HOW TO CUT SLOTS, SERRATIONS, SIMPLE CONTOURS

Unit 1-P53(C) Parts I, II, and III Pages 265 to 292

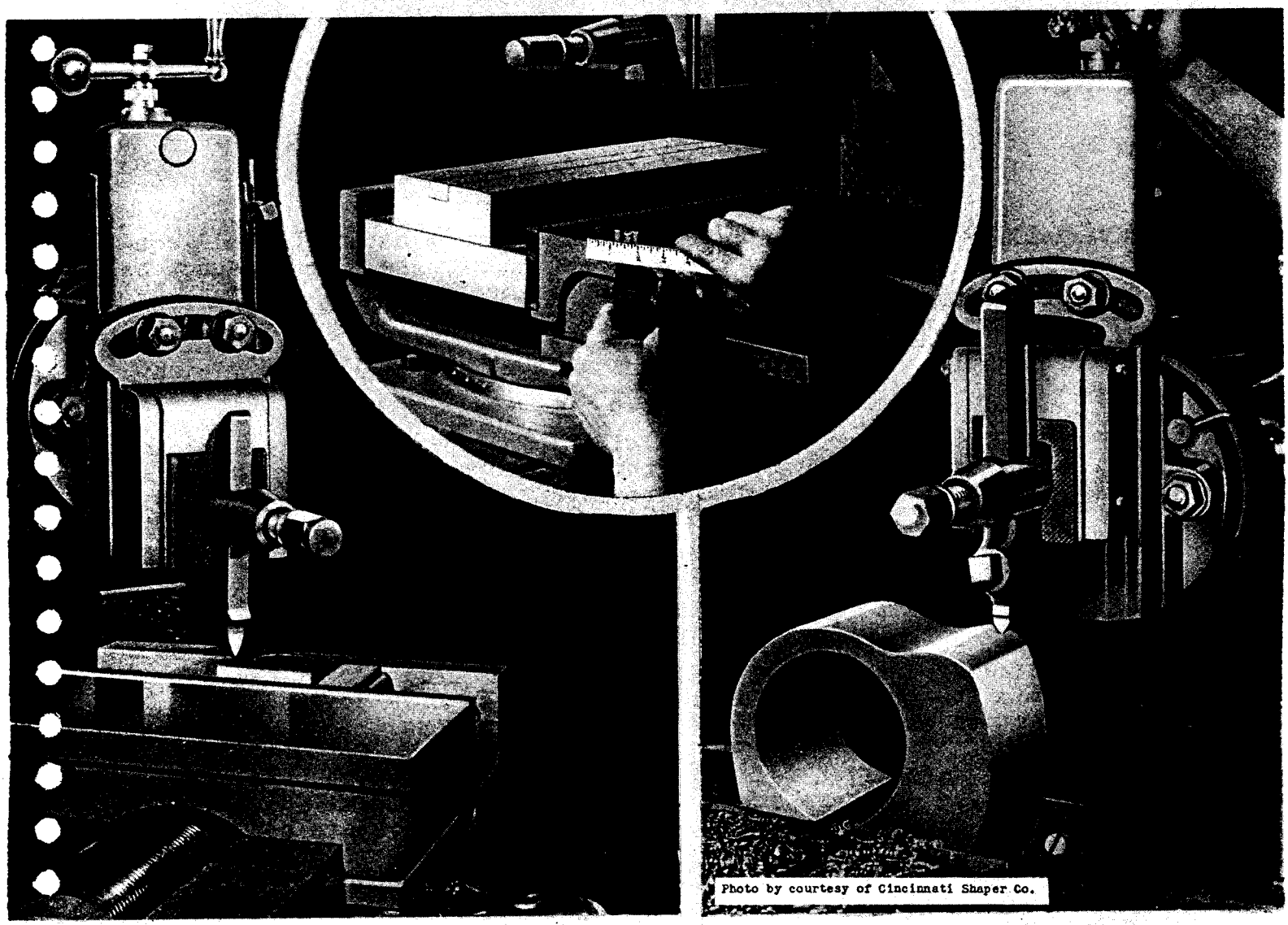


Photo by courtesy of Cincinnati Shaper Co.

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

OBJECTIVES OF UNIT

1. To explain how to cut off material and how to cut slots.
2. To explain how to cut a serrated surface.
3. To explain how to produce simple form cuts or contours.

INTRODUCTORY INFORMATION

Material is often cut off in the shaper when it cannot be held conveniently in the power saw or when the ends of the pieces cannot be finished satisfactorily and with the desired degree of accuracy by this means. For example, material which is too large for the saw vise may be clamped to the shaper table where pieces may be cut off accurately in respect to length and with a reasonably good finish on the ends.

Slots which vary considerably in width, in depth, and in shape can be cut in the shaper, and it is these factors which determine to a large extent the cutting procedure itself. For example, a single cut made with a tool ground to the exact width may be satisfactory for cutting a narrow slot, but for a wide slot, or one of irregular shape, several cuts will be more expedient.

The pattern of a serrated surface is determined by a combination of factors, such as the shape of the tool used to cut the grooves, the spacing of the grooves and, finally, the position of the job in relation to the stroke of the ram. A change in any one of these factors alters the design of the serrations.

Instructions are given for two procedures which may be used to produce simple contours or forms; in one, the vertical adjustment of the tool and the horizontal movement of the work are both controlled by hand; in the other, the work is moved horizontally by means of the automatic feed, and the vertical movement of the tool is controlled by hand. Both these methods require judgment in determining the amount of movement of the tool and the work. First attempts to shape the curve may be unsatisfactory, but with a little experience and a little care, good results should be obtained.

TOOLS AND EQUIPMENT

Shaper	Measuring and Gaging Tools	Brush for Chips
Mill File	Goggles or Shield	Rawhide Mallet
Wrenches	Magnifying Glass	Cleaning Cloth
Coolant	Cutting Tools	Slot Cleaner
Tool Holder	Brush for Coolant	Parallel Blocks

HOW TO CUT OFF AND CUT SLOTS

PROCEDURE

MOUNTING THE VISE AND THE WORK

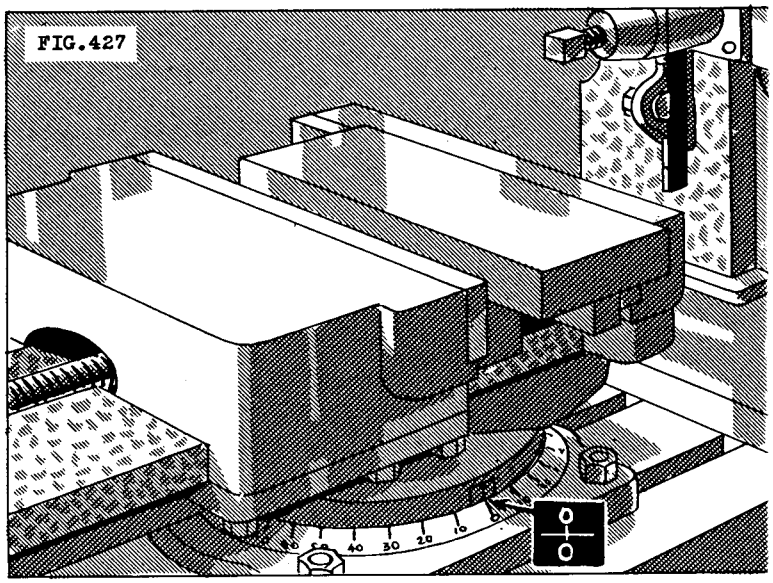


FIG.427

1. If it is necessary to mount the vise on the table, follow the directions given on pages 119 to 121. Select the procedure to suit the style of the vise.

2. Set the vise at 90° to the direction of the stroke. The zero marks on the vise will coincide with the zero graduations on the base (Fig. 427).

3. Thoroughly clean the face of the jaws and the working surface of the vise.

4. Select two parallel blocks that will hold the top surface of the bar about even with the top of the vise jaws (Fig. 427). The parallels may be omitted if the bar is large enough to reach the top of the vise.

5. Clean the parallels and place them in the vise.

6. Use whatever protecting strips are necessary to safeguard the work, the top of the parallels, and the faces of the vise jaws from injury. Refer to note on page 244 for this information.

7. Place the bar on top of the parallels, allowing it to extend beyond the right side of the vise a distance about 1/4" more than the length of the piece which is to be cut off.

8. Hold the work down on the parallels and clamp the vise securely.

9. Tap the work down on the parallels with a lead or rawhide mallet until the pieces of paper are gripped between the bottom of the work and the top of the parallels (Fig. 427).

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.

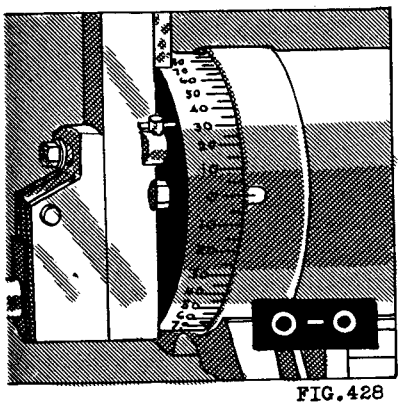
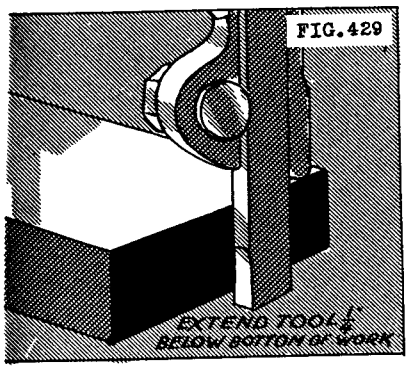


FIG.428

SETTING THE TOOL AND THE TOOL HEAD

1. Examine the setting of the tool head (Fig 428) and, if it is not exactly in the vertical position, make the necessary adjustment. This is important, for if the tool is not fed down in a position that is exactly perpendicular, it will bind in the slot. An alternate method of setting the tool head with a square is explained on page 213, steps No. 2 to No. 5.

2. Select a straight cutting-off tool (Fig. 210) and a blade as shown on page 166.



3. Place the assembled tool and tool holder in the tool post, being certain that the heel of the tool holder clears the plate and that the tool projects beyond the holder a distance about 1/4" greater than the height of the work (Fig. 429).

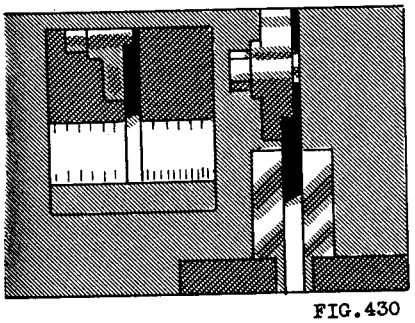


FIG.430

4. Manipulate the tool and work until the top surface of the work can be used to set the tool square (Fig. 430). A small square, the edge of a scale, or a small square block may be used to set the tool square with the top surface of the work. (Refer to page 172 for setting the tool square.)

