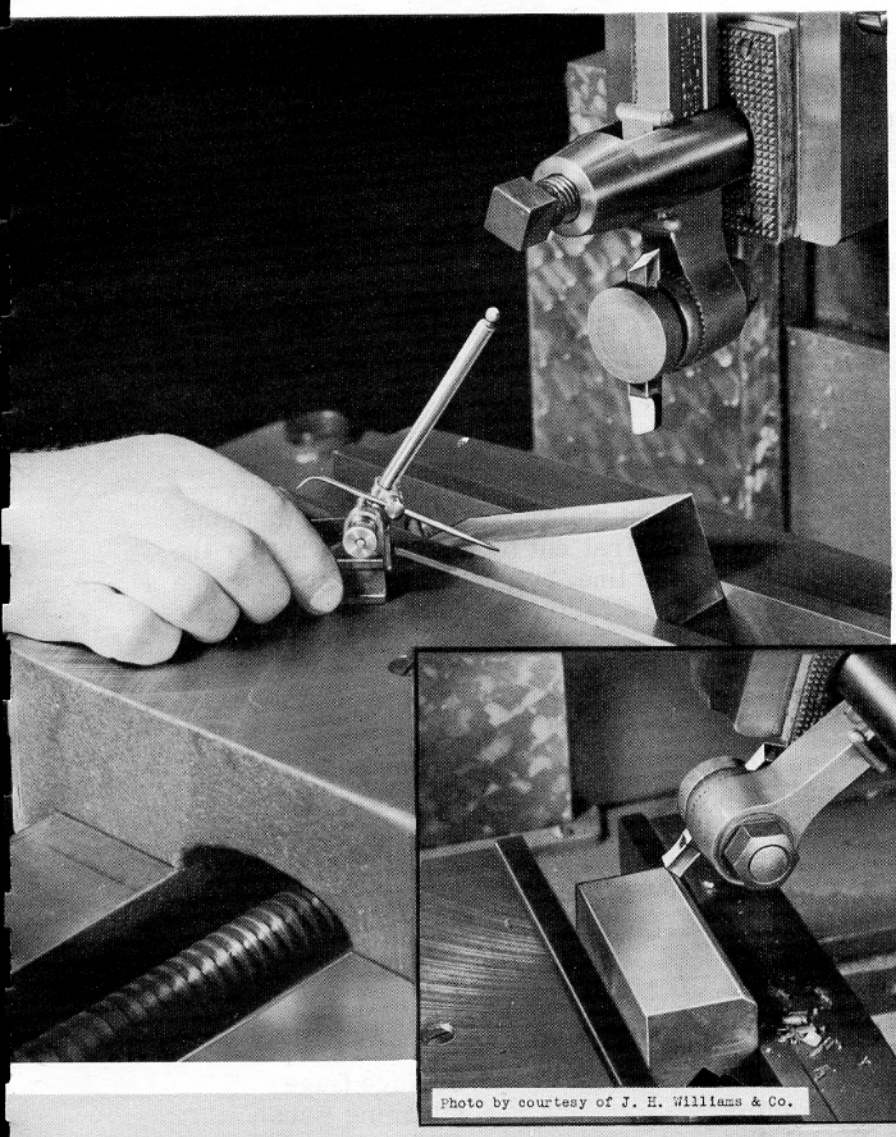
HOW TO PLANE ANGULAR SURFACES



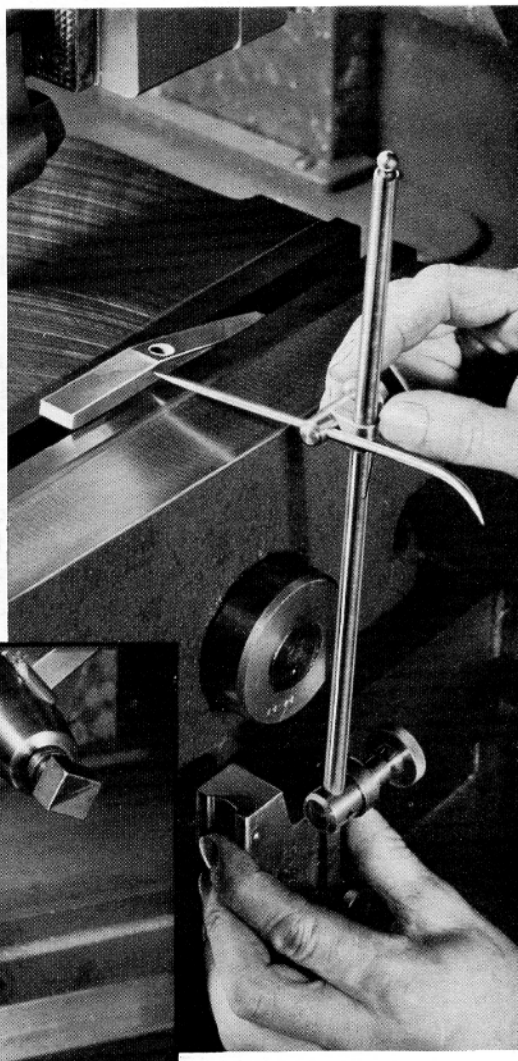


Photo by courtesy of J. H. Williams & Co.

