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UPGRADING A ROTARY TABLE

Geoff Andrews adds a larger faceplate and some useful accessories.

A SHEET METAL FOLDER

Alex du Pre makes a small but useful sheet metal folding machine.

LOCK AND KEY

A key to the secrets of a mortice lock.

INSIDE THIS PACKED ISSUE:

- ACCURATE TOOL POSITIONING FOR REPEATABLE MACHINING. ■ MICRO-ADJUSTABLE GRIP-TRU CHUCKS EXPLAINED. ■ METAL SHAPING IN THE WORKSHOP. ■ WE REVEAL THE WINNER OF THE 2024 STEVENSON TROPHY. ■ EXPERIENCES WITH A DENFORD CNC LATHE. ■ A 3D PRINTING TIP. ■ HOW TO MATCH IRREGULAR CONTOURS FOR REPAIRS. ■ PLUS ALL YOUR REGULAR FAVOURITES!

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The next issue will be on sale 15 November 2024

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On the Editor's Bench



Caveat Emptor

By the time you read this, I will be, hopefully, demonstrating 3D resin printing with the Society for Model and Experimental Engineering at the Midlands Model Engineering Exhibition. Naturally I want this to go well, so I decided to change the FEP film on my printer. I opened up a new packet of film, clearly marked with the correct size, only to find it contained five films to fit a smaller printer.

The price of film varies a lot, and I succumbed to the temptation of ordering a packet of the correct size from overseas at a competitive price; the delivery time was reasonable, and it arrived last week. Fitting a new film was straightforward, the Halot Mage Pro doesn't have locating pegs, just screws making the task a little easier than for the Halot One featured in a recent article. I did some test prints which were OK, but when I came to do

a large object it failed, with a big hole. I went through the cleaning routine and tried again. After a few more tries I discovered that resin had leaked through a pinhole and set on the screen beneath (thankfully it didn't get inside the screen).

I put this down to bad luck, although I couldn't think how the film could have been damaged (I made sure the film and screen were scrupulously clean before filling with resin). But when I went to fit a replacement from the same pack, I found that all four remaining pieces had a slit through them. As I had opened the pack by hand and never taken them out, this must have been there from the start. My conclusion is that my source of 'cheap' FEP is selling material from reject batches, possibly that's how I came by the undersize FEP as well.

I have reordered from a, hopefully, reputable UK supplier; fingers crossed that all will be well for MMEX!

Neil Wyatt

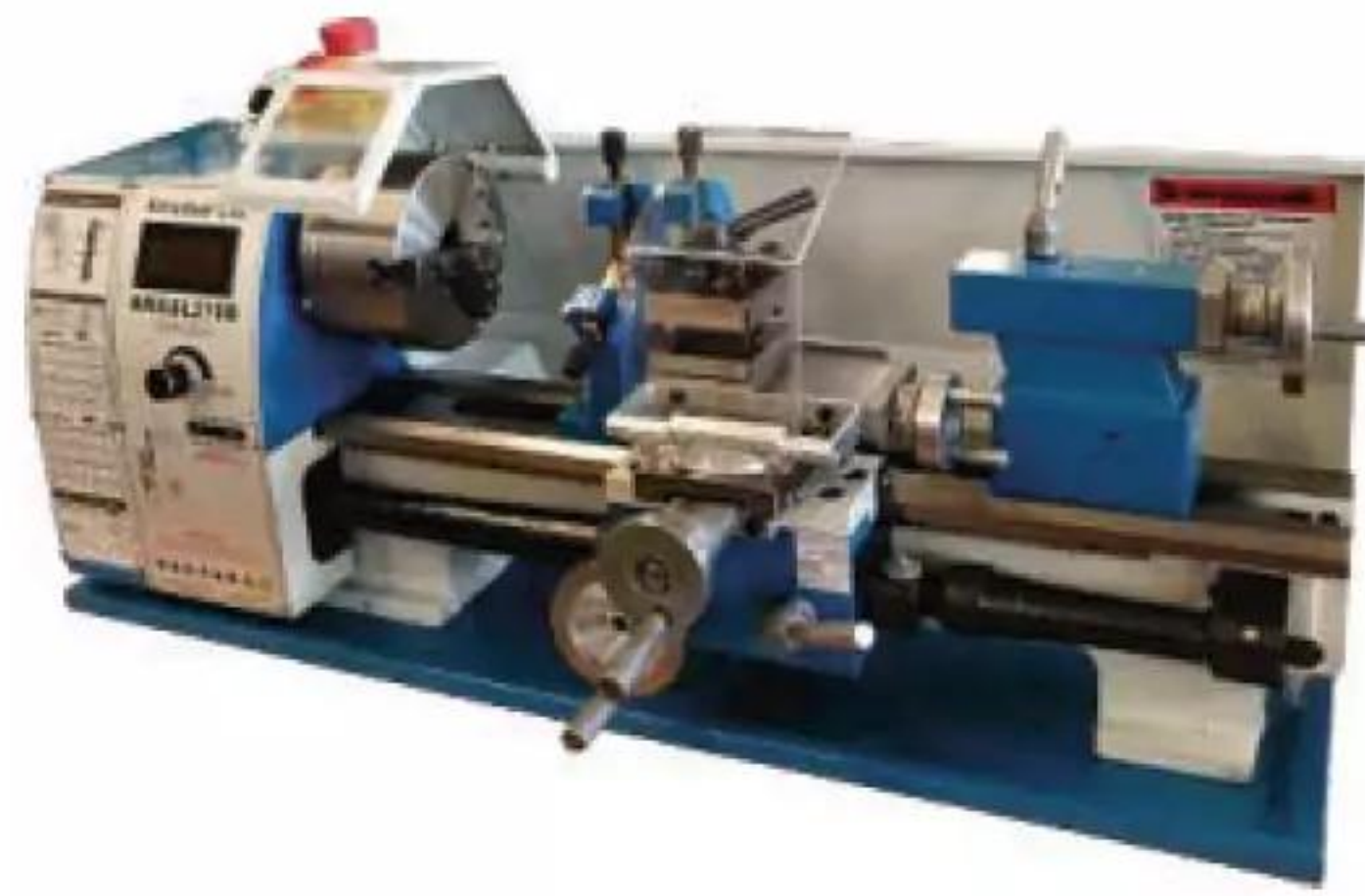


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SPECIFICATION:

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Taper of spindle bore: MT3
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Spindle speed: 50-2500mm
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Price: £595



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SPECIFICATION:

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Taper of spindle bore: MT5
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Number of spindle speeds: Variable
Range of spindle speeds: 50~2500rpm
Weight: 65Kg

Price: £1,185



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SPECIFICATION:

Distance between centers: 750mm
Taper of spindle bore: MT4
Spindle bore: 26mm
Number of spindle speeds: Variable
Range of spindle speeds: 50~2500rpm
Weight: 140Kg

Price: £1,904



VM25L Milling & Drilling Machine Belt drive & Brushless Motor

SPECIFICATION:

Model No: AMAVM25LV (MT3) / (R8)
Max. face milling capacity: 63mm
Table size: 700x180mm
T-slot size: 12mm
Weight: 120Kg

Price: £1,431

W DRO – Price: £1,921

W DRO + PF - Price: £2,210



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W 3 AXIS DRO- Price: £955



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SPECIFICATION:

Model No: VM18 (MT2) / (R8)
Max. face milling capacity: 50mm
Table size: 500x140mm
T-slot size: 10mm
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VM32LV Milling & Drilling Machine Belt drive & Brushless Motor

SPECIFICATION:

Model No: AMAVM32LV (MT3) / (R8)
Max. face milling capacity: 76mm
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T-slot size: 14mm
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Geoff Andrews fits a faceplate to increase the capacity of his rotary table, and shares the details of several other improvements to usability.

17 Tool tip zero setting for DRO lathes

Simon Davies' completes the construction of his tool tip setting device and explains how to calibrate and use it..

28 The Stevenson Trophy Competition 2024 – The Results!

Readers! You have voted and now we can reveal the results of the 2024 Stevenson Trophy Competition.

30 Extended Length Tee Nuts for a Milling Machine Table

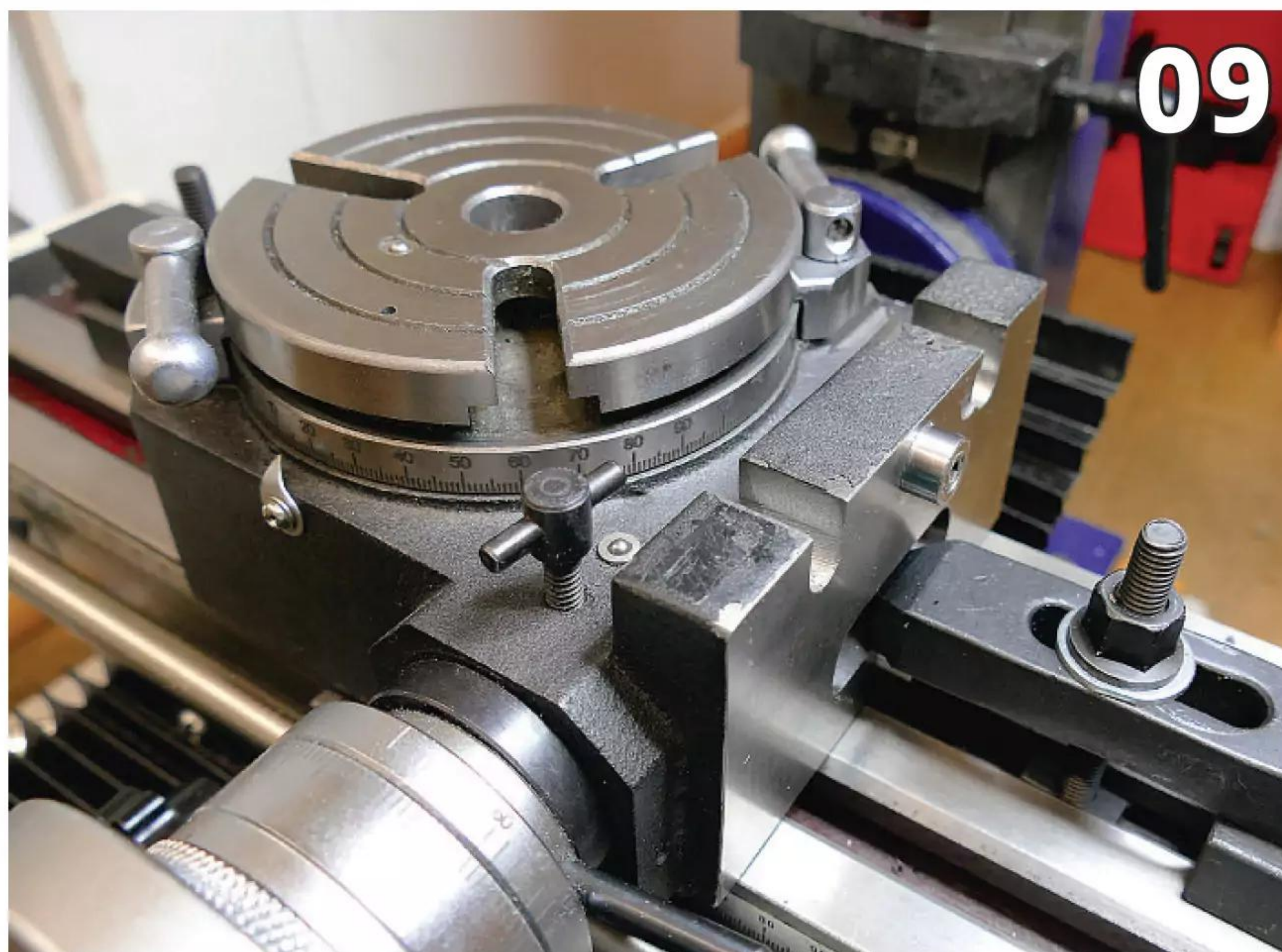
Keith Keen avoids the possibility of tee slot damage by making extended tee-nuts to spread the load.

34 Learning to love my Denford NovaTurn, Part 5

Mick Knights concludes the story of his experiences with CNC on a Denford Novaturn lathe.

34 Pull-Out Print

Our centre pages this month feature 'The Lathe' by Jeanette Chadwick.



38 My Railway Journey

The Editor's Hornby railways and the chance to win a trainset from Hornby's new TT:120 range.

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Andrew Johnston takes on a metalworking challenge using intense heat to help bend 3mm steel into complex shapes.

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Keeping with the shape forming theme Geometer shares some gentler approaches to metalworking.

50 A Workshop Diary

To conclude our journey into metal-forming techniques, we visit Alex du Pre's workshop once more as he details the making of a small but very effective sheet metal folder.

58 From the Archives

In this issue we look at a very useful explanation of how Burnerd Grip-Tru chucks operate.

59 Unlocking a Secret

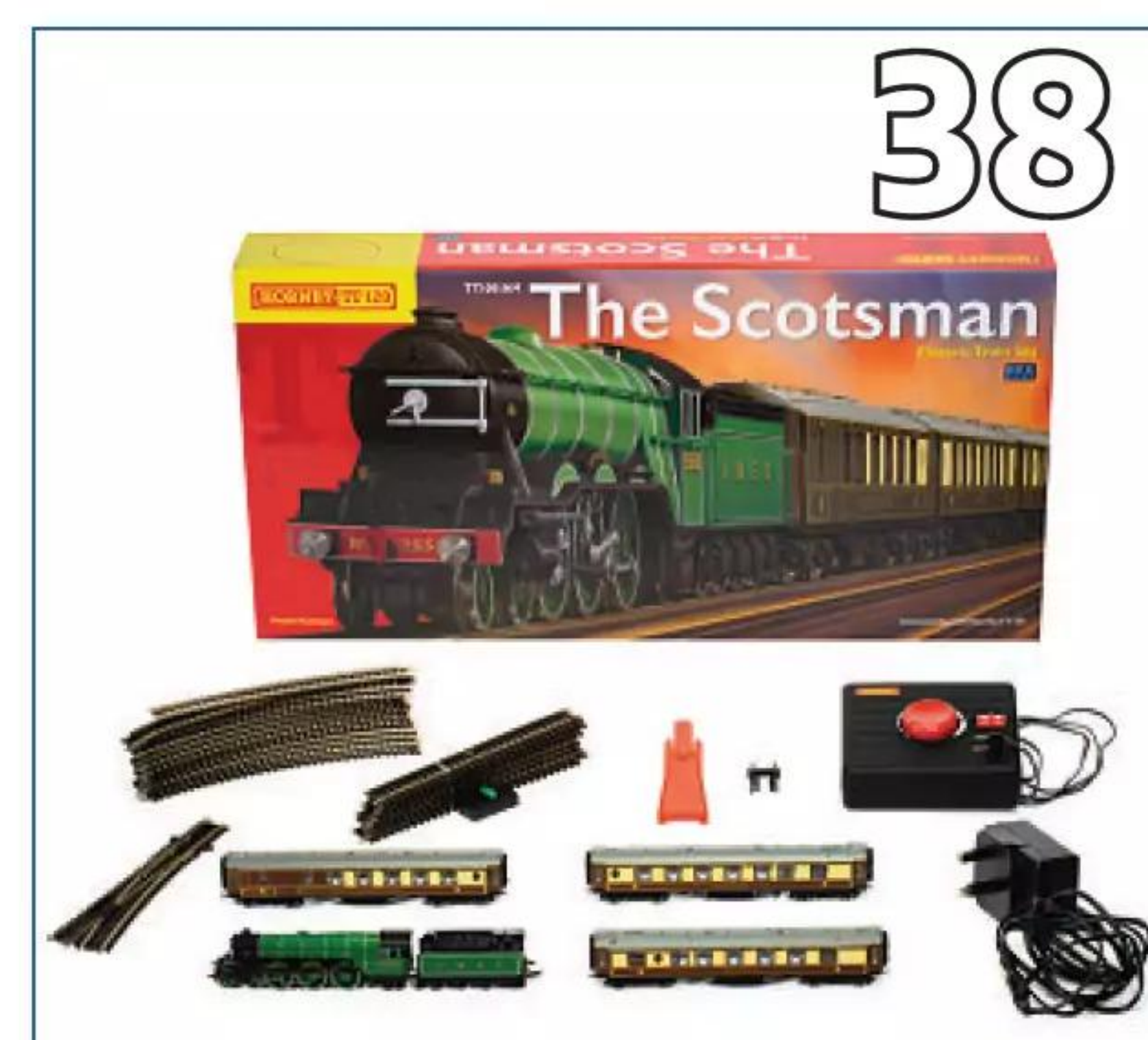
Stub Mandrel finds fitting a key to be an interesting exercise in hand work and along the way explains the workings of a mortice lock.



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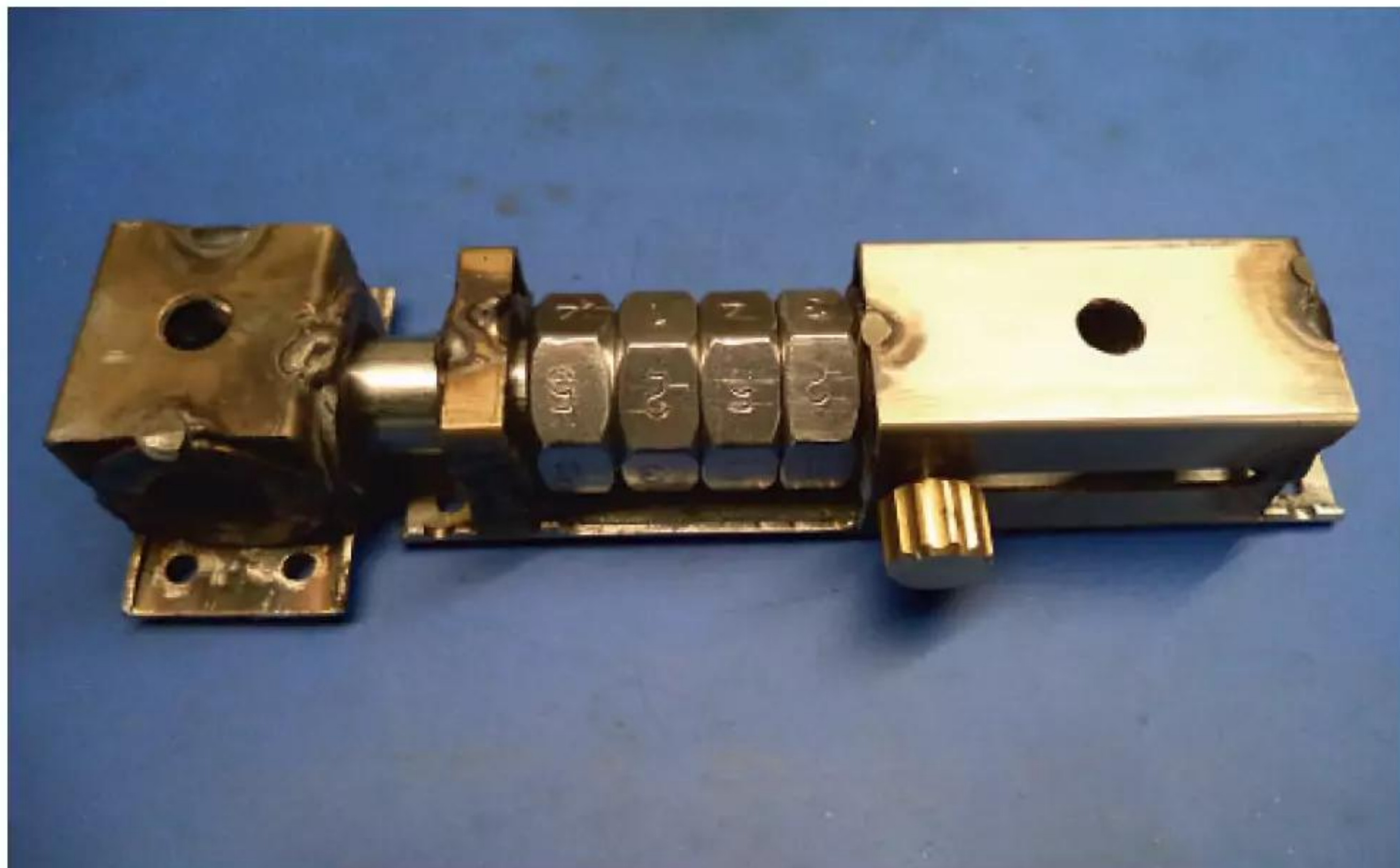
See page 24-25 for details.



Coming up...

in our next issue

In our next issue Stewart Hart details how to make a combination bolt to help keep your workshop secure.



Regulars

3 On the Editor's Bench

The Editor is kicking himself for 'buying cheap'.

26 Scribe A Line

This month we get some responses to Wing Nut's request for suggestions for fireside reading this winter. We are always keen to hear from you – send the editor your thoughts at meweditor@mortons.co.uk.

16 Readers' Tips

This month our winner is a tip for easing the fit of 3D printed parts. Send your tips to meweditor@mortons.co.uk, you could win a prize.

32 On the Wire

This month, the Garden Rail show for 2025 has been announced, a viaduct is restored and the story of two queens.

64 Readers' Classifieds

This month we have a tremendous selection of readers' for sale and wanted adverts, is it time for you to grab a bargain?

ON THE COVER

Our cover features one of the operations in making Alex du Pre's sheet metal folder. For more details of how he made this useful device, see page 59.

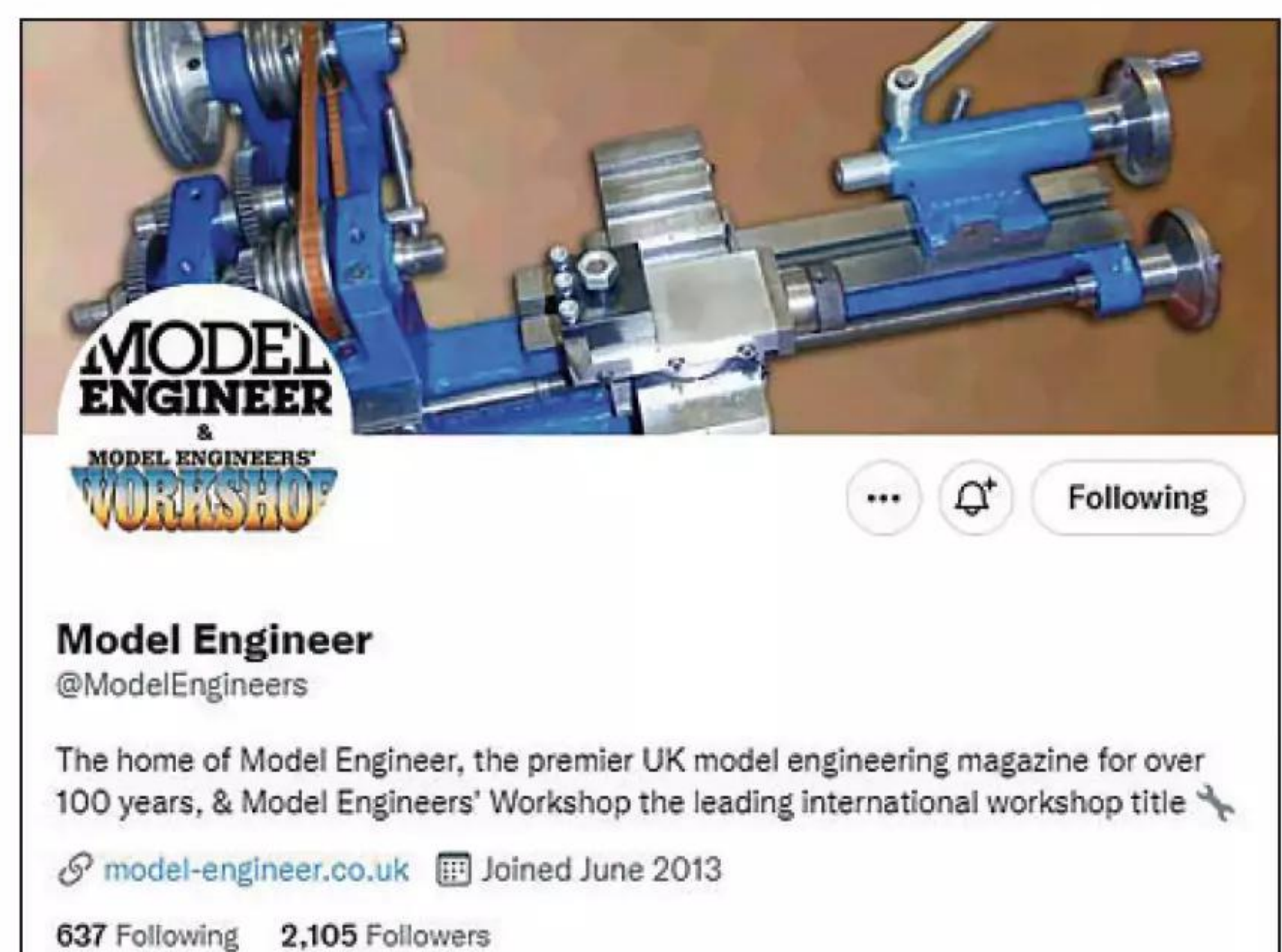


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THIS MONTH'S BONUS CONTENT

Extra Content!

Visit the Model Engineer Forum to find extra content and discuss this issue of Model Engineers' Workshop!

www.model-engineer.co.uk

Hot topics on the forum include:

Milling vice Choice started by John Grey 7.

What's the best size of vice for a benchtop milling machine?

Bed for 6040 CNC? Started by Steve355.

What's a good choice for a CNC Router Build?

Super7 Spindle run out opinions

started by chrisem.

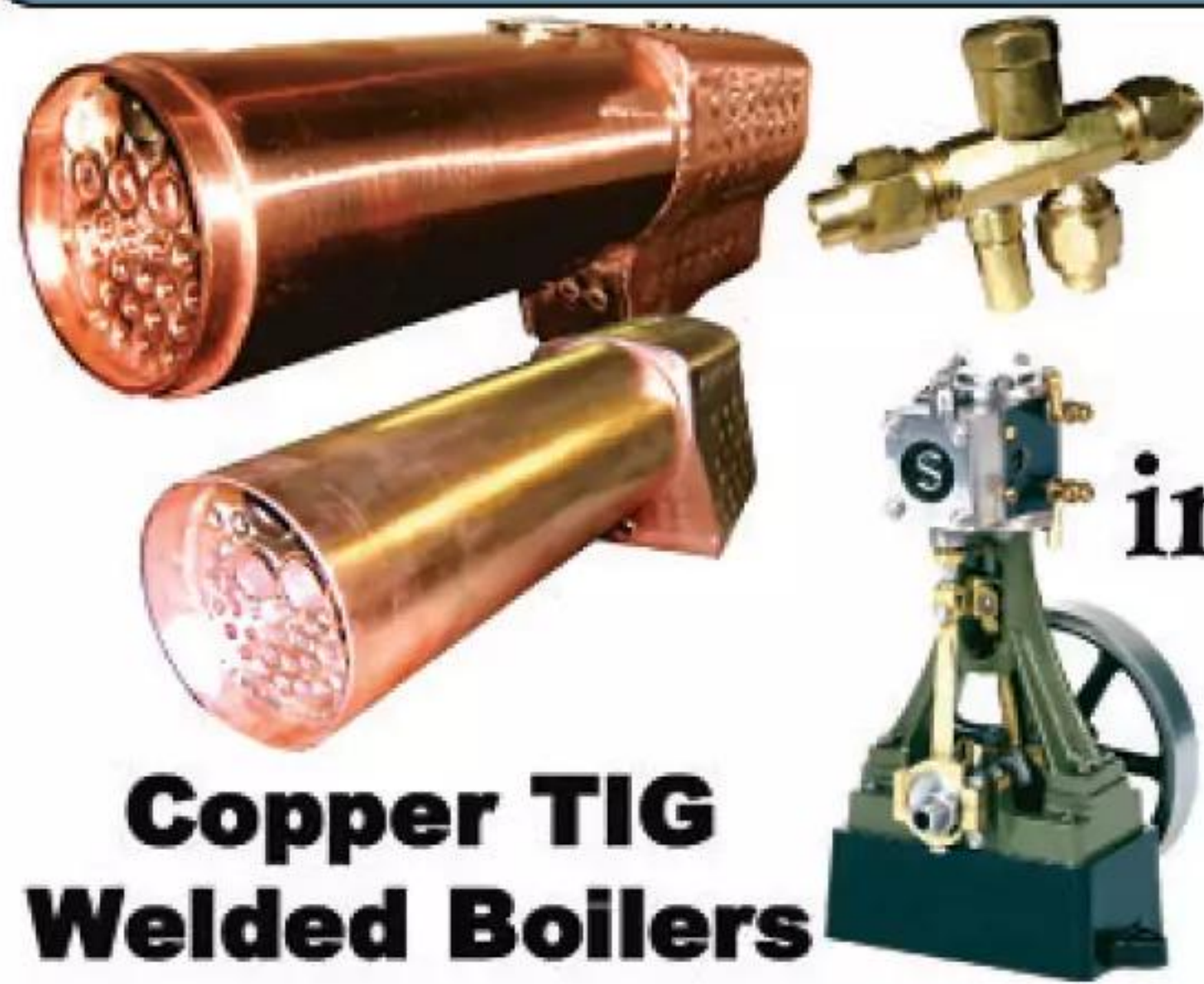
What's the best way to ensure a well-used lathe is set up to achieve good results?

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. Come and join us – it's free to all readers!

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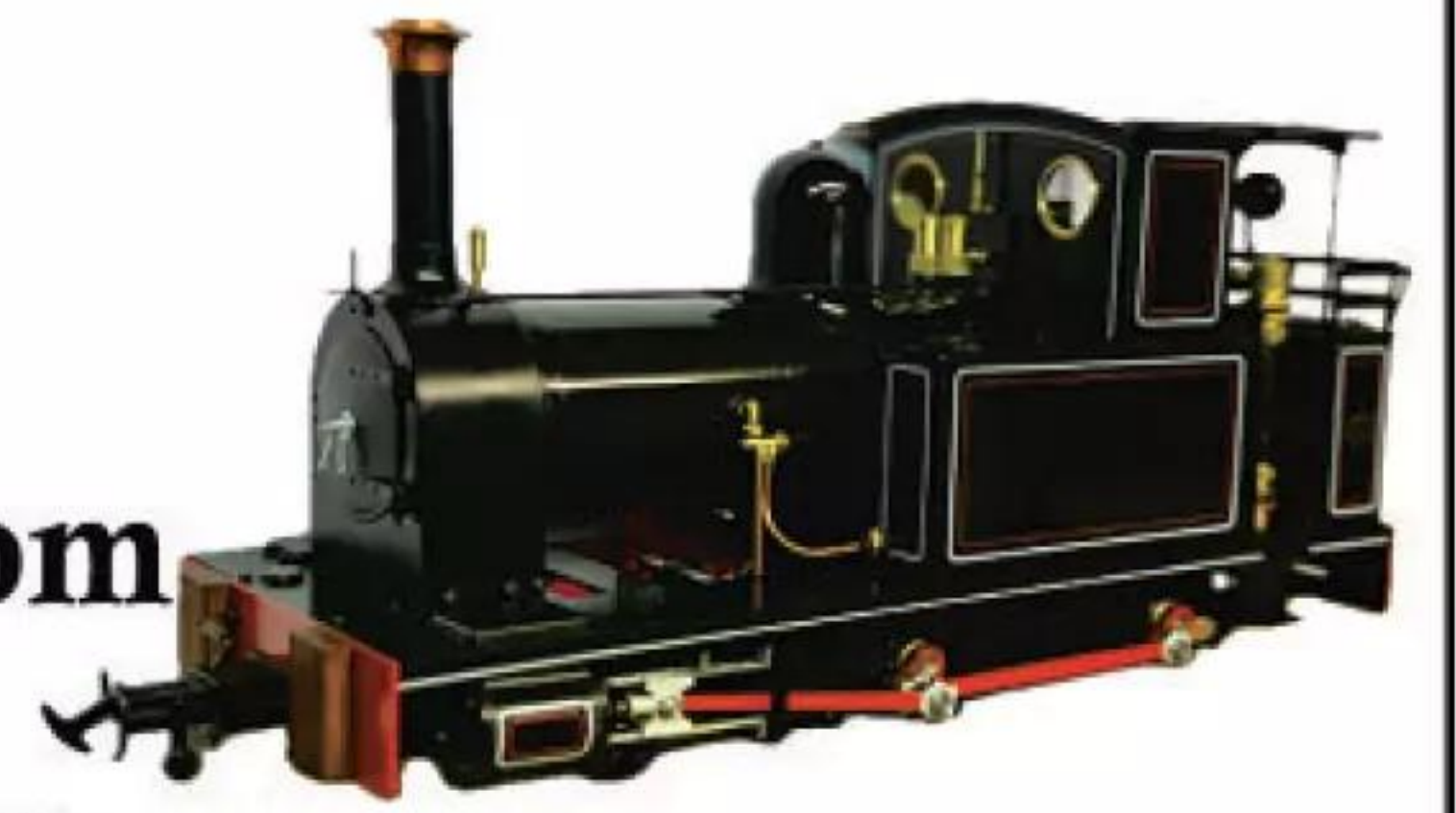
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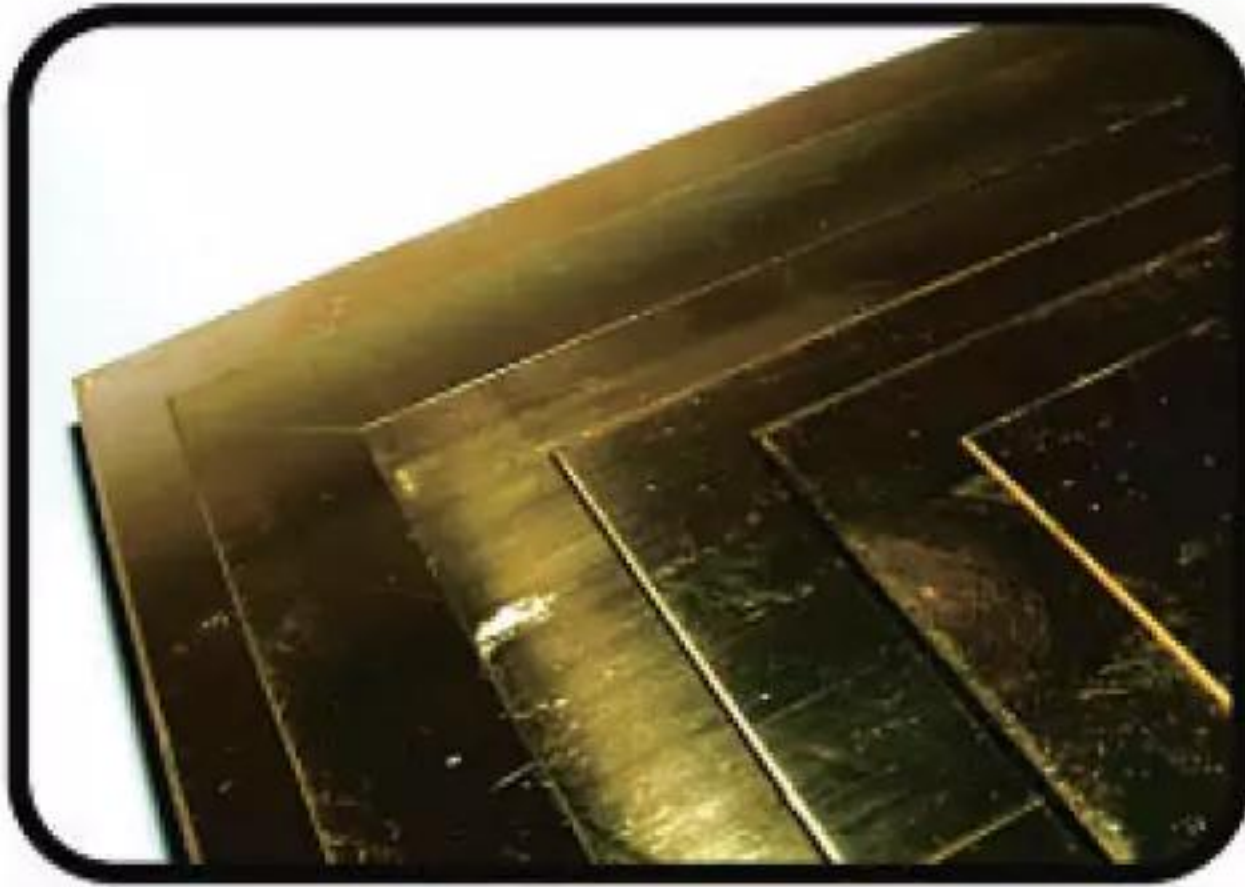
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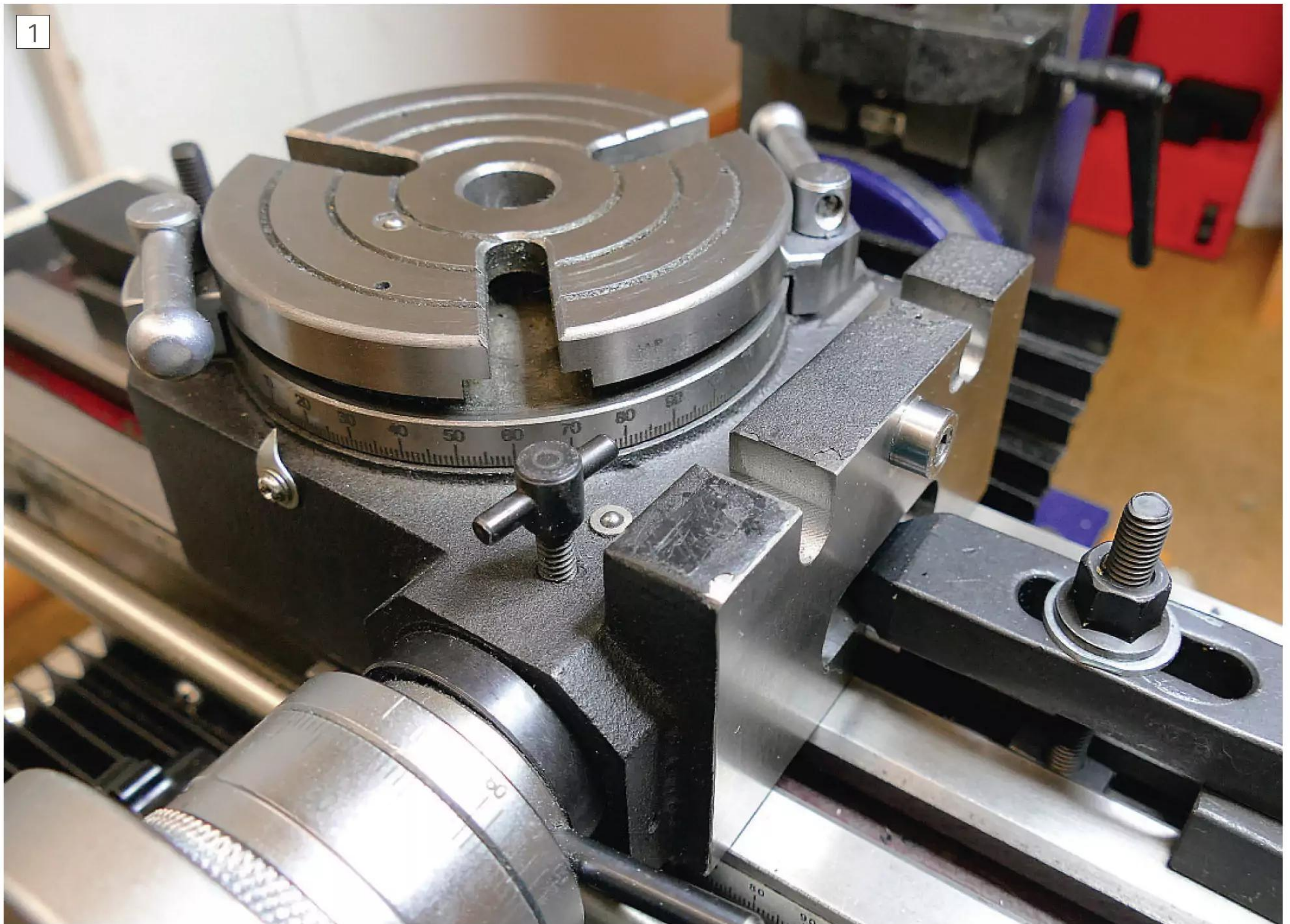
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Enlarging a Small Rotary Table



Geoff Andrews explains how to increase the capacity of a 100mm rotary table, and details some other improvements he made as the job went along.



original table with locating 'buttons'.

