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

No. 3

Of a Series of Booklets for Training Operators

Turning, Forming and Cutting Off

Brown & Sharpe Mfg. Co.
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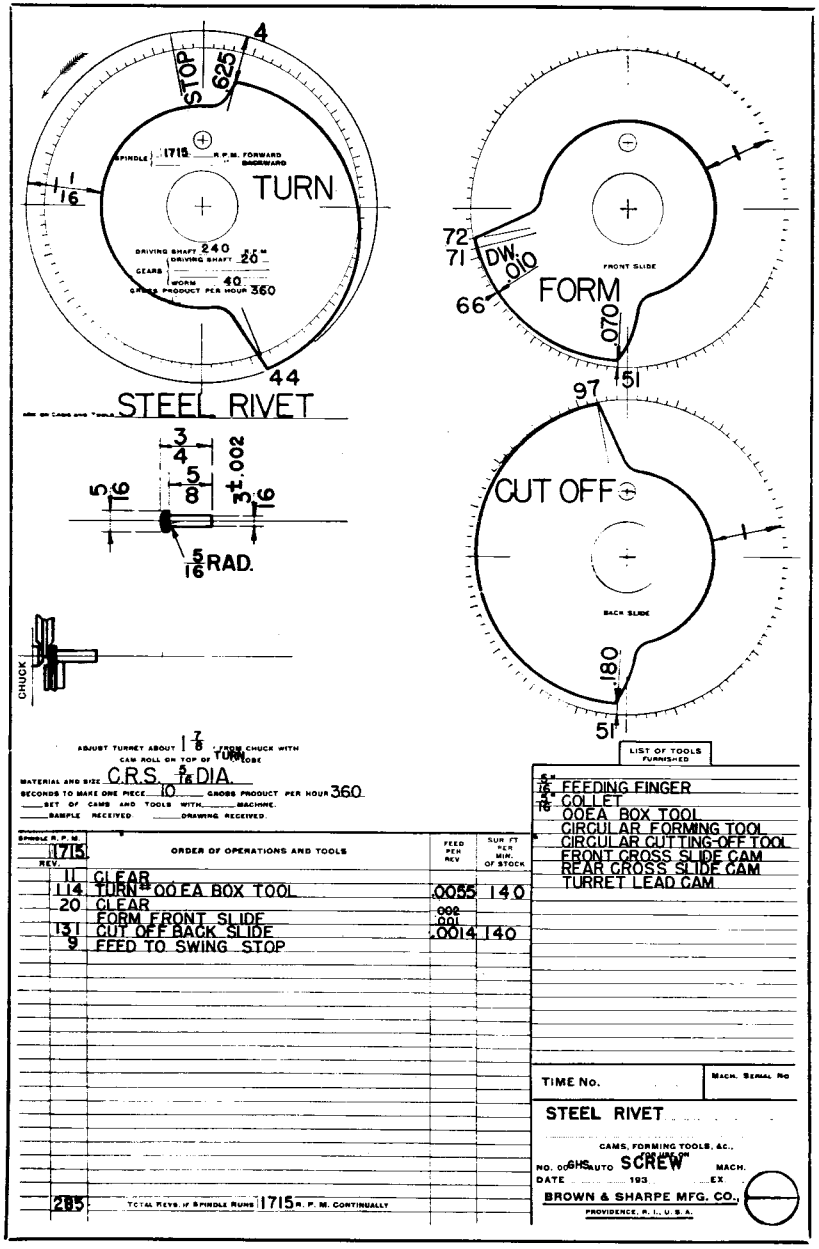

Fig. 1. Work Sheet for Job No. 2

NO. 3 OF A SERIES OF BOOKLETS FOR TRAINING OPERATORS

JOB NO. 2

Turning, Forming and Cutting Off

The work sheet for our second job is shown in Fig. 1. The piece is a round-headed rivet to be produced in 10 seconds. The interesting variations of this job from Job No. 1, are the accurate diameter which must be held within plus or minus .002", and the turned body which is machined by a turret tool.

In setting up for this new job, many steps will be exactly the same as those described for Job No. 1. Where this is the case, detailed instructions will not be given, for if you have any doubt about exact procedure, you can refer back to that section of Job No. 1 which describes fully the adjustment questioned. Here will be discussed, only those points in the set-up or adjustment which are different from Job No. 1.

Strip the Machine.

Remove Tools
Remove Cross Slide Cams
Remove Turret Cam
Set Chuck Lever Trip Dog on its side
Set Turret Lever Trip Dog on its side
Back off Cross Slide Stop Screws

Insert proper Collet. (5/16" round.)

