HOW TO PLANE ANGULAR SURFACES

Unit 1-P53(B) Parts I, II, and III Pages 235 to 258

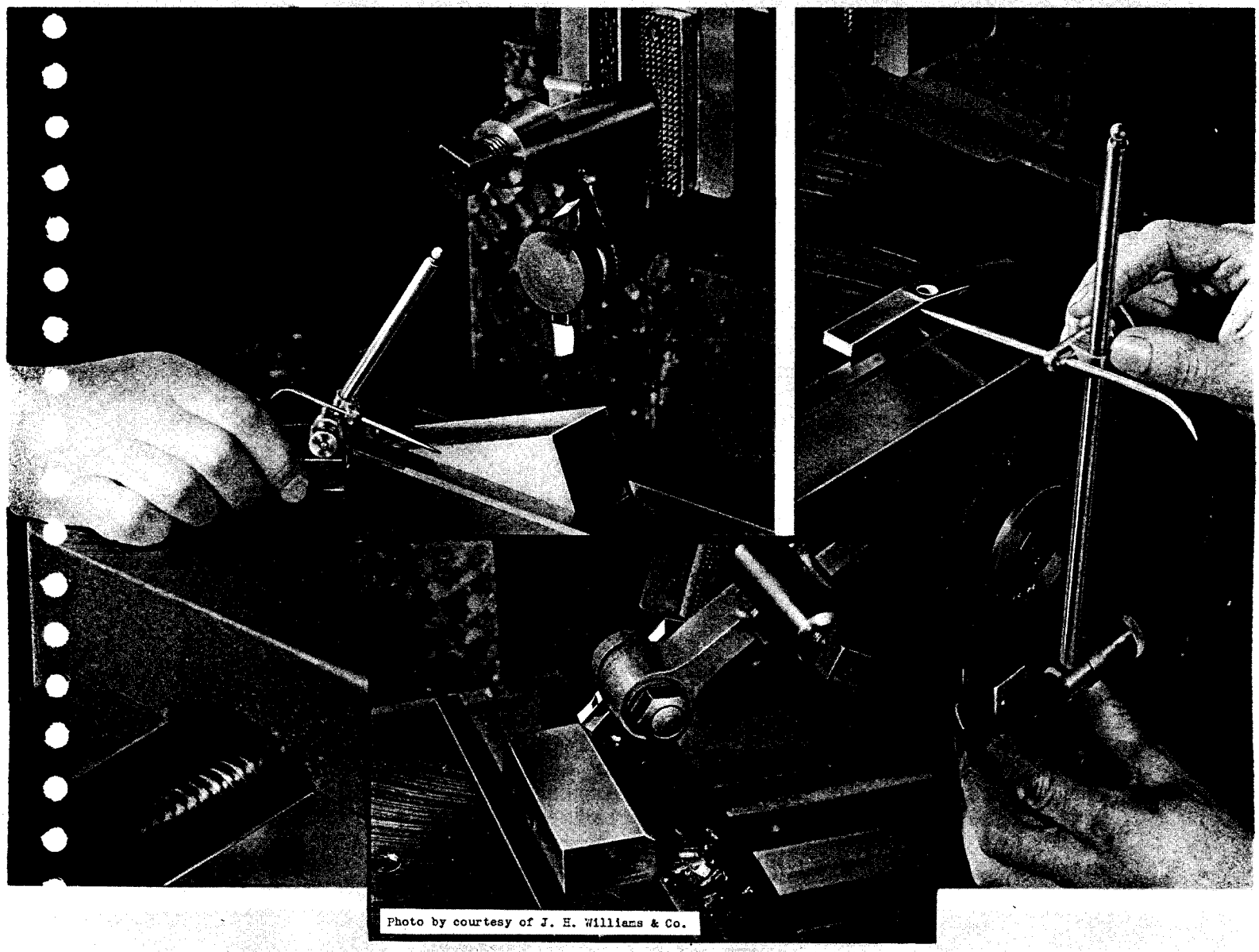


Photo by courtesy of J. H. Williams & Co.

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

OBJECTIVES OF UNIT

1. To show how to plane an angular surface when the work is held in a position at which a horizontal or vertical cut will form an angle with an adjacent surface.

2. To show how to form an angular cut when the cutting edge of the tool is set at an angle to the vertical or horizontal position.

3. To show how to cut an angular surface when the tool head is swiveled either to the left or to the right of the vertical position.

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 and the tool guided in an angular direction.

Regardless of the method employed, the work is laid out previously to being set in the machine. The accuracy of the setting is tested after the cut has been made 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, in some cases, save time spent in laying out the work, frequently eliminate errors in angular calculations, and, in general, insure uniformity of product. When greater accuracy is required for checking the angular surfaces, other tools and methods are used. Since these methods require a knowledge of simple trigonometrical functions, the topic is left for a more advanced treatise on the subject.

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

HOW TO PLANE ANGULAR SURFACES *when Work is set with the Surface Gage*

PROCEDURE

SETTING UP THE WORK TO A GUIDE LINE

1. If it is necessary to mount the vise on the table, follow the directions given on pages 119 to 121.

2. Set the vise at 90° to the direction of the stroke. The zero mark on the vise will coincide with the 0° graduation on the base (Fig. 361). Refer also to page 124.

3. Clean the vise thoroughly, first with a brush and then with a clean cloth.

4. Remove any burrs from the vise jaws with a fine file. Usually a file will remove the burrs unless the jaws are extremely hard; then an oil stone may be used. Extremely hard jaws often chip instead of forming burrs.

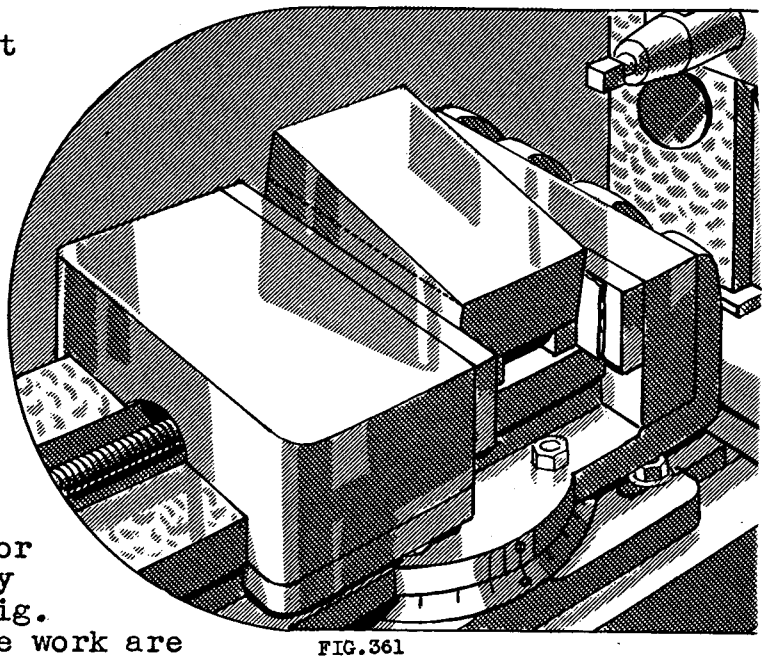


FIG.361

5. Place pieces of paper or strips of cardboard between the vise jaws and the sides of the work if the work surfaces are rough or if there is any danger of injury to the vise jaws or the work (Fig. 361). Even if the sides of the work are smooth, the vise jaws may be in poor condition and injure the sides of the work when the vise is tightened. The vise jaws should be in good condition and every means should be used to keep them so.

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). Refer also to page 209.

7. Tighten the vise enough to hold the work in position, but loose enough to allow 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 the top of the movable jaw to support the surface gage, or use the shaper table as a leveling surface.