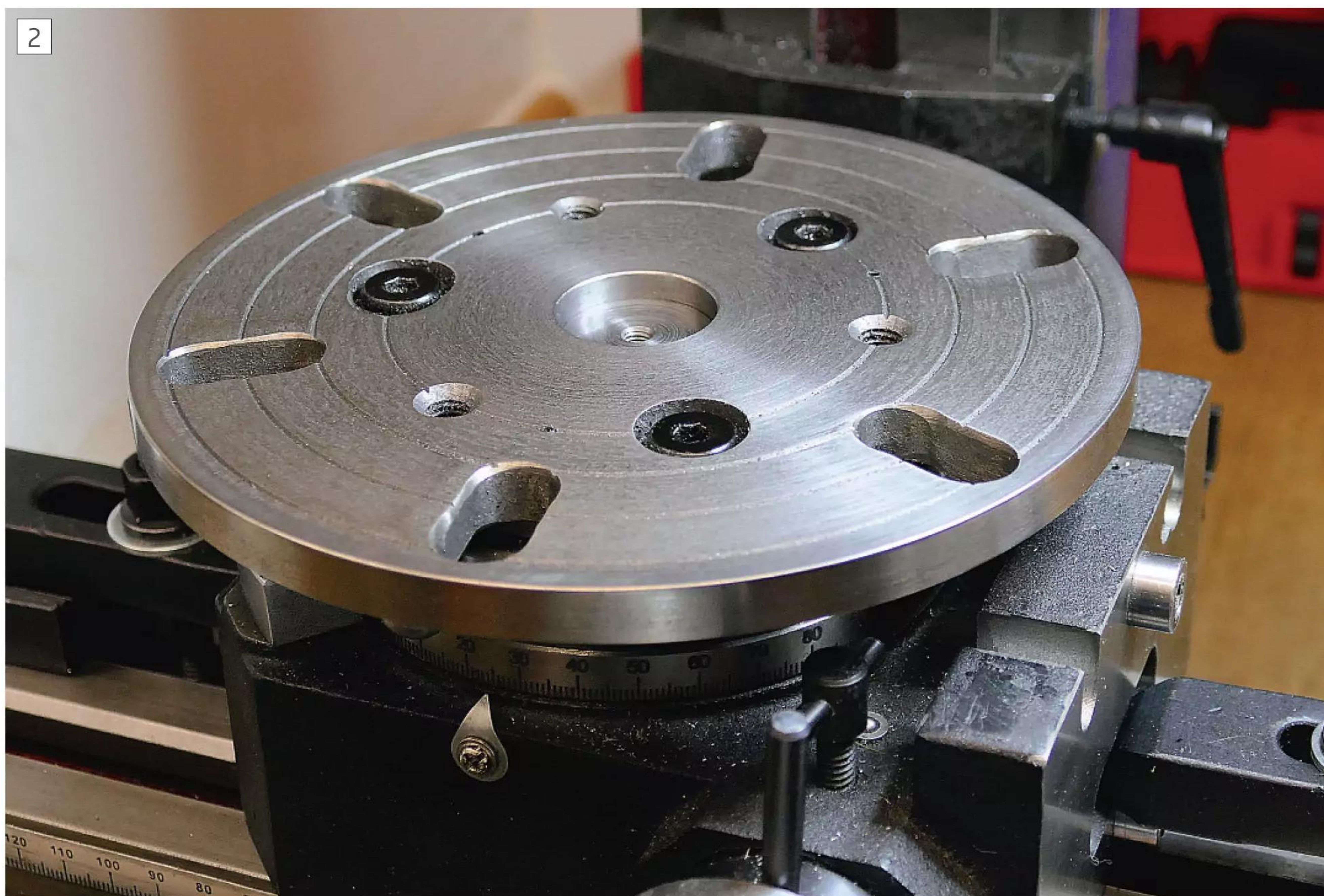
I had seen an advertisement with a well-priced offer for a 100mm diameter rotary table at Axminster Tools and co-incidentally I was on holiday in Dorset the following week I placed an order for me to collect when there. The table is of a Verco type of design but with no identifiable maker. It is however a very good quality device, so I was pleased with my purchase.

On arriving home I first had to replace the rectangular base locating pins as

these were too wide for the slots in the table of my milling machine. Rather than make new rectangular pins I turned circular locating 'buttons'. These had a diameter to fit the groove already in the rotary table base and a slightly smaller diameter to suit the milling table slots. These were held by the original M4 screws, so installation was simple. There was no groove in the end surface of the table for when it may be used vertically so after very carefully marking,

drilling and tapping M4 fixing positions, two locating 'buttons' were turned of a constant diameter to suit the milling table slots and fitted here also.

The original table with these fitted can be seen in **photo 1**. Putting the rotary table squarely on the milling machine either horizontally or vertically is now automatic and simple. I had already fitted these 'buttons' in the same way to my milling vice and to my angle vice.



Face plate & pin in place.

While keen to try my new accessory out on the milling machine it was only then I realised that in fact at 100mm diameter it was in effect quite small and difficult to fit anything of any size together with the holding clamps. A 150mm diameter table would have been much better although as I was not about to change the table, I began to think about increasing the diameter. My lathe faceplate is 170mm diameter, so very suitable in size and for which, by some quirk of fate, I happen to have two so this was the direction to go. If I could devise a way of repeatably centring the face plate onto the table and securing it, this could be a solution. Face plates of course already have slots for clamp fixings so once fitted it would achieve what I wanted to do, and one of the two face plates could be fitted permanently.

The face plate for the mini lathe is fitted by a recessed location on the rear which fits to a small shoulder on the lathe spindle. It is held in place to the lathe spindle by three screws with nuts into threaded holes of the faceplate. The rotary table has three 'T' slots also but

unless I was to drill the threads out and use screws into 'T' nuts in the table these fixing positions were not going to be of use. In addition keeping the tapped holes would provide three additional fixing locations.

The rotary table itself has a number 2 Morse taper central hole so it was clear this had to be the primary means of centring the faceplate onto the table. Clearly using a number 2 Morse taper 'pin' would be the answer. If the internal taper of the table should need to be accessed when the face plate was fully secured the pin could be removed temporarily otherwise it would remain in place. I had the idea also of using a similar pin to quickly and accurately centre the table itself, in line with the centre of the milling spindle, but this would have to be of a different design so to make both, I bought two M2 blank end arbours. The soft section of these was 30mm diameter x 40mm long.

The first task was to make sure the faceplate was running true. This was done by fitting it to the lathe and skimming across the face. Easier said

than done in this case. Because I had modified the cross slide on my mini lathe (see MEW article issue 320), tool travel across the 170mm diameter and turning the perimeter was no problem. However, the plate is either made of particularly hard material or finished possibly within the crust of the original casting and so is quite hard. The TCT tool managed the job but getting a really nice finish while not reducing its thickness too much was difficult. I trued up the outer edge of the plate and then bored the central hole to bring this true. I finished with an internal diameter of 27mm. Quite an arbitrary dimension, but it would do the job needed at this size.

I wanted the arbour to be a close fit yet easy to remove if needed to retain access to the rotary table's taper. I fitted a No. 3 to No. 2 sleeve into the lathe spindle and then fitted the arbour into the lathe with a draw bar to hold it well in. At 40mm it was too long, so I parted off 20mm and then reduced the diameter. In the final stages it was a fitting job so instead of relying on measurements alone I offered up the faceplate to achieve the final fit.

The rotary table had been mounted on the milling machine and centred true using my dial test indicator, DTI, fitted to the milling spindle and reading the internal diameter of the table adjusting the X and Y axis in turn. With the new locating pin installed the face plate was fitted and checked for rotation with the DTI. There was no variation from the bore of the table. The same was true for the external edge of the face plate. **Photograph 2** shows the faceplate with the locating pin fitted. The increase in table size is very evident compared to photo 1 and shows the recessed pin forming a recess - as described below.

My original intention was to finish the new centring pin flush with the top of the faceplate. However, by chance I came across a YouTube video by Blondiehacks "Corner Rounding and End Rounding Made Easy!" She shows in the video an excellent idea using a number 2 Morse taper pin she had made fitted in the rotary table taper in which she has a recess turned in the top face into which replaceable inserts of various diameters

can be interchanged. This is ideal for quickly centring and rounding the end of a bar or for a plate having screw holes in each corner. A bar, for example, with a hole near to the end is placed onto the pin of the hole's diameter, the bar is clamped and the end rounded easily because the pin immediately locates the bar on centre. These inserts being interchangeable, they can accommodate inserts to suit any hole diameter.

Following this idea, if instead of making my locating pin flush with the face plate top as intended it could be left at a lower level thus forming the recess for fitting interchangeable inserts as she had shown in her video. My centring pin would now be doing two quite separate jobs.

Fortunately the diameter of the rear locating ring of the face plate for fitting to the lathe spindle was just less than the diameter of the rotary table so it would sit securely. The table has three slots and so three 8mm diameter holes were drilled in line with these slots and at the same radius as the original face plate screw fixing positions.

These were on the line of the first ring in the face of the plate. Another consideration was that I wanted two of the slots in the face plate to be in the same plane as the milling machine table and thus the axis of its travel when the indicator of the rotary table was set to the zero mark. This I felt was much better than the slots appearing randomly. This meant that the new fixing holes are slightly off set radially from the original screw fixing holes of the face plate. This however is purely cosmetic and having the alignment is much more important.

The fixing holes being as far outward as I could brought them close to the outer diameter of the table. Recessing these holes in the face plate for a socket headed screw could have brought the recess too close to the edge of the ring and may break through. It seemed appropriate, therefore, to use M8 Flat headed screws which required a shallower recess and had a larger holding diameter of 14mm. I marked and drilled the three holes on my pillar drill.

Using the centring pin to locate the table and a bolt in two of the holes to 'T' nuts in the table I used an end mill to provide the recess with a square bottom. My nearest size was 18mm diameter, so I used this rather than buy a new end mill just for this purpose. Even though all was locked down the hard surface of the face plate made this difficult work. My first attempt caused the recess to run off centre slightly. This unfortunate event may just be seen in the photograph. After working more steadily I had the recess bored correctly. The other two recesses were done steadily and formed as required.

If I wanted to remove the centring pin for some reason to leave the Morse taper in the table still accessible, I did not want to rely only on the screws to hold the face plate in register. For this reason I fitted three small roll pins through the face plate into the table to ensure centring remained accurate. As the screws were very near to the edge of the table the length of the 'T' nuts had to be shortened on one end so as not to interfere with the locking groove in the perimeter.

A diagram of the arrangement can be seen in **fig. 1** which also gives the

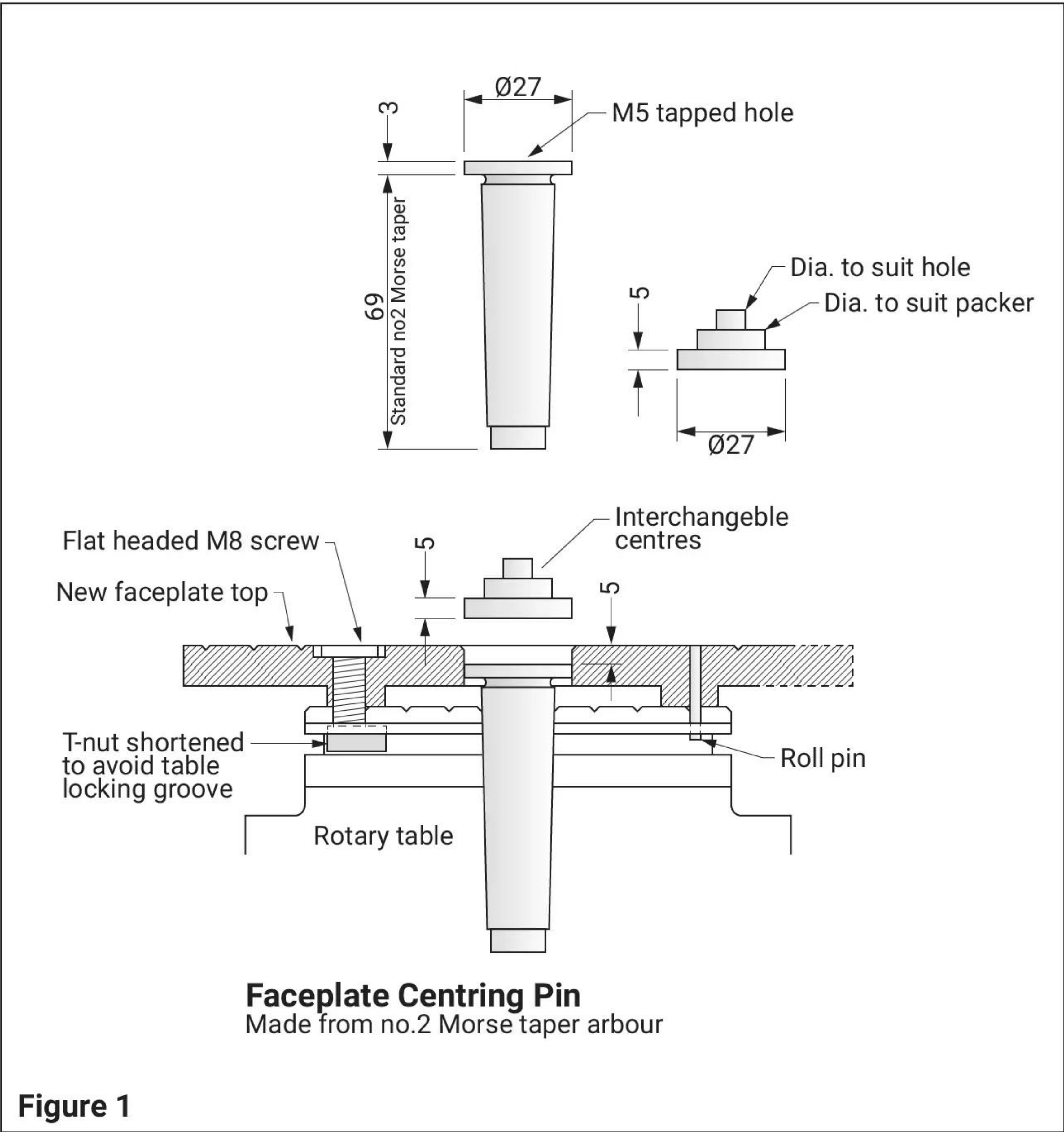
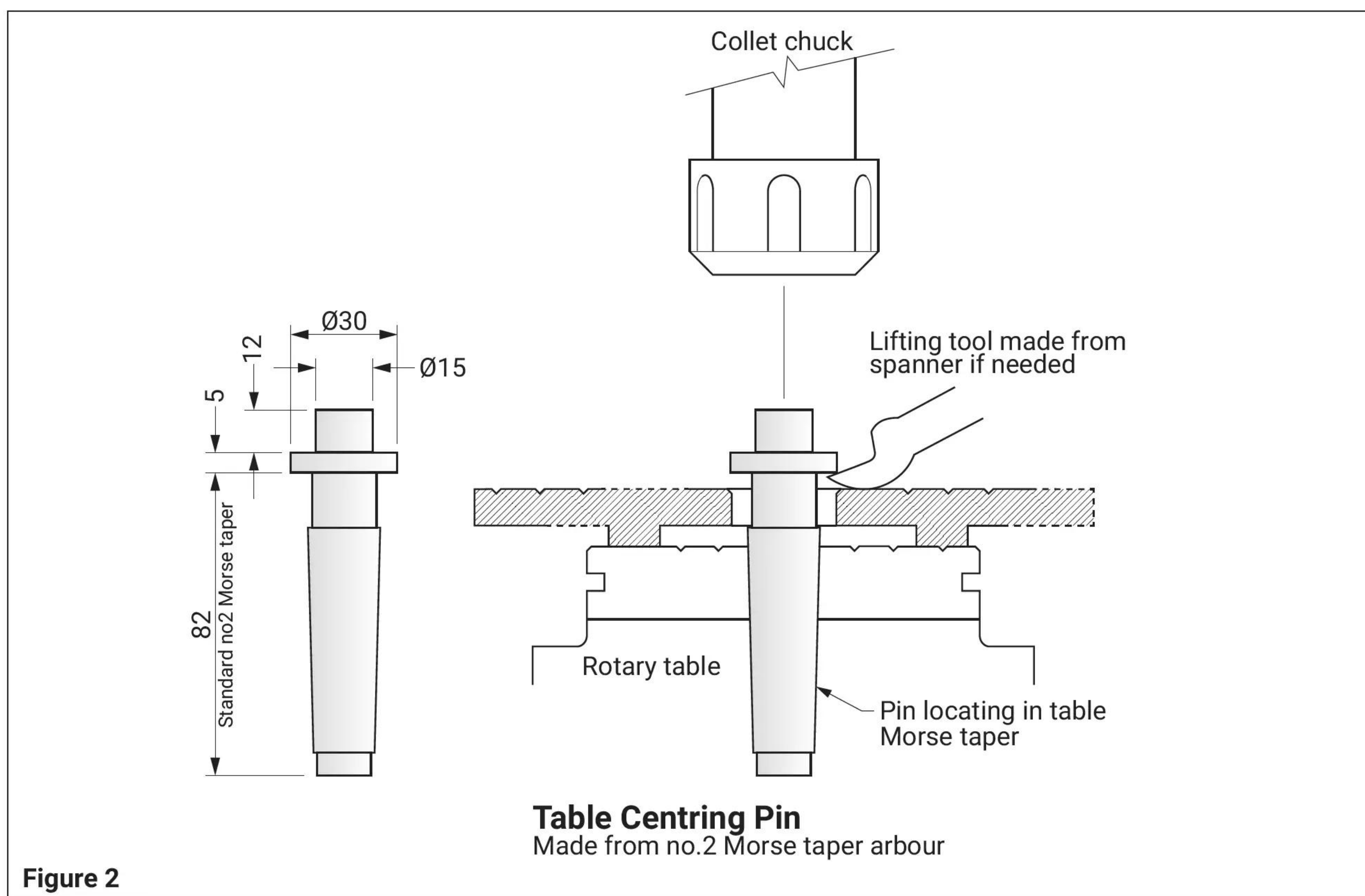


Figure 1



dimensions which I found appropriate. As can be seen the 27mm diameter of the pin at 3mm high was sufficient for the job whilst leaving a recess 5mm deep for the interchangeable inserts. I put an M5 thread in the centre of the top of the pin, this is to hold a 5mm deep blanking insert to be flush with the top of the face plate when the recess is not in use and prevent swarf build up. This thread can also be used if it should prove necessary for a socket screw to be fitted, and the pin can be levered out with my improvised lifting tool. Providing the pin has not been fitted too firmly it would obviate the need to remove the table from the milling machine in order to knock the centring pin out.

This lifting tool was made by removing one arm of a 13mm spanner using an angle grinder cut off disc. This is shown in **photo 3** and using it is shown in **fig. 2**. The centring pin is there to radially locate the faceplate and other than being firm does not need fitting tightly into the taper.

After fitting I checked the face plate again with my DTI and it remained true. I now have what I consider to be a fully permanent rotary table of 170mm diameter.

Figure 1 also shows an example of an interchangeable centre. I have made a few of these for the most common sizes of hole I think I am likely to use. 10mm, 8mm, 6mm, 5mm plus the blanking

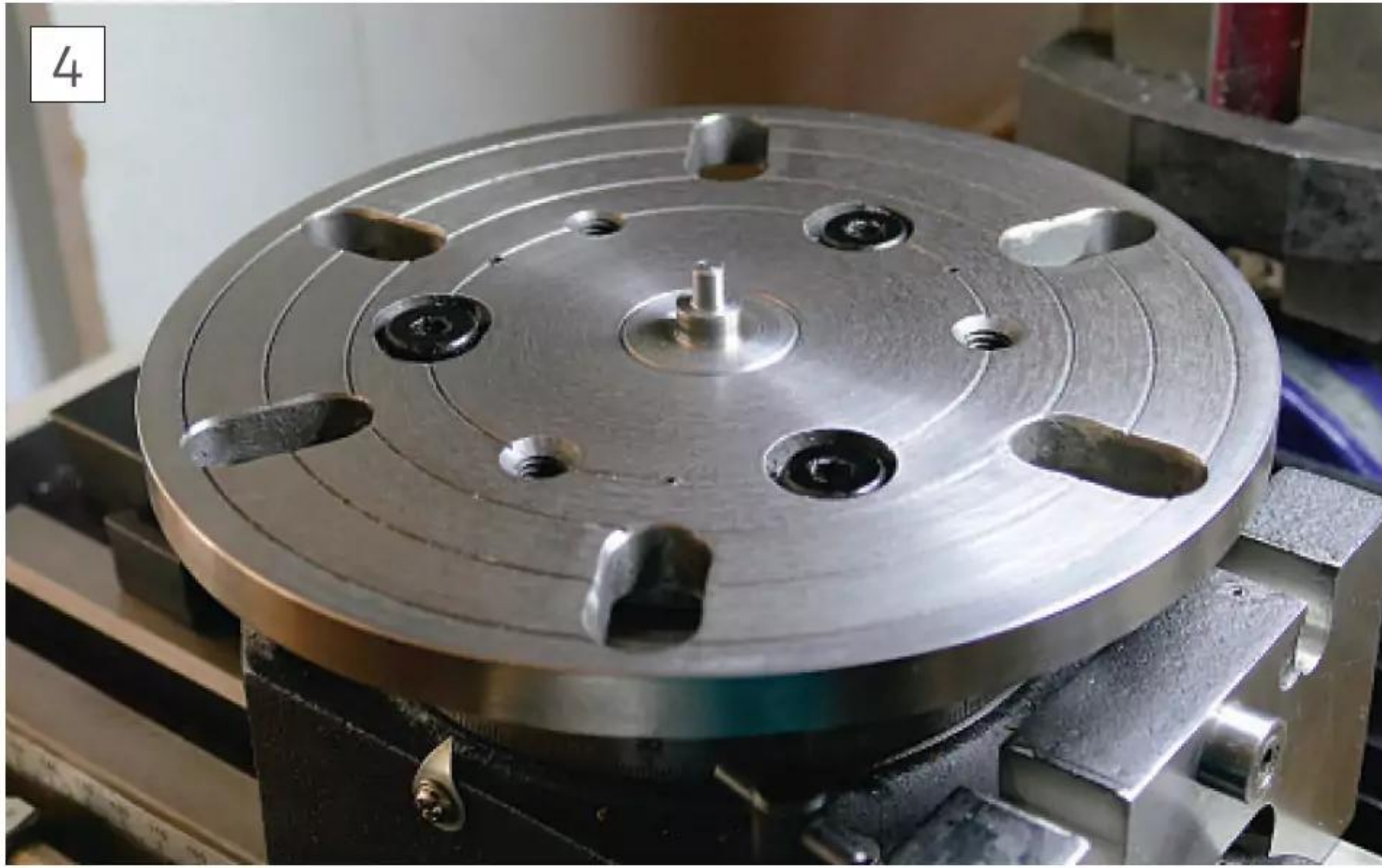
insert which is held by the M5 csk. screw. I also made some 'blind' inserts into which can be fitted separate pins if the need arises for an odd size. It is much easier to make a pin than to set up and make a special insert. The head of my cap head stainless steel M5 socket screws for example are 7mm diameter so there is one ready-made pin if needed. **Photograph 4** shows a 5mm insert pin in place and **photo 5** shows a range of sizes.

To make the inserts I started with a 30mm diameter mild steel bar turning a length about 60mm long to the 27mm diameter. I did temporarily remove the face plate from the table to check the fit. I preferred to make a length of material at this diameter and part off as required. I put a 5mm diameter hole in the centre.

The first insert was to be the blanking plate, so this was countersunk in the top face to fit the M5 countersunk screw I was to use for fixing it in place then parted off with the lathe centre in the tailstock to 5mm long. The finish on the rear of this was not as good as I would have wished but it fitted and was flush with the top of the plate, so it has remained.



Spanner lifting tool.



4
5 mm diameter insert.



5
Selection of insert pins.

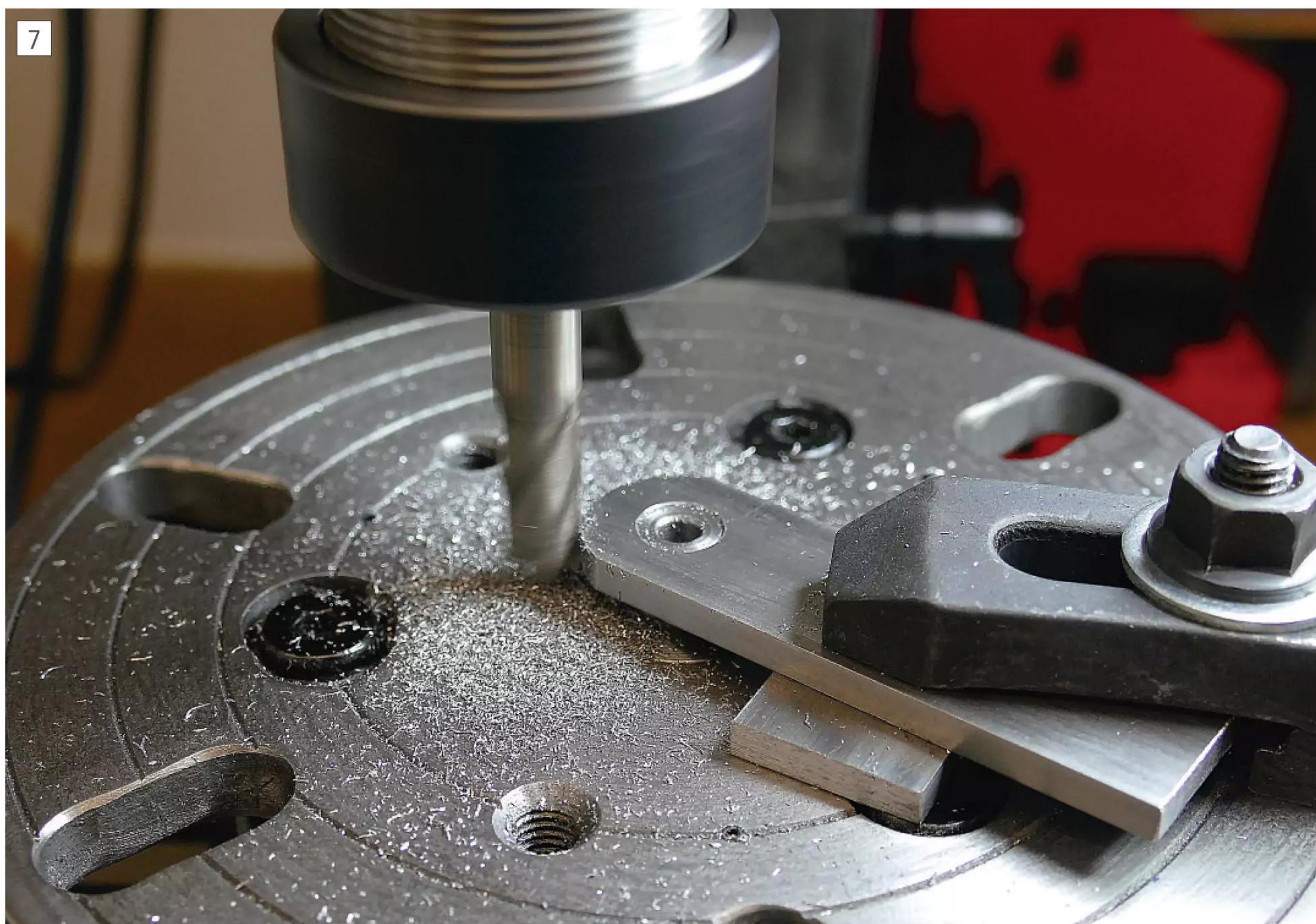
I decided to use a piece of 7/8" x 3/16" flat stock for the packer under any workpiece to keep the milling cutter above the table surface. This actually measured 22.13mm x 4.75mm. The width is immaterial, but the height is important. As this has to be the height of the material support section of the insert. I also determined to

make this support 2.5mm wider on the radius for the workpiece to fit but allow a radius to be formed quite close to the original hole drilled in it. After facing off the blank insert I turned the insert to suit a 10mm diameter hole. This meant that the support diameter would be 15mm. the locating pin 10mm diameter and a shoulder between the

two at 4.75mm long. This would then be parted at something longer than the 5mm recess depth to be faced back at the next stage. I continued this with the other inserts then reversed each in the chuck to face off to the 5mm recess depth. The final insert (8mm) can be seen being parted off in **photo 6**.



6
Parting off the last insert (8mm).



Forming radius using 10mm insert.

Photograph 7 shows a workpiece with a 10mm diameter hole fitted into the insert and the end mill forming the end radius. In **photo 8** the finished radius and, minus the swarf, the insert can be seen.

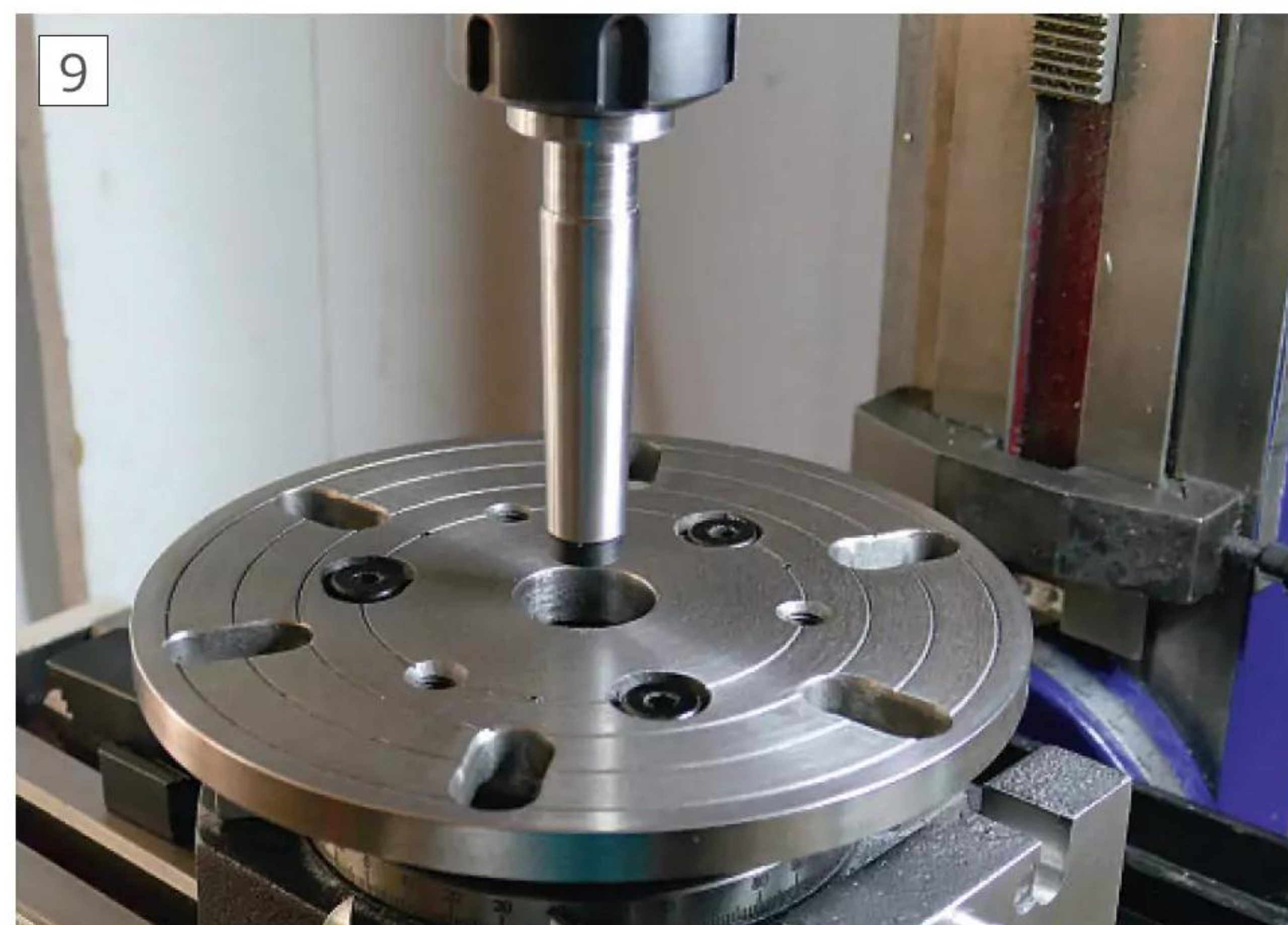
It seemed that the easiest way to ensure that the rotary table itself was centred correctly with the milling machine spindle was to again use a

number 2 Morse taper. The second blank arbour was accordingly turned down to provide a 15mm diameter upper section to be held in an ER32 collet. The rotary table is already located in the milling table slots and clamped down to the table, so the X and Y position is adjusted until the taper locates into the rotary table. This is a quick process providing care is taken to ensure that the taper pin does in fact

enter the table easily. After testing this a few times now it is possible to quickly achieve a concentricity of less than 0.051mm (0.002"). This is fine for most of my applications but can of course be improved if really necessary by using the DTI as is normal. **Photograph 9** shows the pin in use. **Photograph 10** shows both the faceplate centring pin and the table centring pin.



Radius completed - 10 mm insert.



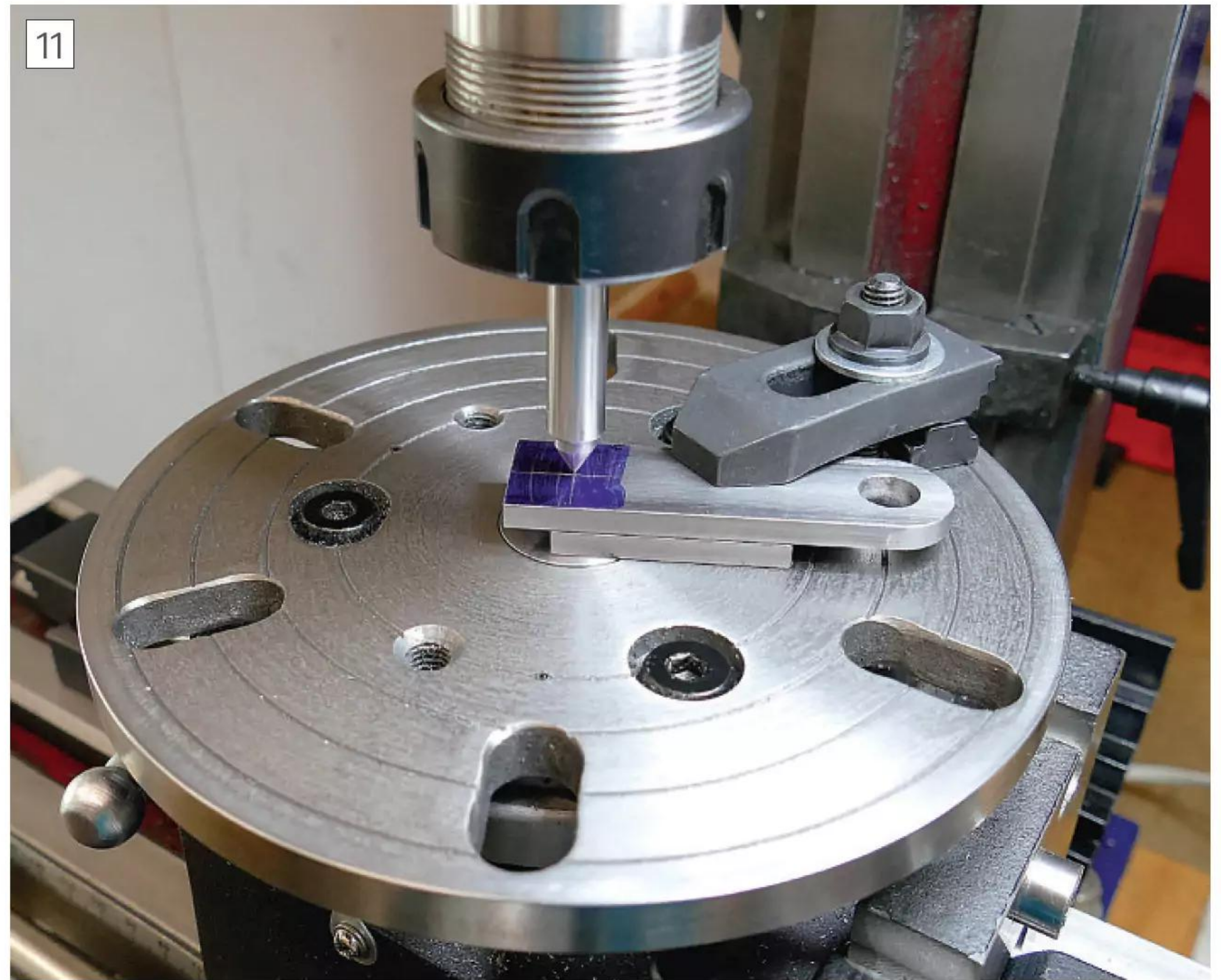
Using the table centring pin.



Faceplate and centring pins.

Details are shown in fig. 2 which also shows the use of the larger diameter ring in this pin. If perchance the taper fits too tightly the pin can be released from the collet and the improvised lifting tool used to ease the taper pin out of the table.

In cases where there is no fixing hole around which to form the radius for general work, the table is still centred by using the centring pin, but this is then replaced by a turned true centre this can be used to position the workpiece on the table by placing it onto the marked centre of rotation position of the workpiece. I made this from a 60mm length of 10mm diameter silver steel held in a collet chuck in the lathe. Additional clamping may be needed as



Setting up to form a radius without a centre hole.

the locating position will not be there and the piece will need supporting under the position to be radiused, **photo 11**.

This simple arrangement has given me

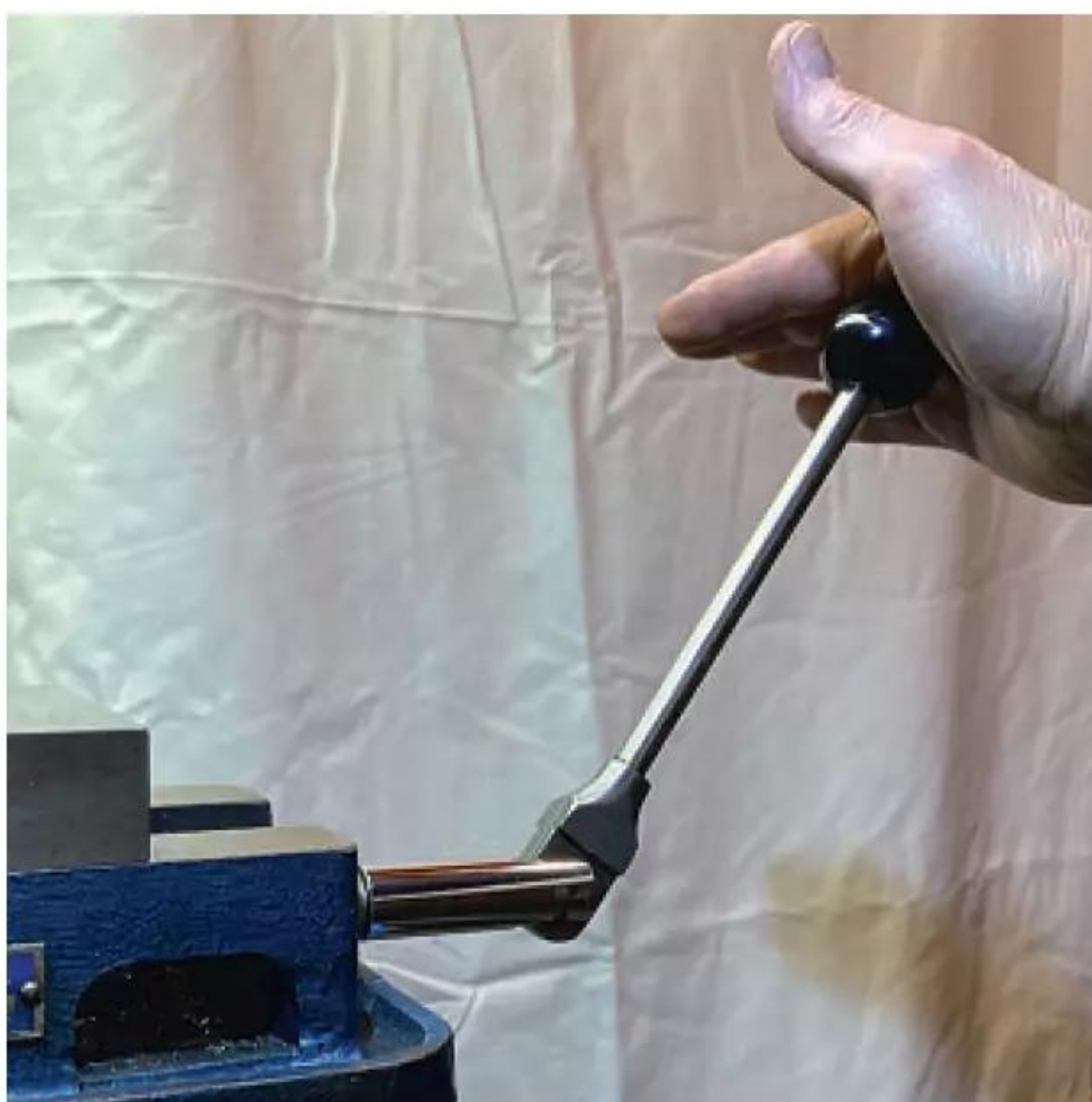
both a larger rotary table which is very useful and an easy means of locating a workpiece for rounding corners where it has a fixing hole or not. ■

In our Next Issue

Coming up in issue 346,
December 2024

On sale 15 November 2024

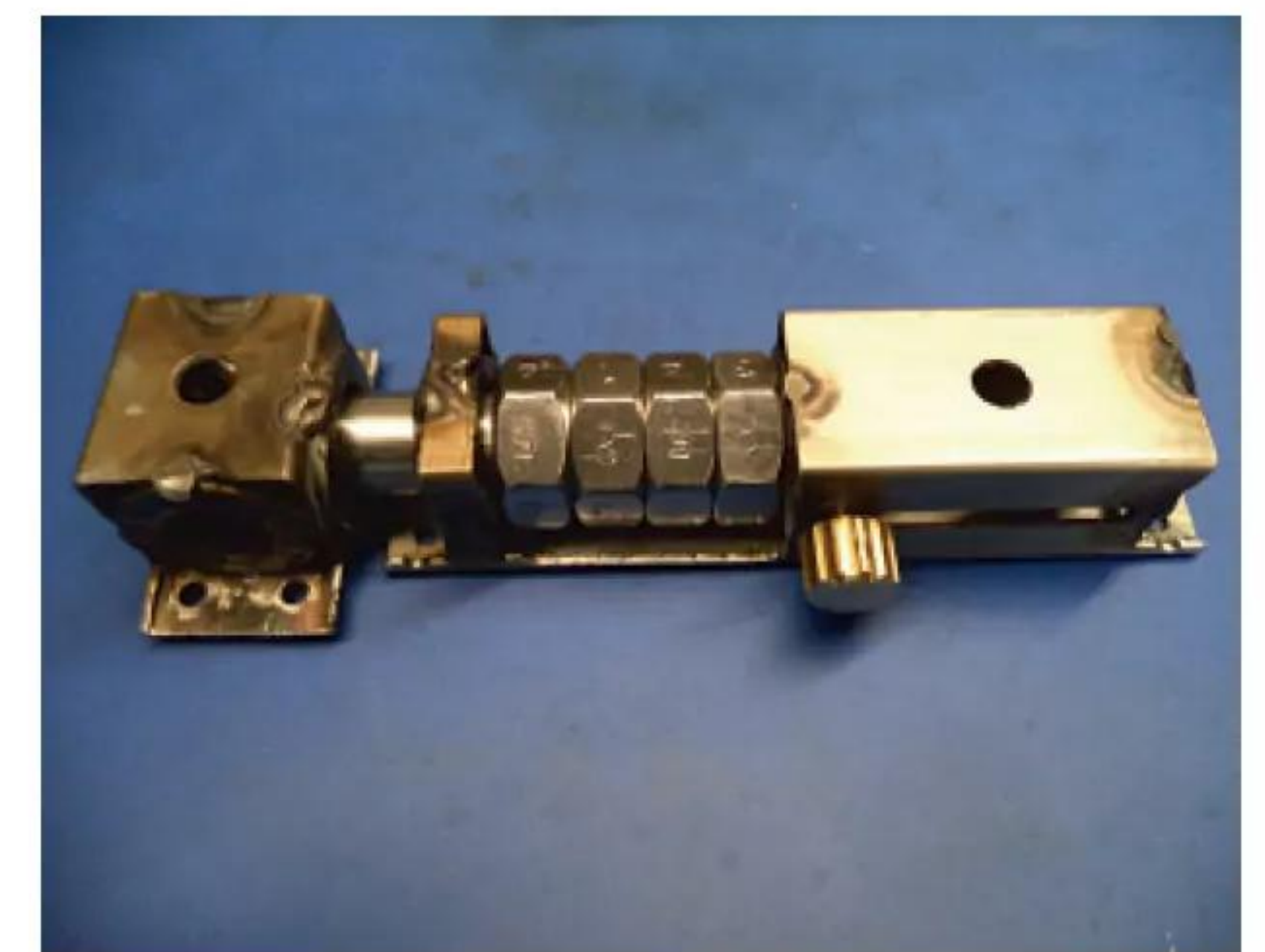
Contents subject to change



Make life in the workshop a little bit easier with **Greg Widin's** Universal Mill Wrench.