Insert proper Feed Finger. (5/16" round.)

Insert Bar of Stock. (5/16" round cold rolled steel.)

Adjust Length of Feed Slide Movement. (About 1 inch for 3/4" piece.)

Adjust Chuck Pressure.

Set Spindle Speed. As in Job No. 1, a high speed, forward-direction spindle speed is used.

Shift Spindle Clutch to high speed side.
Check Spindle Direction—reverse motor if necessary.
Check Driving Shaft Belt.
Put on Change Gears (46-49, 1715 R.P.M.)

Disconnect Spindle Reverse (Disengage coupling).

Mount Feed Change Gears. (20-40.)

Put on Cross Slide Cams.

Put on Turret Lead Cam. Fig. 5, Booklet No. 1, shows the location of the cam. A nut and collar clamp it in position.

Grind Cutting-Off Tool. This cutting-off tool does more forming than cutting off. It shapes the round head of the rivet and chamfers the end of the bar. Since it has formed cutting edges, the tool must be ground as a form tool. The sharpened surface cannot be given a rake or hook and must be ground horizontal and 1/8" below tool center. Only if a form tool has been especially designed for rake, can it be ground with a hook and then the angle of hook must be the same as that for which the tool was calculated. For our case, we will assume a standard tool and will grind it flat as in Fig. 8, Booklet No. 2.

Mount and Adjust Cutting-Off Tool. Get it on center, square with the work, and close to the chuck.

Set the Swing Stop. Get length within plus or minus .010".

Adjust Back Cross Slide to Depth. Turn driving shaft until rear cross slide cam lever roll is on top of cam (position 97 on work sheet). Set for depth as in Job No. 1.

Select Roller Box Turning Tool. The single tool mounted in the turret is a Roller Box Turning Tool, Brown & Sharpe Style 4, as pictured in Fig. 2 and shown in action in Fig. 3. Such tools are usually used for heavy finishing cuts. The cutting blade is followed closely by two rolls mounted directly opposite from the blade and about 1/64" behind the blade. The rolls bear on the diameter of the stock which has just been turned by the blade. The rolls have two functions. First, they serve as back rests for the work and prevent it from being pushed away, or deflected by the cutting pressures of the tool. Second, they roll or burnish the surface of the piece and

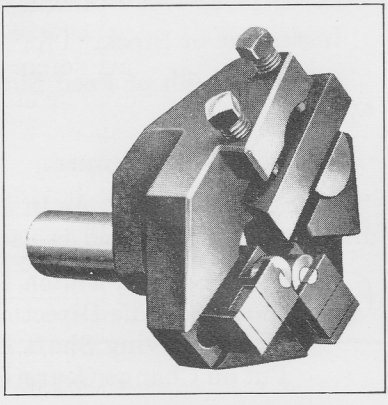

Fig. 2. Roller Box Tool

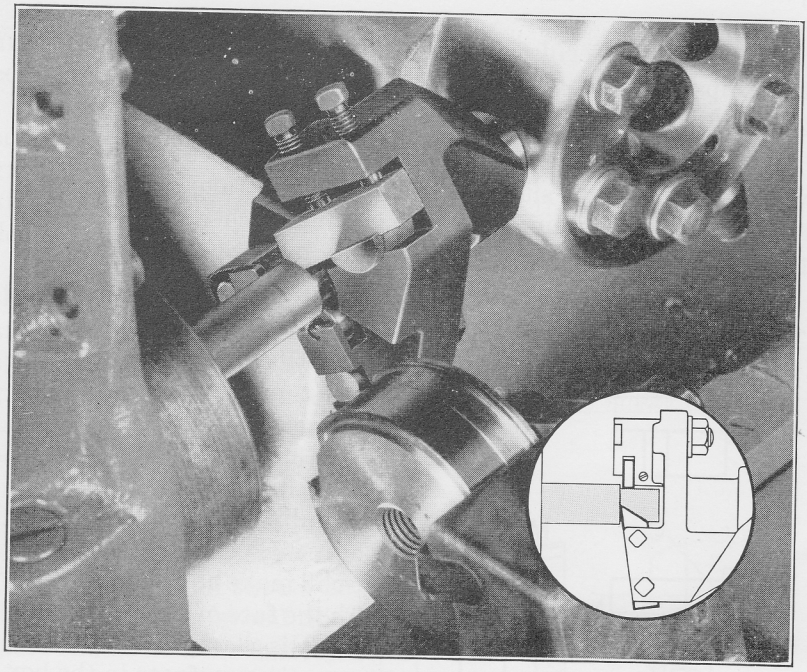

Fig. 3. Taking cut with Roller Box Turning Tool

leave a smoother, brighter finish than could be produced by the cutting bit alone.