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^{o} to the direction of the stroke. The zero mark on the vise will coincide with the 0^{o} 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.

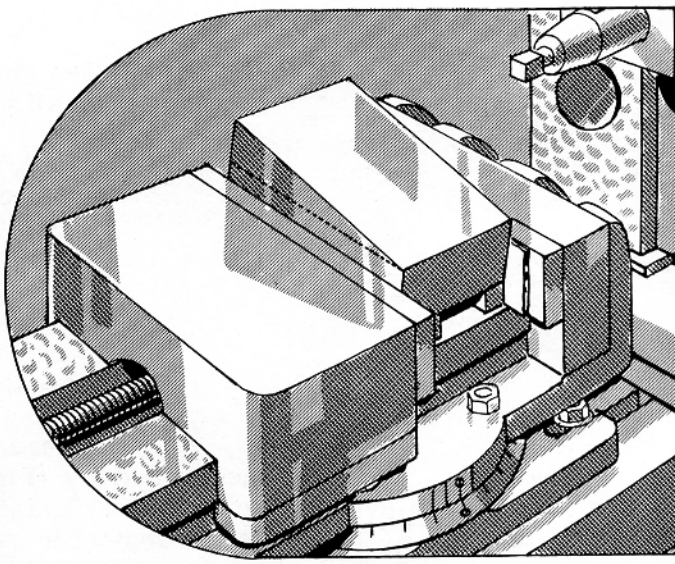


FIG. 361

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.

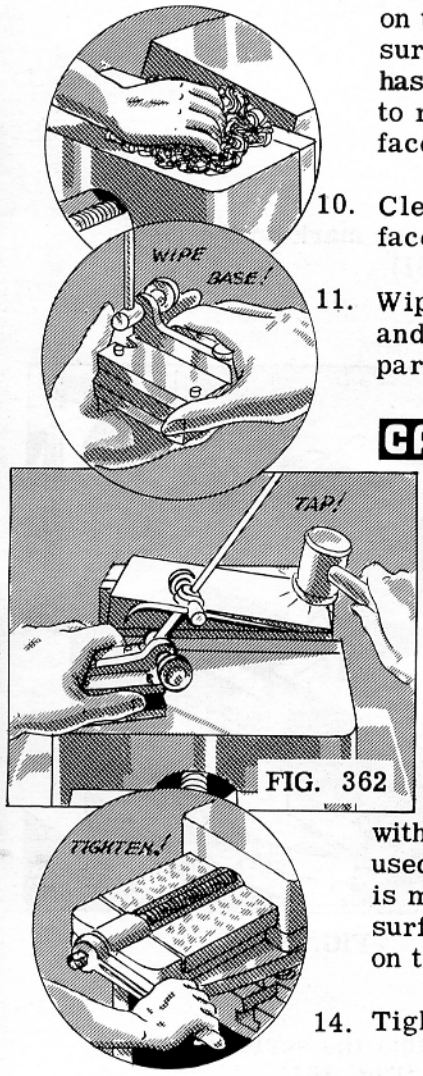


FIG. 362

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.

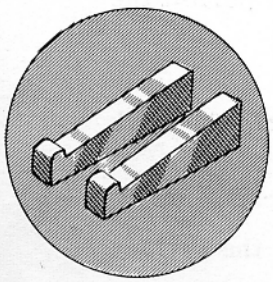
12. Adjust the point of the surface gage scriber to correspond with one end of the scribed line on the work (Fig. 362).

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.

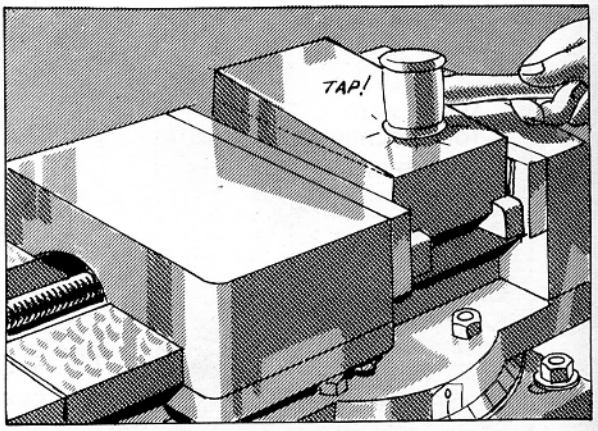


FIG. 364

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.

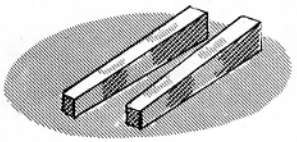


FIG. 365

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.

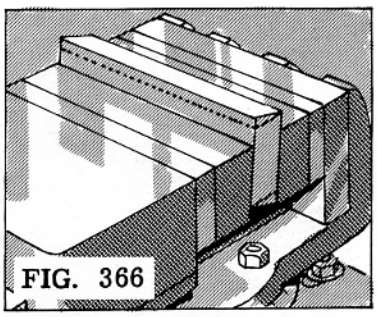


FIG. 366

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.

