SET-UP and OPERATION
of
Brown & Sharpe
Automatic Screw Machines

No. 11

Of a Series of Booklets for Training Operators

Centering, Forming, Drilling, Bottoming, Knurling, Recessing, Tapping, Forming and Cutting Off

Brown & Sharpe Mfg. Co.
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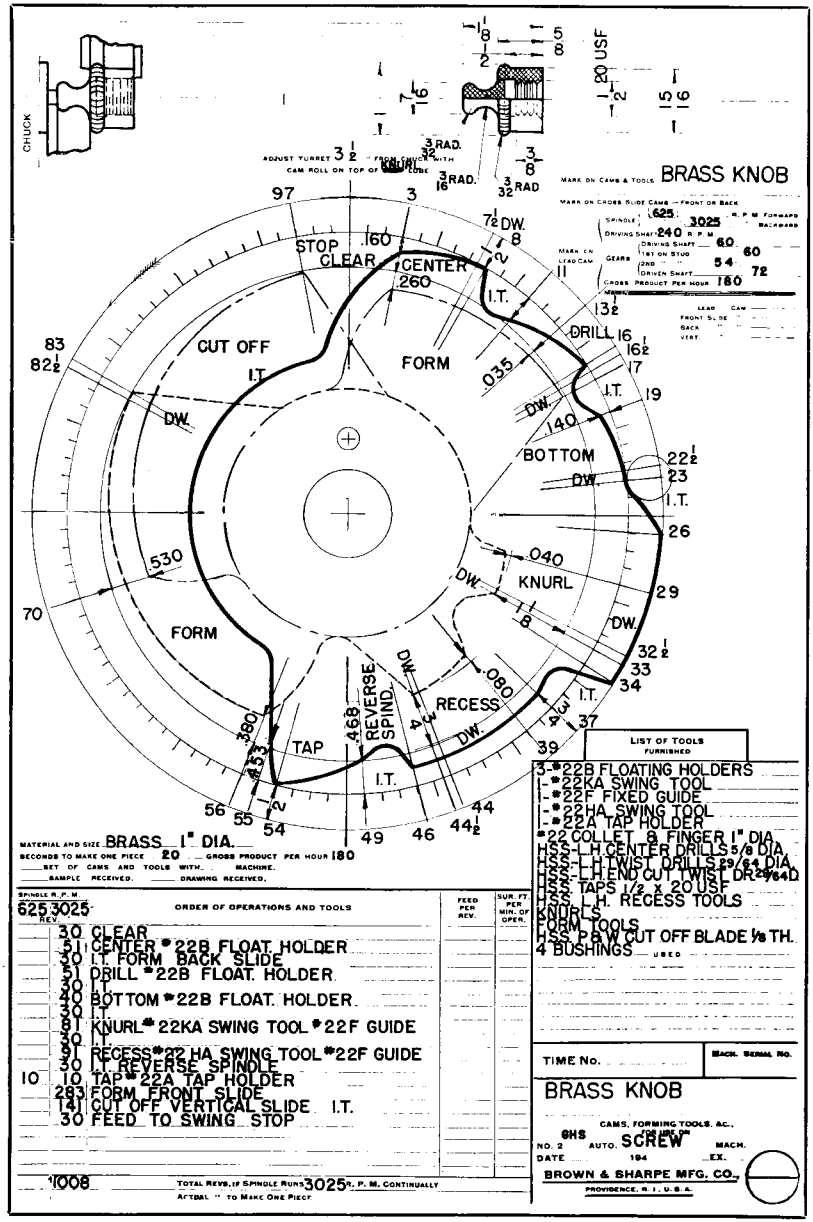

Fig. 1. Work Sheet for Job No. 10

NO. 11 OF A SERIES OF BOOKLETS FOR TRAINING OPERATORS

JOB NO. 10

Centering, Forming, Drilling, Bottoming, Knurling, Recessing, Tapping, Forming and Cutting Off

With its turret completely filled with tools, with form cutters in both cross slides and with a vertical slide for cutting off, a No. 2G Machine is kept busy performing the 9 operations of Job No. 10. Among these operations listed on the worksheet, Fig. 1, are several which have not been described before in these booklets. The bottoming cut produces the flat surface at the end of the drilled hole, the tapping operation produces the internal threads, and a new attachment (the vertical slide) is employed for cutting off. In addition, the knurling swing tool operates in a different manner from any of the knurl holders already considered.

Strip the Machine.

Back off cross slide stop screws.
Insert feed finger, collet and stock.
Adjust length of feed and collet pressure.
Put on feed change gears.
Make changes to get spindle speeds.
Put on cross slide and turret lead cams.
Adjust turret 3½" from chuck.

Set All Carrier Trip Dogs. Fig. 2 shows approximate trip dog settings. From your experience with preceding jobs, you can explain why the locations shown were used. On the work sheet you will notice that there is, at the end of the bottoming lobe, a dwell from position 22½ to 23. The turret must index while the turret cam lever is on this dwell. Should the index be delayed to a point after 23 the bottoming tool would dig into the work, having been jammed ahead by the steep rise of the knurling lobe.

