14.3 HYDRAULIC COPYING UNIT PRINCIPLE OF OPERATION

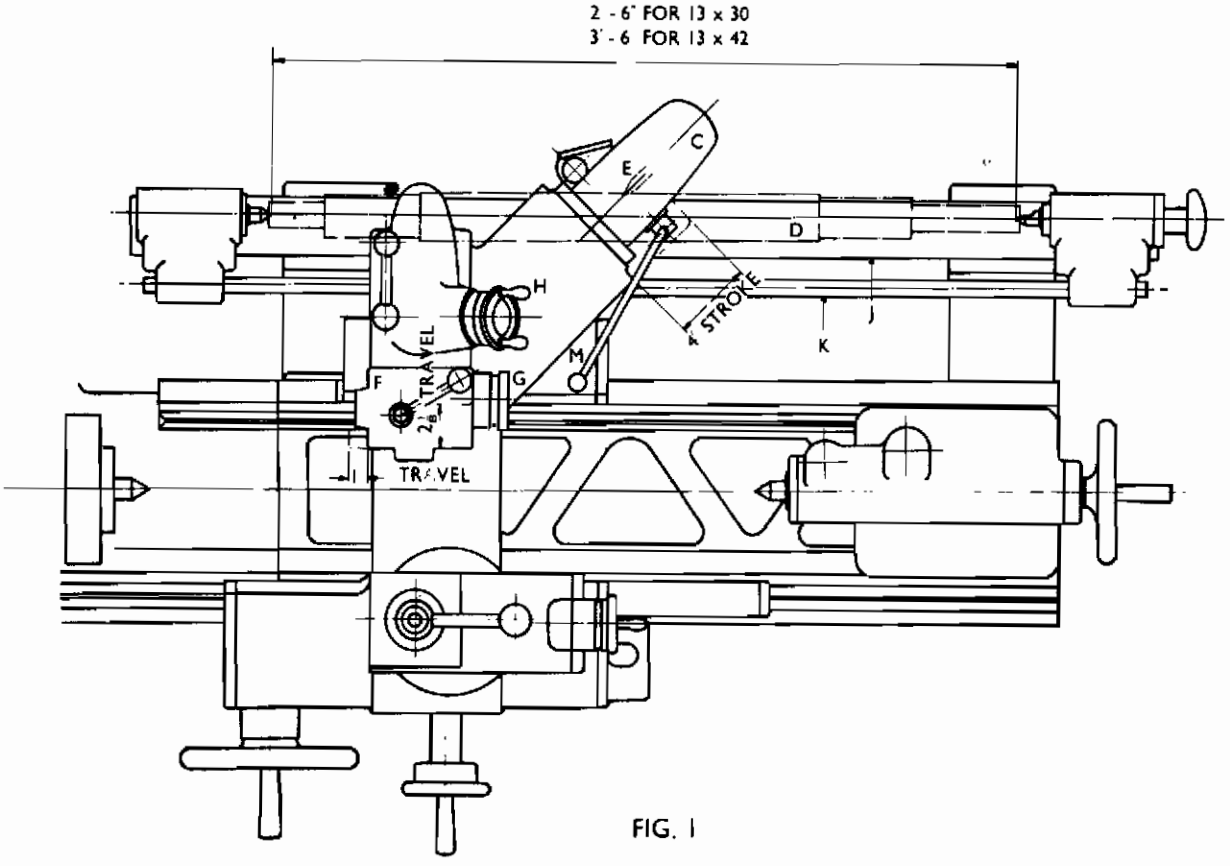


FIG. 1

The unit is intended for external, internal and face copying the shape of a master on the workpiece, without interruption from one diameter to the next.

It consists of a full length cross slide carrying the copying slide and cylinder unit at the rear. The copying slide is operated by a hydraulic cylinder "C" which is controlled by the copy "D" through the medium of the stylus "E". The copying toolholder "F" has side adjustment by knob "G", and is adjusted in or out by handwheel "H". The copying slide is set at a fixed angle of 45° to the spindle axis and interruptions to the traverse of the stylus over the copy caused by shoulders retract the copying slide and allow the stylus to ride up the shoulder.

Copies, in the form of round shafts or flat templates, are fixed to brackets carried on the support beam "J" at the rear and can be set in any position to suit the work. A useful feature for this purpose is the rod "K" to which both brackets can be clamped. By these means both, brackets, together with the copy, can be adjusted along the beam as a unit.

The stylus always traverses along the copy from right to left for longitudinal copying, and normally away from the operator for transverse copying, and by its displacement controls the tool hydraulically.

Manual operation for the advance or retraction of the copying slide is by the lever "M" attached to the side of the hydraulic cylinder unit.

