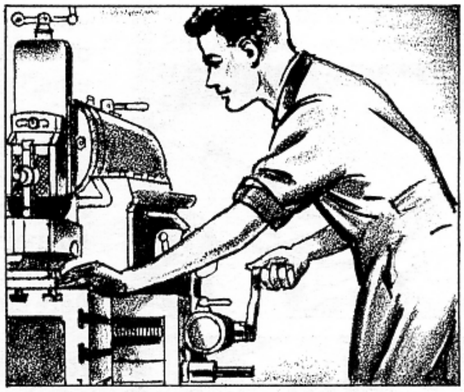


FIG. 264

THE ROUGHING CUT

A roughing cut is one made primarily to prepare the surface of the work for the final or finishing cut. The appearance of the surface is of minor importance.

Roughing cuts may consist merely of taking one or two cuts in order to remove scale and irregularities on castings with the idea of making the surface fairly straight and level preparatory to taking the finishing cut.

Roughing cuts, on the other hand, consist of taking several heavy cuts when considerable excess metal is to be removed prior to finishing the surface.

In either case, to avoid rapid dulling of the cutting tool, the first cut taken from a casting should be sufficiently deep to get under the scale, provided a cut of this thickness can be made without cutting the work undersize.

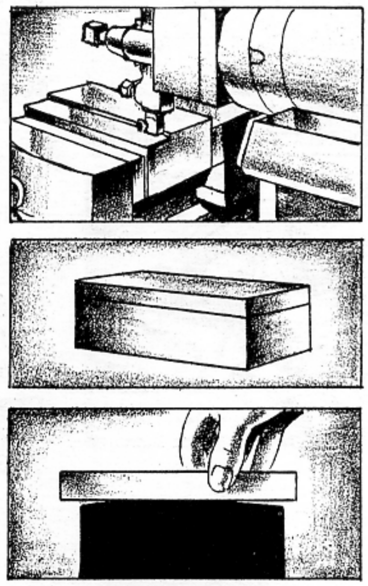
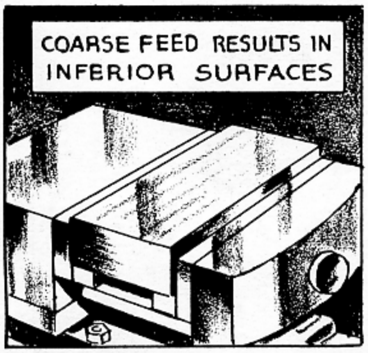
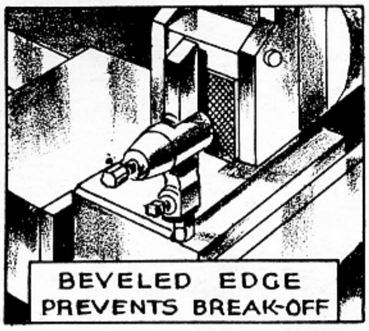


FIG. 265

If the job requires no great accuracy or fine finish, one cut made with a moderate rate of feed may suffice. Since the surface of a rough casting is seldom straight or level, the cut will not be of uniform thickness throughout. The tool will remove a thick chip from high points on the casting and a thin chip from the low spots. This variation in the depth of the cut is reflected to some extent in the machined surface, for the tool springs more when taking a heavy cut than it does when making a light cut. As a result, a surface is produced on which high and low spots are quite apparent when checked with a straight edge (Fig. 265).





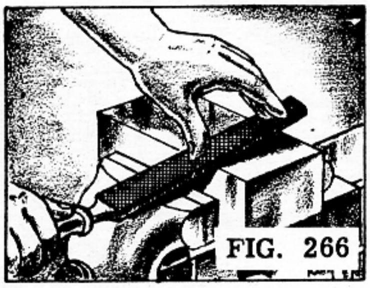


FIG. 266

Therefore, whenever the final surface is to be straight, a second roughing cut is recommended. Approximately 1/16" of metal should be allowed for this cut in addition to the amount usually allowed for the finish cut.

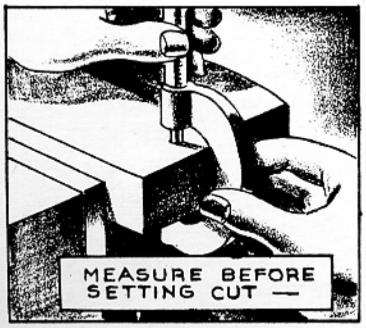
When considerable metal is to be removed, the depth of the roughing cut and the rate of feed should be combined to remove as much of the surplus stock during a single cut as the shaper is capable of removing. The job, the method of holding it, and the size of the tool to withstand the pressure exerted determine the size and feed.

Roughing cuts for removing a given amount of surplus metal can be made by using either a very coarse feed and less depth of cut or by using a heavy cut and less feed per stroke. The deeper cut with less feed is usually preferred. The wide spacing of the feed marks and the greater tear in the metal which accompany the very coarse feed, result in an inferior surface which consequently requires a greater number of finish cuts to produce a smooth surface of good appearance.

As a general rule, it is best first to set a rate of feed which will result in a surface having the desired finish. Then, set a depth of cut suitable to the job, the tool and the power of the machine.

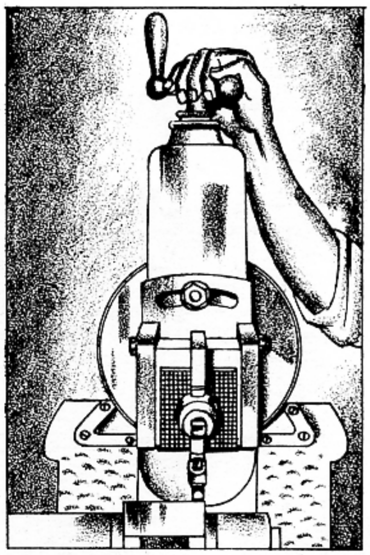
The edge at the end of the cut, especially on cast materials, is likely to break off leaving the edge ragged. This undesirable condition can be avoided by beveling the edge about 45°, approximately to the depth of the intended cut. Use a file or a cold chisel if considerable material is to be removed (Fig. 266).

A FINISHING CUT



A finishing cut is one made for the purpose of machining the work to size and at the same time giving it a smooth surface of good appearance.

The amount of material which must be removed to produce the required finish on a job is dependent upon the surface produced during the last roughing cut. Ordinarily, the feed marks and rough surface caused by the roughing tool can be removed from the work if between ten and fifteen thousandths is allowed for the finishing cuts. If the feed used during the final roughing cut is exceptionally coarse or if the tears caused by the tool during this cut are unusually deep, the amount of material allowed for the finishing cuts must be increased provided the size of the job is to be accurately maintained.



The number of finishing cuts required will be determined largely by the kind of finish desired and by the degree of accuracy demanded, and not by the amount of metal which is to be removed.

For example, when neither the final dimensions nor the finish specified on the job are too exacting, one finish cut made with the same tool used for roughing, but with the feed reduced somewhat, may produce the desired results. On the other hand, several cuts will be required if the surface is to be perfectly true and if the dimensions are to be extremely accurate at the same time.

The tools used for roughing cuts on steel and cast iron are quite similar in shape, although different side and top-rake angles are recommended for each of these materials. However, the tools used for finishing these materials differ considerably and should not be used interchangeably.

FIG. 267

The tool best suited for finishing cast iron has a rather broad and flat cutting edge ground at right angles to the stroke of the ram. This cutting edge must be set parallel with the surface of the work so that a feed approximately one-half the width of the cutting edge may then be used (Fig. 267). In this way, one cut overlaps the next considerably and produces a smooth surface (Fig. 268).

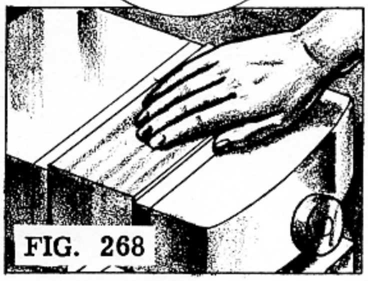


FIG. 268

When broad surfaces on cast iron are being finished, it is not unusual to use a tool having a cutting edge 3/4" to 1" in width. Because of its broad contact with the work "chatter" and "digging in" are likely to occur. These objections can be eliminated by setting the cutting edge of the tool directly under, or preferably a short distance behind the fulcrum (A) as shown in Fig. 269. In solid tools this is accomplished by shaping the tool as shown in Fig. 269. This tool is known as a spring tool and for obvious reasons also as a "gooseneck" tool. The same effect (spring) can be obtained with special types of spring tool holders.

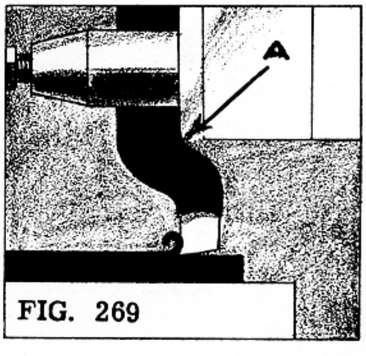
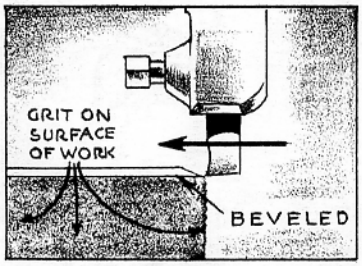
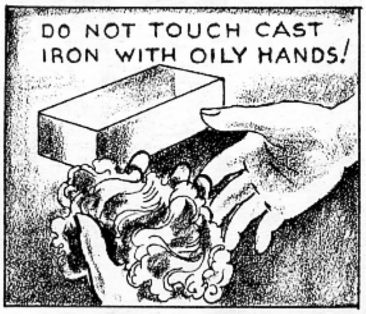


FIG. 269

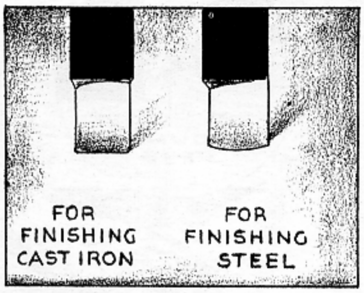


Finishing tools used on cast iron will remain sharp for a longer period if the edges of the castings are beveled slightly (see illustration) so that the tool will not come into contact with the sand and scale usually present on their surfaces.

Oil should also be kept from cast iron, especially during finishing cuts. When oil is present, the oil tends to glaze the surface. As a result the cutting tool slides over the metal instead of cutting it.



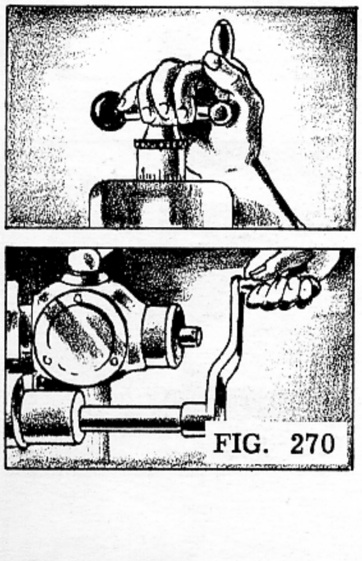
Steel offers a greater resistance to cutting than does cast iron. For this reason, the broad-nosed tools and the coarse feeds generally used in the finishing of cast iron are not practical for finishing steel because these tools tend to gouge or "dig" into the surface.



The width of the flat cutting edge is considerably less on a tool used for finishing steel than on one for finishing cast iron. Furthermore, in contrast with the cutting edge of the tool used for cast iron, the cutting edge of a finishing tool for steel should be ground so that it approaches the work at an angle, and takes what is known as a shear cut. A shear tool produces a very smooth surface if used with a fine feed and a suitable cutting lubricant. If the cutting edge is set behind the fulcrum as has been suggested for the cast-iron finishing tool, all possibility of its "digging in" can be eliminated.

THE VERTICAL CUT

Vertical cuts are used for squaring the ends of long work, for squaring shoulders, for cutting slots and keyways and for shaping other work of a similar nature.



There are two ways in which a vertical surface can be shaped. In the first, and by far the most frequently used method, the tool is fed to the work in a downward direction by means of the downfeed screw.

In the second method, the work is fed to the tool in an upward direction by means of the elevating screw - the cross rail, the table and the work being moved up on the ways of the column as a unit (Fig. 270).

FIG. 270

In order that the operator may be fairly certain that an end or a shoulder will be machined square with both a side and the base of the job, these two locating surfaces must have a definite relationship with the stroke of the ram and with the upper surface of the machine table, respectively. The side which is to be square with the end must be located at right angles to the stroke. The base must be parallel with the top of the table.

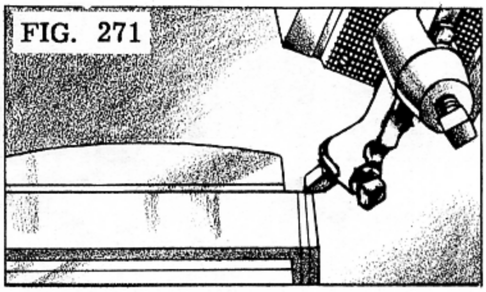


FIG. 271

To meet these requirements, the work can be placed either on parallels in the machine vise having its jaws set square across, or it can be placed crosswise on the machine table and squared with the side of the table. As a precaution against cutting into the vise or the table, the work should be extended at least one-eighth inch beyond the side of the work-holding device than is necessary for cutting the work to length (Figs. 271 and 272).

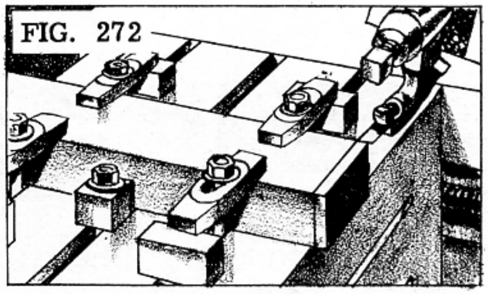


FIG. 272

In order to complete the set-up for shaping an end or a shoulder, the tool slide, the tool, and the clapper box must also be correctly adjusted (Fig. 273). When the down-feed method is used, the tool slide must be set square with the table. This setting determines the direction of the tool during the cut. When the vertical cut is made by feeding the work to the tool by raising the table, the setting of the slide is of minor importance because the work is guided vertically by the ways on the column.

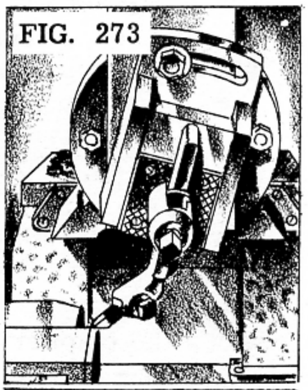


FIG. 273

Either a straight or an offset tool holder (or a solid tool) can be used with equal facility for vertical cuts, provided the tool bit used in each of these holders is ground accordingly and that the tool holder is correctly positioned in the tool post.

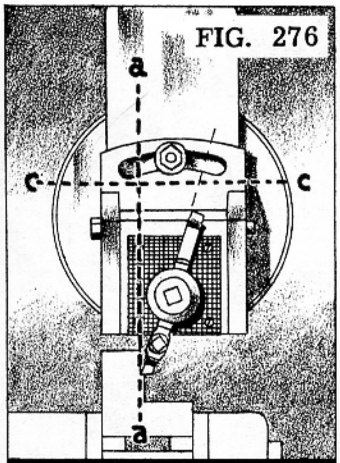
Best results are achieved when the cutting edge of the tool is set in an approximately horizontal plane. In order to obtain this condition when a straight tool holder is used, the cutting edge must be on the end of the tool bit. The tool holder must be set at a slight angle in the tool post so that it will clear the work when the tool is fed down (Fig. 274).

FIG. 274

On the other hand, when an offset tool holder is used, the cutting edge must be on the side of the tool bit instead of on the end, if the cutting edge is to approach the work horizontally (Fig. 275).

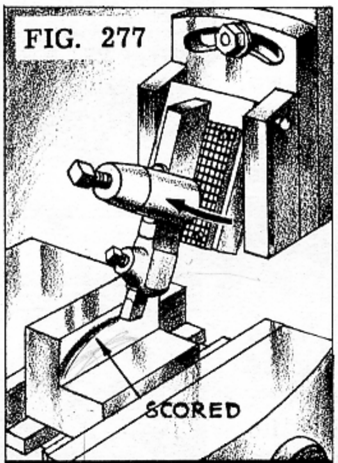
FIG. 275

FIG. 276



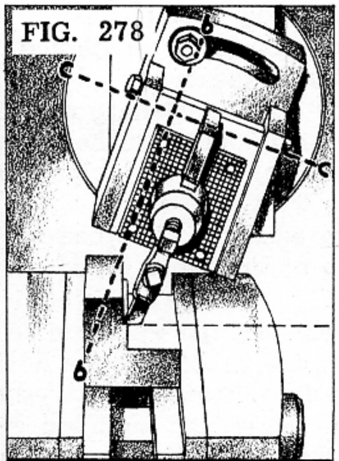
TOOL SWINGS UPWARD ON HINGE PIN IN A PLANE a-a WHEN CLAPPER BOX IS VERTICAL —

FIG. 277



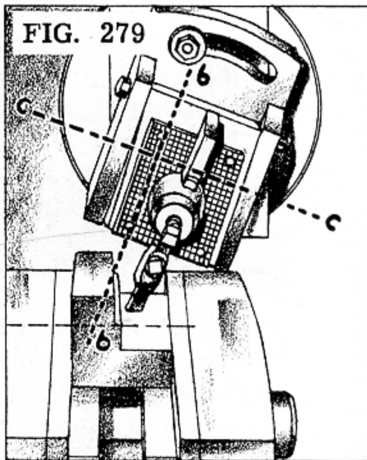
THIS FORCES TOOL TO RIDE UP ON VERTICAL SURFACE AND CAUSES SCORING —

FIG. 278



TOOL SWINGS UPWARD ON HINGE PIN IN A PLANE b-b WHEN CLAPPER BOX IS SWIVELED TO RIGHT —

FIG. 279



THIS CAUSES THE TOOL TO SWING AWAY FROM THE VERTICAL SURFACE DURING RETURN STROKE —

FUNCTIONING OF THE CLAPPER BOX

For all vertical and angular cuts, except slots and similar operations, the clapper box must be set at an angle from its vertical position. The position of the clapper box, either to the right or left, depends upon the location of the shoulder or the end which is to be squared.

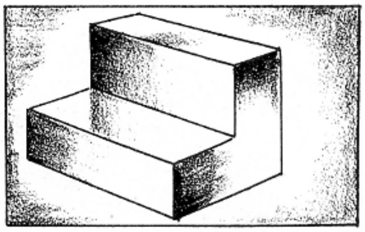
The adjustment is made to prevent the tool from dragging over the planed surface during the return stroke when the tool, together with the tool block, swings forward and lifts slightly on the hinge pin.

When the clapper box is in a vertical position, the tool point swings upward in a plane "a—a" (Fig. 276) during the return stroke of the ram. If the clapper box is not changed from this position for a vertical cut, the tool will drag over the finished surface, causing it to become scored as shown in Figure 277.

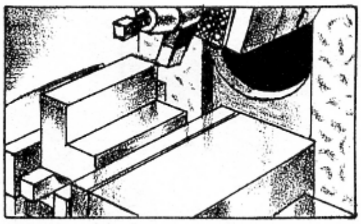
It is for the purpose of overcoming this objectionable condition of scoring that the clapper box is set in an angular position. In this position, the tool point swings in a plane "b—b" at right angles to the axis of the hinge pin "c—c", on which the tool block swivels (Figs. 278 and 279). Since the plane "b—b" is not paralled with the surface of the work, the tool point moves out from the finished surface (to the right) as soon as it swings upward. As a result, the tool does not score the planed surface. Obviously, the outward movement of the tool would be in the opposite direction if the clapper box were swiveled to the left.

Correct location of the clapper box is assured if the upper end of the clapper box is moved in a direction away from the vertical or angular surface which is to be planed. In other words, the upper end of the clapper box must be swung to the right (Fig. 278) for squaring shoulders and ends on the right side and vice versa for vertical cuts on the opposite side. The cutting tools must be ground accordingly for both roughing and finishing cuts.

COMBINED HORIZONTAL AND VERTICAL CUTS



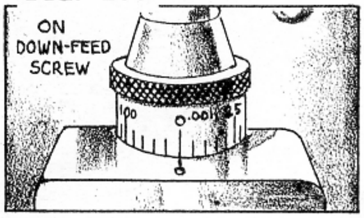
A shoulder comprises a vertical surface which extends upward from a horizontal surface perpendicularly. Cuts in both a horizontal and a vertical direction are generally necessary to square a shoulder of any appreciable height (usually more than one-half inch high).



The only new element involved in machining a shoulder is that of forming the corner where the horizontal and the vertical surfaces meet. Aside from this, squaring a shoulder simply combines in one job, two operations which were described separately heretofore --- horizontal and vertical shaping.

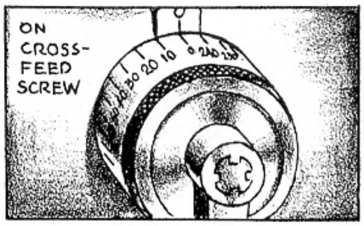
FIG. 280

Work of this kind should be roughed out close to the layout lines, or close to the dimensions specified if a layout has not been made. The job should be placed in the machine to best advantage and a series of horizontal cuts should be made with a round-nosed tool having a small radius (Fig. 280).



Since the horizontal cuts do not run entirely across the work but end somewhere on its surface to form a shoulder which becomes increasingly higher as each succeeding cut is made, the clapper box should be adjusted as for vertical cuts.

After the job has been roughed out, the horizontal surface should be finished to size first. This should be followed by finishing the vertical surface with a suitable tool. When the vertical cut is being made, care must be exercised that the tool is not fed below the horizontal surface (Fig. 280).



If the corner is to be square, a tool shaped with a less than 90° point should be used to remove the fillet left by the round-nosed tool. Micrometer control of the amount of metal removed is provided in both directions — vertically by the micrometer collar on the down-feed screw; horizontally, by the graduated collar on the cross-feed screw.

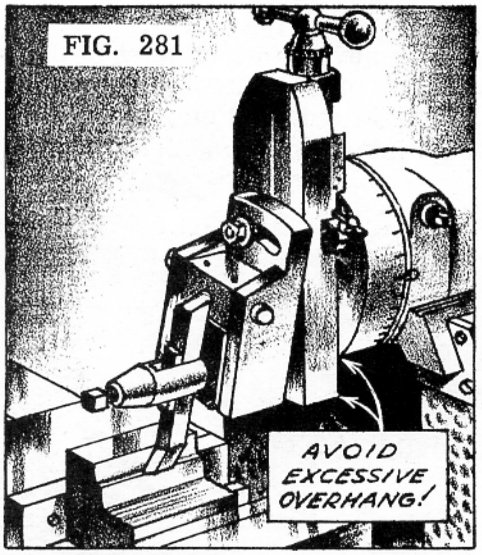


FIG. 281

The length of the vertical cut which can be made on any shaper varies with the size of the machine. It is inadvisable to plan on using this entire distance for a vertical cut, for when the slide is fed down this distance, it will extend beyond the swivel block considerably. In its extended position, the slide is inadequately supported by the tool head. As a result, it is likely to break (Fig. 281).

It is good practice when shaping a vertical surface to have the slide high enough at the start, and thus avoid this hazardous condition as far as possible. If for any reason the slide must be used in its extended position, the cuts must be light. Care must be used when feeding the tool that it does not dig in the metal.

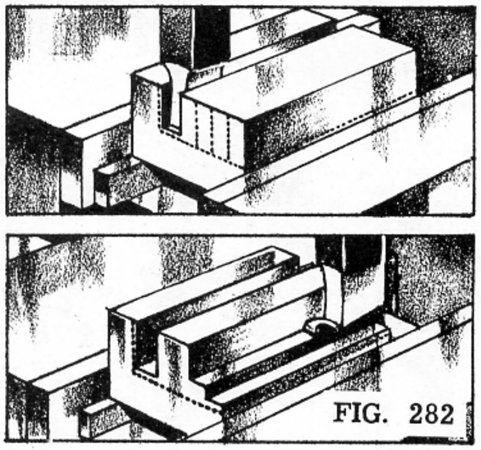


FIG. 282

For jobs on which the shoulder is not very high — not over one-half inch — a square-nosed tool can be used, not only for squaring the shoulder but also for shaping the entire job. Its use saves changing tools for this type of tool can be fed down to cut the shoulder and to remove most of the remaining metal. It can also be fed crosswise for taking a light cut to finish the horizontal surface (Fig. 282).

Whenever the height of the shoulder makes the use of a square-nosed tool practicable, the clapper box need not be swiveled. Instead, it can remain in its usual position during both the vertical and horizontal cuts.

HOW TO SHAPE HORIZONTALLY AND VERTICALLY

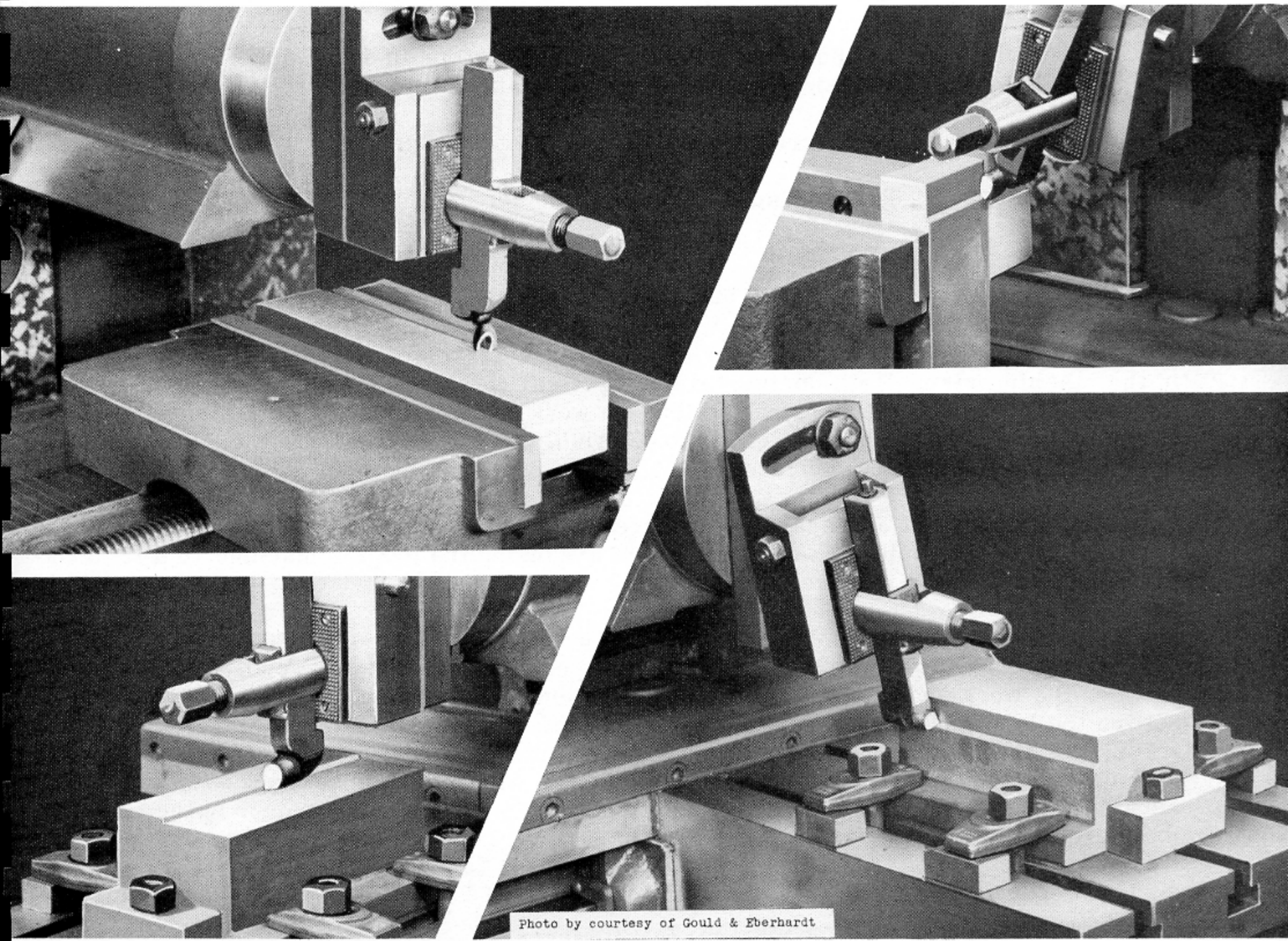


Photo by courtesy of Gould & Eberhardt

UNIT P 53 (A)

Parts I, II, III Pages 189 - 224

HOW TO SHAPE HORIZONTAL SURFACES

OBJECTIVES OF UNIT

1. To show how to set-up the shaper.
2. To tell how to shape a horizontal surface on work held in the vise.
3. To show how to take successive steps in shaping the four sides of a square or rectangular piece.
4. To describe how to shape a vertical surface.
5. To show how to square a shoulder.

