DESCRIPTION OF ANGULAR CUTS

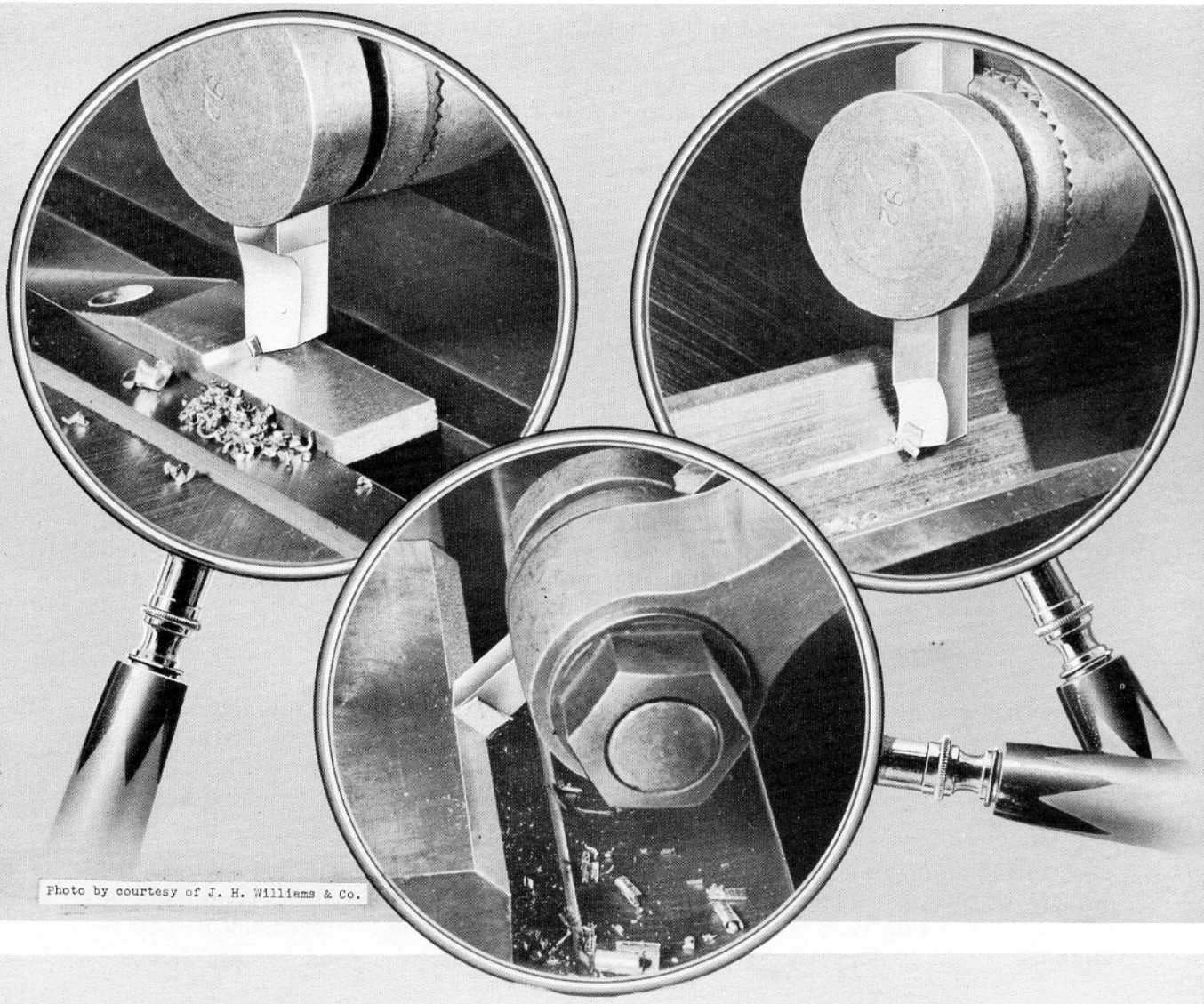


Photo by courtesy of J. H. Williams & Co.

UNIT T 53 (B)

Pages 225 - 234

DESCRIPTION of ANGULAR CUTS

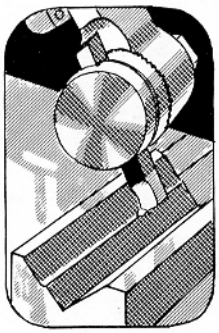
OBJECTIVES OF UNIT

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."