We could all do with a bit of extra cash these days; **Martin Berry** suggests some ways to make the hobby pay its way.



Improve the security of your workshop by making **Stew Hart's** combination door bolt.

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DON'T MISS THIS GREAT ISSUE-SEE PAGE 24-25 FOR OUR LATEST SUBSCRIPTION OFFER

Readers' Tips



Assembling 3D Printed Pipe Parts

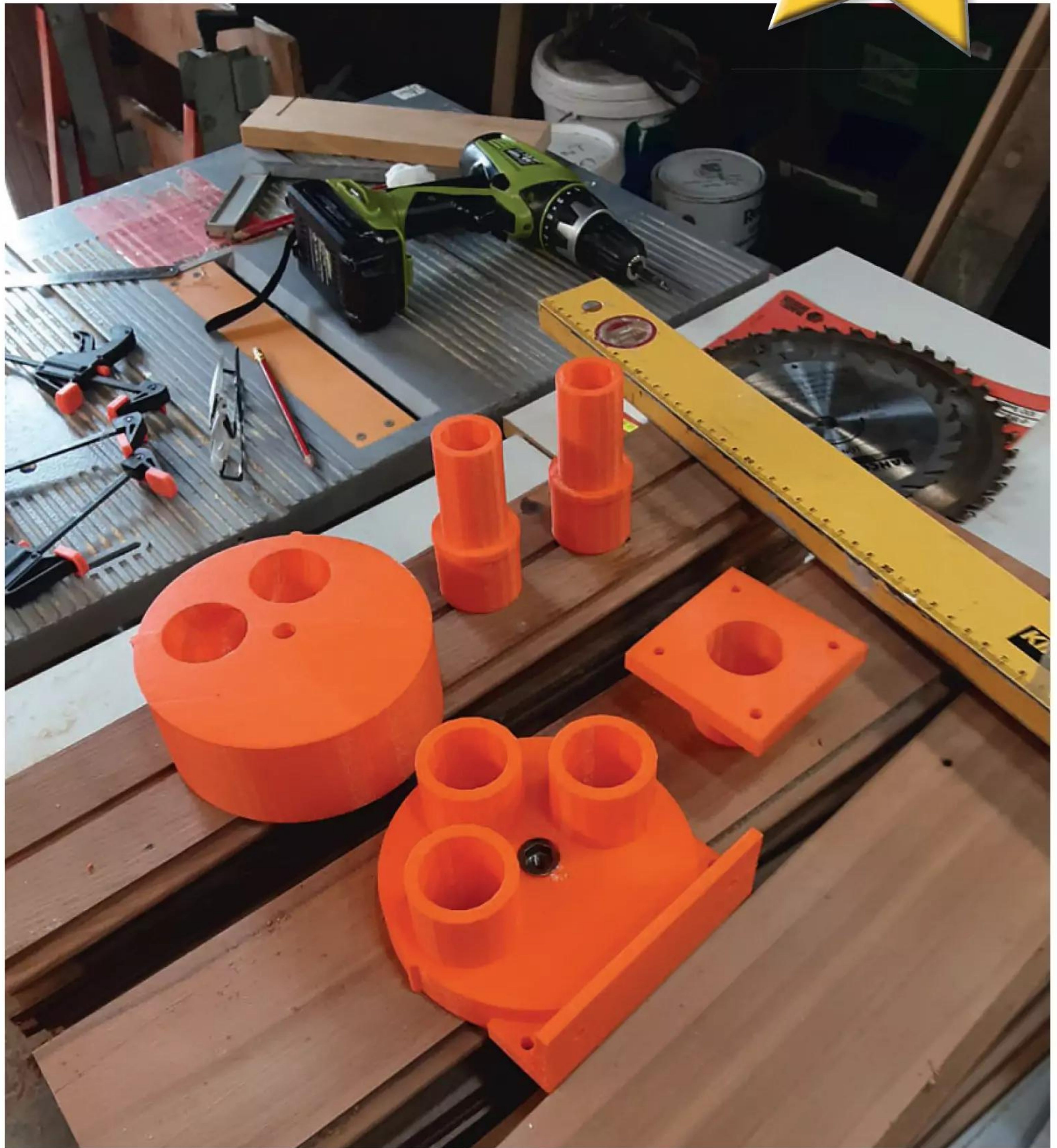
TIP OF
THE MONTH
WINNER!

This month's winner is Brian Hooper with a tip for easing the fit of 3D printed parts.

As part of adding a vacuum system to my mobile work bench I decided to make the air connection components with my 3d printer. After taking great care with my measurements I still found that the flexible tube connections were too tight to fit. I decided to insert the tubing into hot water to soften the plastic to assist fitting. I found the 3d printed part became soft but retained its shape. Making the final fitting easy.

The bottom line is dip tight parts in hot water to get that final fit.

Brian Hooper



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

Email your workshop tips to meweditor@mortons.co.uk marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. Don't forget to include your address! Every month we'll choose a winner for the *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.

Tool tip zero setting for DRO lathes



Re-purposing the original vertical support for the locking cam.



Finish machining the cam under CNC. A radius table could perform the same task.

Simon Davies completes the construction of his tool tip setting device.

The locking cam, **fig. 2**, relies on the machined surface under the bed normally used by the tailstock locking plate. Using a cam means that attaching the tool and locking it into place is a simple and swift process. The overall length of the locking cam should be slightly less than the maximum available space under the bed. The curved cam shape only needs to provide clearance to the cam when it is inserted into place and tightened by the M6 bolt. In use, the cam is rotated to be in line with the bed and the unit located on the V groove. The cam is then rotated 90° clockwise until it locks in the sheers and the bolt is tightened suitably.

I started with a piece of scrap plate offering a 20mm x 68mm free piece.

This was milled out using CNC but could equally easily been machined on a rotary table or even filed by hand. The arc of the curve is centred on the opposite corner of the rectangular

plate for marking out purposes. The centre hole was drilled and tapped for M6 and was mated with a M6 x45 cap screw. **Photographs 22 and 23** show the cam being machined from the

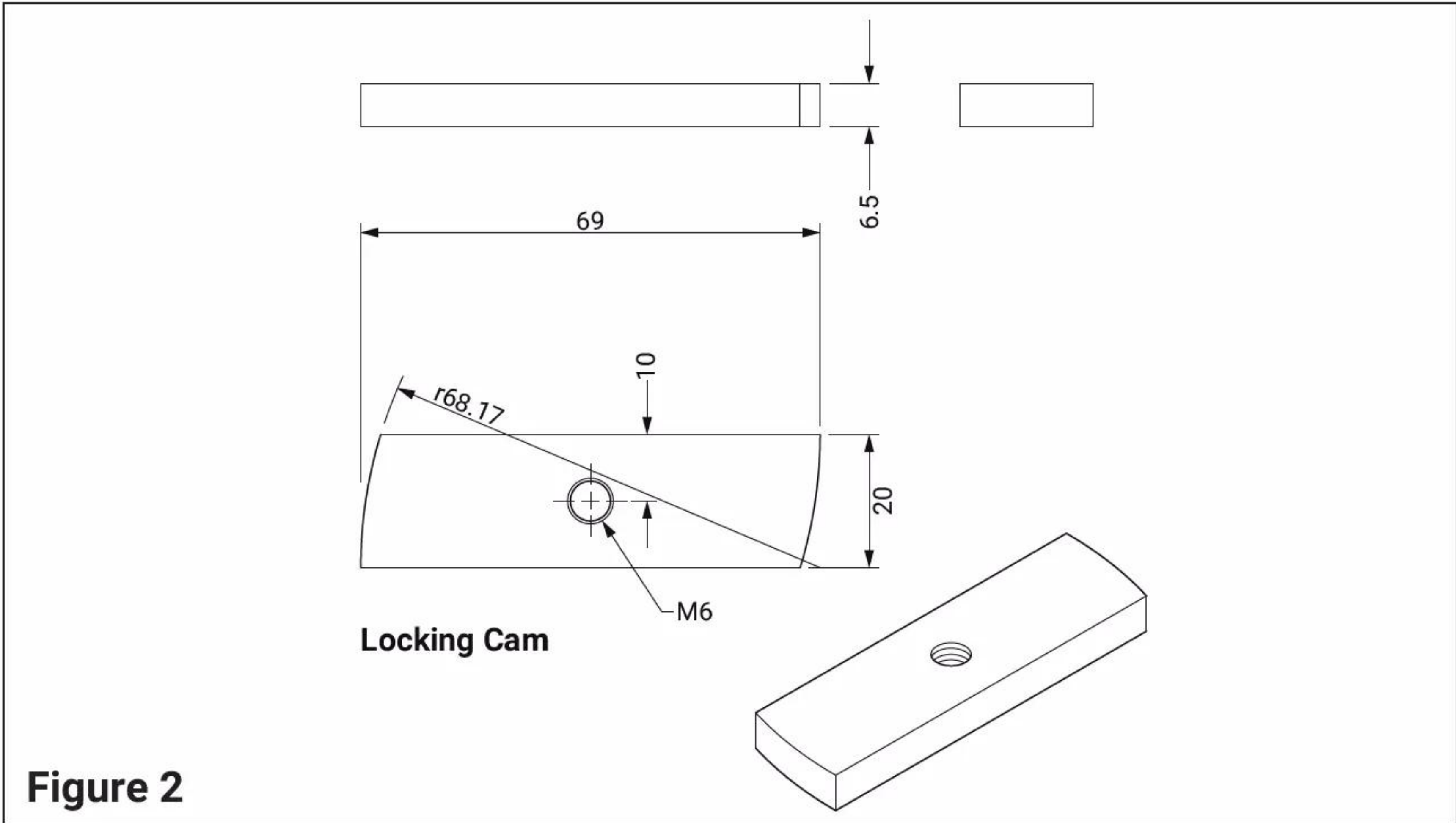


Figure 2

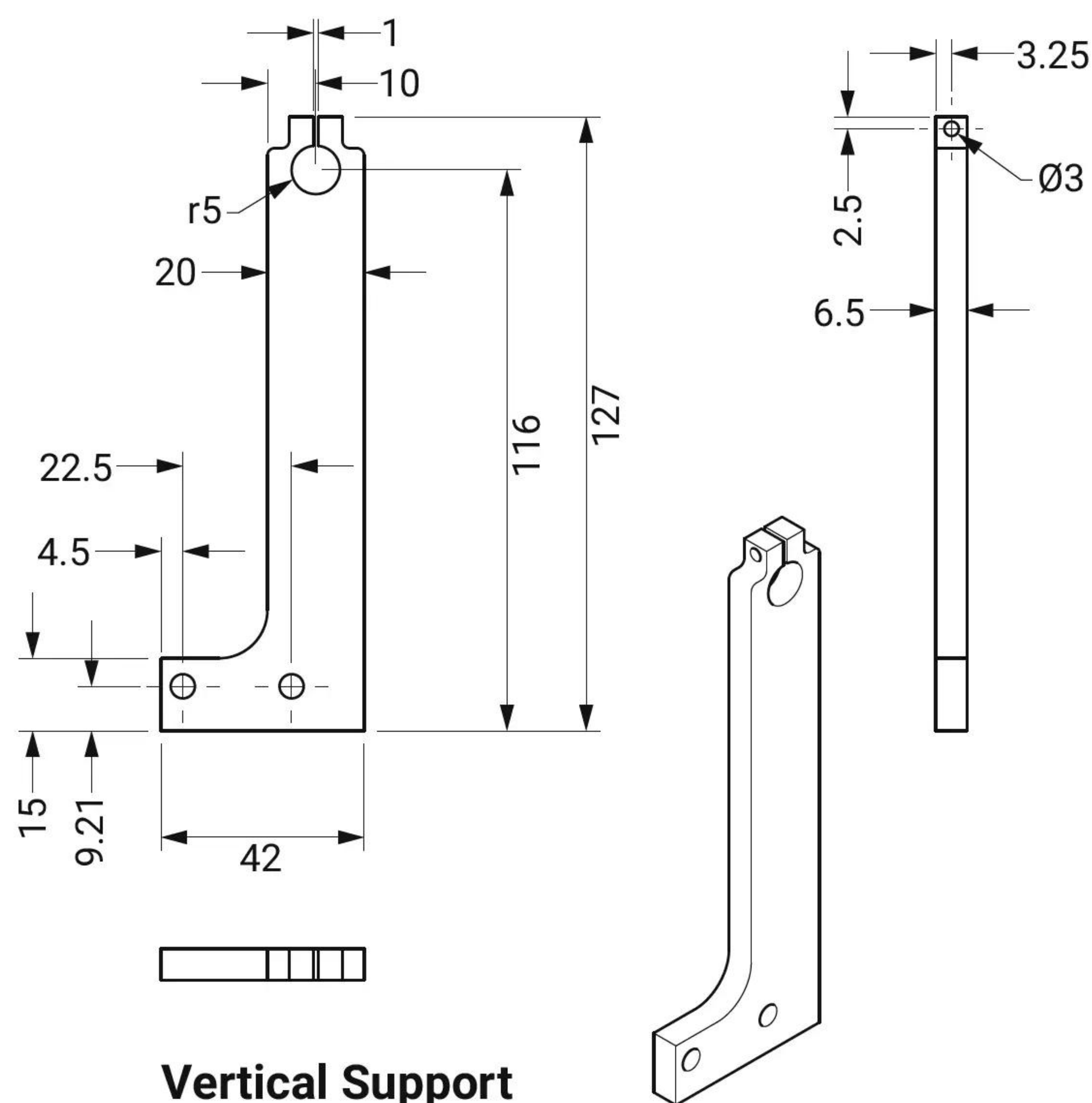


Figure 3

redundant initial version of the vertical support – waste not, want not!

Vertical support

This component, **fig. 3**, needs to present the optical switch bracket to the tip of a tool and needs to crank across from the bed bar to give sufficient access. It has a pinch bolt solution to allow the optical switch mount to be set to the optimum height. This could be redesigned to merge these two components if desired.

This was adapted from the original version 1 and has a few unnecessary holes now. It is a simple piece of aluminium or steel plate cut to shape as shown in **photos 24** and **25**. I drilled the mounting holes towards the bed bar first (M5 clearance) then clamped the two components together and onto the lathe bed. A lathe tool was used to scratch the centre height to allow a precise position for the switch mount hole. In spite of this, the hole is actually too low on mine, compensated by twisting the switch mount. The principle was excellent, the workmanship was unfortunately lacking!



Start again by cleaning the surface of a piece of plate.

The pinch section at the top was created by drilling the M3 tapping hole followed by a M3 clearance hole to half depth, **photo 26**. Final step was cutting the slot with a slitting saw in my case, but a hacksaw would give equal service.

Optical switch mount

This component, **fig. 4**, incorporates the mount for the switch and the shaft and its holder as well as a pin to connect to the vertical support. A 3D printed version was initially created to understand what the final steel version needed to look like

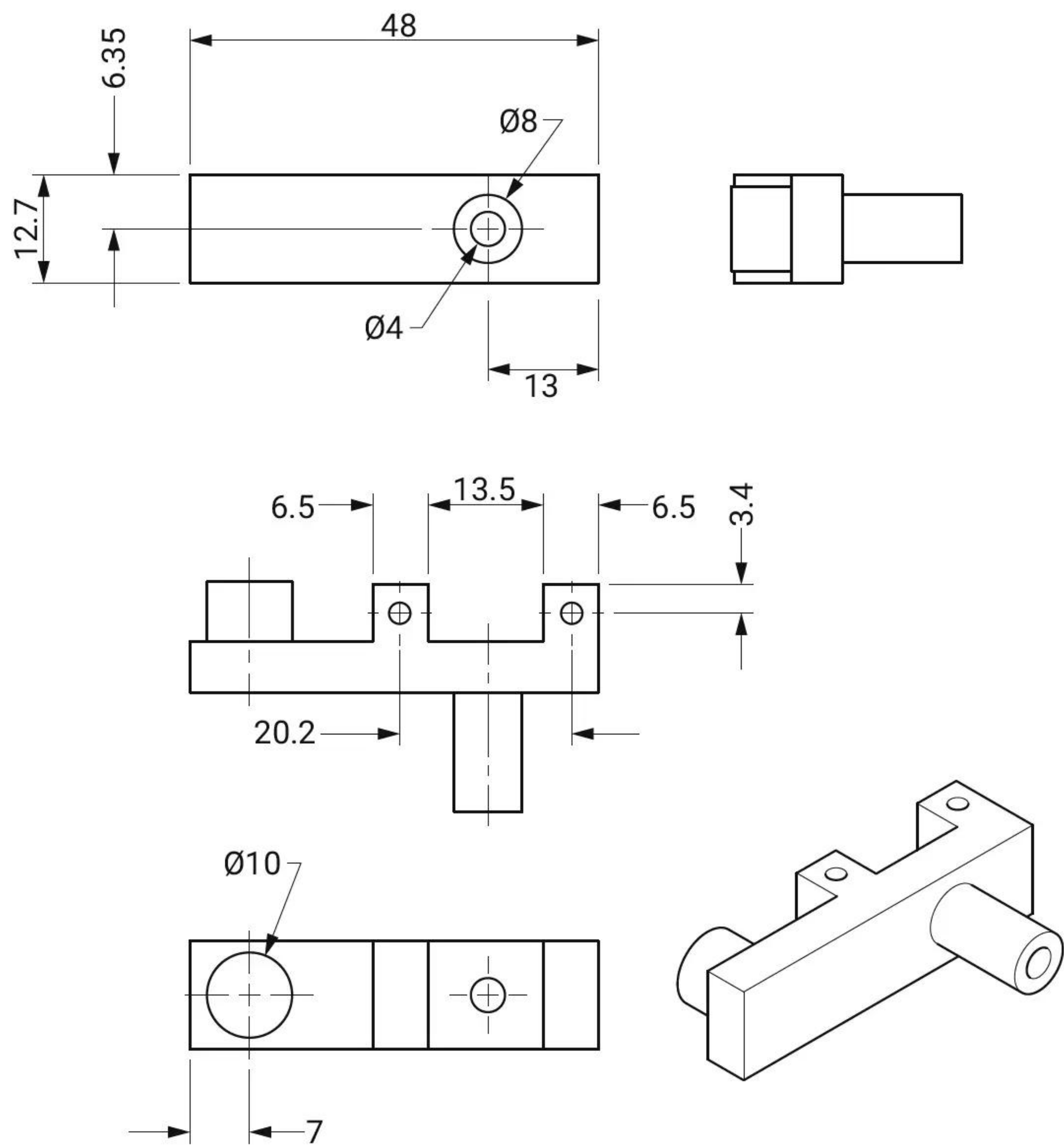
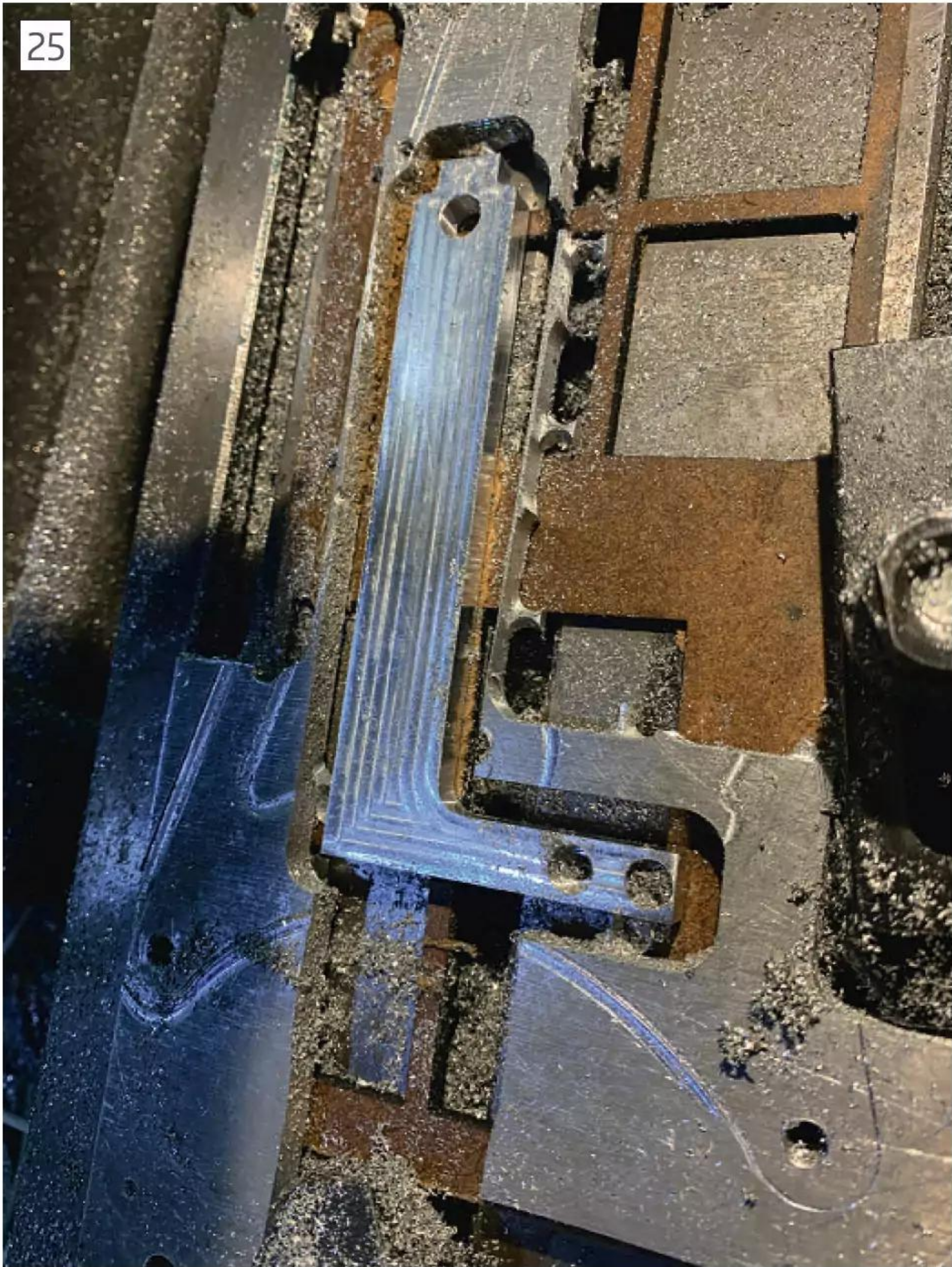


Figure 4

Optical Switch Mount



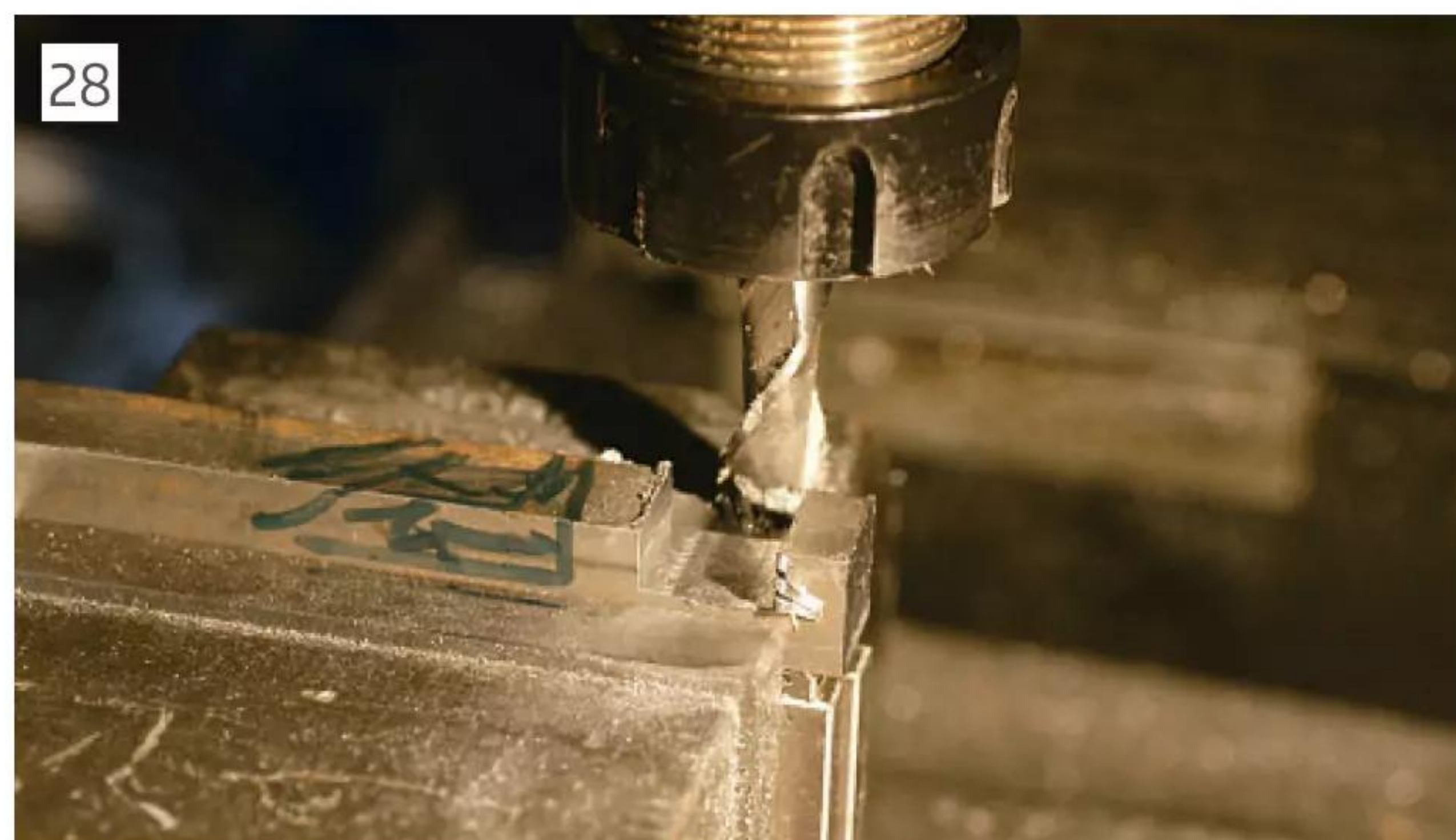
Revised vertical support ready to be removed and cleaned.



Milling the pinch screw hole.



3D printed concept piece – swiftly printed and it shows!



First stage in making the optical switch mount. Lots of marker pen to show what to remove.



Slots hacked out and holes machined for the two rods. The 3D printed concept piece in the foreground.

as shown in **photo 27**. I used a length of square section bright mild steel (BMS), drilled for the holder at one end and a short shaft at the other.

The back side of the BMS was machined away to give space for the optical switch and to allow it to be bolted in place with the mounting holes in the switch pcb as shown in **photos 28** and **29**. I contemplated a 3D printed mount, but it was easier to do it this way on this occasion. I did however model the optical switch board and mounting holes to get my head around how to actually attach it. Screws are critically spaced to ensure that they fit the circuit board and place it in the correct place for the beam-breaking rod to pass through the optical switch. I used M2.5 socket cap screws because I

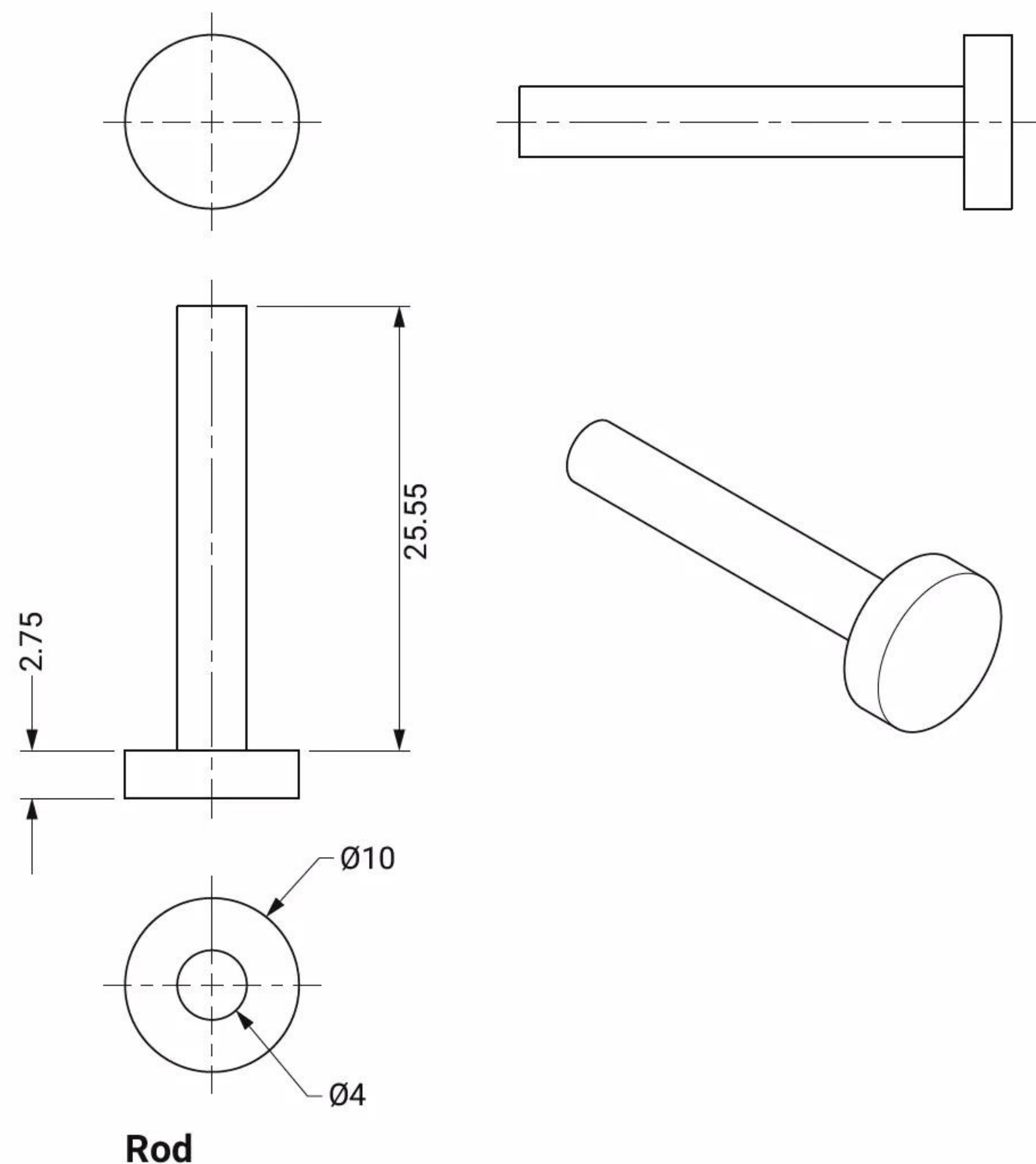
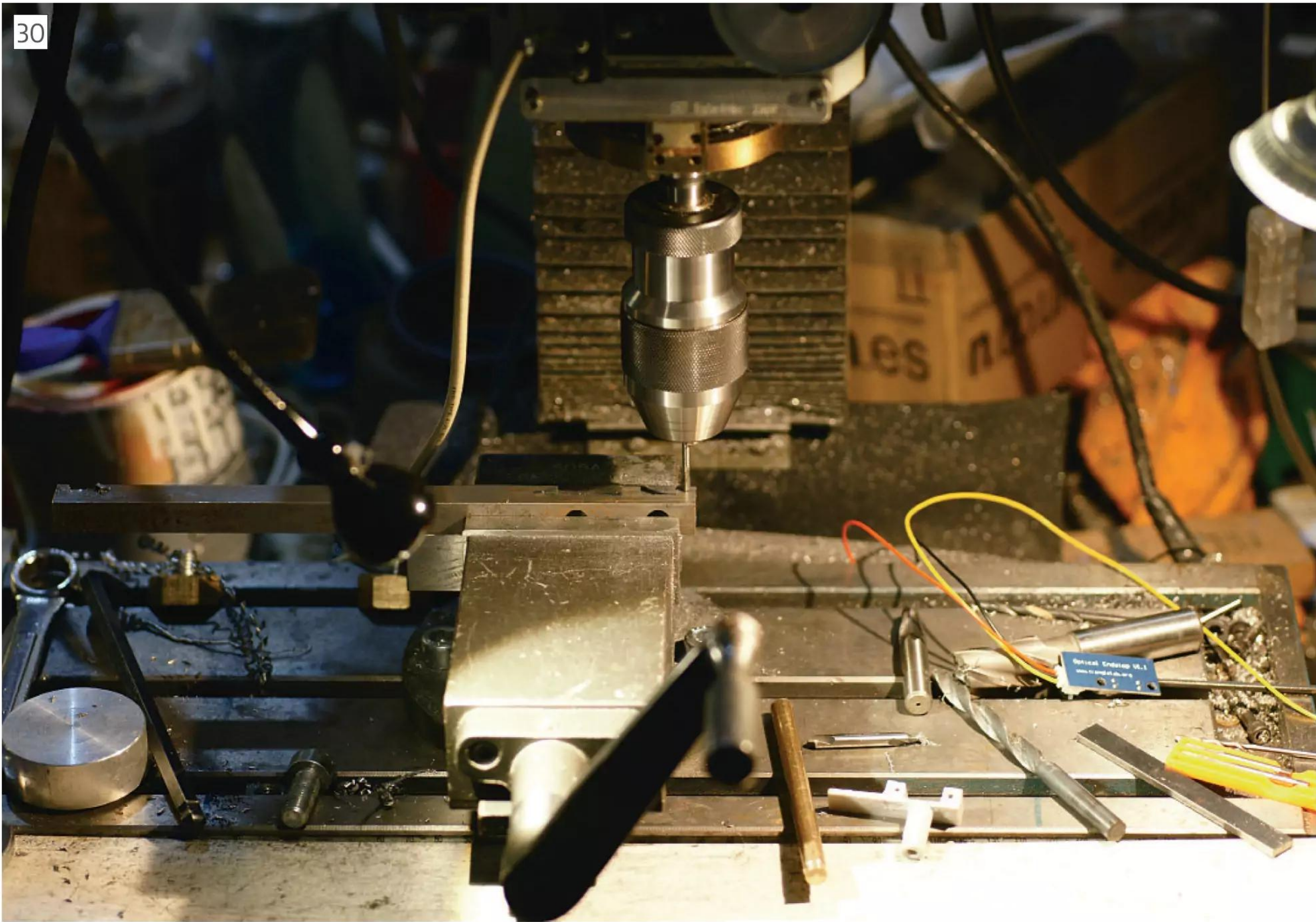


Figure 5



Tapping optical switch mount holes.



Ready for silver soldering. The rod shaft bar was a bit undersized so I knurled it for a fit prior to silver soldering.



Drilling for the beam breaking rod. The parting off tool is photo-bombing and plays no part in the machining.

had some to hand but anything similar with a small head would do, **photo 30**. Two brass shafts were silver soldered into place and are shown in **photo 31** ready for soldering. The rod shaft holder was held in a 3-jaw chuck and drilled and reamed to suit the 4mm beam-breaking rod, **photo 32**.

The rod, **fig. 5**, is a length of 4mm silver steel with a brass cap glued to the

end with one of the permanent fix glues similar to Loctite 601. It was then faced flat to a good finish.

Setup and Use

Start by putting a piece of scrap rod in a 3-jaw chuck and skim with a suitable tool. Apply several cuts to ensure that any tool spring is accounted for. Measure the rod as

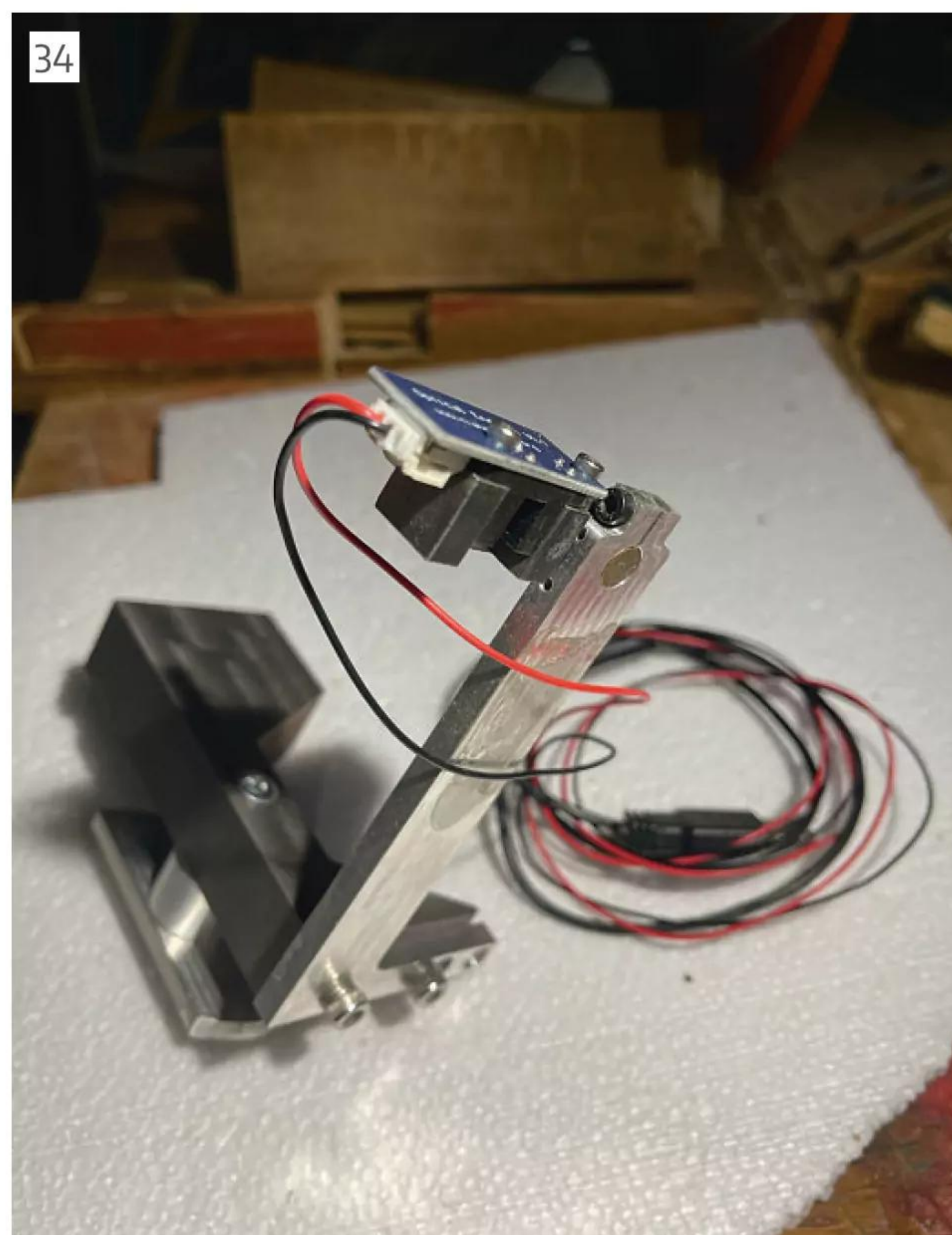
accurately as possible and enter this value on your DRO.

Connect up the optical switch assembly. In my case, it operated with 5V so a USB cable was butchered and grafted onto the optical switch connector. Power is supplied via a redundant USB power block.

