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Rack Tailstock Design

By Martin Cleeve

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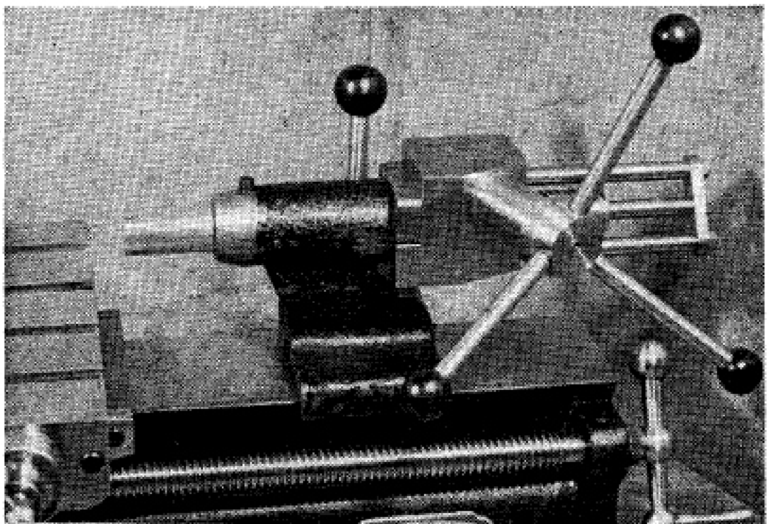
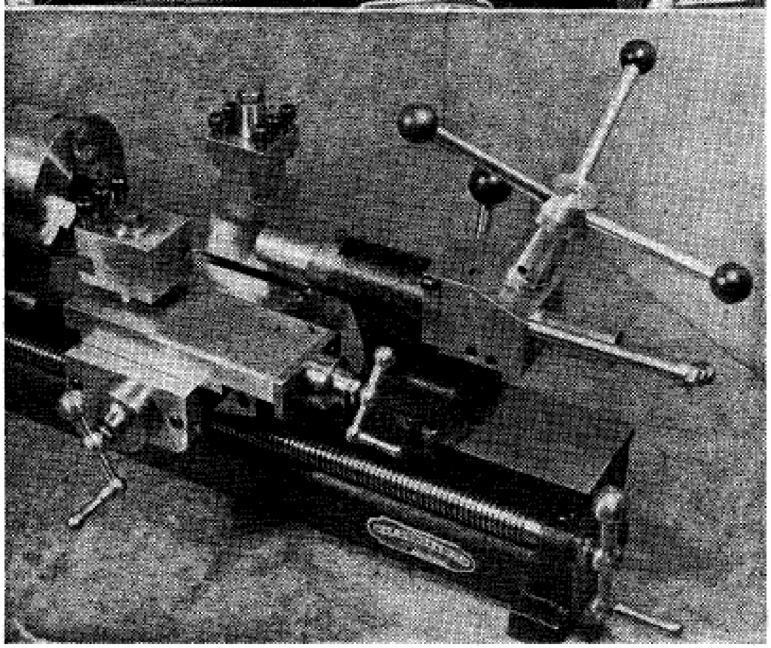
MARTIN CLEEVE adds some more improvements to the EW lathe

RACK TAILSTOCK DESIGN





Top, Fig. 1: The rack unit with 3 in. barrel travel and tool ejector. Above, Fig. 2: This unit may be used in any position

BEFORE I go into the constructional details of a skew rack tailstock unit there are a few points on the question of efficiency which I should like, if possible, to clear up.

It has been held that the skewing of the rack must result in inefficiency, as one reader put it, "from forcing the barrel against the side of the bore." This aspect I have already dealt with in Postbag, where I tried to show that while a certain amount of end-thrust was imparted to the pinion shaft the opposing force took the form of a twisting tendency to the barrel which could result in slight reduction of efficiency owing to increased friction between the key and keyway. Nevertheless, these effects pass entirely unnoticed in practice; in efficiency at least, the old fashioned screw type will not stand comparison with the rack, either skew or right-angular.

Nut and screw efficiency

In questioning the efficiency of the skew type, everyone seems to assume that the orthodox screw barrel itself has a reasonable figure. I think it is an established but not a generally known fact that the efficiency of an average screw and nut is less than 50 per cent. If screws and nuts were made with a better efficiency, each time a nut was tightened, it could spin loose immediately the spanner was removed !