For this job, obtain a right-hand Roller Box Tool. A right-hand tool is one which will cut when the stock has a forward direction of rotation. A left-hand tool is used with backward spindle rotation.

Grinding Box Tool Bits. Remove cutting blade or bit. There are two clamp screws to be released.

Almost all bits are square or rectangular blocks of high speed steel. In grinding or sharpening bits, there are two purposes to be accomplished. First, the tool must cut freely and produce the desired finish. This is primarily a question of obtaining a sharp tool having the proper rake and clearance angles. The second purpose has nothing to do with the good cutting qualities and is solely that of forming or breaking the chips so that they will not tangle in the tools. Turning bits ground without chip control grooves will often produce long coiling chips which go winding around until they cause trouble, as in the case when they jam between the back-rest rolls of a box tool. On hand machines, the operator is always close by

to remove interfering chips, but on an automatic machine, the chips have to be closely coiled or broken. Chip control grooves are a necessity on steel and most brass jobs.

First, a simple tool or bit without a chip breaking groove will be described to show the clearance and rake angles necessary for good cutting. Having ground such a tool, we will proceed to a tool having a chip coiling or breaking groove.

Fig. 4 shows three views of a simple bit in cutting position. The edge M in contact with the shoulder of the stock is doing the cutting. This being the cutting edge, there must be clearance provided below it, as shown by the clearance angle at C. This angle is not ground on the bit, but is given by the tool itself. The flat side of the bit will make an 8 degree angle with the face of the work when the bit is clamped against its supporting surfaces in the box tool. Hook or side rake from the cutting edge is also shown at C. This angle must be obtained by grinding the bit. A rake angle of 10 to 20 degrees is desirable, with steel requiring a little greater angle than brass. Since the axis of the bit will be tipped 8 degrees by the tool, the actual included angle which will give a cutting rake of 15 degrees will be 67 degrees, or looking at the side of the bit, which will be parallel to the work axis, an angle of 23 degrees can be measured. See Fig. 5.

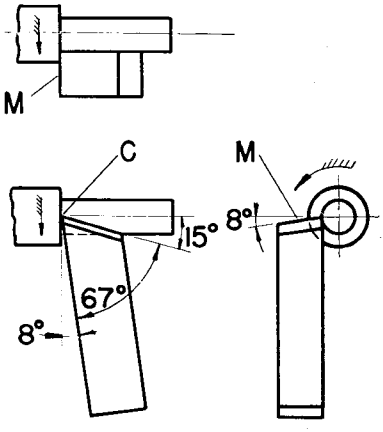

Fig. 4. Box tool bit in cutting position

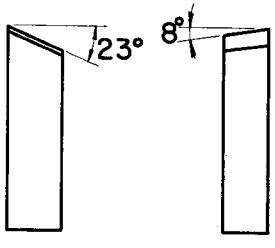

Fig. 5. Side view of box tool bit

The tip of the cutting edge M is located on center with the work. The rest of the cutting edge is usually permitted to drop below center so that the edge makes an angle of 8 degrees with the horizontal. This angle has been called the shear angle or back rake angle and is used to pull the chip away from the work axis or to move it out from the heart of the tool. This

angle gives a little freer cutting and aids finish. The cutting edge side of the bit looks like Fig. 5.

The bit can be ground on a bench grinder. A single flat surface is ground by holding the tool against the side of the grinding wheel. This flat surface must make a 67 degree edge angle (approximately) with one side of the tool and an 82 degree edge angle with the adjacent side.

A tool ground for chip control has the same fundamental clearance and rake angles as the bit just described. These are however obtained by a different group of grinding operations. Before the groove is cut in the bit, the piece would be ground with two flats as shown in Fig. 6. The shear or back rake angle of 8 degrees would be maintained and a side rake of 8 degrees would replace the 23 degree used in the simple tool previously described. This 8 degree land should be about 1/8" wide. Beyond this, there should be a much steeper rake angle (about 30 degrees). Nothing touches this rear surface and it is simply ground to get it out of the way. These two surfaces or lands are ground against the flat side of a grinding wheel.