INTRODUCTORY INFORMATION

The shaper is intended primarily for shaping flat surfaces on work usually held in the machine vise. Both horizontal and vertical cuts can be made with equal facility. The shaper is so constructed that the work can be fed under the reciprocating tool to produce a horizontal surface. Also, the tool can be fed down on the work to produce a vertical surface.

Considerable work of a preparatory nature is required before actual cutting is possible. This preliminary work consists of arranging the job, the machine, and the cutting tool and is referred to as "setting up the shaper".

Setting up includes proper placement of the work in the machine and adjustment of the various parts of the machine required to establish the proper relationship between the work and the tool. It also includes other adjustments necessary for setting the length of stroke, speed, and feed to meet job specifications. Finally, it includes the selection and placement of the cutting tool for the type of cut to be made and the material in the job. The entire set-up should be made with a view to having it as rigid as the construction of the shaper and the nature of the job make possible.

TOOLS AND EQUIPMENT

Crank or Hydraulic Shaper	File	Tissue Paper
Swivel Base Vise and Bolts	Brush	Wiping Cloth
Lead or Soft-Faced Mallet	Chalk	Surface Gage
Micrometer	Parallels	Steel Rod
Outside Caliper	Cardboard	Steel Rule
Tools and Holders	Oil Can	Steel Square

PROCEDURE

HOW TO MOUNT THE WORK IN THE SHAPER VISE

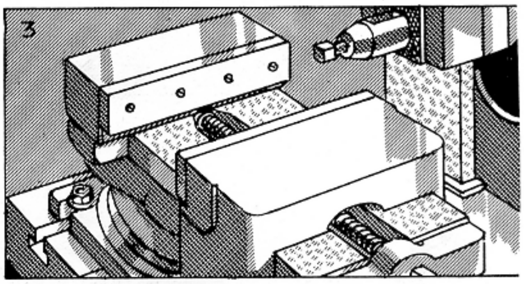
1. Mount the vise on the shaper, if it is not already in place. Note first, the type of base on the vise. Then, select the one which is appropriate for mounting a vise having this kind of base.

CAUTION The weight of the vise makes it imperative that assistance be sought when placing it on the shaper.

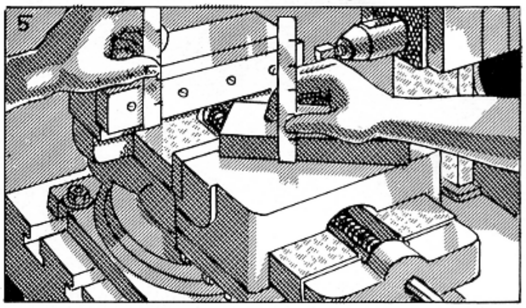
2. Swivel the vise on its base if necessary, placing the index line on the vise above the 90° graduation on its base so as to set the jaws parallel with the stroke. For approximate settings, set the shaper vise with the aid of the graduations on the base. For accurate settings, set the vise parallel with the direction of the stroke with an indicator.

3. Open the vise jaws to receive the work (see Illustration 3).

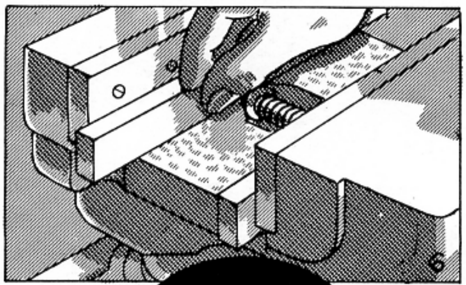
4. Brush chips and other foreign material from the vise jaws and from the bottom of the vise opening. Wipe these surfaces with a clean cloth. Remove any burrs which will interfere with the subsequent seating of the work.

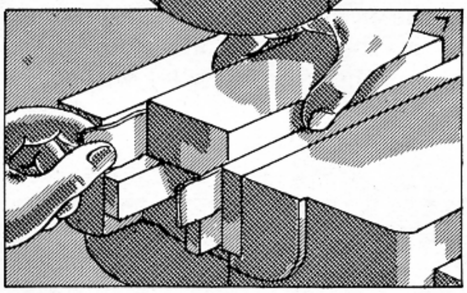


NOTE: One of the important factors contributing to accurate machine work is cleanliness. To a machinist, cleanliness means not only freedom from chips and dirt, but freedom from burrs as well. Whenever a job is to be set in the shaper, the work holding device, and the parallels, if they are used, should be absolutely clean.



5. Measure the depth of the vise jaws. Then measure the thickness of the job to check whether or not the layout line indicating the depth of cut will extend above the vise about 1/8" when the job rests on the bottom of the vise opening. See Illustration 5.





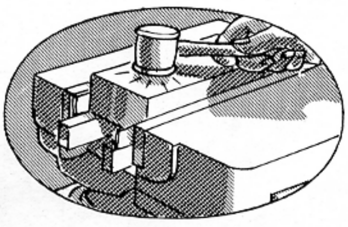
6. Place two identical parallels of correct height under the job, if the work is too low in the vise. Refer to Illustration 6. Space the parallels as widely as possible.

   NOTE: Two narrow parallels are usually preferred to a single one of greater width. This is especially true in supporting castings as a casting seldom has a straight surface. The use of narrow parallels makes it easier to determine whether or not the work has been properly seated. The narrow parallels contact the work near its outer edges only and thus avoid contact with any high spots likely to be present in the center of the casting.

7. Place cardboard against the vise jaws if a casting is to be clamped (Illustration 7). It will absorb irregularities on the surface of the casting and protect the faces of the jaws. At the same time, the cardboard tends to distribute the pressure of the jaws evenly over the work.

8. Place the work on the parallels, approximately in the center of the vise. Then, tighten the vise. Exert enough pressure on the vise crank so that vise jaws hold the work securely during subsequent cuts.

NOTE: When the vise is tightened, the work sometimes lifts slightly and does not rest solidly on the parallels intended to support it during the cut. When the vise is tightened, the jaw advances until it grips the work. Then, as additional pressure is applied on the crank, the jaw, no longer able to advance in its original direction, lifts slightly and carries the work up with it. Lost play between the vise jaws and the body of the vise is responsible for this action. It cannot be eliminated entirely where parts must be free to move on one another.



9. Tap the work lightly to seat it on the parallels. Use a lead mallet or block for such materials as steel and cast iron, and a plastic or leather hammer for softer materials such as aluminum, so that the surfaces will not be marked.

   NOTE: A light blow usually is sufficient to seat the work. If too hard a blow is struck, the work tends to rebound from the parallels. The intensity of the blow required can best be determined by slightly moving a parallel under the work while at the same time delivering light blows with the mallet. If the parallels are still loose, the intensity of the blow can be increased to the point where the work will be forced down and the parallels can no longer be moved (Fig. 283).

10. Test the parallels by trying to move them by hand to see whether or not they are tight under the job, if for any reason the vise requires additional tightening after the work once has been seated on the parallels. The work invariably lifts after each tightening of the vise. Therefore the seating procedure must be repeated each time the vise is tightened.

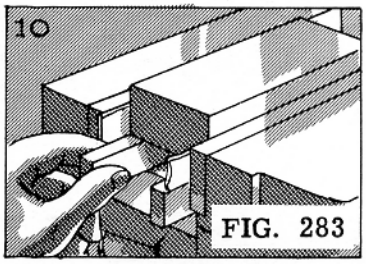


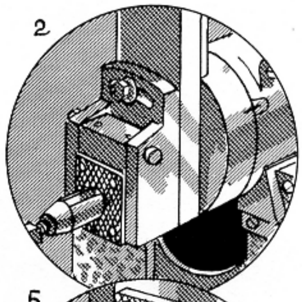
FIG. 283

OIL Oil the shaper as previously directed in HOW TO OIL THE SHAPER.

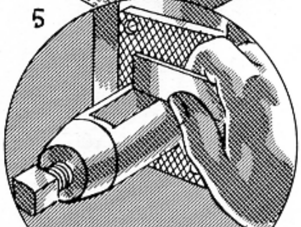
HOW TO ADJUST THE CUTTING TOOL AND THE TOOL HEAD

1. Review the description of the horizontal cut beginning on page 176.

2. Set the tool head at right angles to the machine table (see Illustration 2). Place opposite the zero index line on the ram whichever of the graduations on the swivel block (either zero or 90°) that will square the head with the table.

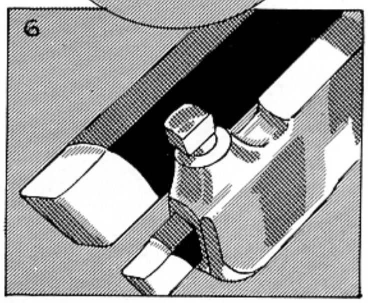


3. Set the clapper box in a vertical position for light or medium cuts. For heavy cuts, swivel the upper end of the clapper box in the same direction as that in which the work is to feed.



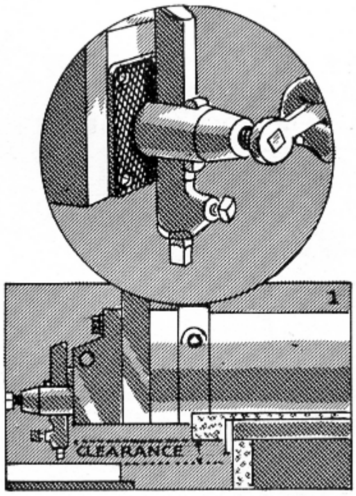
4. Run the tool slide up on the head so that it will not extend below the swivel block when the tool is later set to machine the work.

5. Measure the opening in the tool post so that either a forged tool or a tool holder of the correct size may be selected. Refer to Illustration (5).



6. Select a straight left-cut forged tool ground for taking a horizontal roughing cut on the kind of material in the job. If a straight tool holder is to be used instead, insert a tool bit ground to a similar shape as shown in Illustration (6).

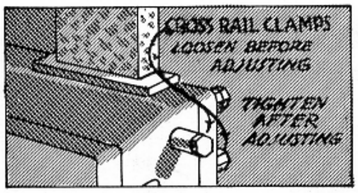
CAUTION Grip the tool bit in the holder as short as practicable for the cut being made.



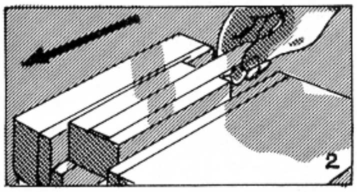
7. Clamp the tool or tool holder securely in the tool post in a vertical position. Ordinarily, allow it to extend no more than 1-1/2 inches beyond the tool block. If the cut is to be heavy, clamp the tool in a position slightly away from the work so if the tool moves, it will not dig into the work.

HOW TO ADJUST THE SHAPER PRIOR TO TAKING A CUT

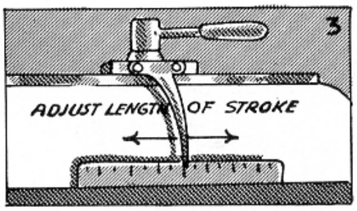
1. Adjust the cross rail on the column so that the surface to be planed is approximately two inches below the ram.



CAUTION Make certain that the bolts which clamp the cross rail to the column, as well as those which clamp the table support, have been loosened before attempting to raise or lower the cross rail. It is equally important that these bolts be tightened again, in the order previously described, after the rail has been relocated.



2. Measure the length of the surface to be planed. Add approximately one inch to this dimension in order to provide for clearance by the cutting tool at both ends of the stroke (refer to Illustration 2).



3. Adjust the ram stroke for this length (Illustration 3). To review the adjusting of the crank shaper, refer to HOW TO ADJUST THE STROKE on pages 79 and 80. For the hydraulic shaper, refer to HOW TO ADJUST THE STROKE AND THE POSITION OF THE RAM on page 92.

4. Adjust the position of the stroke so that the tool covers the entire surface which is to be planed.

5. Consult a table of ALLOWABLE CUTTING SPEEDS – FEET PER MINUTE to determine the cutting speed in feet per minute which is to be used. Base the cutting speed on the kind of material to be planed, the type of cut (whether roughing or finishing) and the material in the cutting tool.

   NOTE: Most cone-driven shapers are not provided with charts such as appear on direct gear driven shapers.

6. Determine the number of strokes per minute which will result in a cutting speed in feet per minute approximately the same as that decided upon in Step 5.

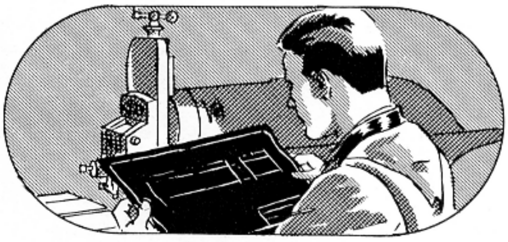
7. Select from the procedures given for setting the speed on various types of shapers, the one which is appropriate for the shaper being used. Adjust the shaper for the number of strokes per minute decided upon in Step 6. For setting the speed on a crank shaper, review HOW TO ADJUST THE SPEED OF THE RAM on page 82. For setting the speed on a hydraulic shaper, refer to HOW TO ADJUST THE SPEED OF THE RAM ON A HYDRAULIC SHAPER on page 94.

   CAUTION Do not attempt to shift gears while the shaper is in operation as improper meshing may result in stripping the gear teeth.

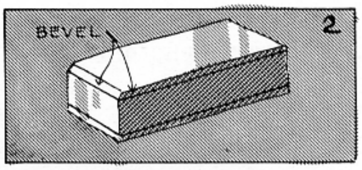
8. Adjust the automatic or cross feed to a rate of feed commensurate with the depth of cut to be taken and the surface finish desired.

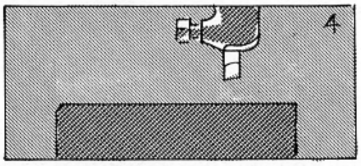
   NOTE: The depth of cut and the resistance of the material being cut vary to such an extent on different jobs that it is impossible to recommend a feed which will function equally well under all conditions. It is best, therefore, to begin the cut with a light feed, and increase the feed just as soon as it becomes apparent this can be done to advantage.

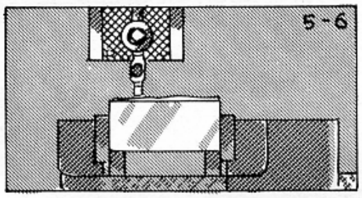
HOW TO TAKE THE ROUGHING CUT

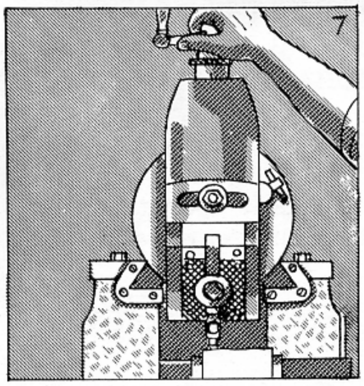


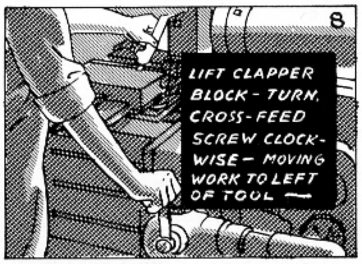
1. Consult the blueprint or job layout to determine the finished size of the job and how much material is to be removed.











2. Plan to remove approximately half the excess material from the top surface and the other half from the opposite side when both surfaces are to be shaped.

3. Bevel the edges of the casting at the ends of the cut to prevent breakage of the corner below the finished surface (Refer to Illustration 2).

4. Make certain that the tool is higher than the surface of the work and the ram will also clear any projections which may extend from irregularly shaped work.

5. Move the work and table by means of the cross-feed screw to bring it into position with the cutting tool (Illustration 5-6).

6. Move the ram so that the tool is over the surface to be planed.

7. Bring the tool down (while the ram is not in motion) by turning the down-feed screw in a clockwise direction until the tool just barely touches the work. Then adjust the micrometer collar by placing the zero graduation opposite the index mark.

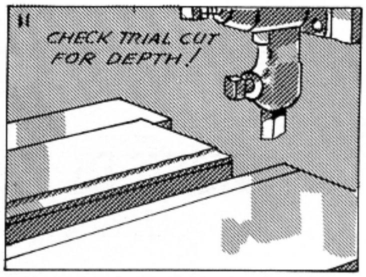
8. Lift the tool together with the tool block on the hinge pin to prevent interference with the work. Then, move the work to the left of the tool, as a left-cut tool has already been placed in the tool post.

9. Set the tool, with the aid of the graduations on the micrometer dial, to the desired depth for the first roughing cut. Then, lock the tool slide in place. Remove at least 3/32" of metal in order to get under the scale on the casting, provided this amount of metal can be removed without cutting the work undersize.

V HAVE ENTIRE SET-UP *CHECKED* BY YOUR INSTRUCTOR V

10. Start the shaper. Feed the work to the tool BY HAND until the cut is just started and its depth can be determined.

CAUTION Wear goggles as a protection from flying chips and keep the face and the eyes a safe distance from the work.



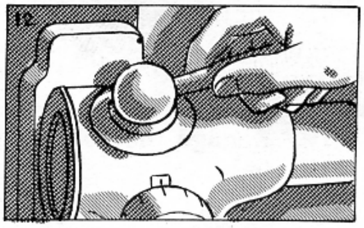
11. Stop the shaper and check the correctness of the tool setting. If further adjustment in the depth of the cut is necessary, make it only after the work has been moved from under the tool. See Illustration (11).

12. Start the shaper again. Then engage the automatic feed and complete the cut (Illustration 12).

13. Disengage the feed. Bring the table back to the position for starting the cut. Take additional roughing cuts if needed. Allow between .010" and .015" for the finishing cut.

CAUTION

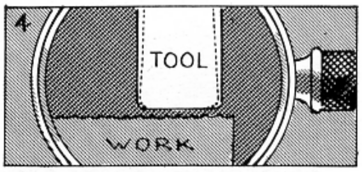
KEEP FINGERS AWAY FROM CUTTING TOOL, WORK AND VISE WHEN SHAPER IS IN OPERATION ——



HOW TO TAKE THE FINISHING CUT

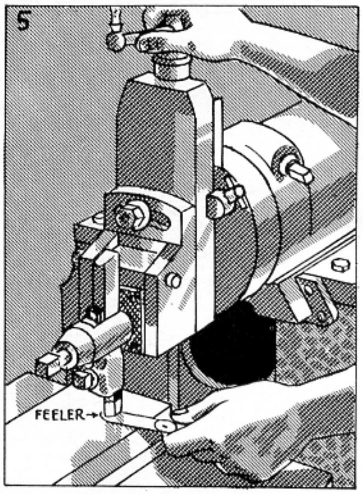
1. Stop the shaper. Replace the roughing tool with a finishing tool ground for cutting the kind of material in the job.

2. Bevel the edges of castings with a file to prevent the keen cutting edge of the finishing tool from coming in contact with sand and scale.



3. Position the work and ram so the tool is again over the machined surface. Set the cutting edge of the finishing tool parallel with the shaped work surface.

4. Clamp the tool holder lightly in the tool post with the cutting edge of the tool close to the work. Tap the tool holder until the cutting edge is exactly parallel with the surface to be finished. Then, tighten the tool-post screw to hold the tool securely.



5. Place a piece of paper or the blade of a thickness gage on the work and carefully lower the tool until it barely touches the feeler. This will aid in setting the finishing tool to the work preparatory to adjusting it for a cut of the desired thickness. See Illustration 5.

6. Set the graduated collar on the down-feed screw at zero. Move the work clear of the tool. Then, lower the tool the thickness of the feeler blade in thousandths plus the number of thousandths necessary to take a cut to the desired depth.

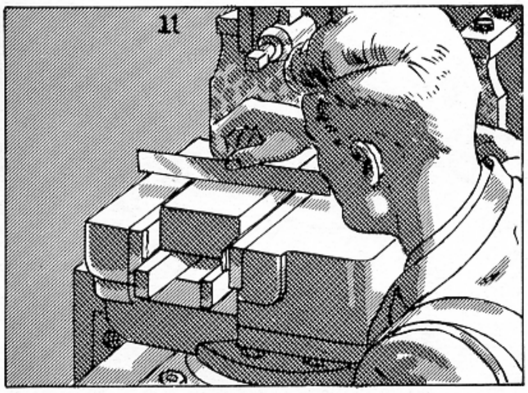
CAUTION When extreme accuracy and a good finish are required, plan to remove the metal allowed for finishing in two cuts instead of one. In this case, the first cut will serve as a trial cut only.

7. Reduce the speed somewhat whenever a finishing tool having a wide cutting edge is used. For round-nosed tools, however, use the speeds recommended in tables of **ALLOWABLE CUTTING SPEEDS IN FEET PER MINUTE.**

8. Start the shaper and note whether or not the stroke still clears the entire length of the work. A change in ram position may occur when the roughing tool is replaced with a spring-type finishing tool.

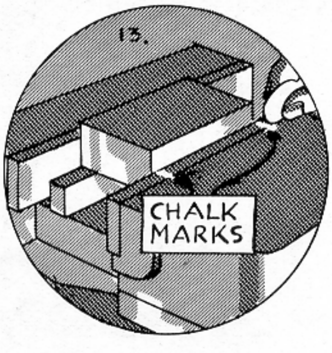
9. Increase the rate of feed so that the tool will move over approximately one-half the width of the flat cutting edge for cast iron. For steel, use a fairly fine feed per stroke.

10. Engage the automatic feed and take the finishing cut with the tool slide locked in place.



11. Stop the shaper with the ram in its rear position. Brush the chips from the work. Test the planed surface with a straight edge. Finally, take measurements to determine whether or not the work has been accurately machined (Illustration 11).

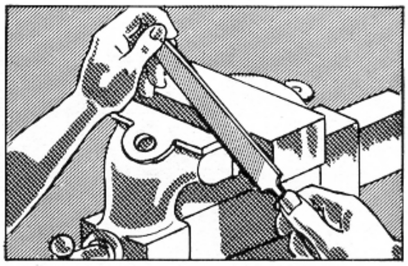
12. Bring the table back to position for starting a cut. Make further adjustments of the tool with the aid of the micrometer dial, if the work is still oversize.



13. Place a chalk mark when planing short work on the vise at each end of the work to place it in the vise in the same position for subsequent cuts. This prevents changing the position of the ram stroke each time the job is removed from the vise. (Illustration 13).

14. Remove the job from the vise and file from its edges the burrs produced by the tool. Be careful not to mar the finished surface.

15. Brush all chips from the machine and job when the work is finished. Return parallels and other accessories to their proper places in a clean condition.



HOW TO PLANE THE REMAINING SIDES OF A SQUARE OR RECTANGULAR JOB

NOTE: When several surfaces on a job are to be planed, it is considered good practice to rough out all these surfaces before finishing any one of them, in order to relieve internal strains which are likely to be present, especially in castings. The finishing cut will be taken immediately after the roughing cut on each side has been completed.

HOW TO CLAMP THE WORK AND TAKE THE CUT ON THE SECOND SIDE

1. Clean the vise and make certain that the finished surface on the work is absolutely clean too.

2. Set the work in the vise with the side just finished against the fixed jaw, and on parallels, if they are needed. The surface to be planed should be slightly above the vise jaws.

3. Place a round piece of steel horizontally between the movable vise jaw and the work as shown in Figure 284. Then draw the vise up tightly.

   NOTE: This steel rod should be placed about halfway upon the vise jaw. It makes only a line contact with the work and the vise and thus causes the finished surface of the work to be brought squarely against the fixed jaw of the vise. The fixed jaw should be square with the table.

   When the rod is not used and the vise is tightened on the unmachined surface of the work instead (Fig. 285), the finished side of the work is quite likely to change its relationship with the fixed jaw as shown in Figure 285 at (A). As a result of this condition, the side and the top surfaces will not be cut square with each other.

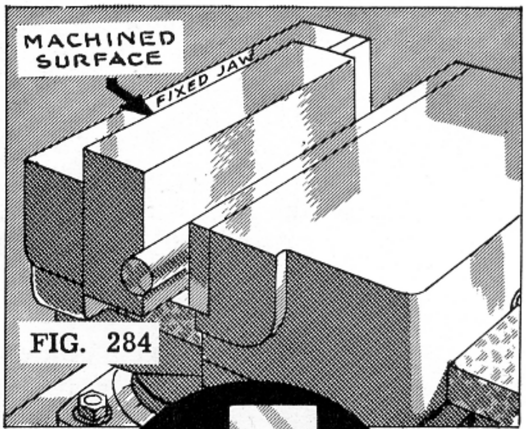


FIG. 284

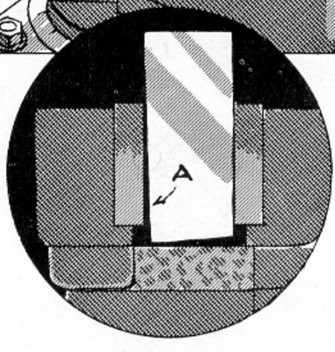
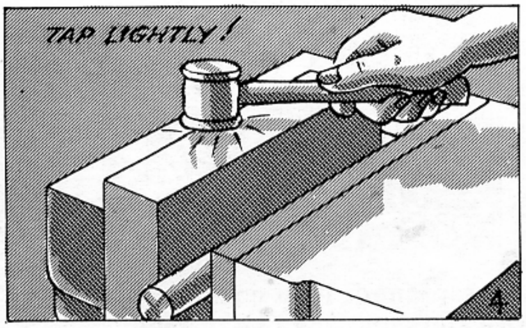


FIG. 285



4. Tap the work lightly with a lead mallet to seat it on the bottom of the vise or on the parallels, whichever means is used for supporting the work.

5. Remove the finishing tool and replace it with the roughing tool used for shaping the first surface.

6. Make certain that the position of the ram stroke is such that the tool will cover the entire surface of the work. Unless the work has been placed in the vise in the same lengthwise position as before, an adjustment of the ram position will be necessary.

