DESCRIPTION OF ANGULAR CUTS

Unit 1-T53(B) Pages 225 to 234

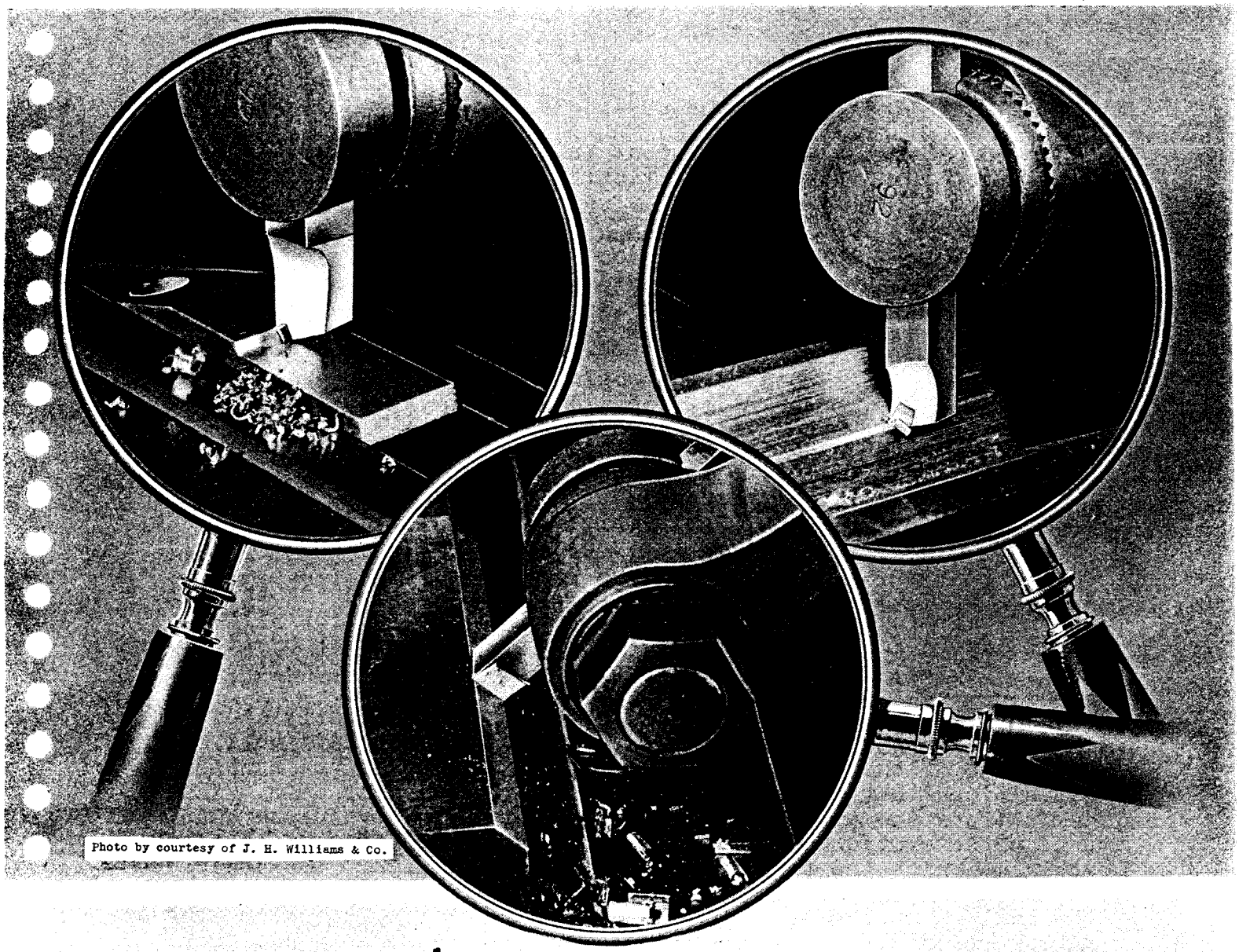


Photo by courtesy of J. H. Williams & Co.

