No.304

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS

MODEL ENGINEERS' WORKSHOP

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JUNE 2021

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On the Editor's Bench

His Royal Highness Prince Philip, the Duke of Edinburgh

The sad news that His Royal Highness Prince Philip, the Duke of Edinburgh had passed away reached us too late to mention in the last issue.

We extend our condolences to the Royal Family.

Many readers will be aware that Prince Philip had a lifelong interest in both full-size and model engineering matters, and this was in no way better exemplified by his establishment of the Duke of Edinburgh Trophy. This is the most highly regarded trophy in model engineering, awarded in a competition open only to previous winners of gold or silver medals in the Model Engineer competition.

A British Pathe newsreel of the Duke at the 1952 Model Engineer Exhibition can be found here: **model-engineer.co.uk/DOE**, the excerpt below is from the October 30 1952 issue of our sister magazine, Model Engineer.

H.R.H. at the "M.E." Exhibition

● AFTER THE opening of the "M.E." Exhibition by the Duke of Edinburgh, and His Royal Highness had toured the show thoroughly, we learnt that he had enjoyed himself immensely and had been profoundly impressed by the quality of craftsmanship revealed in everything that he had examined. His searching gaze seemed to miss nothing of importance, and his rapid fire of questions kept his lucky guides busy for an hour.

It was noticeable that explanations of technical points were largely unnecessary. As he departed from the show, he was graciously generous in his warm-hearted praise. To have had the honour of being with him during his tour of the show was an experience we shall never forget.

H.RH.. the Duke of Edinburgh with Mr. Kenneth E. Garcke, Chairman of Messrs. Percival Marshall and Co., Ltd., examining the model of H.M.S. "Magpie" which was presented to His Royal Highness after the Opening Ceremony

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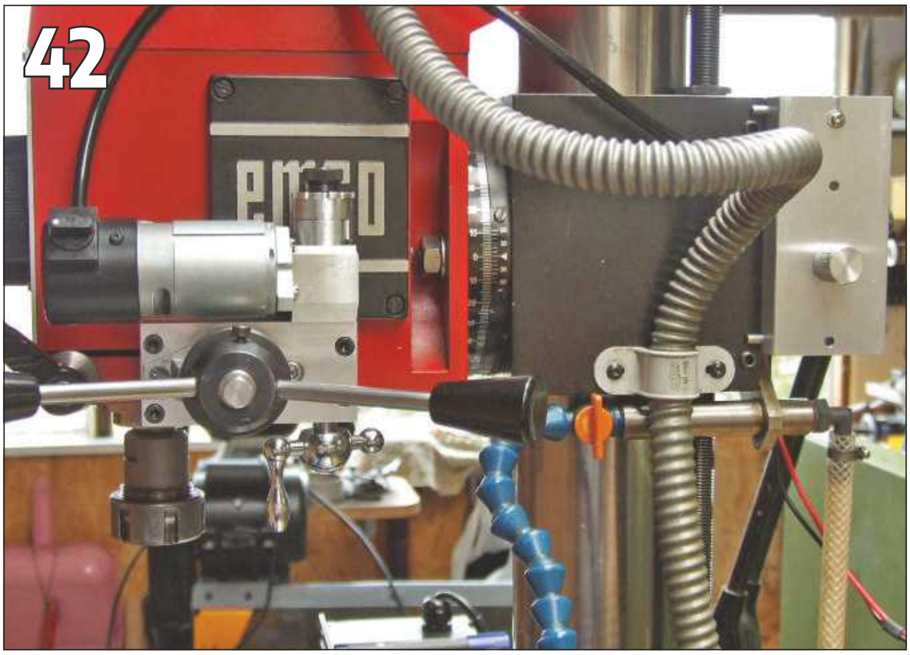

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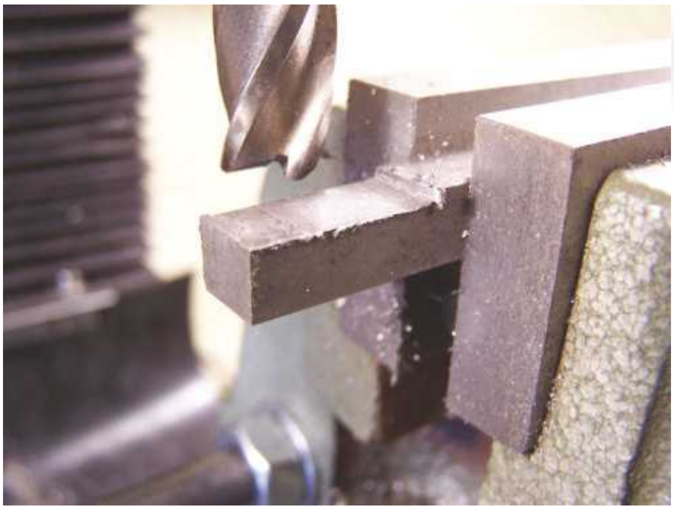
Coming up...

in our next issue

In our next issue we feature a a Bluetooth DRO for a Myford, a fabricated vertical slide and adding versatility to the Diamond Toolhlder



Regulars

ON THE COVER »»

This month's issue shows the swarf flying as a cutter held in one of Ian Johnson's KX-1 quick-change holders gets to work. Read more on page 37.

THIS MONTH'S BONUS CONTENT

Log on to the website for extra content

Visit our website to access extra downloads, tutorials, examples and links.
www.model-engineer.co.uk/extracontent

Drilling and Tapping Size Chart
As well as the Model Engineers' Workshop Drill Size Chart originally given away as a pull-out in MEW, we plan to make the Model Engineers' Workshop Tapping Drill size chart available too soon.

How to make a spring
Advice on making a heavy-duty spring for an antique gun.

Home workshop insurance.
Sharing experience of ways to protect your workshop and equipment.

Stringer EW lathe
This fascinating old thread has come back to life with new contributions from owners of these vintage lathes

Come and have a Chat!
As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. If you feel isolated by the lockdown do join us and be assured of a warm welcome.

A Lathe Mandrel Back Stop for a Myford Lathe

Peter Hodgkinson describes this aid to accuracy made for an ML10 lathe which should also fit the ML7 lathe.

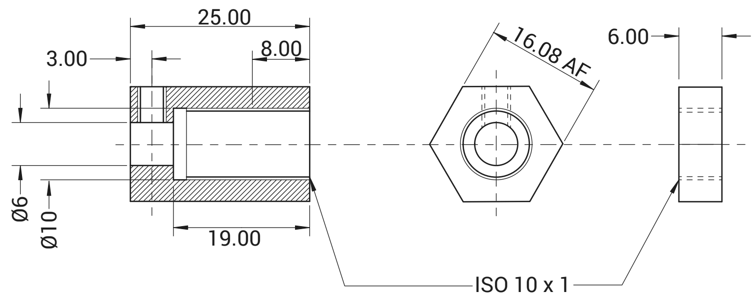
For many years, I have owned a Cowell 90ME, which has proved to be an accurate and solid workhorse capable of handling work beyond its capacity. However, the dream was always to own a lathe of similar durable construction but of larger capacity. The opportunity arose when I was informed of a Myford ML10 lathe (the 'Speed' version in long bed format) in very good condition 'VGC'. Once the ML10 was up and running a sense of déjà vu –all the bits I had made over the years for the Cowell had to be re-made or adapted for the ML10.

This article covers the re-design of the of a mandrel backstop based around designs by Radford and Thomas, but with modifications to suit my needs for long axles, nut thinning and even used with ER collets for stud production. The design allows maximum distance in the mandrel bore, can be fitted without removing the chuck and allows fine adjustment from the quadrant end of the mandrel.

The ML10 suffers from having a 25 tooth 20 DP gear fixed to the rear of the mandrel which precludes the routine removal to fit a device to a concentric diameter, therefore all the back stop parts have to fit within the +5⁄8" bore and run concentrically. When I started with the hobby of small-scale engineering, I decided to go metric, even though imperial stock and equipment was the more common. As I work mainly from scrap/off cuts of material, I make no apologies for mixed dimensions, if that is what they are on the job.

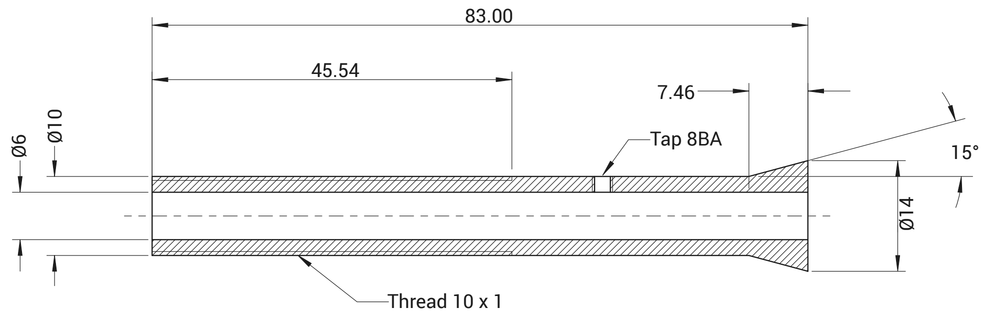
All the material is mild steel except for the depthing rod, which is 6mm, silver steel and the coupler which is 12mm silver steel. ¼" silver steel can be used so long has you correct the appropriate

Fig.1



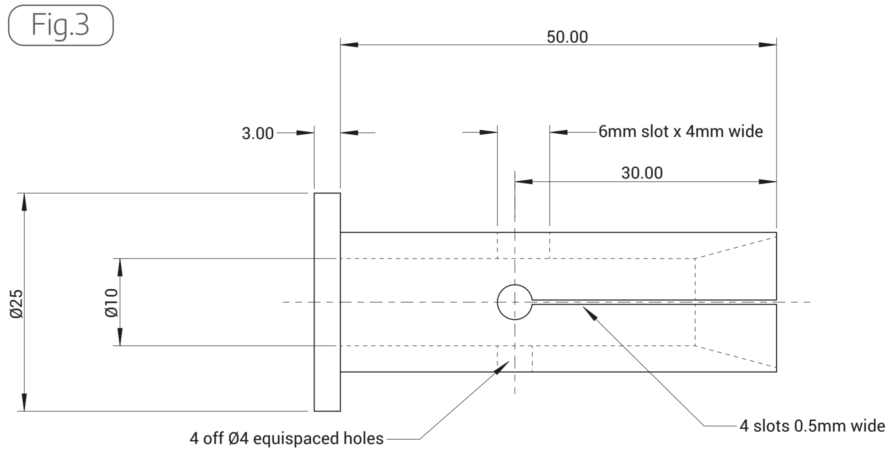
Adjuster And Lock Nut

Fig.2

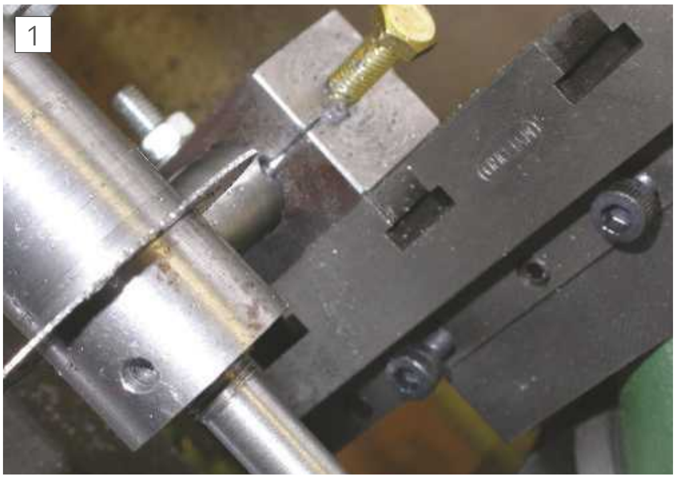


Expansion Pin

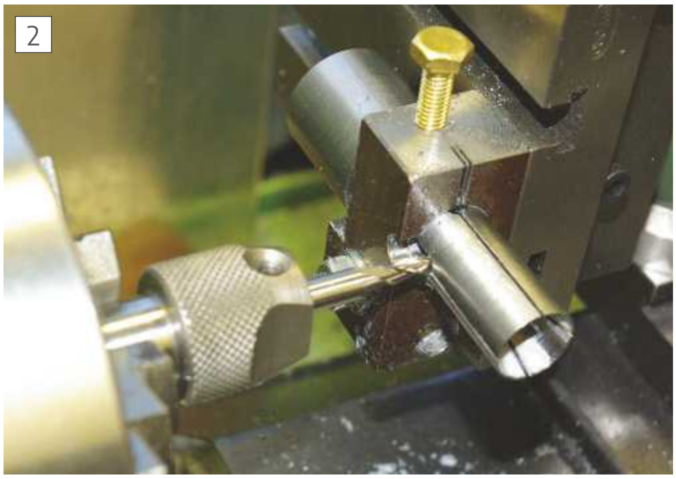
Fig.3



Expansion Collet



Slitting the collet in a simple jig.

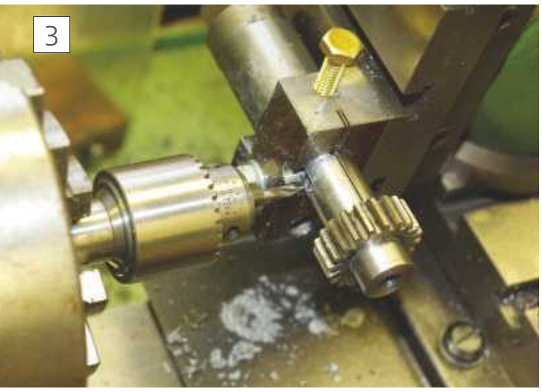


Jig modification to allow cross hole drilling, slitting, slotting and taping to take place with minimum work changes.

bores. All the dimensions on the mandrel bore are based on a nominal 16mm. The ML7 version requires a longer length of silver steel. Silver steel is readily available from stockist up to 1m, however, check against your lathe.

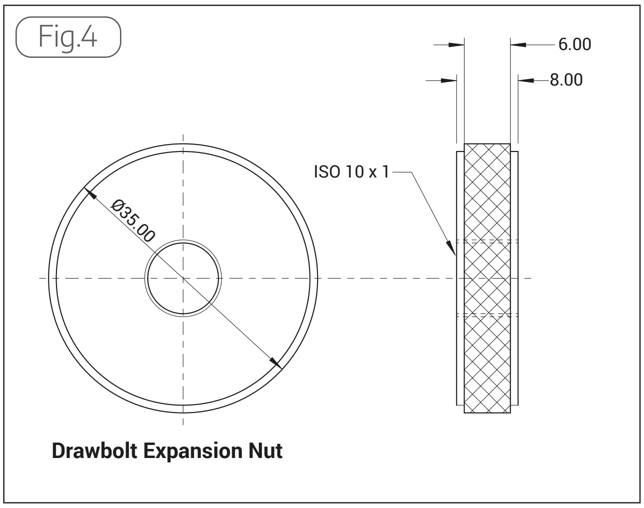
I suggest that the fine adjuster nut and lock nut are made first, **fig. 1**, followed by the draw bolt and then the collet and finally the depthing rod with attachments.

Select a suitable piece of hexagon bar that will pass through the gear train cover and long enough to make both the adjuster and lock nut plus material for parting off and cleaning up. Chuck the hexagon bar face, centre drill and drill through in stages to 5.9mm. Open up to 8mm for the required depth and finally bore to 9mm and screw cut 10 x 1mm (a standard spark plug size and taps and dies are readily available). I particularly like this size as it gives fine adjustment 1revolution=1mm and is close to 1⁄25" for imperial work. Now open up the 5.9mm hole with a 6mm reamer and check with the silver steel rod for a nice sliding fit. Part-off a section wide enough for the lock nut clean up and finally drill and tap the adjuster nut for the 4mm grub screw. This part will be used later as a gauge when screw cutting the draw bolt.

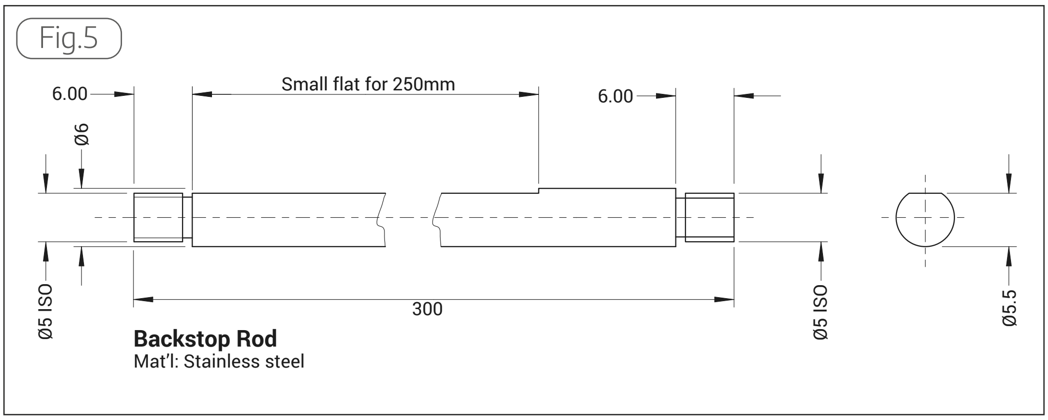


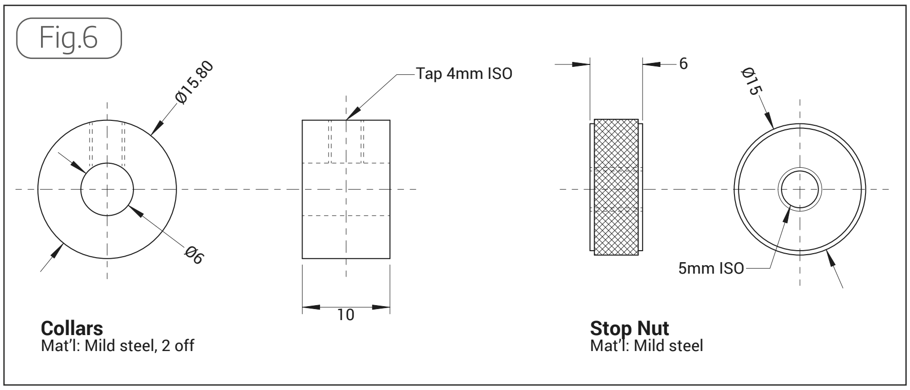
Drilling for the 8BA retaining screw. The same set up is used to mill the 4mm slot for the 8BA retaining screw.

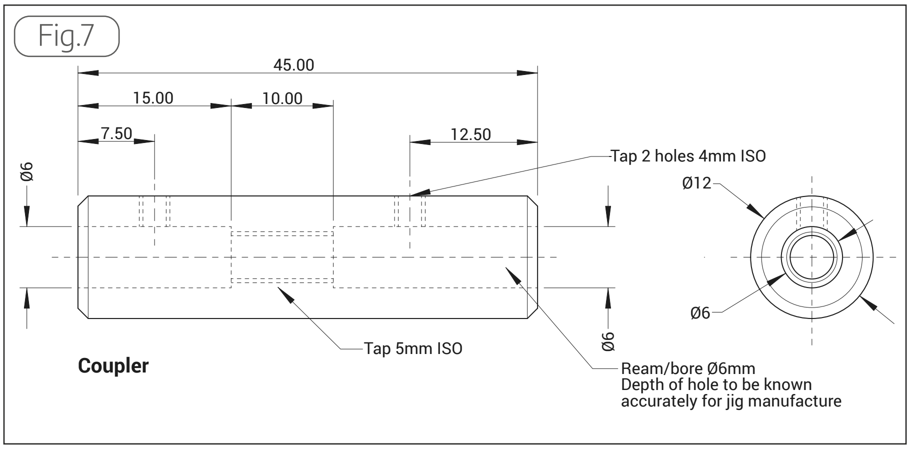
Next, comes the draw bolt/expansion pin, **fig. 2**. This is made from 16 or 15mm mild steel. The length needs to be long enough to allow all the machining except the bore at one setting. First face and centre one end of the bar keeping the centre small. Extend the bar far enough to complete all the turning work and support with a live centre. Take a light cleaning cut and reduce the stock to 10mm for the required length, screw cut 10x1mm and obtain a nice fit with the adjuster nut. Set over the top slide to 15 degrees and with a sharp tool cut the taper section. Now reduce the bar to 14mm and part off. I left a short parallel after the taper, this was for an idea that did not materialise. Reverse the draw bolt and lightly grip in the chuck or collet. Face, centre drill, and carefully drill in stages to 5.9mm and finally ream to 6mm. The position of the 8BA tapped hole for the retaining screw is determined later during work on the collet.

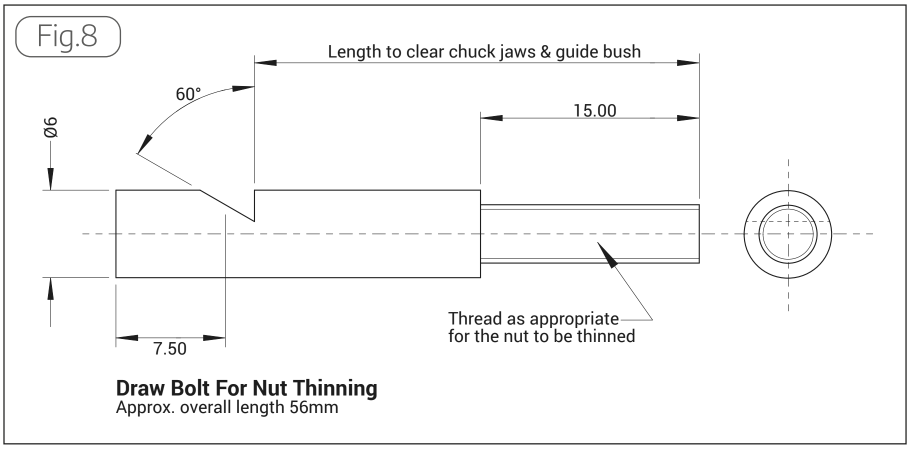


The collet body is next, **fig. 3**, and I made mine from 25mm stock, but any size material near this could be used. You will need enough bar to complete the turning in one operation. Carefully



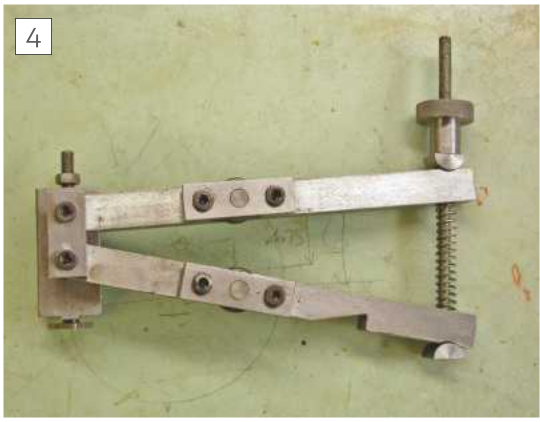






face and centre one end, support with a live centre and reduced to finished diameter to suit the mandrel bore- nice sliding fit. Face the area that sits against the mandrel end to ensure a square shoulder. With a fixed steady set on the nominal 16mm, drill in stages to 10mm and check with the expansion pin/bolt that this is a clearance size. (10.1mm will do nicely). Set up a small boring bar and with the cross slide set over at 15 degrees cut the taper leaving a small land at the end of the collet. Remove the chucking excess and face to length.

