

No.285

THE MAG FOR MAKERS, MODEL AND HOBBY ENGINEERS

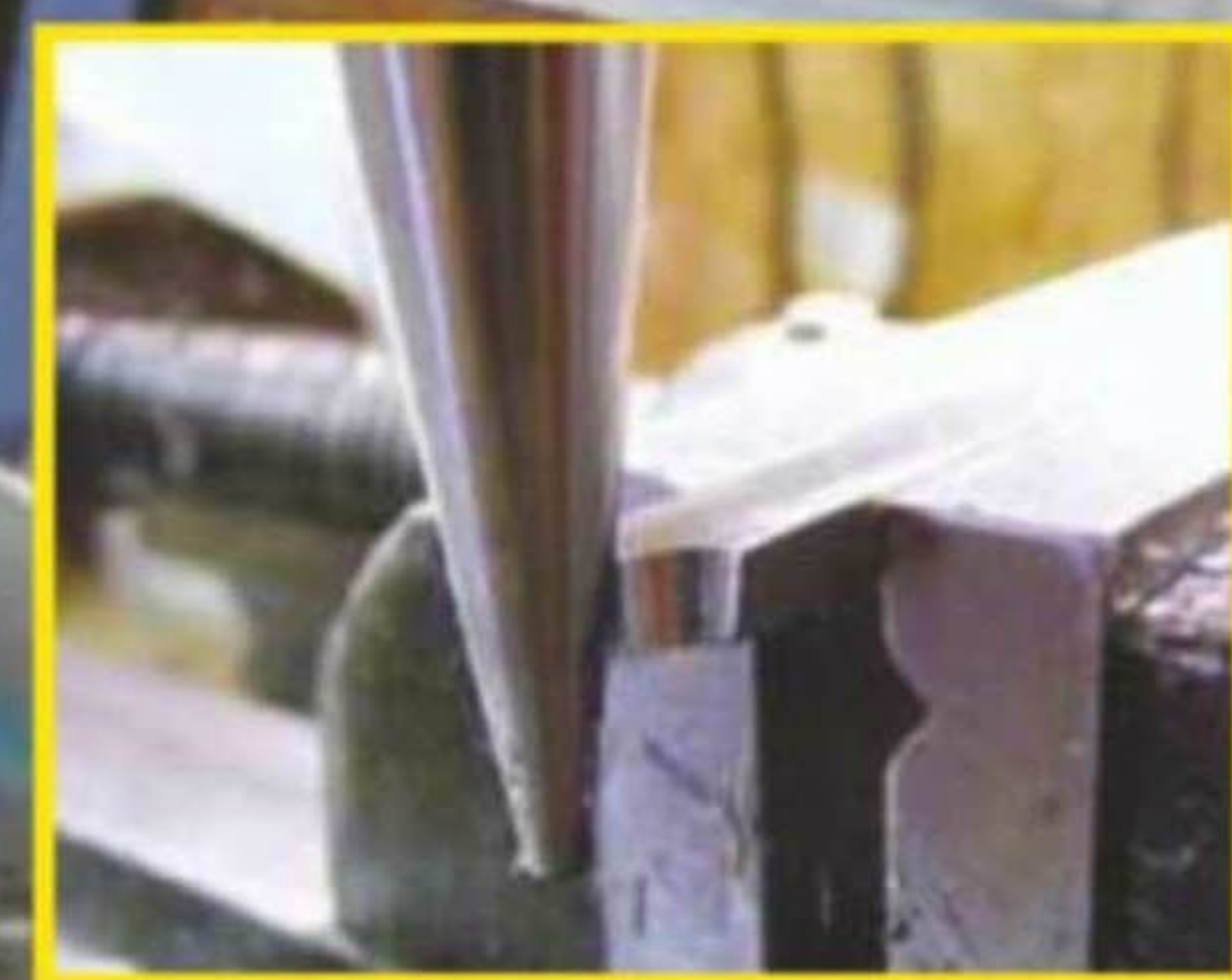
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INSIDE

- Making a press tool
- Square Pegs in Round Holes
- How to reverse a Compound Table
- Improving a budget vice
- Touching up lathe tools



Easy Gear Cutting

COVER STORY

Measuring bed wear on Myford Lathes



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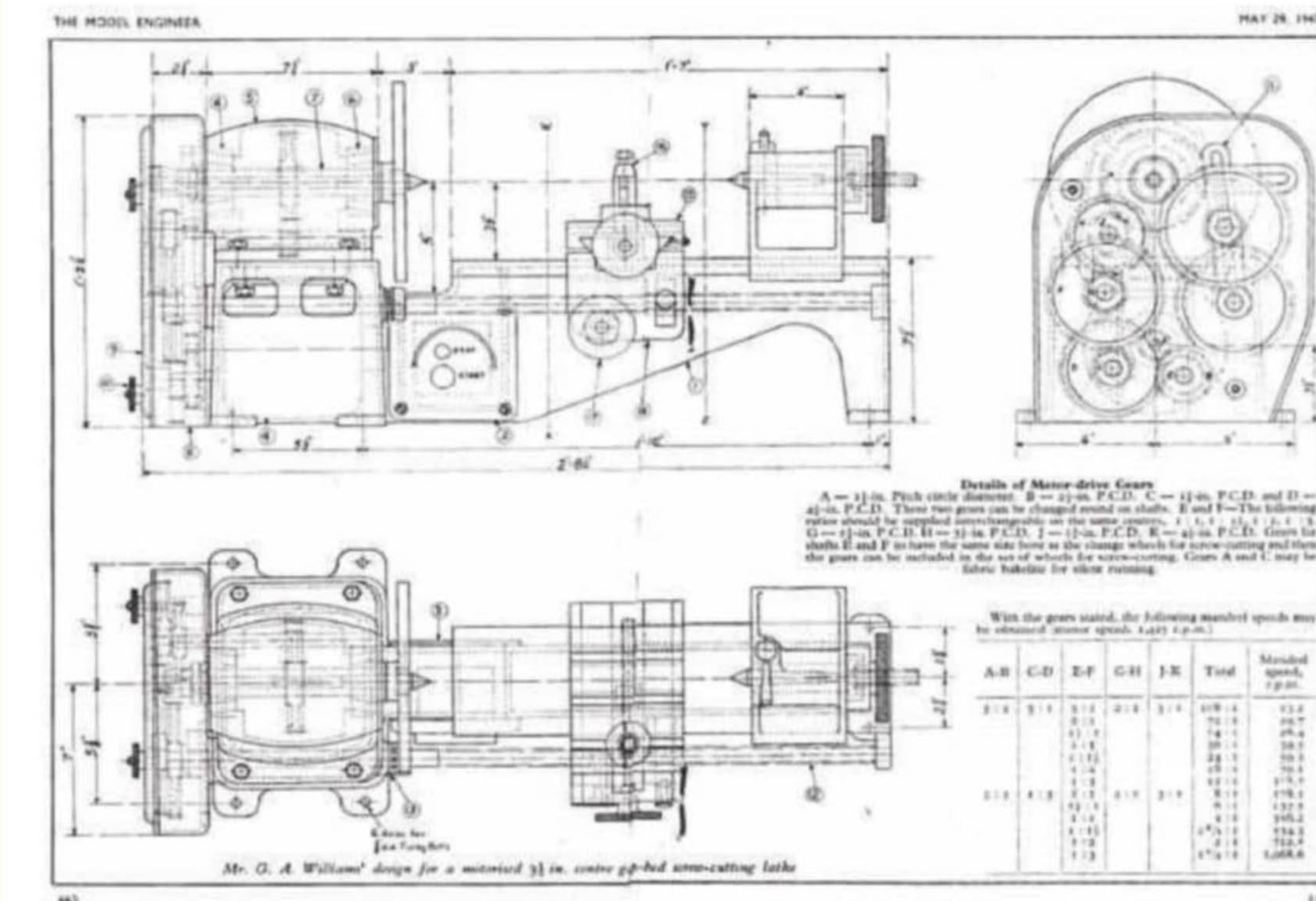
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On the Editor's Bench



Lathes of the Future?