5. Tighten the tool holder in the tool post and the tool in the tool holder.

6. Check the setting to make certain that the position of the tool did not change during the tightening process.

ADJUSTING THE SHAPER PRIOR TO OPERATING

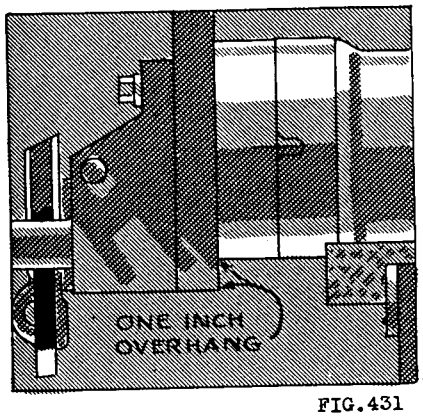


FIG.431

1. Adjust the tool slide so that it is projecting not more than 1" beyond the bottom edge of the swivel block (Fig. 431).

2. Move the table horizontally until the side of the tool is about even with the edge of the work (Fig. 432). Refer to page 78, How to Adjust the Table Horizontally.

3. Raise or lower the table until the cutting edge of the tool is slightly below the bottom of the work (Fig. 429). Refer to page 77, How to Adjust the Cross Rail.

4. Raise the tool slide until the tool is above the top of the work (Fig. 432).

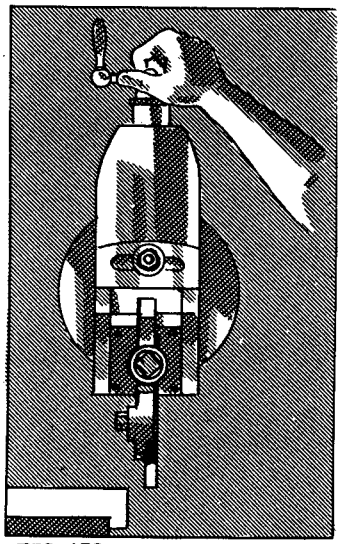


FIG.432

5. Adjust the stroke of the ram. Refer to page 79, How to Adjust the Stroke, and to page 92, How to Adjust the Stroke on the Hydraulic Shaper.

CAUTION Often a tool of this kind has a tendency to bind in the slot, and, as a result, it does not release from the slot on the return stroke in time to allow the tool to drop clear of the work and ready for the next cut (Fig. 436). To overcome this, 1/4" to 1/2" more than the usual 1/2" may be allowed between the work and the beginning of the stroke (Fig. 433). This will allow the tool to be pulled clear of the slot.

6. Adjust the position of the ram so that the cutting edge of the tool is 1/4" beyond the front end of the work when the ram is in the forward position (Fig. 433). Refer to page 81, How to Adjust the Position of the Ram on the Crank Shaper, and to page 92, How to Adjust the Position of the Ram on the Hydraulic Shaper.

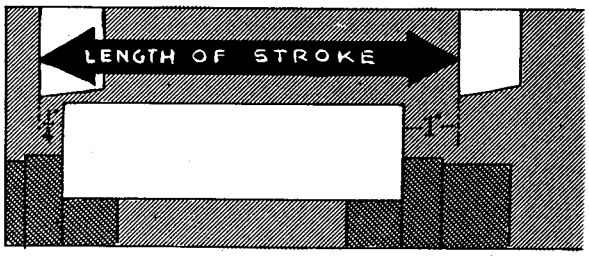


FIG.433

7. Set the speed of the machine for a roughing cut. Make the necessary calculations to suit the kind of material and the length of the stroke. Refer to page 82, How to Adjust the Speed of the Crank Shaper, and to page 94, How to Adjust the Speed of the Hydraulic Shaper. (For speed calculations, refer to page 303.)

TAKING THE CUT

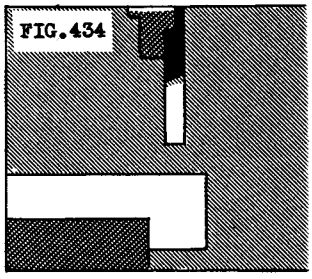


FIG.434

1. Move the ram to bring the tool directly above the work (Fig. 434).

2. Move the tool down with the down-feed crank until the tool nearly touches the work (Fig. 435).

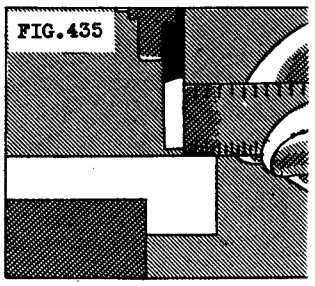


FIG.435

3. Place a scale against the side of the tool and move the table horizontally until the edge of the work coincides with the graduation on the scale (Fig. 435).

HAVE ENTIRE SET-UP *CHECKED* BY YOUR INSTRUCTOR

Oil the shaper as directed in How to Oil the Shaper, beginning on page 47.

4. Start the machine.

CAUTION Stand clear of the ram when the machine is started. This is merely a precautionary measure in case some adjustment has been overlooked.

5. Move the tool down a few thousandths at a time until the tool starts to cut.

CAUTION Goggles or a shield should be worn to protect the eyes from flying particles. Keep the head to one side of the tool and as far away from the work as practicable.

6. Stop the machine; check the length of the piece, and make any necessary adjustments by moving the table horizontally to the left or to the right.

7. Start the machine; apply a small quantity of coolant with a brush, and continue to move the tool down a few thousandths at the beginning of each stroke.

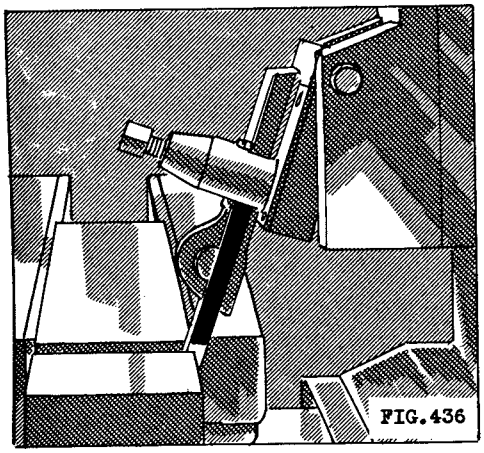


FIG.436

8. Observe the action of the tool as it cuts deeper into the metal. If the tool binds in the slot, look for one of the following reasons: (1) the cutting edge of the tool may be dull; (2) the tool may be incorrectly set; (3) the clearance angles of the tool may be incorrectly ground.

9. Remedy the causes of the above conditions by regrinding and resetting the tool. (Refer to page 166 for tool clearance angles.)

10. Continue cutting down until the piece has been completely cut from the bar.

CAUTION To avoid injury if the piece should fall from the bar, keep the hands and feet from underneath the part being cut off.

11. Stop the machine; raise the tool; and move the work out from the vise, ready for the next cut.

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

13. Remove and clean all tools, and return each part to its proper place.

14. Brush the chips from the vise and the table.

CUTTING A SLOT

PROCEDURE

MOUNTING THE VISE AND THE WORK

1. If it is necessary to mount the vise on the table, follow the directions given on pages 119 to 121. Select the procedure to suit the style of the vise.

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 (Fig. 437).

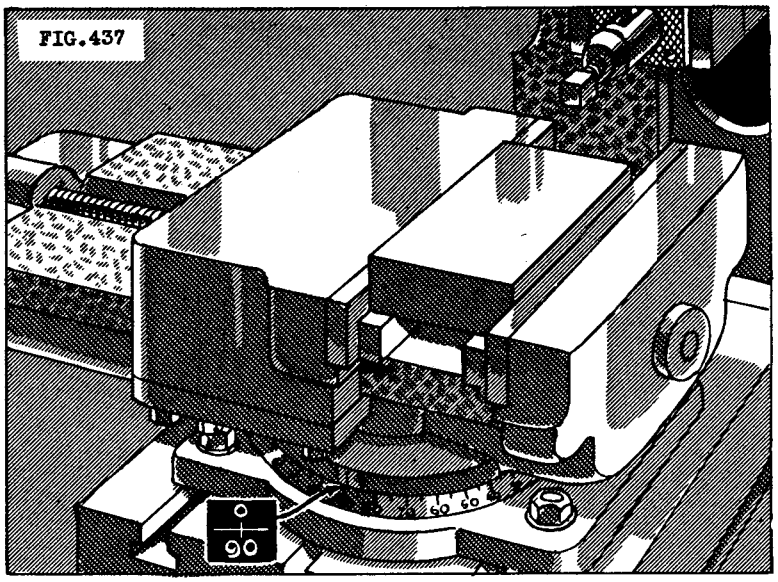


FIG.437

3. Mount the work in the vise, being careful to follow the procedure given on page 191, How to Mount the Work in the Shaper Vise.

SETTING THE TOOL

1. Set the tool head in a vertical position by using the graduations on the swivel block, or by placing the blade of a square against the side of the tool slide (Fig. 438).

2. Select a tool holder as shown on page 155, Fig. 205.

3. Select a tool bit for slot cutting as shown on page 166, and grind it to the exact width of the slot.

4. Assemble the tool in the tool holder so that the cutting edge of the tool will be held behind the point of support (Fig. 439). Have the tool project beyond the tool holder about 1/4" more than the depth of the slot.

5. Place the assembled tool, and the tool holder, in the tool post and tighten the tool-post screw to hold the tool holder and the tool temporarily in a vertical position.

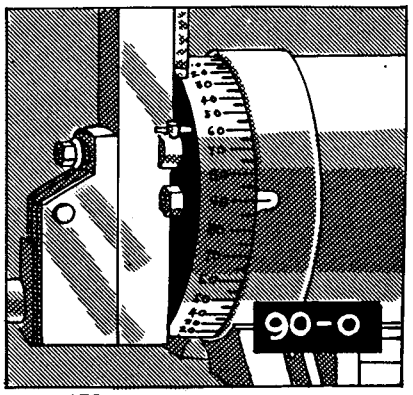


FIG.438

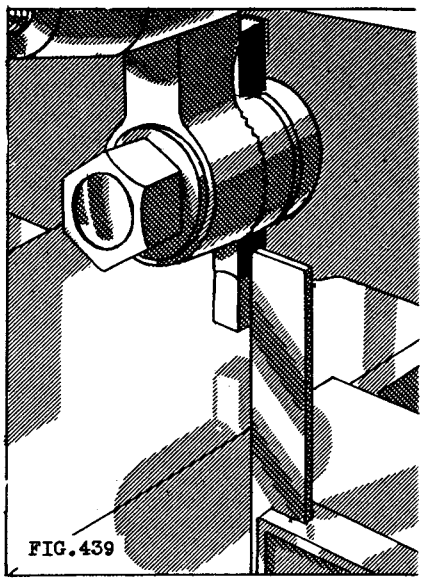


FIG.439

6. Move the tool and the work until the top surface of the work can be used to support a gage to set the tool square (Fig. 439).