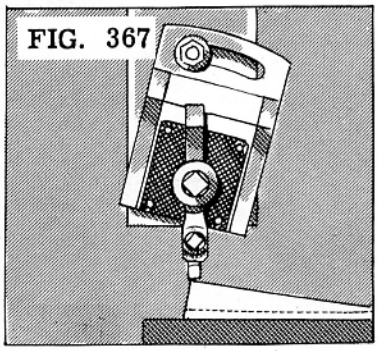


FIG. 367

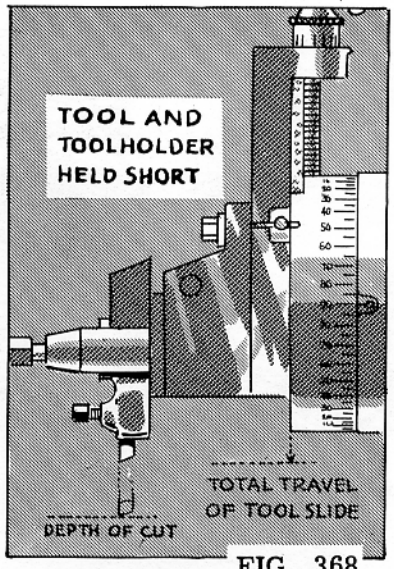
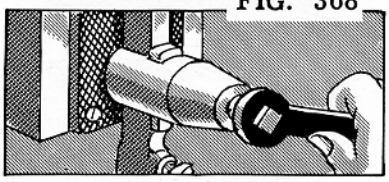


FIG. 368



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.

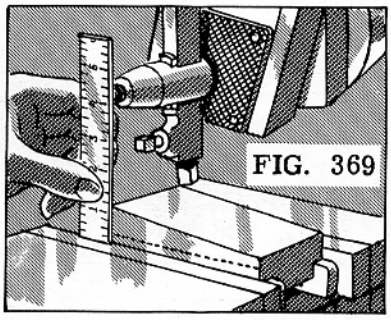


FIG. 369

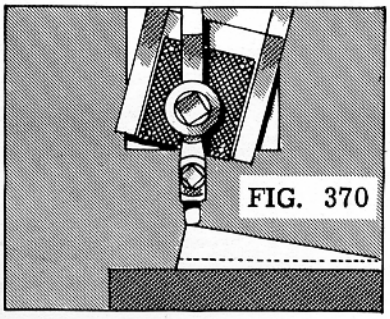


FIG. 370

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).

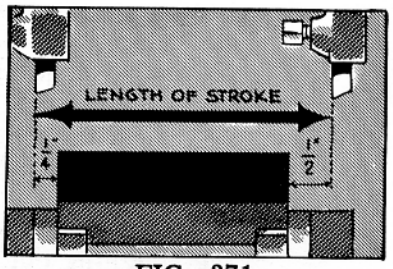
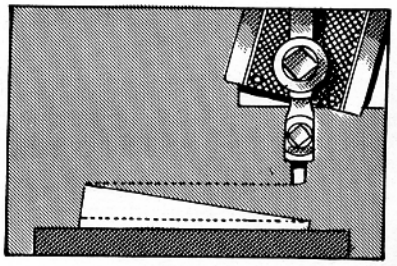


FIG. 371

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.

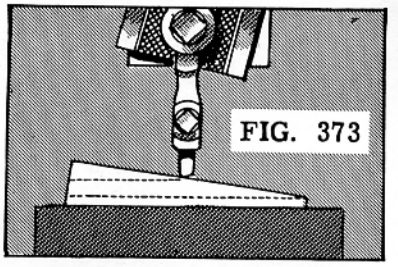


FIG. 373

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.