PRINCIPLE OF OPERATION continued

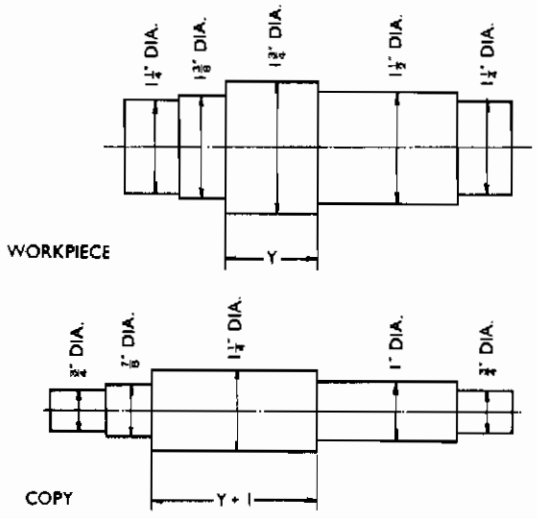


FIG. 2

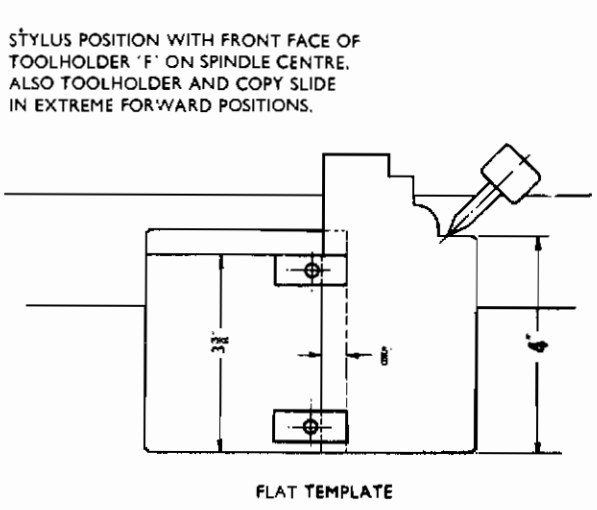


FIG. 3

For shafts having square shoulders, parallel lengths, tapers and small radii, and which can be easily turned and ground, the cylindrical copy is easiest and most accurate to produce. It is also automatically located parallel on the copy centres. With these limitations its sole disadvantage is that compared with a flat template it is bulky to store. The cylindrical copy can be made smaller in diameter than the workpiece, consistent with rigidity, provided that the diameter steps and the lengths are the same on the copy as on the workpiece. Local flats or changes of shape can be introduced on the copy to be brought into operation by rotating the copy to engage the stylus for a second operation.

A typical cylindrical copy is shown in fig. 2. Where the shaft has smaller diameters each side of the largest, the shaft is turned in two operations, turning from one end to the largest diameter, and then reversing the copy and shaft end for end. The length of the largest diameter part should be made 1 in. longer on the copy than on the workpiece, this allows turning the full length of this diameter without break by preventing the stylus running off the end of the copy.

Flat templates, fig. 3, are required for copy turning irregular shapes and shapes having large radii, and for parts which are large in diameter in proportion to length. They can be made from flat steel about $\frac{3}{16}$ in. thick, and need not be hardened unless a very large number of parts are required. The templates are clamped to the special brackets carried on the support beam and must be set up square to the bed, since this setting determines the accuracy obtained on the workpiece.

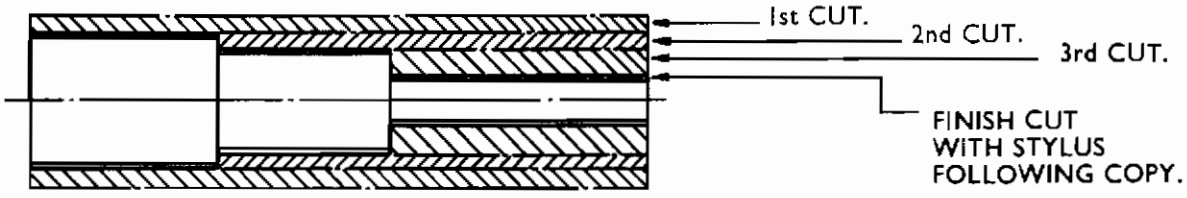
To obtain parallel work, it is essential that the surface to be copied is parallel to the bed ways and the tool cutting edge on centre line of spindle. Flat templates can be set using a dial gauge fixed to the rear of the lathe saddle which is traversed along. If the workpiece is not parallel or correct when copied from a cylindrical copy, first check the tool height, parallelism of the copy, then the bed level. The support beam is adjustable and can be reset using a parallel bar between the copy centres. The beam is set parallel and should not be adjusted unless it is necessary.

OPERATION

14.32 HYDRAULIC COPYING UNIT PRINCIPLE OF OPERATION continued

The lathe spindle runs in the normal direction, and the copying tool is fixed in an inverted position in the toolholder at the rear of the workpiece. The height of the cutting edge is $3\frac{1}{2}$ ins. above the top of the cross slide.

After switching on the pump unit, the copying slide can be brought forward or retracted by the lever "M" (fig. 1). The tool must be retracted in this way immediately after every cut and on no account should the stylus be allowed to contact the copy when traversing the saddle from left to right as this will bend or break the stylus. Cutting must always be from right to left when longitudinal copying.



