

No.240

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MODEL ENGINEERS' WORKSHOP

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APRIL 2016

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On the Editor's Bench



On My Bench

I'm delighted to report some genuine metal-mangling in the editorial workshop. As you will read in my report from the Manchester show, I was inspired by a pair of 'Poppin' flame licker engines. This design was originally described by Dr. J.R. Senft in the November 1980 issue of the American magazine *Live Steam*. Progress has been quite good, starting with the cast iron cylinder and piston. I am very pleased with the excellent fit of the piston which, as the original description requires, will drop through the cylinder under its own weight but stay in place if you seal one end of the cylinder with your thumb. I'm now working on the standard, which involves milling or cutting away most of a large lump of aluminium alloy! More news next month, I hope.

Issue 239 - a successful experiment

Last month's issue of *Model Engineers' Workshop* was an experiment, cram packed with short builds and tips. I must admit I have never had so much positive feedback on an issue before, both by email and on the forum, so I'd like to thank everyone who expressed their appreciation.

This month is a return to a more normal balance of articles, but I have tried to include a good sprinkling of short, practical articles. The longer articles in this issue will both conclude next month.

Clearly, though, many readers will welcome more short and to-the-point articles and I would like to include more in the future, but my stock of them is not as big as I would like. But now as you have issue 239 to refer to for inspiration, isn't it time you chose your favourite workshop tool, gadget or tip and wrote it up? I'd also be keen to receive plans and a short description for more simple tools that could be presented as a four-page plan like the boring head in that issue.

Cam Action Lathe Stops

Thanks to Andy P. on the www.model-engineer.co.uk forum for spotting a couple of matters in the lathe stop article in issue 239 that could be clarified. The M6 hole in one half of the body is for the screw that holds both parts together (see matching counterbored hole in the other part) as mentioned on page 16 and illustrated in photo 8. The M3 hole is for a grub screw to lock the screw in place, once you have the device adjusted to suit your lathe. The purpose of reducing the height to 19.5mm after machining the hole for the cam is to make the hole more or less oval, this allows the cam to force the two parts apart when the lever is moved.

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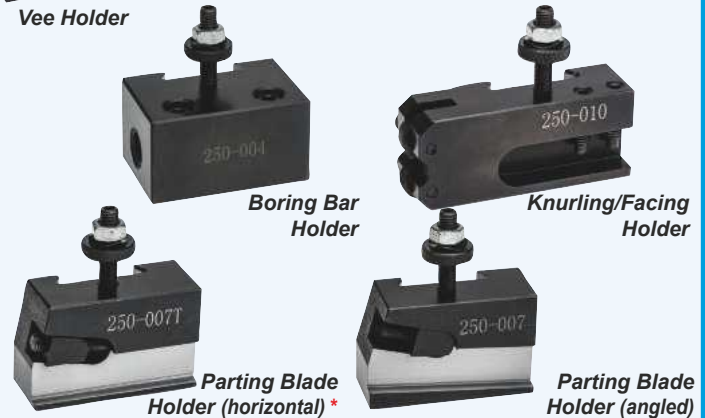
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060-325-39516	S16R-SCLC-R	$\varnothing$ 16mm	CCMT09T304	£21.00

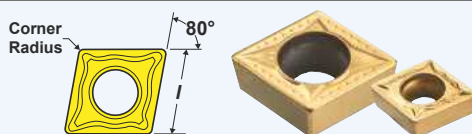
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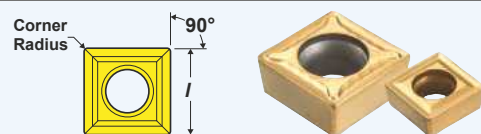
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060-326-10934	1				£3.70
060-326-10936	10	CCMT 09T304	0.4mm		£24.50
060-326-10938	1			9.7mm	£3.70
060-326-10940	10	CCMT 09T308	0.8mm		£24.50

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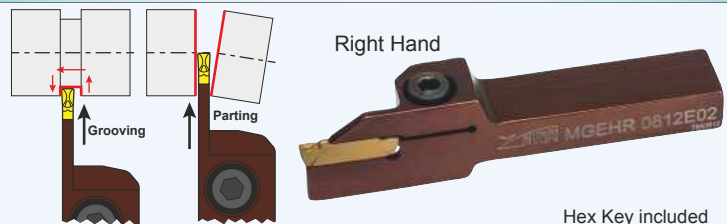
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060-326-11630	10	SCMT 060208	0.8mm	9.525mm	£19.00
060-326-11934	1				£3.70
060-326-11936	10	SCMT 09T304	0.4mm		£24.50
060-326-11938	1			9.525mm	£3.70
060-326-11940	10	SCMT 09T308	0.8mm		£24.50

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060-325-21202	QA 1212 R02	12x12mm		£20.95
060-325-21602	QA 1616 R02	16x16mm		£22.55
060-325-21603	QA 1616 R03	16x16mm	GTN3	£22.55

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060-325-23010	MGEH R 1010 E02	10x10mm		£22.00
060-325-23012	MGEH R 1212 H02	12x12mm		£25.75
060-325-23016	MGEH R 1616 H02	16x16mm		£27.50

MGMN 200 Rectangular TiN Coated Carbide Inserts



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060-326-20202	10			£38.00

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060-326-20012	10				£19.00
060-326-20003	1	GTN3		3.1mm	£3.50
060-326-20013	10				£19.00

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060-320-20012	12mm	15x15mm	80mm	£5.00

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060-325-22210	SLTBN 10 02	10mm			£27.95
060-325-22212	SLTBN 12 02	12mm			£27.95
060-325-22216	SLTBN 16 02	16mm	NCIH 19-3	3mm	£29.95
060-325-22306	SLTBN 06 02	6mm			£26.95
060-325-22308	SLTBN 08 02	8mm			£26.95
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060-325-22008	SLTBN 08 02	8mm			£15.95
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060-320-01008	8mm		£20.00
060-320-01010	10mm		£21.00
060-320-01012	12mm		£21.00
060-320-01016	16mm	M42 HSS-Co8 Blade 2x13x110mm	£25.00

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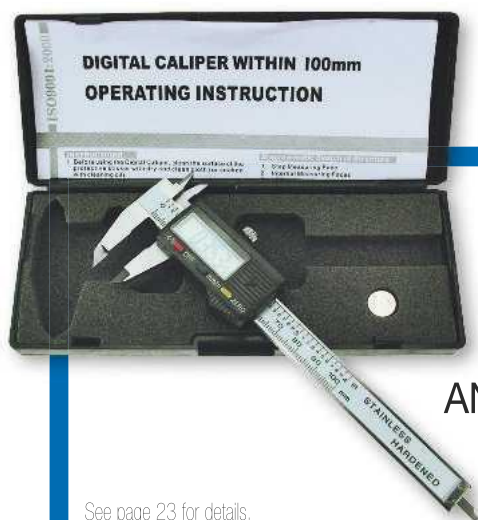
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- 68 A TAILSTOCK CENTRE SET**
Peter Tucker show how you can create an impressive set of accessories from the scrap bin.



Coming up...

in the May issue

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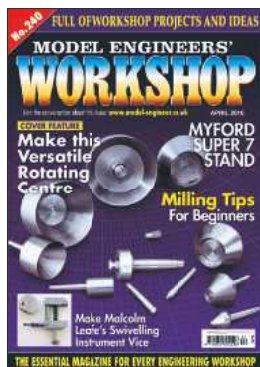
Barry Chamberlain fits a four-jaw chuck to his lathe, John Pace describes a precision cutting head for milling leadscrews and Mike Checkley is back with a slitting saw arbour.

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ON THE COVER >>>

Peter Tucker's impressive tailstock centre and its various accessories is described on page 68.



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Corrected Tables for HV6 Dividing Heads

The tables supplied with some Vertex HV6 dividing heads contain errors – download a corrected version courtesy of Howard Lewis.

Universal Spreadsheet for other Dividing Heads

If you have a different type of dividing head, don't despair – this download Christopher Taylor's spreadsheet and take the pain out of calculating dividing ratios.

Other hot topics on the forum include:

> 'What Did You Do Today' and 'The Workshop Progress' Thread

Give us an update on what you have been up to in the shop!

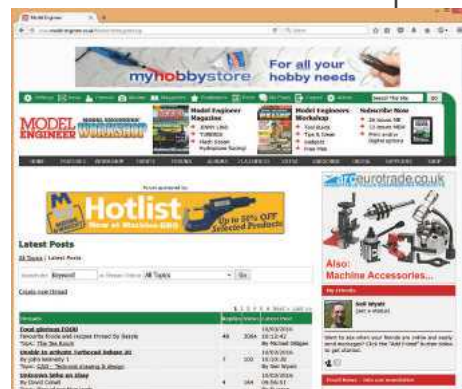
> Stirling Engines

The saga continues – but we now have all three builds working!

AND:

> Motorcycle General Discussion

Come and see some of the wonderful vintage bikes restored by forum members – and a few pictures of mis-spent youth on two wheels!



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A Heavy-Duty Boring Tool Holder



Alastair Sinclair revisits an old design by D.H. Downie.

An email to the Editor in the January *Scribe a Line* (MEW No 237) from David Byways asking for his help caught my attention concerning a boring bar tool holder illustrated in issue 235, pages 64 and 66. This is shown in **photo 1**. The query elicited a reply from Ian Strickland which referred David to an article in *Model Engineer* issues 3465 and 3466 from 1973. These contained an article by D. H. Downie giving details of just such a tool post. Information was therefore forwarded to David from Ian which no doubt helped him to go on and make this.

The Milne Boring Tool Holder

My interest in this was initially aroused because upon reading the email, I remembered that an old text book from 1950, *Machine Shop Methods*, (reprinted in 1998), showed a 'Heavy Duty Boring Tool Holder' which I was sure was similar, if not identical, to the one illustrated in issue 235. I do not have the *M.E.* article to which Ian Strickland referred so cannot confirm if it is the same but it seems very likely given the details illustrated in the 1950's text book (*it does appear to be so - Ed.*). The book, by Lorus J. Milne, was originally an American publication and gives construction details of a good number of tools, jigs and fixtures in Chapter 17 entitled 'Useful Tools and Fixtures.' From this, two line sketches of such holders are reproduced in **fig. 1** where the similarity to the holder in photo 1 is, I think, quite clear. It is described as a heavy duty item providing excellent support for stiff boring bars taking heavy cuts.



The boring bar holder shown in MEW 237 page 34.

Fig. 1



Fig. 8.17. Light boring toolholder.

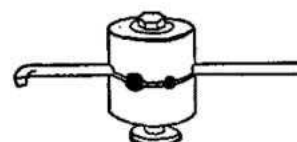


Fig. 8.18. Heavy-duty boring toolpost.

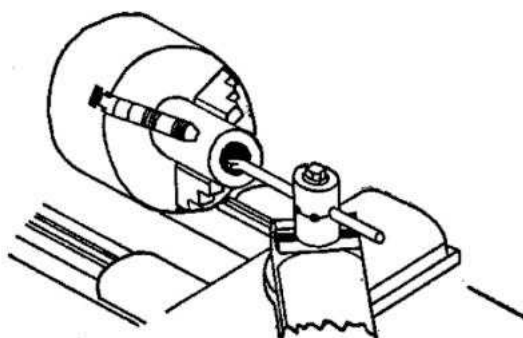


Fig. 8.19. Boring work held in a chuck.

Sketch illustrations of the Milne tool holder in use.

Design and Construction

The design of the holder is shown in **fig 2** which is the drawing scanned from the book. Included with that is Milne's description of its construction

also giving information on the materials required together with an outline of the construction procedure. It is shown with a $\frac{3}{4}$ inch hole to accept a stiff boring bar but also shows provision for smaller

bars of $\frac{1}{2}$ and $\frac{3}{4}$ inch diameter. The work is relatively simple involving a straight forward turning exercise, both external and internal together with thread cutting for the clamping nut. All the dimensions are imperial, which will no doubt suit some

readers, but nowadays most I am sure will be more comfortable with the metric system so conversion to rounded out mm sizes will probably be required to be carried out. It would be necessary in any case for the final dimensions to be worked

out to suit the particular lathe concerned and its cross slide tee slots. That applies especially to the height from the upper surface of the cross slide to the lathe centre line and clearly that's a dimension that would require to be accurately measured taking account of the level of the cutting edge of the boring tool. The dimensions of the tee slots also require to be checked to ensure that a neat fit is achieved to anchor the holder to the cross slide.

The design taken from the book shown in fig 2 is not visually correct in that the parting tool cut to the outer cylindrical part (into parts B and C) required by the construction procedure is not shown. As shown the tool holder would not work properly to clamp both the boring bar and the holder equally securely. I have re-drawn this in **fig 3** to exactly the same dimensions but showing a gap created by a parting tool at the same height as the bar centre line. This not only allows for good clamping action of the bar and the entire holder to the cross slide, but also allows somewhat undersize bars to be used equally well. The lower drawing shows the effect of fitting a 16 mm bar in the $\frac{3}{4}$ inch hole; in this case the lower limit before going to the alternative smaller $\frac{1}{2}$ inch hole.

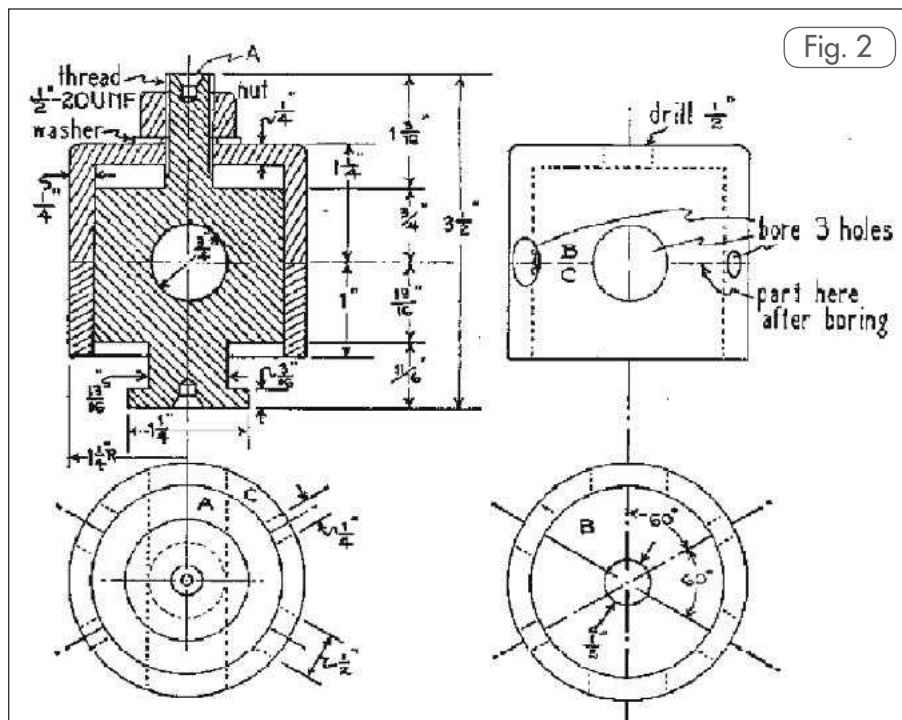


Fig. 17.8. Heavy-duty boring-tool holder.

HEAVY-DUTY BORING-TOOL HOLDER—Specification 8 (Fig. 17.8)

PURPOSE: To support boring tools and boring bars ranging from $\frac{1}{4}$ - to $\frac{3}{4}$ -in. diameter.

MATERIALS: $2\frac{1}{2}$ -in. cold-finished steel rod, 6 in. long; one $\frac{1}{2}$ -in. 20 UNF steel nut and one $\frac{1}{2}$ -in. steel washer.

CONSTRUCTION: Parts B and C should be worked together; cut this length of stock from the rod and face the ends, breaking the corner at one end as indicated. Chuck and bore the center 2-in. diameter 2 in. deep, and drill out the central $\frac{1}{2}$ -in. hole. Lay out the three equally spaced bored holes to be machined through the work and hold the workpiece in a four-jaw chuck while these openings are bored. The two portions, B and C, may be separated with a narrow parting tool as the final step. Part A should be faced and provided with center holes, then held in the four-jaw chuck while the $\frac{3}{4}$ -in. hole is bored. Mount on centers and turn to size; then chuck accurately and thread to fit the $\frac{1}{2}$ -in. 20 UNF nut.

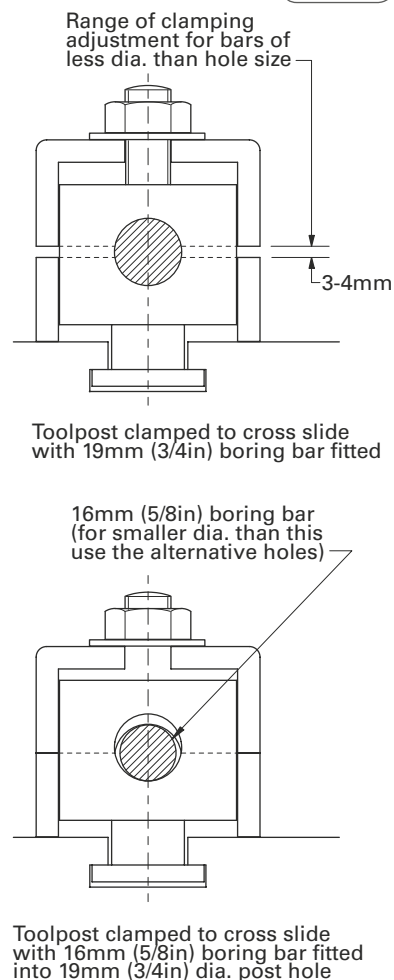
CRITICAL DIMENSIONS: The 1-in. height of part C, that is, to the axis of the bored holes, must correspond to the height above the compound rest of the axis of rotation for the lathe. Similarly, the form of the base of part A must correspond to the T-slot in the compound-rest top. It is important that all bored holes be accurately at right angles to the vertical axis of the tool post, so that boring tools and bars will slant neither upward nor downward when extended.

USE: This heavy-duty boring-tool holder is illustrated in Figure 8.19.

COMMENT: Excellent support is provided for heavy cuts. If difficulty is experienced in that part C falls from the assembly when not in use, a deeply counterbored clearance hole for a No. 6-32 machine screw can be provided in its wall at one side, and such a machine screw tapped into the mating surface of part B.

Fig. 2

Fig. 3



Milne Heavy Duty Tool Holder

Adjusted detail showing correction to figure 2.

Construction detail of the L. J. Milne heavy duty boring tool holder.

Adjustments

It will be noted that there is no adjustment provided for the height of the tool tip in this design. That is a problem, which, by the nature of the design, is not easy to solve. Trying to do so would greatly complicate the essential simplicity of the holder and could possibly reduce its necessary rigidity. In his notes on critical dimensions Milne clearly assumes that the centre line through the boring bar is at the lathe axis between centres. That would require that the cutting edge of the tool be at that level, i.e. at half the depth of the boring bar. This would apply equally to smaller diameter boring bars in the other two locations provided through the holder. That can of course be arranged but in my experience the cutting edge will normally be at somewhat higher than half of the diameter and that would have to be taken into account when working out the dimensions of the body of the holder, particularly the height dimension to the bar centre line.

What if there are no tee slots ?

The possible use of this type of boring bar holder on a mini-lathe for example or any other similar lathe which doesn't have any tee slots but only a vertical threaded pin on the top slide for typically mounting a 4-way tool post is not at all ideal. The pin would have to pass up through the body of the holder to one side of the boring bar holes. That might be possible to arrange particularly if the overall diameter of the holder is increased to allow additional space for the offset clamping screw but it may not work quite as well or be as rigid as the normal arrangement. A better set-up for the mini-lathe which should work would be to remove the top slide and replicate its mounting design so that the holder then sits on the surface of the cross slide. The tee slot fixing at the bottom of the inner body of the holder would in consequence have to be in the form of a circular plate with two 6mm holes 32 mm apart to match those in the recessed



Boring a fabricated cylinder using an alternative holder design.

disc provided in the cross slide allowing rotational alignment and fixing down with the M6 cap screws.

An Alternative

Another arrangement for achieving nearly as rigid a system is shown in **photo 2**. The gray casting used is one from another machine scrapped by an industrial user some years ago and fits the purpose ideally. The casting is clamped to a vertical 25mm stub pillar mounted on top of the compound slide using the pin intended for the tool post. This allows the casting and hence the boring bar to be adjustable for height. The horizontal hole in the casting for the boring bar is 20mm diameter and will accommodate a range of different diameters of boring bars if these are mounted in 20mm tubular collars which grip the bars with grub screws. A number of such collars can be made with holes through them in various common

diameters to suit boring bars to hand. An illustration of some such holders is shown on page 52 of the 25th anniversary edition of *MEW*. On page 53 of the same edition is a drawing of the casting used and a fabricated version of it in mild steel to achieve a similar end.

Editor's Note: I have looked up D. H. Downie's article and although his holder works on exactly the same principle as Lorus J. Milne's it has two noticeable improvements. The walls of the cylinder are thicker, and the central section correspondingly narrower, making the clamp more rigid. He also fitted a dowel pin to keep the three sets of boring bar holes in register, making it quicker and easier to change the size of boring bar.

I will be putting a copy of the 1973 article on the Model Engineer website www.model-engineer.co.uk, it is well worth reading. ■

Stub Mandrel's Short End Split Bushes and Mandrels



A myth of the modern workshop is that of the inherent inaccuracy of the three-jaw chuck. Only the best can be relied upon, and overtighten such a device just once and it is ruined forever, or so we are warned! I chucked a six-inch piece of silver steel in the three-jaw chuck that came with my far-eastern lathe the other day. Testing along its length with a dial gauge, it was still no more than 0.002" off centre a few inches from the chuck. Others have reported similar results. Admittedly I only carried out this check at one diameter but my experience in resetting work does suggest that even this inexpensive chuck has a good level of basic accuracy. This is after many years of use and abuse, so check your own you may be surprised. Incidentally, the late George Thomas performed similar tests

on a number of drill chucks, and was surprised at their accuracy.

Even so, at times you may want to be absolutely sure that work is held truly concentrically. The simple way of achieving this is a split bush, bored in situ to a good fit on the work, but drilled and reamed if the bore is small. A 'top hat' shape is convenient, as it can be positively located against the chuck jaws. If the slit is made opposite to jaw number 1 you can have a sporting chance of locating it accurately enough to use it again in the future.

Most scrap can be used to make such a bush, but brass is a good material, being easy to work accurately and to a good finish, while having a degree of 'springiness'.

For hollow work, then a mandrel that fits inside the work is needed instead. Turned

in place such a mandrel will be accurate. If you turn such mandrels from offcuts of hexagon material (marked for number 1 jaw) they can be re-used for less critical applications.

This can be turned to a tight fit, relieved to give a slight taper at the outside end. This is the most accurate solution, but the danger is always there that the work will skid and be scored on its bore. A threaded end for a nut and washer, or a screw and washer, can be used to hold most work secure. Another alternative when you need to be able to turn the whole face of the work is to thread the mandrel undersize for a large screw (just use the tip of a taper tap), then split it with a neat sawcut; once fitted inside the work it can be expanded by fitting a suitable screw. ■

Readers' Tips



We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'.

Email your workshop tips to **neil.wyatt@mytimemedia.com** marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. **Don't forget to include your address!** Every month we will choose a selection for publication and the one chosen as **Tip of the Month** will **win £30** in gift vouchers from Chester Machine Tools. Visit www.chestermachinetools.com to plan how to spend yours!

Our winning tip from Roland Varley will be of use to anyone with a round column mill.

Laser Mill

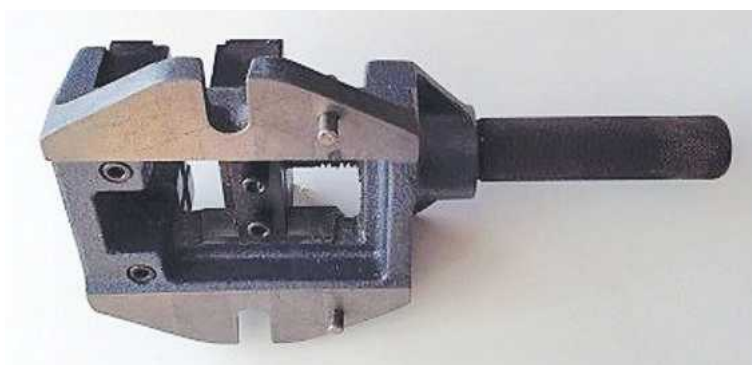
As a newcomer to model engineering, never actually having been an engineer, I purchased a Myford ML7 and a Chester milling machine, and, being a pillar-mill is prone to losing its setting when the head is raised or lowered. Having read about the use of a laser to align the milling head, I designed a dual-purpose one, easy to make from an old broken laser-level and easy to use. The laser is approx 30mm long and 12mm diameter, as seen in the photograph.

I machined a tube and bonded the laser into it and then made a flanged boss to bolt onto the side of the milling machine. When inserted, the laser projects a dot onto the adjoining wall (approximately 6ft away). I then aligned the head with the table by measurement, and drew a vertical line on the wall where the laser shone. Any raising or lowering of the milling head can be instantly realigned with the line on the wall. As my milling head can be rotated for angled milling, the laser will align this as well. Since any change in height of the milling head will prevent the use of a fixed line on the wall, I lower the head to where it needs to be, realign it to the wall line and lock it off. I then place a piece of white paper on the wall and put a felt-tip dot where the laser shines. The head can now be slackened and rotated to do the angle mill. When completed, the head can be rotated back to the wall dot and locked off.



Due to the distance to the wall from the laser, this is extremely accurate and completely repeatable - merely taking a few minutes. The battery has been removed for clarity.

Our runner up is Ron Howells, who offers a nice tip for repeatable vice setting on the mill- without the need to make a tenon. Ron wins a set of ten Shaviv deburring blades with a Mango II handle.



Critical Alignment

I have a small vice I use on my milling machine and bench drill. Often when using it on the mill, it needs to have the vice jaws clocked parallel to the table axis. To aid in this, I clamped a parallel in the vice and bolted the vice onto the bed of the mill, making sure the vice jaw were clocked in.

Next. Using the mill machine head, drill and reamed two Ø6mm holes in the vice body over an empty slot under the vice, making sure not to drill the mill bed. Removed, de-burred the vice and fit two Ø6mm silver steel dowels.

Job done. Now I can set the vice up in minutes, by pushing the dowels so they protrude under the vice and making sure the dowels are pushed against the slot in the mill bed, before bolting the vice into place.



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Three Jobs in the Workshop



Laurie Leonard tells the story of a few task he should have done a long while ago.

There always seems to pressure on the job in hand although for most of us, time in the shop is leisure. As jobs progress there are many occasions when a particular tool causes us to think, 'I must sort that' but the pressure to see the current job finished gets in the way.

A while ago I decided that I had had enough of

- Looking for the lathe chuck keys
- Trying to prevent the tailstock drill chuck from slipping in the tailstock barrel
- Coaxing a tray full of suds to run down the lathe suds tray drain hole

Time to take time out and sort it.