If like me, you do not have a milling machine you will have to make a small simple jig before cross drilling and slitting using the lathes vertical slide. The jig is a short length of 25mm square bar bored to take the collet with a 6mm taped hole for the clamping bolt and a 6mm clearance hole to clamp the jig to the vertical slide. The bored hole is not on the centreline so that the 25mm can clear the slide. Drilling of the four cross holes is a simple matter of inserting the collet having first marked the distance in from the taper and used my tool height setting gauge (See George Thomas' book, the 'Model Engineers' Workshop Manual') to mark the position of the four hole centres and slots. The tool setting gauge was used to locate the top of the collet and then the slide was raised half the collet diameter and with the aid of a 'sticky pin' and hand lens the centres of the holes can be located. **Photograph 1** shows the jig in use, however the jig was modified



Knurling tool used for the Thumb nut

later to make the task easier, **photo 2**. I have had no problems with this set up providing light cuts are made.

Location of the 8BA tapped hole uses the jig set up as **photo 3**, with the expansion pin pulled tightly in position. The collet is prevented from over expanding by use of the ⅝" bored gear.

The knurled thumb nut, **fig. 4**, is probably the most difficult part to make, however a simple alternative might be made from plain round stock with tommy-bar holes or large section hexagon bar. The thumbnut is made from 35mm bar, which was faced and then skimmed to remove hard spots. With enough material out of the chuck, cut a groove 8mm in from the face and some 10mm wide. My Knurling tool, **photo 4**, is one made for the Cowell and mounts on the rear of the cross slide. With the use of a raising block the knurling tool will just manage 35mm. I set the knurl wheel on the lathe centre line and 75% onto the work. The lathe is set at the slowest speed for this diameter and the knurls pinched up. They knurls are then traversed to 25% passed the knurl face and traversed back to the start. Pressure is increased in small amounts until the correct diamond pattern is achieved. I apply copious amounts of lubrication fluid (60% SAE40 oil to 40%

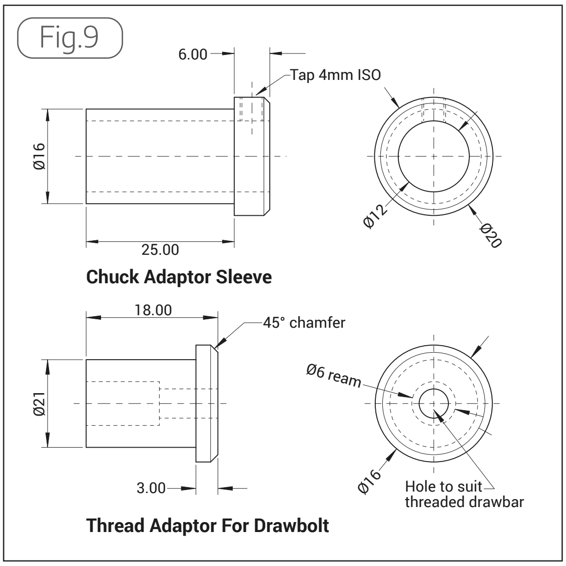
Filing the 0.5mm flat on the depthing rod. ›

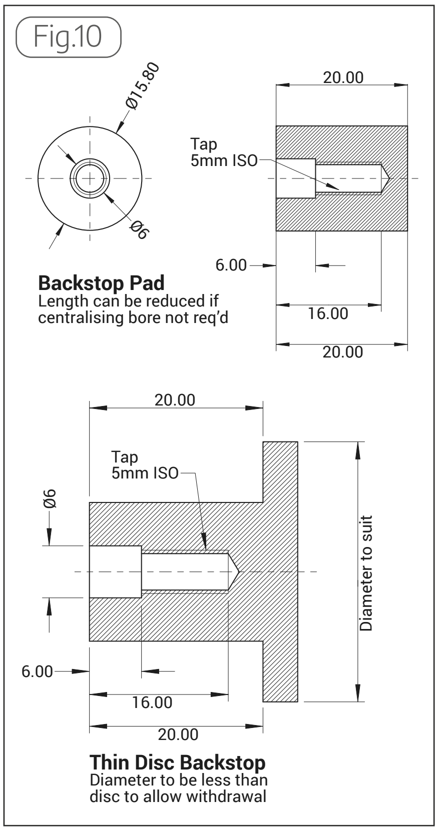
The major components.

All the bits ready for use . Bits on the right are accessories made as you need them.

white Spirit) I this find works well, as it washes away the metal shards and lubricates the knurls.

The depth rod is next, **fig. 5**, and of all the items, the long parallel flat face on this rod gave me greatest concern. However, I managed to file the flat, which took less than forty minutes. The first operation is to turn the end diameters down to 5mm and screw cut the 5mm threads (they need to be concentric). The end that attaches to the accessories will need a small relief turning to coincide with the locking screw. This relief area is identified from the screw witness mark as and when the coupler is made. Once all the threading is complete, the rod is clamped to a piece of heavy-duty angle as in **photo 5** and using a single cut file the flat was formed. The angle iron helps to keep the file parallel, and the fine adjusting nut and grub screw are used as a gauge. The result was a 'flat' parallel to better than 0.02mm. The main parts are shown in **photos 6** and **7**.





Accessories

The accessories are mainly simple turning jobs and don't require much detail. The collars are used to provide pull when thinning nuts and to centralise the depthing rod in the mandrel bore, **fig. 6**, **photo 8**. The stop nut is to provide a more positive fixed point when thinning larger steel nuts. A spacer tube is placed between this stop nut and the adjuster. I make these as required from 10mm OD tube or simply drill a piece of suitable length rod 6.5mm

Next is the accessory coupler, **fig. 7**, this requires a little delicacy in getting the 6mm bore flat bottomed and concentric.

The coupler is made from stock 12mm silver steel bar held in a collet chuck. Drill through 4.2mm open out one end to 5.9mm and with a 6mm end mill held true in the tails stock form the 25mm deep x6mm bore, reverse in the collet and complete the 15mm deep bore. Finally tap 5mm and drill and tap the two 4mm holes. The 15mm deep hole screws onto the depthing rod, whilst the other end holds the other bits.

The nut thinning attachment, **fig. 8**, **photo 9**, is used in conjunction with a simple chuck and reducing sleeve, **fig. 9**. The simple chuck is a piece of 20mm bar reduced to 16mm and bored 12mm. The 12mm bore needs to register correctly with your chuck, so once the 16mm is turned the item needs parting off and then reversed in the chuck. I marked the location of No1 jaw with a small centre pop mark, this usually give a fair degree of return concentricity. When marked the 16mm bore can be cut, drill in stages to 15mm and finally bore out to 16mm. Finally drill and tap for the 4mm retaining screw. The sleeve is a similar turning operation again marking with a centre pop so that they all line up with Jaw No1. I make sleeves to suit, as when required.

I make back stop pads, **fig. 10**, as required from off cuts. It is advisable to think ahead and make new ones prior to being required. ■

Set up for nut thinning

The depthing rod and collar being used to pull the nut against the face of the sleeve

1 *Roughing out the HSS Blank*

Making D Bits for Injectors

Stewart Hart explains how to make special tapered high speed steel D-bits by grinding.

Tapered "D" bits for making the cones of steam injectors are usually made from Silver steel, with the taper machined in the lathe, with the compound slide set at the required angle, they are then sectioned and hardened and tempered.

This method will result in a perfectly functional D-bit. However, the method is not without its difficulties and short comings. The taper needs to be turned with a razor sharp tool set perfectly on centre, to avoid deflecting the point of the bit this results an inaccurate taper, and the turning marks needs polishing out. When you harden the bit, there is a danger that the very point of the bit will melt due to uneven heating and it will distort when quenched and it is very difficult to get an even temper.

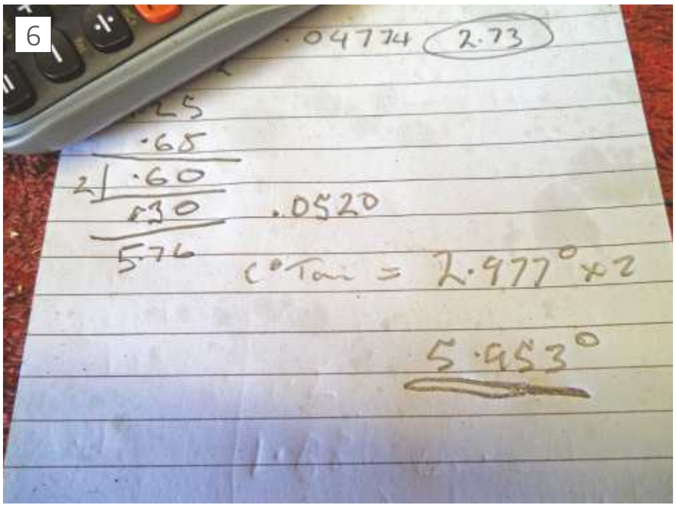
I have successfully made injectors using D-bits made by this method, but the difficulties led me to developing a method of making bits from high speed steel. Key to the method is the availability of a cutter grinder with an end mill grinding attachment, my own cutter grinder I put together using commercially available parts: an X-Y Table, a Myford vertical milling slide, and an ordinary bench grinder, all bolted together and fastened to a base plate. The end mill grinding attachment I fashioned from a 2" square chunk of aluminium, and a straight shank ER32

2 *Setting the fixture to required angle*

3 *Grinding the taper by rotating by hand*

Measure the diameter over the stop

Measure the height



Example of calculation

Sectioning D Bit with stone point held in the mill

collet holder, with an index ring and detent. But any of the home workshop tool grinding fixtures such as the “Quorn” or Harold Hall’s fixture can be adopted for the purpose.

The starting point is 5mm diameter high speed steel blanks, these come in 4” length and are available through any of the suppliers or online. Two bits can be made from a 4” length so the first job is to cut a length in half this is easily done on the bench grinder, and again using the bench grinder with the blank held in a drill, rough grind a taper for ½” length, to reduce the amount the TC grinder will have to remove, **photo 1**.

You will need a grinding wheel with a fairly hard bond of about ½” width, first dress the wheel up square to the table using a diamond, then set the end mill grinding fixture over to the desired angle, **photo 2**. Grip the D-bit in the fixture, remove the detent, and simple rotate by hand and gradually grind back until it cleans up, **photo 3**. To check the accuracy of the taper you will have to resort to a bit of trigonometry. First you will need to make a 5mm stop bush, clamp this bush to the D-bit using a grub screw and using a digital Vernier measure the diameter of the D-bit at the stop position and note it down, **photo 4**. Then zero a digital height gauge on the point of the D-bit, move the bush up the D-bit a couple of mm, measure the diameter again and measure the change of height making a note of the sizes, **photo 5**. Work out the change in diameter by taking one from then divide by 2, then divide by the change of height, this will give you the tan (tangent) of the angle and the arc-tan will give you the angle, multiply this by 2 and you will have the inclusive angle of the taper of the D-bit. Make any adjustments and repeat the process until you get the desired angle. In the example in **photo 6**, I was aiming for a 6 degree angle and achieved 5.953 degrees: close enough for me.

To section the D-bit first rough out on the bench grinder then with a stone point held in the mill at fast speed (in my case 1800RPM) and the bit held vertical grind back to 2.6 mm – half the blank diameter plus 0.1mm, just over centre, **photo 7**.

I’ve found that this method of making D-Bits is far easier than the turning method and in use they cut very smooth, clean and accurate and give an excellent finish and are long lasting, **photo 8**. ■

Selection of D-bits and Injector cones.

Readers' Tips

CHESTER MACHINE TOOLS

Bandsaw Roller Support

TIP OF THE MONTH WINNER!

This month our lucky winner of £30 in Chester gift vouchers is David Ambrose from West Sussex who has come up with a simple support to help with managing longer stock on a workshop bandsaw.

Like many of us, my workshop is in our garage. However, unusually for this day and age, we also keep our car in the car in the garage. This means that space is at a premium, so my new bandsaw had to be of the portable variety, so it could be stored on a shelf. It is normally placed on my Workmate for use. This meant that when I decided I needed a roller stand for supporting longer material, it would also have to be of the portable variety.

Having seen what I had in stock, I came up with this very basic, but effective, solution. The roller is from a piece of solid steel curtain pole. It may be mild steel, but it is certainly not free-cutting, as I found when I faced, drilled and tapped it. It is also coated with some sort of plastic, which has rusted slightly underneath. The "trunnions" are a pair of old curtain pelmet brackets, and the timber base was cut from a piece recovered from a skip. Weirdly, the combination of roller, brackets and timber resulted in the top of the roller being almost exactly 12cm above the bench, which is the same as the height of the vice on the saw, so no shimming or trimming was necessary.

Not very elegant, but does the job perfectly, and cost nothing..

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 I'll chose 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.chesterhobbystore.com to plan how to spend yours!

Please note that the first prize of Chester Vouchers is only available to UK readers. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

Shaping A Keyway

Richard Lofting has written three books in the Crowood metalwork series, *Welding, Brazing and Soldering, and Heat Treatment*. He has also written the book Vintage and Classic Tractor Restoration and writes a monthly workshop column for *Tractor and Farming Heritage* magazine. Here he describes the making of a special tool to cut an internal keyway on a shaper

I have been keenly reading Bill Morris's series on setting up the shaping machine, as I had bought an Alba 2S model that had been lurking in the old defunct machine shop of a local factory, if the motor label is anything to go by it is a 1938 model. In fact the guy that was in charge of the sales (eBay) said the machine shop had been closed up since 1985 as they were buying in stuff rather than making it on site and the decision had now been made to sell off the equipment. The machine, on our arrival at the factory was still 'plumbed in' to the three phase supply, so we could see the machine operating. Once at home I managed to find the star connection buried inside the motor and bring the wires out to the connection box and wire it in a delta configuration so that I could run the machine from 240 volts provided through a cheap Chinese VFD obtained from Ebay.

It's the old story, I was not actively looking for a shaper, I was browsing ebay when I stumbled upon the advert and it was less than 10 miles away from me. I then thought of all the jobs I needed it for and put a silly bid on and forgot about it, several days later I had won the machine. The most pressing job on the list had been a pulley repair from one of our vintage tractors.

I had also recently purchased a Centec 2b milling machine, and had used this to bore out the centre of the cast iron pulley as it had worn internally due to the retaining nut that holds the pulley to the hydraulic pump having loosened over the years, the pulley is just too large to fit in our Myford ML10 lathe so I made an adapter to put the lathe chuck on the mill and made a tool post to fit on the table. Turning a replacement sleeve was achieved on said lathe. The sleeve was glued, screwed and for good measure 'Dutch screwed' into the bored out pulley. The remaining job that was left was to cut the keyway in the new sleeve.

The completed adapter.

The adapter after machining and thread cutting

The tool bit holder after cutting the slot.

I wired the two pieces together for silver soldering.

The last time I had used a shaper was some 43 years ago at college and that was some plain cutting, nothing as fancy as a keyway! If I remember correctly, it was a Boxford. I did some initial practice reducing the shanks of some large cutting tools that came with the machine as they were too big to fit the lantern post. From looking at a brochure on the machine, found on the internet, I saw they originally supplied a special tool for internal cutting that was fitted in the clapper box. I realised this was what I needed for the keyway job, but rather than make a one off tool as it would need to be rather small diameter as the hole through the pulley is only 15mm, I thought I would make a tool holder to fit the clapper box and then make a tool to fit this so when I have other similar jobs of different sizes I can then make another tool to fit the holder rather than starting from scratch each time.

The Tool Holder

I had bought a 6 foot length of 1¾ inch diameter mild steel bar cheaply and with a 4½ inch section of this sliced off with the power hacksaw, I began by measuring the lantern post that is in the shaper and transferring these measurements to the piece of steel. A friend had given me several bags of nuts and bolts that were surplus to his requirements, if I hadn't had them, they were destined for the scrap yard, I hate waste, so soon found them space! In the mixed bag of mainly Imperial nuts, I found one large nut that had the same inside diameter as the lantern post and with a thread gauge managed to deduce that it was 12 tpi and from a thread table worked out it was 1¼ UNF. The nut was castellated, this was soon turned off in the lathe as it was not needed for this job. The lathe was set up to turn the 12 tpi thread, I had bought a 60° carbide tipped thread cutting tool, so this was a good opportunity to give it a try. I cut a recess where I wanted the thread to end to the depth of the inside of the thread in the nut. As the thread neared completion, I slackened the tail stock and tried the nut on the thread for fit, it was tight, this took several goes taking a very fine cut until the nut would run up the thread without binding, and a fine file took the peaks off the threads. I had initially used the tailstock with a revolving centre as a support as I was taking some hefty cuts to get the stock down to size on the small lathe!

Once the thread was completed a trial fit on the shaper was in order, and it fitted nicely with the thread just going through the clapper hole. I bored the business end of the tool holder to ¾inch diameter then bored and tapped two holes M6 through the side as I had some cap head screws to secure the tool in position, **photo 2**, after reducing the length and tiding up the ends.

The completed tool as used to cut the keyway.

The Keyway Tool

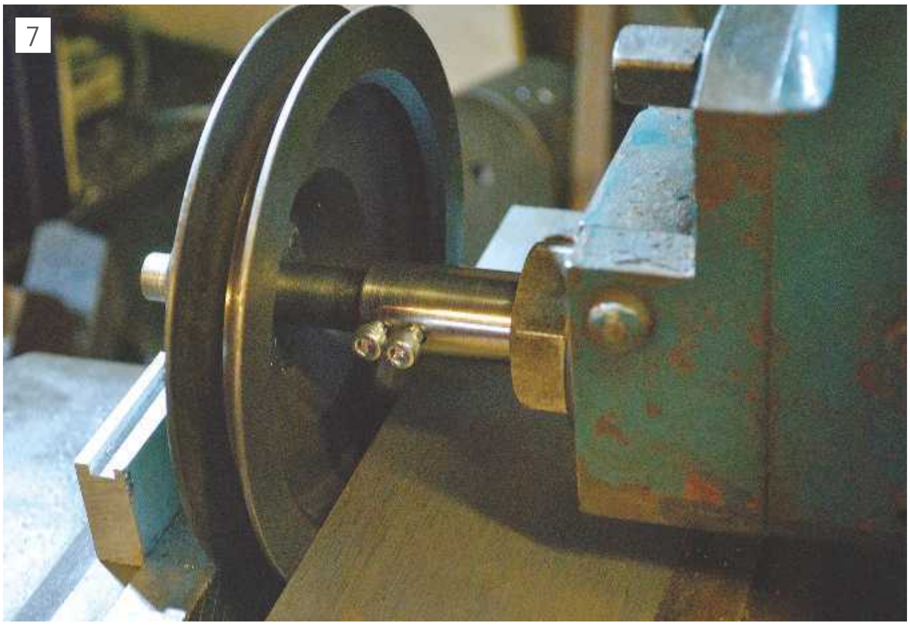
The hardest part of making the tool is cutting the square hole, **photo 3**, through the round shank of the tool, my idea is not original as I saw it somewhere on the internet but seems

Setting up the pulley and tool for alignment in the shaper vice.

the most logical and easiest way to produce it without a broach. The keyway needed to be 3/16inch in the pulley so this is the size of the hole through the tool. I cut the slot through with the shaper, I could have done it on the mill, but at that time I hadn't got the right sized cutter. Although I needed the finished tool to have a diameter less than the 15mm hole in the pulley I started with a section of a large bolt of ¾inch diameter as the locating hole in the tool holder I bored at ¾inch. My thoughts were that it would be easier to cut the hole through the larger diameter and once complete to turn it down to size in the lathe, it would also be a good time to bore and tap the end of the tool for the tool bit holding bolt, this was an M4 grub screw with an Allan key head. The technique is to cut a slot from the end of the bar and then make a cap to fit and then silver solder the two together, **photo 4**, ending up with a square hole of the right dimensions so the tool bit is a snug fit, **photo 5**. Once both parts were machined to size and silver soldered together, the tool was put back in the lathe and turned down to just over ½ inch diameter, this would give the clearance for the cutter that needs to extend 3/32 inch just under 94 thou from the tool body. At the ¾ inch end of the tool I milled a flat for the two locking screws to hold the tool in position.

Clamping the Pulley

Thoughts had turned to how to accurately align the pulley to the axis of the shaper, I have a swivel vice attached to the shaper, this came via a friend, as a standard 6inch machine vice came with the shaper originally when I purchased it and I soon worked out that to clamp it 90° to the direction of cut was going to be a challenge. Discussing this dilemma with said friend over a cup of tea revealed he had a spare swivel vice he had been tripping over and wanted to get rid of it, ok its a little on the large side, it would probably have been fitted to an 18inch cut shaper, but it fits the table on my mere 14 inches of cut Alba. Now with the vice 90° to the cut there was not enough room to get the cutter and pulley in, as the ram was already as far back as it would go. I am a self-confessed skip raider and have been hoarding several chunks of steel that I found in a skip, they looked like counter weights of some description, powder coated in bright orange. Again, the shaper was put to work removing the coating and squaring up one of the blocks. This was just the right size to put against the fixed jaw of the



At this stage I also set the stroke length to suit.

The first tool bit, shaped freehand on the bench grinder.

Once all the machining had been done the tool was tightened in position.

After a few strokes there was a bang and the tool bit shattered as it dug in!

The second attempt with a new tool bit, cutting upwards, went as it should.

vice, moving the pulley approximately 4 inches away from the ram giving enough room to complete the job.

I had already ascertained that the swivel vice does not conform to the angle scale on its side, I am not sure whether it is my table or the vice that is out as I still have to do a few tests as advocated by Bill in his shaper series recently in this magazine. Having fitted the tool into the adapter before finally sizing the shaft to allow for clearance, I turned it to the size of the shaft of the pump the pulley fits on. I fitted the pulley to this, **photo 6**, and then tightened the vice followed by the swivel locking bolts. The angle indicator is showing it is out by almost a degree. By turning the machine by hand, the tool goes in and out of the pulley without binding. At this stage I set the stroke length and position, **photo 7**, for this job as I was happy with the alignment. The pulley was left in position in the vice while I removed the tool and turned it down to final size so on refitting it would be still in alignment.

The Tool Bit

I carefully ground a tool bit freehand from a length of $\frac{3}{16}$inch HSS tool steel on the bench grinder and then finished the cutting edge with a diamond file, the bit was cut to length by nicking the four corners and giving it a clout, **photo 8**.

Once all set up and the tool bit installed in the holder, **photo 9**, and the VFD set to a slow pace, I began. The first few strokes all went well with fine shavings emerging as the tool came through the pulley, but as the tool reached the full width of cut there was a bang and the tool bit cracked! **photo 10**. After manually cranking the machine to move the tool from the pulley it revealed a dig in. I had forgotten about the clapper, it then dawned on me that most pictures on the internet show keyway cutting upwards rather than downwards. The tool had been riding up slightly on each stroke allowed by the clapper until the tool pulled in. As the Alba has no locking mechanism on the clapper I decided to turn everything upside down and cut upwards. The biggest problem with this was aligning the part started keyway.

I realised that I had in fact put too much front rake on the tool and rather than try to salvage the broken one I decided to start again, this time with less rake. Second time lucky, all went well with nice rolls of swarf emerging from the end of the pulley with every stroke, **photo 11**, I found that by allowing three strokes for every small increase in the depth of cut, each pass produced swarf as the tool flexed. ■

The finished keyway, not bad for first attempt.

