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

No. 8

Of a Series of Booklets
for Training Operators

Forming, Threading, Taper Turning and Cutting Off

Brown & Sharpe Mfg. Co.
North Kingstown, R. I., U. S. A.

1968

PRINTED IN U.S.A.

1M-12-68

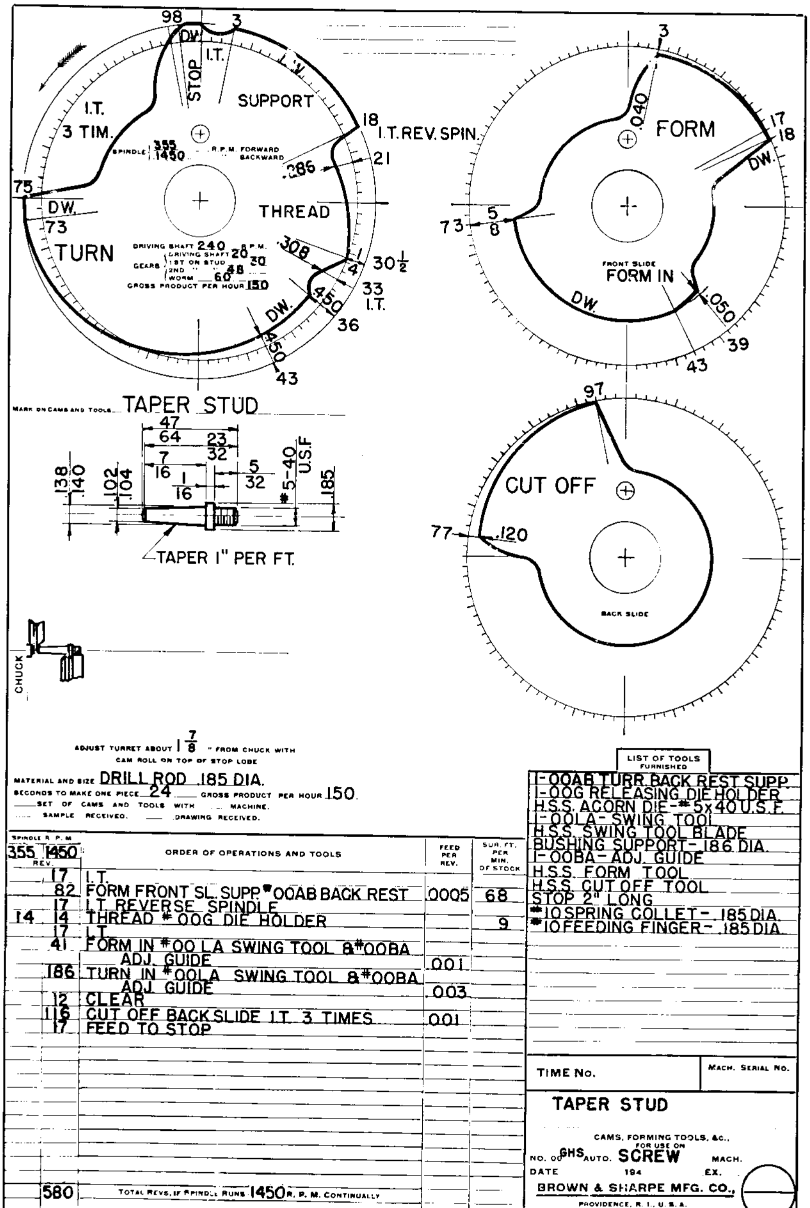

Fig. 1. Work Sheet for Job No. 7

NO. 8 OF A SERIES OF BOOKLETS FOR TRAINING OPERATORS

JOB NO. 7

Forming, Threading, Taper Turning and Cutting Off

When the length of a work piece is several times greater than its diameter, as is the case with the taper stud of Fig. 1, a back rest should be used to support the work while a form tool is cutting. Thus in this job, we use for the first time a back rest mounted in one of the turret stations. This job also introduces the operation of taper turning, an operation which requires a swing tool held in the turret and actuated by the co-ordinated movements of the turret slide and front cross slide.