Chuck Keys

There were two problems associated with chuck keys. The tommy bar in the 3-jaw chuck must have come loose under previous ownership and had been fixed with a round head screw (**photo 1**). This screw had a tendency to cut into the hand, particularly when pulling the chuck round during tapping operations. The problem was solved by finding a metric grub screw slightly larger than the imperial tapped hole and re-drilling and tapping the key to suit; one of the problems of having a stock of metric fastenings and working with old imperial equipment. The length of grub screw was adjusted so that the screw sat just under the end face of the key (**photo 2**).

Construction of and fitting a simple rack together with personal discipline enables the chuck keys to be found first time. The

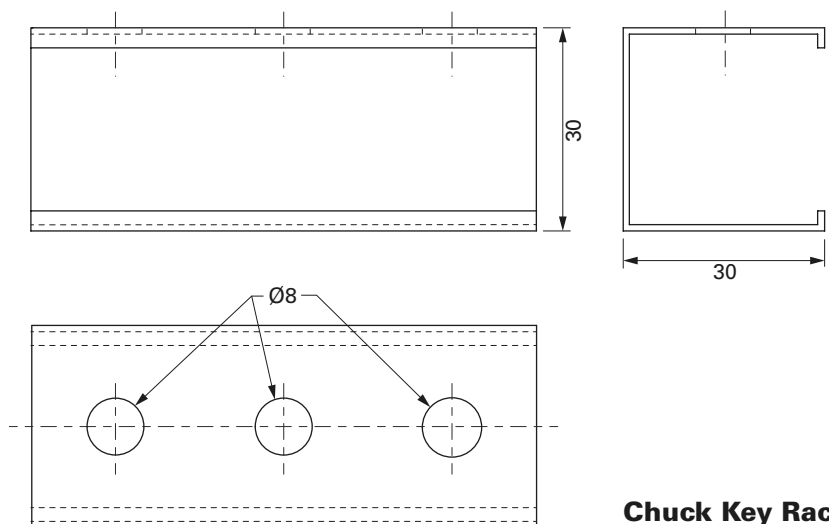


3 Jaw chuck key as purchased with round head securing screw.



Chuck key with grub screw fitted.

Fig. 1



Chuck Key Rack

rack was made from a piece of aluminium channel a venetian blind, found in the scrap box. Rough dimensions are shown in **fig. 1** and reflect the keys used with my equipment and the material to hand. The original idea was to use a piece of angle but using the channel prevents the keys from flopping. The only other point to note is the positioning of the rack in relation to the suds tray lip. It has to be low enough to allow the keys to be entered into the rack without fouling the lip of the tray. The finished set up is shown in **photo 3**. Similar to many home workshop owners, a lot of my equipment is second or third hand. The stand for my Myford 7 seems to have suffered a lot in previous hands judging by the many holes that previous owners have drilled in it.

Tailstock Barrel

When drilling holes in material held in the headstock chuck using a no. 2 Morse taper tailstock drill chuck, the drill chuck was prone to slip in the tailstock barrel. It was concluded that the inside of the barrel had been chewed up. A no. 2 Morse taper reamer was purchased to dress it. The operative word here is 'dress'. There was a concern that if the job was attacked in the wrong manner or with too much effort the barrel could be made worse and/or alignment problems may be introduced. There was also some concern relating to the relative hardness of the barrel and reamer. In the event this did not cause a problem.

The initial idea was to put the reamer in the headstock and use the geometry of the lathe to assist in keeping things true. However, this would prevent any real 'feel' for the metal being removed and the reamer would have to be gripped in a chuck with attendant concentricity issues. I decided to remove the barrel from the tailstock and carry out the work by hand.

A half centre in reasonable condition was blued and then lightly rotated inside the barrel. When withdrawn the marking as shown in **photo 4** was evident giving an indication that all was not well within the barrel.

The tailstock barrel on a Myford 7 is easily removed by removing rotating the handwheel (**photo 5**) to give access to the single screw holding the 'C' plate, removing the screw and then easing the C plate out of its groove. The barrel can then be withdrawn. The tailstock was removed from the lathe bed but this is not considered necessary and was actually done because the original plan was to ream the barrel whilst it was still in the tailstock and room to swing the reamer would have been needed which was not available in situ. The screw and C plate are shown in **photo 6**.

With the barrel withdrawn and held up to the light it was possible to see scoring to the inside (**photo 7**). Earlier in the article it was noted that it was considered important to be able to feel the cutting action of the reamer so it was gripped in the vice and the barrel rotated on it by hand (**photo 8**). **Photograph 9** shows the small metal particles removed by the reamer during the process. The barrel was only rotated lightly and the stage could be felt when very little metal was being



Chuck key rack fitted to Myford 7.



Blued centre showing bad engagement.



Tailstock handwheel rotated to give access to the 'c' locking plate screw.



'C' locking plate removed from tailstock.



Visible signs of scoring in tailstock barrel.

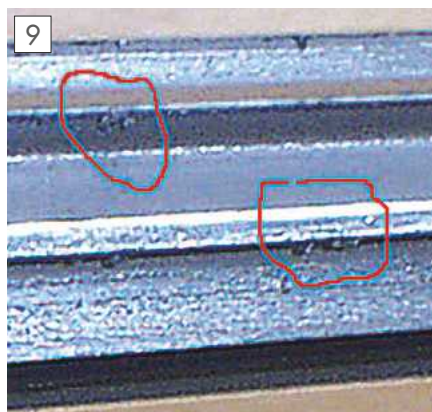


Set up for hand reaming barrel.

removed with the light pressure. The test with the blued centre was repeated and **photo 10** shows nice even bluing on the centre and a view of the barrel removed from the tailstock. The tailstock was rebuilt and all now seems well.

New Suds Tray Drain

When I positioned my second hand Myford 7 in my shed I did not expect to be in the house for long nor was I sure that it was in the best place. I had laid a concrete base and the lathe was stable on it - I was in business. I had read several articles on how to turn true and the importance of making sure the lathe bed was level in both planes so when I had the opportunity of borrowing an engineers' level I took it and decided to true up the lathe on its mounting blocks. Some time later I bought a suds system and discovered that the tray was not quite level but worse still it tipped away from the drain hole. At the end of a turning session suds collected at the wrong end of the machine (**photo 11**).



Particles removed by reamer.

Having levelled the machine and no longer having access to the engineers' level I was loath to disturb anything that may upset it. The only solution I could think of was to fit a new drain on the downhill end.

The factory fitted connection is a welded spigot on the lathe centreline but a new

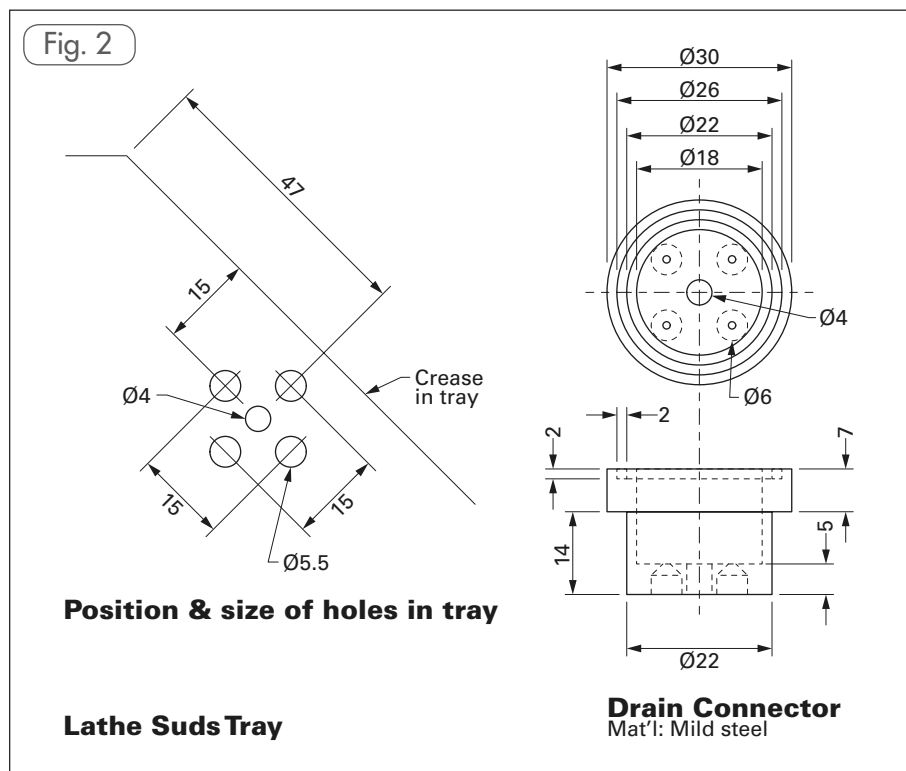


Even bluing on centre from reamed barrel.

one would be difficult to position similarly on the other end due to access. It was decided to position the new one as near to the centre of the suds pool as possible. This was found to be close to the fold in the edge of the tray. Measurements were taken of the space (**photo 12**) between the edge of the tray and the stand base. These determined size of the new drain branch. A method of fixing other than welding was also required and although adhesive was considered the cleanliness of the area, not to mention the lack of trust in glue, weighed against this method.

The solution was a manufactured branch held in place with a screw and sealed to the suds tray with an o-ring. The dimensions chosen are shown in **fig. 2** and suit the suds tray limitations and match the discharge hose (ex-washing machine).

The external turning, including the reduced diameter for the hose, was carried out before parting the part from the stock bar. After facing, the parted end was bored and the groove for the o-ring was made with a tool ground to a width slightly less than the width of the groove to allow it to be machined to dimensions (**photo 13**).



The problem: pool of suds at the non drain end of the tray.



Underside of tray showing area available to fit new drain.



Machining the o-ring groove.



Centring the new drain branch on the rotary table.



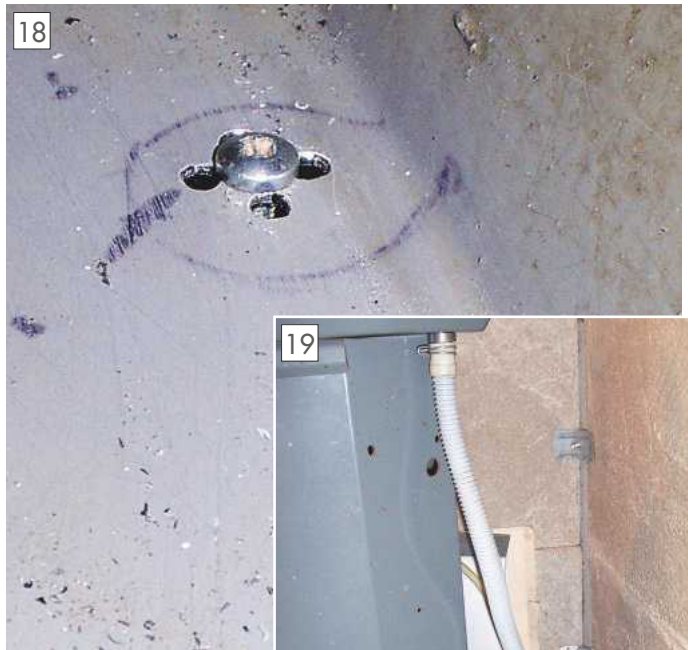
Drilling the drain holes in the branch on the milling machine.



The new drain branch and o-ring.



Underside view of tray with new drain branch fitted.



Tray view of new drain.

The four drain holes in the branch were drilled using a rotary table on the milling machine. **Photographs 14 and 15** show the branch being set up with a clock gauge and the drilling in progress. The machined branch and o-ring are shown in **photo 16**.

The finished branch was used to mark the holes to be drilled in the tray thus

making sure that the o-ring would seat fully on the underside of the tray. With the o-ring in place in the groove the branch was screwed to the tray (**photos 17 and 18**) and the hose connected (**photo 19**).

Now what was the next job? ■



The completed drain system.



The Manchester Model Engineering Exhibition

The Manchester Model Engineering Exhibition is a new addition to the hobby's calendar. It took place on the 27 and 28 of February, at the Middleton Arena. The exhibition was organised by the Northern Association of Model Engineers (NAME), supported by the Southern Federation of Model Engineering Societies. Apparently the actual organisation and the running was the responsibility of just four people, and they should be congratulated on having put on a very worthwhile event.

This was the first NAME exhibition since Warrington in 2004. Although the 'Middleton Arena' sounds vast, it is actually a relatively modestly sized venue so the show was kept strictly to model engineering. This meant that related hobbies which dilute or enhance (depending on your point of view) some of the larger shows were absent. Instead there were displays from around a dozen model engineering clubs and ten trade stands.

The small size did mean that the venue was rather crowded, but this did give the event a very busy atmosphere. On the down side, the good attendance meant no room in the car park and most visitors having to park in surrounding streets or supermarket car parks. The queue for the coffee shop was something of a marathon as well!

Most of the 'action' was concentrated in the main hall (**photo 1**) which had club displays in the centre, and various trade



Timpdon Lake was a rather whimsical 16mm live steam layout.



Chester's Crusader lathe is a large and well-specified machine.



A magnificent triple compound engine, only ever run on air.

The Exhibition was modest in its size, but well planned and executed - it did not disappoint and the organisers should be congratulated on a successful event.

stands arrayed around the outside, including Blackgates, Model Engineers Laser, CuP Alloys, Noggin End Metals and JB Cutting Tools. Amongst the club displays was also 'Timpond Lake' (photo 2) a 16mm scale (32mm gauge) live steam layout that included various rather whimsical elements such as a smoking barbecue and a suspicious character who kept popping up from under a manhole! From time to time the traditional rolling stock was joined by a marauding train manned by 'minions' or a hamster-powered locomotive. Despite the realistic appearance I was assured by *Model Engineer* diarist Geoff Theasby that the hamster was an electronic one.

On a mezzanine floor upstairs were several more clubs and a very busy display from Chester Machine Tools (photo 3). In the foyer NAME had their own display mostly consisting of curios and talking points!

The majority of models on display were live-steam locomotives, and I have to admit that although I admired the workmanship I forgot to photograph any.

There were other subjects, including stationary engines – steam and stirling, but not much in the way of 'internal combustion'. Highlights included Neil Carney's Cornish Mine Engine which was described recently in *M.E.*, and a large triple compound engine (photo 4).

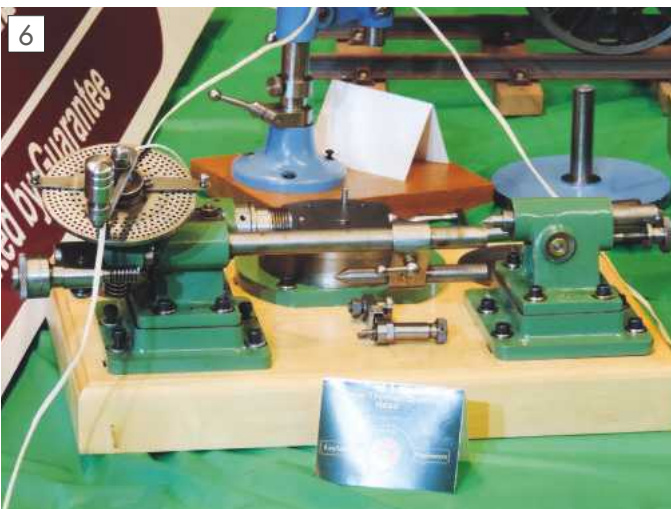
Sadly, as seems to be the way at most shows these days, there was very little tooling on display. The exception was the stand of the Leyland Society who had some very nicely made and presented items to George H. Thomas designs including the pillar tool (photo 5) and dividing head (photo 6).

Finally, attracting a great deal of attention were a delight pair of 'Poppin' flame-licker engines (photo 7) being demonstrated by the maker's grandson. I must admit I found these particularly interesting and have already started making one!

In summary, the Manchester Exhibition was modest in its size, but well planned and executed – it did not disappoint and the organisers and NAME should be congratulated on a successful event. I hope it will run again next year. ■



A neat example of the George Thomas pillar tool.



A George Thomas dividing head.



A pair of Poppin flame licker engines.

A Clock Pillar Holding Device



Glenn Bunt describes a work holding tool made to hold a piece of brass bar in the lathe whilst shaping it into a clock pillar.

In Alan Timmins excellent book (one that I would recommend to anyone), *Making an Eight Day Longcase Clock*, he describes two methods of making clock pillars. Both provide challenges for work holding whilst turning on the lathe. My clock is a traditional design but using more modern methods to manufacture it. Therefore, I chose to profile turn the clock pillars using my converted Myford CNC lathe. But this still presents many challenges for work holding.

Clock Pillars

The purpose of a clock pillar (**photo 1**) is to support the clock plates at a defined length, add rigidity and reduce any distortion in the plates. The added bonus is a decorative bit in the middle of the pillar. Therefore, the most important part of the clock pillar is the distance between the shoulders where the plates locate and the diameter of the spigots at each end.

On my clock I decided that the pillar would locate into the back plate by a brass threaded stud that screwed into a threaded hole in the back of the pillar. The front of the pillar would locate into the front plate by traditional spigot and locking pin.

The Holding Device

The work holding device I made allows a brass bar with its ends previously turned to be held between a collet and a live centre and the decorative profile to be machined. It also offers up a rigid assembly for turning and allows for important clearance for the cutting tool at both the headstock and tailstock end of the lathe.

Figure 1 is an exploded view of the assembly and **fig. 2** shows the details of the clock pillar holding device.

Photograph 2 shows the holding device.

To prepare the workpiece that will eventually make a clock pillar I face the end of the bar and then drill and tap an 10/32 UNF thread. Next a 1/4 inch diameter



The finished clock pillars.

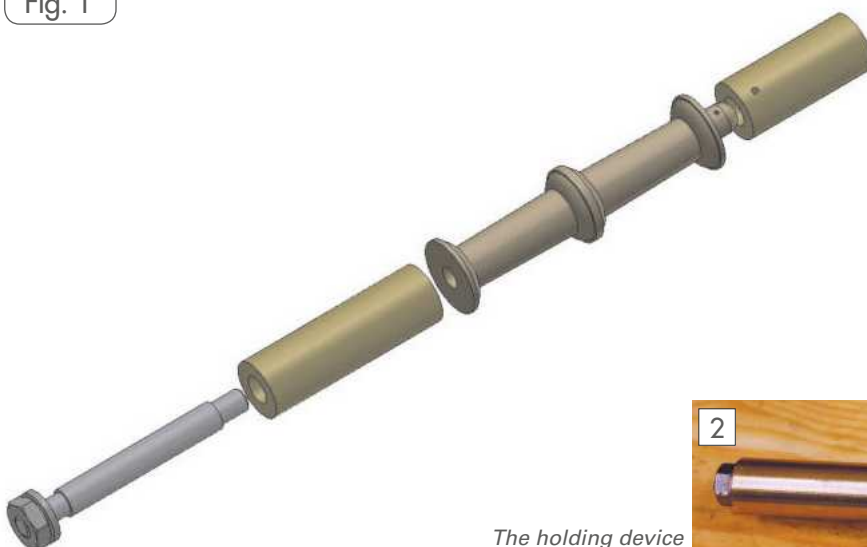
spigot and front shoulder is turned. I use a spindle back stop to make sure the length of each pillar is identical (**photo 3**).

I locate the spigot end bush of the work holding device onto the previously turned pillar front spigot and slide it up against the pillar shoulder. A length of wire is then inserted through the hole in the end bush and twisted around. At the other end of the work holding device the lock bolt is screwed into the brass bar via the thread end bush, it is then locked in place by the 10/32UNF nut and washer.

The assembly is held in the lathe by a collet located on the thread end bush and by a live centre into the end of the spigot end bush.

Photographs 4, 5 and 6 show the steps in making a pillar. As you can see from the photographs the clock pillar holding device worked well. By using this method, I ensured that all six of the clock pillars were the same length and an identical decorative profile was turned on them. ■

Fig. 1

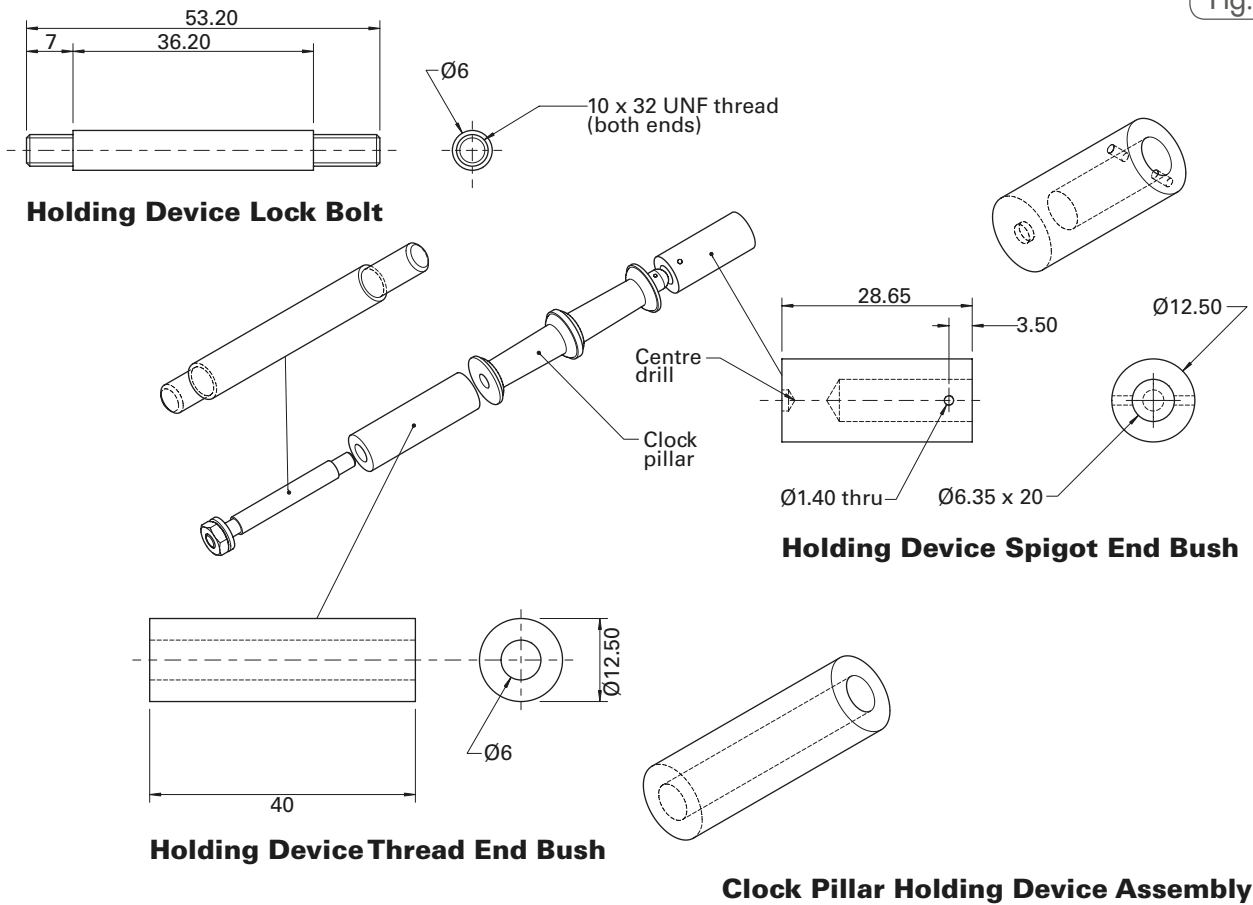


The holding device and brass bar ready for profile turning.

2



Fig. 2



The front spigot and shoulder of the clock pillar being turned.



The brass bar being rough turned.



One of the finishing operations.



The finished clock pillar.

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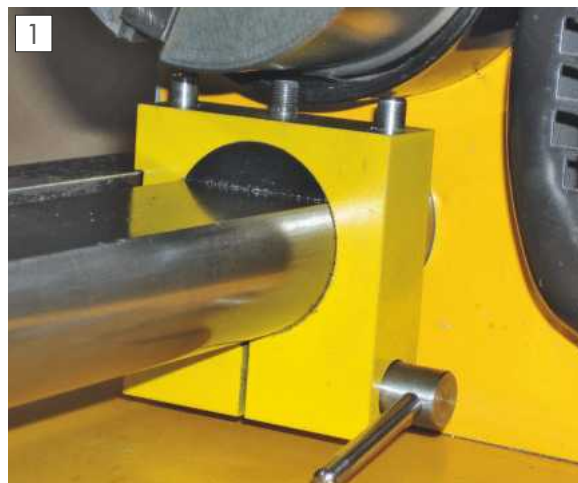
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Hobbymat Md65 Accessory Base An Update



Alan Wain details some improvements to this useful device for the round bed Hobbymat.

In issues 216 and 217 of *MEW*, I described the manufacture of a fixed steady for the Hobbymat MD65 lathe. Not liking the 'U' bolt securing method seen with Hobbymats for sale on eBay, I chose my own route and designed a proper cast iron 'accessory base' that remains fitted to the bed and stowed beneath the chuck until needed. My steady, used with the accessory base, has served me well ever since and is easy to position by sliding the accessory base along the bed and securing with the single clamping lever. Nothing in this world is perfect, though, and a design flaw soon became apparent.



Protruding stud of original arrangement.

A Design Flaw

As originally designed, alignment dowels and the securing stud were fitted to the accessory base rather than the steady to avoid swarf entering holes that may not always have been plugged when the base is not in use (**photo 1**). Another thought was that repeatedly tightening and loosening a steel screw in the 5mm thickness of cast iron may wear the thread. On reflection, this should not cause a problem for many fittings and removals; after all, the majority of model aircraft compression ignition (diesel) engines use cast iron pistons running in steel cylinder liners. The only issue with the original

arrangement that came to light in use was the possibility of opened chuck jaws catching the protruding stud if the base was inadvertently moved out from its stowage without being noticed. The first couple of occasions when this occurred came as a bit of a shock. No damage was done apart from slight bruising of the thread; easily remedied. The third time the bruising was more severe and stud replacement considered. After three times, however, a pattern could be seen developing that must be stopped! I suppose it was time to accept that the original design was flawed and introduce a modification.

Thinking about the thread wear issue and the aforementioned diesel engine usage, I decided that my fears were probably groundless and, if wear did eventually occur, the hole could easily be opened up, plugged and re-tapped, maybe even using a different material. In the original design, a nylon anti rotation pad was kept in place by a 5mm diameter spigot on the bottom of the stud. If the stud must go, then an alternative method of keeping the pad in place is necessary. The simplest way I could think of to accomplish this was to fit two roll-pins as dowels through the top of the base into the nylon pad either side of the stud position. Once fitted, the dowels would maintain alignment after the stud was removed. **Figure 1** shows the idea.