VERTICAL SLIDE ATTACHMENT

This attachment is usually used on jobs where both cross slides are supporting form tools. In this job a single form tool would have had to turn the small work stem diameter as one of

the first operations, and very poor rigidity would have been obtained for the severe operations of knurling and tapping which follow. By using two form tools the first tool does the turning which must precede knurling, and the second tool does

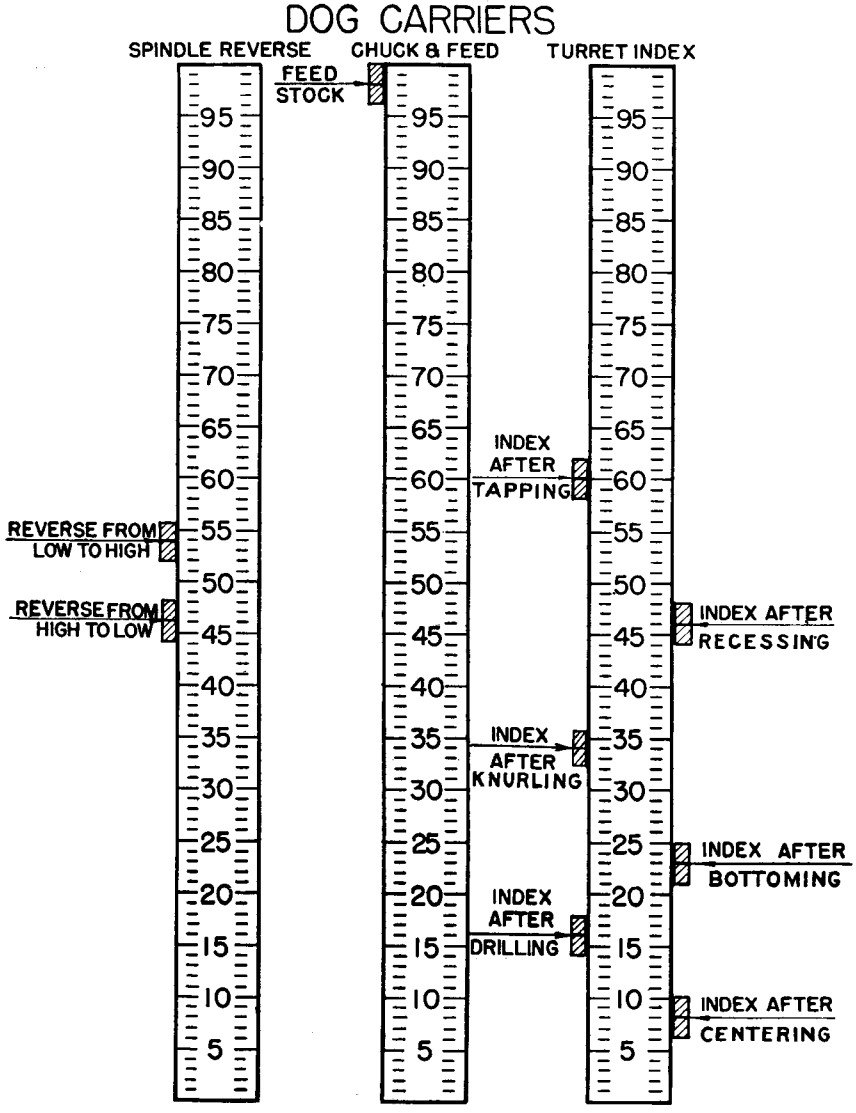

Fig. 2. Dog Settings for Job No. 10

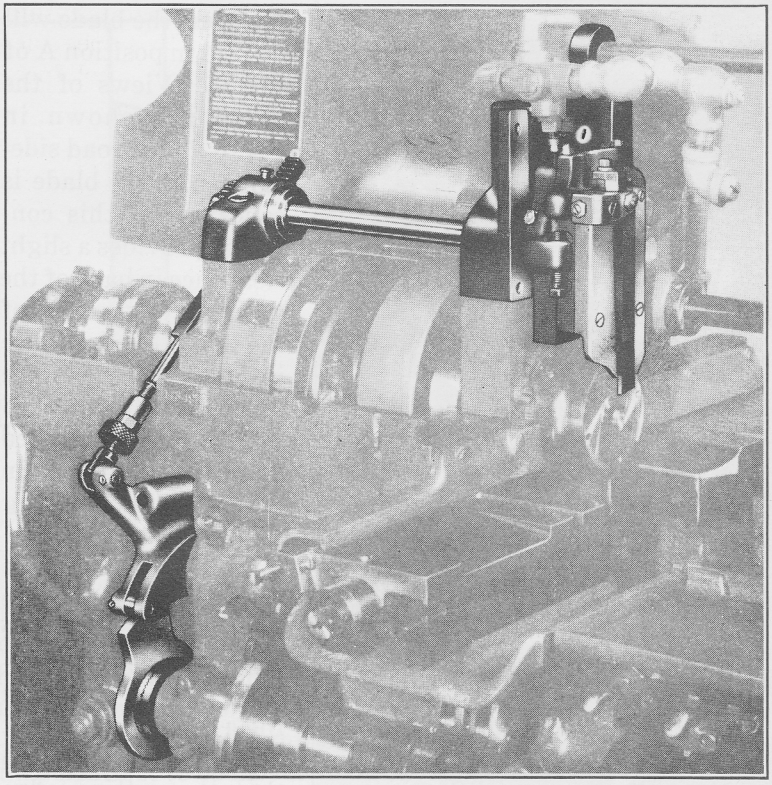

Fig. 3. Vertical Slide Attachment

the deep cutting only after all other operations but cutting off are completed.

