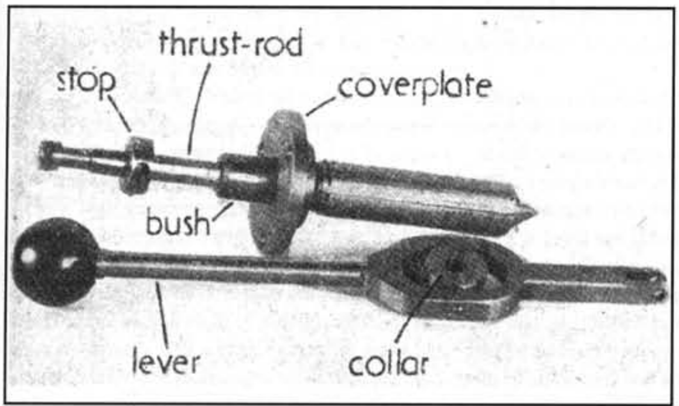


Fig. 13: The parts of the attachment.

tailstock is illustrated in Fig. 12. If desired, the T-handled locking-screw for the clamp, shown in the sectional drawing Fig. 11, may be replaced by an Allen cap-screw, as seen in the illustrations of the complete tailstock. This arrangement has the advantage of providing a locking-screw that does not project above the surface of the clamp.

It is not proposed to give detailed drawings of the fitment here. Those readers who wish to apply the device to their own lathes will no doubt find that a number of small modifications are needed to meet individual requirements. However, if the principles shown in the illustrations are followed, successful results will be obtained.

These drawings must be read in conjunction with those in Fig. 8 that relate to similar parts. In Fig. 9 only those measurements that need modification are given; the remaining information will be found in the previous set of drawings.

Hand Lever Attachments That May be Constructed in the Small Workshop

2. Attachments for Tailstocks Having an Internal Working Thread. The conversion of the type of tailstock illsutrated in Fig. 10 and, in section, in Fig. 1B, is a somewhat more difficult matter; moreover, it is not possible to arrange matters so that the tailstock barrel can be moved either by the handwheel or by means of the lever at will. The user will, therefore, have to content himself with providing lever operation only.

The handwheel and feedscrew seen in the illustrations are removed and replaced by a thrust-rod and cast-iron bush, as depicted in Fig. 11. The thrust-rod screws into the barrel of the tailstock and is moved by means of a lever acting on a collar attached to the thrust end. The collar is free to turn on the rod; so by loosening the clamp on the tailstock casting, the lever may be set in any desired position around the axis of the tailstock. The complete

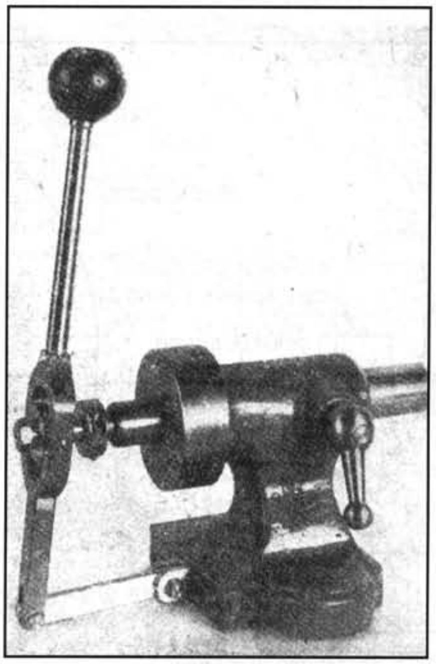


Fig. 14: Simlified lever-operated tailstock.

A Useful Stop

When using a lever feed tailstock it will be found that a stop to limit the tavel of the tailstock barrel is an advantage. This stop is easily fitted to the type of tailstock now being discussed, for it takes the form of a simple split collar that may be slid along the thrust-rod and locked in any desired position. By this means, for example, the tailstock travel can be adjusted to enable a number of similar components to be drilled to the same depth.

The form of collar suitable for the purpose is illustrated in the general arrangement drawing and may also be seen in the illustrations of the complete tailstock. The making of these collars has been described many times in the past, so requires no further comment now.

The conversion, to lever operation, of tailstocks fitted to precision lathes such as the Boley, though practicable is, perhaps, inadvisable. Makers of precision lathes do not sell conversion attachments; they supply complete interchangeable tailstocks only.

For those who do not need a lever feed attachment that can be adjusted and swung around the axis of the tailstock, the simplified device illustrated in Fig. 14 may suffice.

As will be seen, the clamp is discarded and the anchorage for the link is a fork that screws into the base of tailstock casting. Apart from this alteration the parts of the attachment are the same as those previously illustrated.

In making the attachment it is advisable to lap both the thrust-rod and the cast-iron bush; in this way the movement of the parts will be made smooth. ●

Model Engineer 106 445 (1952)

Automatic Facing and Boring Head

by J. A. Radford

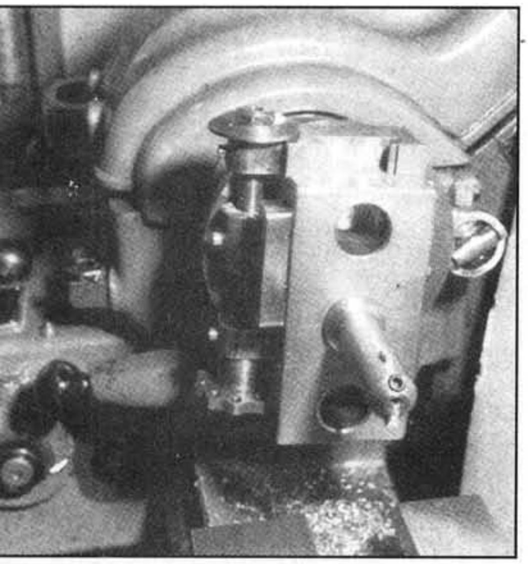
Boring/Facing Head

The ability to face a casting fixed to the lathe saddle is very valuable, especially as it is not always possible to swing work over the bed, nor indeed to hold it in some circumstances. In choosing among the designs of head available, I was looking for elegance combined with simplicity, the ability to index out to larger diameters at each revolution and inbuilt rigidity which stems from a short overhang beyond the lathe mandrel. Radford's design fulfils all these criteria.

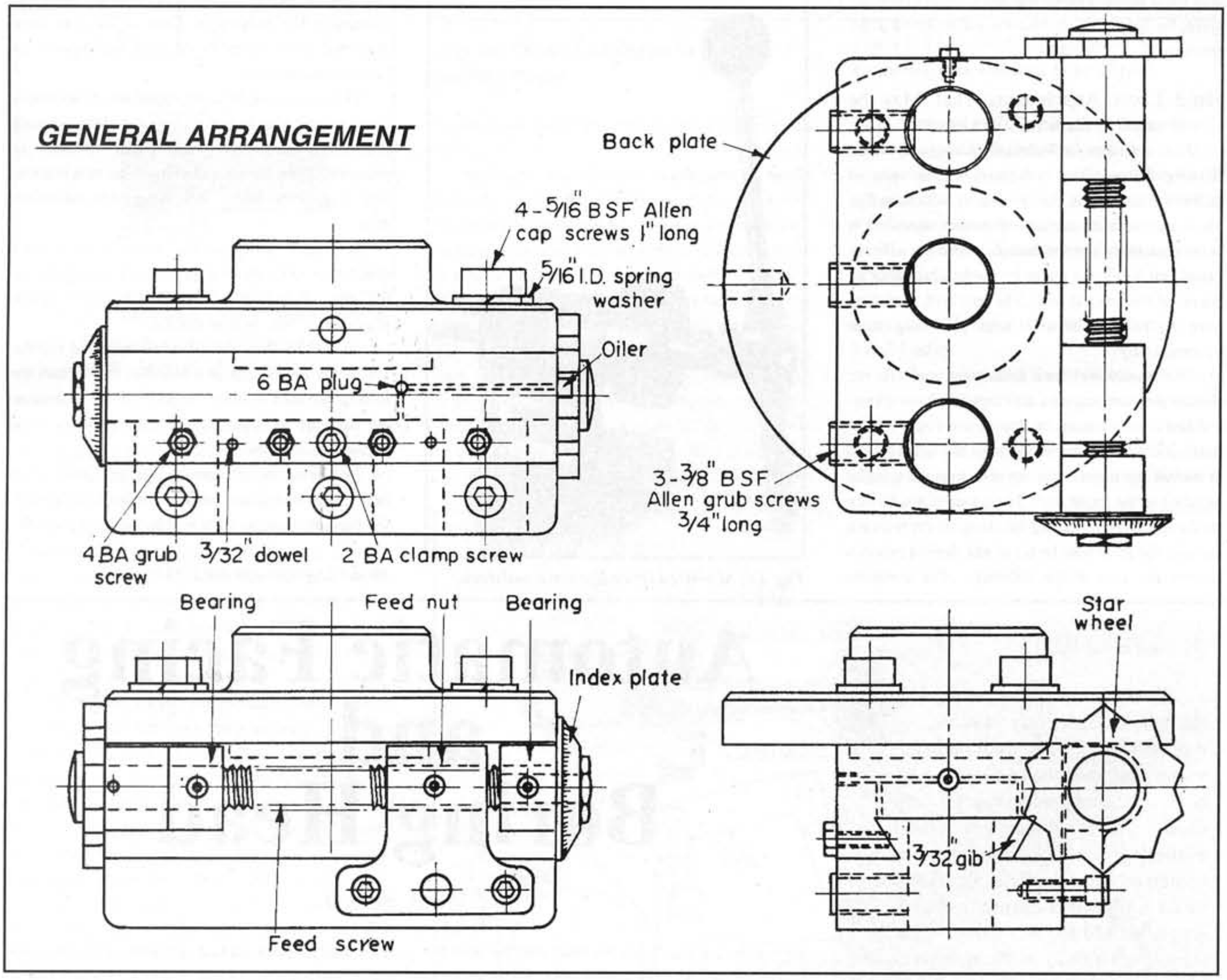
I have recently designed and made an Automatic Facing and Boring head which will bore and face to a maximum diameter of 6½ in. with an automatic facing feed of 0.005 in. per turn, which may be of interest to readers. In addition to these orthodox functions, the head may be used for fly-cutting, setting the diameter swept by the cutter to the most suitable size and traversing the job by means of the cross-slide. If suitable split bushes are made, the crank and cam journals on crank-shafts can be machined, the throw being accurately set by means of the index plate on the feed screw of the head.

The usual orthodox facing feed is outwards from the centre, but a third hole is provided so that facing can be done towards the centre as for instance when it is necessary to face up to a shoulder. With the cutter bar in this position, turning a spigot on a part that is too big to swing in the lathe can be done, the job being held on the cross-slide or vertical-slide.

I used the ⅜ in. BSF thread provided in the Myford head for the collet attachment, for supporting a hardened steel roller against which the ten point star wheel impinges, this moves a ⅜ in. BSF feed scew (20 t.p.i.) so giving the 0.005 in. per turn of the head. For boring, the roller is positioned clear of the star wheel



The facing and boring head in position on the lathe.



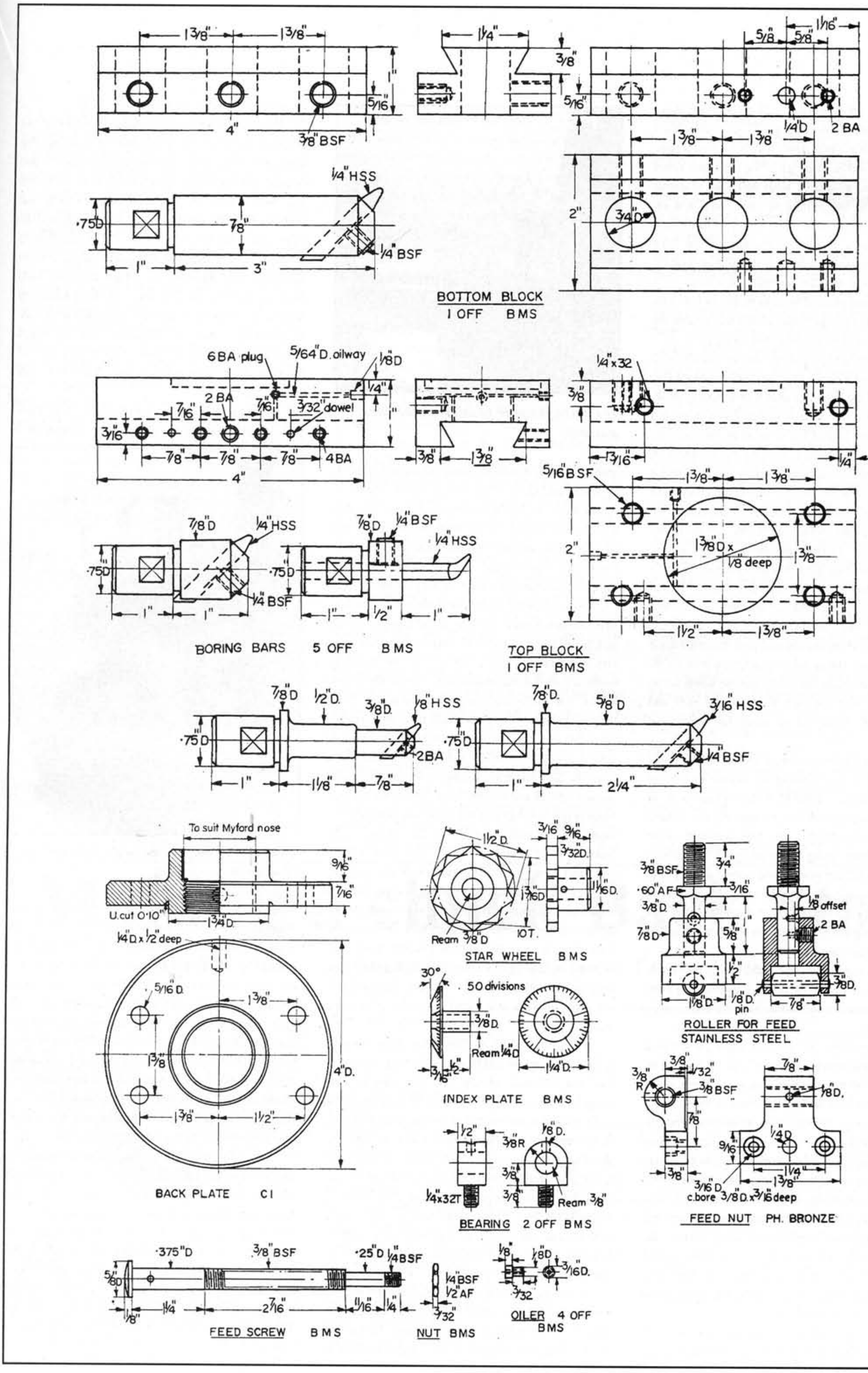
and the slide is locked by means of the locking screw provided. I have made five boring and facing bars which take care of a wide range of work.

I had some 2 in. x 1 in. b.m.s. left over from the Quick Change Toolholders and I used this for slides, the backplate is a standard Myford 4 in. chuck backplate. At the maximum diameter the head will clear the bed of the lathe, but in any case the total width is less than the width of the gap, so a swarf guard fitted to the saddle can be used, which is an important point.

Two pieces of the 2 in. x 1 in. steel were cut off 4 in. long full and faced off to 4 in. I found that these pieces were true on the faces to the surface plate and truly parallel, so decided not to face the pieces at all. The first piece was set up true to the dial gauge in the four-jaw chuck and truly central and bored 1 3/4 in. dia. to a depth of 0.125 in., undercutting slightly in the corner for the spigot to be turned on the backplate. The backplate was drilled 1/4 in. into the edge for a tommy bar, allowing for the turning off for the spigot,, and turned on the face leaving the spigot at 0.10 in. depth a very close fit in the steel piece and also very slightly undercut. While working on the backplate it may as well be finished off; first get the outside diameter to 4 in., as you will find it slightly large and then mount the steel piece on the spigot at right-angles to the tommy bar hole and scribe two lines alongside the steel. Remove the steel piece and mark out the four holes for the 5/16 in. Allen cap screws either Whit. or BSF. Note that one of the holes on the opposite side from the tommy bar hole is spread out 1/8 in. to clear one of the bearing piece spigot screws.

The steel piece can now be spotted through and drilled and tapping size, but do not under any circumstances go deeper than 9/16 in. to the point of the drill. Make a flat bottom to the holes and tap with a plug tap to finish. Countersink all holes on both sides of the plate slightly and on the steel piece before tapping. Tap through the plate for truth. The steel piece is milled along the centre, first with an end mill and then with a 60 deg. dovetailed cutter. A 1/32 in. flat edge is left on the slides and on the tommy bar hole side, this edge is 9/16 in. from the centre and on the other side it is 7/16 in. from the centre. This is to allow for the gib piece. This slideway must be truly parallel to the sides and exactly 3/8 in. deep, and true to the face of the piece. Make sure of this. The other piece of 2 in. x 1 in. steel is also milled with an end mill and the same dovetailed cutter again, leaving the edges 1/32 in. wide and bringing the edges of the two pieces of steel flush. The gib piece is made of 3/32 in. thick gauge steel which at the angle is about 1/8 in. wide, so a little latitude is allowed to get the sides flush while milling. Have a piece of gauge plate handy while milling and make it to a close push fit.

May I be allowed a little New Zealand "skite" here? I did just this and it is almost impossible to feel the edges at any position of the slides and the gib



BOTTOM BLOCK
1 OFF BMS
3/8" BSF
1/4" HSS
1/4" BSF
1/4"D
2 BA
6BA plug
5/64"D. oilway
2 BA
3/32" dowel
4BA
1/4"x32
5/16"BSF
1 3/8"D x 1/8" deep
TOP BLOCK
1 OFF BMS
BORING BARS 5 OFF BMS
2BA
1/8" HSS
3/16 HSS
To suit Myford nose
U.cut 0·10"
1/4"D x 1/2" deep
5/16 D.
4"D.
BACK PLATE CI
Ream 3/8"D
10T.
STAR WHEEL BMS
50 divisions
Ream 1/4"D
INDEX PLATE BMS
3/8"R
1/4"x32T
Ream 3/8"
BEARING 2 OFF BMS
3/8" BSF
·60" AF
1/8" offset
2 BA
1/8"D. pin
ROLLER FOR FEED
STAINLESS STEEL
3/8" BSF
3/16 D.
c.bore 3/8"D x 3/16" deep
FEED NUT PH. BRONZE
·375"D
3/8"BSF
·25"D 1/4"BSF
FEED SCREW BMS
1/4"BSF
1/2"AF
NUT BMS
OILER 4 OFF
BMS

piece is quite a tight push fit. There are many ways of milling these slides, I have a 27 in. planer that I have converted to a plano-mill with No. 30 taper nose and double Timken bearings at the nose, ten speed back gear, four all-geared feeds and a lot of useful attachments so the milling is now quick and no trouble. If I did not have this, I would probably have milled the slides in place on the nose of the lathe using my milling attachment, or it could be done on the vertical-slide with the cutters in the chuck.

This second piece of steel is milled to 0.010 in. shallower than the other piece (0.365 in.), so that the bearing surface is on the outer two faces.

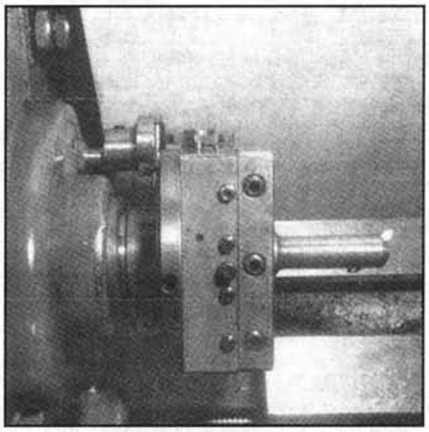
Some time ago I picked up from the foundry a 10 in. disc of cast-iron about ¾ in. thick. I faced this both sides of the lathe and used it as a lapping plate. I lapped both sides of the first slide and with the gib piece removed, lapped the other slide into the first using fine paste. Next I clamped the gib piece in place with two clamps and a small piece of round steel and drilled the two ⅓₂ in. dowel holes right through the gib at 1¾ in. centres and in the centre No. 24 for the 2 BA Allen cap screw which is the clamping screw. The four gib screws are 4BA at ⅞ in. centres and the four gib screw nuts are made from ¼ in. a.f. hexagon steel. These screws were all drilled until the point of the drill just indented slightly into the gib. The parts were all now cleaned up, the gib and screws all fitted and the backplate mounted using the cap screws cut to maximum length with ⁵⁄₁₆ in. spring washers under the heads, and the whole set up in the lathe with the slide flush on the ends and locking screw tightened up ready for boring and reaming for the bars.

The centre hole was centre drilled, drilled, bored and reamed ¾ in., allowing the boring tool to go below the surface of the first slide about ⅓₂ in. to allow for reaming with the machine reamer; a hand reamer is useless for this job. Then setting the slide 1⅛ in. off centre, using the vernier gauge, the second hole was bored and reamed and setting the opposite way the third hole was done the same way. The holes were very slightly chamfered on the outer edge. You will notice that the gib screws are on the same side as the tommy bar hole.

The three grub-screws for the boring bars are ⅜ in. BSF, ¾ in. long and the points flattened off a little. These are drilled ⁵⁄₁₆ in. centres from the bottom edge and tapped.