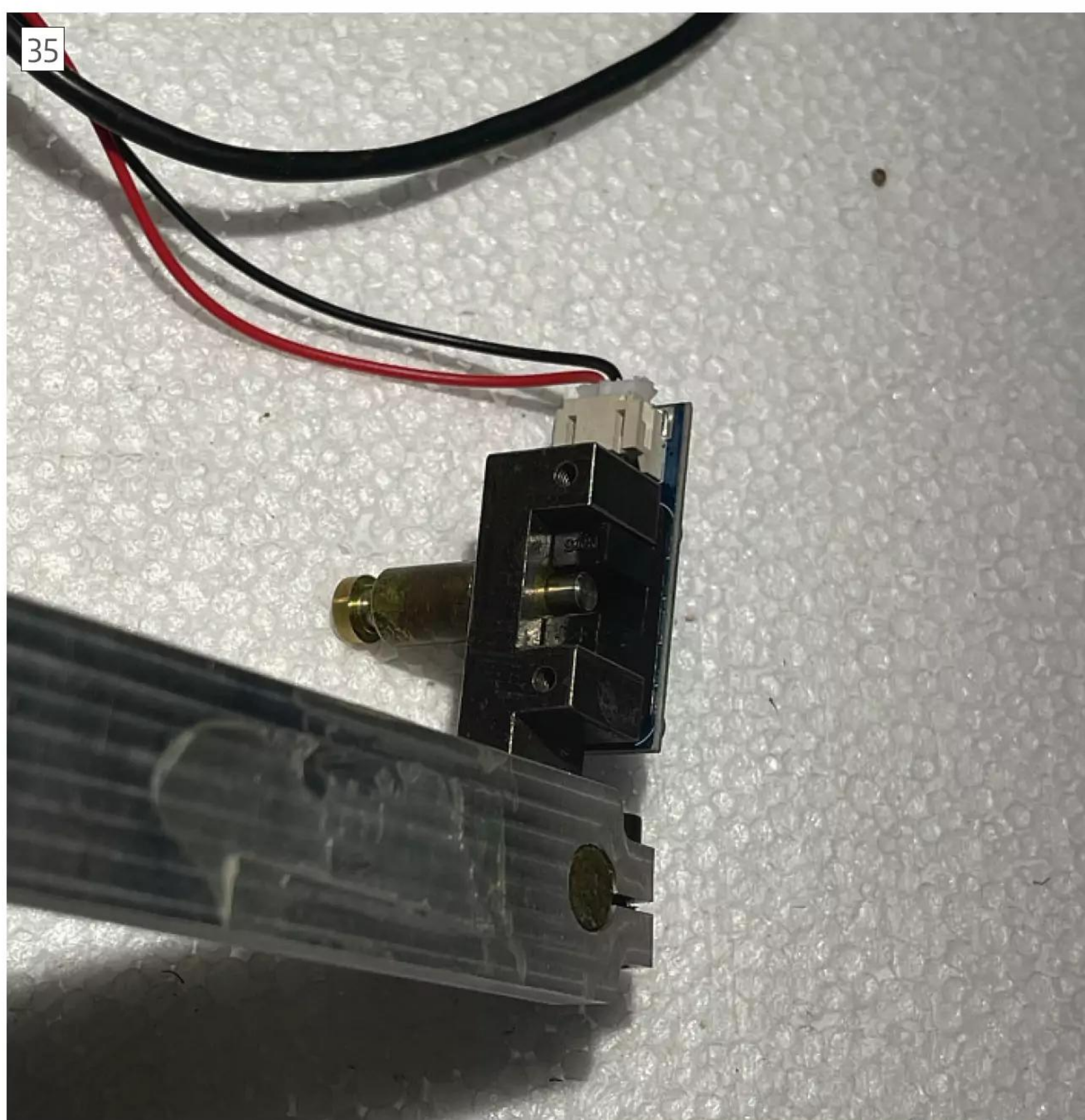
Photographs 33, 34 and 35 show the final version ready for use.



The final version waiting for use. The cables could be tidier but they are never used when anything is running.



Rear view showing the optical switch board mounting.



View showing the plunger at the point of breaking the optical switch beam.

Calibration

Assemble the tool and install on the lathe bed. If the locking cam dimensions are correct, a simple nip up with a ball ended hex key should suffice to hold the tool in place. It is worthwhile using roughly the same amount of force each time if possible, to ensure that the beam bends by the same (tiny) amount.

Photograph 36 shows how it should be installed. Manoeuvre the lathe tool so that it touches the rod and advance the cross slide until the beam is broken as indicated by the optical switch tell-tale LED as shown in **photo 37**. Note the value on the DRO and then wind the cross slide out and back, repeating several times to ensure that the results are consistent. Once satisfied with this, note and save the DRO reading as the standard offset. I have noted this value in permanent marker on the bed bar of the tool to ensure it isn't forgotten!

Tool Use

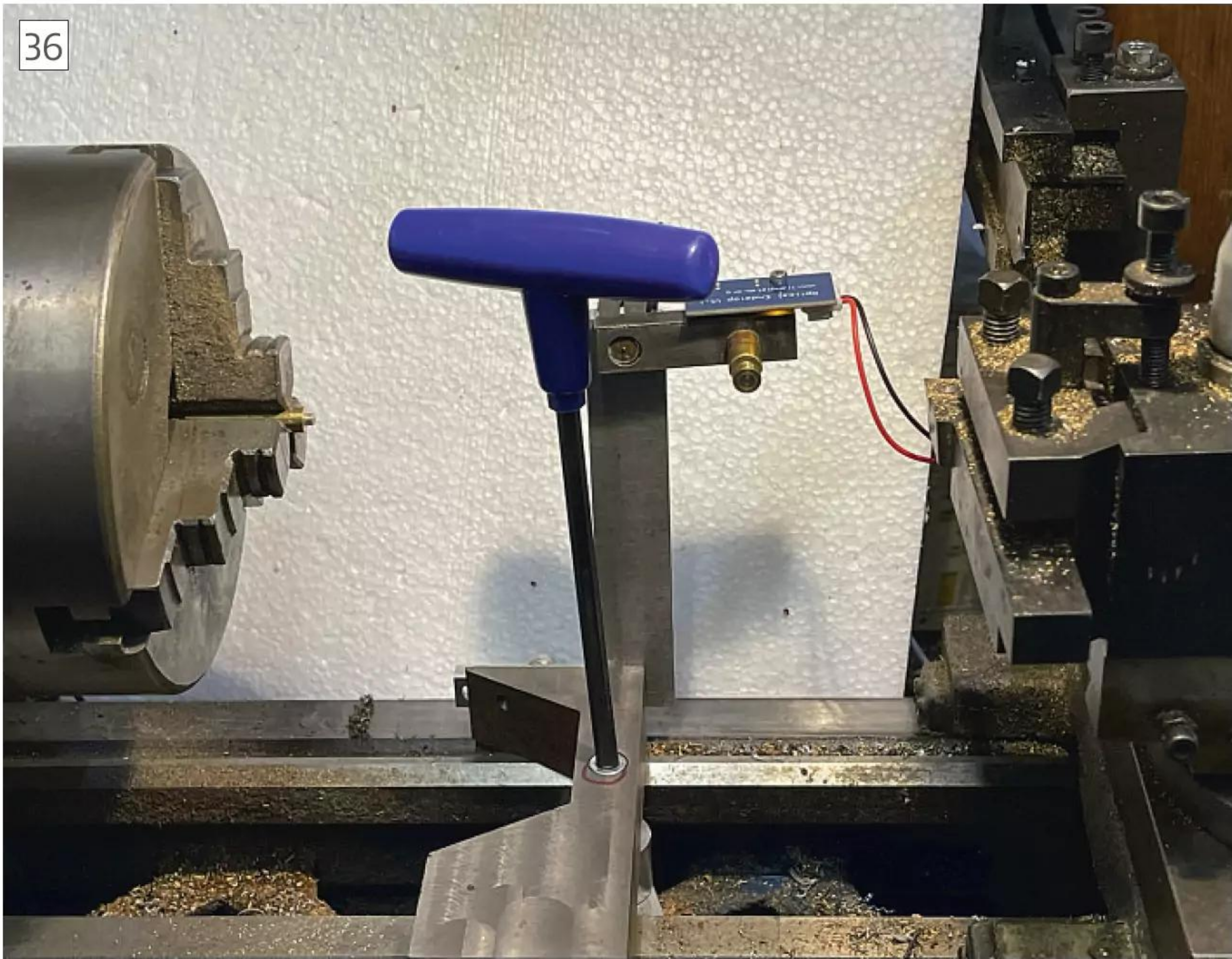
Insert a toolholder with the desired lathe tool and adjust the toolpost angle if necessary. Install the zero setting tool and advance the cross-slide until the optical switch

illuminates. At this point, the tool tip is at the standard offset distance from zero. Enter the DRO standard offset and the new lathe tool should now be calibrated for use.

Conclusions and Final Thoughts

If I were to start again, I would contemplate casting up an aluminium block rather than having sundry components all bolted together. However, this was in the way of being an experimental solution and, as my three versions show, not one that I got right in the first place. Secondly, as ever, beware of what you find on the internet. Even though I found people with experimental results showing microswitch repeatability far better than I ever achieved, their circumstances differed from mine and should have only served as a guide, and not the absolute truth.

Overall, I feel this is a worthwhile tool and means that I can reliably change tools and continue to use the DRO settings from earlier tools, even if I have

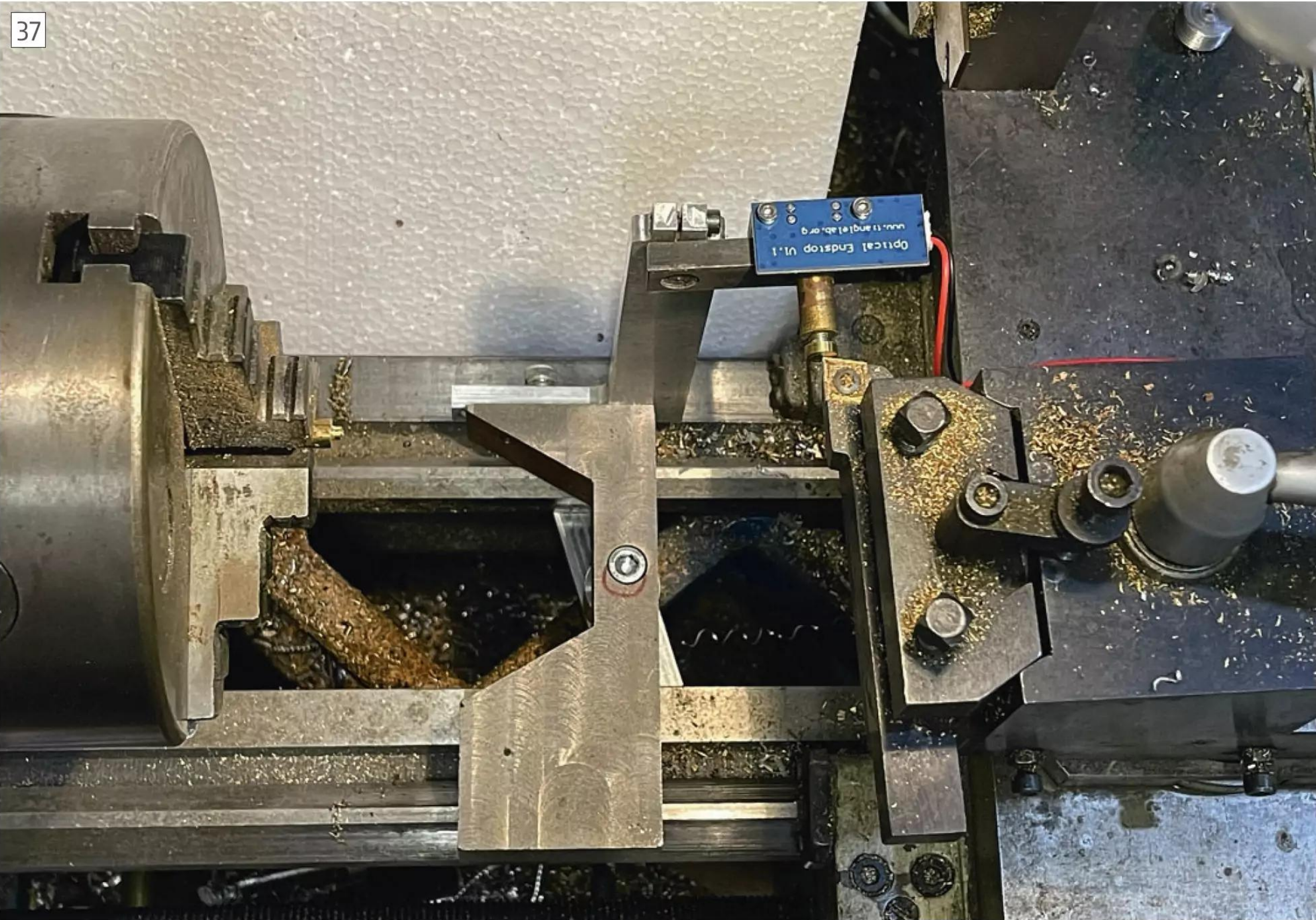


A T bar is useful for installing.

twisted the toolholder or changed the compound slide angle.

So, in summary, I'm really pleased with

it and think it's great – but to quote a certain lady's response to a judge "he would say that, wouldn't he?". ■



Getting close to tripping. The glow of the LED can just be seen mid-way along the front of the pcb.

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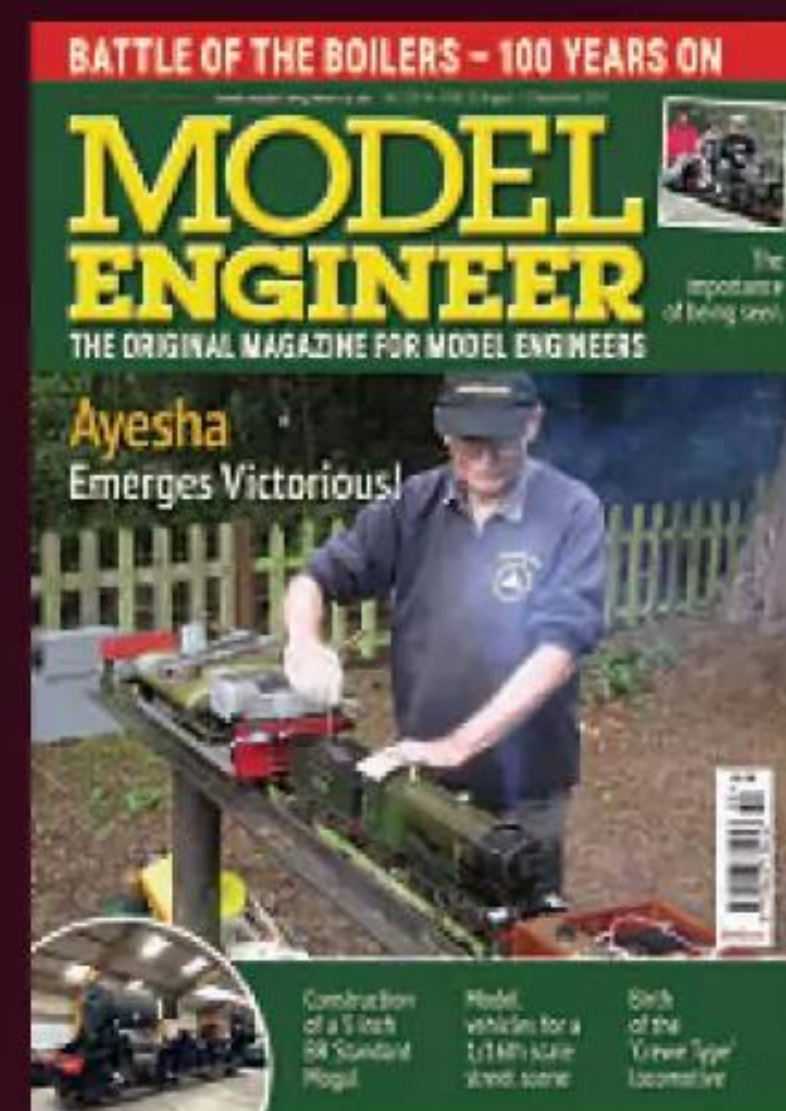
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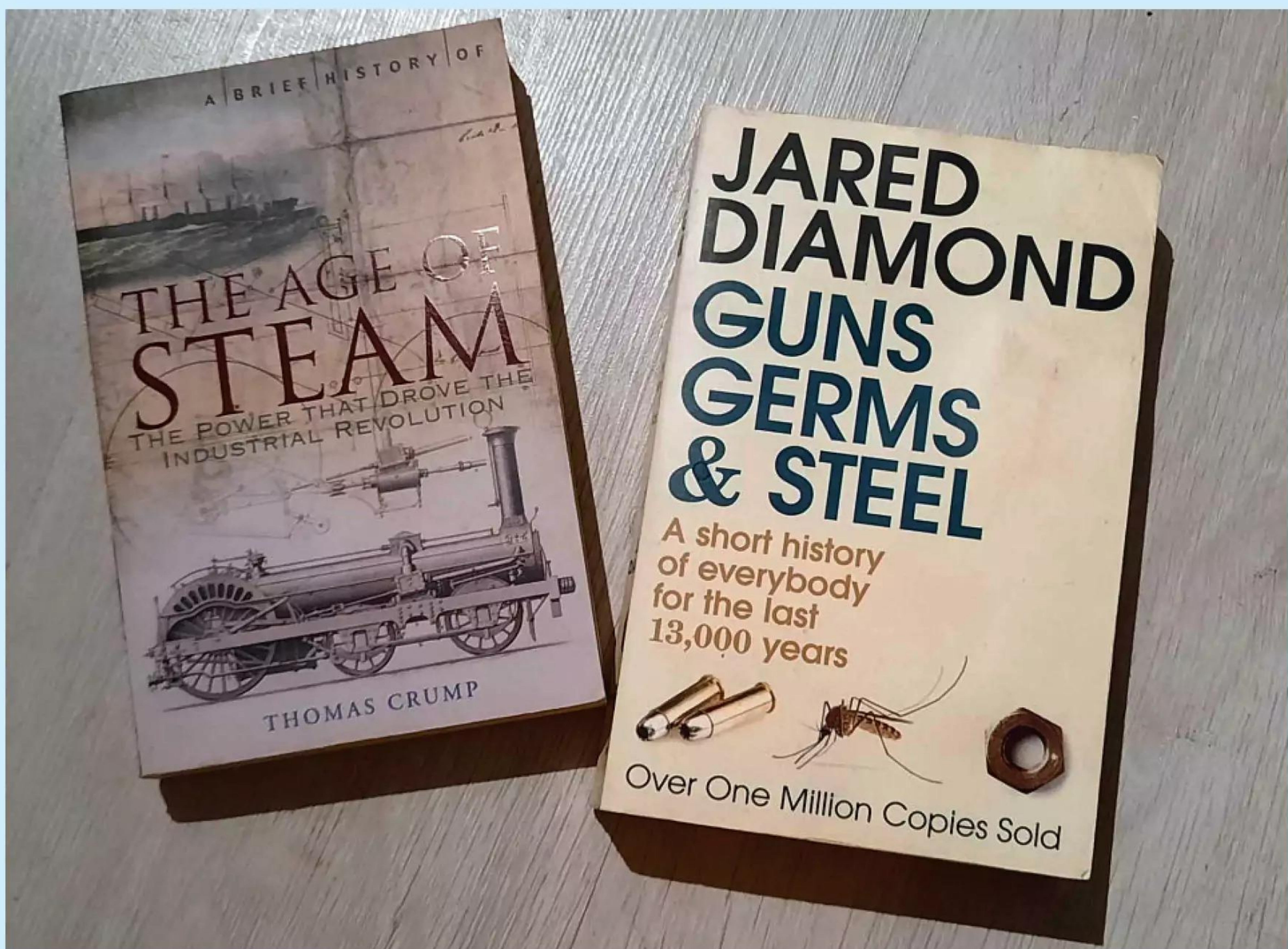


Scribe a line

YOUR CHANCE TO TALK TO US!

Readers! We want to hear from you! Drop us a line sharing your advice, questions or opinions. Why not send us a picture of your latest workshop creation, or that strange tool you found in a boot sale? Email your contributions to meweditor@mortons.co.uk.

Fireside Reading 2



Dear Neil, further to Wing Nut's letter asking for suggestion for winter reading, may I offer the following suggestions to him.

Any of the publications by the Rolls Royce Heritage Trust.
Stages To Saturn by Roger E Bilstein. A Technological History of the Saturn Launch Vehicles.

The Spinning Mule by Harold Catling. A history and description of an amazing machine.

Pegasus - The Heart of the Harrier by Andrew Dow. The story of the engine.

Matthew Briggs, by email

Many thanks Matthew and Andrew. I'll throw in two suggestions of my own, that put engineering into the context of global history, rather than our more usual 'heart of the Industrial Revolution perspective. The first is The Age of Steam, by Robert Crump; secondly an even wider view in terms of time and perspective: Guns, Germs and Steel, by Jared Diamond.

Online Indexes

Here's a reminder that David Frith's latest Index for Model Engineers' Workshop can be downloaded on from the Forum at www.model-engineer.co.uk – just select Forums and then the Model Engineers' Workshop topic. Alternatively scan the adjacent QR code.

If you prefer the paper indexes, don't worry, David will be producing these in the future, carrying on Barry Chamberlain's sterling work.



More Information on Hardness Testing

Hello Neil, Thank you for publishing my article on hardness testing in MEW 343. I inform you that there is an article about hardness measuring in the N°80 issue of MEW with all the comparison charts between the different units, this information could be added to my article or in "scribe a line" if too late.

Jacques Maurel, France

Thanks Jacques, you were just too late for this to accompany your second article in MEW 344, but here's the information for readers. The article by Phil Amos is very comprehensive and covers the history, methods and systems of hardness measurement. It is a very useful complement to your measurement devices.

Just For The Record

Hi Neil, I was going through my 45 records so today had a go at making your weight, as featured in MEW 342, see my pic.

Geoff Warner, Nottingham



Fireside Reading

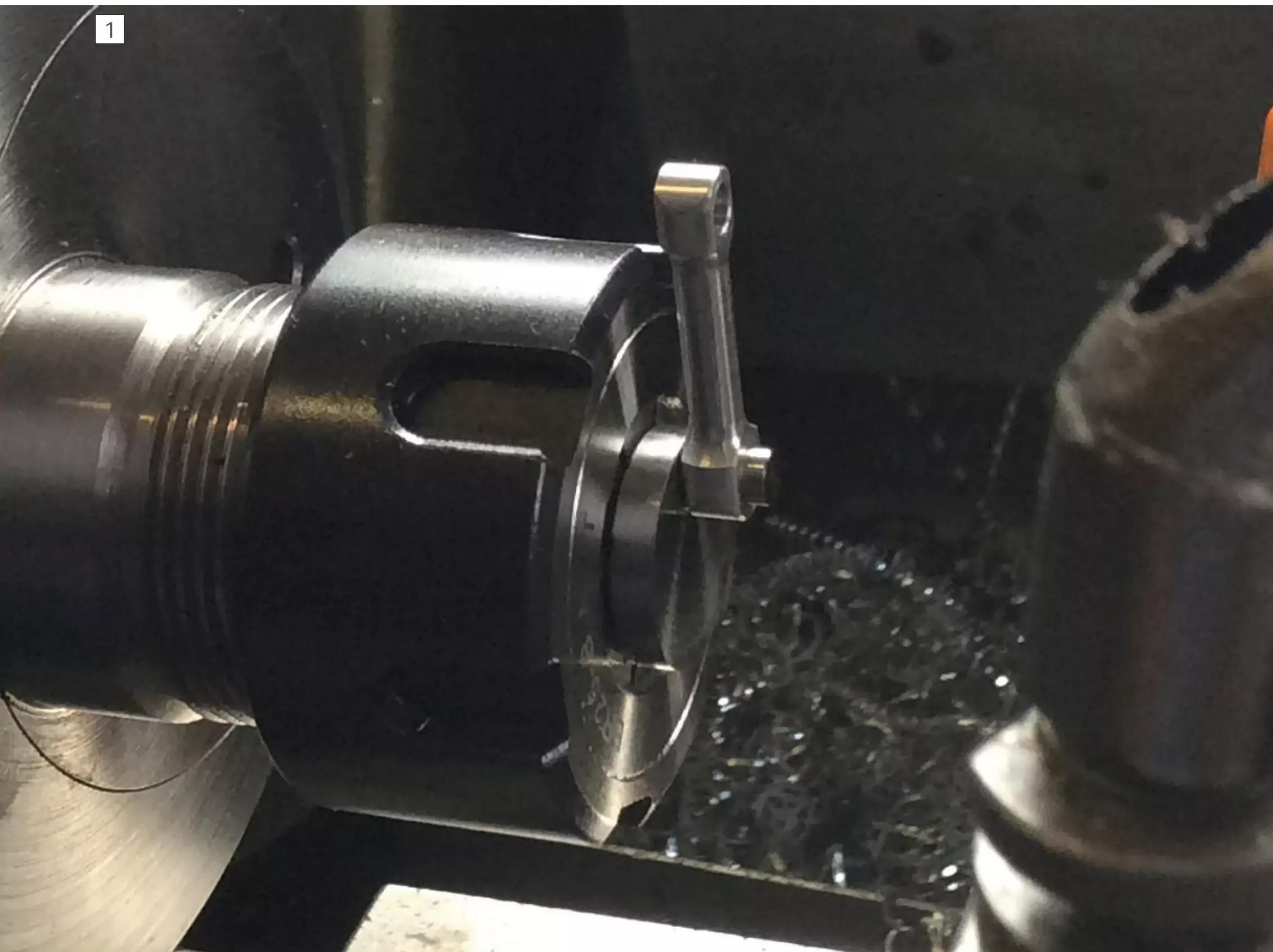
Dear Neil, regarding the request from "Wing Nut" for suggestions as to reading material for the winter may I suggest "A Treatise on the Steam Engine" by John Farey, published in 1827, and available as a reprint. I have learnt more about early engines from reading this than from any number of the more popular books written during the last fifty years. It certainly answered many of my nagging doubts about how early engines were both operated and, as interestingly, how the technology was then understood.

Andrew Williams, by email

The Stevenson Trophy Competition 2024 – The Results!



The late John Stevenson



Bernard Towers.

We can now share the results of the 2024 Stevenson Trophy Competition. This is the fifth time the trophy funded by readers and members of the www.model-engineer.co.uk forum in memory of John Stevenson has been awarded.

In accordance with John's feelings about competitions and 'glass case models', all entries had to be a piece of practical workshop equipment i.e. a tool, jig, fixture or a modification to or accessory for an existing piece of equipment. The entries were all profiled in issue 343,

September 2024, and online voting, open to all readers and forum members, ended on the 30 September.

Voting was initially brisk, but then went a bit quiet, but we had a big rally at the end of September with nearly a third of the votes arriving in the final weekend!



Brett Meacle.



Bob Reeve.



This year's winner Bernard Towers with the Stevenson Trophy following his previous win.

This year there were clear front runners, but with all the other entries close behind. I can announce the winners as:

First Place: Bernard Towers' Eccentric Chuck, **photo 1**.

Second Place: Brett Meacle's Tailstock Tap Holder, **photo 2**.

Third Place: Bevel Gear Test Rig, **photo 3**.

This is the first time the Stevenson Trophy has been won twice by the same person, with Bernard retaining the trophy for a second year! **Photograph 4** shows him with the Trophy and his

entry for the previous competition, and indexing head.

Congratulations to everyone who entered; Bernard will be represented the Trophy at this year's Midlands Model Engineering Exhibition. ■

Extended Length Tee Nuts for a Milling Machine Table

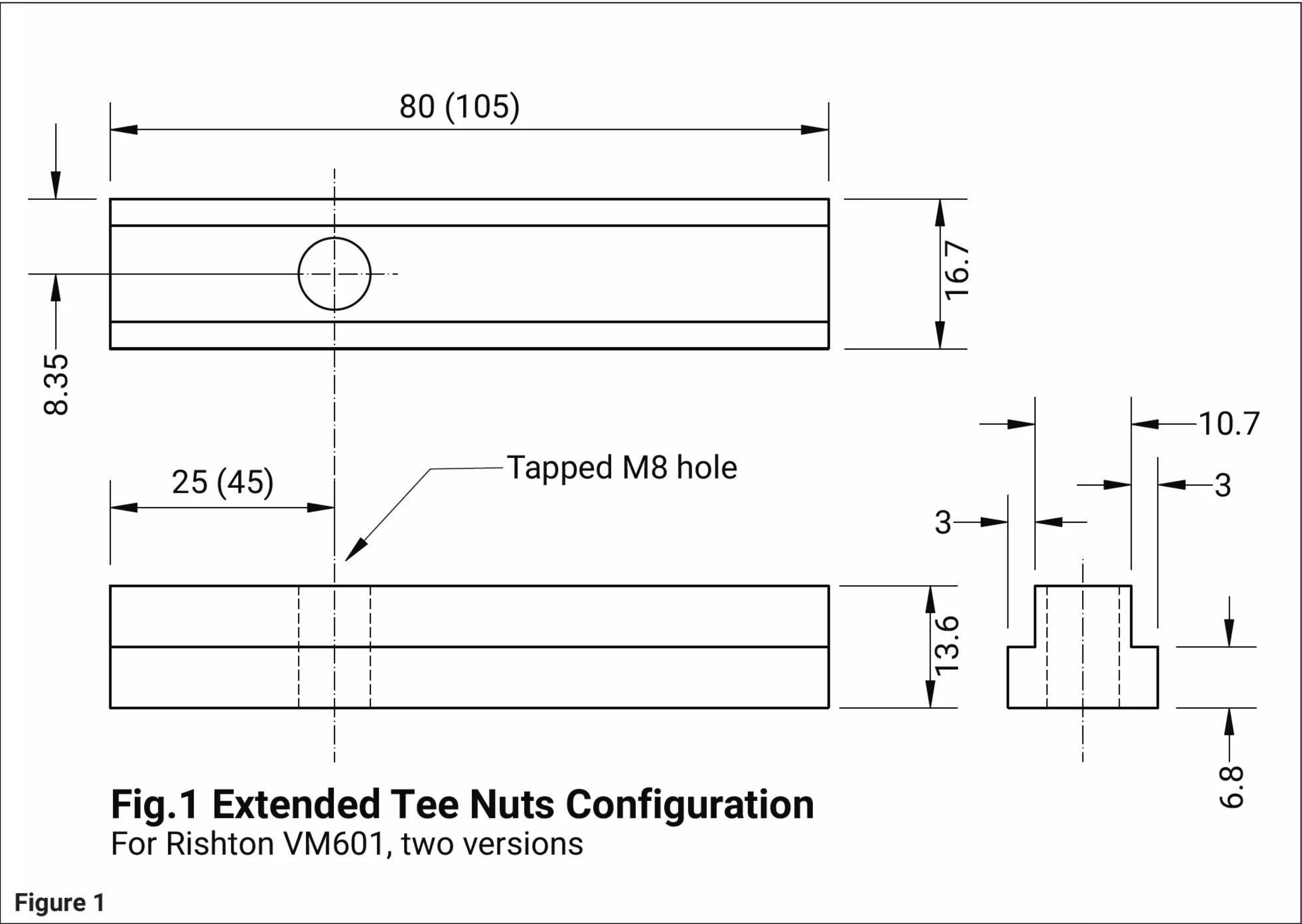


Keith Keen makes extended length tee nuts for his cast iron milling machine table to avoid the possibility of tee slot damage.

I have always understood that one way to clamp a workpiece to a milling table is as shown in **photo 1**, using clamping bars on the workpiece, with a support at the back and using tee nuts in the table tee slots with studs and flanged nuts. However, I recently came across an old MEW article by Mike Haughton and David Jones (MEW 186, February 2012) regarding broken machine table tee slots. As they say, milling machine

tables are usually made of cast iron, and not steel. And that although cast iron is strong in compression it is weak and brittle in tension, and it is not uncommon to see machine tables with broken tee slots. What is more, as Steve Fisher has described (MEW 189, May 2012), it is very difficult to repair a broken cast iron milling machine table. I can easily imagine that with the arrangement shown in photo 1, with the small tee nuts (which can be

seen to be slightly canted) that the upward force from tightening the fastening nuts could cause a tee slot in the machine table to burst. But this would not happen if the tee nut lengths were extended so that the ends of them were below both the clamped work piece and the clamping supports. For this reason, I have made some extended length and well-fitting tee nuts in mild steel for my Rishton VM601 milling machine table.



I actually made two sets of extended tee nuts, one set with lengths of 80 mm for use with short clamping bars, and another set with lengths of 105 mm for use with longer cranked clamping bars. These two sets of extended length tee slots are shown in **photo 2** along with the commercially available tee nuts that I have used previously. On my milling machine, a thin plate can be removed from one end of the machine table, so that useful pieces of any length can be inserted into the tee slots.

Figure 1 shows the dimensions of the extended tee nuts that I made for my particular milling machine table. Of course, these dimensions might not be appropriate for other types of milling machine.

Photograph 3 shows the longer 105 mm tee nuts in use with cranked clamping bars that are longer than the clamping bars shown in photo 1. It can be seen that the tee nuts are fully underneath the clamp bar supports, and also below the plywood sheet under the workpiece, which is there to prevent accidental drilling into the machine table.

Making the extended length tee nuts was quite straightforward. I made these from 3/4 inch mild steel square bar, by first cutting slightly oversize lengths with a disc cutter and then facing the pieces to the required 80 and 105mm lengths (not critical) in the lathe, with the bar section being machined held in a 4 jaw independent chuck. Following that, milling was carried out in the vertical milling machine using a 20 mm slot drill and a 20 mm end mill, and with the bar section held in a milling vice. Some time ago I purchased a pack of assorted metric sized square-section key steel bars which I cut to suitable lengths for use in the milling vice to raise up the workpiece to a suitable height, which I used for this task. However, I find that I always need to tap the workpiece down with a rubber hammer while tightening the milling vice, to ensure that the workpiece is properly level. Drilling and tapping were also carried out in the milling vice, but this time with small square section wood blocks under the workpiece. The holes were drilled 7mm and then tapped M8 using a tap guide holder as described in MEW 313 (March 2022). ■



Workpiece clamping on the milling machine using the usual size of tee nuts in the table tee slots.



The two sets of extended length tee nuts that were made for the Rishton milling machine table, shown with the small tee nuts that were used previously.



Clamping using the longer length tee nuts with cranked clamping bars.

Restoration of the Wheatley Viaduct



Extensive restoration and repair work has been undertaken at the impressive Wheatley Viaduct, which has stood over the north west of the town for the last 130 years. The iconic viaduct dominates the Halifax skyline has been returned to its former glory thanks to major renovations funded by National Highways' Historical Railways Estate (HRE).

The condition of the 100 feet tall structure had deteriorated over time and a full programme of works, including refurbishment and waterproofing, were needed to keep it in good condition.

The line started from Holmfild, near Ovenden, running across Wheatley Valley on the Wheatley Viaduct,

travelling on to St Paul's Station at Queens Road.

The viaduct has been closed to the public since the 1960s for safety but has been accessed by trespassers and vandalised over the years.

Dave Martin from contractors AmcoGiffen explained "This was a big project, with more than 2000 metres of repointing completed, 100 metres of fractures repaired and more than 200 anchors installed. We also stripped, waterproofed and reinstated 1600 square metres of the deck."

Built for the Halifax High Level Railway in 1844, Wheatley Viaduct measures around 600 feet long with a slight curve. It was mainly used to transport coal, with

the last goods train running in 1960.

Ecologists carried out bat surveys in advance of the repair works to identify if bats are using the structure and to put in place measures to work around them and stop them entering the structure during the works. Four bat boxes were installed as part of the work and 95 bat crevices were left open for bats to use during the hibernation season.

The Historical Railways Estate (HRE) is a collection of over 3100 structures and assets which were once part of Britain's rail network. Since 2013 they have been responsible for looking after it on behalf of the Department for Transport. Many of the structures were built more than 100 years ago.

2025 Midlands GARDEN RAIL SHOW

The 2025 Midlands Garden Rail Show will take place on Saturday 1st & Sunday 2nd March again at the Warwickshire Event Centre.

This event attracts nearly 2,000 enthusiasts from all over the UK and offers visitors the opportunity to see layouts in the larger gauges and scales including Gauge 1, O Gauge, G Scale and more.



Once visitors have been inspired to build their own layout, they can visit nearly forty specialist suppliers at the show who are more than happy to guide them in the right direction of the best

product to purchase.

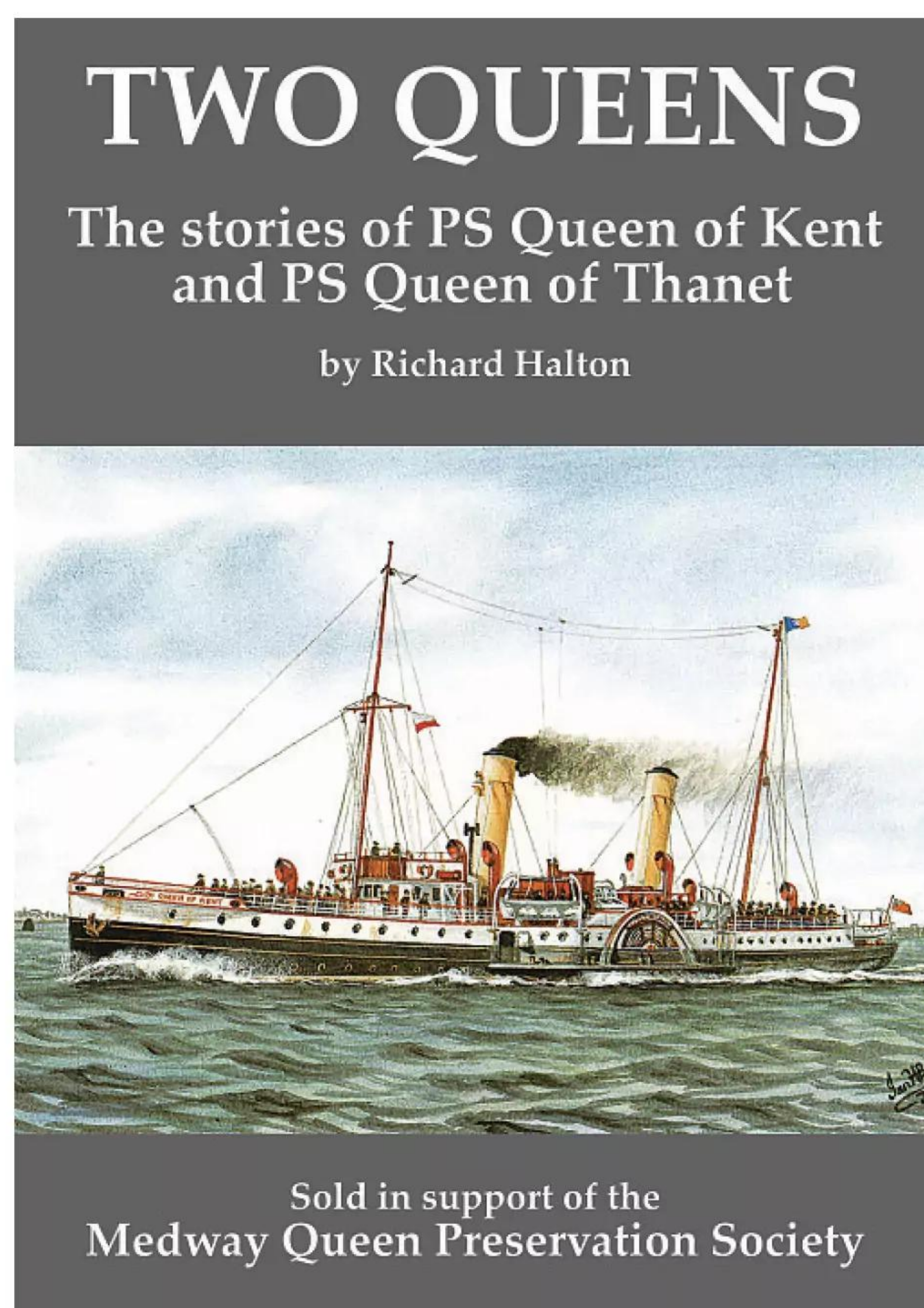
To see more information on exhibitors and layouts attending see www.midlandsgardenrailshow.co.uk
Advance tickets are on sale now!

Two Queens

This new book by Richard Halton details the history of two excursion paddle steamers operated by the New Medway Steam Packet Co. in the 1930s and for a short while after the war. PS Queen of Kent and PS Queen of Thanet were both built as Racecourse class paddle minesweepers in 1916. They were sold out of naval service in the late '20s for the excursion trade and then requisitioned again in 1939 to sweep mines once more. One went to Dunkirk in 1940 and the other survived a very close encounter with a V2 missile in 1945! After the war they were converted back to being excursion vessels and were briefly operated by NMSPCo. once again, before being sold on to Red Funnel. Sadly, they were both scrapped in the early 1950s.

The book tells their stories from build to final withdrawal. It is published by Mainline and Maritime, as was Richard's earlier "PS Ryde" book. The book is A4 format with 72 pages, laminated cover and more photos than the author expected to find!

The book is not a Medway Queen Preservation Society funded project, but sales will benefit the restoration and upkeep of the ship. You can buy the "Two Queens" book at www.medwayqueen.co.uk or you can buy in person at the Medway Queen Visitor Centre when it is open on Saturdays 11am to 4pm, last admissions 3pm). Alternatively, signed copies can be purchased by post, direct from the author, through the "Medway Queen West" support group. The book is priced at £18.95 plus £2.70 UK P&P. Please send a cheque, payable to "R. Halton", to 2 Drury Close, Hook, Royal Wootton Bassett, SN4 8EL.



Learning to love my Denford NovaTurn, Part 5

Mick Knights concludes his story of experiences with CNC on a Denford Novaturn lathe.

All the other tool offset values are established in the same way but are entered via the 'tooling' window. To demonstrate I'll set T07 (parting). Bring the tooling window up on the screen and click the coloured button for T07. Below this row of buttons there's a bar marked tool change, click this, where a prompt will ask if you want to change the active tool to T07, click OK. In the same way as T01 jog the tool to

the work piece and with the spindle running incrementally advance the tool until it just touches the reference face (photo 26) This time click the Z axis zero button in the tooling window to establish the Z axis coordinate of T07. Jog the tool to a position just above the reference diameter, start the spindle and incrementally advance the tool until it just touches. Click the X axis zero button in the tooling window, enter the same

reference diameter as T01 and click OK. The X offset of T07 is now set, **photo 25**.