Figs. 3 and 4 describe the vertical slide attachment. It is mounted directly over the end of the spindle and is actuated by a cam on the left-hand end of the cam shaft. The attachment will most likely be already in position on your machine. Insert a hand lever in the cam lever and lift the lever while you observe the general action of the attachment. Notice that the cutting-off blade, held by a gib in the vertical slide, moves in a radial line toward the work axis.

Sharpen the Cutting-Off Blade. One end of the blade is prepared for forward direction of work rotation and the opposite end is ground for backward rotation. This job has backward

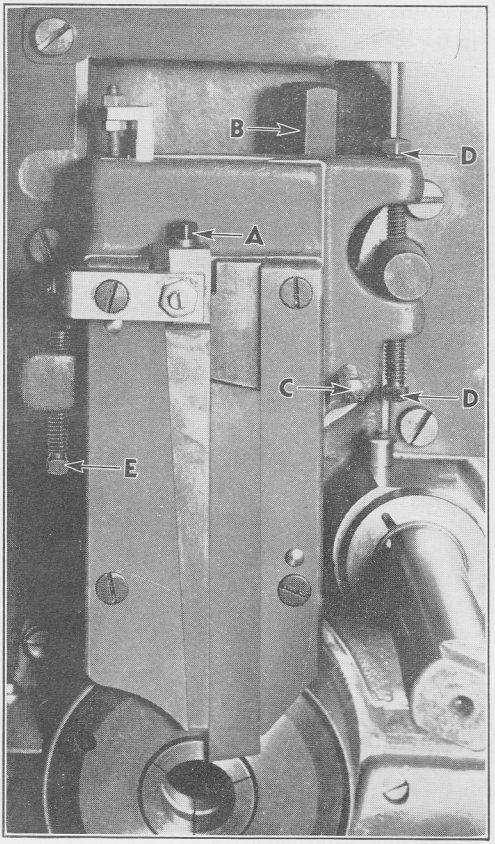

Fig. 4. Adjustments of Vertical Slide Attachment

rotation for cutting off and thus the blade will be held in position A of Fig. 5. Views of the blade are shown in Fig. 6. The broad side-surface of the blade is concave and this concavity provides a slight clearance in back of the vertical cutting edge of the tool. This clearance is inherent in the blade and is not dimensioned in Fig. 6. The beveled edges are used in clamping or holding the blade in the slide.

The first step in sharpening a new blade is to grind away the angular side (the beveled edge) of the blade for a distance of about 5/8". This is done so that the cutting edge will be parallel to the work axis. Once this edge is squared it does not need to be touched in successive sharpenings. Actual resharpening is done by grinding the end surface. This surface has a double angle. Looking at the side of the blade there is an angle of 10 to 20° which represents the clearance angle behind the cutting edge. Looking at the front, or thin edge of the tool, there is an angle of 15° to give the tool a point to clean off the teat on the work piece as it is cut from the bar. The ground flat surface can be obtained by holding the cutting-off blade at the proper angles and pressing its end against the flat side of a grinding wheel.

Mount and Adjust the Cutting-Off Blade. Back off the gib screw A shown in Fig. 4 until the gib is withdrawn a small

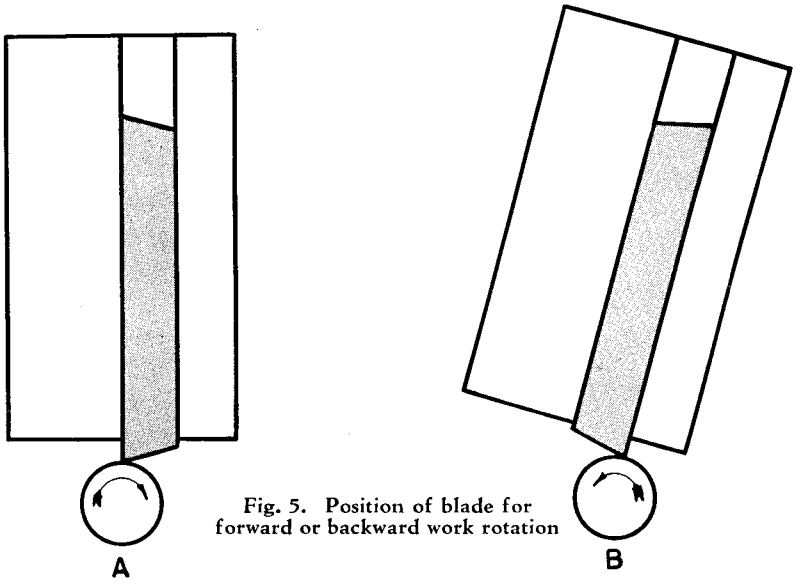

Fig. 5. Position of blade for forward or backward work rotation

amount. Put the cutting-off blade in position with its cutting edge about 5/8" below the base of the slide or beyond the end of the gib. Now turn in the nut A until the blade is wedged securely in position by the gib.