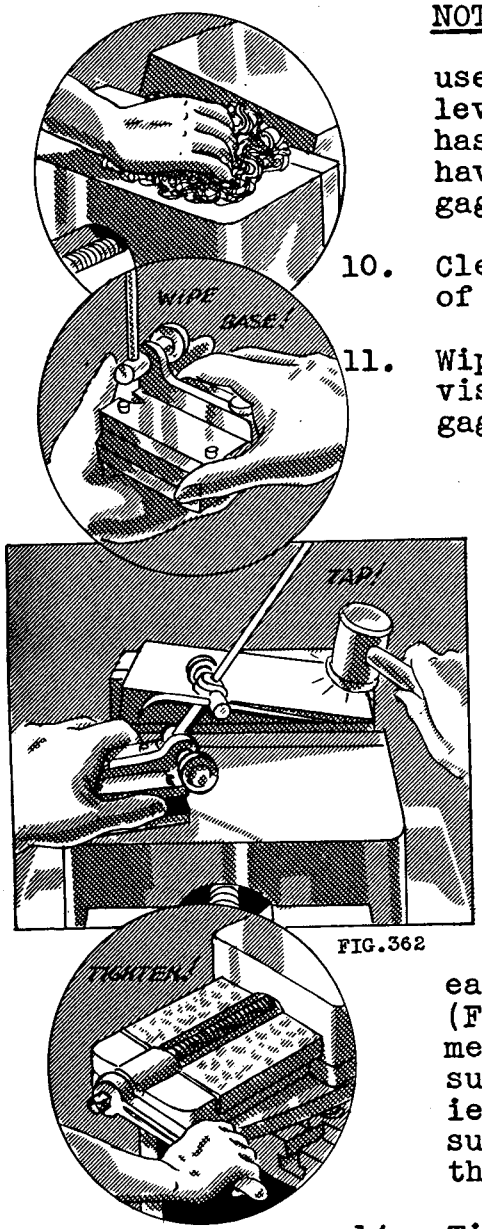


FIG.362

NOTE: The single-screw vise usually has a planed surface on the top of the movable jaw which may be used as a surface to support the surface gage and to level the work in the vise (Fig. 362). If the vise has a double screw or, for any other reason, 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, however, that no small steel cuttings are on the surface that is being cleaned with the hand, for they may get into 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 scribed line, and at the same time raise one end or lower the other end of the work until the scriber corresponds at each end of the work exactly with the scribed line (Fig. 362). In other words, the surface gage is a means of setting the scribed line parallel with the surface of the table. It is a little more convenient, however, to use the top of the movable jaw to support the surface gage than it would be to have the base of the surface gage supported on the table.

14. Tighten the vise securely.

SETTING UP THE WORK ON TAPERED PARALLELS

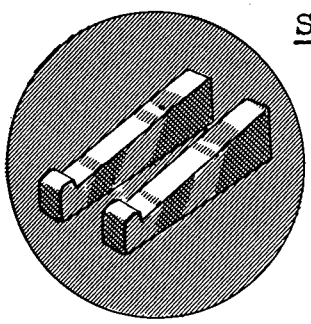


FIG.363

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. Be sure that the vise, the work, and the parallels are clean.

2. Place the parallels in the vise and the work on the

parallels with protecting strips of heavy paper or cardboard between the jaws of the vise and the sides of the work (Fig. 364). Refer also to note on page 244.

3. Tighten the vise securely.

4. Tap the work down on the parallels with a soft mallet. The tap with the mallet must be heavy enough to seat the work on the parallels but not heavy enough to cause the work to rebound from the parallels.

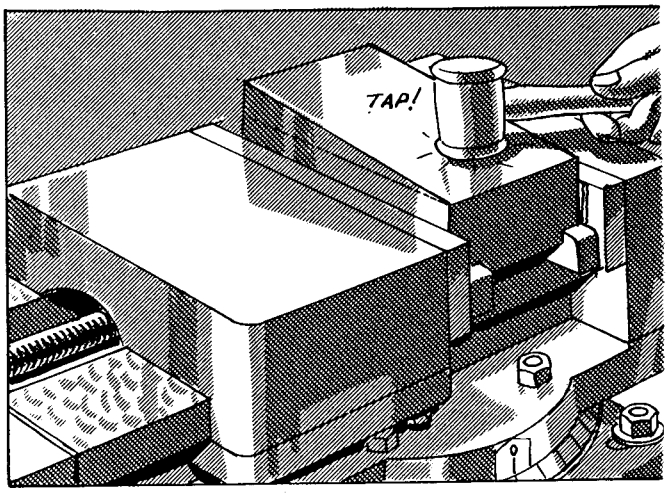


FIG.364

NOTE: The parallels may be made without the shoulder (Fig. 365). The shoulder, however, prevents the parallels from slipping when the work is seated with a mallet.

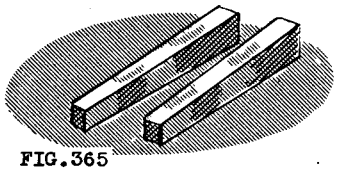


FIG.365

SETTING UP THE WORK WITH DEGREE PARALLELS

1. Use the same precautions regarding cleanliness when the setup is being prepared as those given at the beginning of the unit.

2. Place the parallels in the vise and place the work between the parallels with projecting strips of paper between the vise and the parallels, and between the parallels and the work (Fig. 366).

3. Tighten the vise securely.

4. Tap the work down with a soft mallet.

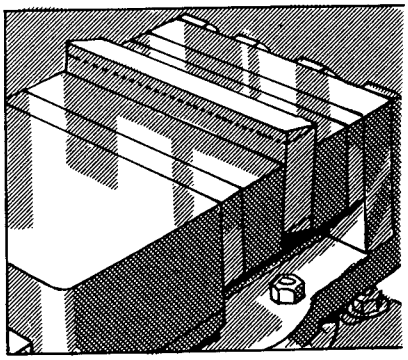


FIG.366

SETTING THE TOOL (THE WORK 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 when it is feeding from the left to the right. Refer to page 170 for setting the clapper box.

2. Arrange 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).

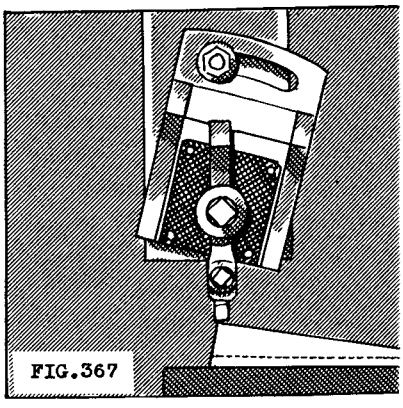


FIG.367

3. Measure with a scale (Fig. 369) the material to be removed.

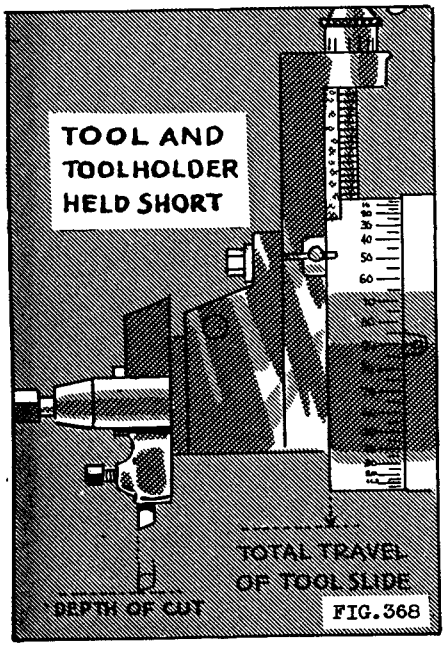
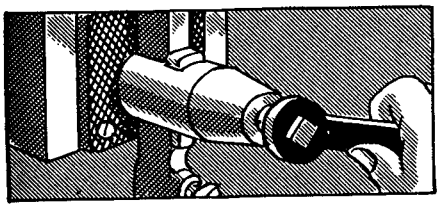


FIG.368



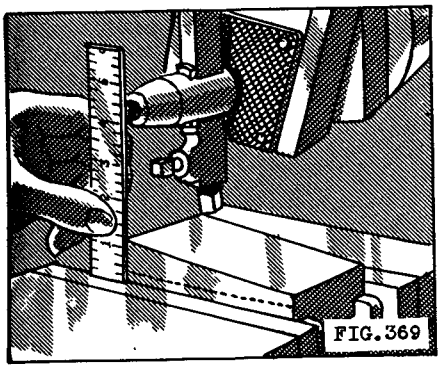


FIG.369

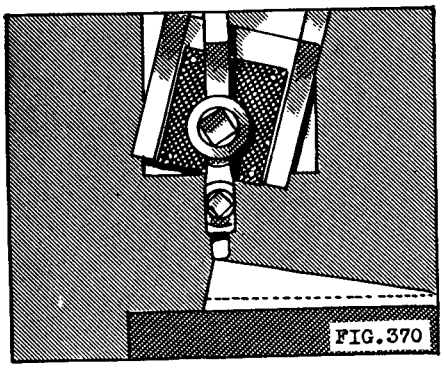


FIG.370

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 tool holder from the available stock, preferably one that holds the tool parallel with the base and sides of the shank. (Refer to page 153.)