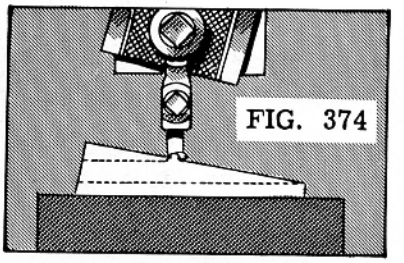


FIG. 374

THE ROUGHING CUT

1. Start the machine and move the work until the tool touches the work (Fig. 374).

2. Engage the feed mechanism.

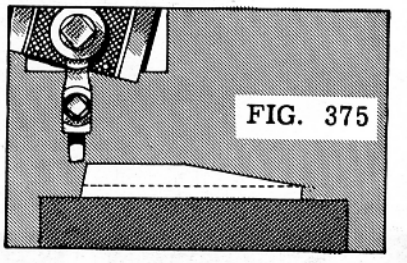


FIG. 375

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

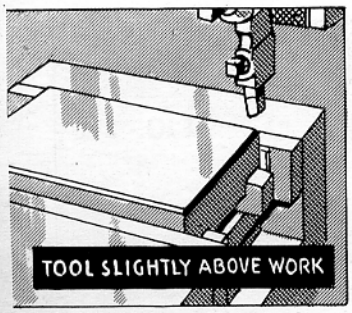


FIG. 377

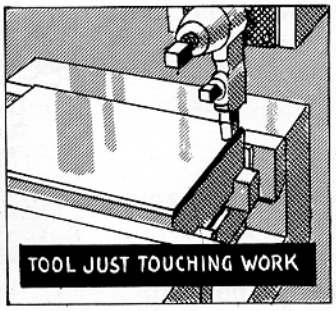


FIG. 378

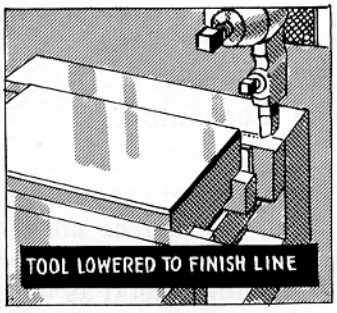
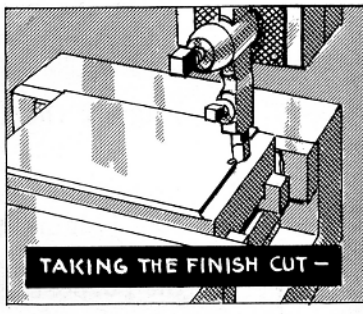


FIG. 379



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.

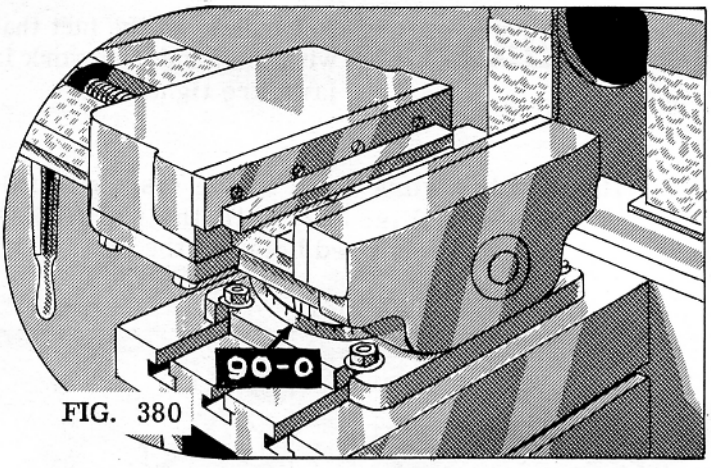


FIG. 380

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

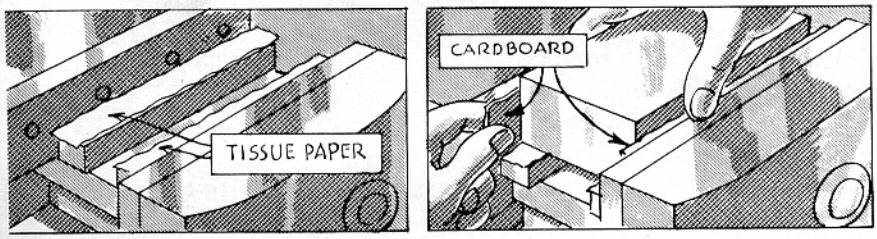
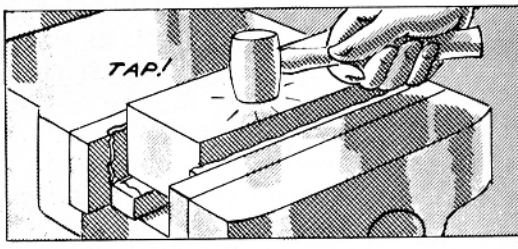


FIG. 382



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).

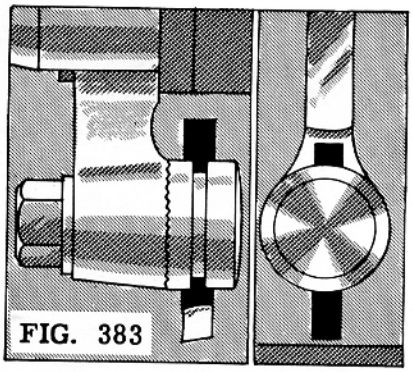


FIG. 383

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.

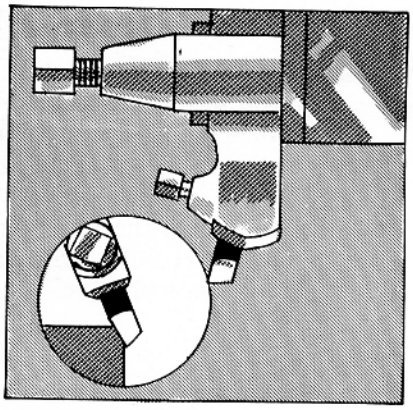


FIG. 384

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.