From this, a generous efficiency figure for a threaded barrel and handwheel can be taken at 45 per cent. But if we go a step further and consider the added frictional loss brought about by the restraining half-washer, or other device included to change the rotary motion of the handwheel into a linear movement of the barrel, an over-all efficiency figure of 35 per cent would hardly be an exaggeration. An appalling efficiency of this kind precludes, of course, any possibility of causing the handwheel to spin by pushing or pulling the barrel: indeed, the handwheel would not revolve even a fraction of a turn if the barrel were subjected to pressure from an hydraulic press.

Conversely, if a skew rack unit is held with the barrel vertical, the barrel will fall and, by its own weight alone, will cause the capstan handle to revolve ! I have not yet bothered to make any direct experiments in obtaining an efficiency figure for the rack tailstock, but I would feel it conservative to hazard a guess at something between 75 per cent and 85 per cent.

There are, admittedly, some who favour the self-locking factor inherent in the screw type as it acts as an additional safeguard against a possibility of the barrel's retracting under load when machining work between centres. In my opinion this is a rather negative approach to danger, somewhat akin to keeping one's brakes applied as a precaution against running backwards when cycling uphill.

Barrel travel

The liberal barrel travel which I favour for these rack units (4 in. for the ML7, 3 in. for the EW) has also been held in question, largely on the mistaken assumption that the sole object is for deep hole drilling, an operation which I am often volubly assured is so seldom required that to make provision for it is unnecessary. I certainly agree that deep holes are not often called for—but this is by no means the sole object of long travel.

It often happens that half-a-dozen or so components need to be chucked for centre drilling. If drilling is performed with the tailstock barrel almost fully extended, it can be instantly retracted 3 or 4 in. to clear the drill, thus allowing plenty of room for the exchange of components.

A generous barrel travel is also of great advantage in using a six station tailstock turret unit such as that recently described by Exactus of MODEL ENGINEER workshop. These turrets are often loaded with tools which vary considerably in length, and it sometimes happens that a short centre drill is needed for use in one station, followed by an ordinary long twist drill in another. Without

