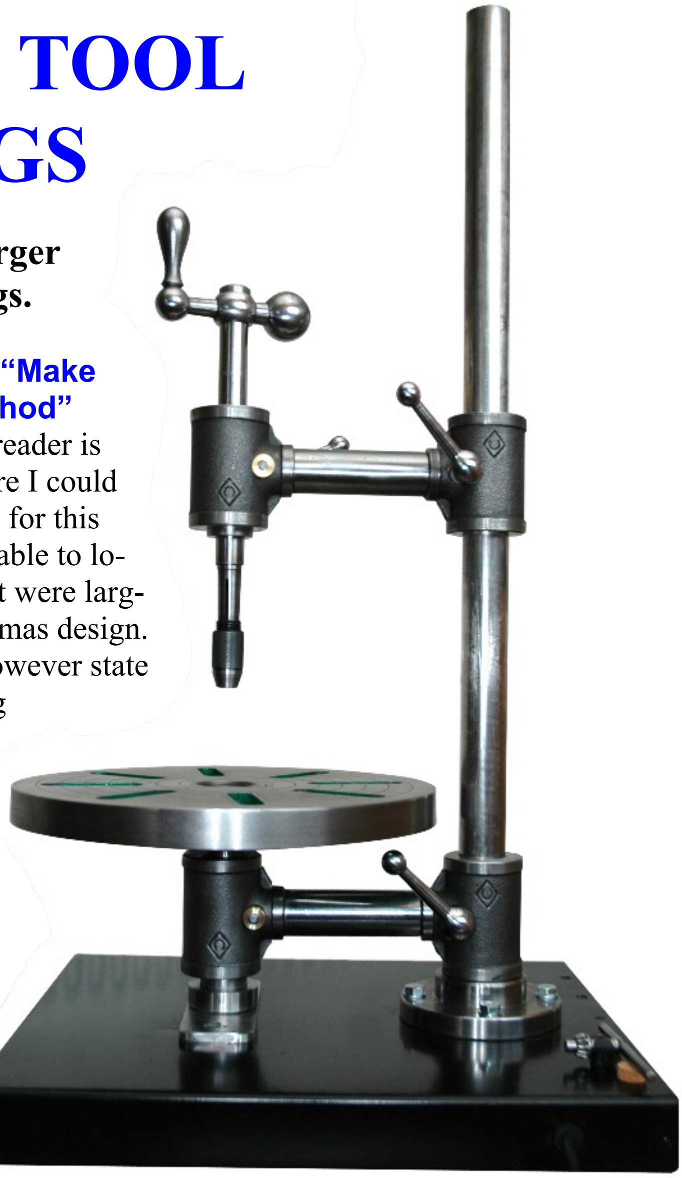
MAKING A PILLAR TOOL WITHOUT CASTINGS

David Haythornthwaite describes making a larger than usual pillar tool without the use of castings.



I had been thinking for some time of making a pillar tool as designed by George Thomas and available in kit form from Hemmingway. My problem was however, that I had always considered this to be a little on the small side for my requirements. I already had a 9” (228 mm) diameter lathe faceplate that had been given to me and which I had screw-cut to fit my Myford ML Super7B. It would be ideal if this could double as a pillar tool table. I also had a motorised sensitive drilling head which had been adapted from a very broken cloth drill – used in the clothing industry. Unfortunately both of these items would require the tapping arms to have a reach of 5½” (140 mm) between centres as opposed to the George Thomas design which has a reach of 3½” (89 mm) between centres.

Designing by the “Make Do and Mend Method”

I am sure that some reader is about to tell me where I could obtain some castings for this project, but I was unable to locate any castings that were larger than the Geo. Thomas design. Hemmingway did however state that this is something that they had been considering offering for some time. I considered various design ideas – including the design by Harold Hall in MEW Issue 105, but I prefer a round pillar so that the arms may be swung out of the way.

Whilst considering how I could make the arms with my poor welding ability, I looked at a cast “Steam Tee” in a box of steam pipe fittings at work and I considered that two of these could be utilised to make an arm for a tapping tool / pillar tool. I therefore visited the local suppliers of steam fittings and purchased two 1” x ½” steam tees as illustrated in **Photo. 1.** The 1” and ½” dimensions refer to the