The original lantern post and the new adapter with the cutting tool in the centre.

MODEL ENGINEER

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Wakefield
John Arrowsmith visits the Wakefield Society of Model and Experimental Engineers.

Lubrication
Rhys Owen looks at the phenomenon of friction and explores the various approaches to locomotive lubrication.

Rotary Broaching
Jacques Maurel explains how rotary broaching is used to create polygonal holes.

Is it a fake?
Noel Shelley wonders what distinguishes a replica from a fake.

Content may be subject to change.

ON SALE 21 MAY 2021

BEGINNERS WORKSHOP
These articles by Geometer (Ian Bradley) were written about half a century ago. While they contain much good advice, they also contain references to things that are out of date or describe practices or materials that we would not use today either because much better ways are available or for safety reasons. These articles are offered for their historic interest and because they may inspire more modern approaches as well as reminding us how our hobby was practiced in the past.

Special files and shapes

GEOMETER writes on the application of non-standard shaped files for metal and wood working

As EXPERIENCE IS gained in using files, it is soon discovered that there are occasions when the ordinary varieties are unsuitable because of their size or shape. Also, it is apparent there are forms which it is virtually impossible to produce with precision by mere unguided filing.

Happily, however, there are available at the present time numerous special types of files to meet unusual situations and some of the more common geometrical shapes, one-off or repetitional, can be produced with reasonable ease by the use of simple jigs and templates.

Special files

Ordinary files are not well adapted to curved bores such as may be encountered in making a model engine or doing a little home tuning to motorcycle or car, when it is required to reduce sharp corners in ports and smooth the interior of manifolds, where the riffler file (A) is useful.

It is double-ended, as shown, with curved tooth surfaces and made in a variety of sections-round, oval, rectangular, D-section, etc. No particular skill is required in its use, it is only necessary to ensure that any adjacent seating surface is not damaged in the process.

The rotary file (B) is employed in model engineering, toolmaking, diesinking and in circumstances where, for any reason, machining is not admissible. It is used in an electric drilling machine, or driven from a flexible shaft, the shank being round to grip in a chuck. Again, there are various sections and generally two cuts at least, coarse and fine.

Common sections are round (ball) round parallel, barrel shape and taper-sided. Some of the larger rotary files may be screwed on shanks.

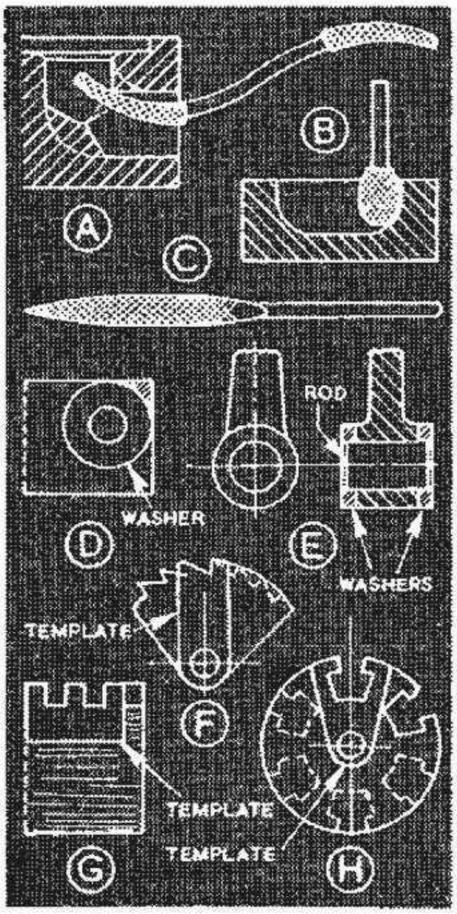
Rotary files

Use of rotary files to produce the desired results demands practice and manipulative skill, since the rapidly-revolving tool tends to drag itself along a surface, so the drill or flexible-shaft head must be held firmly, yet at the same time moved to produce the required contour. Particularly to be guarded against are involuntary movements when a cut is almost completed and resistance is suddenly reduced, for then the tool may jump and cut an unwanted hollow before the corrective movement can be applied.

Needle files, of which C depicts an example, are the smallest sections produced, generally for working in very small slits or apertures. The shanks are generally circular, though the files are intended for use by hand. As with larger files, there are numerous different sections.

A lever! link or connecting rod usually fimshes with a rounded end or boss and when precision is required, the component is produced by milling or grinding on a jig or rotary table. Very good results, however, can be achieved by filing, using as a guide a washer, or a disc of metal from a bar.

Some of the many shapes of files used for special work. Their application is described in the text



When a radius is required at a corner (D), the washer can be located flush with the side and end of the work and the two clamped in the vice, surplus material sawn off and the radius carefully filed to fit the washer.

To produce a nicely-rounded end on a connecting rod *(E)*, the bore should be finished (as by drilling and reaming), then a pair of washers of similar bore and required outside diameter placed one each side on a close-fitting rod, which is just short of the total length, so washers and con-rod can be gripped in the vice.

For one-off work, steel washers need not be hardened-though they should be case-hardened for continuous use-or better, made in steel such as cast steel, which can be hardened outright by heating to red and cooling in water.

Use of templates

A template considerably facilitates working where the same feature has to be repeated a number of times. Depending on the use to which it is to be subjected, a template can be in mild steel, unhardened, case-hardened, or in cast steel, hardened and tempered.

The material need be no thicker than that necessary not to bend or deflect easily in use, having regard to the size. Using a template, it is necessary, of course, to file squarely.

To produce a ratchet quadrant (F), the template has a locating hole and a vee-nick of the required size, moved round the work in filing each tooth-in which way small saws and cutters can be produced.

Filing slotted joints

Slotted dovetail joints for a wood box (G), can be filed from a metal template, long enough to embrace width, or moved for the necessary number of tongues and grooves.

Small numbers of special armature laminations for a motor or dynamo can alsb be filed from a suitable template, (H), in this case swinging round to the required angular positions.

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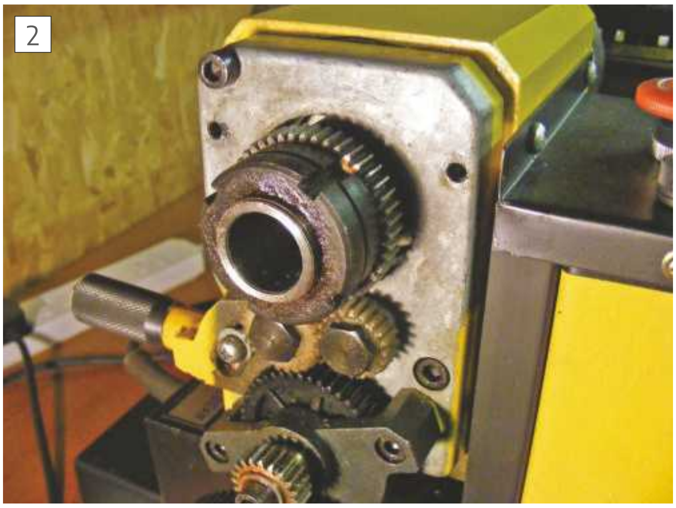
Mini Lathe Spindle Improvements and Modifications

Part 1. Spindle extension. Mike Cox commences a series of three related articles on spindle modifications for the popular Mini Lathes with this spindle extension.

The gear cover on a minilathe. The end of the spindl;e is inside the cover.



The rear of the spindle is directly over the chane gears.

The Asian mini-lathes that are sold in the UK all have a design flaw. The lathe spindle does not extend out the back of the cover enclosing the change gears, **photo 1**. A consequence of this is that any swarf or metal dust that migrate along the spindle bore then falls onto the change gears immediately below the spindle, **photo 2**. The amount of swarf migrating along the spindle during normal turning of the out diameter of components is usually very small but if the lathe is used for through boring of a component then a large amount of swarf and metal particles travel back along the spindle and drop onto the change gears.

When I first came across this problem, I made an extended bottle brush, **photo 3**, that I could push through the bore between passes to clear the spindle of debris. This was not very effective until the hole being bored was at least as large as the spindle bore. In fact whilst the bore was small using the brush tended remove most of the swarf as it was withdrawn depositing it over the change gears!! The extended brush is not totally useess and I use it to clean the bore and the chuck at the end of any turning session.

The obvious solution to the swarf problem was to replace the outer most lock nut on the back of the spindle with a purpose made threaded spindle extension, as shown in **photo 4**. The grooves on the side closest to the spindle are so the extension can be tightened on the spindle with a C spanner.

The spindle extension

The spindle extension, **fig. 1**, was made from a length of 50mm free cutting mild steel. A 38mm length was cut off and mounted in the external jaws of the lathe chuck. The end was faced, centre drilled, and then drilled out to 13mm using successively larger drills. The end of the piece was turned down to 27mm diameter for a length of 20mm. All edges were then chamfered.

The piece was turned round in the chuck so that it was gripped by the 27mm end and faced to a good finish. The outside was turned down to 45mm diameter. Using a 10mm boring tool, **photo 5** the 13mm bore was opened out to 20mm for the whole length. The bore was then enlarged to 25.5mm for a distance of 11mm from the end. The final operation before threading was to undercut the bottom of the 25.5mm bore to 27mm for a distance of 2.5mm to provide a run out groove for threading.

The 25.5mm bored section was then single point threaded to give an M27 x 1.5mm thread using a 60 degree threading tool, **photo 6**. I have a 1.5mm pitch metric leadscrew on my mini-lathe so any gears providing a 1 to 1 ratio between the spindle and leadscrew are good for this operation. I used the gear combination 20, 65, 20. The threading was done using small cuts and using

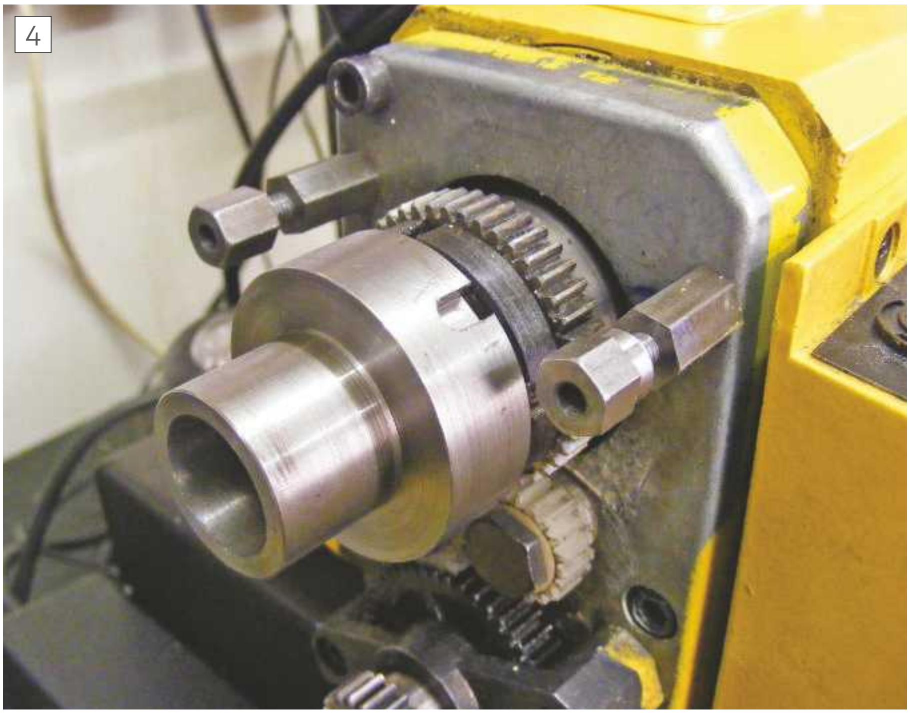
a spindle handle rather than under power. Doing it this way it is easy to feel when the tool reaches the run out groove. Threading was continued until the tip of the tool had been advanced 0.65mm into the steel. At this point the extension piece was marked with a felt tip pen where it met jaw No 1 of the three jaw lathe chuck. It was then removed from the chuck.

The outer ring nut was removed from the spindle and the new extension was screwed on. If the fit had been tight at this stage, then the extension could have been removed and replaced in the chuck so that the mark lined up with the No 1 jaw and a further light cut taken. Throughout the threading and testing the leadscrew half nuts were kept closed.

3

The modified bottle brush.

4



The rear spindle extension.

Once the fit was acceptable the positions of the four C spanner grooves were marked out, and the grooves were cut using my X1L mill. An alternative to the C spanner slots would have been to drill four 6mm holes through the rear projection, close to the shoulder, so that a tommy bar could be used for tightening.

The rear extension can now be screwed onto the spindle instead of the second ring nut and it should be tightened to lock against the first ring nut. Check that the spindle turns freely and that there is no axial or radial play in the spindle. If there is then loosen the extension and tighten the first ring nut to eliminate any play and then relock the extension to the ring nut. The ring nut must not be over tightened as this will cause exessive heat generation in the bearing.

The final step in the project was to

Fig.1

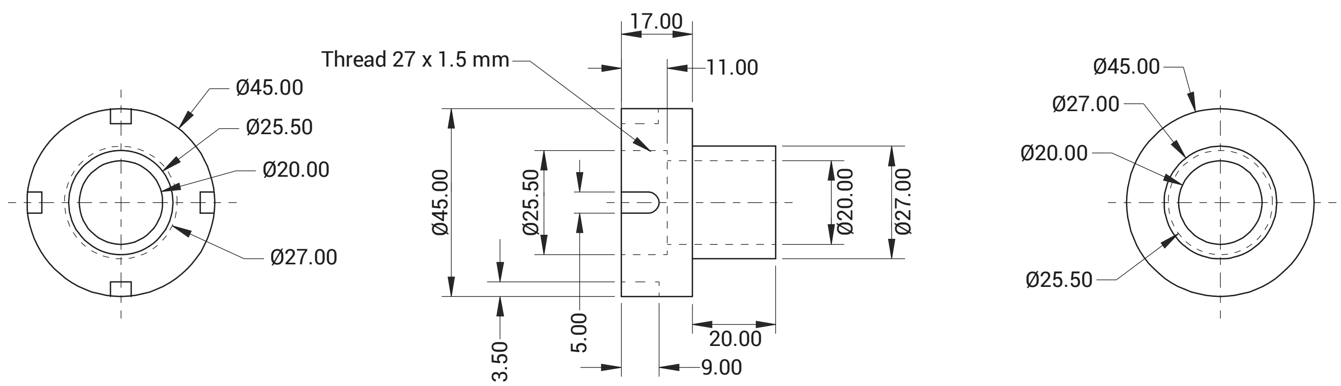


Fig 1. The Spindle Extension
Mat'l: Mild steel

The boring bar.

The 60 degree threading tool.

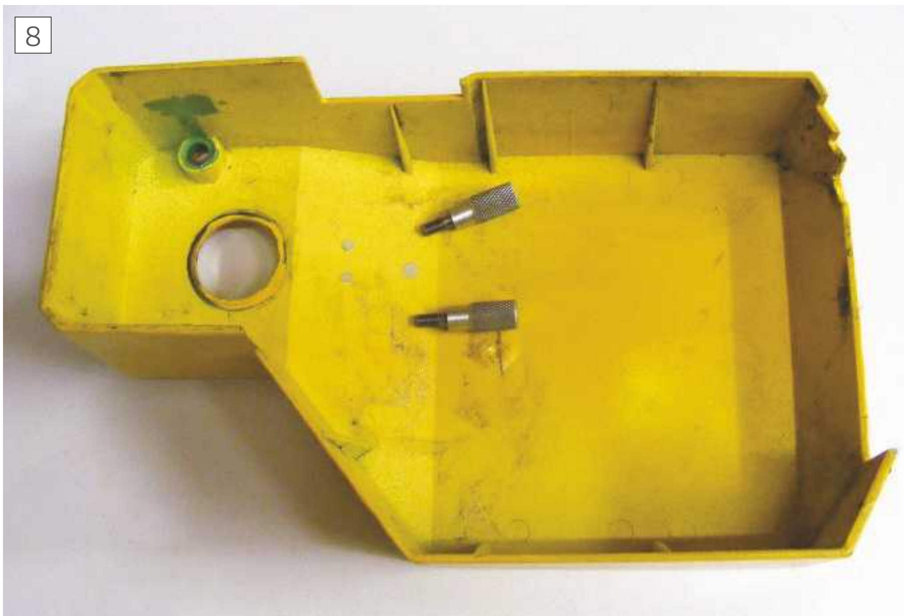
I did this the hard way using a half round file and abrasive paper because I had no alternative at the time. Step drills are cheap and readily available, and this would be a much easier way to enlarge the hole.

enlarge the hole in the change gear cover so that the extension protrudes through it. I did this the hard way using a half round file and abrasive paper because I had no alternative at the time. Step drills are cheap and readily available, and this would be a much easier way to enlarge the hole.

Fixing the change gear cover

I found the standard long M4 socket head allen screws that secure the cover very frustrating. Firstly, when ever I wanted to remove or replace the cover, I had to find the correct allen key. Secondly, the screws were a pain to get started in the holes on the headstock. To solve both these problems I replaced the screws with small studs in the headstock and then screwed a 32mm of 10mm hex bar that had been drilled and tapped M5, **photo 7**. I cut away some of the material inside the change gear cover, **photo 8**, so that it would fit over the hex bars and then secured the cover in place with small M5 knurled screws. This makes removing and replacing the cover much easier. ■

The threaded hex bars screwed to the headstock.



The cover after modifications. Note the knurled attachment screws inside the cover.

Introducing Drilling Machines

After a lathe, a bench drilling machine is probably the commonest machine in most workshops.

Although many small milling machines are sold as ‘mill drills’, they are rarely as convenient in use as a true drilling machine. Given that the cost of a basic bench drill is a fraction of that of a milling machine, many users feel it makes sense to have both machines in the workshop.

A typical entry-level drill press, such as the Warco Hobby Drill, **photo 1**, will have five speeds. Speeds are changed by loosening a screw on the motor mount and moving a belt up or down a stack of pulleys – this takes about a minute. It has a no-volt release emergency stop and has an adjustable cast iron table. The Hobby Drill comes with a keyed chuck with a capacity from small drills up to 13mm (½”).

Industrial quality drill presses are typically much larger and have more powerful motors. The Clarke CDP302B is an example, **photo 2**. It has sixteen speed belt drive and a heavy table which can be raised using a rack and pinion system. It comes with a 16mm keyed chuck and has an MT2 spindle which allows the user to easily change to a smaller chuck or to use larger drills and reamers with taper shanks.

Even larger pillar drills are available, usually as floor-standing machines which are useful if you would rather not give up an area of bench space to a drill press.

Chucks

Unlike the chucks on hand-held power drills, which screw on, those on drill presses usually use a taper such as B16, either on the end of the spindle or on a morse taper arbor. The usual way of fitting these is to assemble them by hand, then lower the fully open chuck against a block of wood on the mill table. Firm pressure applied with the feed lever should then be enough to ensure the chuck is securely fitted.

The commonest style of chuck is the ‘Jacobs’ type which uses a separate key for tightening and loosening, but you can also get good quality keyless chucks, **photo 3**. If you have a small drill press you should be aware that keyless chucks can be much longer and might restrict the ‘headroom’ you have for longer drills.

Drills

You might be surprised how many different choices there are when it come to drills! The basic morse twist drills used for metalworking usually have a 118-degree angle at the tip and curved flutes. As well as metric (millimetre) and imperial (fractional inch) sizes, you can also get ‘number’ and ‘letter’ drills in closely spaced sizes. You may find these number and letter sizes on older plans, they can usually be satisfactorily substituted for using a metric drill chosen to the nearest 0.1mm.

Usually you will find drills with a curved surface behind the cutting edges, but two other types are often found. Four-facet and six-facet drills are very effective and preferred by some users, they are also easier to sharpen freehand. Split-point drills are good at starting holes (large drills of other styles are best used to follow a smaller pilot hole) but quite difficult to regrind.

Specialist styles of drill include short ‘spotting drills’ with a more pointed end, used for setting out holes on a workpiece and centre drills for putting a 60-degree conical hole in the end of lathework to allow it to be held between centres. You may also come across ‘slow spiral’ or straight flute drills, these are ideal for drilling sheet material as they are less likely to grab or distort it.

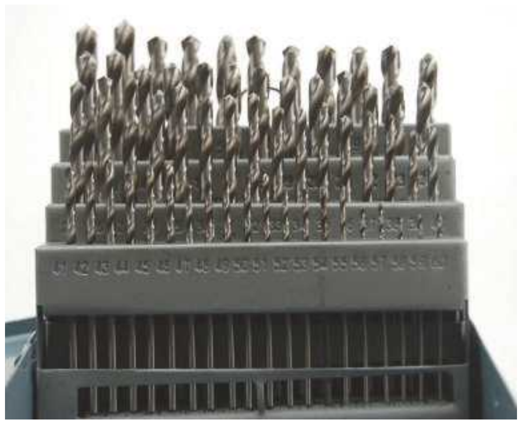
Most drills are HSS, but if you have a lot of holes the same size to drill in

Warco’s Hobby Drill is an entry level drill press.

This large Clarke bench drill has sixteen speeds and an MT2 spindle.

Not to be confused with cheap plastic-bodied types, good quality keyless chucks hold drills securely and are quick to use.

tough materials, you might consider investing in a solid tungsten carbide drill. Good advice for beginners is to buy a 'mid range' set of drills to cover their immediate requirements and as they wear out or break the most used drills, replace them with better quality items.



This set of number drills comes in a combined box and holder.

Reamers

Reamers are special drill-like tools which are used to give an accurate size to a previously drilled hole, for example where you need an accurately sized pin or shaft to have a particular type of fit. Reamers should be run at about half the speed you would use for a drill of the same diameter, and the previously drilled hole should not be too close to the final size – reamers need to be able to take a modest cut or they will blunt rapidly.

Lubrication

It is almost always a good idea to use some form of cutting fluid or oil when drilling. Although in industry floods of coolant are the norm, simply brushing a little neat cutting oil on a drill or reamer will make a big difference, reducing the pressure required and improving the finish of the final hole.

Drill safety

Although drill presses are relatively simple in principle, there are a few things to bear in mind to ensure safety and that you get the best results:

- Drill presses are generally rather top-heavy, so they MUST be securely attached to the bench. Usually a pair of M10 screws with washers to spread the load are more than adequate.
- Always hold work in a drill vice or clamp it to the drill table; even a small item that grabs and spins in your fingers can cause unpleasant injuries.
- When drilling all but the smallest work drill vices should be clamped to the table.
- Always use the guard – its job is to stop flying swarf.
- Use a bent metal rod to pull swarf clear of the drill, never use your fingers
- Never wear gloves when using a drill press, they can get pulled off if caught by a drill. ∎

Cutting Oils

Our New Zealand correspondent, Peter King, gets some thoughts about coolants and cutting oils off his chest.

I have observed that many correspondents to 'Model Engineer's Workshop' regard "suds", "cutting oils" etc as the same thing and use these terms interchangeably. They are not the same thing but are both coolants.