7. Reduce the rate of feed to that used for the first roughing cut.

8. Take a roughing cut.

9. Take the finishing cut.

10. Use a fine file to remove from the corners of the work the burrs produced by the cutting tool. Then wipe the two machined surfaces clean.

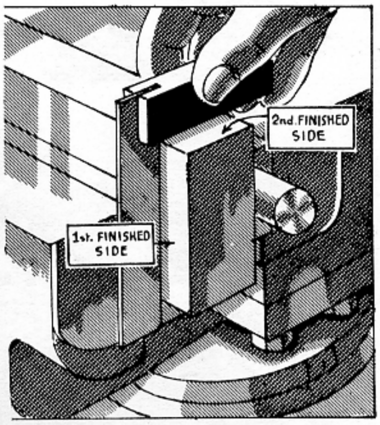


FIG. 286

11. Determine whether or not the finished surfaces are at right angles to each other. Hold the beam of a precision steel square against the surface just finished and the blade across the other finished surface (Fig. 286).

NOTE: If all light is excluded from under the square when its beam is held firmly against the surface just finished and its blade has been brought carefully to the other finished surface, these two sides of the work are at right angles to each other. The remaining sides of the work can then be machined with reasonable assurance that they too will be square with each other, provided the necessary precautions are observed when the work is clamped in the vise.

However, if light is visible under the blade, the work is not square. This condition may be corrected at this time by using one of the methods suggested on page 203.

12. Remove the work from the vise and prepare to plane the third side of the work.

HOW TO CLAMP THE WORK AND TAKE A CUT ON THE THIRD SIDE

1. Make certain that the vise opening and both finished surfaces on the work are absolutely clean and free from burrs.

2. Place the work in the vise. The surface that has just been finished should rest on the bottom of the vise opening, or on parallels if needed. The first side planed should rest against the fixed jaw (Fig. 287).

3. Place the rod between the movable jaw and the work as for the previous cut. Tighten the vise and seat the work.

   NOTE: In order to check that work which does not require the use of parallels has been properly seated in the vise, a piece of tissue paper should be placed under each end of the work and allowed to extend so that it can be pulled with the fingers. (Fig. 287) The work has been properly seated when the paper is tight and cannot be withdrawn from under the work.

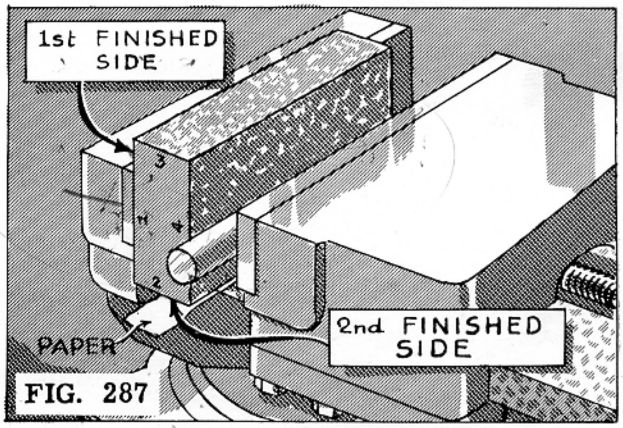


FIG. 287

4. Take a roughing cut as previously directed.

5. Remove burrs from the corners of the work with a file or abrasive stone. Clean the machined surface. Then check the work with a square as shown in Figure 286.

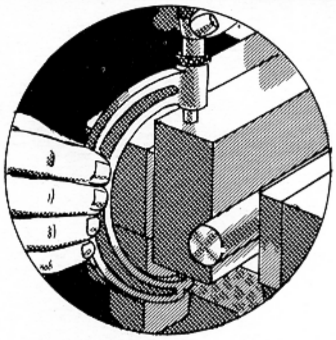


FIG. 288

6. Take a measurement with a micrometer at both ends of the work to determine whether or not the side just finished is parallel and to see how many thousandths must be removed to shape the work to size with the finishing tool (Fig. 288).

7. Take the finishing cut. Remove burrs and recheck with micrometer for size.

HOW TO CLAMP THE WORK AND TAKE THE CUT ON THE FOURTH SIDE

1. Make certain the vise opening is absolutely clean and that the three sides of the work which already have been machined are clean and free of burrs.

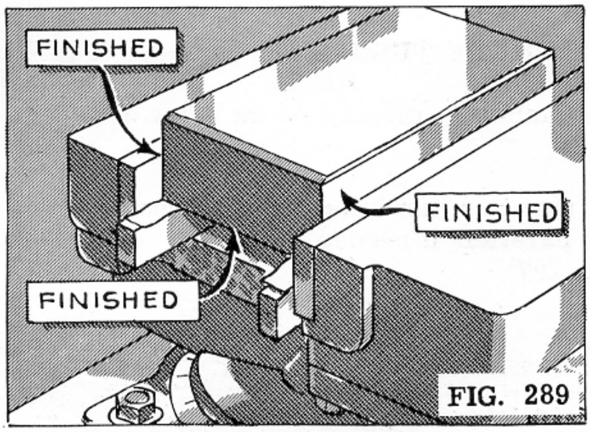
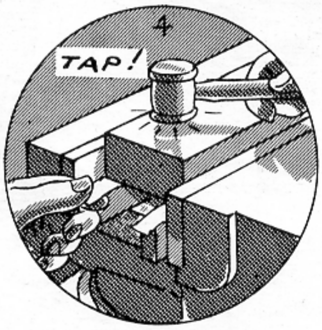


FIG. 289

2. Place the work in the vise with the first side machined resting on strips of tissue paper placed in the vise under both ends of the work. If the work is supported on parallels, place a strip of tissue paper under each corner of the work as shown in Figure 289.

3. Tighten the vise, leaving out the rod which was used before. Tap the work with a lead mallet to seat.

4. Pull lightly on the paper strips to check whether or not the work has been seated properly. (Illustration 4).



5. Take the roughing cut.

6. Take the finishing cut and check with micrometer for size.

7. Give the machine a thorough cleaning. Return all parallels and other accessories free from burrs to their proper places in a clean condition.

HOW TO SQUARE THE ENDS

The ends of short pieces may be planed square with their sides by following the directions below for clamping the work and taking a horizontal cut.

The ends of longer pieces are planed to best advantage by taking vertical cuts. The procedure for this kind of cut is explained later in How to Shape Vertical Surfaces.

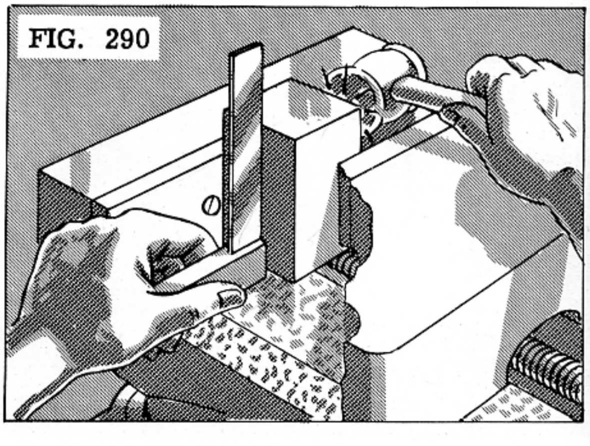
1. Swivel the vise on its base so that the jaws are at right angles to the stroke.

2. Make sure that the work and the vise are clean and free from burrs.

3. Place the work in the approximate center of the vise with one end on the bottom surface of the vise or on parallels (Fig. 290).

4. Hold a steel square down firmly against the bottom of the vise. Then set the side of the work parallel with the blade of the square. Tighten the vise lightly.

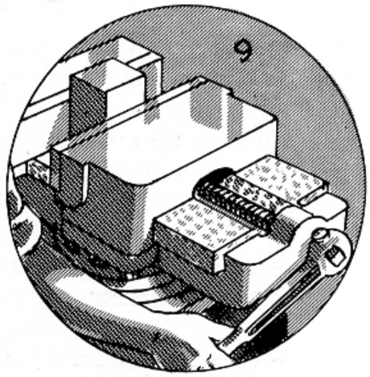
FIG. 290



5. Check the setting of the work with the square (Fig. 290). Move the square away from the work. Tap the work lightly. Then bring the square against the work to check for squareness.

6. Tighten the work securely in the vise when it is square.

7. Follow the same directions for taking a horizontal cut as previously described.



8. Check whether or not the end has been planed square with the sides with a steel square.

9. Square the opposite end by placing the work in the vise with the finished end down. Tap the work to seat it properly. Then take successive cuts to machine the work to size.

HOW TO CORRECT INACCURACIES BETWEEN RIGHT ANGLE SURFACES

Even though the procedures for clamping the work and planing its sides have been followed conscientiously, subsequent testing with a precision steel square may show that these sides do not form perfect right angles.

This inaccuracy, evident by light visible under the blade of the square, may be the result of carelessness at the time the work was placed in the vise. On the other hand, it may reflect inaccuracies caused by wear on the vise jaw or wear in the machine. Regardless of the cause of the inaccuracy, steps (a), (b) and (c) which follow, should be taken first to eliminate errors resulting from carelessness before attempting to eliminate inaccuracies resulting other causes.

The logical time to make this correction is immediately after a true cut has been taken from the second side of the work.

FIG. 291

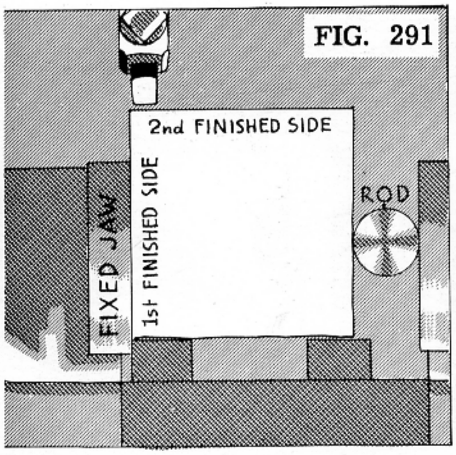


FIG. 292

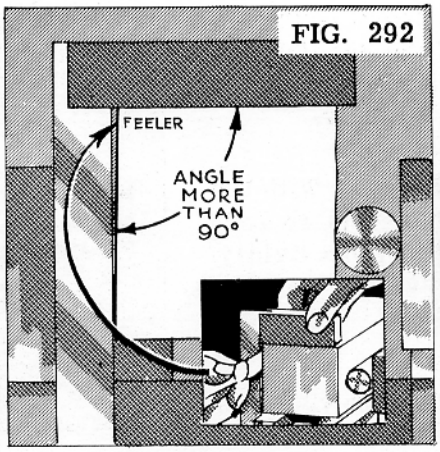
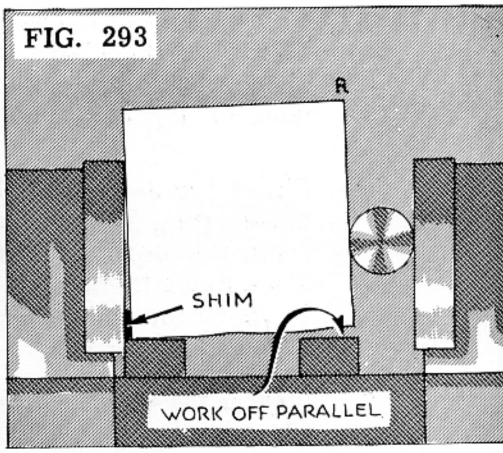


FIG. 293



A test with a steel square shows that the surface just planed is not square with the first surface which now rests against the fixed jaw of the vise (Fig. 292).

a. Inspect thoroughly the work, vise and parallels too (if they are used). Remove foreign material and recheck for burrs which may have been overlooked before and may have prevented the proper seating of the work in the vise.

b. Place the work in the vise again. Observe carefully all the precautions regarding cleanliness and proper clamping and seating. Then take a light cut.

c. Remove the burrs produced by the tool. Clean the surfaces of the work. Finally, check their squareness with a steel square by placing its beam on the surface just finished and bringing the blade to the adjacent side (Fig. 292).

NOTE: If the adjacent side is still not square with the upper surface, proceed to correct this condition by retesting the fixed jaw for squareness with the aid of an indicator. The inaccuracy may also be corrected by using paper shims between the work and the vise jaw as directed below.

1. Place the work in the vise following the planing of the first side, and take a light cut on the second side (Fig. 291). Test the work with a steel square (Fig. 292).

2. Measure the opening between the blade of the square and the side of the work. Use a paper feeler or the blade of a thickness gage in order to determine the approximate thickness of the shim required to correct the inaccurate condition in the work.

FOR ANGLES GREATER THAN 90° (FIG. 292).

3. Place along the bottom of the work a paper shim similar in thickness to that of the feeler used for measuring the opening between the square and the work (Fig. 293).

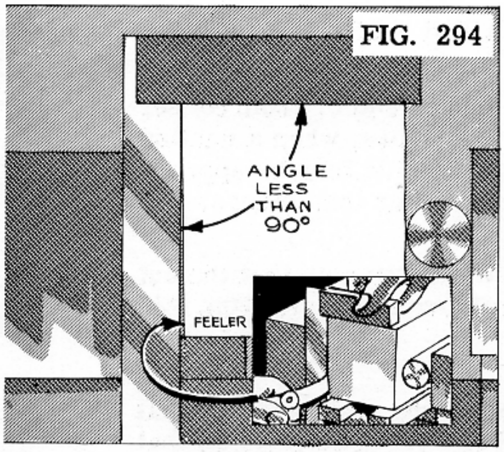


FIG. 294

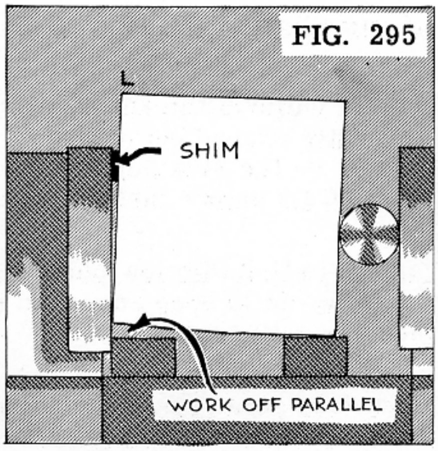


FIG. 295

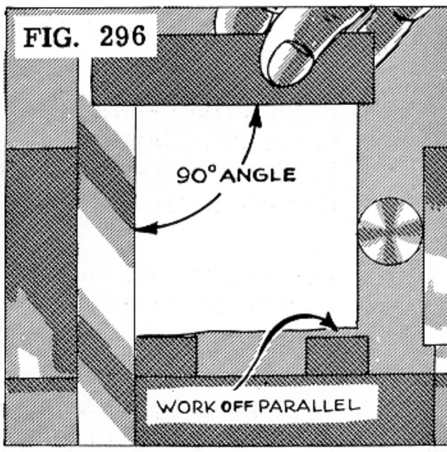


FIG. 296

The shim will cause the work to tilt slightly in the vise, raising its right-hand edge. As a result, the cut will remove slightly more material at (R), Fig. 293, than at the other side of this surface.

FOR ANGLES LESS THAN 90° (FIG. 294)

4. Place the paper shim along the top (Fig. 295) to tilt the work slightly in a direction opposite to that in Figure 293. The tool will now remove slightly more material at (L) Fig. 295 than at the other end of this surface.

If the adjacent sides are not at right angles after inserting the shim and taking a trial cut, replace the shim with one which is thicker, if the opening still occurs in the same place as before taking the trial cut. This indicates that the work has not been tilted sufficiently. A thinner shim, of course, should be used when an opening shows along the square at the end opposite that at which it occurred before the shim was inserted and the trial cut taken.

NOTE: When a shim has been placed alongside the work in the vise, it will be impossible to seat the work so that both parallels are tight under the job. With the use of a shim, even though it is very thin, the work is tilted somewhat, with the result that the bottom of the work is now no longer parallel with the bottom of the vise surface (Fig. 295).

Work on which the bottom side is not at right angles with the side placed against the fixed jaw of the vise (Fig. 296) cannot be seated on both parallels. In this instance it is the work, and not a condition created by the insertion of a shim, which causes one edge of the bottom surface to be higher than the other edge.

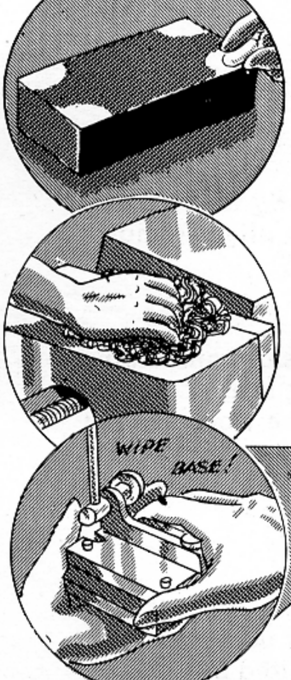
HOW TO USE THE SURFACE GAGE ON SHAPER WORK

Even a flat casting is seldom of uniform thickness from end to end or from corner to corner. Castings are frequently warped out of shape. Therefore, when a casting has been placed on parallels or on the vise surface, its underside may be approximately level, but some point on its upper surface may be lower than others.

One use for the surface gage is to find this low point on the casting so that the cut may be set from this point. If the cut is deep enough to remove the scale from this place, the rest of the surface also will be "cleaned up."

Another setup for which the surface gage is frequently used on the shaper is one that requires the upper surface on a casting, instead of the lower one, to be level so that this surface can be planed by taking the smallest cut possible.

In addition, the surface gage is used for scribing lines parallel with the machine table to show the location of finished surfaces, and for setting up work according to layout lines on the job.



HOW TO FIND THE LOW CORNER ON A CASTING HELD IN THE MACHINE VISE

1. Wipe the upper surface of the movable jaw, or the top of the vise with a clean cloth. Then rub the palm of the hand over that portion of the surface on which the surface gage is to be used to check for burrs.

2. Rub chalk on the corners of the work so that the slightest touch of the scriber will be seen immediately.

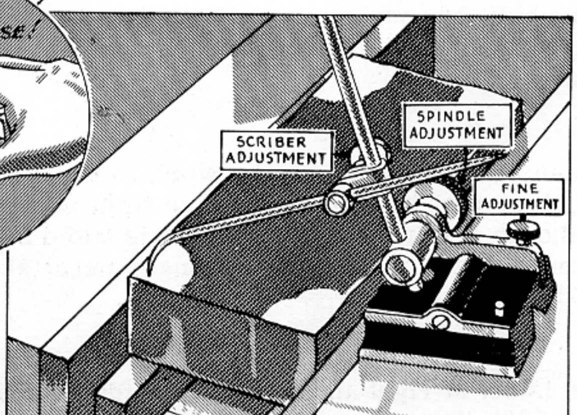


FIG. 297

3. Wipe the base of the surface gage clean. Draw it across the palm of the hand to remove any small particles of dirt which may not have been removed with the cloth and to check for burrs.

4. Place the gage on the movable vise jaw. Adjust the spindle and the scriber (Fig. 297) so that the four corners of the work can be reached with the bent end of the scriber.

5. Move the surface gage so that the scriber passes over one corner of the work. At the same time, turn the adjusting screw (Fig. 298) to bring the scriber to the work gradually. Obviously, the scriber touches the work when it scribes a light line on the chalked corner. It is also possible to "feel" when the scriber touches.

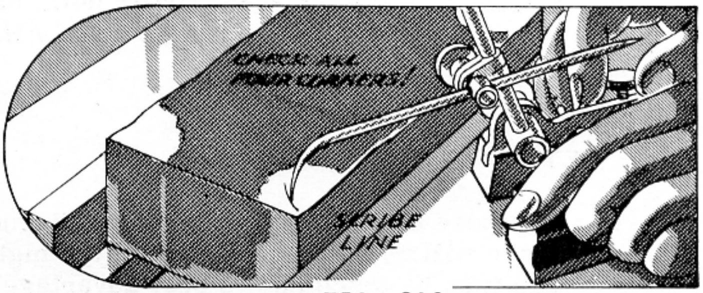
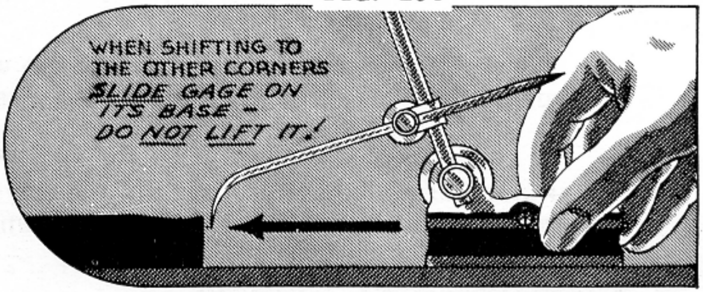
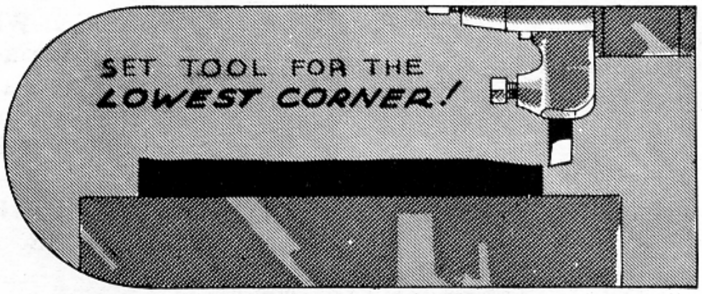


FIG. 298



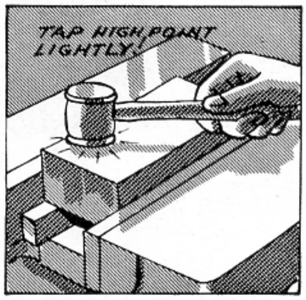
6. Compare the height of the other corners with the one to which the scriber has been adjusted by sliding the gage on its base. Refer to illustration. In this way the scriber is brought to work from the side. Its setting will not be changed if a corner is higher as might be the case when the surface gage is lifted and the scriber is brought down on a higher corner.



7. Check to see which of the corners is the lowest so that the tool may be adjusted to this place for taking the cut.

HOW TO LEVEL THE SURFACE ON A CASTING HELD IN THE VISE

1. Place the work in the vise with its upper surface as nearly level as possible. Tighten the vise temporarily by applying only enough pressure on the work to hold it in place while its surface is being leveled more accurately.



2. Clean the vise and gage and check for burrs. Adjust the scriber.

3. Bring the scriber to each corner of the work and note which one is the highest.

4. Tap the high corner down to the approximate level of the others with a lead mallet. Then check all the corners again with the surface gage.

5. Continue to tap the high corner down after each check is made with the gage until the four corners are as nearly the same height as the condition of the casting will permit.

SETTING WARPED CASTINGS

6. Set those corners level which are diagonally opposite each other. In this way there will be a balance between the high and the low corners, and the casting can then be machined to best advantage.

7. Tighten the vise sufficiently to hold the work during the cut. Recheck the work after tightening to make certain that its position in the vise has not changed.

8. Place shims under the parts of the job that do not rest on parallels or on the vise if the work is likely to move down in the vise as a result of the cutting pressure (Fig. 299).

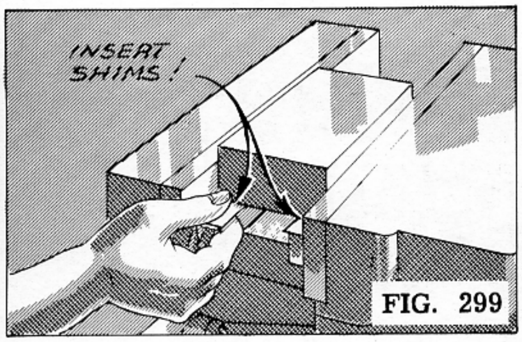


FIG. 299

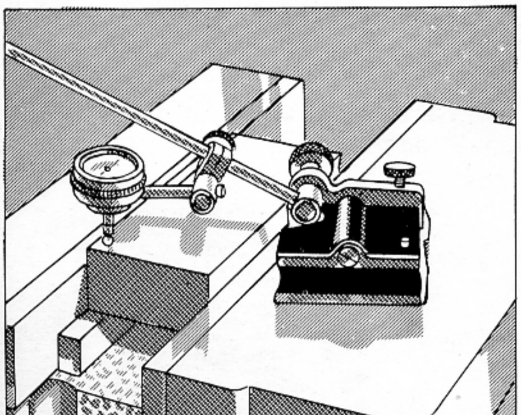


FIG. 300

NOTE: When it is necessary to level a finished surface accurately, instead of leveling a rough surface approximately, a dial indicator can be used on the surface gage in place of a scriber as shown in Figure 300.

HOW TO SCRIBE LAYOUT LINES ON WORK HELD IN THE VISE

1. Rub chalk on the ends and on the sides of the work.

2. Clean the surface gage and check for burrs.

3. Hold a scale in a vertical position with one end on a parallel which supports the work, or on the bottom of the vise if the work is seated on it. (Fig. 301).

4. Set the point of the scriber to the dimension on the steel rule which coincides with the thickness of the finished work. (Fig. 301).

5. Scribe a line on the side of the casting from which the cut is to be started. Draw the base of the surface gage across the top of the vise jaw. At the same time, keep the scriber in contact with the side of the work (Fig. 302).

NOTE: If a line must be scribed on another face of the work which is inaccessible to the surface gage in its present adjustment and location, transfer the gage to another true surface and readjust the scriber point to the first line scribed.

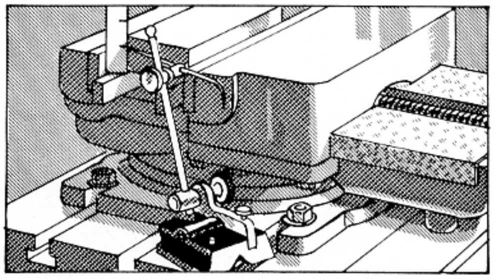


FIG. 301

HOW TO SET UP WORK ACCORDING TO A LAYOUT

1. Clamp the work in the vise temporarily with the layout line which indicates the finished surface as nearly level as it is possible to set it by eye (Fig. 303).

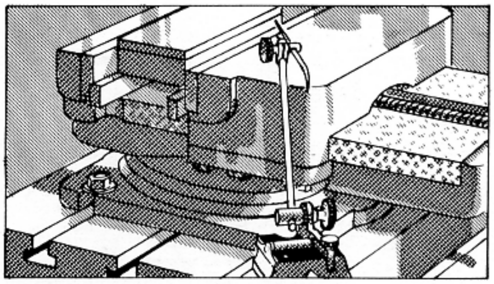


FIG. 302

2. Clean the vise jaw and surface gage and check for burrs.

3. Place the surface gage on the surface which has been prepared for its use. Adjust the point of the scriber to one end of the layout line (Fig. 303).

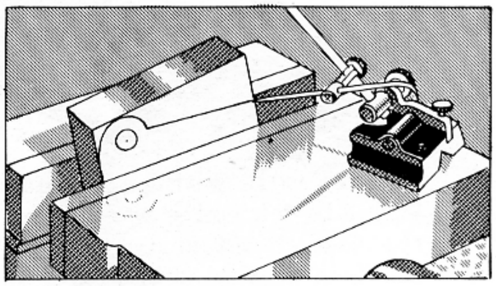


FIG. 303

4. Slide the surface gage to the opposite end of the layout line and note any variation between the height of the line and the scriber. (Fig. 304).

5. Tap the work as required to bring the layout line level with the scriber point.

6. Continue to check and adjust the work in the same way until there is no apparent deviation in the height of the line from end to end.