While we're looking at T07, I'll show how to adjust the tool's position using the offsets. During prolonged machining cycles some dimensions may not correspond to the ones programmed, perhaps due to tool wear. There are two ways to rectify this, one is to edit the program by entering different dimensions for the diameter in question

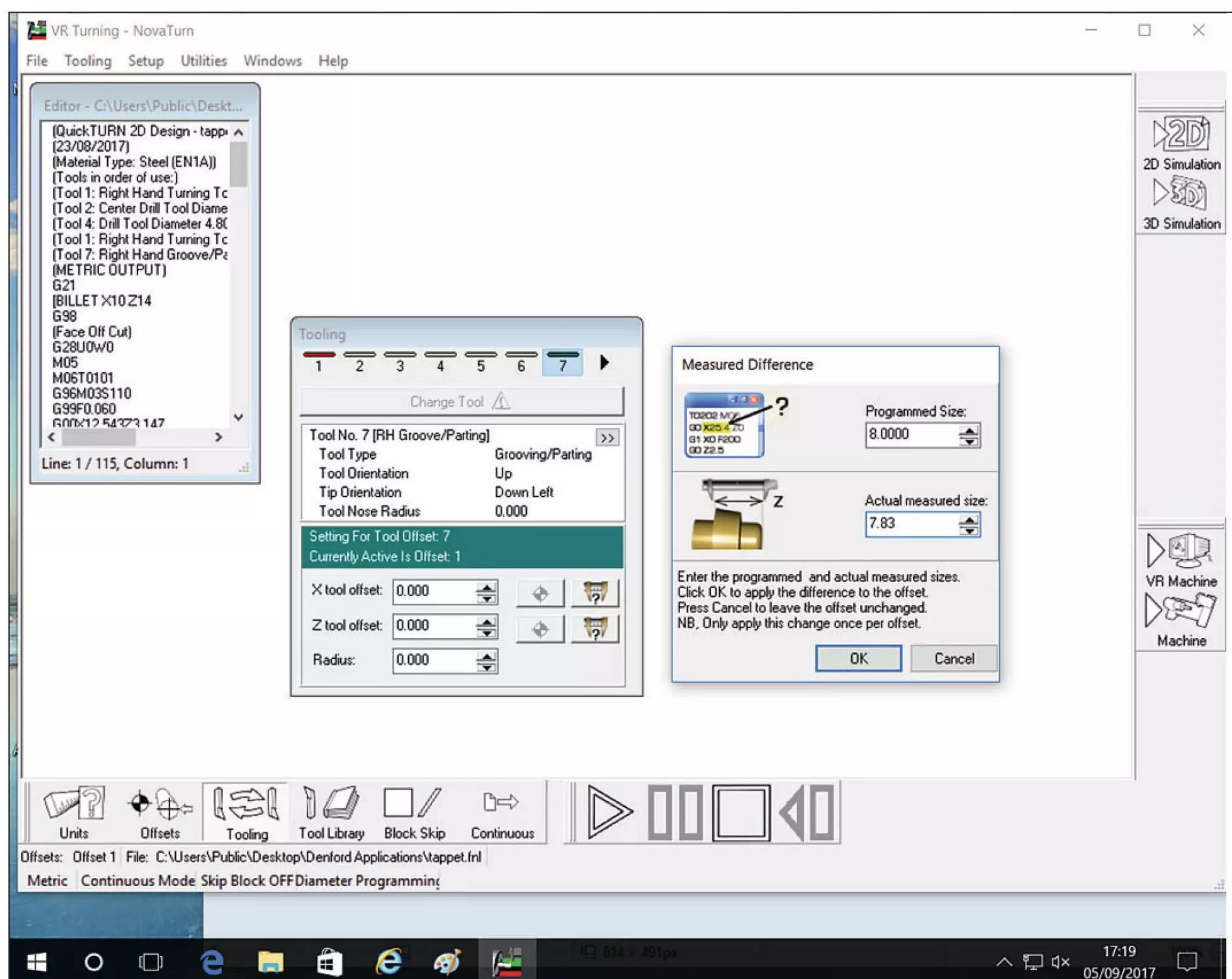


Figure 17. Entering relevant values

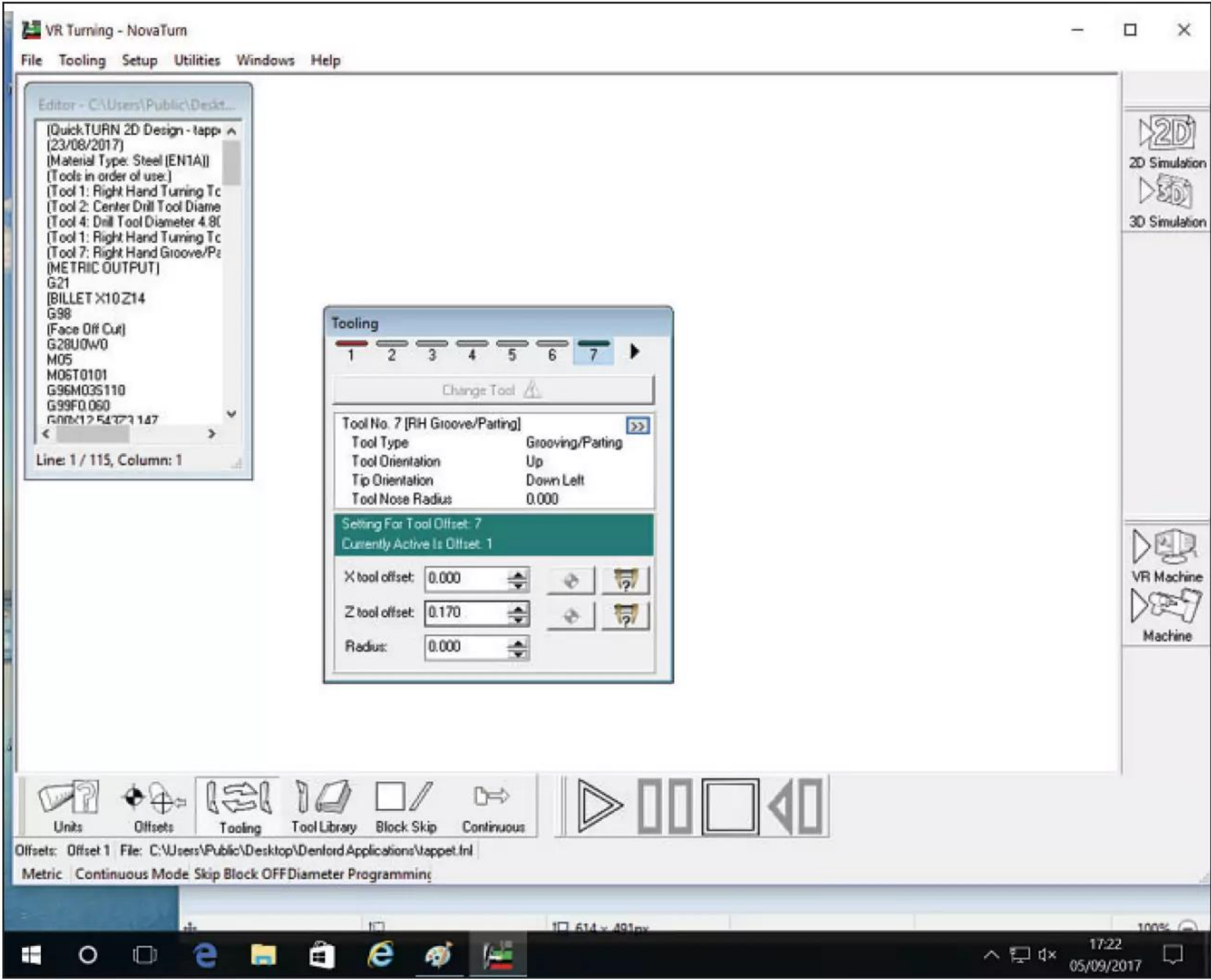


Figure 18. New offset value applied.

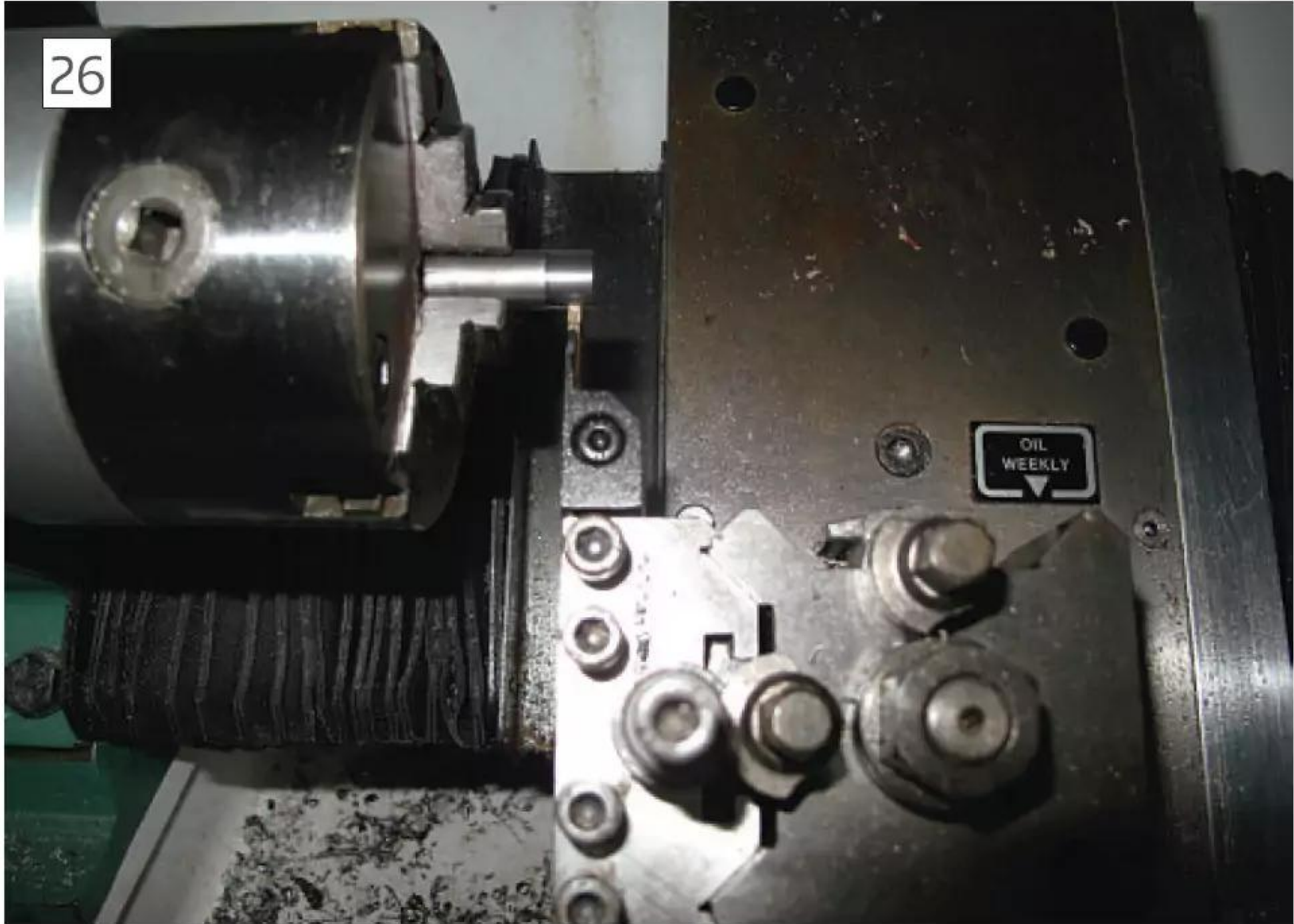
on the appropriate line of program, the easy way is to change the tool's offset, so let's say the component has been parted under its programmed dimensioned length. Select the tooling window and click on T07 and then click tool change, click on the graphic of an open calliper which is alongside the zero button, a second window will appear, **fig. 17**. This window asks for the programmed size to be entered in one box and its actual measured size in the other, once entered click OK and the new offset value is applied, **fig. 18**. This process of editing is identical to the work piece offset window, where any adjustments to the T01 offsets can be applied.

The parting and grooving tool (T07) takes the double ended dog bone style insert, these are especially useful on both a manual and CNC machine, they differ from the standard parting insert as they can cut in three directions, as the side edges are also cutting faces, **photo 26**, so they won't deflect in the same way a parting tip would when cutting the flank of a groove or shoulder. They can be used for light turning in both forward or back cutting passes and are particularly useful for simple components that are just faced, straight turned and parted as only one tool is required, you can even chamfer the front and back edges with them when using a CNC control.

Setting internal tooling on a machine with an ATC is quite straight forward as the locating bores should automatically index to the centre line of the spindle and so there's no need to establish the centre height. Setting the internal tooling on the manual tool change is a bit more complicated as not only has the centre line of the spindle got to be established, but the centre height of the tooling also has to be set. To get the bore of the tool holder somewhere close I set a piece of round stock in the three-jaw chuck slightly smaller than the bore to be set, then using a combination of incremental jog and adjusting the height of the tool holder move the position of the bore until the bar stock enters the bore. For final positioning I fine adjust the tool holder's bore against a DTI held in the chuck. Once the X zero position has been established and before the position is zeroed the distance from the home position to the position in the X axis the tool holder is currently in should be noted as the X offset of that individual tool holder for any future applications if a different tool needs to be set in that holder. The X offset of the tool being set should also be zeroed in the tooling window using the same method as previously discussed for the external tooling. Of course this initial setting must be applied to all the internal tooling holders, as they were all machined individually and the X zero position for one will not be the same for the others. To set the Z zero offsets of drills etc. jog the tool until the point is about 1mm away from the reference face and zero.



Establishing the Z zero offset for T07



Setting the X offset for T07

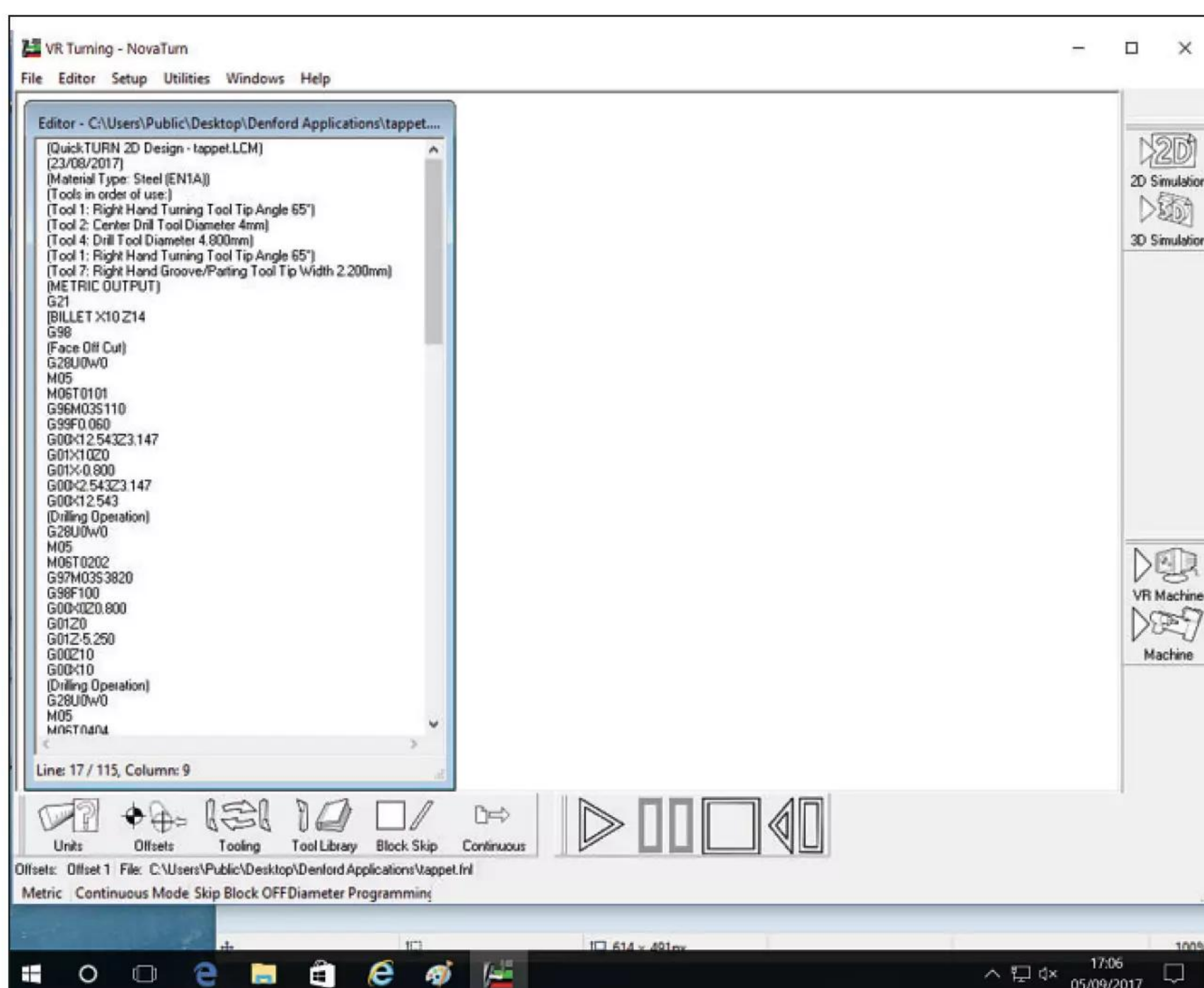


Figure 19. *The unedited part program.*

To machine the component click 'Auto' in the machine control window. Depending on how confident you're feeling a continuous machining cycle, or a block-by-block cycle can be selected. Clicking on the start icon on the bottom tool bar will start the cycle, but before that it's time for the first editing of the program. Setting the distance from the chuck that the bar stock protrudes with a depth probe every time, as suggested in the user's guide, would be a bit of a chore, better to use T01 as a distance stop, this means sending the tool to a position 0.5mm before absolute zero, pause it, advance the bar stock to it and

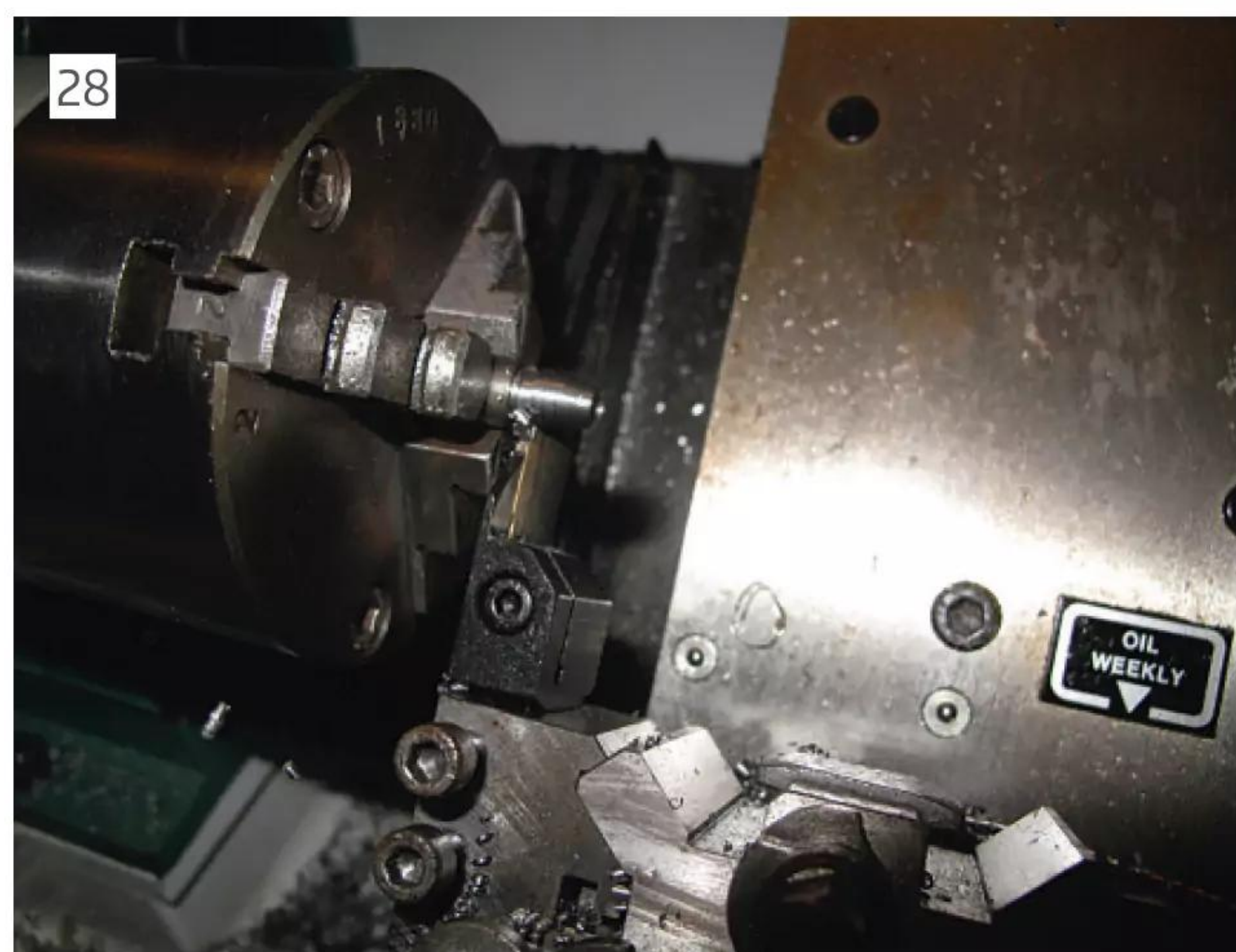
tighten the chuck, then send it away for a short distance before starting the spindle and facing the bar to Z zero. Now I've seen pages of G code published just to illustrate a particular aspect of a machining cycle, if you can't read G code then there's very little point, if you can read G code, and if you have an attention span similar to mine, you'll probably lose the will to live after the first couple of lines. With this in mind I'll keep my explanations as brief as possible. At the head of the program you'll find the program parameters, which you don't really need to worry about as they are CAM generated,

scroll down until you come to a line that says: M06T0101. M06 is calling for a tool change. We know that T01 is the required tool and the 01 is to pick up the offset for that tool, **fig. 19**. Click return to create a space beneath and type G00 Z0.50 X6.0 and in a space below that type M00, which is the program stop command. This block of programming will send T01 away in rapid to a position 0.5mm away from absolute zero, and to a position below the stock diameter, when the bar stock is advanced against the tool it will leave 0.50 to face off, the M00 command will pause the program. Create another space below this command and type: G00 Z20 X10 these are nominal positions, but far enough away from the work piece to safely start the spindle, **fig. 20**. Press the program start icon again and the program will resume its cycle.

There was a time when the machine controls of the day would only respond to programming written in upper case, today most controls will read programs in both upper and lower case, but just to be on the safe side I always use upper case, old habits etc. If you're interested in learning more about G codes, then you could do worse than go to the 'CNC cookbook' site, where all the G and M codes are explained in an easy-to-understand format, the site also has some very good, free to use, tutorials on how to get started on two and three axis machines. Just to explain the difference, all G commands are feed movements, while all M coding are programme modes, tool change, programme stop etc.



The component prior to parting.



Final operation, parting to length.

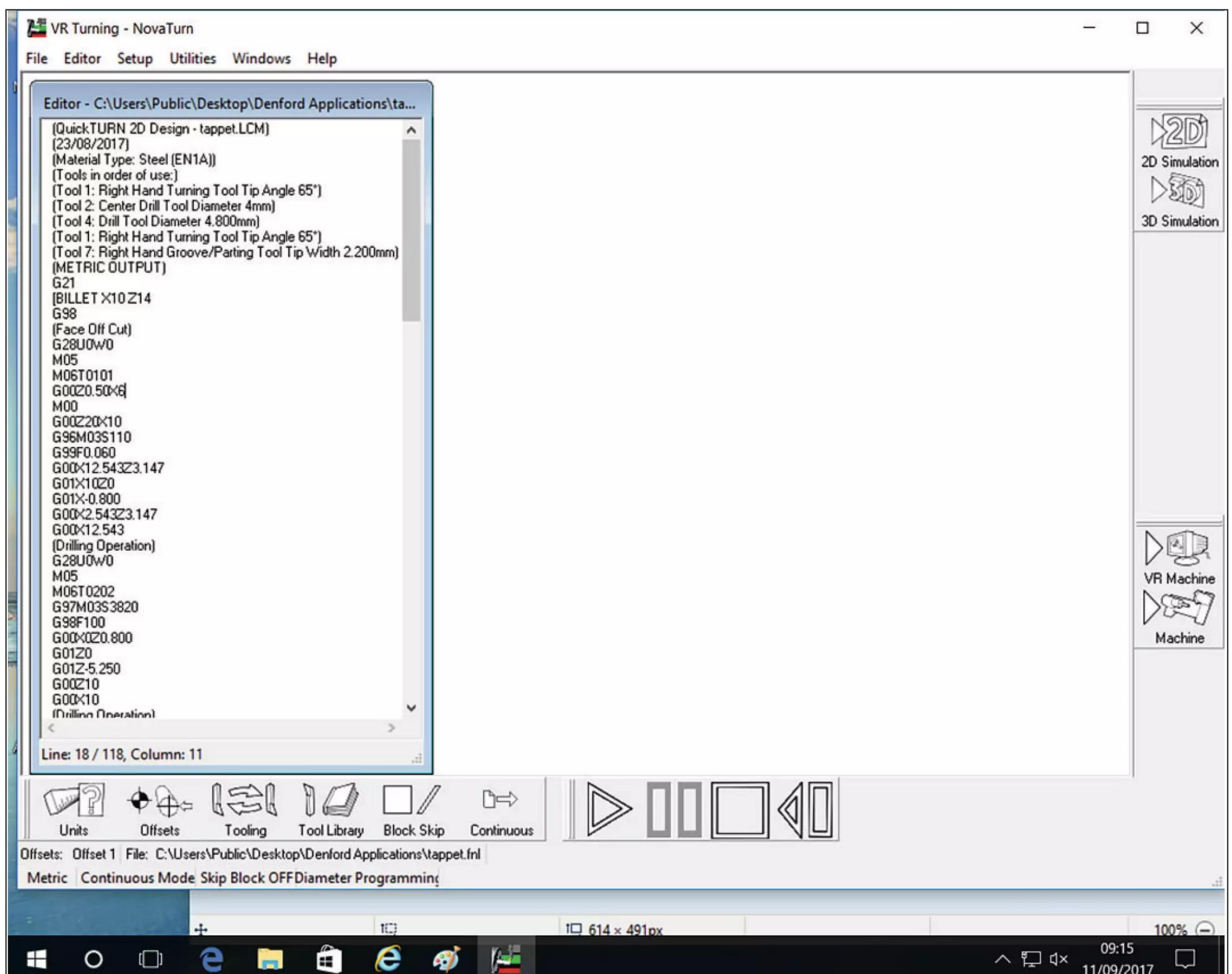


Figure 20. Program with the edit applied..



The finished component.

To edit feeds and speeds look just beneath a tool change command and you should find the speed on the same line as the M03, spindle start command, with the letter 'S' in front of the actual rpm. So just edit the rpm to a speed more suited to the machining conditions, likewise the feed will be shown with the letter 'F' in front, again just change this to a faster or slower value. Edit changes will be active until you exit the control screen, where you will be asked whether or not to save any changes. All pretty straight forward and no black magic involved!

Getting to the end now, with the actual machining cycle. This is, as we know a CAM generated part program and is perhaps not the sequence of operations that I would have chosen if I was writing it by hand, as T01 is called to face off the bar stock, then called again after the hole has been drilled to turn the profile, **photo 27**, which wouldn't be an issue with an ATC, but for manual tool change requires an extra tool change operation. The CAM generated sequence of operations can be seen at the head of the part program. The control will not start the next part of the cycle until a screen prompt requesting the tool change has been verified, this is pretty much a standard safety precaution, as the same situation occurs using the Mach3 control on my CNC milling machine. During the drilling operation coolant was applied using an oil can as the coolant can be directed up

the bore when the drill retracts on its peck cycle, a little hand eye coordination is required though! During the turning and profiling a little cutting oil was applied just in front of the cutting tip. The parting operation, **photo 28**, was over so quickly and seeing the material was EN1A no coolant was used. **Photograph 29** shows the ball joint retaining cup pinned to its cam follower.

In conclusion, the journey was not as I had anticipated and there were a few dark moments when I was thinking about cutting my losses and putting it back on the auction site, describing it 'as seen' but now that I've completed several batch runs I'm very happy with the machine and yes, the control as well. There is no way that the NovaTurn can be called a toy, it's a sturdy fully functioning CNC lathe, which I'm looking forward to using for more ambitious work pieces over the coming years. ■

My Railway Journey

Editor, Neil Wyatt, recounts his interest in model railways, and the role Hornby played in it.



Part of my 00 layout with Hornby 'Pug' and Pullman coaches.



My rare Hornby Type 37, in a fanciful green colour scheme.

Like most model engineers, my interest in engineering was inspired by the steam locomotives I saw as a boy, and later the rows of 'scrapped' engines in Woodham's Yard – I grew up in Barry. It was not unusual to see full-size locos come along our street on low-loaders on their journey to preservation.

Naturally, I had a magnificent train set – in my case it was a large selection of elderly Hornby Dublo three-rail. It seems hard to believe now, but I was allowed a huge board that hinged down on an old sideboard to give me a layout that was four feet by eight feet in size, occupying most of my dad's modelmaking workshop! Among my prized locos were

a Hornby Black Five and Bristol Castle. My dad also converted a Hornby Jinty to run on the three-rail track. I had a big collection of Hornby buildings and other trackside features, from pre-war cast metal toilets and kiosks to 1970s plastic mouldings. Today the Hornby Skaledale range are a huge jump up in realism from those early plastic buildings. Sadly this was passed on long ago to fund my time in university, and I have still to find any photos of the layout with its towering central hill made of cardboard and brown paper.

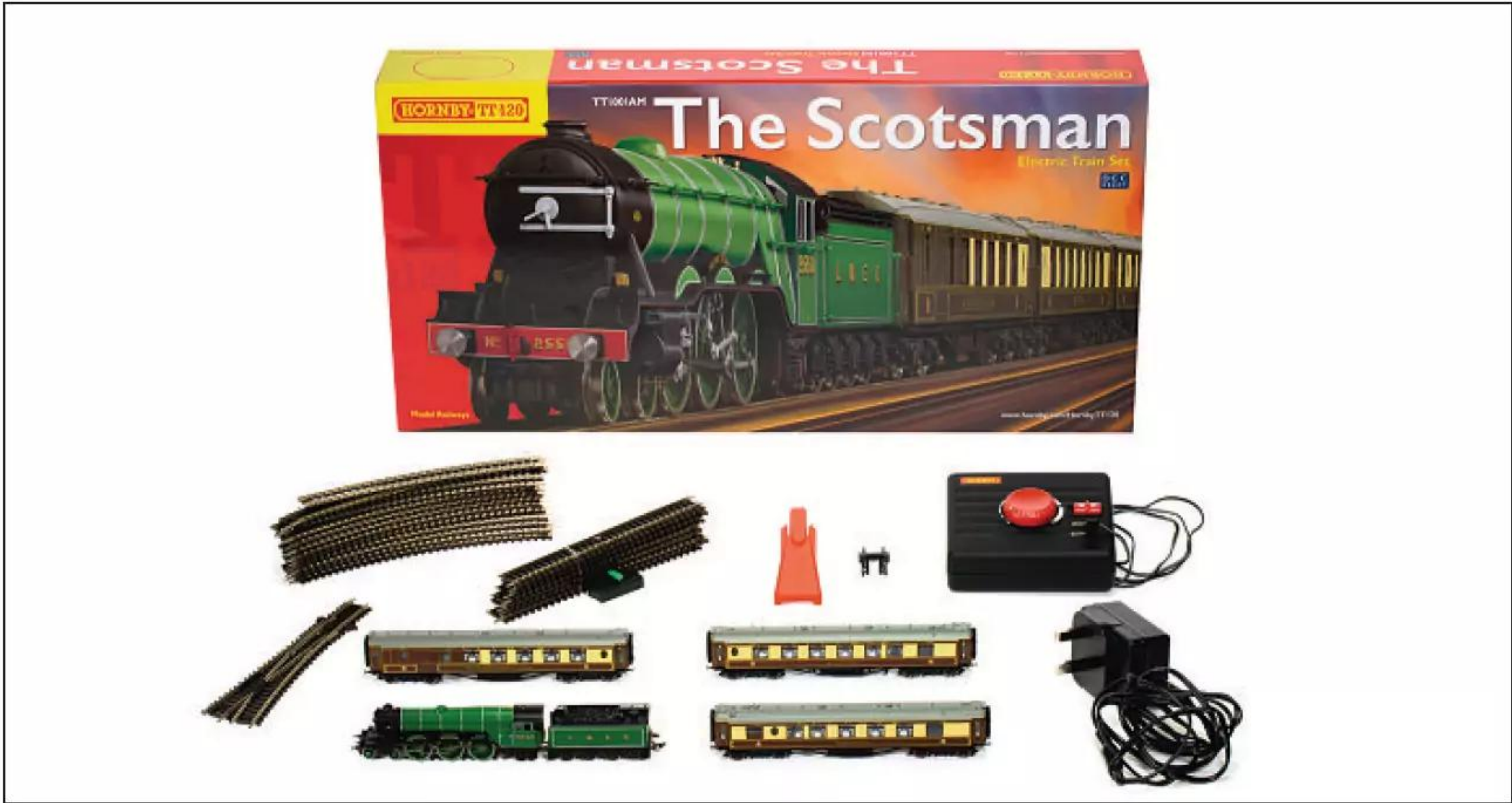
But the railway bug is persistent. I briefly experimented with N-gauge but found it a bit too small for my taste. Twenty years ago I acquired Hornby's 00 Flying Scotsman train set. It was a while before I started on a new layout, but the size was a bit ambitious, so before it was completed, I changed course and made an 00 gauge train layout, **photo 1**. The use of small radius curves means most of my locos and rolling stock are goods wagons and shunters, I particularly like the little Midlands Railway 'pug'. I've always enjoyed the scenic side of modelling as much as running the layout.

Over the years, I've detoured into 3 1/2" gauge constructing my Hudswell Clark shunter, but presently I have a partly laid-out 00 layout on a 6x4 board, awaiting me finding a bit more space in my workshop. My most recent acquisition towards this was a charity shop find – a Hornby Class 37 in green, **photo 2**. This turns out to be a very rare model that was only produced for one year!

If I was starting from scratch, I would strongly consider Hornby's new TT:120 range, **photo 3**. Sized between N-gauge and 00 gauge, Hornby TT:120 makes model railways easier for those with limited space, so I could have had a more complex layout. More easily manageable than N-gauge, the scale means models have high detail and realistic features. The range has rapidly



'The Easterner' is another example of a TT:120 train set.



'The Scotsman' set contains everything you need to get started.

expanded to include everything from rolling stock, locomotives, buildings and more to create fully detailed layouts. I'm a member of the Hornby TT Club to keep me informed, although I haven't acquired any TT:120 yet.

An example of the range is the TT3021TXSM BR Class 43 HST Train Pack, **photo 4**. This has a 120 BR blue and yellow Inter-City 125 train pack with an HM7000 Next18 decoder pre-loaded with a Class 43 (Valenta) sound profile. A sugarcube speaker helps to enhance the realism of the sound.

My own choice would be the TT1001AM The Scotsman Train Set. The LNER A1 4-6-2 locomotive has Pullman coaches with working lights. It represents how the Flying Scotsman™ may have looked in the LNER heyday of the 1930s, that being the Flying Scotsman service and not the somewhat famous

locomotive named after it. This service would run non-stop between Edinburgh and London, departing at 10:00 in each direction. The set contains a starter oval of track and a siding providing a good size layout to get started that can be

expanded with Hornby's easy-to-add track extension packs.

Win the Scotsman Train Set

Win your own Hornby **TT1001AM The Scotsman Train Set** worth £249.99! A great gift, or treat for yourself, the Scotsman Train Set will take you on a special model railway adventure.

To enter simply complete the Hornby Prize Draw entry form below, cut it out (photocopies or printouts of the form will be acceptable for those of you who do not wish to deface your magazine or have a digital subscription) and mail it back to us with your answer to the question:

- What year was 'Flying Scotsmans' centenary year?**
- a) 2020
 - b) 2023
 - c) 2010

Send your form to: Hornby Prize Draw, Model Engineers Workshop, Mortons Media Group, Media Centre, Morton Way, Horncastle, Lincs LN9 6JR

Please note, in order to be included in the draw, your entry form must be with us on or before the closing date of Friday, November 10, 2024. Good luck, everyone!

TERMS & CONDITIONS

N.B. For this prize draw we can only accept entries from those residing in the UK. The closing date for receipt of entry forms will be Friday, October 25, 2024. No cash alternatives to the prize are available. Terms and conditions apply. To view the privacy policy of MMG Ltd (publisher of Model Engineers' Workshop) please visit www.mortons.co.uk/privacy

HORNBY PRIZE DRAW

Name: _____

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Hot Flanging Steel Sheet



Andrew Johnston explains how he approached a tricky process that requires some good preparation and careful work for best results.

When starting to assemble the motion work on my two 4" scale single crank compound Burrell traction engines, **photo 1**, I needed to make a spectacle plate and frontplate. These are steel plates bolted above the boiler and between the hornplates. The spectacle plate, at the front, carries a casting for

the throttle and singling valve operating rods and has cutouts for the connecting rod, valve gear eccentric rods and governor drive belt. The frontplate, at the rear (a hangover from portable engine terminology) carries the steam distribution casting, the pressure gauge and has a cutout for the water pump drive rod.

On some engines these plates are flat sheet with angle bolted on that can, in turn, be bolted to the hornplates. However, on the Burrell these plates are flanged from one piece of sheet. In full size the flanging would have been done with the metal red hot and bent over a former using hammers. While thinking about how to



Burrell SCC Traction Engines



Partial Former and Trial Corner Bend

make the plates, I wondered if it would be possible to hot form the flanges, as per full size.

Initial Trials

Hot forming a flange on a straight edge is fairly straightforward. It is simply a matter of heating the metal and bending it over a former using a hammer. However, an issue arises with flanging around a corner. For a convex corner the length of metal on the blank around the curve before bending is larger than the length of the metal on the curve after forming. The metal has to go somewhere. Whilst it could get thicker, under the influence of being hammered it is more likely that it will tend to stretch,

making the flange deeper than on the straight edges. A problem occurs if the metal starts to buckle rather than simply stretching and making the flange deeper. Once the metal had buckled it would be impossible to straighten, thus scrapping the part.

As designed the internal corner radius on the spectacle plate is 1" while on the frontplate it is $\frac{3}{4}$ ". Each plate has a final flange depth of $\frac{3}{4}$ ".

Only one former would be needed for both plates, with the different radii on opposite edges. As I had the metal in stock, I made the former from a length of 25mm thick hot rolled steel. Rather than make the complete former I decided to initially make only one corner

and experiment with bending sheet around a corner. If this didn't work, then not much work would be lost. The partial former, wooden mallet and trial piece are shown in **photo 2**. The corner radius on the former was machined on a CNC mill. The mallet is home made from an offcut of timber and a length of broom handle. A wooden mallet is used to prevent bruising of the metal while hot, as it is very soft. As long as the mallet is kept damp it takes some considerable time for the wood to char as the contact time per strike is short. For heating a cutting nozzle on an oxy-acetylene set was used to give heating over a wider area compared to the intense, but localised, heating from a welding nozzle. One needs to be careful not to trigger the extra oxygen flow used for cutting.

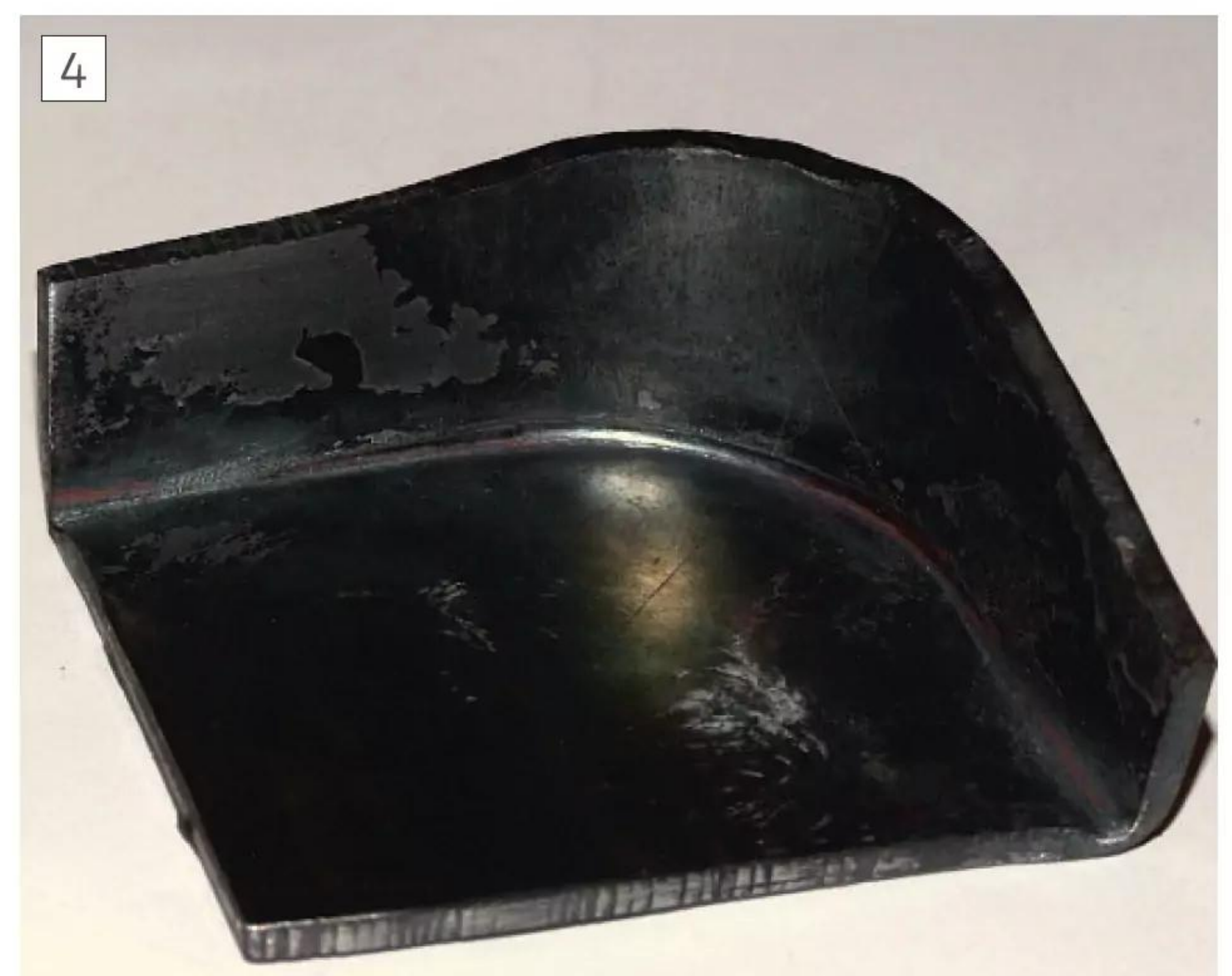
Bending was done with the metal bright red in subdued lighting. The flanging was done in several stages, bending a small amount each time. Any tendency of the metal to buckle was immediately sorted out by heating the uneven bulge that precedes buckling and flattening it. An external view of the test piece is shown in **photo 3** and an internal view is shown in **photo 4**. Note that the depth of the flange around the corner is greater than on the straight parts of the flange, showing how the excess metal has flowed.