Over the past couple of decades we have seen a strange mix of innovation and conservatism in the design of our workshop machines. CNC aside, a lathe operator from the 19th century would probably be able to use one of our modern machines, with only the electrical controls being truly unfamiliar. Yet there have been huge changes in the details and style of our machines - not least a 'blockier' appearance which has more to do with enabling mass-production using jigs than aesthetics. We now take for granted things like built-in motors, resettable dials, large bore-spindles and variable speeds, even on the cheapest machines. What changes will we see over the rest of this century?

Many years ago, in the late 1940s, Model Engineer ran a contest for people to design the 'perfect' model engineering lathe. This generated interesting ideas from readers, with three finalists having detailed drawings of their designs published in the magazine. Looking back, all three designs look very much of their time - D.R. Greater's design is illustrated here, equipped with a 'foot motor'! Even so, they are thought provoking given they appeared less than a year after the Myford ML7 was unveiled in August 1946. If there is interest from readers, we could republish these designs.

This issue sees a series of drawings by Kevin Barry, who proposes a lathe modification with a horizontal boring head to replace the tailstock, something I haven't encountered before. Over the years we have published Alan Jackson's Stepperhead and visitors to the forum will see some interesting modifications to machines by Joe Noci and Niels Abildgaard, to name but a handful of many innovators.

I'm sure readers who are aware of the host of modifications made to my CL300 mini-lathe over the last 20 years (where did they go?) while not as radical as other's work it is true that many of us have our own ideas of what the 'ideal' lathe should be.

I'd like to encourage you to share your ideas for the lathes, and other workshop machine tools, of the future with fellow MEW readers. This could be just a letter with an idea, sketch or wish-list for Scribe a Line, or an article with a detailed concept like those from 1947, or even a fully worked out design, like Stepperhead.

Drop me an email at neil.wyatt@mytimemedia.com to share your ideas, and to request the author guidelines if you want to submit a full article. If you are planning anything more than a brief submission, I suggest you send me a summary first.

I look forward to receiving your ideas!

Neil Wyatt



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Frustrated by a table that went the 'wrong' way, John Crammond decided to make a simple reversing gearbox.

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Coming up... in our next issue

Coming up in our October issue, number 286, another great read



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ON THE COVER >>>

Just because a machine is old, and even worn, doesn't mean it's ready for the scrapheap. But how can you make an informed assessment of its condition? Peter Barker takes readers through checking wear on an old Myford ML7. See Assessing Myford Bed and Saddle Wear on page 53 for the full story.

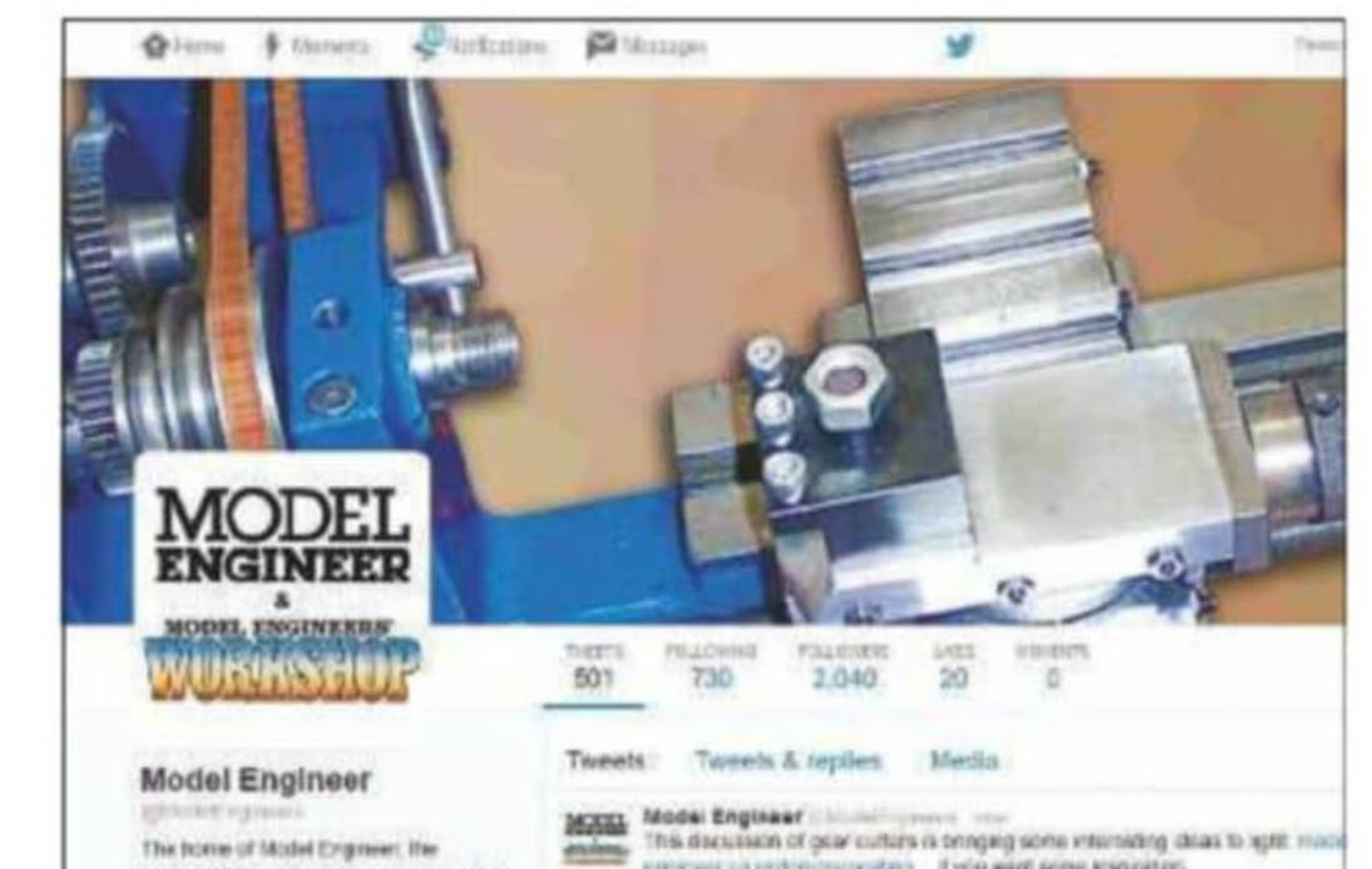


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THIS MONTH'S BONUS CONTENT Log on to the website for extra content

Visit our website to access extra downloads, tutorials, examples and links. Visit the link below to find a selection of workshop articles online:

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Any questions? If you have any questions about our recent Alibre Atom3D or current Lathework for Beginners or Milling for Beginners series, or you would like to suggest ideas or topics for future instalments, head over to www.model-engineer.co.uk where there are Forum Topics specially to support these series.

Where are you? Come and join one of the busiest and friendliest model engineering forums on the web at www.model-engineer.co.uk?

Hex Silver Steel/Tool Steel?

■ It seems that octagonal; tool steel used to be readily available – but where can we find it today?

Boring Problem

■ What's the best way to bore a replacement bearing for a Stuart Turner 5A steam engine?