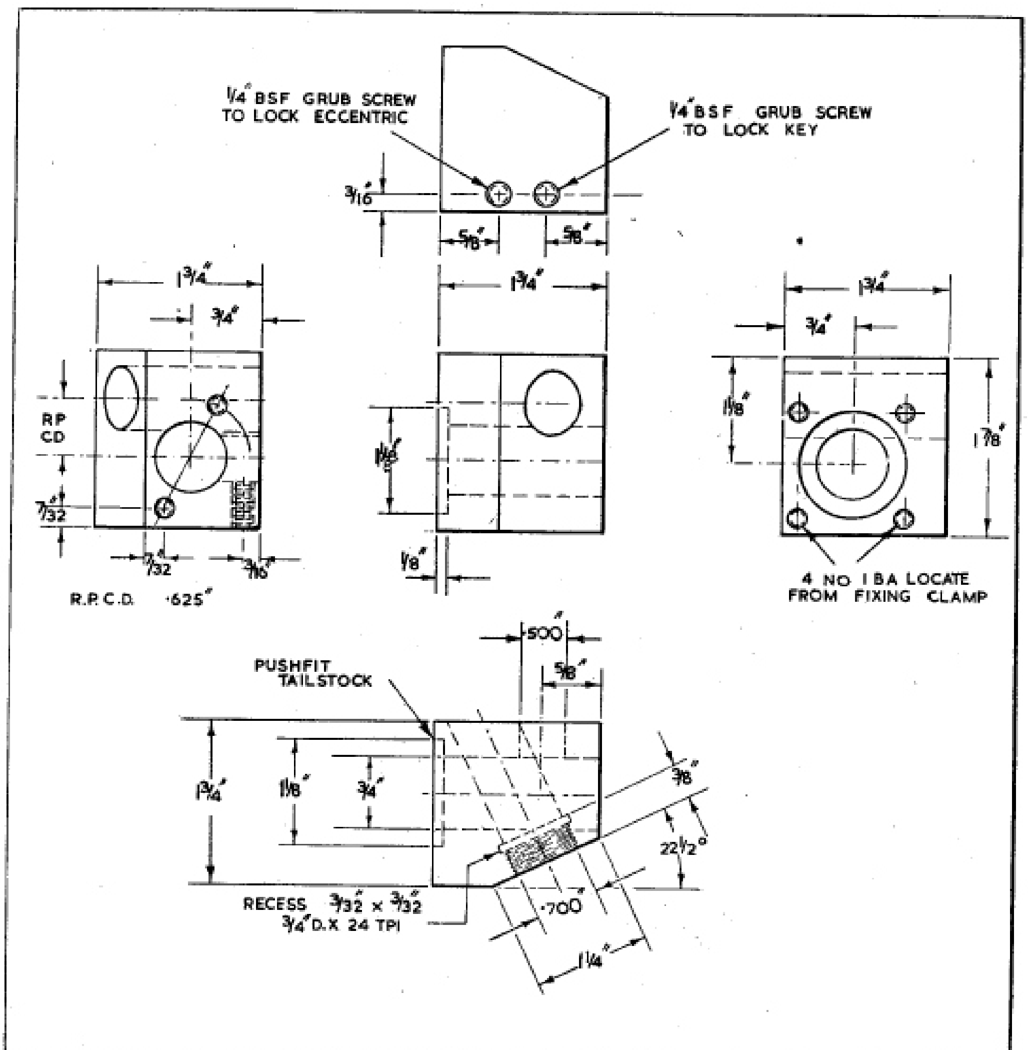


Fig. 3: Dimensions and details of the main block

a reasonable barrel travel, the tailstock has to be moved as a whole: an arrangement with obvious disadvantages in working to stop depths. It is not always convenient to mount the centre drill in a special extension piece.

I hardly need to emphasise the great value of a tailstock barrel which can be moved over its whole travel range in less than one second. This property is particularly advantageous for reaming, especially a material such as mild steel which requires that the reamer shall be withdrawn after each advance of about $\frac{1}{8}$ in. for chip clearing.

Tap and die running is also simplified, as no special provision has to be made to give the required free sliding action. Taps, of course, can be held directly in the tailstock drill chuck. I often use my own unit for pushing a bush in to a housing or for fitting or removing mandrels, particularly where it is not desired to hit the mandrel with a mallet and where the bench vice will not open sufficiently to admit the mandrel.

Fig. 1 will give a good idea of the appearance of the fitment. Basically, the general arrangement and method of attachment to the tailstock body is the same as that adopted for the ML7 version, but in detail there are two important modifications. One is that the keyway, instead of being in the orthodox place at the front end of the barrel, is at the rear of the rack, the key being fitted into the mechanism housing block. This alteration gives a twofold advantage. It makes possible the fitting of a hardened key of reasonable length and it allows the whole to be swivelled into any desired position, the barrel merely following the movement.

In this we have the answer to those who prefer the capstan handle on top instead of at the side, although, in my opinion, the on-top appearance is rather inelegant, as may be seen in Fig. 2. My friend uses his in the just-off horizontal position.

The other modification consists of fitting eccentric bushes for the pinion shaft. This obviates all bother and worry over marking out and boring at the exact centre distance for rack and pinion meshing; and it gives the added satisfaction of being able to make final adjustments to a nicety.

Making the components

The machining operations needed to produce the chief components are very similar to those already described for the ML7 skew rack, details of which appeared in MODEL ENGINEER for 12 and 26 July 1956. These two articles also gave large illustrations of the set-up used to drill the barrel and cut the skew rack, keyway and pinion. In making the unit some modified methods were used and some of the other operations were photographed.

Details of the main block are given in Fig. 3. It may be made from a nominal $1\frac{5}{8}$ in. length of $1\frac{3}{8}$ in. square bright mild steel. The faceplate mounting method shown in Fig. 4 is suitable for all operations, particularly for holding the block on the skew for facing off and boring the skew hole.

The main $\frac{3}{4}$ in. bore need not closely fit the barrel over its full length. In fact, if this is attempted it will be found impossible to line up so that the barrel slides freely through both the block and the tailstock body. Bore from the end that will fit the tailstock body (which will be machined to suit) and give a 5 to 10 thou relief to this half of the $\frac{3}{4}$ in. bore.

After many years with a workshop, I am still without one of those impressive-looking protractors, or combination sets as they are sometimes called. Whether or not the angle is exact is of little importance here, provided that those on the main block and the rack teeth are the same within reasonably close limits. To gauge these angles, a triangle of sheet zinc was marked from a school protractor, the metal being snapped off along the deeply scribed lines.