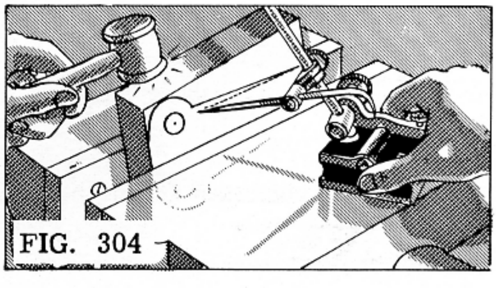


FIG. 304

7. Tighten the work securely in the vise. As a precaution, check again after tightening in order to detect any shifting of the work which may have occurred.

HOW TO SHAPE VERTICAL SURFACES

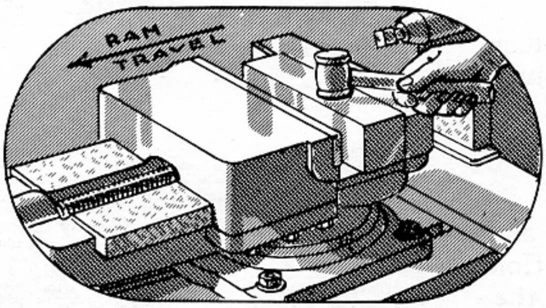
PROCEDURE

HOW TO MOUNT THE WORK IN THE VISE FOR A VERTICAL CUT

1. Bolt the vise to the table. If the vise is not already mounted, select from the several methods given in How to Mount the Shaper Vise (page 119) the one which is appropriate for mounting a vise of the type selected.

2. Swivel the vise on its base, if necessary, so that the jaws are at right angles to the stroke, or as expressed in another way, so that the jaws are parallel with the face of the column.

3. Place the index line on the vise over the zero graduation on the base. When a more accurate setting is desired, set the vise at 90° to the direction of the stroke with an indicator.



4. Place the work in the vise -- on parallels if it must be raised -- so that the end which is to be squared extends approximately one-half inch beyond the right side of the vise. At the same time, place a strip of paper under each end of the work if it rests on the vise, or under each corner of the work if it rests on parallels.

5. Tap the work with a lead mallet to seat in the vise. Pull lightly on the paper strips to determine whether or not it has been properly seated. In order to have the ends planed square with its sides, the work must be placed parallel with the table as well as at the right angles to the stroke of the ram.

6. Bevel the edges of the work at the end of the cut, almost to the depth of the cut.

HOW TO MOUNT THE WORK ON THE TABLE FOR A VERTICAL CUT

1. Remove the vise from the table.

CAUTION For heavy machine vises, secure help in removing from table.

2. Clean the table thoroughly. Then remove any burrs or high spots with a smooth file or abrasive stone.

3. Clean the surfaces of the work. At the same time, inspect these surfaces for burrs which must be removed before placing the job on the machine table.

4. Place a single thickness of thin paper on the shaper table for the purpose of increasing the amount of friction between the work and the table and reducing the likelihood of the job shifting during the cut (Fig. 305).

5. Place the work on the table with one of its sides as nearly parallel with the face of the column as it is possible to set by eye. At the same time, allow one end to extend about one-half inch beyond the right side of the table.

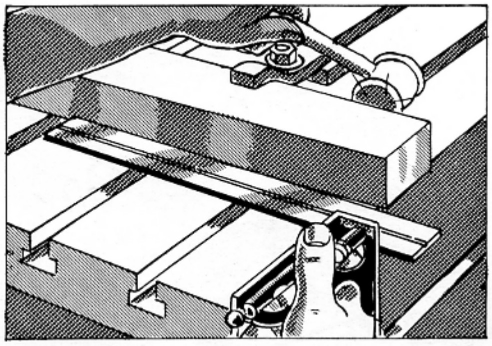


FIG. 305

6. Clamp the work to the table lightly. Use straps and the shortest bolts possible which will still provide a full thread for the nut. If gooseneck clamps are available, use these. Their construction makes it possible for the bolt and nut to be below the clamp itself. This feature of having the top of the bolt no higher than the strap is important, especially when vertical cuts are taken. Any extension of the bolt above the work adds to the distance the tool slide must be extended from the head during the cut.

7. Recheck the side of the table which is to be used for squaring the work to see that it is free from burrs and clean.

8. Place the head of a combination square (or the blade of a steel square) against the side of the table. Extend the blade long enough to permit the work to be squared. (See Figures 305 and 306.)

9. Press the head of the square firmly against the side of the table and carefully slide it toward the work. Note which end of the blade comes in contact with the work.

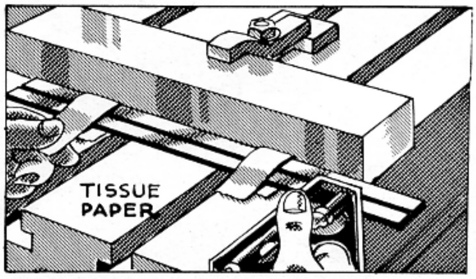


FIG. 306

10. Move the square back. Then tap the end of the work which did not touch the blade until the opening between the work and the square disappears and the work is parallel with the blade. This indicates that the work is now at right angles to the ram.

11. Recheck the alignment of the work more accurately with the square. Place a piece of tissue paper between the work and each end of the blade. With the blade removed tap the work and continue to test until the same amount of "drag" is felt on both pieces of paper when they are withdrawn from between the blade of the square and the work (Fig. 306).

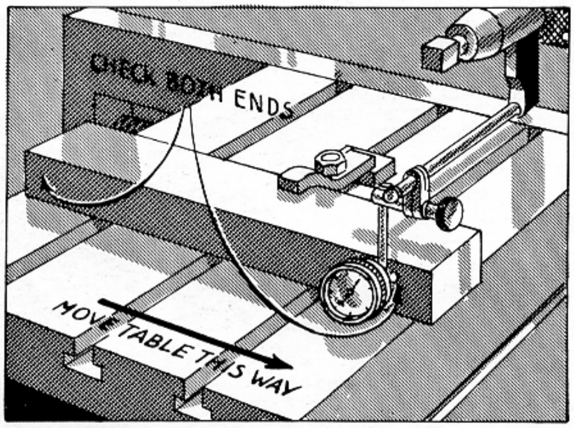


FIG. 307

12. Align very accurate work with a dial indicator instead of a square. Clamp the indicator in the tool post with its contact point against the front face of the work. Move the work crosswise by means of the crossfeed screw to determine the amount the work is out of alignment. Adjust the work in the same manner as before, until the indicator reading does not change during the movement of the table and work (Fig. 307).

13. Tighten the work securely. As a precaution, check its alignment again to see whether or not its position changed when the bolts were drawn down tightly.

14. Place a suitable stop in front of the work at the right and another in the rear of the work at the left (Fig. 308) as an additional precaution against shifting of the work during the cut.

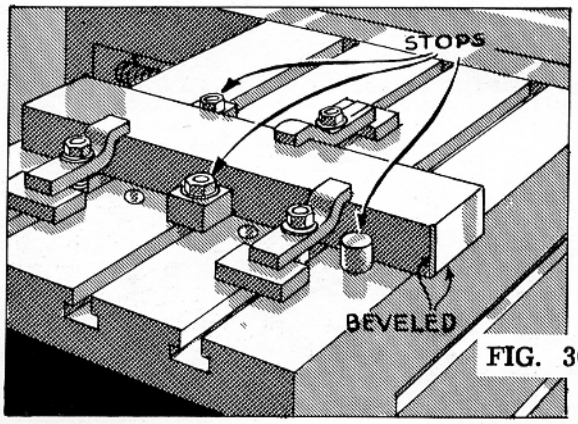


FIG. 308

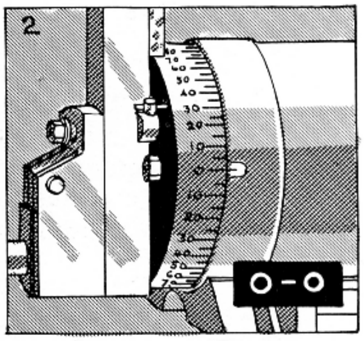
CAUTION If stops having screws are selected, be careful not to force the screws against the job so hard that the work is shifted out of alignment. Recheck alignment with indicator after all straps and clamps are secured.

15. Bevel the edge at the front of the work with a file, almost to the depth of the cut.

OIL Oil the shaper before starting a cut.

HOW TO ADJUST THE CUTTING TOOL AND THE TOOL HEAD

1. Set the tool head at right angles to the machine table by placing opposite the index line on the ram whichever of graduations – zero or 90° – will cause the head to be positioned square with the table (Illustration 2).



2

2. Tighten the clamping bolts just enough to hold the tool head in this position.

3. Check the accuracy of this setting with a square (Fig. 309). Hold the head of the square down firmly against the finished surface on the table or vise. Carefully slide the square against the side of the tool slide and note whether or not it is parallel with the blade of the square.

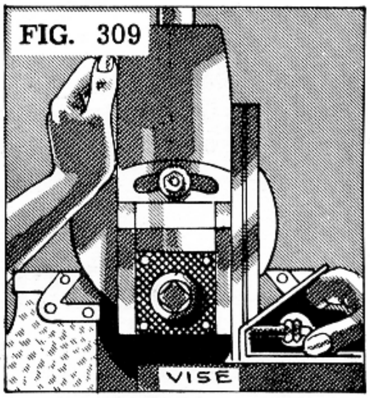
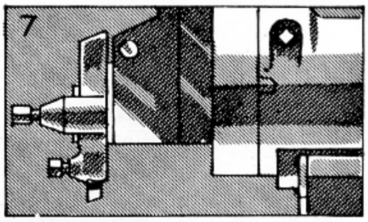


FIG. 309

4. Move the square away. Then tap the tool head with the palm of the hand or with a soft hammer until no light is visible between the square and either end of the tool slide (Fig. 309).

5. Tighten the clamping bolts on the head securely when the head is square.

6. Loosen the binder bolt on the clapper box and swivel its upper end to the right to the limit of the elongated slot. Then tighten the bolt again.


7

7. Note the height of the vertical surface which is to be shaped. Run the tool slide up far enough at the start of the cut so that when the cut has been completed and the tool has reached the lower edge of the vertical cut (Fig. 310), the slide will not extend much below the swivel block.

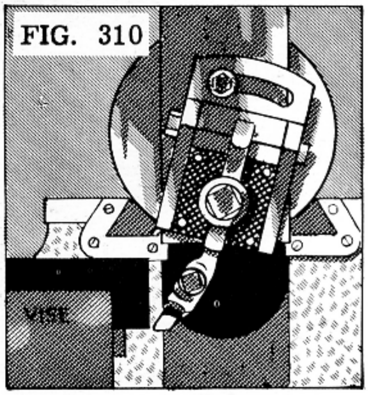


FIG. 310

8. Measure the opening in the tool post so that either a forged tool or a tool holder of the correct size may be selected.

9. Determine whether a straight or an offset tool holder can be used to better advantage on this cut. Then select a tool bit that has been ground especially for taking a vertical cut on the right-hand end of the job and for

cutting the kind of material in the work. If a forged tool is selected instead of a tool holder and a tool bit, its selection too should be based on these same factors.

10. Clamp the tool holder in the tool post in such a position that the vertical cut can be made without interference between the holder and the job. Extend the tool holder beyond the tool block the shortest distance possible for making the cut. In no instance should this distance be less than the height of the vertical cut, if rubbing of the tool slide on the work is to be avoided (Fig. 310).

HOW TO ADJUST THE SHAPER PRIOR TO TAKING A VERTICAL CUT

1. Adjust the position of the cross rail on the column up or down so that a space of approximately one inch is apparent between the ram and the top of the work, or between the ram and the straps and bolts, whichever is higher.

CAUTION Before raising or lowering the table, loosen the bolts for clamping the cross rail and those for clamping the table support. Tighten them again immediately after the rail has been moved to its new position on the column.

2. Measure the length of the surface which is to be planed; add approximately one inch to this dimension in order to provide for clearance of the work by the cutting tool at both ends of the stroke.

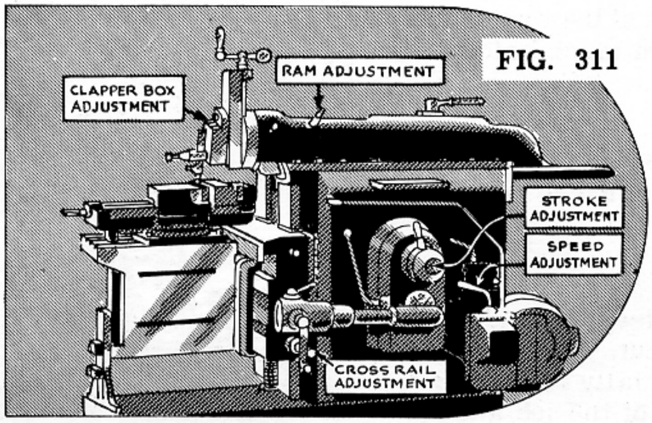


FIG. 311

3. Adjust the ram stroke for length.

4. Adjust the position of the stroke so that the tool covers the entire surface which is to be planed.

5. Consult a table of Allowable Cutting Speeds in Feet Per Minute. A typical

table is given on page 308. From this table, determine the cutting speed in feet per minute which is to be used. Base the decision on the kind of material to be planed, the type of cut (whether roughing or finishing) and the material from which the cutting tool is made.

NOTE: Most cone-driven shapers are not provided with charts such as appear on direct-driven shapers.

6. Determine the number of strokes per minute which will result in a cutting speed in feet per minute approximately the same as that decided upon in step 5.

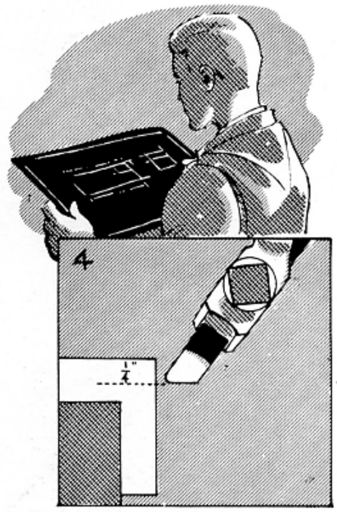
7. Adjust the shaper for the number of strokes per minute decided upon in step 6.

CAUTION Shift gears only when the shaper is not in motion.

8. Check whether or not the cut can be made without any part of the ram striking the work by feeding the tool down for the length of the cut while the ram is not in motion. Then carefully move the ram through one complete stroke by hand.

HOW TO TAKE THE ROUGHING CUT (VERTICAL)

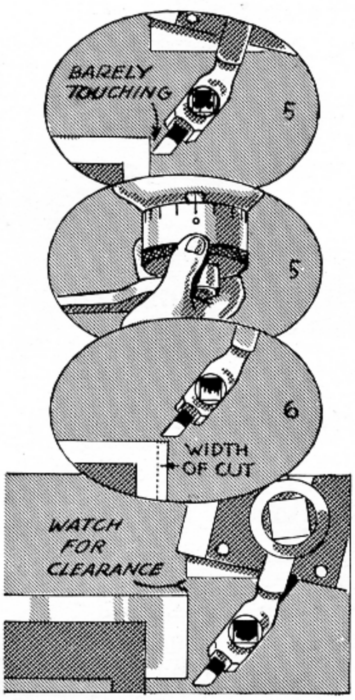
1. Consult the blueprint or the job layout to determine how much material is to be removed by the tool.



2. Plan to remove approximately one half the excess material from each end when both ends must be squared and the job must be planed to a definite length at the same time.

3. Bevel the vertical edges at the ends of the cut to prevent breakage of the corner below the finished surface.

4. Set the tool for a cut of the desired thickness by moving the work to the left of the tool. Then, by means of the down-feed screw, move the tool down about 1/4" from the top of the vertical surface (Illustration 4).



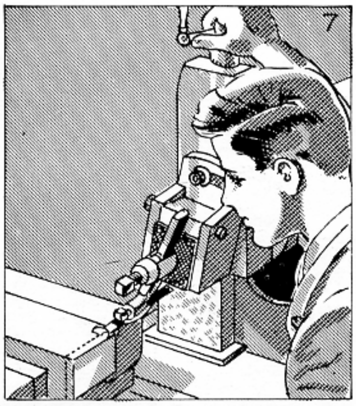
5. Move the work toward the tool carefully by means of the cross-feed screw until they just barely touch. Set the micrometer dial on the cross-feed screw to zero (Illustration 5).

6. Raise the tool so that it just clears the top of the job. Move the work to the tool for the desired cut, measuring its thickness by means of the graduations on the dial on the cross-feed screw.

NOTE: During the vertical cut, the tool is frequently extended farther from the tool post than usual so that the cut can be made to the bottom of the work without interference between the tool slide and the job. For this reason both the rate of feed and the width of the cut should be somewhat less than they are for horizontal shaping.

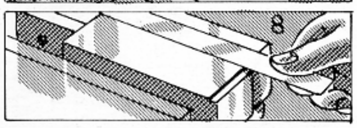
HAVE ENTIRE SET-UP *CHECKED* BY YOUR INSTRUCTOR

OIL Oil the shaper before operating.



7. Start the shaper. Feed the tool down carefully by hand until the cut is started and the width can be seen (Illustration 7).

CAUTION Wear goggles as a protection from flying chips and keep the face and the eyes a safe distance from the work.



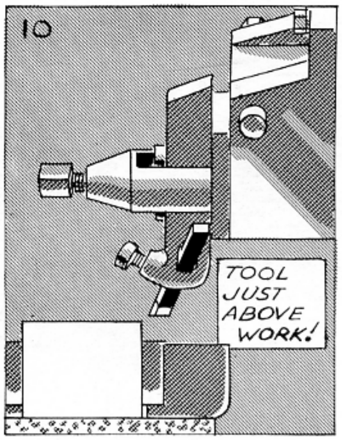
8. Stop the shaper to measure the work and make certain that the work in its present position will not be cut undersize because too heavy a cut is removed.

9. Start the shaper again. Feed the tool down about .010" at the end of each return stroke of the tool (Illustration 9). Continue the feeding until the entire vertical surface has been shaped.

NOTE: Inasmuch as both the size of the cut and the quality of the finish desired may vary considerably, it is impossible to specify a rate of feed suitable for every combination. The recommended procedure, therefore, is to feed the tool to the work slowly at first. Then increase the rate when the action of the tool makes it apparent this can be done with safety.

CAUTION Keep the fingers and hands away from the cutting tool while the shaper is in operation. It is extremely dangerous to place the hands directly behind the vise, or the work, at any time while the shaper is in operation.

10. Stop the ram in its backward position when the cut has been completed and raise the tool to the top of the work for starting the cut.



11. File the burrs from the edges of the work preparatory to testing it with a square. Wipe the upper surface and the end in order to remove the filings and any other foreign material which may be present.

12. Test the work with a steel square as shown in Figure 312 to see if the end has been planed square (at right angles) to the upper surface.

NOTE: When the surface of the work is unusually rough and irregular before it is machined, this condition is very likely to be reflected on the finished surface as a result of spring in the tool. A second, light cut, made for the purpose of removing these irregularities, is advisable for correcting this condition. Then a true surface will be produced which indicates the actual position of the head in relation to the upper surface of the work.

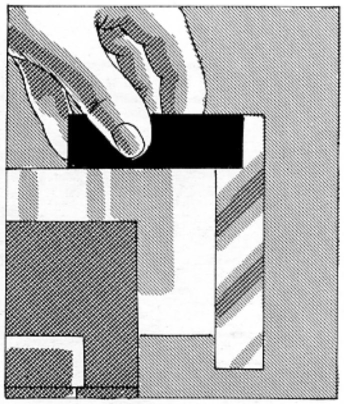


FIG. 312

13. Test the work with a square by pressing its beam down firmly against the upper surface of the work. Carefully move the blade toward the end just machined. Then note whether or not the vertical surface is parallel with the blade.

NOTE: If the work and the tool head have been set up correctly, the end should be machined square with the top of the work. If this is the case, the blade of the square will touch the end from top to bottom and neither an opening nor light will be visible between the work and the blade of the square.

The work is not square when light is visible between the square and the end of the work. To correct this condition, the tool head must be swiveled slightly in one direction or the other depending upon whether the light is visible at the upper or the lower end of the blade.

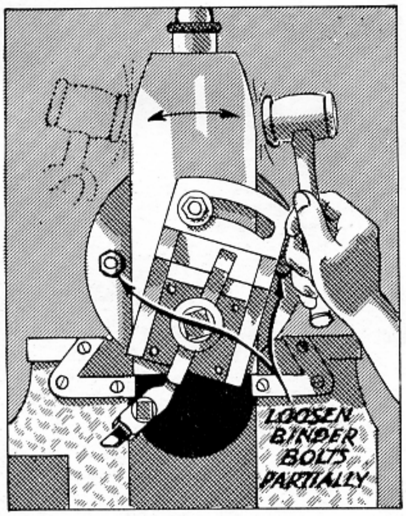


FIG. 313

14. When the position of the tool head is to be changed only a small amount for correcting a slight inaccuracy in the cut, partially loosen the binder bolts holding the swivel block to the ram.

    Swivel the head in the direction desired by tapping it lightly with a block of wood or lead, to the left when the opening occurs at the lower end of the square; to the right when the opening occurs at the upper end (Fig. 313). The number of adjustments required to make the work square will depend upon the operator's ability to estimate the amount of swiveling needed on the head to produce the desired correction in the cut.

15. Reset cutting edge of the tool with the work after each adjustment of the head. Their relationship changes each time the head is swiveled. Take another light cut and check the result with a square as before.

CAUTION When taking several trial cuts to square the work, be careful not to cut the work undersize.

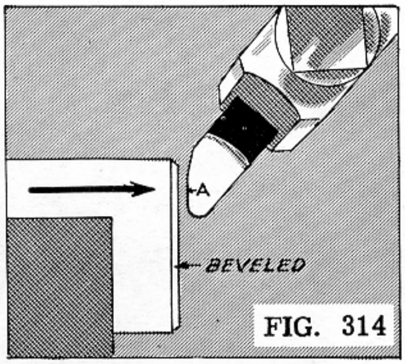


FIG. 314

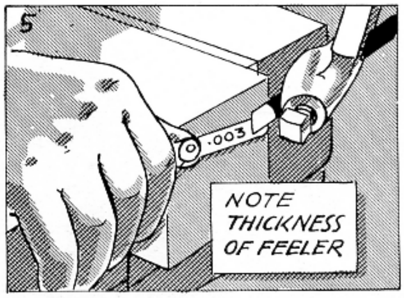
HOW TO TAKE THE FINISHING CUT (VERTICAL)

1. Replace the roughing tool with a left-side finishing tool ground for cutting the kind of material in the job. Locate the tool in the tool post and position in relation to the cut.

2. File a small bevel on the edges of castings to prevent the sand and scale on their surfaces from dulling the keen cutting edge of the finishing tool. (Fig. 314).

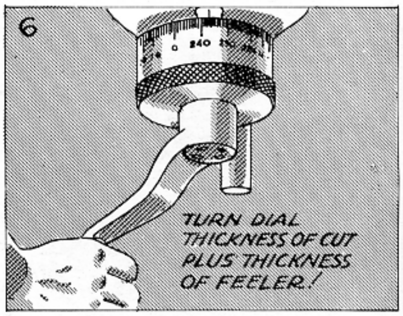
3. Move the ram to position the tool opposite the vertical surface. By means of the down-feed screw, lower the tool so that it extends alongside this surface. Then, using the cross-feed screw, move the work over until it almost touches the tool.

4. Adjust the tool in the tool post so that its cutting edge at (A) in Figure 314 is parallel with the vertical surface. Tighten the tool-post screw.



5. Place a feeler blade against the end of the tool. Continue to move the work carefully toward the tool until a slight "drag" is required to withdraw the feeler from between the work and the tool (Illustration 5). Set the graduated collar on the cross-feed screw to zero.

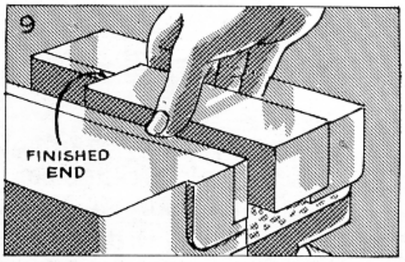
6. Raise the tool so that it clears the job. Move the work to the right a distance equivalent to the thickness of the cut desired and the feeler. Use the micrometer collar to measure the distance. (Illustration 6).



7. Start the shaper. Feed the tool down at the end of each return stroke of the ram. Use a fine feed when finishing steel and a coarser feed for cast iron.

8. File the burrs from the edges. Wipe the surfaces clean. Test the work with a square.

9. Square the opposite end of the work by reversing its position in the shaper.



NOTE: If the work is long enough to project beyond the vise jaws or table, the second end may be shaped to length by swiveling the tool holder and clapper box in the opposite direction using a cutting tool ground for taking a cut on the left side of the job.

10. Replace the finishing tool with the roughing tool.

11. Take the roughing cut allowing .010" to .015" on the overall length of the work for the finishing cut.

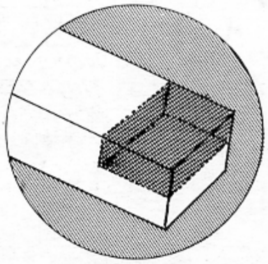
12. Replace the roughing tool with the finishing tool used for the opposite end and proceed to take a finishing cut the same as on the first end.

13. Measure the overall length of the work. If the job is oversize, take additional cuts. Use the micrometer dial on the cross-feed screw to determine the amount of metal to be removed.

14. Brush all chips from the machine, and return the parallels and other accessories to their proper places in a clean condition at the completion of the job.

HOW TO SHAPE COMBINED HORIZONTAL and VERTICAL SURFACES

PROCEDURE



Squaring a shoulder is usually preceded by horizontal and vertical cuts. As a rule, the shoulder is squared immediately after these cuts have been made and before the work is removed from the shaper. Therefore, directions for mounting the work will not be given in this unit.

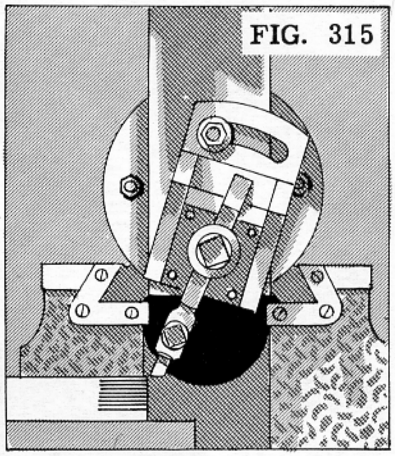


FIG. 315

1. Set the tool head at right angles to the table.

2. Swivel the clapper box to the right as for a vertical cut.

3. Select a round-nosed roughing tool suitably ground for taking a horizontal cut on the material in the job. The tool should have its cutting edge on the left side and a relatively small radius on the corner.

4. Mount the tool holder in the tool post. Allow it to extend just far enough for the tool to reach the lower horizontal surface without having the tool slide strike the job. At the same time, place the tool holder in a position (slightly angular) which will enable the tool to cut to the corner without having its holder rub on the vertical surface (Fig. 315).

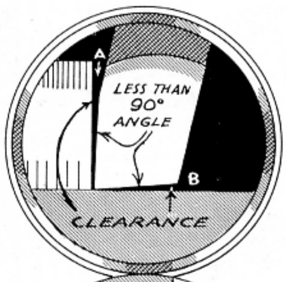
5. Make certain that the length of the stroke, its position relative to the cut, and also the speed of the shaper have been adjusted to suit the job.