6. Select one tool illustrated on page 161, Fig. 228, to suit the tool holder, also taking into consideration the kind of material (cast iron, steel, etc.) and the direction of the feed (right to left, or left to right). Refer to page 157 for description of tools.

7. Set the tool holder in the tool post in a vertical position with as little overhang as possible (Fig. 368). (Refer to page 170.)

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.

HOW TO SET THE SHAPER PRIOR TO TAKING THE CUT

1. Move the table horizontally until the work is under the tool (Fig. 370). Refer to page 78 for adjusting the table horizontally.

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. Refer to page 77 for adjusting the table vertically.

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). Refer to page 79 for adjusting the stroke.

5. Position, or adjust, the ram so that the tool will be about one-quarter of an inch beyond the work when it is at the extreme forward position (Fig. 371). Refer also to page 81 for positioning the ram.

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 ready for the next cut (Fig. 371).

7. Set the speed of the ram for eighty strokes per minute, assuming that a roughing cut is to be taken on soft steel and that the length of the cut is six inches. (Refer to page 82 for setting the speed, and to page 299 for calculations.)

8. Set the feed for 1/32" (31 thousandths), using judgment as to whether or not the feed should be increased to 1/16" or more. (Refer to page 90 for setting the feed, and to page 304 for feed selections.)

9. Start the machine and move the tool down with the down-feed handle until the tool scrapes the high point of the work (Fig. 370).

10. Stop the machine and move the work to the left of the tool (Fig. 372).

11. Set the graduated dial on the down-feed screw at zero. Refer to page 65 for adjusting the dial.

12. Set the cut for 1/4", or 250 thousandths, on the graduated dial (Fig. 373). The depth of the cut may be increased, if necessary, consistent with the power of the machine and the rigidity of the work.

CAUTION The student may have the instructor check the setting of the work and the adjustment of the shaper before starting the cutting operation.

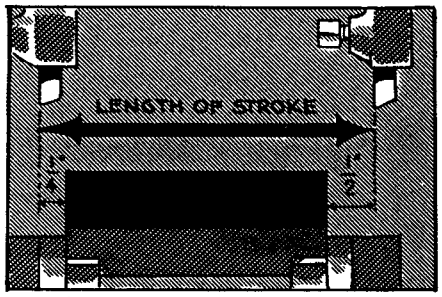


FIG.371

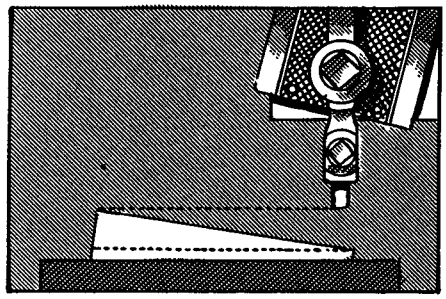


FIG.372

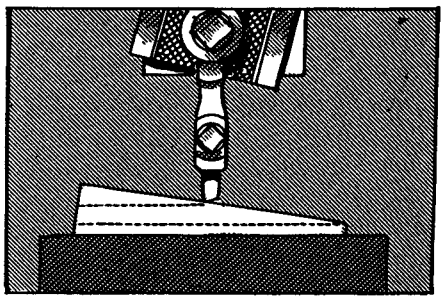


FIG.373

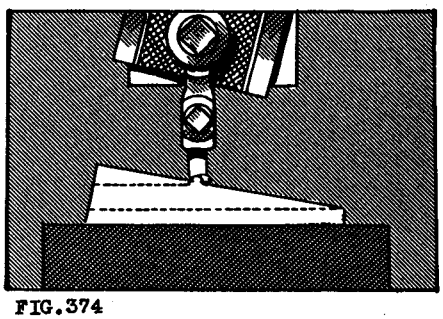


FIG.374

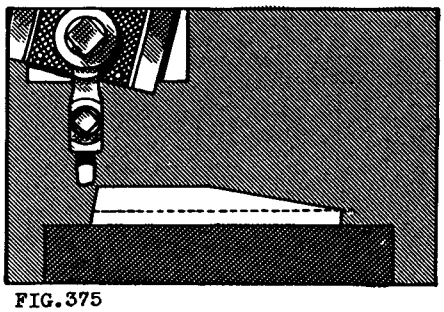


FIG.375

THE ROUGHING CUT

1. Start the machine and move the work over carefully until the tool scrapes the work (Fig. 374).

2. Engage the feed. Refer to page 59 for feed operation.

3. Observe the performance of the shaper and use judgment as to whether or not the feed and the depth of the cut can be increased.

These are roughing cuts and the purpose is to remove metal as quickly as possible.

4. Disengage the feed when the tool has finished the cut (Fig. 375).

5. Move the work again to the left of the tool, put on another cut, and engage the feed.

6. Continue to take a series of cuts, but be certain to leave from 1/32" to 1/16" 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. (Refer also to page 181.)

7. Stop the machine after the work has been roughed out.

THE FINISHING CUT

1. Remove the tool from the tool holder.

2. Regrind and stone the edge of the tool, or use the tool illustrated in Fig. 235, page 163.

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 tool down with the down-feed handle until the tool scrapes the work (Fig. 377).

6. Move the work to the left and clear of the 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 and allow the tool to cut far enough along the work to observe the full depth of the cut (Fig. 379). If the cut is too deep,

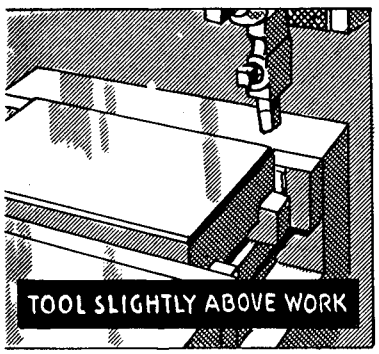


FIG.376

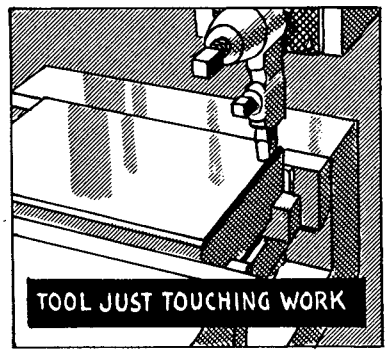


FIG.377

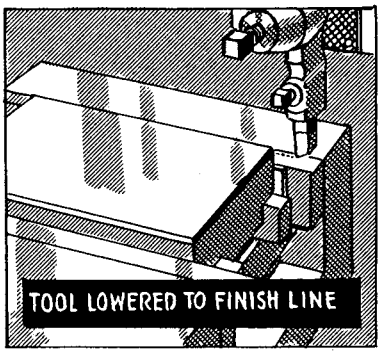


FIG.378

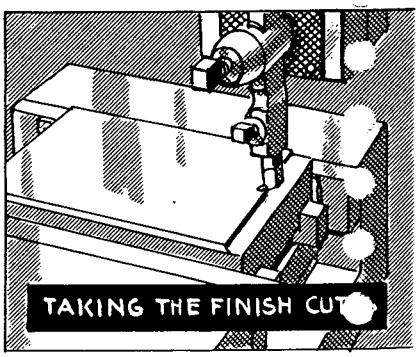


FIG.379

raise the tool slightly, take the back lash out of the screw, and try the cut again.

9. If the cut is not deep enough, increase its depth. When the setting is correct, engage the feed.

10. Place a little coolant on the surface, with a brush, to improve the finish.

11. Stop the feed and shut off the machine when the tool has finished the cut.

12. Remove the work from the vise, and remove the burrs with a fine or mill file.

13. Clean the vise and the table, and replace all tools in their proper places.

HOW TO CHAMFER A SURFACE *when Tool is set at an Angle —*

SETTING THE WORK IN THE VISE

1. If it is necessary to mount the vise on the table, follow the directions given on pages 119 to 121.

2. Set the vise parallel with the direction of the stroke. The zero mark on the vise will coincide with the 90° graduation on the base as pointed out on page 124. (Refer also to page 132.)

3. Clean the vise thoroughly, first with a brush and then 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 oil stone 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 held as low as possible in the jaws to hold the work securely, but high enough to allow the tool to cut without interference.

