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

No. 2

Of a Series of Booklets
for Training Operators

Forming and Cutting Off

Brown & Sharpe Mfg. Co.
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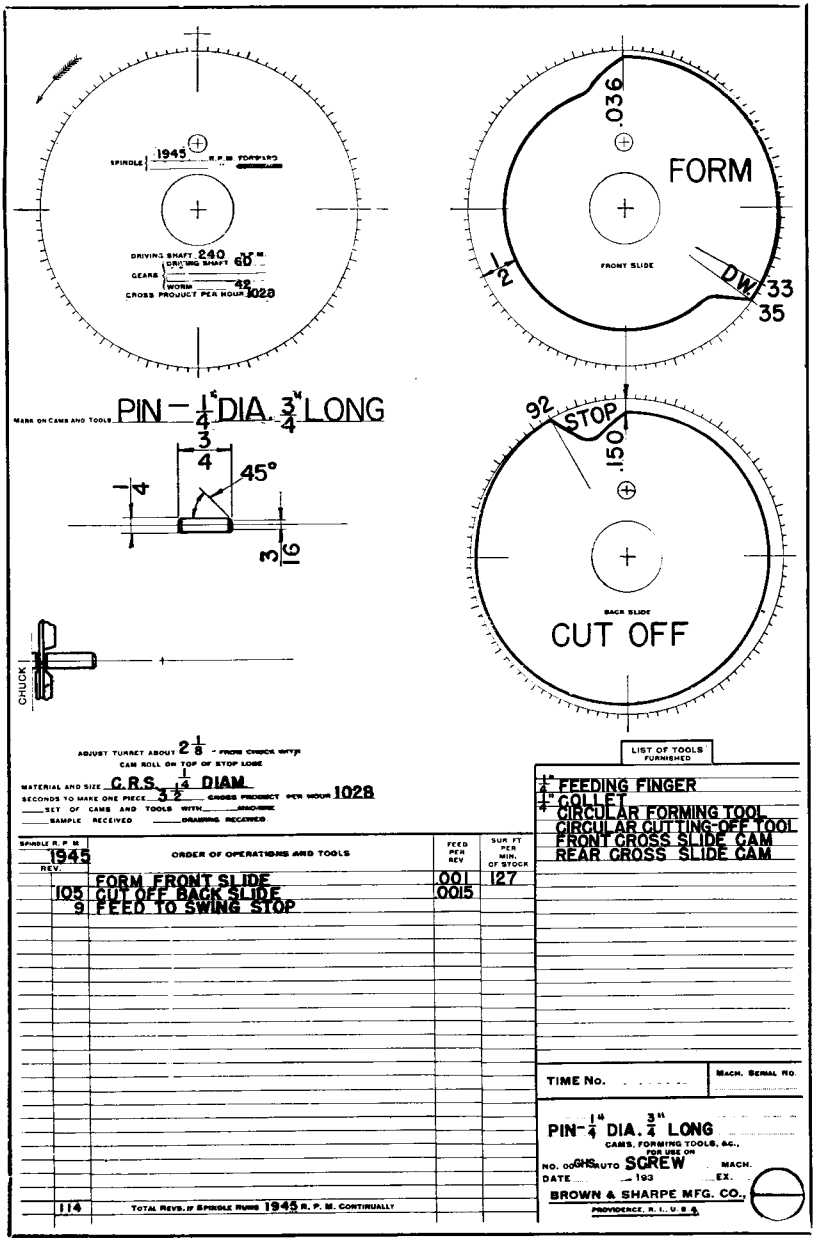


Fig. 1. Work Sheet for Job No. 1

NO. 2 OF A SERIES OF BOOKLETS FOR TRAINING OPERATORS

JOB NO. 1

Forming and Cutting Off

It is the purpose of this booklet to put a Screw Machine to work on an actual job. Each step in the set-up and operation will be described in exact detail in the expectation that a new man, who carefully follows the sequence of moves and adjustments, could, under the guidance of an experienced operator, produce this piece or one similar to it. At the same time, we will give many of the reasons "why" and will explain the purpose behind each important adjustment.

THE WORK SHEET

The job will very likely come to you as an order to make a given number of pieces as described on an accompanying work sheet. Fig. 1 is the work sheet for our job. This sheet is a standard form that is used by most Screw Machine Departments. On it is a dimensioned drawing of the piece and a list of the operations required to produce it. Note that the cam surface is divided into hundredths, with figures indicating the positions of importance.

Study the Work Sheet. Know what the piece looks like, how close its limits are, how many tools are to be used and the order in which they perform.