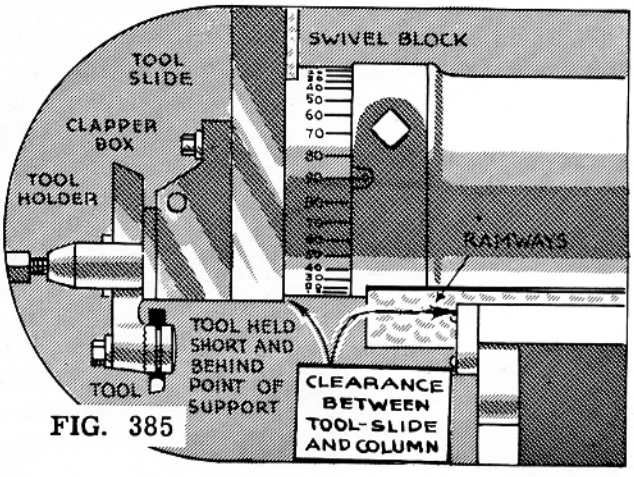


FIG. 385

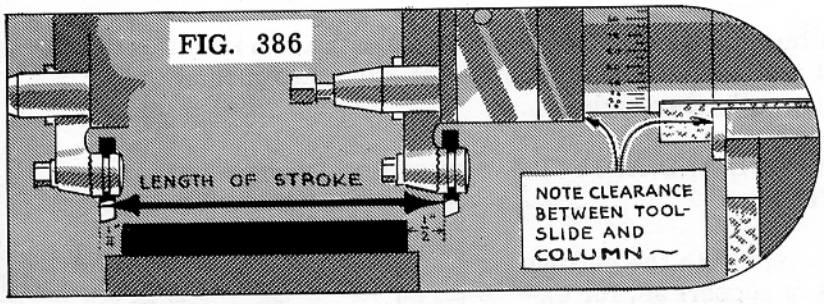


FIG. 386

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.

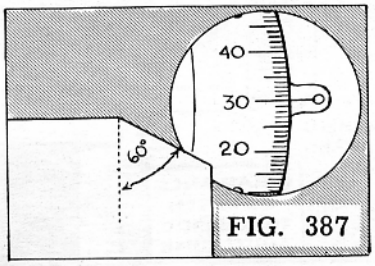


FIG. 387

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.

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.

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).

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.

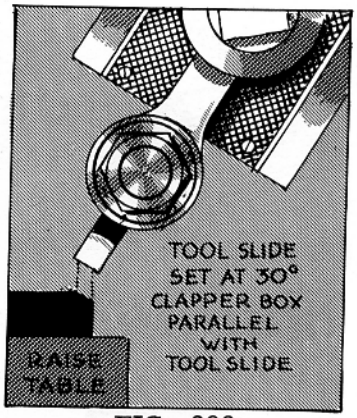


FIG. 388

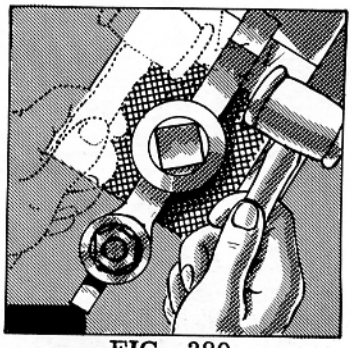


FIG. 389

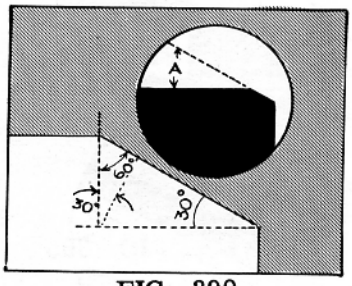


FIG. 390

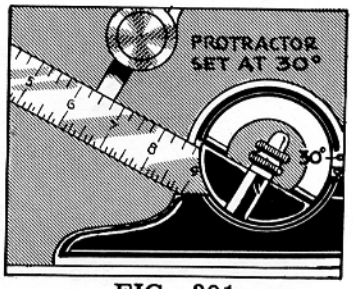


FIG. 391

HOW TO TAKE THE CUT

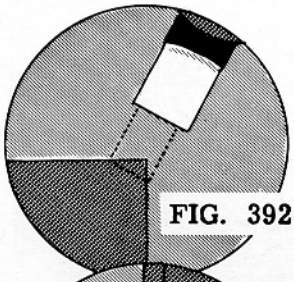


FIG. 392

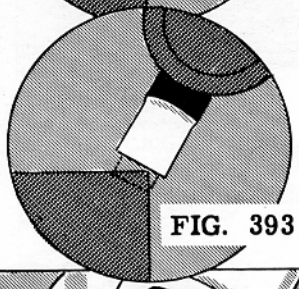


FIG. 393

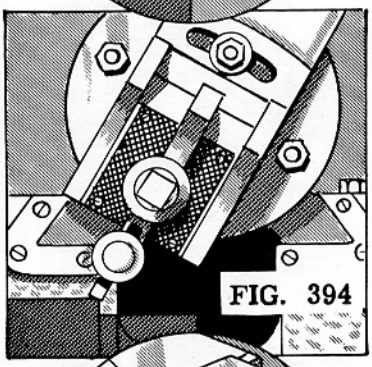


FIG. 394

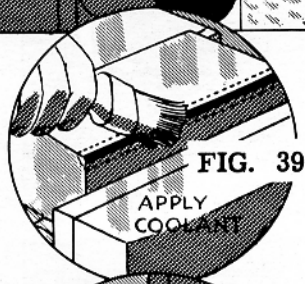


FIG. 395

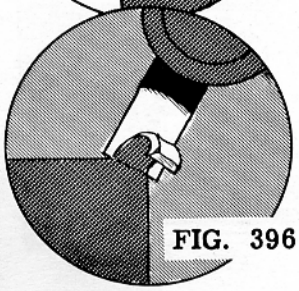


FIG. 396

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.