Loosen the large clamp bolt B. This releases the slide head and permits it to be moved in or out in a direction parallel to the work axis and also to be swivelled about the driving shaft axis. As was the case with the circular cutting-off tools, the vertical blade should make its cut as close to the spindle nose as possible to get good rigidity and little overhang for the work. With the bolt B loose, either turn the screw C to move the head away

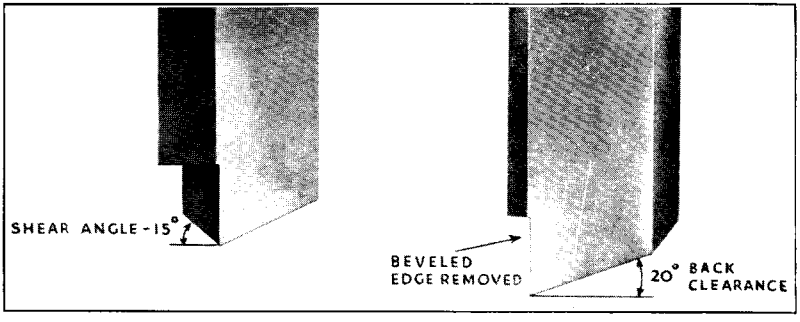

Fig. 6. Sharpening blade for Vertical Slide

from the spindle or back off C and tap the head in to get the cutting-off blade closer to the spindle.

Before clamping the head, swivel the head with the screws D (screw in one and back off the other). Lift the hand lever inserted in the cam lever and test the position. The screws D should be adjusted until the cutting edge of the cutting-off blade moves in a direct radial line to the work axis. Having set the blade on-center, clamp the head tightly with bolt B. As an added check against twisting of the head, have both adjusting screws D turned in until they press against the cylindrical stop.

Back off the stop screw E. This is a stop adjustment similar to those on the cross slides and is used to get a very accurate depth position for the vertical slide. If the cutting-off tool was forming some diameter as well as cutting off, such a stop would be helpful; but for the simple cutting-off operation employed for this job it need not be used.

To test the on-center setting of the cutting-off blade, start the machine, trip the chuck and feed trip lever and engage the driving shaft clutch long enough to feed stock. Now lift the cam lever with the hand lever and cut off the projecting piece of stock. If the blade moves through easily and leaves a teat on the bar, then the cutting edge is behind the work axis. If the blade moves hard and tries to push through or crush a small teat, then the cutting edge is too far forward (with backward spindle rotation). Make any necessary swivel adjustments to get the blade exactly on center.

Mount Vertical Slide Cam on Cam Shaft. On the work sheet, Fig. 1, the cam outlined with a repeating single long and two short dashes is the vertical slide cam. It has a single lobe. The cam is mounted on a toothed or serrated driving disc and its rotational position is dependent on the engagement which is made between the disc and the mating cam holder which is keyed to and rotates with the cam shaft. You will remember that a similar adjustable cam holder was used on the Screw Slotting Attachment, Booklet No. 6, Fig. 11.

Mount the cam and the driving disc on the end of the cam shaft, making sure that the pin in the disc engages the hole in the cam. Do not clamp the members together with the shaft nut. Now turn the driving shaft handwheel until the chuck and feed trip dog carrier is about one hundredth from the position

where its dog will trip the feed trip lever (about position 97). Leave the cam shaft in this position and proceed to rotate the vertical slide cam and driving disc while holding the cam lever up with the hand lever. Bring the cam around until the lever roll is right at the peak of the cam lobe, position 97, and clamp it in this position by engaging the driving disc teeth with the cam holder teeth, and locking the members together with the shaft nut. With this position of the cam the vertical slide blade will have completed cutting off just before the automatic feed occurs.

Leaving the cam lever on the peak point of the cam, adjust the slide for depth of feed. Above the cam lever is a knurled rack-adjusting nut. Loosen the clamp screw in this nut and adjust the nut until the inner point on the cutting edge of the cutting-off blade is a few thousandths beyond the exact center of the bar of stock. Lock the adjusting nut in this position by tightening the clamp screw. In a good set-up the cutting-off blade projects as little as possible beyond the supporting slide and full depth settings are obtained with the adjusting nut. A tool with a large amount of overhang has poor rigidity.

With the blade adjusted for depth, turn the driving shaft handwheel to check the timing and to see that the cutting-off blade is withdrawn before the stock actually starts to feed forward.

Set the Swing Stop. Measure the $1\frac{1}{8}$" distance from the nearest edge of the cutting-off blade.

Sharpen, Mount and Adjust the Circular Form Tool. Set the tool so that it will face off about .005" to .010" of stock on the end of the work piece. This tool is mounted on the back cross slide and for backward rotation must be mounted on a raising block.

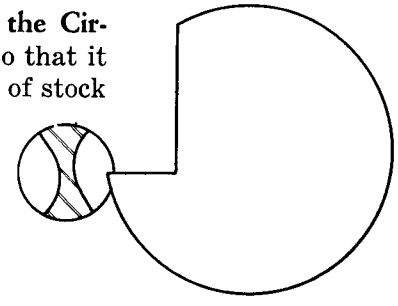

Fig. 7. Relation of center drill and form tool

Sharpen, Mount, and Adjust the Center Drill. A $\frac{5}{8}$" drill is employed to cut a $1\frac{7}{32}$" chamfer diameter. Notice on the work sheet that the lip of the circular form tool on the back cross slide moves in far enough to be inside the largest diameter of the center hole. To avoid any possible interference between the center drill and the form tool, mount

the drill in such a position in its floating holder that a flute will be directly in front of this lip of the form tool. See Fig. 7.