For our job, the piece is a chamfered pin. The cylindrical surface of the pin will be that of the original bar, for the only machining operations are those of chamfering and cutting-off.

INSERTING COLLET

Stop the Machine. Press the motor stop button or move the belt shifter for the overhead belt works.

Disengage the Driving Shaft Clutch. Throw the lever shown in Figs. 3 or 5, Booklet No. 1.

Trip the Feeding Mechanism Trip Lever. See Figs. 5 and 7, Booklet No. 1. Use your finger.

Turn the Driving Shaft Handwheel. A part turn will open the chuck and advance the feed slide. Stop before the chuck

begins to close, but not before the feed slide moves forward.

Back off the Chuck Adjusting Nut. Although the chuck or collet in the machine is open, the new collet which is to be inserted might be partly closed unless this nut is loosened. Refer to Fig. 8, Booklet No. 1.

Remove the Spindle Chuck Nut. See Fig. 8, Booklet No. 1. Use a pin wrench.

Pull out the Chuck or Collet.

Wipe off Dirt. Dirt and bits of metal have probably been scraped from preceding bars of stock. Remove these and wipe clean the bearing surfaces against which the collet will press.

Check Position of Chuck Sleeve. If the chuck sleeve has been disturbed in cleaning, be sure it is properly seated (the small pin in the spindle lines up with the slot in the chuck sleeve).

Insert Proper Collet. For our job a 1/4" round collet must be obtained from the tool crib.

Replace Chuck Nut. Turn the nut up tight and tap wrench lightly with a brass hammer.

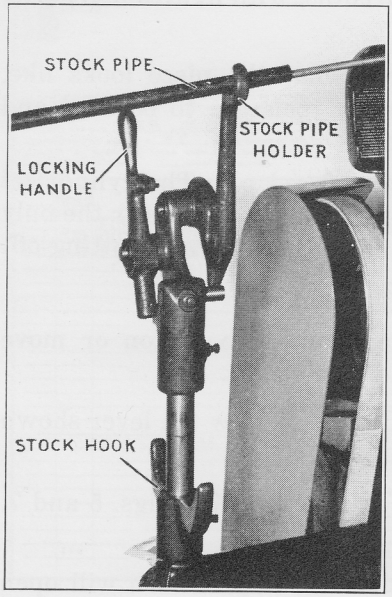


Fig. 2. Stock support

INSERTING FEEDING FINGER

Move the Stock Pipe. Throw back the stock pipe locking handle, Fig. 2. Then, lift the front end of the pipe out of its cradle and set it on the stock hook.

Tip back the Stock Pipe Holder.

Lift the Feed Latch and Remove Feed Tube.

Insert Feed Finger in Tube. Grip the feed tube in a vise (brass jaws) and with a key or pin in the tapered slot of the feed finger, unscrew the finger (left-hand thread). Insert the desired finger, which in this case is a 1/4" round

finger obtained from the tool crib. Turn up tight, and for the larger-size fingers tap the key or pin lightly with a brass hammer.

Change Feed Tube Bushing. A bushing for use in the rear end of the feed tube for steadying and supporting the stock is easily installed by removing the nut at the end of the tube and inserting the nearest standard size in the feed tube.

Put Tube in Spindle. Don't reengage the latch, but push the tube forward until it thrusts against the end of the spindle.

Bring Stock Pipe Holder Back to Position.

INSERTING A NEW BAR OF STOCK

Place the Front End of the Stock Pipe in the Top Crotch of the Stock Pipe Holder. This is shown in Fig. 2.

Chamfer Both Ends of the Bar of Stock. For our piece, the bar will be ¼" diameter cold rolled steel. Bars should be already chamfered. If not, chamfer the ends of the bar, using the chamfering means available in your department. Stock will enter the feed finger far more easily if its ends are tapered or the square shoulders broken.

Wipe the Bar of Stock. With an oily rag or piece of waste rub off dirt and dust which has accumulated on the stock. If abrasive particles of dirt are left on a bar, tools will dull rapidly.

Insert Stock in Machine End of Stock Pipe. See Fig. 2, Booklet No. 1.

Place Stock Pipe in Spindle Position.

Drop the Stock Pipe Locking Handle.

Insert Stock in Feed Tube. Push the stock in as far as possible. Pull back the feed tube and then gripping the bar firmly, hurl the bar and feed tube forward. Don't, however, pull the feed tube so far back that its key is withdrawn from the spindle keyway. As the tube thrust hits the end of the spindle, the impact will carry the stock into the feed finger. Do this a few times until the stock has moved through the collet and projects about ¼" beyond the nose of the collet.