7. Use a small square, the edge of a scale, or a small square block to set the tool square with the surface (Fig. 439). (Refer also to pages 268 and 171 for setting the tool square.)

NOTE: An experienced mechanic will often set the tool square by sighting the tool with the eye. Then, if the tool should bind on one side as it feeds into the slot, a further adjustment is made. However, when the tool is set by using a squared edge, first against one side and then against the other, the trial-and-error procedure is eliminated.

8. Tighten the tool-post screw to hold the tool holder in the tool post, and tighten the tool securely in the tool holder.

9. Check the tool setting to make certain that the tool did not change during the tightening process.

ADJUSTING THE SHAPER PRIOR TO OPERATING

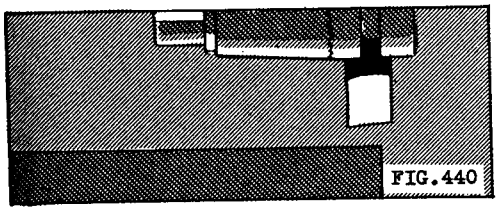


FIG.440

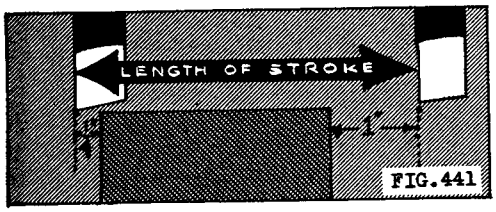


FIG.441

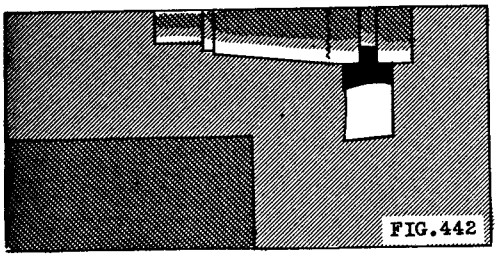


FIG.442

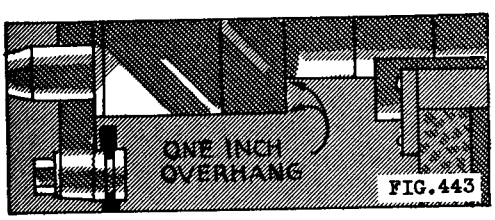


FIG.443

1. Raise the tool slide so that the tool is above the top surface of the work (Fig. 440).

2. Adjust the stroke of the ram. Allow 1/4" for the tool to travel beyond the forward edge of the work and allow about 1" between the cutting edge of the tool and the edge of the work when the ram is at the beginning of the stroke. This 1" clearance will enable the tool to pull clear of the work if it should bind in the slot (Fig. 441). Refer to Caution on page 269.

3. Adjust the position of the ram so that the cutting edge of the tool is about 1/4" beyond the front edge of the work when the ram is in the forward position (Fig. 441). Refer to page 81 for adjusting the ram on the crank shaper and to page 92 for adjusting the ram on the hydraulic shaper.

4. Move the ram back until the tool is at the beginning of the stroke (Fig. 442).

5. Adjust the tool slide so that it is projecting not more than 1" beyond the bottom edge of the swivel block (Fig. 443).

6. Adjust the table until the cutting edge of the tool is level with the bottom of the slot (Fig. 444). The tool is now set so that it will reach the bottom of the slot without the tool slide projecting more than 1" below the bottom edge of the tool head. Refer to page 77 for adjusting the table vertically.

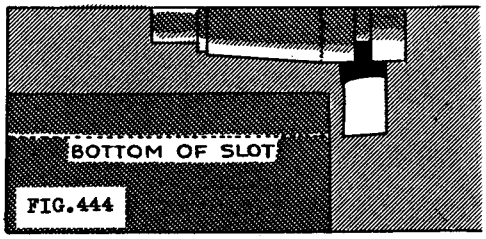


FIG.444

7. Make certain that the cross-rail clamps are tightened and that the table support is adjusted properly.

8. Raise the tool until it is above the top surface of the work (Fig. 445).

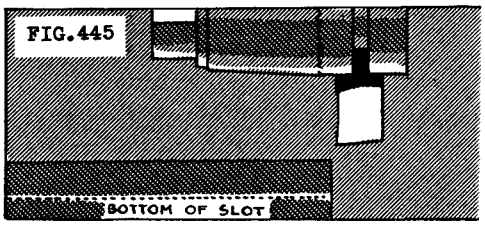


FIG.445

9. Set the speed of the machine for a roughing cut, basing the selection on the kind of material and the length of the piece. Refer to page 82, How to Adjust the Speed of the Ram, and to page 94, How to Adjust the Speed of the Ram on a Hydraulic Shaper. (For speed calculations, refer to page 303.)

CAUTION Check carefully before starting the machine to see that the speed of the ram is correctly set. An excessive speed and a long stroke may damage the shaper.

CUTTING THE SLOT

OIL Oil the shaper as directed in How to Oil the Shaper, beginning on page 47.

1. Move the ram forward until the tool is above the top of the work (Fig. 446).

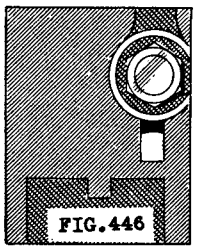


FIG.446

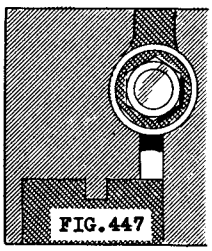


FIG.447

2. Move the tool down until the tool touches the top surface of the work and then set the graduated collar on the down-feed screw at zero (Fig. 447).

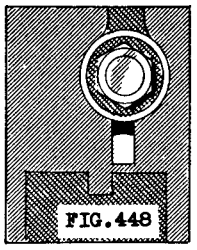


FIG.448

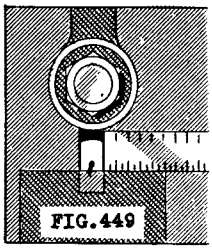


FIG.449

3. Raise the tool slightly (Fig. 448) to prevent it from dragging on the surface of the work during the time the work is being moved into position.

NOTE: A number of procedures may be used to set the tool: (1) the tool may be set to the layout line; (2) a scale may be used to locate the side of the tool with the edge of the slot (Fig. 449); (3) the work may be moved a distance indicated on the graduated collar that is attached to the table feed screw (Figs. 450 and 451).

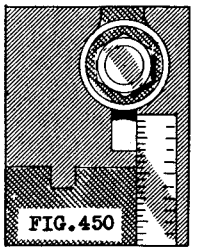


FIG.450

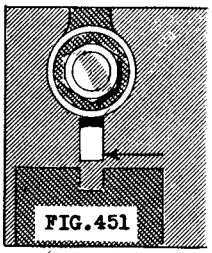


FIG.451

4. If the tool is set to the layout line, move the work until the sides of the tool coincide with the layout lines representing the position of the slot.

5. If a scale is used to set the tool, place the edge of the scale against the side of the tool and then move the work until the desired graduation on the scale coincides with the side of the work (Fig. 449). A magnifying glass may be used to see whether or not the side of the work and the graduation on the scale coincide.

6. If the tool is set with the aid of the graduations on the collar of the feed screw, first move the work until the side of the tool is even with the side of the work (Fig. 450); next, set the graduated dial at zero, making certain that the back lash is out of the screw; and, finally, move the work the desired distance (Fig. 451), using the graduated collar to indicate the distance the table and the work have been moved.

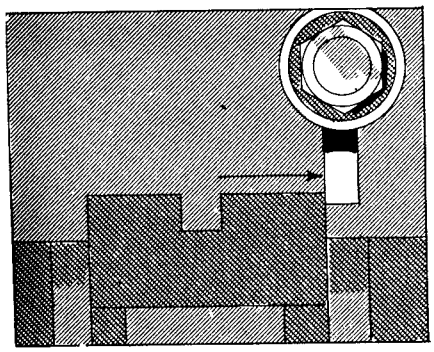


FIG.452

NOTE: An alternate method of setting the side of the tool even with the side of the work is shown in Fig. 452. When this method is being used, raise the tool after it has been set lightly against the work, and then move the work over the desired distance plus the width of the tool.

7. Check the setting.

8. Calculate the number of complete turns and the additional partial turn of the down-feed screw that must be made in order to feed the tool down to the correct depth of the slot. For example, if the graduated collar is divided into two hundred divisions and the slot to be cut is 3/8" (.375") deep, the down-feed crank will be given one complete turn and one hundred seventy-five divisions on the graduated dial.

9. Start the machine and feed the tool down a few one-thousandths at a time during the interval when the tool drops clear of the work on the return stroke and before it starts again on the forward stroke.

CAUTION Do not use a coolant on cast iron.

10. Feed the tool down until the full depth of the cut has been attained. Since the graduated collar was set at zero, as instructed in step No. 2, the down-feed crank will finally make one complete turn and one hundred seventy-five divisions on the graduated collar.

11. Stop the machine and test the depth of the slot with a scale, a depth gage, or a micrometer depth gage (Fig. 453).

12. Raise the tool clear of the slot.

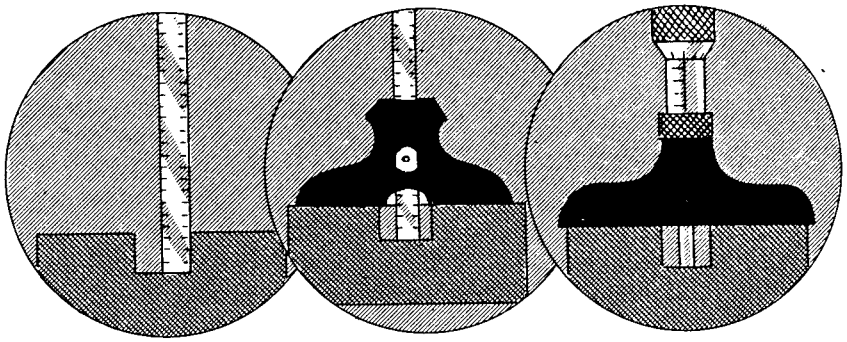


FIG.453

NOTE: If a slot is being cut with a tool ground to the exact width, the slot will be finished when the correct depth has been obtained. When, however, a slot is to be cut wider than the width of the tool, the procedure will be the same for cutting the first side of the slot. In this case, do not change the setting of the work because this can be used as a starting position for the second cut of a slot.