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).

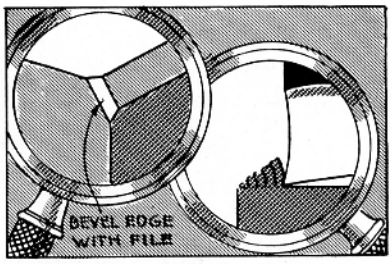
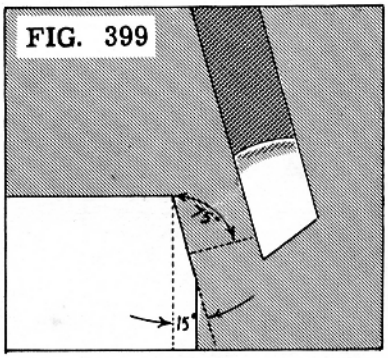


FIG. 397 FIG. 398

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:



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).
6. Adjust the length of the stroke so that it will be 3/4" longer than the length of the work.

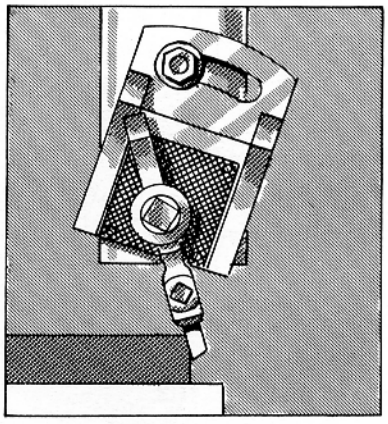


FIG. 400

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.

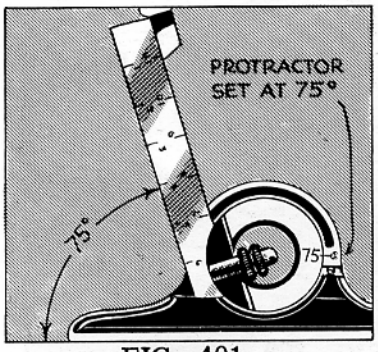


FIG. 401

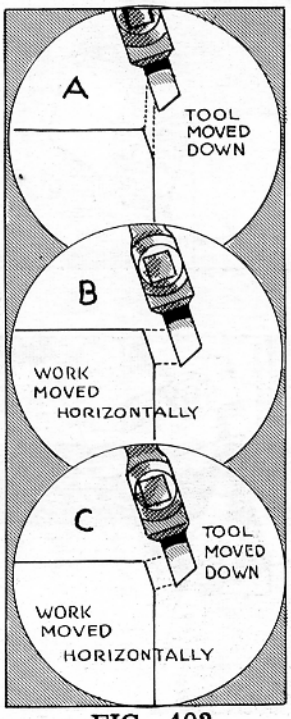


FIG. 402

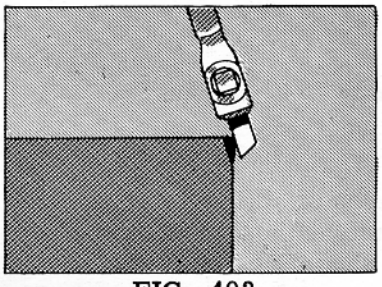


FIG. 403

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.

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

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.

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.

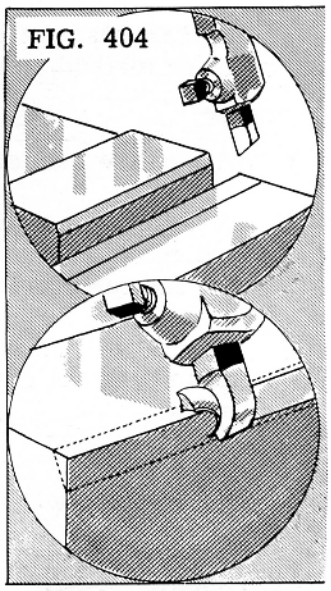


FIG. 404

FIG. 405

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.

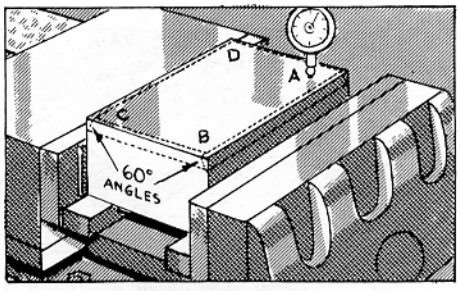


FIG. 406

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.

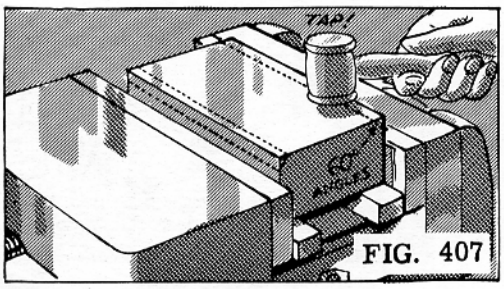


FIG. 407

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

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.

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.

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.

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.