Scale Gauges

■ Is there any logic behind the bewildering array of model locomotive gauges and scales?

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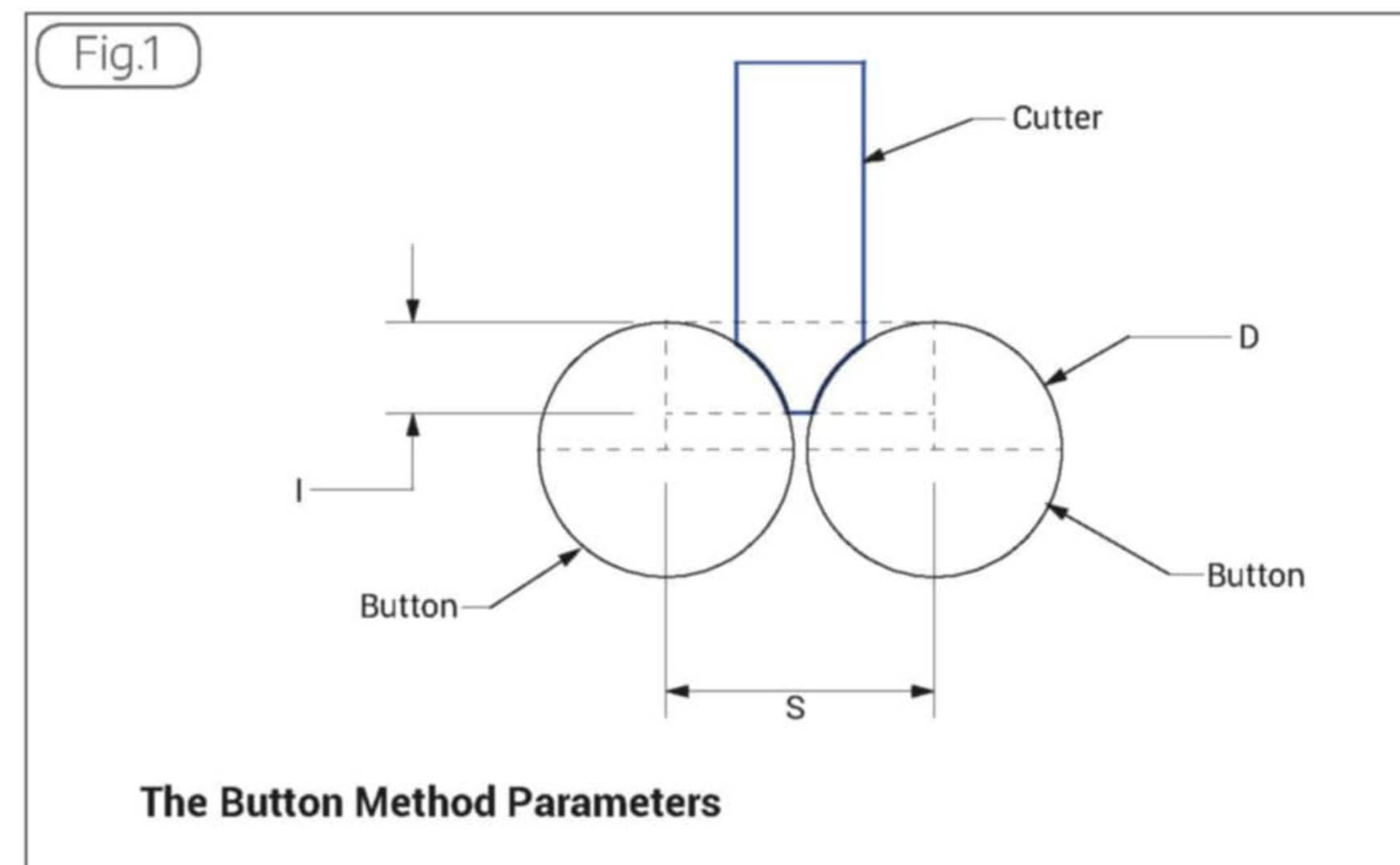
Gear Cutters and Gear Cutting



Michael Cox introduces the art and science of making your own gears.

Sometime ago I wanted to make a 21 tooth change gear for my mini-lathe. I had never made a gear before and like most amateurs I turned to Ivan Law's book "Gears and Gear Cutting" for inspiration. In the book he describes a method for making a gear cutter using what has come to be known as the "button method". This method is based on using a circular arc to approximate the involute curve.

Making a cutter by this method is quite involved and time consuming. It involves making two hardened steel discs, the "buttons", of a precise size and mounting them at a precise separation on a steel plate. This composite tool is then used to profile the edge of a piece of high carbon steel which after hardening and tempering



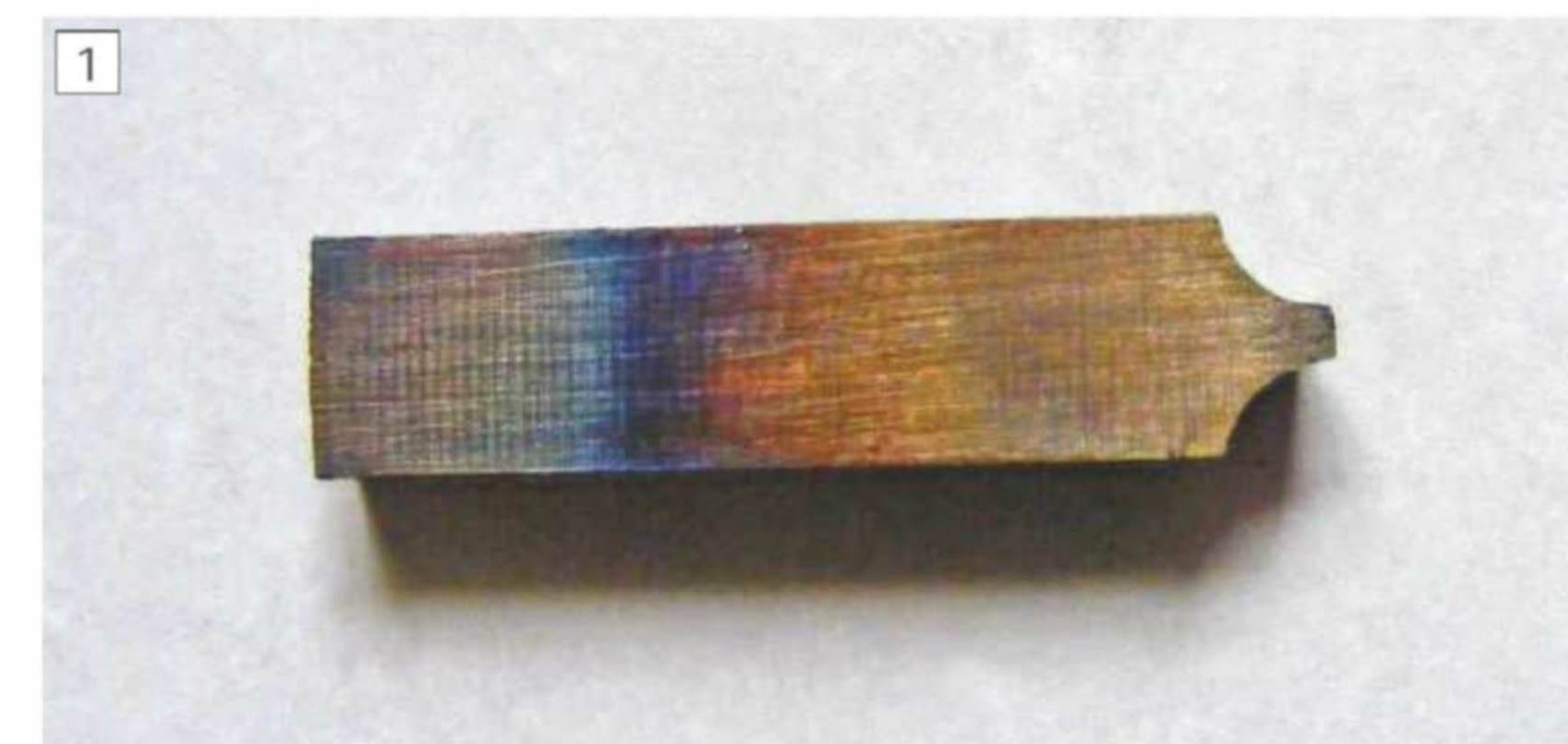
In other words, it involves making a tool to make the tool that is used to cut the gear.

becomes the gear cutter. In other words, it involves making a tool to make the tool that is used to cut the gear. It is, however, an essential step in making multi-tooth gear cutters.