As these slides are "steel on stteel", I provided for good lubrication by drilling a ³⁄₆₄ in. oil hole 1½ in. deep and ⁵⁄₁₆ in. from the backplate in the centre of the end, the same end as the star wheel is fitted, and a cross hole to go through this drilled from the gib screw side and about 1¾ in. deep. Two vertical holes the same size were drilled from inside the backplate recess to just strike the corners of the slideways as shown on the drawing. The ends of these holes were plugged with a 6 BA grub-screw except for the end one and four oiler nipples were made from ⁵⁄₁₆ in. b.m.s. turned a full ⅛ in. for ³⁄₁₆ in. long, drilled through ⅟₁₆ in. and parted off leaving a ⅛ in. high head for the oil gun. One of these nipples was pressed into the end hole after drilling ⅛ in.

Make a little pattern for the feed nut and get it away to the brass foundry for one off in phosphor-



The boring head in position on the lathe mandrel.

bronze, so that it will be ready when you need it. Now drill and tap the two ¼ in. x 32 t.p.i. holes no deeper than ½ in. for the two bearing blocks. The one next the star wheel is ¹¹⁄₁₆ in. from the end and clears the offset hole drilled from the backplate, the other end is ¼ in. from the end. they are both a full ⅜ in. from the backplate, and must be truly in line.

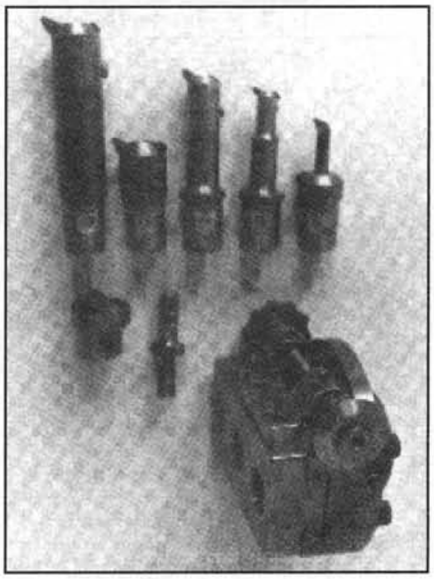
The two bearing blocks are made from ¾ in. key steel and this is set to run true in the four-jaw chuck and turned to ¼ in. for ⅜ in. long and screwed with dies in the lathe ¼ in.x 32 t.p.i. The fine thread is necessary so that the blocks can more easily be set square. Part off the pieces square across at ¾ in. from the base and screw them into place, marking the outer face of each block. Setting this outer face ⅛ in. out from the jaws of the chuck and with the centre ⅜ in. from the base and truly central, ⅛ in. is turned off, centred, drilled and reamed ⅜ in. The other bearing block is machined exactly the same and then they are pushed over a stub mandrel and the opposite side faced off ⅛ in. leaving the blocks ½ in. thick x ¾ in. wide and ¾ in. high. The outer ends can now be rounded off to ⅜ in. radius. To secure these bearing blocks permanently in place I did not want to braze them with the possibility of distortion so I spread a little Araldite over the threads and the bases and screwed them firmly into place getting the two bores truly in line with a piece of ⅜ in. rod. This was left overnight until the star wheel and index plate were made.

A piece of 1½ in. b.m.s. about 4 in. long was held in the chuck and the end faced and centred. A parting tool and left-hand turning tool was used to turn roughly down to ¾ in. for about ¾ in. long leaving a ³⁄₁₆ in. wide disc on the end of the piece the full size. A narrow side and face cutter was used and the dividing plate was set for ten divisions. The cut was taken to a depth of ¼ in. with the cutter set ¹⁹⁄₃₂ in. from the other side of the centre, the distance between the two milled faces was 1³⁄₁₆ in. After milling and the points of the star very slightly rounded, the job was drilled, bored and reamed ⅜ in. and parted off a full ⁵⁄₁₆ in. from the star.

A stub mandrel was then turned and the journal turned to ¹¹⁄₁₆ in. dia. and of a length that would allow for a ⅟₆₄ in. fibre thrust washer between the bearing block, so that the star wheel just cleared the end of the slide; this should be about ⁹⁄₁₆ in. long.

The index plate was made from 1¼ in. b.m.s. and is turned down to ¾ in. a nice free fit in the bearing block for ½ in. long, centred, drilled letter D and reamed ¼ in. It was parted off a full ⁵⁄₁₆ in. at the full dia., held in the ⅝ in. collet and faced to ³⁄₁₆ in. and with the top-slide set to 60 deg. it was turned until the edge was about ⅓₂ in. wide. The graduating attachment was then set up at this angle and 50 divisions were indexed; the single divisions were made ⅟₁₆ in. long, the fifth was ⅛ in. long and every tenth was ¼ in. long. They were numbered with ³⁄₃₂ in. numbers in a clockwise direction. The nut which holds this index plate was now made from ½ in. A/F hexagon steel and tapped ¼ in. BSF. The nut is ⁵⁄₃₂ in. thick.

We can now make the feedscrew to fit all these reamed holes and checking the lengths exactly from



Some of the components of the boring head showing the tools used.

the job. The screw is made from ⅝ in. b.m.s. and is made a tap-in fit in the star wheel, a free fit in the two bearing blocks and a tight push fit in the index plate. Another ⅟₆₄ in. thick fibre thrust washer is fitted over the index plate and the shoulder on the feedscrew against which the index plate presses should be of such a length that the feedscrew will be free but without end play. The index plate is fitted this way so that it can be set to coincide with the zero mark on the fixed slide on the tenth and fifth divisions each turn of the mandrel. The thread at 2 ⁷⁄₁₆ in. long is ⅜ in. BSF and must be screw-cut to fit an item which is of phosphor-bronze.

The phosphor-bronze nut should now be machined on the back face, noting that it is relieved to clear the fixed slide by ⅓₂ in. and to clear the backplate. The base should well clear the outer face of the moving slide and clear the fixed slide. It is drilled No. 24 at 1¼ in. centres and centred in the centre only, for the dowel pin. It is now clamped to the moving slide with the centre at 1⅟₁₆ in. from the same end as the index plate. This will leave ⅛ in. of further offset movement to clear a boring tool more easily.

The moving slide is now drilled No. 24 through from the nut to ½ in. depth to the point of the drill, and drilled letter D for the dowel pin, which is reamed ¼ in. and a silver steel dowel fitted. The nut is counterbored 5/16 in. for the two ½ in. x 2 BA cap screws and the heads are set in so that they are just slightly above flush.

The two slides together are next set up on the cross-slide of the lathe with a true running piece of ⅜ in. rod in the chuck and the back centre which is passed through the bearings. When clamped to the cross-slide, this rod should still be free to turn and the cross-slide is locked. This is to bring the two bearing blocks in line with the centres of the lathe. The feed nut is mounted complete with screws and dowel pin and a sharp ⅜ in. drill is put in the three-jaw chuck and the nut is drilled until the lip of the drill just enters. The drill is now changed for a 21/64 in. drill and the nut drilled through. The nut can be tapped through the bearing, bringing the plain shank of the tap to line up in the bearing. This will make a truly in-line thread which will run very freely.

Star wheel

The star wheel is pinned with a 3/32 in. silver steel pin, but after drilling and before the pin is fitted, the star wheel should be thoroughly case hardened. The spigot for the roller holder is made from a piece of 0.60 in. hexagon steel (Whit. size) and is first turned to ⅜ in. for 1 in. long, leaving a nice radius and then reversed in the chuck and turned ⅜ in. leaving a full 5/16 in. of hexagon. This is now screw-cut and threaded to fit the Myford ⅜ in. BSF thread in the head of the lathe. Check the position of this hole by fitting the spigot and the facing head. If it is the same as mine, there will be a full ⅛ in. between the edge of the backplate and the ⅜ in. shank of the spigot, and this will allow the roller holder to be removed at any time without removing the facing head.

There is no reason why this eccentric roller holder should not be turned in the facing head, using the graduations to ensure the correct offset. So cut off a piece of 1¼ in. b.m.s. 2½ in. long and turn one end a close fit in the ¾ in. reamed holes of the head to 1 in. long. File a flat for the grubscrew (these flats for the boring bars, by the way, are filed slightly deeper on the end nearest the shoulder, which prevents them working out). This is now mounted in the central hole and set to the zero mark. Set the slide ⅛ in. eccentric and lock it and turn to ⅞ in. dia. for a length of ⅝ in. Now set out a further amount to ¼ in. eccentric and turn to 1⅛ in. dia. to close to the slide and centre the end, drill, bore to clean up and ream to ⅜ in. to fit the spigot. This should leave the thin side approximately ⅛ in. thick. The piece should now be parted off at 1¼ in. long.

Gripping the 1⅛ in. dia. part in the three-jaw chuck with parted off face outward, the end is now faced and recessed to ⅞ in. dia. to a depth that will leave ⅛ in. of metal at the bottom of the recess. The edges of the recessed part are cut away, leaving the two lugs for the roller pin 5/16 in. high and in line with the offset. The roller is turned to ⅝ in. dia. and the centre hole is reamed ⅛ in., the ends of the roller being radiused to fit in the ⅞ in. dia. recess. The roller and pin are made from silver steel and hardened. The ¼ in. BSF grub-screw is fitted in the centre of the ⅞ in. dia. part right on the high side. To get the position of the two holes centre drilled in the spigot, one for engagement of the roller and the other for clearance, the spigot is tightened up in place and the roller is put in place, the facing head fitted and the roller set so that it will just clear the index plate, the angle of the roller is then set so that the star wheel strikes it squarely. The grub-screw is tightened in this position and tightened again in a position ¼ in. further in to clear the star wheel. The indentations made by the grub-screw can now be drilled with a centre drill to about ¼ in. wide in these two positions.

Apart from the fitting of the other three oil nipples, one in each of the bearing blocks and the other in the centre of the feed nut, all that remains now is to make the five boring and facing bars. They are all made from ⅜ in. b.m.s. Cut off one piece 4⅛ in. long, one piece 3 5/16 in., another 3 1/16 in. and one piece 3¾ in. long, which will make the two shorter bars. I set up each piece in turn in the three-jaw chuck and faced and centred the end. With a parting tool 1/16 in. thick, I cut into the steel 0.070 in. at 1 in. long to the inner face of the tool and turned to a very close fit in the bores of the facing head, bevelling the outer corner slightly. This was made a good twist-in fit in each case, not forgetting to do both ends of the 3¾ in. long piece. The flats were all filed now, using a good square file and making them ⅜ in. square, but as stated, slightly deeper on the shoulder end to give a slope to the bottom face. Getting the centre hole in the facing head true to the dial, the slide was locked and each tool was faced on the end, bevelled and turned to the drawing. The bevelled ends are at 45 deg. and are made the same width as the tools as shown. The tools are round tool bits in h.s.s. with a flat ground on the side for the Allen grub-screws. The smallest tool is a piece of ¼ in. round which had to be forged over, ground to shape and then rehardened. The grub-screw in this case is at right angles.

The tools were all ground with slight top rake (positive) and also a slight positive side rake and with ample clearances on the ends and the diameters. They bore an face to a beautiful finish and accurate diameters. This facing and boring head can be made in a few hours and amply returns the time to make it over makeshift methods which are seldom satisfactory. ●

Model Engineer* <u>137</u> *352 (1971)

Making a chuck Back Stop

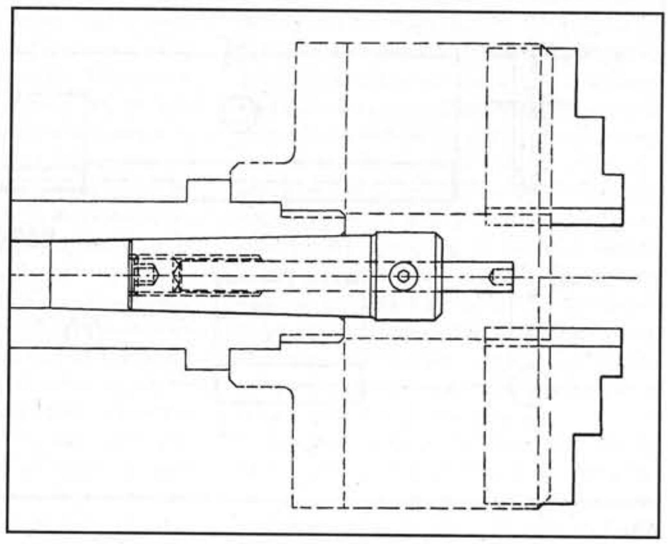
Martin Cleeve also offers some hints on Taper Turning

<u>Chuck Back Stop</u>

The ability to reproduce components to fixed length is very useful in small batch production. The present article seems to have some advantages over others available, although none so far is ideal!

Although at frist sight a chuck backstop may not appear to be a very exciting accesory, it is a most useful one. Its chief job is to assist in machining sets of identical components to correct lengths within close limits, but it is also very convenient as a stop to limit the degree of entry of a component into the jaws of a chuck when comparatively heavy roughing cuts are being taken with tailstock support.

The chuck back stop in position.



Used in this way, the backstop eliminates the risk of cutting stresses moving the component away from the supporting centre. Again, there are occasions when it is necessary or expedient to aim for higher accuracy when components are driven by a chuck, and with tailstock support. For example the work may not have a centre at the end to

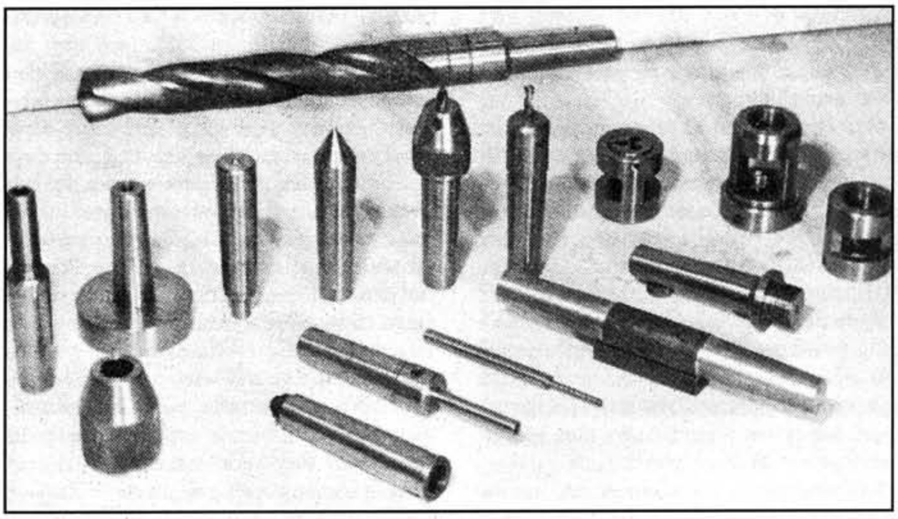


Fig. 1

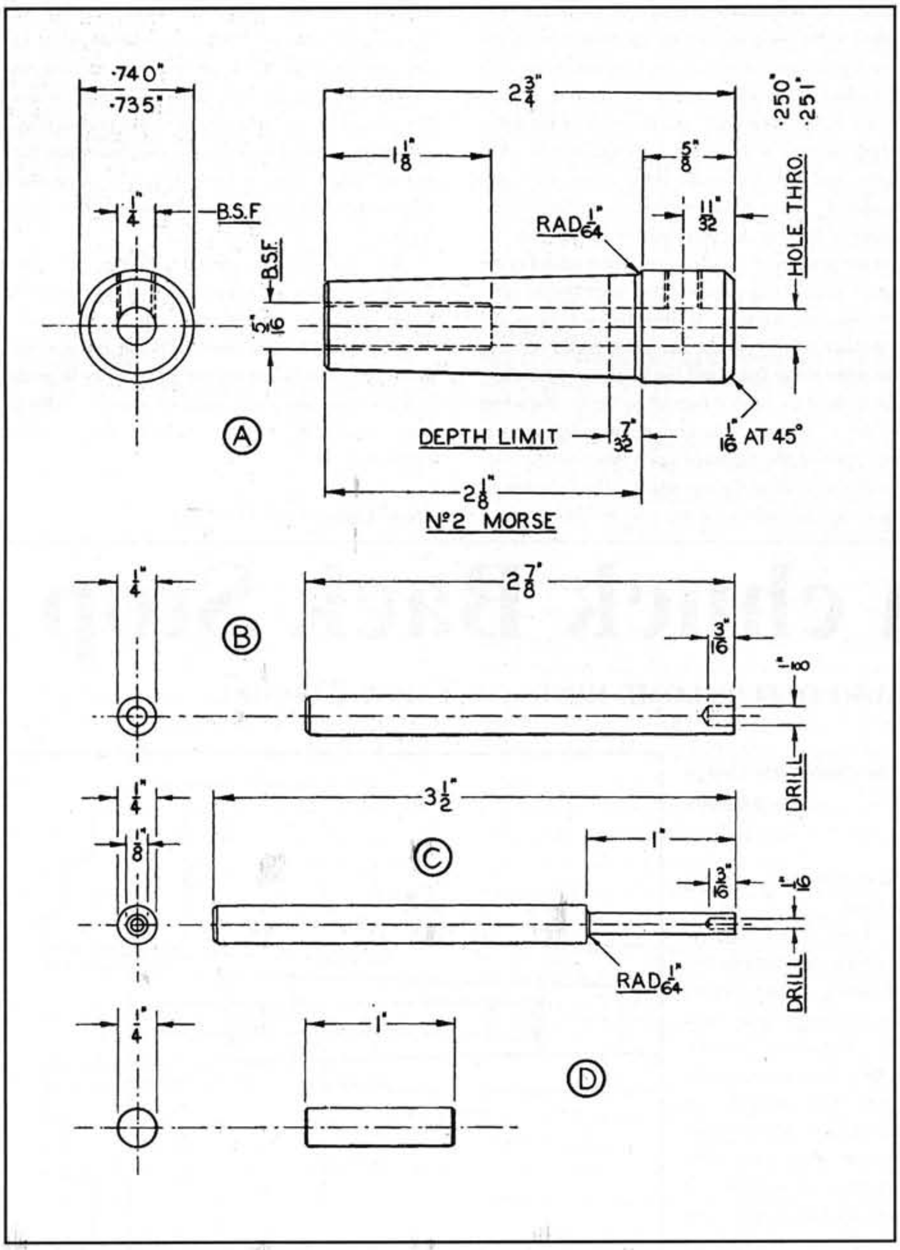


Fig. 2

be driven, or that end may be too short to permit the use of a driving dog. In these cases it is advisable to set the chuck back-stop in such way that the length of the chuck jaws engaging the work is at a minimum consistent with driving without slipping; then, if the jaws gripping faces are not quite parallel with the lathe centre-line, the distortional effects which otherwise would be introduced are minimised and control over step lengths on subsequent components is maintained.

The ability to machine a good taper is a worthwhile achievement, and has wider applications than may at first be thought.

Fig. 1 shows a selection of taper shank tools made by the writer. The chuck back-stop may be seen in the centre foreground with one stop rod lying just to the right. Other tools shown are: middle row, left to right, drill chuck shank, tailstock drill pad, female centre, H.S.S. inserted lathe centre, centre drill holder (for inmediate availability), stub-drill holder (drills without pre-centering). At the extreme right there are three tailstock die-holders and one shank threaded to suit them. The large drill at the rear is of 1 in. dia. and is extremely useful with the No. 2 Morse taper shank which I machined to fit the tailstock barrel – although chucking and supporting to turn the taper and maintain concentricity was very difficult.

You will find details of the chuck back-stop on the drawing, Fig. 2. The degree of projection of the stop rod is adjusted by a 5⁄16 in. BSF socket head grub screw bearing on the rear end, and the rod is locked by one ¼ in. BSF grub screw fitted radially in the boss of the holder, as at A. Although this radial screw would hold the rod fairly tightly, it would not be secure against a series of knocks from repetition work, whereas with the rear screw the whole is proof against all kinds of adverse treatment: an important aspect from an industrial point of view.

The drilled recess in the projecting ends of the stop rods B and C is to accommodate any central stem or pip that may remain attached to a piece of stock after a previous parting-off operation. The make-up piece D (Fig. 2) is occasionally used interposed between the rod and the thrust screw to give extra extension to rod B. The stop rod C is handy when chucking components of small diameter and to a set degree of projection.

Taper Turning

There are three chief ways of using a centre lathe for taper turning.

(1). For the occasional and comparatively short taper the top-slide may be set off parallel, and there is, of course, no limit to the degree of such setting.

(2). For more lengthy work requiring a comparatively gradual taper the tailstock may be offset.

(3). A taper turning attachment may be used. This, briefly, consists of a guide bar that can be securely fixed at the rear of the lathe bed and which can be set off parallel to the desired amount. The lathe cross-slide is freed of its feed screw, but, by means of an adaptor, is coupled to the guide bar so that when the saddle is traversed along ths lathe bed in the normal way, the cross-slide is caused to

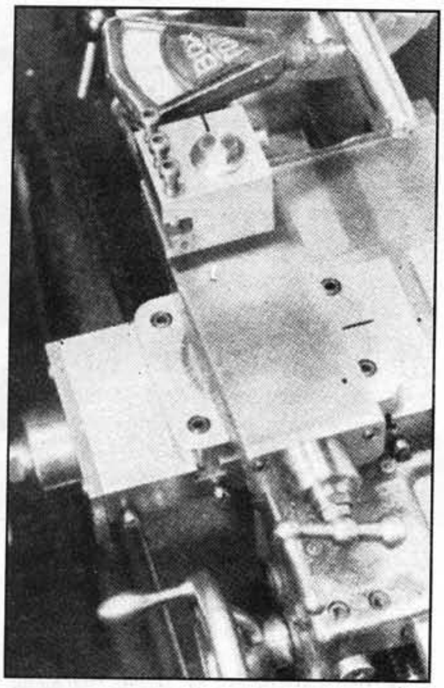


Fig. 3

advance or retard to a degree decided by the slope of the guide bar. Since, with this method, the cross-slide cannot be used to adjust individual cuts, the top-slide is made to serve for this purpose by setting it at right-angles to the lathe bed. The attachment is very suitable for Morse and similar tapers but cannot be used for angles steeper than about 30 deg.