'Suds' originated as a mix of ordinary soap and water about 200+ years ago, and this was a very early aid to turners. Water, being very good at taking up heat, cooled the 'Carbon Steel' cutters they used and prolonged their use before they failed due to loss of 'temper'. The blend, because of the soap being made from fat and lye, to a degree blended with the water, cooled tool and job and 'eased' the passage of the chips over the tooling and also left a greasy coating on the work and prolonged the period to the onset of corrosion (rust) on the 'super-clean' machined surfaces. This can be 'home-made' – I do not recommend it, as it does not take very long before it smells very bad!

Modern 'suds', is a mixture of a special formulation of oils (and a modicum of bactericide – hence the clinical 'smell') with clean water. It is not 'soluble' (despite the common name for it), the oil disperses as minute 'globules' of oil in the water and gives a 'milky' appearance to the mix. Once again the water cools the tooling and the job and the oil eases the passage of the chips over the tool. It also, again, coats the super-clean machined surfaces and - much more than soap – defers the onset of corrosion (rust) by preventing access of oxygen to those surfaces. A further advantage is that the water soon evaporates and it leaves a trace of oil on the surfaces of the machine tool. The formulation is cheap. Soluble oil on its own, burns due to the heat of machining and smells rather nasty and does not cool work or tool. The only place I have ever used it 'straight' is hand tapping when I ran out of formulated 'tapping lubricant' - it does a reasonable job.

"Cutting oils" do not have any water and are formulated firstly to penetrate easily to the tooling's cutting edges to ease the passage of chips and reduce, if not eliminate, build-up of some alloys on tool tips, and secondly to carry away the heat of machining – lastly, again to coat the work surfaces to prevent corrosion. It is intended to be used as a flood not a drip. The formulations are not cheap.

Even a relatively small drill can benefit from a constant flow of suds.

"Cutting solutions" do not usually have any oils and are a melange of chemicals, often in a water solution and do the same as above. The formulations – there are lots – are very 'not cheap' and are often only sold in large containers, like 44 gallon drums. They are primarily used for rapid automated mass production.

All of the above are intended to be used as a flood over the work, not as a sparing drip. Yes, you will get it on you from the spray thrown off – that is why the turners wore overalls and are to be seen sometimes in old photographs wearing a sort of bib over them! My larger lathe delivers between about 1 and 5 litres per minute and my mills each maintain between 2 and 5 litres - partly also this is to wash chips away and prevent 're-cut'.

If you use "air / solution" spray application on your work – which relies on the 'air' to cool the work (inefficiently) and you want to live longer, then acquire breathing 'filter masks' as the last three formulations mentioned above, when ingested into your lungs from the air will not improve your longevity! It is difficult to acquire oxygen if your lungs have a coating from oil mist designed and formulated to prevent it. The last two in particular have some chemical combinations that will not be appreciated by your lungs.

Examination of photographs of 'turned' items provided by some correspondents clearly show who uses adequate coolant – nice clean bright finishes close to a ground finish (right cutting speed, right feed, right tool, right depth of cut, adequate coolant) there being no evidence on the work of 'build-up' on tooling. Then there is the work that looks – as my tutor (Father- an AMIMechE) a long time ago, described as "hacked out with a half round bastard file" (all wrong and with great scars from 'build-up' on tooling). ■

Model Engineers' Workshop Data Book

MODEL ENGINEERS'WORKSHOP DATA BOOK

DRILL SIZES			DECIMAL SIZES	
METRIC	INCH	NO./ LETTER	METRIC	INCH
24.75			24.750	0.9744
25.00			25.000	0.9843
	63/64		25.003	0.9844
25.25			25.250	0.9941
	1.00		25.400	1.0000

BEYOND THIS SIZE, METRIC DRILLS ARE LISTED AS FOLLOWS.
0.25mm INCREMENTS UP TO 32mm
0.50mm INCREMENTS UP TO 51mm AND
1.00mm INCREMENTS UP TO 100mm.

INCH SIZE DRILLS ARE LISTED AS FOLLOWS
1/64in. INCREMENTS UP TO 2in.
1/32in. INCREMENTS UP TO 3-1/2in. AND
1/16in. INCREMENTS UP TO 4in.

READERS NOTES.

MODEL ENGINEERS' WORKSHOP DATA BOOK

BENDING ALLOWANCE--METRIC SIZES

THICK-NESS mm	RADIUS mm 1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.5	1.9	3.5	5.0	6.6	8.2	9.7	11.3	12.9	14.5	16.0
0.6	1.9	3.5	5.1	6.7	8.2	9.8	11.4	12.9	14.5	16.1
0.7	2.0	3.6	5.2	6.7	8.3	9.9	11.4	13.0	14.6	16.1
0.8	2.1	3.6	5.2	6.8	8.4	9.9	11.5	13.1	14.6	16.2
0.9	2.1	3.7	5.3	6.8	8.4	10.0	11.6	13.1	14.7	16.3
1.0	2.2	3.8	5.3	6.9	8.5	10.1	11.6	13.2	14.8	16.3
1.1		3.8	5.4	7.0	8.5	10.1	11.7	13.3	14.8	16.4
1.2		3.9	5.5	7.0	8.6	10.2	11.7	13.3	14.9	16.5
1.3		4.0	5.5	7.1	8.7	10.2	11.8	13.4	15.0	16.5
1.4		4.0	5.6	7.2	8.7	10.3	11.9	13.4	15.0	16.6
1.5		4.1	5.7	7.2	8.8	10.4	11.9	13.5	15.1	16.7
1.6		4.1	5.7	7.3	8.9	10.4	12.0	13.6	15.1	16.7
1.7		4.2	5.8	7.4	8.9	10.5	12.1	13.6	15.2	16.8
1.8		4.3	5.8	7.4	9.0	10.6	12.1	13.7	15.3	16.8
1.9		4.3	5.9	7.5	9.0	10.6	12.2	13.8	15.3	16.9
2.0		4.4	6.0	7.5	9.1	10.7	12.3	13.8	15.4	17.0
2.1			6.0	7.6	9.2	10.7	12.3	13.9	15.5	17.0
2.2			6.1	7.7	9.2	10.8	12.4	13.9	15.5	17.1
2.3			6.2	7.7	9.3	10.9	12.4	14.0	15.6	17.2
2.4			6.2	7.8	9.4	10.9	12.5	14.1	15.6	17.2

NOTES

The material in any bend will be under tension in the outer part, whilst in the inner part it will be under compression. The position of the neutral axis (path of no change in length) will depend on the relative strengths of the material under compression and tension.

The bend allowances given in the following tables are based on the neutral axis being at a position of 0.4 times the material thickness and nearest the inside.

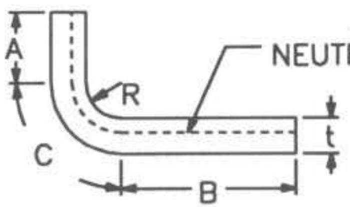
Bend allowance C therefore equals, for 90 degree bend.

$$C = \frac{\pi \times 2 \times (0.4t + R)}{4} = 1.57(0.4t + R)$$

R = Inside bend radius.

The value of 0.4 should prove adequate for most materials. However, in critical applications a trial should be carried out on a test sample.

Length of material = A + B + C



For bends other than 90 degrees

$$\text{allowance} = \frac{C \times \theta}{90}$$

Where C = allowance as per tables.
θ = angle of bend.

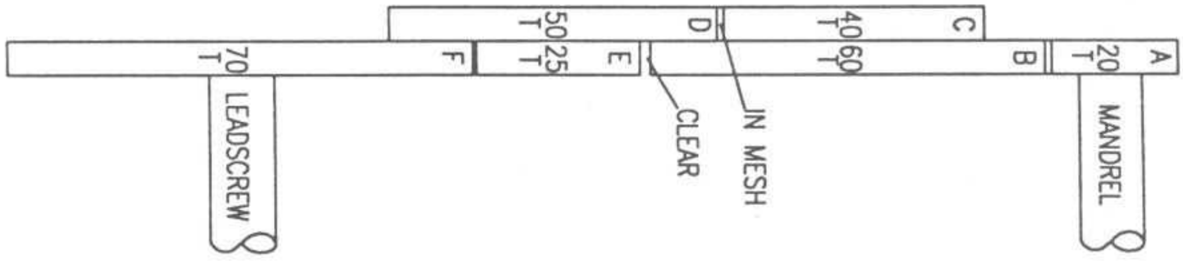
THICK-NESS mm	RADIUS mm 1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
2.5			6.3	7.9	9.4	11.0	12.6	14.1	15.7	17.3
2.6			6.3	7.9	9.5	11.1	12.6	14.2	15.8	17.3
2.7			6.4	8.0	9.6	11.1	12.7	14.3	15.8	17.4
2.8			6.5	8.0	9.6	11.2	12.8	14.3	15.9	17.5
2.9			6.5	8.1	9.7	11.2	12.8	14.4	16.0	17.5
3.0			6.6	8.2	9.7	11.3	12.9	14.5	16.0	17.6
3.5				8.5	10.1	11.6	13.2	14.8	16.3	17.9
4.0				8.8	10.4	11.9	13.5	15.1	16.7	18.2
4.5					10.7	12.3	13.8	15.4	17.0	18.5
5.0					11.0	12.6	14.1	15.7	17.3	18.8
5.5						12.9	14.5	16.0	17.6	19.2
6.0						13.2	14.8	16.3	17.9	19.5
6.5							15.1	16.7	18.2	19.8

FOR LEADSCREW HAVING FOUR THREADS PER INCH

THREADS PER INCH	MANDREL	FIRST STUD DRIVEN	FIRST STUD DRIVER	SECOND STUD DRIVEN	SECOND STUD DRIVER	LEADSCREW
22	20	55	30	idler		60
24	20	60	40	idler		80
25	20	50	40	idler		100
26	20	65	30	idler		60
27	20	60	40	idler		90
28	20	70	40	idler		80
30	20	60	40	idler		100
32	20	60	30	idler		80
33	20	55	40	60	35	70
34	25	85	40	idler		100
35	20	70	40	idler		100
36	20	60	30	idler		90
38	25	95	40	idler		100
39	20	60	40	65	35	70
40	20	80	40	idler		100
42	20	60	40	50	25	70
44	20	55	35	70	40	80
45	20	45	40	60	30	100
48	20	60	25	idler		100
50	30	75	20	idler		100
56	20	70	25	idler		100
60	20	60	30	75	40	80

BENDING ALLOWANCE--IMPERIAL SIZES

THICKNESS in.		RADIUS in. 0.063 1/16"	0.094 3/32"	0.125 1/8"	0.157 5/32"	0.187 3/16"	0.219 7/32"	0.250 1/4"	0.312 5/16"	0.375 3/8"	0.500 1/2"
0.032	1/32"	0.12	0.17	0.22	0.27	0.31	0.36	0.41	0.51	0.61	0.81
0.063	1/16"	0.14	0.19	0.24	0.29	0.33	0.38	0.43	0.53	0.63	0.82
0.094	3/32"		0.21	0.26	0.31	0.35	0.40	0.45	0.55	0.65	0.84
0.125	1/8"			0.27	0.33	0.37	0.42	0.47	0.57	0.67	0.86
0.157	5/32"				0.35	0.39	0.44	0.49	0.59	0.69	0.88
0.187	3/16"					0.41	0.46	0.51	0.61	0.71	0.90
0.219	7/32"						0.48	0.53	0.63	0.73	0.92
0.250	1/4"							0.55	0.65	0.75	0.94
0.313	5/16"								0.69	0.79	0.98
0.375	3/8"								0.82	1.02	1.02



SET UP FOR CUTTING 42 THREADS PER INCH WITH 4 THREADS PER INCH LEAD SCREW. SEE TABLE.

SCREW CUTTING ON THE LATHE CHANGEWHEEL COMBINATIONS

Notes

The combinations listed on the following pages have been proven to be mathematically correct. Their acceptability on any machine will depend on the machine in question.

Most obvious potential problem is insufficient changewheels available, due to them not being included in those supplied initially, or having been subsequently lost.

Just possibly, though unlikely, is that if wheels listed are too large, the resultant centre distance between gears may make fitting them to the quadrant impossible. The larger diameter may also make them foul some part of the machine, typically the changewheel cover.

The combinations given in the lists are in no way exclusive, others can be used to suit the wheels available. Even so, combinations that are mathematically correct may present problems in fitting.

In the example on the left the 1:3 ratio of the mandrel (20) to first stud driven (60) could be replaced with 30 and 90 tooth wheels as neither are being used elsewhere.

On examination this will not work as the sum of the teeth on gears C and D (90) would not be greater than the sum of B and E (115) thus eliminating the essential clearance between B and E.

However, if the 40 and 50 tooth gears were replaced by 80 and 100, an acceptable gear chain would result. From this it can be seen that other combinations can arrive at the same result. If therefore gears are not available for the quoted arrangement, do look for other possibilities.

MODEL ENGINEERS' WORKSHOP DATA BOOK

BENDING ALLOWANCE--SWG

THICKNESS		RADIUS in.									
		0.032	0.063	0.094	0.125	0.157	0.187	0.219	0.250	0.312	0.375
SWG	in.	1/32"	1/16"	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"	3/8"
22	0.028	0.07	0.12	0.16	0.21	0.26	0.31	0.36	0.41	0.51	0.61
21	0.032	0.07	0.12	0.17	0.22	0.27	0.31	0.36	0.41	0.51	0.61
20	0.036		0.12	0.17	0.22	0.27	0.32	0.37	0.42	0.51	0.61
19	0.040		0.12	0.17	0.22	0.27	0.32	0.37	0.42	0.52	0.61
18	0.048		0.13	0.18	0.23	0.28	0.32	0.37	0.42	0.52	0.62
17	0.056		0.13	0.18	0.23	0.28	0.33	0.38	0.43	0.53	0.62
16	0.064		0.14	0.19	0.24	0.29	0.33	0.38	0.43	0.53	0.63
15	0.072			0.19	0.24	0.29	0.34	0.39	0.44	0.54	0.63
14	0.080			0.20	0.25	0.30	0.34	0.39	0.44	0.54	0.64
13	0.092			0.20	0.25	0.30	0.35	0.40	0.45	0.55	0.65
12	0.104				0.26	0.31	0.36	0.41	0.46	0.56	0.65
11	0.116				0.27	0.32	0.37	0.42	0.47	0.56	0.66
10	0.128				0.28	0.33	0.37	0.42	0.47	0.57	0.67
9	0.144					0.34	0.38	0.43	0.48	0.58	0.68
8	0.160					0.35	0.39	0.44	0.49	0.59	0.69
7	0.176						0.40	0.45	0.50	0.60	0.70
6	0.192						0.41	0.46	0.51	0.61	0.71
5	0.212							0.48	0.53	0.62	0.72
4	0.232								0.54	0.64	0.73
3	0.252								0.55	0.65	0.75

Quick change tool system for my Sieg KX1 CNC mill

Ian Johnson explains a quick-change system for a benchtop CNC mill

I have had my KX1 CNC mill for over a couple of years now, and have made some very nice work on it, and overall I'm very impressed and pleased with its capabilities. Standard fitment on the KX1 is the number 2 Morse Taper (2MT) spindle, which can be used in conjunction with various tool holders or collet adaptors. In my opinion the 2MT spindle is cumbersome and is not the best method of changing tools. I want my machine to be much easier to use. This is my effort to solve what became a frustrating fight with the 2MT spindle, **photo 1**.

One of the finished tool holders.

What's wrong with 2MT on a CNC milling machine?

With jobs requiring multiple tool changes, I quickly found that the 2MT tool holding method is not ideally suited for CNC! To change tools the spindle needs to be locked and the spindle draw bar unscrewed, to release the tool holder, **photo 2**. Even with the self-extract draw bar this can require some effort to loosen off the 2MT. Worse is having to clout the draw bar with a good sharp tap with a hammer, which can't do the carefully trammed head or bearings much good at all!

Using 2MT end mill holders and a 2MT ER25 collet chuck, does make CNC tool changes slightly easier, but I rapidly realised that I wasn't getting the full benefit of the whole CNC experience which includes, quick tool changes, consistent tool positioning, repeatability and ease of use.

CNC and Tool offsets

CNC milling machines need to know the tool length (or 'offset') of each tool, usually taken from the bottom of the tool to the top of the material to be machined. This information can be stored in the 'tool table'. On my machine it is Mach 3. It is very difficult to achieve a repeatable offset for multiple tools using the 2MT end mill holder or ER collets, because every time the tool is loaded, due to variable position, each tool will have a slightly different height every time it is used. Therefore each tool height offset needs to be individually set every time before it is used, and the biggest nuisance is, of course, releasing and tightening the 2MT.

No more doing this! Extracting 2MT from the KX1

New tool holder needed!

After deciding that the 2MT tool change just wasn't for me, I set about making a simple quick change tool holder system, which would enable me to use my existing 2MT mounted ER25 collet chuck.

The system relies on using just one single 13mm ER25 collet. This one collet would hold a series of home-made standard size tool holders all with a 13mm diameter shank.

Why 13mm? I had previously made a small tool holder with a 13mm diameter shank, to hold a ⅛" engraving bit which worked very well in the ER25 collet. So I reasoned that if it worked okay once, it would work okay lots of times! This is the only reason why all the tool holders have the same diameter shank. They can of course be made any size.

Essentially it will be a tool, held in a tool holder, which is held in a tool holder, which is held in the spindle. Let's see how it all works out!

Material choice and making the holders

Material of choice was 19mm round steel bar, I think it was re-enforcing bar I got from a steel stockholder years ago, probably high carbon steel? I don't know, but it is tough stuff, certainly good enough for a few little tool holders, **photo 3**.

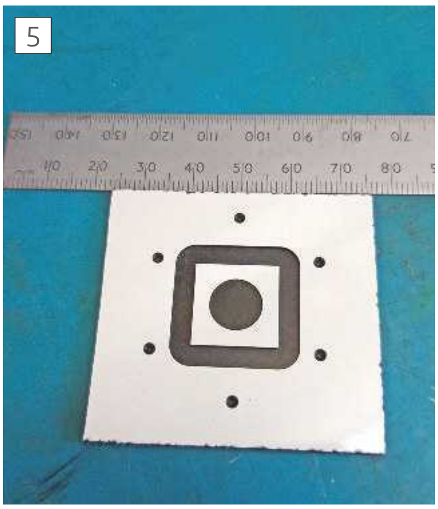
Cutting the bar into short lengths made it easier to machine on my Mini Lathe. The first step was to machine the 13mm shank 32mm long, and clean up the 19mm diameter body to 18.5mm x 18mm long, giving it a shoulder which will sit squarely against the collet face and won't interfere with the collet clamping nut. We now have two good datum faces, from which we can reference all the tool heights and offsets.

Now to drill and ream the tool holders. Gripping the 13mm shank in the 3 jaw chuck, clock true, face off, chamfer, centre drill, drill and ream for the different diameter end mills. The holders were then drilled and tapped for M3 and M4 grub screws to hold the cutters.

Uh oh! Run out!

Over to the KX1 for a concentricity check. A 3mm end mill was secured into a tool holder, then gripped in the 13mm collet and rotating it against a DTI showed a runout of just over 0.001". The 4mm diameter tool holder had a little less runout but the 6mm diameter holder had slightly more run out of about 0.002" – 0.003". A check of the end mill shank diameters showed them all to be slightly under the given diameter by one or two tenths of a thou. I also found I had slightly bigger reamed holes of a couple of tenths which would give the resulting run out, **photo 4**. Cumulative error!

I later made another couple of holders and carefully honed the bores to suit the milling cutters, this resulted in a much more accurate fit and minimal run out of a couple of tenths. A good test was removing the end mill with a sharp 'pop!'



Success! With the three tool test in laminate

A nest of little tool holders.

Checking for tool run out

Apologies for mixing units of measurement, I haven't got a metric dial gauge!

Test programs

Test one was: A 3mm end mill (T2) machining a 10mm diameter circular pocket; a 4mm end mill (T4) machining a 16mm square profile; and a 4mm spot drill (T3) to spot drill six holes at 36mm PCD. The program is saved as a 'Mach2/3 ATC Arcs(mm)(*txt)' file. This ATC program introduces an M06 tool change pause in the program whenever a tool change is needed. For example, T2M06 for the 3mm end mill etc. For this test I used a small offcut of white on black 1.6mm laminate, mainly because it shows up better on photos, the depth of cut is only 0.8mm deep.

Test two: A simple circular pocket to accept a 22mm diameter ball bearing. Both tests are produced with Vectric Vcarve.

Setting the tool offsets and pressing the 'go' button

The 3mm end mill and holder (T2) was secured in the 13mm collet, making sure the shoulder was pushed firmly up against the face of the collet. The 'Z' axis was lowered down towards the top of the job and touched off using a piece of paper. This is 'Z' zero' for tool T2. Repeat for tool T3 and T4 always making sure the shoulder of the tool holder was firmly up against the collet face (which is now our reference face) and tightened. Tool offsets and information is all done in a few minutes.

I have now completed my 'tool library'.

We are now ready to start machining.

T2 (which is the first tool to be used in this job) is put back into the collet 'Cycle start' is pressed and off we go! The small 10mm circular pocket is milled out and completed, and the machine has paused and stopped to do a tool change. With T4 secure I pressed 'cycle start' and off it went to cut the 16mm square profile. After the square profile is completed, there is another program pause for T3 the 4mm spot drill.

For all the tool changes a 'c' spanner and collet peg spanner are all that's needed to quickly undo the collet, dead easy, dead quick and dead civilised! No fiddling with the self-eject device or hammering at the spindle to get a 2MT holder out of the spindle.

Success!

It worked like a dream, the pocket, the profile and the six spot drills all machined as programmed, with a good surface finish. A quick check with a digital caliper showed that the 16mm square was 16.03mm, not too bad! And the 10mm diameter pocket was 10.07mm, a little larger than I hoped, but this could be due to the small depth of cut giving the calipers a false reading. I repeated the program again, resulting in only slight deviation in tool cut depth resulting in some removal of material, although this was no more than expected from doing a spring pass. Proving that the tool height had not changedsignificanty, **photo 5**.

Completed tool holders in wooden rack.

The second test was a lot better, using one tool to mill a 4mm deep pocket in aluminium, for a ball bearing of 22mm diameter, resulted in a 21.97mm pocket, a tight tap-in fit, which isn't too bad considering the tool is held in a home-made tool holder, which is held in a tool holder, which is held in the spindle. That'll do me!

It was quick and easy to change tools without having to individually re-set the tool height offsets. As long as the face of the tool holder is firmly pressed up against the collet, the tool Z height offsets will certainly be accurate to within 0.05mm (0.002") or better.

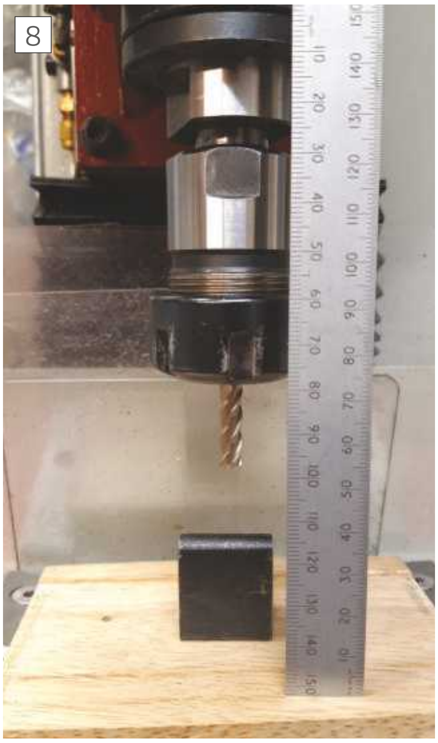
It actually works better than I thought it would. Once I got used to populating the tool table with the tool offsets, I found it so easy to machine with multiple tools, usually making a note on which tool holder has which tool. Indeed, the new tool holder system worked very well on a recent engraving job using four different tools.