Latch the Feed Tube to the Feed Slide.

ADJUSTING CHUCK PRESSURE

Now that the bar of stock is in the chuck, the chuck must be adjusted to grip the bar securely.

Tighten the Chuck Adjusting Nut.

Close the Chuck. With a pin lever in the chuck fork pin

hole throw the chuck fork sleeve to the closed position. After moving the lever to the resistance point, a good bump with the palm of your hand should carry it to the closed position. If you can close it by a simple pull, the setting is on the weak side and the stock may slip. If you have to bruise your hand to close it, the setting is too tight and may injure the chuck levers. Ask one of the experienced operators to let you try, with a pin lever, the adjustment he has made on one of his machines. After snapping the chuck fork sleeve into and out of the closed position a few times you will be able to tell the difference between a normal adjustment and one which is too tight or too weak. The final locking or checking of the adjusting nut should be done with the chuck open.

Turn Driving Shaft Handwheel. Complete the feeding action by turning the wheel until feed clutch is disengaged.

ADJUSTING LENGTH OF FEED

The piece to be produced is $\frac{3}{4}$" long. To be certain that the stock will move this distance and be held firmly against the swing stop, the length of feed should be set between $\frac{7}{8}$" and 1" ($\frac{1}{8}$" to $\frac{1}{4}$" overtravel).

Turn the Feed Adjusting Crank until the Feed Pointer reads 1" on the Feed Scale, Fig. 9, Booklet No. 1.

SPINDLE DIRECTION

In screw machine practice the following definitions are accepted for directions of rotation.

Forward Rotation. The top of the spindle or stock will be coming toward you as you stand in front of the machine. Looking from the turret end, the spindle will be rotating counter-clockwise.

Backward Rotation. The top of the spindle will be going away from you as you stand in the operating position. Looking from the turret, the spindle will be rotating in a clockwise direction.

SETTING SPINDLE SPEEDS

The work sheet calls for a single forward spindle speed of 1945 R.P.M. The speed plate on the machine, Fig. 12, Booklet No. 1, will give the diagram of change gears to be used. According to the plate, 1945 R.P.M. is one of the high speeds on our machine.

Snap the Motor Reversing Switch to give a forward direction in high speed. Start and stop the spindle to test directions.

Engage the Spindle Clutch in High Speed. Place a pin lever in the clutch fork pin hole and throw the clutch over if it is not already engaged in high speed.

Disconnect Low Speed Drive. No low speed is used for this job. Use speed ratio pickoff gears that do not mesh, as was mentioned in Book 1.

Check the Driving Shaft Belt. The driving shaft must always rotate in the same direction. For a forward direction of high speed, an open belt must be used on the driving shaft pulley. If a crossed belt is in position, replace it.

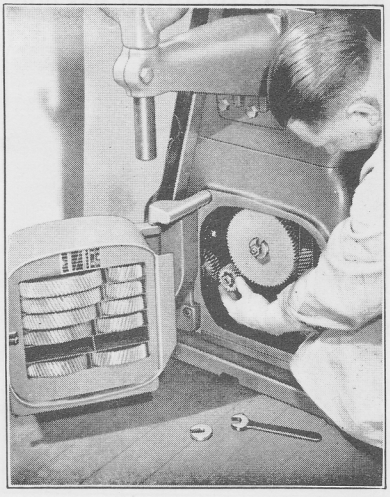


Fig. 3 High speed change gears

Put on Change Gears. According to the spindle speed plate, an upper gear of 46 teeth meshing with a lower gear of 49 teeth will give the 1945 R.P.M. speed. See Fig. 3 for method of changing gears.

DISCONNECTING SPINDLE REVERSE

Since but one spindle speed is to be used on Job No. 1, the spindle reverse will not be used and at no time will the reverse clutch trip lever be tripped. To make the trip-dog carrier inactive, the reversing shaft coupling clutch is pulled back.

Disengage Reversing Shaft Coupling. Pry the coupling back with a screw driver. A small detent plunger serves to hold the coupling in the "off" or "on" positions. On larger machines, a screw clamp on the coupling is used to lock it in the "on" and "off" positions. See Fig. 4.

