A COMPACT MICROMETER BORING HEAD

by G.A. Harding

Part 1

THE DESIGN OF a boring head for my Unimat 3 involved a good deal of "head scratching" (and sometimes hair tearing!). I first consulted *Model Engineer*, and found Mr. B. R. Davies' excellent design (Volume 146 No. 3644) for modifying the Unimat 3 topslide. But I do feel it had some disadvantages, apart from the obvious one of having to buy another topslide.

1. Balance. I needed a head that would remain stable at all speeds.
2. Size. Mr. Davies' design was of necessity rather long. I wanted to keep the business end as close to the bearings as possible.
3. Accuracy. The Unimat top slide is graduated in 0.1 mm divisions, so 1 division increase would produce an increase of 0.2 mm on bore size. I needed something with an accuracy of at least 0.1 mm.

With all these points in mind, I remembered a design of head I watched my father use while I was an apprentice. It was adjusted by turning a scale running right round the body. I later used them myself and found them easy to adjust and very accurate. The only problem was, how did the blooming thing work? The sight of a spotty young apprentice pulling a precision head apart "just to see how it works" would have resulted in the shortest apprenticeship in history! So I never found out, but a root round in my father's tool box (he is now retired and losing tools fast) produced a set of tools for this type of head, and I set out to design a head around these tools. I am not much of a draughtsman so a few sketches were made and the details left to sort themselves out "on the bench". After a fortnight of flying swarf and flying curses, a working head was produced. However, there had been a number of "design modifications" along the way, so I decided to remake the job properly incorporating other modifications shown to be necessary during tests with the original.

Materials

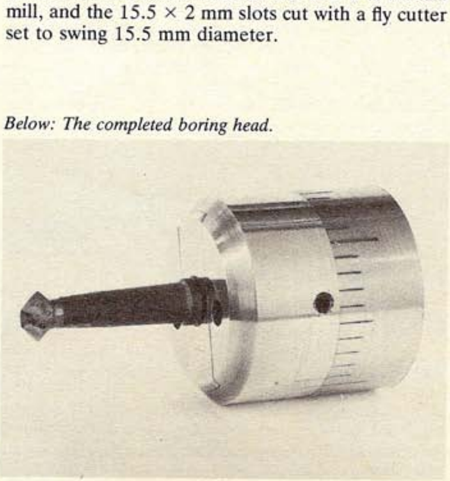
I have used brass for the exterior and steel for the interior which could be case hardened, but these materials were used simply because they were to hand at the time. The exterior could be made from Dural, or even nylon, although I think brass makes a better looking job.

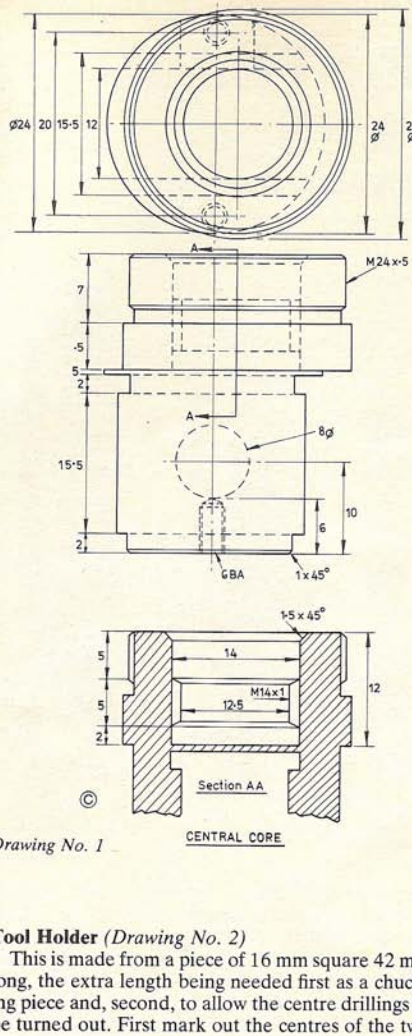
Central Core *(Drawing No. 1)*

First, bore and thread cut a piece of 30 mm mild steel 33 mm long as section AA, making sure you go no deeper than 12 mm with a flat bottom to maintain the 0.5 mm wall separating the bore from the slide beneath. The job may be screwed to the spindle nose, the 24 and 25 mm diameters turned and the 30 mm dia. just cleaned up (no deeper than 29 mm dia.). Do not cut the M24 thread yet as you will have to hold on this area for further operations. Now hold in the four jaw chuck to turn the 24 mm dia. offset by 2.5 mm (photo 1). If, like me, you possess a clock with a 5 mm range this job is a piece of cake but, if not, you will have to rely on the cross slide, e.g. touching the tool on the high spot of the job, turning 180 deg. and noting how far the slide may be advanced before it touches the job again. Make sure that the job is firmly back against the chuck to keep everything square. When this balancing act is complete, centre deeply, support with the tailstock and turn to size and length.

