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

No. 6

Of a Series of Booklets
for Training Operators

Turning, Forming, Threading,
Cutting Off and Slotting

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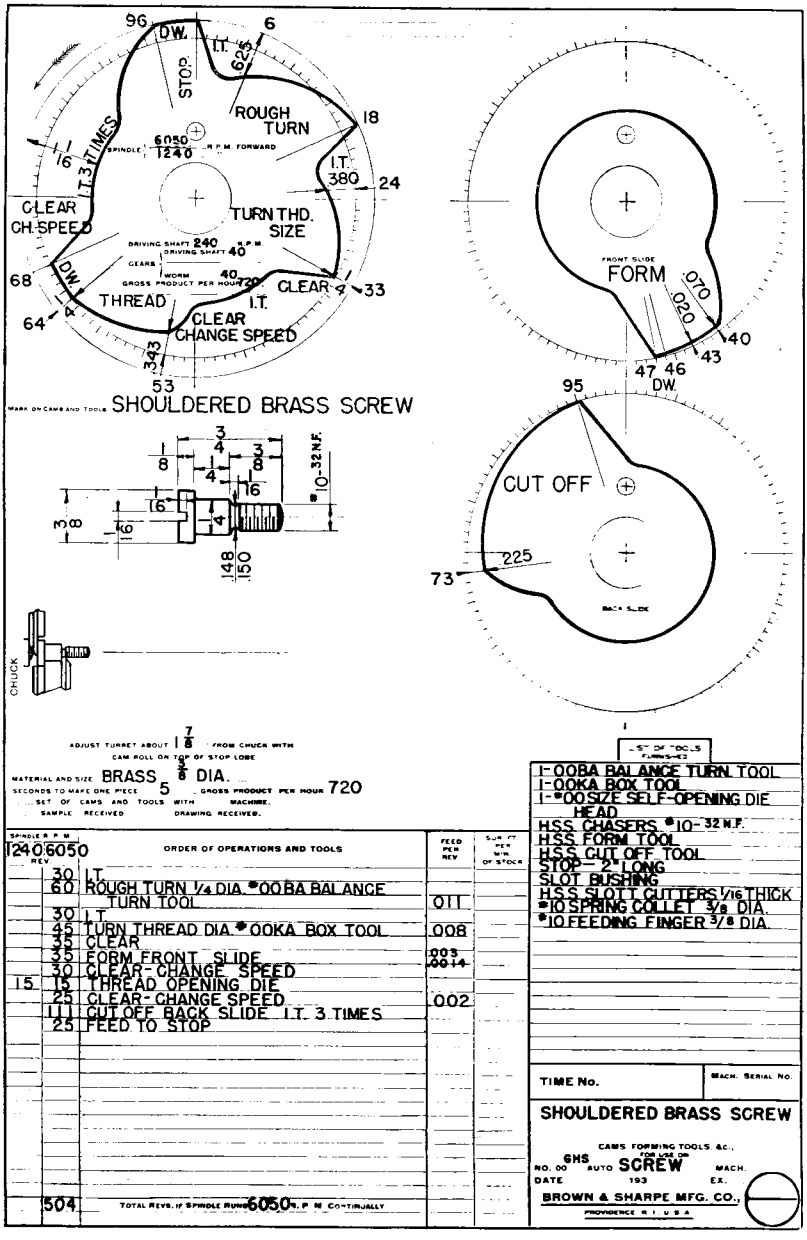

Fig. 1. Work Sheet for Job No. 5

NO. 6 OF A SERIES OF BOOKLETS FOR TRAINING OPERATORS

JOB NO. 5

Turning, Forming, Threading, Cutting Off and Slotting

Four turret stations are used in the production of the shouldered screw shown on the work sheet, Fig. 1. In one of these stations is mounted a balance turning tool. This is a roughing tool not employed in any of the preceding jobs. The 1/4" shoulder diameter is rough turned for a length of 5/8" by this tool at a feed rate of .011" per revolution of the stock. Following this rough turning, a box tool turns the 3/16" diameter to proper size for threading and a form tool comes in and finishes the 1/4" diameter and adjacent shoulder.

The screw has a slotted head. A slotting attachment mounted on the machine will cut the slot in screw No. 1 while the machine is producing screw No. 2. The machine cycle with a slotting attachment is the same as the cycle without the attachment, for the attachment arm swings down and picks up the screw without interrupting the cycle of operations listed on the work sheet. Thus the machine cycle will be described just as though no slotting operation was required and the operation and adjustment of the attachment will be considered as a separate subject at the end of this chapter.

By this time you have inserted hundreds of bars of stock and made many chuck and feed adjustments. Some of the routine directions for this new job may thus be lumped together as follows:

Strip the Machine. Insert collet, feed finger and stock. Adjust length of feed, and chuck pressure.

Set Spindle Speed. Job No. 4 had the same directions and ratio of speeds.

Mount Feed Change Gears.

Mount the Turret Lead Cam and Both Cross Slide Cams. Engage the spindle reverse dog carrier shaft coupling.

Sharpen, Mount and Adjust the Circular Cutting-Off Tool.

Set All Carrier Dogs.

(a) Turn the driving shaft handwheel until the turret lead cam lever roll has begun to drop off the stop lobe of the cam. Trip the turret trip lever and set the first turret carrier dog about position 1.