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.

Set All Trip Dogs. Fig. 2.

(a) Turn the driving shaft handwheel until the turret lead cam lever roll is at the end of the stop lobe dwell, at position 0. Set a carrier trip dog to index the turret at this position.

(b) Bring the turret lead cam lever to the end of the supporting lobe dwell, position 18, and set the second trip dog for turret index.

(c) While still at position 18, set a spindle reverse carrier trip dog to reverse the spindle from high to low speed. The actual change in speed should not occur until the front cross slide has pulled back a few thousandths, for we do not want the form tool in contact with the work when the speed reverses. The trip dog may be set enough beyond position 18 to insure tool withdrawal before spindle reversal.

(d) Turn the driving shaft handwheel until the turret slide has just started to withdraw from the threading operation, about position 31. Set a spindle reverse carrier trip dog to reverse the speed from low to high.

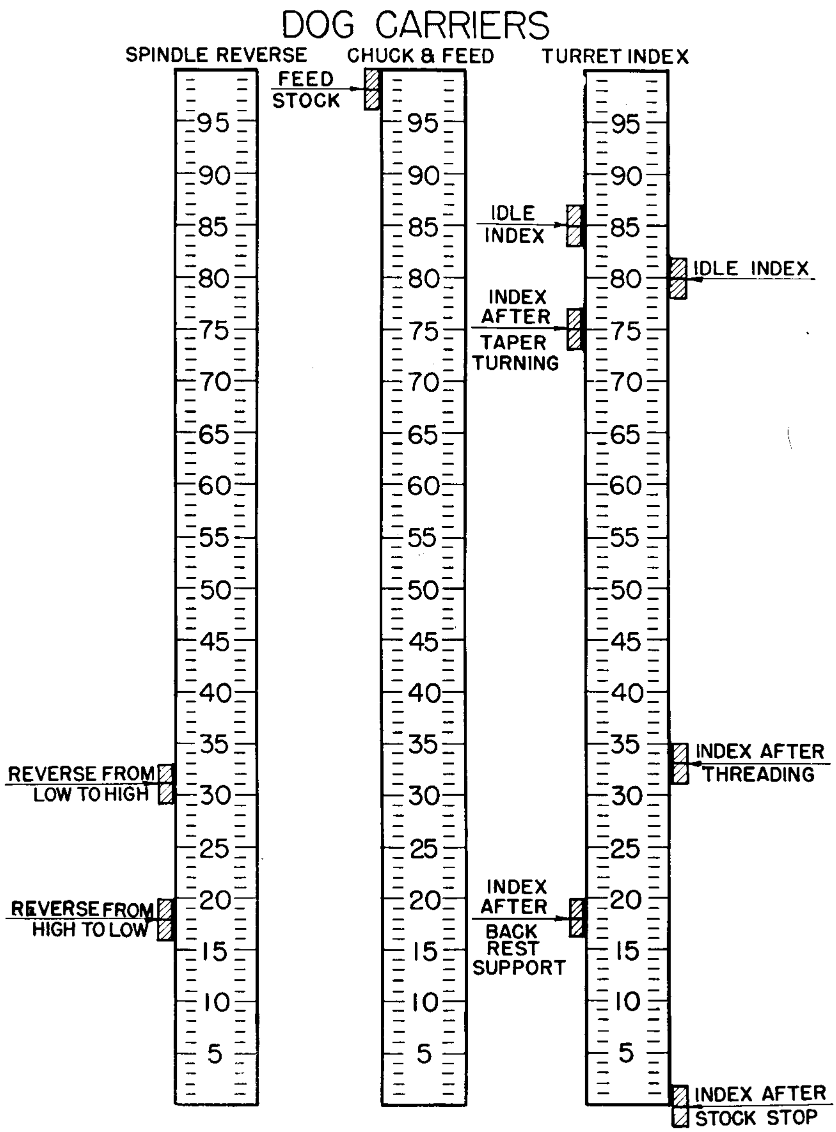

Fig. 2. Dog Settings for Job No. 7

(e) Bring the turret lead cam lever to the bottom of the drop on the threading lobe, position 33. Set the third trip dog for turret index.