For the sake of completeness it is worth mentioning that on some lathes provided with an automatic cross-feed, it is possible to so relate the saddle traverse and cross feed rates that a desired taper can be produced.

Methods (2) and (3) have the advantage that the automatic saddle traverse can be used to produce a more uniform finish, but method No. (2) is objectionable for two reasons. The head and tailstock centre do not make proper engagement with the centre holes in the component, and considerable time is usually needed to test and readjust the tailstock alignment on completion of the job for which it was offset.

Ornamental Tapers

Purely ornamental tapers of over 4 in. or so in length and with quite wide limits on diameters may be machined by adjusting the saddle traverse to feed towards the small end, then, during traversing by the normal self-act, advancing the cross-feed slowly and uniformly, by hand, over the approximate number of thousandths of an inch required to bring the small end of the taper to the desired diameter. I speak from experience here, and the results can be quite good. A job that may otherwise take an hour or so to set up can be done in a few minutes, although a touch with a file to blend remaining irregularities is often called for, and on a long component the initial roughing may have to be broken up into two or three stages calling for a certain amount of estimation, otherwise, with one single roughing cut from end to end, the depth of cut may become uncomfortably heavy as the diameter decreases. I have also used this method for short tapered threads, although a taper turning attachment is the proper accessory for that kind of screwcutting.

Setting to Taper Turn

The more popular small lathes today have a No. 2 Morse taper in the spindle nose and tailstock barrel, so this is the size I have chosen to discuss.

Commercially, of course, the Morse tapers are made to definite lengths and fixed distances (with the usual working limits) between the large and small ends, and by these means the depth of entry into a corresponding taper bore is controlled. The standard dimensions can be found in all reference books and in many catalogues and you will also find them in Model Engineer Handbook. However, although I shall explain some elementary methods of measuring and checking tapers, we shall make ours to rather less exacting standards, but which, nevertheless will be of considerable help towards an understanding of the subject.

A majority of tables show No. 2 Morse as increasing or decreasing by 0.049951 in. in diameter for each inch of length, and the diameter at the large end, at the terminating line of full engagement with the corresponding tapered bore as 0.7000 in.

None of my reference books show the angle in degrees formed by the taper, so, although we shall not require it except as a rough guide, I worked it out as a matter of interest. Subject to correction by those with superior trig. tables, I make the included angle 2 degrees 52 minutes. Accordingly we have to set the top-slide, which we shall use for this job, off parallel by one half the above amount: 1 degree 26 minutes, and the best we can do with that figure is to call it "just under 1½ deg." Our final setting is done by concentrically chucking a known good No. 2 Morse taper, such as a lathe centre, and making further final adjustments to the top-slide, by tapping it around until a dial indicator referred to the setting taper reads zero, or remains steady while traversed over the length of the setting taper. The photograph, Fig. 3, shows this operation.

In setting up like this, tests should first be made to see that the sample shank is at least parallel to the lathe bed. A slight eccentricity due to chuck inaccuracy will not matter provided such eccentricity is the same at both ends of the sample. When you are traversing along the setting taper to set the top-slide, the indicator probe should contact the test piece at the line of maximum radius, or as near as you can reasonably get there to. When you are tapping the top-slide for final adjustments you must take care not to be misled by back-lash in the cross-feed screw, or by the D.T.I. being only partially fixed.

If for any reason there should not be a suitable sample taper available, it is possible, if your dial test indicator is one of the kind that reads over more than a few thousanths of an inch, to set the top-slide by referring D.T.I. to a length of parallel stock held in the lathe chuck. For No. 2 Morse taper you need to adjust the top-slide to such an angle that when traversed over, say, exactly 2 in. as read from the top-slide feed dial, the D.T.I. from a "0" start at what is to be the large end of the taper reads plus 0.049951 in. – a figure which, for practical purposes may be taken as 50 thousandths of an inch, this being only 49 millionths of an inch too great. You will appreciate that one half of the taper over a length of 2 in. is equal to the taper as given for 1 in.

When making an adaptor such as the chuck back-stop, an extra length of stock is always needed for chucking, but having taken the trouble to set the top-slide for taper turning, I find it pays to add sufficient material to machine two tapers, one each end, and with enough stock between to form the desired component and a "blank" for some other purpose, such as a soft centre, stub-drill holder, and so on, as illustrated in Fig. 1. Accordingly, for this job, I recommend a nominal 6 in. length of ¾ in. dia. b.m.s.

Initially, the length that has to project from the chuck is rather great and there is a tendency to chatter. I should mention here that although tailstock support would be an advantage, in practice it cannot easily be given because the tailstock body is so close to the top-slide feed handle that turning this becomes very awkward, or impossible. Occasionally the top-slide handle may be brought further away from the tailstock body by using a turning tool with an extra long shank. Again, the feed handle can be "stirred" by means of a length of flat strip with a hole at one end which fits loosely over the handle. Sometimes, too, it is possible to provide the top-slide feed screw with an extension rod of sufficient length to clear the rear end of the tailstock. In practice, of course, these ideas are seldom put into effect until more direct avenues have been explored. It so happens that for this job, if the taper is roughed at one end, and the piece is reversed, the roughed end will enter the lathe spindle-nose sufficiently to reduce overhang for the second end and allow machining to be carried out comfortably without tailstock support.

Machining the Taper

I found it convenient to use an adjustable-height type of toolholder (Fig. 3) to hold the D.T.I. when setting the top-slide to the taper angle, and I changed to a four-tool turret for machining. This was because I knew I should find there a suitable tool ready set at exact cutting height, which, for taper turning, is an especially important requirement. Possibly you will have to set a tool when you have finished with the D.T.I., and it is worth noting that the most certain way in which to position the cutting edge at a proper height is to take a series of light facing cuts on an odd piece of mild steel, and to add or remove packing until the tool faces without leaving any sign of a central pip. For the round nose tool it is necessary to temporarily set the shank parallel to the lathe bed when you are ascertaining the amount of packing needed, you will then be sure that you will have the edge that will take the final cuts at the required height, as distinct from the left side of the tool which, on a round nose tool with side rake, is a fraction above the front cutting edge. Paper or card slips may be used for final height adjustments.

I roughed the first end at about 500 R.P.M. by taking three cuts of about 15 thou. in depth at the start, and held chatter to a minimum by giving a fairly rapid hand feed to the slide. This end was to be

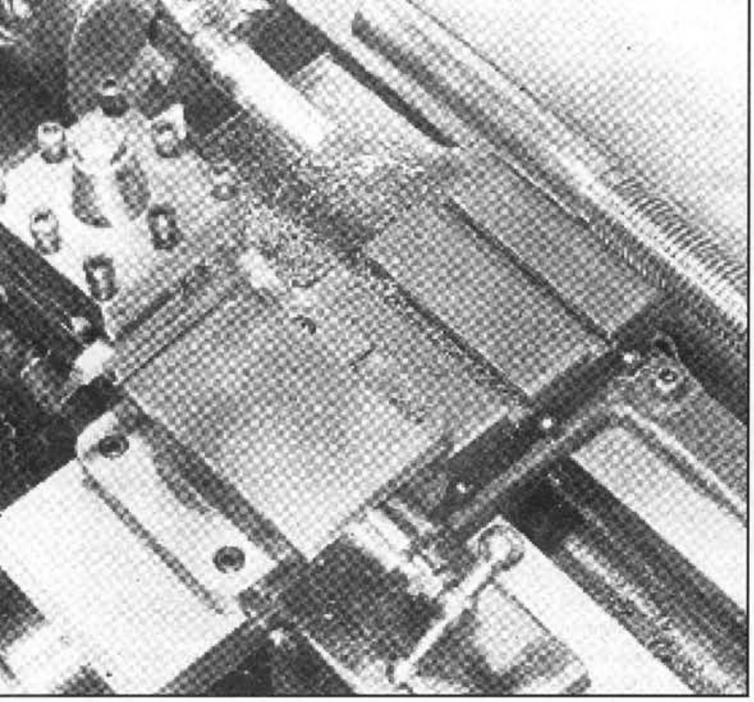


Fig. 4

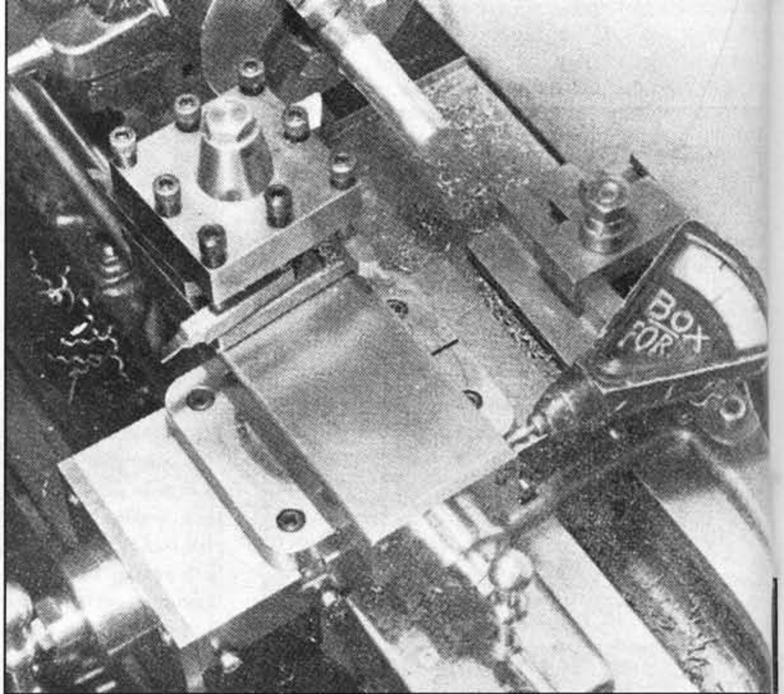


Fig. 5

finished after completion of the second end, so there was no point in my checking the taper in any way. Upon reversing the blank I made sure that the roughed taper was just free of engagement with the lathe spindle taper, otherwise, due to inevitable chuck inaccuracies, severe distortional strains would have been set up when the chuck was tightened.

Before machining the second taper I used the lathe tool to mark a ring to show the termination of the turned portion, then I locked the saddle to the lathe bed and made three taper cuts, each of about 15 thou. in depth at the start, and with fairly rapid hand feeds again; these I followed with two finer cuts of about 5 thou only, at a slow hand feed, but with the work rotating at about 780 R.P.M. and lastly a pretesting cut of only one thou. in depth.

As the photograph, Fig. 4 shows, I used the barrel from my tailstock as a preliminary gauge for the taper. This barrel is free because I use a rack-feed tailstock, but if your barrel happens not to be so readily available, I do recommend that you remove it from the tailstock for testing. You will not be misled by the slight misalignement always present in tailstocks, and you will have a much more delicate feel when holding the light barrel on its own. All you need do is to make sure the bore is thoroughly clean. Pull a strip of rag right through the bore and make a test with a known good taper by noting the degree of seizure when you insert one by a brisk flick of the wrist.

The component is checked by wiping it clean and after making three longitudinal chalks marks along it, one opposite each of the three chuck jaws, carefully bringing the test bore over the piece until engagement is felt, and then gently twisting and simultaneously pushing. My first test showed friction marks over about one third of the length at the large diameter end, and this indicated that the taper was too acute. This deviation, which is not unusual, was probably due to either the D.T.I. probe not being at exact centre height during setting, or to the different behaviour of the lathe when actually cutting, or to a combination of both.

As a matter of interest I took another light cut at the same top-slide setting, but during feeding I applied a gradually increasing pressure to the slide as it approached the maximum diameter. A subsequent test with chalk showed a surprisingly uniform result from end to end, and but for the fact that this was a trial run, it would have served its purpose after polishing. However, from the indications first received I estimated that the top-slide angle needed reducing very slightly and I chose a figure of 1 thou. at a radius of about $2\frac{1}{2}$ in. from the slide swivel pivot. I fixed the D.T.I. as in Fig.5, and after carefully setting it to read "0" I eased the tailstock swivel clamp and gently tapped the slide until the D.T.I. showed minus 1 thou. After re-locking the slide swivel and taking a further light cut, the chalk test showed complete contact over the whole length of the taper. Thereafter, of course, it was merely a matter of taking repeated light cuts until the taper entered the test bore by the desired amount: a space of about $\frac{7}{32}$ in. between the face of the test gauge and the turned shoulder will suit our purposes here.

For this trial run it was not necessary to obtain a final polished finish, and I merely reversed the component and machined the other end to a satisfactory depthing in the test piece, as before. Nevertheless, once uniform chalk indications have been obtained it is a simple matter to lightly file and polish these shanks, although tests should be repeated at frequent intervals to ensure that you are not being too heavy-handed with the file in the wrong places.

The gripping power of a well-fitting taper shank is severe indeed, so during the final polishing and testing stages care must be taken not to twist the gauge on too tighlty, although if the whole does have to be removed from the chuck to tap out the taper, eccentricity on rechucking will not matter for polishing. I should mention that for cleaning the taper bore after each test, I use a tapered bottle-brush – one of those with bristles held in a twisted wire handle. I also use this brush every time before inserting a taper tool in the head or tailstock bores.

Finishing the Back-stop

On completitition of the tapers, your double-ended blank may be sawn or parted in such a position that you obtain one shank and boss which will finish face to the length required for the tool in hand, then you may insert the blank in the lathe spindle nose taper and proceed as follows:

Face the end. Centre drill, give tailstock support and put on the nose chamfer by a direct in-feed with a suitably shaped tool. Skim the $\frac{3}{4}$ in. dia. to a concentric finish. Drill right through $\frac{17}{64}$ in. at about 1500 R.P.M. making the usual frequent withdrawals to clear chips and apply fresh coolant to the drill tip. Follow up by drilling $\frac{1}{4}$ in. at about 700 R.P.M. and with a slow and steady feed. Those with more experience could drill with letter C and then ream $\frac{1}{4}$ in., but unless a reamer is VERY frequently withdrawn and the chips cleared from the flutes with a brush, seizure is a certainty and the reamer will either break, or will revolve in its holding chuck, the jaws of which will so score the shank as to make subsequent accurate chucking a doubtful proposition.

You can now grip the piece in the three-jaw chuck by holding the boss end, then counter drill $\frac{17}{64}$ in. to a depth of $1\frac{1}{4}$ in. and thread $\frac{5}{16}$ in. BSF. One way of using a tap in a normal screwbarrel type of tailstock is to remove the feed-wheel so that the barrel is free to slide. A tap may then be held in the normal drill chuck and the lathe belt can be hand pulled. If the strain is felt to be too great to complete the tapping, at least a square start can be obtained for the tap, and threaing can be completed in the bench vice. Castor oil makes one of the best lubricants for tap and die running.

Finally you may drill and thread for the stop-rod locking grub screw in the boss, but when you have done this you should hand twist the $\frac{1}{4}$ in. drill or reamer through the main bore to remove the threading burrs and debris.

I used $\frac{1}{4}$ in. dia. silver steel for the stop-rods, and, although I did not bother, for a refined job you could harden the ends when you are quite satisfied these are absolutely square to the axis.

To Harden Silver Steel

One of the best ways in which to assure a correct quenching temperature for silver steel is to heat in until it is just past the non-magnetic stage, then quench. The loss of magnetic properties on heating can, of course, be tested with a small permanent magnet such as made by "ECLIPSE'. ●

Model Engineer 132 865 (1966)

A SPHERICAL TURNING TOOL

DESCRIBED BY J. A. RADFORD OF NEW ZEALAND

Ball Turning Tool.

Several spherical turning devices have been described over the years, most of them rotating the horizontal cutting tool about a vertical axis, thus requiring a considerable overhang of work beyond the chuck and restricting their operation somewhat. Radford's tangential tool operating about a horizontal axis is a refreshing change and works very well, with little overhang required. Materials for a slight variant on the Radford design are marketed by Hemingway.

As a complete different animal, Chaddock's form tool method can be recommended from personal experience. The professor described it as part of the method for making the Quorn Grinder in 1974 and an extract is produced to give an easy method of making ball handles in particular.

This spherical turning tool has several advantages over the more usual one that is bolted to the cross-slide of the lathe and usually uses a horizontal tool, generally adjustable in the toolholder to reduce the diameter turned.

It is fitted to the lathe with no more trouble than changing a tool. It will turn right down to the centre leaving no pip, if used with a half centre with the flat uppermost. It will turn to within half-an-inch of the chuck jaws. It will turn from 2 in. dia. to nothing with no difference in overhang of tool, indeed there is no overhang as the tool is end cutting and not subject to deflection or spring.

It is inherently accurate, simple to use and not difficult to make; materials to make it can generally be found in the scrap box.

Start by making the head part A. A piece of $2\frac{1}{2}$ in. b.m.s. shafting was parted off 1 in. full and faced off both ends. This was milled top and bottom to 2 in. length or it could be turned in the 4-jaw chuck. As I had a 60 deg. high speed cutter that I had made for another job, I used this for making the slideway after end milling to $1\frac{1}{8}$ in. wide x $\frac{5}{16}$ in. deep, the milling of the slideway being done in one cut. This could have been done by using a cutter only $\frac{3}{4}$ in. wide, in which case the slide piece B is milled first by bolting a piece on the vertical-slide and milling the two sides. This is then used as a gauge to mill the head A to fit to a fairly stiff push fit. No gib pieces are used as they are unnecessary if a good fit is made. In my case I had to mill part B afterwards which meant that I had to make and fit toolholder part C and also an additional piece of $\frac{5}{8}$ in. square steel at the other end and hold the two pieces in a vice and so mill the two angles faces (after a preliminary skim over the face) to fit the head. Make sure that the corners on the slide B are sufficiently removed to clear before fitting.

After head A is milled and slide B is milled to fit toolholder C, a piece of $\frac{5}{8}$ in. square b.m.s. $1\frac{3}{8}$ in. long is held in the 4-jaw chuck with the centre $\frac{3}{16}$ in. from one edge but on the centre line, it is drilled $\frac{11}{64}$ in. for a depth of $\frac{3}{4}$ in. only and is then turned in this position to 30 deg. setting on the top-slide to leave about $\frac{3}{64}$ in. of flat on the face. Do not drill right through at this stage. Reverse in the chuck, but pack out at front of one jaw and rear of the opposite jaw to tilt the piece about 5 deg. and central between the other two jaws. This is to give cutting clearance to the tool. Turn in this position to $\frac{1}{2}$ in. dia., leaving $\frac{13}{16}$ in. of the squared part and thread $\frac{1}{2}$ in. x 32 or 26.

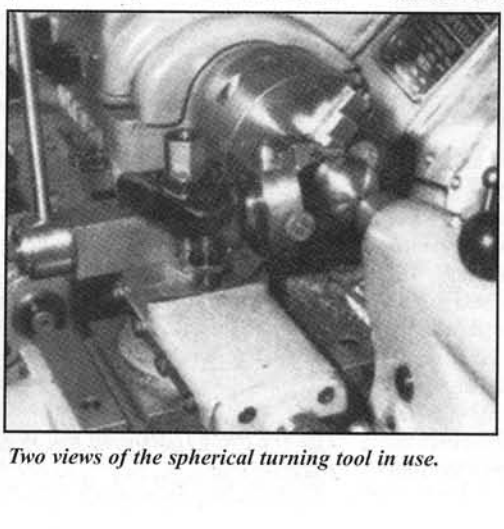
Going back to slide B, the other side is reduced in width to $\frac{3}{4}$ in. leaving $\frac{3}{8}$ in. to stand proud of the head recess. Drill and tap $\frac{1}{2}$ in. x 32 or 26 at a position $\frac{5}{16}$ in. centre from the top edge; a second hole could also be drilled and tapped at the bottom in the same position (as I did) which can be used for a concave turning tool. Now fit tightly part C to slide B, filing the face a little to bring the tool hole to the top and square. Before final fitting, clean thoroughly with petrol and flux with Easyflo on face and threads, then fit up and run Easyflo around the square face and thread.

Now set up head A and slide B together in a machine vice in the drilling machine, with the top face of both pieces flush and drill down in the centre, half in head and half in slide, right through $\frac{5}{16}$ in. Open out in stages to $\frac{1}{2}$ in. for a depth of nearly $\frac{5}{16}$ in. and finish with a flat bottom to the hole using a $\frac{1}{2}$ in. D bit to $\frac{5}{16}$ in. depth. Reverse the pair in the machine vice, again bringing square with a piece of $\frac{5}{16}$ in. rod in the hole and bringing the two faces flush, open out as before to $\frac{1}{2}$ in. and finish once again with a $\frac{1}{2}$ in. D bit, leaving $\frac{1}{4}$ in. undrilled in the slide part. The shoulder left in the head part will be very little, due to bringing the face flush each time. This shoulder should be removed with a round file in the head part only leaving half shoulder in the slide. This is to fit the lead screw.