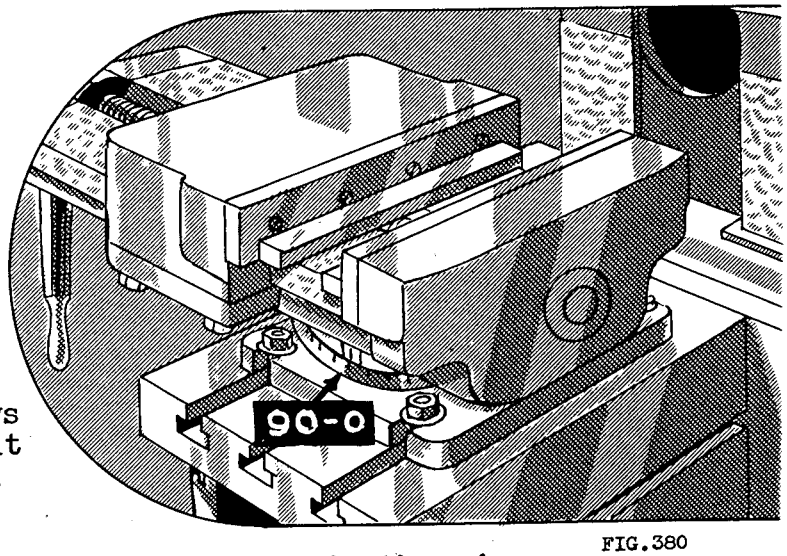


FIG.380

6. Clean the parallels thoroughly and place them in the vise parallel with the jaws.

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. This is especially important when a vise is new and the jaws are true and the ground surfaces are undamaged. 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 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 be used to test the work when it is being seated on the parallels. Frequently, however, 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. If the vise is old, the jaws in poor condition, and the machining requirements of the work not especially accurate, the immediately preceding practice of not using protecting strips may be justified. Judgment, however, must be used in all cases.

7. Put strips of tissue paper on the parallels and 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 (Fig. 381).

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. (Refer to note on page 192 for explanation.)

10. Tap the work down in the vise with a lead or rawhide mallet until the pieces of tissue paper are gripped between the bottom of the work and the top of the parallels (Fig. 382).

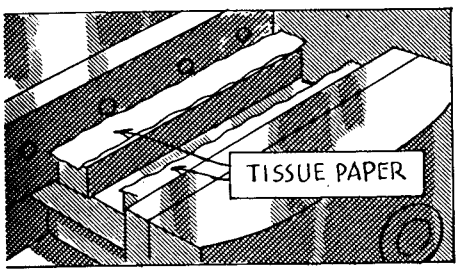
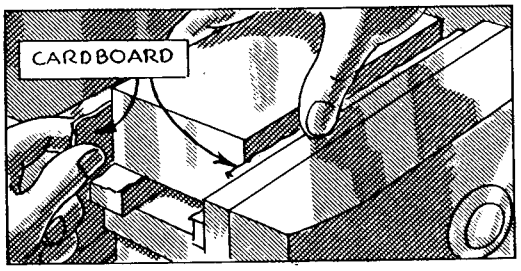


FIG.381



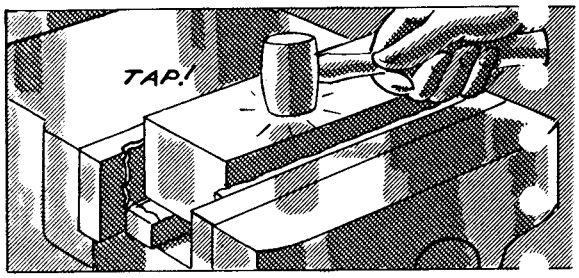


FIG.382

CAUTION The tap with the mallet must be heavy enough to seat the work on the parallels, but not heavy enough to cause the work to rebound from the parallels.

SETTING A SQUARE-NOSED TOOL AND ADJUSTING THE SHAPER PRIOR TO OPERATING

1. If a square-nosed tool is used, select a toolholder that can be set with the cutting edge of the tool behind the point of support (Fig. 383). (Refer also to page 154.) If a tool that will cut on the side is employed, an ordinary holder may be used (Fig. 384).

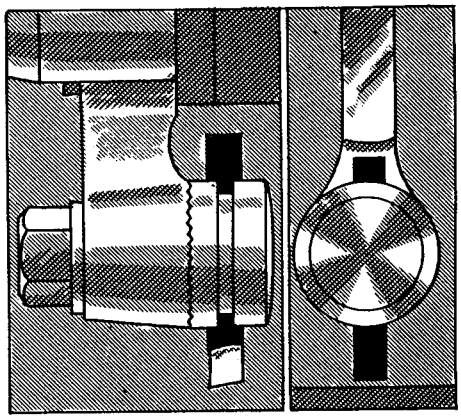


FIG.383

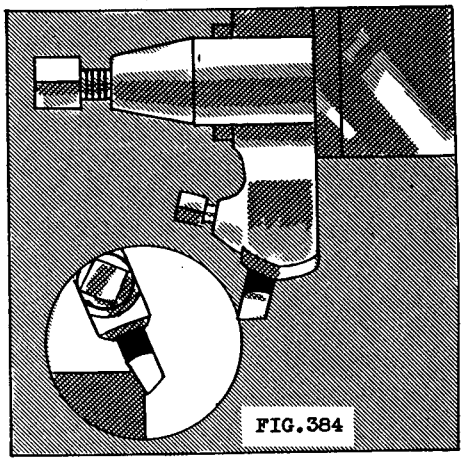


FIG.384

CAUTION When a wide cut is being made and the tool is set ahead of the supporting point, tremendous pressure is built up during the cutting action on account 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. When, however, the tool is cutting on a side edge, 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 there would be in the former case (Fig. 383).

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, or, in other words, "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 about 2-3/4" or less, if the tool does not interfere.

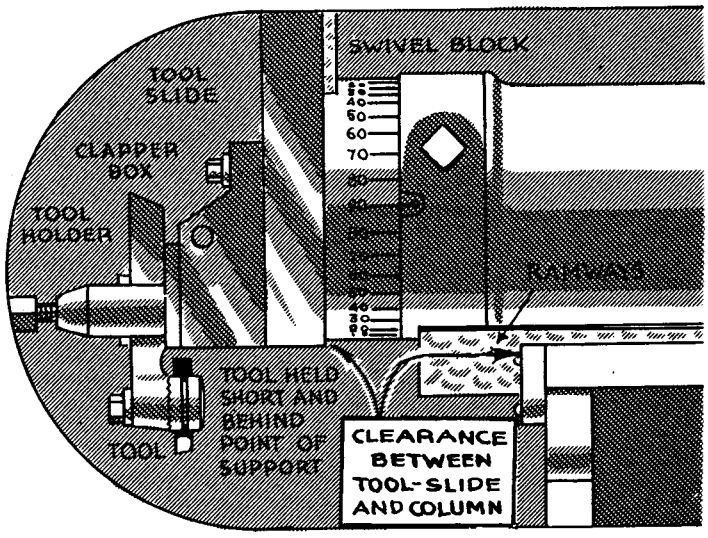


FIG.385

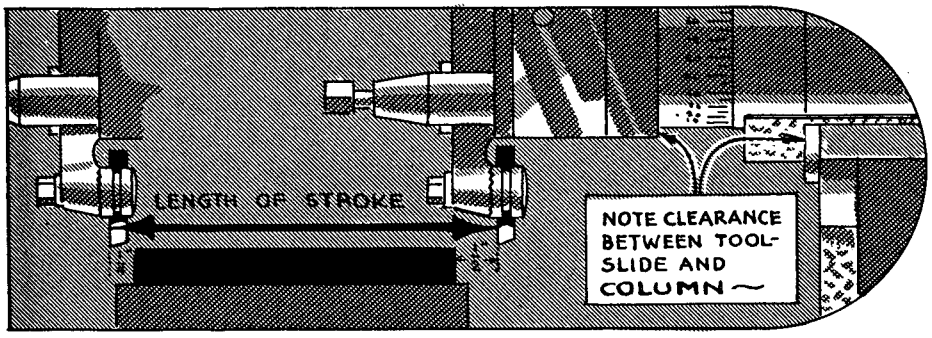


FIG.386

6. Tighten the tool holder in the tool post.

7. Tighten the tool in the tool holder after the tool holder has been clamped securely in the tool post. If the tool holder has been clamped first in the tool post, the tool holder will be rigidly held when the tool is being tightened.