(f) Continue the cycle until the turret lead cam lever is at the end of the taper turning lobe, position 75. Set the fourth trip dog for turret index.

(g) Two more indexes are necessary to complete the circuit and get back to the stock stop lobe. Since this is a 24 second job, the 1/4 second required for indexing represents about one hundredth of cam surface. So long as trip dogs are one hundredth apart the timing will be correct. Since we have plenty of time, the fifth turret index trip dog might be set at position 80 and the sixth at position 85.

(h) Bring the turret lead cam lever to the top of the stop lobe, position 98, and set the chuck and feed carrier trip dog.

Sharpen, Mount, and Adjust the Cutting-Off Tool. Since the circular cutting-off tool produces the rounded form on the end of the taper stud and chamfers the end of the bar, it should be sharpened as a form tool and should have no hook or rake. For a backward turning speed, the tool post will be mounted on a raising block to get the cutting edge "on center" with the work. The tool should be as close to the spindle nose or chuck as possible.

Set the Turret Stock Stop. The stop must be 23/32″ from the cutting-off blade when the cam lever roll is on the stop lobe dwell, position 99.

Sharpen, Mount, and Adjust the Form Tool. Set the tool post in such a position in the front cross slide T-slot that the 1/16″ shoulder will be 5/32″ from the end of the work piece. Set a cross slide stop screw to control the .125″ diameter when the cam lever roll is on the front slide cam dwell or between positions 17 and 18.

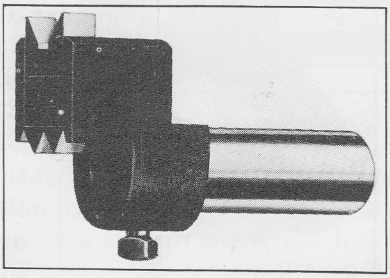

Fig. 3. Back Rest

Mount and Adjust the Back Rest. In Fig. 3, a back rest is shown. It is a member mounted in a turret station and has a

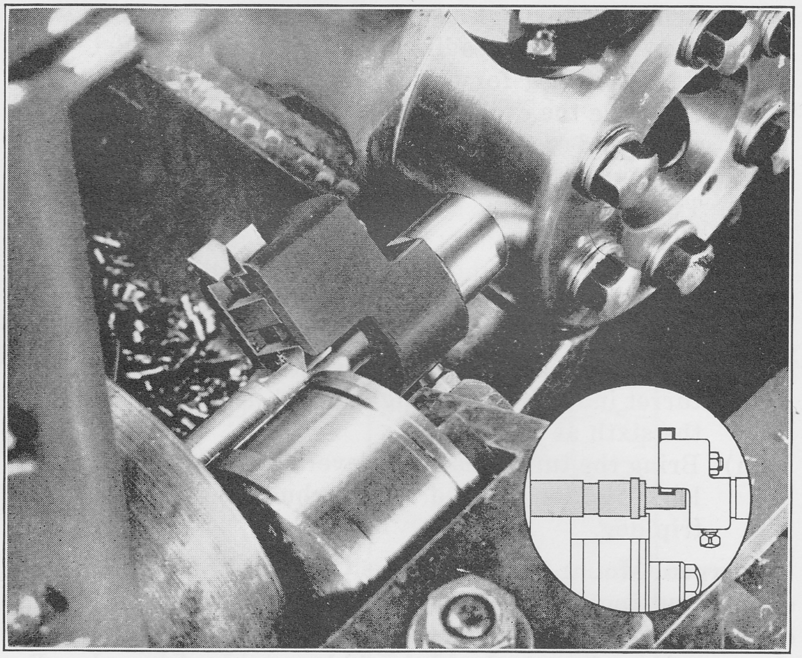

Fig. 4. Back Rest supporting work during forming cut

V-block which supports the work piece. Loosen the clamp screw which holds the blocks in position and clean the tool so that the blocks will seat squarely. Mount the back rest in the turret station just after the stock stop. Turn the driving shaft handwheel until the turret lead cam lever is on the dwell of the supporting lobe, position 3 to 18. Now move the back rest forward in its turret station until the V-blocks are in back of the $\frac{1}{16}''$ shoulder or band on the work piece. The rest must also be approximately opposite from the form tool. Clamp the back rest in its turret station. Now with your fingers press both of the V-blocks forward until they touch the work. Clamp them tightly in this position. The V-blocks must not push the work piece off-center and yet must touch the work so that form tool pressures will not be able to deflect it.