CUTTING A SLOT WIDER THAN THE TOOL

1. Follow the procedure given in the preceding section for cutting the first side of the slot.

2. Subtract the width of the tool from the width of the slot (Fig. 454). For example, if the width of the slot is 3/8" and the width of the tool is 1/4", the amount left after subtracting 1/4" from 3/8" will be 1/8" (.125").

3. Make certain that the back lash is out of the table feed screw; then move the work over the desired distance. Use the graduated collar to indicate the space through which the table must be moved.

4. Start the machine and take a trial cut about 1/64" (.015") deep (Fig. 454).

5. Stop the machine and check the width of the slot with a scale or a gage block (Figs. 455 and 456).

6. Compensate for any inaccuracy in the width of the slot by moving the table to the left

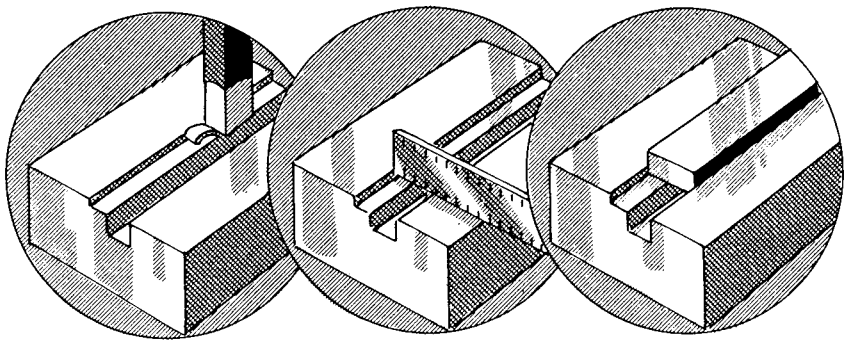


FIG.454 FIG.455 FIG.456

if the slot is too wide, and by moving the table to the right if the slot is too narrow.

NOTE: If the adjustments are made carefully in the beginning, the width of the slot should be correct to within a few one-thousandths of an inch. Also, a trial cut should not be taken too far over when the width of the slot is being machined, and not cut too deep when the depth of the slot is being cut. These precautions allow the cut to be increased after the measurements have been checked.

7. Start the machine and cut down to the full depth of the slot when the tool setting is correct.

8. Stop the machine and make a final check of the depth and width of the slot.

NOTE: Sometimes the slot is wider than twice the width of the tool. When this is the case, the center may be cut out first and then the sides and the bottom of the slot trimmed afterwards.

CUTTING A SLOT WIDER THAN THE DOUBLE WIDTH OF THE TOOL

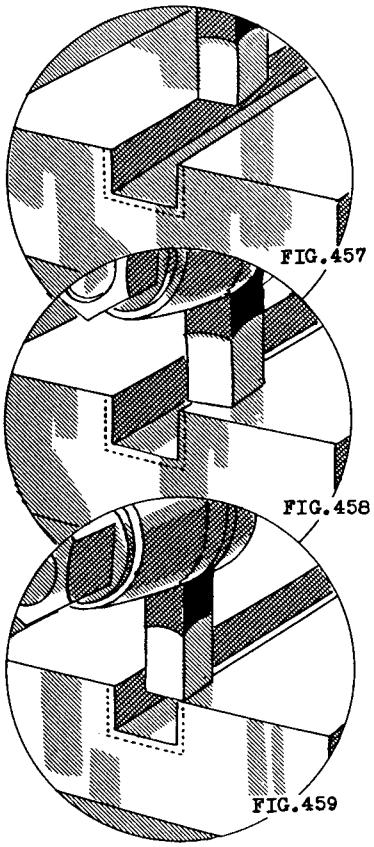


FIG.457

FIG.458

FIG.459

1. Cut out the material in the center of the slot, leaving about .015" on each side for trimming and the same amount at the bottom of the slot for finishing (Fig. 457). If the tool is dull, regrind it for finishing the slot.

NOTE: Use one of the methods given on page 274, starting with direction No. 4, for locating the tool the proper distance from the side of the work. If a more accurate method is required, a micrometer may be used to check the measurements, and the following procedure should be used.

2. Move the tool until it is in a position so that it just touches the top surface of the work and then set the down-feed dial at zero (Fig. 458).

3. Move the work so that the side of the tool is set to trim lightly the right side of the roughed-out slot (Fig. 459).

4. Take a trial cut; then stop the machine and measure the distance A (Fig. 460) with a micrometer. The distance must be

greater than the required dimension because it is used as an approximate distance to gage the final cut.

5. Check the distance at the front A and at the back B of the slot (Fig. 460) in order to test the parallelism of the slot with the side of the work. If the slot is not parallel with the side of the work, proceed as follows.

6. Loosen slightly the nuts on the base of the vise; then tap the vise to the right if the distance A is the greater, or to the left if the distance B is the greater (Fig. 460).

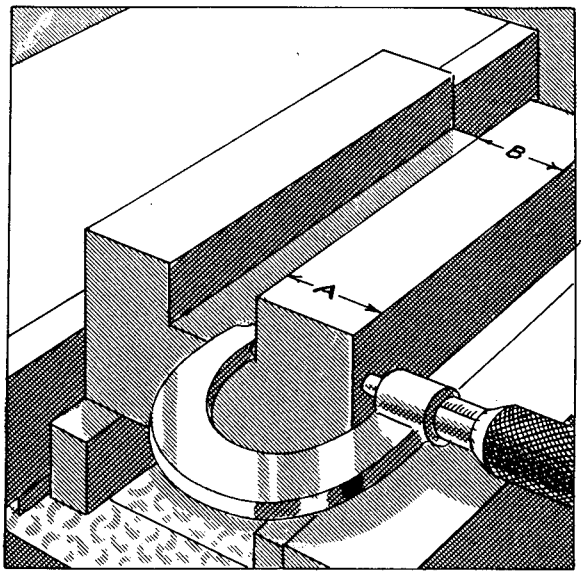


FIG.460

NOTE: If preferred, an indicator may be used to determine the distance the vise must be swiveled either to the right or to the left.

7. Tighten the nuts on the vise.

8. Move the work to the left two or three one-thousandths of an inch.

9. Take another trial cut and stop the machine.

10. Check the distances A and B again. Then, when the cut is parallel with the side of the work, determine how many one-thousandths of an inch the work must be moved to locate the edge of the tool at the correct distance from the side of the work.

11. Make certain that the back lash is out of the table feed screw; then move the work to the left the desired number of one-thousandths, using the graduated collar to indicate the distance.

12. Start the machine and move the tool down a few one-thousandths at a time, trimming the side within about .003" of the full depth of the slot (Fig. 461).

13. Stop the machine and set the tool to trim the opposite side of the slot (Fig. 462).

14. Start the machine and take a trial

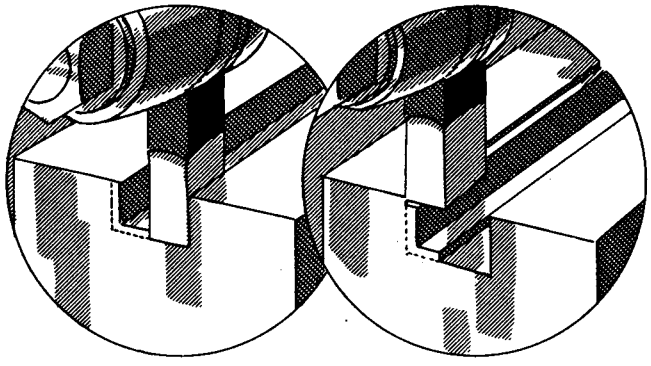


FIG.461 FIG.462

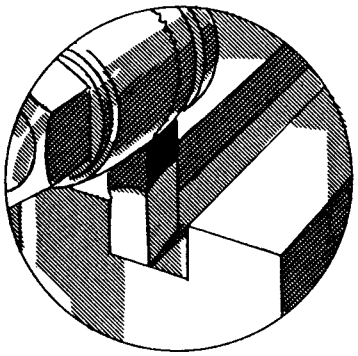


FIG.463

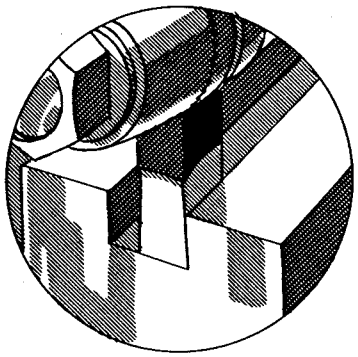


FIG.464

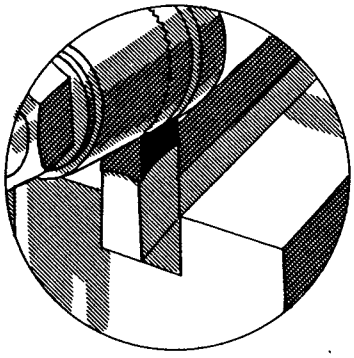


FIG.465

cut about 1/64" deep (Fig. 462).

15. Stop the machine. Use a scale or a gage block to measure the width of the slot, and, when the correct setting of the tool has been obtained, cut down to within about .003" of the full depth of the slot (Fig. 463).

16. Without changing this setting, move the work to the left with the table feed screw a few one-thousandths at a time until the tool has passed to the other corner of the slot (Fig. 464).

17. Stop the machine and measure the depth of the slot with a depth micrometer. Note how many one-thousandths more the depth of the slot must be cut.

18. Move the ram so that the tool is clear of the cut.

19. Move the tool down the required distance, using the graduated collar to indicate, in one-thousandths of an inch, the distance moved.

20. Start the machine; then carefully feed the work to the right until the tool has cut to the opposite corner of the slot (Fig. 465).

21. Make a final check of the width and the depth of the slot.

NOTE: An alternate method of cutting the slot is shown in Fig. 466. The two sides are first cut down to the full depth of the slot; then the excess metal is cut out and the bottom of the slot is cut to the proper depth.