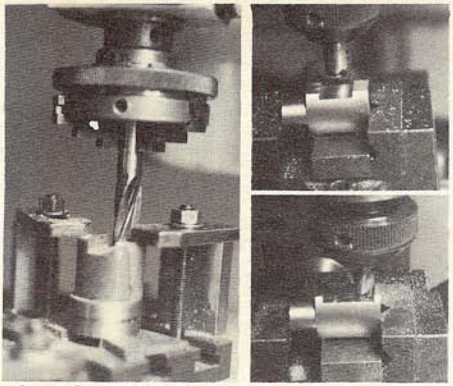
The 12 mm slot is now cut (photo 2) being careful to get it exactly parallel with the 2.5 mm offset, the job being held to the table by the stud in the top of the milling column with a clamp each side just to make sure. The slot was milled out with a 3/8 in. end mill, and the 15.5 × 2 mm slots cut with a fly cutter set to swing 15.5 mm diameter.

Below: The completed boring head.





Drawing No. 1



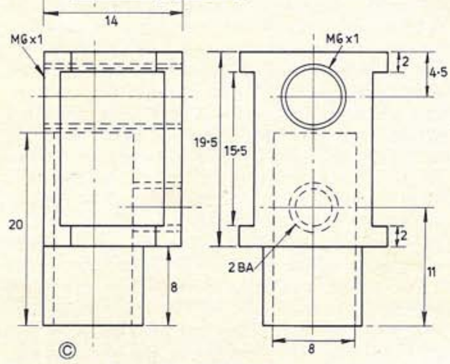
Above, photo 2. Top, photo 3, bottom, photo 4.

Tool Holder *(Drawing No. 2)*

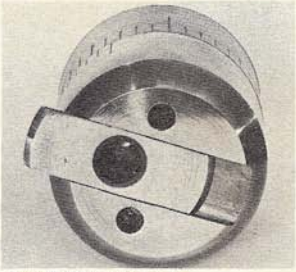
This is made from a piece of 16 mm square 42 mm long, the extra length being needed first as a chucking piece and, second, to allow the centre drillings to be turned out. First mark out the centres of the two 12 mm radii and the 8 mm tool hole. Now, holding in the four jaw, true up one of the 12 mm radii, centre lightly and support with the tailstock for turning. Repeat for the other radius and finally centre the 8 mm dia. tool hole. Turn the 10 mm dia. deep enough to remove all the previously drilled centres. Face the front as close to the centre as possible, then drill and bore the tool hole 6 mm dia. for now. The job can now be cut from the chucking piece, and faced to length. The machine vice can now be set up for milling the sides (all measurements coming from the 10 mm dia. boss), roughing out with a small fly cutter and finishing with a Clarkson "throwaway" cutter (photos 3 and 4). Everything was left a little tight and finished by hand with the aid of a file and smear of high spot.

Continued

Below: Photo 1.



Drawing No. 2



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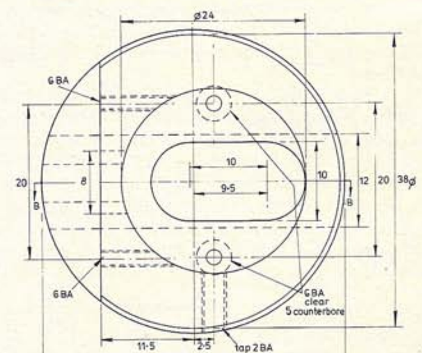
Part II (Conclusion)

From Page 693

Outer shell *(Drawing No. 3)*

A 46 mm dia. piece of brass 30 mm long is bored 24 × 20 mm deep then clamped on the milling table for drilling the securing holes and milling the 10 mm and 12 mm slots. The fixed jaw may now be removed from the machine vice, to hold the body as in photo 5, to mill the 12.5 mm step, using a large fly cutter to rough out, and (photo 6) finishing with an end mill.

The central core is now to be placed in the machine vice and clocked true. The outer shell can now be placed over the top and the 12 mm slot clocked true and clamped lightly; the securing holes may now be pricked through, the shell then removed and the 6 BA holes drilled and tapped. The core, tool holder and shell can now be assembled and screwed to the dividing head, making sure that both the core and shell are set exactly vertical. The holes for the tool clamp and slide lock may now be drilled, and also the hole for leadscrew may be drilled 5 mm dia. right through the shell and through the tool holder, then open up the shell to 8 mm. Start the tap in the drill chuck to keep it square, everything can now be stripped down, cleared of swarf and finish tapped.