The actual rework was very straightforward, taking less time than dismantling the lathe tailstock and carriage from the bed to remove the accessory base. The original article described this disassembly, so I won't repeat it here. With the accessory base removed from the lathe, the anti rotation pad was removed to allow application of heat to the stud. The stud was originally fitted into the base using thread locking fluid, so a flame played onto the exposed threads allowed it to be unscrewed from the accessory base with a pair of pliers without burning the paint finish (damaged thread remember). Once free, the stud and anti-rotation pad were re-assembled into the base. After marking centre lines between the stud and each of the dowels, and dowel positions along these centre lines 22mm in from the front and rear edges of the base, the



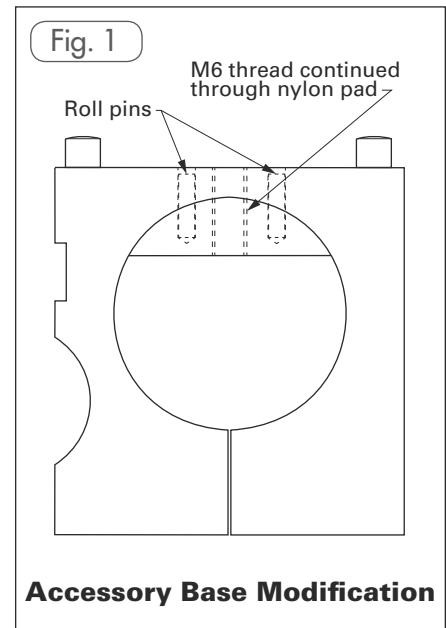
Modified accessory base and steady fastener.

intersections were punched ready for drilling. The positions of the dowels are not critical but the dimensions given put them where there is a reasonable depth of the anti-rotation pad to take the dowels.

I used a suitable length hex-head machine screw and nut as a makeshift jack in the accessory base bore to keep the pad firmly in place whilst centre drilling and drilling the dowel holes. I drilled them 12mm deep through the top of the cast iron base into the pad, NOT all the way through. These holes must be vertical, so free-hand drilling is not an option. I used my home-brewed mill drill but otherwise I would have used the lathe as I did when first making this accessory. That would mean reassembling the lathe and then taking it to pieces again; thank goodness for a proper drilling machine. Dowel sizes are also not critical; I used a $\frac{1}{8}$ x 1 inch roll pin cut in half because I had one, and only one. I would regard 3mm as the smallest suitable diameter. Once cleaned up, the lengths of my

resulting two dowels conveniently allowed them to press in below the top surface of the base. With the stud unscrewed and removed again, I ran a M6 tap through the original thread and on through the anti-rotation pad to take the steady retaining nut that must now change gender to become a bolt. Modification of the nut involved no more than a piece of threaded rod screwed into the nut with thread lock fluid and allowed to protrude 14mm (I used a piece of cut down socket cap screw). **Photograph 2** shows the modified base ready for refitting, along with the steady fastener (the modified nut). There is only one further item to actually make or obtain – a grub screw to blank the hole when the base is not being used. Must remember to fit it!

The steady has been a really useful accessory and easy to set up onto the accessory base. I still haven't got around to using the base for any other 'accessories' but at least the chuck jaws will no longer collide with it. ■



Accessory Base Modification

In our Next Issue

Coming up in issue 241

On Sale 22nd April 2016



Barry Chamberlain fits a  four-jaw chuck to his lathe



 John Pace describes a precision cutting head for milling leadscrews

 Mike Checkley is back with a slitting saw arbour



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Part no	Leg length	Ex vat	Inc Vat
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- For measuring the inside of a bore or hole
- Constant force ratchet thimble.
- Tungsten carbide measuring faces.
- 0.01mm resolution.
- Locking clamp for positive locking of spindle
- Complies with: DIN 863.
- Hard storage case.

Part no	Range	Ex vat	Inc Vat
MEB-MW280-01	5-30mm	£43.00	£51.60
MEB-MW280-02	25-50mm	£47.00	£56.40
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Precision Engineers Level - M&W



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Part no	Length	Ex vat	Inc Vat
MEB-ELS	165mm/6"	£121.00	£145.20
MEB-ELM	310mm/12"	£177.50	£213.00

Value Line External Micrometer 200 series - M&W



- Metric or imperial available.
- Constant force ratchet on thimble for one handed operation.
- Carbide measuring faces.
- Tapered for easier access to difficult areas.
- Metric type: 0.01mm - Imperial type: 0.0005" resolution.
- Setting standard included (over 25mm/1").
- Complies with DIN 863
- Hard storage case.

Part no	Range	Ex vat	Inc Vat
MEB-MW200-01	0-25mm	£20.50	£24.60
MEB-MW200-02	25-50mm	£22.50	£27.00
MEB-MW200-03	50-75mm	£25.50	£30.60
MEB-MW200-04	75-100mm	£31.50	£37.80
MEB-MW200-01i	0-1"	£20.50	£24.60
MEB-MW200-02i	1-2"	£22.50	£27.00
MEB-MW200-03i	2-3"	£25.50	£30.60
MEB-MW200-04i	3-4"	£31.50	£37.80

Micrometer Stand 279 Series - M&W

- Designed for micrometers up to 100mm.
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- Angle adjustable.

Part no	Ex vat	Inc Vat
MEB-MW279-01A	£12.00	£14.40

Value Line External Micrometer Set 215 series - M&W

- Metric micrometer set, packed in storage box with standards and adjusting keys.
- Constant force ratchet on thimble for one handed operation.
- Carbide measuring faces.
- Tapered for easier access to difficult areas.
- 0.01mm resolution.
- Complies with DIN 863

Part no	Range	Ex vat	Inc Vat
MEB-MW215-01BL	0-75mm (3 mics)	£55.00	£66.00
MEB-MW215-02BL	0-100mm (4 mics)	£76.00	£91.20
MEB-MW215-03BL	0-150mm (6 mics)	£131.00	£157.20
MEB-MW215-04BL	0-200mm (6 mics)	£196.50	£235.80

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A Stand for a Super 7

Albert Bishop adapts a Myford type 4 Cast Iron Stand to take a Super 7



I have owned a Myford Super 7 for about four and a half years, but I had not made a great deal of use of it because it was in the garage of my friend's calibration laboratory. At first I used to use it there at weekends, until I lost a set of his keys. Although I happily paid for new locks and keys, I did not feel right about asking him to trust me again at weekends. I have managed most jobs with my modified Clarke CLM300 in the meantime, but the time had come for the Super 7 to come home to my garage/workshop.



The original stand.

The original plan was to move the lathe onto wooden blocks while I brought down the original steel and wood bench for installation and levelling, then to follow on with the lathe. I had the opportunity to buy a cast iron stand from an earlier Myford (as seen at Chesterfield MES, MEW 220). This has a cast in plinth for the earlier model (**photo 1**) which was not suitable for the Super 7, so I had to set about adapting the stand.

The requirements for the stand were:

- The stand had to be fitted with new mountings to suit the Super 7.
- I wanted to use the existing chip tray, which needed to be flat and level on the stand before fitting the Super 7.
- And, most importantly, the new mountings must accept the Super 7 first time of trying, as I would be dependant on help from friends to lift it into place, and I didn't want them to have to work by trial and error.

The new plan became:

- Level and bolt down the cast iron stand and establish the position for the Super 7.

- Make and fit a block for the tailstock end mountings, similar to the normal Myford raising blocks. This would be used to establish the datum for the rest of the work.
- Fit a piece of 8mm steel plate over the existing plinth with an overhang to provide mountings for the headstock end of the Super 7.

The first stage was straightforward using a level on the top edges of the stand, packing the feet as necessary, and bolting down. I used some self-cutting bolts directly into the concrete floor.

A line was then marked across the stand to mark an approximate centreline for the tailstock end mountings.

A piece of 50x50mm BMS was cut to 150mm length, deburred, marked with a centre point, and mounted in the vice on my vertical mill. (The vice is semi-permanent and squared to the table travel). To locate the centre point, I used my fine scribe tip in the drill chuck, see technique in **photo 2**. It is quite easy to see the tip, using a magnifier if necessary. I sometimes use one of the twin lens

headband magnifiers, but as I do work for Rolls-Royce I have to have pass very stringent eyesight tests, and as a result I have appropriate high power safety glasses. The centre point was then lightly drilled with a 60-degree point drill, followed by a BS3 centre drill.

The mounting holes for the Super 7 are offset from the spindle centreline. So I moved longitudinally 52.5mm and repeated the drilling sequence. I then moved 117.5mm in the opposite direction and repeated the drilling sequence. The reason for only centre drilling so far was to give an opportunity to verify the correct hole positions prior to final drilling.

I then drilled through the third hole 6.9mm and tapped it M8 x 1.25. I start taps using the drill chuck and hand feeding using the manual down feed whilst turning the spindle by means of the drawbar nut (**photo 3**). I then moved 117.5mm to the other end hole and repeated the drilling and tapping. Then I moved 52.5mm back to the central position and drilled through with a letter-P drill for 8mm clearance.



Using a scribe tip to locate a centre.



Tapping on the mill.



Datum block in position.



Centred bolt.



Plate clamped to vice.



Plate bolted in position.

The block was then transferred to my bench vice to continue tapping the two holes as deep as possible (standard taps will not usually tap the full 50mm through) for the eventual lathe mounting studs. After deburring of the holes, the block was then located on the stand as near as possible to the previously marked centreline for the tailstock end mounting studs and used as a guide for spotting the centre hole using the letter-P drill in a pistol drill. This mark was then drilled 6.9mm through the bottom of the stand and tapped M8 x 1.25.

I then counterbored the central hole in the block to accommodate an M8 cap head bolt. I did not have a counterbore so I first drilled 15mm to sufficient depth and used a 15mm end mill to give a flat bottom.

The block was then placed in position on the stand, with the 65mm spaced hole to the front, and loosely bolted down. It was then raised with packing pieces until it was level with the top of the stand, and squared to the front edge of the stand (**photo 4**). I am afraid I had to use a woodworking square - it was the only one I had that was big enough, and it is accurate.

Now comes a little tip: Later, I would have to accurately mark out the positions of the remaining four holes, two to attach one end of a plate to the plinth, and the remaining two for the headstock end mounting bolts/studs for the Super 7. These all needed to be set from the positions of the first two mounting bolts/studs.

In order to be able to datum from tapped holes, I keep various hexagon headed bolts that I have lightly centred by drilling with the 60degree point drill in the lathe. This provides accurate centres of the threaded holes for use as datums for marking out when parts are too large for my marking out table (**photo 5**).

I bought a piece of 8mm plate quite a lot larger than I needed. I thought, without much enthusiasm, about hacksawing out a piece 150 x 410mm, and then wondered, with a little more enthusiasm, who could do this for me. Now came one of the benefits of my work. I just happened to be visiting a small engineering company to calibrate their instruments, and they kindly cut it to size for me on their large bandsaw.

After removing all burrs, I established a centreline on the plate by pop marking the centre at each end and joining the dots. I had to establish the positions of the four threaded holes in the plinth and I found that I firstly needed two $\frac{5}{16}$ inch clearance holes 62mm from one end, and at 110mm spacing centred across the plate.

I marked out a line 62mm from one end, and centre popped the intersection with the longitudinal centre line.

I did not want to disturb the vice on the miller, and anyway it did not have sufficient opening to handle the 150mm wide plate. I decided to clamp the plate securely to the top of the vice (**photo 6**), and tapped it until the main centre line aligned with the 'Y' axis of the miller, using the famous scriber tip again. A quick check that the longitudinal travel covered

the two hole positions and oops!! start again. When all was lined up and ready, I found the intersection point of the two centrelines and moved 55mm to the left. I then used the point drill and centre drill to give a start for drilling. Then I moved 110mm to the right and repeated this. A quick check that the marks were at 110mm centres and central to the plate, and the $\frac{5}{16}$ inch clearance holes were drilled on the pillar drill.

I could then position the plate over the plinth with the two holes at the end of the plinth nearest to the datum block and fix it with two $\frac{5}{16}$ BSW bolts with centred heads (**photo 7**).

I now had four datum holes from which I could mark out the two remaining positions for the plinth bolts and the two remaining lathe mounting points. I decided that this would be done using my precision trammels, set up with my calibrated length bars, and slip gauges. I have an old 600mm digital caliper that failed electronically, a common occurrence, that I use as a beam for the trammels. (*Readers may find it useful to know that replacement caliper read heads for some models are available from several of our advertisers - ED*).

I coated the plate with marking out blue in preparation for marking out, and calculated the distances, both in X-Y direction and diagonally.

My trammel heads have been machined so that the machined sides are exactly 7.5mm from the centres of the pointed inserts (**photo 8**). They were set up using



Trammel head.



Setting trammel with length bars and slips.

my calibrated length bars and gauge blocks (**photo 9**). As the length bars are Imperial, I used imperial gauge blocks with them. The calculated dimensions were converted to imperial sizes. I am happy working quite fluently in either imperial or metric, but mixing the two never makes sense. The positions of the two holes to mount the plate on the plinth worked out at 4.331 inches between centres in the Y direction, 8.779 inches in the X direction, and 9.789 inches diagonally. The trammels were set up for longitudinal (X) and diagonal sizes, and the centres marked off. The intersections were checked to be 4.331 inches (110mm) apart, and the intersections were centre popped.

I took the plate to the vertical mill, but this time I clamped a threaded piece of bar to the back of the plate, and mounted the bar in the vice. This was more satisfactory than just clamping the plate on top of the vice. Each hole centre was located using the scriber tip again, and the holes were drilled lightly with the 60 degree point drill, centre drilled, and drilled through the $\frac{3}{16}$ inch clearance holes. After deburring, the plate was fitted in place over the plinth. It was already coated with marking blue previously, so the trammels were now set up to mark the remaining mounting positions for the Super 7.

These positions were marked on the plate in a similar manner with the trammels, centre popped and drilled and tapped M8 x 1.25 on the vertical mill. The plate was once again fitted to the plinth on the cast iron stand, this time permanently. Before mounting the chip tray, packing pieces were made to fit on top of the plate in order to level it with the block at the other end.

The 8mm studding was then cut to about 3 inch lengths, and screwed onto the Super 7 mounting positions. The chip tray was placed in position and once again checked for level. When this was confirmed, it was fixed down with 8mm penny washers and 8mm nuts (**photo 10**). These nuts would be adjustable later to finely level the Super 7.

I collected the Myford from my friend's works and brought it home.

With the help of a very kind and strong neighbour, we carried the lathe into position, and with the very slightest amount of wriggling it dropped neatly into place, and proved to be very nearly level. **Photograph 11** shows the lathe nestled well on it's new stand.



The stand ready for the Super 7.



The Myford in its final position.

I since levelled the bed with a precision level, adjusted the spindle bearings to stop oil from spraying out behind the chuck (which incidentally brought the driving pulleys back into proper alignment), and

performed some successful trials. I am now building some wooden racking up behind the lathe to hold all of its accessories tidy and out of the way when not in use. ■

Making Taps for Cutting Square Threads



Andrew Johnston describes his approach to making custom taps.

The brake shaft and nut on my 4-inch scale traction engine requires a $\frac{1}{2}$ inch diameter 8tpi single start square thread. Although I am conversant with screwcutting on the lathe, I have never cut a square thread before. This article describes the machining of the square threads, and specifically the manufacture of taps to cut the internal threads in the nuts. The finished brake shafts and nuts are shown in **photo 1**.



Finished brake shafts and nuts.

Square Threads

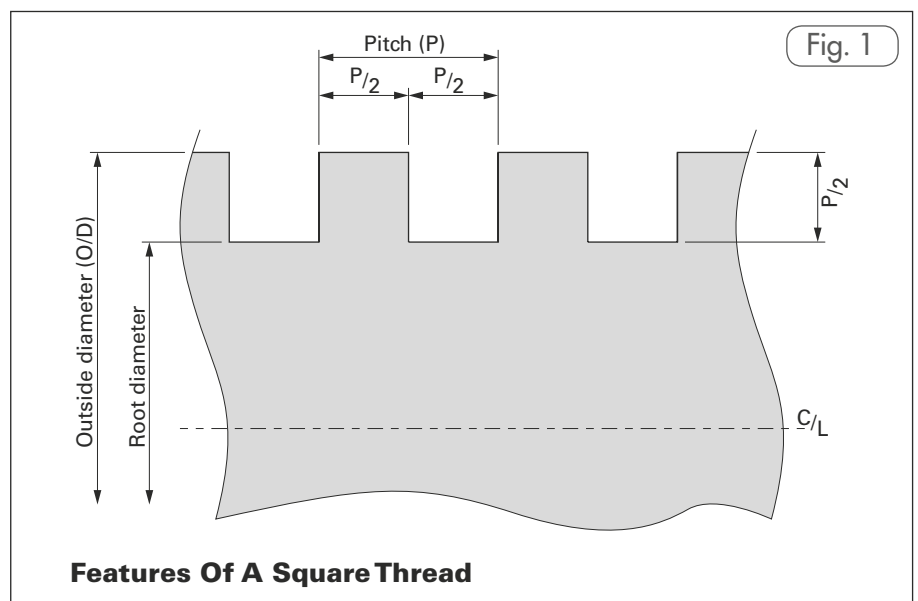
The principle features of a single start square thread are shown in **fig 1**. The width of the thread crest, the width of the thread root, and the depth of the thread are all equal, and are half the thread pitch (P). In general, for a square thread the loads are axial, there are no radial loads. This can be an advantage for something like a flypress, where the load is required axially. However, it can be an issue for, say, a lathe leadscrew where some radial force can help to disengage the half nuts when the half nut lever is operated. There are three points where a square thread can interfere, the root diameter, the outer diameter and on the thread flanks. The three points are independent, clearance on one does not affect the clearance, or otherwise, on the others.

Screwcutting the External Thread

Cutting an external square thread on the lathe, in terms of technique, is no different to any other thread form. Only the shape of the tool changes. In plan form the tool needs to be rectangular with a width equal to half the pitch, $\frac{1}{16}$ inch in this case. Ideally the tool will have different clearance angles on the leading and trailing edges. The leading edge requires a clearance angle determined by the helix

angle at the root diameter of the thread. The trailing edge requires a clearance angle set by the helix angle at the outer diameter of the thread. For the brake shaft thread these angles are 6.05 degrees and 4.55 degrees respectively. A HSS toolbit was ground by hand, using a micrometer to check the width of the cutting edge, and a combination square to assess the side clearances. To provide clearance with respect to the nut on the flanks of

the thread on the brake shaft I considered making the tool wider than needed, cutting the square thread on the shaft, and then reducing the tool width to make the taps. However, I wasn't sure how much clearance would be needed, so it seemed better to make the tool exactly $\frac{1}{16}$ inch wide and adjust the fit after both the shaft and nut had been made. A trial 8tpi square thread was cut on a suitable piece of $1\frac{1}{4}$ inch diameter scrap (**photo 2**).





Trial external square thread.

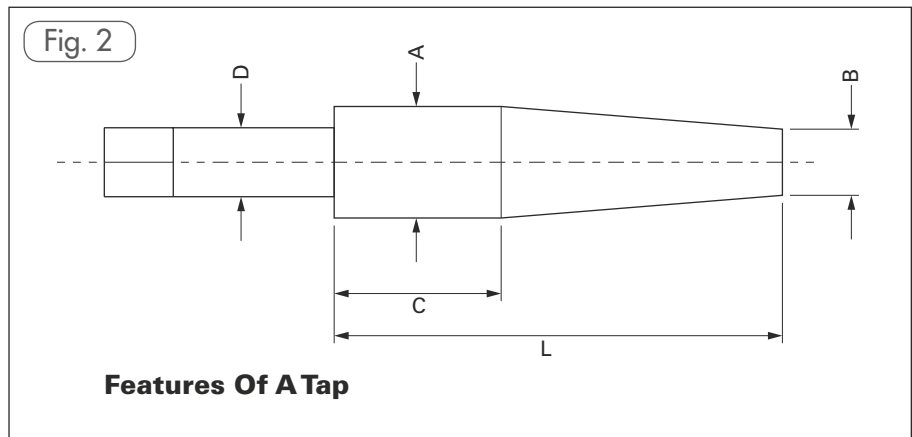


Finished brake shafts.

Following the satisfactory trial, the brake shafts were made. The OD of the brake shaft was reduced from the nominal $\frac{1}{2}$ inch by a few thou, for clearance. Running the lathe at slow speed, and using needle files, care was taken to ensure that all fine burrs were removed from the thread after screwcutting. The finished brake shafts are shown in **photo 3**.

Designing and Making Taps for the Internal Thread

While it would be possible to screwcut the internal square threads in the bronze nuts, the nuts would have been difficult to hold due to their shape. Instead I decided to make a set of serial taps to cut the internal threads, if for no other reason than it would be interesting. Serial taps are different to normal hand taps in that successive taps only cut part of the full thread depth, even when fully engaged. Serial taps can have V-shaped threads for use in tough alloys such as Inconel, but



are most commonly used for square and Acme thread forms.

The basic features of a tap are shown in **fig 2**. Tables recommending the number of taps, and their diameters, for varying square and Acme threads can be found in Machinery's Handbook. I chose to use a set of three taps, with thread depths of 41%, 80% and 100% of full depth. From this the diameters A can be calculated, these are 0.426, 0.475 and 0.500 inch. The small end of each tap (B) also varies, but I failed to notice this and made all my taps with the small end equal to the root diameter. Ideally the shank diameter (D) is equal to the root diameter minus 5 thou, but I left it as the root diameter, 0.375 inch. There is some flexibility on the length of the taps, I chose L to be 2.5 inch and C to be 1 inch for all the taps.

The taps were made from silver steel. Machining the shank, the thread OD, the taper, cutting the square threads and milling the driving square on the end are all straightforward.

Before hardening the taps need to be fluted to produce the cutting edges. A look at some of my commercial taps indicated that the flutes were of circular form. Having decided upon four flutes I made a sketch in CAD to experiment with diameter and depth of the flutes. The flutes could be cut with a ball nose cutter, but I have a horizontal mill and a $\frac{1}{8}$ inch radius convex cutter bought some years ago on a whim. Clearly it would be quicker to cut the flutes using the horizontal mill. Depth of cut was 0.145 inch. Cutting the flutes, in one pass, is shown in **photo 4**. Note the home

made extension to the dividing head tailstock centre to prevent the cutter from cutting it.

As with the brake shafts great care was taken, with the aid of needle files, to remove all fine burrs on the taps resulting from the machining process. The three taps, before hardening are shown in **photo 5**.

The taps were hardened using an electric furnace, soaked at a temperature of 780 degrees C for half an hour. The taps were then quenched in brine. The taps were tempered at 215 degrees C, soaking for another half hour, and then quenched again in brine.

The final operation on the taps was to grind a relief on the cutting edges on the tapered section. This could have been done using a needle file before hardening. However, I bought a tap and drill grinding accessory for my Clarkson T&C grinder last year, so this was an opportunity to use it. The instructions are somewhat sparse, as befits an item from a time when the foreman would know what was what, without the need for detailed instructions. In simple terms the tap is held in a 6 jaw self-centring chuck. The whole assembly is then rotated on the base so that the taper on the tap is parallel with the grinding wheel. The chuck is then rotated clockwise, looking from the tap end, and at the same time a collar with a spigot on the end of the chuck shaft bears on an angled plate which causes the chuck, and tap, to move back, away from the grinding wheel, as well as rotating. The result is that as the tap rotates towards the cutting edge less



Cutting the flutes.



Taps before hardening.



Grinding the relief on the taps.

material is taken off the taper. The set up is shown in **photo 6**. The collar, with four studs, and the angled plate can be seen centre left in the picture. The cut is applied using the cross slide handle. After grinding the taps easily cut a test thread in a piece of scrap brass bar.

Making the Nuts

To simplify holding the nuts they were made as a pair, and separated as the last operation. The nominal root diameter of the thread is 0.375 inch (9.525mm). I drilled the nuts 9.7mm to allow for some clearance on the root diameter. Tapping the nuts proved to be rather more difficult than the brass test piece. This was due to two reasons. First, I hadn't hardened the first tap properly and although it cut well it twisted slightly. The lack of hardness was because I didn't agitate the tap enough when quenching. The second problem was failing to take account of the fact that the small end of the tap should increase with each tap. It should be equal to the OD of the previous tap, minus 0.005 inch. Since I didn't do this it meant that the second and third taps were cutting on fewer teeth, with a consequent increase in depth of cut, than they should have been.



Embryo nuts.



Effect of relief and no relief.

However, by using the second and third taps a turn at a time, and swapping back and forth between them, the threads were eventually cut. I also found that a large dollop of Rocol RTD cutting compound helped. The tapped embryo nuts are shown in **photo 7**. In the picture the threads have been counterbored with a 1/2 inch slot drill, so that the sharp start to the thread is not exposed. When grinding the

relief on the taps it wasn't clear whether the operation had worked. However, after cutting the threads in the bronze nut it is clear that the teeth on tapered section are relieved, as they are clean, whereas those on the parallel section without relief, are smeared with bronze (**photo 8**).

At this point the brake shafts would screw into the nut a couple of turns, but no further. Interference on the OD and the root diameter have already been allowed for, so the only remaining interference must be on the thread flank. This was addressed by putting the brake shaft back into the lathe, still set up for screwcutting, and shaving a couple of thou at a time off the thread flank until the nut fitted smoothly. Re-aligning the screwcutting tool with the existing thread is simple. The lathe is set up for screwcutting, but with the tool clear of the work. A dummy screwcutting run is then started, and stopped part way through by killing the power to the motor rather than disengaging the half nuts. The top slide can then be used to move the tool parallel to the lathe axis until it aligns with the existing thread. Thereafter the top slide can be moved a couple of thou at a time to take material off the thread flank. I needed to take off about 4 thou to get a good fit.

Conclusion

This proved to be an interesting exercise, and it is useful to know that custom taps can be made if required in the future. ■

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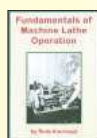
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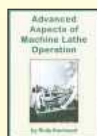
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Fundamentals of Machine Lathe Operation • 95 mins • DVD £30.54

THE DVD for the beginner to the lathe - there really is no better way to start learning how to use a lathe. However, it is basic, so if you have some experience in lathe operation, don't buy this DVD, buy the one following.



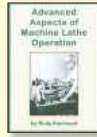
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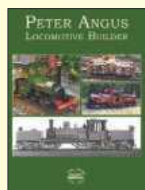
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Shows you the methods by which your mill can be highly accurate in every function. Rudy Kouhoup also describes techniques that will expand the usefulness of your mill and dramatically improve your skill levels.



Grinding Lathe Tools 125 mins • DVD £30.54

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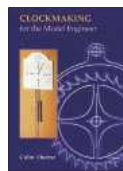
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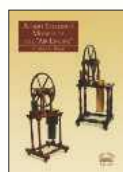
Model Steam Locomotives • 1954 Greenly rev. Steel • £20.15

A reprint of the eighth (1954) edition of this wonderful book, revised and updated by Greenly's son-in-law Ernest A. Steel, and daughter Elenora, but still very much Henry's work. Greenly's experience of designing and building model locomotives ranged from Gauge 1 to 15" gauge; all are covered here, but the mid-range gauges are stressed. The first four chapters cover choice of scale and gauge, locomotive types, principles of model locomotive design and boiler design. Another twelve chapters cover specific parts of the locomotive. All are very fully illustrated with drawings, tables and photographs. Any book which effectively remained in print over fifty years has to have been top quality, and this is one of the very best books written on building model and miniature steam locomotives, and an invaluable reference for locomotive builders in the 21st century. 322 pages and paperback.