In preparing to angle off the main block by taking a series of facing cuts, the $22\frac{1}{2}$ deg. line is first scribed on what will become the top of the block. Then, in mounting on the faceplate, this line can be carefully set parallel to one of the clamp jaws by reference to a further parallel strip of appropriate width. Provided that the block is reasonably square all over for facing, it may be set for vertical by referring the inner corner to the faceplate itself. Paper or stiff card should be interposed as a precaution against slipping.

Without taking more time and trouble than is worth while for a one-off job, the position of the skew hole cannot be marked until after the angular facing operation; the block must, therefore, be removed for marking.

The barrel hole, having its centre line $1\frac{1}{8}$ in. down from the top of the block, shows that from the same reference point the centre line of the skew bore will be 1.125 in. minus 0.625 in. = 0.500 in., and in the centre of the $1\frac{1}{4}$ in. angled off face width. As eccentric adjustable bushes are being fitted, the exact positioning of the bore does not require so much care as previous units.

Spot drill $\frac{1}{16}$ in. and follow up with a B.S. No 2 centre drill.

★ *To be concluded on October 23*

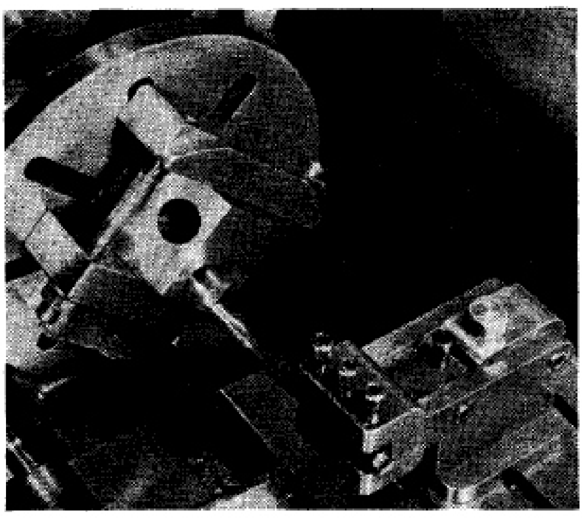


Fig. 4: Swing-clear holder employed to bore the skew hole

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Completing the

RACK TAILSTOCK

MARTIN CLEEVE gives the final details of his device for the EW lathe

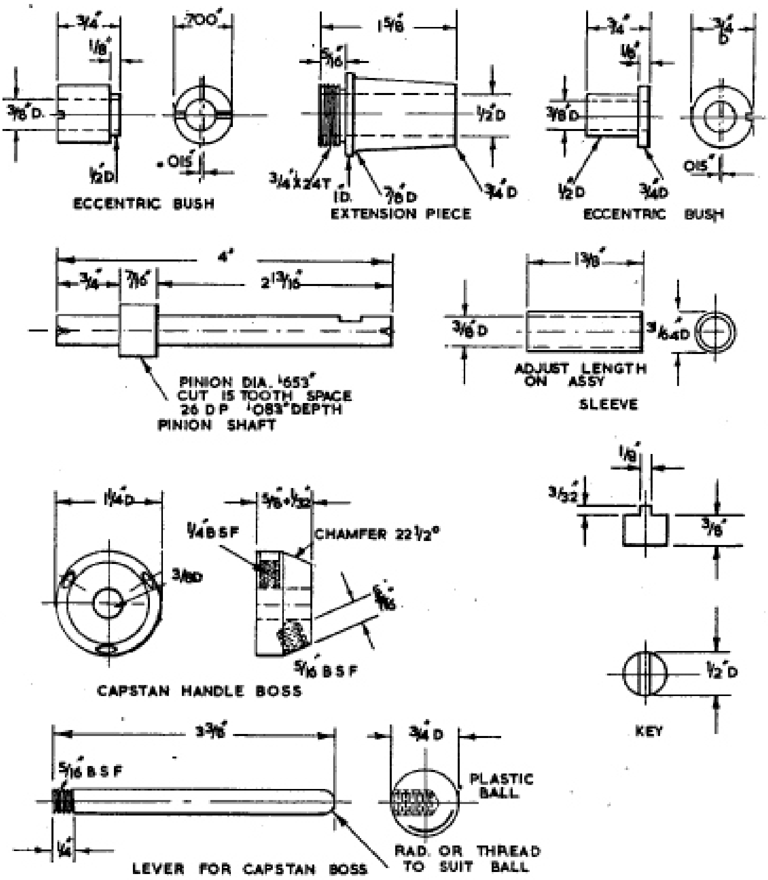


Fig. 5

BEFORE drilling, boring and threading the skew hole in the main block, you will find it helpful to prepare a threaded blank for the pinion shaft extension piece, details of which are given in Fig. 5. This can then be used as a gauge for the corresponding thread in the block, and when it is fitting properly it may be drilled, bored and taper-turned *in situ*, as shown in Fig. 6.