The important geometrical parameters for the composite tool are the button diameter D, the button separation S, and the infeed I, see **fig. 1**.

The late John Stevenson suggested an

alternative method for making gear cutters that is also based on the arc approximation to the involute, see: tinyurl.com/gearcut. This method is much simpler and less time consuming and can be used to make single point cutters. Basically a strip of gauge plate (or similar high carbon steel) is mounted horizontally in a milling vice and then, using a conical milling cutter, the end of the strip is profiled with two circular



A typical gear cutter.



Cone drill set.

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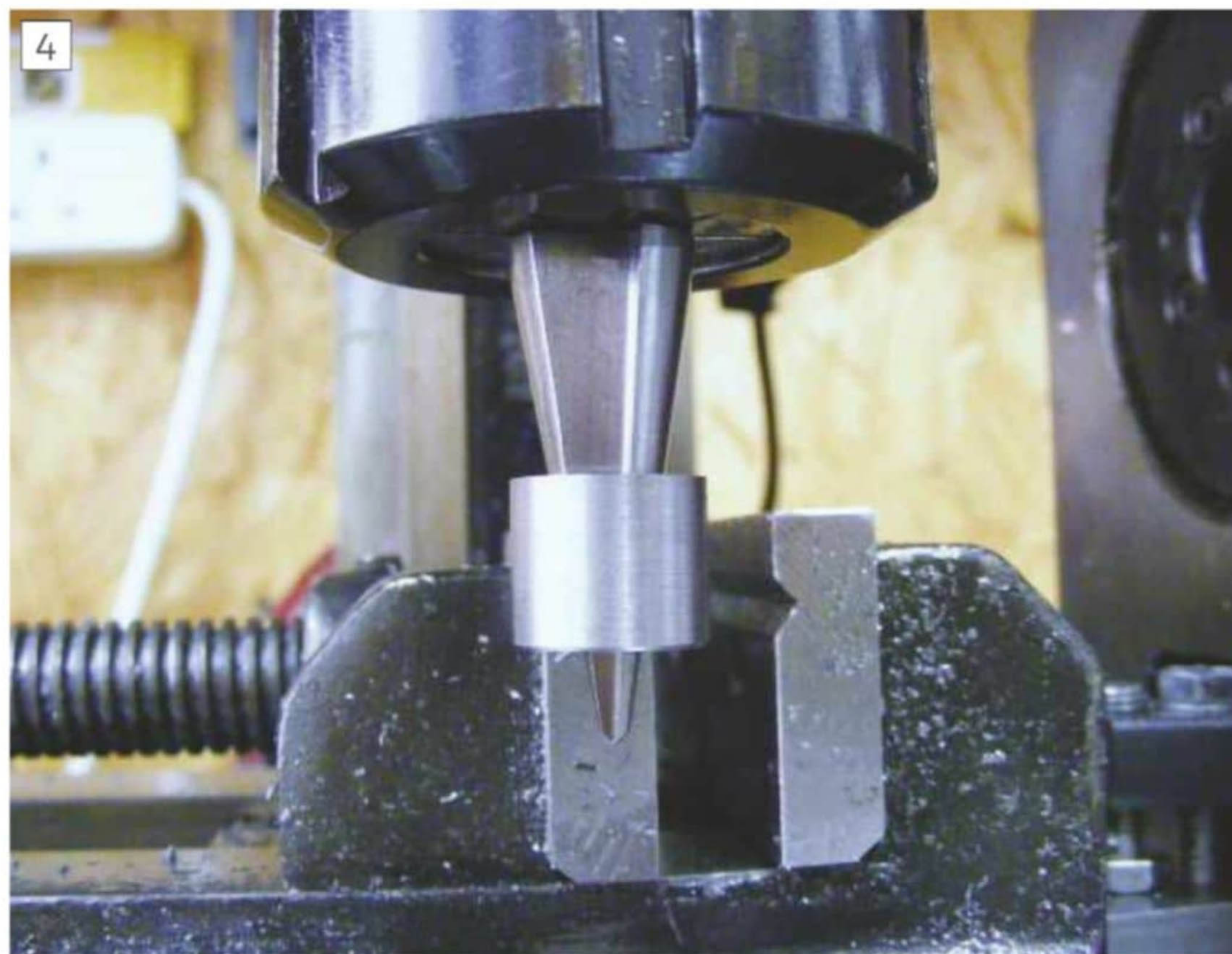
Cutter mounted on diameter of 16 mm arbor.

The only problem with John Stevenson's method is that conical milling cutters are not readily available from typical model engineering suppliers.

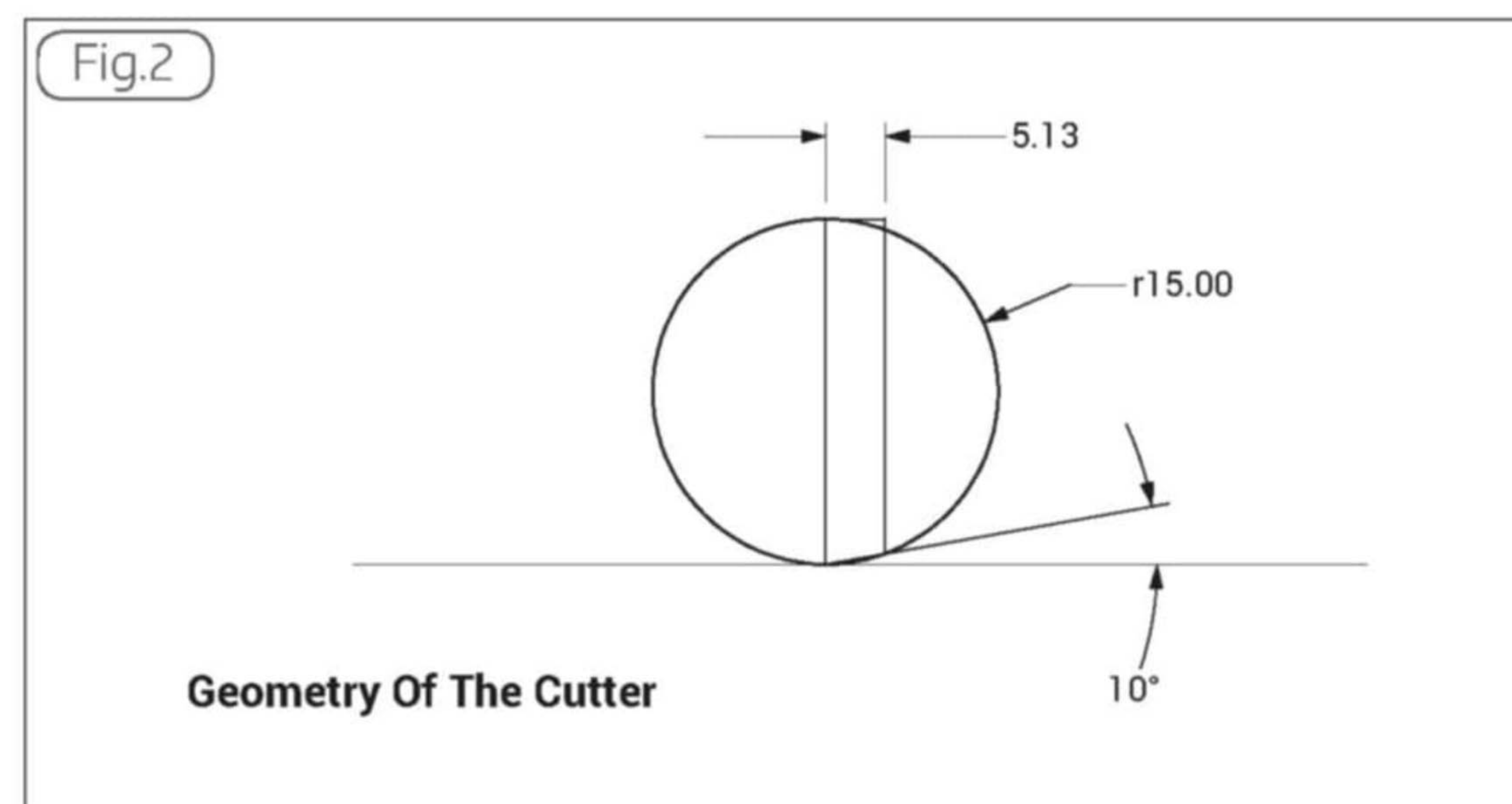
arcs of the same precise size as the buttons and with the same separation and infeed. This creates the gear cutter form directly and after hardening and tempering it can be used to cut gears. A further advantage of this method is that since the cutter is conical it automatically provides clearance behind the cutting edge. A typical cutter made by this method is shown in **photo 1**.