CAUTION Carefully move the ram through one complete stroke to make certain that the above adjustments have been made correctly.

6. Take a series of horizontal cuts and rough out the work to within 1/64" of the final dimensions on both the horizontal and the vertical surfaces.

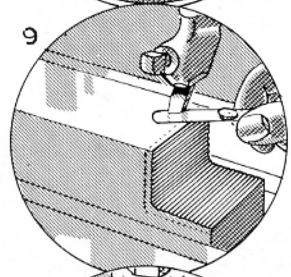
7. Remove the roughing tool and replace it with one ground especially for squaring the corner. Surfaces (A) and (B) on this tool (Fig. 316) form an angle slightly less than 90°.

FIG. 316



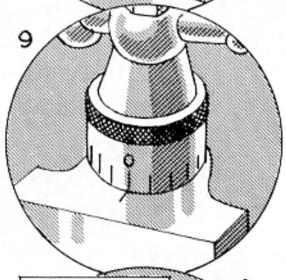
8. Adjust this tool to the work so that a slight opening appears at (B) when the point just barely touches the horizontal surface. A similar opening must appear at (A) when the point touches a vertical surface such as the end of a scale placed against the side of the tool as shown in Figure 316.

9



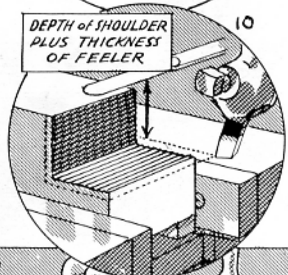
NOTE: Although it is intended primarily for squaring right-angle corners, a tool ground like the one shown in Figure 316 functions equally well as a finishing tool for both the horizontal and the vertical surfaces which form a shoulder. The procedure for its use in this manner has been explained here. The practices to be followed when a tool of this kind is used only for squaring the shoulder will be covered later (page 223).

9



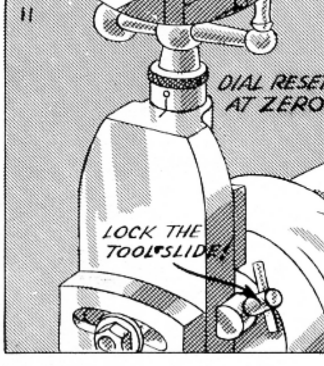
9. Set the tool so that it just barely touches a feeler placed on the upper surface of the work when the height of the shoulder must be accurately maintained. Then set the micrometer collar on the down-feed screw to zero.

10



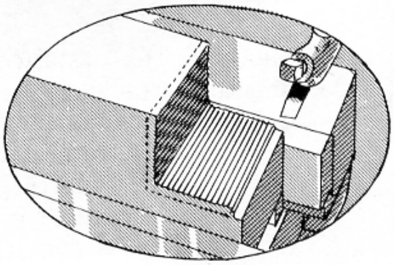
10. Move the work to the left so that it is no longer under the tool. Then use the micrometer dial and feed the tool down a distance equivalent to the height of the shoulder and the thickness of the feeler (Illustration 10).

11



11. Lock the tool head in place (Illustration 11). Reset the micrometer dial at zero and start the shaper.

12. Adjust a rate of feed which will produce the kind of surface finish desired. Engage the automatic feed. Then take a finish cut on the horizontal surface (Illustration 12).



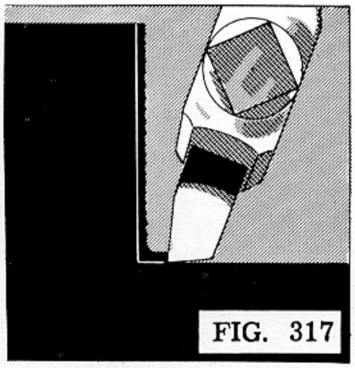


FIG. 317

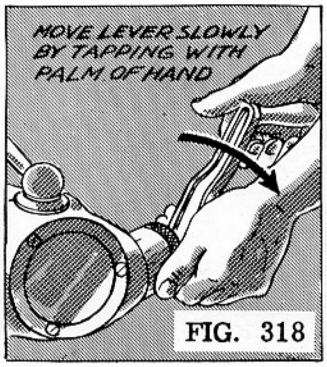


FIG. 318

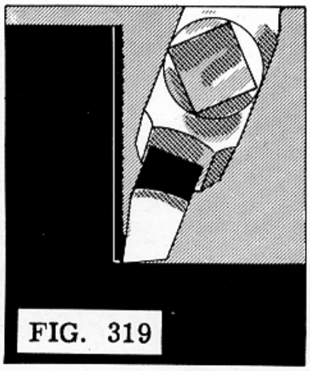
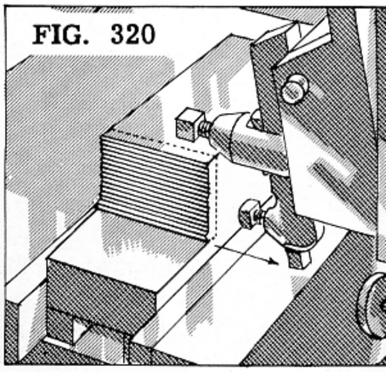


FIG. 319

FIG. 320



13. Disengage the automatic feed just before the tool reaches the corner (Fig. 317). Use the hand feed and move the work toward the tool slowly. Tap the handcrank lightly with the palm of the hand to control to best advantage the amount of feed per stroke (Fig. 318).

14. Continue the hand feeding until the metal left in the corner by the round point on the roughing tool has been removed and the tool has cut almost to the layout line indicating the location of the shoulder (Fig. 319). Then stop the shaper at the end of its backward stroke (Fig. 320).

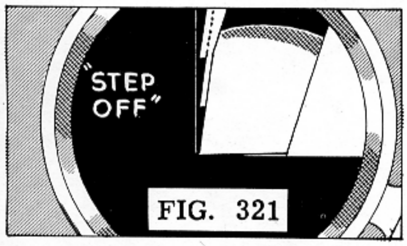
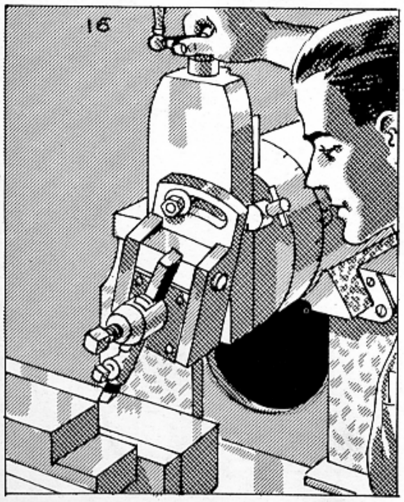


FIG. 321

NOTE: If a large fillet has been left in the corner, it may be necessary to "step it off". That is, it may be desirable to remove the fillet by taking several light cuts rather than by taking a single heavy one (Fig. 321).



15. Raise the tool to a position slightly above the vertical surface. Adjust the work to the tool preparatory to taking the vertical cut.

16. Start the shaper. Feed the tool down carefully until the cut is just started. Make further adjustments of the work, if necessary, so that the final setting will result in a cut which splits the vertically scribed line.

17. Measure the distance from the end of the work to the shoulder whenever it must be maintained accurately by using the graduations on the micrometer collar of the cross-feed screw. Move the end of the work against the left side of the tool (Fig. 322), using a feeler between them. Set the micrometer collar to zero (Fig. 323). Raise the tool above the vertical surface (Fig. 324). Move the

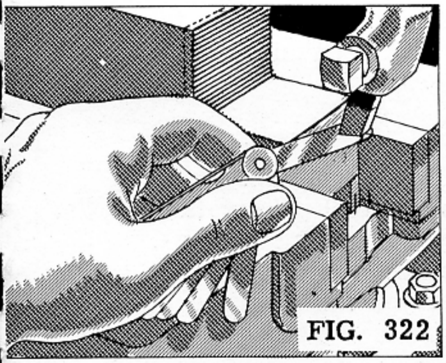


FIG. 322

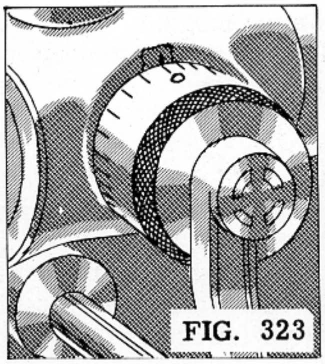
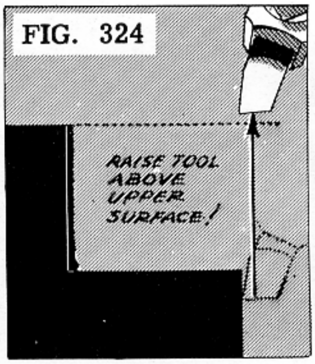


FIG. 323

FIG. 324



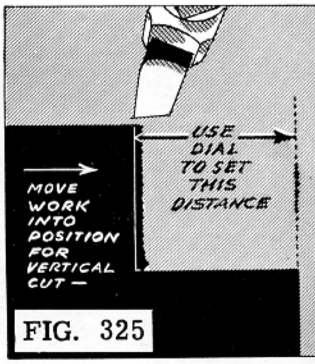


FIG. 325

work over the number of thousandths required to locate it in position for taking the finishing cut on the vertical surface (Fig. 325). Include the thickness of the feeler in moving the work to this dimension.

18. Decide upon the rate of feed to be used. Feed the tool down this distance at the end of each return stroke.

19. Continue to feed the tool down steadily until it reaches the horizontal surface and the zero on the graduated dial on the down-feed screw is again opposite the index line. In other words, the tool should be fed down until it is again in the identical vertical position it occupied when the finishing cut was made on the horizontal surface.

20. Feed the work slowly away from the tool by hand so that the surface in the corner merges with the horizontal surface. When the tool is fed down, the slight angle at which the lower surface of the tool has been set is duplicated on the horizontal surface in the corner (Fig. 326). Consequently, point (A) is slightly higher than the remainder of the horizontal surface. It is for the purpose of removing this point that the work is fed away from the tool slowly after the tool has reached the horizontal surface (Fig. 327).

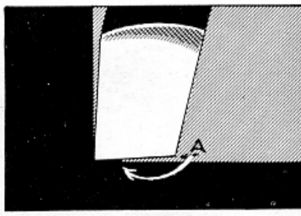


FIG. 326

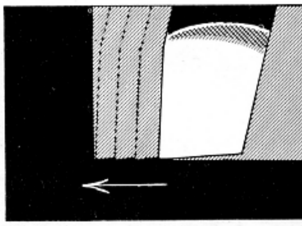
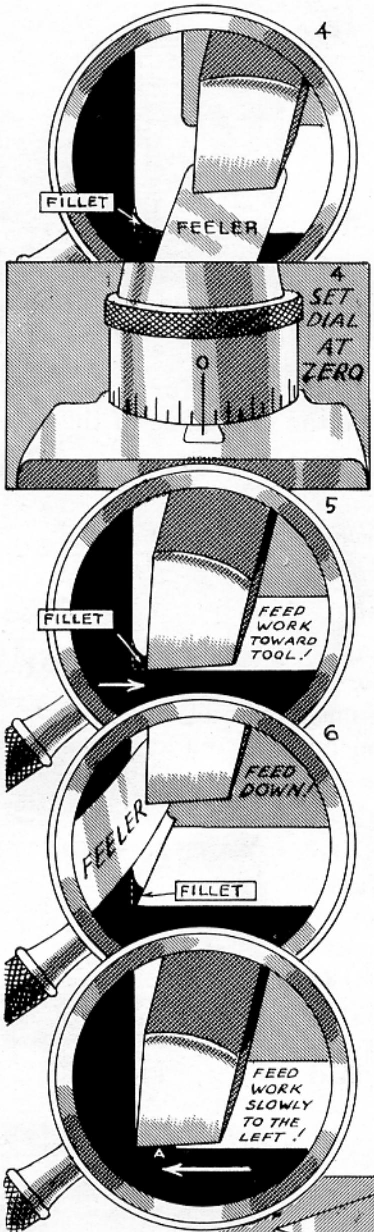


FIG. 327

NOTE: When finishing cuts have been taken on both the vertical and the horizontal surfaces with a round-nosed tool, leaving a fillet in the corner, the shoulder can be squared as follows:

1. Select a tool similar to the one used for squaring a corner.

2. Set the tool in relation to the work so it will not rub for either the vertical or horizontal surface.



3. Make certain the length of stroke, its position relative to the cut and the speed of the shaper have been adjusted to suit the job.

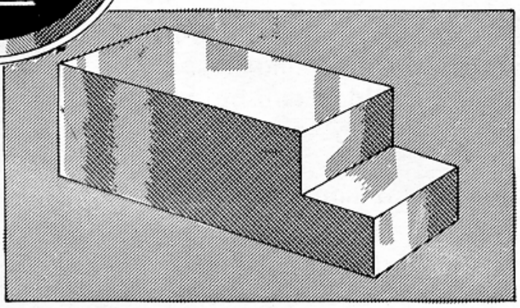
4. Place a feeler of known thickness (in thousandths of an inch) on the horizontal surface under the tool (Illustration 4). Move the tool down carefully (with the ram stationary) until a slight drag is felt when the feeler is withdrawn. Set the micrometer collar on the down-feed screw at zero (Illustration 4).

5. Start the shaper. Feed the work toward the tool by hand until the side of the tool is almost in line with the vertical surface.

6. Raise the tool so that its point is above the fillet. Then carefully move the work toward the tool. Tap the crank on the cross-feed screw lightly by hand until the tool just barely scrapes the shoulder.

NOTE: This adjustment can also be made by placing a feeler between the work and the tool while the ram is stationary. Then move the work toward the tool a distance in thousandths equal to the thickness of the feeler. This distance can be measured by means of the micrometer dial on the cross-feed screw.

7. Feed the tool down carefully until it reaches the horizontal surface and until the zero on the micrometer dial on the down-feed screw has been turned beyond its index line a distance in thousandths equal to the thickness of the feeler used under the tool when it was adjusted for the horizontal cut.



8. Turn the handcrank on the cross-feed screw in to feed the work slowly to the left so that the tool will remove the slight projection at (A) and cause the surface in the corner to merge with the horizontal surface.

DESCRIPTION OF ANGULAR CUTS

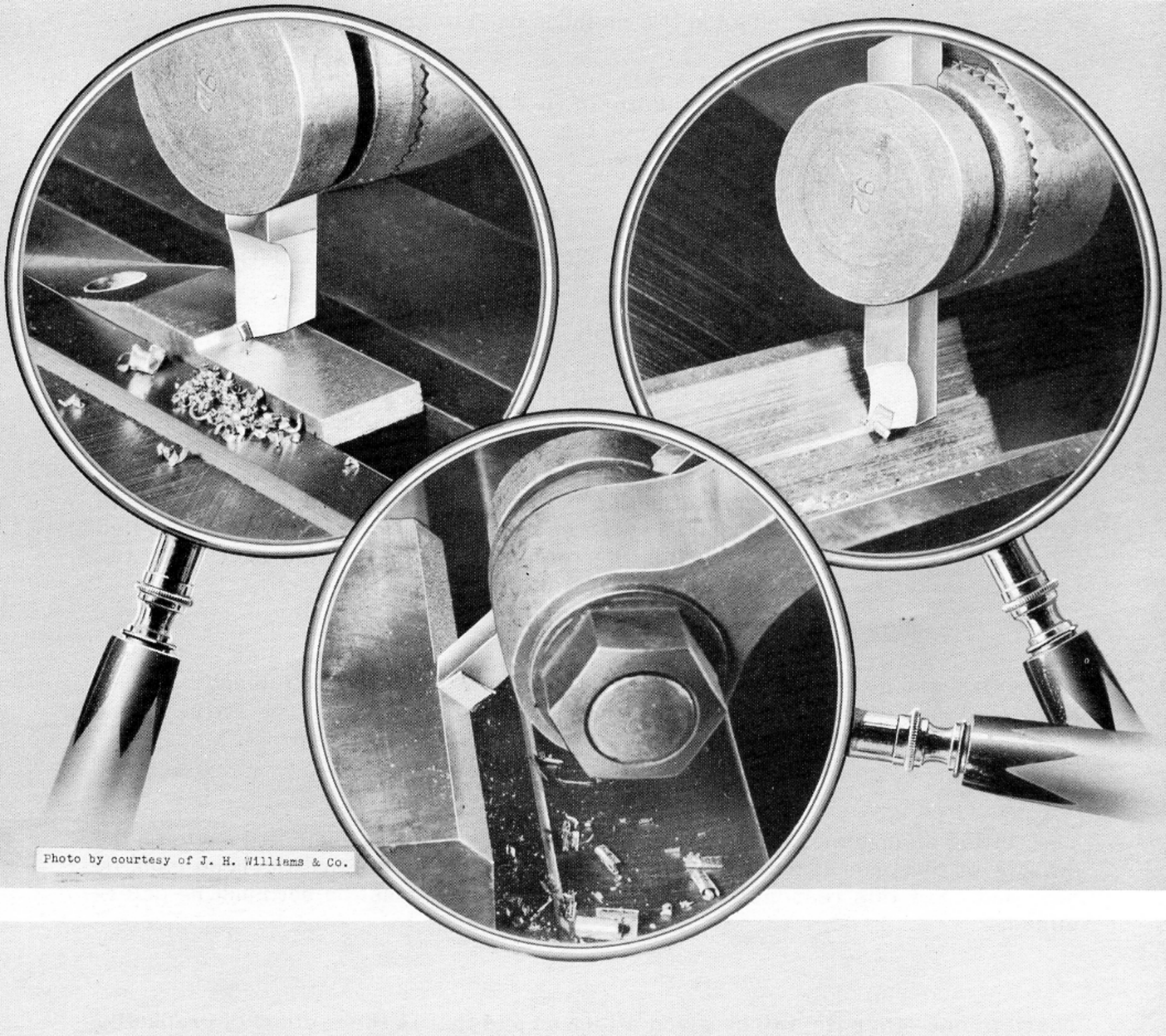


Photo by courtesy of J. H. Williams & Co.

UNIT T 53 (B)

Pages 225 - 234

DESCRIPTION of ANGULAR CUTS

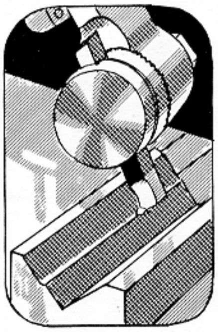
OBJECTIVES OF UNIT

1. To point out different methods used to produce angular surfaces or cuts.

2. To describe the two methods used to graduate the tool head.

3. To determine the angle to which the head must be swiveled to produce on the angular surface a specified number of degrees.

INTRODUCTORY INFORMATION



Angular surfaces can be produced in the shaper by using three principal methods: (1) the work may be held in the machine in such a position that a horizontal or a vertical cut will form an angle with an adjacent surface; (2) the cutting edge of the tool may be set at an angle to the vertical or the horizontal axis of the machine and brought into proper relation to form an angular surface; and (3) the tool head may be swiveled and then the tool fed in an angular direction by the down-feed crank.

As the first two methods depend upon the positioning of the work and the setting of the tool, more detailed instruction will be given in the following unit. The setting of the tool head, however, requires some knowledge of angular measurements.

The cutting of angular surfaces is frequently confusing. The indicated angle on the drawing or blueprint is not always given in terms of the angle that the head must be swiveled. For this reason, the angle at which the head must be set must be determined.

There is one other item to be given attention and that is the method of graduating the swivel block. Unfortunately there are two methods of graduating the head. Both methods are easily understood although they are different.

DESCRIPTION OF ANGULAR CUTS

Angular surfaces are those which approach each other from different directions in contrast to those which are parallel with each other. The definition should be limited to exclude the right angle because, in shaper work, the right angle is formed by the combination of horizontal and vertical cuts. It should be understood then that when cuts are made at an angle with the horizontal or the vertical, they are called "angular cuts."

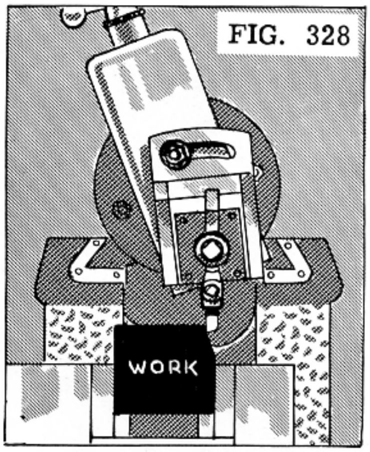


FIG. 328

Correctly speaking, angular cuts can be made on the shaper only when the head is swiveled either to the right or to the left of the vertical position. The cut is made by feeding the tool into the work at the desired angle (Fig. 328).

However, it is not always necessary to swivel the head to produce a surface which is machined at an angle to another surface. There are several other methods which can be used to do this.

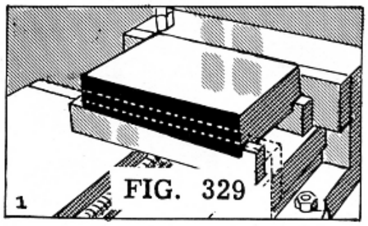


FIG. 329

1. The work may be set to a line which has been scribed on the work to form an angle with another surface. The line is set in a horizontal position with a surface gage and the surface machined to the mark.

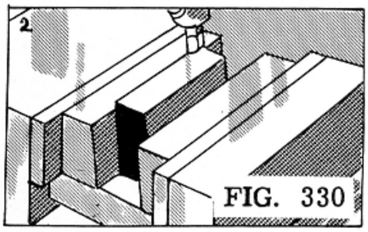


FIG. 330

2. The work can be supported on tapered parallels in the vise and a cut taken across the piece in the usual manner (Fig. 329). This method is usually used for slight angles or tapers.

3. Degree parallels placed in the vise offer a convenient method of setting the work at a slight angle with the vertical. When the work is held between the parallels and a cut is taken across the top of the piece, an angular surface is machined with the sides of the work (Fig. 330).

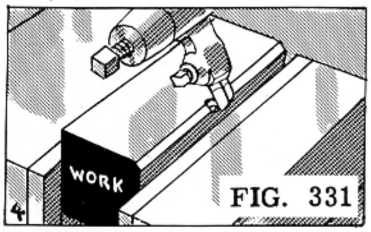
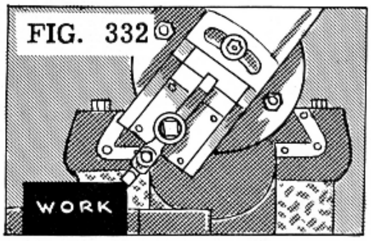


FIG. 331

4. Setting the edge of the tool to suit the angle of the cut is another method of producing an angular surface. The edge of the tool may be set approximately, or a protractor or a gage can be used to set the cutting edge accurately. When these cuts are comparatively narrow they are often called chamfers (Figs. 331 and 332).

FIG. 332


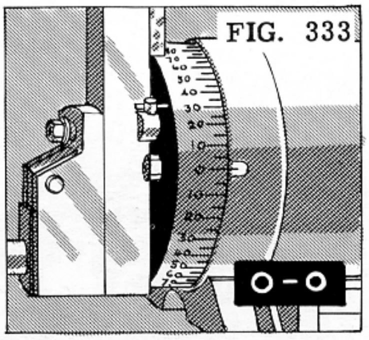


FIG. 333

Since these four methods depend upon the manner in which the work is held in the shaper vise or the way the tool makes contact with the work, the problem is simply a matter of setting the work or the tool correctly.

The setting of the tool head, however, requires some understanding of how the head must be positioned to correspond to the angular surface of the work.

For setting the tool head in a vertical position, there is a zero mark located on the head of the ram which corresponds with either a zero or 90° graduation on the base.

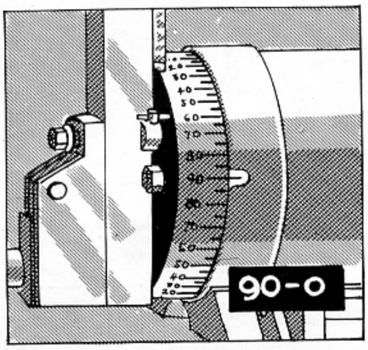


FIG. 334

Those heads which start with a zero graduation when the head is in a vertical position are graduated to indicate an angular position from 0° to 60° on each side of the vertical position (Fig. 333). Other heads have a 90° graduation which coincides with the zero mark on the ram when the head is in the vertical position (Fig. 334).

In other words, the graduations are arranged to increase numerically from the zero in each direction in Fig. 333, and are arranged to decrease numerically from the 90° in each direction in Fig. 334. Both, however, will indicate an angular position through sixty degrees on each side of the vertical position. This factor must be taken into consideration whenever the head is swiveled for an angular cut.

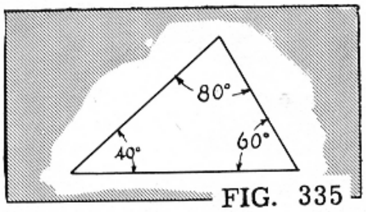


FIG. 335

As the head will be swiveled either to the right or to the left of the vertical position, the mechanic must first determine the angle that the surface to be machined will make with a vertical line. This angle can be easily determined if the construction of the triangle and the principles of opposite, corresponding and complementary angles are understood.

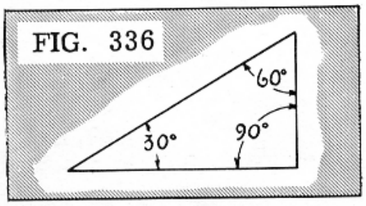


FIG. 336

1. The sum of three angles in a triangle always equals 180° (Fig. 335). Therefore, if two angles are known, the third can be found.

2. In a right-angle triangle one of the angles is equal to 90° (Fig. 336). If one other angle is known, the third angle can easily be determined.

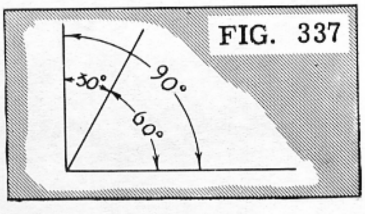


FIG. 337

3. The two angles contained in a right (90°) angle are called complementary angles. Each is called the complement of the other (Fig. 337).

4. When two straight lines intersect, the opposite angles formed by the intersecting lines are equal. The angles marked (X) and the angles marked (O) are equal (Fig. 338).

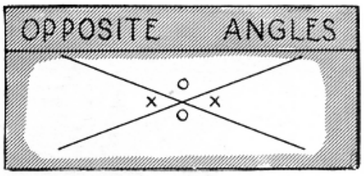


FIG. 338

5. When two straight parallel lines are intersected by a single straight line, the corresponding angles formed by the intersecting line and the parallel lines are equal (Fig. 339). The angles (X) are all equal and the angles (O) are all equal. The upper set of four angles correspond with the lower set of four angles.

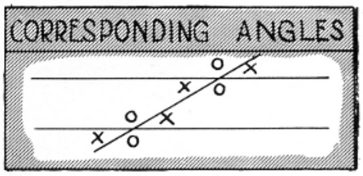


FIG. 339

These principles must be understood because they are essential for complete understanding of angular problems.

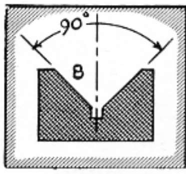


FIG. 340

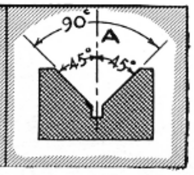


FIG. 341

A few examples will show the method of finding the angle at which the head must be set.