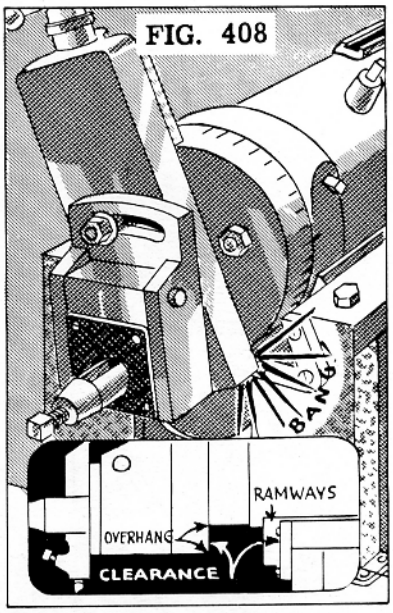


FIG. 408

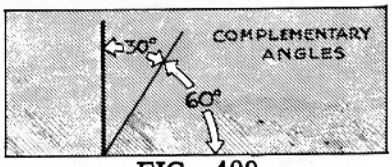


FIG. 409

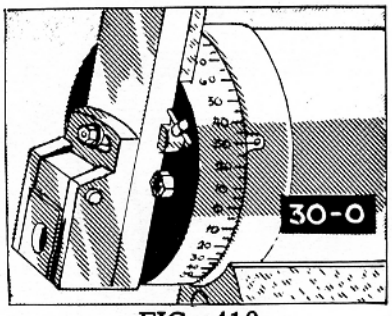


FIG. 410

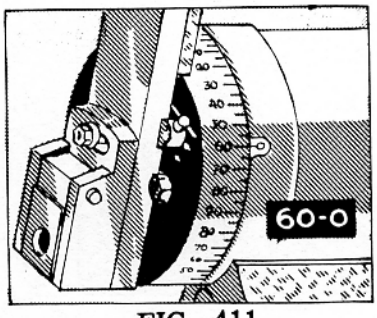


FIG. 411

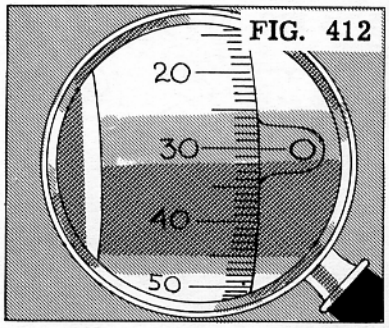


FIG. 412

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.

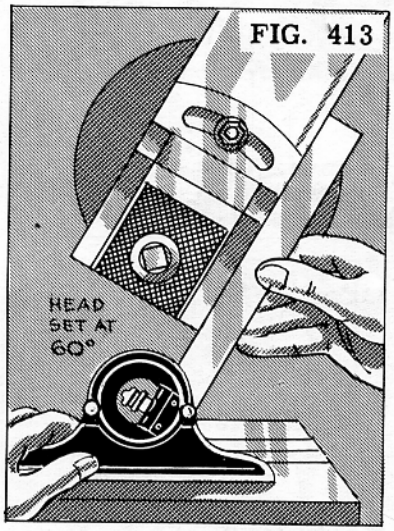


FIG. 413

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

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).

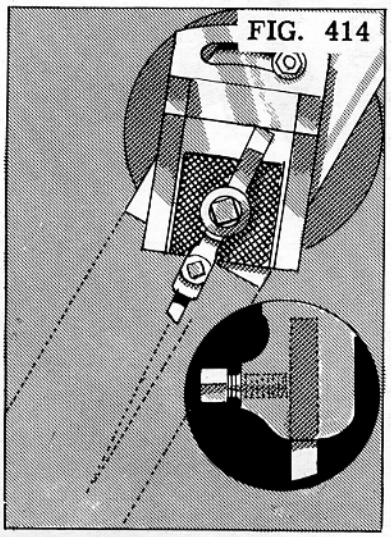


FIG. 414

2. Place the tool holder in the tool post at a slight angle of about 5^{o} to 10^{o} 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).

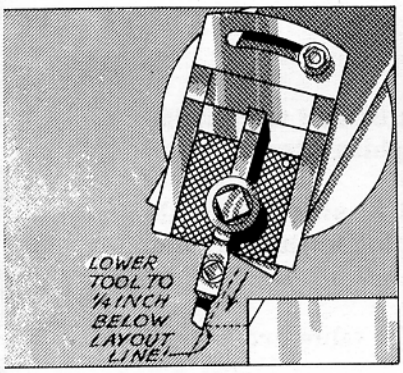


FIG. 415

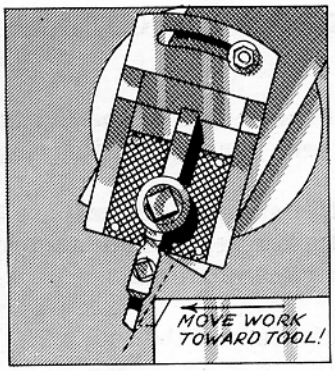


FIG. 416

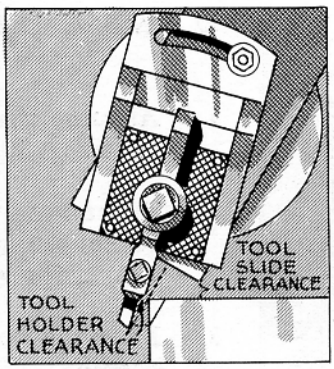


FIG. 417

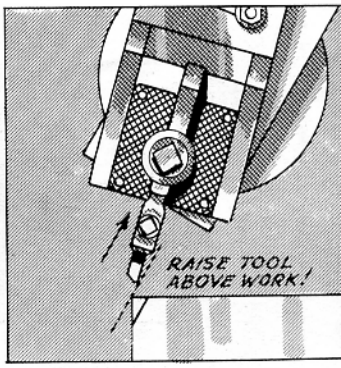


FIG. 418

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.