TOTAL MAXIMUM STEP NOT TO EXCEED $4\frac{3}{4}$" ON DIA.

FIG. 4.

METHOD OF TURNING A SHAFT.

1. Move the whole unit well back on the saddle.

2. Advance copying slide to end of its stroke with stylus clear of copy.

3. Bring the unit forward using saddle and apron handwheels until stylus touches right-hand end of copy.

4. Set the tool to the end of the workpiece using side adjustment "G" (fig. 1).

5. Using the saddle and apron handwheels, bring the stylus to touch the largest diameter of the copy.

6. Using the infeed slide handle "H" (fig. 1), set the tool to within .010 in. of final turning size. NOTE: A finished sample workpiece is useful for this setting.

7. Lock the side adjustment and infeed slides by means of the handles and retract.

8. Set depth of first cut using saddle handwheel and dial. Advance tool by lever "M" to clear right-hand of workpiece and take first cut over full length of workpiece. Retract. NOTE: The stylus will not touch the copy until it reaches the shoulder of the largest diameter.

9. Successive cuts can now be taken using the saddle handwheel to control the depth of cut, retracting by lever "M" when tool ceases to cut, until stylus is in contact with copy over full length being turned.

10. The final size can now be set by infeed slide handle and a last cut taken. This size should not now be distrubed as it will give correct diameters for all successive parts. The total depth of cut can be subdivided on the saddle handwheel dial using the pointers for easy reading as exact positioning is not required.

14.33 HYDRAULIC COPYING UNIT PRINCIPLE OF OPERATION continued

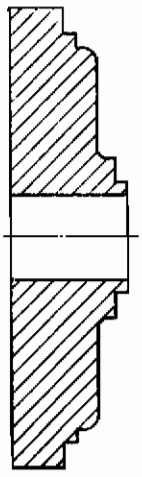


FIG. 5.

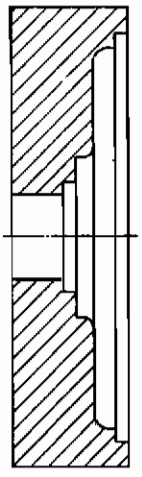


FIG. 6.

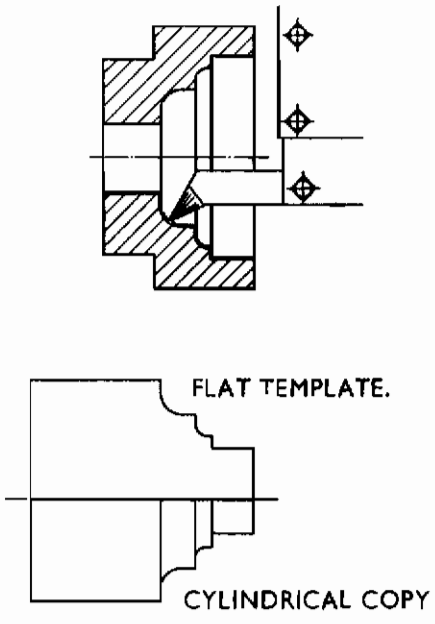


FIG. 7.

TRANSVERSE COPYING OF WORKPIECE SHOWN AT FIG. 5.

The bulk of the metal to be removed should be taken off using tools in the front toolholder, leaving enough for one or two finishing cuts by the copying tool.

To set the copying tool after roughing out:

1. Advance the copying slide to the end of its stroke and bring the stylus to bear on a diameter and against a shoulder at the extreme left of the copy using the saddle and apron handwheels.
2. Set the tool to the corresponding work faces and retract by lever "M" (fig. 1).
3. Put on the depth of cut required using the side adjustment handle "G" and set for diameter using the infeed slide handle "H".
4. Advance the tool using lever "M", and bring it towards the centre of the workpiece using saddle and apron handwheels until the stylus bears on the copy.
5. Take the first cut by engaging cross feed away from operator and retract.
6. Subsequent cuts are taken in the same way, putting on the depth of cut by the side adjustment handle "G"

TRANSVERSE HOLLOW COPYING OF WORKPIECE SHOWN AT FIG. 6.

The bulk of the metal to be removed should be taken out by the front toolholder. The copying tool in this case is applied to the workpiece at the operator's side of the centre and is held in a special toolholder to apply it with the cutting edge uppermost and at the correct height. The spindle runs in the normal direction. The operation then follows that for fig. 5 with the exception that the cut commences at the front and feeds inwards to the centre.

COPY BORING-FIG. 7.

This is done with the tool at the front of centre as for hollow copying, but the longitudinal feed is usually required. The copy can be a flat template or a cylindrical copy having the same contour as the bore in the workpiece.

14.4 HYDRAULIC COPYING UNIT TOOLS AND FEEDS

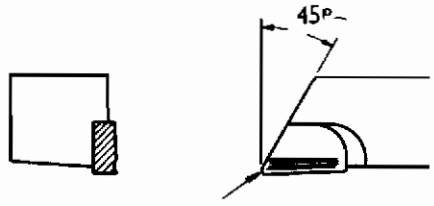


FIG. 8.