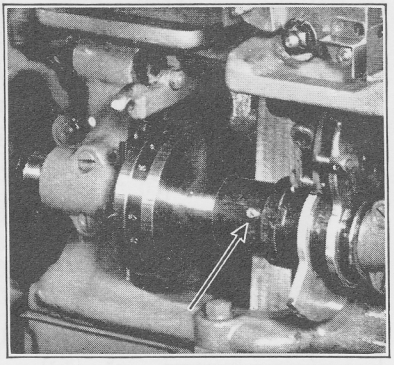


Fig. 4. Reversing shaft coupling

MAKING THE TURRET INOPERATIVE

According to the list of operations and cam drawings on the work sheet, the turret has nothing to do in Job No. 1. The turret will not be indexed nor will the turret slide be advanced.

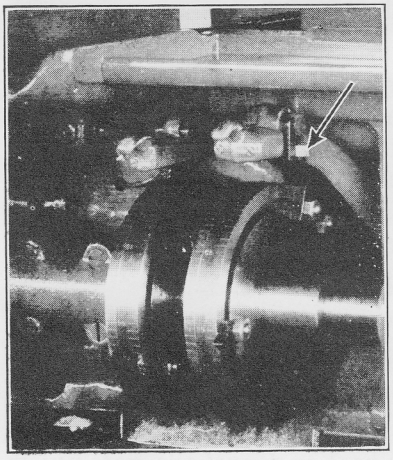


Fig. 5. Turret trip lever dog

Set Turret Trip Lever Dog. Tip the dog over on its side so that it cannot be tripped by the dogs in the carrier. Fig. 5.

Remove Turret Lead Cam. A nut and collars clamp the cam in position.

ELIMINATION OF FEED TRIP LEVER DOG

For the time being, we don't want the automatic feed to be tripped by dogs on the carrier. Tip the feed trip lever dog to one side so that it can't function.

MOUNTING FEED CHANGE GEARS

The work sheet has been planned for a 3½ second job and specifies the change gears 60 and 42, to give the cam shaft a speed of one revolution in 3½ seconds.

Remove Driving Shaft Handwheel and Drop Guard. See Fig. 5, Booklet No. 1.

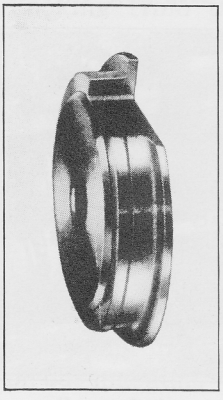


Fig. 6. Circular cutting-off tool

Put Gears in Position. The 60 tooth gear goes on the top or driving shaft and the 42 tooth gear on worm shaft. These two gears are not in mesh and have to be joined by an idler gear mounted in the pivoted arm. Use any idler which will span the gap. First slide the idler stud in the arm until the idler gear is in proper mesh with the driving shaft gear. Clamp the stud firmly. Now swing the idler arm until the idler gear is in proper mesh with the change gear on the worm shaft. Clamp

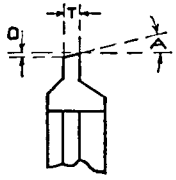
the arm. Be sure a slight amount of freedom in the teeth is provided.

Replace Guard and Handwheel.

CROSS SLIDE CAMS

For our first tool adjustments, it is safest to have no cross slide cams on the cam shaft. If there are any now on the machine, remove them by taking off the nut and collars which clamp them in position.

TABLE OF ANGLES AND THICKNESSES FOR CIRCULAR CUTTING-OFF TOOLS



A is 23° when cutting brass, aluminum, copper, silver and zinc.
A is 15° when cutting steel, iron, bronze, and nickel.
Least thickness used when cutting off into tapped holes is the lead of two and one-half threads plus .010″
Least thickness used when cutting off into reamed holes smaller than $\frac{1}{8}$″ diameter is .040″.
Thickness used when cutting off tubing is two-thirds *T* as given below for corresponding diameters of stock.
Thickness used when angles or radii start from outside diameter of tool is governed by varying conditions and determined accordingly.

Diameter of Stock	*T* Thickness	*D* Depth of Angle	
		for Brass	for Steel
$\frac{1}{16}$	.020	.0085	.0055
$\frac{3}{32}$	.030	.013	.008
$\frac{1}{8}$	.040	.017	.011
$\frac{3}{16}$	.050	.0215	.0135
$\frac{1}{4}$	.060	.0255	.016
$\frac{5}{16}$	.070	.030	.019
$\frac{3}{8}$	.080	.034	.021
$\frac{7}{16}$	.090	.038	.024
$\frac{1}{2}$ to $\frac{9}{16}$	.100	.042	.027
$\frac{5}{8}$ to $\frac{3}{4}$	.120	.051	.032
$\frac{13}{16}$ to 1	.140	.059	.038
$1\frac{1}{16}$ to $1\frac{5}{16}$	.160	.068	.043
$1\frac{3}{8}$ to $1\frac{7}{8}$	.190	.081	.051
2 to $2\frac{1}{2}$	.220	.093	.059