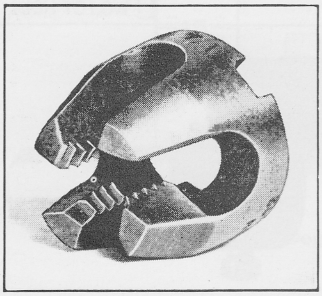

Fig. 5. Acorn Die

Sharpen the Acorn Die. The die used for cutting the screw threads is called an "Acorn" Die and is pictured in Fig. 5. The four cutting jaws are much the same as those in a button die except that they are supported by a solid ring of metal at one end of the jaws rather than by a slotted ring of metal on the outside of the jaws. The die is adjusted by pulling a conical ring on to the tapered jaws and thus bending them in to cut a smaller pitch diameter.

The jaws do all their cutting on the chamferred threads at the front end of the jaws. To sharpen a die the chamfers must be re-ground. The chamfer will be the same as already described for opening die chasers. The chamfer should normally cover 2 to 3 threads but since in this case we are threading as close to a shoulder as possible, a 40 degree, one thread chamfer should be used, see Fig. 5, Booklet No. 5.

Equal grinding of the jaws is important if all jaws are to share the cut and a good thread is to be obtained. If possible, use a grinding fixture or special machine for sharpening Acorn dies. If hand-grinding with a pencil wheel must be done, try patiently to sharpen the die so that all jaws will be cutting as the screw is threaded. The chamferred surface in back of the cutting edge must be low or must have clearance as already described for button and opening dies.

Assemble Die in Releasing Holder. Back off the holder check nut, and remove the conical adjusting nut, Fig. 6. Clean the holder and adjusting nut, mount the Acorn die in position with its keyway engaging the two keys of the holder, and screw on the adjusting nut until it locates the die in position. Acorn dies are usually furnished with a screw sample cut with the die. Use this, or a master screw as a test piece and tighten the adjusting nut until the screw can just be threaded into the die by hand. Lock the adjusting nut in this position by tightening the check nut. If you have no sample screw, tighten the adjusting nut lightly with the intention of having the first screw come a little large, rather than a little small.