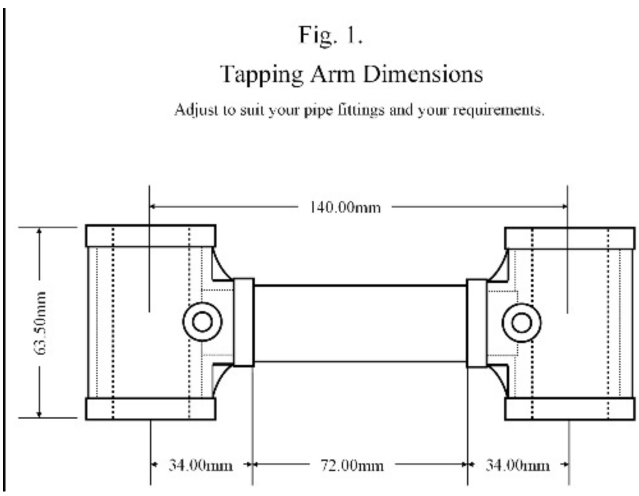


Photo.1 The Original Pipe Fittings

Photo. 2 Boring Out for the Pillar Sleeve

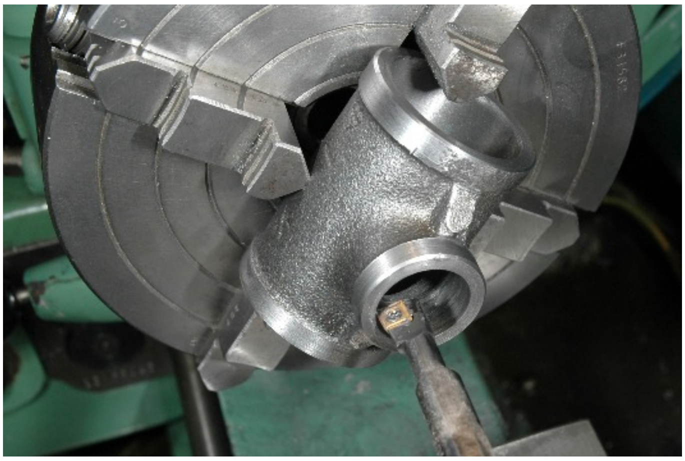


Photo. 3 Boring Out for the Cross Arm

inside diameter of the **pipe** not of the Tee fitting. If you intend to follow my method, I recommend that, if possible, you obtain the type with the small fillet between the vertical and horizontal sockets. Steam tees are available, in Britain, both with, and without the fillet. They are not expensive and I obtained two as a trial for £1.90 each. **Fig 1.** shows the dimensions that I was aiming at, but you will have to adapt these according to the tees you are using and the required reach that you require. I decided to use a 1" (25.4 mm) stainless steel column 20" long (508 mm).

I decided to start by, in effect, making a solid "casting" by boring the tees and filling them with steel, then boring the resulting arm to fit on the pillar. I considered that the best plan was to make the parts a good push fit and to Araldite (slow 2 part epoxy) the whole thing together. As the clamping arrangement is to be of the type which embodies a sliding brass cotter to press on the pillar, it was necessary to ensure that the inside of the tee was completely filled with steel, so that the clamping arrangement was not situated in a void.

Adapting the Pipe Fittings

The first task was to remove the threads from the ends of the pipe fittings and to obtain a smooth bore. I placed the 1" end into the 3 jaw chuck on the Myford, using the outside jaws and lined it up by inserting a large diameter rotating tailstock into the other end whilst the chuck jaws were fairly slack. Upon tightening the 3 jaw chuck, the fitting ran quite true and turning could begin. The first point to make is that a fairly rigid boring tool is necessary as the pipe fitting is 63.5 mm long and therefore you need to have a boring tool with this reach. With the lathe stopped, first, wind the boring tool fully into the pipe fitting until it touches the chuck jaw. Then back the saddle away from the chuck by a few thou and set either a saddle stop or set the DRO / dials to zero. Check it again and turn the lathe by hand to ensure that the tool is not touching the jaws. Withdraw the boring tool and bore right through, increasing the diameter until you have a smooth, accurate bore from end to end as in **Photo. 2.** In my case this was 35.2 mm diameter. At the same time, clean up the outer diameter at the end of the fitting so that you have a collar that is symmetrical to the bore. Also face the end. Apart from making it look good, it means that you can now reverse the fitting in the chuck and have a reasonable chance of it running true. Make a note of the outside diameter so that you can make both ends the same size. Now reverse in the chuck and finish the other end. Tidy up the last few thou of the bore, turn the end collar to the same outer diameter as the first end and face off the end. Mine came to exactly 2½ " long which I show as 63.5 mm.

Now mount the fitting in the 4 jaw chuck as shown in **Photo. 3** in such a way that the ½" outlet is facing the tailstock and in line with it. I sat the fitting into the jaw grooves of the chuck and pushed it back with a large rotating centre. Upon tightening the jaws it ran surprisingly accurately. My pipe fitting had nicely chamfered ends to the threads which is important if you use this method of alignment. If you didn't make both end collars of the larger bore the same size, then it will not sit at right angles in the chuck when aligning by this method. Bore right through into the larger bore and note the inside diameter so that you can make the second tee fitting exactly the same size. Mine was bored to 21 mm. It is not important if the two tees have different bores, it just makes producing the sleeves and cross arm more convenient. Clean up the outer ring and face off the end. Now do the same to the second pipe fitting.