Table No. 1

CIRCULAR CUTTING-OFF TOOL

A high speed steel circular cutting-off tool will be used on Job No. 1. Such a tool is pictured in Fig. 6 and outlined in

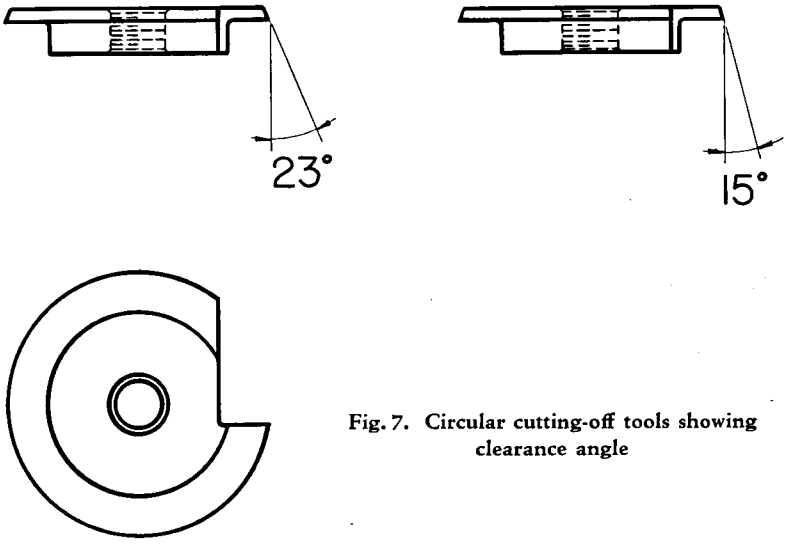


Fig. 7. Circular cutting-off tools showing clearance angle

Figs. 7 and 8. The tool may be sharpened hundreds of times for all axial sections of the tool have the same form. Looking down on the ground cutting surface of the tool, it will be noticed that the tool has a leading edge or corner. The outermost point on the tool is always placed on the side of the piece being cut off and its purpose is to clean off the teat on the work before or just as the piece is severed from the bar. The edge angle which is inherent in the tool has a value of 23° for tools intended for brass, aluminum, copper, silver, and zinc; for steel, iron, bronze, and nickel, tools are made with a 15° edge angle. Since Job No. 1 is on steel, select a 15° tool.

The width of a cutting-off tool controls the waste or the number of pieces which can be obtained from a bar of stock. If, however, too thin a tool is selected, it will not have sufficient rigidity and will tend to wander in the cut, leaving a wavy, unsquare surface. Table No. 1 gives recommended values for tool width. For ¼″ stock, we will select a tool .060″ wide.

GRINDING CIRCULAR CUTTING-OFF TOOLS

Circular tools are designed to have the cutting edge a set distance below the center of the tool and should be mounted

with the cutting edge in line with the center of the work. The purpose of these relationships is to obtain a clearance angle between the work and the surface of the tool just under the cutting edge. See Fig. 8. The distances established for standard tools give clearance angles of 8 to 10 degrees. Now, if these drops are not maintained or if the tools are mounted

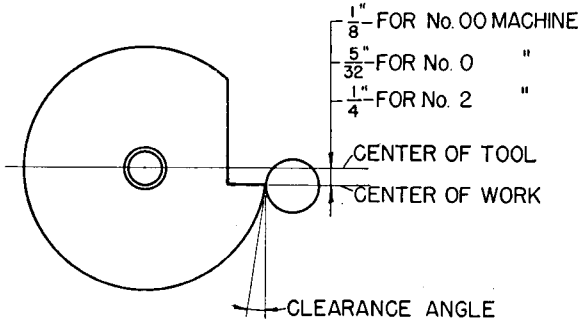


Fig. 8. How face of circular tool is ground

with cutting edges above or below work centers, the operating clearance angles will be changed. A small angle produces rubbing between the tool and work and increases the resistance of the tool to feeding into the stock. A large angle encourages chatter or vibration. Maintain the drop given in Fig. 8.

A horizontal cutting surface as just described would be used for brass. For steel, operators usually put a little hook on their tools, that is—grind the cutting surface at a receding angle, so that when the cutting point of the tool is on work center the surface running back from the point will be below center. This hook or rake gives a little easier cutting action and reduces the force required to feed the tool into the cut.