Spectacle Plate and Frontplate

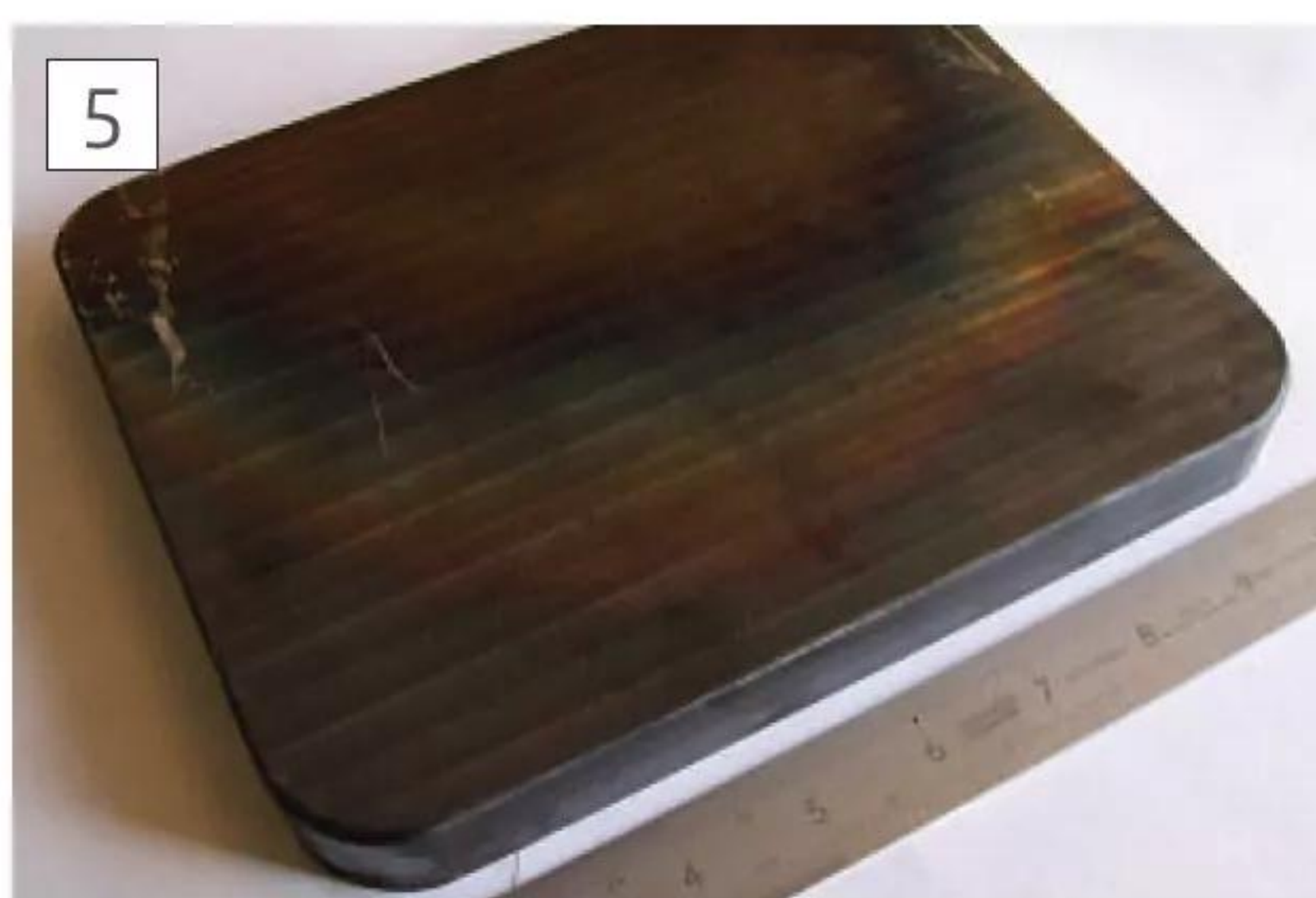
The success of the trial corner bend encouraged me to finish the former and



External View of Corner Test Piece



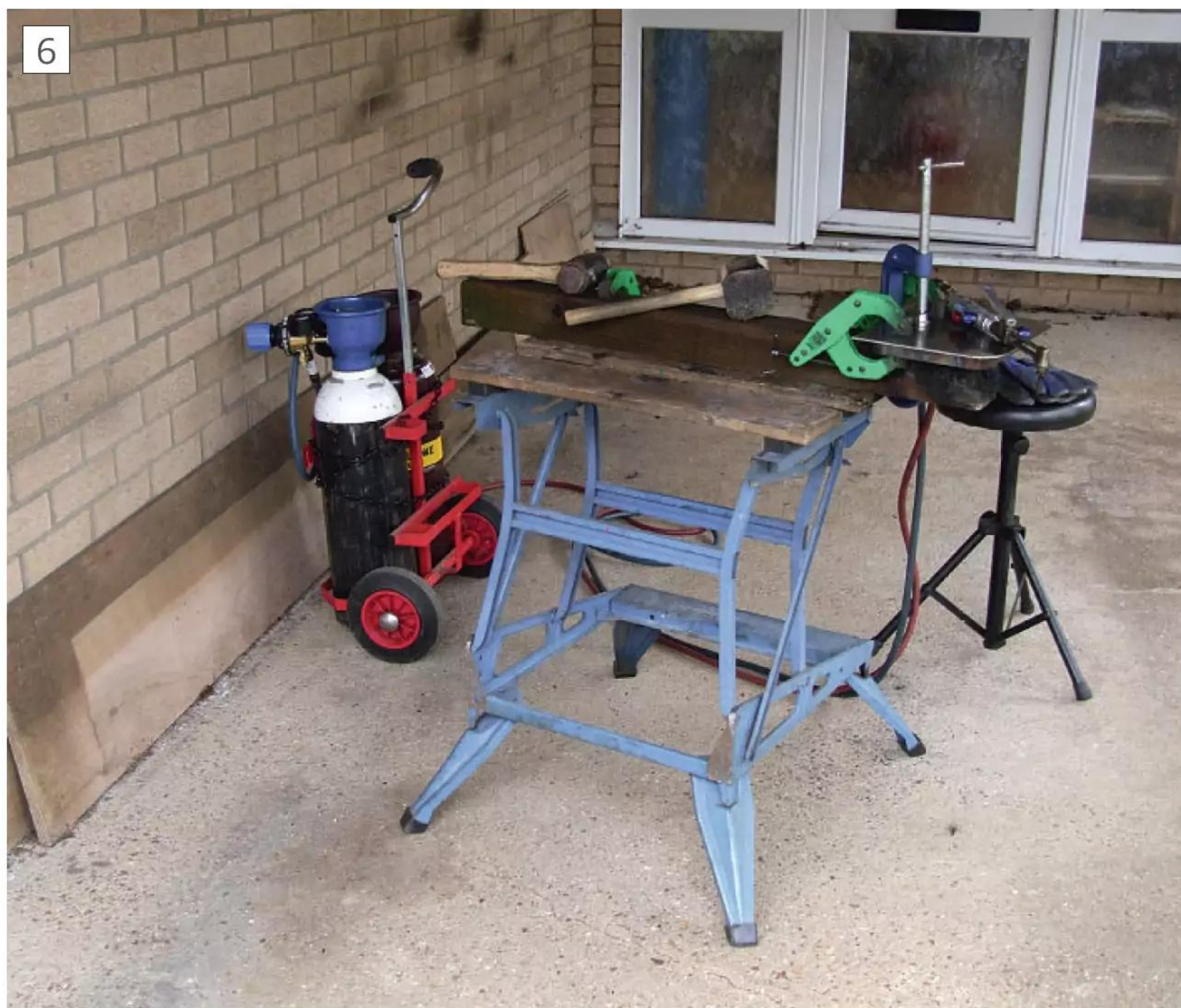
Internal View of Corner Test Piece



Finished Former

start on flanging the spectacle plate. The finished former is shown in **photo 5**. A small radius can be seen around the periphery of the former, done with files, so that the internal corners of the flanges will be slightly rounded.

To start with an oversize blank was guillotined from 3mm cold rolled steel plate and marked out with the shape of the plate. The finished flange depth is $\frac{3}{4}$ "; based on the trial part I allowed 1" of excess material, marked out with dividers using the former as a guide. The trial piece also showed that the



Set Up for Flanging



Close Up of the Plate Prior to Flanging



Spectacle Plate After Flanging



Underside of Spectacle Plate After Flanging



Spectacle Plate After Machining and Cleaning



Spectacle Plate In Situ

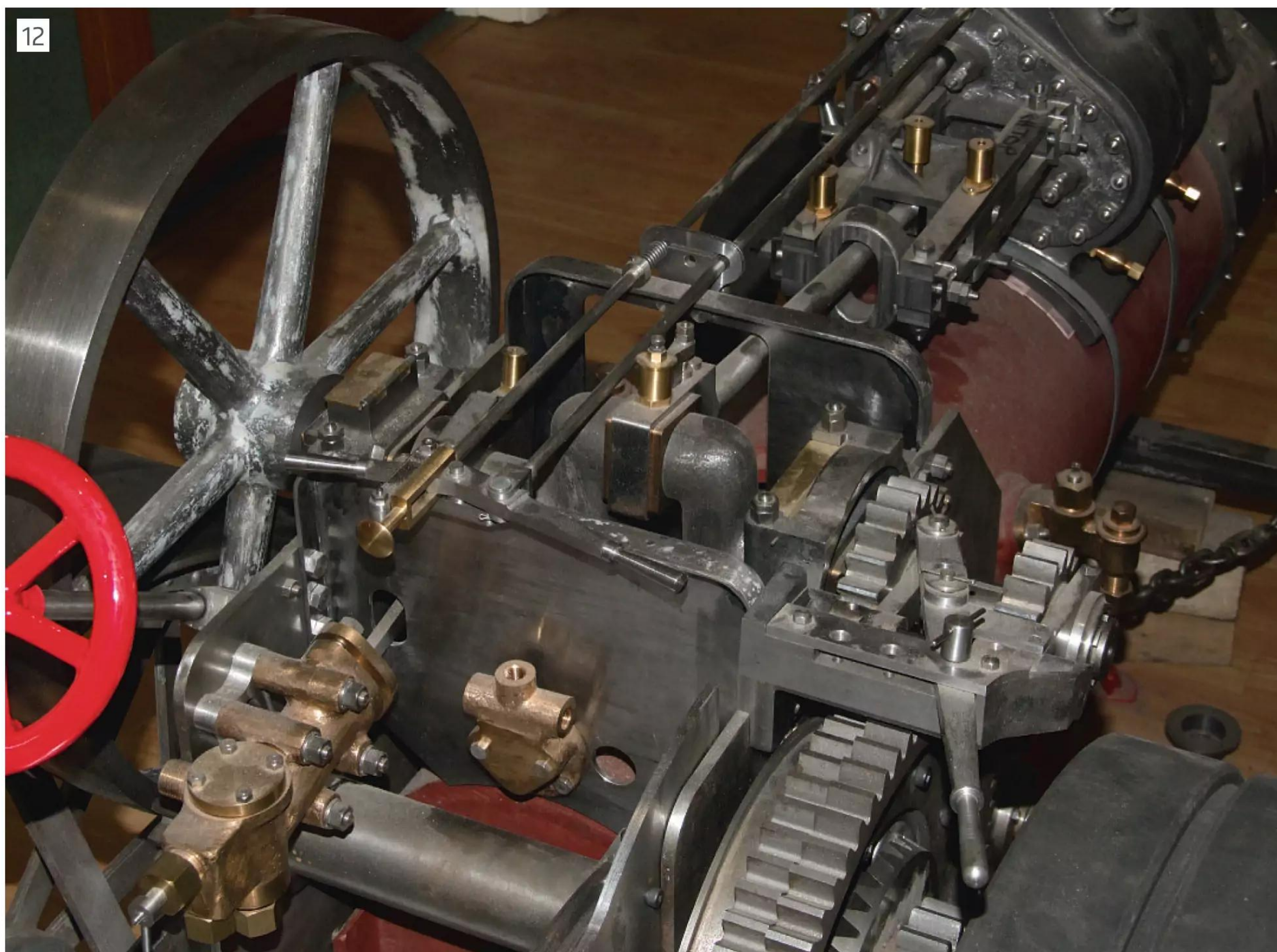
full allowance is not needed on the corners, so I used an allowance of $\frac{3}{4}$ " as the flange will grow in depth over and above the straight flanges. The blank was clamped to the former and in turn the former was clamped to a length of timber, itself clamped to a Workmate. A general view set up is shown in **photo 6**. A closer view of the plate and former is shown in **photo 7**, where it can be seen that there is access to the three sides that need flanging. The side flanges do not run the full depth of the spectacle plate, so surplus material was removed from each side with a hacksaw before flanging.

Flanging of the plate took about 30 minutes and used a $\frac{1}{4}$ of a bottle each of acetylene and oxygen. Initial flanging was done with the wooden mallet followed by a couple of passes with a copper mallet to ensure that the flanges were in close contact with the former. The flanged plate is shown in **photo 8**, and the underside in **photo 9**, showing the close contact between flange and former. Note the slight increase in the height of the flange at the transition from straight to corner and the lower height in the middle of the flanged corner due to the reduced allowance. The plate cools faster than the former and it proved impossible to remove the spectacle plate from the former until the complete assembly had fully cooled.

After forming the flanges were reduced to the finished height of $\frac{3}{4}$ " in the vertical mill, and scale cleaned off with a flap wheel, **photo 10**. The angles and radius on the bottom of the spectacle plate were marked out by hand and sawed and filed to fit the boiler. The spectacle plate slipped nicely between the hornplates without needing any adjustment, **photo 11**. However, using the copper mallet to ensure a close fit on the former had a downside in that it left marks on the spectacle plate flanges.

For the first frontplate I changed technique and only used the wooden mallet. This left a better finish, but the flanges needed a lot of filing so that they would fit between the hornplates.

When it came to the spectacle plate and frontplate for the second engine I used a combination of mallets. The wooden mallet was exclusively used on the top and corners to avoid marking the metal. But on the sides the flanges were



Spectacle Plate and Frontplate in Position

finished with the copper mallet to ensure a good fit on the former. Any marks left by the copper mallet will not be seen once the plates are assembled.

The various cut outs in the plates were designed in 3D CAD to ensure the necessary clearances and pocketed out on a CNC mill. The finished spectacle plate and frontplate, in position, are shown in **photo 12**.

Oiler Tray

After finishing the spectacle plate and frontplate I needed to make a small tray, with a curved flange, for oilers for the second shaft and axle shaft on the engines. The 1" radius on the former was just right for the curved flange. This was an easy job in 1mm thick cold rolled steel plate and was done using only the wooden mallet. The tray, and parts for the oilers, are shown in **photo 13**. The straight bends on the underside were done using a box and pan folder.



Tray and Oiler Parts

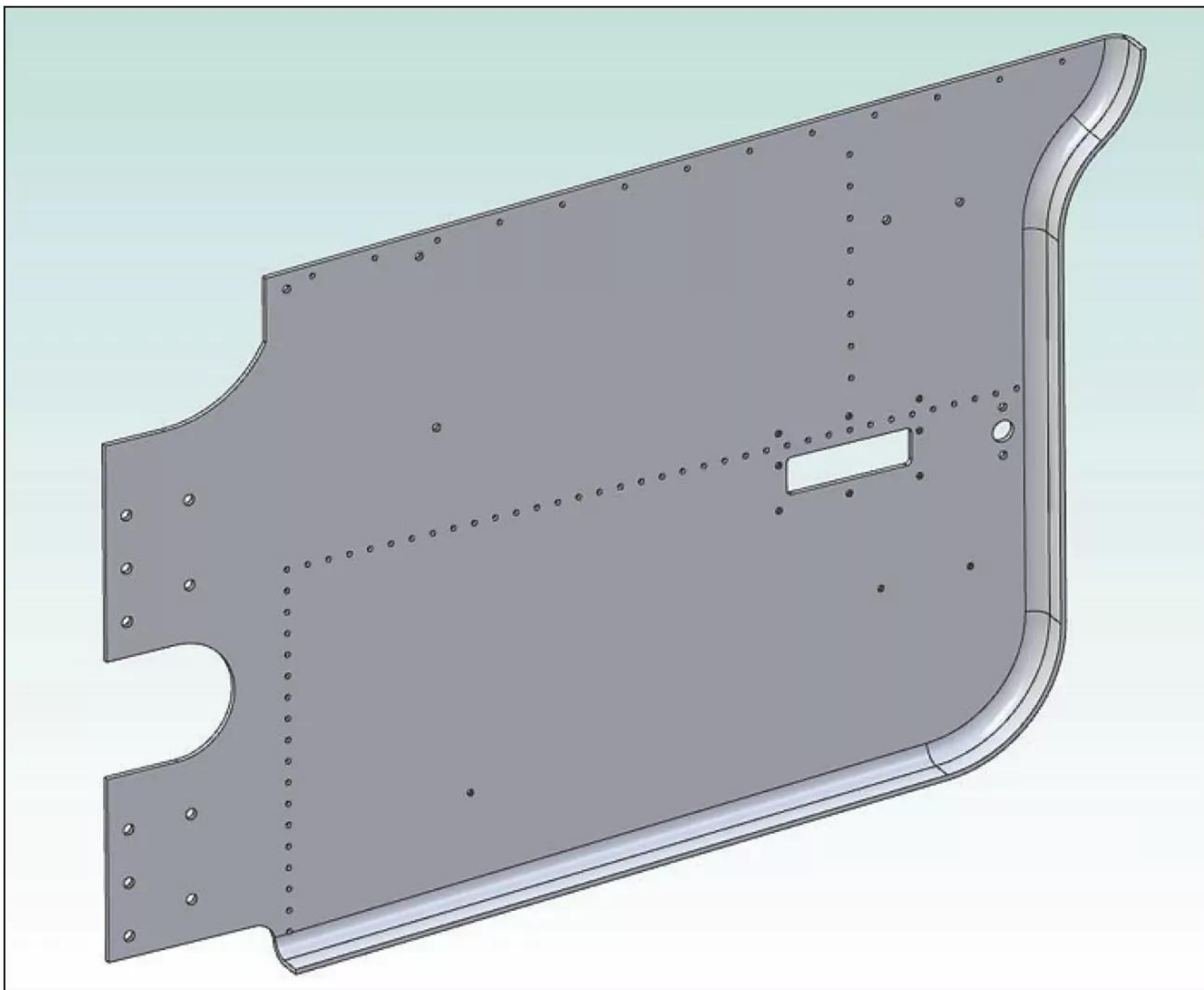
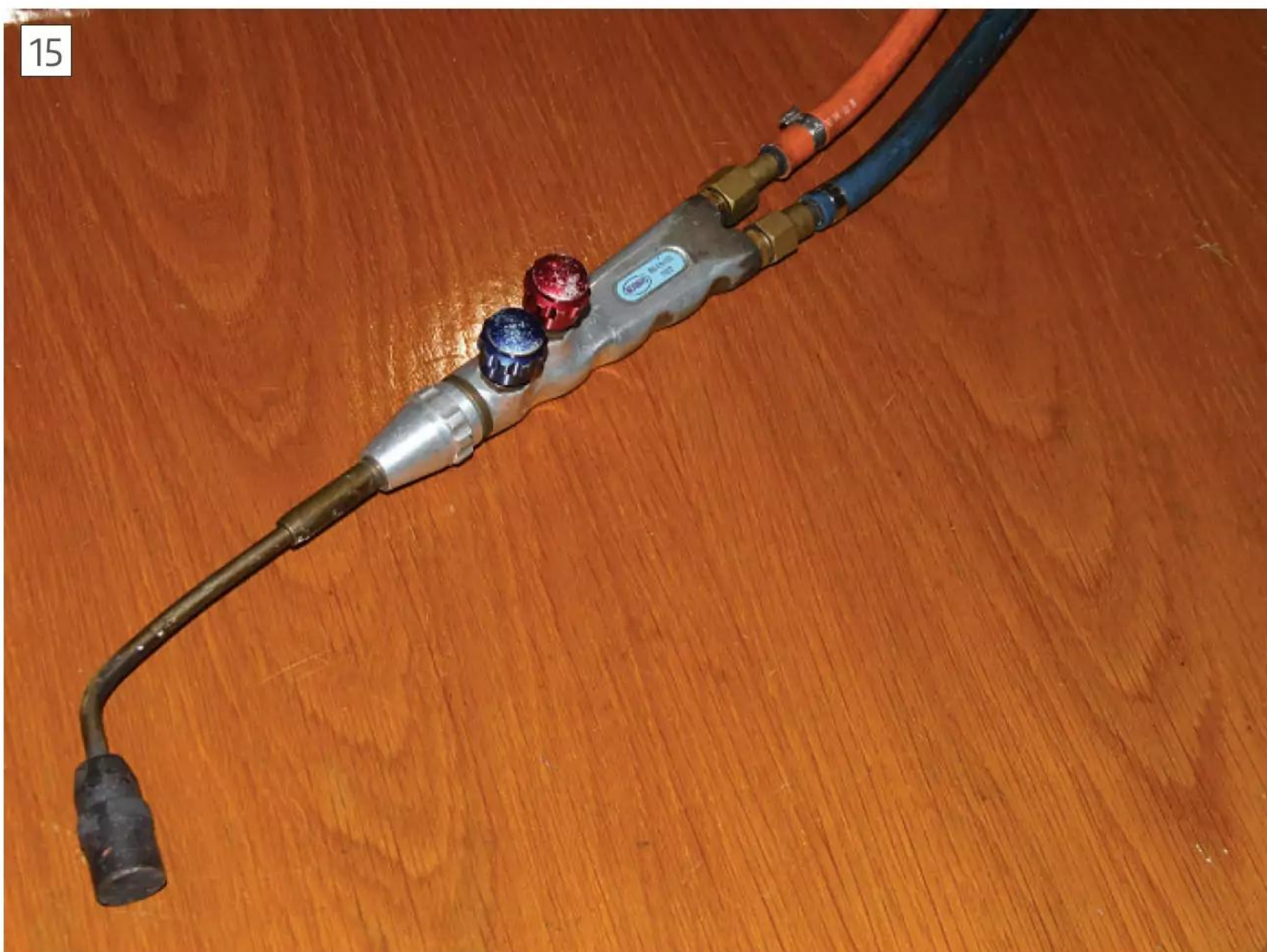


Figure 1. CAD Model of Tender Right-hand Side



Oxy-propane Heating Nozzle

Tender Sides

When it came to constructing the tenders for my engines, I also wanted to form the tender sides by hot flanging, as per full size. The tender sides were much larger, approximately 25" by 17", than the previous plates and the internal bend radius of the flange needs to be 3/8" rather than a small non-critical radius. The finished flange depth is 1". The tender sides also have both convex

and concave corners. A CAD model of the right-hand side of the tender, seen from the inside, is shown in **fig. 1**. As for the previous plates the metal around the convex curve will need to shrink, but around the concave curve it will need to grow to maintain the correct flange depth. Based on the knowledge gained from the previous plates the excess material for the complete flange was set at 1.25" from the edge of the former,



Tender Side Former

except for the concave curve where it was set at 1.5".

I started by making a former from hot rolled steel, bolting the parts together, **photo 14**. The 3/8" radii on the straight sections were machined on the horizontal mill with a concave radius cutter, while the radii on the convex and concave sections were machined on the CNC mill using a 10mm diameter 3-flute carbide ballnose cutter. The former is two sided as both left- and right-hand tender sides are needed. The two stops on the top of the former can be turned over as needed for the left and right-handed sides. Although the tops of the tender sides slope down towards the front, for the purposes of flanging the tender side top edge was left perpendicular to the front of the tender side to aid alignment with the former.

When flanging the spectacle plate and frontplate I had used about a quarter of a tank of both acetylene and oxygen per plate. From this I estimated that flanging the tender sides might use a bottle of acetylene, and of oxygen, per tender side. Given that there were four tender sides this was potentially a considerable expense. Instead I explored the possibility of using oxy-propane for heating. The requirement is to get the metal red hot rather than to welding temperature. Therefore, amount of heat rather than absolute flame temperature is the important factor. I already had a propane cylinder, for silver soldering, but needed to buy a proper regulator and orange coloured hose to fit my oxy-acetylene handle. I also bought a heating nozzle specifically for oxy-propane, **photo 15**.

The first set of four tender sides were a disaster, for several reasons; the lessons learnt will be highlighted. The biggest mistake, unrelated to the flange forming, was welding in studs for the



Set Up for Flanging Tender Sides



Clamping Arrangement

furniture that was below the water level in the tank. This caused the tender sides to distort badly and whatever I tried to flatten the sides just made the situation worse. This, plus the forming mistakes, led me to scrap the four sides. New material was ordered and the cut outs and holes re-machined.

The set up for forming the flanges on the tender sides is shown in **photo 16**. The front of the tender side overhangs the front of the former by exactly 2" and the top of the tender side is butted up against the stops on the top of the former. A close up illustrates the first lesson learnt; clamp everything down in as many places as possible using lengths of hot rolled steel to keep the metal flat, **photo 17**. Inevitably as the tender side is

heated, flanged and cooled it will move slightly. On the first attempts I didn't use enough clamps, so movement was excessive. On cooling the gap at the top was variable and up to 1/4". This had the downside that left and right flanges were mismatched, which would have made assembly of the tender difficult. With the clamping arrangement shown in **photo 17** the left and right tender sides moved less than a 1/16" from the stops at the top.

From the start it was apparent that the wooden mallet simply wasn't heavy enough to flange the metal even when red hot. Instead I had to use the copper mallet, but in conjunction with a length of rectangular hot rolled steel as a bolster. This transmitted the impact from the

mallet to the metal but spread it over a couple of inches so that the hot metal wasn't marked too badly. When the tenders are assembled the flat part of the flange will not be seen; it is only the radius section that needs to look good. The long flange at the bottom and the first part of the convex curve were formed first, taking about five passes. After forming a final pass was done using the copper mallet and bolster to ensure that the flat part of the flange was tightly against the former. The oxy-propane nozzle initially took some while to get the metal red hot. But once the former was up to temperature getting the tender sides red hot was much quicker. The forming was done three inches or so at a time to prevent cooling before the forming could be done. Once the bottom edge was done, clamps were moved so that the convex curve and the first part of the vertical straight could be formed.

I had made a wooden mallet with a pointed nose to form the concave curve. This proved to be useless as it didn't have enough mass to bend, and stretch, the metal, even when red hot. Instead I resorted to using a length of 1.25" diameter brass bar. This had the necessary mass and didn't mark the metal too badly. Each side took about an hour and a half to fully flange. Thick welding gloves were used to move, and turn over, the side and former to access the next part of the flange while it was still hot. The complete flange, after forming, is shown in **photo 18**, illustrating the increase in flange height round the convex curve and the reduction in height round the concave curve



Complete Flange After Forming



Set Up for Correcting Lengthwise Bowing



Finished Flanged Tender Sides

After I exhausted my small bottle of oxygen I swapped for a larger bottle from the same supplier; this is the tall yellow/white bottle shown in photo 16. Not only is the bottle taller with a larger diameter, it is also charged to 3000psi rather than the 2000psi of the smaller bottle. This bottle did all four of the second set of flanges and was still 2/3rds full. The 13kg propane cylinder was by no means full to start with and did all eight sides with gas left at the end. This was certainly a lot cheaper than using

oxy-acetylene, even taking into account the purchase of the regulator, hose and heating nozzle.

After flanging each tender side was left to fully cool while clamped to the former. After release the tender side was bowed outwards in two perpendicular directions, caused by the flanges shrinking as they cooled. Before correcting the bowing the flanges were rough machined on the vertical mill, leaving them about 1/16" over height. To correct the bowing the side was

clamped down over a rod, **photo 19**, and the appropriate flange heated red hot along the full length and left to cool. Once cool the clamps were removed, normally leaving the side slightly concave. The concavity was reduced as required by heating 1" lengths of the flange in two or three places along the length of the flange and letting the flange cool with the tender side unclamped. The aim was to have the outer face flat to slightly concave. This was so that, during assembly, the tender sides would need to be forced slightly outwards by internal spacers rather than having to pull the sides together with cumbersome external clamps or straps. For the long flange along the bottom a 1/4" diameter rod was used and for the short flange along the back a 3/16" diameter rod was used.

After correcting the bowing the flanges were machined to the finished height of 1" on the vertical mill. The sides were then descaled inside and out with a flap wheel and portable drill. Next the external sides of the flanges were shaped with files to remove any slight waviness and poor finish, concentrating on the radius portion as this will be seen. A final pass was then done the flap wheel.

The four (second attempt) finished tender sides are shown in **photo 20**. The left and right sides were selected in pairs to give the closest match. The selected pairs were mirror images to less than 1/16". This will make assembly easier as the curved bottom/back of the tender will be covering the same distance on each side.

Conclusion

The process of hot flanging has proved to be an interesting exercise, and a lot has been learnt. Despite some setbacks the process eventually went well. In addition, the parts look right and have been made in a similar way to that used by the engine builders in full size. With the experience gained I now use formers and heat to form a lot of parts for the engines that need to be bent, especially where an accurate radius is needed for accuracy and/or aesthetics. The design and manufacturing techniques used to assemble the tender, and the tow bar and wire rope guide, will be covered in a future article. ■

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 may be 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.

METAL WORKING

Beginner's Workshop

By GEOMETER

THE DUCTILITY of most metals and alloys is one of their most useful characteristics, enabling many operations to be performed that would otherwise be impossible. For without stretch and flow in metals there would be no simple operations like riveting and bending, nor manufacturing processes such as rolling, wire-drawing, forging, panel-beating. Equally, however, there are occasions when it is undesirable for metals to change their shape, if no more than because subsequent rectification will be necessary; and with recognition of such cases a considerable amount of trouble and wasted effort may be avoided.

Common processes where pressure is (inadvertently) put on the metal are shearing and chiselling. Thus, in cutting a strip from a piece of sheet, as at A, using shears, there is always a tendency for the strip to bend, because of the wedging action of the blades B (left). This is in addition to the curling which occurs.

In chiselling, a similar wedging action is involved, B (right), when the sheet is laid flat on a metal block for cutting. Again, the strip is bent, though this time without curling. Tapping down the ragged edges can also stretch the metal along the cut edge, increasing the curvature; and this operation on the edge of the sheet may render it wavy or unstable.

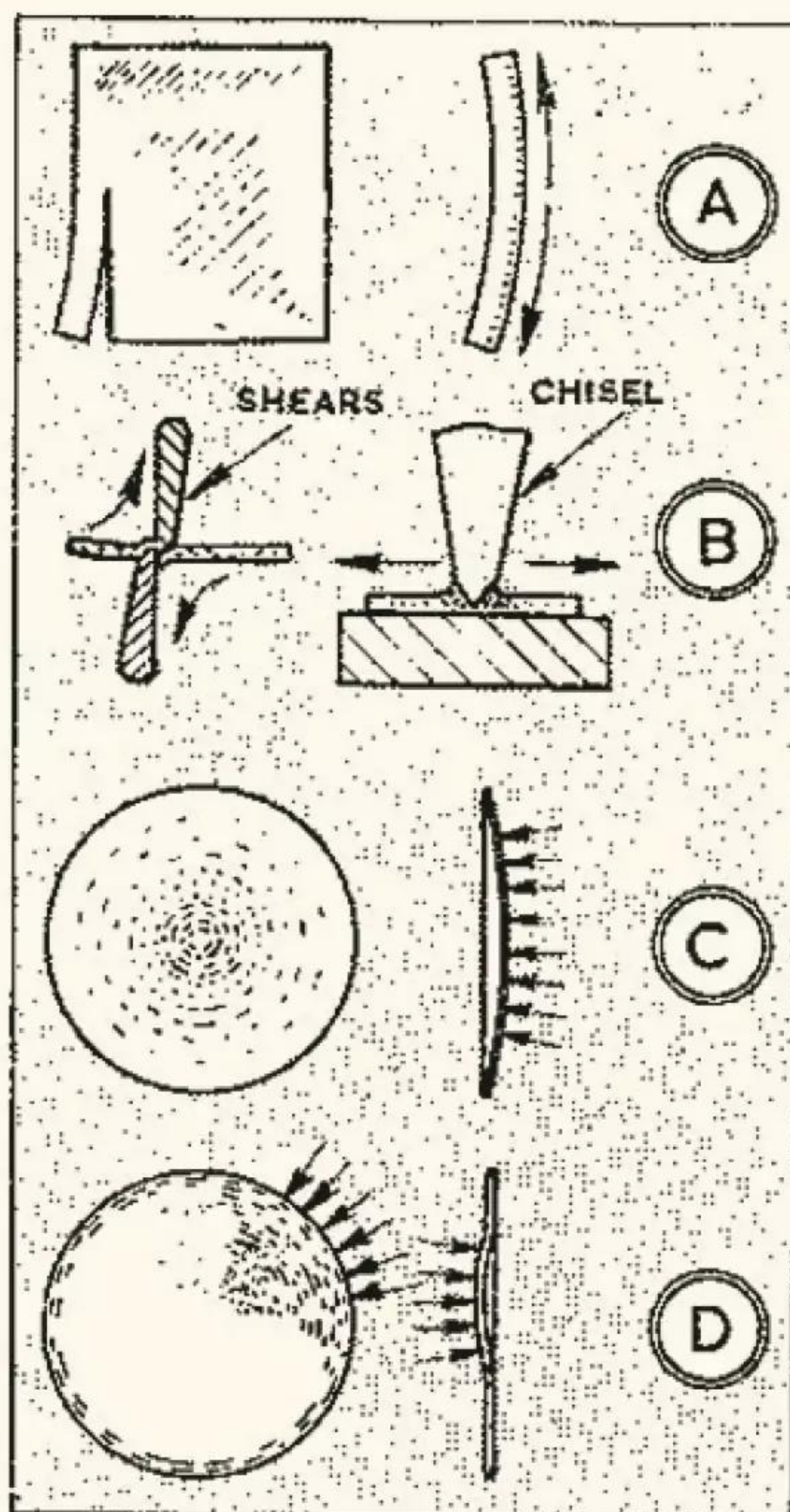
From this it will be seen that, to minimise the effects, shears and chisels should be sharp, and chisels slender at the end. To maintain metal in really good shape, however, it should be sawn, if necessary gripping or clamping thin sections between wood with the strip projecting, using a blade with fine pitch teeth, and slanting it so that they cannot dig in.

Even with sawing, bending sometimes occurs on strips cut from rolled bar sections, due to release of internal strains; the writer once had this occur with material for the rack of a small lathe. Usually, it is effective for mild steel to heat the bar red and cool out slowly, relieving the strains.

Hammering metal on a surface results in thinning and stretching, which can be helpful or the reverse. When a strip or bar is bent, it is helpful to hammer along the edge of

smallest curvature to straighten it by stretching, and usually this is preferable to attempting straightening in the vice by pulling—which in many instances introduces a reverse bend or kink.

Hammering can cause difficulty with sheet metal through either of two effects. Taking a disc as an example, hammering and stretching in the central area C initially produces an



“oil can bottom,” when if the perimeter is held the centre can be pushed one way and the other. Hammering the edge, however, particularly if not all round, renders this unstable, D, and laying the disc on a flat surface shows the edge to be upstanding in places. Pushing these down causes spring-up in other places.

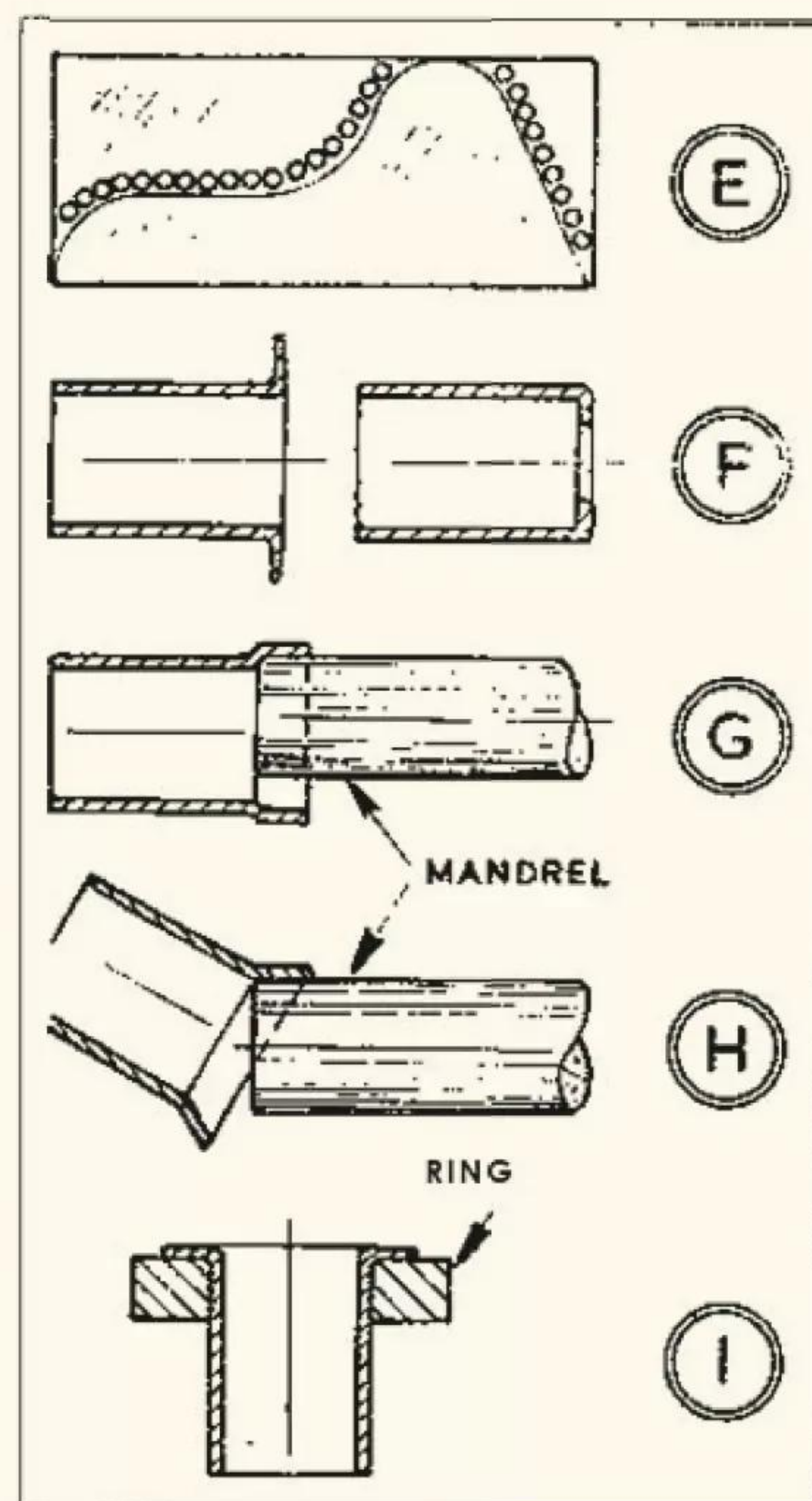
Rectification to flatten the disc consists for the domed centre C, of hammering the edge with diminishing blows to the centre, and for the unstable edge D of hammering the central zone, though experience must

guide as to weight and location of blows.

When sawing is impracticable, drilling round a perimeter is best, E, then the metal between the holes can be safely cut with a chisel, and the edge file-finished, avoiding hammering.

Flanging a tube is an instance of extremes required in metal working, F. For an outer flange, stretching to the larger diameter is necessary, and for an inner flange the metal must be compressed. The latter is the more difficult since ruckling tends to occur and only a small flange is practicable.

The diameter of a tube can be increased by hammering round on a mandrel G, and a flare produced by inclining the tube and hammering round, H. This should also be done in producing an outer flange, for the metal must stretch gradually, otherwise splits appear. Final flanging can be done in a ring, I, but only when the flange has been initially well formed. Naturally, the need for annealing should not be overlooked, as hardening occurs with hammering. □



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A Workshop Diary - Part 2

We visit Alex du Pre's workshop again as he is making a small but robust sheet metal bender



Welcome to the second instalment of my workshop diary series. Last time, I was extolling the virtues of angle iron as a cheap and convenient starting point for improvised workshop tooling. This time, I will be continuing the theme and showing you how I made a heavy-duty sheet metal bender. As with my previous excursion, this project came about not so much because I was fulfilling a long-held ambition to own such a tool, but because I needed one to progress from A to B on a project I was working on, which required a number of parts made from fairly thick sheet metal bent to shape (the project was an experimental tricycle, in case you were wondering, but that is very much a tale for another day).

In this case, 'fairly thick' and 'heavy duty' mean the ability to bend 2mm

sheet steel in widths of up to 100mm or so. Trivial for an industrial machine, of course, but very much at or above the limit for the sorts of cheaper bending machines you see advertised for small workshops. Bending 2mm sheet requires two things, namely, a robust and rigid machine and a degree of muscle on the part of the operator. For want of the latter, I concentrated on the former.