8. Set the stroke of the shaper 3/4" to 1" longer than the length of the surface to be machined (Fig. 386). (Refer to page 79.)

9. Position the ram so that the tool is about 1/4" beyond the work when it is at the forward position (Fig. 386). (Refer also to page 81.)

NOTE: The setting of the tool for angular cutting will depend upon the accuracy of the angular surface. 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, or 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 at 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 notice whether or not the head will strike the column when the head 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, however, care must be observed that the tool head does not strike the column on the return stroke.

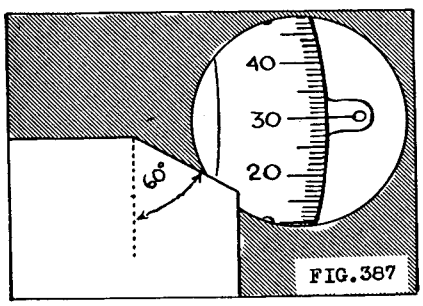


FIG.387

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). (Refer to page 228 for calculations and to page 91 for setting the tool head.)

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 if there is too much space between the bottom of the tool and the top of the work. Be sure that the cross rail is clamped and the table is properly supported after the height of the table has been adjusted (Fig. 389). (Refer also to page 77, How to Adjust the Cross Rail.)

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. Stand in front of the work and the tool, and place the head in such a position that the cutting edge of the tool is in the same line of vision with the scribed line on the surface of the work.

16. Adjust the tool holder by loosening the toolpost 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. (Refer to page 228 for angular calculations.) The tool holder is then adjusted until the edge of the tool and the blade of the protractor are parallel.

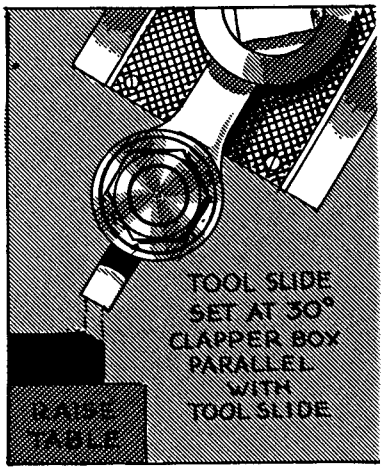


FIG.388

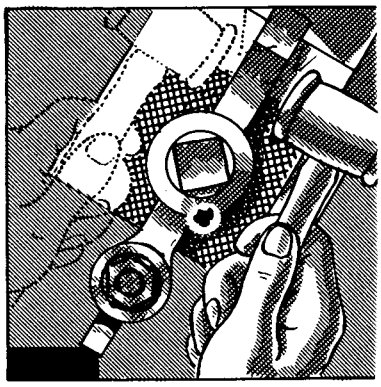


FIG.389

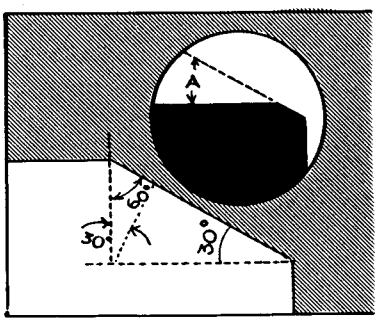


FIG.390

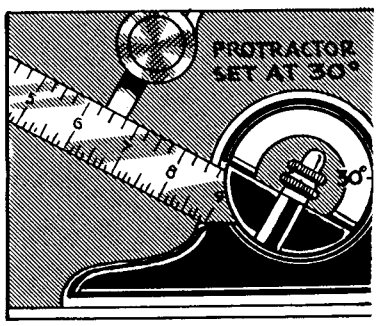


FIG.391

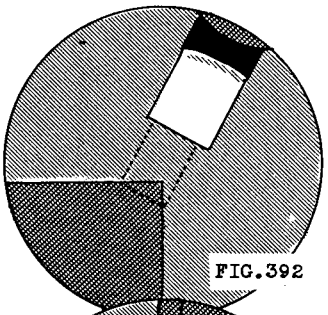


FIG.392

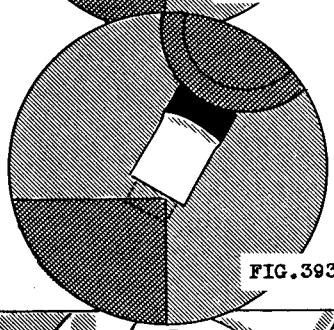


FIG.393

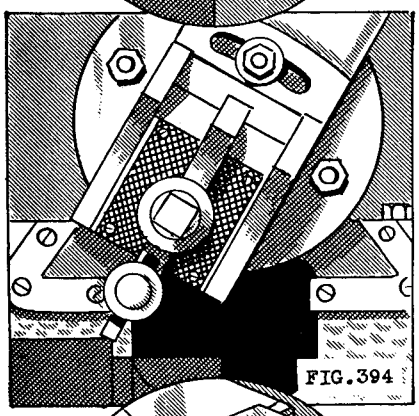


FIG.394

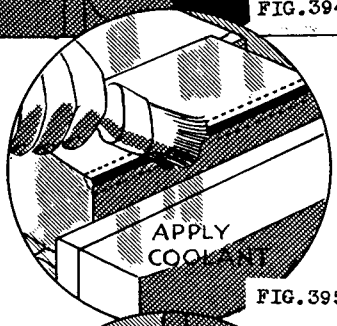


FIG.395

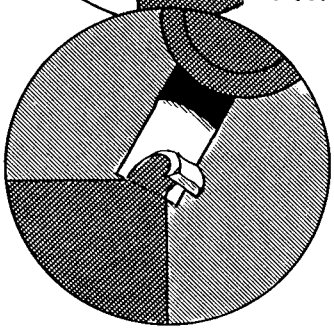


FIG.396

TAKING THE CUT

1. Engage the back gears and set the machine for a slow speed. (Refer to page 82.)

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 and are taken with the back gears engaged because considerable power is required and the speed is reduced to eliminate chatter. Start with a slow speed and increase the speed carefully in accordance with the finish and the type of cut desired.

2. Adjust the work and the table with the cross-feed hand crank until the tool is directly opposite the edge to be cut (Fig. 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 that there is nothing in the path of the tool, and that the speed is correctly set, that the work is securely held, and that all necessary clamps are tightened. This is a good point at which to have the setup 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 coolant to the surface with a brush. This will help preserve the cutting edge of the tool and will produce a smooth, bright surface (Fig. 395). Cast iron is machined dry.

6. Move the tool down about 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, the amount of feed will be gradually decreased.

7. Continue feeding the tool toward the surface until the required width of the cut has been attained.

8. Stop the machine.

NOTE: If the work is made of cast iron, the tool will leave the forward edge of the work broken and rough. To avoid this, a slight bevel is filed 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).

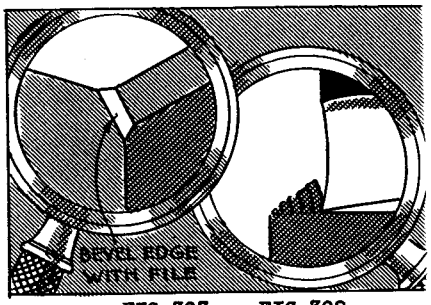


FIG.397 FIG.398

SETTING 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, on the assumption that the surface makes a 15° angle with the vertical position, the head would be moved through 75° in order to feed the tool perpendicularly to the angular surface (Fig. 399). The head is graduated through only 60° for each side of the vertical position. Therefore, the following setup is more convenient.

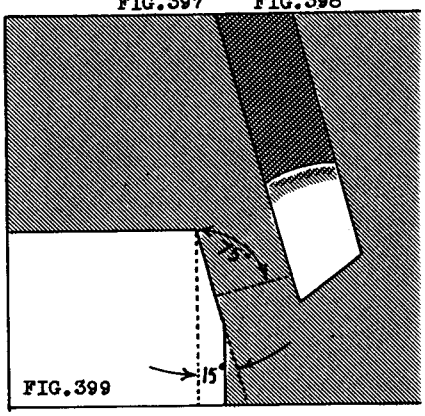


FIG.399

1. Set the tool head in the vertical position (Fig. 400). (Refer also to page 91.)
2. Set the clapper box over to the right (Fig. 400). (Refer also to page 170.)
3. Place the tool holder in the tool post and tighten the tool-post screw securely.
4. Select the tool illustrated in Fig. 399 and on page 166.
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. (Refer to page 79.)