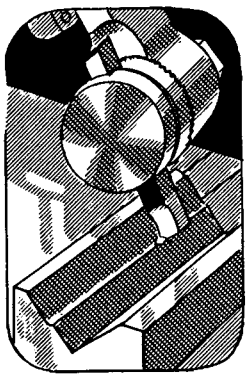
UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
BUREAU OF INDUSTRIAL AND TECHNICAL EDUCATION

DESCRIPTION of ANGULAR CUTS

OBJECTIVES OF UNIT

1. To indicate the various 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 that the head must be swiveled to correspond to the angular surface of the work.

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 the moving tool 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, guided by the tool slide.

As the first two methods depend upon the arrangement of the work and the setting of the tool, more detailed instruction will be given in the following unit (page 237). The setting of the tool head, however, requires some knowledge of angular measurements.

The cutting of angular surfaces, or cuts, is frequently confusing to the beginner. The angles, though, are not difficult to determine if the operator is familiar with some of the simple definitions that are used when dealing with angular cuts. These definitions are easily understood and they are invaluable when used to determine the relationship of the machined surface to the angle at which the tool head must be set. However, 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 is first determined and then the head set to correspond with the angular surface of the work.

Finally, there is one other item to be given attention, and that is the method of graduating the swivel block. Unfortunately for the beginner, there are two methods of graduating the head, both of which are described in this unit. Both methods, however, are easily understood; the only difficulty is that they are different, and this must be taken into consideration.

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 the horizontal and the 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.

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 then made by feeding the tool along the surface with the tool slide after the head has been swiveled to the desired angle (Fig. 328).

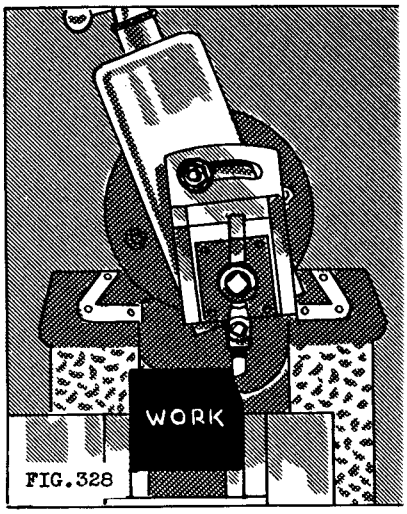
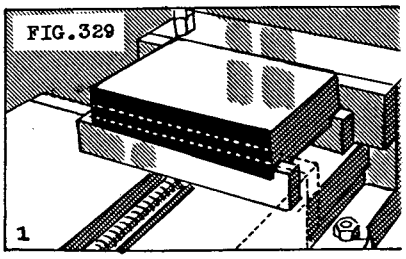


FIG.328

Practically, 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.

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 (page 237).



2. The work can be supported on tapered parallels in the vise and a cut taken across the piece in the usual manner. This method is usually used for slight angles or tapers (Fig. 329).

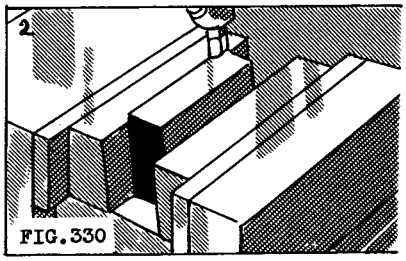
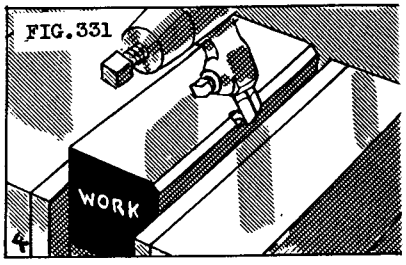
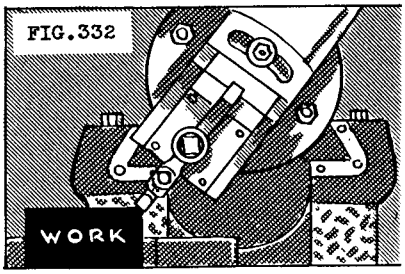


FIG.330

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 cut is formed with the sides of the work (Fig. 330).