Clockmaking for the Model Engineer Thorne • £14.60

Provides the model engineer with an ideal introduction to the fascinating world of clock making. There are no instructions on how to get the best from your lathe, how to set-up work etc. - it is assumed that you know these things already. Colin Thorne takes you through the construction of a typical clock, describing those techniques of the clockmaker that differ from, or are seldom used, in model engineering. Finally, drawings are provided for one simple, and unusual, clock which requires you to make all the pieces likely to be found in more complex timepieces. Any model engineer considering making his first clock should have this book on his bookshelf. 88 A4 format pages. 58 drawings in text plus 9 drawings for the Benjamin Franklin Clock and 11 B & W photos. Softcover.



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A Simple Chuck Back Stop



Peter Darveniza details a device to help you turn a series of objects with repeatable accuracy.

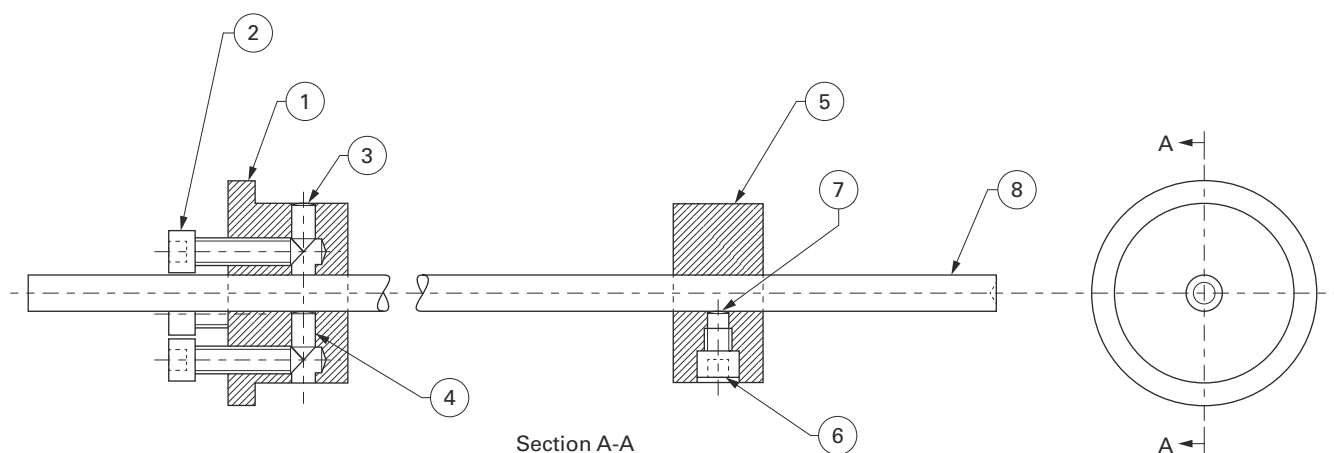
A requirement to cut a number of steel rods accurately to the same length in the lathe set me thinking about how to achieve this. I did some research, consulting numerous articles on chuck back stops in *Model Engineer*, *Model Engineers' Workshop*, other magazines and books. I felt the designs I found were all overly complex and required a lot of work to build. I thought about the problem and came up with the solution presented here.



Original Depth Stop (left) and the New one (right).

The design is simple and can be constructed very quickly, in fact my first attempt was made from scrap and was completed in less than 2 hours and has been in use frequently over the past 5 years. The design worked so well I decided to remake it in better material. While the design presented here is for a larger lathe, the project can be scaled and measurements modified to suit most lathes. The design is very simple and great accuracy is not required in construction for it to work. While a rotary table or indexing device can be used to index the holes in the main body, this is not necessary, my initial and recent attempts were done without using either of these devices.

The device essentially consists of a spigotted boss anchored in the rear of the lathe spindle through which an adjustable rod, the backstop, fits. The boss, or main body is anchored in the spindle by 3 pins which push out and clamp to the inside of the lathe spindle. The pins have 45 degree tapers on their inside ends which are in contact, at 90 degrees, with screws also having a 45 degree taper. Turning a screw causes the pin to move outwards as the taper on the screw pushes the taper on the rod. The adjustable backstop rod is fitted with a moveable stabilizing collar situated in the spindle behind the chuck to prevent 'rod whip'. In use, the rod is adjusted and set to provide a 'backstop' for material

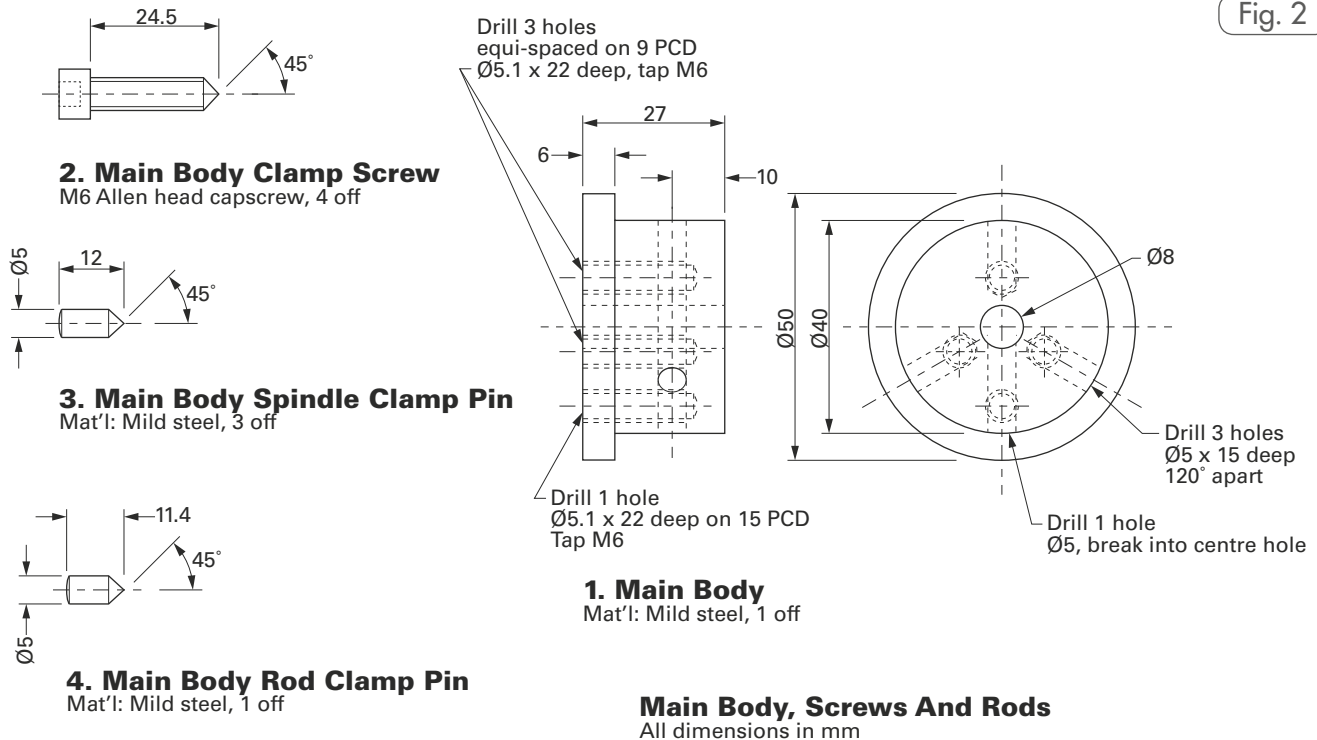


General Arrangement

Showing sectionalised Main Body & Stabilizing Collar with Capscrews, Clamping Pins & Rod
Hidden detail not shown

Fig. 1

Fig. 2



Using parallels to set the work for machining the spigot.



Machining the spigot, the central hole has been drilled.

mounted in the chuck, it can be set at any depth and is then clamped. Material to be cut to length is placed in the chuck with the inside end butted against the stop. The lathe saddle is then locked and only the cross slide is used to feed a parting off tool into the work. This process is repeated, thus cutting successive rods to the same length. The new depth stop is shown in photo 1 (on the right) alongside the original depth stop made from scrap (on the left). A sectioned general arrangement is **fig. 1** which shows details of the device.

Main Body

The dimensions of the Main Body are shown in **fig. 2**. Make a start by chucking a length of 50mm diameter mild steel squaring and cleaning up both ends to 27mm final length. Next, set the material

up in the chuck so that the spigot can be turned gripping about 5mm in the chuck jaws. Setting the material correctly so that it runs truly is often a problem. Parallels can be set between the chuck face and the work to set the work square (**photo 2**) the parallels **MUST** be removed before turning on the lathe. As you will be machining close to the lathe chuck be careful not to hit the chuck jaws with the cutting tool. Measure the diameter of the rear of the lathe spindle bore with a pair of inside calipers. Turn the spigot on the main body to fit this measurement; try to achieve a neat easy fit into the rear of the lathe spindle tube, in my case 40mm. Finally, drill the central 8mm diameter hole for the rod (**photo 3**). A better and more accurate hole size and finish can be achieved if the hole is bored first with say, a 7.5mm drill followed by an 8mm drill. An inaccurately ground drill can drill oversize if the cutting

edges are ground to different lengths, that is, if the point is not central. Two stage drilling removes this risk and results in a correctly sized hole as an off centre drill point has no effect on the final hole diameter. A reamer, of course will give a more accurate and better finish, use that if you have one. Remove all sharp edges on the job as the work progresses.

Reverse the job and re-chuck, holding it on the machined spigot. The 120 degree divisions can be laid out by using the 3 jaws of the lathe chuck and a piece of wood to index the marks as shown in **photo 4**. Before doing this turn off and unplug the lathe, an accidental start could be dangerous and disastrous. Now mark the periphery and face of the spigot in 120 degree divisions with a HSS lathe tool (a carbide tool could chip) set on centre height rotating the chuck by hand and using the wood and the chuck jaws to



Method of dividing a circle into 3 using a block of wood.



Marking out the pin hole positions.

divide the circle into 3. Loosen the tool post so that the tool can swivel, hold it against the face by hand pressure and wind the cross feed back out dragging the tool across the work to mark the face (**photo 5**). Run one mark right across the face on one division, one side of centre is for a external peripheral clamping pin, the other side is for the internal rod clamping pin and screw. The other two marks run from the centre to the periphery. Remove from the lathe and use a jenny, odd legs or even dividers used like odd legs to mark the screw hole depths from inside the 8mm central hole (**photo 6**). Alternatively, these points can be marked using a sharp lathe tool (re clamp the tool post) fed very slightly into the work while it is still mounted in the chuck turning the job by hand and marking a circle.

Next, the 4 holes for the clamping pins must be drilled. Three holes are for the pins which clamp the spigot in the end of the lathe spindle and one hole is for the pin that clamps the depth rod. While these holes can be drilled using a rotary table or indexing mechanism to index the holes, this degree of accuracy is not really necessary. Set the main body up in a vice on a short length of 8mm rod using a square to sight and set one of the marked divisions to vertical as shown in **photo 7**. Centre the drill press on the periphery of the outside of the job using a flat ruler and point mounted in the drill chuck as shown

in **photo 8**. Move the mill table backwards and forwards in the Y-direction holding the point on the ruler with the other hand until the ruler is flat or level, this indicates that the point is now at a tangent to the periphery. I prefer to use a point as shown rather than a drill bit as the drill point has a flat on it which can result in a centring error. Start each hole with a centre drill followed by the 5mm drill. A neater more accurate hole can be achieved by first drilling an undersized hole followed by the 5mm drill as previously described. This will ensure that the 5mm clamping rods will be a close fit in the holes. Drill the 3 pin holes just past the point where the tightening screw will push against the pin, they should not intersect the central 8mm hole (**photo 9**). Re-centre the main body for the drilling of each new hole as the work is rotated. The hole for the back stop rod holding pin is next drilled from the periphery into the 8mm central hole. The central 8mm hole will need cleaning out using a drill or reamer to remove the burr created by the intersection with the pin hole. Ensure that the pins are a reasonable sliding fit in the holes, that way the pins will not fall out in use and a retaining mechanism will not be required. If they are loose the mechanism will still work, the pins will just fall out whenever the device is removed from the lathe spindle.

Lastly, to complete work on the main body, 4 x M6 holes must be drilled and



Setting out the screw hole PCDs using odd legs.

tapped in the back face to take the tightening screws. Carefully locate and centre punch the positions previously marked, set the job up in the vice on parallels or pieces of suitably sized material and drill and tap the 4 holes using a 5.1mm drill and M6 tap (**photo 10**). The holes should be drilled and tapped through, and past, the pin holes, this allows enough thread to be formed in top of the hole using a taper tap. Be very careful when the drill breaks into the existing cross hole to ensure that the drill bit does not grab and break, peck drill the hole, carefully moving the drill bit up and down until breakthrough is achieved. Tapping can be carried out as



Setting up for drilling a pin hole.



Centralizing the drill press on the diameter.



Drilling the pin holes.



Drilling a clamping screw hole.



Starting a tap by hand using the drill press to keep it square.



Pin and screw holding devices.

each hole is drilled by starting the tap in the job by holding it in the drill press and turning the chuck by hand with the power off. This ensures that the tap starts squarely and it is less likely to break when tapping. Use the chuck key to rotate the chuck and start the tap (**photo 11**) once the tap bites loosen the chuck, raise it and finish tapping the hole using a tap wrench. Finish with a bottoming or plug tap if you have one to ensure the thread runs as close to the bottom of the hole as is possible, but as previously described a taper tap should provide sufficient thread for our requirements. This completes the main body other than clean-up work to remove burrs and to ensure that the pins can slide in and out of the holes firmly but easily.

Clamping Pins

The clamping pins are made next. I was fortunate to have been given a number of standard stainless steel machine pins which I used. Alternatively, I would have made the pins out of bright mild, stainless, or silver steel. Cut the pins roughly to length and slightly dome the end which is to bear against the inside of the lathe spindle. This can be done in the lathe using a standard lathe tool to provide a slightly flat point or, use a form tool to create the dome, aim for

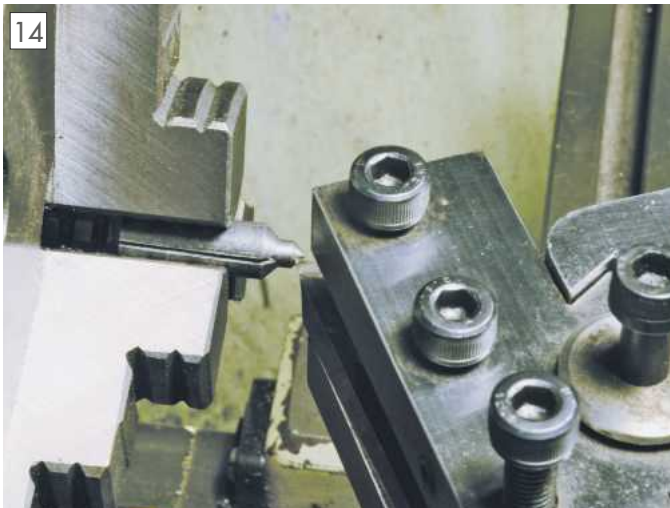
a flattish dome. At this stage, the pins can be tried in the drilled holes, finished pin length should be just long enough to for the pin to extend to the centre of the tapped hole when the domed end of the pin is just inside the periphery of the spigot, that is, the end of the pin should be visible through the tapped hole. The rod holding pin should be made in the same way, the length of the pin being to the centre of the screw hole when the dome is level with the outside of the rod hole. This sounds more complicated than it is. Once cut to length, a 45 degree taper is machined on the opposite end of each pin to the dome. Make a pin holder as per **photo 12** to hold the pins when machining the taper. The pin holder is a 10mm diameter 20mm long piece of mild steel with a 5mm hole drilled through it, a hacksaw cut through one side forms a primitive collet. Clamping in the chuck should close the holder on the pin ready for machining (**photo 13**). If the holder is too stiff and the chuck will not close on the pin another hacksaw cut on the other side, opposite the first cut, partially, but not all the way through, should make it more flexible. Set the topslide over to 45 degrees to cut the taper. As the pins are short beware of the proximity of the rotating chuck to the cutting tool when machining the taper.



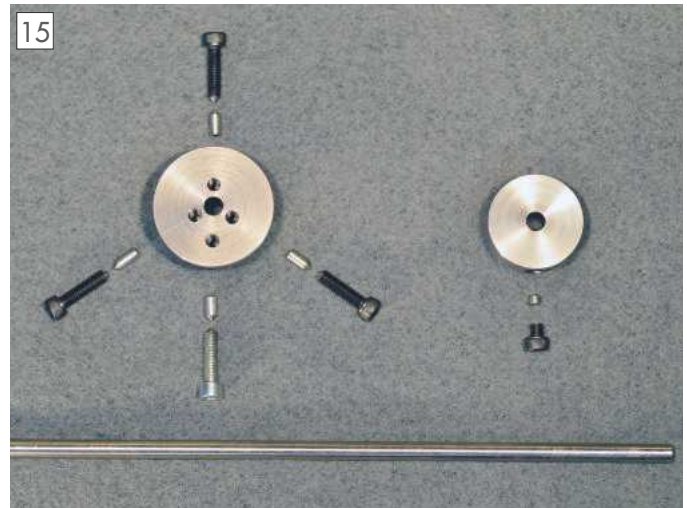
Setup for machining the 45 degree taper on a clamping pin.

Screws

The pin tightening screws are machined next, 4 x M6 are required, they can be slotted, Allen cap screws, or hex cap head. I used 3 black Allen head screws for the peripheral clamps and a silver screw for the rod clamp to avoid confusion when using the device. A 45-degree taper is turned on the end of each screw. Make a small jig, which is just a 10mm long length of 10mm steel tapped M6, to accept the screw. A locknut is necessary



Setup for machining the 45 degree taper on a screw.



Completed Components with a 300mm rod.

on the screw to ensure that the screw does not unscrew when machining the taper (**photo 14**). When the pins and screws are finished assemble the work and check to see that the pins are the correct length. That is, they mesh nicely with the screws on the tapers, they are below the surface when withdrawn and that they rise above the surface when the screws are screwed in. Adjust as necessary. Grease/oil the 45 degree tapers on the rods and screws when complete.

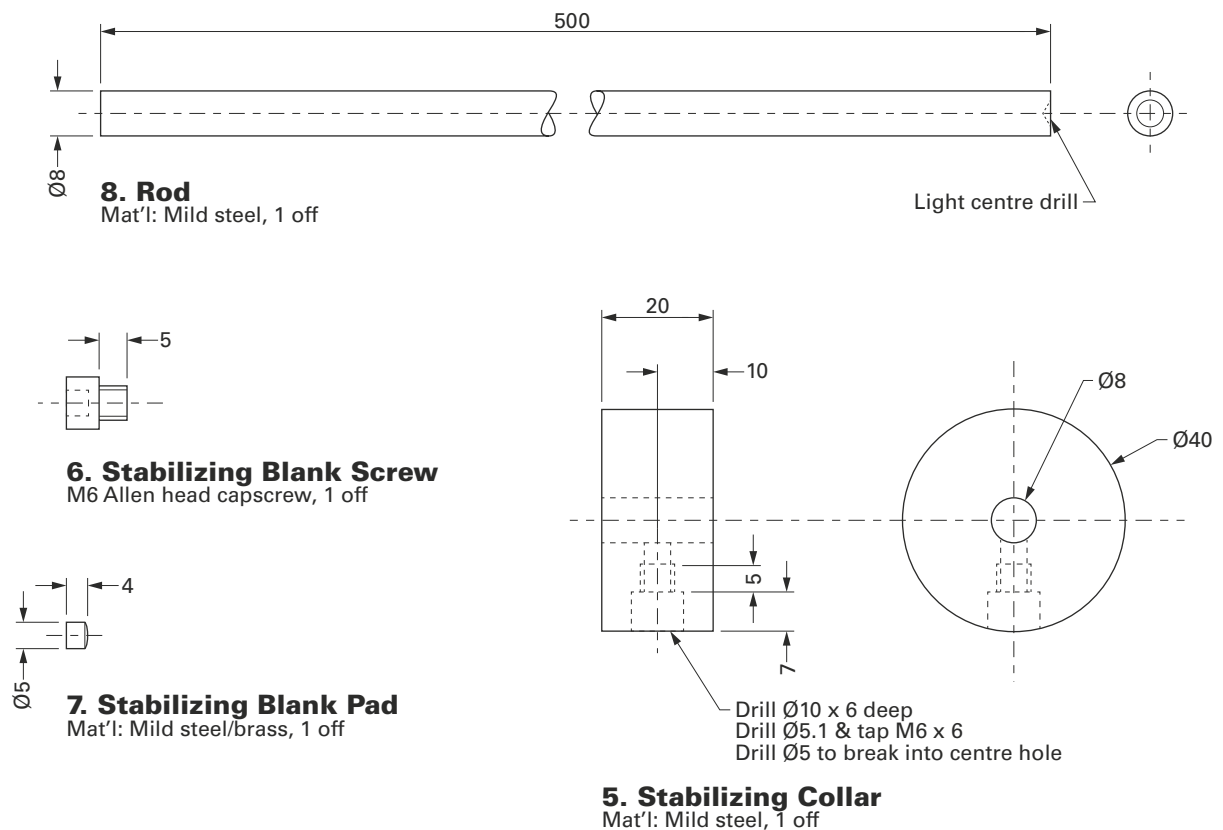
Depth Rod

The depth rod can be made out of any suitable material; my first rod was made from $\frac{3}{8}$ inch black hot rolled mild steel. In the revamped version I used 10mm ground stainless steel. This is cut to length (500mm) and each end finished in the lathe to provide a neat square face. Finally, use a centre drill to machine a small depression in rod end to provide a recess into which pips on rods being cut to length can project. These pips are often the result

of squaring up work in the lathe using a tool not quite on centre height, they are hard to see and can affect the repeatable accuracy of rods being cut to length, providing a recess for them allows for that problem.

Stabilizing Collar

A stabilizing collar is required on the end of the rod to prevent the rod from whipping around inside the spindle when the back stop is in use. The collar should



Stabilizing Collar, Rod, Pad And Screw
All dimensions in mm

Fig. 3

be a neat sliding fit inside the spindle so that it does not rattle in use, particularly at high spindle speeds (**fig. 3**). The collar is drilled and tapped to take a 6mm Allen screw to hold it onto the rod, a small pad should be placed between the tightening screw and the rod to prevent the screw from digging into the rod and damaging it. The head of tightening screw must be counter bored into the collar so that it does not protrude above the surface of the collar. Alternatively, the cap screw could be replaced by a grub screw. Machining operations for the tightening collar screw and pin are similar to those for the main body. Set the collar up in the vice on the drill press; find the collar centre as previously described using a point and ruler. Firstly, drill a 10mm diameter hole 6mm deep for the screw head, mill the bottom of the hole flat so the screw head can seat properly. (or leave it, this is not critical) Test the size and depth of the counterbore using the screw head ensuring that the head is below the surface when fitted. Next extend the hole by drilling a 5.1mm diameter tapping hole 12mm deep, followed by a 5 mm hole (for the pin) breaking into the centre hole. Tap the 5.1mm hole M6 over a length of 5mm. Make a 5mm diameter 4mm long pin for the bottom of the hole and cut a 6mm screw to 5mm in length (the screwed section). When making the pin, initially cut it over length and file to reduce the length testing in the collar until the correct

length is achieved, use a piece of bent wire inserted into the 8mm centre hole to remove the pin from the hole during testing. Finally, assemble and ensure that the screw has enough travel to clamp the pin to the rod and that the head of the allen screw is below the peripheral diameter of the collar when the rod is clamped. **Photograph 15** shows all the components laid out including a short 300mm rod.

Assembly & Use

Finally, assemble the items and check that the pins clamp the main body in the rear of the spindle and that the rod clamping pin actually clamps and holds the rod. The rod can be set to any length inside the spindle tube and then clamped using the clamping screw.

In practice, when cutting rods to the same length, I find greater precision can be achieved using a two stage process to machine rods to length. Initially, the number of items required is parted off slightly oversize using the backstop. Once this is completed each rod is placed back in the chuck successively (against the backstop) and machined to length using a very sharp cutting tool with a fine finishing cut across the face with the saddle clamped.

Hollow items with internal diameters greater than that of the rod can be cut to length using the stabilizing collar as a backstop.

If parting off or machining large quantities to the same length tool wear must be taken into account, using the two step process mentioned above would help alleviate this problem to some extent.

As the device projects from the end of the lathe it should be guarded if access to the rear of the lathe is possible to prevent entanglement with the spinning screw ends.

Conclusion

I found the back stop worked very well in use, it is easy, quick and simple to fit and gives repeatable accurate results. The central rod can even project into the jaws of the chuck if the work is short and larger than the rod diameter. An embellishment could be to make a rod or rods with a flat plate on the end which could be used as a backing plate to help mount larger diameter items squarely in the chuck.

A variation in construction for smaller lathes is that the clamping pins may be replaced by balls, this would require much shallower 'ball holes' and result in a smaller diameter main body. A ball retaining mechanism would be required to ensure the balls do not fall out when the device taken out of the lathe, this could simply be 3 or more centre pop marks on the very edge of each hole, made after the balls are inserted, to deform the edge of the hole to hold the balls in. ■

Scribe a line

YOUR CHANCE TO TALK TO US!

Drop us a line and share your advice, questions and opinions with other readers.

Signing off

Dear Readers, Elsewhere In this issue of *Model Engineers' Workshop* you will find a short piece of 'how it was done my way' being the very last such item from my keyboard. The reason is that I have been diagnosed as having Parkinson's Disease - a degenerative disease of the brain, for which there is currently no cure, though there are treatments which may extend my life a long time. The downside is that signals from brain to limb muscles are often incorrect giving rise to tremors. For example, this once professional typist now uses one finger. Using smaller tools, drivers, keys, 10BA nuts and screws is next to impossible. I have also surrendered my driving license but due to generosity of friends I can still get to local and club events. I intend keeping up my interest in this greatest of many hobbies and hope to continue encouraging others as and when.

I first read *Model Engineer* in 1955, commenced cutting metal c.1963 on a Centrix Micro lathe mounted in a home writing desk in the living room corner. I started a Rob Roy loco on this lathe and, wanting a boiler finished met the late Alec Farmer who, living in my same post-code area, encouraged me to join the Birmingham SME in 1968 - the same month that Alfred John Reeves, founder of that famous ME supplier, died. Alec and his BSME friend Don Crisp bought the Company that year and took me on the staff in October 2nd 1970 to write letters and general background office duties. Eventually I learned foundry pattern making - mostly brass fabrication; then ink-tracing older drawings and more recent ones too and then into design of my own creations or at the desire of my employers. I also made a number of special tools including a hand-cranked

device to make brass 'Olivers' for fairground models, and a set of forming rolls for the American 5-inch gauge 'Rogers' 4-4-0 which I designed along with three other locos.

Sadly, the original Reeves went into voluntary liquidation on 22nd December 2000 making myself and five others redundant. The trading rights changed hands the following week, now known as Reeves 2000 with whom I have no connection. I was fortunate to be taken on to the staff of Barrett Engineering of Walsall, makers of gauge one live steam locomotives. I reached retirement age in July 2004 and have continued my interests supported by my lovely wife Mary, and promoted to the rank of 'Chief Domestic Technician'.