In the end I made 18 little tool holders including ⅛", 3mm, 4mm, 5mm, 6mm diameter holders, a 10 mm holder for an edge finder, a fly cutter, a small Jacobs chuck, and spare blanks, all neatly held in a wooden tool holder. I thought I'd have a go at blacking them in engine oil, photo 6, they don't look too bad unless you get too close!

Problems and benefits?

The run out was slightly annoying but didn't seem to have too much of an

Tool height comparison. New holder.



Tool height comparison. ER25 collet.

Tool height comparison. 2MT end mill holder.

effect on accuracy, although rotating the holder and tool did make some improvement. The honed holders have better concentricity.

Tool stick out looks horrendous when comparing between a 2MT end mill holder, and the 2MT ER25 collet holder, it is about 35mm extra! The end mill holder looks as though its the most rigid with the least stick out, but so far it is not a problem. See **photos 7**, **8** and **9** for tool stick out comparison.

Wear and tear on the one collet could be an issue? Maybe after a few years of use.

The benefits far outweigh any problems. The tool holders are reasonably accurate and true to the spindle (better than I expected), I can now expect to cut and repeat to within 0.05mm or better. Making multiple parts with different tools is now amazingly simple, I can quickly change tools by using just the usual two ER collet spanners, confident they will be set to correct Z tool height offsets and repeat consistently. As I use them more, I will be able to compensate for any errors or runout. Eventually the most used tools will be permanently populated in the Mach3 tool table and the Vectric Vcarve software.

10

Machining mild steel ring with 3 flute 6mm end mill.

Overall verdict

Essentially, they work! After a few months of using the tool holders, apart from taking the photos for this article, I haven't once taken the 2MT ER25 collet holder out of the spindle. The KX1, with its new tool holders, has successfully machined plastic, aluminium, brass and mild steel, with a variety of cutting tools. Tool life is no worse or better than before, and repeatability is very good, **photo 10**.

Oh! The biggest bonus – see photo 2 again – I no longer have to extract the 2MT from the spindle for every tool change, or re-enter the Z offsets. Yay! ■

References

My bloggy website:
www.thesmallworkshop.co.uk

KX1 bought from:
www.arceurotrade.co.uk

CAD/CAM: **www.vectric.com**

CAD/CAM: **www.machsupport.com**

Cutting tools: **www.rennietool.co.uk**

Cutting tools:
www.jbcuttingtools.com

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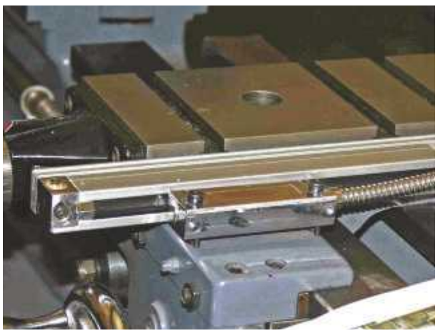
Content may be subject to change

Look out for MEW 305, your July issue, which brings you more great workshop builds and ideas:



Jacques van Damme fits a Bluetooth DRO to a Myford lathe.

Terry Gorin makes a vertical slide to suit a small lathe.

R. Finch adapts the Diamond Toolholder to take smaller bits.

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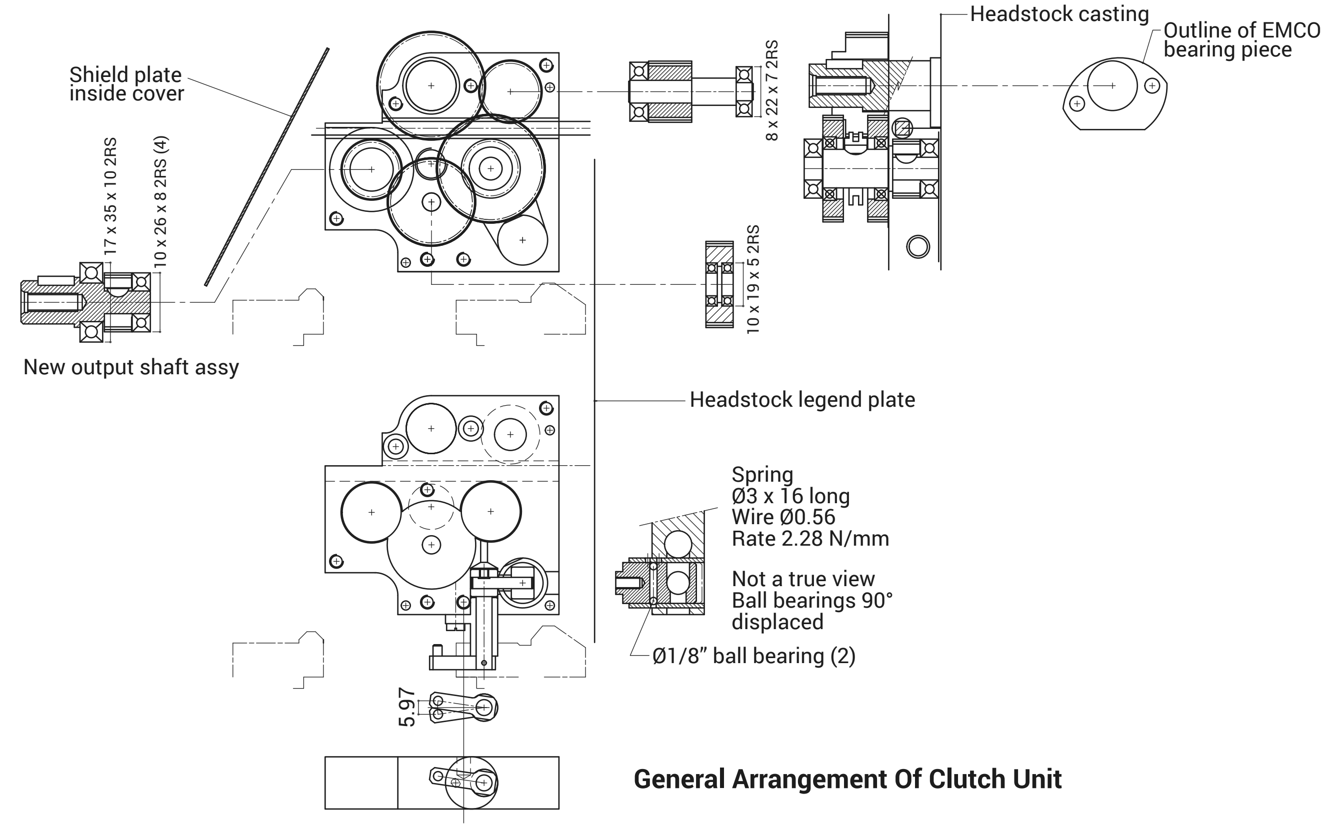
Fitting a Screwcutting Clutch to the Emco Maximat Super 11

Graham Meek describes an accessory thirty-three years in the making.

Fig.1

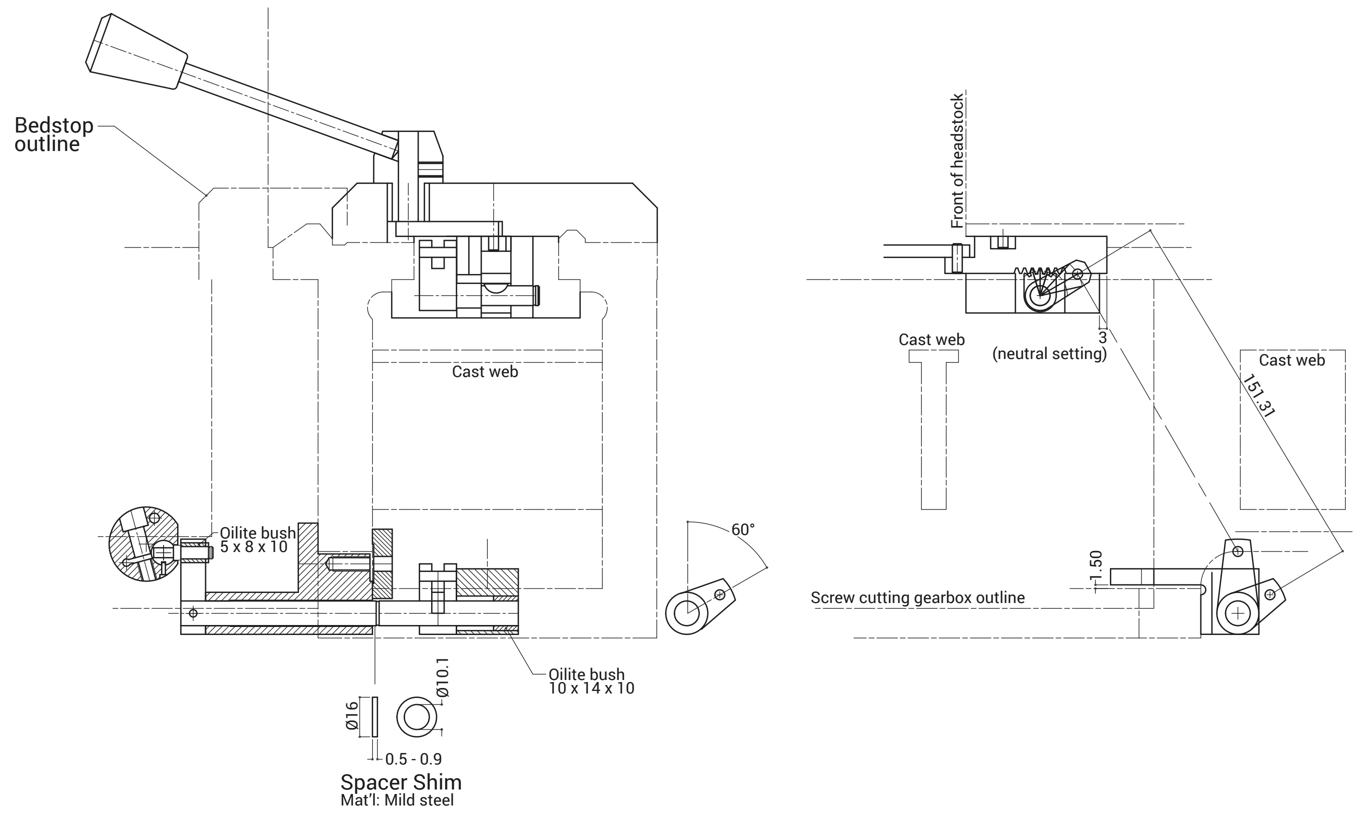


General Arrangement Of Clutch Unit

The initial design of a screwcutting clutch for the Emco originated as I was putting the finishing touches to the Myford Super 7 design in 1986. The fitting of the attachment to my Emco lathe has only just come to fruition 33 years later. The design presented here is not my initial design, as this was intended to be fitted within the headstock gearbox, utilising the gear positions of the standard Emco feed reversing mechanism.

The beauty of the first design is that it introduced only one more gear into the system. The big stumbling block with this approach was the need to strip the headstock down in order to fit the attachment. Emco UK had originally agreed to lend me a complete headstock unit, but all this fell through when Emco, Austria closed their UK base. They did however give me a full set of working drawings. With the lathe in daily use earning my daily bread for nearly 10 of those years the idea was put on the back burner. Health issues finally dealt the killer blow for the idea, as I did not want to strip the machine down and then be unable to reassemble for months due to my illness kicking in.

Early in 2018 a member on a US forum asked if I had ever succeeded in fitting the clutch. This prompted a review of the idea but with a view to fitting the clutch externally. Sadly after about five attempts this too came to a full stop due to fouling issues with the control rods and the changewheel quadrant banjo. I therefore had to declare it could not be done. Then towards the end of 2018 a further question was asked on the ME forum. However I did not pick up on this request until early in 2019. Initially I responded with my previous reasons and the failed attempt to fit the clutch



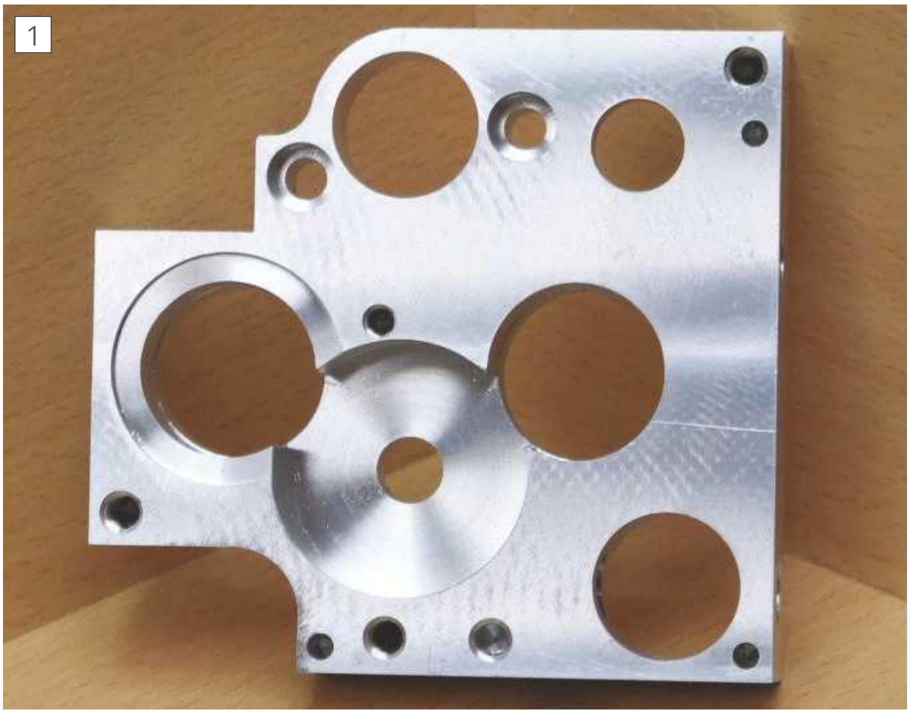
General Arrangement Of Control Unit

Fig.2

> Sadly after about five attempts this too came to a full stop due to fouling issues with the control rods and the changewheel quadrant banjo.

externally. However a few evenings later the penny dropped that up until now I had only tried fitting the clutch inboard of the change wheel banjo. What about fitting it external to the banjo?

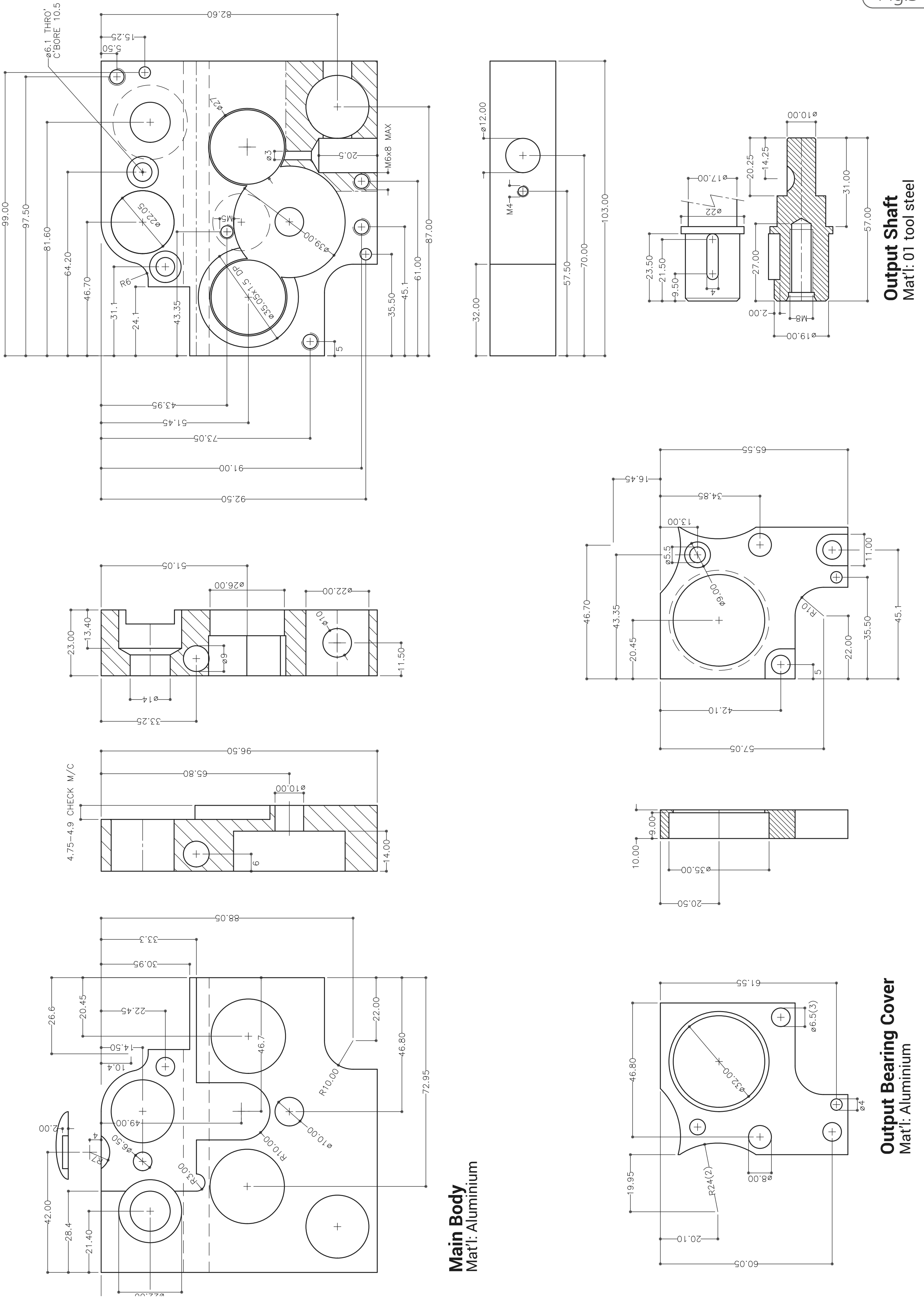
Thus began a few evenings at the drawing board and eventually a working schematic emerged, **figures 1**, **2** and **3**. This however was not the final design, the Mk2 eventually became the Mk3, and even this went through several revisions eventually finishing at "E". Most of those revisions were down to the Emco drawings being of later production machines than mine. Some were due to the expensive bearings chosen for the Mk2 design.



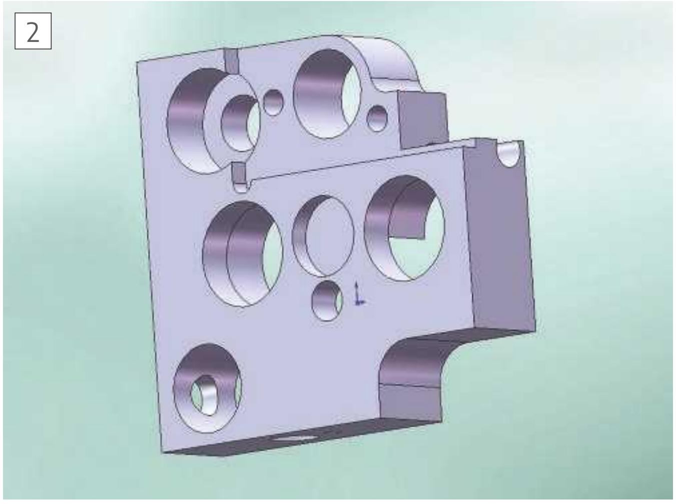
Main body-front view.

Work started on the main body, and that was nearly the end of the project. A few operations from the end I found a crack running through the thickness of the cast iron tooling plate. There was no alternative but to start again, but this time a piece of aluminium was used, **photos 1** and **2**. The 20mm flat bottom hole in the centre of the rear view, to clear the oil drain hole on the

Fig.3

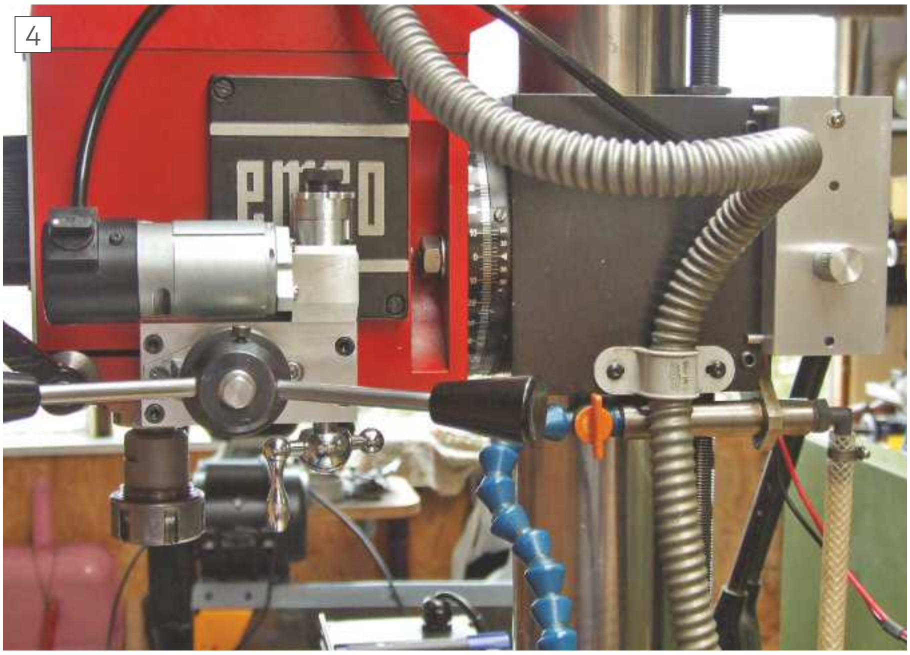


Main Body
Mat'l: Aluminium
Output Shaft
Mat'l: 01 tool steel
Output Bearing Cover
Mat'l: Aluminium
ø6.1 THRO' C'BORE 10.5 x 9
M6x8 MAX
4.75–4.9 CHECK M/C



Main body rear view.

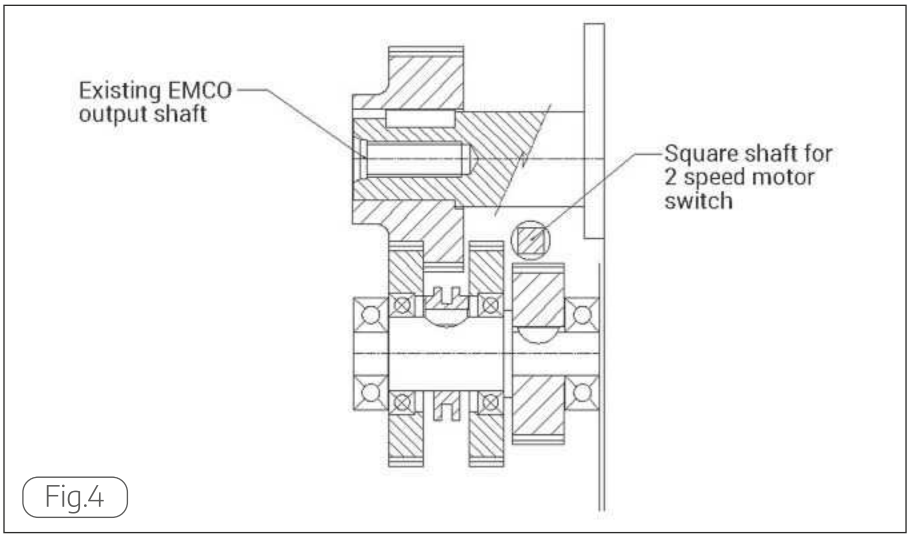
Boring & facing head with torque arm.