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 correctly. When these cuts are comparatively narrow, they are often called chamfers (Figs.331 & 332).



Since the four above methods depend upon the manner

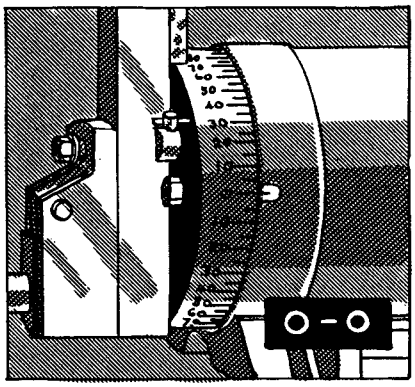


FIG.333

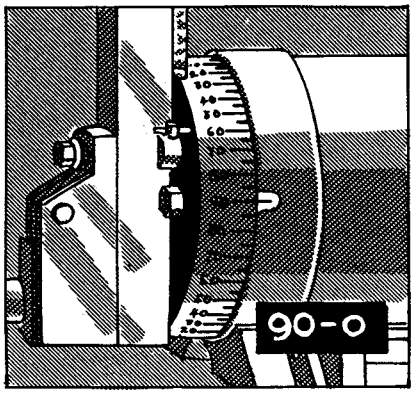


FIG.334

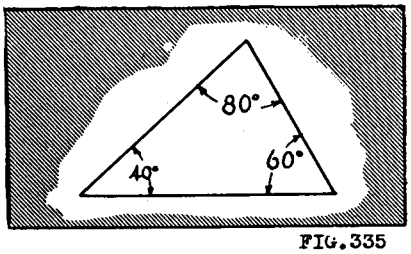


FIG.335

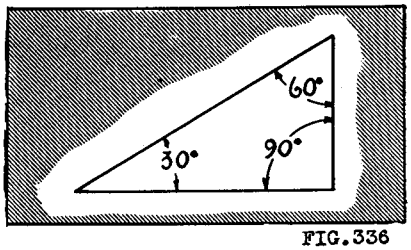


FIG.336

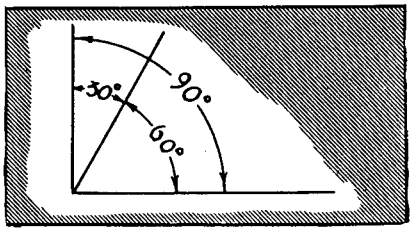


FIG.337

that 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. This is fully described in the next unit.

The setting of the tool head, however, requires some understanding of how the head must be set 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.

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 corresponding with the zero mark 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, of course, must be taken into consideration whenever the head is swiveled in preparation for an angular cut.

As the head will be swiveled either to the right or to the left of the vertical position, the student must first determine the angle that the surface to be machined will make with a line vertical to the work and to the tool head when the head is in a vertical position. This angle can be easily determined if the angular construction of the triangle and the simple principle of opposite, corresponding, and complementary angles are understood.

1. The sum of three angles in a triangle always equals 180° or two 90° angles (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 is easily determined.

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).

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 four angles correspond with the lower four angles.

These principles should be properly understood because they are essential for the proper understanding of angular problems.

A few examples will show the method of finding the angle at which the head must be set.

The job shown in Fig. 340 has a 90° opening. If a line A, Fig. 341, is imagined or 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 being 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; then, 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.

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. Care should be observed, however, because of the two methods of graduating the head.