The job shown in Figure 340 has a 90° opening. If an imaginary line (A), Fig. 341, is drawn perpendicular to the work, the 90° angle will be divided into two 45° angles. This, then, is the angle at which the head must be set when the surface (B) is machined. In this particular case, it is unimportant whether or not the head starts with a zero graduation (Fig. 333) or a 90° graduation (Fig. 334). As 45° is halfway between 0° and 90°, the head may be set first at 45° to the right of the vertical position. To finish the opposite surface, the work may be reversed in the vise or the head may be set 45° to the left of the vertical position.

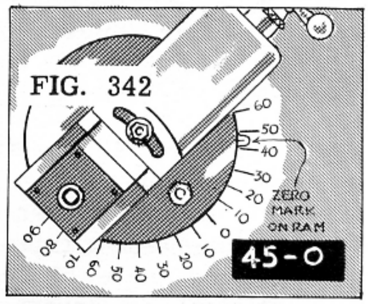


FIG. 342

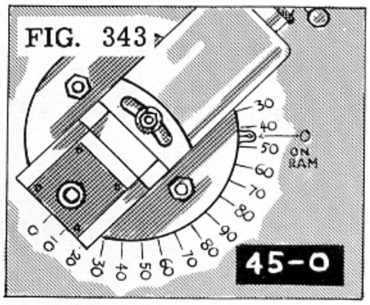


FIG. 343

The second illustration (Fig. 344) has an angular cut at 30° to the vertical. No calculations are necessary in this example because the angle indicated is the angle to which the head must be swiveled from the vertical position. However, care must be taken because of the two methods of graduating the head.

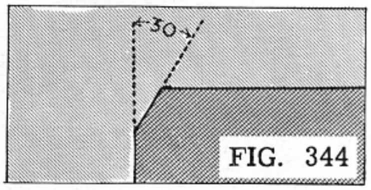


FIG. 344

The rule is as follows:

1. When the graduations start with a zero opposite the zero mark on the ram and the head is in a vertical position, the angle is set "direct," which would be 30° (Fig. 345).

FIG. 345

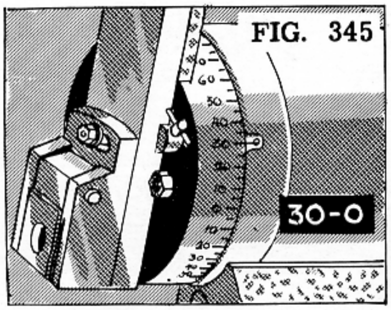
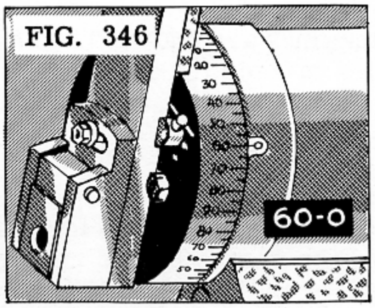


FIG. 346



"Direct" means that the graduations will be set at the same angle that the angular surface of the work makes with a vertical line.

When the graduations start with a 90° graduation opposite the zero mark on the ram, the head must be set at the complement of 30° which is 60° (Fig. 346).

If the angle is designated as in Figure 347 and a line (A) is drawn vertical with the piece to form a 90° angle with the base of the work, the remaining angle is 30°, or the complement of 60°. The head must be swiveled 30° to the right if the graduations start with zero (Fig. 345). If the head is graduated as in Fig. 346, the head will be moved through 30°, but 60° will correspond with the zero mark on the ram.

In Figure 348, the angle is indicated in a slightly different manner. The angle at which the head must be set can be found by forming a right triangle (Fig. 349). The triangle would then contain a 90° angle and a 40° angle. The third angle must be 50° because a triangle contains 180°. A second method may be used to find the setting angle. If the lines in Fig. 350 are extended to (A), (B), (C) and (D), the principle of corresponding angles can be used. The lower 40° angle corresponds to and equals the given angle of 40°. Since 50° is the complement of 40°, the head must be swiveled through 50° to cut an angular surface as shown in Fig. 348. The head is set at 50° if the graduations are arranged as in Fig. 351. It is set at the complement, or 40°, if the graduations are arranged as in Fig. 352.

FIG. 347

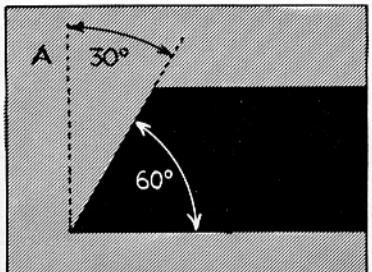


FIG. 348

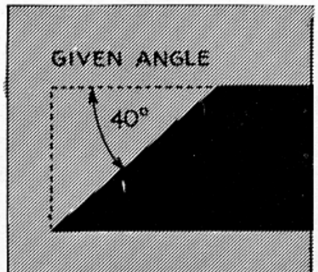


FIG. 349

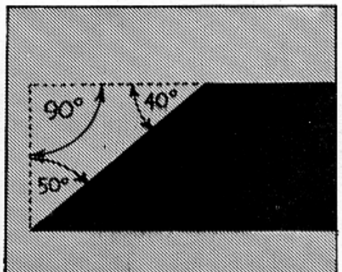
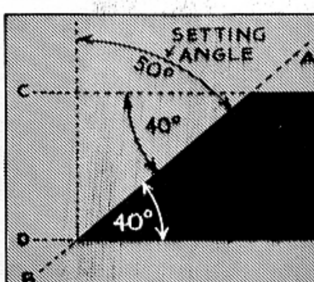


FIG. 350



Sometimes the angle may be given as illustrated in Fig. 353. A triangle may be formed by drawing a perpendicular line AA, Fig. 354. As the 130° angle contains a 90° angle, the other angle must be 40° ($130^{\circ} - 90^{\circ} = 40^{\circ}$). Since the triangle A B C, Fig. 355, now contains a 90° angle and a 40° angle, the third angle must be 50°.

FIG. 351

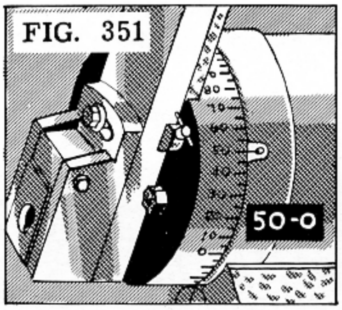
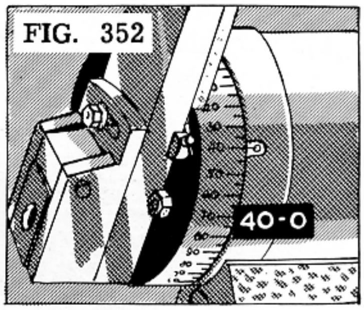


FIG. 352



The angle to which the head must be swiveled from the vertical position to make an angular cut of 130° (Fig. 353) is 40°. If the head is graduated as in Fig. 346, the reading will be 50°, or the complement of 40°. Other methods may be used to compute the angle at which to set the tool head. However, the principles described cover most cases.

SUMMARY

The following steps should be followed to find the angle at which the head must be swiveled:

1. Determine the angle to which the tool head must be swiveled from the vertical position.

2. If the angle is not given, either form a triangle or make use of the principle of opposite, corresponding, or complementary angles.

3. Swivel the head the desired number of degrees, starting from the vertical position. Read direct if the head is graduated as shown in Fig. 345. Set the head at the complement of the desired angle if the head is graduated as illustrated in Fig. 346.

FIG. 353

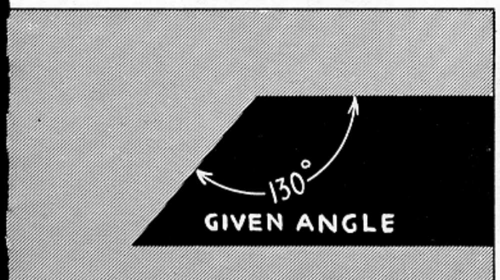


FIG. 354

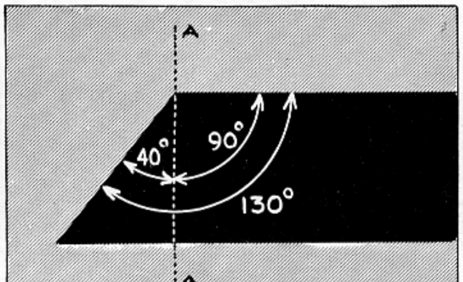
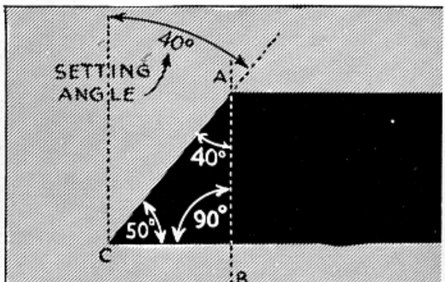


FIG. 355



There is another method of arranging the work in the machine which depends upon the angular setting of the vise to produce an angular surface.

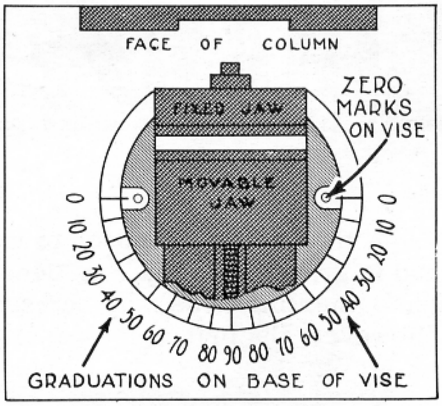


FIG. 356

The graduations on the base of the vise are arranged as in Fig. 356 so that when the jaws are set parallel with the column of the shaper, the two zero marks on the vise coincide with the two zero graduations on the base. This may be used as a starting position from which the vise may be swung either to the left or to the right for angular cutting. The angle at which the vise must be set depends upon the angular relation of the required angle to the stroke. In other words, the angle that the cut makes with the direction of the stroke is the angle at which the vise is set.

For example, the job represented in Fig. 357 has an angular cut at 30°. Assume that the work is in the vise in the position shown and the vise at the zero position (Fig. 356). By swiveling the vise 30° to the left as illustrated in Fig. 357, the work then will be in a position for the tool to take an angular cut of 30° as indicated.

The angle that the cut makes with the direction of the stroke is not always shown on the drawing. The angle may be indicated as 60° in the manner shown in Fig. 358. It is obvious that the cut makes an angle of 30° with the direction of the stroke.

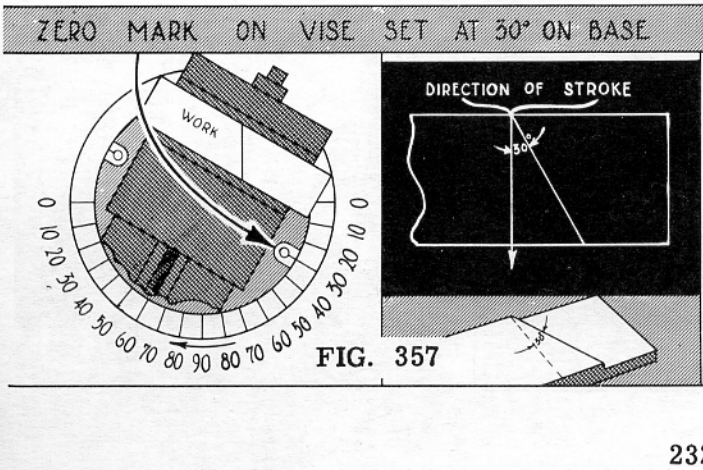


FIG. 357

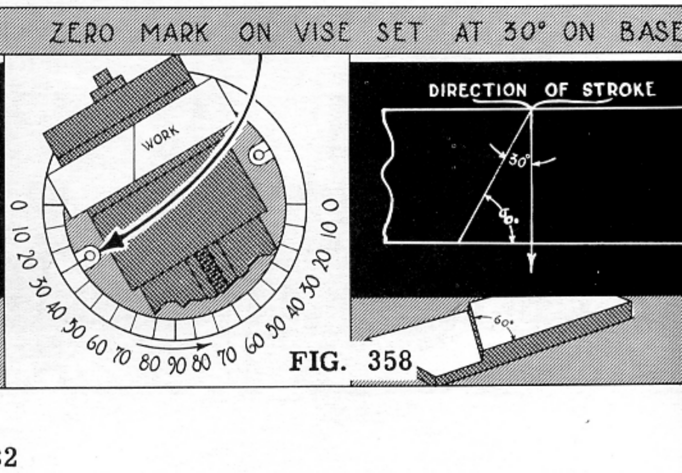


FIG. 358

In the diagram (Fig. 358), if a line is drawn representing the direction of the stroke, it will form a right triangle. The edge of the cut is the second side; the edge of the work is the base. Since the triangle now contains a 90° and a 60° angle, the third must be 30°.

$$(90^\circ + 60^\circ = 150^\circ \text{ and } 180^\circ - 150^\circ = 30^\circ)$$

The vise then is swiveled 30° to the right. The following rule can be used to determine in which direction to swivel the vise. Whenever the edge of the cut slopes from left to right from the vertical position (Fig. 357), the vise must be swiveled to the left. Oppositely, whenever the edge of the cut slopes from the right to the left of the vertical position (Fig. 358), the vise must be swiveled to the right.

Another method of indicating the angle of the cut is shown in Fig. 359. The given angle is 50°. If a line is imagined or drawn to represent the direction of the stroke, it makes an angle of 90° (a right angle) with the side of the work. By subtracting the given angle of 50° from 90°, the angle at which to set the vise is 40°. These angles are also called complementary angles because the two angles are equal to 90°. One is the complement of the other. If one is known, the other is determined by subtracting the value of the known angle from 90°.

One other example is given in Fig. 360. The given angle is 110°. If the same procedure is followed — that of imagining or drawing a line to represent the direction of the stroke — it can be readily seen that the line makes a 90° angle with the side of the work. Subtracting 90° from 110° leaves 20°, which is the angle the cut makes

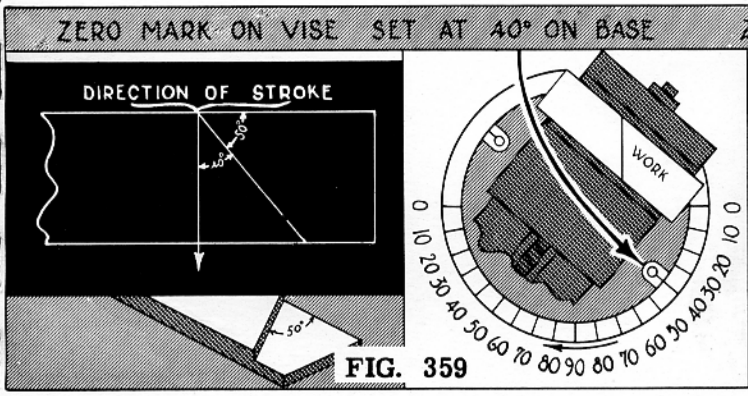


FIG. 359

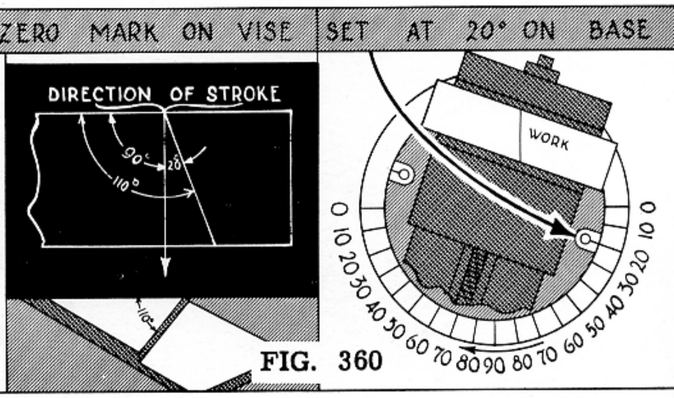


FIG. 360

with the direction of the stroke and is the angle at which to set the vise.

Two conditions are encountered: either the angle that the cut makes with the stroke is given on the drawing and no calculations are necessary; or the angle that the cut makes with the sides of the work is shown and a few simple calculations must be made.

SUMMARY

When the angle given on the drawing represents the angle that the cut makes with the stroke, the vise is set at the given angle.

When the given angle is the angle that the cut makes with one of the sides of the work, one of the following steps should be used.

1. Draw or use an imaginary line to represent the direction of the stroke (Fig. 358). This will form a 90° triangle with the given angle as one of the angles in the triangle. Since the three angles of a triangle are equal to 180°, the third angle is found by subtracting the given angle and the right angle (90°) from 180°.

2. If the angle is given, subtract the given angle from 90° and the answer will be the angle at which to set the vise.

3. When the angle is greater than 90°, subtract the 90° angle from the given angle. The answer is the required angle.

HOW TO PLANE ANGULAR SURFACES

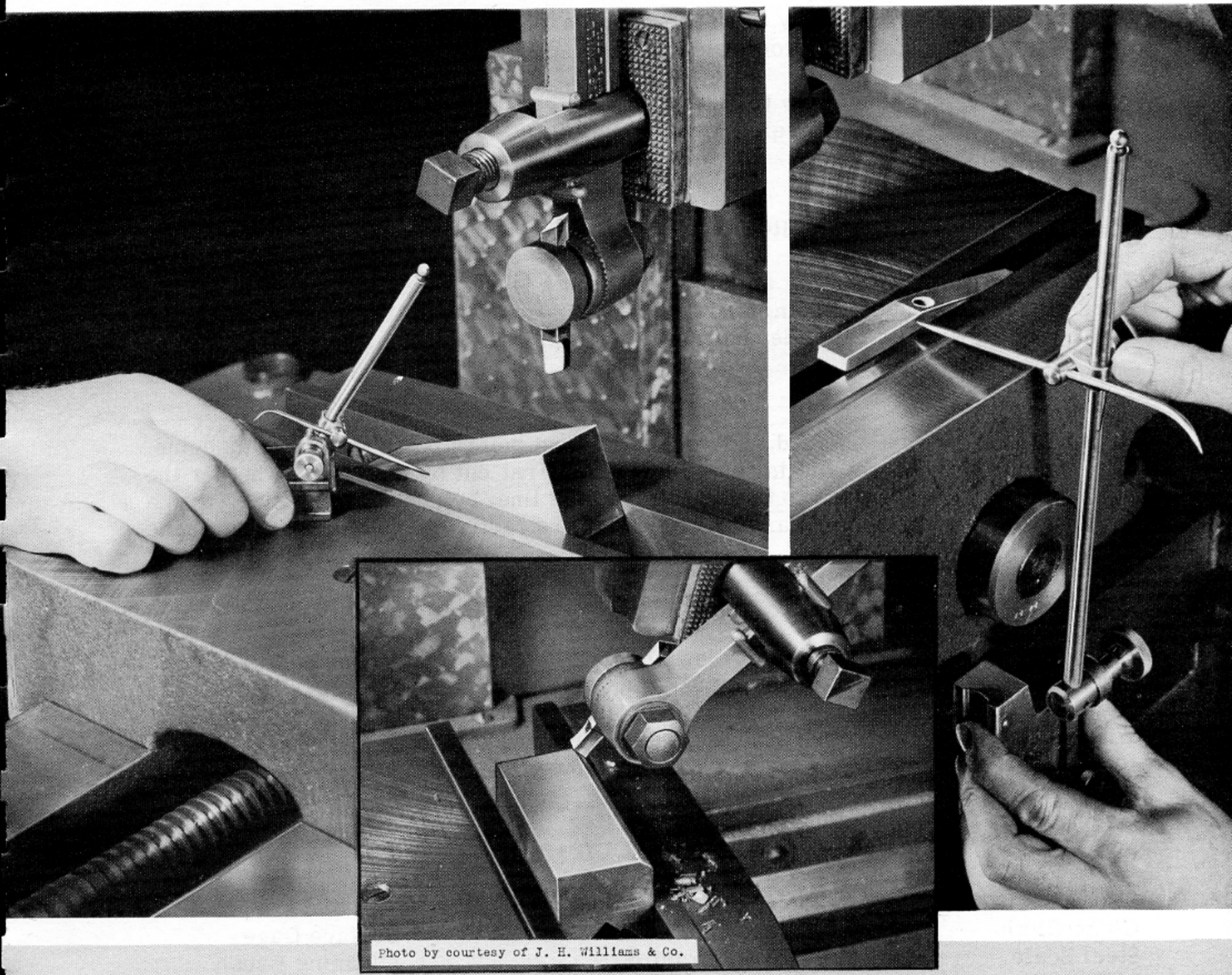


Photo by courtesy of J. H. Williams & Co.

UNIT P 53 (B)

Parts I, II, III Pages 235 - 258

HOW TO PLANE ANGULAR SURFACES *when Work is set with the Surface Gage —*

OBJECTIVES OF UNIT

1. To show how to shape an angular surface when the work is held at an angle in the vise.

2. To show how to take an angular cut when the cutting edge of the tool is set at an angle.

3. To show how to cut an angular surface when the tool head is swiveled at an angle.

INTRODUCTORY INFORMATION

Three methods of producing angular surfaces are explained in this unit: (1) the work is set to produce the angle; (2) the tool is set to form the angle; and (3) the tool head is swiveled to guide the tool in an angular direction.

Regardless of the method used, the work is laid out before being set in the machine. The accuracy of the setting is tested after the first cut by observing whether the surface has been machined to the layout or guide line, by checking the sizes with a scale, or by testing the angular surface with a protractor which has been set at the correct angle.

Whenever duplicate parts are made in quantity, a gage may be made and used to test the angular surfaces. The use of a gage will save time spent in laying out the work, eliminate errors in angular calculations, and insure uniformity of product. When greater accuracy is required for checking the angular surfaces, other precision tools and methods requiring mathematical computations are used.

TOOLS AND EQUIPMENT

Shaper
Clean Cloth
Steel Scale
Indicator
Oil Stone
Tool Bits
Soft Mallet
Tool Holders

Universal Protractor
Bevel Protractor
Taper Parallels
Degree Parallels
Parallel Blocks
Strips of Tissue Paper
Heavy Paper or Cardboard

Pad and Pencil
Surface Gage
Cleaning Brush
Fine-cut File
Magnifying Glass
Coolant and Brush
Necessary Wrenches
Necessary Blueprints

PROCEDURE

HOW TO SET UP THE WORK TO A GUIDE LINE

1. Clean the table and mount the vise.

2. Set the vise at 90° to the direction of the stroke. The zero mark on the vise will coincide with the 0° graduation on the base (Fig. 361).

3. Clean the vise thoroughly. First use a brush and then a clean cloth.

4. Remove any burrs from the vise jaws with an abrasive stone or fine file. A file will remove the burrs unless the jaws are hard. Then an oil stone should be used. Extremely hard jaws often chip instead of forming burrs.

5. Place pieces of paper or strips of cardboard (Fig. 361) between the vise jaws and the sides of the work if the work surfaces are rough to prevent damage to the jaws. The vise jaws should be checked constantly and kept in good condition.

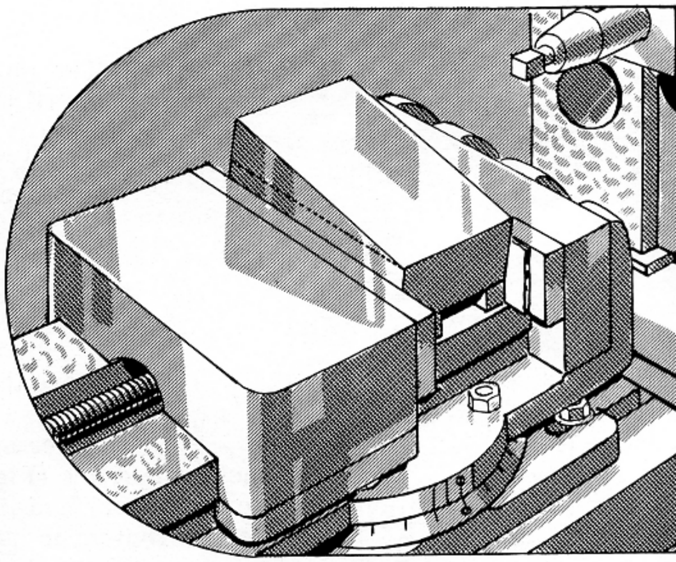


FIG. 361

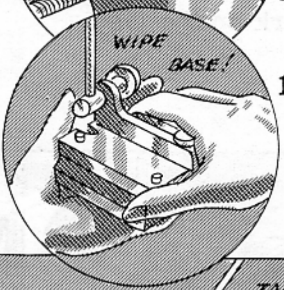
6. Place the work in the vise and hold it with one hand so that the scribed guide line lies approximately parallel with the top of the vise (Fig. 361).

7. Tighten the vise to hold the work in position and at the same time permit the work to be adjusted.

8. Support the work temporarily if the work is heavy until the jaws grip the work sufficiently to hold it in place.

9. Use the machined surface on top of the movable jaw as a base for the surface gage, or use the shaper table as a leveling surface.

NOTE: The single-screw vise usually has a machined surface on the top of the movable jaw which may be used to support the surface gage to level the work in the vise (Fig. 362). If the vise has a double screw or does not have a finished surface upon which to rest the surface gage, the table may be used as a leveling surface.



10. Clean the surface of the vise or table and the bottom of the surface gage with a clean cloth.

11. Wipe the palm of the hand over the surface of the vise or table and under the bottom of the surface gage to remove any small particles of grit.

CAUTION The palm of the hand acts like a soft pad when small particles of grit have to be removed. Care should be exercised that no small chips are on the surface that is being cleaned for they may cut the flesh and cause infection or injury.

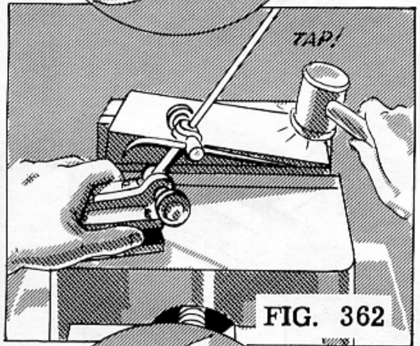
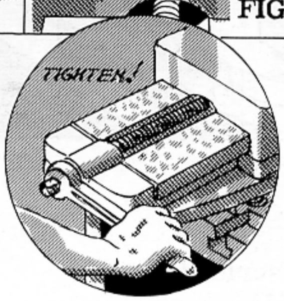


FIG. 362

12. Adjust the point of the surface gage scriber to correspond with one end of the scribed line on the work (Fig. 362).

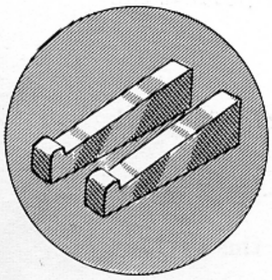
13. Move the scriber point to the other end of the layout line. Tap the high side of the work until the point of the scriber corresponds at each end of the work with the scribed line (Fig. 362). In other words, the surface gage is used to set the scribed line parallel with the surface of the table. It is more convenient to use the top of the movable jaw to support the surface gage than to have the base of the surface gage supported on the table.



14. Tighten the vise securely; then recheck for accuracy of setting.

HOW TO SET UP THE WORK ON TAPERED PARALLELS

FIG. 363



NOTE: If there are a number of pieces to be machined at some specific angle, tapered parallels machined at the desired angle to hold the work may be used (Fig. 363).

1. Check the vise, work, and parallels to be sure they are clean and free of burrs.

2. Place the parallels in the vise and the work on the parallels. Use

protecting strips of heavy paper or cardboard between the jaws of the vise and the sides of rough surfaces.