In remounting the block for skew hole boring, use the tailstock centre as a setting reference, and a test indicator to check that the angled-off surface is revolving in a true plane. It is very difficult to achieve the dead true running of both the face and the centre hole, but if the total indicator reading does not exceed, say, plus or minus two or three thousandths of an inch it may be considered satisfactory.

Before the bore is begun, the face may be lightly resurfaced to conform to the new setting and to ensure a proper seating for the extension piece. After drilling to about ½ in. dia., you may open out the whole of the skew bore to 0.700 in., this being also the tapping size for ¾ in. × 24 t.p.i.

Details of the barrel are given in

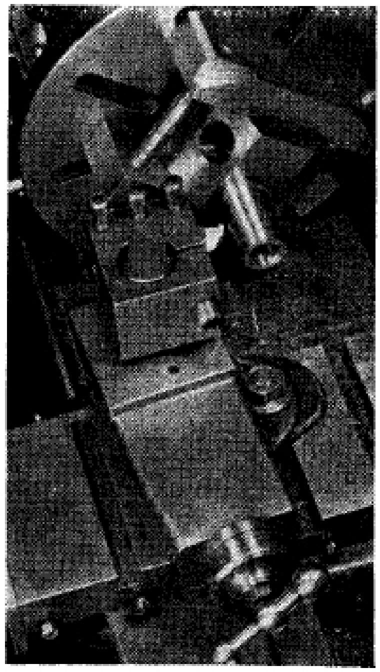


Fig. 6: The main block held for skew facing, boring and threading, and for finishing the extension piece

Fig. 7. The barrel was made from ¾ in. dia. silver steel after checking this for reasonable circular truth. A bushing type fixed steady was used for extra support during the lengthy drilling and taper boring operations.

In cutting the rack teeth, the barrel was held at the required skew angle in a special fixture mounted on the cross-slide and so arranged that on passing beneath a gear cutter the tooth spaces were at once cut at the required depth. Indexing was carried out with the help of the saddle dead stop and a distance piece whose thickness equalled the circular pitch (0.121 in.).

A forward dead stop for a tailstock barrel is often very useful; but whereas the end of the keyway normally acts as a stop, the arrangement here calls for a stop screw at the open end of the keyway.

For the pinion and shaft (Fig. 5) silver or axle steel is preferable to ordinary mild. The sleeve is easily made and obviates the machining of an additional step.