Joining the Tees Together

I was now faced with the task of completely filling the inside of both pipe fittings with steel to make a solid unit. First I made the cross bar to join the two pipe fittings together. This is made from a 118 mm length of 1" Dia. (25.4 mm) free cutting mild steel (FC-

Photo. 4 The Arm Ready To Insert The Sleeves

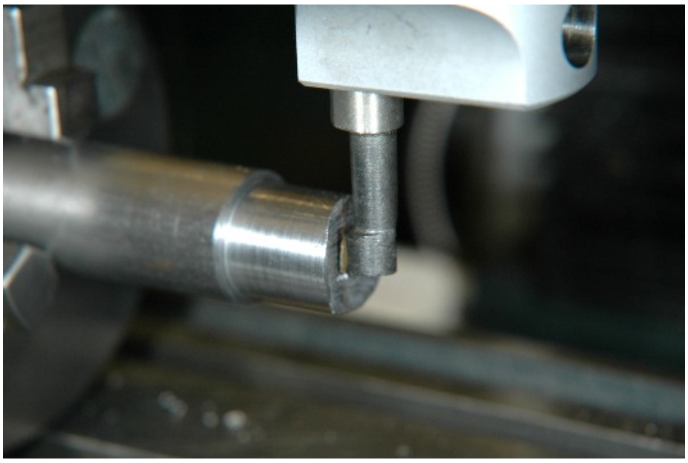


Photo. 5 Curving The Ends of the Arms

MS). This was reduced at both ends to a whisker under 21 mm Dia. for a length of 23 mm. I used the previously bored pipe fittings as a gauge to ensure a tight sliding fit.

Having turned down both ends of the cross arm you will be left with a central spacing length of bar which is 72 mm long and 25.4 mm diameter. Ensure that the central part is long rather than short. This should be just slightly too long to give you 140 mm centres on the final pillar arm. Assemble the unit dry and you will have something similar to that shown in **Photo. 4.**

Clamp together and carefully measure between the insides of the large bores. Add the diameter of ONE bore and you will have the centre spacing measurement – which should be just over 140 mm. Return the cross bar to the lathe and adjust the shoulder of the central, spacing, portion so that the three pieces will clamp together at exactly 140 mm. The central part on mine needed to be 72 mm but a millimetre either way is not important as it may be corrected during boring of the sleeves. The ends of the cross bar will stick out (or is it in?) into the main bores and the next task is to curve the ends of the cross bar so that they will be a snug fit up to the sleeves which shall be inserted into the large bores. Mark both pipe tees and the ends of the bar so that you can identify them and ensure that they will always be mated in the same way. Also mark the top of the cross bar in some way at both ends of the central portion.

Mount the cross bar horizontally on the milling machine table either by securely clamping on V blocks or, as in my case in a chuck on a rotary table. Mount with the top line at the top. Now place the appropriate pipe tee on the end of the bar and place parallels and shims under the tee so that the tee is supported and the bore is vertical. Adjust a boring head to the diameter of the pipe bore and lower it into the tee with the machine at rest. Spin the mill by hand – preferably backwards, to ensure that the boring tool would in fact bore the bore of the pipe fitting at that setting. Lock the Y direction and take a note of the DRO / Dial settings in the X direction. Raise the milling head to remove the tee and move the table left in the X direction.

Mill the end of the cross arm curved using the boring head, taking small cuts with this intermittent cut. Be particularly careful that the shaft is clamped securely if using V blocks. Move the table slowly right until the DRO / Dials

Photo. 6 The Curved Crossbar End

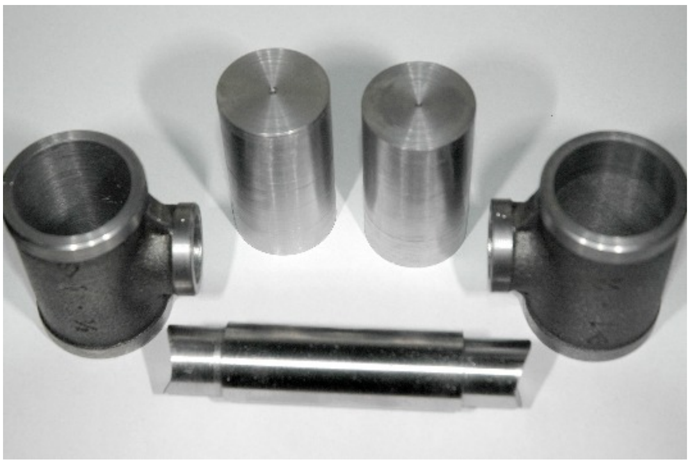


Photo. 7 The Parts Before Assembly

read the same as previously noted. If you place the tee on the end of the shaft now, it should appear as in **Photo. 6**. Reverse the shaft and mill the other end in similar fashion, making sure that the two ends are in line by utilising the "top" marks on the shaft.