Sharpen, Mount and Adjust the Drill. Remember that the angle of the drill point should be a little flatter than the center drill angle to get the drill to center itself accurately. When the

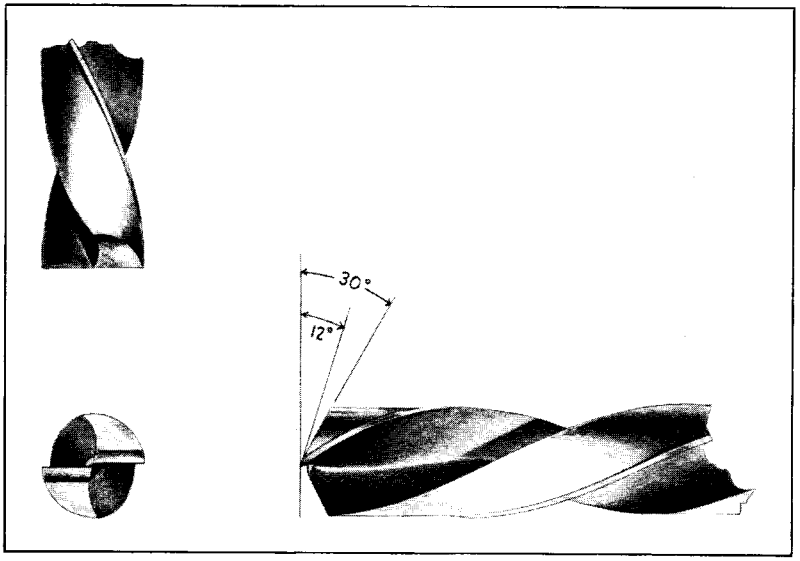

Fig. 8. Method of sharpening bottoming drill

drill is adjusted to proper depth, the point of the drilled hole should be ½″ from the face of the work piece. Perhaps the easiest way to obtain the proper depth setting is to cut off the work piece, turn the driving shaft handwheel until the turret lead cam lever is at the peak point on the drilling lobe (position 16) and measure the distance from the edge of the cutting-off blade to the drill point. This should be 1⅛″ minus ½″, or ⅝″. It is good practice to locate a drill flute in front of the back cross slide form tool just as was done with the center drill.

Sharpen the Bottoming Drill. For the bottoming operation, a flat-ended drill is used instead of a drill having the usual 120 degree point. The bottoming drill is in most cases ground from a standard twist drill. Press the tip of a standard $^{29}/_{64}$″ twist drill against the flat side of a grinding wheel and grind away the point until you have a flat surface over the full $^{29}/_{64}$″ diameter. Now running back from each cutting lip, grind a

land about $\frac{3}{64}$" wide at an angle of 12 degrees. This is the clearance angle necessary to keep the end of the drill from rubbing as it is fed in. Behind the $\frac{3}{64}$" land, grind a surface making a 30 degree angle with the end plane. This surface does not touch the work piece and is ground at this steep angle to get it out of the way. Fig. 8 shows the properly ground drill. Having ground the two lands behind each lip, grind away some of the web to insure that the drill will produce a clean cut right up to the work axis. Fig. 8 shows the metal cut away in reducing the web. The cut can be made with the corner of a disc wheel, by holding the drill with its straight cutting edge in line with the flat side of the wheel.

Mount and Adjust the Bottoming Drill. Mount the drill in a floating holder and clamp the holder in the third turret station. Turn the driving shaft handwheel until the turret lead cam lever is at the peak of the bottom lobe or between positions 22½ and 23. If the work piece is not cut off proceed to cut it off with a hand movement of the vertical slide. Now adjust the floating holder in its turret station until the distance from the flat end of the drill to the edge of the cutting-off blade is $\frac{5}{8}$".

Start the machine and engage the driving shaft clutch. Let the cycle run until regular drilling is completed and the turret is ready to go forward for the bottoming operation. With the clamp screws loosened on the floating holder, and guiding the drill with your fingers, bring the turret slide forward with the hand lever. See that the bottoming drill is free in the hole and is not crowding against the side wall; then clamp the floating holder bolts.

Engage the driving shaft clutch and let the machine run until the work piece is cut off. Examine the hole. If the bottom surface is not cleaned out and still shows the cone left by the pointed drill, adjust the bottoming drill in its turret station to cut a little deeper or withdraw the regular drill a small amount to decrease the initial hole depth. The depth of the finished hole should be

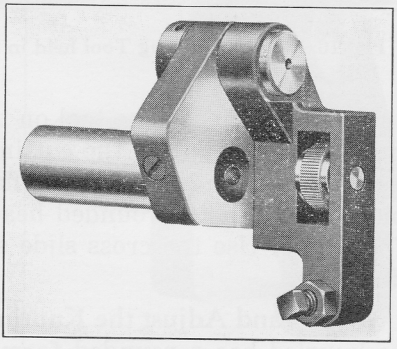

Fig. 9. Knurling Swing Tool

½". This dimension can be checked accurately with a depth gage or closely with a scale.