TOOLS

Shank width	$\frac{3}{4}$"
Shank depth	1"
Tool length	$5\frac{1}{2}$"

Carbide tipped tools are essential for long life and to maintain correct size of work. A suitable chip breaker is required to facilitate chip disposal.

Tool shape depends on the profile to be produced Attention must be given to clearance of the form where there are slopes and curves. The shape shown in Fig.8 is suitable for square shouldered shafts and shafts with reducing tapers up to 20° slope. The radius on the tool point for finishing cuts must be equal to the stylus radius, i.e., up to 1/32 in. If the tool radius is larger it will produce an incorrect shape on a curved profile and the tool always leaves its own radius in a square corner.

FEEDS.

The rate of feed for right ang ed shoulder turning depends upon the spindle speed and is limited by the speed of the feed shaft and gearbox, see section 5.11.

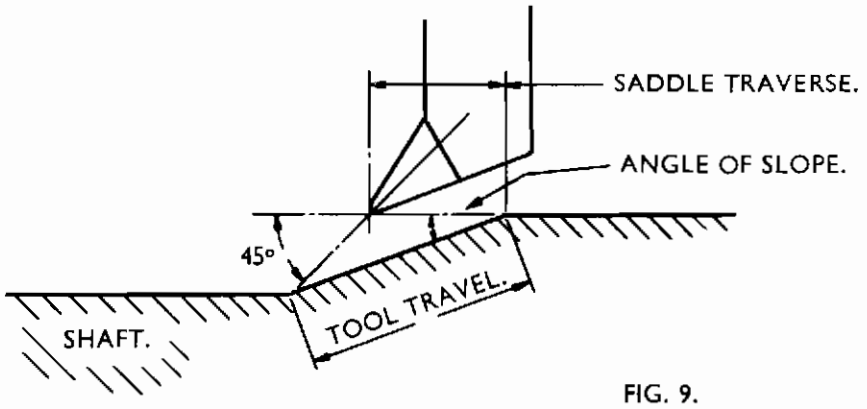


FIG. 9.

For turning reducing tapers or curves, the feed should be reduced due to the extra travel of the tool on the copying slide above that of the saddle. (SEE FIG. 9).

To obtain feed box setting for a required feed on taper, multiply feed required by value "r":-

Angle of slope on slide	5°	10°	14°	17°	20°
Value of "r"	0.9	0.8	0.73	0.66	0.6

Example: Let required feed on taper be .020 in. and slope 20°.
Feed box setting = .020 x 0.6 = .0120 in. per rev .

14.5 HYDRAULIC COPYING UNIT HIGH SPEED THREADING

The function of this attachment is to provide for automatic withdrawal of the threading tool after each pass through the workpiece. It may be used for internal and external threads. Both parallel and taper threads may be cut close to a shoulder without provision of a recess or undercut. Cutting speeds can be greatly increased and maximum advantage taken of cemented carbide tools.

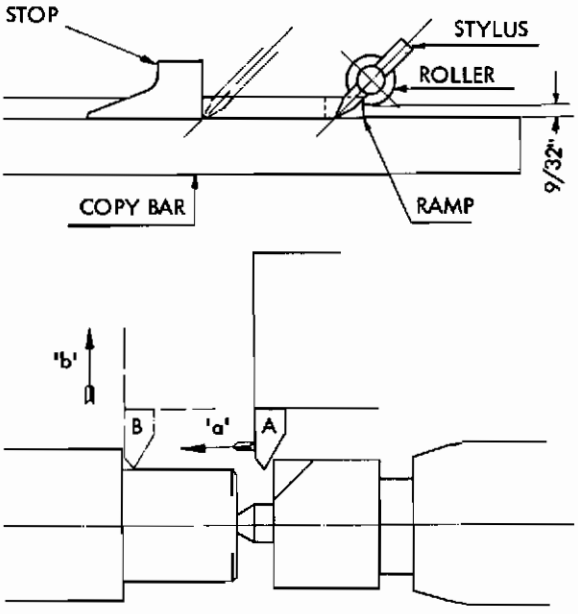


FIG. 10

The cycle of operation illustrated at Fig. 10 is as follows:—

1. Engage leadscrew nuts with tool at position "A".
2. Cutting the thread the tool travels in direction arrow "a" and the roller attached to stylus is pushed below the copy bar by the ramp.
3. When tool reaches position "B", stylus strikes stop on copy bar and tool is withdrawn by movement of stylus in direction of arrow "b", permitting roller to rise from under copy bar.
4. Disengage nuts.
5. Return to position "A" by hand, roller engaging with outside edge of copy bar and holding tool out of thread until roller leaves edge.
6. Tool is now in original position and cut may be added and cycle repeated.

NOTE:—Tool must always cut in direction of arrows, therefore left-hand threads must be cut with spindle and tool reversed.