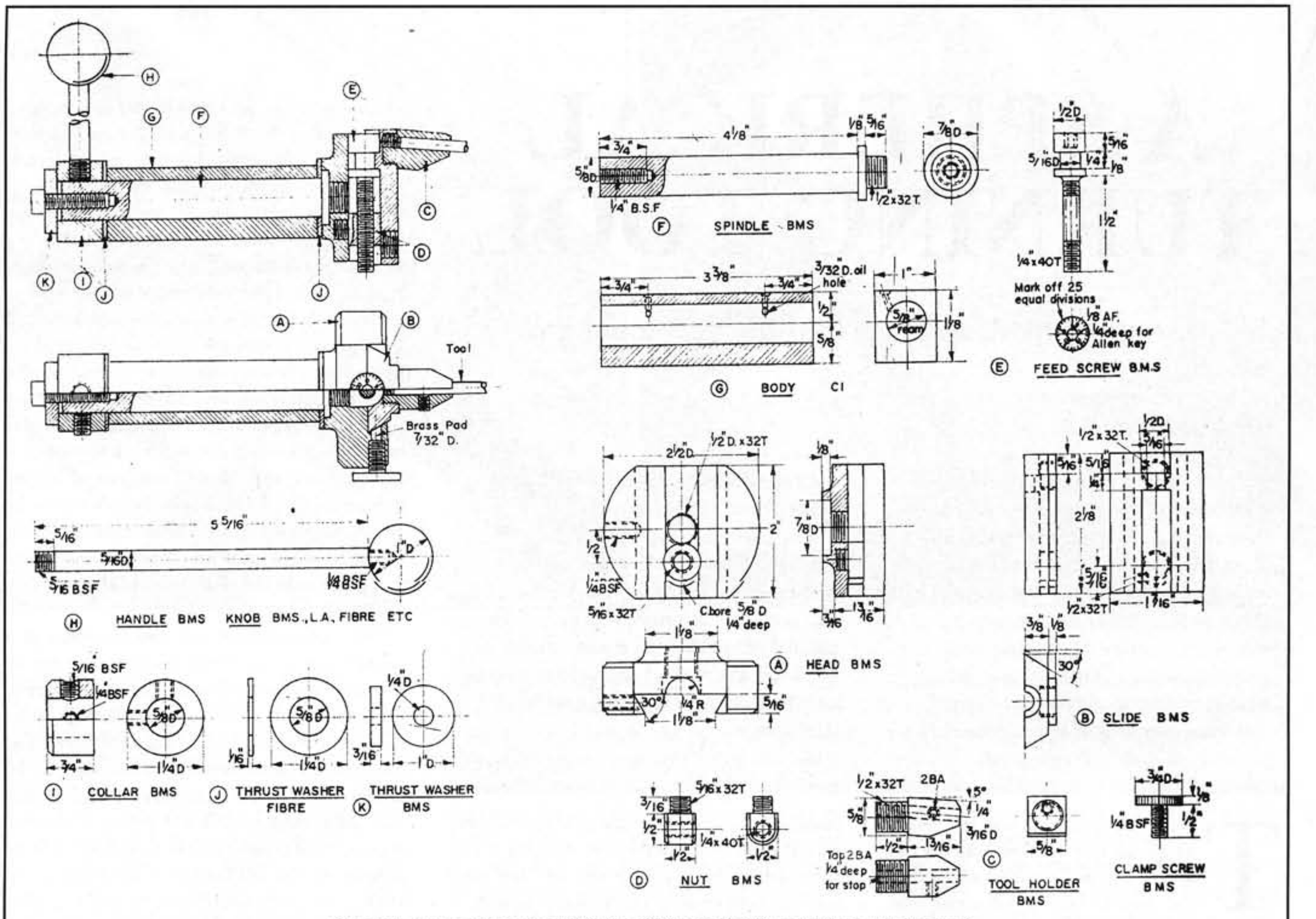
The lead screw could now be made in mild steel and to the dimensions shown to fit the slide. It is screw cut and threaded with dies to $\frac{1}{4}$ in. x 40 t. and graduations are made on the head (25) to indicate one thou per graduation.

Set up the head A in the 4-jaw chuck, milled face outward and $\frac{1}{2}$ in. off-centre vertically as drawing and turn a flat $\frac{11}{16}$ in. dia. to the depth of the bottom of the half round groove left by the $\frac{1}{2}$ in. drill. Drill and tap $\frac{5}{16}$ in. x 32 for a depth of $\frac{1}{4}$ in. This is for the lead screw nut which is made to fit from a piece of $\frac{1}{2}$ in. square b.m.s. The hole for the lead screw is best marked off and drilled with the slide and head in place in the drilling machine, marking off with a $\frac{5}{16}$ in. drill and then drilling $\frac{7}{32}$ in. and tapping $\frac{1}{4}$ in. x 40t. This will ensure that the thread is in line. The head is now replaced in the 4-jaw chuck, this time with the back outside, and run centrally. It is turned to $1\frac{1}{4}$ in. dia. for a depth of $\frac{3}{16}$ in. drilled and tapped $\frac{1}{2}$ in. x 32 or 26 and counterbored $1\frac{1}{8}$ in. dia. to a depth of $\frac{1}{8}$ in. for the shoulder of spindle, part F.

The main body part G should now be made. I used a piece of $1\frac{1}{2}$ in. round cast-iron milled or turned on four sides to $1\frac{1}{8}$ in. x 1 in. and $3\frac{1}{2}$ in.



Two views of the spherical turning tool in use.



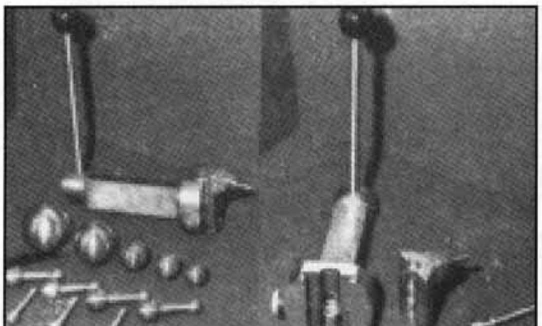
General arrangement and details of Mr Radford's spherical turning tool

long, but a simple pattern could be made to save this work. Leave a little on the bottom face for finishing truly flat. I hand scraped this face to the surface plate.

This piece of cast-iron (steel is not suitable) is now gripped in the toolholder parallel with the lathe bed, using in the barrel of the tailstock or a parallel bar to bring it truly parallel, the centre of the piece being brought central with the lathe centres. It is then centre drilled in place right through 1/4 in. dia. with the drill in the 3-jaw chuck and the cross-slide locked. I used a piece of wood between the tailstock and the piece for feeding as then there is no twisting motion. Finally it is drilled 9/16 in. dia. I forgot to mention that a boring bar made of a piece of 1/2 in. b.m.s. should be got ready first with a tool from a short piece of 1/8 in. round H.S.S. held with a 4 BA grub screw. This boring bar is now passed through to bring the hole in the main body to 5/8 in. dia. Before removing from the lathe, face off the reverse end also to bring the length to 3 3/8 in. A couple of oil holes are drilled and countersunk as shown.

The spindle part F is turned from 7/8 in. b.m.s. 4 7/8 in. long and is made a nice sliding fit in the body G; then it is screw cut 1/2 in. to fit the thread in the head A. The other end is tapped 1/4 in. BSF for the thrust screw, which is adjusted to give a stiff movement to the spindle. This spindle is now silver soldered into the head and the Easyflo should run nicely around the 7/8 in. dia. shoulder to make secure. Face this shoulder after brazing.

The toolholder C can now be finished off. The 11/64 in. hole is carried right through and reamed 3/16 in. to fit a piece 3/16 round H.S.S. An Allen screw is fitted in the end of this hole to form a stop for the tool and a 2BA Allen



The finished tool together with some of the work preduced

screw is fitted in the side bearing on a small flat ground on the tool. The tool is ground to 10 deg. on *the end only* to give a 5 deg. top rake to the tool, and should not be touched on any other face. The tool is approximately 1 1/4 in. long. A knurled screw 3/4 in. dia. on the head and 1/4 in. BSF thread is made and fitted into the side of the head as shown, this bears against a 1/4 in. piece of 7/32 in. brass rod angled to 30 deg. to clamp the slide during cutting.

Two fibre washers are made from 1/16 in. sheet, 1 1/4 in. dia. and 5/8 in. bore to act as Thrust collar part I and thrust washer part K are simple turning jobs. Make the thrust colar I a good push fit on the spindle and the 1/4 in. Allen grub-screw should have the point flattened off. At right-angles, the 5/16 in. BSF hole is tapped for the handle which is a 5 5/16 in. piece of 5/16 in. b.m.s. rod. The handle can be your first turning job using the tool and can be turned in place on its own rod.

By fitting another tool holder in the bottom hole of the slide B and pointing the tool downwards, concave faces can be turned, and using the tool on a vertical-slide insteaad of the toolpost, handles and hand wheels can be made.

In use, the tool edge is brought to the centre position and the cross-slide is locked. I use a halfcentre in the tailstock with the flat uppermost and I usually rough turn away the corners of the piece beforehand. The feed screw has a 1/8 in. hexagon hole about 1/4 in. deep, drilled

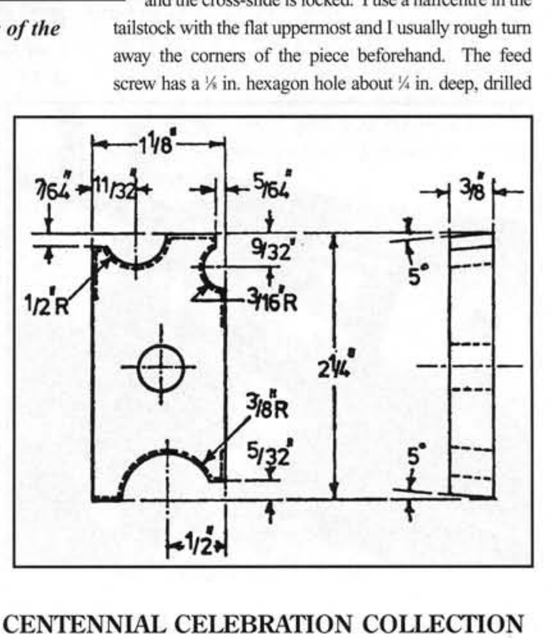


Fig. A: FORM TOOL 1 off tool steel H&T

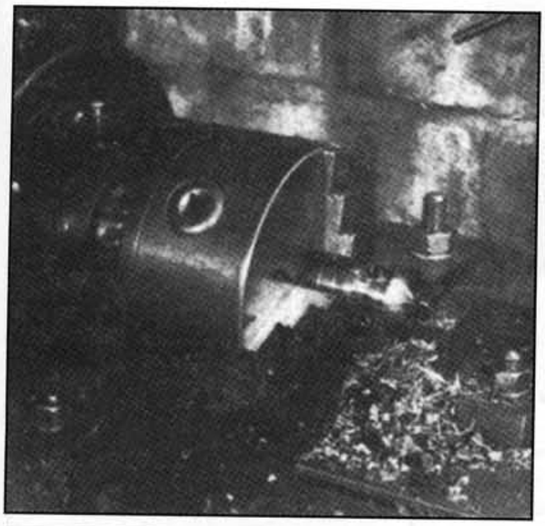
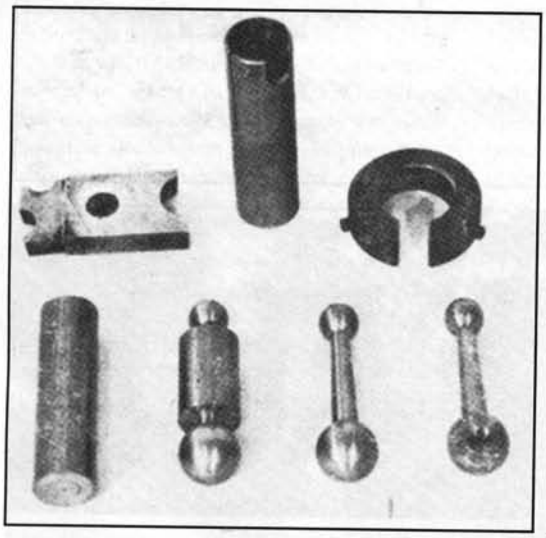


Fig: B. form turning a 3/4 in. dia ball in a single operation.



all handles in various stages of machining, with the tools used to produce them.

⅛ in. and punched with a short piece of Allen key rod, for feeding, and after a preliminary touch over the high spots, a 25 thou cut or one turn is the usual feed. The slide is locked for each cut.

For turning diameters greater than 2 in. using the vertical-slide, an especially angled tool could be made and the feed made not on the centre line of the lathe but in front of it. I have not tried this but it should work out all right.

The five steel balls illustrated are 1¾ in., 1½ in., ⅞ in. and ¾ in. dia., all in free cutting mild steel, turned at speeds of 425 for the two larger ones and 615 for the others. Machining time is between one half and one minute each. No tools marks were left on the work and the only finishing was a quick rub over with a bit of 220 "wet and dry" paper.

The four small clamps handles are only 1½ in. centres and the ends are ¾ in. and ½ in. dia. turned from a piece of ¾ in. b.m.s.; the other three little handles are ½ in. and are for a star wheel for an ejector for the rack feed tailstock.

Now there follows a completely different approach by Professor Chaddock, published in 1974 in his series on the Quorn Tool & Cutter Grinder.

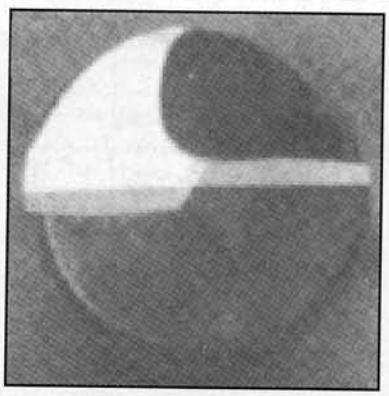
Although a number of spherical turning attachments have, from time to time, been described in Model Engineer and of them that described by Mr. Radford is in the writer's opinion far and away the best, they do present clearance problems if, as in the present case, over 80 per cent of the periphery of the ball is to be machined at a single setting. The writer therefore decided to make the form tool shown in Fig. A which would not only form the complete ball in a single operation but would also leave a shank of the right diameter which would serve as a witness for the final turning operation. By a miracle of foresight in design only three sizes of form tool are needed because the small balls on the large handles are the same size as the large balls on the small handles! In fact all three are incorporated in a single tool made from an old flat file softened and then machined to shape. Since the work produced by a form tool can be no better than the tool itself the various radii are best produced by internal turning with the work clamped off centre on the lathe faceplate. This not only ensures that they are of good shape but by setting the top-slide over to an angle of 5 deg. gives accurate control over the clearance angle. The clearance angles on the flat faces are most accurately put in by milling.

After hardening and tempering to a light straw colour, the tool is used upside down on the back toolpost as in Fig. B. This may appear to be a rather formidable operation and although one can start with the lathe in open gear, as the width of cut increases it is necessary to "change down" finishing in low back gear in order to provide the torque necessary to sutain a cut over 1 in. wide. In Fig. B the witness mark of the original bar diameter is just about to disappear – when it has gone the ball is sized and the cut is stopped. The work needs to be very firmly held in the chuck; close examination of Fig. B will show that it has, in fact, slipped, but this is no matter because this part of the blank will be completely turned away in a subsequent operation. ●

Model Engineer __134__ 968 (1968) __140__ 486 (1974)

The end of boring problem Sharpening small drills

D. A. G. Brown was impressed with the effectivenes of four-facet drill sharpening, developed an ingenious unit for reconditioning tiny drills and commences his description of its construction.



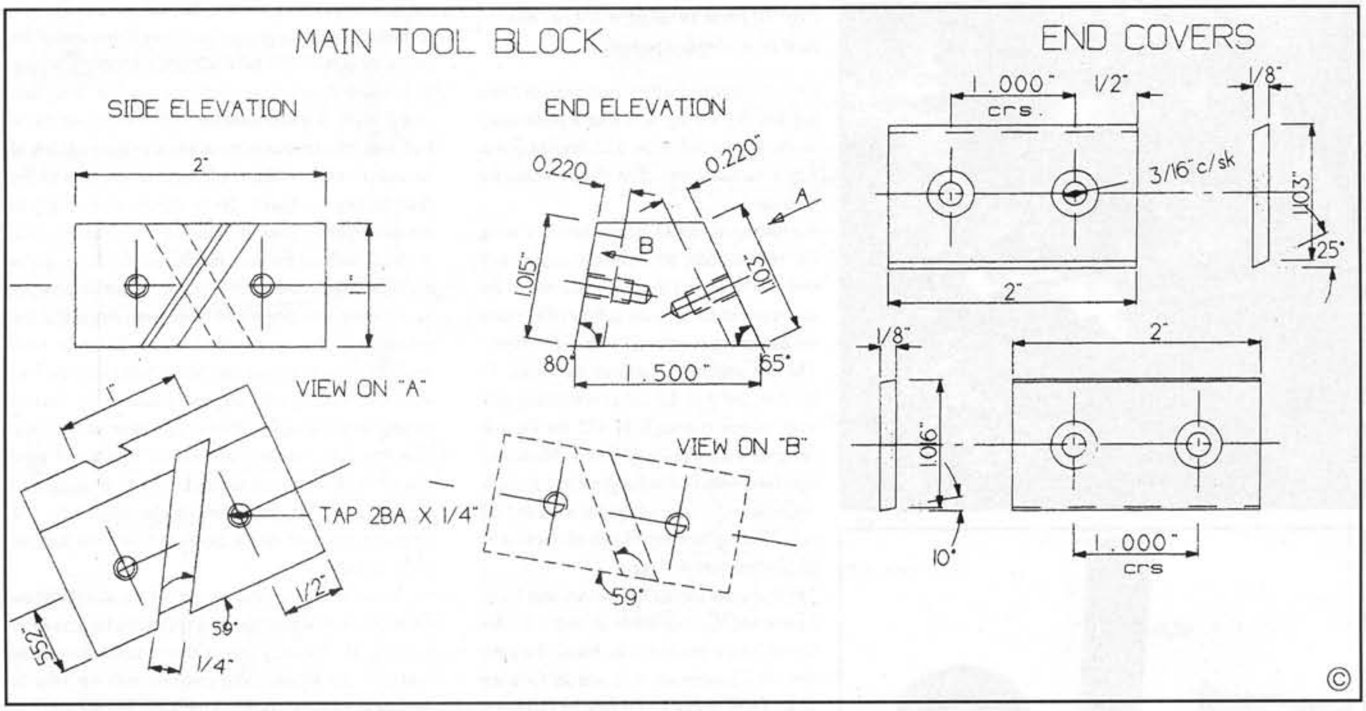
End view of a drill ground by the 4-facet method.

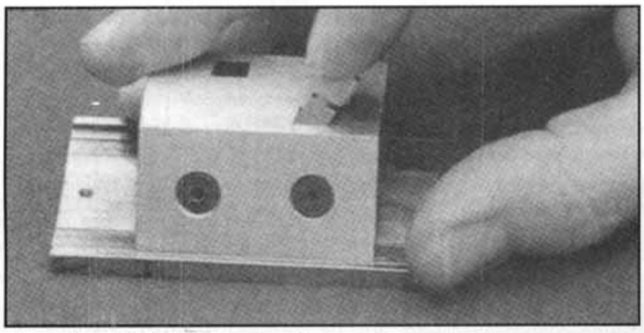
<u>Sharpening Small Drills.</u>

"Well you would put this one in, wouldn't you" I hear you say. Seriously, the ability to recondition tiny drills soon pays for the time spent making the device. Several hundreds have been made and used successfully.

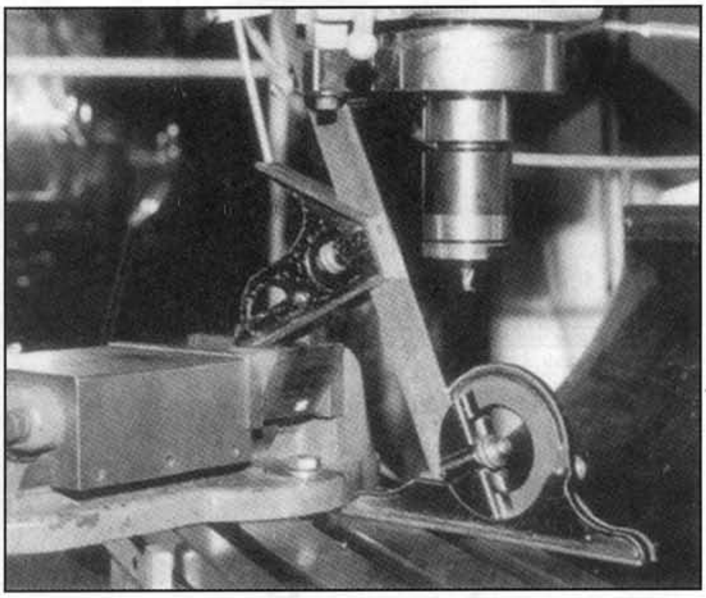
It was nearly 20 years ago that I first saw Professor Chaddock's demonstration of drill sharpening on the Quorn cutter grinder, using the 4-facet method. Since that time I have used the method for sharpening my own stock of drills and have appreciated its ability to start a hole without prompting from a centre-hole.

To recapitulate on the method, let me explain where it differs from the traditional method to be

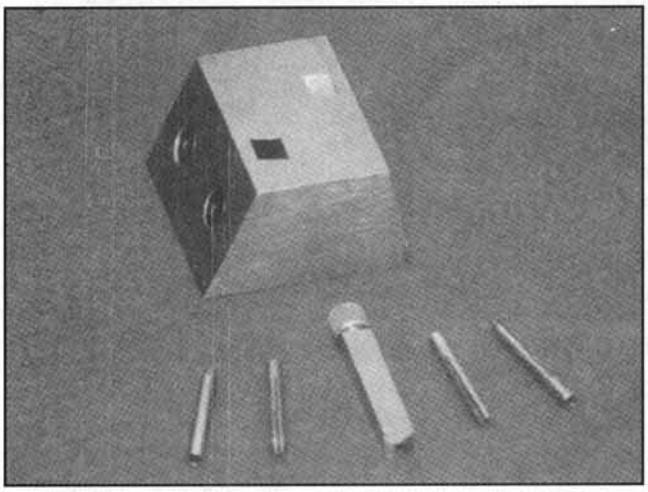




Operation of drill sharpening jig on a diamond pad.