Gear cutters - button method

Module		1					
Pressure angle		20 degrees		0.34907 radians			
No of Teeth	Pitch circle diameter mm	Crest circle diameter mm	Root circle diameter mm	Base circle diameter mm	Button diameter mm	Button spacing mm	Infeed mm
135	135.000	137.000	132.686	126.859	46.173	44.772	16.091
55	55.000	57.000	52.686	51.683	18.811	19.056	7.083
35	35.000	37.000	32.686	32.889	11.971	12.624	4.827
26	26.000	28.000	23.686	24.432	8.893	9.727	3.809
21	21.000	23.000	18.686	19.734	7.182	8.116	3.242
17	17.000	19.000	14.686	15.975	5.814	6.825	2.786
14	14.000	16.000	11.686	13.156	4.788	5.855	2.442
12	12.000	14.000	9.686	11.276	4.104	5.207	2.210



Collar fitted to cone drill.



The only problem with John Stevenson's method is that conical milling cutters are not readily available from typical model engineering suppliers. They are available

from specialist suppliers, but they are expensive. In this article I will describe how to make gear cutters using cheap conical drills rather than conical milling cutters. These drills are more widely available, my set, **photo 2**, cost about £22. The drills have a half angle of 10 degrees and cover the size range from 3 mm to 30 mm.

Designing a cutter.

The size and profile of a gear cutter depends on the gear being made. The first thing to establish are the mod value and pressure angle of the gear that you want to make. In my case the mini-lathe change gears have a pressure angle of 20 degrees and a Mod=1. The circular pitch of the teeth of a Mod 1 gear is 3.14 mm so the gear cutter needs to be wider than this. I chose to make my gear cutters 6 mm wide because this makes them easy to handle and to grip in vices etc.

The length of the cutter is not critical, but it is advantageous to make the cutters fairly short since the radius of



Profiling the cutter with the cone drill.

rotation when mounted in an arbour will then be small and the cutter can be run at higher speeds. I chose to make my cutters about 25 mm long so that when mounted in a 16 mm arbour, **photo 3**, about 6 mm of the cutter protruded. Thus, the radius of swing of the end of the cutter is about 15 mm.

The thickness of the cutter is critical. For cutters designed for a radius of swing of 15 mm and profiled using a conical drill with a half angle of 10 degrees then the thickness of the cutter cannot exceed 5.13 mm or else the back edge of the cutter will foul the gear blank, see **fig. 2**.

Thus, the nominal cutter blank size that I used was 3 x 6 x 25 mm gauge plate for Mod 1 gears. In fact, it is easier to hold the blanks if they are 3 x 6 x 50 mm. Two different cutters can be formed at each end of the blank and then the long blank can be cut in half forming two cutters.

The required button diameter, button spacing and infeed are given in **Table 1** for MOD 1 gear cutters with a 20 degree pressure angle. These values have been calculated from the geometry of the arc approximation to the involute. Full details of this calculation are available, see: mikesworkshop.weebly.com/designing-gear-cutters.html.

The calculations have been summarised in two spreadsheets one for MOD gears and one for DP gears. In the spreadsheets the MOD or DP can be selected as can the pressure angle so they can be used for any involute gear. Copies of the spreadsheets are available on request using the contact form on my website.

For the 21 tooth gear it can be seen that the required parameters are button diameter = 7.18 mm, button separation = 8.12 mm and the infeed is 3.24 mm.

The first task was to make a collar or washer with a hole the same size as the required button diameter.

The piece was then parted off 12 mm from the end. This collar fits onto the end of the cone drill and the upper edge of the conical hole defines where the drill is 7.18mm in diameter.

The cutter blank was set up horizontally in a vice on the milling table with about 8 mm protruding from the end of the vice. Using an edge finder in the drill chuck the two side edges of the protruding blank were found and the table was then positioned so that the blank was centred under the drill chuck. The graduated collar on the mill was then set to zero and locked.

The next step was to replace the edge finder with a cone drill. The prepared collar with the 7.18 mm hole was then slipped onto the cone drill. Because the cone angle is only 10 degrees it stays stuck to the drill by friction, **photo 4**. Keeping the drill on the centreline of the cutter blank the other axis was adjusted so that the drill can be lowered until the collar was below the blank. With the mill rotating slowly the drill was slowly raised using the fine spindle distance control until the edge of the cutter blank causes the collar to fall off the drill. The z axis was then locked in position. This sets the drill height such that diameter of the drill in the plane of the underside of the cutter blank is 7.18 mm.

The mill was now started, the table locks released and the front edge of the cutter blank was machined across its



Tip view of the finished cutter.

Making a gear cutter

The first task was to make a collar or washer with a hole the same size as the required button diameter. For the 21 tooth gear a short length of 12 mm diameter steel was faced on the lathe, drilled out 4 mm and then the cone drill was used to enlarge the hole to 7.18 mm on the face.