God bless you all.

David Piddington, Birmingham

Centring Tips

Dear Neil, I very much enjoyed Jouni Pirritimäki's article in the March issue. However, it is perhaps fair to point out to newcomers that it is not good practice to rely on the DTI when centring a rough sand casting in the four jaw chuck.

The outer coating of sand and iron melted together can be very tough and abrasive as well as often quite irregular, which can easily wear the tip of the probe, and because of the 'humps and hollows' give a false reading. For smooth regular work it is fine.

The other point to remember is that what comes to us from the foundry is not necessarily round; it can vary quite a lot and still look right. I have in the past destroyed a couple of castings by not allowing for this, I am inclined to think that the 'rapping' of the pattern on the sand may well be the cause.

Nowadays I prefer to mark out with a centre finder from four points around the circumference, which often leaves a small triangle or rectangle in the middle. A carefully placed centre do in the centre of this will give a fairly accurate true centre, and then I use the 'two centre' method as shown in photo 15 of Jouni's article. For rough setting I find that a piece of white card or plastic placed below the work give a good chance of gauging any run-out; a tool placed near to the closest inward point gives an idea of how much adjustment is needed. In fact, I often set up by eye, and on checking find that the wobble is only a couple of thou.

Before starting on the turning operation I place the tool at the largest diameter position required, and swing the lathe over by hand, which is the final check to make sure that the job will come out of the casting so mounted.

I bet that it takes me less time to set up and centre in this fashion than it took me to type this letter.

Ted Jolliffe, Clapham

Fairly Quick Tool Change!

With only minor modifications the neat tool tip holders described by Jacques Maurel can form the basis of an effective 'fairly quick tool change' system when combined with a simple slot in a block type tool-post whether single, double or four way. The inherent upwards tilt angle of the tool means that cutting tip height is defined by how far forward it projects from the holder. So, if some means of repeatably locating the holders at the same projection in the tool-post, tool-in-holder assemblies can be interchanged retaining the tool tip height and projection from the post just like a proper (expensive) Quick Change system.

The simplest location method is step close to the front of the tool-holder engaging against the base of the tool-post. Alternatively make all the tool-holders the same length and butt them up against a stop fitted inside or across the end of the

MEW Inspiration

Dear Neil, Thank you VERY MUCH for your magazine. I enjoy my retirement thanks to *MEW*. I am an absolute beginner and I like the diversity of the articles. The advanced ideas give me a vision, the simple ones a working method.

I saw the table protector in issue 239, page 36. I made it directly from plywood, that I have waxed (!).

You can see on the photo some of the tools I have made. Amazing that I did it myself, completely alone, without any direct help. Today, I have still seen nobody working on a lathe or a milling machine.

Because my floor is combustible, or may be because I am French (oh yes), I was not charmed by the 'shades of Lord Nelson's cannon balls' (Jock Miller, *MEW* 215, page 19). Thus I have not soldered the self-turned brass ball on my chuck key, it is screwed...

Thank you very much.

Bernard Zaegel, Leidschendam, The Netherlands.



tool-post slot. If the stop were made to screw in place an alternative position or two could be provided for when more tool projection is desirable to clear features on the job in progress. Off machine setting makes life much easier, especially when sharpening or touching up tools mid job. Best done with a simple jig comprising a replica of the tool-post slot and locating device with a tip height setting indicator fixed a suitable distance in front. Although a simple stop would work fine as only the projection distance needs to be set a scribed line indicating the tip height is probably sensible as a sanity check.

Slotted block tool-holders are easily made by screwing and gluing standard stock plate and bar sections together. Chewing out from solid in the usual way needs a fairly hefty mill if the job is to be done in reasonable time. Two slot versions are narrower than the common four-way and better suited to smaller machine where space is limited. In retrospect I've pretty much never used more than two slots on a four-way so two parallel slots on opposite sides of the block would have done just fine. A standardised two slot block system would work well with Peter Nicolson's threading tools and Peter Shaw's parting tool too.

Realistically some sort of indexing/locating key or device is desirable. Especially when rotating a two slot block to keep two tools in operation on the same job. For example, paired roughing and finishing or turning and facing tools. Given a locating device its perfectly practical to make extra tool-posts so as to have enough toolsets ready to go do a complete job. Changing a tool-post complete with tool-holders is probably quicker than swopping out tools even if the hold down device is an ordinary stud and nut. There are various ways to make changeover faster by using only a partial turn to release rather than unscrewing a

normal nut. An interrupted thread or some sort of rotary cam action device are probably the obvious ones for a commercial device. However, both appear to have certain design subtleties making the difference between working ... sort of/usually okay / really well ... which is probably not the sort of thing you want to tangle with in the home shop. An inherently reliable, more easily made, system is to hold the tool-post it down onto the top-slide via a freely rotating, but vertically restrained, pillar cross drilled near the top passing through a hollow castellated head bolt screwing into the block. A suitably stout tommy bar can be running through both cross drilling and nut castellations generates the actual holding down forces. Clearly once the basic position of the hollow bolt has been set only a fraction of a turn is needed to loosen the tommy bar enough for it to be withdrawn allowing the tool-post to be lifted off and a replacement fitted whereupon a similar fraction of a turn in the opposite direction will lock things solidly again. One of the 14TPI pipe threads would probably do just fine for the hollow nut giving around ¼ or ⅓rd of a turn between release and lock.

If going to the trouble of making multiple blocks carving one from solid to take a direct mounting version of Peter Shaw's parting tool or one of the commercial blades, HSS or carbide tip according to taste, would probably provide a welcome increase in rigidity compared to simply mounting a holder in the slotted tool-post. The other side of this solid tool-block could usefully mount a bar type boring tool holder using eccentric bushes to set tip height as per the George Thomas design published many years ago in *Model Engineer* and reproduced in his book *Model Engineers Workshop Manual*.

Clive Foster, Crowborough, Sussex

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Cutting Identical Lengths for the Novice Mill User

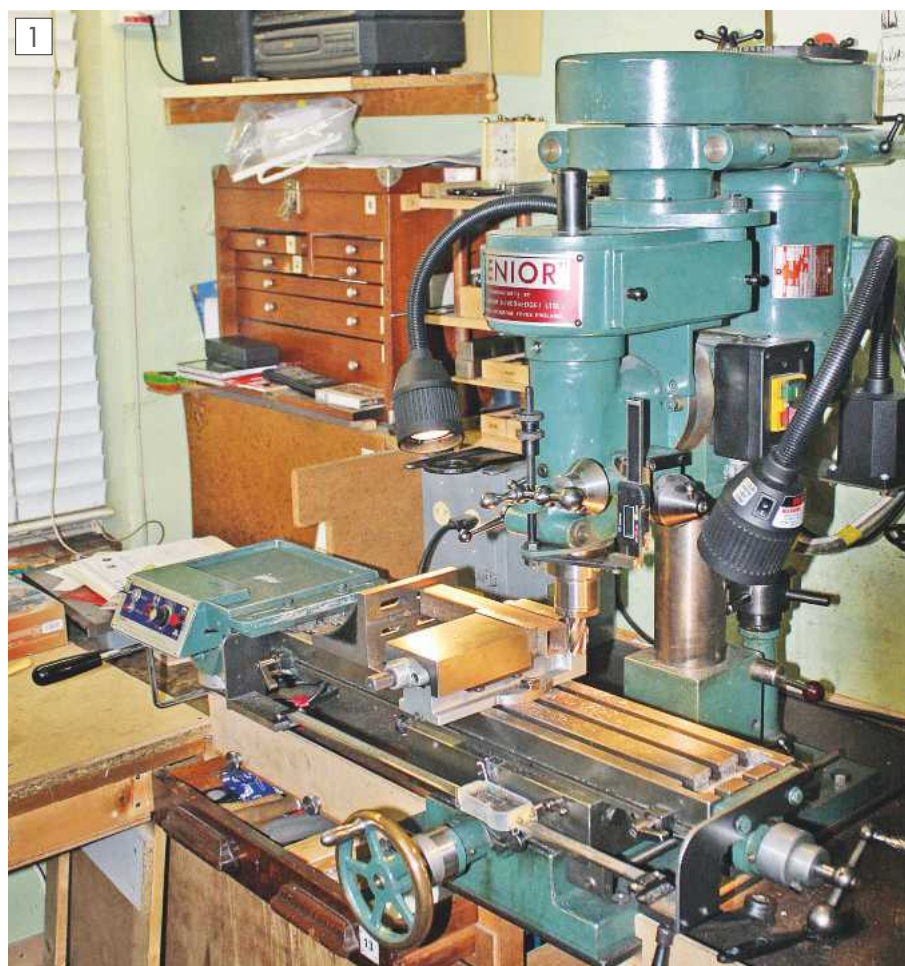


David Piddington offers some wise words to workshop novices.

There is currently increasing evidence of a desire to encourage younger people – teens to forties (and older?) – to enter the model engineering hobby, and quite right too if it is to survive the onslaught from alternative electronic, athletic and other interests. For the purpose of encouraging newcomers to this best of all hobbies, I have used the word ‘novice’ instead of ‘beginner’ though there is little difference between the two. My copy of the Oxford Dictionary of English introduces ‘beginner’ as ‘a person just starting to learn a skill or take part in an activity’, and ‘novice’ as ‘a person new to and inexperienced in a job or situation’. I prefer the latter for the purpose of these notes as ‘inexperienced’ suggests that some knowledge of our hobby has already been acquired.

I must apologise in advance that this narrative uses only Imperial inch/foot measurements, for that is what I was trained in and still use as it comes naturally to me. I suspect many novices are by this time fully conversant with electronic calculators and conversion one to the other should not be a problem. My Casio AZ-45F pocket calculator actually does fractions as well and I recommend sourcing one of these.

Inevitably in the 21st century, these lads and lassies will come from family backgrounds outside of traditional engineering, and may also not have had



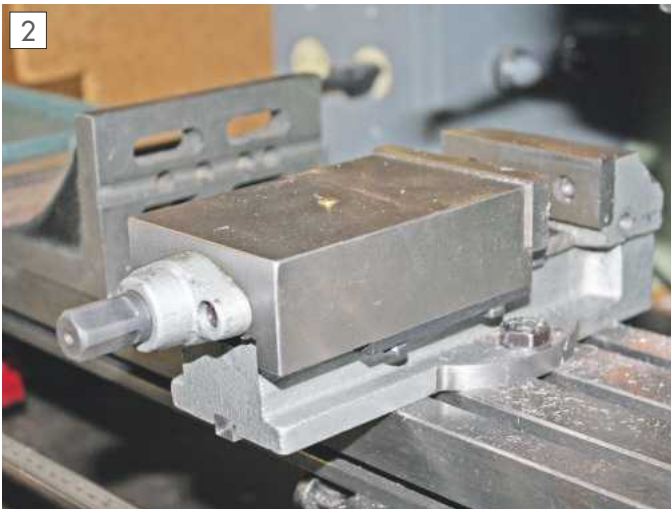
Tom Senior vertical mill.

access to industrial-type machinery within their educational backgrounds. It is therefore, that we as active model engineers using such tools in our home workshops, should endeavour to ‘fill the gap’ of teaching the ‘getting started’ steps into this hobby for those who have had the initiative to ask questions like ‘how do I start?’ My personal answer to that question is, ‘Go to your nearest ME club and ask questions about everything you see there’. If the seed falls on good soil, then the fertilizer can be gently added and the crop will increase.

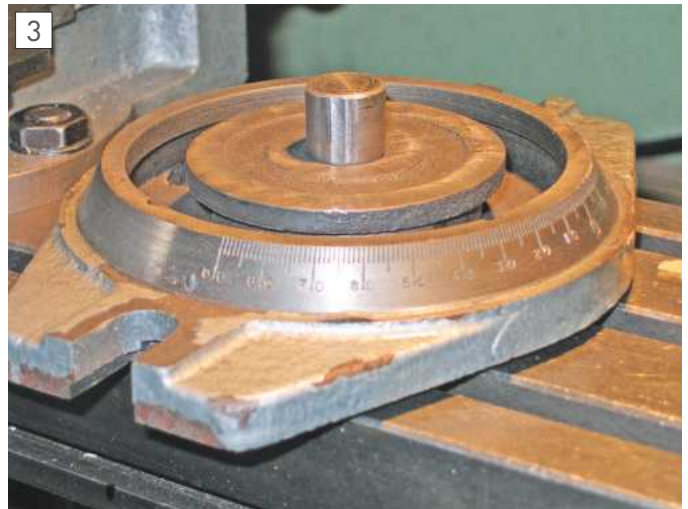
The almost universal machine tool for this hobby is the lathe on which there are copious volumes of instructions available. The book I would recommend for novices is *The Amateurs Lathe* by Lawrence Sparey, first published in 1948 (ref 1), my copy being a 4th edition, and now running to several more. Although I had an engineering apprenticeship, I did very little

actual machining due to my dry skin being easily damaged by the coolants of the 1950s, and I spent most of my time in the fitting and assembly departments. On acquiring my first Myford Super 7 lathe second hand in 1968, ‘Sparey’ became almost my bible and I recommend it to you also.

I was recently asked by a friend, currently without his workshop which is being rebuilt, if I would machine to length some identical pieces of 30mm square by 2.5mm steel tube of which he had roughly hand-sawn to length prior to finishing. The easy, quick way would be to have set the lengths across the mill table at 90 degrees and traverse the table appropriately past a revolving end mill that had a $1\frac{1}{16}$ inch length of flute. Most of my cutters are imperial inch sizes which is what I was trained in half a century ago, as are the feed screws of my Senior ‘E’ mill and Myford S7 lathe. The lengths of



A typical milling vice of robust construction.



Rotary base for the milling vice.

these tubes were also specified in inches at $7\frac{1}{4}$ and $8\frac{1}{2}$ inches and my mill cross travel is only 5 inches. Unfortunately although my mill was fitted with dual-reading linear scales in 2006 and 7, the longitudinal scale (**ref 2**) has decided to fail and is, temporarily anyway, out of action. So for this particular work, recourse was made back to the original 10tpi leadscrew with its 100 divisions on the feed dials. This, I feel, is where the novice to the arts of milling may find my notes of use for this is how I worked for well over 15 years until fitting the readouts, and I feel it is good to know, and use, the 'old fashioned' ways of measurement.

WARNING – Milling machines and drilling machines, in common with most powered tools, are dangerous. Health and Safety demands that anything revolving should have a guard around it. Unfortunately for model engineer workshops, guards can be a considerable hindrance, and inconvenience, in getting at components for measurement without damage to ones person. So, for what follows in this narrative please take note that in all instances where I have used the ancillary equipment, I always stop my machine first. Rotating multi-tooth milling cutters are very adept at removing unwary fingers and/or catching hold of loose clothing, or even long hair, with disastrous results.

Having already told of my lack of experience of using milling machines; none whatsoever of the **horizontal** milling machine where rotary cutters are secured to a driven mandrel horizontally disposed above the worktable. I will assume that the novice reading these notes will have acquired a **vertical** milling machine of which there are two basic types. Firstly what I call a 'mill drill' of which most I have seen have a vertical column without a keyway, so that the drive head may be quickly positioned where it is needed. The 'true' milling machine, such as my 'Senior E' (**photo 1**) has such a keyway and thus all components to be machined have to be set to where the cutter will operate. With practice, hole centres, areas etc. can be repeated on successive components. My 'Senior' also has the facility of rotating the drive head in the longitudinal, vertical plane to enable drills and cutters to work at angles. Useful on rare occasions but has

the disadvantage that it is difficult to accurately reset to the normal vertical position at which my machine is now permanently set. It is easier, for me anyway, to set the component to the desired angle.

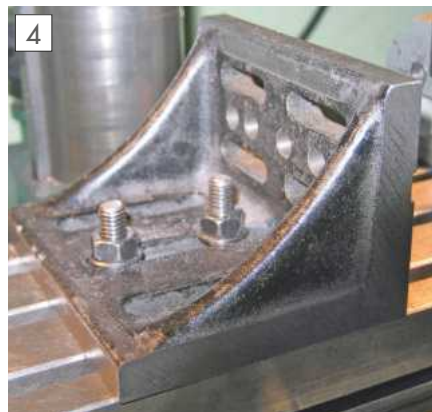
For holding cutters I recommend a 'Clarkson Autolock' chuck but there are other similar chucks. Most will have the facility for gripping threaded shank cutters, which are always, as far as I know, threaded to the Clarkson chuck metric and imperial standards. It is also vital that you have a drawbar with locking nut to secure your chuck through the machine spindle.

I will assume that included in your basic equipment you have a machine vice. Do not buy cheaply. Go for the best you can afford, preferably new and, if possible, buy one that has the axis of the feed screw slightly **above** the vertical centreline of the vice jaws. Most vices however seem to be of the on-centreline type, which are fine when new, but after use gripping components tightly with the upper halves of the jaw only, wear occurs at the business end of the screw. The jaw will tilt backwards ever so slightly, and work under cutting loads can move upwards and be spoiled. With the screw axis **above** the jaw centre, the tightening force will 'push' the work downwards into the vice.

My vice, which is of the former type, (**photo 2**) is shown here set across the mill table. This vice was supplied with a base enabling the vice to pivot on a centre stub that should allow a work piece to be set to an angle away from the nominal square setting once this is achieved. A 180

degree section of angular divisions were engraved on the base. Additionally, there was a 'central' longitudinal keyway on the bottom and at the end of each was fitted a location plate which was not correct for my machine so I knew I would have to adapt to suit. I examined one of these vices at an exhibition trade stand and asked to buy one, which was given to me pre-boxed from under the counter. When I checked it at home – after the exhibition had closed of course, and the trader's business was a long way away – I checked the vice, and found that the angular scale had been put with its centre about 25 degrees off-centre. Grrr! It's another story, not for novices, how I corrected this but I learned the lesson to check the one in the box as well as that in the display. It was while checking that I also found that the rotation stub was not on the axis of the underneath keys, which I could not have checked at the exhibition anyway. That had to be corrected too. Another Grrr! (**photo 3**)

The next almost essential piece of equipment that is good to consider is a 90 degree angleplate, commonly of cast iron and purchased ready machined accurately on all faces except those within the angle. Mine measures 5 x 4 x 3 inches, has web strengtheners at each side of the unit, three vertical slots on the 5-inch face and four horizontal slots on the 3 inch face. On the latter face I machined a $\frac{3}{8}$ inch groove to accept a tenon to locate the angle plate accurately in line on the machine table. (**photos 4 and 5**) An improvement I made to mine was to machine the top of the



Angle plate fixed to the table.



This groove accepts a tenon to help with accurate location.

inner face at the very top as shown, say $\frac{1}{8}$ inch. I went a bit far with mine, but some of the cast surface adjacent to the slot/s must remain for clamp nuts and washers to grip on. Remove just enough metal to clean up across the surface, no more as in **(photo 6)**. We will use this later.

In order to machine the square tubes, or any other pieces of material, we must first set the vice jaws parallel to the axis of the machine table. For accuracy this is best done with a d.t.i. - a dial test indicator,

clock gauge or some other term depending on where you live. **(photos 7 and 8)** shows how I used mine. Note that the indicator is held in the mill chuck with a made-by-me adapter. I achieved an error of 0.0005 inches as can be seen, this over a length of 3 inches; good enough for this particular job,

Next position the angleplate from the vice. A quick way is to use a setsquare as shown in **photo 9**, but the precision method uses the d.t.i. in exactly the same

way that the vice itself was set (**photo 10**). You will, of course, have to estimate where the vice and angleplate are set in relation to the work so that there is minimal overhang from the vice to the cutter. This has to be minimised to avoid vibration during the cutting process.

We can now start to cut metal. The 'blanks', pieces cut off prior to machining, should be made $\frac{1}{8}$ inches (3m) longer than actually required i.e. each end has only $\frac{1}{16}$ or half the allowance machined off. The



Machined flat at top rear of angle plate.



Checking alignment of chuck jaws at RHS...



...and LHS.



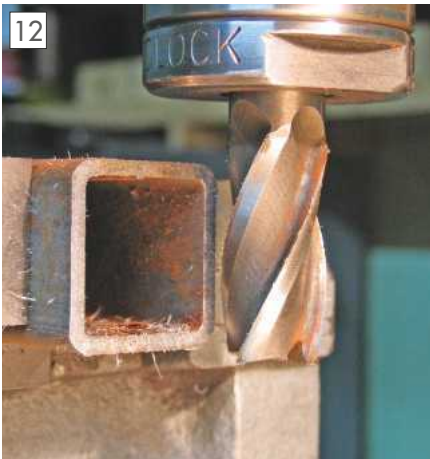
Setting angle plate with a square.



Alternative method using the DTI.



Cutter just touching the work.

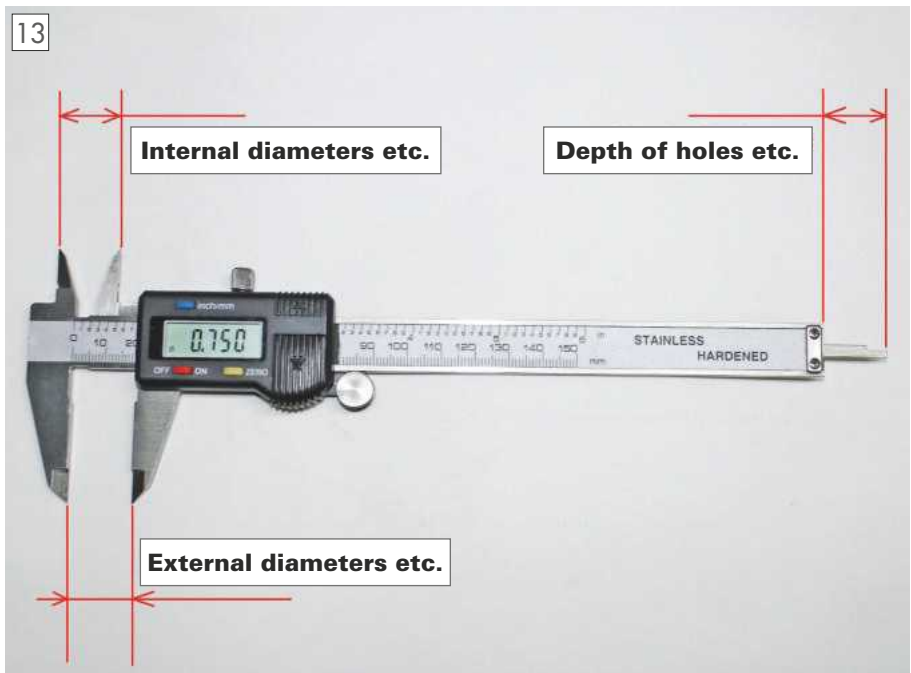


End of work after cleaning up.

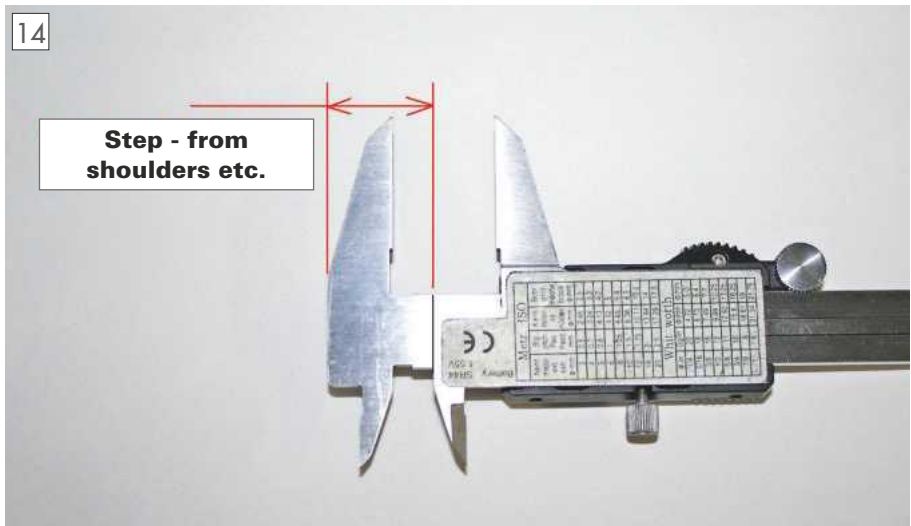
extra metal is called the 'machining allowance'. A cutter must be selected and here is an apparent conflict for a rotary cutter which cuts on the end is called a 'Slot Drill', whereas an 'End Mill' is generally used for cutting on its side flutes. A slot drill will also cut with its side flutes but usually has only two flutes instead of the end mill's three or four. For the job in this description, I used a four-flute end mill of $\frac{1}{16}$ inch diameter, which has a flute length slightly longer than the material we are facing to length.

Place your first piece of metal in the vice with the other end resting against the angleplate (**photo 11**). Wind the 'x' and 'y' axes until the rotating cutter revolving at around 300rpm just touches the bar, then set the 'x' dial reading to zero and by small amounts traverse the table a few 'thou' ('thousandths of an inch') in the x-axis to 'put on the cut'. Cut across the end by traversing the y-axis so the work moves against the direction of rotation of the cutter. Wind the slide back after each cut before taking. You will note that the cutter revolves clockwise when looking down at it in the normal mode. If you attempt to feed the cutter in the reverse direction past the work, this is called 'climb milling' which is not recommended as there is every chance that the cutter will 'climb' out of its contact with the work and damage is almost inevitable. **Photograph 12** shows the face cleaned up right across. Please note that the cutter is left in the just finished position; another indication that it revolved clockwise as stated before. Repeat for all the bars noting that they should be placed on your bench ready for their finishing cuts each the same way around. It is very easy to forget so the same end is, accidentally, machined twice and the other end not at all.

We must now consider measurement of the lengths. I expect that most readers will, by this time, have one or more micrometers but with a job like this in the mill where one end cannot be accessed without removal from the machine, something like a depth gauge – a micrometer with one end only – is more useful. Even better is a vernier, of which there are basic engraved and electronic reading styles'. Both types have Metric and Imperial inch scales. The electronic type makes things really easy for readers who perhaps may not understand the principle of a vernier scale. The vernier scale was invented in its modern form in



Three ways of taking measurements from a digital caliper.



The step measurement facility.

1631 by the French mathematician Pierre Vernier (1580–1637). Its use was described in detail in English in *Navigatio Britannica* (1750) by John Barrow.

Photograph 13 shows the front face of my digital reading calliper on to which I have superimposed text indicating the three main uses for this instrument which covers, external sizes, internal diameters and sizes, plus depths of holes. There is a cut-away on the extreme end of the latter, which is to get to the extreme bottom of a bore should the boring tool tip have a small radius on it. There is one more facility accommodated on this tool, shown in the picture of the reverse (**photo 14**) which is called 'step' and we will use this to measure the length of our work. As my pal's tubes were longer, $7\frac{3}{4}$ inches, than the capacity of my measuring equipment, i.e. the vernier, an intermediate block will be required to allow for the increase. This is where seasoned modellers like me have an 'odd and sods' box containing odd ends of material, too good to throw away, but no immediate use for. Anyway, I found a

piece of $\frac{1}{2}$ inch square mild steel just over 5 inches long, which I carefully machined in the lathe to 5.000 inches exactly.