CAPACITY —Maximum length of thread cut with standard copy bar=7½ inches. (Special length copy bars may be supplied).

Maximum depth of thread=0·260 inch with $\frac{9}{32}$ inch stylus projection.

The minimum diameter of external threads is determined by the size of centre for threads at end of component, as illustrated at Fig. 11.

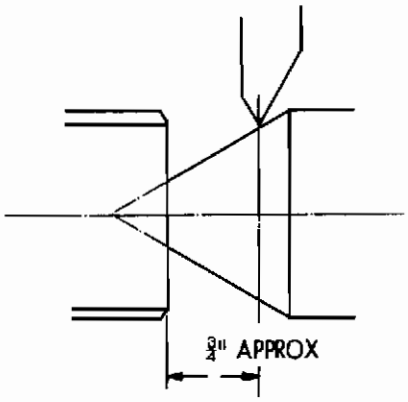


FIG. 11

The minimum diameter of internal threads is determined by the proportion of the threading tool and the speed of the tool.

See instructions for internal threads.

Maximum rate of saddle traverse=60 inches per min. and must not be exceeded.

The latter figure is determined by speed of the cylinder in the hydraulic unit, and this determines maximum work speed which may be found from.—

$$\text{Max. work speed (r.p.m.)} = \frac{60}{\text{Lead of screw to be cut}}$$

$$= 60 \times \text{TPI for single start threads}$$

$$= \frac{60 \times \text{TPI}}{\text{No. of starts}} \text{ for multi-start threads.}$$

14.51 HYDRAULIC COPYING UNIT HIGH SPEED THREADING continued

EXTERNAL THREADS —Two methods of applying the depth of cut to the tool may be used:—

METHOD 1 allows stylus to remain clear of copy bar during cutting and cut is applied from saddle handwheel. This method is only suitable for parallel threads.

METHOD 2 allows stylus to follow copy bar, the cut being applied from infeed handwheel on copy slide. This method is suitable for both taper and parallel threads.

Method 1 is recommended for threading parallel work.

SETTING PROCEDURE FOR METHOD 1, FIG. 12.

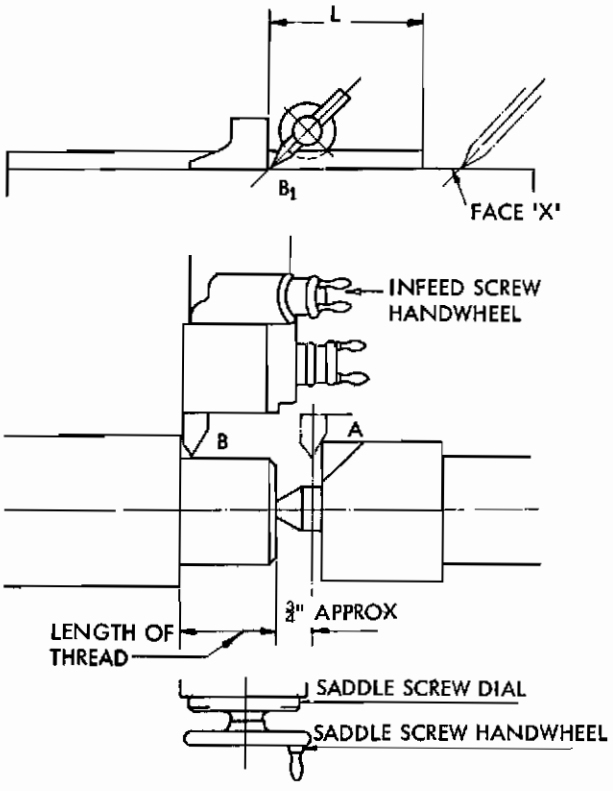


FIG. 12

1. Clamp copy bar to bracket making sure locating edges are clean. Replace standard stylus with roller type.
2. Set stop on copy bar so that distance L=Length of thread + 1¼ inches.)
3. Start hydraulic pump motor and advance copy slide to maximum forward position.
4. Advance stylus until approximately ·010 in. clear of face "x" on copy bar, using saddle handwheel.
5. Insert work piece.
6. Clamp threading tool in copy slide toolholder, adjust position "B", i.e., touching diameter and clear of shoulder approximately 0·005 inch.
7. Slide copy bar and bracket until stop is contacting stylus at "B " with roller under copy bar.
8. Hand traverse saddle towards headstock permitting tool to withdraw and roller to rise, reverse direction or traverse to bring tool to position "A", approximately ¾ inch from end of thread.
9. Set longitudinal back stop against saddle.
10. Adjust tool by infeed screw handwheel by an amount equal to depth of thread, and lock slides.
11. Set saddle screw dial to zero. Retract tool clear of thread diameter.
12. All tool adjustment for depth of cut is now made from saddle screw handwheel. Before taking first cut, it is advisable to check settings, firstly by hand traversing through the cutting cycle and repeating, using leadscrew nuts as in normal cutting.