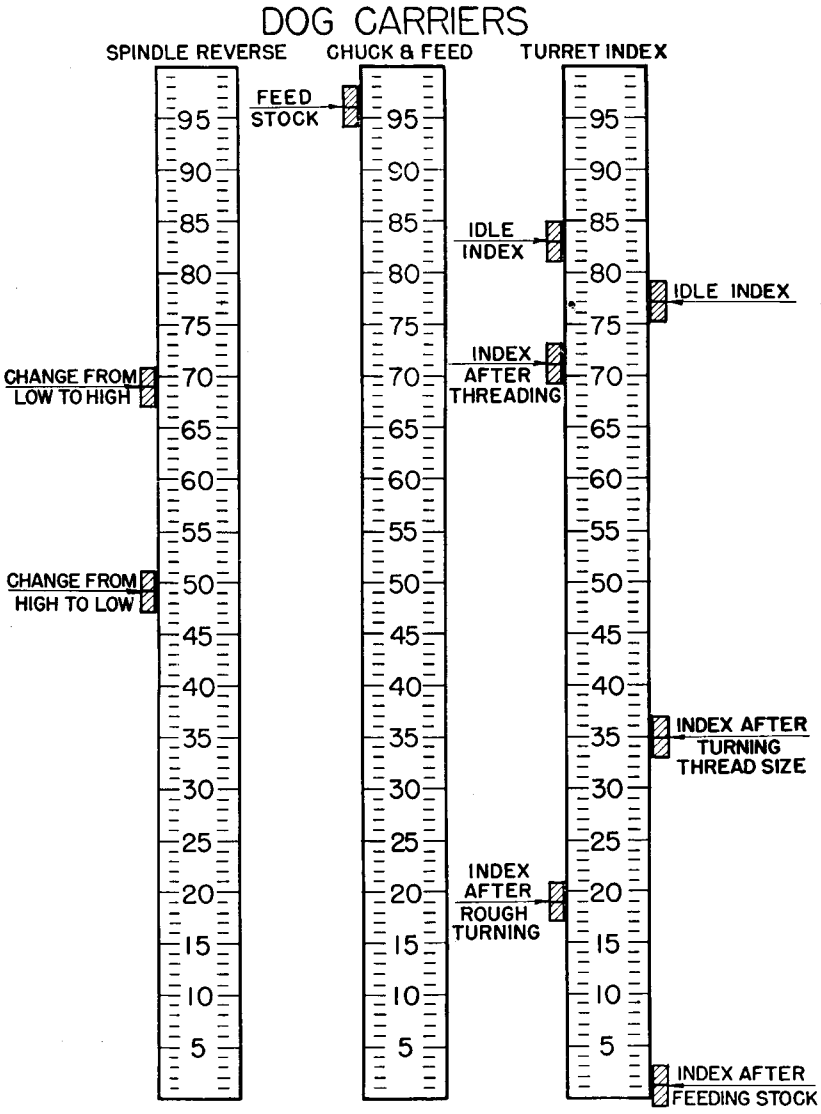

Fig. 2. Dog Settings for Job No. 5

(b) Continue to turn the handwheel until the turret slide begins to withdraw from its maximum forward position on the rough turning lobe. Set the second turret carrier dog. This will be close to position 19.

(c) Turn the handwheel further until the turret slide has withdrawn from its forward position for turning the thread diameter. Set the third turret carrier dog. There is plenty of time for this index, for the turret has to wait for the form tool to complete its cut before it can advance for threading. Position 35 should be satisfactory.

(d) Place your finger on the front cross slide and turn the driving shaft handwheel until the slide just begins to move back. Set a dog on the spindle reverse carrier. This will be close to position 49. Having passed by the dog the spindle should be in low speed. If it is not, start the machine, engage the driving shaft clutch and trip the spindle reverse trip lever once by hand. Stop the machine while still on the threading lobe of the turret lead cam.

(e) Continue turning the handwheel until the turret slide has started back from its forward threading position, about position 69. Set a spindle reverse carrier dog to change the speed from low to high.

(f) Before the next feeding operation the turret must be indexed three times. This piece is a 5 second job. Thus one second represents 20 divisions on the work sheet or carrier. The 1/4 second required for turret indexing on this machine would thus represent 5 cam divisions or 5 carrier graduations. Therefore in setting turret trip dogs, the dogs must be at least 5 divisions apart. Suppose we set the fourth turret index dog at 71, the fifth at 77, and the sixth at 83.

(g) Watch the cutting-off tool. Turn the handwheel until the tool just clears the work and then set the chuck carrier dog. This will be close to position 96.

See Fig. 2 for diagram of dog positions.

Set Turret Stock Stop. While the turret slide cam lever roll is on the dwell of the stop lobe (96 to 100) mount a turret stock stop in the turret and set it to the proper distance from the edge of the cutting-off blade.

Select Balance Turning Tool. The balance turning tool is the favorite screw machine tool for the rapid removal of stock. The tool gets its name from the two oppositely mounted bits which produce balanced cutting forces. See Fig. 3 for a picture of the tool alone and Fig. 4 for one in action.

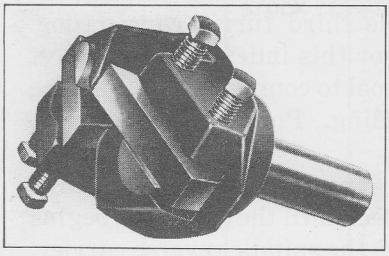

Fig. 3. Balance Turning Tool

Sharpening Bits. The bits in a balance turning tool are very similar to those used in box tools. They are ground in the same manner, have the same chip control grooves and can be judged by the same set of rules as box tools. Turn back to Booklet No. 3 and read again the section on sharpening box tool bits.