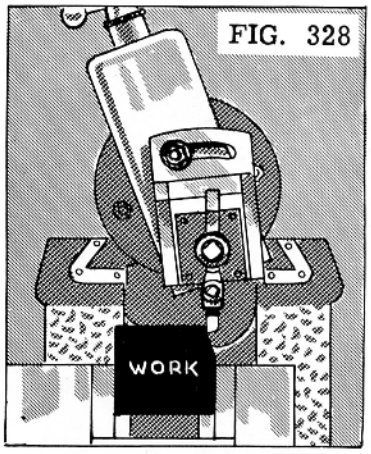


FIG. 328

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.

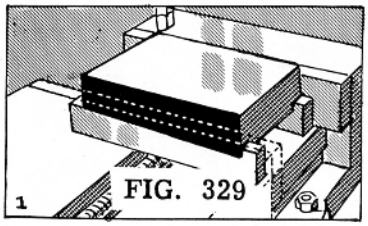


FIG. 329

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.

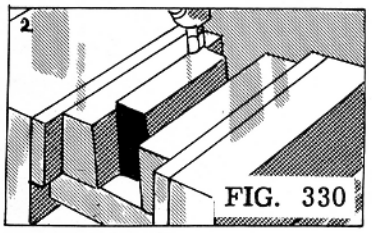


FIG. 330

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.

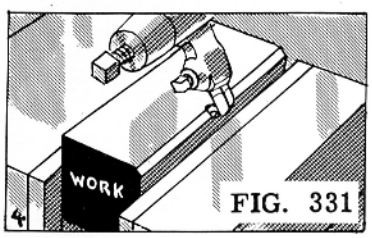


FIG. 331

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).

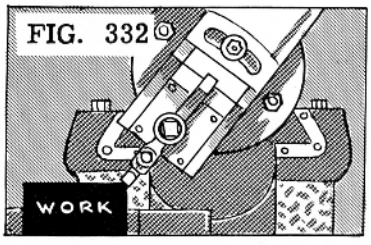


FIG. 332

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).

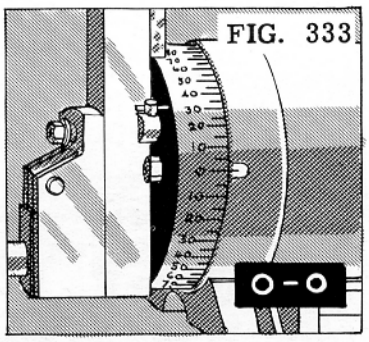


FIG. 333

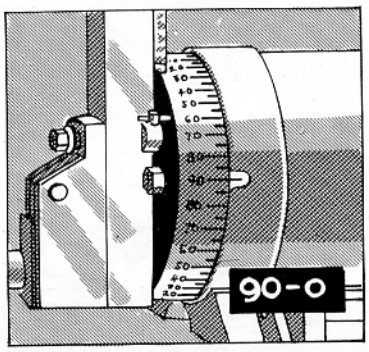


FIG. 334

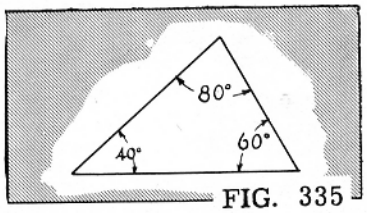
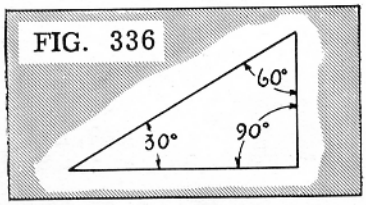
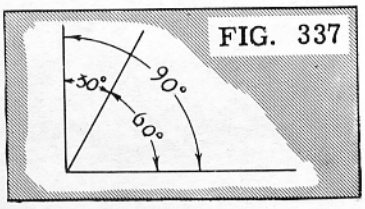


FIG. 335





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^{o} 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^{o} to 60^{o} on each side of the vertical position (Fig. 333). Other heads have a 90^{o} 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^{o} 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.

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.