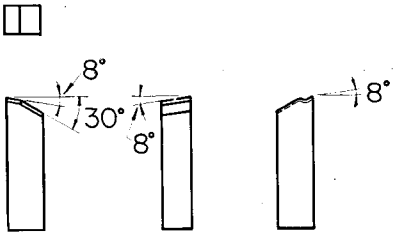

Fig. 6. Bit with chip breaking groove

To form the chip breaking groove, the rounded edge of a thin wheel is used. The groove is to be ground in the 1/8" 8 degree land and will be parallel to the cutting edge of the tool. The groove should be so located and of such a form that a cross section of the groove would approximate that shown in Fig. 7. One side of the groove runs right to the cutting edge and gives the effective rake angle for cutting. The sharp curvature of the other side of the groove gives the chip a tightly wound form and the final abrupt edge tends to break the chip into short sections. By changing the radius of the groove, the coiling of the chip may be varied.

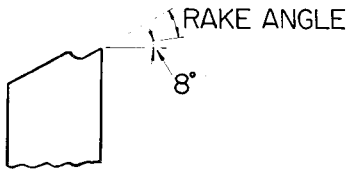

Fig. 7. Chip breaking groove

Although the bit just described is a good one and has been ground to have free-cutting qualities and to produce a good finish, do not be surprised if the skilled operator right next to

you uses a different shape of bit, and has a preferred set of angles. Methods of grinding differ greatly, for each experienced operator has usually developed his own style of grinding.

The following general rules are more important than exact specifications for angles. Remember that these rules apply to newly sharpened tools, for dull tools can give all sorts of queer symptoms:

(a) A bit has too little rake or hook if the tool seems to be laboring and the cutting oil is smoking. Rake helps the tool to feed into the stock and with insufficient rake, it will be difficult to move the turret slide forward by hand. The tool resists feed and tries to push the stock ahead. Judge your tools by the hand lever force.

(b) A bit has too much rake if the cutting edge dulls rapidly, and has a tendency to chip or break down. Too much rake reduces the metal supporting the cutting edge and weakens the tool. Look at the tool bit after cutting the first bar of stock.

(c) A tool has too little clearance when rubbing marks can be seen on the clearance surfaces. Rubbing of the stock on the sides of a tool wastes power, makes feeding difficult and wears the tool. If a tool rubs, grind away the bearing areas. The clearance of a box tool is fixed at 8 degrees, but if in an unusual job, you see evidences of rubbing, grind the bit to get additional clearance.

(d) Too much clearance may contribute to break-down of the cutting edge and is a waste of supporting metal. Use only enough clearance to avoid rubbing.

(e) Back rake or the shear angle pulls the chip away from the work axis. If the chip does not move out, increase the shear angle. Too great a back rake leaves the tool too pointed and without sufficient physical support. Use the smallest angle which will throw the chip as you want it to move.

(f) Chip control grooves wind the chip. If the chip has too great a coil diameter, use a smaller radius for the groove.

Reassemble Tool. Unclamp the roller blocks and slide them

back or away from the center of the tool. Put the bit in position and clamp lightly.

Mount Tool in Turret. Put the tool in an approximate position so that when the turret slide is moved forward, the tool will be able to turn some length of stock. Clamp the tool shank securely with the turret clamp bolt.

Set the Tool for Size.

(a) Locate cutting point on center. Tap the bit forward until the cutting point is on center as in Fig. 4.

(b) Loosen one clamp screw and tighten the other, swivelling the bit until the cutting point is about $\frac{3}{32}$" from the axis of the stock. Clamp the bit.

(c) Turn a short length of stock. Start the spindle and bring the turret slide slowly forward by hand, using the hand lever in the turret cam lever.

(d) Measure diameter and reset bit. Stop the spindle and with a micrometer measure the turned diameter. Make necessary adjustments to give a diameter .002" to .003" less than $\frac{3}{16}$". Notice that if the cutting bit is swivelled very much that the "on center" adjustment is changed and the bit will have to be tapped forward or back to maintain a correct position.

(e) Test the new setting. Start the spindle and bring the tool forward by hand. Check the diameter turned. Continue adjusting until the .002" to .003" small figure is obtained.

(f) Set the rolls. With the spindle stopped and the turret slide forward in cutting position, bring both roller blocks in until the rolls press on the turned diameter of the stock. Clamp the blocks tightly in position.