Above: Set-up to machine the main tool block: note how the vice is set over at 31 deg. and the protractor at 80 or 65 deg. to align the top of the tool block.



Left: Components of the drill sharpening jig: note the 4 collet sizes.

found on commercially produced items. Fig. 1 is a photograph of the end of a large drill, re-sharpened by the 4-facet method; the primary cutting angle can be described as the angle seen by the material as the drill approaches it. It is analogous to the front clearance angle on a lathe tool and has a value depending on the material being cut, but 10 deg. is found to give a satisfactory performance for most purposes. If that angle were continued right across the face of the drill, it would not cut at all, since the angle falls away from the high point at the centre of the drill to point on the circumference at the trailing end of the helix, which would then be above the level of the cutting edge at the cricumference.

In order to achieve the necessary clearance, a backing-off angle of at least 25 deg. is required. A 25 deg. flat, rather than a continously varying curve, results in a set of 4 facets which come together at a point in the dead centre of the drill, a useful attribute which provides the drill with the ability to locate properly. It will be noted that the edges dividing the facets form a straight line precisely across the centre-line of the drill. This is the hall-mark of the method; in sharpening drills, failure to achieve correct alignment with the drill edges inmediately alerts the operator to an error in the set-up which can then be easily corrected.

Very small drills

The Quorn grinder does a good job until one comes to the smaller sizes of drill, say smaller than 3/32 inch. *The present jig enables simple reconditioning of drills from this size right down to No. 80*, by using an abrasive surface of an oil-stone or diamond pad, rather than a grinding wheel. I settled for 10 and 25 deg. as the relevant clearance angles and for 118 deg. as the included point angle, as normal commercial practice. It will become apparent during the development of the method that the case for a diamond sharpening block becomes overwhelming, especially for the smallest sizes of drill; but read on, such a piece of kit need not frighten the average model engineer on account of price!

Construction details

Making the tool is quite a straightfoward job, the only tricky components being the collets which grip the drills during sharpening. The assembly is shown in fig. 2 and the component parts in fig. 3.

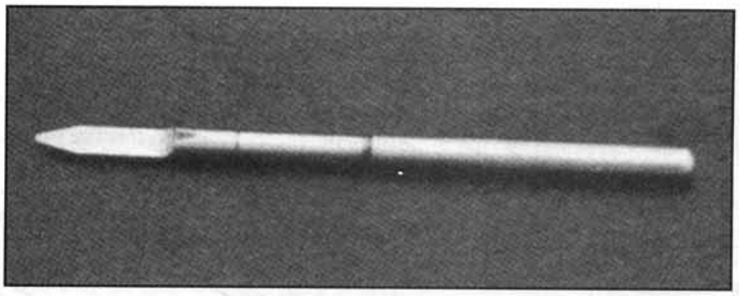
Start with the main tool block. This is machined from a piece of 1½ x 1 in. mild steel, 2 in. long. Face both ends to finished length and hold by the ends in a machine vice as shown in fig. 4. The photograph shows that the vice is set over at 31 deg. to impart the correct tool tip angle to the job. Starting with the face at 80 deg. to the base of the block, this is achieved by inclining the block by 10 deg. in the vice jaws against a protractor, so that an end-mill removes more metal form one edge than the other. Having faced this side of the job, do not remove it from the vice but change the cutter for a ¼ in. dia. slot-drill or end-mill and mill a slot exactly 0.220 in. deep through the middle of the block. Its position is not critical, although it should pass near the centre-line of the block. Changing the tool for a drill chuck, the 2BA tapped holes can now be put into the machine face, in the knowledge that they will be truly normal to the surface. All these operations can now be repeated on the other face, except that the angle at which the block is inclined is increased to 25 deg.

Caution! It is very easy to incline either the vice or the steel block at an angle which is the reverse of that illustrated. This results in the manufacture of a left hand drill jig!

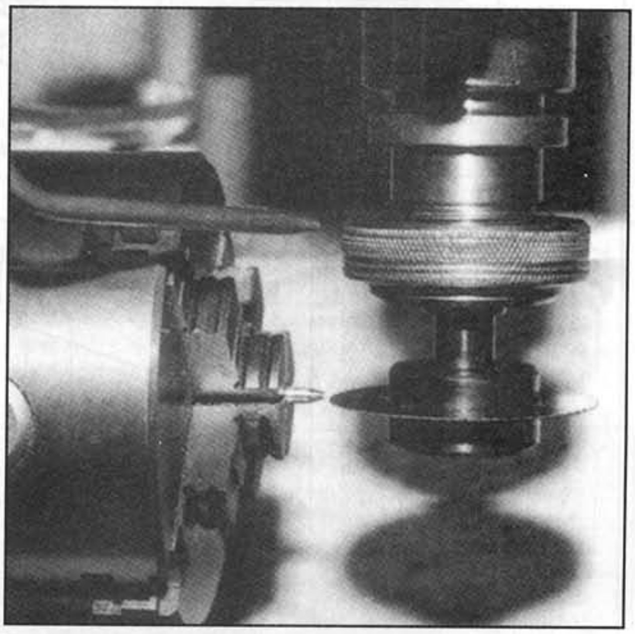
The end covers are a simple job. I cut these oversize, finishing them at the required angles after bolting up; the precise heights are given to assist anyone who wishes to machine to finished height before assembly; otherwise these figures may be ignored.

Holding the drill

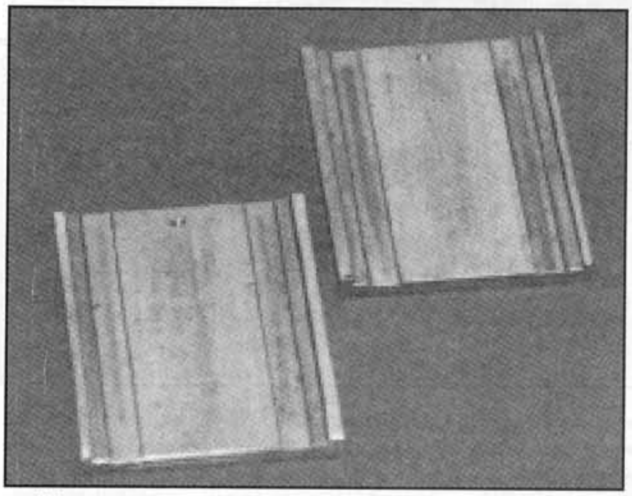
The drill holder is machined from ¼ in. square mild steel bar. Its rectangular form ensures that it cannot be misaligned. Arrange the material to run true in your 4-jaw chuck, allowing almost 1¾ in. to protrude from the jaws. Drill No. 26 x 1¼ in. deep, deepening the hole with a No. 42 drill for a further 5/16 inch. The 30 deg. included angle is reamed using a silver steel D-bit hardened and tempered to pale straw having first been made to the dimensions given in the drawing and shown in fig. 5. After tapping 2BA to 3/8 in. deep, transfer the piece in the chuck to the dividing head or rotary table and machine equal amounts from two opposite faces to leave the bar 0.219 in. thick in one direction; the objective here is for the drill holder to make a shake-free fit in the rectangular hole in the tool block. Part off and shorten the No. 42 end of the holder until the parallel section of the hole almost disappears. Finally, file the end of the holder to conform to the shape of the bottom of the tool block, so that no sharp edges are present and the end of the No. 42 hole sits as close to the bottom plane of the block as possible.



D-bit reamer for the end of the drill holder.



Set-up for slitting the end collets: the slitting saw enters the gap between the chuck draws.



Prototype diamond pads after sharpening many dozens of drills.

No comment is necessary on making the clamp screw, save to say that it is made from brass to ensure that it slips easily against the end of the collet without seizing when it is tightened.

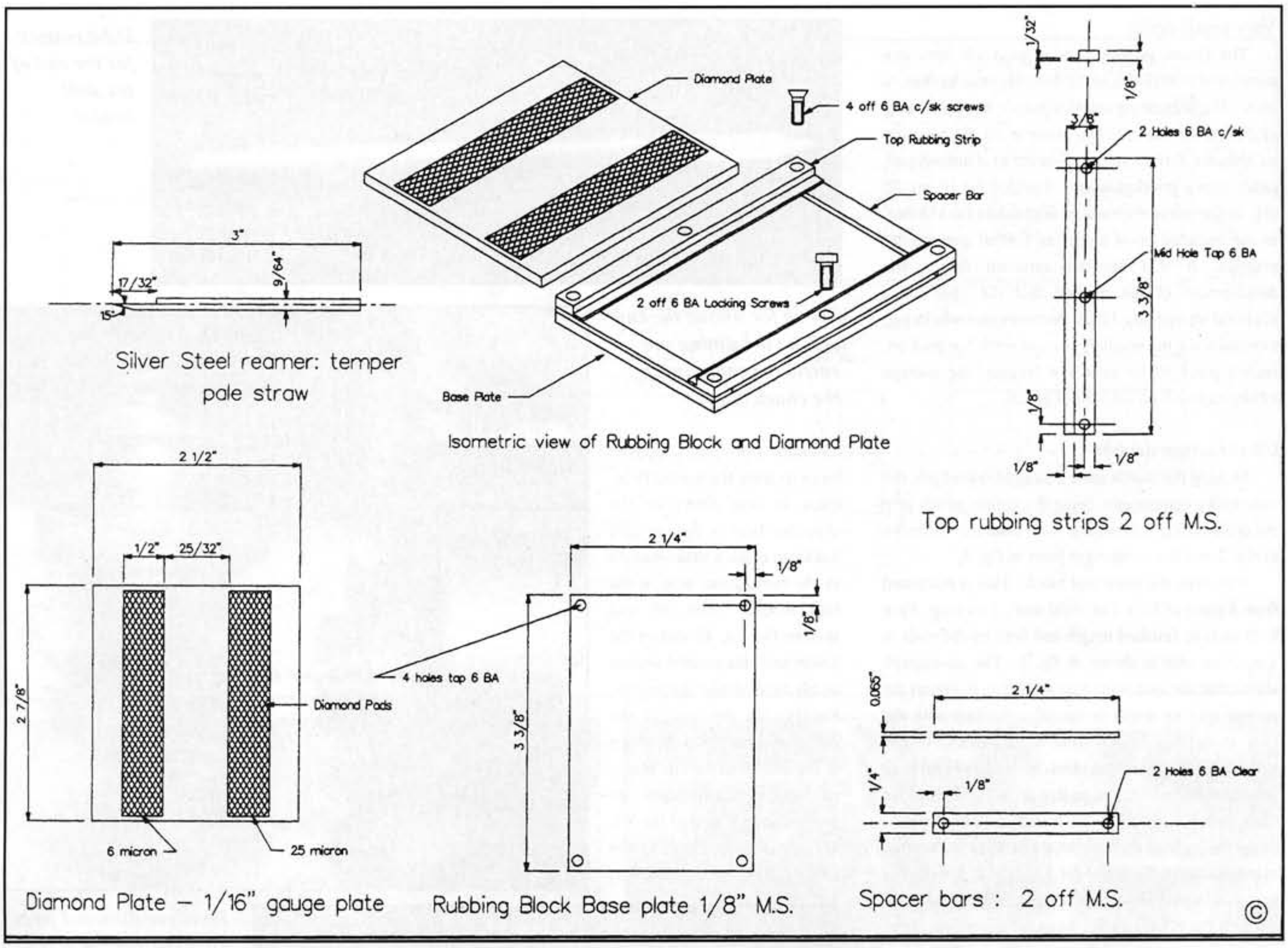
Collets

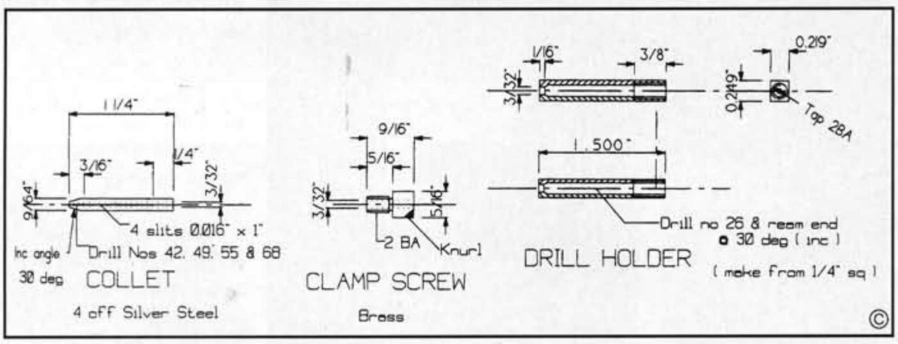
Turning now to the collets, a set of 4 is required to cope with the range of drills from Nos. 42 to 80. If you can obtain some 9/64 silver steel, set it in a 4-jaw to run true; otherwise it is necessary to reduce some larger stock, using a very sharp tool. Do not worry if you finish up with the outer end of the material 0.002 in. bigger than at the chuck end due to spring in the job, so long as it will clear the bore of the No. 26 hole in the drill holder. A slightly small diameter collet nose could be an advantage. With the stock running true, drill 3/32 in. x 11/16 in. deep to form a hole up to the back side of the gripping part of the collet, but do not drill the business end. Next part off to length and reverse in the chuck, once more setting it to run true, but with 3/8 in. protruding from the chuck jaws. Centre drill through with the appropiate size drill (4 required), as shown in the accompanying table.

Drill size range	*Drill through*	
(numbers)	(Nos)	(mm)
42 - 48	42	2.4
49 - 54	49	1.9
55 - 67	55	1.4
68 - 80	68	0.9

Finish the collet profile by setting over the top-slide to 15 deg. and turning the end until the face of the collet almost disappears.

Transfer the chuck to the dividing head and rotate the mandrel until the chuck jaws are at 45 deg. to the





milling machine table; there should now be enough daylight between the chuck jaws to enable a fine slitting-saw to pass between them, see fig. 6. If the chuck jaws are blunt ended to the extent that they come too close together then it may be necessary to sleeve the embryo collet before setting it to run true to within 0.0005 inch. Mount a 1/64 in. slitting-saw in the machine spindle and set it to just touch the top of the collet blank; next, move the spindle down or the table up by an amoun equal to half the sum of saw thickness + collet diameter. Run the saw slowly and gently plunge it into the end of the collet, feeding no more than 3/16 in. into the job. Index the dividing head by 90 deg. and repeat the performance, this time cutting to twice the depth. Rotate by 90 deg. once more and go to the previous depth. Any attempt to gain the full 1 in. depth with so flimsy a component will probably lead to an expensive demonstration of metal destruction, so having established the correct slot shape in the area of the collet where it matters, it is probably best to finish the slots with a fine piercing saw by hand, although forming perfect slots by such means is not all easy.

Trial run

Having completed the jig components, it is now possible to test the assembly on a drill. Originally, I tried it out on a smooth oil-stone with a fair degree of success in the larger drill sizes. First, select the corrrect size of collet, lightly clamp the drill in the drill holder with about 1/8 in. protruding (less for the smaller drills). Rotate the drill so that the two cutting edges are parallel (set by eye) with the 0.249 in. faces of the drill holder. For the smaller drills I found a x20 eyeglass to be an invaluable aid. Tighten the clamp screw, insert the assembly into the main tool block and away you go! Gently rub the whole unit across the surface of a well oiled stone, turning the holder 180 deg. every few strokes. Start by forming the 25 deg. backing-off clearance facet and remove metal right across the face of the drill until the two facets look perfect and equal. Transfer the holder to the 10 deg. slot in the tool block and apply a very few strokes to form the cutting edge, finishing with the break line between the facets straight through the centre-line of the drill, as recalled in fig. 1.

Improvements with diamonds

Now for a remarkable revelation. Small drills quickly plough furrows in oil-stones, ruining the latter for other fine work. Even Arkansas stones, despite their hard, fine nature, suffer damage and are slow in removing metal. Exhaustive tests with diamond plated surfaces have proved the most remarkable properties for this material, in terms both of its longevity and the truly outstanding finish imparted to the job. Industrial diamonds, carefully graded for size, are electro-plated in nickel onto a steel surface, previously relieved to give clearance for the rest of the tool thereby avoiding unwanted surfaces coming into contact with the diamond abrasive surface which is readily blinded by mild steel. The original diamond blocks used in this development work are shown in fig. 7. Side cheeks guide the tool block in a straight line over the diamond surfaces and the drill always follows the same path across the block. It must be admitted that the original very fine diamond surface used was very slow in removing metal and has suffered a very small amount of damage due to abuse in operation (too high an applied pressure). It is however, still serviceable after sharpening many dozens of drills. Further work has centred on establishing the optimum grade of diamond and altering the wear surface in order to extend its life almost indefinitely.

The drawing of the rubbing block shows that two ½ in. wide diamond surfaces are available which can be moved and locked under the path of the drill to give eight or so renewable lives of diamond surfacce. These will be plated respectively with fine and coarse diamond particles and will be available as a standard item from a trade supply. Making the block needs no explanation, save to comment that the tool block should slide very easily inside the cheeks of the rubbing block. The components are held together by four 6BA csk screws; the two centre holes in the top rubbing strips are for clamping the diamond plate in place.

Remember that the enemies of diamond tools are impact, very high local pressures and use on soft materials. Keep the jig for sharpening high speed steel drills only; apply oil to the cutting surface to float away the swarf thereby avoiding blinding the abrasive surface, and have some paper tissues handy to clean the drill surface for inspection. The use of paper tissue is kinder than using your pocket handkerchief!

The best grades of diamond for this work seem to be 25 micron for roughing work and 6 micron for the fine side and for all work on drills smaller than No. 70. The coarse diamond is capable of reclaiming a broken No. 42 drill in 30 to 40 strokes per cutting edge, so be warned of the very quick metal removal rate!

In developing the device to this stage I have had discussions with the diamond tool supplier, Clifford Northifeld Ltd, West End House, West Street, Geddington, Kettering, Northamptonshire NN14 1BD (Tel 01536 744041) and have agreed with them the dimensions of the diamond block made from 1/16 in. gauge plate. Their price, including U.K. postage and VAT is £12.50. They can also supply x 20 eyepiece magnifiers in an order for diamond plates at an extra £17.00 inclusive. ●

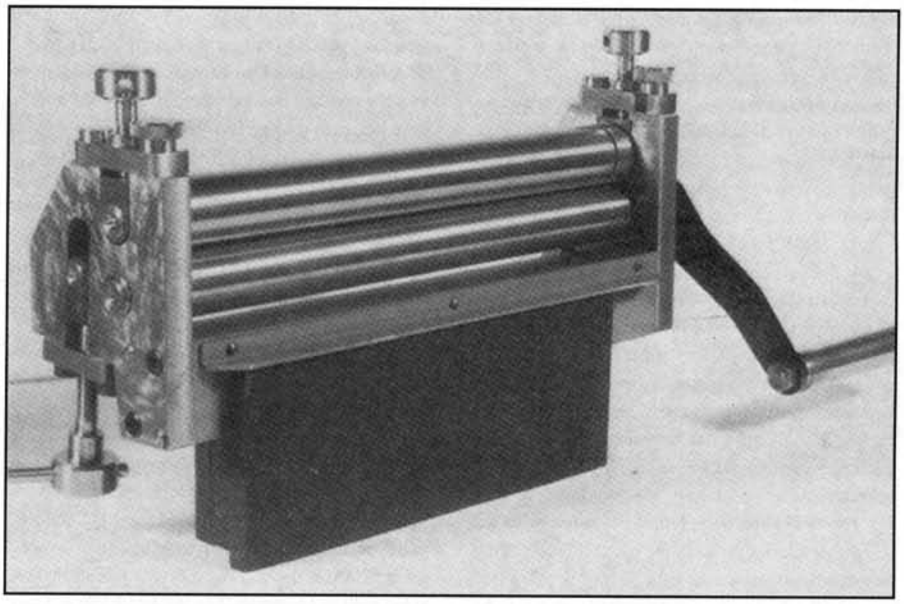
Model Engineer 172 36 (1994)

WORKSHOP BENDING ROLLS

by George H.Thomas

Bending Rolls.

Accurate rolling of sheet metal makes life so much easier. This design stands head and shoulders above the rest for two reasons: firstly the double roll nip bends the metal exactly up to its end, if desired and secondly the four gear drive between rolls maintains depth of engagement as the roll gap varies, thus preserving a smooth transmission of effort, without producing corrugations in the metal. Do not be put off by the relatively short length of roll (10 in.). Lengthening the rolls would seriously affect rigidity.



Front view of the completed rolls

Two or three years ago, after having tried my hand at bending sheet-metal around beer bottles and pickle jars, I decided that the time had come to make a proper tool for the job. I knew several people who had made sets of rolls of the "pyramid" type in which the material is carried on a pair of rollers, front and rear, which are geared together so as to turn in the same direction and the desired curvature is obtained by pressing a third roller down into the gap between the other two.

Whilst it could be claimed that rolls of this form are simple to make, they do possess some serious drawbacks in operation, the worst of which is that the starting and finishing ends will be left straight and have to be hand-worked afterwards—or cut off—due allowance being made for this when planning the work. The action of these rolls will, I hope, be made clear in Fig. 1(A) where the piece of material is acting as a beam freely supported at the ends and having a load applied at the centre. Under these conditions, the maximum bending moment, and stress, will occur at the centre and when the stress exceeds the yield point of the material permanent deformation will occur at this point. Bending will take place progressively along the material as it passes under the central roller until the end slips over the supporting roller. It will be clear that, for a distance equal to approximately one half of the span of the supporting rollers, at each end, the material has not been subjected to the maximum bending stress and these ends will, therefore, remain comparatively straight.