Threading may be carried out as general screwcutting instructions.
Note that the stylus must never touch copy bar during cutting, otherwise copy slide will be moved and tool will be displaced.

SETTING PROCEDURE FOR METHOD 2, FIG. 13.

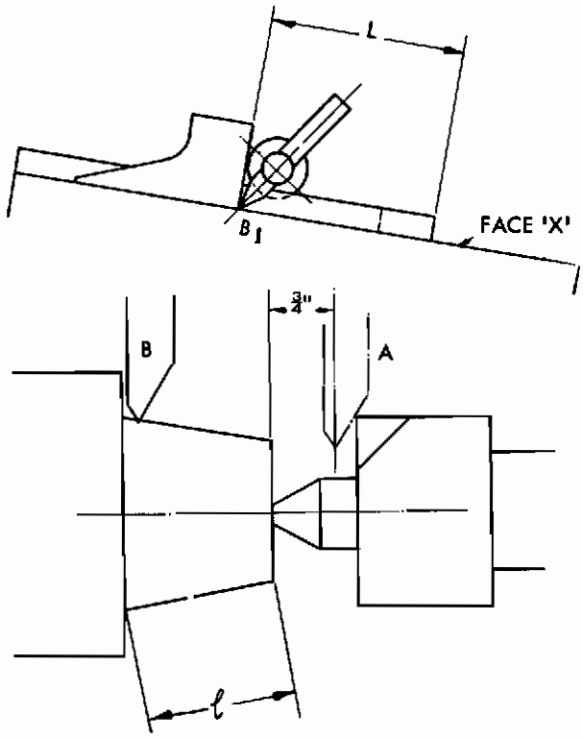


FIG. 13

1. Set copy bar on bracket to approximate angle and mount dial gauge in copy slide toolholder. Replace standard stylus with roller type.
2. Advance copy slide and bring stylus to face "x" with hydraulic pump motor on.
3. Set dial gauge to work piece.
4. Hand traverse saddle and adjust angle of copy until dial gauge indicates zero error over full length of threaded portion. Remove dial gauge.
5. Set distance "L" $= l + 1\frac{1}{4}$ inches and slide copy bar bracket to position stylus at "B_1".
6. Clamp threading tool in copy slide toolholder, adjust to position "B", i.e., touching diameter and clear of shoulder approximately ·005 inch. Set dial of infeed screw to zero.
7. Hand traverse saddle towards headstock, permitting tool to withdraw and roller to rise. Reverse direction of traverse to bring tool to position "A", approximately $\frac{3}{4}$ inch from end of thread.
8. Set longitudinal backstop against saddle.
9. All tool adjustment for thread depth must be made from infeed handwheel on copy slide. Settings may be checked by retracting tool to clear threaded diameter and hand traversing through the cutting cycles then repeating using leadscrew nuts as in normal cutting.

Threading may be carried out as general screwcutting instructions. All adjustments for cutting depth must be made on infeed slide which should be locked after each adjustment.
The pitch produced on taper threads is shorter than indicated at the gearbox, the error increasing with the taper. This error may be corrected by setting gearbox and change wheels to cut a pitch equal to: Axial pitch of component $(1 + \text{Tan } \theta)$ where θ is half included angle of taper.

INTERNAL THREADS —The attachment is not intended for small internal work below $1\frac{1}{4}$ inches diameter and has limitations when used for threading up to internal shoulders. Setting for internal threads is similar to that for external threads, and again two methods of applying depth of cut are available.