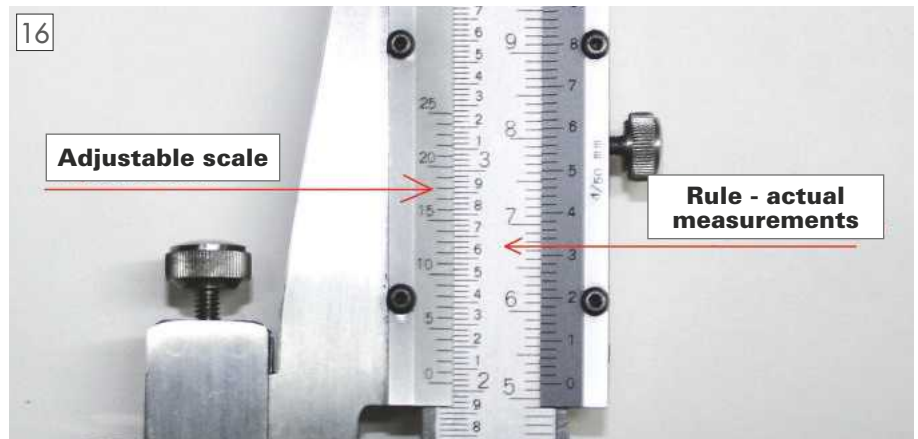
We can now measure the 'step' from the end of the machined bar and add on the measuring bar length. As you use the step function, use the slide locking screw to retain the measurement while you are handling it to read the other side. From that we can then remove metal from the bar in known increments using the graduations on the feed handle dial until the final size is reached. At this point set a length stop to the 'x' (longitudinal) axis of the mill table. I recommend that with the second bar, as you approach the stop position, check, and re-check as the cutter advances. If the table has not quite reached the stop, which may be a very small amount, then its position can be altered accordingly.

My pal who asked me to machine these tubes for him, admitted that he did not know the principle on which a vernier worked. It is quite simple but requires good close-range eyesight, or use of a lens.



Scale of a vernier height gauge.

Photograph 15 is the measurement department of my vernier height gauge, not an electronic one, but much older, manual, and best for showing the principle of how verniers work (**photo 16**). The two primary elements are the rule and the adjustable scale. The rule is permanently fixed into a substantial base, not shown here, and the rule is guaranteed to be truly vertical. The scale has a knurled locking screw, as does the adjuster block. Both the latter and the scale are connected with a thread having a knurled nut for adjusting. When the adjuster is locked to the rule, then turning the knurled nut the scale may be moved in either direction and, in its turn, may be locked to the rule.



Close up of the scales.

Photograph 17, a 'posed' image, shows that the '0' (zero) on the scale has been set exactly adjacent to the '2' i.e. 2 inches. Counting upwards on the rule's scale we come to line 49 corresponding to the '25' on the Adjustable Scale. There is no particular need to have as many as 49 divisions, but there has to be a different number.

Now go back to photo 15 where the Scale was set arbitrarily at the rule position between the first and second digit above the '2'. We now move upwards on the scale to where two lines, one on each are exactly opposite each other. In this instance it is the position '11' (eleven). For novices I recommend locking both slides

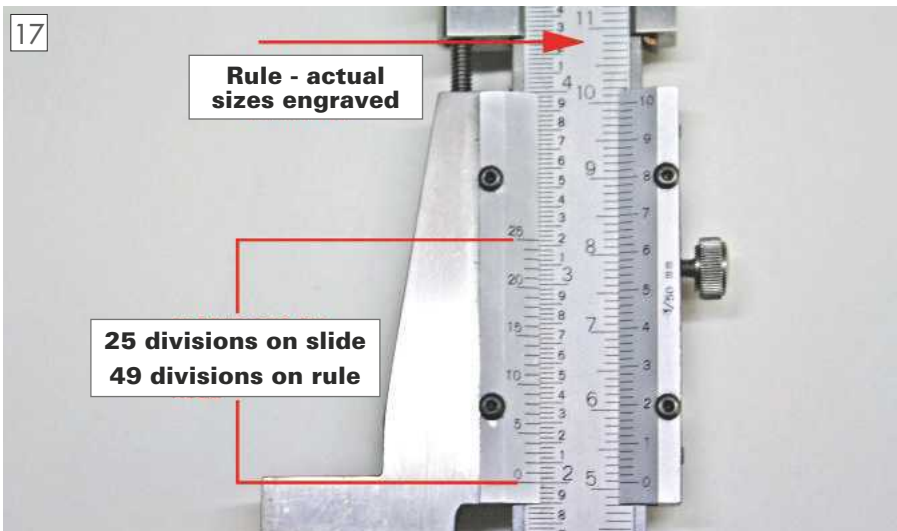
so that the setting is saved while we calculate the measurement (**photo 18**).

Now to the calculations. The rule is marked on the left side in inches so that each division is 0.025'. The photo shows the aligned lines are above the rule's '2' so that the measurement is: 2 inches plus 0.025 inches plus eleven divisions on the sliding scale = 2.036 inches.

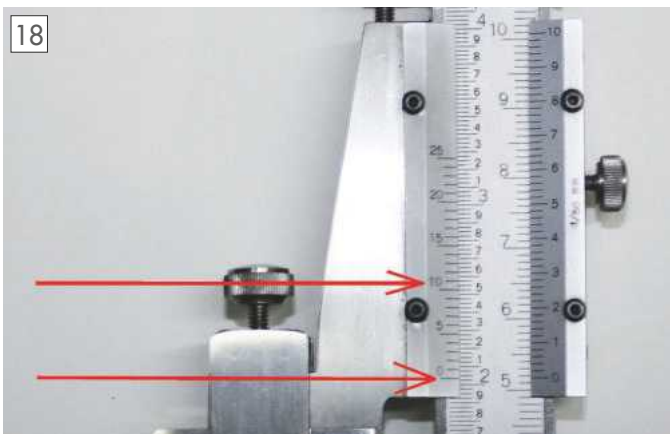
Now comes the completion of our task.

Look back to image 12, now look at **photo 19**, a 'posed' image once more showing how the vernier is now used with the step function to measure the bar length. So for these tubes, the vernier reading from the angleplate will be 5 inches plus 2 1/4 inches total 7 1/4 inches, or put into decimal measurement, which is what the digital vernier uses, we have 5 + 2.25 = 7.25 inches.

When the finish dimension is nearly reached, say 0.005' or 0.03mm, set a travel stop tight enough for it to move slightly but not over tight just yet. When you have taken the final cut and measured to satisfaction, tighten the stop fully. Replace with the next bar, and as you approach the stop, recheck with the vernier say, at 0.002 inch intervals, to ensure that the stop is correctly set. Having completed that you may have confidence in the whole batch, be cautious and do not wind the machine table hard into the stop. Gently does it! ■



Scale zeroed at 2 inches.



Scale at 2.036 inches.



Using the digital vernier to check the length of the bar.

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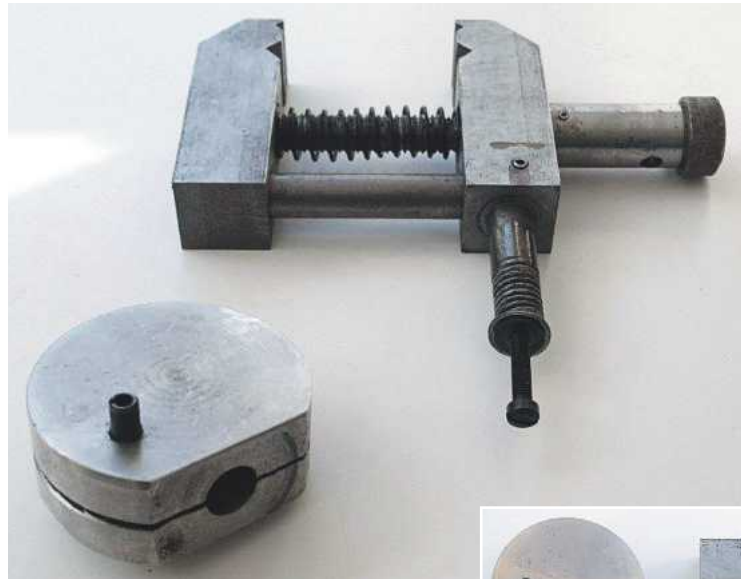
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A Quick Instrument Vice with an easy swivel and tilt

Malcolm Leafe describes a 'quick and dirty' solution to a gripping problem.

This article was prompted by Brian Moseley's series in *MEW* issues 226 and 227 where he produced a fine multi-adjustable vice (*A Useful Mini-Vice*) and also by an earlier series by David Piddington where he machined a very nice similar vice from a set of castings. My vice, whilst again similar, follows a different approach – I had accumulated a small pile of machined components which required de-frazing/ breaking of sharp edges or harridging (acknowledgements to the aforementioned D. Piddington for the latter splendid word). However, due to a recent house move; I had mislaid my 15-year-old instrument vice and so, armed with various bits of scrap from the stores i.e. the rusty pile in the workshop corner, I set to making a quick and dirty replacement. The size and materials used will depend on your own 'stores' and ambitions but I have appended a few sketches and, a selection of photographs of the item together with a few notes on sizes/ techniques.



Construction of the vice.

The first items produced were the jaws. The trusty bandsaw soon chopped off two 3 inch(ish) lengths of 1 inch square bar – mine started out as matt chrome plated scrap but this is an option. The two were nipped in a milling vice and a few minutes with a ½ inch endmill soon cleaned up the ends, a change of position saw the same cutter bringing the other ends to 45 degrees and, reversing their position, two useful-looking 90 degree vee-notches were equally quickly cut. I have a number of ½ inch thick hardened and ground blocks with standard angles which makes jobs like this quick to set up, however, I have not yet used the notches.

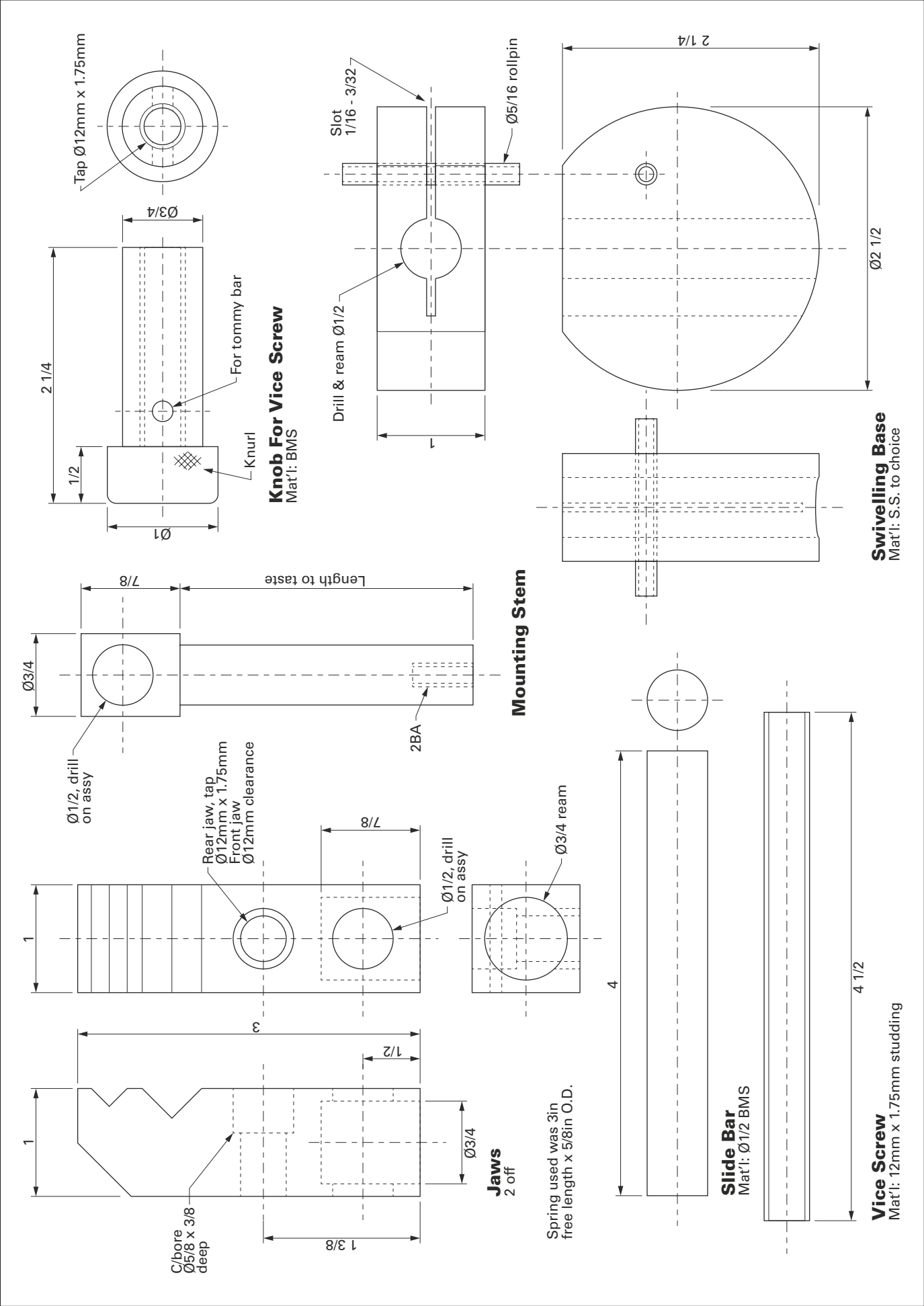
A number of holes were now required in the jaws. That for the vertical stem was the first to be tackled. This could be a 4-jaw and wobbler job in a lathe but for this and



the other holes I used a jig borer. The hole was drilled and reamed to 0.75 inch diameter and about ⅞ inch deep – check that you are working on the correct end of the jaw. The mounting stem was also from scrap (a shaft of unknown provenance), hence the superfluous thread on the end which is shown in the photos. The end which fits into the jaw was left at the original 0.75 inch diameter and the section between the 0.75 inch bit and the thread was turned to 0.5 inch diameter. This was then fitted into the end of the jaw with Loctite – or a similar glue. The stem length is to choice – whether you will wish to have the opportunity to raise the vice or, as in mine, simply wish to swivel and tilt it. After a suitable elapsed time the two jaws were clamped, vees uppermost and side by side, in a machine vice and the holes for the lower guide bar and for the clamp screw were drilled/ bored/ reamed as appropriate – those for the guide bar are 0.5 inch diameter and those for the



The vice attached to the swivel base.





Instrument vice mounted in a bench vice.



How the cross bar facilitates angle setting.

screw were 12mm – a tad of modernity creeping in here. The lower hole in the fixed jaw thus passes through the 0.75 inch diameter part of the already drilled-in mounting stem. A couple of parallels will be found helpful in avoiding creating extra holes in the vice.

I had considered using a circlip to retain the clamp screw in the fixed jaw but a change of mind (the design was constantly under review, as they say) I settled on a coil spring to separate the jaws and so $\frac{3}{8}$ inch deep (in both jaws) in the upper holes provided for the clamp screw, to accommodate the spring when the vice was closed – this will depend on the spring chosen.

The clamp screw was economically made by using a piece of 12mm studding which was screwed and glued into an appropriately sized axial hole drilled (and tapped 12mm) into the end of a selected piece of 1 inch diameter scrap BMS – this latter was skimmed to clean it up and a short knurled section was produced on the outer end to improve the grip on the vice screw knob. A neat alternative would be to fix the clamping screw into the rear jaw and to simply thread the clamping screw knob so that on tightening the vice the knob swallowed the vice screw – it would look neater. I failed to think of this earlier but, as I noted previously, the design was 'in a state of continuous development'.

The fixed jaw, with both the slide bar and mounting stem in place, was drilled 3mm and a rollpin was knocked in thus retaining both items. A similar hole and pin were also used to secure the 12mm clamp screw into the handle/ knob whilst a tommy bar hole was also drilled through the knob – size to taste. The excess length of the rollpins was ground flush.

At this stage the vice can be assembled or even polished if you so desire, as the photos show, mine is *au naturel*. The complications of the swivelling/all singing and dancing mount now came to the fore and the excuse of the design being constantly under review again has a major influence on the 'design'. The published designs referred to earlier use very neat versions of a possibly archetypal style for the base. I wanted a vice mounted rigidly and somewhat higher than bench-top height and one which could be quickly dismounted and cast aside (or even stored carefully) – plus it had to be quick to make – the vice was a tool not a project. I had long considered that I would mount the instrument vice from a bench vice to give the desired height and quick disassembly requirement.

My solution is very likely not original. I cut and faced a 1 inch thick slice of 2.5 inch diameter bar – I chose stainless as there was a length of it conveniently lying just under the bench; but other suppliers and materials abound – this was drilled diametrically and reamed through at 0.5

inch diameter to suit the mounting stem. A slot (0.060 inch wide) was then cut from the periphery through to the 0.5 inch bore and as, when trying out the device, the clamping action seemed to need a few more foot-pounds than I had reckoned on, the slot was extended a further $\frac{3}{8}$ inch past the central bore – a largish slitting saw (5 inch or so) will be needed for this and a milling machine will be useful. A $\frac{1}{4}$ inch deep flat was then machined on the periphery of my particular block, as I wished only to use a short mounting stem and the vice would be in contact with the top face of the block at all times. After due consideration, a $\frac{5}{16}$ hole was drilled near to the edge positioned $\frac{5}{8}$ inch down from the flat and $\frac{3}{8}$ inch set in from the periphery, a $\frac{5}{16}$ inch rollpin was knocked through the block leaving about 8mm protruding on each side. The mounting block is then slipped over the mounting stem – it is useful to drill the end of the stem and fit a 2BA screw and washer to prevent the block being lost.

All that remains is to open the jaws of the bench vice, pop the instrument vice mounting between the jaws, allow the rollpin to rest on the jaws of the bench vice and 'Robert is your mother's brother' you have a swivelling/ tilting small part vice which is adjustable in most directions, conveniently clamping it with a flick of the bench vice handle. ■

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Building an Electronic Lead Screw

Chris Gabel describes the fitting and use of a kit solution from Automation Artisans.

The use of change gears on a lathe and the use of a gear train can be traced back as far as Leonardo Da Vinci where the use of a geared lead screw shows in one of his sketches. However, I find that configuring an appropriate gear train to cut a variety of threads is time consuming and frustrating.

Think what it would be like to be able to key in a thread pitch, in Metric or in Imperial, or to be able to dial a fine finishing feed without having to reconfigure the machine. If it didn't take months to build, An Electronic Lead Screw could increase my productivity in the workshop while making threading and fine turning an enjoyable activity (**photo 1**).

I had found an Electronic Lead Screw described on the pages of Lester Caine's Model Engineers Digital Workshop website (**ref. 1**). It seemed so obvious: use an electronic control to run the Lead Screw and cut any thread or turn with any feed simply by keying in the dimensions of the thread or feed. But you needed four components, The ELS controller, a sensor on the lathe spindle so the controller knows where it is, a stepper motor, and a power supply to make it all go (**photo 2** and **fig. 1**).

As a project this seemed a considerable departure from the construction and tool

making I had been doing, and I shelved the idea until further research had been carried out.

Background Research

There is a great deal of excellent material about this kind of work and spending a bit of time reading can ensure success and prevent a lot of frustration. If you are new to controllers, and steppers I suggest reading *CNC Cookbook* (**ref. 2**) as a basic introduction. This could be followed by Jones on Stepper Motors (**ref. 3**). Then you could explore the Automation Artisans website (**ref 4**) where the development, building and use of an Electronic Lead Screw is fully described. One could join the Yahoo user group E-LeadScrew (**ref 5**). This user group was set up 8 years ago by John Dammeyer and others with the purpose of developing an ELS system. There are many picture files, and many conversation threads posing questions and giving answers. Original plans and diagrams are on file too. The end result is ELS sold primarily as a kit of parts along with a good manual. This is backed up by an excellent user group and forum with prolific levels of help and advice available from users and developers around the world. Lester Caine has supplied superb customer service and backup whenever I had queries or misunderstandings.

The concept of an electronic Lead Screw is firmly based in CNC. Simply stated, the mechanical ratio of the gears that drive the lead screw to produce specific threads and feeds is replaced by a processor controlled stepper motor. However, my interest is not in programming or batch production of parts. I really don't need a CNC lathe, I



Gear change wheels and the stepper motor alternative.

need more efficient use of my time in the workshop, as well as access to flexibility in set ups. An ELS system could provide this.

The three aspects to building an ELS system are:

1. Amendments to the lathe, consisting of connection of a stepper motor to the lathe's Lead Screw (**photo 3**) and a sensor on the main spindle of the lathe that puts out a signal once per revolution (**photo 4**). With properly thought out changes, it should be easy to return the lathe to its original configuration.
2. The ELS controller itself. The system I have chosen to use is by Automation Artisans (**photo 5**) distributed in the UK by Lester Caine of MEDW. This is the actual computer control. It also has the drivers for the stepper motor built in too. This requires assembly with lots of soldering, as well as enclosing the board in a functional case.
3. The Power Supply (**photo 6**). The ELS uses 12 volts, the spindle sensor 5-30 volts, and the stepper motor 25 to 50 volts, all DC. So you need a dedicated power supply to meet these specifications.

Modifications to the lathe

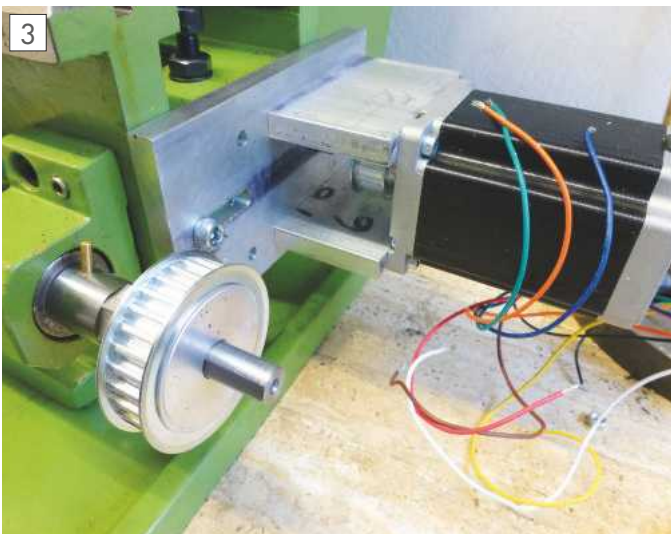
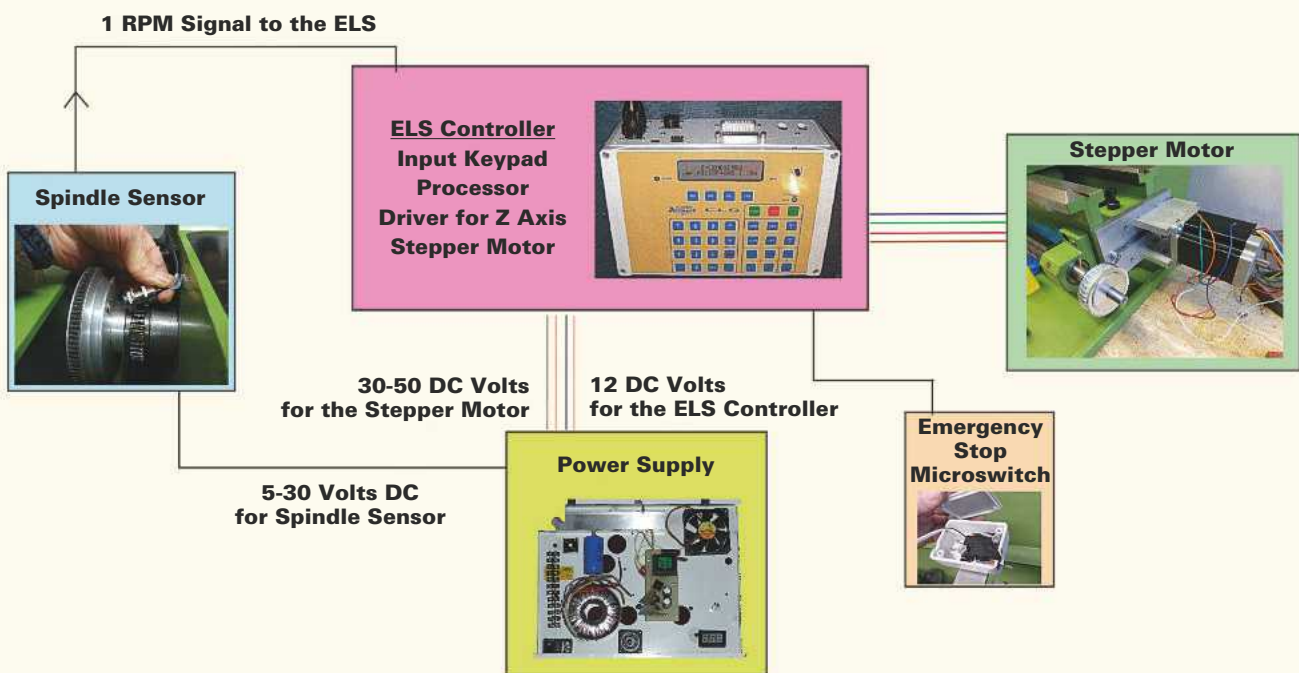
The stepper motor is quite small and needs to be connected to the lead screw in a manner which will enable very fine rotational control. That means a firm



My system: controller, stepper, and power supply.

Fig. 1

Electronic Lead Screw Block Diagram - Single Axis



Stepper motor and pulley position.



Spindle sensor.



My version of the automation artisans els controller.



Power supply.

bracket system is needed. Good practice suggests that torque is more important than speed, and a 1:2 pulley/belt system is suggested. This means you need to place a stepper motor with pulley, a belt, and a larger pulley on the Lead Screw, all attached on one end of the machine or the other. The motor needs to be adjustable + or - 10mm to allow for belt adjustment and fitting.

The Warco 250 lends itself to this conversion, as there is ample room for installation of the spindle sensor and good options for placing the stepper motor on either end of the machine. I chose to drive the Lead Screw from the right hand end, screwing and pinning directly onto the stub end of the Lead Screw (**photo 7**) after it had emerged from the support bearing. It was easy to place the stepper motor in line with this shaft extension. The end of the bed casting is flat and clear of fixtures, making a mounting bracket for the motor easy to attach.

The lead screw extends beyond the bearing a good 20 mm. There are two nuts which provide loading of the bearing. These were replaced with a spindle which screws onto the lead screw, providing a shaft for the pulley (**photo 8**). The lead screw stub is threaded M12x 1.25. A tap in this size is readily available. It is common as a small sparkplug tap. A tapping hole of 10.5 x 35mm deep was drilled. I tapped this using the lathe to get started, having bevelled the top lip of the 10.5mm hole first. This is a large thread and requires a lot of effort and needs to run true as is possible. I milled a hex into the diameter 20 stock to enable tightening of the spindle. If you mill each side of the hex 1.5mm you generate a size for a 17mm spanner.