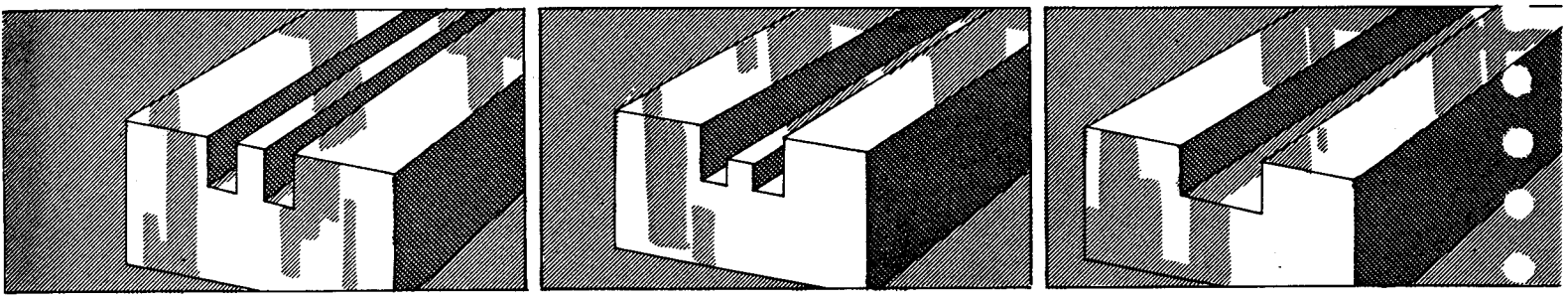


FIG.466

HOW TO CUT SERRATIONS

AT RIGHT ANGLES TO SIDES OF THE WORK

PROCEDURE

MOUNTING THE WORK IN THE VISE

1. Set the vise at 90° to the direction of the stroke. The zero mark on the vise will coincide with the zero mark on the base (Fig. 467).

2. Mount the work in the vise, following the procedure given on page 191, How to Mount the Work in the Shaper Vise.

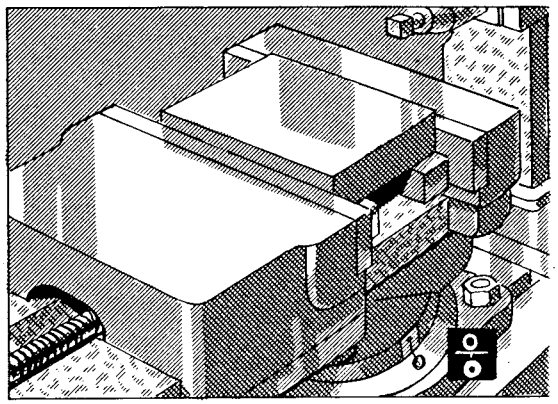


FIG.467

SETTING THE TOOL

1. Set the tool head in a vertical position, using the graduation on the head to indicate when the head is in a vertical position (Fig. 468).

2. Select a tool holder as shown on page 155, Fig. 209.

3. Use a tool bit ground as shown in Fig. 474.

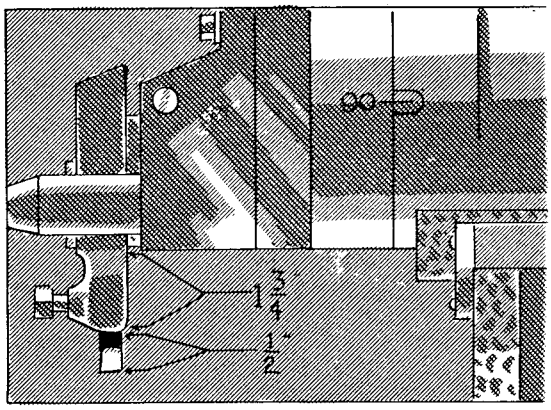


FIG.468

NOTE: Since it is not necessary to have a sharp corner at the bottom of the groove, a flat of about 1/64" should be ground on the extreme point of the tool as illustrated in Fig. 469.

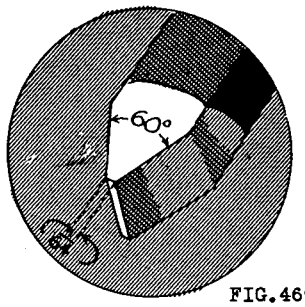


FIG.469

4. Place the tool in the tool holder so that the point of the tool projects about 1/2" beyond the end of the tool holder (Fig. 468).

5. Tighten the tool-holder set screw just enough to hold the tool in position.

6. Place the assembled tool and tool holder in the tool post in a vertical position and have the end of the tool holder project about 1-3/4" beyond the bottom of the clapper box (Fig. 468).

NOTE: If greater accuracy is required when the tool is being set, a center gage may be used to square the point of

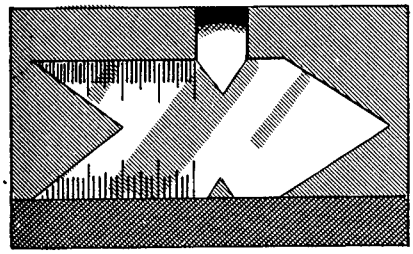


FIG.470

the tool with the surface of the work (Fig. 470). This, however, as a general rule, is not considered necessary.

7. Tighten the tool-post screw to hold the tool holder securely in place.

8. Tighten the tool-holder set screw to hold the tool securely in the tool holder.

9. Adjust the tool slide until it is about even with the bottom of the tool head (Fig. 468).

ADJUSTING THE SHAPER PRIOR TO OPERATING

1. Adjust the stroke of the ram so that it is 1" longer than the length of the work. Refer to page 79 for adjusting the stroke on the crank shaper, and to page 92 for adjusting the stroke on the hydraulic shaper.

2. Position the ram so that the cutting edge of the tool extends 1/4" beyond the work when the ram is at the extreme forward position. Refer to page 81 for adjusting the ram on the crank shaper, and to page 92 for adjusting the ram on the hydraulic shaper.

3. Adjust the table vertically until the point of the tool is slightly above the level of the surface of the work. Refer to page 77, How to Adjust the Cross Rail.

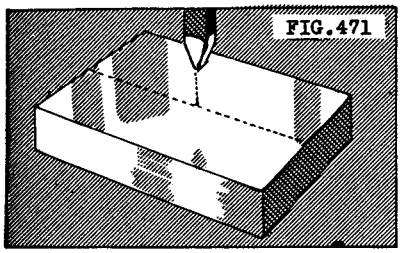


FIG.471

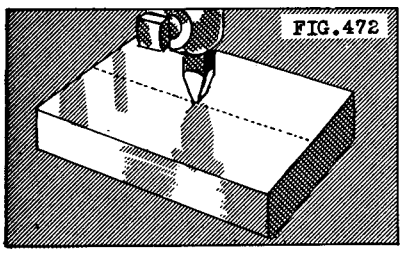


FIG.472

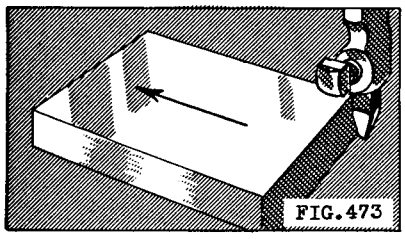


FIG.473

4. Move the ram until the tool is directly above the top surface of the work (Fig. 471).

5. Move the tool down until the point of the tool touches the top surface of the work (Fig. 472).

6. Set the graduated collar on the down-feed screw at zero.

7. Raise the tool slightly by lifting the clapper box, and, at the same time, move the table until the work is to the left of the tool (Fig. 473).

8. Lower the clapper box.

NOTE: Whenever it is possible, the serrations should be cut to their full depth with one setting of the tool. This is a much simpler process than beginning by cutting the serrations to a partial depth. If the serra-

tions are cut to a partial depth, it becomes necessary to reset the tool for a deeper cut and to rearrange the feed so that the tool cuts exactly in the path of the first cut.

9. Calculate the speed of the machine for rough planing the surface; then set the speed for one or two speeds slower than would be used for roughing.

NOTE: When the serrations are machined in one cut as suggested in the preceding note, the tool cuts on both sides at the same time. This kind of cutting action requires a slower speed than usual and needs considerably more power than ordinary cuts that are taken with one side of a tool. The speed suggested in step No. 10 should be approximately correct, unless the cut is a heavy one. A good procedure, however, is to start with a slow speed and increase the speed in accordance with the depth of the cut, the power of the machine, and the finish required.

10. Assume that a tool with a 60° point (Fig. 474) is used and that the width of the groove is 3/64" wide. Assume also that the distance between the grooves is 1/16" (Fig. 475).

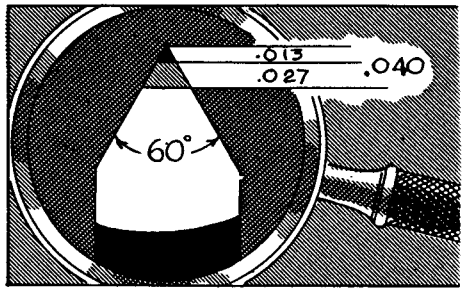


FIG.474

11. Calculate the distance the tool must be moved down to cut a groove 3/64" wide. Since the height of a 60° triangle is .866 of the base, the height of a triangle having a base equal to 3/64" is .866 x 3/64", or .866 x .0468", or .040".

If the .013" which has been ground off the point of the tool (Fig. 474) is subtracted from the height of the triangle (.040" - .013"), the remainder (.027") will be the distance the tool must be moved down.

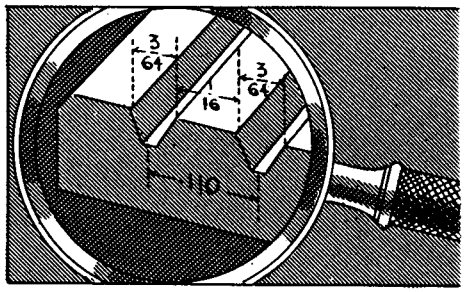


FIG.475

12. Move the tool down for a cut of .027" (Fig. 476).

13. Calculate the distance between the grooves by adding the width of the flat surface to the width of the groove (Fig. 475). For example, 1/16" + 3/64" = .0625" + .0468" = .1093", or approximately .110".

14. Set the feed for .110", or as near to this as possible. Refer to page 90 for setting

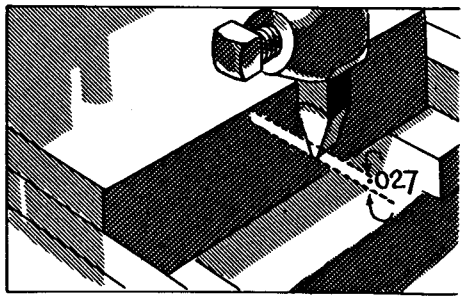


FIG.476

the feed on the crank shaper, and to page 95 for setting the feed on the hydraulic shaper.

NOTE: On some shapers it may not be possible to set the table feed at exactly .110". As a rule, however, it is not important to have the distance between the grooves particularly accurate, and a few thousandths of an inch more or less will not affect the purpose for which a serrated surface is used. Nevertheless, it is very important that time enough is allowed between the moment when the tool drops clear of the work and the instant the tool again starts to cut, for the work to move over and stop feeding. Unless the adjustment is properly made, the beginning of each groove will be cut at an angle and an unnecessary strain will be placed upon the feeding mechanism.

15. Check the feed as illustrated on page 90.

CAUTION Make certain that the work is moved over far enough to the left so that the tool does not strike the work when the feed is being checked.

16. Make a final check of all adjustments before starting the machine.

TAKING THE FIRST SERIES OF CUTS

OIL Oil the shaper as directed in How to Oil the Shaper, beginning on page 47.