3. Tighten the vise securely.

4. Seat the work on the parallels with a soft faced hammer. The tap must be solid enough to seat the work on the parallels but not too heavy to cause the work to rebound from the parallels.

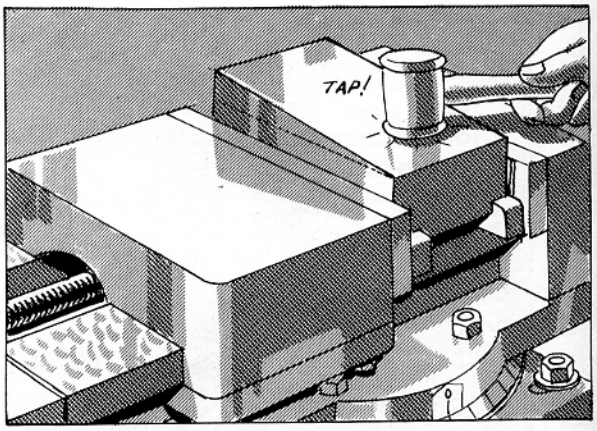


FIG. 364

NOTE: The parallels may be made without the shoulder (Fig. 365). However, the shoulder prevents the parallels from slipping when the work is seated with a mallet.

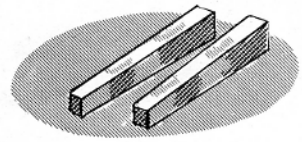


FIG. 365

HOW TO SET UP THE WORK WITH DEGREE PARALLELS

1. Check the work, vise and parallels for cleanliness and burrs.

2. Place the parallels in the vise and the work between the parallels (Fig. 366). Use protecting strips of soft metal or paper between the vise, parallels, and work.

3. Tighten the vise securely.

4. Tap the work down with a soft faced hammer to position.

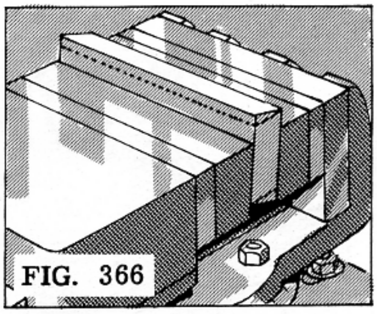


FIG. 366

HOW TO SET THE TOOL WHEN THE WORK IS SET TO A SCRIBED LINE

1. Loosen the nut on the apron and move the clapper box to the right. This will allow the clapper box to swing the tool away from the work.

2. Position the tool slide so that when the tool is moved down to the finished size,there will not be more than one inch overhang of the tool slide (Fig. 368).

3. Measure with a scale (Fig. 369) the material to be removed.

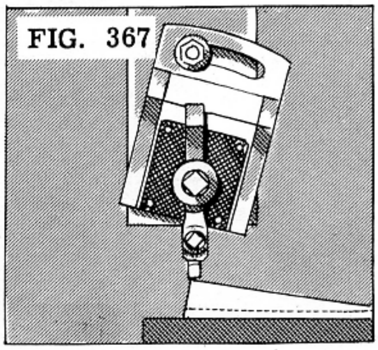


FIG. 367

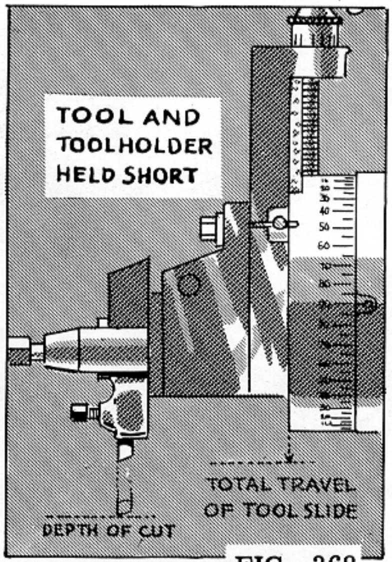
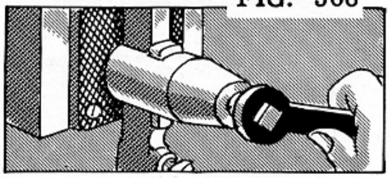


FIG. 368



4. Raise the tool slide above the bottom edge of the swivel block about one inch less than the measured depth of the material to be cut.

5. Select a straight shank tool holder.

6. Select a cutting tool to fit the tool holder and ground for the kind of material in the job (cast iron, steel, etc.), the operation, and the direction of feed.

7. Set the tool holder in the tool post in a vertical position with as little overhang as possible (Fig. 368).

8. Tighten the tool post screw securely. This will hold the tool holder securely in place.

9. Hold the tool short in the tool holder (Fig. 368) and tighten the tool holder set screw to hold the tool in place.

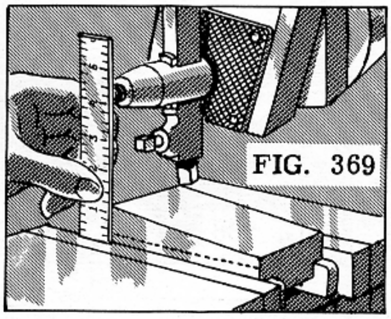


FIG. 369

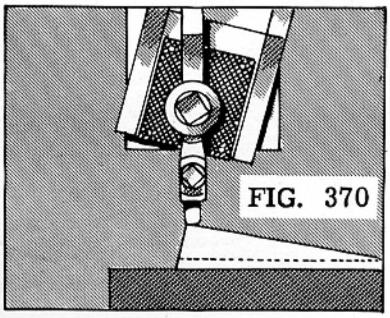


FIG. 370

HOW TO SET THE SHAPER PRIOR TO TAKING THE CUT

1. Move the table horizontally until the work is under the tool (Fig. 370).

2. Loosen the clamps on the cross rail and adjust the table vertically until the work just touches the tool (Fig. 370).

3. Tighten the clamps on the cross rail and adjust the table support.

4. Adjust the ram for a stroke of about three-quarters of an inch longer than the length of the surface to be machined (Fig. 371).

5. Position the ram so that the tool will extend about one-quarter inch beyond the work when it is at the extreme forward position (Fig. 371).

6. Move the ram to the extreme end of the return stroke. There should be just enough clearance for the tool to drop clear of the work for the next cut (Fig. 371).

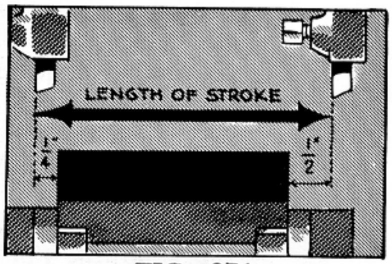
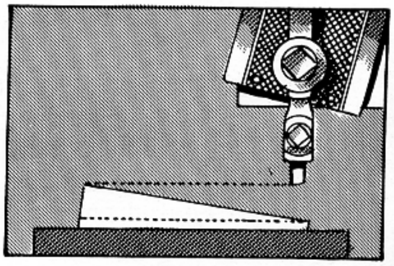


FIG. 371

7. Set the speed of the ram for the material and operation. Refer to page 299 for methods of calculating speeds.

8. Set the feed for 1/32" (31 thousandths), using judgment as to whether or not the feed should be increased for roughing cuts or decreased. (Refer to page 304 for feed selections.)

9. Start the machine and move the tool down with the down-feed handle until the tool touches the high point of the work (Fig. 370).



10. Stop the machine and move the work to the left of the tool (Fig. 372) for the start of the cut.

11. Set the graduated dial on the down-feed screw at zero.

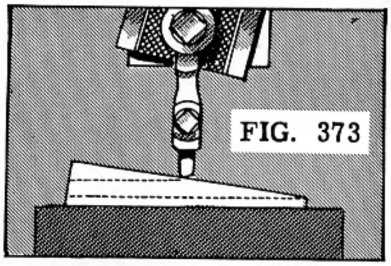


FIG. 373

12. Set the cut for 1/4" (250 thousandths) on the graduated dial. The depth of the cut may be increased or decreased consistent with the power of the machine, the rigidity of the work and the amount of material to be removed.

CAUTION The student should have the instructor check the setting of the work and the adjustment of the shaper before starting the cutting operation.

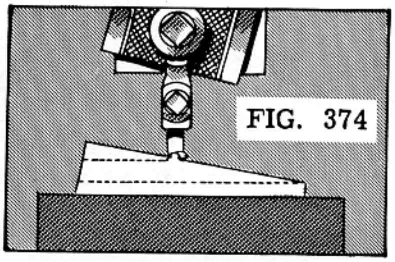


FIG. 374

THE ROUGHING CUT

1. Start the machine and move the work until the tool touches the work (Fig. 374).

2. Engage the feed mechanism.

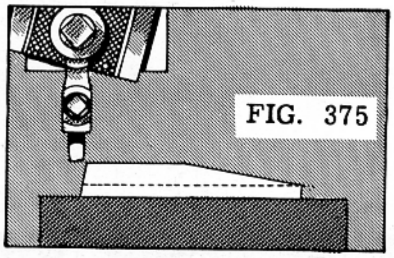


FIG. 375

3. Check the performance of the cutting tool and shaper. Use judgment as to whether or not the feed and depth of cut can be increased. These are roughing cuts and the purpose is to remove metal as quickly as possible.

4. Disengage the feed at the end of the cut (Fig. 375).

5. Move the work again to the starting position to the left of the tool. Set the tool for another cut. Engage the feed. Start the machine and take the cut.

6. Continue to take a series of cuts, but be certain to leave from 1/32" to 1/6" of metal to be removed by the finish cut. The amount that should be left for finishing can be estimated after observing the condition of the surface left by the roughing cut.

7. Stop the machine after the work has been roughed out.

THE FINISHING CUT

1. Remove the cutting tool from the tool holder.

2. Regrind and stone the edge of the tool, or use a finishing tool.

3. Start the machine.

4. Move the work over with the cross-feed screw until the work is under the tool (Fig. 376).

5. Move the cutting tool down with the down-feed handle until the tool just touches the work (Fig. 377).

6. Move the work clear of the cutting tool (Fig. 378).

7. Move the tool down the estimated depth of the finishing cut.

8. Feed the work carefully by hand with the cross-feed screw. Allow the tool to cut far enough along the work to observe the full depth of the cut (Fig. 379).

NOTE: Extreme care should be used in setting the cutting tool for the finish cut. If the cut is too deep, one edge of the work will be machined undersize and the job may be spoiled.

FIG. 376

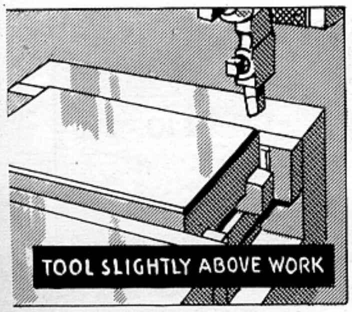


FIG. 377

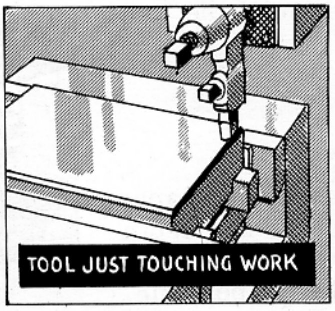


FIG. 378

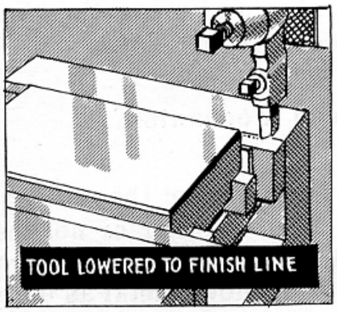
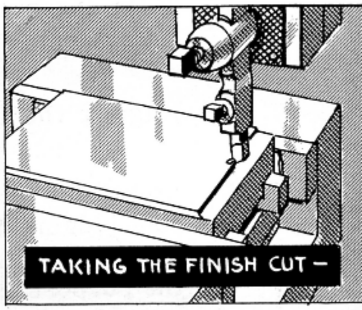


FIG. 379



9. Increase the depth of cut if the cut is not deep enough. When the setting is correct, engage the feed. Note: If the tool is brought down too far, raise the tool slightly, take the back lash out and reset for depth of finish cut.

10. Place a little cutting lubricant on the surface with a brush to improve the finish.

11. Stop the feed and shut off the machine when the cut is finished.

12. Remove the work from the vise. Then remove the burrs with a fine or mill file.

13. Clean the vise and the table, and return all tools to their proper places.

HOW TO CHAMFER A SURFACE *when Tool is set at an Angle —*

HOW TO SET THE WORK IN THE VISE

1. Mount the vise and secure to the table.

2. Set the vise parallel with the direction of the stroke (Fig. 380). The zero mark on the vise will coincide with the 90° graduation on the base.

3. Clean the vise thoroughly. First use a brush and then follow with a clean cloth.

4. Examine the vise jaws for burrs. If burrs are present, remove them with a file if the jaws are soft, or with an abrasive if the jaws are hard.

5. Select two parallel blocks that will hold the work at the correct height in the vise. The work must be positioned as low as possible in the jaws to hold the work securely, but high enough to allow the tool to cut without interference.

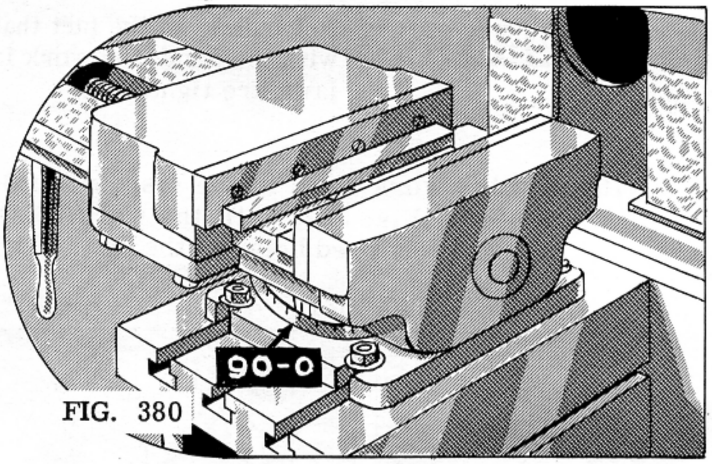


FIG. 380

6. Clean the parallels thoroughly and place them in the vise parallel with the jaws. (Fig. 380).

NOTE: The finished surfaces of work, parallels, and vise jaws must be protected against injury caused by their coming into contact with rough or irregular surfaces. Castings and work with rough surfaces should have a protecting strip of cardboard or soft metal between the vise jaws and the work. If the surfaces of the work are finished, strips of heavy paper should be placed between the jaws of the vise and the work.

Likewise, strips of cardboard or thin soft metal strips of equal thickness should be placed on top of the parallels to protect them from rough and irregular surfaces. When the work has a finished surface, tissue paper may be placed between the top of the parallels and the work. These pieces can also be used to test the work when it is being seated on the parallels. On jobs that do not require accurate machining, no protecting strips or pieces of paper for testing are used between surfaces. The surfaces are cleaned thoroughly, clamped in the vise and tapped down on the parallels.

7. Put strips of tissue paper on the parallels (Fig. 381). Lay the work centrally in the vise and upon the parallels. This central position of the work will equalize the pressure against the jaws when they are tightened.

8. Place strips of paper between the vise jaws and the sides of the work.

9. Hold the work down with one hand, and clamp the work securely in the vise.

CAUTION Regardless of the fact that the work is held down on the parallels with the hand, the work is usually raised slightly when the vise jaws are tightened.

10. Tap the work down in the vise with a lead or rawhide mallet or plastic tip hammer (Fig. 382) until the work is seated accurately and pieces of tissue paper are gripped between the bottom of the work and the top of the parallels.

FIG. 381

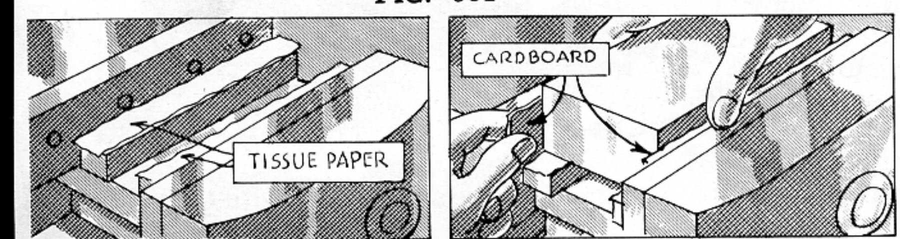
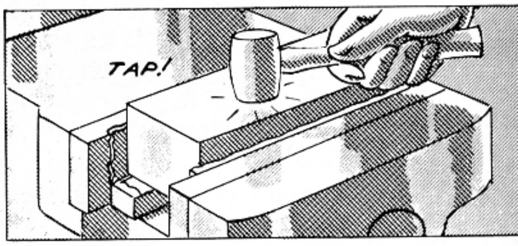


FIG. 382



CAUTION The tap with the mallet must be solid to seat the work on the parallels, but not heavy enough to cause the work to rebound or spring away from the parallels.

HOW TO SET A SQUARE-NOSED TOOL AND ADJUST THE SHAPER PRIOR TO OPERATING

1. Select a tool-holder that can be set with the cutting edge of the tool behind the point of support as, for example, the square nose tool shown in Figure 382. For a side-cutting tool, use an ordinary holder (Fig. 384).

   CAUTION When a wide cut is taken and the cutting tool is set ahead of the support, tremendous pressure is built up during the cutting action because of the downward spring of the tool.

   When a tool is set with the cutting edge behind the point of support, the tool swings away from the work, the pressure is released, and the cutting action is smoother. However, when the side of the tool is cutting (Fig. 384), the tendency of the tool is to spring sideways and, although the tool is set ahead of the point of support, there is not the same tendency to dig in as with the square-nose tool.

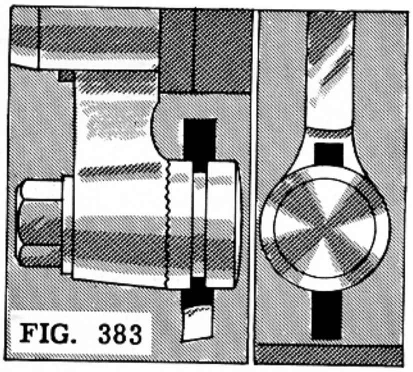


FIG. 383

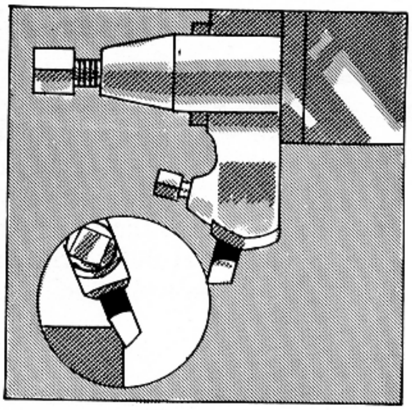


FIG. 384

2. Adjust the bottom of the tool slide until it is even with the bottom of the swivel block (Fig. 385).

3. Hold the tool in the tool holder so that the cutting edge of the tool will be held behind the point of support (Fig. 385).

4. Have the tool project about 1/2" to 3/4" beyond the tool holder. "Hold the tool short." Tighten the tool in the tool holder with the fingers.

5. Place the tool holder in the tool post in a vertical position and have it project below the clapper box as little as the tool and job will permit.

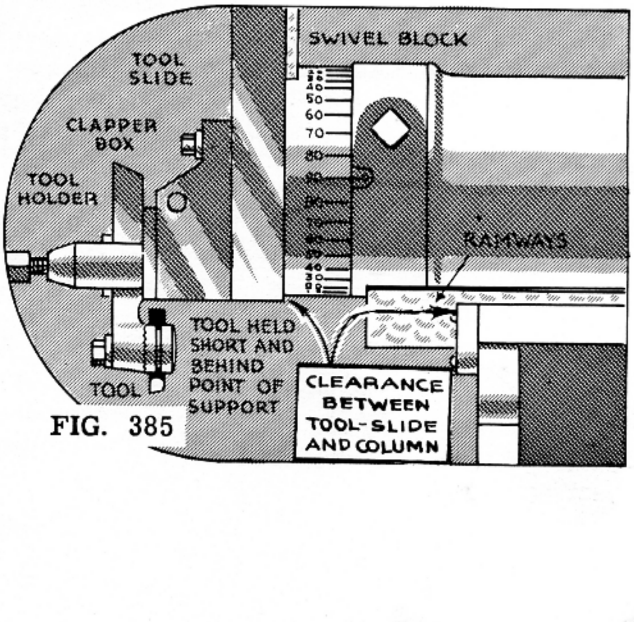


FIG. 385

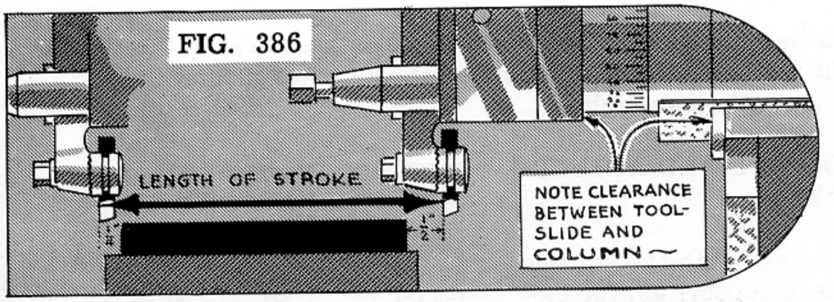


FIG. 386

6. Tighten the tool holder in the tool post securely.

7. Tighten the cutting tool in the tool holder.

8. Set the stroke of the shaper 3/4" to 1" longer than the length of the surface to be machined (Fig. 386).

9. Position the ram so that the tool extends about 1/4" beyond the work when it is at the forward position (Fig. 386).

NOTE: The setting of the tool for cutting an angular surface will depend upon the accuracy of machining that is required. When an angular cut is made by this method,it is usually approximate. The tool is set to break or chamfer the edge as a safety feature; the cut may be made to improve the appearance or to provide clearance. If the corner of the work has been laid out, the tool may be set to the scribed line. The head may be set vertically or swiveled up to an angle of 90° to the angular surface to be machined. In this setup, the tool head will be swiveled.

10. Move the ram to the beginning of the stroke and check to see whether or not the head will clear the column when it is swiveled (Fig. 386).

CAUTION The shaper is designed so that the tool head will pass between the two ram ways when the head is in the vertical position. When the head is swiveled, care must be used to see that the tool head does not strike the column on the return stroke.

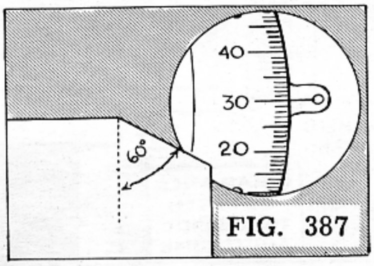


FIG. 387

11. Swivel the tool head, for example, 30° to the right of the vertical position, assuming that the angle to be cut is indicated as 60° (Figs. 387 and 390).

NOTE: The head is swiveled to this position because it provides a better direction in which to feed the tool. The accuracy of the angular cut will depend upon the correct alignment of the cutting edge of the tool with the scribed line on the work or with the blade of a protractor.

12. Move the ram and the tool to the forward position.

13. Move the table until the work is under the tool (Fig. 388).

14. Loosen the cross-rail and raise the table (Fig. 388) if there is too much space between the bottom of the tool and the top of the work. Be sure that the cross rail is clamped and the table is properly supported after the height of the table has been adjusted.

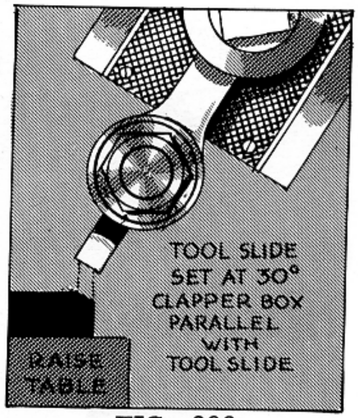


FIG. 388

NOTE: If the space between the bottom of the tool and the top of the work is excessive and the tool slide is moved down instead of the table being raised, the tool slide will overhang too much.

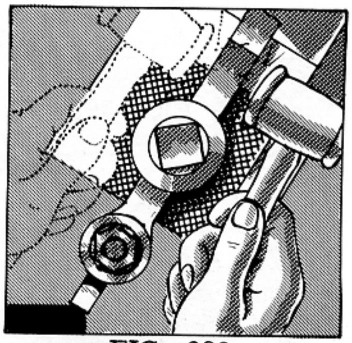


FIG. 389

15. Secure the tool holder in such a position that the cutting edge of the tool is approximately in line with the scribed line on the surface of the work.

16. Adjust the tool holder by loosening the tool post screw slightly and tapping the tool holder to the right or to the left until the cutting edge of the tool is parallel with the scribed line on the work (Fig. 389).

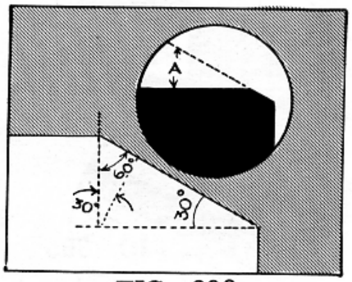


FIG. 390

17. Tighten the tool holder securely when the tool has been adjusted correctly.

NOTE: An alternate method of setting the tool to the correct angle is to use a protractor or gage (Fig. 391). The protractor is set at the angle 'A' which must be determined from the angle given on the drawing, or blueprint. The tool holder is then adjusted until the cutting edge of the tool and the blade of the protractor are parallel.

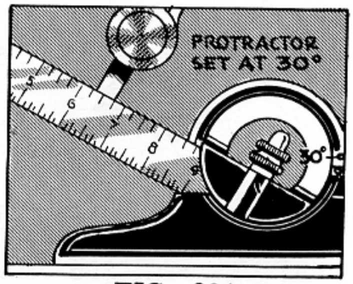


FIG. 391

HOW TO TAKE THE CUT

1. Set the machine for a slow speed.

CAUTION Standard speeds do not apply to broad cuts, and no definite rules are given. The speeds are usually much slower than ordinary cutting speeds. Cuts are taken with the back gears engaged because considerable power is required and a reduced speed will help to eliminate chatter. Start with a slow speed and increase the speed carefully in accordance with the finish required and the type of cut.

2. Adjust the work and the table with the cross-feed hand crank until the tool is above the edge to be cut as shown in Figure 392.

3. Move the tool toward the work with the down-feed crank until the cutting edge of the tool is near the edge of the work (Fig. 393).

CAUTION Be sure there is nothing in the path of the tool, the speed is set correctly, the work is held securely, and all necessary clamps are tightened. This is a good point at which to have the set-up checked by the instructor.

4. Start the machine and move the tool with the down-feed crank until the tool takes a light cut (Fig. 394).

5. Apply a little cutting lubricant to the surface with a brush. This will help preserve the cutting edge of the tool and will produce a smooth surface (Fig. 395). Cast iron is machined dry.

6. Move the tool down to take a cut of fifteen thousandths or more when the tool is at the beginning of the stroke and while the machine is in motion. As the cut gets wider, decrease gradually the amount of feed.