Emco FB2 quill feed finished.

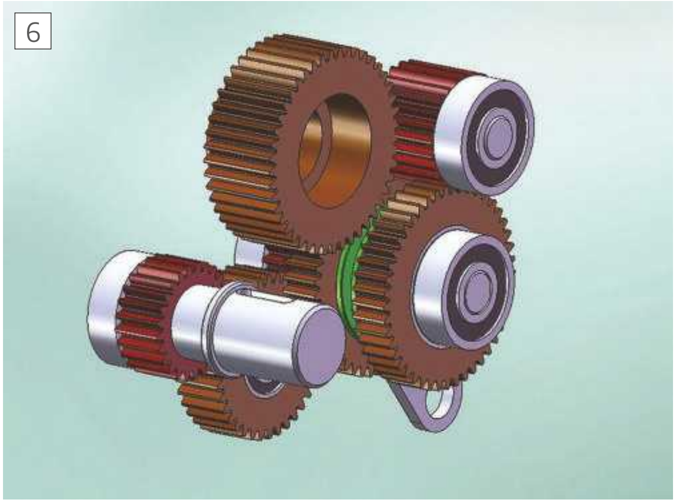
headstock, is now a 20mm wide slot. My drain hole sits higher on my machine than it is drawn on the Emco drawings. Luckily the making of the new main body and the covers was made a lot easier with my new Boring & Facing Head, combined with the power down feed I fitted to my FB 2 some years back, **photos 3** and **4**. The covers are located on dowels to maintain alignment of the various bearings. These covers need to be easy to remove but not that lose that the alignment is lost, **photo 5**.

There are seven new gears in this assembly, they are all 1 module as this is the same size as the changewheels, **photo 6**. In an effort to lessen the noise produced by the extra gears most of them are encased in the aluminium bodied unit. All the gears run on ball bearing races, the dog gears having a single bearing pressed in, **photo 7**. To ensure the gears do not come adrift the press fit needs to be precise, a bore in the dog gear which is 0.02mm down on the nominal diameter will be fine. Be sure to have an undercut in the corner to ensure the bearing sits squarely in the gear, not riding on a radius left by the boring tool. The dog clutch and the dog gears have the dogs milled integral, similar to the Hardinge HLV. An oil nipple in the end of the dog clutch shaft allows the clutch to be lubricated and a connecting hole in the dog clutch allows oil to lubricate the clutch fork. The length of the woodruff key needs to be shortened symmetrically about the key centre-line. If this is not done, then the two dog gears can contact this key and try to drive the shaft in two directions at once. The part that fails might be inside the headstock!



The selector mechanism is the proven Super 7 version, but with a twist. The ball bearing detents are inside the selector on this unit. With the selector bush having three holes to give the engaged and neutral positions. Inserting the balls, spring and the selector into the selector bush can be fun. To make things easier a tapered

Main body with clutch gearbox cover fitted.

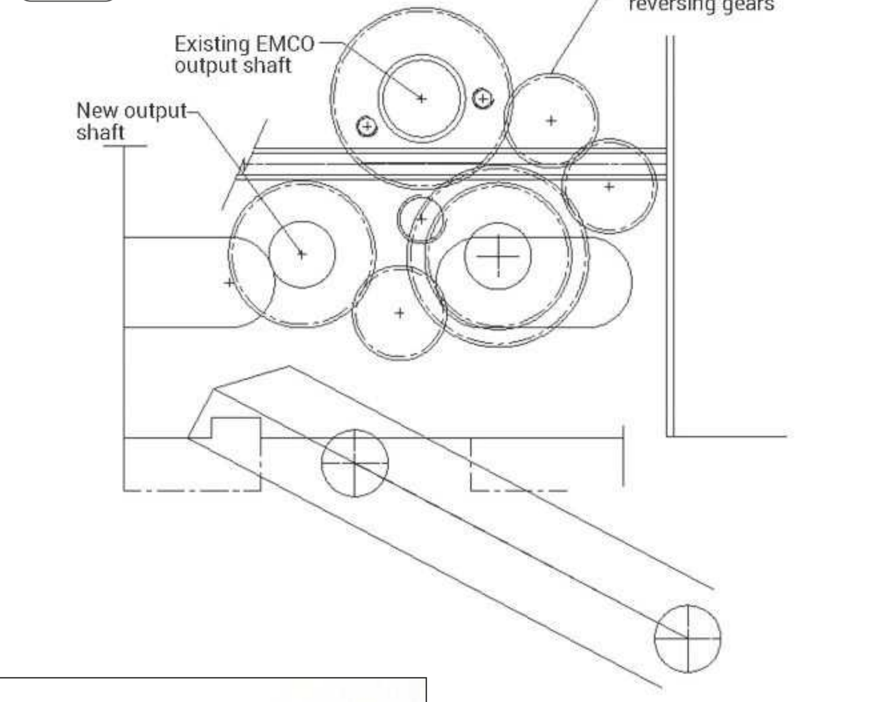


Gear assembly rendered in 3d by Jon Slater.

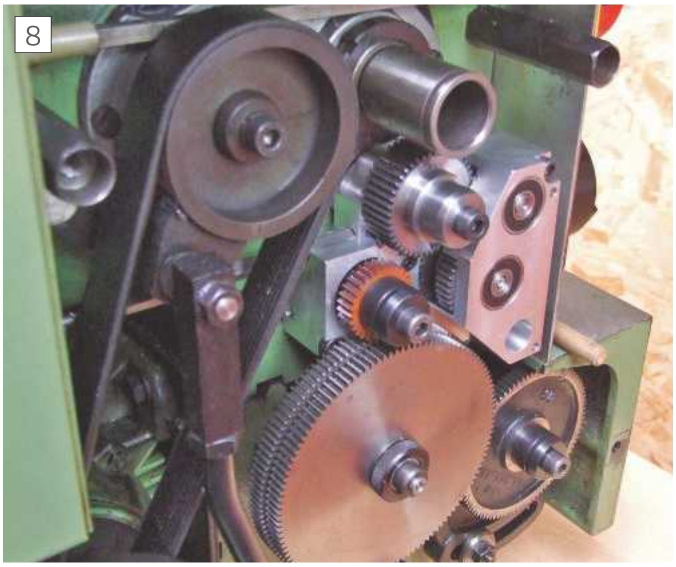
sleeve was used to first assemble the selector then the parts were smartly pushed from the taper to the selector bush. The orientation of the selector bush is important. A flat on the bush clears the dog gear teeth nearest the headstock. To align this correctly a small alignment pin is needed. This fits the 10mm hole in the main body and the 7mm hole in the bush. It is left in position until the Loctite is set on the selector bush, then removed. The bush and selector mechanism are the first items to be assembled into the main body. As access is needed to tighten the M4 grubscrew that locks the selector pushrod. This is through the 3mm hole in the dog clutch output gear cavity in the main body.

All shafts are press a fit in the bearings in the main body with the exception of the output shaft which needs to be a slide fit, but with no shake. This allows the output shaft and cover to be removed as a unit. The shaft that carries the dog clutch cluster and the input idler need to be the same slide fit in the dog clutch cover bearings, as this cover is assembled last when the main body is attached. The control rod for the two speed switch needs to be removed before any attempt to assemble the main body is made. Be sure to make note of the orientation of the chamfer at the operator end of the switch. Care also needs to be taken with the Emco output shaft once the retaining screws are removed. End pressure should always be applied to the end of the shaft. If this is inadvertently pulled out then it will mean a strip down of the headstock to replace the parts that have fallen off inside. The pocket in the

Fig.5



The dog clutch parts.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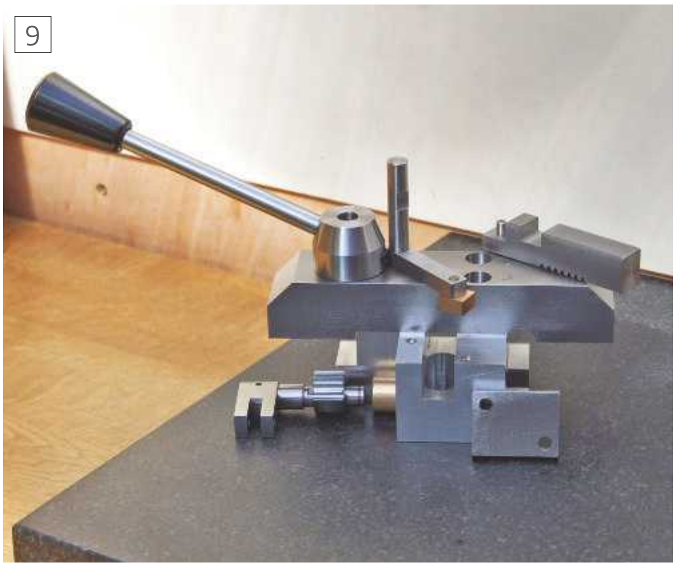
Clutch fitted.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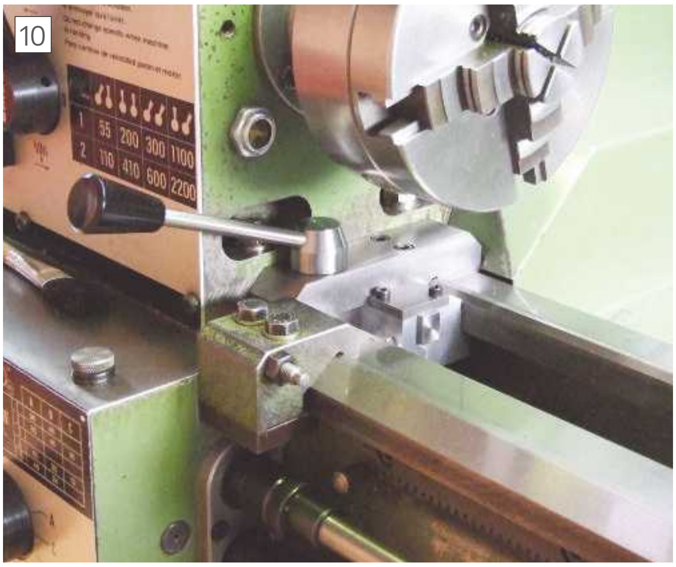
Clutch control lever and associated parts.



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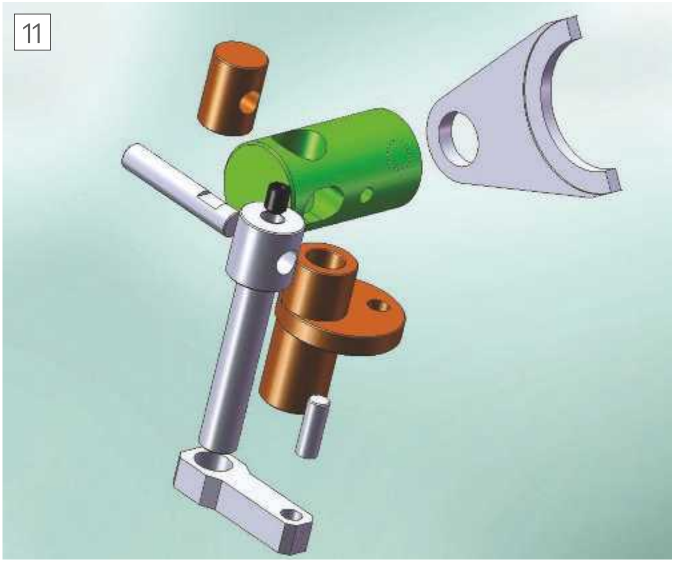
Clutch control lever.


11
Clutch lever exploded view.

rear of the main body needs to be the same dimension or less than the Emco bearing piece plus the gasket, 0.05mm less would be ideal. The manufacture of a simple gauge to test this dimension pays dividends. If the step is larger, then the original Emco bearing piece will not be secured and might leak oil. Further as the main body is not squarely and firmly located the unit could work loose in use. Be sure to pop the connector link onto the selector crank before inserting the main body. Once the main body is firmly attached the clutch cover can be assembled and attention can be switched to the control unit, **photo 8**.

The control unit in front of the headstock, **photos 9** and **10**, transmits motion to the selector by a rectangular connector rod, **photo 11**. The holes in this rod need to be slightly oversize on the dowels used in the selector lever and the control ram. A clearance of 0.05mm was what was used on the prototype, this is needed to aid assembly. Reamers are readily available for the 4mm size. This clearance does not affect the operation as there is some lost motion anyway, (see later).

> The control rod for the two speed switch needs to be removed before any attempt to assemble the main body is made.

Assembly of the control unit like the main body is in stages. The process will be found easier if a piece of BMS (bright mild steel) or aluminium 8 x 30 x 150mm is to hand. First thoroughly clean the underside face of the bedways where the unit sits. Then manipulate the partially assembled, body, ram, ram keep plate and the bell crank assembly between the bedways. Make sure the teeth on the ram mesh correctly with the segmented gear. Hold the assembly while sliding the rectangular bar beneath. The bar sits on the cast web tops and the control unit sits on this while the bed clamp piece is assembled, but minus all the levers. Urge the assembly up tight to the headstock.

●To be continued

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Bandsaw Blade Silver Soldering Station

Will Doggett describes a useful workshop tool for all bandsaw users

Finished soldering station

The concept

When I was using my bandsaw, the blade stopped unexpectedly – the machine was still running but not the blade. At first I thought the blade had come off the drive wheel but on investigation the blade had broken. I had no idea why the blade had broken, the material I was cutting was not difficult to cut and the blade was in good condition.

As the blade was in good condition and sharp I decided to repair it.

The scarfs were linished with a power file and held on a piece of angle for support. That was ok, the process got

Before derusting

After the acid bath

Blade slot

Heating position

Clamps & screws

Lug sweater carbons

difficult when holding the two parts of the blade together for silver soldering.

This was cobbled together with a piece of angle as the base and some mole grips to clamp the blades and a rule to line the blade ends up. The scarf's were coated with flux and a small piece of silver solder placed in the joint .

Then using a small heating torch I melted the silver solder. The whole thing was a lashup, but it did the job at the time and was a success as the blade is working again.

The lash up got me thinking there must be a better way of doing it when silver soldering the two ends back together after a breakage. This was my reason for making a tool to support the blade square, and more importantly, in line with proper clamps to hold the two parts, as well as being able to heat the blade from below as well as from the top.

Construction

To make the tool, **photo 1**, I cut a piece of 50 x 50mm angle 170mm long. I then put it in a citric acid bath for two days to remove the rust on it.

Having soaked it I removed it from the bath and then washed it in water to remove the acid and the rust. To stop more rust forming I dried the angle and then sprayed it with a water repellent that has PTFE in it, **photos 2** and **3** show before and after the acid treatment.

To hold the blade in line I machined a slot in the top face of the angle 5mm in from the front edge of the angle this was 14mm wide and 3mm deep to fit the blade from the bandsaw, **photo 4**.

The two parts of the blade are held in line by the edge of the slot on the back edge of the blade.

To heat the blade from the bottom as well as from the top, I machined a slot through the angle on the centre line of the angle and at right angle to the first slot, **photo 5**, this slot was also 14mm wide.

To hold the blade in position for silver soldering I made two small clamps these were made from 3mm thick steel 15mm wide and 40mm long. They have a small bend on the end so that they clamp the blade, also 3.5mm holes for the fixing screws.

To hold the clamps I used two M3 x 20mm hexagon head screws with a 12mm diameter knurled top that I turned in the lathe. These were counter bored for the head of the screws, they were then drilled and tapped M3. The counter bore was to allow the head to be screwed in to the top and be flush. **Photograph 6** shows the parts assembled but before finishing, the reason for using long screws was so the clamps and screws can stay in position when fitting the blades under the clamps.

Testing the soldering station

To test the tool I used a piece of steel belt strapping this was a bit thinner than the saw blade but would do for testing, using a power file to form a scarf on two ends of the strapping. I then put some silver solder flux on the two scarf faces, these were then held against the edge of the slot to line them up then they were then held in position with the clamps. A small piece of sliver solder was put in the gap between the scarf faces.

To heat the joint is where I deviate from the normal. I did not use a gas torch this time but used a lug sweater – this was an experiment to see if it would be hot enough to melt silver solder. The carbon pads are shown in **photo 7**, as you can see the carbons are new – I had to change them as the other ones were worn down and didn't close properly. I normally use it for sweating copper pipe joints which are in tight places when doing plumbing jobs. The sweated joint is shown in **photo 8**, before cleaning it up.

Note The idea to use the lug sweater was that I had in the past used a bandsaw with a repair station on the side of it. This used an induction heater to melt the silver solder, so this was the thinking behind the use of the lug sweater.

The lug sweater that I have is one of the heavy industrial ones, I do not know if the lighter pipe sweaters from the DIY shops will have enough power to do this but it's worth a try if you have one. If not, it can be done with a small gas torch (I've found a 'cook's blowtorch' is strong enough to silver solder bandsaw blades – Ed.)

Blade scarf holder

After making the clamping tool to hold the blade when silver soldering, I thought that it was not a good idea to do blade scarfs or linishing on it. I made a blade holder for the purpose, from 50 x 50mm angle cut 120mm long.

To clean the angle I used the same process on this angle as I did with the first one i.e. a soak in citric acid. After cleaning with the acid the part was washed in water and sprayed as before.

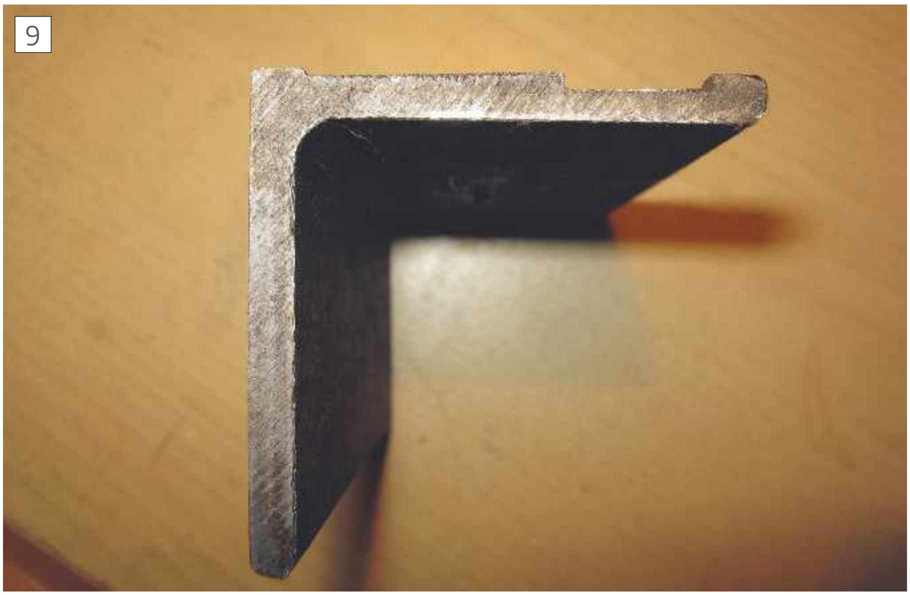
The next step was to mount the angle in the milling machine vice and machine a slot with a 5mm lip on the front edge and 2mm deep by 14mm wide. The rest of the top was milled 1mm deep across to another 5mm lip. **Photograph 9** shows the machining of the base from the end.

To hold the blade in position a small clamp was made to fit the machined top 40mm long, 22mm wide and 5mm thick. The back part was reduced to 3mm leaving a 12mm section at 5mm. It was then drilled M3 clearance 20mm from the front edge, **photo 10** shows the clamp.

The holding down hole was then transferred to the main body and this

8

The silver soldered joint



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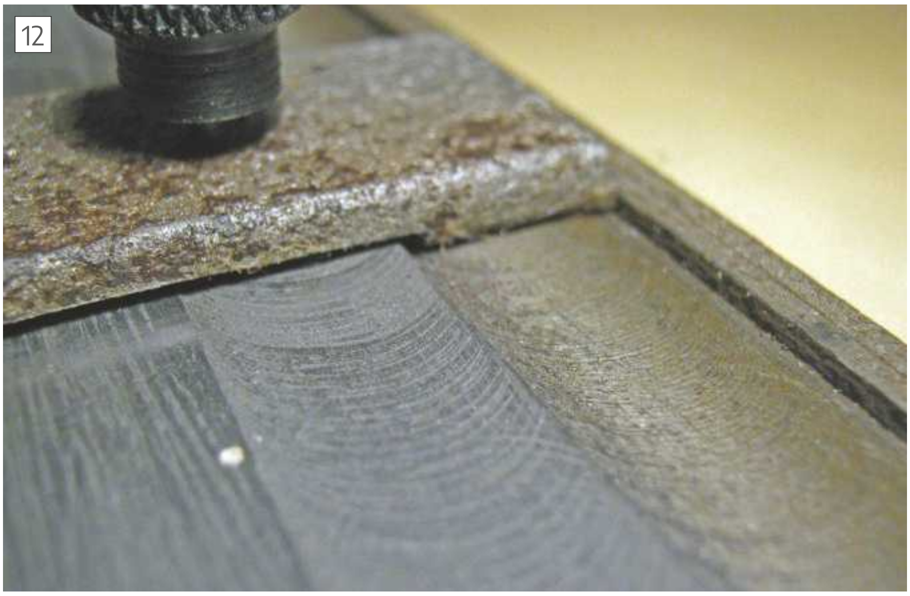
Blade linishing slot

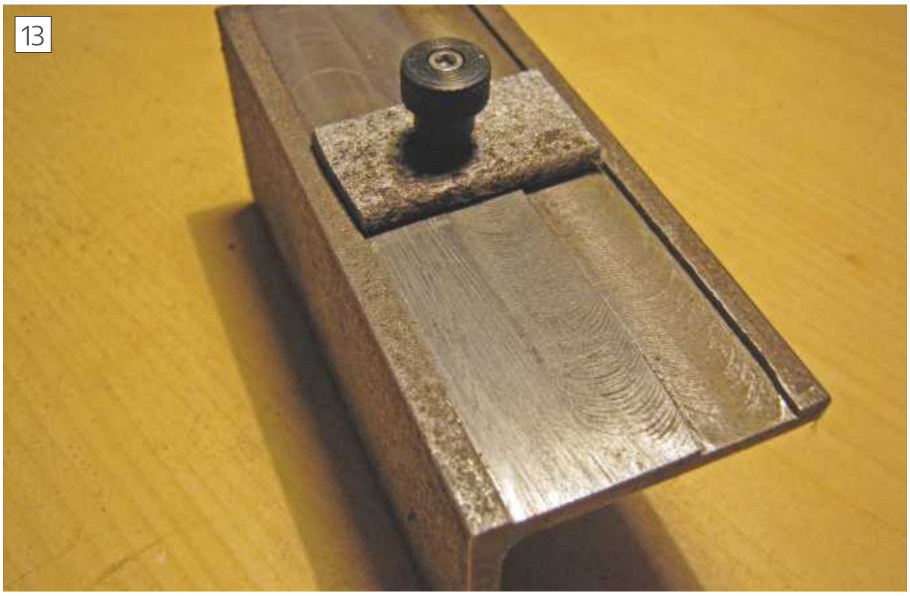
10

Linishing clamp

Linishing clamp fixing screw



Clamp & slot



The finished linishing tool

was drilled and tapped M3 for the screw that will hold the clamp and blade in position.