Drawing No. 3

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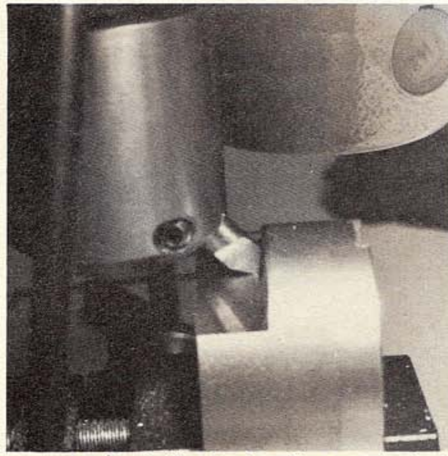
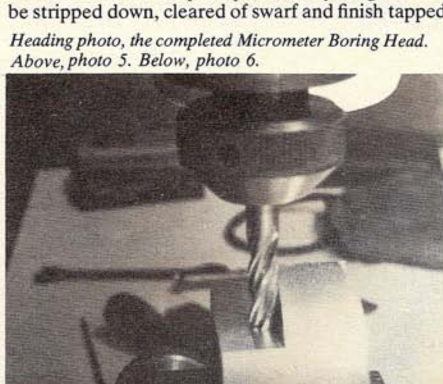
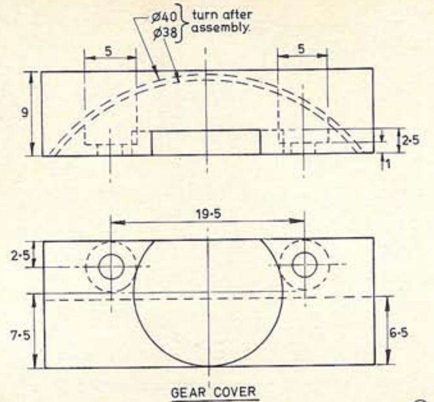
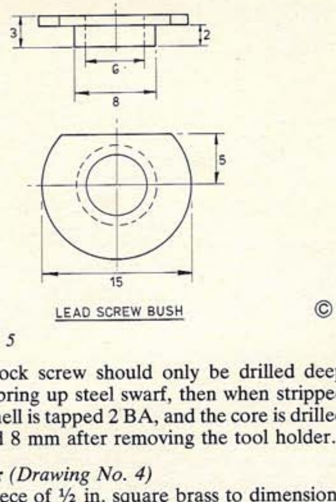


Heading photo, the completed Micrometer Boring Head. Above, photo 5. Below, photo 6.





Drawing No. 4



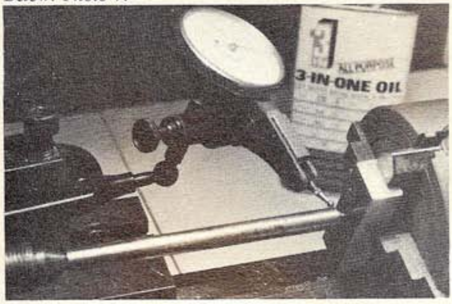
Drawing No. 5

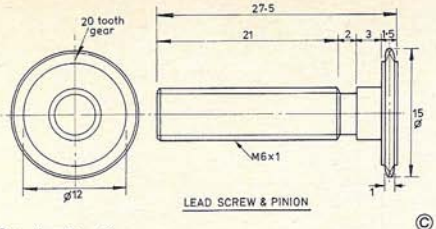
The slide lock screw should only be drilled deep enough to bring up steel swarf, then when stripped down the shell is tapped 2 BA, and the core is drilled and reamed 8 mm after removing the tool holder.

Gear Cover *(Drawing No. 4)*

Face a piece of ½ in. square brass to dimensions shown and mark out the securing holes and the 15 mm dia. bore. I use a 6 mm wobble bar to locate centre pops like this as photo 7. Bore 15 mm dia. by

Below: Photo 7.