Filling in the Bores

The next job is to make two steel cylinders to completely fill the large bores in the pipe fittings. The bores on mine were 35.2 mm, and my bar stock is all imperial, so I cut off a length of 134 mm of 1.5" (38mm) Dia. FCMS which would make the two sleeves needed for one arm. I faced , then centred both ends with small centres and, mounting the bar in the 3 jaw Self Centring (SC) chuck, using outside jaws, I turned the bar down to 35.1 mm for a distance of 67 mm from each end in turn. Parting the bar in the centre gave me two cylinders 35.1 mm Dia. x 63.5 mm long that were a nice tight push fit into the bores of the pipe fittings. Any reader making these arms will perhaps be tempted to bore the sleeves at this stage whilst the bore may be done in the lathe. Always more satisfying boring in the lathe than using a boring head in the milling machine. However there are two reasons to leave the boring until after assembly. Firstly, if the sleeves were bored and then inserted in the arms, you would have no proof that the bores would be parallel to each other in the final assembly or that they would have the correct centres of 140 mm. It would all hinge on the assembly of the parts. The second reason for delaying boring until after assembly is dictated by the proposed method of clamping the arm to the pillar and to the table support. The clamping arrangement requires that an internally threaded brass bar of ½" (12.7 mm) Dia. is inserted into a ½" Dia. hole bored across the pipe fitting and the sleeve in such a way that the boring of the sleeve also cuts away a curved section of the brass bar. This creates a brass wedge or cotter which can be tightened onto the pillar by a bolt drawing the brass cotter into contact with the pillar. At this stage of construction you will have 5 parts for each arm as illustrated in **Photo.7.** These must be degreased with something like cellulose thinners, lightly smeared with 2 part Epoxy resin such as Araldite and everything assembled, making sure that you assemble the correct pipe fitting onto the correct end of the cross arm. It pays to mark with punch marks not with felt tip that you would remove during cleaning. I clamped the whole thing onto a surface plate with a piece of A4 paper to protect it from the epoxy. The setup is shown in **Photo. 8** and in addition to the "G" cramps clamping the pipe tees to the surface plate, there is a woodworking clamp holding the two pipe tees firmly onto the cross arm. Use SLOW Araldite as it is so much stronger than the RAPID variety and put the whole thing in a warm place for curing. At the outset I wondered about the potential strength of this construction, but it has proved to be incredibly strong and rigid. As they say in Lancashire, - "Built like the proverbial brick outhouse".
Now the order of machining will be that, after assembly with epoxy, the cross holes must be drilled in the arms first, to take the cotter pins. The brass cotters must be pulled tightly into the holes by bolts, and the main bores undertaken with everything assembled together so that the curves are cut on the brass cotters to exactly match the bores of the sleeves.

Making New Accurate Bores

Once the epoxy had fully cured I cleaned off the paper and excess adhesive and mounted the assembled arm on the milling machine table. I clamped the arm on two parallels to raise it clear of the table and ensured that it was parallel to the T slots in the table. I found the centre of one of the blanked off bores, using an edge finder and drilled, then reamed a 12 mm hole right through. Then using the dials or DRO according to your equipment, it is necessary to move the table EXACTLY 140 mm in the x