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,"

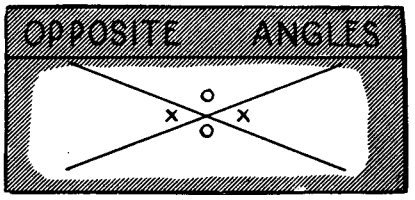


FIG. 338

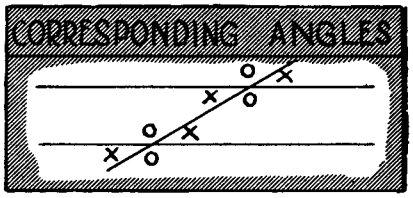


FIG. 339

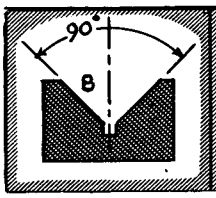


FIG. 340

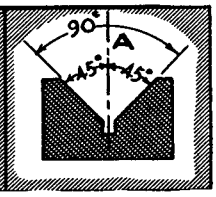


FIG. 341

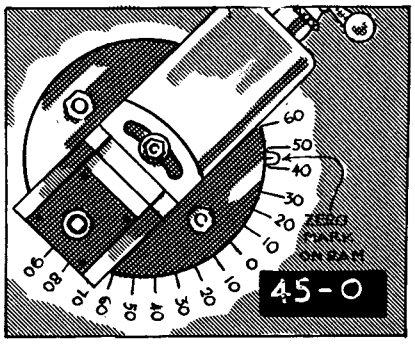


FIG. 342

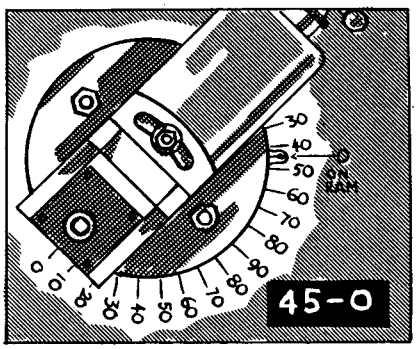


FIG. 343

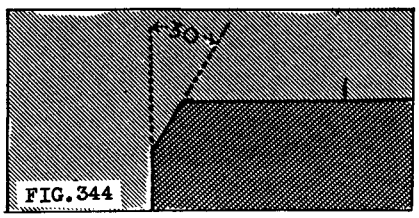


FIG. 344

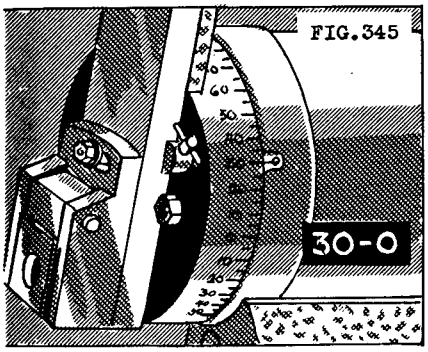


FIG.345

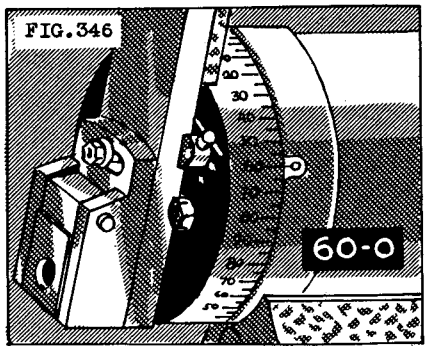


FIG.346

which would be 30° (Fig. 345). "Direct" means that the graduations will be set at the same angle that the angular surface of the work makes with a vertical line.

2. 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). Refer to page 228 for the definition of complementary angles.

If the angle is designated as in Fig. 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 Fig. 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, then, must be 50° because a triangle contains 180°, or two 90° angles. (Refer to page 228 for definition.) 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 is corresponding and equal to the given or upper 40° angle. 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, and it is set at the complement, or 40°, if the graduations are arranged as in Fig. 352.