1. Start the machine.
2. Apply with a brush a small amount of lard oil or other suitable coolant to the surface to be cut.
3. Engage the feed.

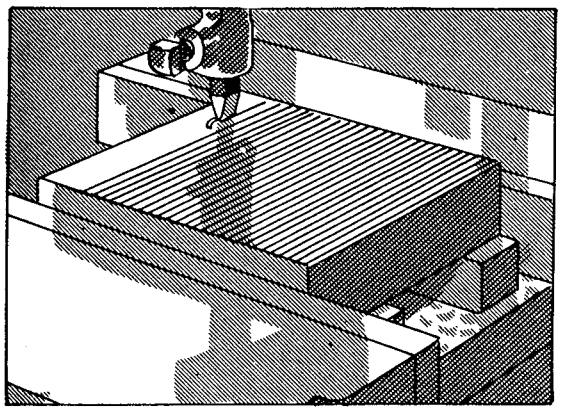


FIG.477

4. Allow the tool to cut the first series of grooves over the entire surface of the work (Fig. 477).
5. Stop the machine.
6. Raise the clapper box and move the table until the work is again to the left of the tool. The clapper box is raised instead of the tool slide in order to keep the same setting of the tool for the next series of cuts.

TAKING THE SECOND SERIES OF CUTS

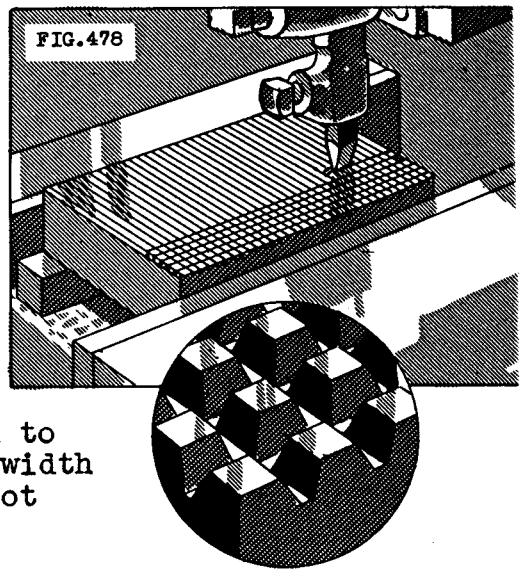


FIG.478

1. Set the vise parallel with the direction of the stroke. The vise and the work will then be moved through an angle of 90° and will allow the second series of cuts to be made at an angle of 90° to the first series (Fig. 478).

2. Make any necessary adjustments in the length of the stroke and the position of the ram. This is necessary because the changed position of the vise will affect the position of the work in relation to that of the stroke, and, also, because the width and the length of the work are frequently not the same.

FIG.479

3. Start the machine and engage the feed.

4. Apply a small amount of lard oil or other suitable coolant and allow the tool to cut the second series of grooves. The spaces between the grooves will now be in the form of small squares with the sides of the squares parallel with the sides of the work (Fig. 479).

AT AN ANGLE OTHER THAN 90° TO THE SIDES OF THE WORK

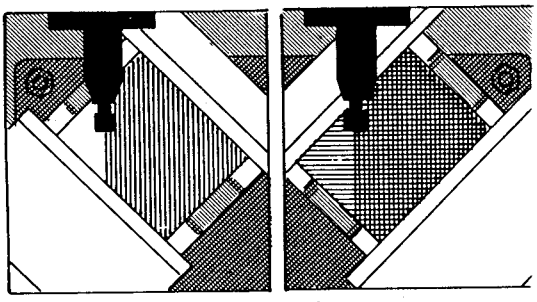


FIG.480

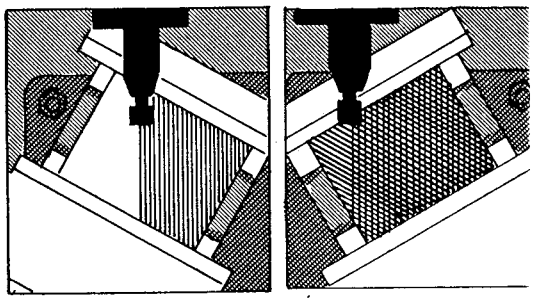


FIG.481

NOTE: The pattern of a serrated surface will vary according to the position in which the vise is set. If the vise is first set at 45° to the left and a series of grooves cut and then set at 45° to the right and a series of grooves cut, the areas between the grooves will be square. The corners of the squares, in this case, will be perpendicular to the sides of the work (Fig. 480), instead of the sides of the squares lying parallel with the sides of the work as in Fig. 478. Again, if the vise is set at an angle other than 45° or 90° to the direction of the stroke and a series of grooves cut at each setting, the areas between the cuts will be diamond-shaped (Fig. 481). The spacing of the grooves also may be regulated by hand. Although this method consumes more time, regulating the distance between the grooves with the aid of the graduated cross-feed dial is sometimes advisable, especially when a second or third cut must be taken.

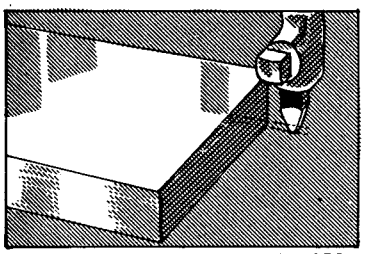


FIG.482

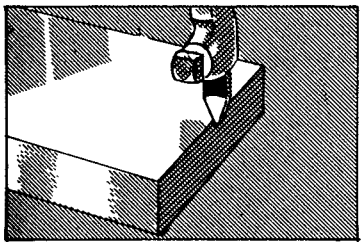


FIG.483

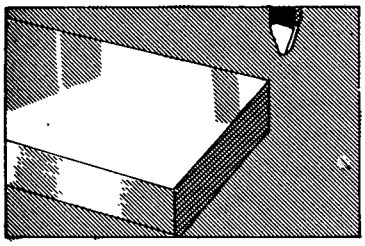


FIG.484

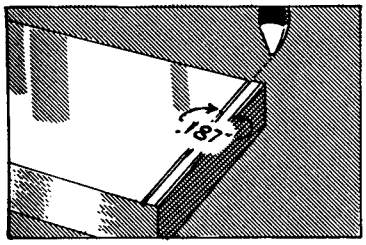


FIG.485

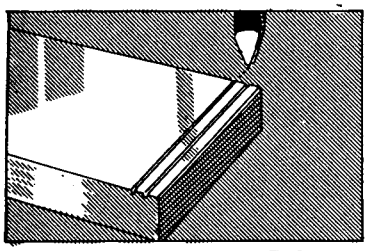


FIG.486

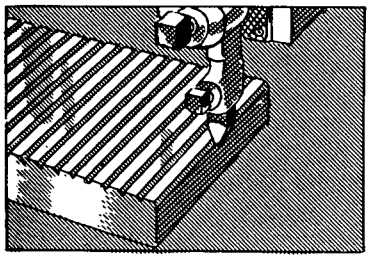


FIG.487

REGULATING THE DISTANCE BETWEEN THE GROOVES BY USING THE HAND TABLE FEED

1. Be certain that the work is moved to the left of the tool and that the tool is set to the desired depth (Fig. 482).
2. Start the machine.
3. Move the work over until the edge of the tool scrapes the work (Fig. 483).
4. Stop the machine when the tool is at the beginning of the stroke (Fig. 484).
5. Be certain that the back lash is out of the table feed screw and then set the graduated collar at zero.
6. Move the work .187" to the right as shown in Fig. 485. (This is an assumed distance between the grooves.)
7. Apply with a brush a small amount of lard oil or other suitable coolant to the surface to be cut.
8. Start the machine and cut the first groove (Fig. 485).
9. Stop the machine at the beginning of the stroke and move the work to the right another .187" (Fig. 486).
10. Cut the second groove.
11. Repeat instruction No. 9 after each cut until all grooves have been machined.
12. Stop the machine and move the work to the left of the tool.

TAKING A SECOND CUT OVER THE GROOVES BY USING THE HAND TABLE FEED

1. Start the machine and move the table until the tool scrapes the edge of the work. The tool is now set in the same position it occupied when the first cut was taken (Fig. 487).
2. When the tool is at the beginning of the stroke

and the machine is running, move the work a few one-thousandths to take the second cut, and then set the graduated collar at zero.

CAUTION When it is necessary to cut the groove deeper, it is preferable to set the work first to cut the groove a little wider; then, afterwards, move the tool down to cut the groove a little deeper. A tool with tapered sides, if fed vertically downward, has a tendency to build up pressure and produce a rough cut. A smoother cut can be produced by the former method.

3. Stop the machine when the tool is at the beginning of the stroke.

4. Move the work to the right .187", and take the second cut.

5. Repeat the operations No. 3 and No. 4 until a second cut has been taken over the complete series of grooves.

6. Swivel the vise to the desired angle, and cut the second series of grooves, following the same procedure given on the preceding page, Regulating the Distance Between the Grooves by Using the Hand Table Feed.

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

8. Remove and clean the parallels; remove the tool from the tool holder, and return each tool to its proper place.

9. Brush the chips from the vise and the table, and absorb with waste the coolant from the vise and the table.

HOW TO SHAPE SIMPLE CONTOURS

PROCEDURE

MOUNTING THE VISE AND THE WORK

1. Set the vise at 90° to the direction of the stroke. The zero mark on the vise will coincide with the zero mark on the base.

2. Select suitable parallels so that when the work is placed in the vise and upon the parallels, enough of the work will project above the vise jaws to allow the tool to cut to the contour line (Fig. 488).

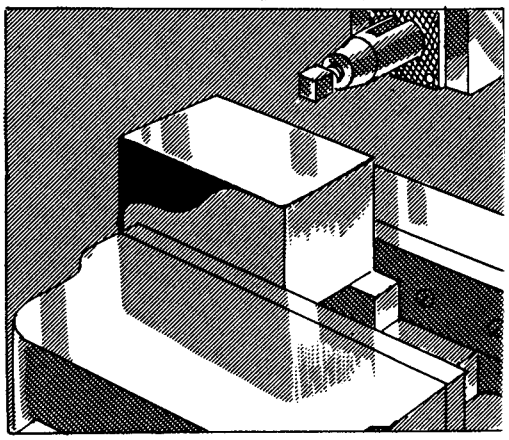


FIG.488

3. Clean both the vise and the parallels before placing the parallels in the vise.

4. Place strips of paper, if necessary, on the parallels, and then place the work centrally in the vise and upon the parallels.

5. Place protecting strips between the vise jaws and the work, and tighten the work securely in the vise.

6. Tap the work down with a lead or rawhide mallet until the strips of paper are gripped between the top of the parallels and the underside of the work. Refer also to page 191, How to Mount the Work in the Shaper Vise.