Since a balance turning tool is used for heavy roughing cuts, the clearance must be greater than that provided in a box tool in order that each bit can be advanced into the work without

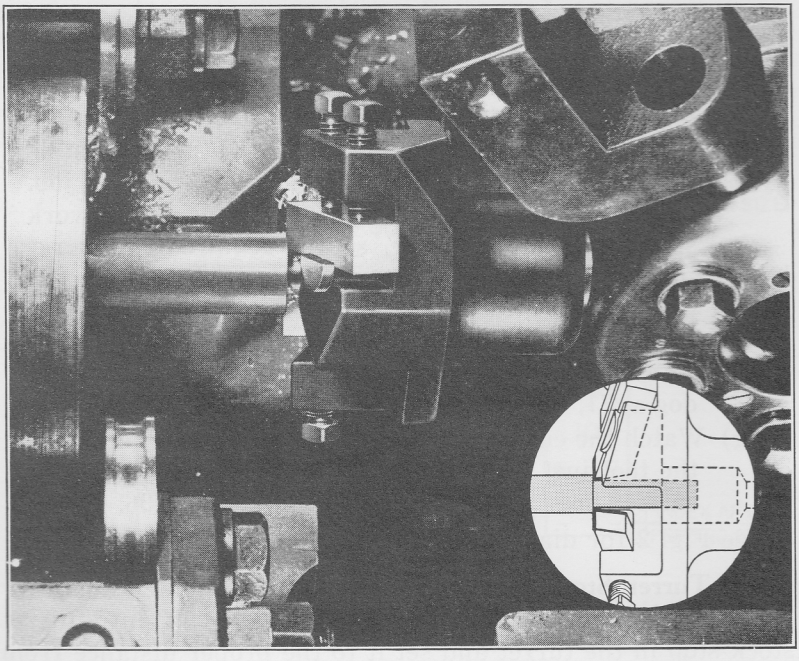

Fig. 4. Balance Turning Tool taking cut

rubbing on the surface below the cutting edge. Thus it is that balance tools are designed to hold the bit at a 15° angle or to have a 15° clearance. See Fig. 5. You will recall that the box tool held the bit to give an 8° clearance.

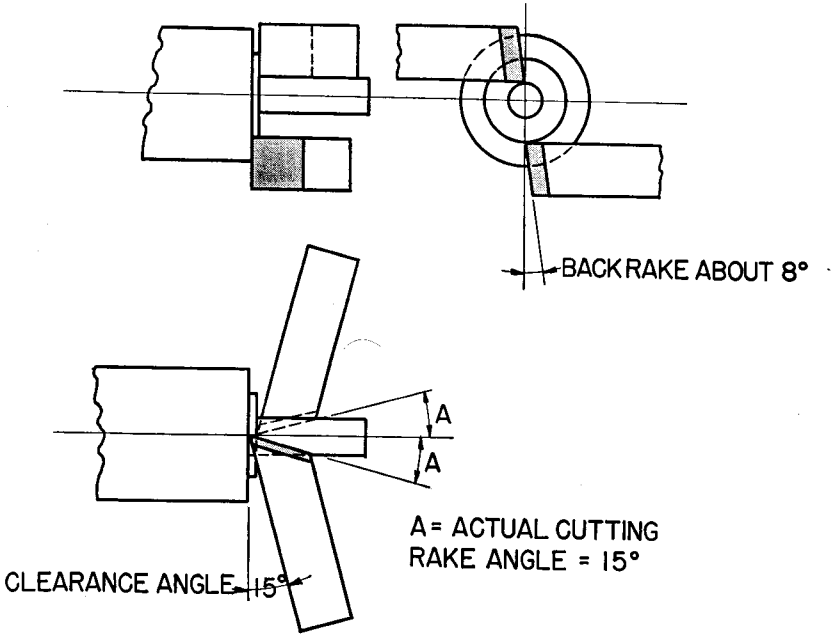

Fig. 5. Balance turning tool bits in contact with work

Now since the bit is tipped 15° by the balance tool, it will be necessary to grind a 30° hook angle to get a working or cutting rake of 15°. In Fig. 6 are shown the views of the two sides of the bit which are adjacent to the highest or cutting point. In

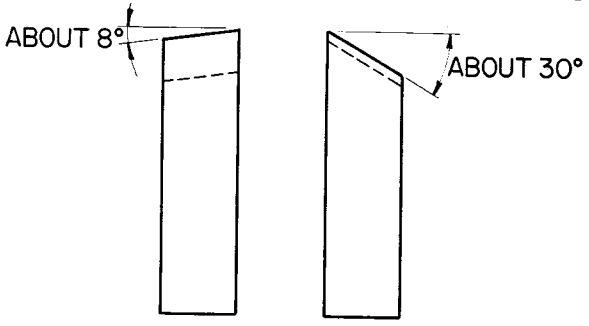

Fig. 6. Back rake and side rake of balance turning tool bit

Fig. 7 a cross section of a bit having a chip control groove is shown.