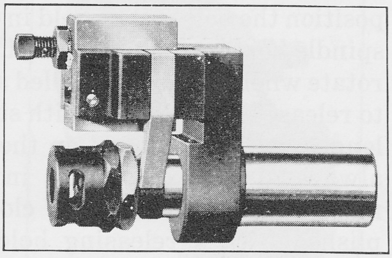

Fig. 6. Releasing Die Holder

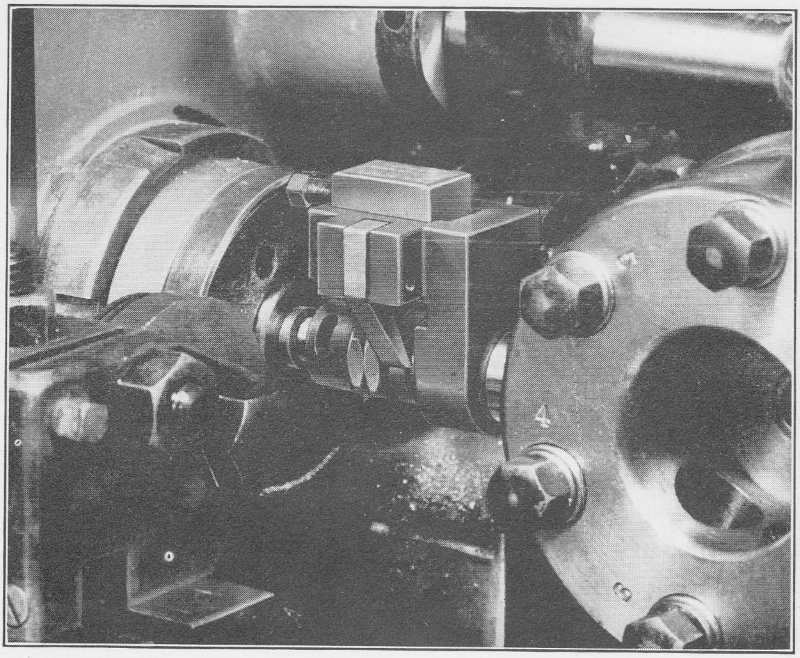

Fig. 7. Releasing Die Holder threading the work piece

Holding the shank of the die holder in one hand, pull out the die head and observe how the holder releases. Also press in on the bolt just above the die head and observe the same relative releasing movements. When in operation the bolt will be adjusted so that when the turret slide approaches its forward position the bolt will be held in contact with the stationary front spindle box nut. The die head will then be free or permitted to rotate when the head is pulled ahead the given distance required to release the die head. With such releasing action, the threaded length does not depend on the point of spindle reversal but is always at an exact point in relation to the spindle of the machine. Threading very close to a shoulder can be accomplished with a releasing holder. The die jaws do not leave contact with the screw but at the instant of release the die begins to rotate with the screw or work piece, and thus does not thread on any further. To back the die off the work, it is necessary to reverse the spindle.

Mount and Adjust the Releasing Die Holder. Place the holder in the next turret station after the back rest. Measure the amount of axial movement or pull-out required to release the die. For the 00G Holder, this distance is about $\frac{3}{16}$″. The actual length to be threaded on the work is $\frac{5}{32}$″, or a smaller amount than the pull-out. Thus to thread to the shoulder and release, the pull-out must begin before the die reaches the work piece. Turn the driving shaft handwheel until the turret lead cam lever is at the beginning of the threading lobe rise, position 21. Bring the die holder forward in its station until the die just clears the end of the work piece and clamp the holder shank tightly in the turret. The adjusting bolt should be directly above the die.

Now screw the adjusting bolt out until its head strikes the front spindle box nut. Make sure it does not touch any rotating part of the spindle. Continue to turn the bolt until the bolt slide and driving finger are pushed back $\frac{1}{16}$″. This means that $\frac{1}{16}$″ of the $\frac{3}{16}$″ pull-out or releasing movement has been used up and that the die holder will release after an additional $\frac{1}{8}$″ of movement (or after the die has threaded a $\frac{1}{8}$″ length of screw). This brings the release point $\frac{1}{32}$″ from the shoulder on the work piece. Lock the adjusting bolt in position with the check nut. Start the machine and engage the driving shaft clutch. Examine the piece produced and measure the distance between the last incomplete thread and the shoulder. Turn in the adjusting bolt a little less than this measured distance and produce another piece. By successive adjustments (always on the safe side) set the adjusting bolt so that the die threads to within $\frac{1}{64}$″ of the shoulder.

Check the screw for size with a thread gage. Adjustments for pitch diameter can be made by tightening or backing off the conical adjusting nut.

Select Swing Tool. A swing tool is mounted in a turret station and has a turning blade or bit which is held in a pivoted arm, Fig. 8. The blade can swing into or away from the work when the tool is in cutting position. An adjustable screw in the pivoted arm presses against a guide on the front cross slide permitting the cross slide to control the swinging movements of the arm