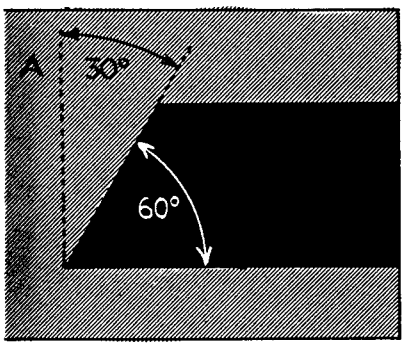


FIG.347

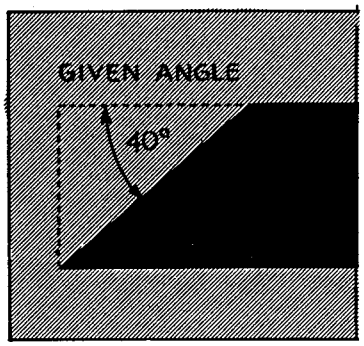


FIG.348

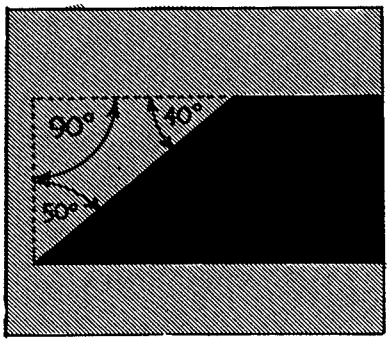


FIG.349

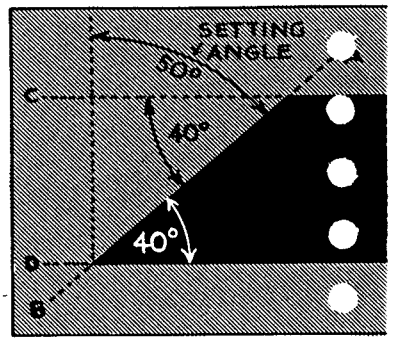


FIG.350

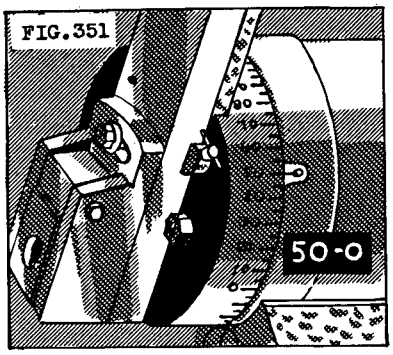


FIG.351

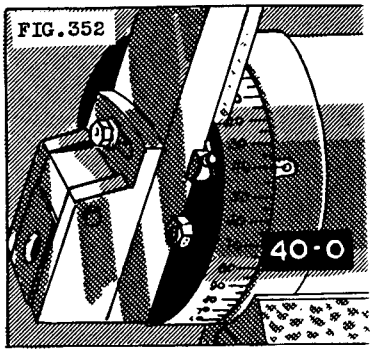


FIG.352

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° - 90° = 40°). Hence, the triangle A B C (Fig. 355) now contains a 90° angle and a 40° angle; the third angle, therefore, must be 50°. The angle, then, 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, but usually the following principles are sufficient for most cases.

SUMMARY

The following procedures 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 directly, try to form a triangle or make use of the principle of opposite, corresponding, and 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.

There is another method of arranging the work in the machine which depends upon the angular setting of the vise to produce an angular