After considering a number of possible (and impossible) arrangements it was decided to go ahead with the system shown in Fig. 1B & C. Here, the material is gripped by screw-pressure between a pair of rollers and driven forwards on to a deflecting roller at the back. The material is no longer a freely supported beam with the load at the centre but a cantilever with the load at the end, the anchorage of the cantilever being represented by the powerful grip of the pair of rollers and maximum stress will occur at this point. Thus far conditions are somewhat similar to those of the previous case but as the work is fed through the rolls, bending will occur progressively right along until the end passes out through the rollers so that, although the front end will be left straight as before, the, curvature, when it starts, will continue right up to the other end. Now, if the material, after passing through once, is reversed end-for-end, the short straight portion will now be the last to pass through the gripping rollers and it will be curved in a similar manner to the rest.

Another trouble experienced with the "pyramid" type of rolls which has been reported from several users is that the material being worked upon will frequently refuse to travel forward, the supporting

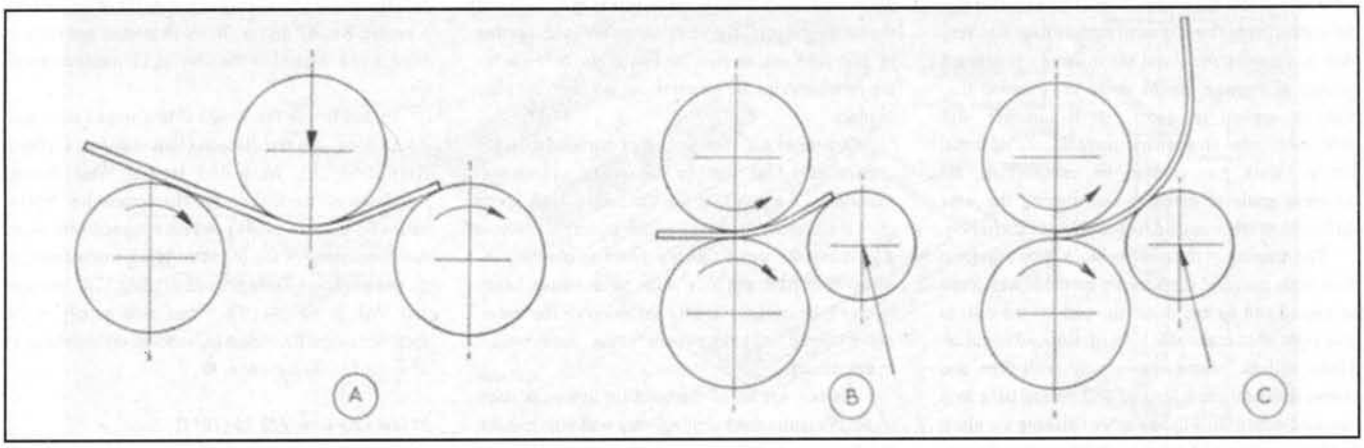


Fig. 1

rollers merely skidding on the underside. It is possible to increase the friction between the driving rollers and the material only by increasing the pressure on the deflecting roller which, in turn, increases the resistance to movement. As I have not used this type of rolls myself, I cannot say what gives rise to this slipping condition; it might be brought about by an attempt to do too much bending at one pass or by screwing down the deflecting roller when the material is already in position underneath. The "pinch" rollers do not suffer from this disability as the pressure required for driving the work forward can be adjusted independently of the resistance of the deflecting roller.

For the type of work which I contemplated,. which did not include rolling large boiler barrels, a capacity of 10in. width was considered ample and, at this span, pinching rollers of 1⅛ in. dia., looked quite sturdy. As the loads on the deflecting roller would be considerably less than those on the pinch rollers, this was reduced in diameter to ¾ in., bearing in mind that the smaller this roller can be made the more closely can it approach the work emerging from the pinching rollers.

The final point to be settled was whether or not to provide gearing between the pinch rollers. Owing to the amount of rise and fall of the upper roller, equal to the thickness of the heaviest material to be worked, in relation to the roller diameter, an ordinary pair of gears was out of the question; the simplest alternative seemed to be a train of four gears between the two rollers. With a pair of rollers geared together each of them will, by friction, apply an equal driving force to the material, the amount of which will depend, among other things, upon the pressure applied by the rollers. If the gearing be disconnected, the lower roller will apply its quota of driving force but the upper roller will now be merely a follower and contribute nothing. Moreover, as the bearings of the upper roller are carrying the full pressure load between the rollers there will be a resistance to rotation of the upper roller which must be subtracted from the frictional force applied through the lower roller so that the nett forward driving force will be less than one half probably 35 - 40%—when compared with geared rollers. However, in view of the fact that considerable pressure could be applied through the screws (and also that I wanted to make the rolls that week!) it was felt that it would probably be safe to go ahead without gearing and, in use, to apply such pressure as was necessary for the job in hand. On this basis I went ahead with construction and four days later I was able to confirm that some, at least, of the guesses had come out right. There are occasions, which I shall mention later, when it might be desirable or essential to work with the smallest possible pressure between the pinching rolls and in these instances gearing is called for.

Construction

The constructional features are shown in the G.A. Fig. 2, on which the upper position of the bending roll and of its jacking screw are indicated in dotted lines. The view in the lower left hand corner shows how the latches can be swung aside for the purpose of lifting out the top roller. This G.A. should appear full-size so that any details not drawn separately can be scaled off.

The main frame consists of a bar of BMS, 1 x 1½ x 10³⁄16 in. long with its ends brought square and parallel. The two end plates of ½ in. thick BMS 3 x 4 in. should have their reference edges, front and top, milled square after dowelling together at two corners, using ⁵⁄32 in. dia. dowels. These two dowels are shown, at top right and bottom left on the detail, Fig. 3. Mark out in accordance with the detail drawing. The line of the slot for the rear roller is at about 9 deg. to the vertical and the easiest way to mark this out is to carry a line from the 1¹¹⁄16 in. dim. from the front (which is the centre of the latch pivot screw) to form a tangent to a ³¹⁄32 in. radius struck from the centre of the lower roller.

Mount the pair on the faceplate and bore the three holes, one for the lower roller (⅝ in. ream) and the other two being the ends of the slots. Now cut away the unwanted metal at bottom right and saw out the slots but leave, for the time being, the top corner which carries a dowel. The sawing was done quickly and accurately on my bandsaw which is a Myford ML8 woodworking bandsaw borrowed (permanently) from my woodwork shop and mounted up with a worm reduction gear bought on the surplus market from one of our advertisers. While still together, clean out the slots to dimensions with an end-mill and mill the sawn edges.

The next job is to attach the two endplates to the main bar in correct alignment and the simplest way to tackle this job is probably as follows:

First mark out for the screws and dowels (one dowel already existing u/s), and also for a hole in the centre of the group as indicated on the detail drawing. Drill through both plates No. 4 (1 in. BSF tapping) for the screws and No.14 for the dowel. The central hole can be drilled a good clearance for 2BA. Mark out for a hole at each end of the bar to correspond with this central hole in the plates; drill No. 22 and tap 2BA. The end plates can now be attached,. accurately lined up and securely clamped to the bar using a 2BA socket screw and washer. It is now possible to transfer the No.4 and No.14 holes through the plates into the bar. Ream the dowel holes (the original ⁵⁄32 in. hole will now have been opened up) ³⁄16 in. before taking apart to open the screw holes in the plates to letter 'F' and counter-boring for the heads—don't forget that these counterbores hand the plates.

The rollers require to be carefully made; they must be parallel and straight but, even more important, the end bearings must be truly concentric with the body of the roll. Mine were turned between centres from 1¼ in. bar, the rolls finishing a trifle under the nominal dimension, but I would strongly recommend, especially for those whose lathes are not quite up to scratch, that they be made from 1⅛ in. precision ground bar. Unless you know of a better one, use the following procedure: After cutting to length, hold the material for about ¾ in. in an accurate self-centring chuck (if it doesn't live up to its name, use a four-jaw) and get the far end running true to indicator. Support this end in a three point steady, pushing the fingers in very gently so as not to disturb the position of the bar. Check again with the "clock", there should be no movement whatever; if there is movement the fingers are not all in contact with the bar. Face the end; put a suitable centre-drill in the tailstock chuck with its two cutting edges in a horizontal plane, i.e. one towards the operator and one towards the back. Put a piece of plain bar or any blunt instrument in the toolpost; start the centre drill into the end of the bar and then bring up the blunt ended "tool" and cause it to bear with slight pressure on the centre-drill whilst it is being fed in. Ease off

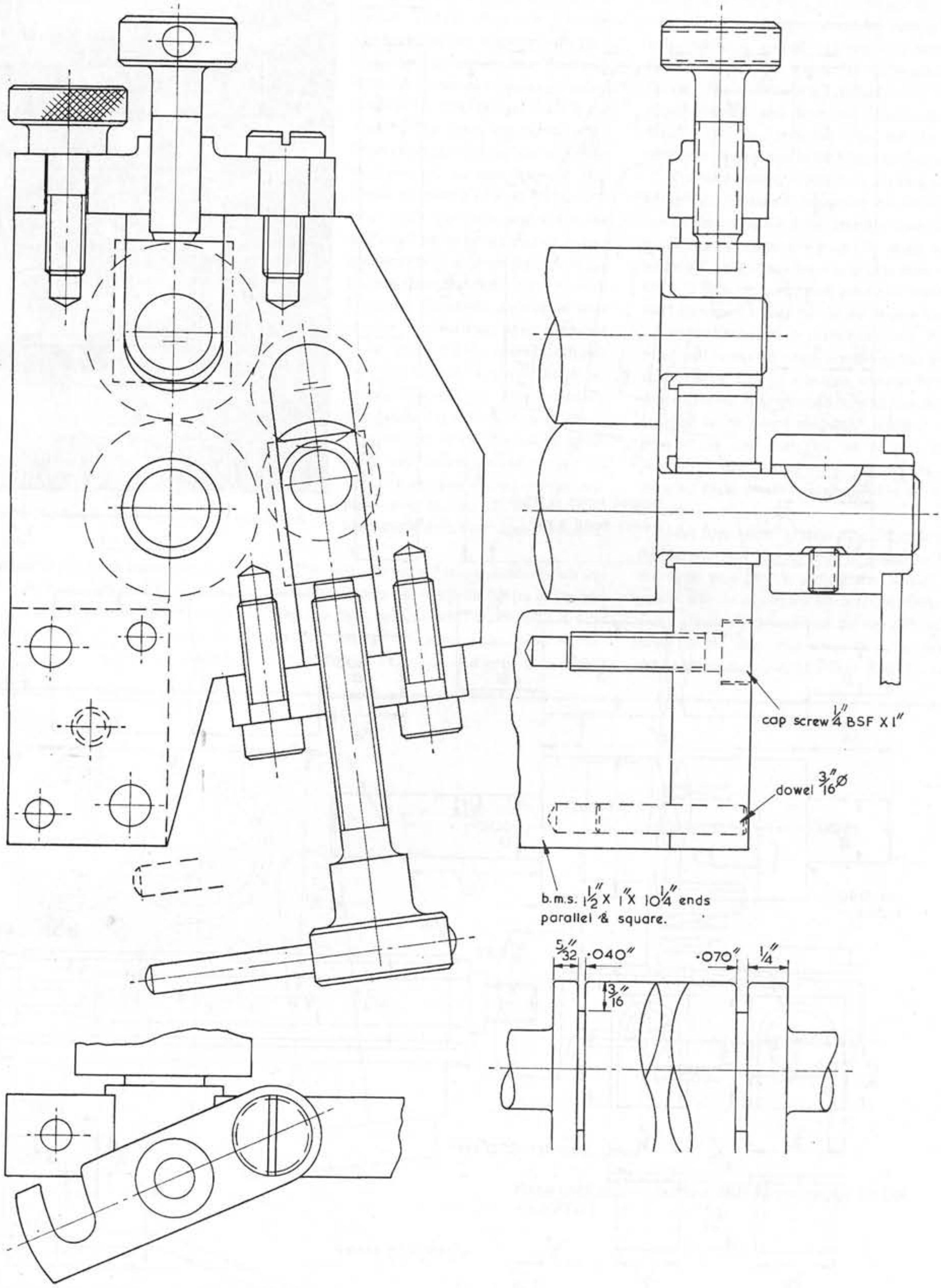

cap screw 1/4" BSF X 1"
dowel 3/16" Ø
b.m.s. 1 1/2" X 1" X 10 1/4" ends
parallel & square.
5/32"
·040"
·070"
1/4"
3/16"

Fig.2

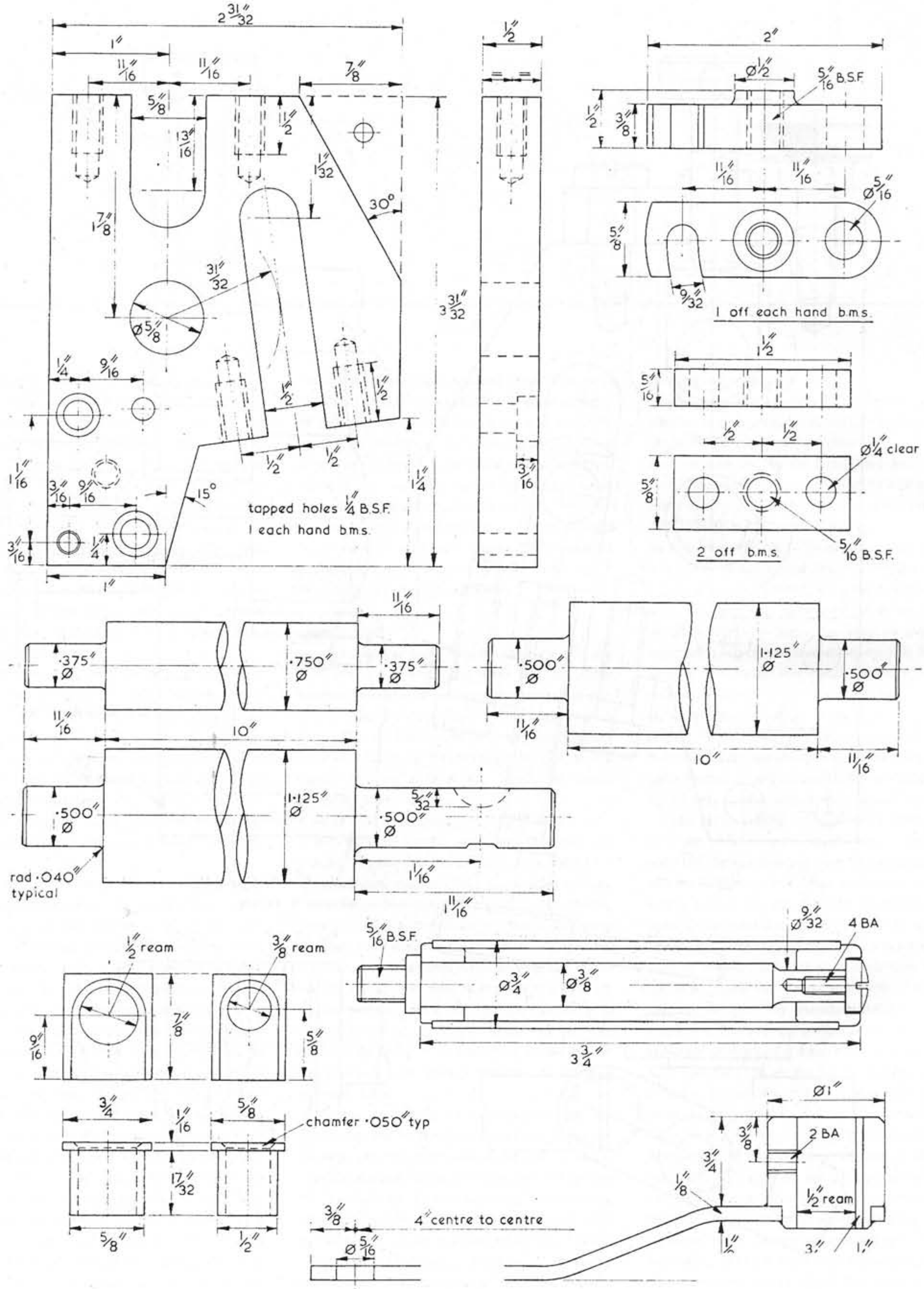
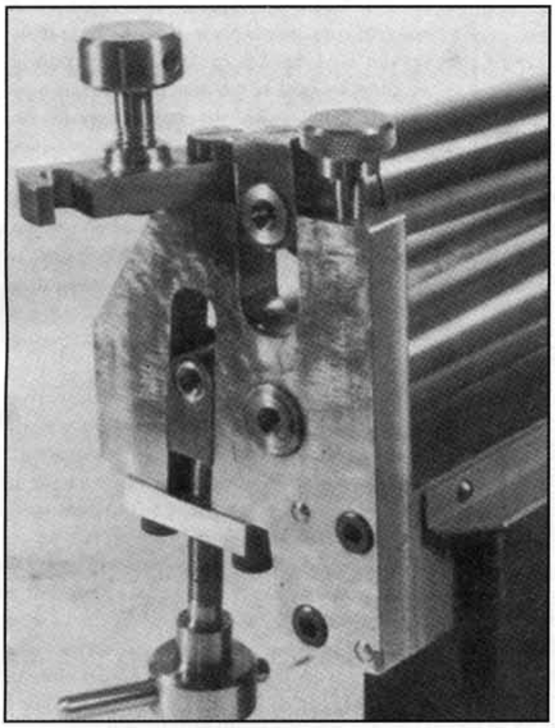

tapped holes 1/4" B.S.F.
1 each hand b.m.s.
5/16" B.S.F.
1 off each hand b.m.s.
Ø1/4" clear
5/16" B.S.F.
2 off b.m.s.
rad ·040" typical
1/2" ream
3/8" ream
5/16" B.S.F.
4 BA
chamfer ·050" typ
4" centre to centre
2 BA
1/2" ream

Fig.3



An end view with the latch open and the top roll lifted.

the pressure gradually as you finish feeding the drill.

This method will produce a true centre even on lathes that leave a lot to be desired and readers might be interested in the results of a test carried out on my own lathe, the alignment of which is beyond reproach. A 10in. length of 1in. dia. PGMS was set-up exactly as described above and, after facing the end, a No. 2 BSS centre-drill was carefully fed in to produce a centre about 3/16in. diameter. The work was then supported on a fixed centre and all support from the steady removed. I obtained an indicator reading (total) at 1in. from the end of the bar of 0.0007in. The steady was replaced and a larger centre-drill fed in a little way under side pressure as recommended after which I obtained a T.I.R. of 0.0003in., in other words the centre was within one and a half tenths (of a thou.) of its true position. I have no doubt that it could be brought closer than that.

If desired, the spindle ends of the rolls could be roughed down whilst supported in the steady and the centres used only for final finishing to size. There is no necessity for such care with the making of the deflecting roll which can be turned from 3/4in. dia. BMS. The making of the straps and latches should present no difficulty and after dismantling the end-plates from the bar all the necessary holes can be drilled and tapped to receive them.

The lower roll runs in P/Bronze bushes which are press-fitted into the plates with the flanges inside, but flangeless Oilite bushes could be substituted if they were left standing 1/16in. proud in the inside. All the sliding bearing-blocks were machined from drawn P.B. bar and the holes bored whilst clamped to an angle-plate on the faceplate using my normal axlebox technique which ensures absolute accuracy. All the sliding blocks have slugs of steel let into their faces where the pressure screws abut. After starting off the holes for these with an ordinary drill they were finished off to depth with a "D" bit to give a flat bottom. The various small turned items are all straightforward and have not been separately detailed. Do not drill the holes for the short permanent tommy-bars in the raising screws yet.

The handle could, of course, be anything capable of turning the lower roll, but as mine has proved to be comfortable in use it is drawn exactly as made though it might, with some advantage, be made a little longer—a throw of say 5in. The quill portion is 3/4in. OD x 18SWG brass tube with brass ends sweated in and I sometimes borrow this for use on other handles.

Before final assembly of the main frame, it might be as well to tap the now unwanted central hole so that it can be used for a jacking screw to force the ends off the bar. Another small item not shown on the drawings is the folded steel angle attached to the front of the main bar. This can be seen in the photograph and is useful to prevent the rolls dropping—with possible damage —when the vice is opened.