SETTING THE TOOL

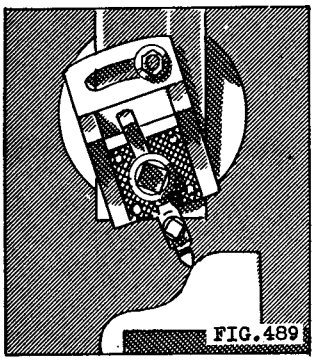


FIG.489

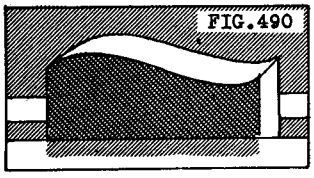


FIG.490

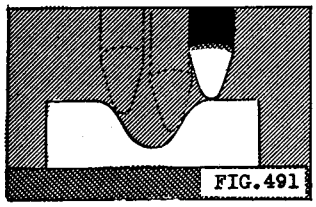


FIG.491

1. Check the position of the tool head. It should be set in the vertical position.

2. Set the clapper box to the left as in Fig. 489.

   NOTE: If the curve of the contour is shallow (Fig. 490), the clapper box should be set in a vertical position. If the curve is steep, the clapper box should be set either to the left or to the right according to the direction in which the curve slopes. For example, the tool is cutting on the left-hand side of the work in Fig. 489 and the clapper box is set to the left.

3. Select a tool holder as illustrated on page 155, Fig. 209.

4. Select a tool similar to the one illustrated on page 161, Fig. 228 C.

5. Grind the tool to cut on the left hand-side of the work and have approximately a 1/16" radius on the point.

NOTE: A smaller radius on the point of the tool may be necessary to allow the tool to be manipulated around a small or steep radius without the work interfering with the side of the tool. An example of this is shown in Fig. 491. In addition, the operator must estimate the distance the tool must project beyond the end of the tool holder to reach the bottom of the curved surface without the tool holder interfering with the other surfaces of the contour.

6. Allow the tool to extend 3/4" beyond the tool holder if the calculated distance that the tool should project beyond the holder is less than 3/4". This distance is not excessive and, in addi-

tion, it will permit the operator to observe the point of the tool more easily.

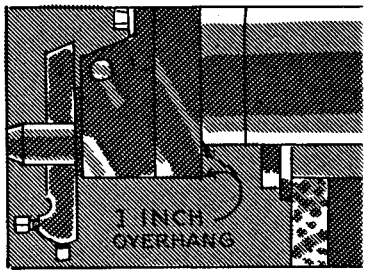


FIG.492

7. Place the assembled tool and tool holder in the tool post with the sides of the tool holder parallel with the sides of the clapper box (Fig. 489), and the end of the tool holder projecting 1-3/4" beyond the bottom edge of the clapper box.

8. Tighten the tool-post screw securely.

9. Tighten the tool securely in the tool holder.

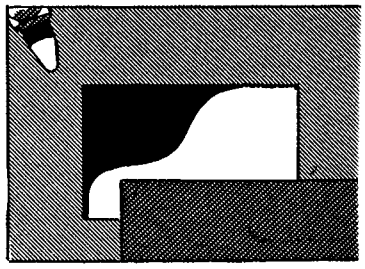


FIG.493

ADJUSTING THE SHAPER PRIOR TO OPERATING

1. Move the tool slide down until it projects about 1" beyond the bottom edge of the swivel block (Fig. 492).

2. Move the work over to the right of the tool (Fig. 493).

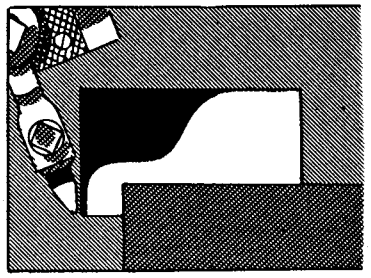


FIG.494

3. Raise the work and the table until the tool is even with the lowest point of the surface to be cut (Fig. 494). Refer to page 77 for adjusting the table vertically. Make certain that the cross rail is properly clamped and that the table support is properly adjusted.

4. Adjust the stroke of the ram so that it is about 3/4" longer than the length of the cut. Refer to page 79 for adjusting the stroke on the crank shaper and to page 92 for adjusting the stroke on the hydraulic shaper.

5. Adjust the position of the ram so that the cutting edge of the tool is 1/4" beyond the front edge of the work when the ram is in the forward position. Refer to page 81 for adjusting the ram on the crank shaper and to page 92 for adjusting the ram on the hydraulic shaper.

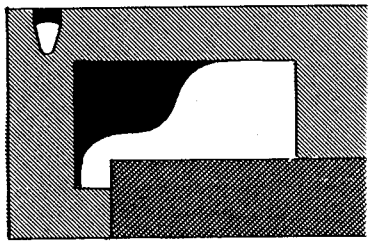


FIG.495

6. Raise the tool slide until the cutting edge of the tool is above the top surface of the work (Fig. 495).

7. Set the speed of the machine for a roughing cut, basing the calculation on the kind of material and the length of the stroke. Refer to page 82, How to Adjust the Speed of the Ram, and to page 94, How to Adjust the Speed of the Ram on the Hydraulic Shaper. (For speed calculations refer to page 303.)

CAUTION Check carefully before starting the machine to

see that the speed of the ram is correctly set. Excessive speed and a long stroke may damage the shaper seriously.

CUTTING THE CONTOUR BY USING THE AUTOMATIC TABLE FEED TO CONTROL THE MOVEMENT OF THE WORK AND BY MOVING THE TOOL DOWN BY HAND

NOTE: Sometimes irregularly shaped pieces are cast in the foundry or are forged from steel bars. The purpose of this is to save metal and also the time which would be consumed when the part is being machined. Whenever a casting or a forging is to be machined, usually enough metal is allowed to machine the parts to size and shape. There are times, however, when the part must be shaped from the solid piece. When this is the case, it is frequently necessary to remove a considerable amount of metal.

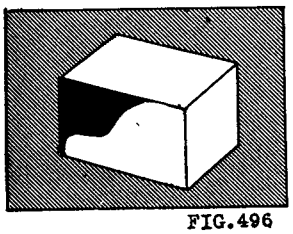


FIG.496

1. Study the blueprint to visualize the contour to be formed. Figure 496 shows a typical job to be machined from a solid piece.

2. Move the work over and the tool down until the top of the tool touches the work (Fig. 497).

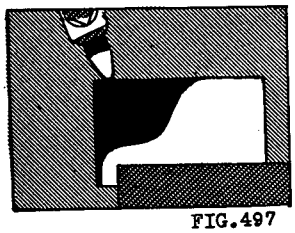


FIG.497

3. Move the work to the right of the tool; then move the tool down 1/8" to 1/4" according to the desired depth of cut (Fig. 498).

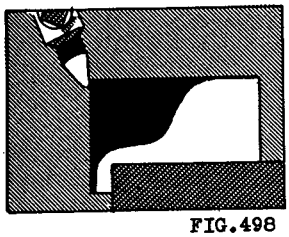


FIG.498

4. Set the feed for about .010" to .015".

   NOTE: The purpose of roughing out is to remove metal; therefore, the cut should be as deep as possible and the feed should be consistent with the power of the machine to remove metal. The operator should start with a fine feed, and then increase the feed in accordance with the rigidity of the work and the power of the machine to stand the increase.

Oil the shaper as directed in How to Oil the Shaper, beginning on page 47.

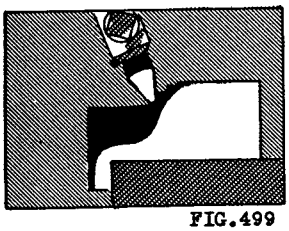


FIG.499

5. Start the machine.

6. Engage the feed and allow the tool to make a horizontal cut to within 1/8" of the contour line. Then, disengage the feed and move the work by hand until the tool is within 1/16" of the contour line (Fig.499).

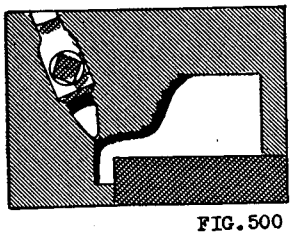


FIG.500

7. Move the work to the right of the tool.

8. Take a series of horizontal cuts until the excess material has been removed and the job appears as in Fig. 500.

9. Stop the machine and move the work and the tool until they are in the position shown in Fig. 501.

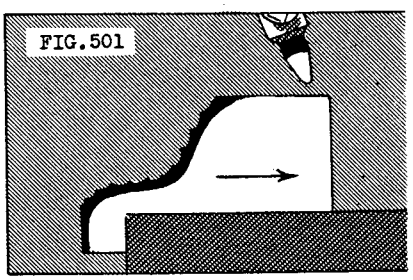


FIG.501

10. Set the controls (or adjust the feeding mechanism) for the finest feed.

11. Set the direction of the feed so that the work moves to the right, or away from the tool, after each stroke of the ram (Fig. 501).

NOTE: With this arrangement there is less possibility of cutting below the contour line. The operator, of course, must be careful not to feed the tool down too much after each stroke. This is especially important when the curve takes the form of a slight incline. The downward movement of the tool, then, will vary with the slope of the curve, a steeply inclined curve requiring a greater downward movement of the tool for each movement of the work than would a curve with a slight incline.

12. Start the machine.

13. Move the tool down and the work sideways until the tool scrapes at a point 1/32" to the left of where the curve drops away from the horizontal line (Fig. 502).

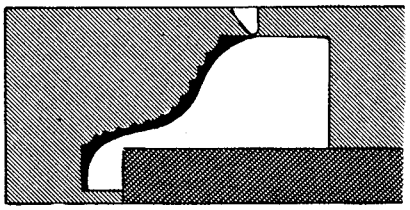


FIG.502

14. Engage the feed, and observe carefully the path of the point of the tool, moving it down so that a machined surface is cut 1/32" from, and parallel with, the contour line (Fig. 503).

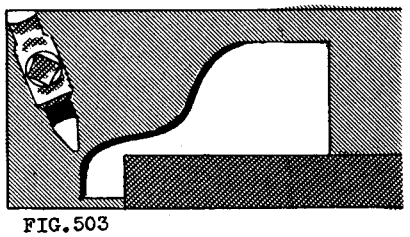


FIG.503

15. Disengage the feed.

16. Use this semifinish cut as an experimental cut, making the curve as regular and as smooth as possible. (If the part were a casting or a forging, this cut would take the place of the roughing cut.)

17. Raise the tool and move the work to the left (Fig. 504).

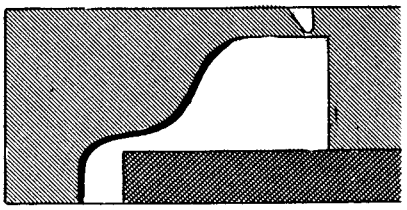


FIG.504

18. Move the tool down and the work sideways until the point of the tool scrapes exactly at the place where the curve drops away from the horizontal line (Fig. 505).