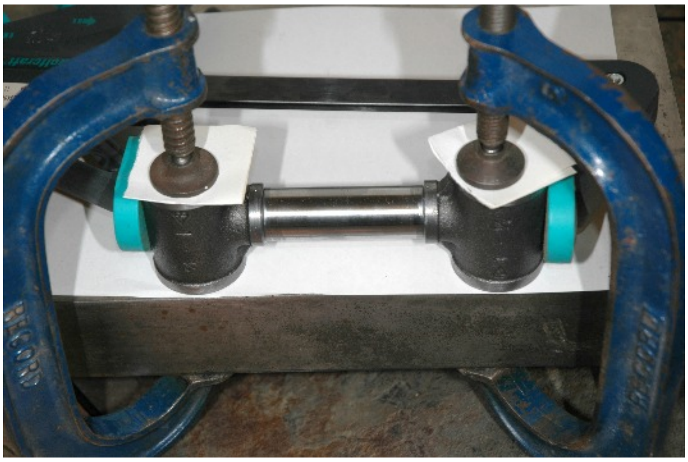


Photo. 8 Assembling with Epoxy Resin

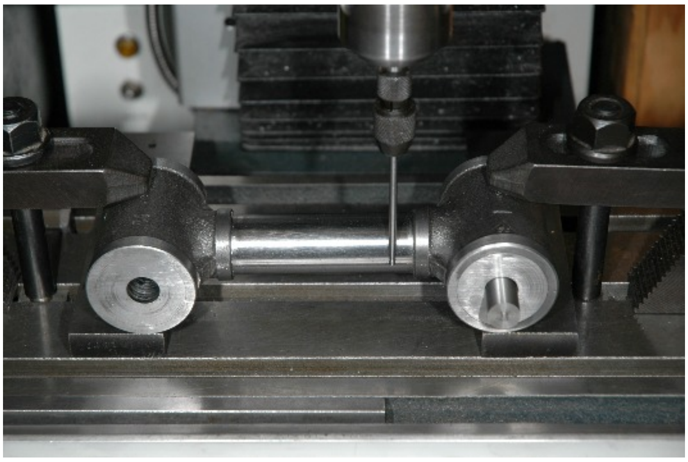
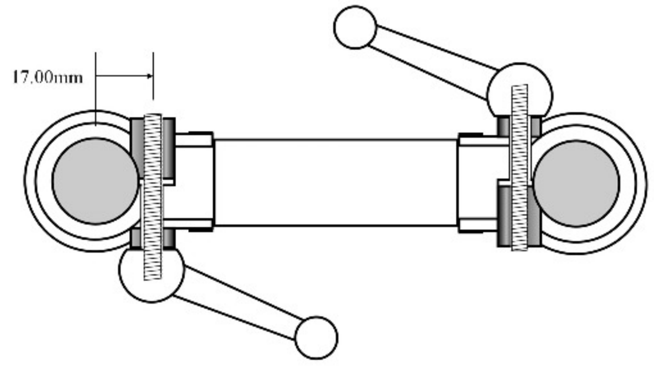


Photo. 9 Using a Wiggler to Centre The Bar

Fig. 2.
Section Through Brass Cotter Clamp



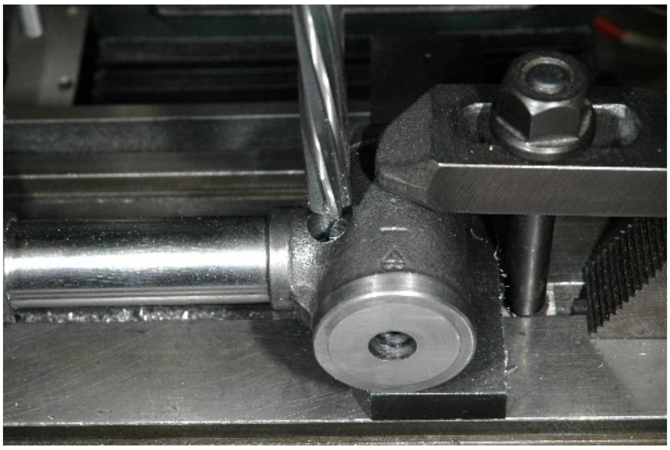


Photo. 10 Reaming the Hole for the Brass Cotter

direction and then drill and ream the 12 mm hole in the other end of the arm. Choose a suitable size for this according to your drills and reamers. I actually used ½”. You will also need a piece of accurate bar of this size and I had some ½” silver steel in the drawer. We do not want bigger holes than 12-15 mm at this stage as we have to fit the brass cotter clamping devices prior to boring out to 25.4 mm Diameter.

Fig.1 illustrates the relationship between the pinch bolt assembly and the 1” bore. The drawing shows a ½” (12.7 mm) brass cotter (wedge piece), drawn in by a 6 mm bolt. The measurements here are critical and it is worth taking some time to be sure that the distance between the centre of the main 1” bore and the centre of the cotter bolt assembly is exactly 17.0 mm. Place a short length of 12 mm silver steel through one of the 12 mm bores that you have created and lay the arm on it’s side on the milling machine table, supported on two parallels as illustrated in **Photo 9**. I have a DRO on my milling machine, so I shall describe the method using this, but using the leadscrew dials is just as effective although you have to be rather more careful.

Line up the arm with the T slots and find the edge of the cross bar using an edge finder or wiggler as in the photo. Touch the edge and zero the DRO Y reading. Cross over to the back and touch the rear of the cross bar. Half the Y reading on the DRO and you now have the centre of the bar at Y=0. Do the same with the 12 mm silver steel bar protruding from the bore but setting the X reading. This will give you the centre of the bore at X=0. Move to X=0 Y=0 and you are at the centre point of the bore and in line with the cross bar. Now move the table 17.0 mm to the right in the X direction and this is the place for the pinch bolt. Lock the table.

The surface of the Tee is curved at this point, so use a slot drill to create a ½” (12.7mm) Dia. flat area and then, after re-checking the dial readings, start with a slocombe (centre) drill and then drill right through at 6 mm dia. Now use a 12mm drill to drill halfway through i.e. to a depth such that the large diameter section comes to the centre line of the unit, then follow this up with a ½” (12.7 mm) reamer for the brass cotter. The bottom of the large hole will be angled – not flat – but this is ok at this stage. We shall use a ½” end mill to flatten this out AFTER boring the main bore. Now move over to the other end of the arm and line up in the same way. Alternatively move the table (140 - 17 – 17) = 106 mm (to the right in **Photo.10).** Please note however that it is more convenient in use if you have the two ball handles on opposing sides of the arm as in **Fig. 2.** so with the second hole, simply make a ½” Dia. flat area and drill right through for the pinch bolt.

Turn the arm over and drill and ream for the ½” brass cotter on the second end, using the through hole to line it up. On the first end it is only necessary on this side to make a ½” flat area for a thick brass washer underneath the ball handle.