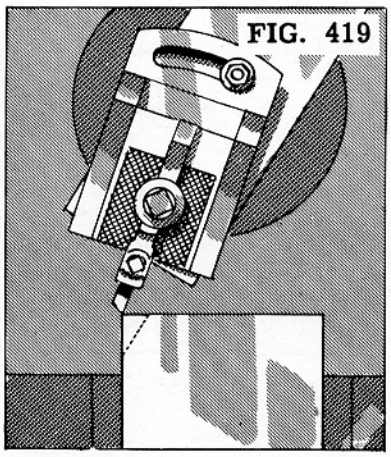


FIG. 419

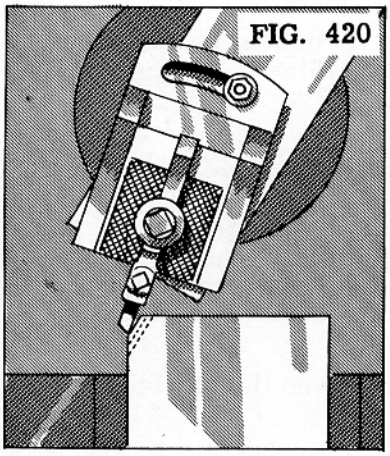


FIG. 420

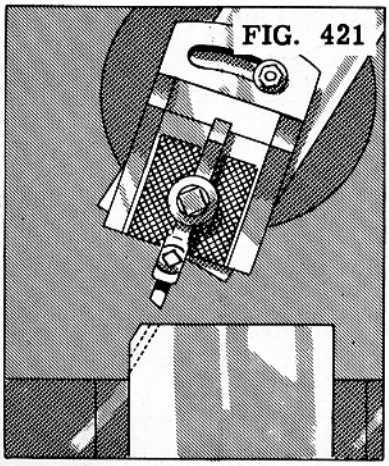


FIG. 421

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.
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.

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.

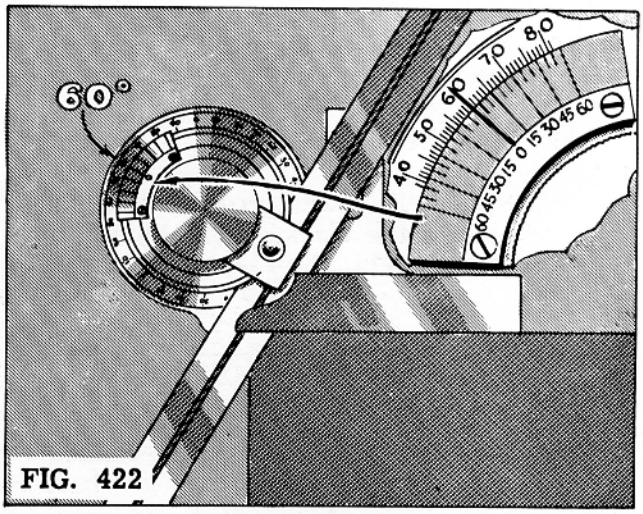


FIG. 422

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

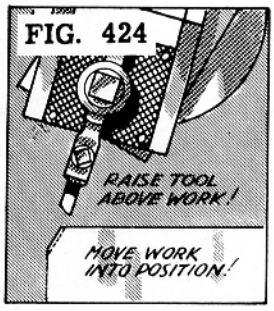


FIG. 424

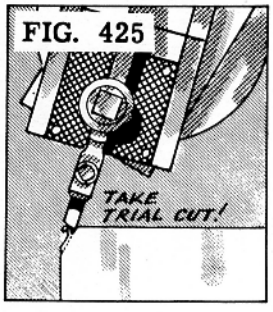


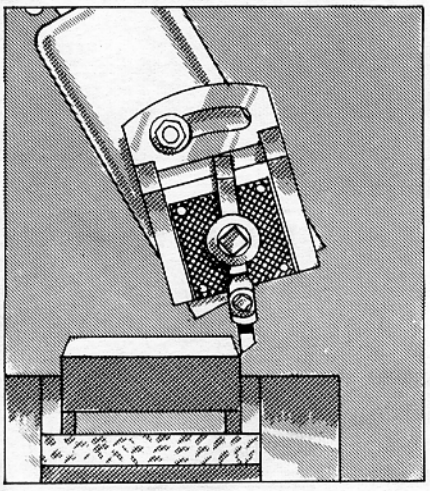
FIG. 425

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.