A 3mm pin keyed the spindle to the lead screw. The hole was drilled in the spindle centrally, 6.5mm from the end. The spindle was then screwed into place and the bearing loading adjusted. I then drilled through the spindle and lead screw, using the spindle as a guide. The hole was then sized with a 3mm reamer and the pin put in place. This method of attachment enabled returning the lathe to original condition simply by removing the pin and spindle, and re-installing the two original Lead Screw nuts. Loading of the lead screw bearing with the extension could be adjusted with shim stock if necessary.

Stepper Motor Selection

The selection of a stepper motor seems more of an art form than science. But as a starting point, a NEMA 23 (frame size) rated at 3.1 NM (power) works on a 10 inch or 250mm Warco Lathe. The CNC blogs, websites and user groups give

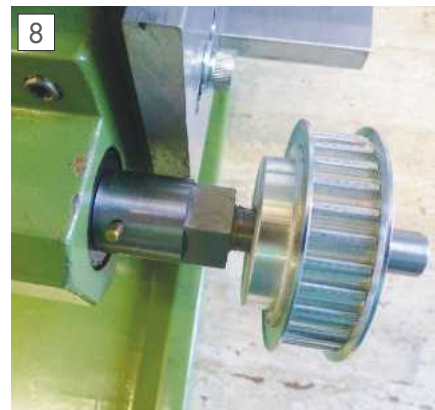


The lathe lead screw end stub.



you a good idea of where to start, but suppliers won't commit themselves about suggesting size or power. There are just too many variables in applications. Under advice I chose a NEMA 23 Stepper, 3.1 Nm, wired in Parallel, with the ELS set for 3 AMP output. This is running at 40 DC Volts and I have not stalled it yet. The belts I used are size T5. Belts Pulleys and Stepper were supplied by CNC4You, ref. 6. CNC4You were very helpful in calculating the correct T5 Belt length, given the pulley sizes and the distance between centres.

The mounting plate for the Stepper Motor is a 10 X 75 aluminium flat, attached to the lathe bed with 2 M6 Cap Screws (**photos 9 and 10**). The holes in the mounting plate are 30mm long slots, to enable sliding tension adjustment for the belt. The stepper motor needs to stand off from this plate by 40mm, so two 10 x 75 x 40 plates were made for the purpose. There are several ways to fasten the motor, using variants of plates or stand-off pillars. This could be studding screwed into the base plate, allowing the motor to be bolted into place. I decided however to attach the two stand-off pillars to the base plate with M5



Lead screw extension with pulley.



Motor support attachment points.

countersink screws. The motor could then be attached with cap screws, screwed into the tops of the pillars.

The Spindle Sensor and E-Stop

In order for the ELS Processor to know where it is, a pulse must be generated by the rotating spindle, once every revolution. There are two types which work well. One is an optical sensor and the other is a Hall Effect Switch. The Hall effect Integrated circuit looks like a standard single transistor. The Hall Effect Switch generates a pulse whenever a magnet passes by the end surface. It is necessary to buy one which states it has a digital output. I found a unit on eBay, which works well. The Hall IC is contained in a mounting, the leads are properly attached, and a tiny red LED confirms that a pulse has been generated every time the magnet passes by. On this model Warco, the magnet can simply attach to the large aluminium drive pulley with adhesive, and the sensor can easily be bracketed from a nearby stud. The bracket for the Hall Effect Sensor was made from 2mm sheet, mounted on the belt cover retaining bolt at the left hand top end of the machine (**photo 11**).

The only other add-on needed to make the system work is an 'E-Stop' emergency stop micro switch (**photo 12**).

E-Stop is a standard facility in all forms of CNC or stepper driven equipment. If, in the case of the lathe, the saddle is on a collision course for the chuck, because you got the numbers wrong, the micro-switch is tripped before actual impact occurs. This does prevent a lot of damage. Mini super magnets to hold the cased micro switch in place might work on some machines. Otherwise an adjustable clamping bracket is called for.



Hall effect spindle sensor bracket and magnet.



Z axis e-stop.



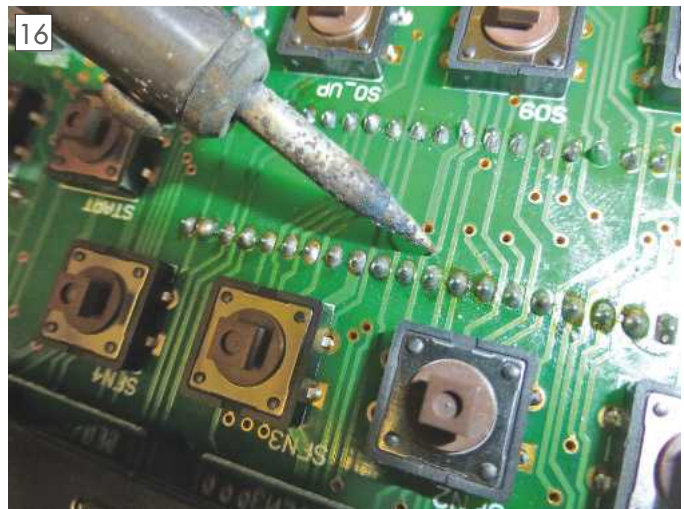
Power supply transformer rectifier and capacitor.



Assembled board top view.



Board bottom view.



200 Plus solder joints.

The Power Supply

There are two ways to go about providing power for your system. Indeed, your personal expertise should dictate which route is taken. This project requires a DC power supply which provides 3 different voltages: 5volts DC for the sensor; 12v for the ELS system controller, and 25-50v DC for the stepper motors. If you are competent, it is not difficult to build, but these are mains powered supplies and can be deadly. If you are not sure, buy a ready-made power supply unit. They are priced from £30 to £60 and are made for the purpose. This is a good, safe, easy option and not that much more expensive than building your own.

I chose to build a power supply, based on a plan/layout found on the Arc Eurotrade projects page of their website, designed to work with their stepper motors (**ref. 7**).

Parts can be found in the UK at RS, Farnell and Rapid Electronics. The local Maplin was good for connectors. I also chose to install a small LED voltage meter on the front, sourced from E-Bay (China supplier).

The starting point is a circular toroidal transformer. These have lots of wires, all colour coded but you need to get the connections right. Make sure you have a data sheet. On mine, there are two primaries (120v each) and 2 secondaries of

25v each (**photo 13**). Rapid Online provided downloadable data sheets for these transformers (**ref. 8**).

The three main components all from Rapid are:

- Toroidal Transformer 160 VA 0-25 0-25
- Bridge Rectifier 25 amp 200v
- Smoothing Capacitor 10000 uf 63V

The additional small board shown in the photo is a separate 12volt DC supply which powers the ELS. The main components deliver 40 volts DC when under load. Again, if you are not sure about this kind of construction, go for a ready-made unit.

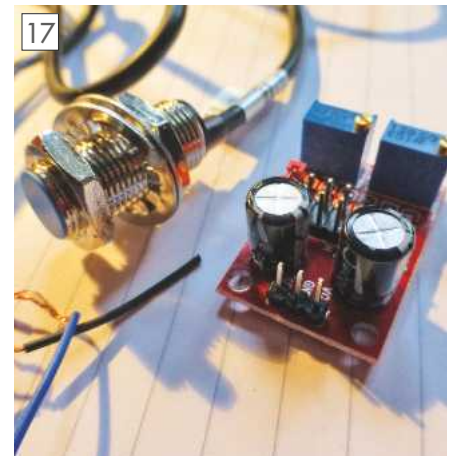
Assembling the ELS Controller

Although you can purchase the controller already assembled, most buy the kit of parts consisting of the PCB board, a whole bag full of push button switches, and about a dozen components which need to be attached to the board (**photo 14**). The 6 x 6 inch PCB board is well made with all of the surface-mount components already in place (**photo 15**). The assembly step by step instructions in the manual are good, and enable the construction to take place quite painlessly.

You need a 15 watt very fine soldering iron and good vision. There are over 200

connections (**photo 16**) given all the buttons, but the board is robust and access is good. I suggest examining all solder joints with a jeweller's loupe, just to make sure. All items in the pack were well labelled and described.

You can test the board quite early on. In order to actually function though, it needs a pulse from the spindle sensor. I bought a small pulse generator measuring about 20mm x 20mm, which can be used in place of the lathe and spindle sensor (**photo 17**). This made first trials much easier.



Sensor and stand alone pulse generator.



Boring button holes.
INSET: Fitting lcd panel.

The Box

Getting the ELS board tucked away safely in an enclosure while allowing connections as well as proper working of the membrane keypad takes good planning and problem solving.

Installing the finished ELS in a box is one of the major parts of the project. The holes for the pushbuttons need to be drilled precisely. Pushbutton elevation within the box needs to be adjustable if the micro switch buttons are to function by pushing on the top keyboard membrane. This is one of the few cases where information in the Yahoo ELS user group is wrong. Layouts for the case hole cutouts which are downloadable from the ELS site do not fit and are just wrong. Perhaps they refer to earlier versions. It is best to do it by measurement. I used a boring head in the mill to precisely locate and drill holes, all by the numbers (**photo 18**). It went together and aligned first time. The original used a box made by Hammond and supplied by Digi-Key. Mine was supplied by Maplin and was Wisner WGA-H2507. On the original box, the board and display were a tight fit (**photos 19 and 20**), which explains why the bottom margin of the membrane keypad is very narrow. While the keypad

membrane can be held in place by either spray adhesive or double sided tape, I will attach an additional frame surround to the top of the overlay to improve the looks and functionality of the keypad.

Adjusting the Switch Button height

The location of the board and its switches have to be at just the right elevation to enable a touch on the membrane to activate the push buttons. This is achieved in two ways (**ref. 9**). First I put kitchen cabinet small circular bumpers on the top of each switch (**photo 21**). 3M 'bumpons' work too. Second, the board is supported at each corner by L-shaped slotted bracket pairs (**photos 22 and 23**). These make a fully adjustable bracket system which makes adjustment easy, thanks to Peter farmer for these ideas.



Checking screen and button fit.

There is a great deal of excellent material about this kind of work and spending a bit of time reading can ensure success and prevent a lot frustration.

Connections

I wanted to proof the system from disastrous damage done by plugging into the wrong socket. The ELS requires 12v and 50v in, four stepper wires out, sensor power out and sensor signal in. I chose to make each connection a different form of plug and socket. This is to prevent mis-connection. If you are only using the Z axis the built-in DB25 connector on the back of the ELS contains the sensor connections, e-stop, and limit switch connections. However, you do need plugs and sockets on the ELS for ELS power in, a plug and socket for stepper driver power in and a connector going to the stepper motor. I chose a 9-way D connector plug and socket for the stepper connection, and mini-din connectors for the others (**photo 24**) with leads soldered and insulated with heat shrink (**photo 25**).



Placing bumpers on the buttons.



Hanging bracket.



Side mounting bracket.

Connections for Sensor, E-stop and Limit switches are not well documented. These all connect to the controller through the DB25 connector. You need to refer to the specific pin-out diagram found on the Yahoo E-LeadScrew Group files but not in the manual (ref. 9).

Working with the unit

If you have a mill, we all learn that the table moves left or right 'across' on the X axis. It moves towards and away from you on the Y axis. The chuck/cutter moves up and down on the Z axis. On a lathe the saddle moves to and fro on the Z axis. If you think about it this is the same as on the mill, where if you move towards and away from the chuck, this is the Z axis. The X on the lathe is the direction the Top Slide moves in. As on the mill, this direction is perpendicular to the axis of the chuck. Surprisingly, it all does make sense.

The ELS is configured for two different jobs: The first is turning, the second is threading. In reality the only difference between the two is the coarseness or fineness of the spiral cutting path which is, of course, quantified as pitch.

In its most simple form the ELS is used to move the saddle up and down the lathe bed at a pre-determined rate. The rate of travel is determined by the spindle rpm while the pitch of cut is selectable. The length of the cut along the stock is selectable. So when you press start on the ELS, it tells you to retract the tool, then it moves the saddle/cutting tool to the starting point, it then tells you to insert the tool. You press start and the cut is taken. The depth of cut is determined manually using the cross slide. The even drive of the stepper motor produces a super smooth cut, assuming your cutting tool is of sufficient quality and sharpness.

The Warco lathe has powered cross feed as well. This can be driven by the stepper motor as well by simply by engaging the cross feed using the engagement lever on the saddle. The cut produced on a cast iron casting was superb. This almost convinced me that adding the X Axis facility to the ELS might be not quite worth the time and expense. Only after successful use of the Z axis drive on the ELS, so very easily making imperial threads and metric threads on a metric lathe, was I convinced.



A variety of plugs.

Further Development

Using just the Z Axis means that you are only using about a quarter of the unit's capabilities. The unit will control the cross slide as well (X Axis), and do it in tandem with the Z Axis.

The ELS has the control and processing for both X and Z axis, but only has a single stepper motor driver for the Z axis. So to use both Axes you have to buy a stepper motor driver as well as the second stepper motor. What do you get for the extra expense? With both axes functioning the ELS will make automatic multiple passes to produce a cut of a specific depth and length. It controls the start and stop as well as the tool insertion and retraction. For threading it will cut the prescribed thread of the prescribed diameter, using multiple automatic passes. The ELS can also cut tapers automatically, and there are standard tapers included in its memory.

Conclusion

This is a great project to gain a basic understanding of CNC while improving productivity and precision. The support group provides good backup when you are stuck. The actual construction of both the board and lathe modifications were quite basic. Connectivity required thought and planning. In terms of craftsmanship, this project requires good soldering skills.

The variety of tasks I can undertake without pain has increased four-fold. The efficiency gain while carrying out basic jobs is considerable too. Suddenly I feel confident in using plans which could contain any variety of non-metric threads.

One of the great benefits gained has been learning to work with precision and organisation too. One actually has to know



Finished connector with heat shrink tubing.

precisely the dimension needed and the cut required. The 'try a bit, see if it fits' approach can still be used, as all aspects of a manual lathe remain intact, but with the ELS new skills quickly develop into being able to use dimensions and plans as they should be used. ■

SUPPLIERS

Automation Artisans for the controller:
UK Distributor Lester Caine MEDW
Stepper Motors and Drivers:
Arc Eurotrade; CNC4You
Power Supplies: CNC4You and
eBay in general
Enclosure: Maplin or Digi-Key
Connectivity plugs and sockets:
Maplin; Rapid Electronics
Digital Meter for the Power Supply
and Stepper Pulse Driver: eBay

REFERENCES

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2. CNC Cookbook by Edward J. Hess ISBN-13: 978-0982110300
3. Jones on Control Of Stepper Motors, a Tutorial <http://homepage.cs.uiowa.edu/~jones/step/>
4. <http://autoartisans.com/ELS/>
5. <https://groups.yahoo.com/group/e-LeadScrew/>
6. CNC4You : <http://www.cnc4you.co.uk>
7. <http://www.arceurotrade.co.uk/projects/PSU/index.html>
8. <http://www.rapidonline.com/pdf/500756.pdf> From Rapid Electronics
9. ELS_Connections(2).PDF From the E-LeadScrew Yahoo Forum

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■ Myford swivelling vertical slide unused in original box £200. 6 Dickson toolholders suit Colchester Student £12 each buyer collects. **T. 01227 464281. Canterbury.**

■ Jones and Shipman 540 surface grinder with 18 x 6 inch magnetic chuck, £900. **T. 01642 321537. Middlesbrough.**

■ Elliot 10M shaper, single phase excellent condition, £310. Myford ML7 drip tray £25 ono. Large swivel base machine vice suit large shaper £45. **T. 01766 540521. Blaenau Ffestiniog.**

■ Myford Super 7 lathe non-powered feed on cabinet stand. A superb little used example of this model. Apart from oil staining to drip tray machine is unmarked. Additional items including 3-jaw chuck £2,750. **T. 01323 507015. Eastbourne.**

■ Surface plate, was the base of a Talysurf 4, so has 2 slots. Size 22.5 x 16 inch. Workshop reorganisation forces sale. Due to size and weight, buyer must collect from North Herts. £50. **T. 01438 721876. Stevenage.**

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■ Owing to bereavement LBSC 3.5 inch gauge Molly. Running bottom half, copper boiler tested. Drawings. £750. 3.5 inch gauge Titfield copper boiler, tested, casting, tender, frame. £450. **T. 0116 2783549. Leicester.**

■ G1 Project loco, well advanced, tender finished, professional boiler. Book all parts to finish £395, ono. Rob Roy complete tested chassis, boiler started, laser cut plus other parts to finish. Drawings, book, £525 ono. **T. 01792 702144. Swansea.**

Wanted

■ Does anyone have a set of Stuart No. 1 castings to dispose of? **T. 0208 4405771. Barnet.**

Books, Plans and Periodicals

■ 9 years bound back issues of *Model Engineer* which belonged to my late father. Good condition. Jan 1967 vol.133 issue 3312 to Aug 1976 vol.141 issue 3543. Full of wonderful articles, still relevant today. £65 ono. **T. 07831 626094.**

■ 4 inch scale Ruston Proctor class SD light steam tractor drawings by Bill Newcombe. 12 sheets folded and unmarked £25. 5 inch gauge 0-4-0 'Ruby' Mk I drawings by Maidstone Engineering, 7 sheets folded all unmarked, £15. Both plus postage at cost. **T. 01323 892042. Seaford.**

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An Adjustable Index Dial for the Rf-25 Milling Machine



Inchanga makes a useful upgrade for his Rong Fu mill.

The writer has been the owner of a Rong Fu RF-25 milling machine for the past 20 years (**photo 1**). One of the outstanding modifications was to fit an adjustable index plate for the quill down feed. The fitted index plate is fixed and this makes measuring the down feed with any accuracy difficult. The index plate looked to be chromed metal but on removing the down feed mechanism bracket it turned out to be made from plastic chrome plated. The original dial is almost totally obscured by the down feed hand wheel. I had in the spares box the original leadscrew hand wheel for my Myford Super 7 when I changed it for a newer one when renovating the machine. This would fit with a little modification. As an alternative a hand wheel as made by Picador would also be suitable.

The down feed bracket when removed was stripped to release the hand wheel and the index plate. This entails unscrewing the three feed lever boss by removing the plastic knob. With the knob removed the handle can be pulled off the main quill rack shaft. Remove the compression spring and key in the shaft, then remove the two cap screws holding the casting to the headstock. The bracket should now be free and can be slid off the main quill drive shaft. A grub screw secures the plastic hand wheel and this can be pulled off the shaft. The graduated dial is also removed and the two screws holding the index plate.

Measurement showed that the hand wheel shaft was $\frac{1}{2}$ -inch diameter and the internal bore of the casting was 35mm. This is to suit the two ball bearings that support the worm wheel that rotates the rack pinion.



The RF-25 milling machine.

The original index plate is shown in **photos 2 and 3** showing the way it fits into the casting.

The replacement index plate was machined from a piece of cast iron bar 55mm in diameter. An alternative would be aluminium or mild steel, as I had a suitable off cut of cast iron this was used. The piece was chucked by the outside

jaws in the 3-jaw chuck and faced off. A centre drill was used to make a hole for the pilot drill. I started with a 5mm drill and drilled a hole 30mm deep. This was opened up to $\frac{5}{8}$ inch to clear the shaft. The end of the rod was turned down to 35mm diameter for a length of 10mm (**photo 4**). The final size was judged by using the bracket as a guide, the size



The down feed bracket removed from the headstock.



The index plate removed from the casting.



Machining the 35mm diameter portion.



Checking the two parts fit correctly.



Parting off the finished part.



Scribing the index line.



Assembled with locking 2BA screw fitted.



Modified index dial and hand wheel.

being slightly under 35mm so it can rotate without too much effort, but not too loose. Having machined the end that fits into the casting the rod was machined for a further length of 10mm to 53mm diameter to suit the outside diameter of the old dial. The bar was reversed and held in the 3-jaw chuck with the inside jaws. The bar was parted off to leave a length of 10mm of the 53mm portion.

The final operation was to scribe an index line on the outside of the index plate

(photo 7). For this I used a V-pointed tool set on its side in the tool post and used the top slide to cut the groove.

A locking screw is needed to hold the index plate. This was marked out and drilled in the side of the casting 5mm back from the end of the bore. It was tapped 2BA and a cap screw fitted (photo 8).

It only remained to reassemble the parts into the casting. The new index plate was inserted and then the graduated dial and

the grub screw fastened to leave a little clearance. The casting could then be bolted back onto the headstock and the other parts fitted.

The hand wheel needed some modification to the bore and length of the boss and it was then attached to the shaft and secured with a grub screw. The final result is shown in photo 9, where it can be seen that the graduated dial is visible through the hand wheel. ■

18 Months with a Tormach



Bob Rodger recounts his early experience with an American made CNC mill.

I first became aware of Tormach Machine tools after having some magazine articles published on the manufacture of various parts for vintage and Veteran Motorcycles. The editor of the magazine (*Home Shop Machinist*) sent several copies of the magazines and on the back pages were some advertisements for Tormach Mills.

I was impressed, the machines looked to be very robust and well presented. I took a look at Tormach's website and was also struck by the quantity and quality of tooling at what were reasonable prices.

I had had nothing to do with CNC machining prior to this, other than admiring the quality and repeatability these machines could turn out. However, a little flame had been lit and before long I could see me using a machine like this for prototyping and a few small production runs as part of my business and also hobby use. Above all I could see it as a great challenge in retirement that would stop my brain from seizing up as I got even older.



The mill uncrated.

I have used computers most of my life since finishing further education so am not afraid of trying new things with them.

There are no import agents for Tormach products in Europe so after a lot of cogitating I decided to bite the bullet and placed my order with Tormach in April 2014, I went for the PCNC 1100 series 3 which is the biggest mill they make. Shipping to the UK was much easier than I expected and the shippers were very flexible regarding delivery etc. The mill was shipped from Tormach's warehouse in Wisconsin USA by road to Halifax Nova Scotia where it was bought across the Atlantic on the Hamburg Express Container ship. For those interested in ships and the sea I was able to follow the ships progress through the Panama Canal and up the Eastern Seaboard of the USA to Halifax where the mill was loaded on the Marine traffic website <http://www.marinetraffic.com> After leaving Halifax I had to wait four days while she crossed the Atlantic before she re-appeared on their screen in the South West approaches, having switched off her positioning transmitter soon after leaving Halifax.

With typical bad luck I had to leave for work offshore for two weeks just after the ship arrived in Southampton. This meant



The transport company stacked these two parcels, however, no damage was done.

that I would probably not be able to be at home when it was released from customs. This proved to be the case and delivery had to be arranged while I was away. On delivery my son and son in law had to assist the truck driver unload the three packages that came. When I spoke to my son in law he told me that 2 parcels had arrived, I was expecting 3, however, after a bit of probing it became obvious that the transport company had loaded one package precariously on top of another

and it had been offloaded by the truck driver this way, there were 3 packages after all.

The packages were pushed into the garage workshop and left for just under a week till I arrived home (**photos 1 and 2**), the anticipation was intense, I just couldn't wait to see what I had bought.

Unpacking

I arrived home and the next day I started the job of unpacking and making sure everything was there, this was no easy task, as well as the mill I had ordered a full tooling package and the duality lathe. The packing was really good, all large and heavy items were packed in wooden crates and smaller less robust items were also well wrapped in cardboard or expanded foam packaging and packed in wooden crates. It took me a day and a half to break open everything and check that it was all there.

Before the mill arrived I sold off my Tom Senior Mill to make a bit of space but it became obvious, even before I had everything unpacked, that a lot more room would be required to get the mill into the workshop. The first thing that had to be done was to take out part of a partition wall between the workshop and bike storage area of the garage and this was about as far as I got before having to go back offshore again.

Installation

My workshop is basically a 2 car garage that is about 11 x 30 feet that is separated into three sections, the machine shop being in the middle. I had a bit of time to think about how I could make some more space but it was all going to take time. First of all, I had to move one of my work benches out of the machine shop and into the hot work area at the far end of the workshop. This was no easy task because it was full of materials and gear that had to be taken out of the storage cupboard underneath it and it also had to be shortened somewhat in order for it to fit. This took up more time and before I knew it I was back offshore again before it could be done, however next time I came home I managed to get it done.

This left, what I thought would be enough space to get the mill into position so with the aid of a 2-ton Engine crane and a pallet truck my son in law and myself proceeded to lift the mill onto the stand. This is not a task for the faint hearted, the

mill weighs 900 lbs and the stand some 500 lbs so it's not something you can shove around easily. Do not attempt doing this unless you buy, or beg for a loan of the special spreader bar that can be purchased for lifting the machine. It is deliberately asymmetrical and designed to balance the mill evenly when used with the lifting eyes provided.

A word of Warning here, if you use an engine crane like I did, you will have to raise the stand high enough to enable the legs of the crane to pass under it. We did this using a 5ft pry bar, lifting the stand and placing blocks of wood packing under each corner of the stand until it was high enough. The crane was used to lift the mill onto the stand. Once done a pallet truck was placed underneath with sufficient packing blocks on it to lift the whole mill/stand up, remove some packing from under the stand and lower it down on the pallet truck again until the mill/stand was sitting on the slightly lower packing under the stand, repeating this process a few times finally had the stand/mill sitting on Terra Firma (**photo 3**). The workshop was like a bomb site by this time, I just couldn't believe how tight for space it was in there.

Despite the mess the workshop was in I returned to work happy with my decision to buy the mill. As part of the package I bought some books and software. The books I took offshore with me and I started reading about CNC machining. One book in particular that stood out it was called Fundamentals of CNC machining by Peter Schmidt. I read this book from cover to cover. The editing of the book leaves a fair bit to be desired with a lot of poor grammar and sentences that leave you scratching your head trying to understand exactly what the author is trying to convey. However, despite this, it is, in my opinion the best of the three books that I purchased by a long way. Even though I had never come across G-Code before, by the time I had finished reading the book I had a reasonable understanding of G Codes and the various other commands used when producing a program for a part. I couldn't write a program but I had a good idea when seeing one what the code looked like and what each line of code represented. This has proved invaluable when editing g-codes to alter such things as speeds and feeds and also various other things such as work and tool offsets. Definitely a book worth buying.

Another nice thing about Tormach products is that manuals can be downloaded so you can read all about the



At last, it's in.

installation of the mill and any accessories even before you purchase. This proved invaluable because every time I went offshore I was able to read the manual and get into my head what would be required to build the mill up and install such accessories as the fourth axis rotary table, the Duality lathe, Power draw bar etc.

On returning back from offshore it soon became clear to me that I wouldn't be able to do anything in my workshop for a long time, the mill took up so much room I was virtually climbing over it to get to the far end of the workshop and I couldn't use any of my other machines either. This was compounded even further when I fitted the chip tray, I'm glad I didn't buy an enclosure otherwise the situation would have been worse.

I just couldn't move in the place, however I pressed on and slowly built up the mill. In the meantime, I ordered the ATC (Automatic Tool Changer) which arrived some months after the mill, this made things even worse in the workshop because it needs a compressor to run it, which takes up room. I think it was some time round December of 2014 before I eventually got the workshop back into some kind of order again.

By this time, I had retired from working offshore so I had a lot more time on my hands and could concentrate on getting the mill to work. I had also managed to make some heavy duty trolleys for my Warco Major Mill/Drill and the Warco BH 600 lathe (**photos 4 and 5**).