To hold the clamp I used the same method as before to make the holding down screw this is a 3mm x 20mm hexagon head screw with 12mm knurled top. The finished screw is shown in **photo 11**.

The clamp and the holding down screw are shown in position in the slot ready for the blade to be put in for finishing with a scarf, **photo 12**.

The finished blade thinning/linishing tool is shown in **photo 13** without a blade fitted.

Both parts were left as they are the only finish is a coat of spray grease to stop them rusting again, as I thought that if I painted them the paint would burn off if was to use a gas torch. Grease can be removed to use the tool with a gas torch and then re-applied after it has been used.

Conclusion

In the last seven years that I have had this bandsaw I have only had one other blade break, and this was fairly worn and not worth repairing so a repair station has not be required until now.

It is not until you have to repair a broken blade that you realize the usefulness of this tool as I said at the beginning lining up and clamping a bandsaw blade without a proper jig is to say the least very frustrating. So with this in mind I think it was worth making it as it doesn't take long to make (after cleaning) and when I require to repair a blade in the future it will be so much easer. The only downside is that you do require a milling machine of some sort or a shaper to make this tool in the way I have made it.

The milling can also be done in the lathe if no other form of machine is available. The other option is to fabricate it with strips of steel to form the blade slot screwed or silver soldered together.

The main point is that you require something to line-up the back plain part of the two blades as this is the part of the blades that runs under the bearing the above the blade. This transfers the pressure of the bandsaw frame onto the job. If this line is not straight, the blade will jump on the support bearings causing the blade to break again. ■

Scribe a line

YOUR CHANCE TO TALK TO US!

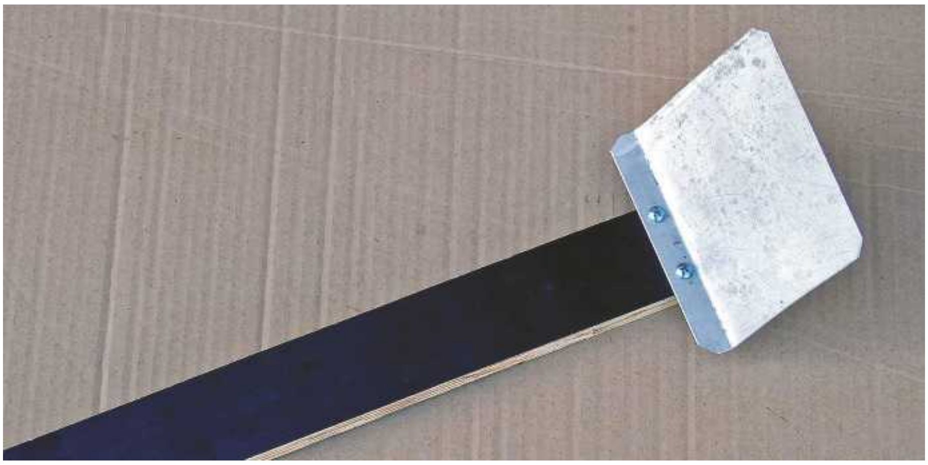
Drop us a line and share your advice, questions and opinions with other readers.

Mystery Tool Quiz

Dear Neil, a test for readers! What is the use of this mystery tool made with a 100mm wide 1mm aluminium plate set at an angle on a wood handle ?

Jacques Maurel

The answer is on the last page of Scribe a Line



Angle Grinder Nuts

Dear Neil, I was interested in reading the article in the May edition of Model Engineers' Workshop about angle grinders. I have also in the past struggled to unscrew the disk nut especially if the press button lock would not hold.

Please see my modification. I put flats on the nut.

This permits it to be gripped in a vice or with a spanner. I have found the supplied 'C' spanners unsatisfactory as they have a tendency to bend.

I can recommend Machine Mart's adjustable 'C' spanner part number 060529901 as much more robust.

William Waddilove, by email

A 'Cribbed' Tip

Dear Neil, I bought a bandsaw from Lidl at a reduced price and was initially disappointed with the vice, a tack-welded folded sheet steel box, even the jaws are 12g sheet. However, on trying it out it held round section metal quite firmly. Why? The moving jaw is tilted forward about five degrees. Simple, but it works – surely the essence of good engineering! Milling or filing the jaw of a cheap cast-iron vice will be as effective (and won't eventually bend).

Now a query – I like Alan Donavan's brazing hearth, but wonder how the heat-reflecting capacity of his lightweight wall blocks compares with that of Fosacil or Folsain as recommended by Tubal Cain? My local builders' merchant claims not to have heard of either, nor of the vermiculite block or sheet recommended by Keith Hale.

Can readers assist?

Johns Smith, Shipston-on-Stour

Hello John. My worry is how will the vice cope with flat objects – will they tip? I can't answer your question, aside from mentioning that I obtained vermiculite blocks for my hearth from Chronos, one of the specialist hobby suppliers, some years ago - Neil.

Workshop Walls

Dear Neil, Glad your house move has gone OK. For your new workshop can I suggest that before you cover the walls with shelves, etc, that you paint them white, It makes a big difference to the lighting. I expect it is full of boxes though at the moment.

Keith Beaumont, by email.

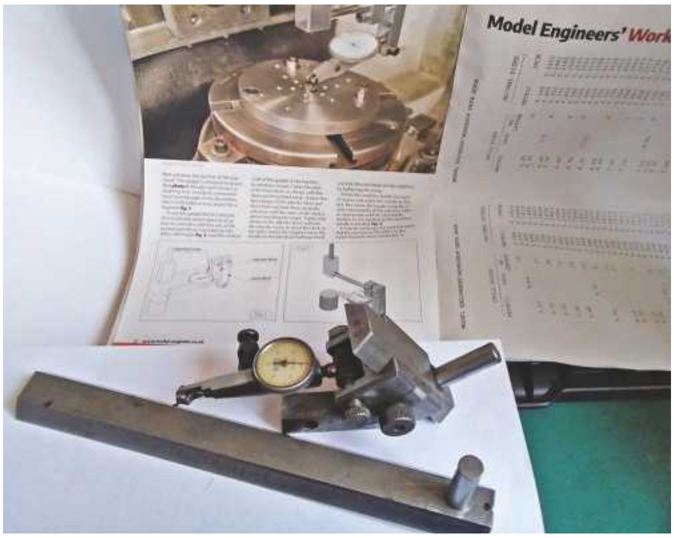
Continued on page 56

Concentrica

Hi Neil, thanks for a very good hobby magazine MEW! I had to smile when I saw the concentrica article by Pete Worden. I made a similar device in the '60s, I enclose a photo for comparison.

I think it will be difficult to adjust Pete's version with the adjusting screw that way round, it would be best on the outside don't you think?

Jim Simpson, by email



Workshop Floors

Hi Neil,
In my 6mx6m garage/workshop, I first had the concrete 'self-levelled ', then laid 18mm waterproof t&g chipboard (green stuff). Before laying it, I glued on thin foam wall insulation, which was the exact width needed. This provides just a little cushioning to take out small variances in the surface and remove 'crunch noises.

It stays strong and for twelve years parked my Mk1 Golf cabriolet on it, without detriment. A Warco GH1236 and large Flott pillar drill now occupy the space.

As well as adding considerably to the warmth factor, it is also easy to paint and rolling stuff around on castors is quiet and easy!

Best of luck with your fitting out and many thanks for the consistently excellent and enjoyable magazine content!

Don Boddy, by email

Flexible Swarf Screen, MEW 303 Tips

What a brilliant idea. Many thanks Rob [Edwards] - I immediately went into my workshop and used a redundant CD holder to make two of them. I haven't yet tried them out in anger, but one thought that I have had is just how much swarf will be attracted to the magnets. It seems to me that perhaps a piece of thin flexibly plastic might be of use to enable easy removal of any swarf on the magnets. Possibly fastened using the same fixing screws and perhaps bent under the magnets. Ok this will cause a reduction in magnetic strength, but I offer it as an idea - I've yet to try it myself.

Peter G. Shaw, by email

Mystery Casting 1

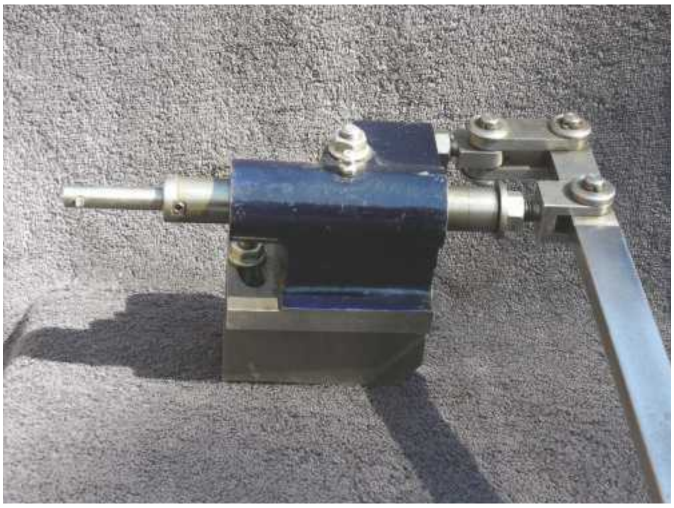
Dear Neil,
Regarding the casting shown in Scribe a Line MEW Issue 303, I am sure that this is a keyway cutter casting.

I bought, what seems to be an identical casting from College Engineering Services many moons ago (2003). I believe that the original design was by Stan Bray and the accompanying article was published in either a very early issue of MEW or in ME. I bought the casting at the Harrogate show and College Engineering gave me a photocopy of the plan and construction details. I have spent half a day looking for the plan details which I would not have thrown away but have failed to locate it. I have also searched MEW (I have every issue) without success.

The finished keyway cutter – or slotting tool, works well and I used the tool for cutting a keyway in my beam engine flywheel.

I would suggest contacting College Engineering to see if they still have drawings.

David Haythornthwaite, by Email



Mystery Casting 2

Dear Neil, regarding the correspondence about the Slotting Tool. It was designed for the Myford 7 Series lathe, by a member of the Peterborough Society of Model Engineers, the late Peter Robinson.

The casting was obtained from College Engineering when the Company was under the original ownership. There was no mention of the casting in the May 2016 catalogue, so it may no longer be available. There is no reason why one could not be carved out of a lump of cast iron, or even fabricated.

Attached is a picture of mine. Having disposed of my ML7, it now sits on a raising block to suit a larger lathe.

Additionally, the device can be swivelled on the raising block, should a need ever arise to cut a keyway or a slot on a taper.

The cutting tool is held in an arbor clamped into the main ram, so that other tool carriers can be used to carry different sized toolbits.

The grease nipple is there to ensure lubrication, and actually seems to tighten the fit of the ram in the casting!

It may not be as cosmetically pleasing as many examples of this tool that have been made, but it does what is required.

Howard Lewis, Peterborough

Angle Grinder Accessories

Hi Neil, I just read the article about improvements for the angle grinder. You can buy a new chuck with key and sds adapter from 'toolstation', this chuck is threaded 1/2" x 20 unf, with a capacity of 13mm.

My plan is to cut the sds adapter down and weld or braze it into the new made adapter, this does away with cutting the thread for the chuck.

Hope this is helpful for those who are going to make the adapter I'm making, Going to make one for my brother as well.

Tony, by text

Araldite in the Edge Finder Series

Dear Neil, may I correct a point - Araldite is a thermosetting plastic. It sets faster, and harder, with increased heating. Once set, it does NOT and cannot "melt"! In fact, eventually it will "char". The only limit to increasing strength with use of higher setting temperatures is that it will start progressively to darken!

For those unaware of its properties, the makers CIBA used to have an advert with a photograph showing a 15 ton road tanker full of the stuff, suspended from a crane by a 1" square lap joint in a steel strip!

That is 15tons per square inch lap in sheer!

I used to rebuild broken laminated wooden squash racquets using 1mm birch 3-ply, from the "Bristol" model shop, laminating the 3-ply with Araldite, bound tightly with easily removable copper wire, and gently cooking the racket for several minutes at a fairly high temperature. The resulting "Dunlop Maxply International" racquets went on to have long and successful lives in the hands of their grateful owners! The sports shop in the country club initially tested the repairs by trying to break them by leaning a full body weight on them against a wall! If the repair wouldn't fail, they would restring the racket.

A glass or other ceramic repaired with Araldite will never break at the repair - always at some other point!

I made the mistake of mending one racquet that had a broken METAL shaft - my repaired metal shaft itself bent, so I cut it off, and used the head as a table tennis bat!

Davina Hockin, Portishead.

Making Screws

Dear Neil, I have been a reader of the M E workshop since it was first launched.

I have looked out for how to make the humble wood screw .now various companies have taken over with their horrible screws. They don't look right in an antique bit of furniture (Chippindale chairs etc.)

I know you can shop around and may find the one you want if your lucky. Then you may have to buy 25, 50 or more when you only need two or three in steel or brass.

I cannot get my head around how to make them on the lathe. I know there must be more clever engineers than myself. Would you be kind enough to run an article in our magazine?

Sid Rawlings, by email.

Can any readers help with some notes on making wood screws? – Neil.

Lantern Chuck - 1

Dear Neil, Sorry but the gremlins have got to the dimensions in the drawing, the dim for the lantern screw is not 0.750 but 0.710 to allow for 0.020 depth threads. It is an important dim because if the maker bored this to 0.750 the part would be scrap and a disappointment depending on how much work on the part had already been done. Have put it on the forum under lantern chuck but that only reaches some of the readers.

Bernard Towers, by email

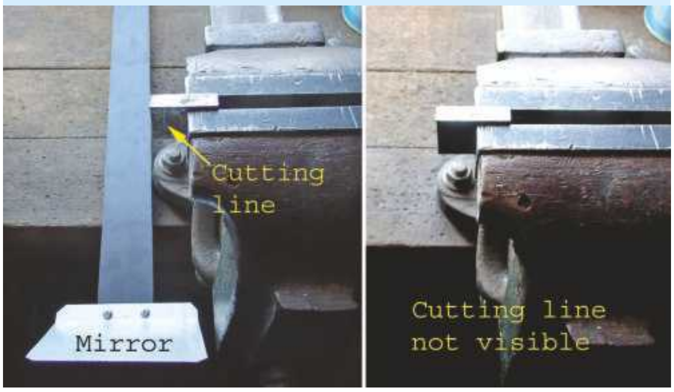
Hello Bernard, when checking the drawing we interpreted it as meaning a 0.750" thread (which would be correct), rather than boring 0.710" and then screwcutting. Hopefully readers will realise the threads in body and cap have to match – Neil

Lantern Chuck - 2

Al Hanson, from Illinois sent these photos of some beautiful oil-blacked lantern chucks made to Bernard's design.

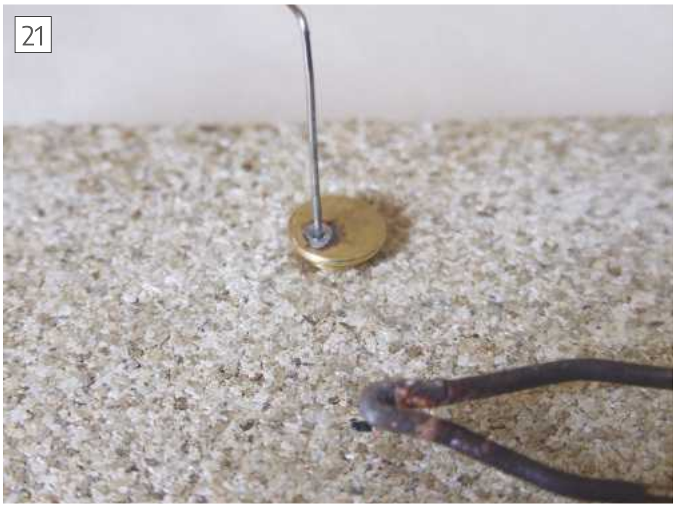
Mystery Tool Answer

It's a "lightening tool" for the bench vice to show clearly the cutting line as the light is usually coming from in front and so the line is not visible in the shadow as can be seen on the photo. Nevertheless this is also a very efficient tool for back scratching! – Jacques Maurel.

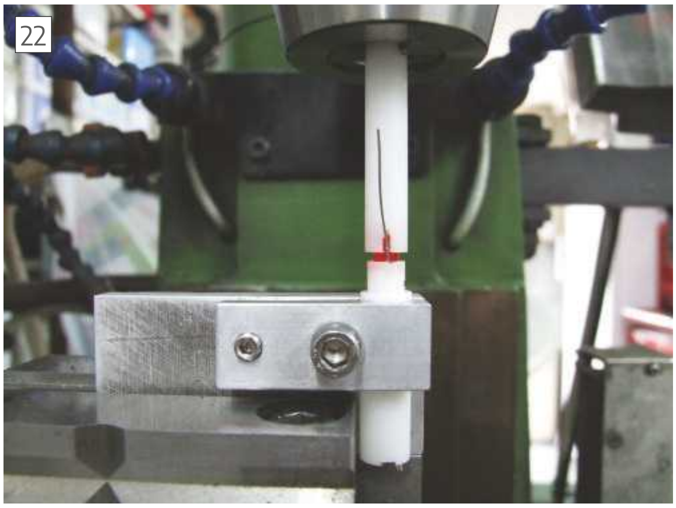


Developing an Edge Finder

Roger Vane describes how he designed and developed an electronic edge finder, together with detailed drawings so that you can make your own - Part 3



Pre-tinning the brass end cap.



Fitting the LED into the cartridge body - note the cathode wire alongside LED lens.

A small hole was drilled into a piece of vermiculite sheet in order to position the end cap, which I then 'pegged' in position with a short length of 0.8mm stainless steel wire, **photo 21**. Once in position all I had to do was apply heat using the solder gun and apply the flux-cored soft solder to coat the inside of the hole and the recess.

As the solder would stick to the wire, I had to remove it before the solder had completely solidified. Allow to cool and then clean up, neutralising any residue as appropriate to avoid future corrosion. Any excess solder in the countersink can easily be removed using the $\frac{1}{8}$" drill rotated by hand in a pin chuck - the idea here is to allow sufficient volume for the white metal solder whilst retaining the tinned surface.

4.4 Fit the LED into the cartridge body

The first real assembly task is to glue the LED into the cartridge body. The resistor wire will be passed through the central holes and into the battery area, and the cathode wire bent to fit into the groove in the base of the LED, again using the flat blade of a screwdriver to assist. The anode (resistor) wire will also need to be

The brass end cap is located in it's holder prior to applying the JB Weld epoxy adhesive.

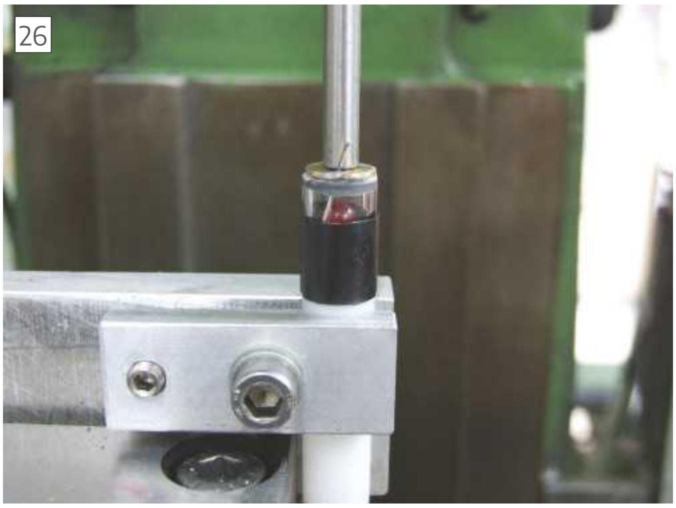
The acrylic tube has now been fitted onto the brass end cap.

bent slightly to fit through the 1⁄16” hole in the cartridge body. Try a ‘dry run’ to see how the wire from the LED slots into the bottom of it’s housing in the cartridge body - you should be able to feel it ‘seat’ (and putting a small alignment mark on the cartridge body also helps).

During the assembly process it advisable to use some form of alignment device. Initially I planned to use the lathe, with the cartridge body held in a collet and the LED supported using an assembly guide such as that shown in fig. 2.5 held in the tailstock chuck. This

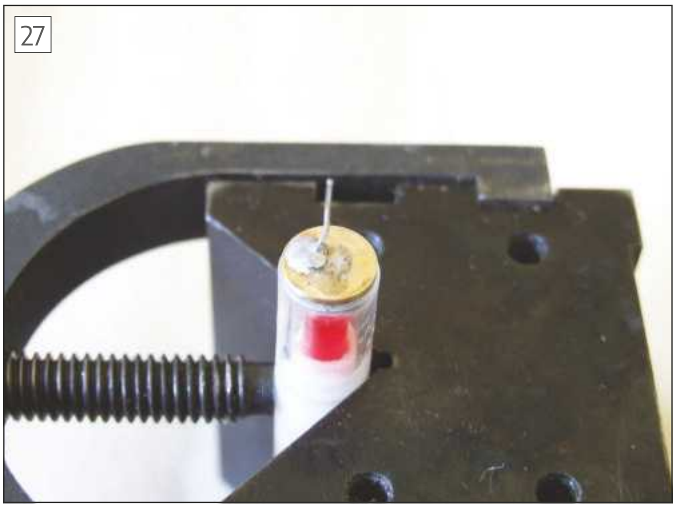
25

Adding the acrylic tube to the assembly - the wire has been guided through the pre-tinned hole before applying the adhesive to the spigot on the cartridge body.



26

Ensuring that the acrylic tube is correctly bedded down onto the cartridge body.



27

The cathode wire has now been soldered into the end cap using the low melting point solder.

would leave any surplus adhesive liable to drip due to the effects of gravity. I decided that it would be safer to use the milling machine to align the parts, with the tube vice holding the cartridge body and the assembly guide held in a drill chuck, **photo 22**. The tube vice was centred under the milling machine spindle in the same way as shown previously, in photo 12. Any surplus adhesive should flow into the 5⁄32” diameter hole out of harms way.

Once happy, it’s time to apply the adhesive. Adhesive ‘placement’ is important as the adhesive needs to be contained and kept away from the LED lens, but using sufficient for a strong joint (the contact area is fairly small). I found that the best method was to apply the adhesive into the seat and then fit the LED. If applied to the LED itself there is always the risk that the adhesive will be pushed outwards as the LED is seated into the recess.

4.5 Fit the end cap into the acrylic tube

As mentioned above, I used a high temperature epoxy adhesive (JB Weld) to make this joint. This brass end cap will become the end face of the cartridge and will be carefully machined to clean-up after assembly has been completed.