1. The sum of three angles in a triangle always equals 180^{o} (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^{o} (Fig. 336). If one other angle is known, the third angle can easily be determined.

3. The two angles contained in a right (90^{o}) 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).

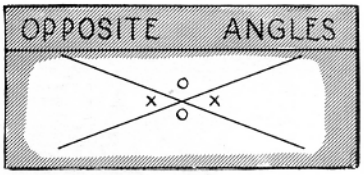


FIG. 338

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.

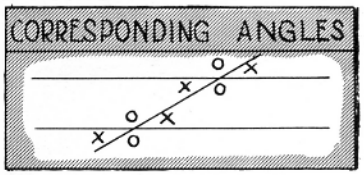


FIG. 339

These principles must be understood because they are essential for complete understanding of angular problems.

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

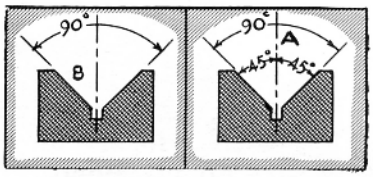


FIG. 340 FIG. 341

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.

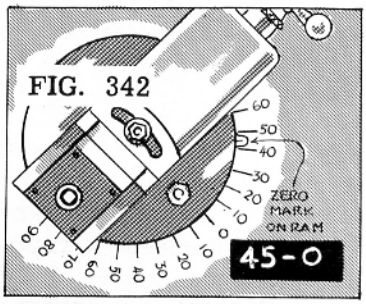


FIG. 342

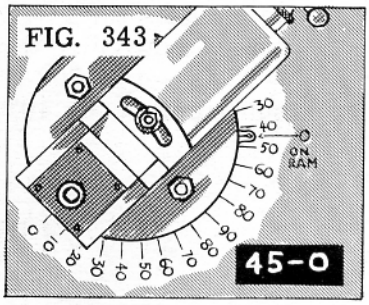


FIG. 343

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.

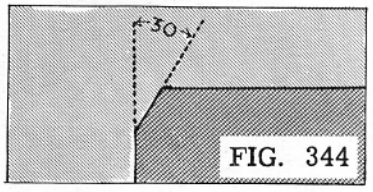


FIG. 344

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).

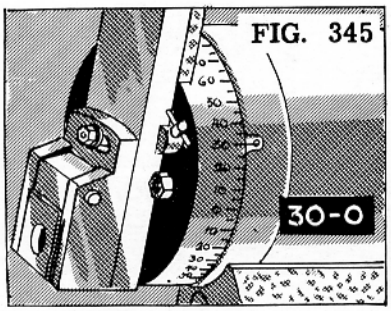


FIG. 345

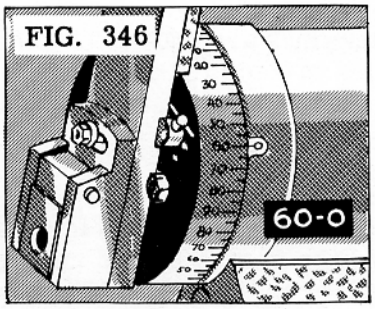


FIG. 346

"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

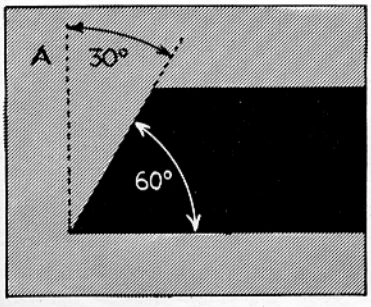


FIG. 348

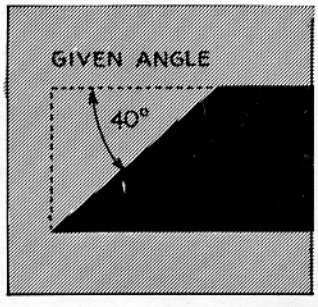


FIG. 349

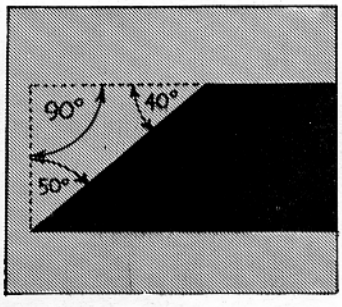
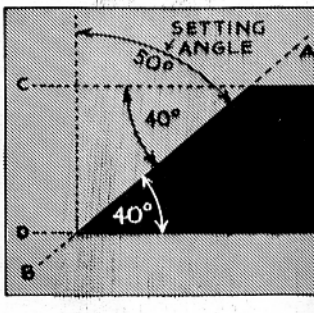