19. Engage the feed; then move the tool down to follow the curved line, watching closely and increasing the downward movement of the tool when

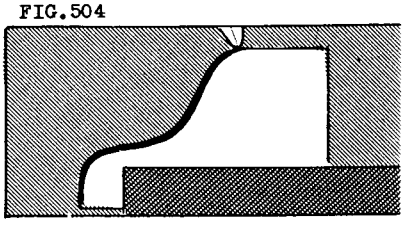


FIG.505

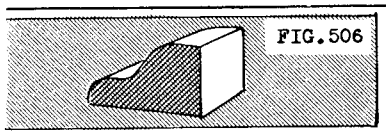


FIG.506

the curve is steep, and decreasing the downward movement of the tool when the curve is slightly inclined (Fig. 506).

CUTTING A CONTOUR BY CONTROLLING THE CROSS FEED AND THE DOWN FEED BY HAND

NOTE: Cutting a contour by operating the table feed screw with one hand and controlling the downward movement of the tool with the other hand requires a little experience and judgment to produce a smooth, regular curve or contour. Moreover, the relative positions of the down-feed crank and the table feed screw increase slightly the difficulty of operating the hand controls when a contour is being followed. To overcome this, some machines are equipped with a hand-feed control shaft which is situated at the front of the table. When a handcrank is placed on this shaft, the table, with the work attached, can be moved with the left hand, and, at the same time, the tool can be moved with the right hand. This arrangement, in addition to allowing the operator to be in the most natural position to reach the controls, also allows him to observe clearly the progress of the tool in relation to the contour line.

1. Assume that the length of the work is the same as that of the preceding piece, and that the settings of the ram, the stroke, and the speed are identical.

2. Set the clapper box in a vertical position.

3. Set the tool holder in a vertical position.

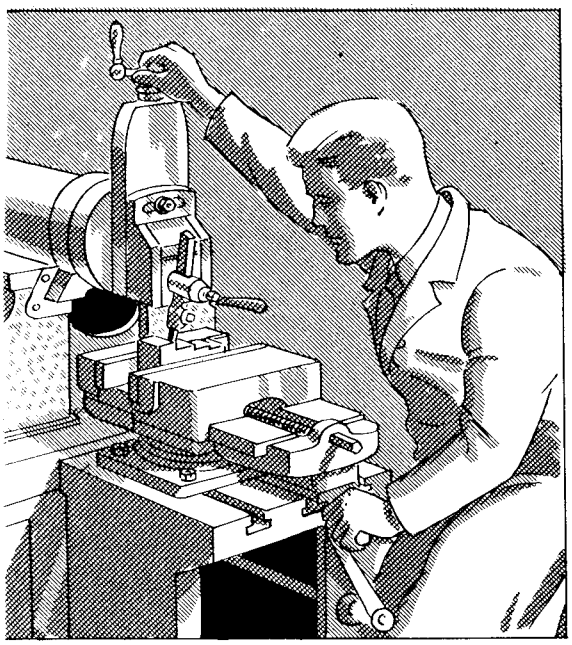


FIG.507

4. Substitute a left-cut tool for the right-cut tool used in the preceding job. Theoretically, two tools should be used, one to cut on the right side of the curve, and the other to cut on the left side of the curve. Usually, however, one is selected according to the side which requires the most cutting and then used to take a continuous cut around the curve.

5. Allow the tool to project beyond the tool holder about 3/4".

6. Assume that the table is equipped with a front hand-feed table control.

7. Stand at the machine, or sit on a stool at the right-front corner of the table (Fig. 507).

8. Start the machine.

9. If the work is a solid piece, it should be partially roughed out first (Fig. 508) by taking a series of horizontal cuts as instructed in step No. 6, page 288.

10. Stop the machine.

11. Use the hand control located at the front of the machine for moving the work.

12. Move the work and the tool until the point of the tool is about 1/16" from the place where the curve drops from the horizontal line (Fig. 509).

13. Start the machine. Move the tool down until it scrapes the surface of the work.

14. Cut a curved surface by moving the work to the right with the front hand-feed control, and, at the same time, move the tool down for each stroke that the tool makes. When the tool reaches the point where the curve inclines upwards, it must be raised slightly for each stroke of the tool (Fig. 510).

    NOTE: The distance the work must be moved sideways and the distance the tool must be moved downwards and upwards depend upon the slope of the curve. The ability to judge the correct movement of the work in relation to the changing position of the tool must be acquired by the operator in order to produce a correct and smooth curve.

15. Continue to take a series of cuts, starting at the right side of the work, and manipulating the tool and the work until the metal is cut to within 1/16" of the curved line (Fig. 511).

16. Move the work until the tool is in the position to cut the left-hand side of the contour (Fig. 511).

17. Move the tool down and the work to the right before each stroke, and take a series of roughing cuts, leaving about 1/16" of metal parallel with the curved line (Fig. 512).

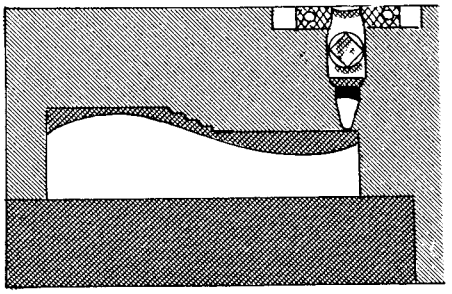


FIG.508

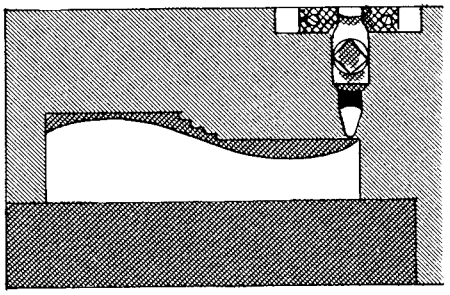


FIG.509

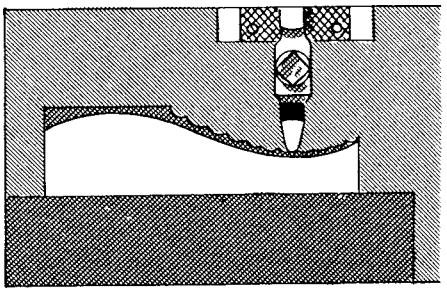


FIG.510

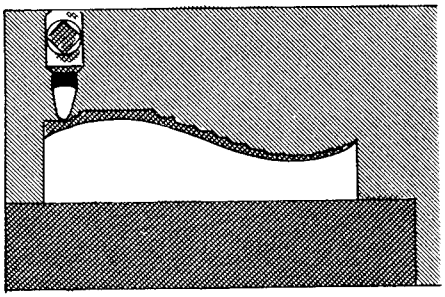


FIG.511

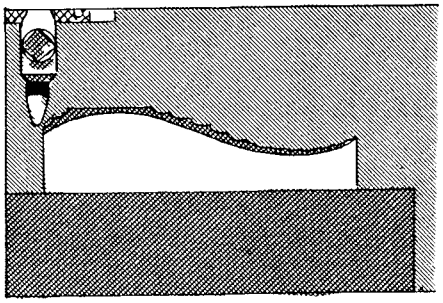


FIG.512

TAKING THE FINISHING CUT

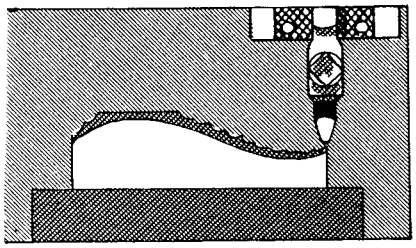


FIG.513

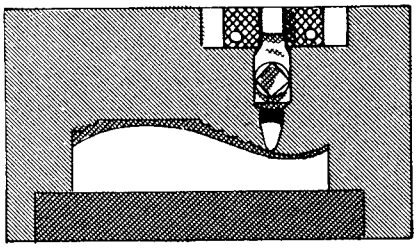


FIG.514

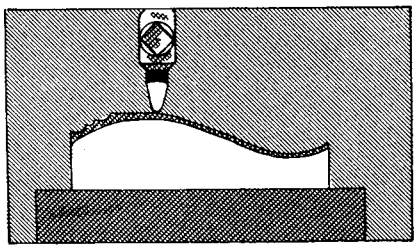


FIG.515

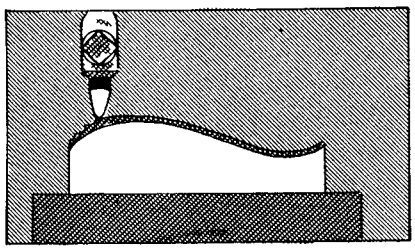


FIG.516

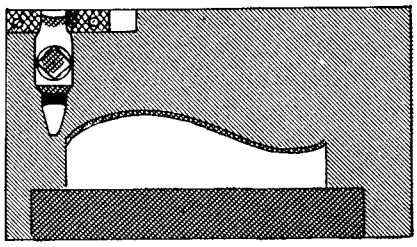


FIG.517

NOTE: Roughing out the curve may leave the surface rough and irregular. In this case a semifinish cut may be taken within 1/32" of the finish line, and then a final cut taken to remove the remaining 1/32". The operator may start at the top of the curve and cut down to the lower point. This procedure may be followed whether the curve slopes to the right or to the left. On the other hand, some may prefer to start at the right of the curve and continue around the curve until the cut has been completed.

1. Take a semifinish cut starting at the right of the curve (Fig. 513).

2. Move the tool down and the work to the right, cutting down to the bottom of the curve and machining the surface parallel with, and to within 1/32" of, the contour line (Fig. 514).

3. Observe that when the tool has reached the bottom of the curve (Fig. 514), it must be raised while the movement of the work continues toward the right. Observe also that the back lash must be taken out of the down-feed screw before the tool will move upwards. (Refer to page 66.)

4. Continue the process until the tool has reached the top of the curve (Fig. 515).

5. Continue to move the work to the right until the tool is 1/32" beyond the point where the contour line drops away from the horizontal line (Fig. 516).

6. Direct the cut downward on the left of the curve (Fig. 517).

7. Take a final cut. Start at the right of the work and manipulate the tool in conjunction with the movement of the work, carefully following the contour line with the point of the tool and making certain that a smooth and even contour is being formed (Fig. 518).

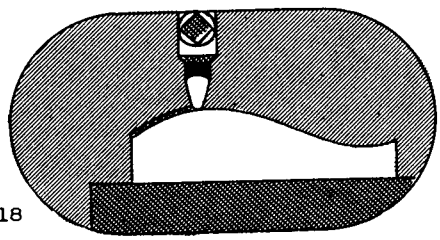


FIG.518