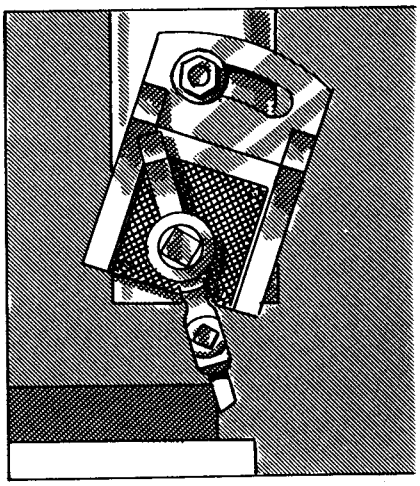


FIG.400

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 (Fig. 386). (Refer also to page 81.)

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 need not be made in any specific order, but should be continued until the tool is set in the desired position.

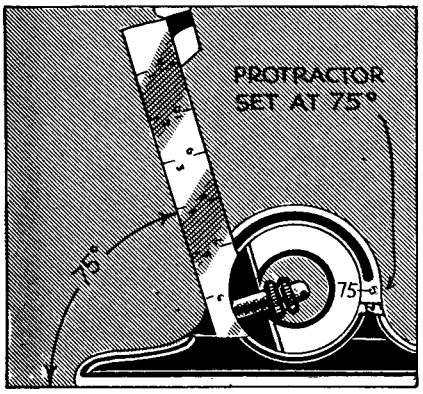


FIG.401

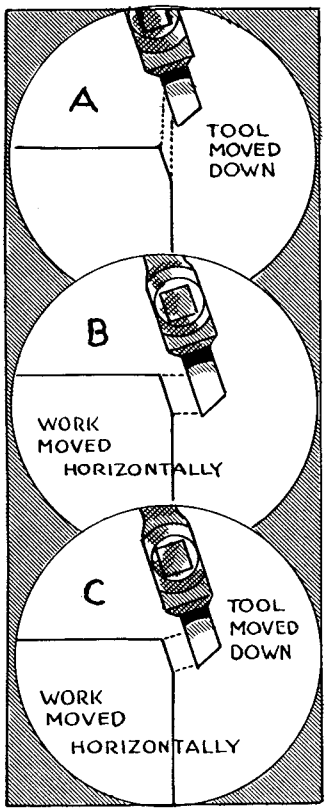


FIG.402

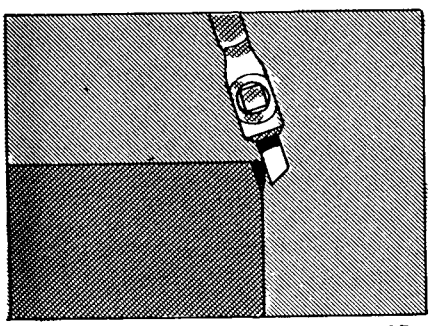


FIG.403

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). (Refer also to page 226 for angular measurements.)

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. For this setting, assume that the tool is to be set in position A.

9. Loosen the rail clamp and adjust the table vertically up or down. Tighten the rail clamp when the adjustment has been made. (Refer to page 77 for adjusting the table vertically.)

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 does not overhang too much when the cut has been completed.

12. Engage the back gears and set the machine for a slow speed. (Refer also to the Caution on page 248.)

TAKING THE CUT

1. Start the machine and move the tool with the down-feed crank until it just scrapes the corner of the work (Fig. 403).

2. Apply a little coolant 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, however, but 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 surface is correct.

6. Stop the machine, take the work from the vise, and remove the burrs from the work with a mill file.

7. Remove the tool from the machine, clean all the tools, and put them in their proper places.

8. Clean the vise and the shaper table.

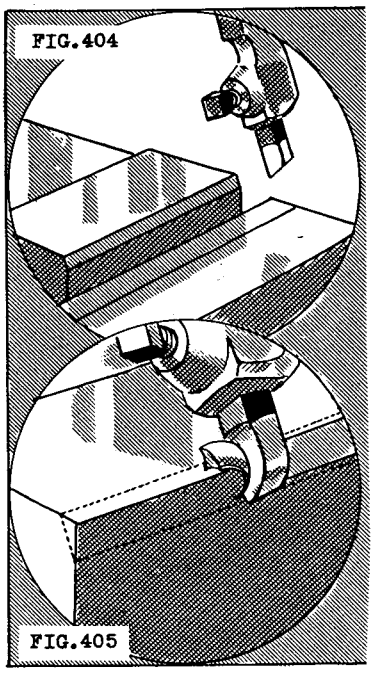


FIG.404

FIG.405

HOW TO PLANE AN ANGULAR SURFACE *when Head is set at an Angle*

MOUNTING THE WORK IN THE VISE ON PARALLELS

NOTE: The degree of accuracy required in both the size and shape of the finished work influences the selection of the procedure to be used when the work is being machined. One of three procedures may be used 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, a cut may be taken across the top surface of the work; (2) the work may be finished on the top, bottom, and sides and then properly seated on the parallels; (3) when greater accuracy is required, the top surface should be leveled with an indicator.

1. Set the work on parallels in the vise following instructions Nos. 1 to 10 on page 243.

2. If enough metal has been left on the top surface for a finishing cut, take a horizontal cut across the top of the work. If the top surface is finished, the proper seating of the work on the parallels will be sufficient.

3. If greater accuracy is required when the top surface of the work is being leveled in the vise, the surface may be leveled with an indicator (Fig. 406).

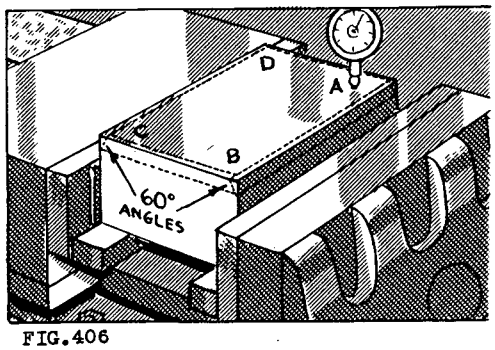


FIG.406

LEVELING THE WORK IN THE VISE WITH AN INDICATOR

NOTE: There is so much similarity between the procedure used to level the vise on the table and the procedure used to level the work in the vise with an indicator that if the word "work" is substituted for the word "parallels," many of the instructions used in the former section, How to Set the Bottom of the Vise Parallel with the Table with an Indicator, can be applied equally well to this section.

1. Attach the indicator to the tool holder. (Refer to instructions Nos. 9 to 14 on page 127.)

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. (Refer to Nos. 16 and 17 on page 128.)

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 leveled in the vise on parallels and has been set down tight on the parallels in the previous setting, a shim must be placed underneath the 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 down with a soft mallet until all paper shims are tight between the work and the parallels.

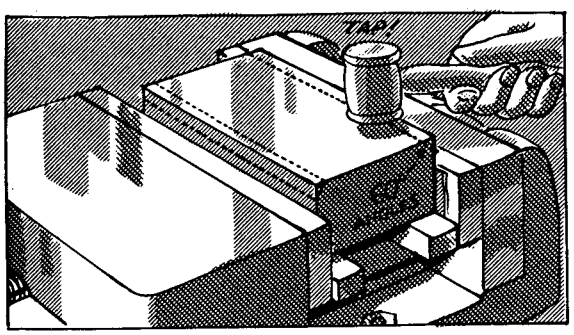


FIG.407

9. Test again the work surface at all four points and repeat the shimming and testing process until all points are level.

10. Remove the indicator from the tool holder, and place the indicator in the box.

SETTING 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. For adjusting the stroke on the crank shaper, refer to How to Adjust the Stroke on pages 79 and 80; for the hydraulic shaper, refer to How to Adjust the Stroke and Position the Ram on pages 92 and 93.

2. Move the ram back until it is at the beginning of the stroke and observe whether or not the tool head will strike 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, for if the tool head were to strike the ram ways on the return stroke, the head would be broken or damaged severely.

3. Assume that an angular cut of 60°, as indicated in Fig. 409, must be made.

4. Determine the angle to which the tool head must be swiveled from the vertical position. This angle is 30°, or the complement of 60°. (Refer to page 228 for the definition of complementary angles.)

   NOTE: The operator should observe which of the two methods, described on page 228, is used to graduate the tool head.

5. Loosen the head lock, and swivel the head to the right until the 30° graduation on the tool head coincides with the zero mark on the ram (Fig. 410). This will be the setting if the graduations start with a zero on the tool head when it is in a vertical position. (Refer to page 91, How to Adjust the Tool Head.)