In comparing these sketches with those for Job No. 2, you will notice that the only difference between the bits is an increase of 7° in side rake or hook for balance turning bits. This increase is made necessary by the 7° larger clearance angle at which bits are supported in the balance tool.

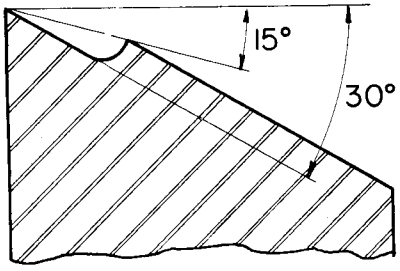

Fig. 7. Chip control groove

For general rules on how to judge whether you have too much or too little hook or clearance see Job No. 2.

For this job, and in all rough turning work, the inside and outside bits are ground to be identical and can be interchanged in their positions in the balance turning tool.

Assemble and Adjust Bits. Clean the tool so that the bits can seat squarely against the clamping surfaces.

Mount the bits in position and adjust them approximately to fulfill the three following conditions:

First, the high or cutting point of the bit must be "on center" or must lie in the work diameter which is square with the side of the bit. The views of Fig. 5 show bits on center with the work. If the cutting point of a bit is above center there will be insufficient side clearance and the stock will rub on the side of the bit. If the cutting point is below center there will be too much side clearance and the bit will tend to dig into the stock and chatter. The "on center" adjustment is made by moving the bit axially or by tapping it forward or back in the tool.

Second, to balance turning forces the bits should be adjusted to share the cut or to remove equal size chips. In our job the total depth of the roughing cut is $\frac{1}{16}$". It would then be good practice to have the outside bit remove a chip $\frac{1}{32}$" wide or to turn the $\frac{3}{8}$" diameter to $\frac{5}{16}$" and to let the inside bit remove the remaining $\frac{1}{32}$" or to turn the $\frac{5}{16}$" diameter to $\frac{1}{4}$". While an exact division of the cut is not necessary, a close approximation is desirable, for there is little purpose in using a balance tool if one bit is to do most of the cutting. A bit is adjusted for width of chip by tightening and loosening the clamp screws and rock-

ing the bit about the pivot support. Notice that large in-and-out or radial adjustments may change the "on center" adjustment.

Third, to have each bit remove its own chip it is necessary to have the cutting edge of the outside blade a little ahead (a little nearer the spindle) of the cutting edge of the inside bit. So long as the cutting edge of the outside blade is a thousandth or so ahead of the inside bit, the outside bit will remove a $\frac{1}{32}$" x .011" chip and the inside bit will do the same. No part of the outside bit can touch the metal to be removed by the inside bit. If, however, adjustments are reversed and the inside bit is slightly ahead, then this bit will remove its own chip and part or all of that intended for the outside blade. The cutting edge is wide enough to remove a $\frac{1}{16}$" wide chip and if this edge is given an advanced position it will do all the work. Of course if both bit cutting edges were exactly even, or in the same plane, equal chips would be cut, but exact adjustments are such time-wasters that it is wise to set the cutting edge of the outside bit a few thousandths ahead of the inner bit edge. The position of the cutting edge is adjusted by tapping the bits forward or back. The small amount necessary to get a thousandth or so advancement of one bit over the other will not seriously affect the "on center" adjustment. Fig. 5 shows an exaggerated case of correct adjustment.

Mount the Balance Turning Tool. Place the tool in the next turret station after the stock stop and clamp it securely. Turn the driving shaft handwheel until the turret has indexed and brought the tool into working position. Start the spindle and bring the turret slide forward with the hand lever until the end of the bar has been turned by the tool.

Measure the diameter of the turned section. Adjust the inside bit until it produces a diameter between .255" and .265". This will allow from .005" to .015" of stock for the form tool to remove in finishing this diameter. Get the inside bit on center. You can judge the "on center" position by bringing the turret slide forward (with spindle stopped) until the bit just touches the work.

Having adjusted the inside bit, make another cut and examine the turned section. If there is a shoulder on the turned face, then the outside bit is ahead of the inside bit as was desired. The depth of the shoulder indicates the amount by which one bit leads the other. Adjust the outside bit until you get a shoulder about one paper thickness deep. The depth should not

exceed .005", for the form tool which finishes the face will usually skim off .005" to .010" and this should remove any shoulder left by the balance turning tool. If there is no shoulder left by the bits the inside bit is leading and doing all the cutting. Tap the outside bit forward until this is corrected and a small shoulder appears.

Measure the widths of the shoulder steps and adjust the outside bit until the two steps are about equal, or until each bit is removing the 1/32" chip desired.

Adjust Tool for Turned Length. Turn the driving shaft handwheel until the turret lead cam lever roll is just starting on the feeding section of the rough turning lobe or is at position 6. Loosen the turret clamp and move the balance turning tool forward until it is a few thousandths from the end of the work piece. Clamp the tool securely. Start the machine and engage the driving shaft clutch.

Disengage the clutch after the piece has been turned and the turret indexed, but before the slide is advanced for the second (thread size) turning operation. Release the turret locking pin and spin the turret for one turn to be sure the balance turning tool has a clear path. If there is any interference, turn the tool about its shank axis until it is in a position to clear.

Reengage the driving shaft clutch and let the machine run until this blank has been cut off and the balance turning tool is in position to turn a new piece. Measure the turned length of the blank which was cut off. The desired value is .005" to .010" less than the 5/8" given on the work sheet. Tap the tool the small amount ahead or back which will give this length.