It should be emphasized, however, that hook or rake can only be used on simple cutting-off tools or tools which have straight blades. If the circular cutting-off tool has a formed edge to produce a specified shape on the work, it must be ground horizontal. Hook or rake will alter the form and will cause errors in the work shape.

Screw Machine Departments are equipped with bench grinders having work supporting plates. Before grinding your tool make sure the wheel is sharp. If necessary, have it trued or dressed. A dull or loaded wheel does more rubbing than cutting and will quickly heat the cutting edge of the tool

above the drawing temperature of the steel and soften it, or as is commonly stated, the cutter will be burned.

Rest the flat side surface of the tool on the supporting plate and move the surface to be ground into contact with the side of the wheel. Don't hold the cutter against the wheel for long periods of continuous grinding. Slide the cutter into and out of contact with the wheel to give the grinding heat a chance to be dissipated through the cutter and not concentrated in high temperatures at the edges of the surface being ground.

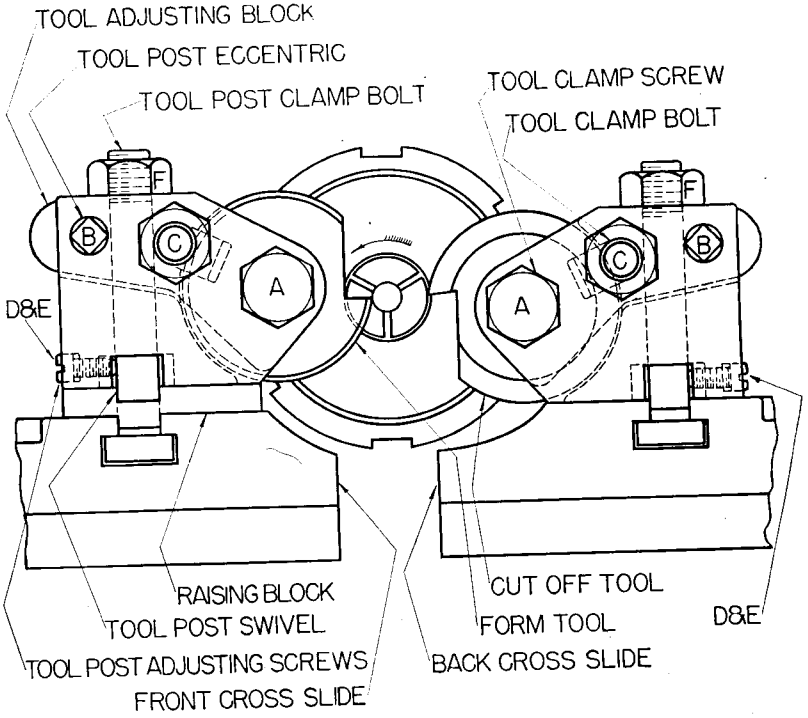


Fig. 9. Cross slides, and cutting-off and form tools

MOUNTING AND ADJUSTING CUT-OFF TOOL

The plan of the work sheet places the cutting-off tool on the back cross slide. For the forward direction of spindle rotation specified, the tool must be mounted with its cutting surface facing down, as shown in Fig. 9. For this direction and position of tool, the tool post is mounted directly on the cross slide.

Clamp Tool in Position. Get the cutting face as close to work center as you can judge by eye and clamp screw A lightly.

Adjust Eccentric. Move the cross slide forward with the hand lever which can be inserted in the pin hole of the cam lever. As the cutting tool touches the bar, turn the eccentric B to get a more accurate adjustment.

Clamp the Tool Tightly. Clamp bolt C and then screw A.

Set Tool Close to Spindle. Move the tool post along the cross slide T-slot until the cutting-off tool is close to the nose of the chuck. The less overhang the stock has when the tools are cutting the better will be the cut. Excessive overhang destroys rigidity and produces chatter.

Set Tool at Right-Angles to Work. The screws D and E swivel the tool post. By loosening one and tightening the other, the post may be turned until the tool is square with the bar. After adjusting (by eye), make both screws tight.

Clamp the Tool Post to the Cross Slide. Use bolt F.

TESTING CUTTING-OFF TOOL ADJUSTMENT

Start the Spindle. The driving shaft clutch should still be disengaged.

Cut off the Bar End. Bring the back cross slide forward by means of the hand lever inserted in the cam lever. Move the tool into the work until it has passed beyond the center of the bar.

Examine Teat on Bar. If a fair sized teat remains, the cutting edge of the tool is above center. (Remember that this tool is inverted or that its cutting surface is facing downwards.)