Drawing No. 6

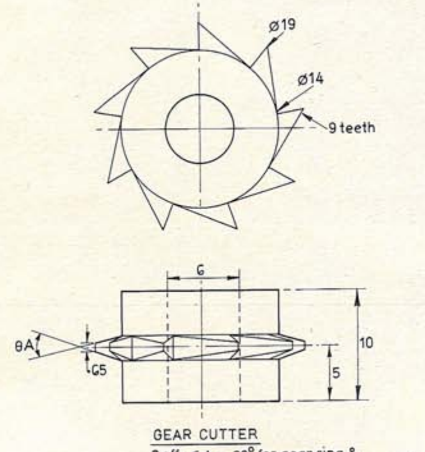
12.5 mm deep, drill the 6 BA clear by 5 mm counterbore. The leadscrew bush may now be turned up and pressed into the shell, the gear cover placed over the top and the securing holes pricked through, drilled and tapped.

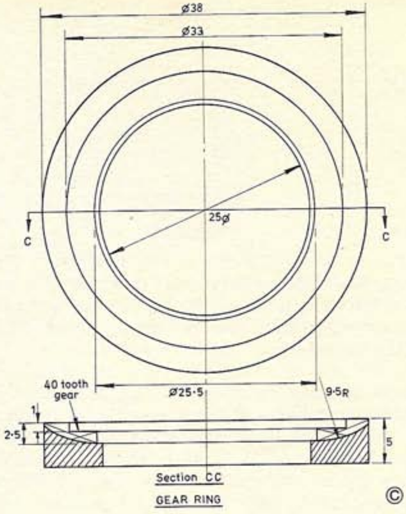
Leadscrew and Gear Ring *(Drawing Nos. 6 and 7)*

These are both fairly straightforward turning jobs, the only awkward part is actually cutting the gears. Much has recently been written about gear cutting which makes my method look like mechanical butchery, but my motto has always been, "if it works, don't fix it"! So my method is to turn up a cutter as shown and cut the tooth 1.5 mm deep, finishing by hand with a needle file, photo 8 shows the gears being cut.

Finishing of the Body

Everything can now be assembled for final turning, including the gear ring which is used to set the tool holder on centre, where it is locked, and finally bore to size. The exterior can now be turned as the drawing, with the slide cover in place simply pressed over the 10 mm dia. of the tool holder. At this stage the 24 mm dia. can be threaded M24 by 0.5 mm, using a 20 by 20 by 20 mm Dural block behind the tool to get it close enough to the headstock.

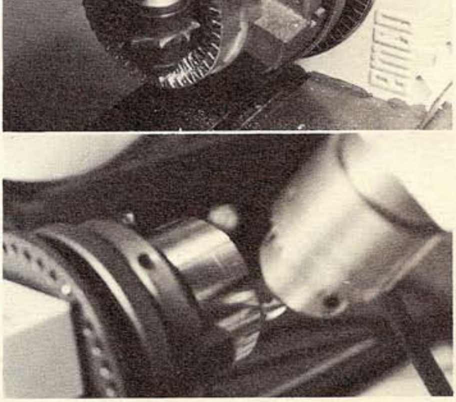


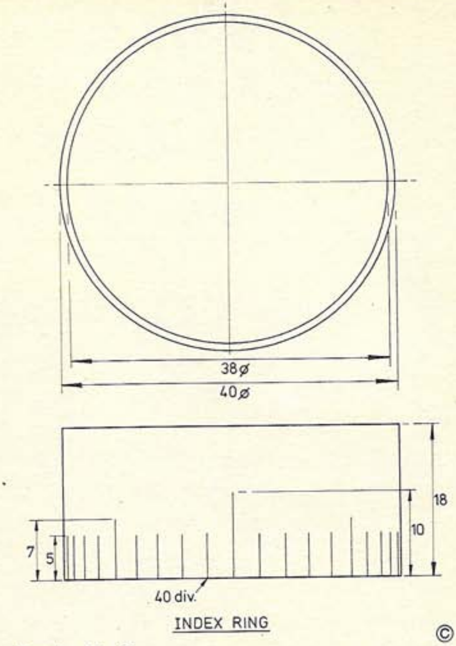


Drawing No. 7

Index Ring *(Drawing No. 8)*

This is simply a 40 mm dia. tube bored 38 mm dia. Bore the first 6.5 mm, 38 mm + 0.01 mm and the rest 38 mm — 0.01 mm, then the gear ring may be pressed in using the body as a mandrel to maintain the position, a drop of Loctite 601 will make sure of things. The outside is now blued up and three rings scribed around the outside for the engraving. I engrave scales with an end mill turned at 45 deg.