(g) Make final setting of bit. Start spindle, bring cutting-off tool forward and cut off piece, engage driving shaft clutch and trip the feed trip lever to feed stock forward. Make delicate adjustments of the bit and turn a new piece; check diameter. Adjustments must be repeated until the diameter is within the limits on the work sheet, or in our case, measures between .1855" and .1895". The setting of the rolls on an undersize diameter was made to put them in a posi-

tion where they would exert pressure on a normal sized piece. Under this pressure, the turned body will be burnished and a smooth finish obtained.

Adjust for Turned Length. Bring the cross slide forward and cut off the work piece. Turn the driving shaft handwheel until the lever roll is on top of the turret lead cam (about position 44 on the work sheet). Now loosen the turret clamp and tap the tool ahead or back until the distance from the front end of the cutting-off tool to the cutting edge of the bit is .003″ to .010″ greater than the thickness of head desired. In this case $\frac{3}{4}'' - \frac{5}{8}'' + .010'' = .135''$. With this approximate setting (lean toward the high side) clamp the tool tightly in turret.

Turn the handwheel and withdraw the tool. Now engage the driving shaft clutch. Trip the feed trip lever at position 98 or when the cutting-off tool has withdrawn enough to clear the stock. Since all the cams are now on the machine, there is only one point in the cycle where automatic feed can occur. This is between positions 98 and 2 when all the slides are withdrawn, giving clearance for the swing stop and the bar of stock.

Leave the driving shaft clutch engaged until the turret has been advanced and withdrawn. Stop the spindle and measure the turned length. It should be about .005″ to .010″ less than $\frac{5}{8}''$. If it is outside this limit, loosen the clamp and tap the tool again. Repeat the test.

Sharpen Form Tool.

Mount and Adjust Form Tool. The tool must be square and on center. (Use a raising block.) Slide the tool post in its T-slot until the tool is in position to face off .005″ to .010″ on the shoulder of the rivet. Bring the slide forward by hand until the $\frac{3}{16}''$ diameter produced by the form tool blends with that produced by the box tool.

Cut Off Piece and Inspect. Check the dimensions and observe whether or not the corner produced by the form tool blends into the curve produced by the cutting-off tool. If not, move the form tool in the cross slide T-slot. Feed a new length of stock forward. Turn the $\frac{3}{16}''$ diameter by hand movement of the turret slide.

Adjust Front Cross Slide for Depth. Turn driving shaft handwheel, until the cam lever roll is on top of the cam. With a wrench turn the cross slide adjusting nut in until the form tool has turned the work diameter .002″ to .004″ small. Now

set up the stop screw R, Fig. 4, Booklet No. 1, until the slide has been pulled back .001″ to .002″. Stops are used to remove spring from the mechanism and thus give accurate sizing.

Set Work Deflector.

Set Feed Trip Dog. Set it at about position 98 and in relation to cut-off tool withdrawal as in Job No. 1.

Make a Complete Cycle by Hand. Turn driving shaft handwheel. Be sure all parts clear or have no interferences. Check the piece produced and if any dimension is beyond the limits specified, make the necessary readjustment.

Make a Few Pieces. Engage the driving shaft clutch and let the machine make a few pieces. Look these over and let the foreman check one of them.

Reloading. When turret tools are being used on a job, the insertion of stock requires a little greater care than used for Job No. 1. When a machine stops after the feed finger has fed the stock as far forward as possible, there is still a piece of stock in the collet 1″ to 3″ long. If, as the collet is opened, a new bar of stock is bumped against this piece, it may go flying out of the collet and break a delicate tool in the turret, or chip a sharp cutting edge.

To remove the last piece of stock, press back the turret locking pin lever, Fig. 8, and turn the turret about ½ station so that no tool is directly in front of the stock. Now, with your fingers extract the stock from the open collet. Return the turret to its original position (be absolutely certain of this) and see that the locking pin is seated.

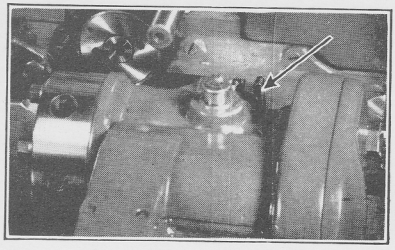

Fig. 8. Turret locking pin lever

Having inserted the new bar and closed the chuck, start the spindle and bring the cutting-off tool forward by hand. Turret tools sometimes have difficulty if they suddenly come in contact with the rough end of a new bar of stock, and it is safest practice to clean off the bar end with the cutting-off tool before throwing in the driving shaft clutch. Looking back at the work sheet of Job No. 2, you will notice that the cutting-off tool not only faces the bar, but also chamfers its end to help the box tool start its cut.