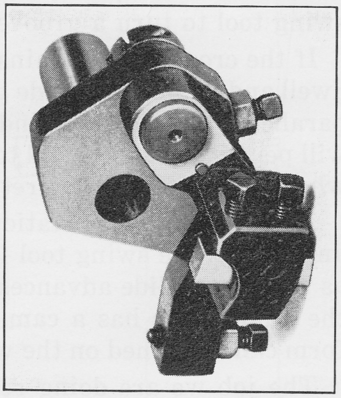

Fig. 8. Swing Tool

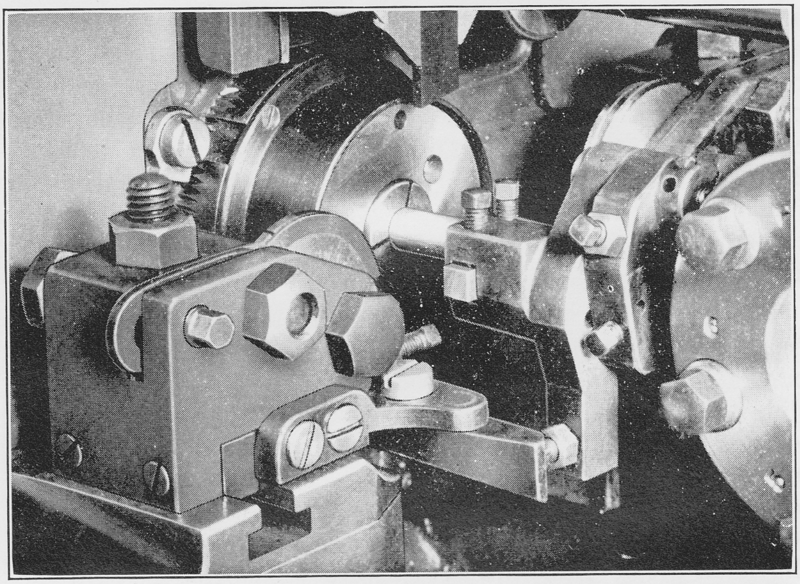

Fig. 9. Swing Tool used for taper turning

or to control the feeding of the turning blade into the work.

If the turret slide remains stationary, or the turret lead cam lever is on a dwell, then movement of the cross slide causes the swing tool to turn a groove or shoulder in the work.

If the cross slide remains stationary or its cam lever is on a dwell and if the cross slide guide is set with its bearing surface parallel to the work or spindle axis, then movement of the turret will permit the swing tool to turn a constant work diameter for whatever length the turret slide feeds.

If the cross slide is stationary but the guide plate is set at an angle, then the swing tool is moved in or away from the work as the turret slide advances. In this way a taper is turned. If the guide plate has a cam or formed surface, then a similar form can be turned on the work.

The job we are doing requires a combination of the movements just described. From position 36 to 43, the turret slide is stationary while the lever roll is on the cam dwell. From position 39 to 43, the cross slide is being fed forward. Thus the swing tool blade turns a groove in the work piece or faces the inner shoulder of the $1/16''$ band. From position 43 on, the cross