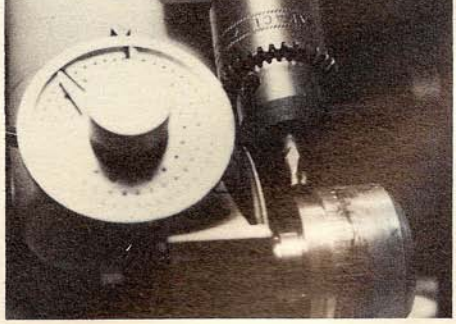
Drawing No. 8

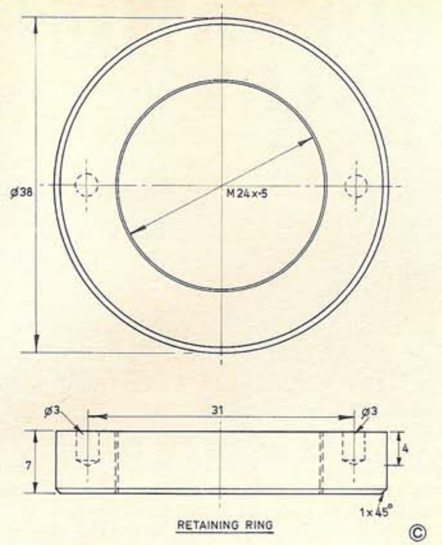
(photo 9). So, set up the dividing head with the 40 mm hole plate in place and engrave four long lines at 0 deg., 90 deg., 180 deg., and 270 deg., then engrave four off 7 mm long lines at 45 deg., 135 deg., 225 deg., then all that remains is to fill in the gaps with short lines.

Vernier Scale

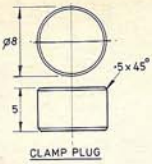
For this you will probably have to enlist the help of a friend with a larger lathe, but as I had already made a dividing attachment for the Unimat I was able to do this. It can be observed that 10 Vernier divisions will cover 9 scale divisions, therefore each vernier division

Left top: Photo 8. Left bottom: Photo 9. Below: Photo 10.

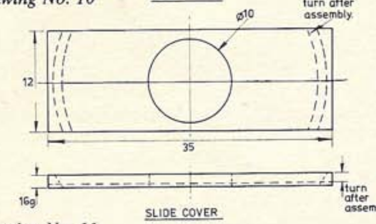




Drawing No. 9



Drawing No. 10



Drawing No. 11

SPECIFICATION.

Height	40 mm
Diameter	40 mm
Tool travel	10 mm
Tool hole diameter	8 mm
Graduation	·1 mm (·01mm with vernier) on diameter.

Use 6BA cheese head screws for securing and 2 BA Allen grub screws for slide and tool locks.

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is equal to $\frac{9}{10}$ of a scale division. Since there are 40 divisions on the scale and 40:1 is the ratio of most dividing heads, therefore one vernier division = $\frac{9}{10}$ of one turn, so any ring of holes divisible by 10 will serve. e.g. $\frac{18}{20}$ or 18 holes on a 20 hole plate, the engraving is done in the same manner as the Index Ring (photo 10).

Final Jobs

The last component to do is the retaining ring which is turned and threaded 24 mm by 0.5. A good fit on the core, two holes are drilled in the top face to allow it to be tightened with a pair of circlip pliers. Everything is now assembled and lightly greased. Lastly a block of Dural was faced up and drilled to take the head and its set of tools (photo 11).

Conclusion

I hope this tool will make a useful addition to excellent Unimat 3 machine and scaled up to about twice the size, could be useful on a larger lathe, perhaps mounted on a No. 1 or 2 Morse Taper.

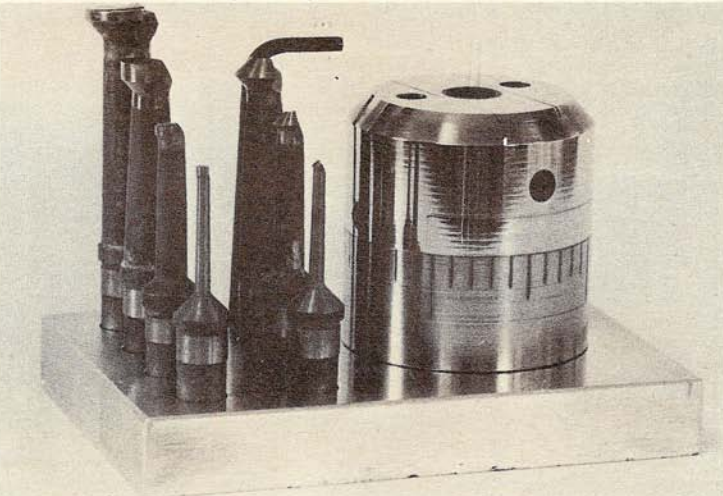

Photo 11.