The next task is to make the brass cotter clamping devices and to fasten them in place prior to boring the 1” (25.4 mm) bores. I chucked a length of ½” brass bar in a collet chuck but the 3 jaw is perfectly adequate. Drill 5.2mm - tapping size for a 6 mm thread for a depth of 25 mm and run straight in with a sharp plug tap guiding it from the tailstock. Chamfer the end of the bar slightly and part off to a length of 18 mm. Reverse the piece in the chuck and remove any burr on the other end. After parting off I ran the tap down by hand again just to clean up the thread after parting off. Note that the outer end should be chamfered for aesthetic reasons, but the inner end is left virtually square. Make the second cotter in the same way, and while you have the brass bar handy, make two thick brass washers 6 mm thick. This time drill through at clearance size i.e. 6 mm.

Put the cotters in the holes in the Tees and use two temporary 6 mm

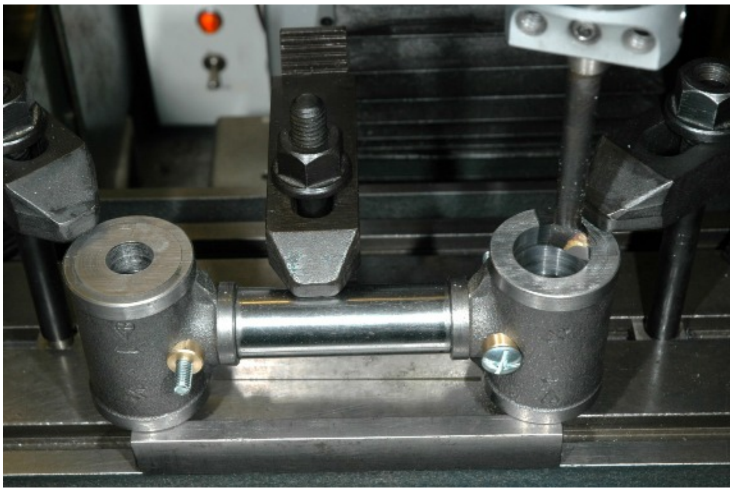


Photo. 11 Boring the Main Bores Using a Boring Head

bolts with the thick brass washers to pull the cotters tightly into the holes ready to bore the main 1" bores. The inner ends of the cotters should pull in to the centre line of the arm.

Boring the Main Bores

Having bored and fitted the cotters, the next task is to bore the main bores (1" in my case) which will also shape the curved clamping surface on the brass cotter. Mount the tapping arm on parallels on the the milling table parallel to the T slots once again, but upright this time as shown in **Photo. 11**.

Bore out, being particularly careful as you approach the final diameter. Test regularly for size using an accurate test bar, taking small cuts in the final stages to eliminate any spring in the boring bar. The photo shows me using a Tungsten Carbide tipped tool, but it didn't like the intermittent nature of the cut when shaping the brass cotter and I finished up making a ½" boring bar to fit my boring head, fitted with a tool steel cutter insert.

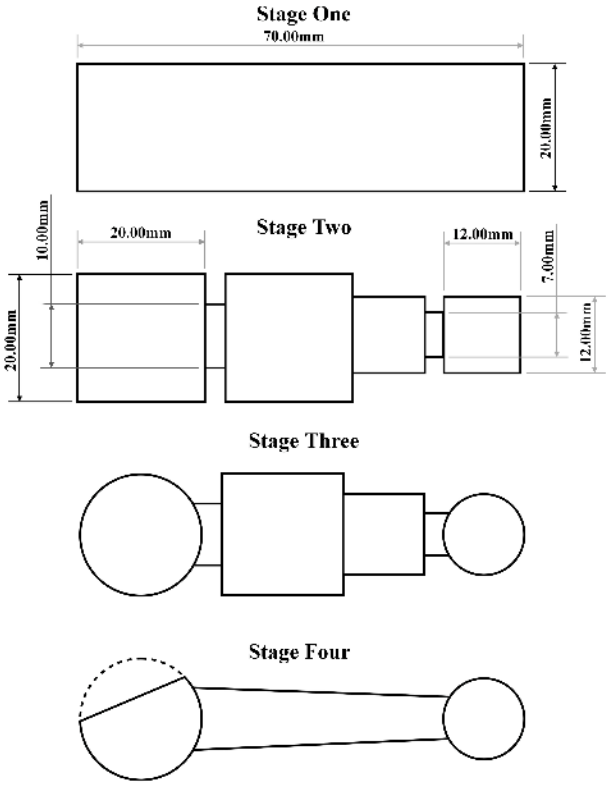
Move across EXACTLY 140 mm and bore the second end. This is your chance to ensure that the two bores are exactly parallel and at exactly the correct centres.