Before the adhesive is applied, I found it worthwhile to place ‘masking’ tape over the tube to avoid adhesive straying onto the outer surface. Initially I used traditional masking tape but found that insulation tape was easier to remove (and so it was). Just roll the tape around the acrylic tube, leaving an overlap which can then be trimmed with a scalpel - much easier and quicker than trying to correctly align the edge of the tape with the end of the tube. Fitting the end cap was straightforward - I placed the end cap in the holder, **photo 23**, and applied the adhesive into the recess and on the inner face of the flange. The acrylic tube was then placed over the flange and seated on to it **photo 24**.

Once the adhesive has fully cured (around 24 hours) the joint can be cleaned up and the tape removed.

4.6 Fit the acrylic tube onto the cartridge body

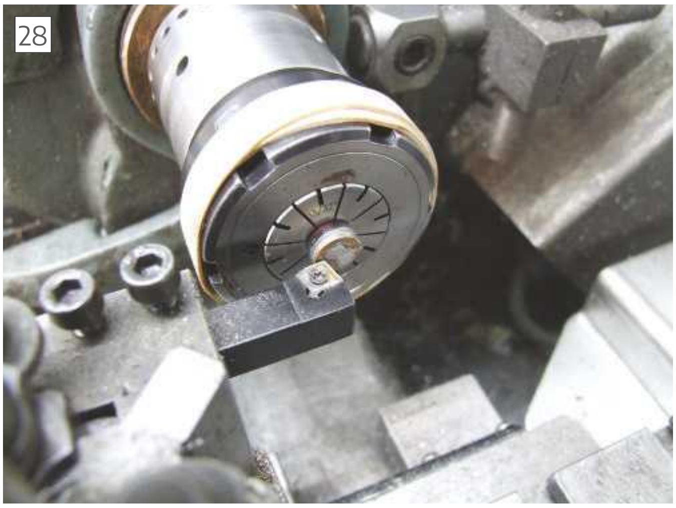
Next, the acrylic tube must be glued onto the cartridge body, which involves threading the cathode wire though the hole in the end cap - a little bit like threading a needle, but at least the thread is rigid in our case. Before fitting though, it is worth placing a band of tape at the open end of the tube to keep adhesive off the outer surface - again I used insulation tape for this. Once the wire had been threaded though the hole, I bent to retain the tube in position, **photo 25**. The adhesive was then applied.

The tube vice in the milling machine was used (with a rod held in the drill chuck) to apply a very light pressure to maintain accurate location, with the spindle having been centralised as described above. This operation is shown in **photo 26**. Once the adhesive has dried the insulation tape can be removed and the joint cleaned up.

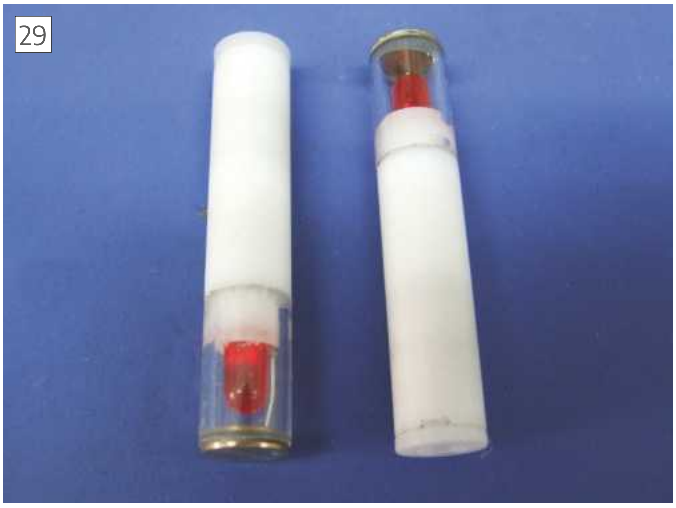
4.7 Soldering the cathode wire into the brass end cap

Warning: too much heat could cause the acrylic tube to distort or even melt. This may inadvertently be caused by using a solder with too high a melting point.

As mentioned above, it is advisable to pre-tin the brass end cap before joining



Skimming the face of the end cap to clean up.



Two completed cartridges.

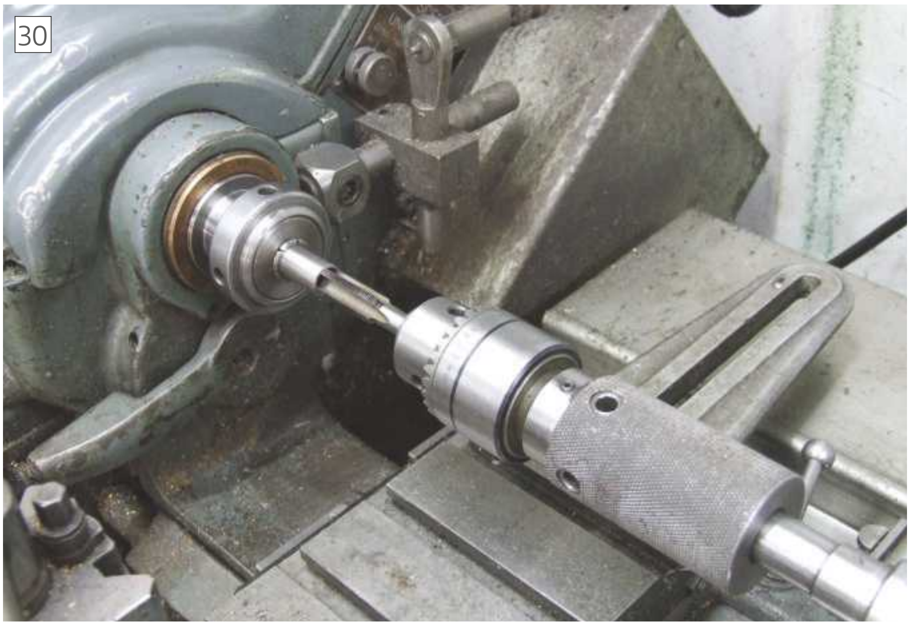
the cathode wire from the LED using white metal solder. For the soldering itself I used the 60W soldering iron, being rather wary of overheating the adhesive joint with the solder gun. With the tip of the soldering iron placed in the centre of the end cap I let the heat 'run' towards the wire. As soon as the white metal melted and ran into the hole, I removed the soldering iron to avoid overheating the adhesive bond and the acrylic tube. All that is now required is to trim the wire, **photo 27** shows the finished joint. By the way, should this happen simply turn the cartridge upside-down and apply heat to the end cap - the solder will flow back into the hole again. Don't ask!

4.8 Finishing the cartridge

Finally, the end cap can be carefully skimmed over to make sure that it is square to the cartridge body and therefore providing the best electrical contact to the probe. It is preferable to hold the tube in a collet, **photo 28**. Light cuts are best here to minimise any stress on the glued joint. It is important that the brass end cap protrudes slightly from the acrylic tube so that good electrical contact can be guaranteed.

The cartridge is now almost complete. We can now bend the wire into the battery case to act as a contact for the batteries. I found the wire easy to bend and manipulate into it's position at the closed end of the battery case. Use a small flat-bladed screwdriver and place the wire evenly across the surface without any overlaps.

Although the process sounds simple, I found that the cartridge would not light up when tested with 'on-board' batteries - the cause was found to be a blob of hardened Araldite on the wire. Once this was removed everything



Using a plug tap to finish the 7/16" x 32 thread.

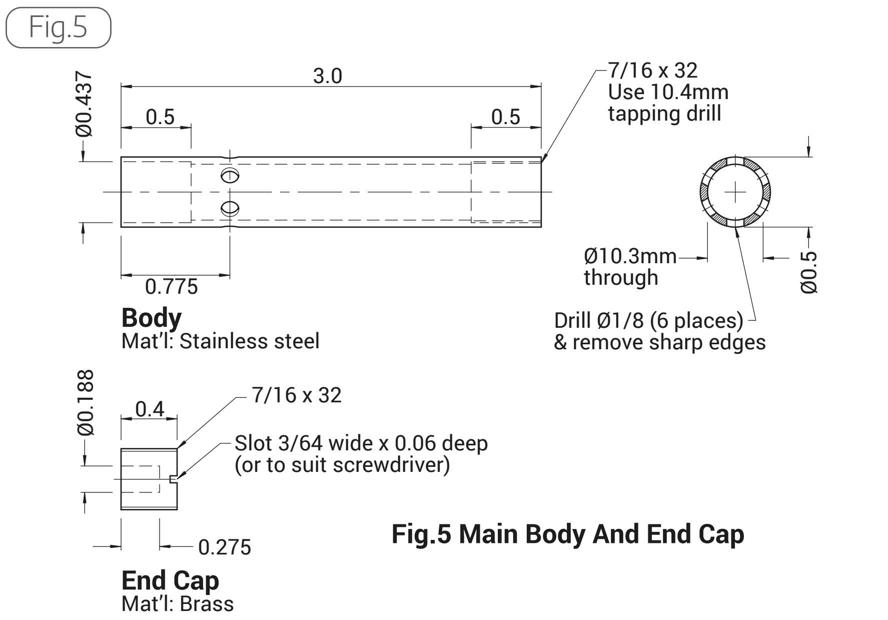


Fig.5 Main Body And End Cap

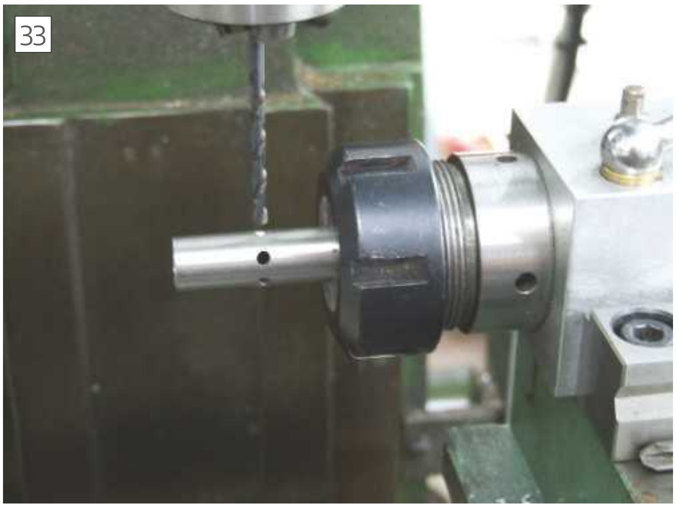
31

Setting the reamer to achieve 0.50" depth for the probe insulation sleeve.

32

Reaming the 7/16" diameter bore with a machine reamer.

33



Drilling the last of six light apertures in the body.

34

Countersinking the light apertures.

worked fine. I also found it beneficial to use an 8mm machine reamer by hand to gently remove a small amount of adhesive that was deposited on the inner wall of the battery compartment. Two completed cartridges are shown in **photo 29**.

Making the bodies

For those readers who are new to this wonderful hobby of ours, I feel that should mention that the photos which show drilling and tapping of large holes are posed. In practice a cutting compound should be used when cutting the steel parts, to both preserve the tools and make the operation easier and to the quality required.

I made the body itself made from ground stainless steel rod, simply because I had a good supply available at the time, but it could just as easily be made from standard rod or even thick walled tubing - preferably stainless. The exact diameter is unimportant here - what is required is a blank that is truly round, particularly if the edge finder is to be held in the drill chuck, the jaws of which only touch the edge finder body in three places. I believe that it is best to avoid potential errors at source if at all possible. Details of the body are shown in the drawing **fig. 5**.

I started the job by facing both ends to achieve an overall length of 3", following which I drilled a ⅛" diameter pilot hole - drilling in from both ends which is just about the limit for a standard ⅛" jobber drill. The hole was then progressively opened up to 10.3mm diameter, initially drilling in from both ends and with the final drill to size being drilled from one end only to ensure 'through' alignment. The use of a 10.3mm drill should allow for some clearance around the cartridge, but if the fit appears to be 'tight' due to some misalignment within the cartridge assembly, then the through hole can be opened up to a maximum of 10.4mm (the tapping size for 7/16" x 32).

Next comes the task of adding the thread for the end cap. At this stage I decided to use a collet to hold the body as any slippage when tapping could cause unwanted marks from the chuck jaws. My charts suggest tapping drills of either 10.3mm or 10.4mm diameter - I used a 10.3mm drill (13/32") on the first body, and apart from being hard work, more seriously I found that threading into such a thin wall caused the tube to spread by a couple of thou making it 'bell-ended'. This was obviously undesirable and had to be carefully rectified by polishing it down to size with a fine file. I then used a 10.4mm drill on the next body without any problems, following which the hole was tapped using a taper tap followed up with a plug tap, **photo 30**.

Once the thread has been tapped the next job is to machine the seating in the other end for the insulating sleeve. This can be reamed with a machine reamer if you have one, or even formed using a 7/16" slot drill - the exact diameter measurement is not that important as the insulating sleeve can be machined to › suit. In the event I used a 7⁄16" diameter machine reamer and then carefully removed the chamfer left in the end of the bore with a slot drill. I could have easily by machined an equal chamfer on the insulating sleeve but felt that such an operation would reduce its strength as it has to be a press fit in the body.

Depth is important here, although the insulating sleeve is initially machined 'slightly long' to allow for trimming after assembly so that any minor deviations can be accommodated. **Photograph 31** shows how I set the reamer to achieve 0.50" depth for the probe insulation sleeve. I used a rule as a feeler gauge and trapped it between the work and the end of the reamer. The rule was 0.030" thick, so once the rule had been removed, I needed to move the reamer 0.530" into the work to achieve the desired depth. Although not strictly necessary this setting step ensures that some material remains for the slot drill to remove. If you have a tailstock micrometer or digital device, then this task becomes much easier. **Photograph 32** shows the reaming operation in progress.

The same procedure was then used to set a 7⁄16" diameter slot drill to remove the corner at the bottom of the bore whilst aiming to achieve a depth of 0.500".

The final task was to drill the six light apertures in the body, where care was required due to the wall thickness, or lack of it. It is all to easy when centre drilling to go in too deep and produce a hole that is too large, ruining the job, so I would recommend that a quill stop is used if you have one on your mill. Apart from that, it is a simple job using an indexing or dividing head. **Photograph 33** shows the final 1⁄8" diameter hole being drilled in the body, where centre drilling has already taken place.

Cutting the screwdriver slot in the end cap.

Before removing the body from the indexing head I used a small 90 degree countersink bit to break the edge of the holes, **photo 34**. The comment regarding the depth stop also applies to this operation, and in my case a depth of around five thou was needed to chamfer the hole out to the complete diameter.

Finally, I ran the 10.3mm drill through the body again to remove the small burrs created during the drilling and tapping operations. It is important to deburr the bore carefully to avoid scratching the acrylic tube. At this stage it is also advisable to check the fit of the cartridge, just in case the bore needs to be opened up a little more.

That completes work on the body, which can now be put aside to await fitting the probe.

End cap and contact spring

The end cap for the body is shown on the same drawing as the body, (fig. 5), and is the same for both styles of edge finder. I made this from 7⁄16" diameter brass rod rather than stainless as it was going to be easier to machine.

The first operation was to face the bar and then thread 7⁄16" x 26tpi for a length of around 1⁄2" to full depth. Once this had been done, I machined the screwdriver slot in the end using a slitting saw. The dimensions for this will depend on your screwdriver, but I found that a 3⁄64" slitting saw did the job nicely and I cut the slot to a depth of around 0.06". **Photograph 35** shows the slotting operation - the bar is conveniently held in the indexing head collet.

Next it was back to the lathe for parting off, but before completing the

Forming the recess in the end cap, using the body as a holder.

The end caps and contact springs, together with a cartridge

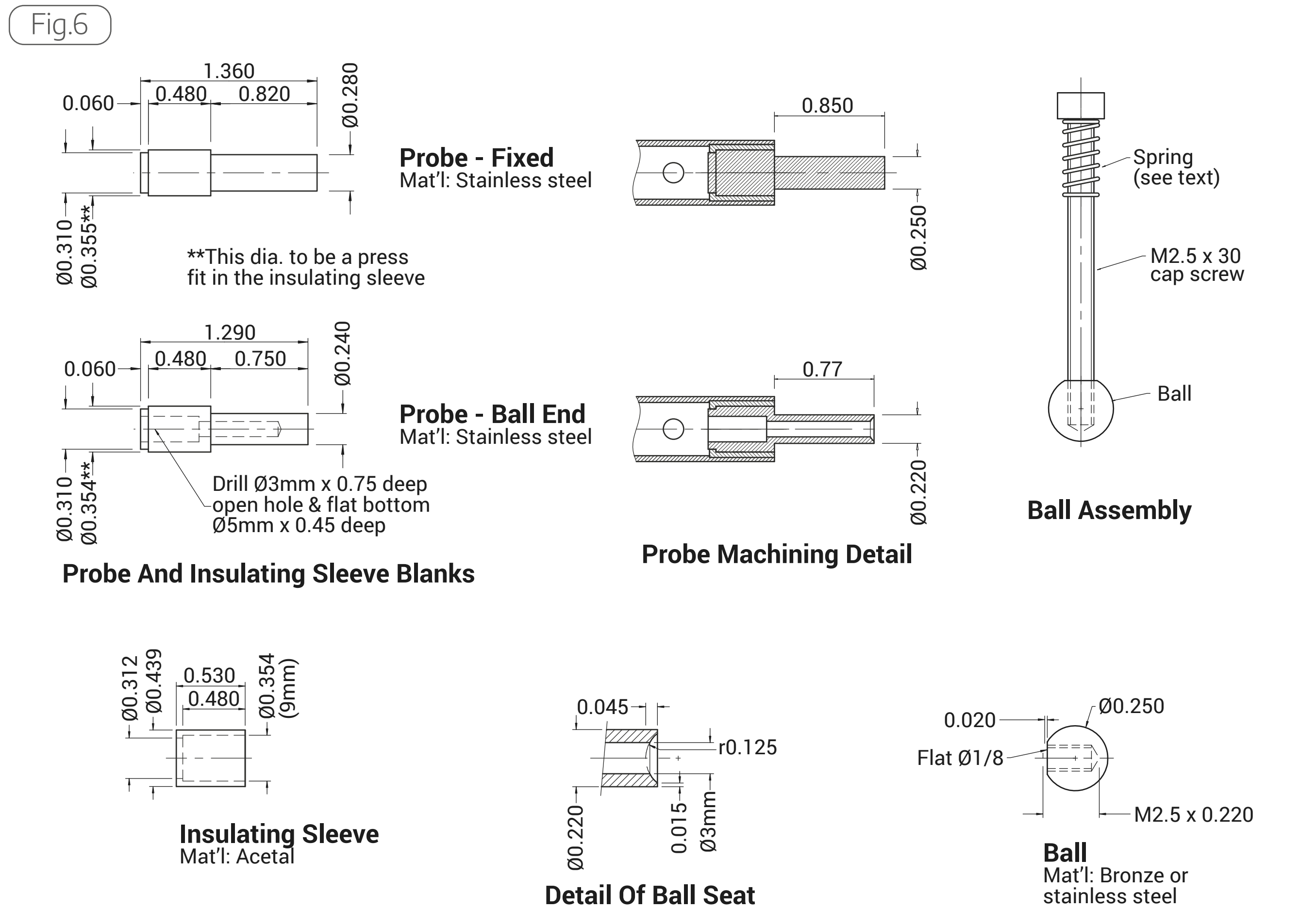


Fig.6 Probes

cut I took the opportunity to chamfer the thread and run the die down it again just to remove any burrs.

All that is now required is to form the spring pocket with drills and a slot drill to finish. So, how to hold the end cap to machine this? The body can be used as a holder if you have a backstop which is small enough in diameter to pass through the body itself, as can be seen in **photo 36**. If such a backstop is not available, then a simple split or threaded bush should do the job.

The contact spring was cut from a length of 3⁄16" x 23swg stainless steel spring supplied by Polly Models (usual disclaimer) - a length of around ¾" has proved to be satisfactory. Flatten both ends and the open up one end slightly so that it grips the inside of the brass cap.

Photograph 37 shows the contact spring fitted into one of the end caps, together with another showing it's relationship to the cartridge.

Now that the bodies have been completed, we can turn our attention to making and fitting the probes and their insulating sleeves.

The insulating sleeves and probe blanks

As the machining and fitting operations of the insulating sleeves and the probes are somewhat intertwined, I have described them together. Details and dimensions are shown on the drawing **fig. 6**.

The insulating sleeve is the same for both styles of edge finder, but the probe blanks and their final machining process are different.

The first job is to prepare the insulating sleeve blanks. I made these from 12mm diameter black acetal, and after cutting-off and facing to an overall length of 0.55" the next stage is to prepare the bores as these will be used as a gauge when machining the probe blanks.

The small 5⁄16" bore is finished with a 5⁄16" diameter slot drill, while the larger of the bores at 0.354" diameter, more correctly 9mm, is formed with a 9mm slot drill - all fairly easy when machining acetal.

We can now move forward to preparing the probe blanks, where the major diameter is machined to suit the bore of insulating sleeve with an interference fit of around 0.001" - the insulating sleeves can be used to gauge the fit.

The probe length can be varied to suit individual requirements regarding access, etc, and with the ball-ended version if the probe is shortened then the screw will also need to be shortened by the same amount. The probe and insulating sleeve are left 'long' by around 0.030" to allow for machining tolerances and final fitting and machining - this has been allowed for on **fig. 6**.

●To be continued

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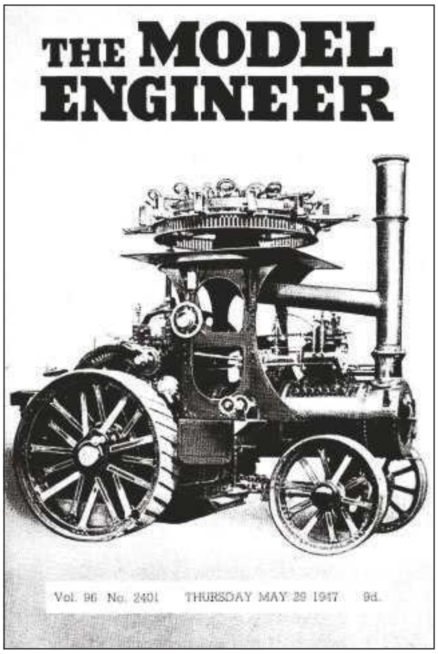

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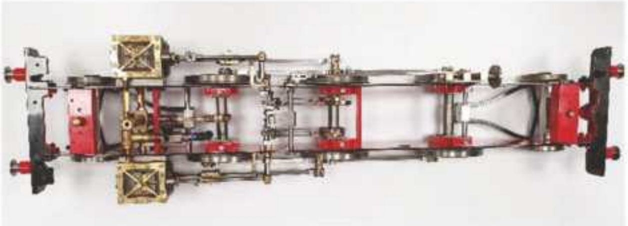

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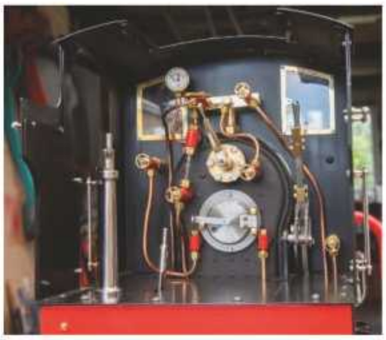

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