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 it is in a vertical position.

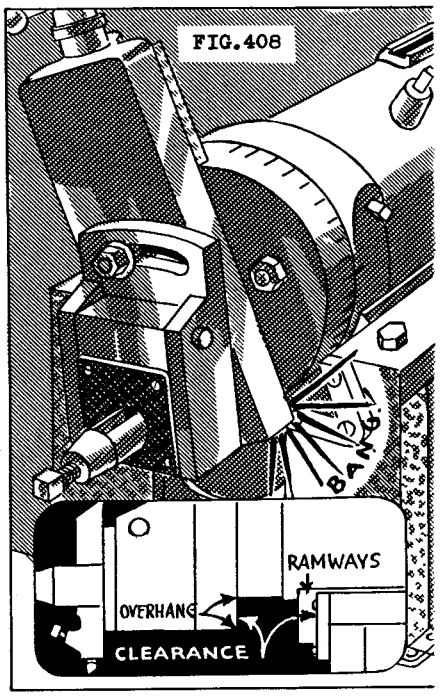


FIG.408

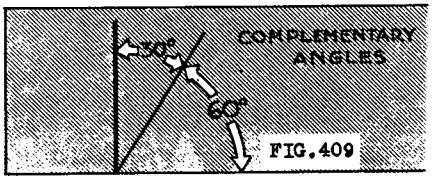


FIG.409

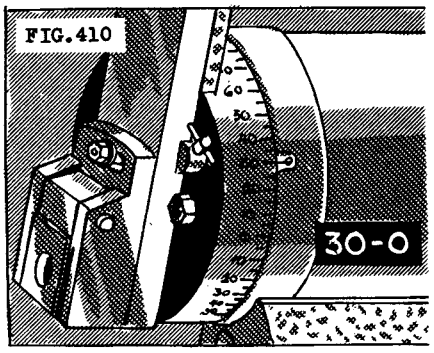


FIG.410

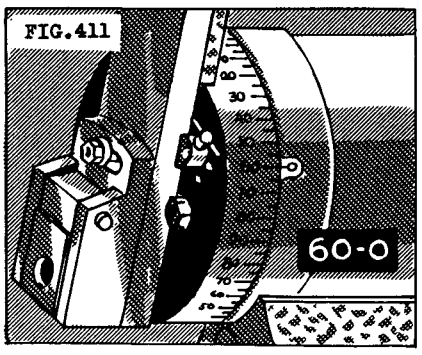


FIG.411

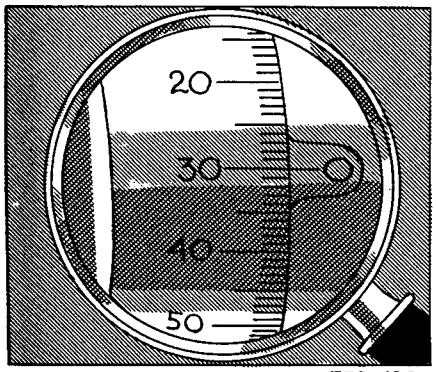


FIG.412

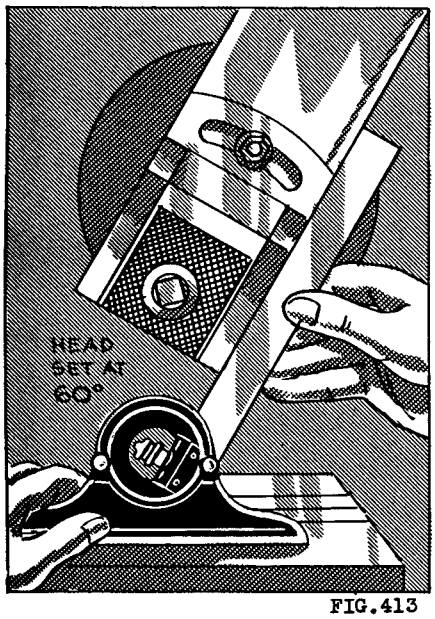


FIG.413

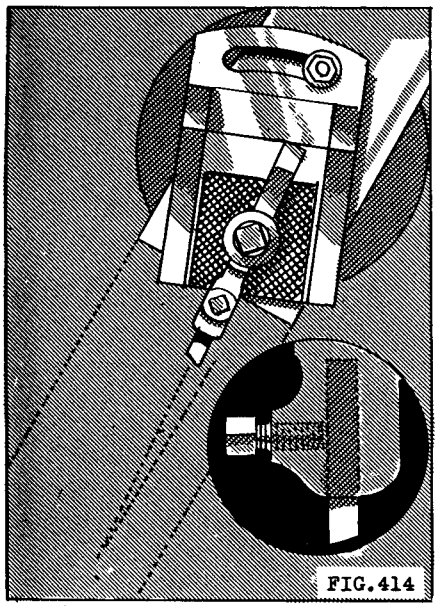


FIG.414

7. Use a magnifying glass to make certain that the zero mark on the ram coincides exactly with the graduation on the head. The glass magnifies any slight variation in the position of the matching lines, thereby making possible a more accurate adjustment of the markings.

8. Tighten the head lock securely after the tool head has been set in position.

   NOTE: The head may be set with the aid of 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.

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. (Refer also to page 179.)

SETTING THE TOOL AND ADJUSTING THE SHAPER PRIOR TO OPERATION

1. Select a tool holder like the one illustrated in Fig. 209, page 155. This will hold the tool parallel (horizontal) with the shank of the tool holder, and will allow the tool to be set at a slight angle to the angular surface without interfering with the side of the tool holder (Fig. 414).

2. Place the tool holder in the tool post so that it makes an angle of about 5^{o} to 10^{o} with a line parallel with the side of the tool slide (Fig. 414).

3. Tighten securely the tool holder in the tool post.

4. Move the tool slide down until there is not more than 1" overhang (Fig. 408).

5. Select a tool similar to the one illustrated on page 162, Fig. 229, but ground to cut on the opposite side.

6. Estimate the distance that the tool must project beyond the holder to permit the tool holder to

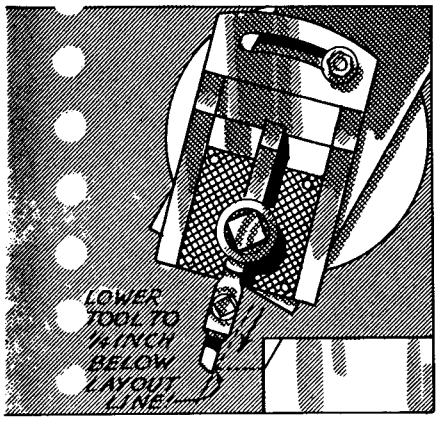


FIG.415

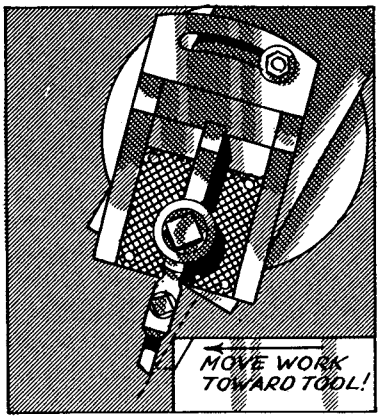


FIG.416

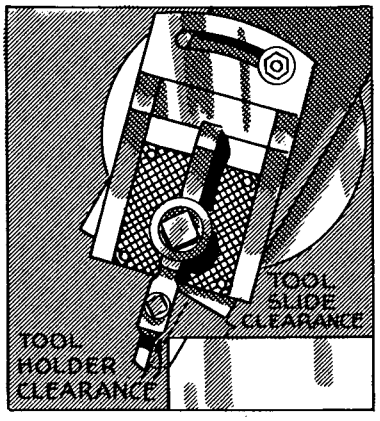


FIG.417

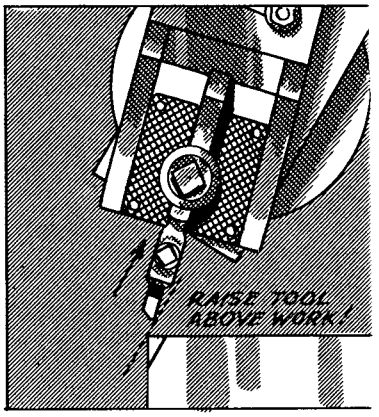


FIG.418

clear the surface being machined (Fig. 417).