Sharpen, Mount and Adjust Circular Form Tool. Although forming with the front cross slide is one of the last operations, it is necessary to adjust the slide at this point in the set-up, for settings used in knurling and recessing depend on the front slide position. Set the tool square and on-center and adjust it along the work so that the form it produces will blend in with

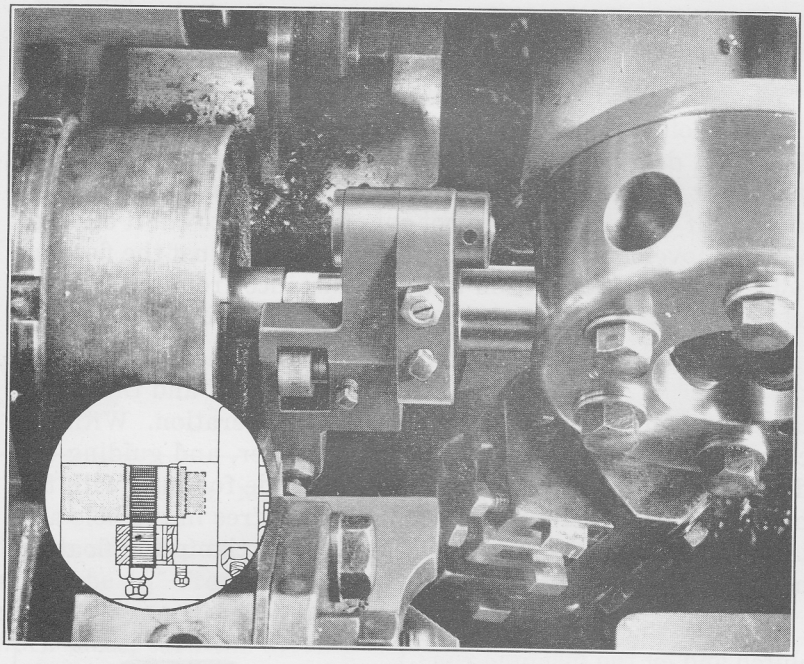

Fig. 10. Knurling Swing Tool held in turret and operated by the cross slide

that already cut by the tool on the back cross slide. It may be necessary to readjust the cutting-off tool by moving the blade along the work axis until the flat left by the cutting-off blade blends in with the rounded head left by the front cross slide form tool. Use the cross slide stop screw to control the knob diameter.

Mount and Adjust the Knurling Swing Tool. The surface to be knurled has a rounded form and requires a special knurl. Because of this form, the knurl holder which is held in the

turret cannot have a turret movement when the knurl is in contact with the work, and feeding of the tool must be obtained from movement of the cross slide. The tool is shown in Fig. 9 and is mounted on a machine in Fig. 10.

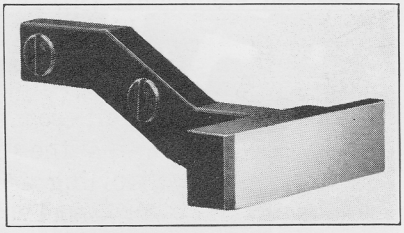

Fig. 11. Fixed Guide

Mount the special knurl in position on the pin and clamp the pin with the set screw. Place the tool in the fourth turret station. With the machine stopped, turn the driving shaft handwheel until the turret lead cam lever is on the dwell between positions 26 and 34. Move the knurling swing tool forward or back in its turret station until the knurl is central with the ring on the work piece which is to be knurled. The tool should also be positioned with the pivot stud vertically above the work axis. Clamp the tool in its station.

The tool is now in position to knurl but must be actuated by the cross slide. Attach the fixed guide, Fig. 11, to the right-hand side of the front cross slide tool post, using the two screws provided. The guiding surface will be in front of the tool post and parallel with the work axis. The lowest adjusting screw on the knurling swing tool will make contact with this guiding surface. Turn in the adjusting screw to give a clearance between the screw head and the guide surface. Now turn the driving shaft handwheel until the front cross slide cam lever is on the dwell of the knurling lobe or between positions 32½ and 33. Proceed to screw out the tool adjusting screw until its head presses against the fixed guide and the knurl touches the work. Then turn the driving shaft handwheel until the front cross slide is withdrawn several thousandths. Give the adjusting nut an additional $\frac{1}{10}$ turn and lock it in position with the check nut.