Sharpen, Mount and Adjust the Box Tool. The directions of Job No. 2 will cover all the necessary steps.

Sharpen, Mount and Adjust the Circular Form Tool. With this wide tool it is particularly important that the tool be set square with the work. Use the cross slide stop to give accurate size on the 1/4" diameter and adjust the tool post along the slide T-slot until .005" to .010" is removed from the screw shoulder, or until enough metal is removed to clean up this surface and eliminate all balance turning tool marks.

Sharpen, Mount and Adjust the Opening Die. The die will thread into the 1/16" recess so that the screw threads will all be full depth threads. The die should be opened when the chasers have advanced 1/32" into the recess or when they are still 1/32"

from the body shoulder. Set the die holder to cut a short length of thread and then cautiously tap the holder forward in its turret station until the die opens about $\frac{1}{32}$" before it reaches the shoulder.

If a die actually strikes a shoulder before it opens, failure of some member will occur. Usually the screw twists off and jams the chasers in the die head. In all threading adjustments lean toward the safe side, thread too short a length rather than too long a length and cut too shallow a thread rather than too deep a thread. Then by small or conservative steps adjust for the exact sizes desired.

Adjust the Flow of Cutting Oil and Produce a Few Pieces. Check one of these against the work sheet and make any adjustments necessary to maintain the specified limits.

SCREW SLOTTING ATTACHMENT

There are two units in a screw slotting attachment, the slotting head and the transfer mechanism. Both of these are shown in Fig. 8. The slotting head, containing the slotting saw and its reduction gears, is mounted on an adjustable slide. The slide and saw driving motor are supported in a position just above

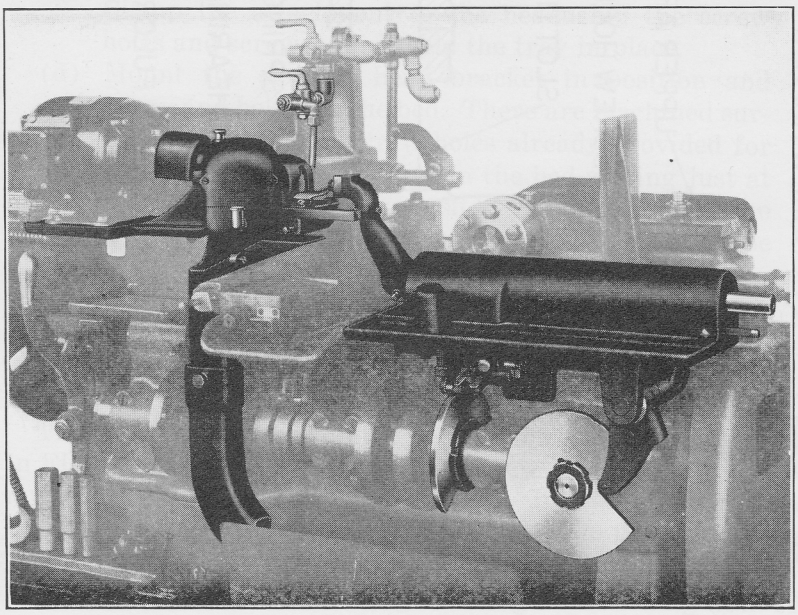

Fig. 8. Screw Slotting Attachment (No. 0 Size Machine)