7. Tighten the tool temporarily in position with the fingers because the final setting of the tool and the work is a combination of the following adjustments (Nos. 8 to 12).

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). Refer to page 77, How to Adjust the Cross Rail.

9. Move the table horizontally until the work is near the tool (Fig. 416). Refer to page 78, How to Adjust the Table Horizontally.

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 surface (Fig. 418).

12. Tighten securely the tool holder in the tool post and the tool in the tool holder.

13. Be sure that the clamps on the cross rail are tightened and that the table supports are adjusted properly. (Refer to page 77.)

14. Move the ram to the forward position.

15. Adjust the ram until the cutting edge of the tool is 1/4" beyond the forward edge of the work. Refer to page 81, How to Adjust the Position of the Ram.

16. Bring the ram back to the beginning of the stroke and make sure that there is enough clearance for the tool to drop clear of the work, ready for the cutting stroke.

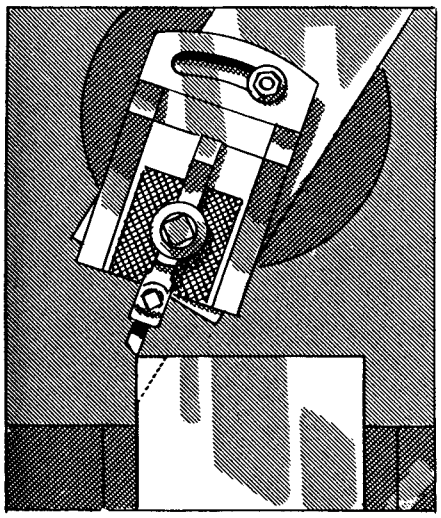


FIG.419

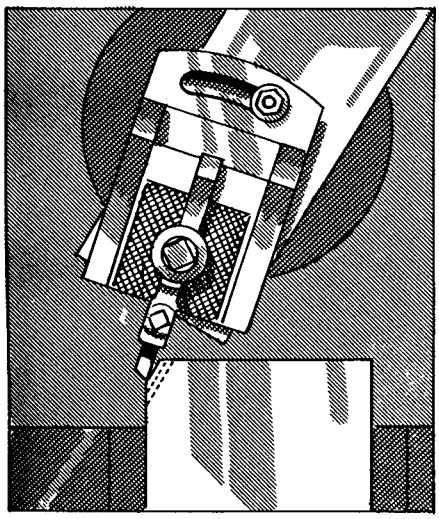


FIG.420

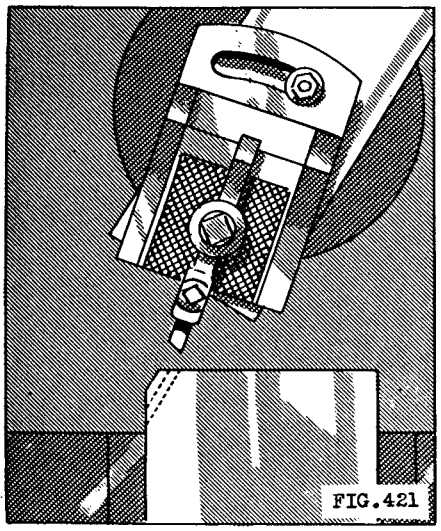


FIG.421

TAKING THE CUT

1. Assume that the length of the cut is 6" and the cutting speed is 80 feet per minute for roughing steel.

2. Either calculate the strokes per minute by using the formula given on page 303 or set the strokes per minute according to the directions given on pages 82 to 88. Choose the instructions to suit the type of shaper that is being operated.

3. Move the work clear of the tool with the table cross-feed handle.

4. Start the machine.

5. Shift the position of 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 about 1/8", or 125 thousandths on the graduated dial, in a direction toward the tool (Fig. 421).

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 a semifinishing cut and may be used to check 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).

13. If the angular surface is incorrect, the head may be adjusted by first loosening the head

lock and then tapping the head in the required direction with the hand or a soft mallet.

14. Tighten the head lock.

15. Start the machine and take a trial cut.

16. Repeat the procedure given in Nos. 11 to 15 until the angular setting of the tool head is correct.

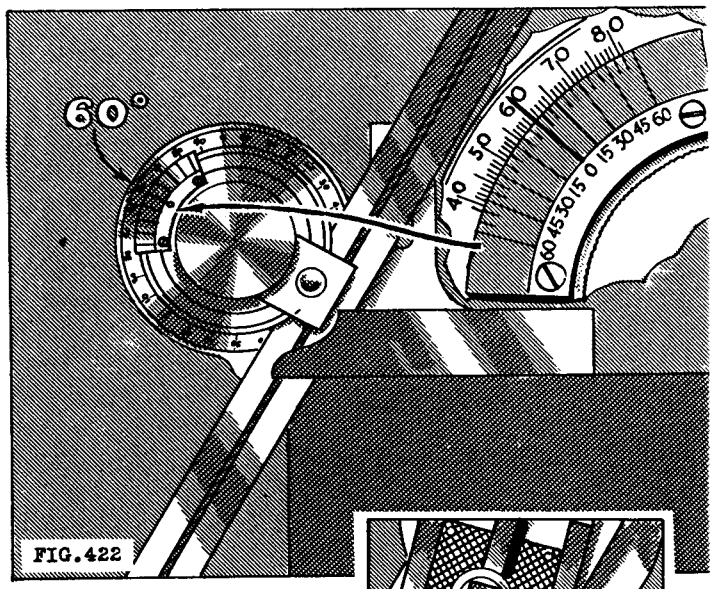


FIG.422

TAKING THE FINISHING CUT

1. Select a finishing tool similar to the one illustrated in Fig. 229 A, page 162.

2. Stone the cutting edge of the tool (page 325).

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, and so that the tool holder and tool slide will have clearance 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 scrapes the edge of the work (Fig. 423).

7. Raise the tool until it is above 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 at a time 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

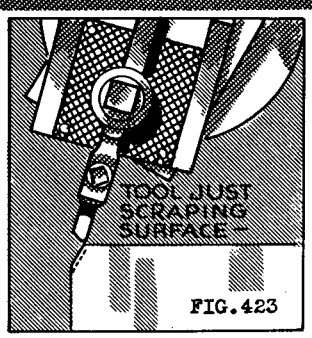


FIG.423

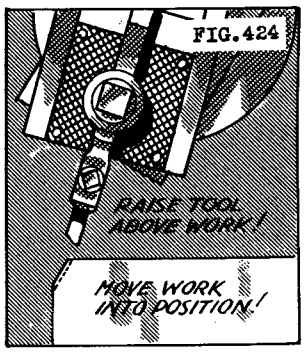


FIG.424

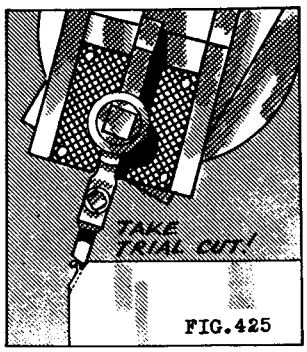


FIG.425

the tool is not cutting to the line, move the work over slightly, but be careful not to cut below the line.

10. Add a little coolant to the surface with a brush, and complete the cut.

11. Stop the machine.

NOTE: The same procedure will be 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. Fig. 426 shows the correct setting of the head in relation to the angular surface of the work.

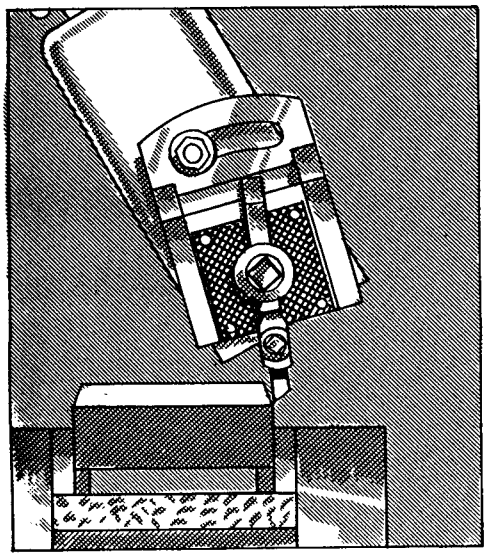


FIG.426

12. Remove the work from the vise after all operations have been completed.

13. Carefully remove the burrs from the work with a file, and 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 absorb with waste the coolant from the vise and the table.