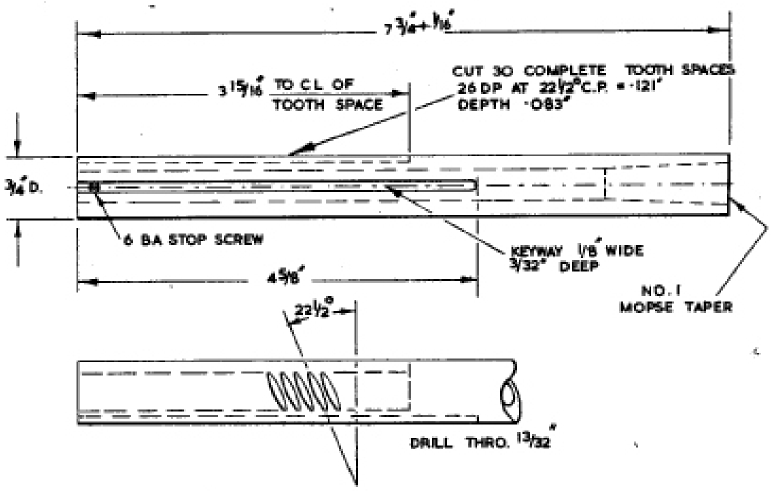


Fig. 7: Principal dimensions of the tailstock barrel

Fitting the key

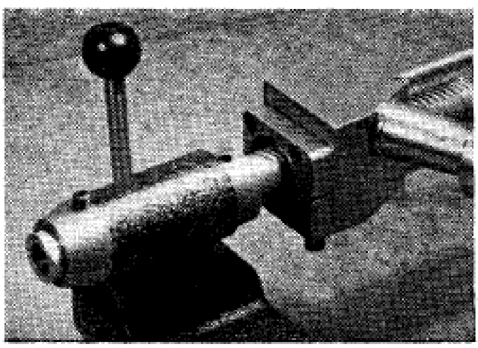
You will find the dimensions of the key (to fit the barrel keyway) in Fig. 5. By beginning with a reasonable length for holding purposes, the flat may be accurately formed on the end by cutting away each side with a slit saw.

The key fits into a ½ in. hole at the rear of the main block (Fig. 3) bored on the same centre line as that of the barrel hole—1⅛ in. from the top of the block, and ⅝ in. in from the ejector assembly end. The round part of the key is locked by a ¼ in. BSF screw passing up from the underside of the block (Fig. 3, top). With this method of key fixing it is possible to adjust the depth of engagement and to set the key in exact parallel alignment with the keyway. The ½ in. length of the key ensures adequate support to resist the higher torques set up by tap and die running.

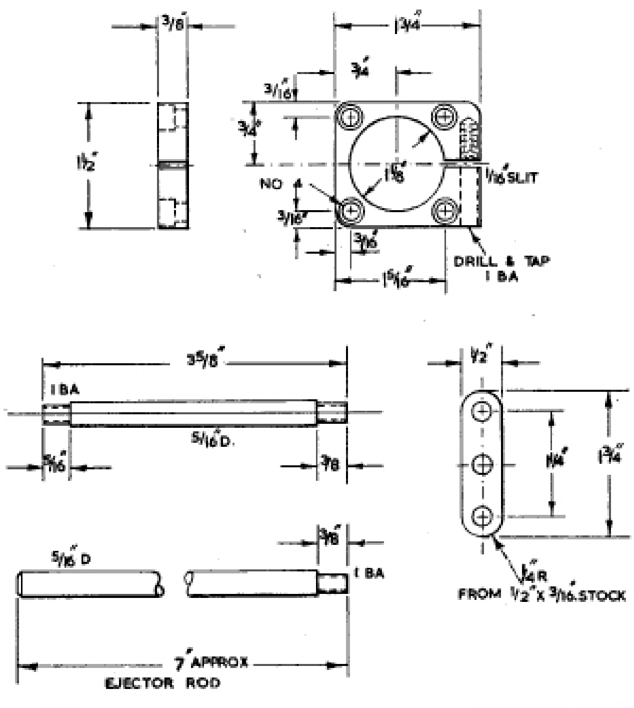
Details of the eccentric bushes for the pinion shaft are given in Fig. 5. One is for the capstan handle end, and fits the extension piece. The other fits into the rear of the main block.

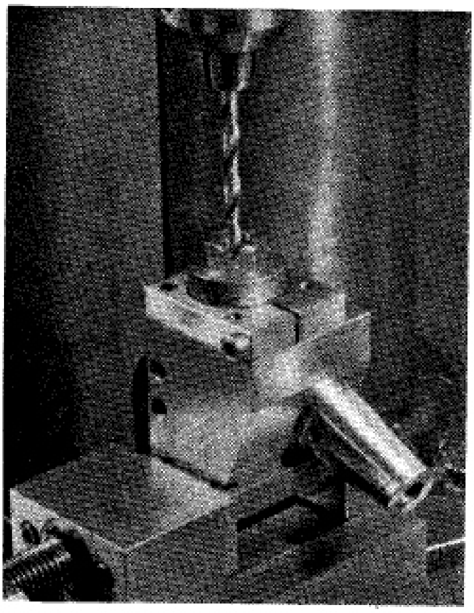
Here is a method of making the bushes. Using the four-jaw chuck, grip a suitable length of bearing material of ¾ in. dia. Adjust the chuck so that this revolves eccentrically plus and minus 0.015 in. (30 thou total indicator reading). Face, centre, drill and ream the bore. Place on a mandrel held in the four-jaw chuck. Offset the mandrel until the outside of the reamed bush runs truly. Machine outer surfaces to the dimensions shown.