7. Continue feeding the tool toward the surface until the required width of the cut has been reached.

8. Stop the machine.

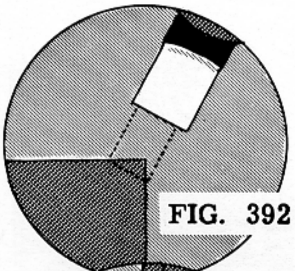


FIG. 392

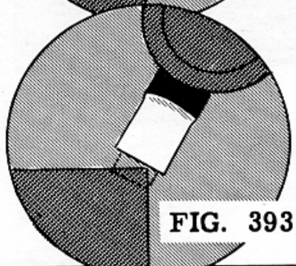


FIG. 393

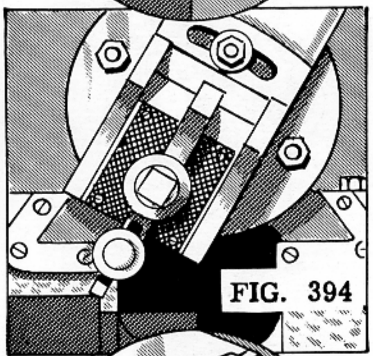


FIG. 394

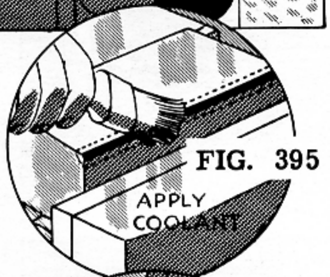


FIG. 395

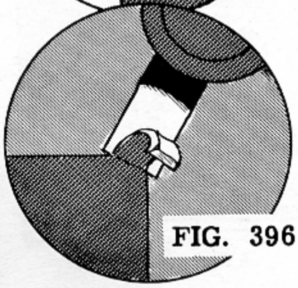


FIG. 396

NOTE: If the work is cast iron, the tool will leave the forward edge of the work broken and rough. To avoid this, file a slight bevel on the corner of the work (Fig. 397). The filed or beveled edge has the effect of gradually diminishing the depth of the cut until no cutting action takes place on the extreme forward edge of the piece (Fig. 398).

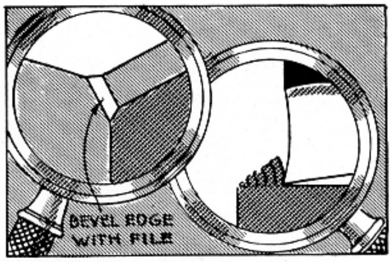
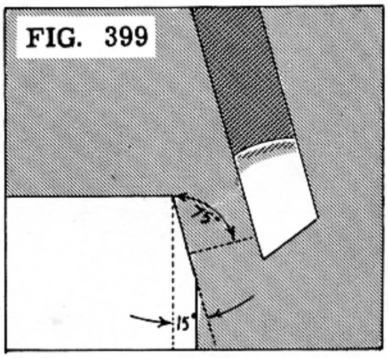


FIG. 397 FIG. 398

HOW TO SET A SIDE-CUTTING TOOL

NOTE: If the angular surface forms a slight angle with the vertical, a side-cutting tool may be used (Fig. 400). For example, if the surface makes a 15° angle with the vertical position, the head would be moved through 75° in order to feed the tool perpendicular to the angular surface (Fig. 399). The head is graduated through only 60° for each side of the vertical position. Therefore, the following set-up is more convenient:

FIG. 399


1. Set the tool head in the vertical position (Fig. 400).

2. Set the clapper box over to the right (Fig. 400).

3. Place the tool holder in the tool post and tighten the tool-post screw securely.

4. Select a side-cutting tool such as the one illustrated in Figure 399.

5. Hold the tool short and tighten it securely in the tool holder (Fig. 400).

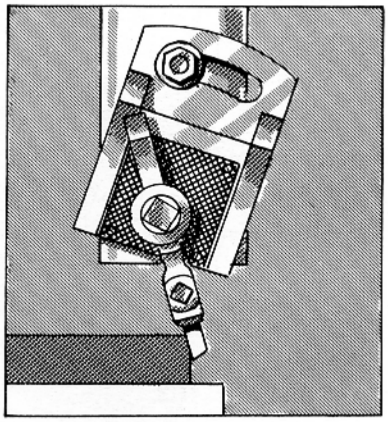


FIG. 400

6. Adjust the length of the stroke so that it will be 3/4" longer than the length of the work.

7. Position the ram so that the cutting edge of the tool is about 1/4" beyond the work when the ram is at the forward position.

NOTE: The tool will be set and moved into position by a series of adjustments. The table will probably have to be adjusted vertically and moved horizontally, and the tool holder set to the correct angle. The adjustments should be continued until the tool is set in the desired position.

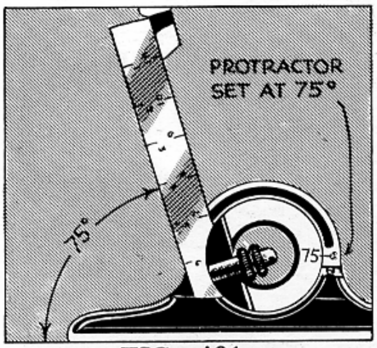


FIG. 401

8. Loosen the tool-post screw and move the tool holder until the cutting edge of the tool is approximately in line with the scribed line, or until the cutting edge coincides with the blade of the protractor set at 75° (Fig. 401).

   NOTE: The tool may be moved vertically downward to the cut, the work may be moved horizontally to the tool, or a combination of both these movements may be used (Fig. 402). If the tool is set in position A, the tool must be moved vertically downward toward the work. If the tool is set in position B, the tool head may be locked and the work must be moved horizontally toward the tool. If the tool is set in position C, a combination of tool and work movements must be made to bring the tool and the work into their proper relation.

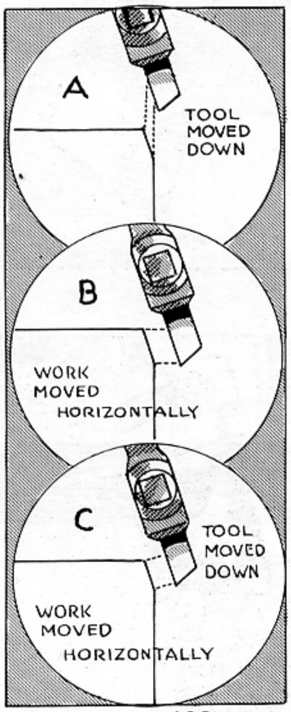


FIG. 402

9. Loosen the rail clamp and adjust the table vertically up or down as may be needed. Tighten the rail clamp when the adjustment has been made.

10. Move the table horizontally if it is necessary to bring the work horizontally nearer to the cutting edge.

11. Check the position of the tool and be sure that the tool head will not overhang too much before the cut has been completed.

12. Engage the back gears and set the machine for a slow speed.

HOW TO TAKE THE CUT WITH A SIDE-CUTTING TOOL

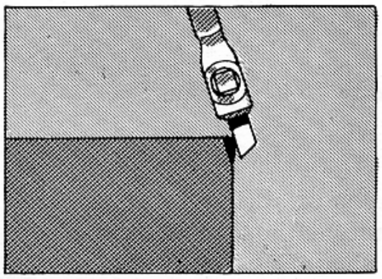


FIG. 403

1. Start the machine and move the tool with the down-feed crank until it just touches the corner of the work (Fig. 403).

2. Apply a little cutting compound to the surface with a brush.

3. Move the tool down about fifteen thousandths while the machine is in motion and when the tool is at the beginning of the stroke (Fig. 404).

4. Decrease the downward movement of the tool to only a few thousandths per cut as the machined surface increases in width. Keep the cut as heavy as possible at all times. However, when the tool is within 1/32" of the finish line, reduce the feed to a few thousandths per stroke.

FIG. 404

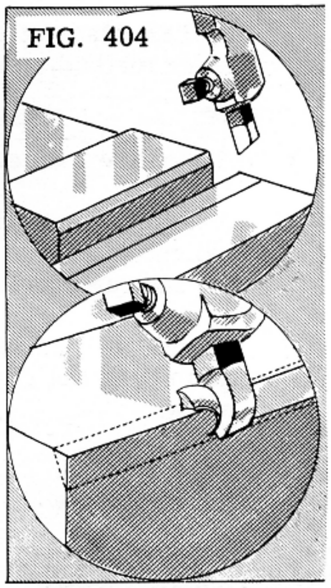


FIG. 405

5. Continue moving the tool downward until the width of the angular surface is correct.

6. Stop the machine, take the work from the vise, and remove the burrs from the work with a fine cut file.

7. Remove the tool holder from the machine, clean all the tools, and put them in their proper places.

8. Clean the vise and the shaper table.

HOW TO PLANE AN ANGULAR SURFACE *when Head is set at an Angle —*

HOW TO MOUNT THE WORK IN THE VISE ON PARALLELS

NOTE: The degree of accuracy required in machining to a desired size and shape influences the procedures to be used. One of three practices may be followed to make certain that the top surface of the work is parallel in the vise: (1) after the work has been leveled on the parallels (if enough metal has been left for finishing), a cut may be taken across the top surface of the work; (2) the work may be finished on the top, and side and then properly seated on the parallels; (3) when greater accuracy is required, the top surface should be leveled with an indicator.

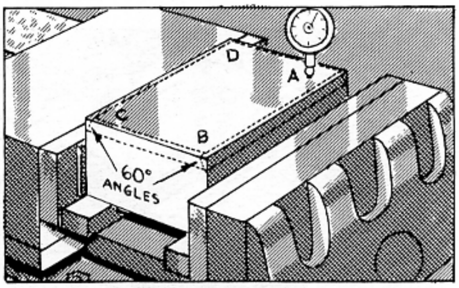


FIG. 406

A. HOW TO LEVEL THE WORK IN THE VISE WITH AN INDICATOR

NOTE: Many of the steps followed to level the vise on the table using the indicator method, are identical for leveling work in the vise.

1. Attach the indicator to the tool holder.

2. Adjust the length of the stroke and position the ram so that the point of the indicator travels within 1/2" of each end of the work. Care must be taken that the indicator point does not ride off the work.

3. Lower the indicator until the pointer registers about ten one-thousandths of an inch on the dial. This will indicate that the point is making contact with the work.

4. Indicate the work at all four points: A, B, C, and D (Fig. 406).

NOTE: As the work has been set down on parallels and leveled in the vise in the previous setting, a shim must be placed underneath any low spot if it is necessary to raise the work at any point.

5. Obtain a shim equal in thickness to the error shown on the dial. Use a micrometer to measure the thickness of the shim.

6. Raise the indicator until the contact point is about 1/2" above the work.

7. Loosen the vise jaws and place the shim underneath the low part of the work and on the top of the parallel block.

8. Tighten the vise jaws and tap the work with a soft faced mallet until all paper shims are tight between the work and the parallels.

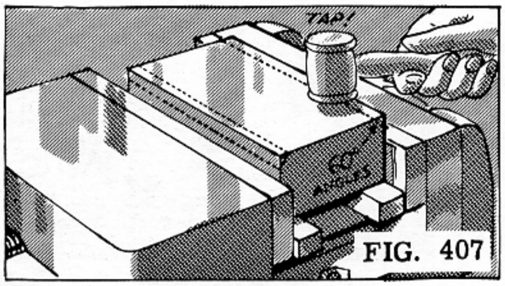


FIG. 407

9. Test the work surface again at all four points and repeat the shimming and testing process until the work is level.

10. Remove the indicator from the tool holder and place it in the proper holder or box to prevent damage.

B. HOW TO SET THE TOOL HEAD

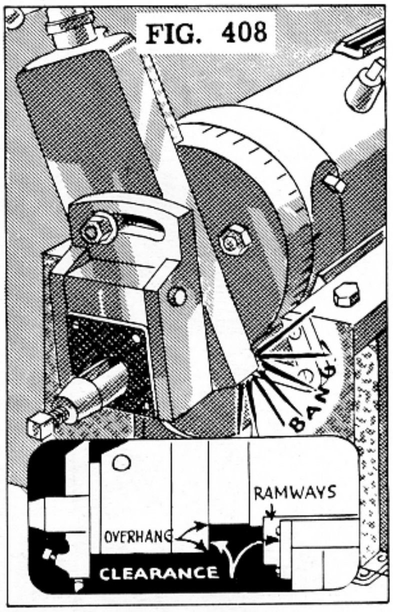


FIG. 408

1. Adjust the stroke of the machine for about 3/4" to 1" longer than the length of the surface to be cut.

2. Move the ram back slowly until it is at the beginning of the stroke. Check to see that the tool head will clear the ram ways when it is swiveled at an angle (Fig. 408).

CAUTION If there is not enough clearance to permit swiveling the head without striking the ram ways, position the ram, or move it forward, until the tool head can be swiveled and there is clearance between the head and the ways. This is an important adjustment to prevent the tool head from striking the ram ways on the return stroke and damaging the head.

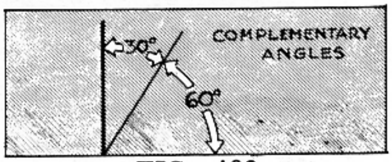


FIG. 409

3. Assume that an angular cut of 60°, is indicated in Fig. 409, must be made.

4. Determine the angle to which the swivel head must be swiveled from the vertical position. This angle is 30°, or the complement of 60°.

NOTE: The operator should check the graduations on the tool head in order to determine the angle to which it should be set.

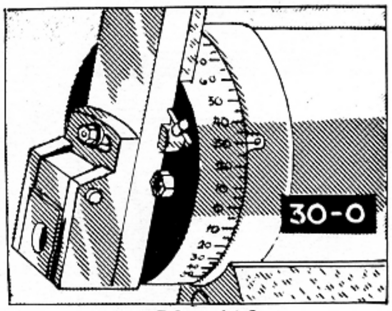


FIG. 410

5. Loosen the locking screws for the tool head, and swivel the head to the right until the 30° graduation coincides with the zero mark on the ram (Fig. 410). This will be the setting if the graduations start with a zero on the swivel head when it is in a vertical position.

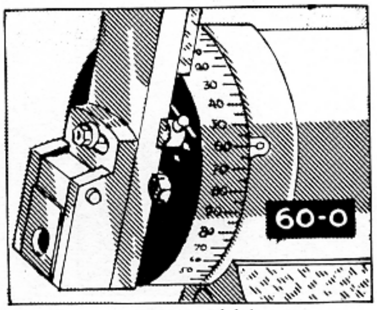


FIG. 411

6. Swivel the head to the right until the 60° graduation on the head coincides with the zero mark on the ram (Fig. 411). This will be the setting if the graduations start with 90° when the swivel head is in a vertical position.

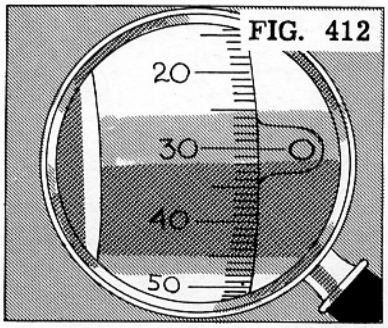


FIG. 412

7. Use a magnifying glass to make certain that the zero mark on the ram coincides exactly with the graduation on the swivel head. The glass magnifies any slight variation in the position of the matching lines, thereby making possible a more accurate adjustment.

8. Tighten the locking nuts securely after the swivel head has been set in position.

NOTE: The head may be set also with a protractor. The protractor is first set at the correct angle and then supported on the movable jaw of the vise, or on parallels supported on the table. The side of the tool slide is then set parallel with the edge of the protractor blade (Fig. 413). This method can be used also to check the angular setting of the head.

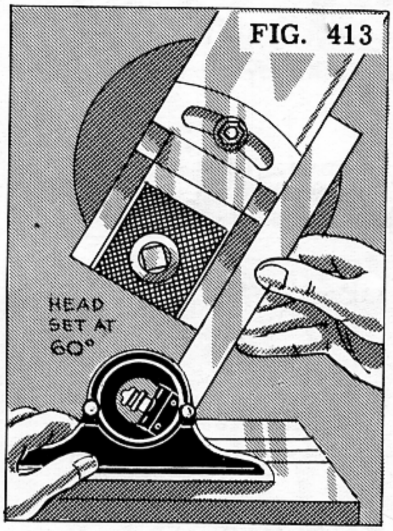


FIG. 413

9. Set the clapper box over to the left as far as possible (Fig. 414). This will allow the tool to swing clear of the work on the return stroke.

C. HOW TO SET THE TOOL AND ADJUST THE SHAPER PRIOR TO OPERATION

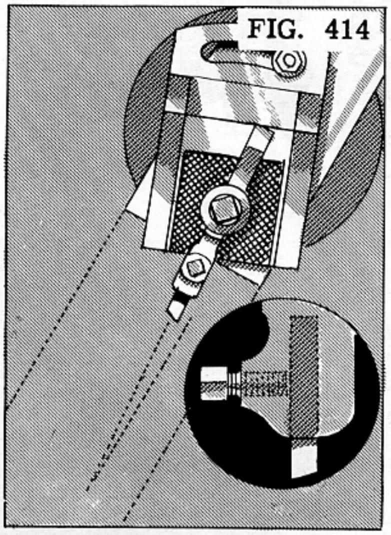


FIG. 414

1. Select a straight shank tool holder. This will hold the tool parallel (horizontal) with the shank of the tool holder, and will allow the tool to be set at a slight angle to the angular surface without interfering with the side of the tool holder (Fig. 414).

2. Place the tool holder in the tool post at a slight angle of about 5° to 10° with the side of the tool slide as shown in Figure 414.

3. Tighten the tool holder in the tool post securely.

4. Move the tool slide down until there is not more than 1" overhang.

5. Select a side cutting tool for the operation at hand.

6. Estimate the distance that the tool must project beyond the holder to permit the tool holder to clear the surface being machined (Fig. 417).

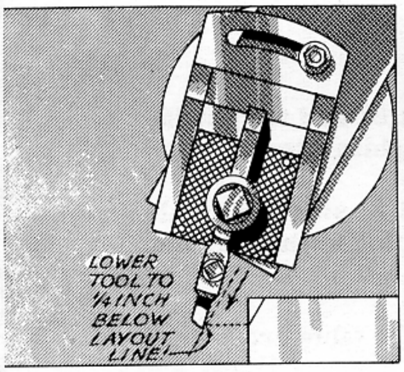


FIG. 415

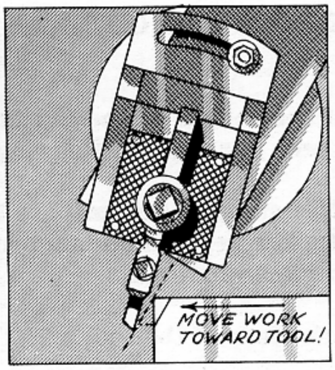


FIG. 416

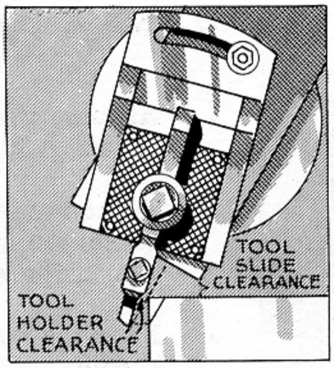


FIG. 417

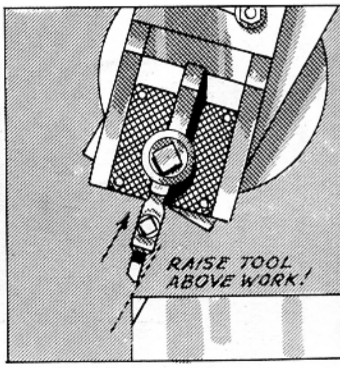


FIG. 418

7. Tighten the tool temporarily in position to permit additional adjustment.

8. Raise or lower the work and the table until the cutting edge of the tool is slightly lower than the bottom edge of the indicated angular cut (Fig. 415).

9. Move the table horizontally until the work is near the tool (Fig. 416).

10. Adjust the tool holder and the tool, if necessary, so that the tool holder will clear the angular surface and the tool slide will clear the work (Fig. 417).

11. Raise the tool slide and make certain that the tool can be moved the full length of the angular cut (Fig. 418).

12. Tighten the tool holder securely in the tool post, and the cutting tool in the tool holder.

13. Check the clamps on the cross rail and be sure that the table supports are adjusted properly.

14. Move the ram to the forward position.

15. Adjust the ram until the cutting edge of the tool clears the forward edge of the work by 1/4".

16. Bring the ram back to the beginning of the stroke. Make sure there is enough clearance at the end of the stroke for the tool to drop clear of the work and be in position for the cutting stroke.

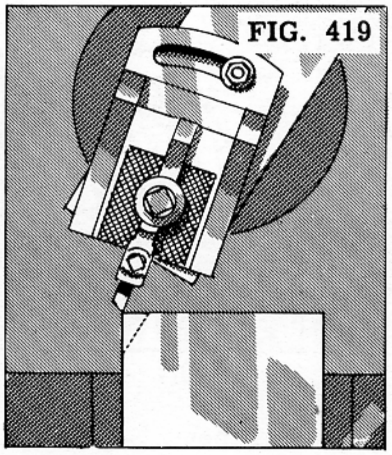


FIG. 419

D. TAKING THE ROUGHING CUT

1. Assume that the length of the cut is 6" and the cutting speed is 80 feet per minute for roughing steel.

2. Determine the strokes per minute by using a formula or set the strokes per minute according to the machine charts for various materials.

3. Move the work clear of the tool with the table cross-feed handle.

4. Start the machine.

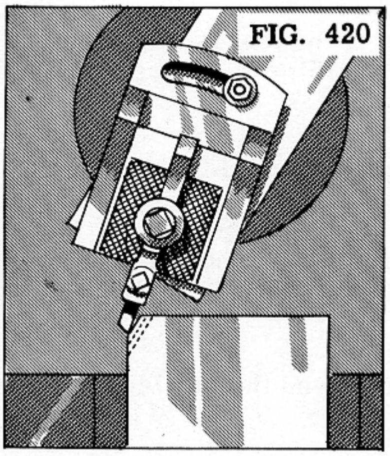


FIG. 420

5. Position the table until the corner of the work is directly below the moving tool (Fig. 419).

6. Feed the tool down with the down-feed crank during the interval when the tool drops clear of the work and before it starts to cut on the forward stroke.

7. Feed the tool down a few thousandths at a time for each cut until the tool stops cutting (Fig. 420).

8. Raise the tool above the work.

9. Move the work toward the tool (Fig. 421) for each successive cut.

10. Continue to take a number of roughing cuts until about 1/32" is left for finishing.

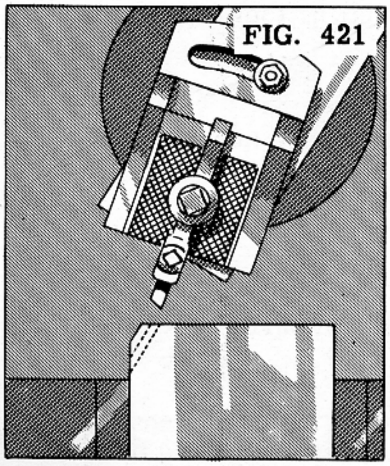


FIG. 421

NOTE: The last of the roughing cuts can be semi-finishing cut and may be used to recheck the angular setting of the tool head.

11. Stop the machine.

12. Check the angular surface of the work with a protractor as shown in Fig. 422.

NOTE: If the angle of the cut is incorrect, the swivel head may be adjusted by first loosening the locking nuts and then tapping the head in the required direction by hand or with a soft mallet.

13. Tighten the locking nuts for the swivel head.

14. Start the machine and take a trial cut.

15. Recheck the angle of the cut until the angular setting of the tool head is correct.

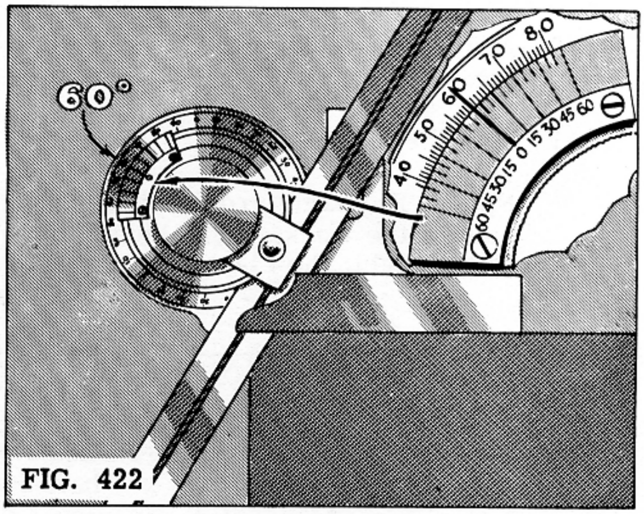


FIG. 422

E. TAKING THE FINISHING CUT

1. Select a tool bit ground for a finishing cut.

2. Stone the cutting edge of the tool to produce a fine finish cut.

3. Remove the roughing tool and replace it with the finishing tool.

4. Adjust the tool and the tool holder so that the tool makes an angle of 5° or less with the angular surface. The practice will provide clearance for the tool holder and tool slide when the tool is at the lower edge of the cut (Fig. 420).

5. Start the machine.

6. Raise the tool and move the work horizontally until the tool just touches the edge of the work (Fig. 423). This will give a starting position.

7. Raise the tool away from the top surface of the work.

8. Move the work over the estimated distance for the finishing cut.

9. Take a trial cut by moving the tool down a few thousandths for each cut until the tool has moved down far enough to show whether or not it is cutting to the line.

   NOTE: As the tool leaves the work, it should split the layout line (Fig. 425). If the tool is not cutting to the line, move the work over slightly. Be careful not to cut below the line.

FIG. 423

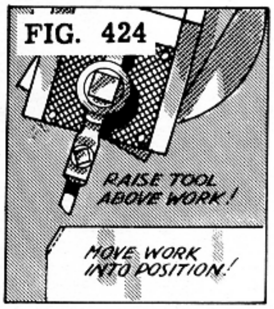
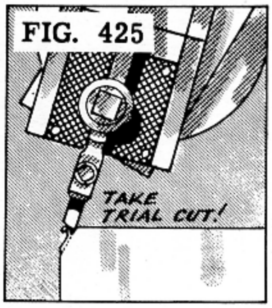

FIG. 424


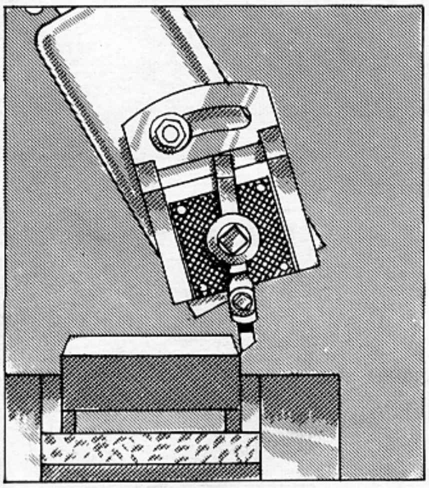
FIG. 425


10. Add a little cutting compound to the surface with a brush, and complete the cut.

11. Stop the machine.

NOTE: The same procedure is used to cut the angular surface on the opposite side of the work. The head, however, will be swiveled to the left instead of to the right; the clapper box will be moved to the right instead of to the left; and a left-cut tool will be used instead of a right-cut tool. Figure 426 shows the correct setting of the head in relation to the angular surface of the work.

FIG. 426



12. Remove the work from the vise after all operations have been completed.

13. File the burrs from the work with a fine file. Clean the work with a cloth.

14. Remove and clean the parallels, remove the tool from the tool holder, and return each part to its proper place.

15. Brush the chips from the vise and table, and with waste, absorb the cutting compound from the vise and the table.