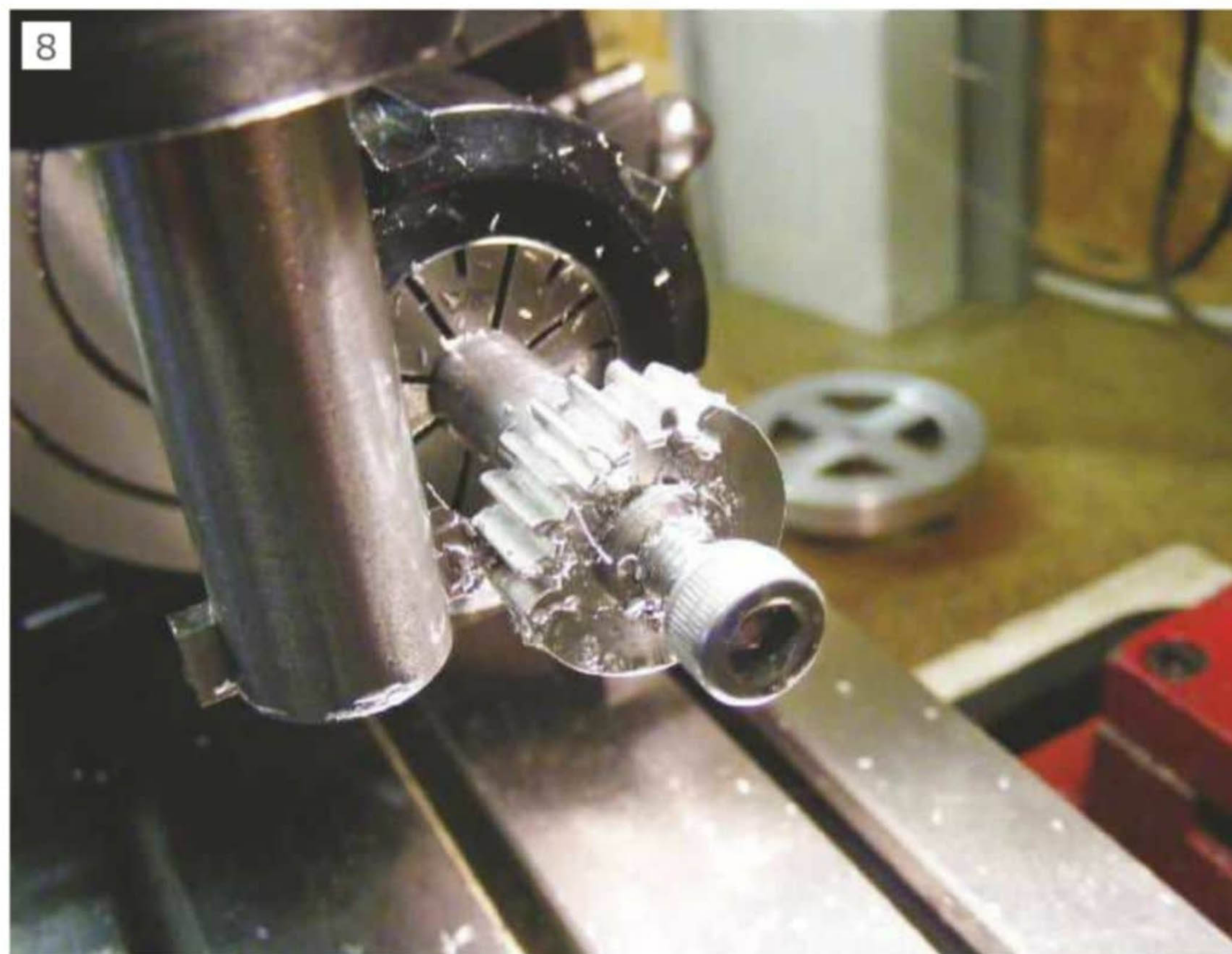
The cutter holder.

It is as well at this stage to mark the cutter with a module number and a number identifying the tooth count since after hardening this will be more difficult.

whole width using the cone drill. Once this was completed the cone drill was returned to the centre of the cutter blank edge. The table was then displaced by half the required separation (4.06mm for the 21 tooth cutter) and locked. The drill was fed into the cutter blank by the required infeed (3.24 mm for the 21 tooth gear). The cone drill was then backed out of the arc that was formed in the cutter blank and it was moved to the other side of the centre line by the full required separation, making allowances for backlash in the feedscrew, and the infeed repeated, **photo 5**. At the end of these operations two arc segments will have been removed from the cutter blank. **Photograph 6** shows the tip of the cutter and the relief angles on all the cut surfaces.

It is as well at this stage to mark the cutter with a module number and a number identifying the tooth count since after hardening this will be more difficult.

The cutter was now ready for hardening and tempering. It was held by the blunt



Cutting the gear.



The finished 21 tooth gear.



A 63 tooth gear in Delrin.

end in an old pair of long nosed pliers and heated gently in a blowtorch flame. As it was warming up it was occasionally dipped into soap shavings cut from household soap. Once it gets hot enough the soap will stick to the metal and melt. When it was completely covered with soap the temperature was raised until the metal glowed bright red and it was then quenched in cold water. This method of covering the metal in soap before heating prevents the formation of scale and decarburisation of the steel. Once quenched remove the cutter from the water. The face that was the underside during the milling operation was polished on a very fine oilstone. This removes any surface colouration and sharpens the cutting edge. The cutter was again held by the blunt end in the long nose pliers and gently heated where it was gripped. As the metal gets hotter the tempering colours start to form and travel along the cutter towards the tip. When the tip of the cutter gets to light straw colour, it was quenched into cold water. The gear cutter is now complete.

The whole process including set up time is no more than an hour. If find this is much quicker than the traditional procedure for making gear cutters by the button method.

The cutter holder

The first cutter holder was simply a short piece of 16 mm bar that was faced on the lathe and a 3 mm diametrical slot was cut as shown in **photo 7**. An M4 grub screw was used to secure the cutter in the slot. The other end was reduced to 12 mm so that it would fit into 12 mm end mill holder.