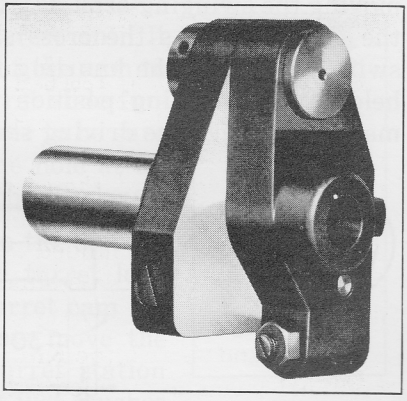

Fig. 12. Recessing Swing Tool

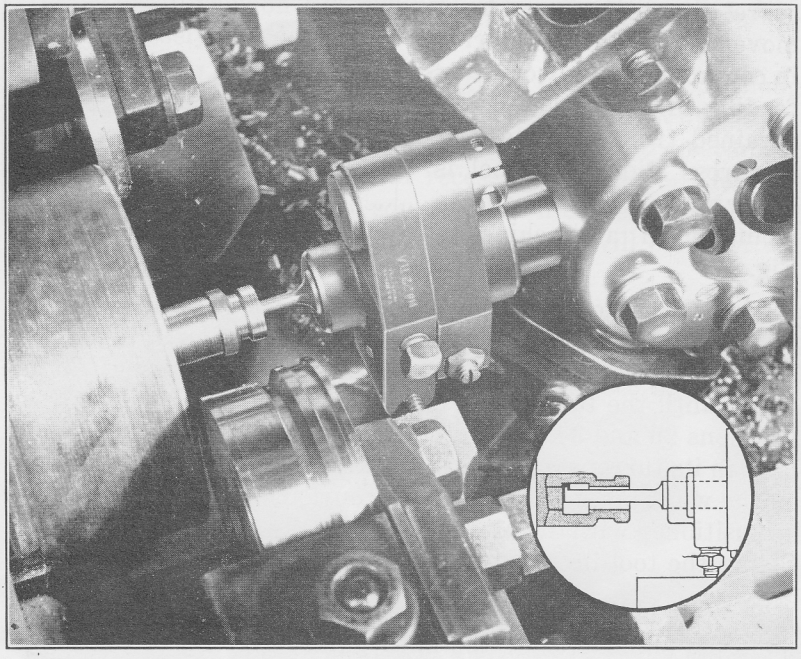

Fig. 13. Recessing Swing Tool cutting recess

Turn the driving shaft handwheel slowly and stop when the swinging arm of the knurling tool has moved back enough to permit the knurl to clear the work when the turret is withdrawn. Loosen the check nut on the tool body just below the pivot stud and turn in the stop screw as far as it will go without moving the swinging arm. Lock the screw in this position with the check nut. As the cross slide is withdrawn farther the swinging arm of the knurling tool will not follow but will be held in this limiting position by the stop screw. Start the machine, engage the driving shaft clutch, and produce a piece.

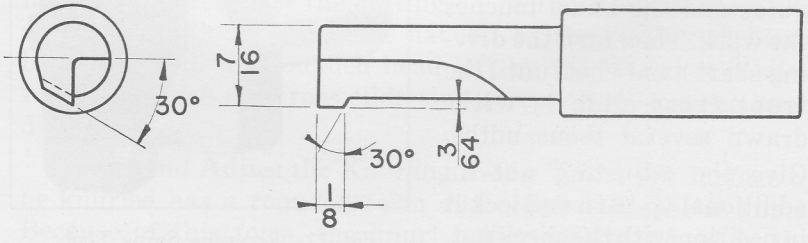

Fig. 14. Bit for recessing swing tool

Examine the knurled ring on the work and make necessary adjustments with the swinging arm guide screw to get the proper depth of serration.

Recessing Tool. This tool forms the groove or recess at the end of the drilled hole. The groove is deep enough to have a diameter a little greater than the root (largest) diameter of the internal thread; and thus when the tap cuts the threads they can all be full depth threads, for the metal which would contain the incomplete threads has been removed. The tool shown in the Figs. 12 and 13 is very similar in its operation or movements to the knurling swing tool just described.

Sharpen the Swing Tool Bit. The special recessing bit, Fig. 14, is very similar to that already described in Job No. 9. It has a single plane surface to be held against the flat side of a disc grinding wheel for resharpening. In succeeding sharpenings the surface is each time ground to be parallel with the original surface.

Mount and Adjust Recessing Swing Tool. Place the bit in the swinging arm of the tool and clamp it lightly. Mount the tool in the fifth turret station locating the arm pivot vertically above the work axis. Now turn the bit in the arm (rotate it about its long axis) until the cutting edge is on-center with the work as it touches the wall of the hole. Clamp the bit tightly in the arm. Let the arm swing back under the spring action of the tool, until the cutting edge of the bit clears the wall of the hole by a few thousandths, but not so much that the cylindrical back of the bit will rub on the opposite wall. Now loosen the check nut on the stop screw located at the base of the tool body and turn in the screw until it limits the backward movement of the arm to the desired point. Move the turret slide forward and back with the hand lever to be sure the recessing tool is clearing the hole at all points. Lock the stop screw with the check nut.

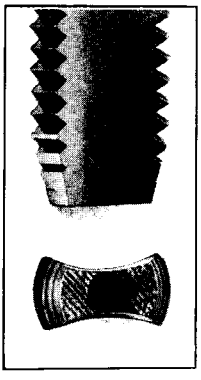

Fig. 15. Tap

With the spindle stopped, turn the driving shaft handwheel and bring the turret lead cam lever to the dwell on the turret cam between positions 37 and 39. Now move the recessing tool forward in its turret station until the end of the recessing bit just touches

the flat end of the bottomed hole in the work piece. Clamp the tool tightly in its station.

Turn the driving shaft handwheel slightly and bring the front cross slide cam lever to the beginning of the feeding rise on the recessing lobe, position 39. Loosen the check nut at the lower end of the swinging arm and turn in the guide screw until it contacts the fixed guide on the front cross slide tool post and swings the bit into contact with the wall of the work. Lock the guide screw in position with the check nut. Start the machine and engage the driving shaft clutch. Take the piece produced, cut it open with a hack saw and measure the diameter of the recess. Make necessary guide screw adjustments to get the desired ½" diameter. At the same time examine the end wall of the hole in the piece and see if the surface swept out by the corner of the recessing tool blends in with the surface produced by the bottoming tool. If a shoulder exists, loosen the turret clamp and tap the tool forward or back a small amount in its turret station.