FIG. 350



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° - 90° = 40°). 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

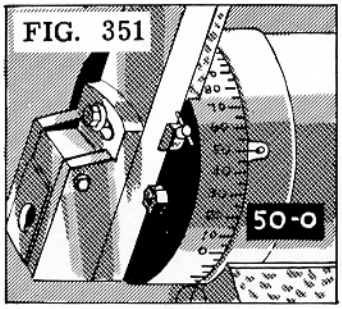
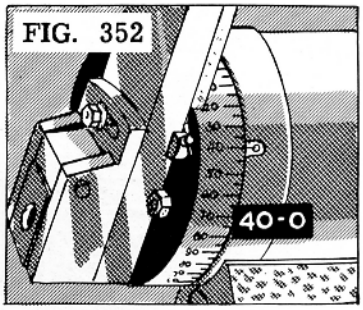


FIG. 352



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

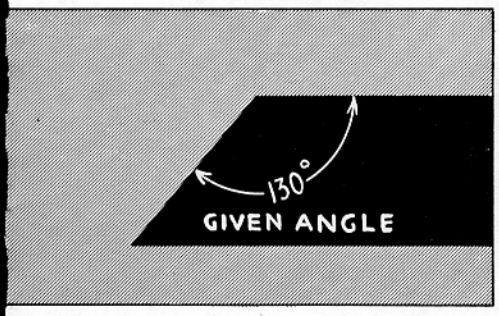


FIG. 354

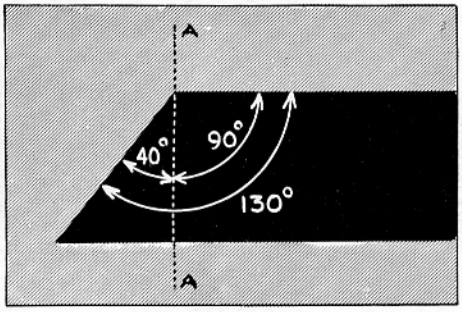
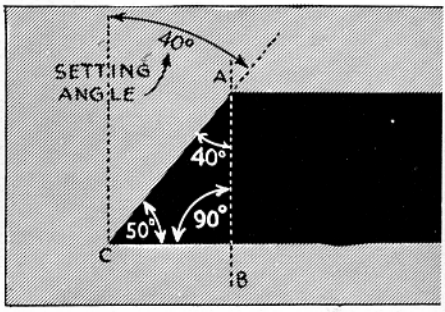


FIG. 355



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.

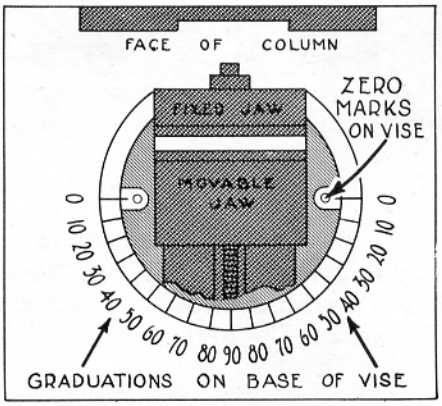


FIG. 356

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.