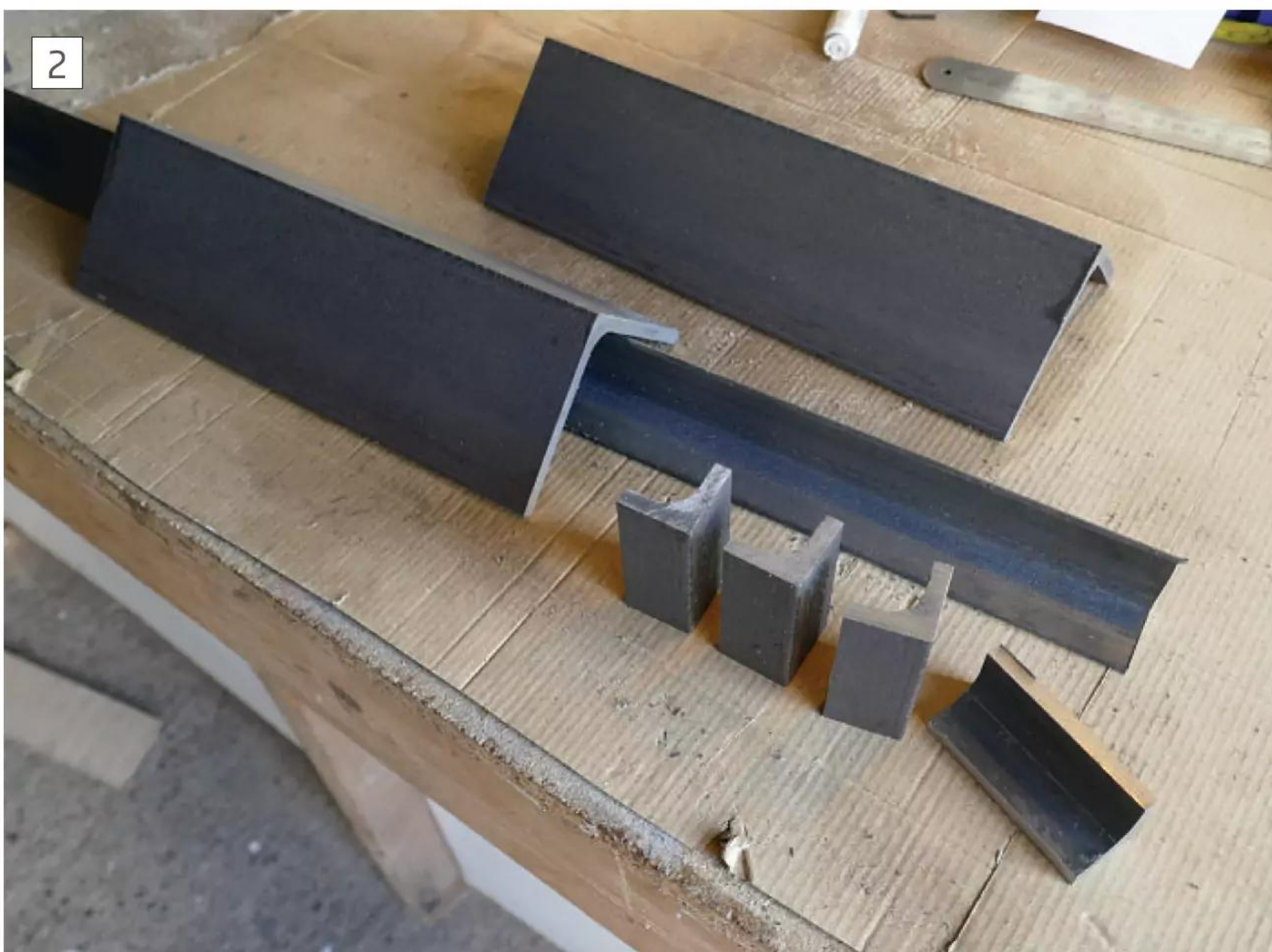
This project was improvised on the go and drawings were limited to some hasty sketches. I don't intend to provide detailed drawings or dimensions as firstly, I haven't got any, and secondly, this article is supposed to be more about the ideas and the experience than the product. Should you wish to make a similar bender, I am quite sure you will be able to come up with your own improved version from my description and photos.

Description

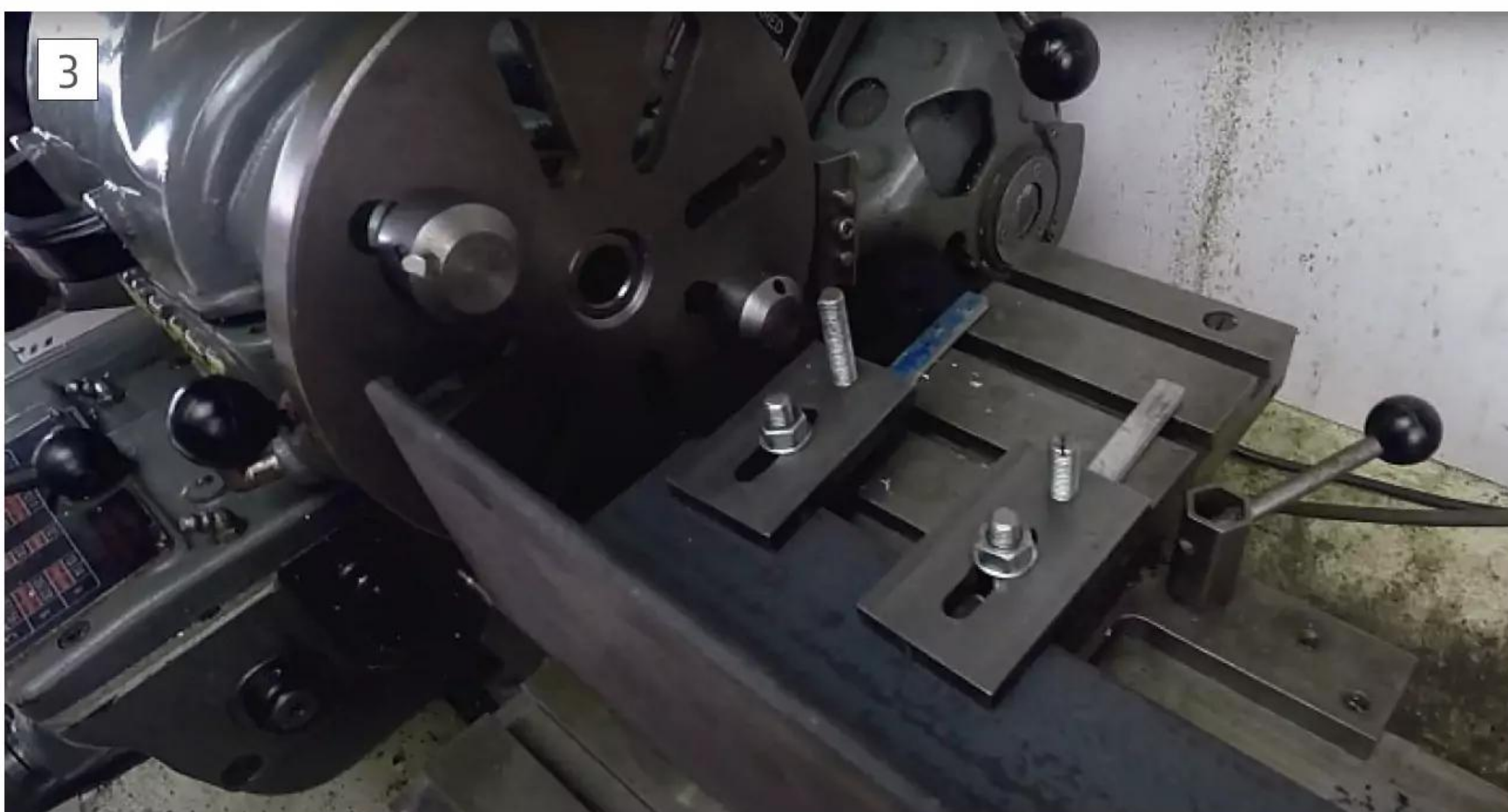
The bender is made from two pieces of angle iron joined together by hinges, which are themselves made from angle iron and steel pins. There are the two main parts, which I shall call the front angle and the rear angle. The rear angle is fixed and forms a flat horizontal surface. In operation, the bender is held by the rear angle in the vice. The front angle is attached to the rear angle by two robust hinges and lifts up and over to fold the sheet metal. Two handles are screwed into the front angle for this purpose. The sheet metal being bent is clamped securely to the rear angle using another, smaller piece of angle and some bolts. Some operations require the material to be further secured with clamps or dogs and a number of M8 tapped holes are provided in the



Cutting the angle iron in the bandsaw.



The angle iron parts prepared. The four small angles will form the hinges and have been cut down from the larger angle material.



Machining the ends of the large angles flat and square using a flycutter bolted to the lathe faceplate. The work is bolted to the cross slide.

rear angle this purpose. The overall width is about 300mm, and this is the maximum width of sheet that can be accommodated. The length of sheet is limited only by the space available around the device or by the nature of the work in hand.

Materials

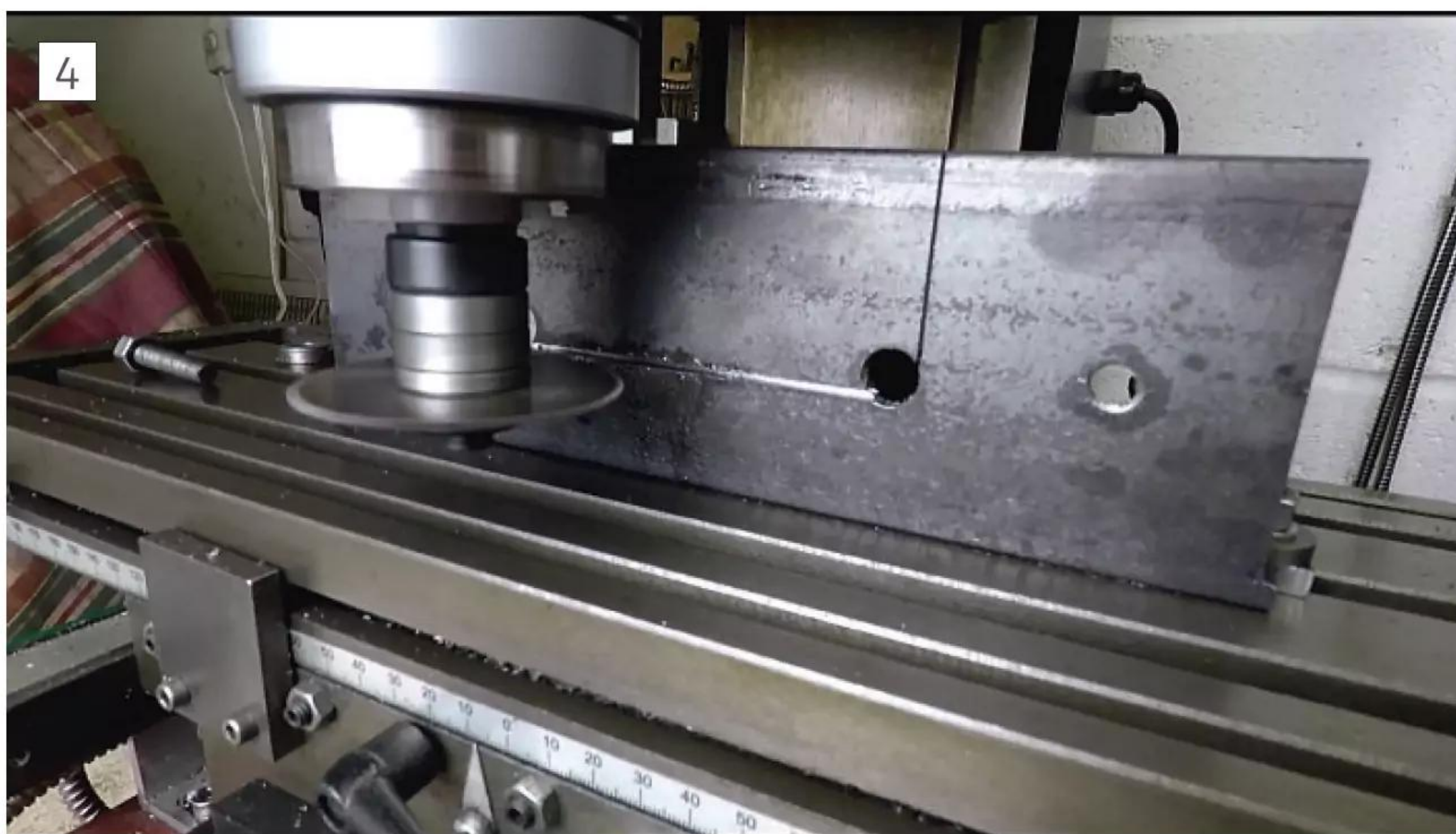
The angle iron I used for the main parts and the hinges is 100x100x6mm, meaning the flanges are 100mm wide and 6mm thick. It is made from 'black' steel, i.e., not bright steel, and is fairly soft and can be easily cut, drilled and machined. Dimensionally, the nominal sizes are pretty approximate. The flanges taper slightly across their width and are rounded on the edge. There is a generous fillet between the two flanges. The outer faces are flattish, but not completely flat, and are at approximately, but not exactly, 90 degrees to each other (something like 91 degrees). These characteristics are significant when it comes to machining some of the parts if they are to fit nicely together.

I used a smaller section of angle iron for the clamp and a short length of steel barstock for the hinge pins. Four M8 countersunk socket screws complete the bill of materials, the total cost of which was about £10.

Front and Rear Angles

The first job is to cut off two lengths of angle iron to form the basis for the two main parts. I used my trusty bandsaw for this, **photos 1** and **2**. As an aside, my bandsaw is fitted to a low-level wheeled trolley and is rolled under the workbench when not in use. All my bandsawing has to be done more or less at floor level which is not so good on the knees but does prevent lumps of metal falling from height and taking chips out of the concrete floor.

I chose not to machine the top faces of the angle iron flat, deeming them sufficiently flat for the purpose already, although I do slightly regret this now as it would have looked better. I machined the ends flat and square by bolting the angles to the lathe cross-slide and using a fly cutter secured to the faceplate. Power cross feed makes this a satisfying job, although hand filing would work as well, **photo 3**.



Cutting away the waste section on the rear angle using a slitting saw.



Breaking away the waste section with an adjustable spanner.



Using a boring head to machine the flats on the angles ready to receive the hinges.

The front angle needs a large section cut out to clear the bench vice; essentially two vertical cuts and one horizontal cut to remove the waste. I drilled the corners for this cut out with a 10mm drill to give a nice fillet and made the vertical cuts with the bandsaw. The horizontal cut was more of a challenge as the bandsaw or hacksaw could not reach it. Chaindrilling or using an electric jigsaw with suitable blade would probably have worked, but I chose to use the slitting saw in the mill, **photo 4**. I could not quite achieve the full depth of cut due to the spindle fouling the work. With about 0.5mm depth of cut remaining, the waste was persuaded to separate by bending it forward and back using an adjustable spanner attached to the edge of the waste as a handle, **photo 5**. The cut edge was finished with a file.

The next job was to machine flat areas, including machining away a portion of the fillet, on the insides of the angles at the ends where the hinges will be fitted. The only way I could think to achieve this was to use a long boring bar in the boring head, using it like an endmill. With lots of very light cuts, this did work in the end but was not desperately enjoyable due to lack of rigidity, **photo 6**. I always slosh on plenty of cutting fluid using a small paintbrush and this does help noticeably.

All that remains is to drill, tap and countersink the M8 holes for the hinge screws and lots of M8 holes in the top surface of the rear angle for the clamps and workpiece holding accessories. These mostly need to be spotted through from the remain parts so must be left for later.

Hinges

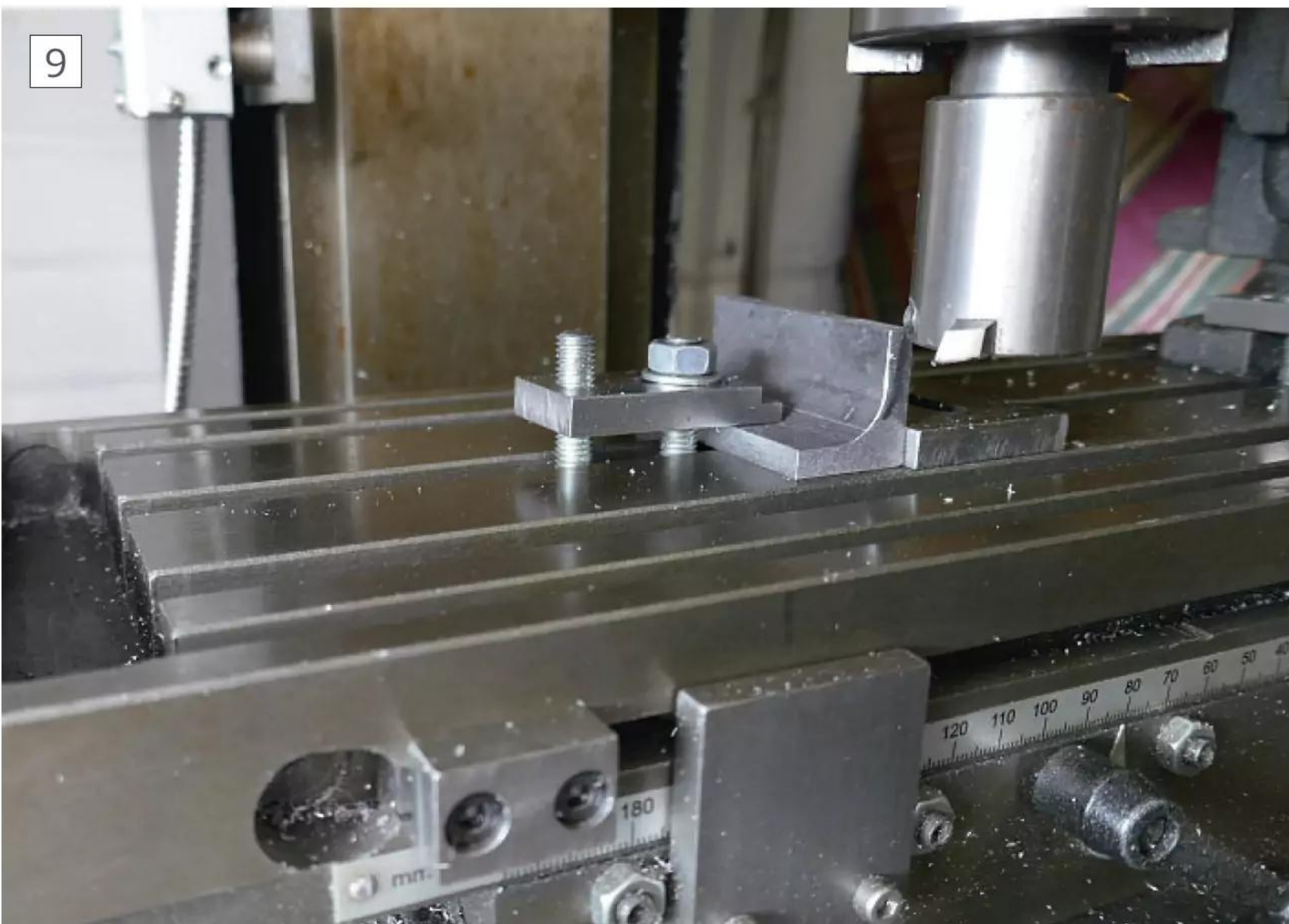
The hinges are two smaller steel angles secured to the main parts with M8 countersunk cap screws. I used the same angle stock to make the hinges, so at this point I cut off further lengths to form the basis for the hinges. Much of the flange material was cut away to leave a smaller, chunky angle for each part. In order to shirk the labour of manual hacksawing, I again used the bandsaw for this. Small parts are tricky hold in the bandsaw vice, which is designed only for holding long



Using a fixture held in the bandsaw vice to secure the hinges for cutting operations.



Squaring up the hinges using a flycutter in the mill. The work is held against a squared block with two engineer's clamps.



Squaring the edges of the hinges using a flycutter. The work is bolted against a fence secured to the mill table. The fence could have been positioned square to the edge of the mill table using an engineer's square, but in this case, it was not necessary.



Removing the fillet on the inside corner of the hinges to create a sharp angle. An end mill was used and the work has been positioned on parallels in the vice to keep it square. The steel rulers are acting as spacers to bring the work to the correct height.

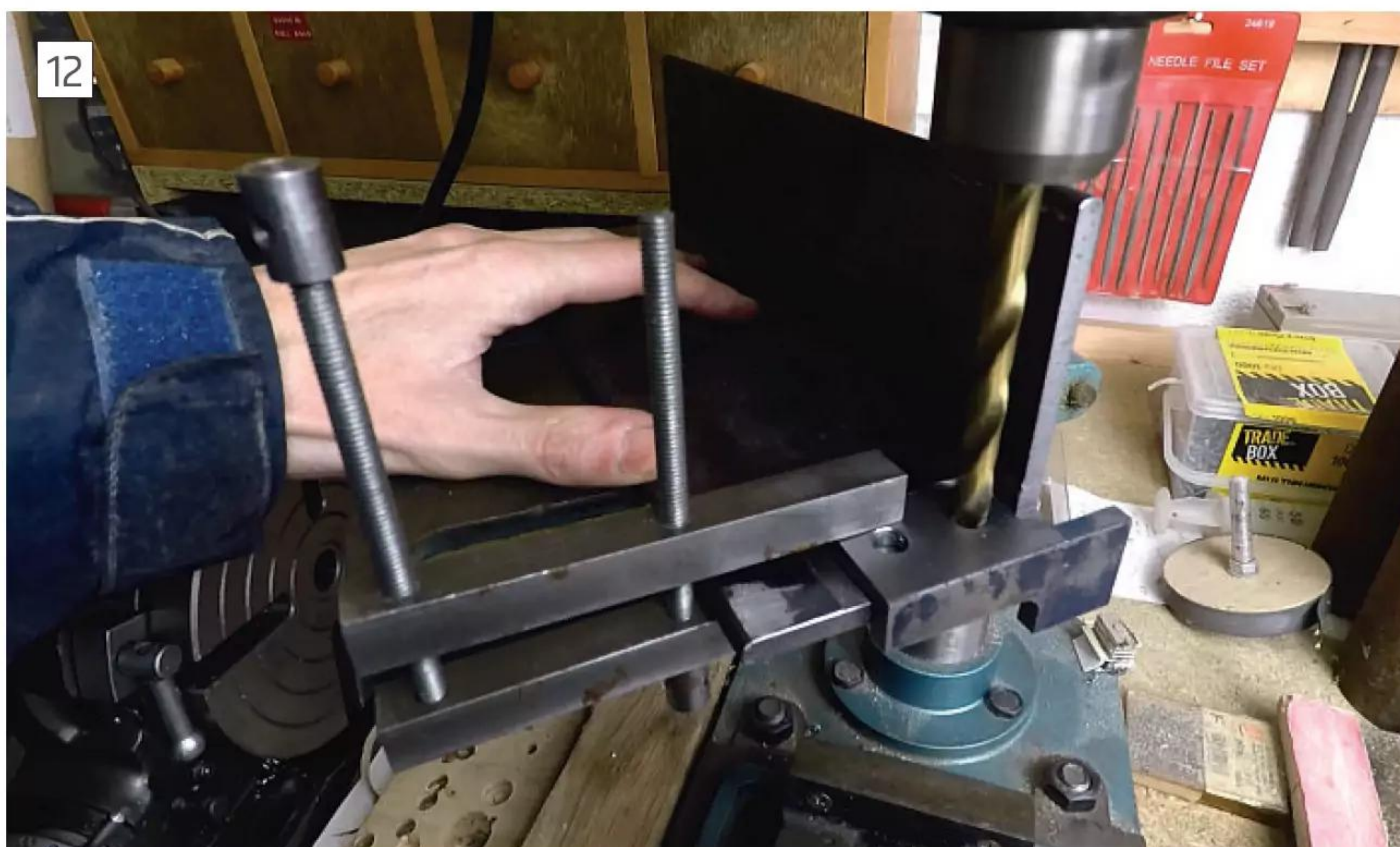
lengths of bar stock. I have a fixture for this, which is a slab of bright steel flat, about 100x14mm in section and 120mm long, into which many M8 holes are made. This is held in the bandsaw vice and positioned close to the blade, and I can then use my milling machine clamps, bolts and dogs to hold pretty much any awkwardly-shaped or small part for cutting, **photo 7**.

With the excess material removed from the hinges via these means, the usefully-sized offcuts were squirreled away in my scrap box for another day and the resulting small angles taken to the milling machine for squaring up. For the reasons already mentioned, the hinges were machined all over to bring them to size and to ensure a crisp 90 degree corner inside and out. The outside faces were machined flat with my home-made fly cutter. I always prefer to use the fly cutter for facing cuts as it is easily sharpened and seems to give a better finish than endmills and put less strain on the mill. Once cut, the first face forms a datum from which the other faces are measured. The machine vice was used to hold the parts for the first facing cut and, as I have checked that the front jaw is truly vertical, I could have used the vice for the remaining squaring cuts. But for reasons unknown, I see from my photo record that I bolted the parts direct to the mill table from this point, possibly for the sake of variety. The photos and captions tell the tale, **photos 8** and **9**. However, it was back to the vice to machine the inside faces using an endmill as the face cutter could not sensibly be used to complete the inner corner, **photo 10**.

Some further bandsawing, slitting and filing removed the waste material



Removing waste material from the hinges using a slitting saw. A drilled hole forms a nicely filleted corner to the work.



Spotting through the bolt holes from the hinges to the angles.



Machining the spanner flats on the handles using the side teeth of an end mill. The mill table stops were used to set the length of the flats.

to form the tabs for the hinge pin, **photo 11**. In one hinge half, the tab is tapped M8 and the corresponding location in the other is drilled to be a close fit on the hinge pin. The bolt holes were marked out and drilled.

The only dimension in this whole project that that is anywhere near being critical is the position of the hinge pins relative to the front and rear angles. The hinge axis needs to be positioned level with the top surface of each angle and at the point where they intersect.

Hinge Pin

This was a simple turning job and needs little description. The threaded portion was given an M8 thread using the tailstock die holder. When threading from the tailstock, I normally use the lathe under power using the slowest back gear, as I did in this case. The Myford's clutch gives good control. I would not contemplate threading from the tailstock under power on my other lathe as it has no back gear and the slowest speed is not nearly slow enough, neither is there any means to quickly stop the spindle.

I did consider case hardening the pin, but I did not think it would be necessary given the amount of use the bender was likely to have. With the pins well-greased, wear should be minimal.

Once the hinges were assembled and complete, they were clamped in place on the front and rear angles, and the positions of the cap screws spotted through onto the angles, **photo 12**. The bolt holes were then be drilled, tapped and countersunk deep enough to position screws below the surface of the angles.

Handles

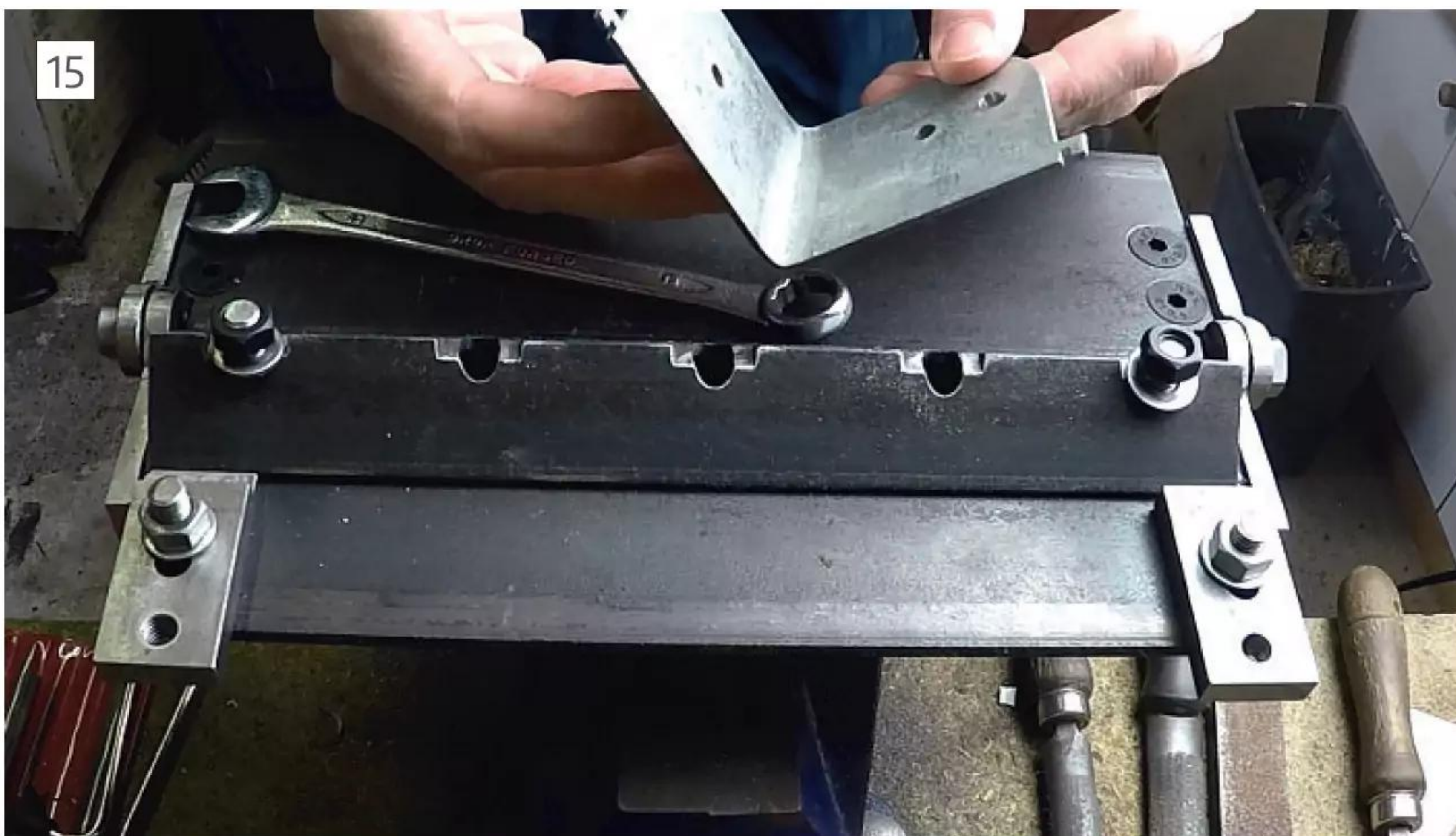
These are lengths of steel bar about 12mm in diameter. One end of each is threaded M8 to fit into matching holes in the front angle. The other ends are chamfered for comfort in the hands. I machined spanner flats on the bar using the side teeth of an end mill, **photo 13**. These are so the handles can be screwed into the front angle with a spanner.

Attachments

Any sheet metal being bent needs to be very securely held in place and the thicker the sheet, the more this applies. The main means of doing this is a clamp



14 Setting a test piece ready for bending. The clamp is bolted down onto the work and the two dogs prevent the clamp from moving under the considerable bending forces.



15 The angle formed in the 2mm thick steel test piece.



16 The clamping arrangements necessary to hold a U-shaped workpiece. The first bend has already been formed and the clamping block is being used to prepare for the second bend.

made from a length of 40x40mm angle iron, which rests on the ends of its flanges on the rear angle and is bolted down according to the job in hand. Five M8 clearance bolt holes were drilled through the clamp with small flats milled in way of these holes for nuts and washers to seat on. Matching M8 tapped holes were made in the rear angle.

For making U-shaped bends (with sharp corners) a short length of rectangular bar stock 14x50mm was cut off with one edge slightly rounded with a file. This is held down on the work with mill table clamps.

Using the Bender

To form a single bend with a fold of up to about 120 degrees (giving an inside angle of 60 degrees), the sheet metal is passed under the angle clamp, which is then bolted tightly down using the bolt holes nearest the sheet after positioning the clamp exactly along the line of the bend. Further clamps or securing measures may need to be taken at this stage to hold the sheet securely, **photo 14**. When all is ready, the bend is formed simply by lifting the front angle using the handles until the required bend angle is achieved. The sheet will spring back slightly so will need to be pushed slightly beyond the final angle to get it spot on, **photo 15**.



The second bend complete.

For a U-shaped bend, the first bend is formed in the same way then the angle clamp removed and replaced with the block accessory mentioned above, positioned such that it sits inside the U and allows the second half of the U to be formed. The block is held down with mill clamps, **photos 16 and 17**.

For all bending work, the clamp needs to be positioned so that there is a gap between its front edge and the face of the front angle in the vertical position, the gap being equal to the thickness of the sheet being bent.

The thicker the sheet, the greater the radius formed on the inside corner of

the bend. The best that can be achieved with this machine on 2mm sheet will be a radius of no tighter than about 3 or 4mm. When positioning the angle clamp or block clamp, this must be allowed for, and the rounded edge filed along the clamps should also be sized to reflect this.

I have found that the clamps already described can be insufficient to hold thicker sheet securely in place, so further tapped holes are provided in the rear angle, which are used for dogs and clamps pinched from the milling machine as needed to provide further security to the work.

That's about as much as I have to say on the subject of angle iron, other than to add that your local steel stockist will be able to provide steel angles, channels, I-beams and so on in many different sizes. You may well find something suitable to use as a starting point for your project. ■

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John Arrowsmith takes a trip to Quainton Road, once the terminus of the Metropolitan Railway, to visit the Vales of Aylesbury model engineers' extensive track.

Steam Plant

Ian Beilby builds a steam plant based on an electric boiler and vertical marine engine from Cheddar Model Steam.

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From the Archives

With over 125 years of Model Engineer magazine and nearly 35 years of Model Engineers' Workshop in our archives, there's a huge selection of fascinating and often useful ideas for the workshop to be found.

From 27, January/February 1995, this article by Allan Jeeves explains the mysteries of the Grip-Tru chuck. Hopefully the text explains the principles well enough if the diagram is a little hard to read.

THE GRIPTRU CHUCK

Allan Jeeves discloses the secrets of the Griptru chuck.

Self centring 3-jaw chucks are an innovation of the 19th century and were a successful method of speeding up the chucking of work in the lathe. The 4-jaw independent chuck, which was a natural progression from the era of faceplate dogs which could be separately adjusted to centre the work (or throw it off centre as the case may be), was a means by which a job could be exceptionally accurately centred but precious time was spent in so doing. If it is not essential for the workpiece to be running dead true, for example if all the turning operations are to be carried out in one single chucking, the self centring chuck is ideal. Contrary to the belief held by many engineers, these chucks are not intended to operate 'dead true'. Although work is sometimes set up quite accurately by this method of workholding, any such exactitude is unanticipated and concentric accuracy of 0.076mm (0.003in.) at 25mm overhang is considered good while 0.127mm (0.005in.) is often the case, especially if any wear has taken place.

If these chucks were intended to provide the benefit of exact concentricity, chucks such as the 3-jaw combination chuck introduced by Pratts of Halifax, West Yorkshire, - a particular type of 3-jaw chuck where the jaws can be accurately adjusted individually prior to being manipulated simultaneously in the usual way - would not have been developed. You can walk into almost any engineering jobbing shop and see 3-jaw chucks which have a 'fairy circle' of punch dots around one of the 3 pinion square drives where the chuck key is located. Presumably by using only this pinion to tighten the chuck, greater accuracy is possible than would be the case if the scroll is rotated by one of the other two pinions.

The year 1954 saw the introduction - by chuck manufacturers F. Burnard & Co. Ltd, then of Kidbrooke, London - (now incorporated within Pratt Burnerd International of Halifax) of a micro-adjustable 3-jaw, geared scroll chuck having the facility of adjusting the concentric location of the chuck unit relative to its mounting on the lathe spindle. That is to say that when the chuck has been secured to the spindle nose of the machine, it can then be accurately adjusted so as to become precisely concentric with the spindle. This feature bestows the chuck with the provision to be set up to within 0.005mm (0.0002in.) needle movement on the dial indicator, correcting the accumulated error of the individual parts when assembled, or compensating for any inaccuracy which may have occurred through reasonable wear and tear of the chuck. This product was named the Griptru chuck.

Even in 1954 the concept of moving the chuck slightly once it had been mounted was nothing new. In its simplest form the back plate or adaptor plate which is normally located to the chuck body by a precise fitting spigot register is, instead, provided with a small clearance which allows the body to be tapped true before the securing screws have been finally tightened (fig.1). The most conspicuous disadvantage with this method is, of course, in the fact that the body can move on the spigot when in use due to the forces present during its operation.

The Griptru chuck is, however, something different. Once set up and secured in position, there is no possibility of the chuck body moving on the spigot register and the device remains an accurate unit throughout its use. The principle of this chuck is fundamentally the same as that shown in fig.1 except that the body is not tapped true with a mallet but is

adjusted by means of 3 conical wedge screws which have hexagonal socket heads and so are moved using an Allen key. The chucks are originally supplied with the appropriate hexagon key machined onto one end of the chuck key tommy bar, an additional feature of this product.

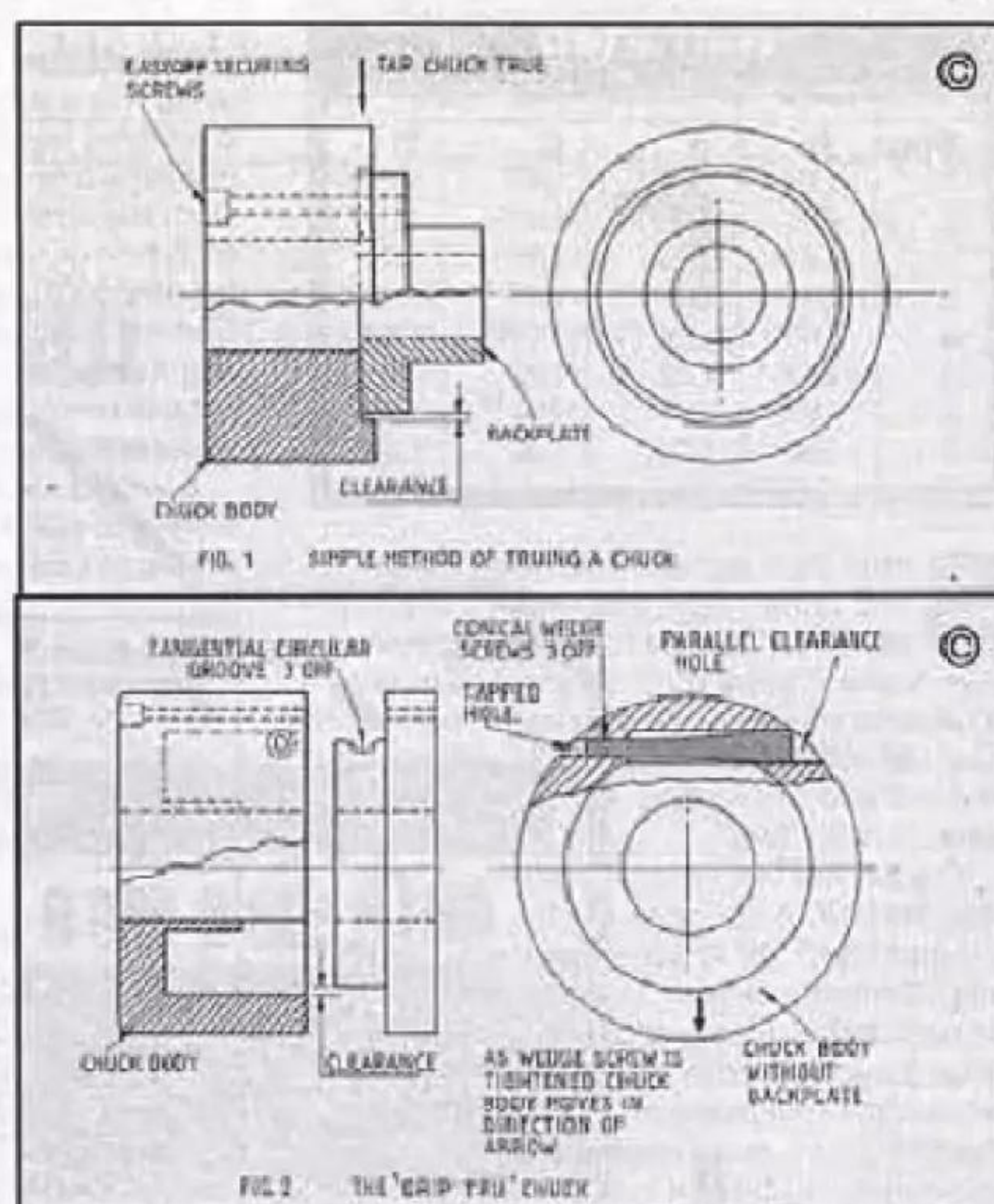
The register spigot is machined with 3 tangential circular grooves which are milled in, equi-spaced, and form the bearing surfaces for the screw wedges (fig.2). These in turn are located in holes which are drilled tangentially in the body. The screws have conical shanks so that when they are screwed inwards they displace the body in relation to the adaptor plate. This is done with the tension on the securing screws relaxed. The movement of the chuck body is so slight when the conical screws are turned that the adjustment is very fine and perfectly within the control of the operator. Once he is satisfied with the truth of the chuck the securing screws are finally tightened.

These chucks were first supplied in 3 1/2, 4, 5 and 6in. diameters; larger sizes were introduced later, notably 8, 10 1/2 and 12 inches. They are now supplied in metric sizes and 6-jaw models are also available. A 4in. (100mm) diameter Griptru chuck has also been produced for direct mounting onto a Myford ML7 or Super 7 lathe.

While these chucks are quite expensive to purchase new, due to the fact that they have been on the market for 40 years or so secondhand examples are commonly found and don't seem to command a higher price than a standard 3-jaw of the same diameter and condition.

I hope that this short article will assist the home workshop enthusiast in recognising this excellent work holding device if he is fortunate enough to encounter one at a bargain price.

The component parts of a 6in. Griptru chuck. They are identical to a standard 3 jaw chuck, with the exception of the three conical wedge screws below the geared spiral ring on the left of the picture.



Unlocking a Secret



Stub Mandrel takes on an interesting exercise in hand work and explains the workings of a mortice lock.

The original request was simple, for a lock or bolt on an internal door, and my initial thought was what simple solution would look neat and be easy to use. I soon realised that the original door lock, which was a typical combination of a sprung latch on the handle and a mortice lock was still in place. It transpired that any unused keys which had come with ownership of the house many years ago had been long lost.