During the final operation care must be taken to see that the bush has a good grip on the mandrel,

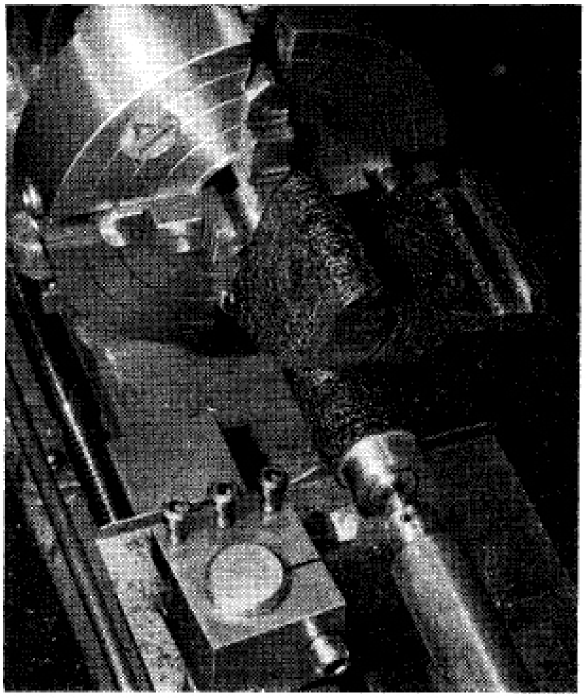


Above, Fig. 8: Method of fixing the unit to the tailstock body. *Right, Fig. 9: These are the details of the fixing clamp and the ejector members*





Left, Fig. 10: Drilling for screw holes



Right, Fig. 11: Here the body is machined to receive the unit

because if it slips through heating up during machining, or from some other causes, the correct eccentric setting will be lost.

The bush for the capstan handle should fit the extension piece with just enough frictional interference to allow of its being turned with a suitable C spanner for adjustment purposes. The other bush is held in place by a grubscrew so it may be machine to an easy fit in the block. The grubscrew hole is at the left of the key screw hole (Fig. 3, top). As this is rather a deep hole, it is best merely to thread the mouth and to grip the bush by interposing a plain rod between the bush and screw.

The split clamp

The unit is securely fixed to the tailstock body by a split clamp. This is shown in Fig 8, and the dimensions are in Fig 9.

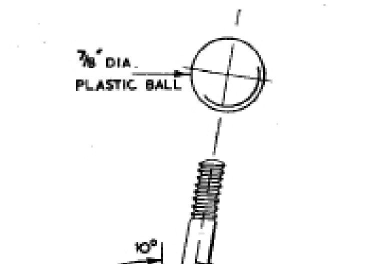
Bore 1⅛ in. dia., drill four holes tapping size, and drill and tap the split clamp hole before slitting. Slit and fit the clamp screw. Assemble as in Fig. 10, which shows the clamp locked around a plug of 1⅛ in. dia. This is a good fit to the recess in the block and is held in position by a bolt passing through the barrel bore. After adjusting for squareness, lock the clamp to the spigot or plug so that it is exactly located for transferring the four hole positions to the main block.

A 1⅛ in. dia. × ½ in. length is machined on the tailstock body to receive the clamp and unit. For turning this step the tailstock body was mounted on a truly running mandrel (Fig. 11). The diameter should be adjusted to offer a slight interference fit to the recess in the main block.

EW tailstock bodies of more recent manufacture are made with a longer barrel holding portion. Either this can be machined away to suit, or the new barrel may be increased in length to compensate.

The machining methods outlined here will ensure that the block barrel bore is in line with that in the tailstock body and that only a minimum closure of the clamp piece will be needed to lock the assembly. Of course, the four screws holding the clamp to the block should not be fully tightened until after the clamp screw has been tightened.

Below, Fig. 12: Lock lever of the tailstock



Purpose of eccentric bush

The presence of the eccentric bush makes it impossible to screw up or unscrew the pinion shaft extension piece when the shaft is in position, and so this should always be inserted or removed from the rear, together with the rear bush. On assembly, the rear bush must be twisted so that its eccentricity setting corresponds with that of the front bush.

The lever bolt in Fig. 12 was made for comfort when locking the body to the lathe bed. The socket screw seen at the nose end of the tailstock body (Fig. 8) is for locking the barrel.

A piece of brass is interposed to prevent marking. Although it grips well enough, it is not very convenient to use, but as a wing screw looked horrible I left the problem to the friend for whom all the modifications were carried out. After all, he had said that he would be glad if I left him something to do. ■