Once you have completed the main bores, remove the cotters ensuring that you know which brass cotter goes into which hole. Mount the arm once more on it's side and run a slot drill or end mill down the cotter holes to make the bottom of the hole square. This will allow the brass cotter to pull further into the hole ensuring that a clamping force can be achieved.

Ball Handles

Of course you may fit any style of handle that appeals to you, but ball handles look so pretty and if you have a ball turning attachment, then I recommend that you fit these and make them in a batch, - I made five. The method of turning the balls will depend upon your ball turning attachment, so I shall not describe this, but **Fig. 4** shows the dimensions that I used and the four stages of making them. The reason for the shape of the central part is to allow the jaws of the vice to grip the central section over the top of an already formed ball in order to turn the second ball. Once you have reached stage 3, you will need a spring cup which fits into the 3 jaw, holding the large ball and preferably a female rotating centre in the tailstock to hold the small ball. This is one good reason for always standardising the size of

Fig. 4.
Stages in Making a Ball Handle



your ball handles. Once thus supported, turn away the centre portion to an appropriate taper using either the top slide or a taper turning attachment.

In order to mill the flats on the ball handles, and to drill for the 6 mm studs, I made two square pieces of MDF and grooved out the shape of the ball handle in such a way that the ball handles could be sandwiched between the two MDF pieces in the milling vice. Each ball handle was thus held at the correct angle with the top of the big ball protruding so that it could be milled away. I then drilled a blind hole 5.2 mm diameter in the centre of the ball and tapped it 6 mm. for the studding. Whilst thus clamped I screwed in a 6 mm x 45 mm setscrew and tightened it up.

Transferring the ball handle to the bench vice, I sawed off the head of the setscrew, then smoothed the end on the belt sander to leave my completed ball handle.

Photo. 12 shows the ball handles in various stages of production.

Photo. 12 Ball Handles in Production

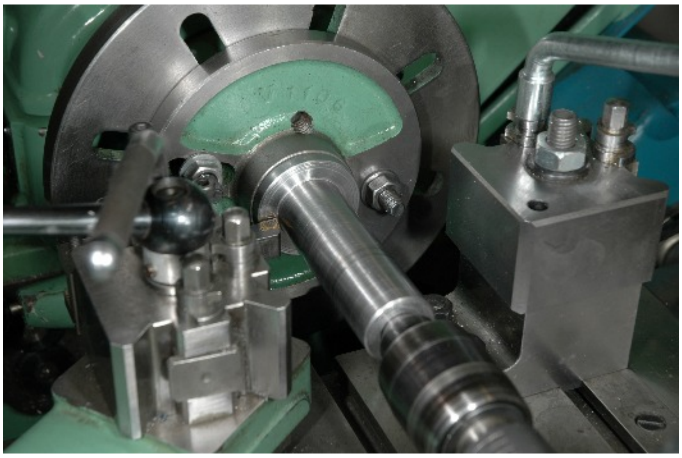


Photo. 13 Turning the Table Boss.

The Stand

The baseplate was adapted from an existing metal baseplate rescued from a skip, in keeping with the policy of using what is to hand, but if making from wood, I would suggest using good quality marine plywood. You will see from the photographs that I made a metal fitting to bolt to the baseplate onto which I can lower the bottom arm when riveting or using number stamps. It is kinder to hammer onto something solid than to let the arm take the strain.

The base for the pillar was turned from a circular piece of cast iron (a small backplate casting) from the "odd bits" drawer and it was then bored to be a close fit onto the pillar which was 1" stainless steel bar. A 3mm hole was tapped in the side of the base and then was fitted with a grub screw which bears onto a small flat milled onto the end of the pillar. The flat is important to stop the grub screw from marking the shaft and causing removal to be difficult. The base was fitted to the baseplate with four 6mm bolts.

The Table and Mounting Boss

As already mentioned, I used a Myford faceplate for the table and I therefore made a boss with a Myford nose on it to support the table. This has the advantage that I can immediately unscrew the table from the pillar tool and fit my lathe chucks or collets in place of the table. To make the boss, I mounted a 100 mm piece of 40 mm diameter F.C.M.S in the lathe chuck and turned a replica of my lathe mandrel nose onto it. I ensured that it was a good fit by screwing my lathe catch plate onto it. Once I was happy with the nose, I drilled the bar right through at ½" dia. using a taper drill in the tailstock.

Once the nose is created, the next process is to turn down the rest of the bar to fit into the end of the pillar tool arm – in my case 1" dia. So that this was concentric with the pre-turned nose, I once more fitted the lathe catchplate to the nose and then reversed the whole thing, bolting it to the lathe faceplate. Take some time ensuring that the catchplate is running true by "clocking" it with a dial indicator. Once it is running true, the shaft may be turned. The setup is shown in **Photo. 13** and the finished boss is shown in **Photo.14.**

The Drilling Head

As already mentioned I had rescued a battered "Cloth Drill" from the skip and I made the drilling head by adding parts to this and repairing the damage. For curious souls who wonder what a cloth

Photo. 14 The Finished Table Boss .