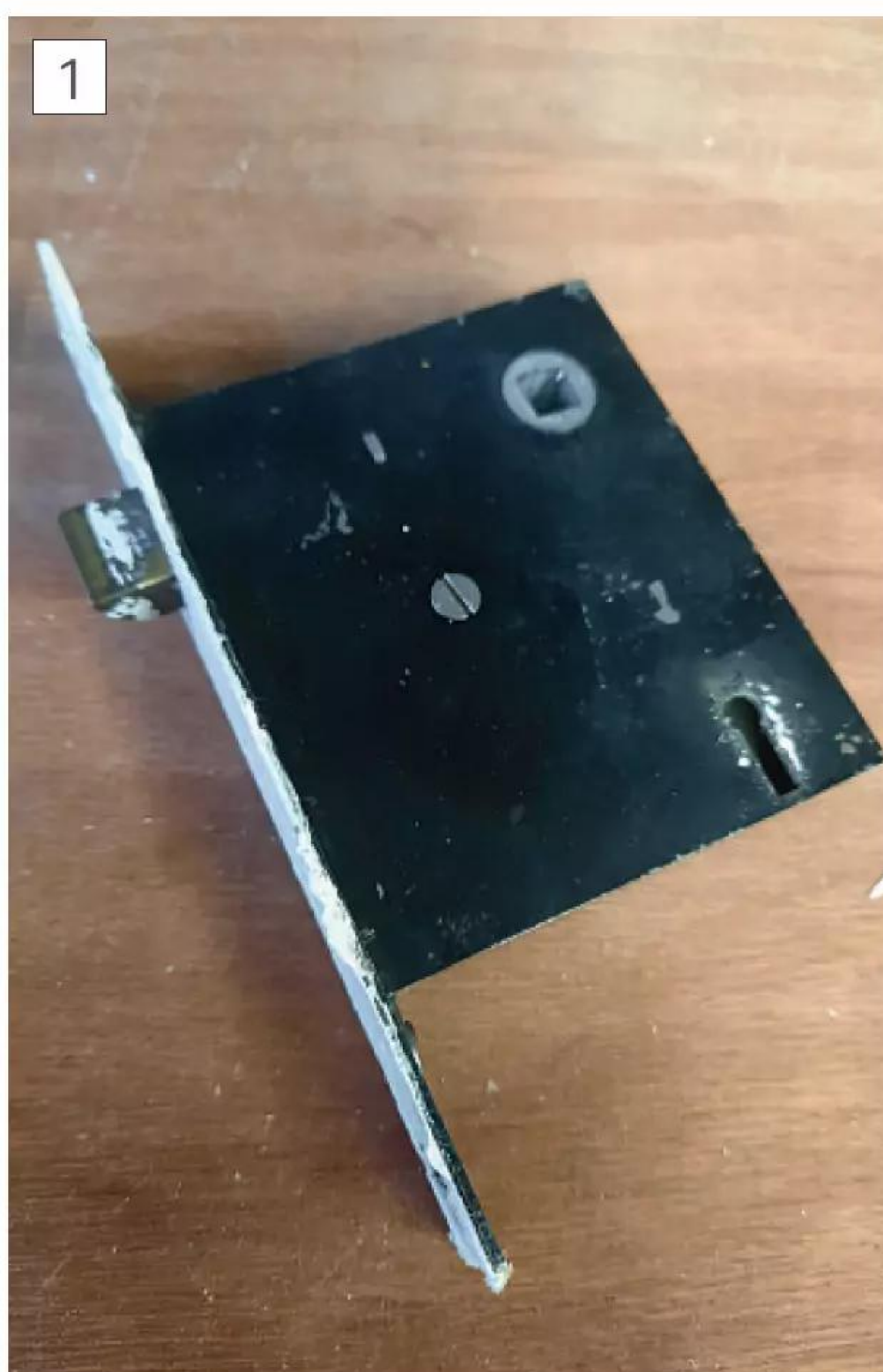
I measured up the lock, **photo 1**. The house is at least 130 years old, but the vertical arrangement of handle spindle and keyhole suggests this is a more modern design (Victorian locks generally have them one behind the other), but it was still several decades old. The most important dimension is the 'backset' or

distance of the keyhole from the front of the lock. In this case it was 2 1/2", however mortice locks are generally classed by their case size and backset can vary for the same size case! A 2 1/2" lock typically has just 44mm of backset. You can get locks with larger backset (typically 67mm) but they are harder to find. Once I started trying to match other dimensions – I wanted to avoid resizing the hole in the door or changing the lock plate on the door frame, it got even harder to find a good match at a sensible price. Significantly the hole for the door handle shaft appeared to be higher than on most locks.

I recalled that in the past I'd been able to restore a very worn lock to working order by adjusting the levers to match the key properly, so I thought maybe I

can make a key to fit. Thoughts of silver soldering crossed my mind, before I realised, I should be able to source a suitable blank. Risking my hard-earned cash, I ordered a generic three-lever key blank from the internet at £1.90 post free.

While we wait for the blank to arrive, let's open up the case and see how a mortice lock works. I removed the single screw and popped it in a magnetic dish for safe keeping, **photo 2**. The side plate popped off easily and the workings appeared nice and clean, **photo 3**. You can see the sprung latch is operated by a simple Y-shaped cam so it operates with either lifting or dropping of the handle. Below this is the locking mechanism, you can see two brass 'levers' one above the other, also **photo 4**, note the lever



The mortice lock, as removed from the door.



This little magnetic bowl has saved me a lot of frustration over the years.



The inside of the lock was clean, suggesting it had been little-used.



The two brass levers with steel springs. A three lever lock has two of these, a five lever has four and so on.



The final lever is the bolt lath, note the bolt stump and 'talon' beneath it.



The bit of the blank was noticeably oversize.

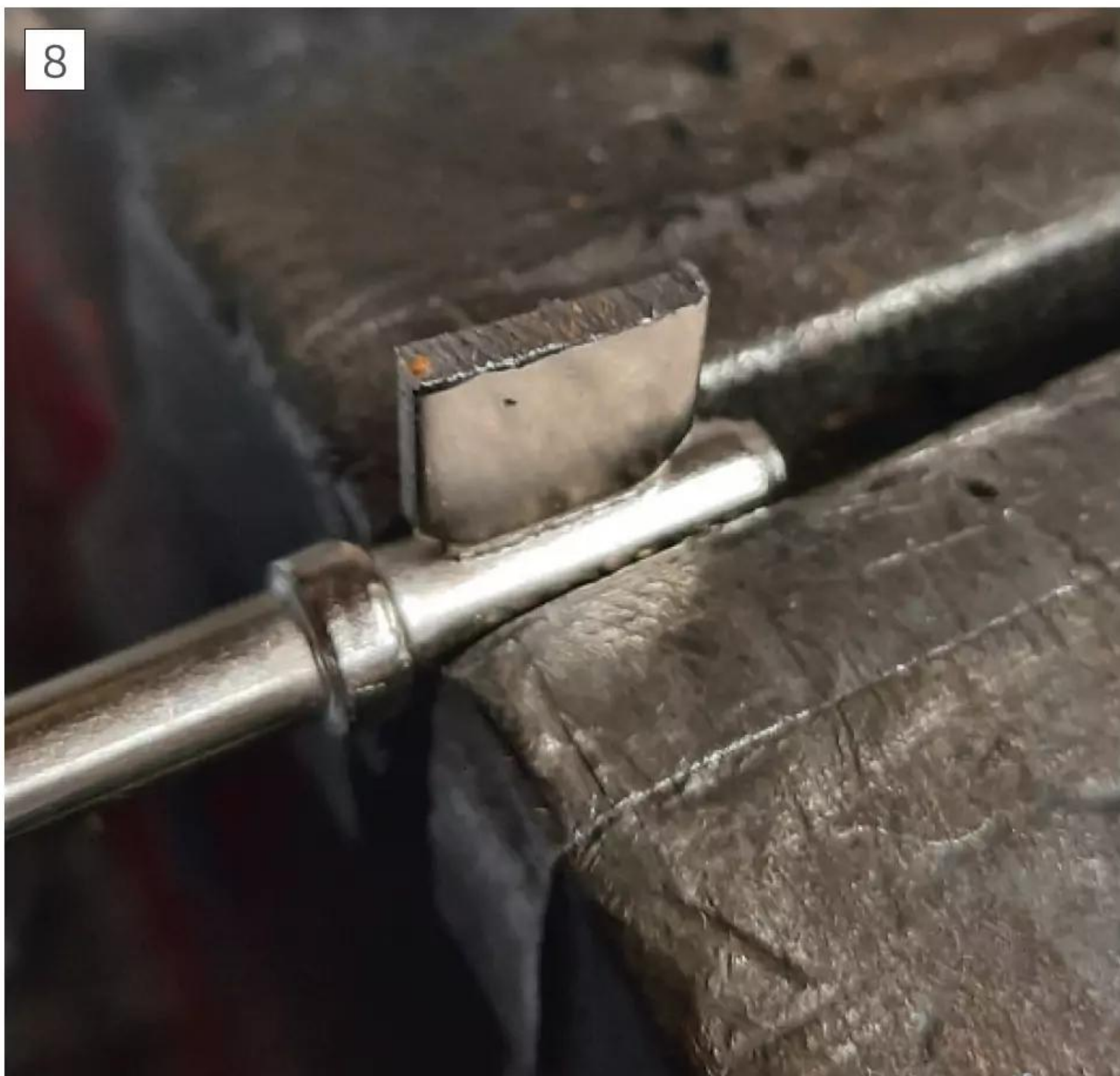


The key blank as received.

springs and H-shaped 'pockets' in the levers. Beneath the brass levers is the third, steel, lever, the bolt lath, which is riveted to the brass bolt head, **photo 5**. You can see a roughly triangular cutout, the talon in the bolt lath. Without the brass levers any key that physically fits the lock will engage the talon and move the deadbolt left or right to lock or unlock the door. The deadbolt is guided by the hole in the case and the steel pin or 'lanket' that fits in the lanket hole. I enjoyed discovering the unusual terminology of all the lock parts, I hope I have it correct.

From the steel lever a small projection, the bolt stump, engages with the shaped hole, the pocket, in the brass levers, and the lever springs, tensioned against the screw post, cause them to be forced down around the pivot, so the bolt stump is constrained in one or other of the upper parts of the pocket by one of the 'bars', depending on whether the lock is set or not. The 'clever' aspect of the mechanism is that the outer parts of the key that contact the brass levers (on the concave 'belly') need to be the right length so that when the key is turned it raises them and aligns with the 'gating' of the pocket to align with the projection, allowing the deadbolt to move freely. Using different belly depths means each lock can only be opened by the matching key.

Is that the post? Yes, here's the key blank, **photo 6**. Important features are the bow, which is then part you hold, the stem or shaft which has a collar before the section called the pin that enters the lock, and the bit, which engages the levers. To fit the lock the pin must enter the round part of the keyhole easily, but not too loosely, while the collar must not enter the hole. The bit needs to fit in the cutout of the steel lever and be slightly less wide than the internal depth of the



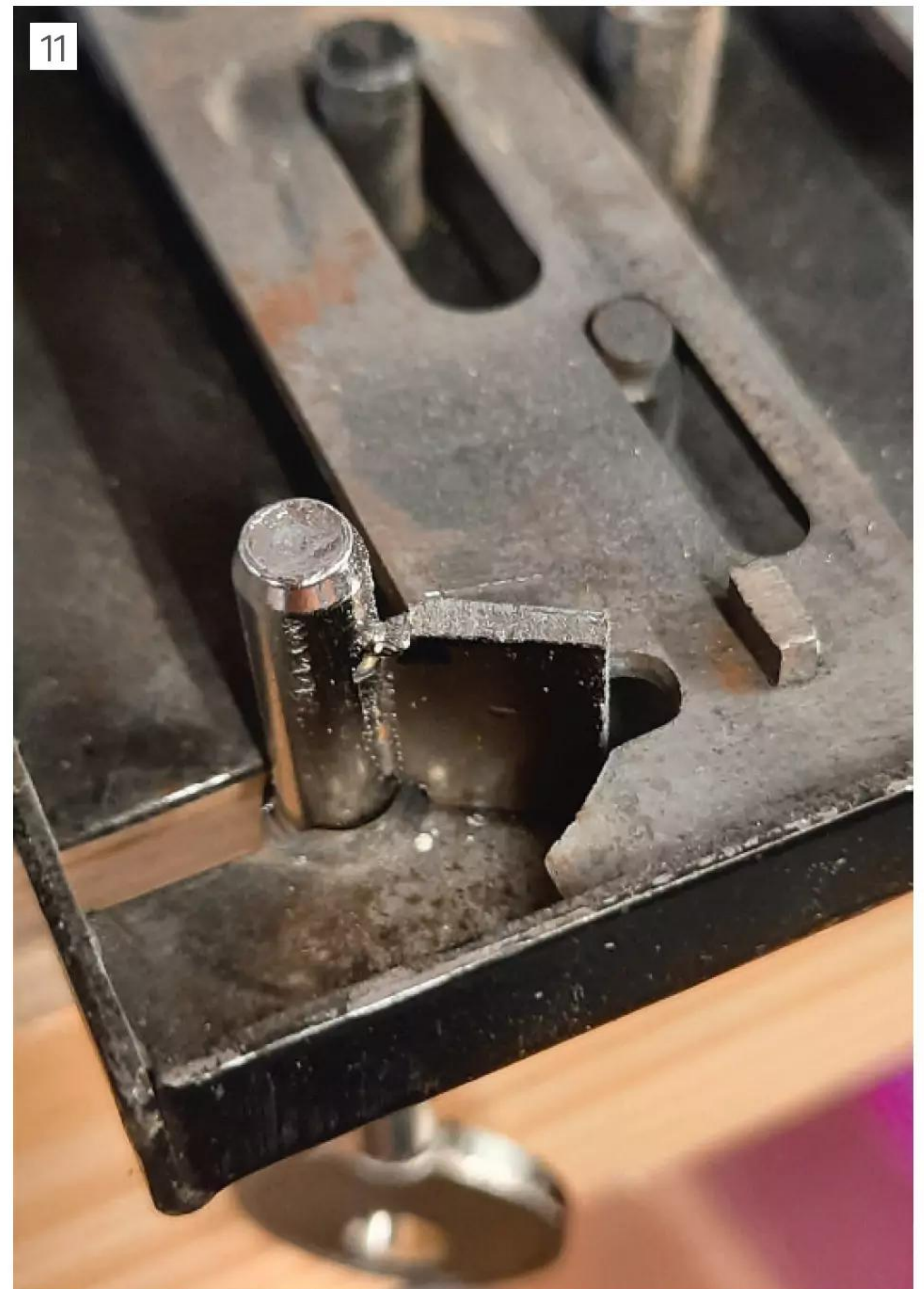
In the process of filing down the blank.



I chose a smooth cut file to avoid the risk of removing material too quickly.



The collar to bit distance had to be increase slightly.



To fully enter the talon, the bit must not catch on the curved sections.

case. You can see a black line on the bit of the key, this was to guide me in filling the oversize bit to match the case.

Photograph 7 shows that the bit was too long for the keyhole. Naturally the first task was to file the bit of the key blank to enter the keyhole, **photo 8**. I

used a smooth file, **photo 9**, as I didn't want to remove material too quickly. The next task was to reduce the width of the bit to match the case, the collar to bit distance also needed to be reduced to match the thickness of the case material, **photo 10**.

Once the key could be inserted and turned with ease, it had to be further reduced so that it did not bind on the angle sections of the talon in the bolt lath, **photo 11**. Once I had the key working, I assembled the lock without the brass levers to make sure the action



With the case cover in place the key must not foul the edges of the far keyhole.



The blank now fits the lock, but is not yet fitted to the levers.



A selection of small 'needle' files with various handles.

was smooth. I found it helpful to put a small bevel on the edges of the bit, just enough to ensure it couldn't catch on the edges of the keyhole, **photos 12 and 13**.

It was now time to reach for some smaller files, **photo 14** to do the detail work on the key. I always use a handle

with these to avoid the risk of stabbing my palm. The small moulded handles are acceptable but the larger commercial and 3D printed handles are a much more comfortable.

It was easiest to work with the key in the 'back' of the lock as this meant

I could see it engaging with the brass levers. I had kept them in order, but as I was fitting a key from scratch the order of the levers wasn't critical.

Photograph 15 shows how the uncut (but fitting) key blank raises the lever too high, so the lower bar stops the bolt stump moving across. Using the cut and try method I gradually filed a narrow notch, these are actually called teeth, until the tooth engaged the belly of the lever and raised the lever just enough for the belly to pass through the gating and allow the lock to operate, **photo 16**. Make sure to test with the cover on the case, as this ensures the key is properly aligned. I then added the second brass lever, **photo 17**, it's easy to see how the curved bellies of the levers don't match. I then filed the end section of the key to fit, **photo 18**.

So now the lock was fully working – except it wasn't, what about when the key is reversed? To fit it from the other side the case had to be closed with the cover. I didn't want to match it by eye, as that seemed a bit hit and miss. So, I went in search for my engineers'



The key needs to be cut to fit the levers as the stump fouls the bar.



The first tooth is cut and the key now raises this lever so the stump can pass through the gating.



By having a different belly on each lever means different tooth depths are needed.



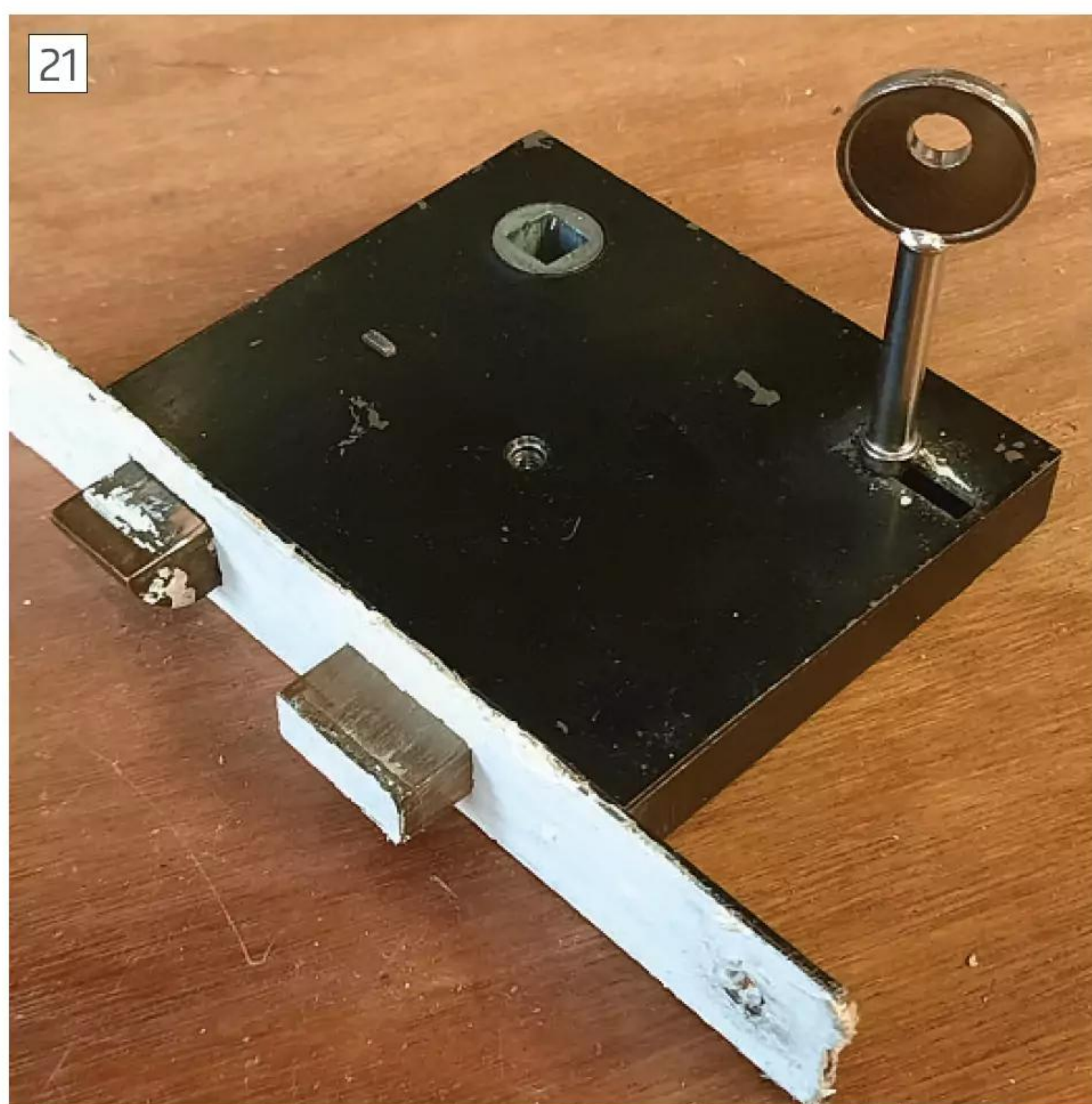
With the second tooth cut, the key can now operate both levers. >



Key sprayed and used from the other side of the lock, the two scratch marks show where it contacted the levers.



Progress with filing the teeth.



The key and lock working together.

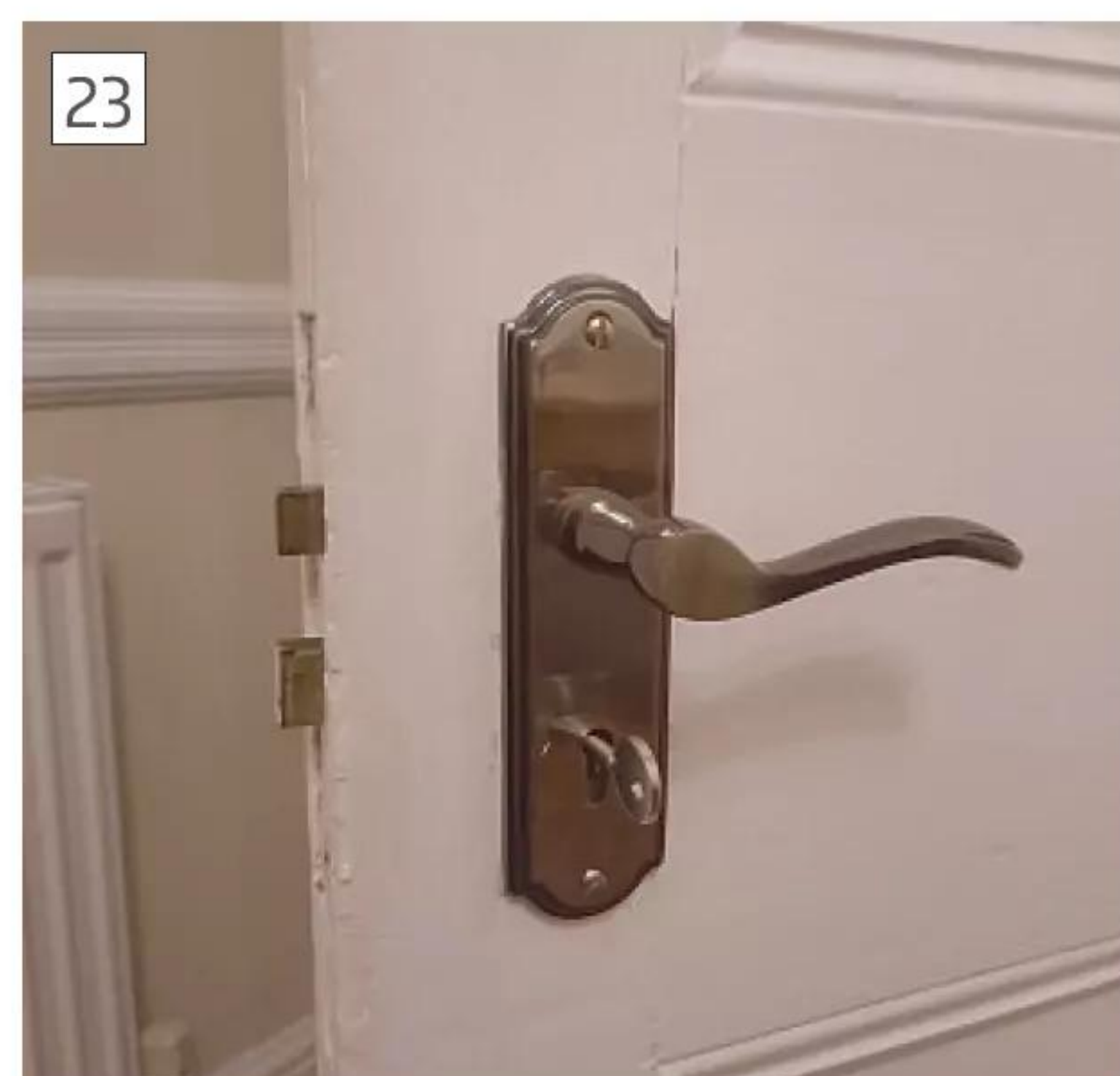


Working parts lightly oiled.

blue to do the job properly. After fifteen minutes I gave up searching, and applied a quick dusting of black spray paint to the key. In **photo 19** you can see two scratches made by the edges of the levers in the paint, I added conservatively scribed marks for the depths of the teeth. I started by filing guided by this line, **photo 20**, then gradually deepened the two teeth until the lock operated smoothly from both sides, **photo 21**.

I then applied very small amounts of light mineral oil to the mechanism,

photo 22. Heavens above! When the lock was replaced in the door, it worked perfectly from both sides, what a relief, **photo 23.** Naturally there are many variations on this basic lock, with more levers, bits with irregular cross-sections and hollow ends, for example. All in all this was a fascinating insight into a clever mechanism that's been optimised for mass production and it gave me more appreciation for the work of locksmiths who can prepare a working key from an existing one in far, far less time that this took me. ■



The lock replaced in the door.

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Models

■ 5" gauge King, brand new, never been steamed, copper boiler, friend whom I ordered it for divorced now for sale 8,500 GB pounds, excellent workmanship free on board to any port the world. **T. 5703282073. Sciota, PA, USA.**

Parts and Materials

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■ **For disposal. Donation to charity appreciated.** 0 gauge coarse scale brass rails and other track parts. Mix of Bonds

and Bassett Lowke. (not ready made track) . Wooden sleepers also available. Collect from outer York.. **E. arbe1950@googlemail.com T. 01904 781832. York.**

Miscellaneous

■ Post Office type 46 master clock,4.5 volt drive. Working and in good order. £280.00 ono. Telephone. **T. 01553 630429. King's Lynn.**

Wanted

■ Wanted: Model Engineer Volume 176 Issue 4015, 19 April 1996, or at least Eric Whittle's article on his V8 four-stroke aero engine. **E. bjsbyl@windstream.net.**

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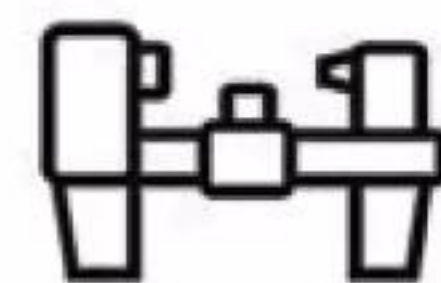
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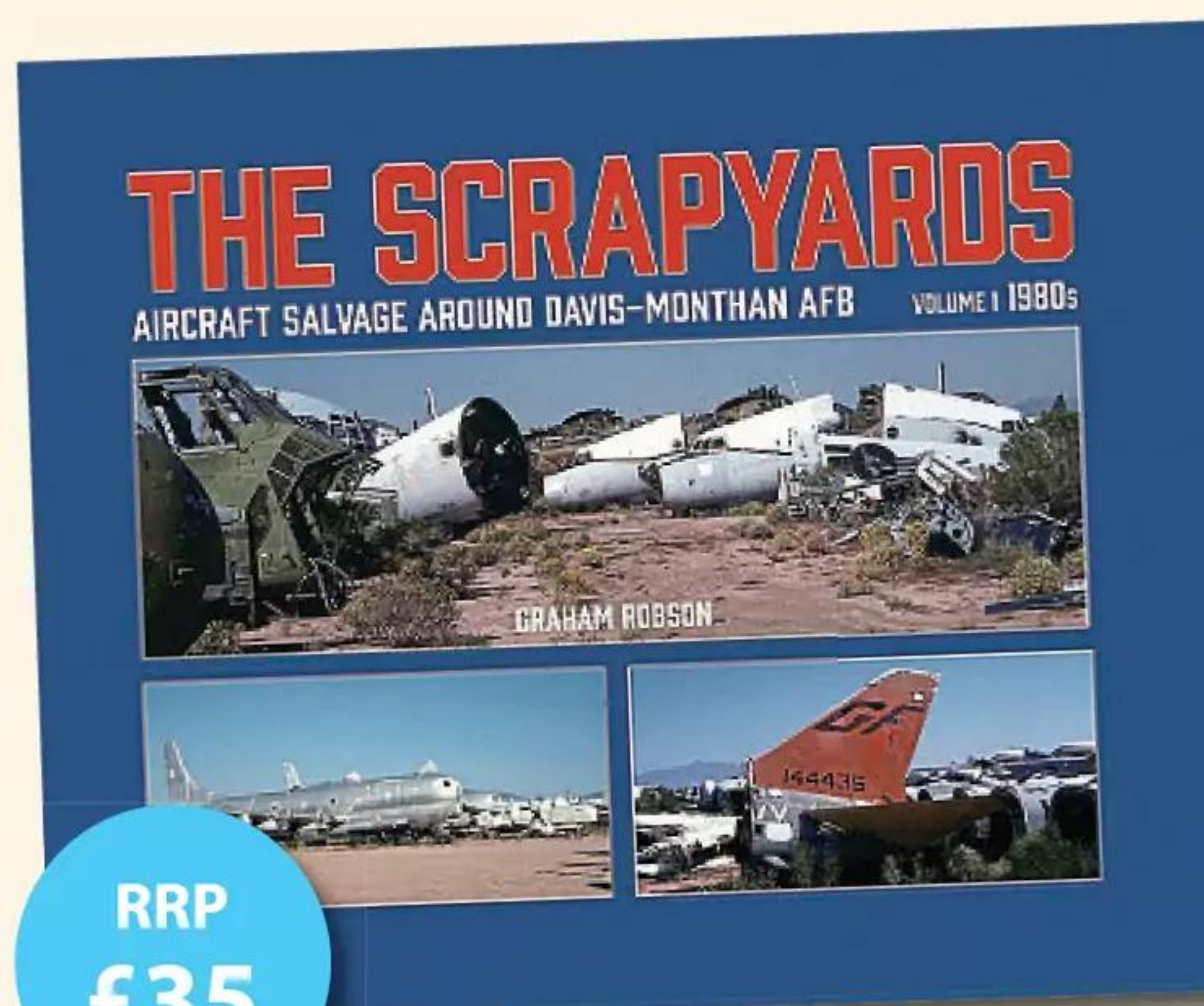
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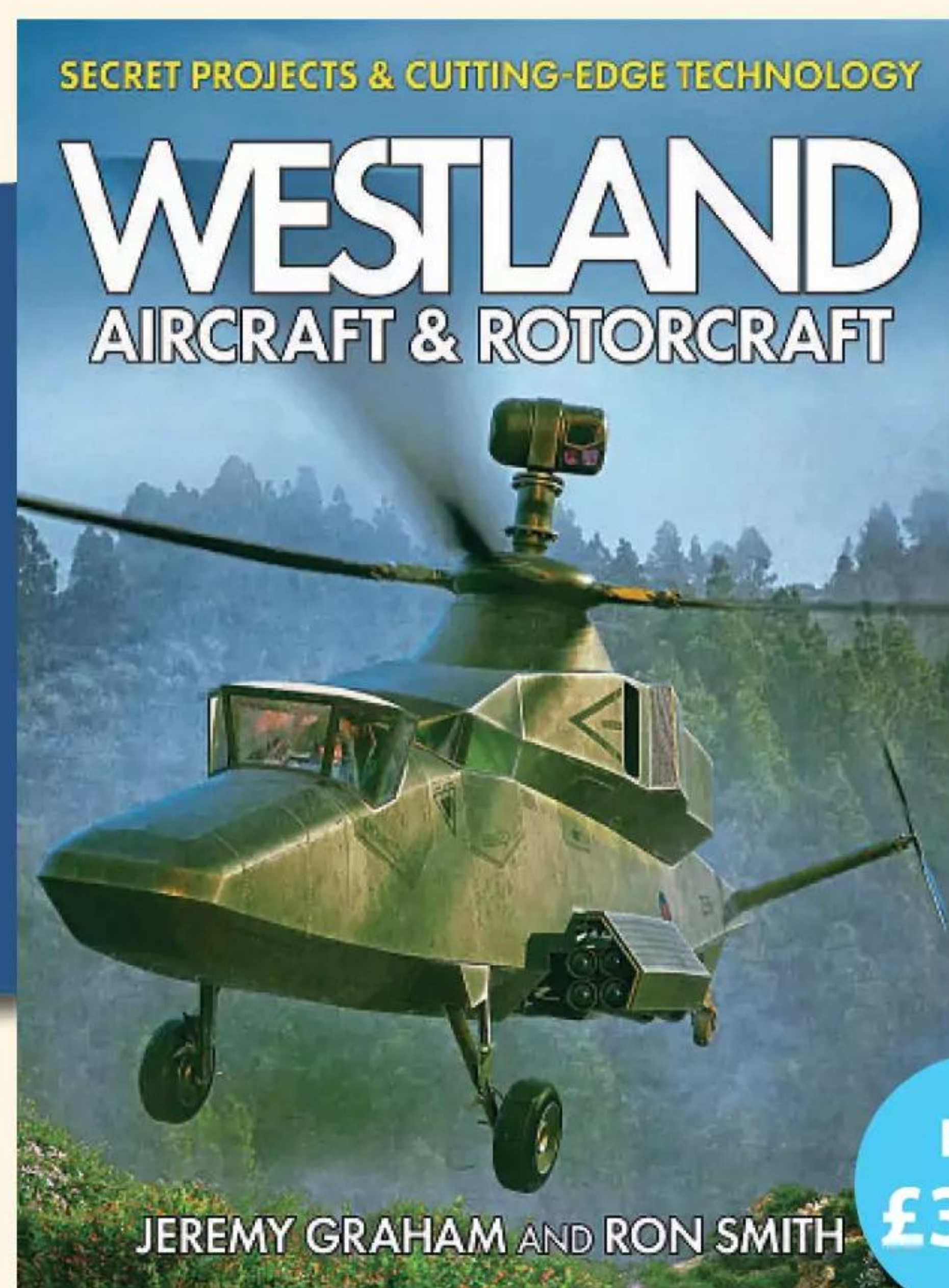
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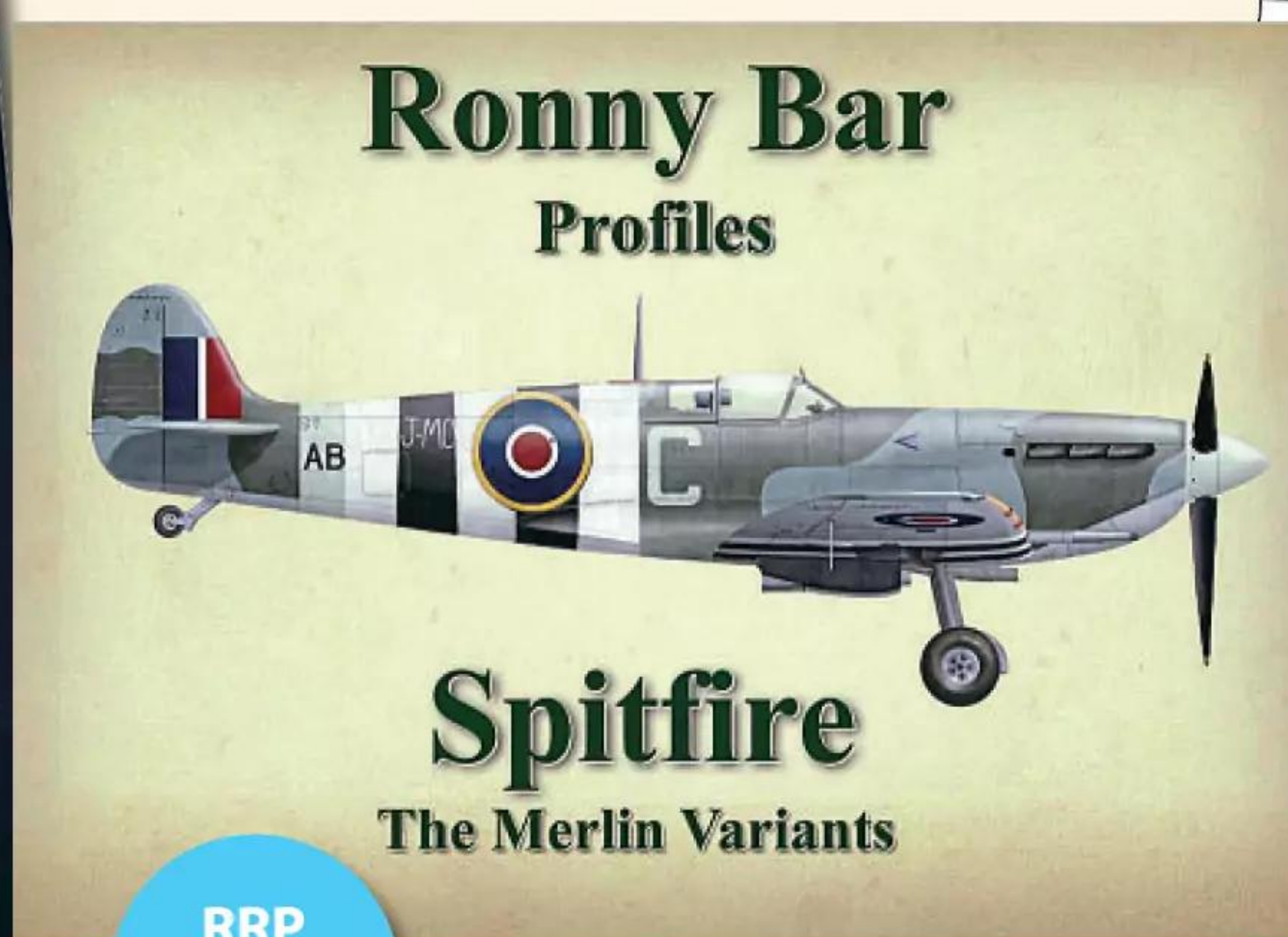
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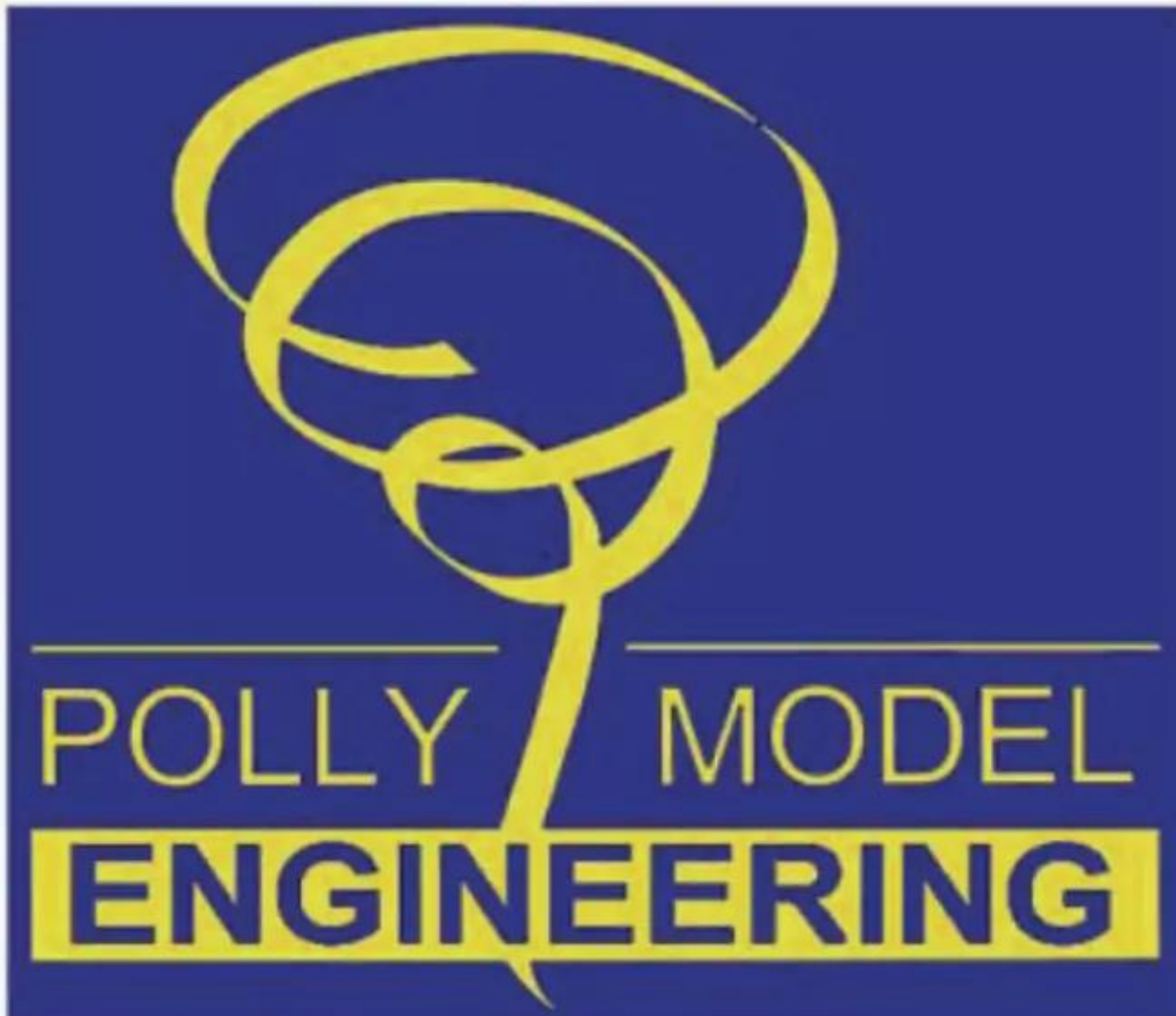
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