4 inch channel and 500kg castors provide support for my manual mill ...and the lathe.





Workshop prior to re-arrangement.



A view down the workshop.



A view down the opposite end of the workshop.



The manual mill & lathe in final position.

This made all the difference, I was able to move the bigger pieces of machinery about the workshop and find the best position for them. By doing this I was able to make a little more room for a materials/tool storage cupboard and bench on which to place the Duality lathe, tool and cutter grinder and the bench drill. I also put up a further 40 ft of shelving around the walls of the workshop. Made from inch plywood these are designed to take a lot of weight and I was able to store some heavier pieces of equipment and motorcycle parts on them thus freeing up more room. At last I had arrived at a solution to my space problems.

Photograph 6 shows the workshop prior to re-arrangement to give more room. The 1927 Humber motor cycle had to be moved into the workshop to enable the mill to be built up. I had to be man handled over the mill to get it back into the bike storage area. The item in the wooden crate behind the rear wheel of the motor cycle is the Tormach 4th axis rotary table.

Photograph 7 is a view down the workshop. The area to the rear is where I carry out my hot work, the Tormach mill is in the left foreground. The lathe and manual mill have had trolleys fitted so that they can be moved easily. New shelving can be seen above the curtain doors which in this view are gathered back against the wall. On RHS of door is my cylindrical grinder. This is more or less the finished layout of my machine shop.

Photograph 8 is a view from behind the cylindrical grinder down the opposite end of the workshop. The Tormach mill with ATC can be seen on the right, on the left the manual mill and lathe. The duality lathe and 110 v transformer can be seen on the new tool/material storage cupboard top. The doors have still to be fitted to the cupboards. The red article in front of the lathe is a tool trolley. As you can see there isn't too much room to walk between the CNC mill & lathe, I always try to park the CNC mill table with it as close to the column as possible. The transformer and

compressor for the ATC & Power draw bar now reside under the space between the cupboard where the Duality lathe is and the mill. **Photograph 9** is the manual mill & lathe in final position. Both have been placed on trolleys to enable easy movement

Tormach's recommendation, when building up the mill, is to build it up as a standard mill, get it running and then, one by one install any accessories in a set order. By doing this it is easy to spot if any problems have been caused by incorrectly wiring things in.



The Tormach with almost all of the bells and whistles attached including the ATC and machine vise.



Fourth axis 8 inch rotary table fitted to mill table.

At this stage I had still not had the machine running, however I had built it all up and was ready for the first run of the machine. I followed the manual to the letter and with some trepidation hit the go button and off it went, producing the first part perfectly. I was absolutely delighted that it had worked so well and there were no problems. Next thing to do was to start installing the accessories one by one. I can't remember which one I started with but the list of accessories was fairly extensive and all had to be wired in, the odd board installed as well as a controller for the 4th Axis.

I am a Luddite when it comes to electrical wiring and electronics. Electricity to me is something that makes smoke come out of wires. As you can imagine I was somewhat nervous about installing all of the accessories, however I needn't have been.

The instructions are easy and simple to use, a bit like painting by numbers, read them through a couple of times to make sure things are clear to you, follow the steps and you will get there. The manuals are backed up by good clear pictures and all of the wiring is clearly tagged with letters and numbers at each end so it is easy to trace wires.

I installed the following: Auto oiling system, Duality lathe E stop button and control cable socket, Power Draw Bar, 4th Axis rotary table and remote USB socket all of which functioned flawlessly right from the first press of the button (photos 10 and 11). The Automatic Tool Changer caused some problems when I tried to get it to pick up tools, however Tormach gave me some tips on what to do and they were resolved quickly and I had the ATC up and running within a few minutes of having spoken to them.



The gear cover.

Cad Cam

I have heard that a lot of people don't realize that to run a CNC machine like this you have to be able to program it. It isn't just a case of pressing a few buttons and off you go, that only comes after you have drawn the piece you want to make in 3-D and produced the G-Code for the machine to read, unless of course it is simple 2D milling that can be carried out using conversational programming.

If you have not had any experience of using computers and drawing programs you are in for a long steep learning curve. I have used 2D drawing packages before and had dabbled in 3D when I was learning to use it but found it very cumbersome. That was at least 10 years ago and things have changed CAD software is getting easier to use, there are plenty out there and you will find one that suits you, like I did.

With the mill set up and all the bells and whistles attached I was running out of excuses for not putting it to good use, however I still wasn't ready. I had struggled with 3D software. Trying to find a drawing package that suited me and I was comfortable with was not easy. I got a good way into the first one I tried before binning it in favour of Iron Cad.

Iron Cad, purchased through Tormach was, I found, much more intuitive. I had struggled with the first 3D drawing package, it took me something like three weeks of hair pulling, steam coming from my ears and lots of naughty words from the surrounding area of the computer before I was able to produce a 3D drawing of the machine vice. With Iron Cad I had produced a reasonable 3D drawing of a gear cover (photos 12 and 13) with scooped out interior and



Inside the cover.

compound curved outer surface in one evening. Buying Iron Cad was a good move, I knew that I would be able (with practice) to draw almost anything I wanted.

I then had to get some G-code. For a CAM Program I had chosen Sprut Cam, this is a Russian developed program available through Tormach at a discount when buying a mill. For the money it represents terrific value, it is much cheaper than a lot of well known CAM programs and is extremely powerful offering full 4 axis capability. I had difficulties but struggled along and eventually produced a few part programs, however I couldn't figure out how to flip the part, so probably like a lot of beginners I wrote separate programs for each side of my gear cover.

My first attempt at getting this part to run was a steep learning curve, I could not get the end mill for the first operation to start where I wanted it to, I kept re setting the X,Y & Z axis zero points until I was happy that the mill would not collide with anything. I set the machine running and cut my first part in MDF. It was far from right because I hadn't noticed that I had entered the wrong tool diameter at the input stages. I changed the program and re ran it again after a lot of messing about with the zero points of axis. This time I had success and the tool changer functioned well with a great peck drill cycle. I played about with this piece trying to get both sides done but eventually gave up with it unfinished and lots of half sides in MDF, plastic and Aluminium scattered about the workshop.

To be continued...

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On the **Wire** **NEWS** from the World of Hobby Engineering

UVEX Ultra Comfort Safety Goggles

I've recently been trying out some UVEX protective goggles from Axminster. These are a step up from the usual 'cheap and cheerful' ones, and they seem to be very well thought out, as well as robust and clearly able to offer excellent protection with a class 1 polycarbonate lens that is CE approved and to EN166 1B 349.

Although they have a close fitting design, they are comfortable to wear over my spectacles. The orange rubber seal around the edges of the lens is softer and more comfortable than cheaper goggles, and provide a better seal.

A hidden advantage of the soft seal is that the (wide) strap doesn't need to be so tight, which means I can wear them pushed up onto my forehead for longer

without developing a forehead like a Klingon.

Ventilation slots are covered by extensions of the lens, making it much harder for small pieces of swarf to find their way in.

The lenses are described as having uvex 'supervision extreme' technology meaning the lens cannot steam up as well as being chemical resistant, anti-scratch and offering 100% UV protection with all round vision. What's not to like?

At £12.96 they may be a bit more expensive, but they should last far longer than cheap goggles and more importantly, comfortable, non-fogging goggles are the ones most likely to be used in the workshop.



New Tech Helps Out

Here's a quick tip I received from from the 'Bodger's Lodge': What do you do if you want two 80 tooth HTD5 pulleys over a weekend and no one is open or even stock them as standard? You 3D print the pulleys and cut the cheek plates out on your laser cutter.

Jobs a good un' – says John Stevenson.

Midlands Model Engineering Exhibition

Planning is underway for the 2016 Midlands Model Engineering Exhibition, which will be held from Thursday 13th to Sunday 16th October at the Warwickshire Exhibition Centre, Leamington Spa.

Each year the event attracts over 11,000 visitors, is attended by specialist suppliers and supported by many 40 clubs and societies. In addition to over 1,000 superb models on display, there is a lecture programme and workshop demonstrations.

See www.midlandsmodeleengineering.co.uk or call 01926 614101 for full competition details, further details of the show or to book tickets.

New Change Gears for Mini Lathes

Readers may be aware that Arc EuroTrade stock 63-tooth change gears for mini-lathes, these allow metric/imperial conversion and I must lay claim to the credit for promoting the idea in an *MEW* article several years ago.

Now, encouraged by work undertaken by Brian Wood, they have added a further pair of custom gears with 25 and 75 teeth that facilitate the cutting of even more screw thread pitches, notably ones that will mesh (as worms) with DP and module gears. The gears are in aluminium alloy and although I haven't done any screwcutting with them, I have tried them on the lathe and they fit securely on the gear stubs and keys and run freely and easily with the stock gears.

The gears will soon be available from arceurotrade.co.uk



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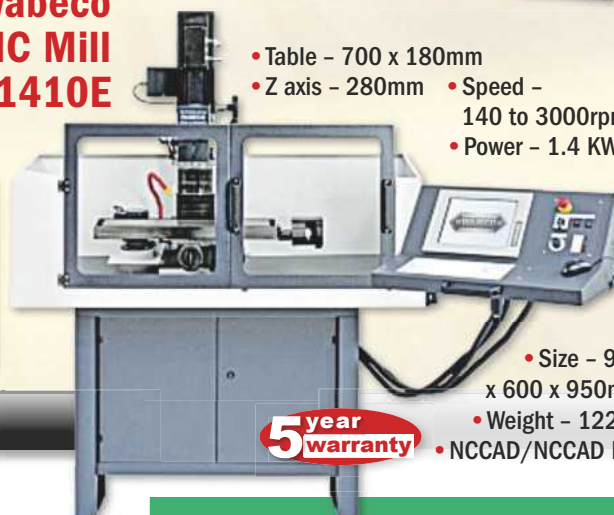
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A Tailstock Centre Set



Peter Tucker's rotating tailstock centre and variety of different shaped adaptors can support a wide range of jobs from the tailstock.

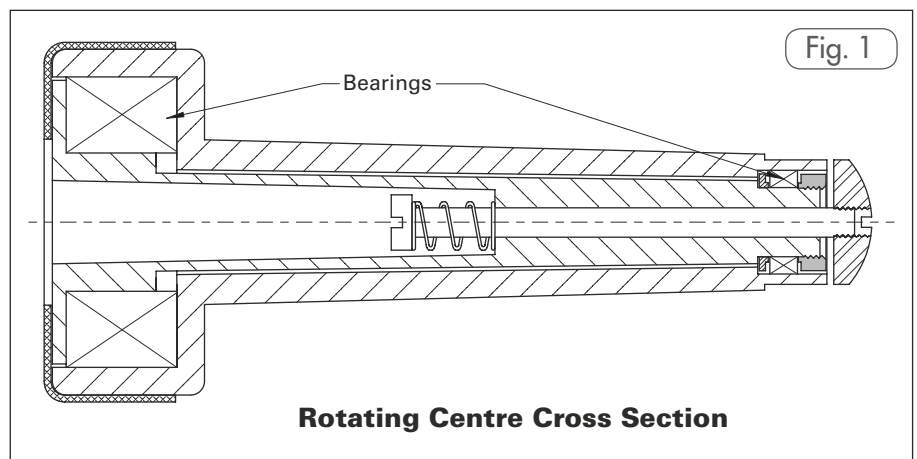
Having been in the construction industry most of my working life and being somewhat of a hoarder I now have a stock of metal of questionable provenance. After retirement I purchased a lathe/mill combination which I am learning to use, turning the scrap into 'useful' items.

This article is about my construction of a rotating tailstock centre (**photo 1** and **fig 1**) the main criterion is that it is made from materials on hand, and that the male and female centres will, hopefully, fit any size tube up to 4 inch galvanised water pipe.

As my material stock has been collected over years (and most is of unknown quality, and I am not from an engineering background) I do not expect anyone to exactly copy my methods or approach, however, hopefully they will be of interest or use to readers. I work in both imperial and metric measurements, as most people tend to be more metric than imperial I will keep mainly to this, however, when things come as imperial I will give them in this system.



Rotating centre complete.



Design

Early in my machining days I made a simple rotating centre with two ball races in the nose, this proved not to be rigid enough so the new design incorporates a taper roller bearing in the nose and a stabilising ball bearing in the tail. Also I wanted exchangeable male and female tube centres so settled on MT1 as the fitting for the nose pieces.

Dummy bearings or packers (**photo 2**) were made from brass to fit in place of the bearings to facilitate the turning of the MT3 on the outer body and the concentric boring of the MT1 in the inner body. These packers are the same size as the taper roller bearing and the same

diameter as the tail bearing. One of them is the same width and bore the other is 10mm long with a concentric centre drill in one end.

The main body (**photo 3** and **fig 2**) is to fit an MT3 tailstock with the thrust bearing being a taper roller bearing ID 20mm, OD 42mm, width 16mm and a steadying bearing OD 15mm, ID 10mm, width 4mm. As the MT shaft was to be hollowed out I wanted it to be reasonably strong so chose a piece of vehicle axle and welded this to a 1 inch length of 2 inch diameter Bar (**photo 4**). I set the top slide over to cut tapers, and it is best to set this up before starting work on the body. The steps to machine the

body were as follows: the 2 inch section was held in the three jaw chuck; the other end centre drilled and steadied with the tailstock dead centre; the weld and shaft were cleaned up. Next a fixed steady was used to support the shaft while it was drilled as deep as possible to 13mm. The hole was bored to 15mm for a depth of 10mm (this needs to be an accurate fit on the bearing), then a thin boring bar used to hollow out the shaft from the 13mm shoulder up as far as possible at a taper parallel with the Morse taper.

The fixed steady was removed and the brass packer with the centre drilling inserted in the shaft and the tailstock dead centre brought up for support. Now the Morse taper was turned to size; the chuck then removed and the body placed in the spindle taper. The outside of the main bearing mounting was cleaned up and machined to size and the body centre drilled through and the recess for the taper roller bearing bored to size.

Inside the Morse taper shaft is now bored out parallel with the exterior, this will need either a left hand boring bar and the spindle running in reverse, or the boring bar inverted, either way the tool will be cutting on the side opposite the operator. The internal taper needs no great precision having only to clear the rotating centre body and leave enough metal on the Morse taper.

The inner (rotating) body is shown in photo 3 and **fig 3**. This piece of metal's intended life was as a stub axle (**photo 5**) but was never used as such, I obtained it in a bucket of scrap. To form this part, the mounting flange was cut away with a band saw, then the stub axle was mounted in the three jaw chuck by the small threaded end and the following processes were carried out: The base was centre drilled and the tailstock centre was brought up for support, then the base was faced up to the dead centre and turned down to 41mm. Using a left-handed knife tool the shank was turned down to fit the taper roller bearing ID, this shaft was cut to leave a two millimetre thick flange. The inner body was now removed and re-chucked on the flange with the step jaws to ensure the axis of the work ran true, this was checked with the dial test indicator on the newly turned shank. The end was now centre drilled and the tail stock centre brought up for support. The shank was turned down to 10mm diameter, an accurate fit for the small bearing ID, from the end to 100mm from the flange. The shank was turned to a taper parallel to the Morse taper, starting at the shoulder to the 10mm shaft, where it has a diameter of 12mm, finishing 13mm from the flange. The 10mm shaft was now screw cut 1.25mm pitch leaving five millimetres plain.

Now is a good time to check the two bodies together for taper clearance and adjust if necessary. The clearance was okay, so a fixed steady was secured at the 10mm shaft position and the tailstock removed. The inner body was machined to length and a four millimetre hole was drilled 50mm up the axis. The inner body was removed from the lathe and assembled with the main body using the dummy bearings. I super glued the larger of these to hold the inner body while forming the female MT1.



Brass dummy bearings.



Main and inner bodies.

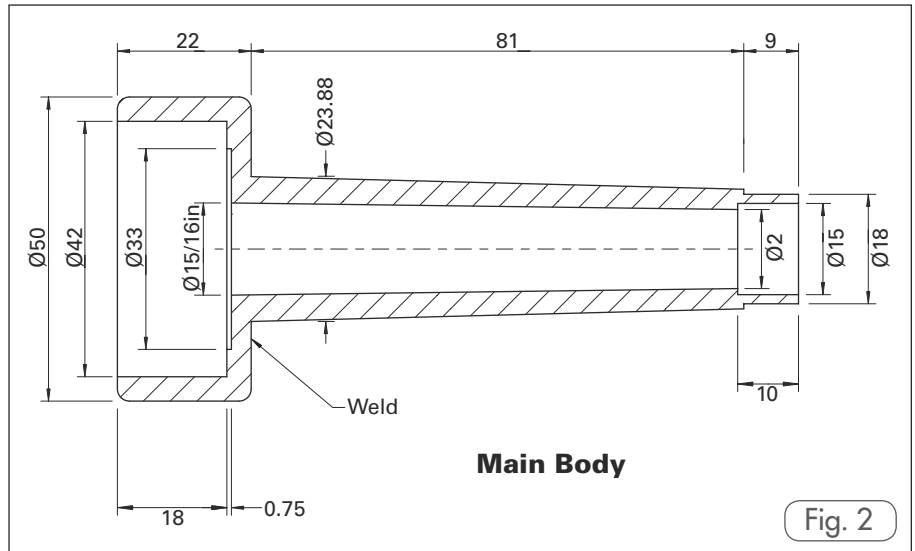


Fig. 2

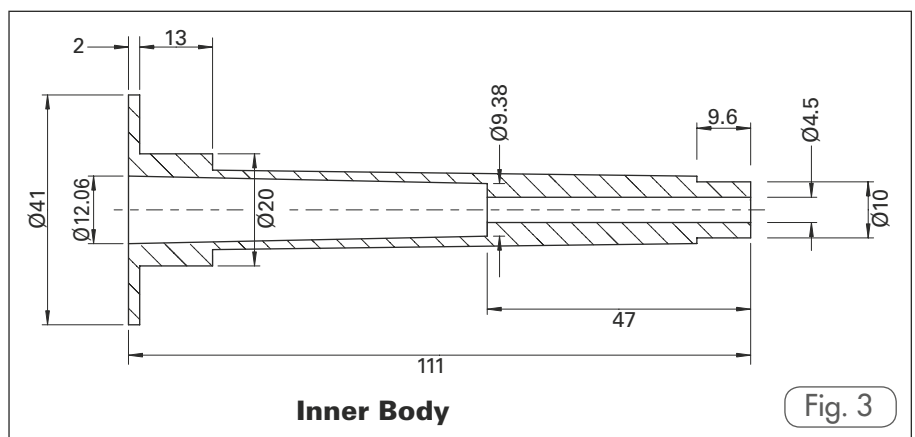


Fig. 3



Main body before machining.



Stub axle used as material for inner body.



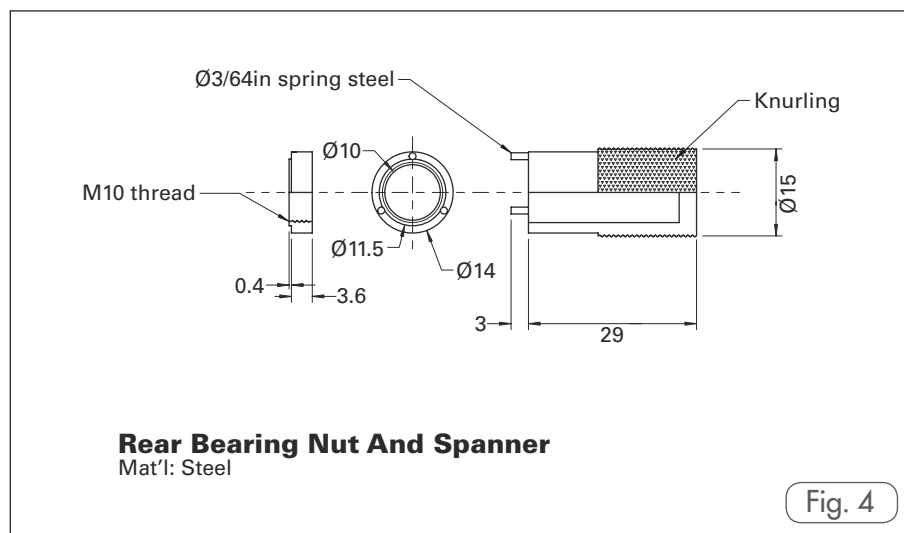
MT3 tapers, upper to make the MT1 drill, lower for the MT1/MT3 adapter.

More tapers

With the top slide set to the MT3 half angle I cut two more tapers (**photo 6**) one was on a short off cut of soft mild steel to make an MT3 to MT1 adapter to be used when forming the interchangeable nosepieces. This soft MT3 was drilled axially to about half its length from the small end with a 4mm bit for an ejector pin to remove the MT1s. The other was on a longer scrap of high carbon steel which was to form a MT1 drill.

The back bearing washer, nut, and spanner are shown in **figs 4** and **5**. The washer is a straightforward turning job, as are the nut and spanner with the exception of the pins in the spanner and holes in the nut. I wanted the washer to be better than plain mild steel so I used a piece of high tensile concrete reinforcing bar. This material is not very high tensile

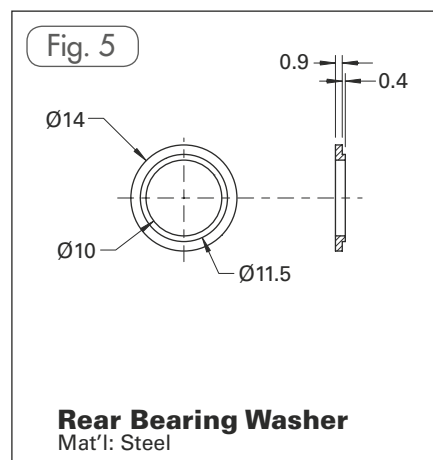
but stronger than mild. This was chucked in the lathe, turned down to 14mm drilled and tapped M10 x 1.25. Two millimetres of the thread were drilled out to 10mm diameter, the washer shape was then formed and parted off. The nut and spanner now had to be formed. I found a spring salvaged from a dismantled printer (**photo 7**) the straight portions of the spring were ideal for the purpose at $\frac{3}{64}$ inch diameter. A rotary tool mounted on the tool post was used to drill three holes through the nut and into what would be the spanner (**photo 8**). Indexing was with a piece of wood between the chuck jaw and the lathe bed (**photo 9**) with a weight hanging off the chuck to keep pressure on



Rear Bearing Nut And Spanner

Mat'l: Steel

Fig. 4



Rear Bearing Washer

Mat'l: Steel



Spring from printer.

the wood indexer. The only hiccup was having to make a $\frac{3}{64}$ inch collet for the rotary tool. The nut shape was formed and parted off and after cleaning up the spanner pin holes were enlarged to 1.5mm for clearance. The spanner was now drilled 10mm, knurled, the pins fitted and cut to length with the rotary tool in the tool post fitted with a friction blade. The spanner was now parted off and cleaned up.



Drilling spanner holes in the back bearing nut.



Indexing the back bearing nut using a piece of wood between the chuck jaws and lathe bed, the chuck key is slung with a weighted strap keeping pressure on the stick (the lathe motor was immobilised for this operation).



MT1 drill.

An MT1 drill

Photograph 10 shows an MT1 drill. Not having an MT1 taper to work from I placed a straight bar between centres on the lathe and, using the clock indicator, set the top slide over to 58 thousands of an inch in 54mm, this being as near as I can calculate the angle of the taper. With the top slide set I turned the 'drill' to MT1. The next challenge was to hold and index the tool while forming the cutting flutes, to facilitate this I made a square box (**photo 11**) which surrounded the MT3 shank with centre pins top and bottom to hold the tool in place and poured molten zinc die cast alloy around the MT3. When the alloy cooled and the box was removed it was a simple matter to clamp and index the tool against a fence on the mill. With four flutes cut, clamping in a V block on the mill (**photo 12**) facilitated cutting another four. The die cast was now carefully melted off and saved. I tend to use this for my jigs, it melts easily, machines beautifully, and you can even re-melt the swarf. A small relief was hand filed on the cutting edges and then the business end of the drill was hardened and the cutting facets honed.

Having formed the MT1 drill it was time to finish the MT3/MT1 adaptor and drill the MT1 socket in the inner body. The soft steel MT3 I had prepared was mounted in the lathe spindle and drilled 65mm deep with a $\frac{21}{64}$ inch bit to match the plain nose of the MT1 drill. As my MT1 drill more closely resembles a reamer than a drill I thought it prudent to remove as much metal as possible before forming the taper so I started with a stepped hole using these drills: $\frac{3}{8}$ inch to a depth of 47mm; $\frac{25}{64}$ inch to a depth of 39mm; $\frac{13}{32}$ inch to a depth of 31mm; $\frac{27}{64}$ inch to a depth of 23mm; $\frac{7}{16}$ inch to a depth of 15mm; and $\frac{29}{64}$ inch to a depth of 8mm. The reaming of the taper was done slowly and with plenty of oil but not without incident - the drill and work locked together on more than one occasion and had to be knocked apart with a pin through the adaptor. Next the inner and outer bodies were assembled using the brass dummy bearings, a couple of drops of super glue were used on the large piece of brass to ensure the inner body rotated with the outer body. This was mounted in the lathe and drilled the same as the adaptor. The body was then disassembled with the aid of a little heat to soften the super glue. The adaptor was now fitted with a spring loaded pin to eject the 1 Morse tapers.

MT1 shanks for nose pieces

With the top slide set over to form the drill I also made MT1s for the interchangeable nose pieces, as these have a small cross section I wanted a stiff material so used scraps of rapid tie bar. For those who do not know it rapid tie bar is a form of threaded rod used to hold concrete formwork in place, rapid tie bar is

extremely tough, and very difficult to bend, I consider it to be super high tensile. This steel did not turn well leaving a rough striated finish, so to achieve a reasonable surface I mounted my rotary tool in the tool post and, with a grind stone fitted, used it as a cylindrical grinder to smooth the tapers. Considering the sizes of pieces of steel available in my scrap boxes and the range of sizes of material to be turned, I found I needed to make 10 MT1 tapers to accommodate all the male and female centres I wanted. The MT1 shanks were tested, and adjusted, to ensure they fitted the adaptor to the same depth so there would be no complications with the ejector pin. The MT1/MT3 adapter was fitted in the lathe spindle and the two shortest MT1 shanks were selected one was pointed at 60 degrees, the other was drilled with a slocum centre bit to form a female centre suitable for pointed shafts. The other eight were set aside to be later welded into the male and female centres I was about to form.

To be continued...



MT1 drill blank in moulding box.



Milling cutting facets in MT1 drill.

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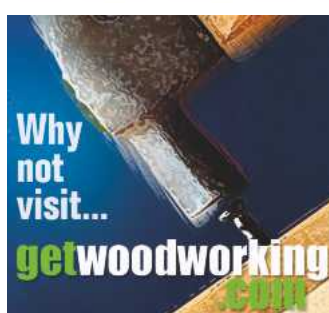
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R8	001-402	1 1/2"x18TPI	7/16"	50mm	1/2"

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10pc Parallel Set

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4" Hobby Tilting Vice

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