If the portion of the tool supporting the cutting edge strikes the small cylindrical teat and tries to push it off, the cutting edge of the tool is below center.

Check Squareness of Tool. With the tool advanced to its cutting position, observe how nearly its side is parallel to the faced end of the bar.

Make Necessary Readjustments. Stop spindle and repeat adjustments already described.

Cut off Another Piece. Start spindle, engage driving shaft clutch, trip by hand the feed trip lever and bring cross slide forward to cutting-off position.

Check Settings as Before.

SWING STOP SETTING

Stop the Spindle and Disengage the Driving Shaft Clutch.

Trip the Feed Trip Lever.

Turn Driving Shaft Handwheel. Watch the swing stop and turn shaft only enough to bring the swing stop to its lowest position.

Adjust the Stop. Loosen the clamp bolt and slide the swing stop on its shaft until it is directly in front of the stock and ¾" from the outer edge of the cutting-off tool. Check distance with a scale. Clamp the stop securely.

Feed and Cut Off Piece. Start spindle and engage driving shaft clutch. Since the feed trip lever has already been tripped, the machine will immediately feed. Bring the cross slide forward and cut off the piece.

Measure the Length of Piece Cut Off. Don't put your hand in the cutting pit to catch the piece and don't try to hold it as it is being cut off. Use a perforated soup ladle or similar device to catch the piece as it drops from the bar.

Use a micrometer to measure the piece.

Improve Stop Setting. If the part is not within limits (plus or minus .010" for our job), loosen the swing stop slightly and tap it lightly with a brass hammer. Clamp tightly and go through the routine of cutting off another piece. For very close limits you may have to make several trial settings.

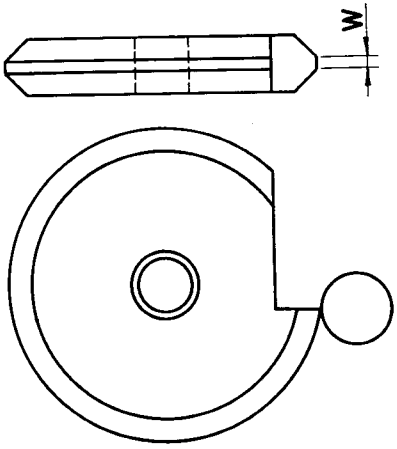


Fig. 10. Circular form tool

CIRCULAR FORM TOOL

The tool on the front cross slide is a circular form tool to produce the 45 degree chamfer. It is very similar to the cutting-off tool. A view of the tool looking down on the cutting surface is given in Fig. 10. In selecting the tool, choose one with a width W less than the .060" width of the cutting-off tool. This is necessary so that the shoulder left by the tool will be cleaned off by the cutting-off tool.

SHARPENING A CIRCULAR FORM TOOL

Form tools are made to have the accurate form desired when they are ground to the drop figures already given in Fig. 8. A greater or lesser amount of drop will alter the form. In the same way, hook or rake on the cutting surface of a form tool should only be used when the tool is designed to permit this, for it too will cause an error in form.

The tool will be ground in the same manner and with the same precautions as the cutting-off tool. Be deliberate, however, in obtaining the drop distance given in Fig. 8 and be sure that the ground surface is horizontal.

MOUNTING AND ADJUSTING CIRCULAR FORM TOOL

Mount the Tool Post on a Raising Block. Since on the front slide the tool must be face up for forward rotation, a raising block is needed to bring the tool cutting edge on center with the work, Fig. 9.

Adjust for Height and Squareness. The tool post adjustments are the same as those described for the cutting-off tool post. Mount the form tool and adjust it to get the cutting edge on center and the sides square with the work.

Feed Bar Forward. Start spindle, engage driving shaft clutch and trip the feed trip lever by hand. Now bring the cutting-off tool part way forward with the hand lever, until a groove has been cut in the bar equal in width to the thickness of the tool.

Adjust Form Tool Post on Cross Slide. Slide the tool post in the cross slide T-slot until the form tool is central with the groove just cut in the bar by the cutting-off tool. Clamp the tool post with the T-bolt.

MOUNTING CROSS SLIDE CAMS

Feed Stock. Cut off the partly formed piece above and trip feed trip lever to bring the stock forward. Disengage driving shaft clutch.

Withdraw Cross Slides. Loosen the clamp screw M of Fig. 4, Booklet No. 1, and turn the nut N until the slide has been withdrawn as far as possible. Do this for both slides.