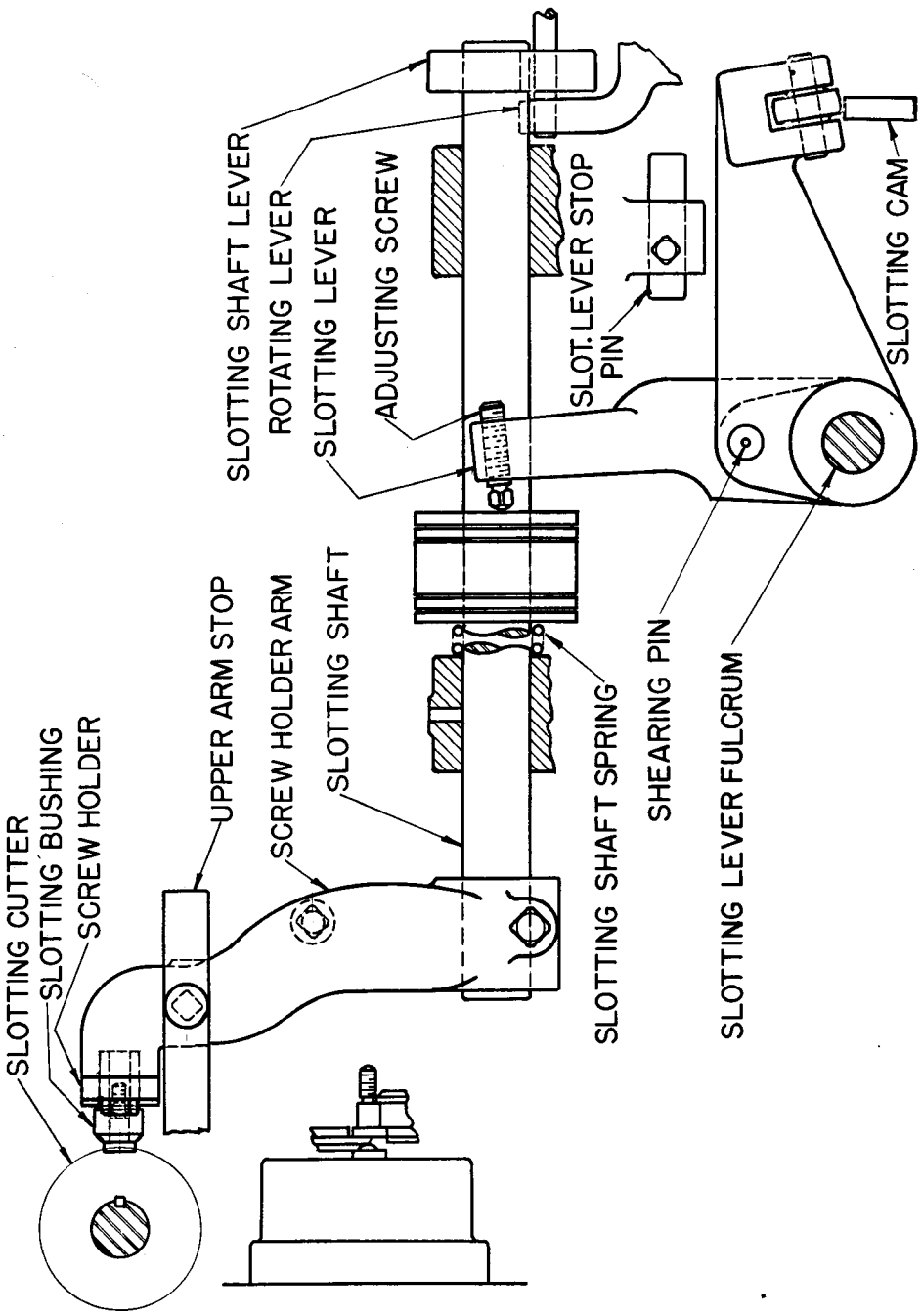

Fig. 9. Side view of Screw Slotting Attachment

the front cross slide by a bracket which is bolted to the machine bed. Although the slide may be moved toward or away from the transfer arm in making set-up adjustments, the only movement in operation is the continuous rotation of the saw.

The transfer mechanism is clamped to the bed wall right in front of the turret. Two cams, mounted on the end of the cam shaft, give the transfer arm of this mechanism a rotative and an axial movement. The rotation permits the arm to swing from the slotting position to the spindle position and back again. The axial movement permits the arm to pick up the screw and to advance it into the saw.

In considering the set-up we will assume the machine has been fitted for an attachment but that the attachment is not now on the machine. Before any further steps can be made on this job the attachment must be mounted in position.

(a) Remove the tool tray or pan from the bed wall opposite the turret. A few screws hold it in position.

(b) Wipe the clamping surface clean and rub it with a smooth file to remove any burrs or high points which might interfere with proper seating.

(c) Place the transfer unit in position, lining up the dowel holes in the bed with the pins in the attachment. Clamp the attachment to the bed using the screw holes and screws which held the tray in place.

(d) Mount the slotting head bracket in position and screw and bolt it to the bed. There are machined surfaces and bolt and screw holes already provided for the attachment. These are in the bed casting just at the left of the front cross slide. There may be some filler screws in the bed screw holes which must be removed before the bracket is put in place.

(e) Cutting oil must be delivered to the slotting saw. A short section of pipe, a shut-off valve and a small nozzle must be attached to the regular piping circuit. The view of Fig. 8 suggests a possible arrangement.

The parts which make up the transfer mechanism are named in Figs. 9 and 10. At the end of the screw holder arm you will notice a pivoted plate or screw holder. In this is mounted a tapered slotting bushing which is pushed on to the work piece just before it is cut off from the bar of stock.

Select and Mount a Slotting Bushing. A bushing can be obtained from the tool crib. The bushing hole should be a few