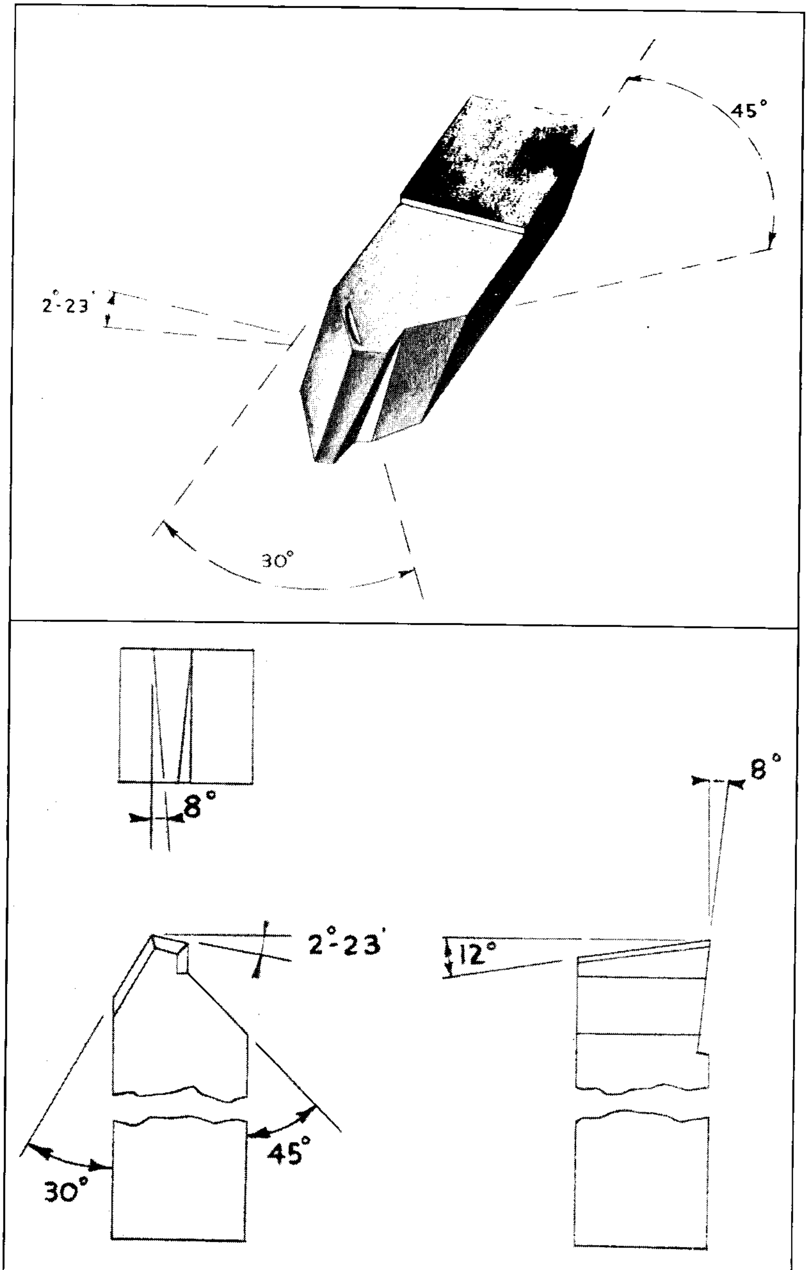

Fig. 10. Swing Tool Bit, showing clearance and rake angles

slide is stationary or dwells while the turret slide is fed in. With an angular setting of the cross slide guide, this turret movement causes the swing tool to turn the desired taper.

Sharpen the Swing Tool Bit. By this time you probably have noticed that the fundamentals of tool sharpening are much the same regardless of the names given to the tools. The cutting edge must have clearance to avoid rubbing on the work and must have rake or hook to get free cutting action. In sharpening the swing tool blade, our problem is again one of getting proper rake and clearance angles and of controlling chips.

To get a smooth finish on the tapered work surface the front edge of the bit is ground to be parallel to the work, or is given the approximate angle of the taper. See Fig. 10. This front edge does the cutting when the bit is first fed into the work by the cross slide cam and has a finishing action as the tool is fed along the taper by the turret lead cam. Below this front cutting edge, a 12 degree clearance angle has been ground and going back from the edge, an 8 degree rake angle is used.

The cutting edge which faces the inner shoulder on the work piece is square with the work axis. A 12 degree clearance angle is maintained below this edge to avoid rubbing between the shoulder and the body of the bit.

On the opposite side of the bit is the cutting edge which has the major duty of roughing off the stock as the taper is turned. This edge makes a 60 degree angle with the work axis. The point of the bit formed by the front and side cutting edges is more sturdily supported and has a greater resistance to breaking down when the angle between the sides can be made greater than a right-angle as has been done in this case. A 12 degree clearance angle is ground below the cutting edge.

For a small tool of this type with its three cutting edges and many angles, an operator would try the tool to see how the chips are formed and only if there is a tendency to obstruct operation and foul the tool would he grind a chip control groove. If the cut and type of stock make a groove necessary, it would be ground parallel to, and blending in, with the 30 degree cutting edge. The groove would not break through the front cutting edge but would converge to a point just behind the front edge as in Fig. 10.