After final assembly, of the main frames with the driving and rear bending rolls in place, the latter should be raised by its jacking screws until it is parallel with the driving roll which can be checked by sighting from the front across the two rolls or one might rest two short rules across them, one at each end, and bring these parallel to each other. The heads

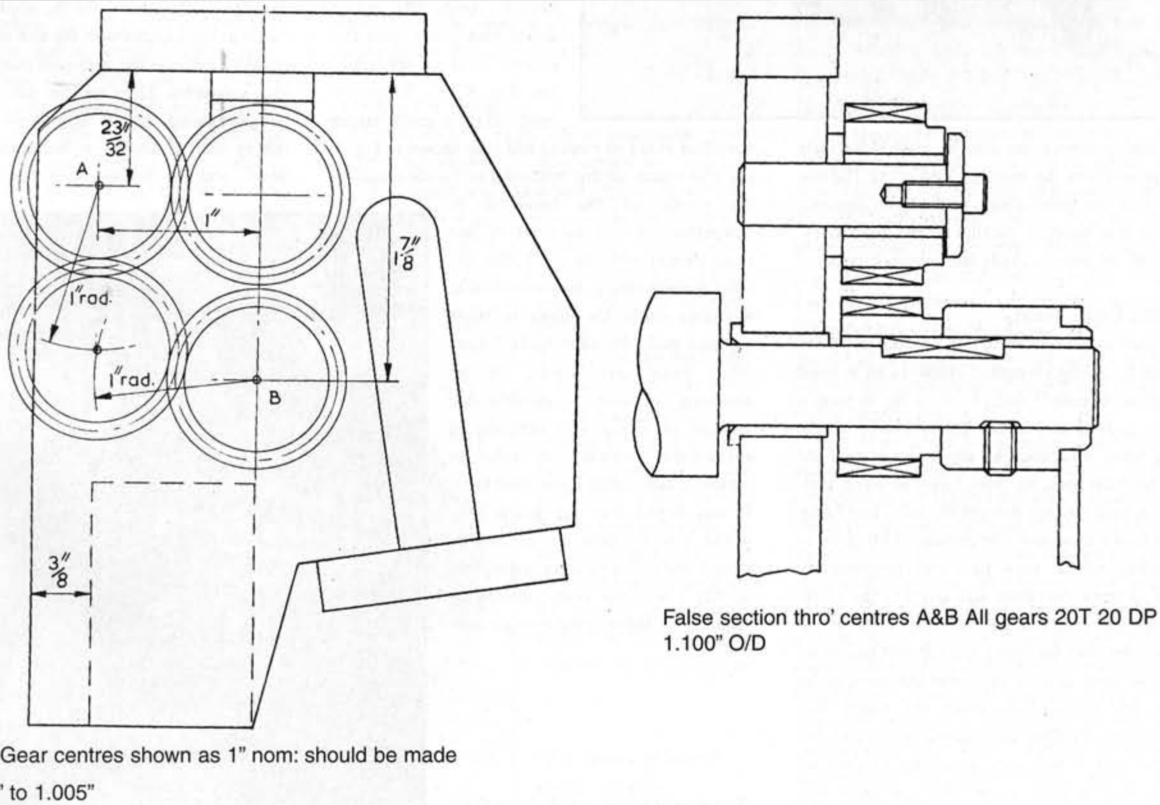


Fig. 4

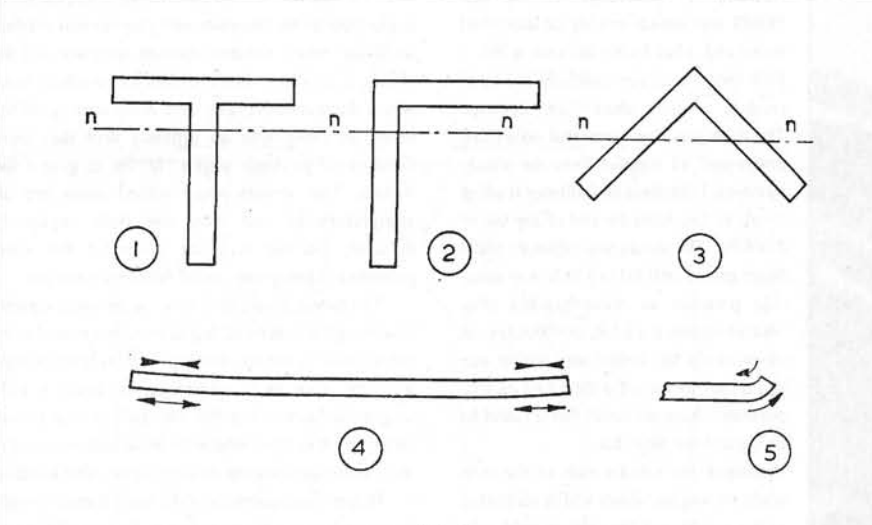
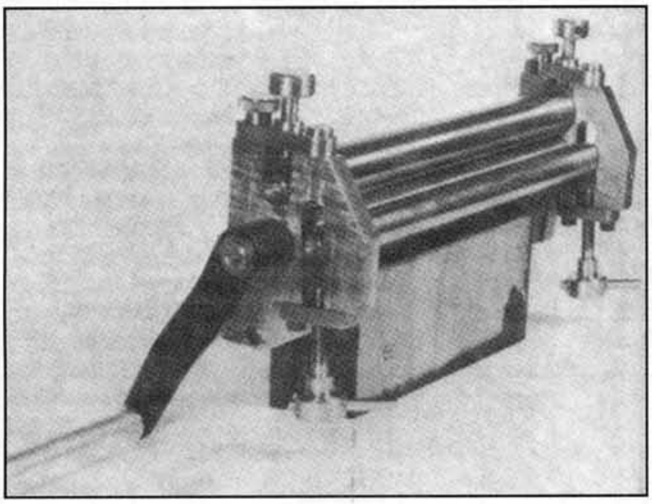


Fig. 5



Rear view of rolls, showing deflecting roll in lower position.

of the jacking screws can now be marked for their tommy holes (5/16 in. dia. handles, a drive fit). The two handles will now point always in the same direction when the rear roller is parallel to the front ones. Number all the screws, straps and bearing blocks.

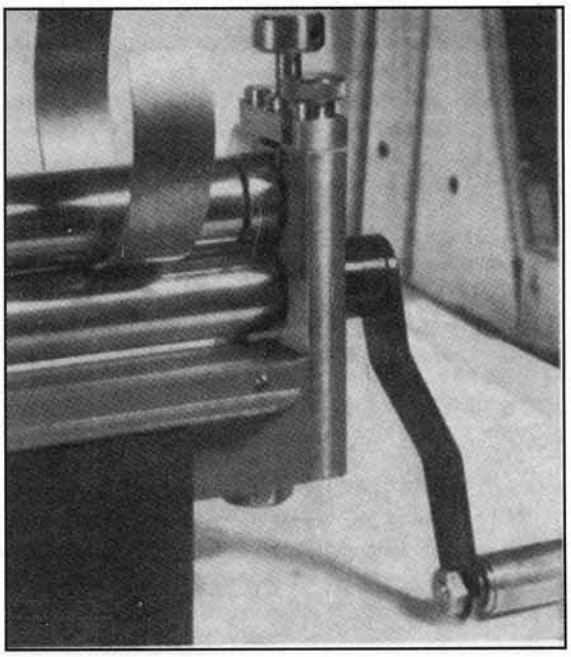
Tests and Conclusions

As soon as the rolls were completed a test piece was made by rolling a length of 18SWG CRCA (cold rolled, close annealed) strip, 1½ in. wide, to form a complete circle about 3 in. diameter. Initially, the rear bending roller was raised by about one turn of the screws for each pass, the work being reversed, end-for-end, at each passage through the rolls, care being taken to feed it in square. The amount of lift given to the bending roll at each pass was progressively reduced as more curvature was given to the work. When the gap between the two ends became too small to pass over the roller, the top roll had to be lifted from time to time to enable the work to be removed and replaced the other way round. The whole process of rolling until the edges met took but little time and it was very gratifying to find, on checking with a slide gauge, that the piece was circular within 0.01 inch.

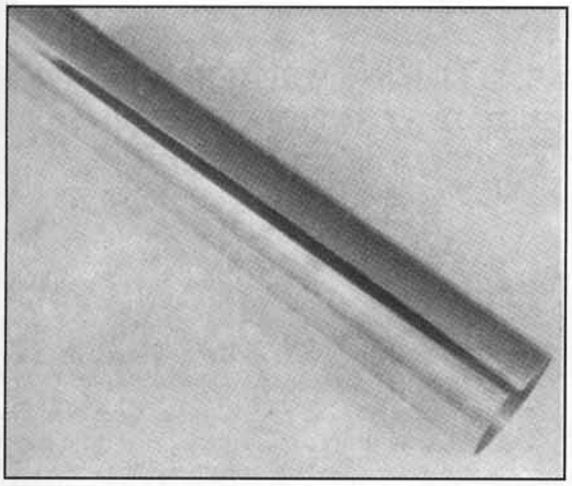
Everyone who has bent a piece of sheet metal will be familiar with the phenomenon which, for want of a better term, I will call "edge lift". When the bend radius is small compared with the metal thickness, e.g. a 1/16 in. internal radius with material of 1/16 in. thickness, the extreme corner lifts and is drawn back away from the general level of the edge. See Fig. 5 (5). When the bend radius is much larger the effect is not so marked and is as shown in Fig. 5 (4). The reason for this behaviour is that the metal on the inside of the bend is in compression whilst the outer surface is in tension with the result that the inner surface tries to flow outwards at the edge whilst the upper or outer surfaces pulls the edge back. I have often found this "lifting" to be annoying because a considerable amount of filing and dressing is sometimes necessary in order to remove it and restore the correct form. It was hoped that the pinch rolls would, due to their ironing action, reduce this effect to some extent and in this I was not disappointed. By standing up the original test-piece on the surface plate it was just possible to nip a ¼ in. wide strip of cigarette paper (0.001in. thick) in the centre of the width. A piece of the same strip material was bent, by hand, to the same radius around a bar and the "lift", which was very noticeable, was measured against the surface plate with feelers and found to be 0.005 - 0.006 inch.

I have, so far, made no mention of the grooves at the ends of the rolls shown in the lower right-hand of Fig. 2. These are provided to enable angles and "T" sections to be rolled. In order to roll one of these sections with its web standing inwards a groove will be required in the upper pressure roller but if the web is to stand outwards there must be grooves in the lower and the bending rolls. I have indicated the dimensions which I used and these grooves will handle sections up to 1/16 in. thickness. Remember that when the web stands inside it will tend to thicken up slightly as bending takes place and some allowance should be made for this in the width of the groove.

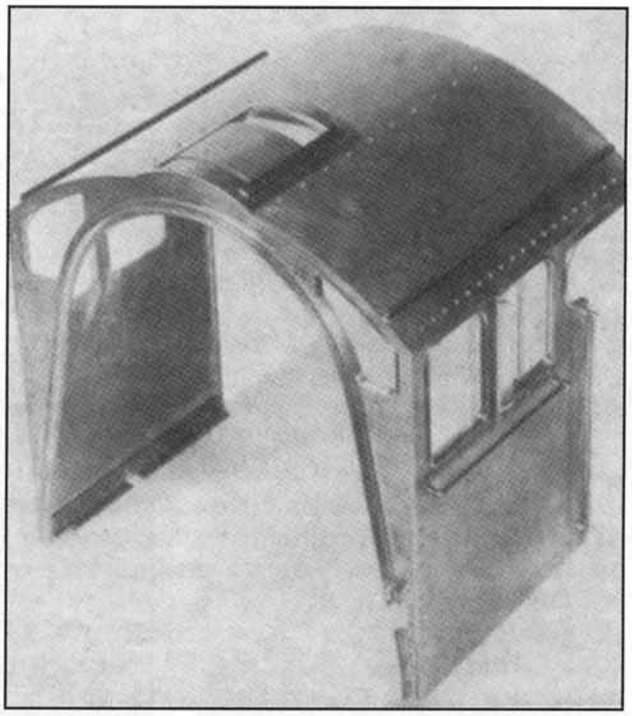
Rolling "T" sections has not presented any difficulties. If the web is standing inward it will be in compression and the flange in tension; a little extra pressure on the pinching rollers will, therefore, be beneficial as this will tend to stretch the flange and so assist the operation. When a curved "T" is required with the web standing outwards, the reverse will apply and the operation should be carried out with the minimum of pressure on the feeding rolls. Angles are a different kettle of fish altogether because they do not like being bent with the neutral axis nn as shown in Fig. 5(2). In this attitude the modulus of section is greater than in the case shown at Fig. 5(3) so the angle tries to twist round into the symmetrical attitude. This can give rise to some horrible results resembling corkscrews. On the whole, I have found it easier to bend angles with the web standing outwards possibly because the web will more readily stretch than compress. Even so, the job is by no means straightforward and is best done in stages, first rolling until distortion is becoming apparent then anneal and knock down with a mallet and wooden



Bending narrow work near the end of the rolls



1½ in. dia. aluminium tube, showing closing of gap at ends.



Locomotive cab, showing varoius curved work on plate, angle and tee.

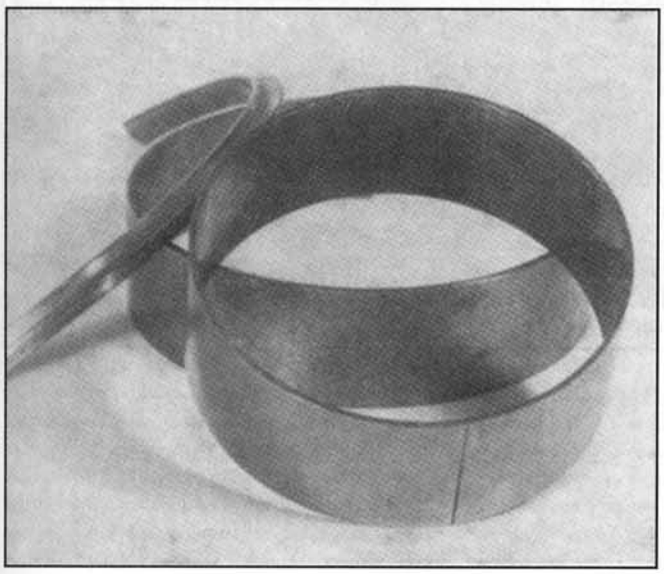
"punches" until sitting flat on a surface plate, then roll again, anneal, flatten, etc. This method sounds and is laborious but it has produced some very satisfactory curved work and beyond this I have no advice to give and await enlightenment from those more expert than myself in this field.

So far, the rolls, as made, have carried out all the normal work for which they were designed with little or no trouble but, before writing these notes, I decided to conduct a few tests on rather more demanding jobs. First I tried to bend some BMS strip ½ in. wide x 5/32 in. thick into a curve of 1½in. radius. Full stop! This obviously needed a bar-bending machine, similar in action to a tube bender. I got as far as a 14in. radius and geared rolls would have taken it further but never to 1½ in. I tried to make a tube 1½ in. dia. x 10in. long, using an offcut of aluminium. When nearing closure (see photo) it was found that the pressure 'of the feed rollers had stretched the two ends of the material by 0.10in. (about 2%) so that the gap was not parallel. Whilst this would not have happened with steel and probably not with ½H brass, the indication was that geared rollers might have done the job without stretching the material. On the other hand, I might have applied more pressure than was necessary.

Gearing for Rolls

For those who might like to incorporate gears and thus be prepared for all emergencies, I show in Fig. 4 a simple and convenient arrangement which includes, apart from the gears keyed to the upper and lower rolls, a pair of idlers which run on fixed studs on the main endplate. This layout still allows the upper roll to be lifted out at will.

The end frames are made, as before, from BMS 4 x ½ in. but a width of 3¾ in. is necessary in place of the 3 inches. The two ends are preferably made to the same external dimensions as this will facilitate lining up on the bar. I have shown the gearing at the same end as the handle as this reduces the possibility of getting a finger in the works! An interesting feature of the proposed gear drive is that any increase in the resistance to movement of the work through the rolls is accompanied by an automatic increase in the pressure between the driving rolls.



Specimens of rolled work. That in foreground is original test piece.

The arrangement is based on the use of four gears having 20 teeth, 20 DP, with a face width and bore of 0.500in. which are obtainable, from Messrs. S. H. Muffett Ltd., 14 Woodbury Park Road, Tunbridge Wells, Kent (Tel. 01892 542111 Fax. 01892 542117)

As supplied by Muffett, the bosses are ½ in. long and these can be reduced to ⅛ in. as shown. Two of them will need keyways ⅛ in. wide and the others can be bushed with brass or G.M. to run on the steel stub axles which are ⅜ in. diameter. The latter can be made a press-fit into the end plate or, better, fixed with Loctite. Perhaps the best method of fixing the gear to the upper roll would be to leave the boss ¼in. long instead of reducing to ⅛in. and tap for 4BA grub-screw—this in addition, of course, to the key which would take the drive.

I have no hesitation in saying that I believe the geared form of rolls to be superior to the simpler arrangement and if I had not already made them and found them capable of doing the jobs for which they were intended, I would include the gearing as a form of insurance against the unknown and unforeseen job, but a friend has made a suggestion for something simpler. He is going to make the two pinch rolls exactly alike, i.e. each having one end extended to take a handle. On the odd occasion, if the drive from one roller proves to be insufficient, he will attach a handle to the top roller also—at the opposite end—and so obtain maximum driving power by turning both handles! ●

Model Engineer 142 950 (1976)

Coolant System.

There has been some muddled thinking put to paper in the past on the subject of using cutting lubricants. In particular if you are milling, you raelly need a copious flow of coolant to keep the tools cool and prolong their lives; furthermore the combined effects of good cooling and sharp tools make for good finish. So, do consider biting the bullet and providing the system as described here. In my own installation of it, I have found the electronic speed control to work as drawn, but I have installed a "Mini" (Car) oil filter in the inlet line to the pump, submerged in the reservoir. The latter is cleaned out frequently and consists of a 4.5 kg Swarfega jar, with wide removable lid; it holds a gallon of cutting oil which does not last for ever and has to be thrown away every few months - a small cost at 20:1 dilution.

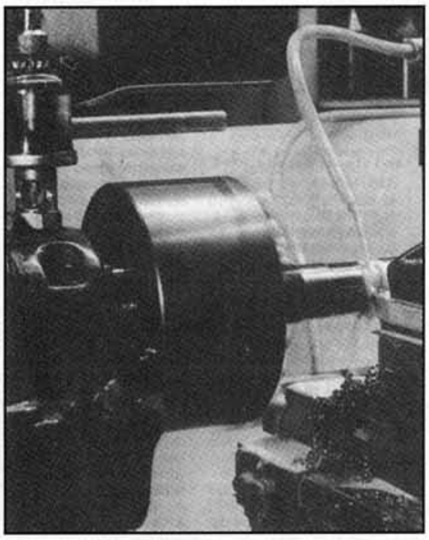
A LOW COST COOLANT PUMP

George Mark

CARRIED OUT A FEW EXPERIMENTS WHICH RESULTED IN THE BUILDING OF THIS LOW COST PUMP UNIT - USING AUTOMOTIVE SURPLUS COMPONENTS AS HIS BASE, A SIMPLE ELECTRONIC SPEED CONTROL IS INCLUDED.

Ever though of fitting a decent coolant system to your lathe or milling machine? Or do you find applying cutting oil with an old paint brush works fine so why bother? For years I have used the latter method and others, including, suspending a container above the machine and letting gravity do the rest. These methods work, but at best are messy and certainly wasteful, they are also hazardous if application by brush is made to rotating work or brought anywhere near a running milling cutter.

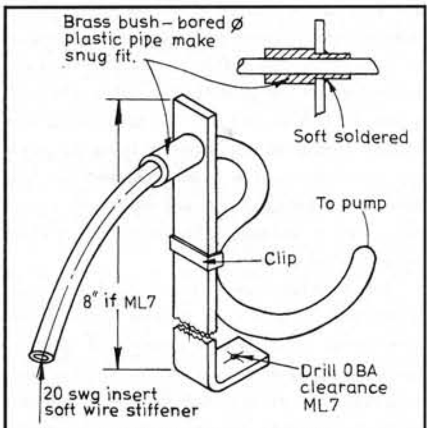
It was when I was fitting a replacement windscreen washer motor/pump to my car that I got to wondering how would one of these pumps perform as a coolant pump on my Myford ML7. Some experimentation was called for. A pump was obtained from a scrap yard and a length of plastic windscreen washer tubing purchased from a car accessory shop. With tubing connected to inlet and outlet ports and the other end of the tubes immersed in water a 12 volt supply was connected to the motor, the pump, which is self priming, was able to lift a fair amount of fluid to a height of more than six feet. The next thing was to find out how it handled soluble oil. Would the oil harm the pump by dissolving some of its vital parts? It was run for several hours pumping coolant out of and into a container, a variable voltage supply was used during these tests and using quite low voltages the pump delivered ample fluid for turning work, also, it ran quietly, mechanically and electrically, producing no radio or TV interference. The oil did not seem to have had any adverse effect on the pump so it was decided to proceed with the project.



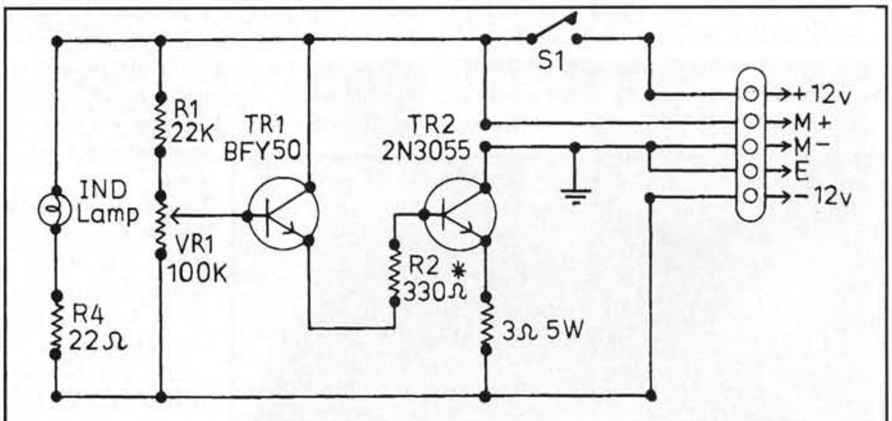
1. A turning operation on a longish bar, the lathe is running at full speed, and the pump is delivering at about "half throttle".

The pump is fitted behind the lathe and a reservoir (a redundant plastic motor oil container serves very well) of coolant placed on a shelf underneath. A drain pipe from the drip tray carries the coolant back to the reservoir via two filters—more about this later. Adjusting fluid flow to the work is accomplished by controlling the pump motor speed through a simple transistor circuit Fig.1.