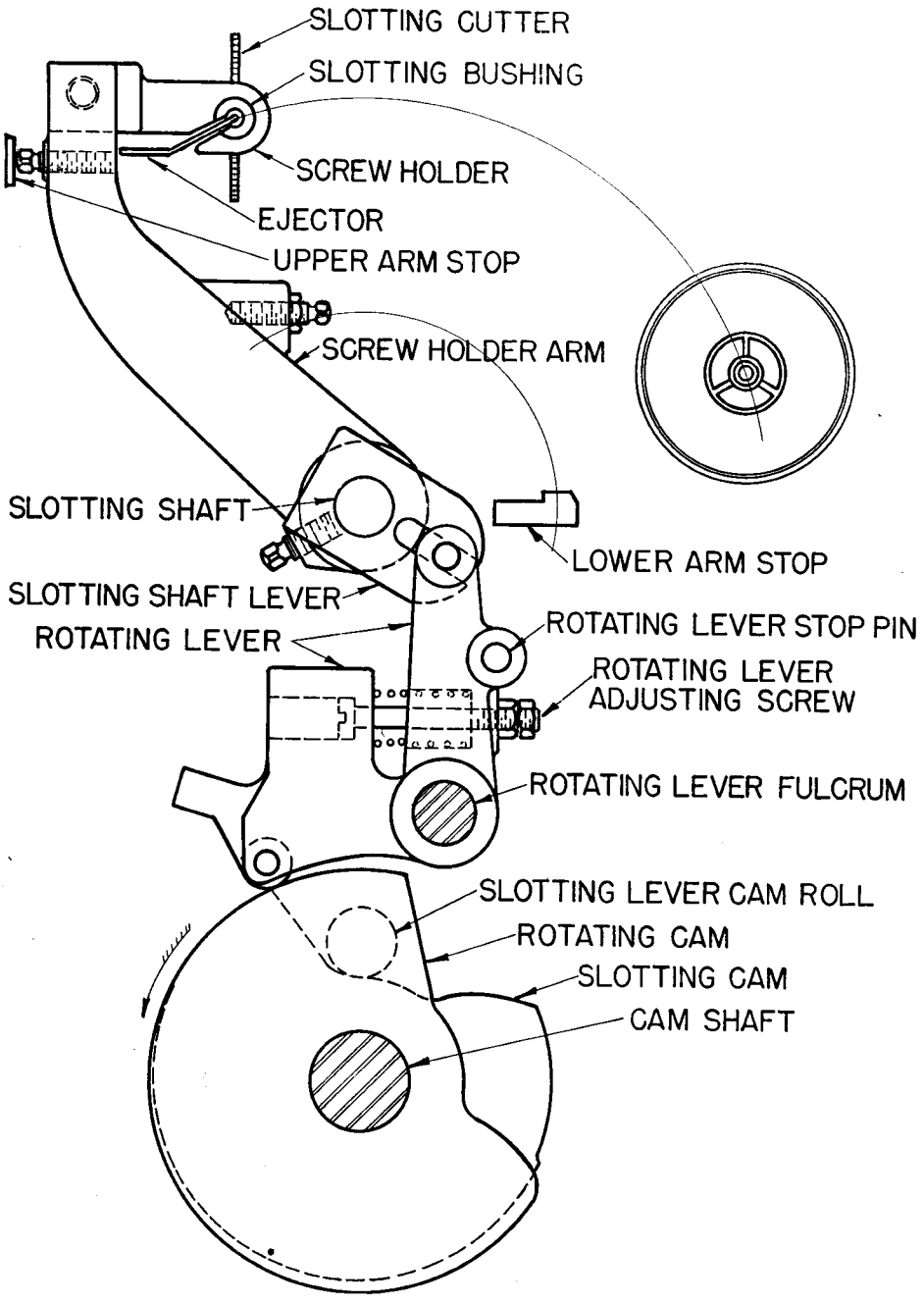

Fig. 10. End view of Screw Slotting Attachment

thousandths (.002″ to .005″) larger than the maximum screw diameter which is to enter the bushing. For our piece the bushing must support the ¼″ body of the screw and should thus have a .252″-.255″ hole. The outer diameter of the bushing is tapered and the bushing is mounted by pressing it into the tapered hole of the screw holder and tapping it lightly. Be sure the slot in the bushing lines up with the slot in the holder.

Start the Machine and let it run until a piece has been turned, formed and threaded. Stop the cycle before the cutting-off tool comes forward.

Adjust the Screw Holder. Loosen the screw holder clamp bolt so that you can oscillate the screw holder with your fingers. Now push the screw holder arm down until the slotting bushing is directly in front of the screw which has just been threaded. Then with a pin lever inserted in the slotting cam lever lift the lever and guide the screw holder while the slotting bushing slides on to the screw body. You can guide the holder with the fingers of the hand which is holding the arm down. As soon as the bushing is on the screw, remove your hand from the screw holder arm and while still holding the slotting cam lever up, move in the slotting lever stop pin until it touches the slotting lever and clamp it in this position. This last move is only a temporary one to free both hands for other adjustments.

Again press down on the screw holder arm, this time with just enough force to relieve all tension on the screw holder so that the slotting bushing is neither pressing down or pulling up on the screw. Clamp the screw holder tightly to the arm.

Set the Lower Arm Stop. Still holding the screw holder arm down so that the slotting bushing exerts little or no pressure on the screw, adjust the lower arm stop screw until its head presses against the stop plate.

To check the last two adjustments lift the slotting cam lever with the hand lever and release the slotting lever stop pin. Now press the screw holder arm down firmly against the lower arm stop, and raise and lower the slotting cam lever. Observe whether or not the slotting bushing slips readily on to the screw body and whether or not there is any binding between the bushing and screw body. Pressure between the bushing and screw may cause roughing up or scoring at high work speeds, or may bend the piece as it is being cut off. If the bushing binds on the screw, repeat the adjustments described.

Mount the Attachment Cams. If the two cams are not already on the machine, mount them on the cam shaft. The slotting cam goes in the inside, and the rotating cam in the outside position. Both cams have their names stamped on them. Identify the drops and rises on the cams before mounting. A drop is usually a straight side or even a concave curve while a rise is more gradual and is rounded to a convex curve.

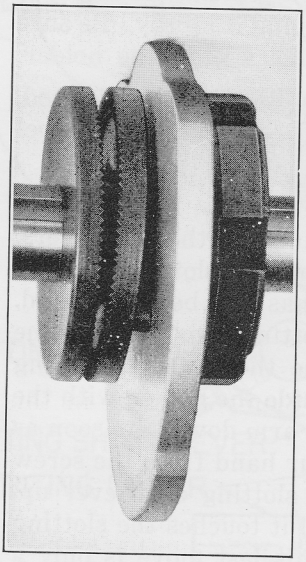

Fig. 11. Attachment Cam

Notice that although the cams are driven by collar pins (Fig. 11) the collars themselves are not keyed to the shaft and are driven only through the serrations on the side of the collar. The collars and cams may thus be adjusted to almost any rotational position before they are clamped for driving. For the time being, leave the cams unclamped.