Sharpen the Tap. A tap is pictured in Fig. 15. It is essentially a hardened screw in which sections of the thread have been cut away to expose sharp cutting edges. The nose of the tap is chamferred to distribute the cutting load over the first few threads and to make the cutting action as easy as possible. The list of angles and number of chamferred threads given for die chasers (page 7, Booklet No. 5) applies equally well for taps. The tap of Fig. 15 has a 3 thread, 15° chamfer, but for this job with a ⅛" work recess provided, no more than 2 threads should be chamferred. Two threads of 1/20 pitch will use up .100" of recess space and if the threads in the work are to be full depth up to the edge of the recess, this 2 thread chamfer is all that can be permitted. Grind a 2 thread, 20 degree chamfer on the tap. The problem in grinding the chamfer is to grind all cutting edges the same amount or to grind so that each jaw will do its share of the cutting.

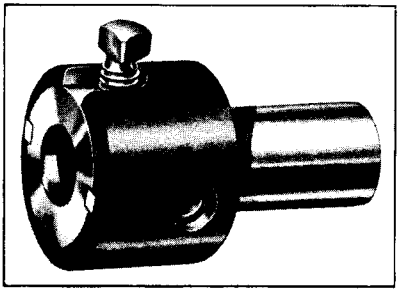

Fig. 16. Non-releasing Tap Holder

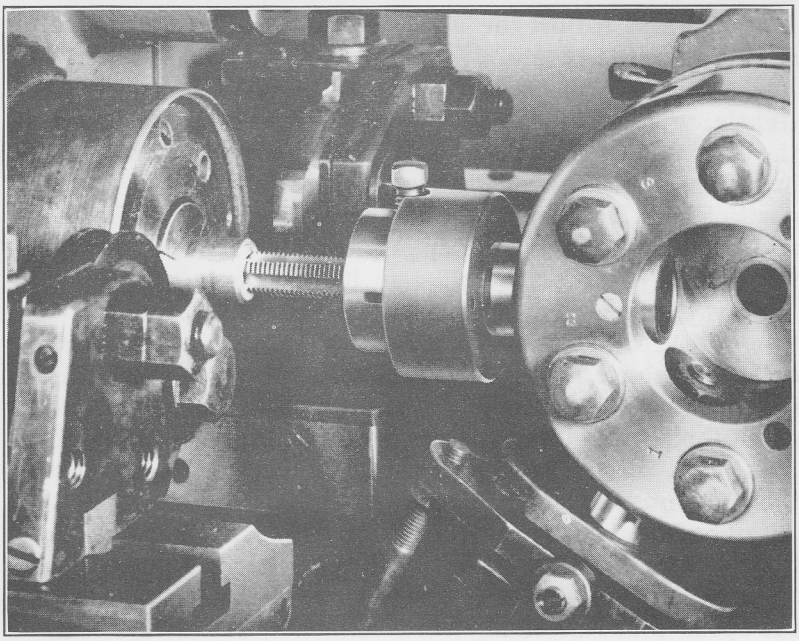

Fig. 17. Tap mounted in Non-releasing Tap Holder

As in all cutting tools, clearance should be ground behind the cutting edge. The tap chamfer must be ground lower or deeper on the trailing surface behind the cutting edge.

The chamferred surfaces are the only surfaces ground in resharpening a tap. The tap can be ground by hand against the flat side of a bench grinder wheel. Great care must be taken in grinding all jaws equally. The clearance can be obtained by "rolling the tap into the wheel" or by turning the tap with increasing pressure, while holding it against the wheel.

Where a cylindrical grinding machine is available, a tap can be mounted on centers and a true cone ground on the nose of the tap. With a true cone, all cutting edges will hold equal positions. Having ground the cone, the clearance surfaces behind the cutting edges must be ground by hand.

As a tap is resharpened, it should also have some of the metal on the flat end ground away. This is necessary if you wish to thread as close to the end of a blind hole as possible. Press the end of the tap against the flat side of a grinding wheel and grind until the maximum width or diameter of the end is a few thousandths less than the root diameter of the tap threads.

Mount and Adjust the Tap. A non-releasing tap holder is shown in Figs. 16 and 17. Select a bushing of proper size, insert it in the holder, mount the tap in position and clamp it tightly. Place the holder in the sixth turret station, and turn the driving shaft clutch until the turret lead cam lever is at the beginning of the threading lead on the tap lobe of the cam, position 49. Now bring the tap holder forward in its turret station until the tip of the tap is about $\frac{1}{8}$" from the end of the work piece. Clamp the holder in its station.

Start the machine and engage the driving shaft clutch. The tap will thread the hole part way but because of the cautious setting we have made, there will still be incomplete threads. Cut the work piece open, examine the threads, and estimate how much farther the tap could go and still clear the bottom of the hole by $\frac{1}{32}$". Move the tap holder ahead in its turret station by this amount. Repeat the machine cycle.

Cut open the second sample and observe whether a full depth thread is obtained right up to the recess. You can also check this with a threaded plug gage and a sample which has not been cut open. Make necessary readjustments, but always lean on the safe side so the end of the tap cannot strike the end of the drilled hole. When a tap hits the solid end wall, the tap will be broken or the work piece will be twisted off.

The general discussion of whether the spindle is reversing too soon or too late, given for button dies on Pages 14 and 15 of Booklet No. 4, applies equally well for taps. The setting "54" given on Fig. 2 should however, be satisfactory and it is unlikely that you will have to reset the trip dog for spindle reverse.

Make the routine adjustments to complete the set-up and produce a few sample parts.