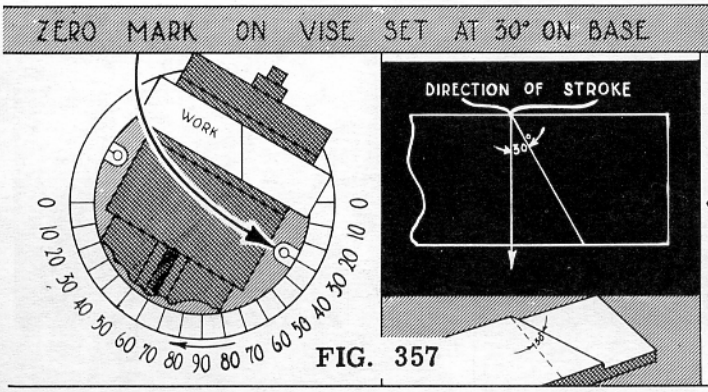


FIG. 357

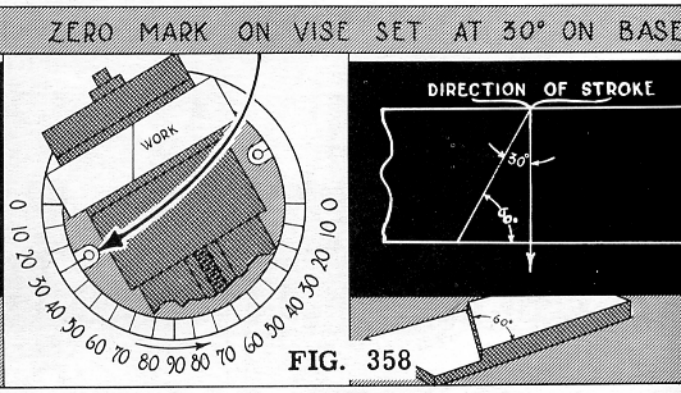


FIG. 358

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^{o} and a 60^{o} angle, the third must be 30^{o}.

($90^{o} + 60^{o} = 150^{o}$ and $180^{o} - 150^{o} = 30^{o}$)

The vise then is swiveled 30^{o} 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^{o}. If a line is imagined or drawn to represent the direction of the stroke, it makes an angle of 90^{o} (a right angle) with the side of the work. By subtracting the given angle of 50^{o} from 90^{o}, the angle at which to set the vise is 40^{o}. These angles are also called complementary angles because the two angles are equal to 90^{o}. 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^{o}.

One other example is given in Fig. 360. The given angle is 110^{o}. 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^{o} angle with the side of the work. Subtracting 90^{o} from 110^{o} leaves 20^{o}, which is the angle the cut makes

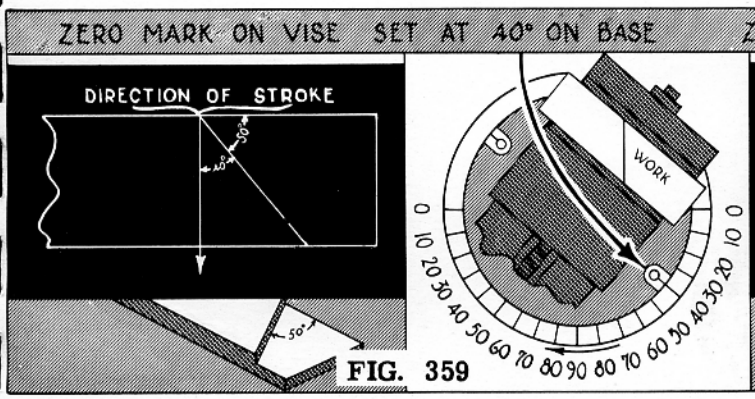


FIG. 359

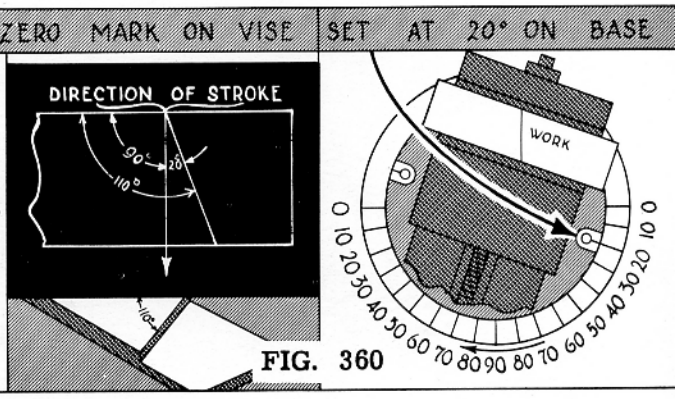


FIG. 360

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^{o} triangle with the given angle as one of the angles in the triangle. Since the three angles of a triangle are equal to 180^{o}, the third angle is found by subtracting the given angle and the right angle (90^{o}) from 180^{o}.

2. If the angle is given, subtract the given angle from 90^{o} and the answer will be the angle at which to set the vise.

3. When the angle is greater than 90^{o}, subtract the 90^{o} angle from the given angle. The answer is the required angle.