Adjust the Rotating Lever Adjusting Screw. Turn the rotating cam and collar until the low portion of the cam is directly under the cam lever roll. The lever will drop, and the work holder arm will swing to the spindle position. The lower arm stop will limit the movement and the lever roll will not quite touch the low section of the cam. With the cam lever suspended in air, the whole rotating mechanism is under spring tension and the arm is pressed firmly against the lower stop while the bushing is being pushed over the screw. If the roll should touch the low section of the cam, this desired location under tension will be lost. To correct this condition, tighten the rotating lever adjusting screw until the lever roll is lifted from the bottom of the rotating cam (about $\frac{1}{16}$"). If the roll is being held too far from the cam (over $\frac{1}{16}$"), loosen the screw, for this large clearance is unnecessary and only increases the striking blow on the lower arm stop.

Adjust the Slotting Lever Adjusting Screw. Back off the slotting lever adjusting screw or let the screw holder arm move back from the work. Now insert a hand lever in the

slotting cam lever and lift it. Turn the slotting cam so that when the hand lever is released the lever roll will rest on the dwell just after the first steep rise on the slotting cam but before the second or smaller rise. With the roll resting on the dwell, turn the slotting lever adjusting screw forward until the slotting bushing is on the 1/4" body of the screw and is just touching the shoulder of the screw head.

Clamp Rotating Cam in Position. Start the machine without engaging the driving shaft clutch. Turn the driving shaft hand wheel until the cutting-off tool has come forward and cut off the screw. Go a little beyond exact center to be certain the work piece is cut off, for we don't want the screw holder arm to begin lifting the screw before it is severed from the bar. In moving the handwheel, the unclamped attachment cams should not turn. Watch to see that both lever rolls remain on the cam dwells. Now turn the rotating cam until the lever roll comes in contact with the cam rise. Clamp the cam in this position.

Set the Ejector. Loosen the ejector finger on the slotting head and move it back away from the head so that the screw holder will not strike it when the arm swings up to the slotting position. Now turn the driving shaft handwheel until the rotating cam lever roll is on the top of the cam rise or until the screw holder arm has just reached its top (slotting) position. Move the ejector in until it just clears the end of the screw as it is held in the slotting bushing. Clamp the ejector in this position.

Set the Upper Arm Stop. While the arm is in its top position, adjust the upper arm stop screw so that its head is pressing against the stop plate. Then give the screw an extra turn or two to put the mechanism under tension and to make sure the arm will be held firmly against the stop while the slotting cut is being made.

Adjust Screw Holder Supporting Rest. When the screw holder arm is in its top or slotting position there is a supporting rest directly under the screw holder. This helps to support the holder while the slotting cut is being made. Release the clamp bolt which is in the slotting head slide and has its head facing the machine spindle. Then push the vertical rest or support up with your finger until it presses against the screw holder. Clamp the rest in this position.

Clamp the Slotting Cam. Without changing the position of the rotating cam which has just lifted the arm to the slotting position, turn the slotting cam until the second or small rise is ready to lift the slotting cam lever. Clamp the cam in this position.

Select Proper Saw Speed. Slotting heads are designed to run saws at high speeds for brass and slow speeds for steel. Changes in speed are obtained by changing the reduction gears in the drive between the motor and saw. Remove the guard or cover on the front of the head and put on the proper gears.

Mount the Slotting Saw. Select a $\frac{1}{16}$" width saw and mount it on the slotting head spindle. The cutting teeth will be moving down when slotting the screw. Mount the saw so that the teeth will be facing in the direction of rotation. On the spindle are several collars of different widths. Arrange these on both sides of the saw so that when the assembly is clamped the saw will be central with the screw, or will cut a slot along a diameter of the screw head. If the saw is not on center rearrange the collars to shift the position of the saw, or for small adjustments change the setting of the upper arm stop screw. As the screw rests in the slotting bushing there is nothing to prevent the screw from turning. A saw cutting off-center provides a turning force. To avoid this condition the saw must be central with the screw head.

Set Slotting Lever Stop Pin. Plug in the slotting head motor and start the machine. Turn the driving shaft handwheel. The screw will be advanced into the saw, withdrawn and ejected. Turn the handwheel until the slotting bushing clears the ejector. Then move the slotting lever stop pin forward until it touches the slotting lever. Clamp the pin in this position for it is not necessary to have the arm go back any further.

Adjust for Depth of Slot. Measure the depth of the slot in the screw just ejected. Move the slotting head slide forward or back enough to give the $\frac{1}{16}$" slot depth desired. It will be necessary to release the clamp bolts on the slide and then to turn the adjusting screw on the under side of the slide. Having made the adjustment, clamp the slide.

Check for Interferences. Turn the driving shaft handwheel and go through a complete cycle. Check to be sure the arm

clears the turret tools as it swings down in front of the stock and see that the slotting bushing clears the end of the screw it is to pick up. Watch the arm as it swings back to the slotting position. Any interferences must be eliminated. Slight changes in the setting of the attachment cams may correct conditions or the turning of turret tools in their turret stations may give the necessary clearances.

Saws. It is common practice to discard slotting saws when they become dull. Time spent in sharpening these fine tooth cutters is more costly than replacement. Thus saws are seldom resharpened.