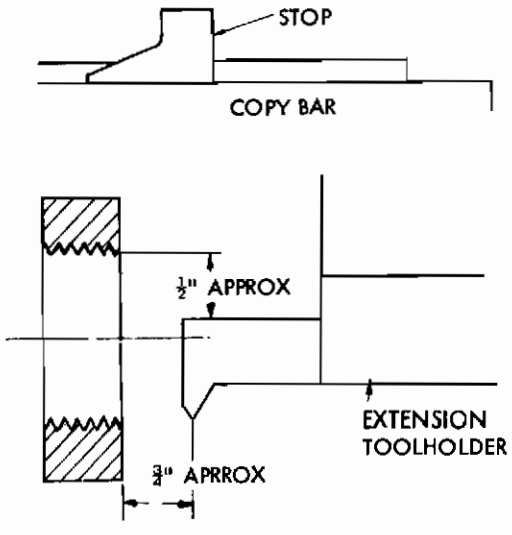
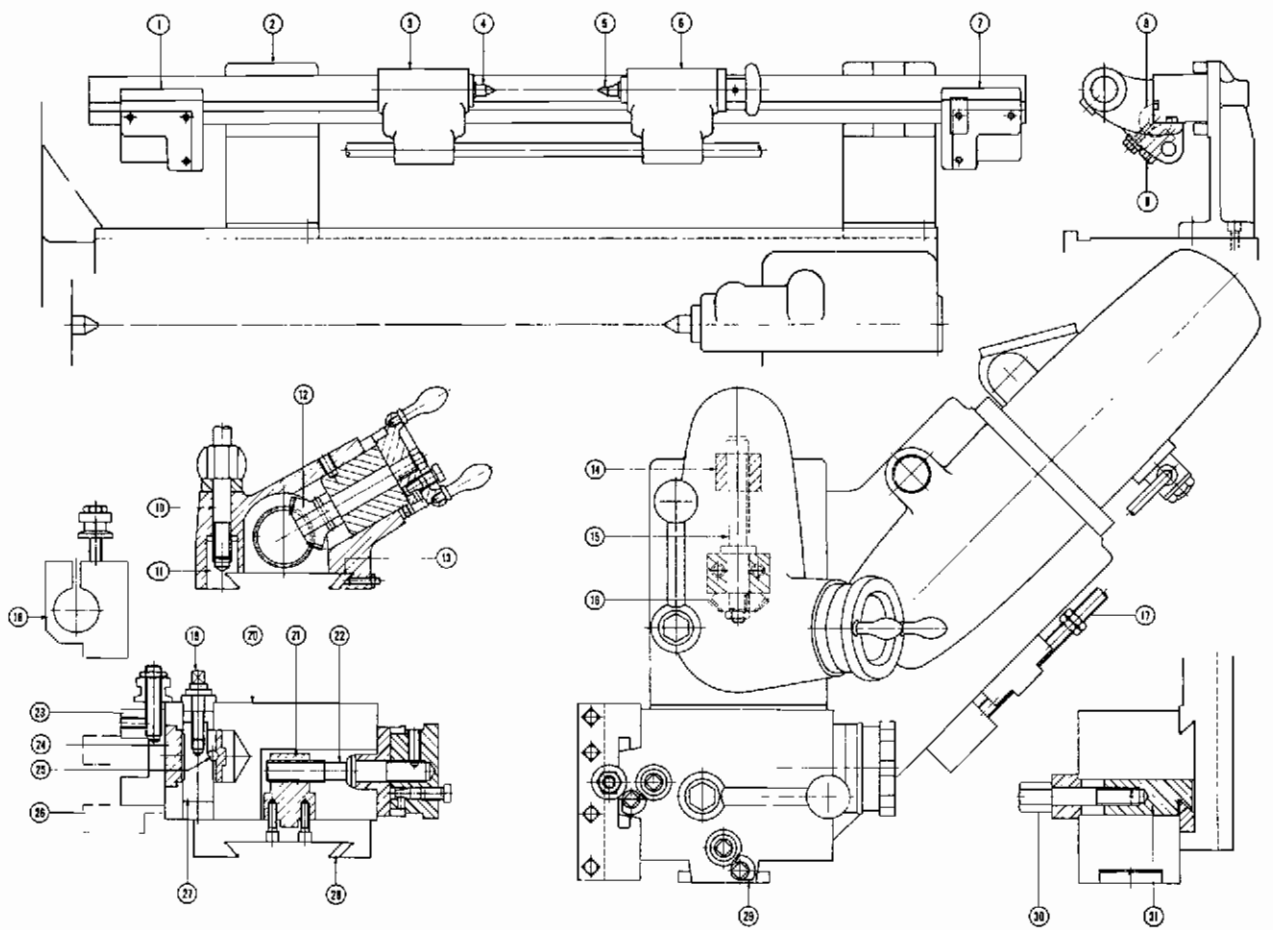


FIG. 14

The following points, together with Fig. 14, illustrates additional setting and indicate the limitations of the attachment.
The tool should be held in boring bar or extension toolholder.
For shoulder threads approximately $\frac{1}{2}$ inch transverse retraction of tool is necessary to permit disengagement of leadscrew nuts, and speed may be limited to extend time available.
For through threads the stop on the copy bar can be reversed so that tool retraction is obtained by the stylus following the tapered face. This increases the time available for nut disengagement.
Note that the tool retraction must be sufficient to permit roller on stylus to lift into position.