Mount and Adjust Swing Tool. Clamp the bit in position in the swinging arm of the tool making sure the surfaces against which it is clamped are clean. Mount the tool in the fourth turret station or just after the threading die. The pivot stud for the swinging arm should be directly over the axis of the work piece or vertically above the central hole in the tool shank. Turn the driving shaft handwheel until the turret lead cam lever is on the dwell of the cam or between positions 36 and 39. Now move the swing tool forward in its turret station until the side of the bit is in position to cut the inner shoulder of the $1/16''$ band. Clamp the tool shank tightly in the turret.

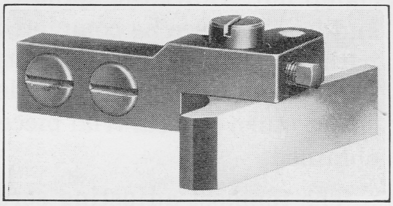

Fig. 11. Adjustable Guide

Attach the left-hand adjustable guide shown in Fig. 11 to the turret side of the front cross slide tool post. There are two screw holes in the post provided for this purpose. Tighten the screws until the guide is held securely. Loosen the clamp screw which locks the guide plate and set the plate at an approximate angle for the taper required. The length of the guiding surface on the plate is two inches. To get a taper of 1″ per foot on the work the spindle end of the plate should be $1/6''$ nearer the work than the turret end of the plate. For a tool which has a 2 to 1 ratio of movement the formula is:

$$\text{Setting} = \frac{\text{Taper per foot} \times \text{length of guide plate}}{12}$$

The plate adjustment is obtained with the square headed screw shown in the picture of Fig. 11. After making an approximate setting, clamp the plate tightly.

Now bring the lead cam lever roll to position 39 by turning the driving shaft handwheel. The turret slide will be dwelling while the front cross slide will be on the verge of feeding forward. Move the tool bit in or out (loosen clamp screws until they just drag and tap the bit lightly) until the bit is just touching the work and the swinging arm is moved slightly out of the vertical toward the front cross slide. The ideal setting is one which will permit the swinging arm to be in the vertical plane when the bit is at the mid-point in the length of the taper. We can closely approximate this condition by having the arm tilt toward the cross slide when the bit touches the outside diameter of the work. By adjusting the two clamp screws which hold the bit, get the cutting edge of the bit "on center" with the work. The bit rests on a cylindrical pin and can be rocked by tightening one screw while loosening the other.

Loosen the clamp nut on the lowest, or bottom, adjusting screw in the swinging arm and turn in the screw until its point touches the adjustable guide plate on the cross slide while the cutting edge of the bit is just touching the work. Lock the clamp nut. Start the spindle, engage the driving shaft clutch and let the piece be completed. Measure the taper or check it with a gage and then make small trial adjustments of the guide plate to get the exact taper desired. It will probably be necessary to turn several trial pieces before a correct plate setting is obtained.

The topmost adjusting screw on the body of the swing tool limits the outward swinging of the tool arm. Set this stop in such a position that the arm can withdraw the bit about 1/64" from the outside surface of the .185" bar of stock, but not so far that the guide screw could ever catch on the end of the guide plate when the tool is moved forward by the turret slide.

Having obtained the proper taper there is but one adjustment left, that of getting the correct diameter for the taper at its large end. This adjustment must be made with the adjusting screw which makes contact with the guide plate, for any movement of the cross slide adjusting nut would upset the depth setting already made for the form tool. Turn the adjusting screw in the arm in or out until the desired diameter is produced. Lock the screw in position with the check nut.

The cross slide stop screw cannot be used with the swing tool for it too has been set for forming. To get a smooth finish on the tapered surface, it is thus necessary to have a smooth surface on the dwell of the front cross slide cam (position 43 to 73), for any roughness or irregularity will cause the cross slide to quiver and will produce tool marks in the turned surface of the work piece. Cross slide cam dwells are often ground for taper turning operations.

Complete the Set-Up. Set the work deflector, adjust coolant flow, go through a complete cycle by hand and make any final tool adjustments necessary to get clearances or to meet work limits. Submit a sample piece to your foreman for checking.