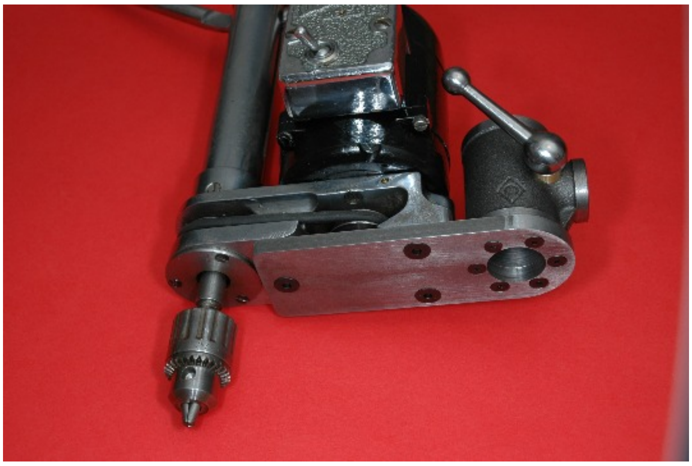


Photo. 15 Mounting the Drilling Head.

drill is, it is used in the clothing trade to drill through the fronts of garments to show the sewing machinist where to fit the pockets. Thus (hopefully) you don't buy a suit with one pocket higher than the other one. As no-one else is likely to have one of these I shall not detail the conversion to a drill head. However, **Photo 15.** shows how the device was mounted by making a single arm end, reversing it, and then attaching a plate with countersunk screws to hold the unit in place.

Holding the Taps

Most tapping tools that I have seen, use a chuck to hold the tap, but I hate using a chuck as they do not adequately hold a hardened tap and the result is often a tap which spins in the chuck.

My favourite tap holder is an Eclipse tap holder number 142 and it holds taps from 12 BA at the smaller end and up to 7 mm at the larger end. This covers most of the tapping that I do, although an additional holder will eventually be made for my larger taps. I have tried cheap tap holders of Chinese origin and have found them very basic and inaccurate. I therefore purchased an "Eclipse 142" and mounted it into a holder as shown in **Fig.3.** The handle of the Eclipse Tap Wrench is case hardened and is 13.8mm Dia. so I bored out the end of a silver steel bar and fitted the eclipse into it using Araldite, 2 part epoxy. I used 5/8" bar for this and it is a close fit to fit this into either 5/8" bar or 16 mm bar. The bar is a sliding fit into a 1" sleeve which clamps into the pillar tool. The sleeve has been made such that the bore at the top is chamfered at an acute angle. When a small "O" ring is stretched onto the bar, it can be rolled up or down the bar, and when the bar is lowered in the sleeve, the "O" ring traps in the chamfered area to stop the bar falling with a crash and possibly breaking a small tap. **Fig. 3.** illustrates this. The handle is an old lathe handle from a car boot sale, in keeping with the project as a whole. The handle is held onto a turned end of the shaft with a 6 mm countersunk setscrew.

Note : - the Eclipse holder will slide out of the 5/8" or 16 mm bore if the cap is removed in order to change tools. It will slide through the main 1" bore with the closing cap in place. A substantial handle as shown is great for tapping with large taps such as 6 mm, but I have made a more sensitive knurled knob 1" dia. for use with smaller taps such as 5 BA or below.

Photo 16 and Photo 17 show the finished article in both Tapping and Drilling configuration. In normal use, both heads are kept on the column all the time and the unused head is swung to one side out of the way. One head was removed for clarity in one of the photos. I am still unsure whether or not to spray the arms and the base with green Hammerite paint, or whether to just keep it oiled and covered.

This project has created a most useful workshop tool by using things that were mainly to hand. I have made many of the measurements vague in the assumption that readers wishing to make this would also adapt the sizes according to whatever they have available and according to whether they work in Metric or Imperial.

Fig. 3.
Tap Holder

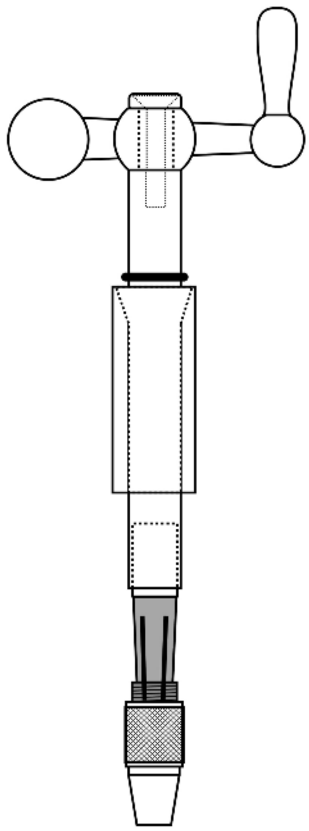


Photo.16 The Pillar Tool Used for Tapping .

Photo.17 The Pillar Tool Used for Drilling.