PLEASE STATE MACHINE SERIAL NUMBER, SHEET NUMBER & ITEM NUMBER

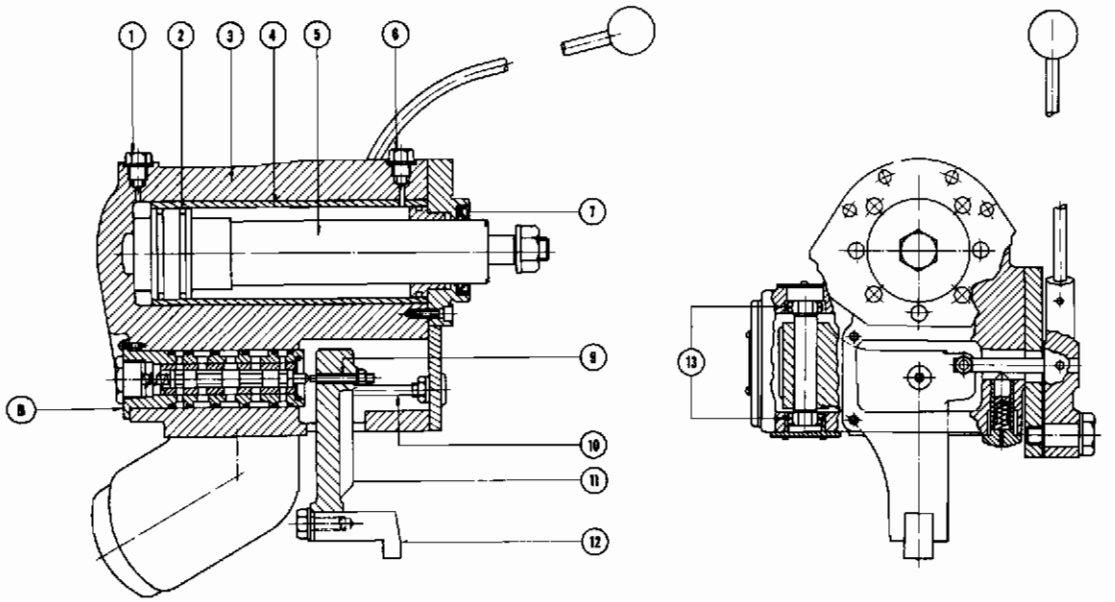


1. L.H. Bracket for flat copies.
2. Beam support bracket.
3. L.H. Copy holding bracket.
4. Centre.
5. Centre with flat.
6. R.H. Copy holding bracket.
7. R.H. Bracket for flat copies.
8. Clamping nut.
9. Lock bolt for adjusting rod.
10. Lockbolt for top slide.
11. Lock pad for top slide.
12. Hand feed shaft bevel.
13. Top slide slip.
14. Hand feed nut.
15. Hand feed screw.
16. Hand feed screw bevel.
17. Adjusting screw.
18. Toolholder for boring bar.
19. Locking screw.
20. Toolholder.
21. Toolholder nut.
22. Toolholder screw.
23. Toolholder for turning tool.
24. Clamping plate.
25. Locking pin.
26. Inverted toolholder.
27. Lock pad.
28. Cross slide slip.
29. Height stop clamp.
30. Lock bolt for toolholder.
31. Lock pad for toolholder.

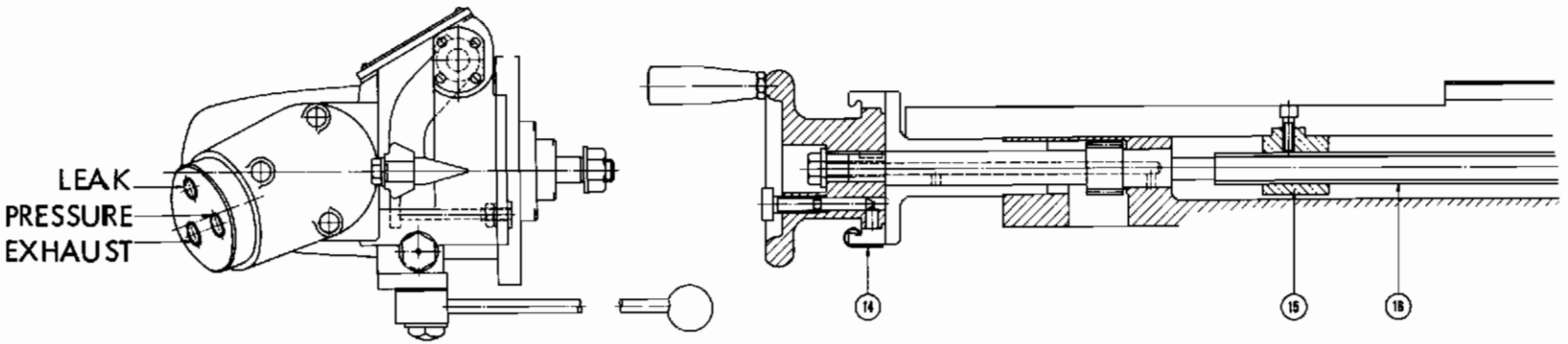
ALL FIXING SCREWS ARE STD. WHITWORTH OR B.S.F. THREADS

14.6 SPARE PARTS LIST FOR HYDRAULIC COPYING SLIDES, ETC.

PLEASE STATE MACHINE SERIAL NUMBER, SHEET NUMBER & ITEM NUMBER



1. Rear bleeder screw.
2. Piston rings.
3. Cylinder body.
4. Cylinder liner.
5. Ramshaft.
6. Front bleeder screw.
7. "Superfect" oil seal.
8. Cartridge assembly.
9. Stylus arm adjusting screw.
10. Stop for stylus arm.
11. Stylus arm.
12. Stylus (ceramic tipped).
13. Stylus arm bearings.
14. Spring index marker.
15. Cross slide nut.
16. Cross slide screw.



ALL FIXING SCREWS ARE STD. WHITWORTH OR B.S.F. THREAD