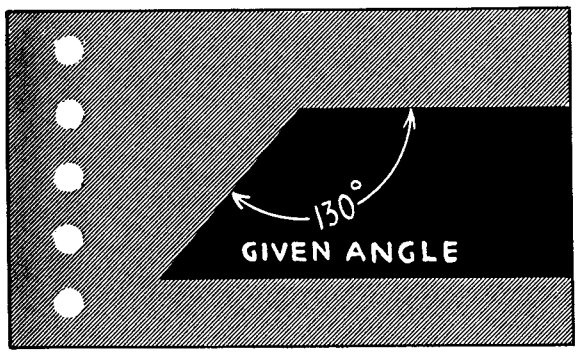


FIG.353

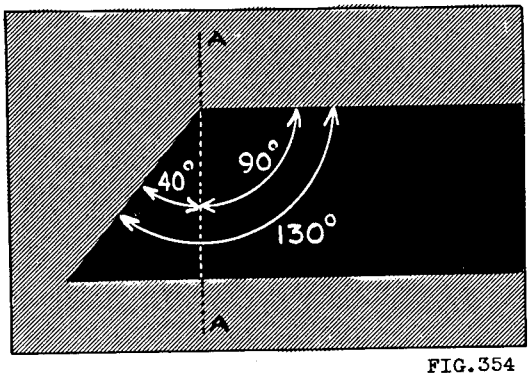


FIG.354

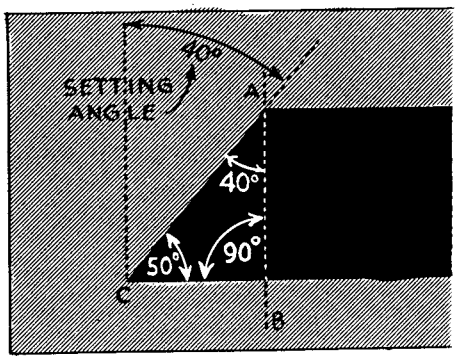


FIG.355

surface. As this method is used to cut slots at an angle to the side of the work and to cut shallow grooves such as are required on a serrated surface, the method will be described in Unit 1-T53(C). This unit parallels the one in which the procedure is given for cutting slots and serrating.

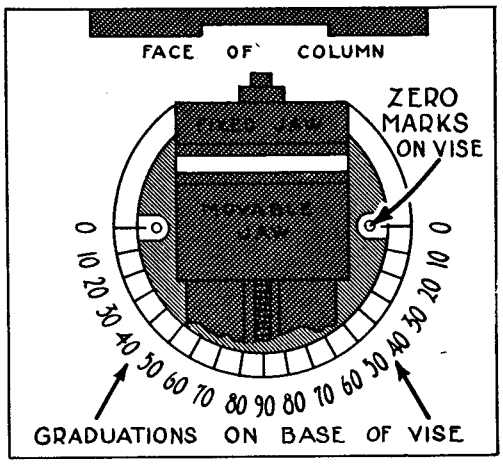


FIG.356

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 cut to that of the stroke, or, 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° as shown. 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.

One may not always be certain that the angle that the cut makes with the direction of the stroke will be shown on the drawing; the angle may be indicated as 60° in the manner shown in Fig. 358. By referring to the definitions given on page 228 it becomes quite obvious that the cut makes an angle of 30° with the direction of

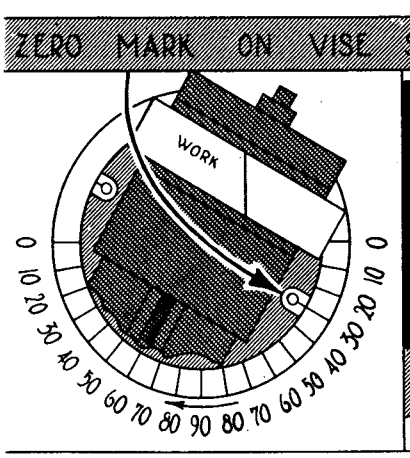


FIG.357

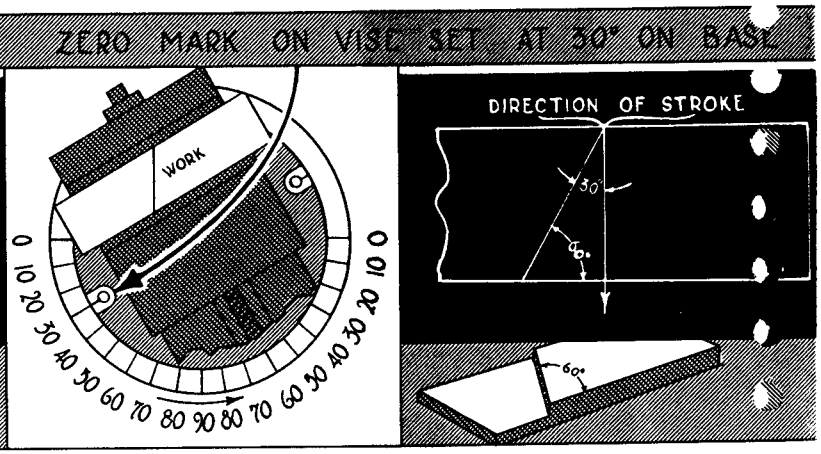


FIG.358

the stroke.