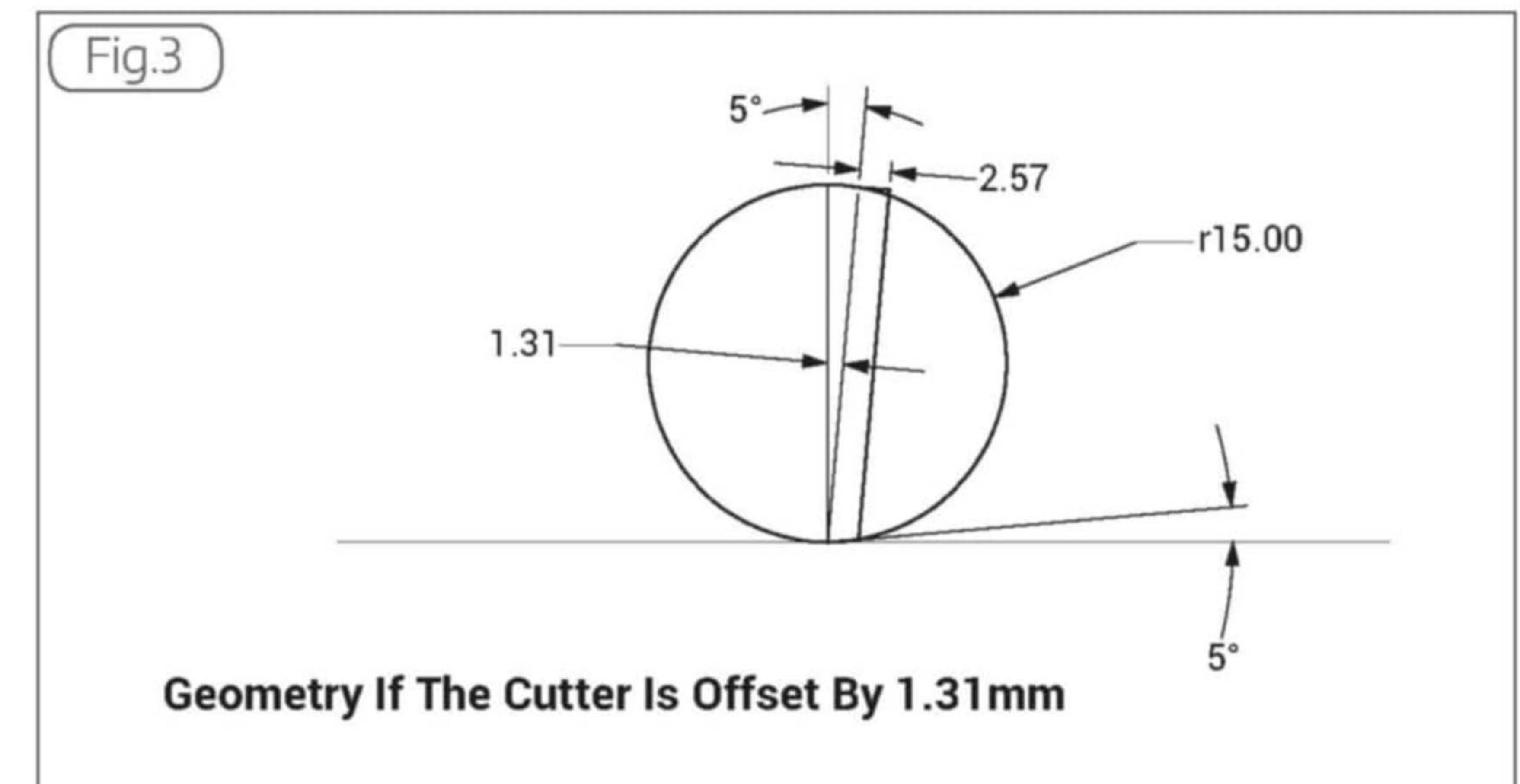
The first tests of the cutter

A piece of 25 mm aluminium bar was

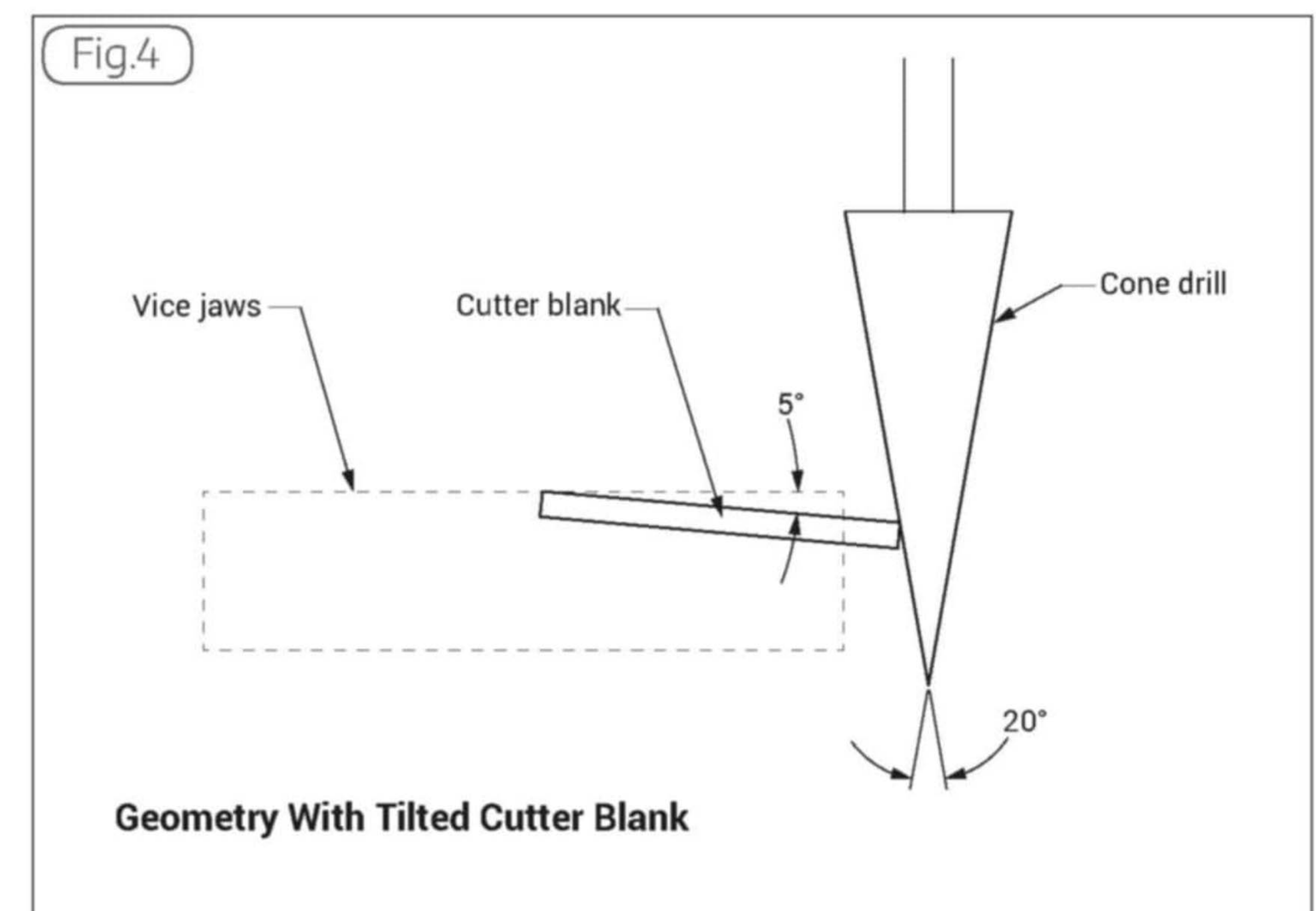
On completion of the first cut the rotary table was indexed around and the second cut taken. This was repeated until all 21 teeth had been cut.

faced on the lathe, drilled out to 12 mm and parted off to provide an 8 mm thick gear blank. This was mounted on a 12 mm diameter expanding arbor that can be fitted in the lathe headstock using an ER32 collet holder with an MT2 stem and an MT2-MT3 adaptor. With this in the lathe the outside diameter of the piece was reduced to 23 mm.

The ER32 collet chuck and expanding arbor assembly was removed from the lathe and transferred to the MT2 socket of my 100 mm rotary table mounted on my X1L milling machine table. The gear cutter was mounted in the cutter holder and this was in turn fixed into a 12 mm endmill holder mounted in the mill spindle. The tip of the cutter was carefully set at the centre height of rotary table. With the cutter rotating backwards the mill table was adjusted until the cutter just contacted the gear blank. The cutter was then moved away to the side of the blank and the full tooth depth, 2.16 mm for a Mod 1 gear, was incremented on the Y axis and this was then locked. The rotary table was set to zero and with the cutter rotating in the normal direction at 100 rpm the gear blank was advanced



Geometry If The Cutter Is Offset By 1.31mm



Geometry With Tilted Cutter Blank

slowly into the rotating cutter. The cutter worked really well, and the chips were flying, **photo 8**. On completion of the first cut the rotary table was indexed around and the second cut taken. This was repeated until all 21 teeth had been cut.

The finished gear is shown in **photo 9**.