The method of applying the coolant to the work in my set-up is as shown in Fig.2. The polythene pipe is too floppy to stay where it is put so a length of 20 SWG soft gas welding rod was pushed up the bore beyond the supporting bracket mounted on the saddle, this has worked reasonably well to test the system, a better more precise method of directing the coolant to the work is planned. A non-return valve is incorporated in the delivery pipe, this prevents the fluid slowly draining back down the pipe during an idle period, there is an instant flow of fluid when the system is switched on. Details of this component are shown in Fig.3. Dimensions and materials are for my particular set-up, these can be varied to suit. The body of the valve is alloy, a steel ball is the active component, after inserting the steel ball give it a gentle tap with a light hammer and drift to make a seat at the inlet bore, a 1.8 mm hole about 8mm from

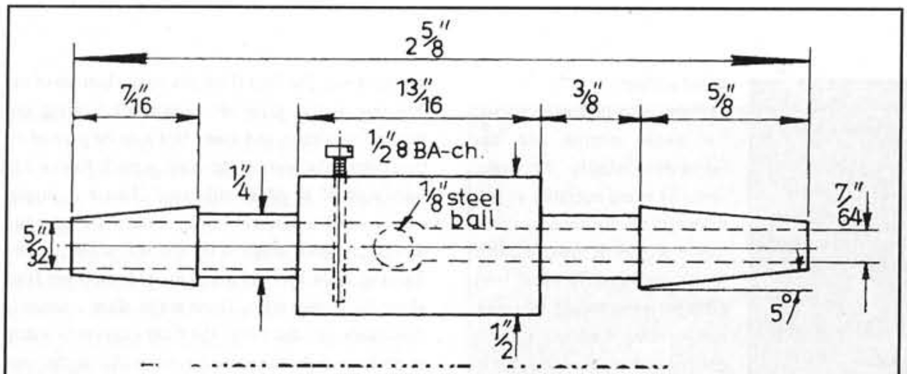


COOLANT PIPE BRACKET
Fig. 2

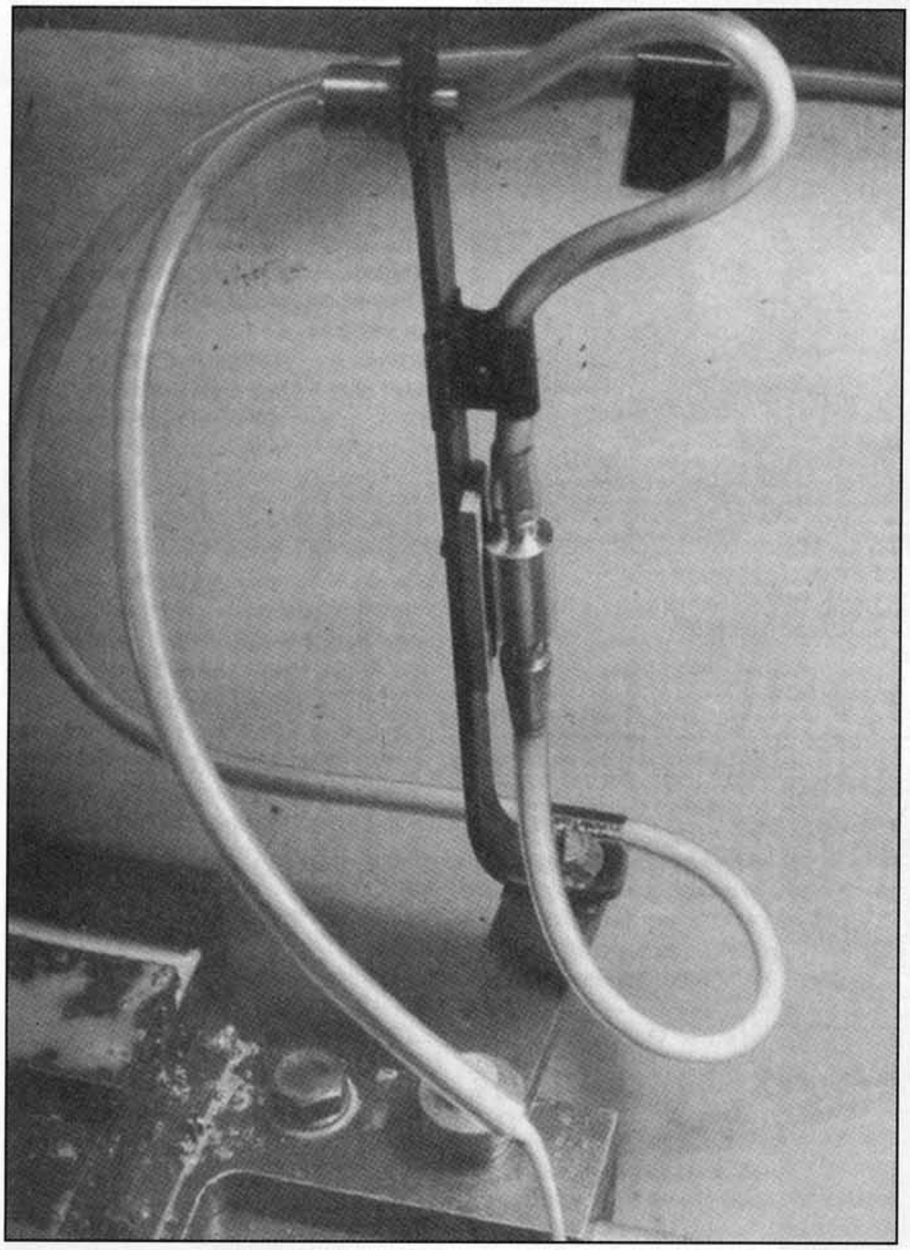


COOLANT PUMP SPEED CONTROLLER *Fig. 1*

*Value given is approximate - see text



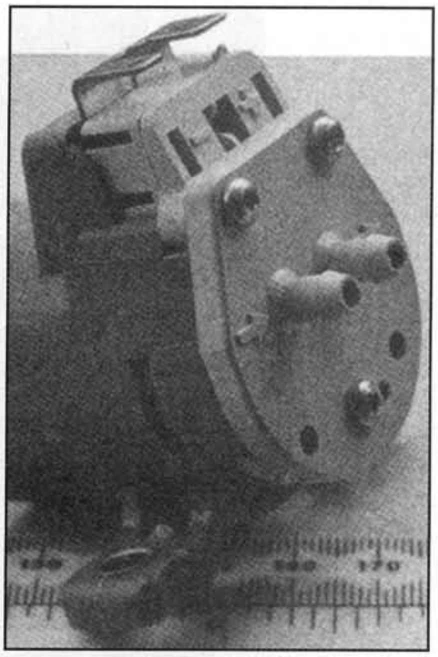
© *Fig: 3. Non-return value – Alloy body*



3: The non-return valve in position and the mounting arrangements of the delivery hose etc. to the stand.

the end of the outlet bore is drilled into the centre of the valve body, the drill will break through into the outlet bore, drill into the opposite side of the bore but not right through, tap hole 8 BA and insert a 8 BA x ⅝ in. CH screw, this restricts movement of the ball during delivery of fluid. After the screw is inserted, test the valve by blowing and sucking. The valve is secured to the coolant delivery assembly upright member using the 8 BA screw with the inlet port at the bottom, gravity assists the ball to close the inlet port.

It was decided to use a No Volt Release Switch to



2: The pump as supplied. This version came from Halfords, but similar units should be obtainable from car breakers.

switch the lathe motor on/off, this is for another project and not an essential part of this system. Fig.4 shows the circuit of the release switch for those who might be interested and to show how the transistor speed controller is connected to this circuit. The switch uses an AC operated relay with a set of three fairly hefty change over contacts, the +12v supply to the pump motor is now wired via two of these contacts, thus ensuring that on starting the lathe the pump also starts. Of course the pump can be switched on/off as required using S1 or S2. The original on/off switch for the lathe motor is still in circuit and serves to isolate the system from the mains if needed.

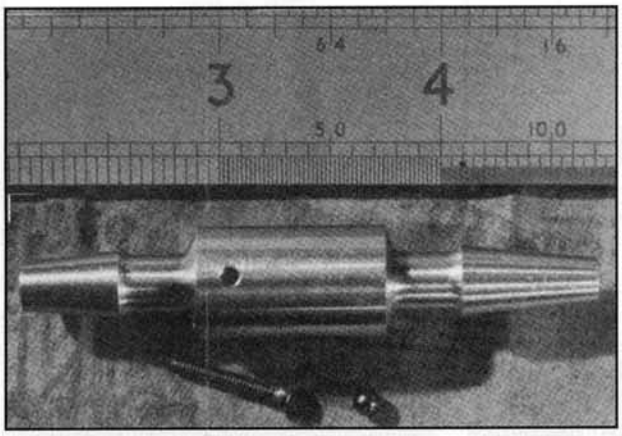
If an identical pump to the one used in this project is required, it can be obtained from most car accessory shops including Halfords (usual disclaimer) (Halfords part No. HWP1 also tubing—8ft. x ⅜ in. part No. HWP11).

The pump used is a convenient size and shape for easy mounting. I am sure similar washer pumps obtained from other sources will perform just as well.

It was found that leaving the end of the delivery pipe open was better for general lathe use, but inserting a small jet of about 2mm produced a quite forceful jet of coolant, useful for washing chippings clear of the cutter during milling operations.

The motor must be used on a DC supply, and it is most important that the polarity of the motor is observed. If any attempt to run the motor in reverse is made the pump rotor may be damaged as the soft neoprene blades are likely to dig into the ports due to their profile and the shape of the pump chamber.

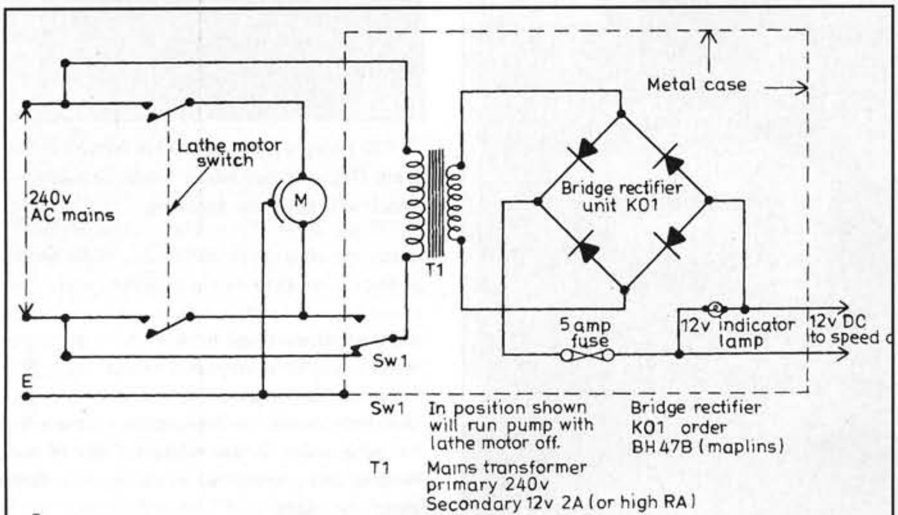
A surplus car battery has been used as a power source, this is capable of running the pump for many hours as the current drain is very low (less than one ampere). There is some advantage in using an unsmoothed DC supply such as the output of a batter charger, the rough DC current tends to start the motor very easily if the speed control has been left on a low



4 A close-up of the non return valve.

speed setting.

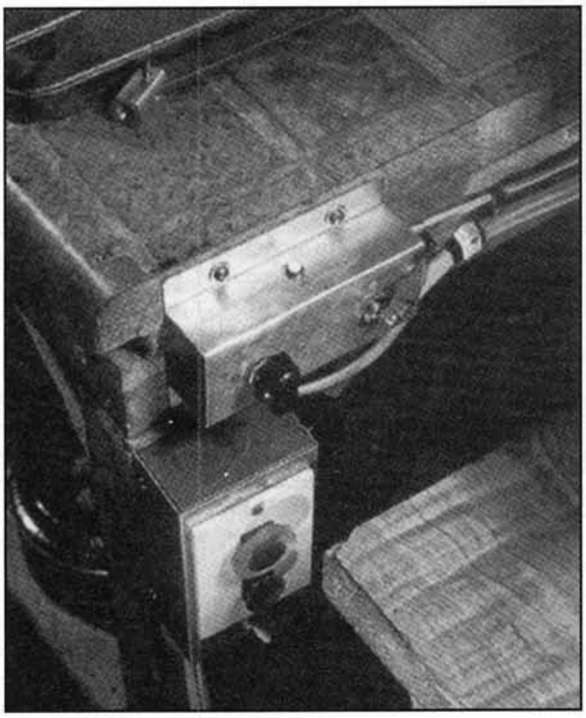
The above set-up has been used for some months and has performed reliably, the pump motor is being operated at well below its normal ratings so one would expect it have a fairly long working life. The only problem encountered was with the actual coolant, it was noticed that certain coolants can stain the lathe bed especially if the ML7 saddle is stationary and the felt strip is in contact with the cast iron bed for longish periods (overnight or longer). It would be interesting to



SUGGESTED CIRCUIT TO POWER SUDS PUMP FROM MAINS SUPPLY

Fig. 5

hear if others have experienced this. As stated, the coolant collects in the drip tray and finds it way back to the reservoir via two filters, the rate of drainage should be able to cope with the maximum delivery rate of fluid. Arranging for this to happen is not too simple as most lathes and their stands with drip tray will have been set level on installation, fluid will tend to spread out fairly evenly across the bottom of the tray and drainage under these conditions is slow. In this set-up a small secondary removable drip tray has been placed between the feet under the lathe, it is slightly tilted towards the drain hole and greatly assists in getting rid of the fluid, also being removable, swarf clearing is easy, just tip it out. The first filter sits on the bottom of the drip tray and is generally capable of filtering out most of the debris and swarf that may be carried by the coolant, the body of the filter is made from a 2 in wide strip of 18 SWG mild steel. This was shaped over a suitable former—in my case a Duraglit tin, overlap the ends about ¼ in. and soft solder, before forming, eight ½ in. long x ¼ in. wide slots are filed along the bottom edge. These are to allow coolant to flow easily into the filter. The filter element is a strip of perforated aluminium the same width as the steel strip and long enough to form about three layers when coiled around the inside surface of the filter body (perforated aluminium is generally used as fly screen on food containers etc., it is sometimes sold as reinforcement for fibreglass paste used on car repairs). A length of 10mm studding is bored 6mm right through, at about 30mm from one end a 5mm cross hole is drilled right through at 90 deg and elongated by filing or milling for about 10mm, clean up the 10mm thread of the studding. This hollow studding is the first part of the drain pipe. A hole has to be drilled through the drip tray and anything else in the way to allow the drain pipe to reach the reservoir, this hole is tapped 10mm, the studding is screwed in to where the bottom of the elongated hole is just below the surface of the drip tray, the filter body with its filter is placed over it, drain slots to the bottom, a large washer and 10mm nut holds the whole filter down on to the bottom of the tray. (I used a dished washer from an old grinder, this centred the filter body quite nicely). It is sufficient to finger tighten the holding down nut. A length of plastic tube, 5/16in. bore, can be conveniently persuaded to fit over the other end of the hollow 10mm stud that should be protruding into the space under the lathe stand. Another filter is placed in the run of this tube before it enters the reservoir. This filter is used as a fine particle filter to catch cast iron dust etc. Originally intended as a fuel filter for use on some Japanese car, possibly a Datsun. The in/out port nipples fit the above tubing, it is a sealed throw away unit that should last for years if used in this project. I obtained two of these units from a car boot sale at 50p each.



5: The pump controller, and the lathe switch gear are handily positioned on the front of the lathe bench.

If this system, or any other, is brought into use on a lathe or milling machine it will be necessary to fit suitable splash guards especially around the chuck area. It is difficult to avoid direct contact with coolant but try to keep it to a minimum, barrier cream can help, avoid eye splashes by wearing goggles or a visor.

Transistor speed controller (Fig.5)

The components should be easy to obtain from electronic stockists. The whole unit is contained in a small metal box and connections are made via a 5 amp terminal strip T1. In case of difficulty try contacting a radio ham or a ham club, they are usually more than willing to help out a fellow hobbyist. The transistors are both silicon NPN general purpose devices and similar types to the ones specified will work OK. The value of R2 might need adjusting within the range 220m Ohms - 2.2k depending on the transistors used. R3 serves as a current limiting device and must be rated at no less than

5 watts.

Tr1 (BFY50) is in a T05 can and this is connected directly to the collector which in this circuit is +12v. Make sure the can does not contact the sides of the container.

Tr2 (2N 3055) is in a T03 can and again is connected directly to the collector. This transistor can be bolted directly to the metal case of the unit thus avoiding the need for insulation bushes and washers, the case acts as an effective heat sink.

Note that the case is connected to the negative terminal of the pump motor and earth.

Vr1 is a standard carbon track 100k log pot Anti-log or linear pots will work OK.

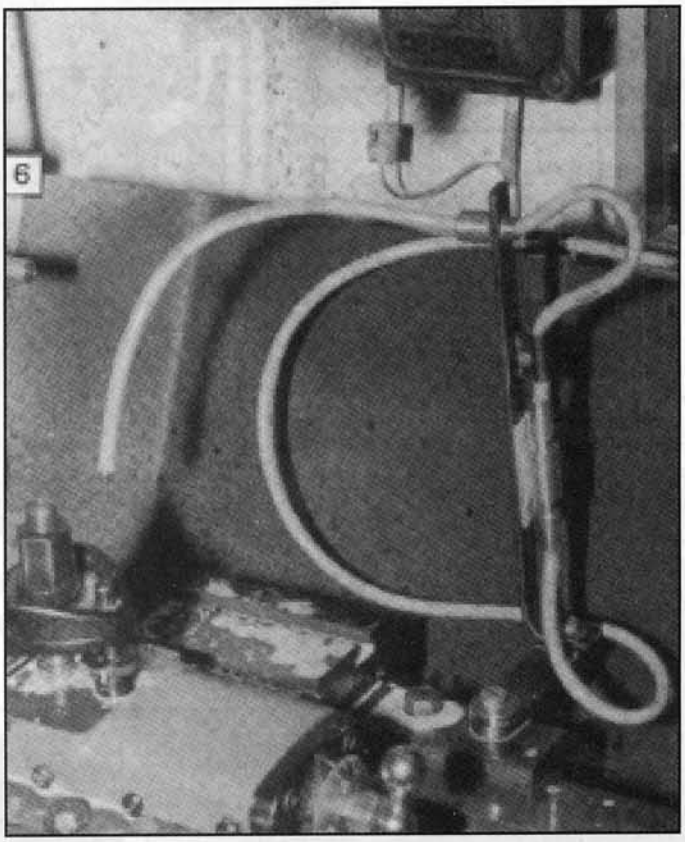
The indicator lamp is optional but is useful and looks nice when lit.

R4 is selected according to the voltage/wattage of the lamp. A LED indicator could of course be used with a suitable series resistor. Due to the small number of components used it is not necessary to use a circuit board, the components can be strung between their own tags and soldered, Vr1 - Vr2 - S1 have three tags each and the terminal strip T1 provides 7 more anchor points.

No fuse is shown but a line fuse of 5 amps rating should be included in the +12 volt line especially if the supply if drawn from a car battery.

If a mains powered 12 volts supply is used make sure the output fuse is not rated too high. ●

Model Engineer <u>168</u> *74 (1992)*



6: The hose is kept in position by a length of welding wire. Note the "No volt" release switch on the wall.

<u>Sine Bar.</u>

A Sine bar is not everybody's cup of tea! It is a most useful device for determining tapers accurately and the concept is simple. Ives' article describes a model which is 5 in. long (a most useful size), with a good provision for holding down. The concept is well presented. Lamma's more expansive treatise on a larger sine table should find good following among those with milling machines. It does save space in a machine of restricted headroom, as the tapered bed comes down very close to the machine table.

Fig. 1

A SINE BAR FOR THE MILLING MACHINE

by E H Ives

THIS WAS THE OUTCOME. of one of those "impossible" jobs we model engineers get asked to do. "Can you cut a bevel gear similar to the one I have to run on the other end of the same shaft and match with the same crown wheel but with two less teeth?" said a friend.

First reaction was to say "No!" but later I promised to see what I could do. A search through my M.E. card index revealed an article by R. S. Minchin in November 1964 and another by D. J. Unwin in October 1971 and armed with these and a pocket calculator, I spent an evening proving that it was just possible if I used the upper limit of the face width for the new bevel. I am able to borrow a dividing head for my lathe, but not for the milling machine, so I had the problem of fixing this to the mill and inclining it to 13 deg. 48 min., the calculated angle. Obviously, I thought, a sine bar is needed. Again recourse was made to the M.E. Index but this time it only revealed one general article on the subject so I had to set to and design one to suit my equipment, although with very little modification it should suit most machines. The result is shown in Fig. 1.

Basically the tool consists of a platform or bar to which are fixed two rollers exactly 5 in. apart. Multiplying the sine of the required angle by 5 gives the height of the packing needed under one of the rollers to produce that angle. The cross-drilled holes take special clamping pins to hold the device to the machine table.

A piece of 3 in. x 1 in. mild steel 6½ in. long is required for the platform and this should be carefully marked out for the clamping holes. Not trusting the drilling machine to drill squarely through the bar, it was set up on the lathe cross-slide and drilled from the chuck using a vee pad in the tail stock to provide the push (Fig. 2). Lightly chamfer the corners of the holes.

The next job is the clamping pins as these are required to hold the bar to the milling machine table for later operations. An odd piece of shafting which happened to be the right diameter provided the material for me but you may have to turn them from ⅝ in. rod. The ends are cross drilled to suit the slots in the machine table and to take my standard set of 5/16 in. BSF studs which, with various tee nuts fit both the lathe and