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 being the second side, and the edge of the work being the base. Since the triangle now contains a 90° angle and a 60° angle, the third must be 30°.
($90^\circ + 60^\circ = 150^\circ$ and $180^\circ - 150^\circ = 30^\circ$)

Similarly, as the three angles are equal to two right angles, the two angles, other than the right angle, must equal 90°. Therefore, $90^\circ - 60^\circ = 30^\circ$.

The vise then is swiveled 30° to the right. The following rule can be used to determine the direction in which 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 answer is 40°, the angle at which to set the vise. 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

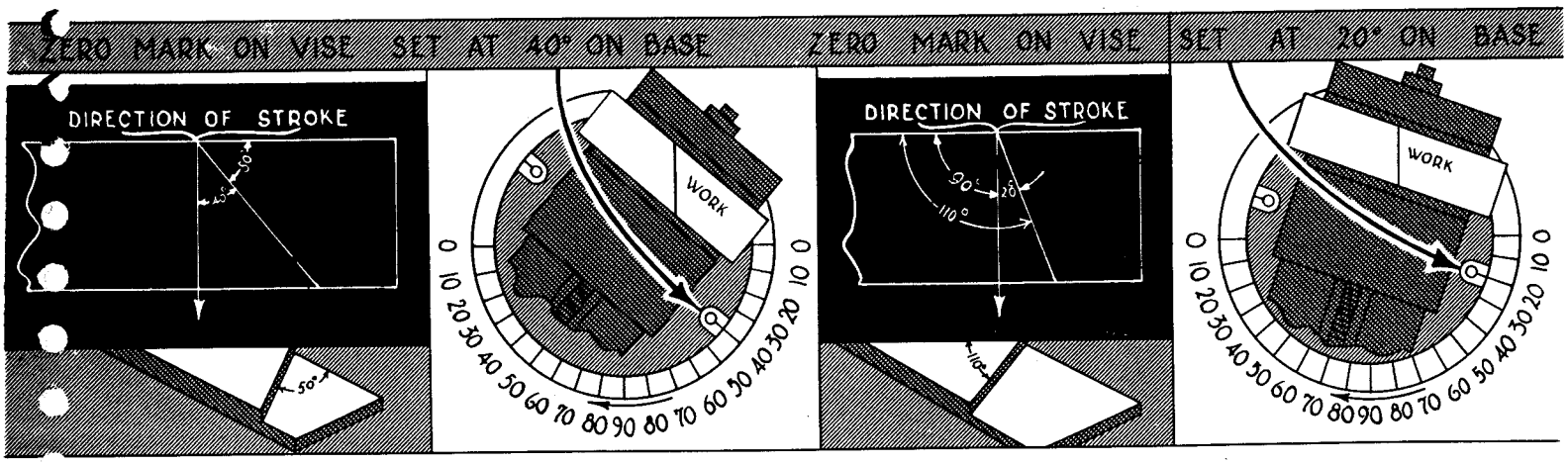


FIG. 359

FIG. 360

makes with the direction of the stroke and, therefore, is the angle at which to set the vise.

Two conditions, then, 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 (Fig. 357) is the angle that the cut makes with the direction of the stroke, the vise is set at the given angle.

When the angle given on the drawing (Figs. 358 to 360) is the angle that the cut makes with one of the sides of the work, one of the following procedures should be used:

1. Imagine or draw a line representing 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 two 90° angles, the third angle is found by subtracting the given angle from 90°.

2. If the angle is given as in Fig. 359, subtract the given angle from 90° and the answer will be the angle at which to set the vise.

3. When the angle is given as in Fig. 360, subtract the 90° angle from the given angle. The answer is the required angle.

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