Put Cross Slide Cams on Cam Shaft. Cams are shown on the work sheet. These are already prepared and can be obtained from the tool crib. Put the cams in position, making sure the

pin holes engage with the driving collar pins, for these pins hold the cams in the exact positions necessary for perfect timing. Clamp the cams securely with the collars and nut provided. In this case only cross slide cams are used, therefore it is necessary to place a round disc on the lead cam shaft to keep the lead lever from riding on the cam holder.

Do not get the cams on backward. There is a direction arrow on the work sheet. The cams, when on the cam shaft, will be rotating with the tops coming toward you. Put the cams on in such a position that when rotating in this manner, the directions on the work sheet will be satisfied. With proper rotation, the cam lever will move out while in contact with a cam rise and will fall when on the cam drop. You will soon be able to differentiate between a cam rise and drop. A rise is usually more gradual than a drop (uses more hundredths of cam surface) and its peak point is a shorter distance from the cam hole than is the peak point on the drop. For example, in the Work Sheet Fig. 1, the peak point (position 0) for the cut-off rise is .150″ nearer the cam center than the peak point (position 92) at the beginning of the drop. You will often see an operator check a cam with his scale before putting it on the cam shaft.

BACK OFF CROSS SLIDE STOP SCREWS

These are the screws R of Figs. 4 and 10, Booklet No. 1. They are normally used to limit the movement of the cross slides, but are unnecessary for this job.

SETTING CROSS SLIDES FOR DEPTH

Set Front Cross Slide Lever on Top of Cam. Turn driving shaft handwheel until the lever is on the highest point of the front cross slide cam (about position 34 on the work sheet).

Advance Front Slide to Position. With a wrench, turn the slide adjusting nut N and move the slide toward the work. Continue until the form tool has cut to proper depth (in Job No. 1 about $\frac{1}{32}$″). Stop the spindle to look at the cut and measure its depth.

Lock the Adjusting Nut N. Some machines use a set screw while others employ a split nut and clamp screw.

Set Back Cross Slide Lever on Top of Cam. Turn the driving shaft handwheel further until the lever roll is on the high point

of the cam (about position 92 on the work sheet).

Advance Back Slide to Position. Turn the slide adjusting nut N until the slide has been advanced enough to permit the tool to cut off the piece and clean off the teat on the bar. The edge of the tool on the spindle side should be a little beyond work center.

Lock the Adjusting Nut N.

SETTING WORK DEFLECTOR DOG

Chips drop directly into the tank or reservoir in the bed. To avoid the necessity of sorting work from chips, a work deflector is provided which swings into the path of the falling piece just before the piece is cut from the bar. The work and a few chips are sidetracked to the work pan.

Set the Deflector Dog. The cam shaft is now in position where the piece has just been cut off or where the cam lever is at the top of the cutting-off lobe. The work deflector should be in working position. Set a dog on the right-hand side of the feed trip dog carrier so that it will be operating at this position of the cam shaft. If, after the job is started, you find too many chips collected or find a few pieces getting by the deflector, tap the carrier dog a little ahead or behind the position you have just given it.

SETTING TRIP DOG FOR AUTOMATIC FEED

Withdraw Cutting-Off Tool. Turn the driving shaft handwheel until the back cross slide cam lever moves down the drop and withdraws the cutting-off tool to or slightly beyond the edge of the bar of stock. This is the position for feeding stock, for the work has been cut off or completed and the tools are out of the way.

Set Trip Dog. Snap the feed trip lever dog down into operating position. Trip the lever by hand. Now slide a carrier trip dog around in the T-slot (pull it toward you or in the direction the cam will rotate). Clamp the dog in position where its tip is just about to slide by the tip of the trip lever dog (about position 94 on the work sheet). Notice that in this position, the trip lever dog will have compressed its spring and will be pressing against the wall of the lever slot. All other trip dogs on the carrier should be removed or turned 90° to the inactive position.

COOLANT OR CUTTING OIL

Check the Level of Cutting Oil in the tank table or bed. It should be well above the pump strainer. Too small a volume of cutting oil will permit the oil to get very hot, as it thus circulates rapidly around the system.

Open Valve to Nozzle. This is located at the top of the machine. Direct the flow right on the work where it is needed and be generous with the volume. Too much oil never burned up a tool.

FINAL TEST

The job is now completely set up and ready for production. Make one complete turn of the cam shaft as a last check of the job. If everything is all right, engage the driving shaft clutch and let the machine produce a few pieces. Take one of these to the supervisor and let him check it to the drawing.