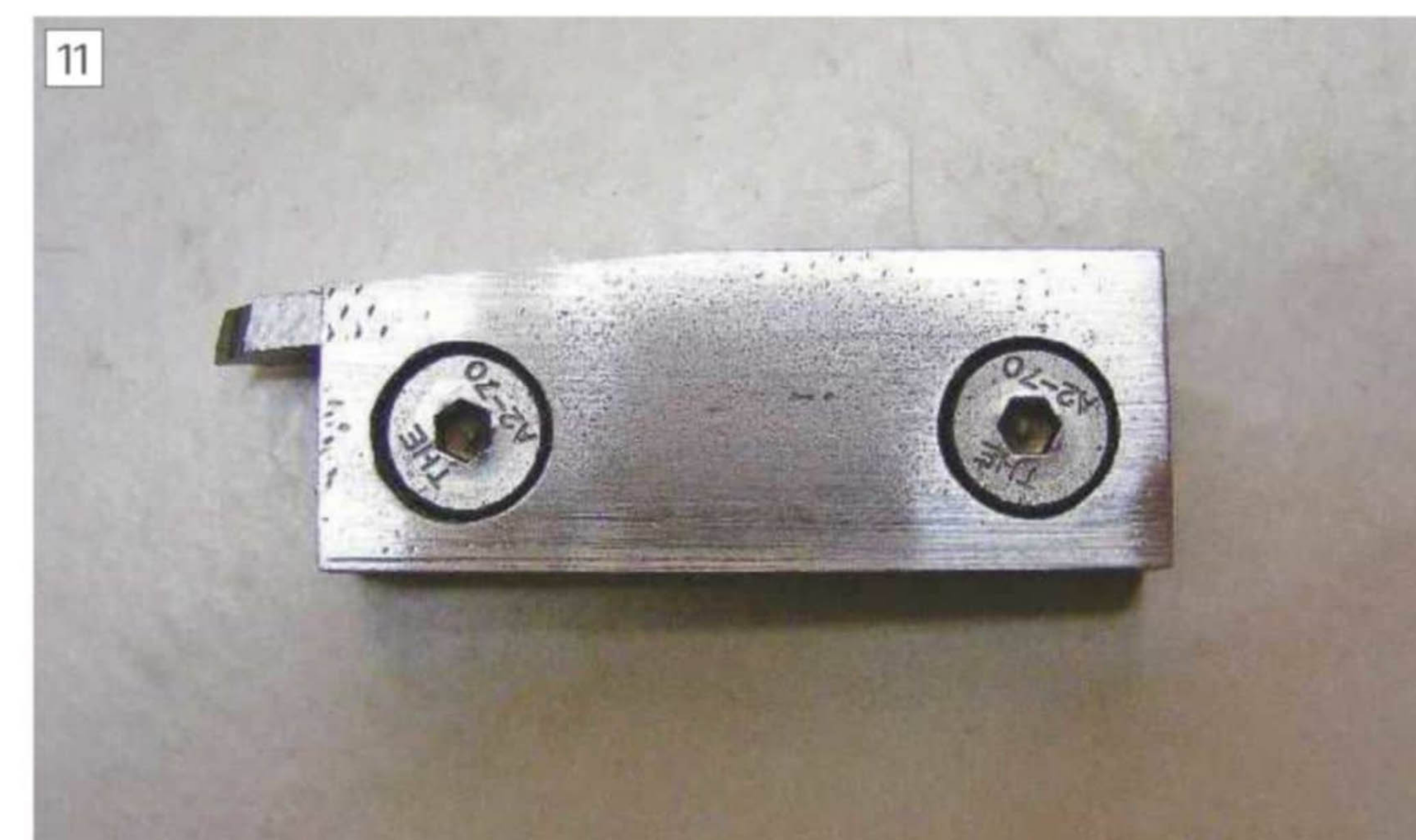
I also made a test to try and cut a 21 tooth gear from a disc of 8 mm thick Delrin. This cut very easily, and the gear was fine until I tried to cut a key way in it. There was not much material between the root of the teeth and the keyway, see photo 9, in such a small gear and the gear split. I have since made a 63 tooth gear using Delrin without any problems, **photo 10**.

I attempted to cut a gear in mild steel using the cutter but even taking small cuts my X1L mill was really struggling.

Some improvements.

These first tests achieved the initial objective of making a usable 21 tooth gear for the mini-lathe. However, the performance when trying to cut steel gears was not very impressive. One way of easing the cutting forces in steel is to give the tool a little top rake. In principle this is easily done by offsetting the tool in the holder. However, there is one small problem with doing this, see **fig. 3**.

With the tool on the centre line the thickness of the cutter blank can be up to



Special angled holder for profiling cutters.

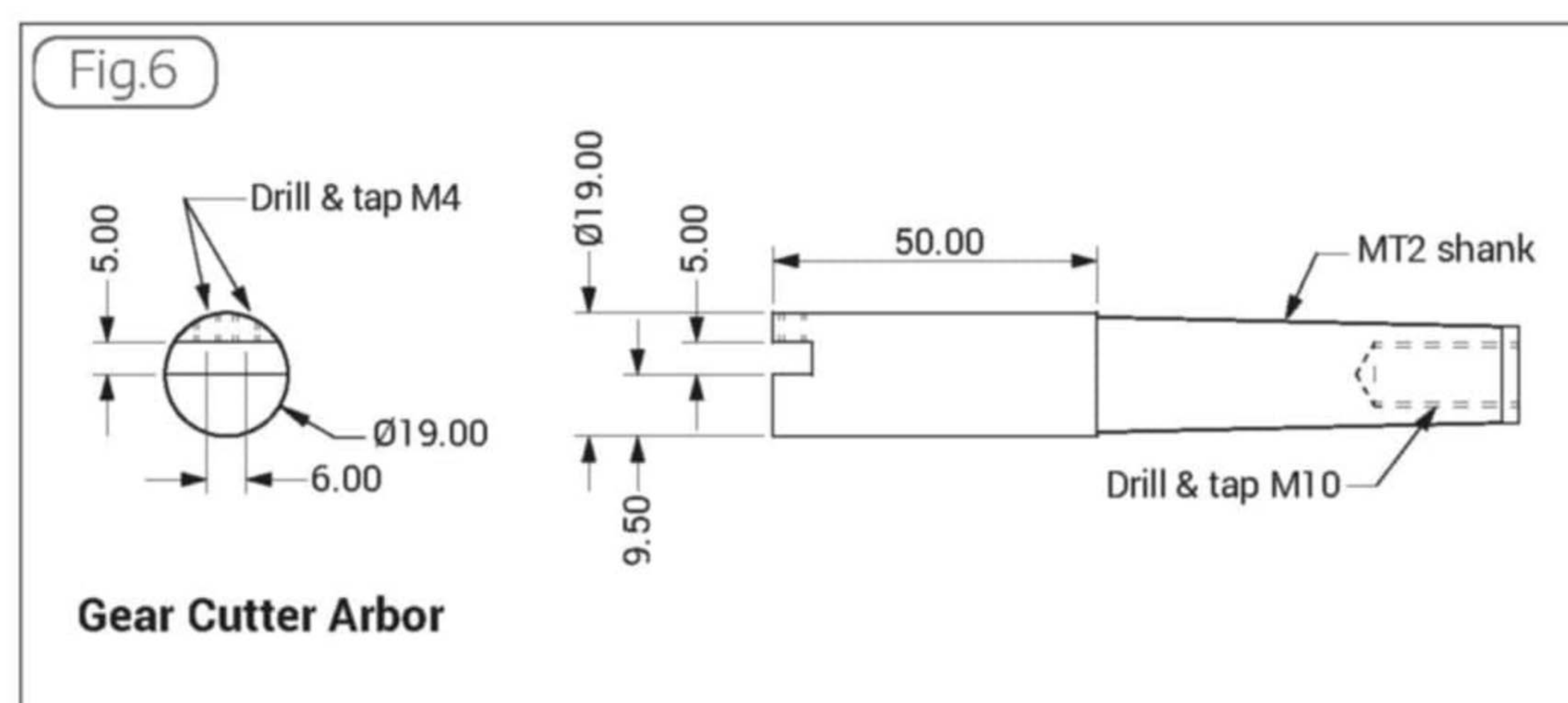
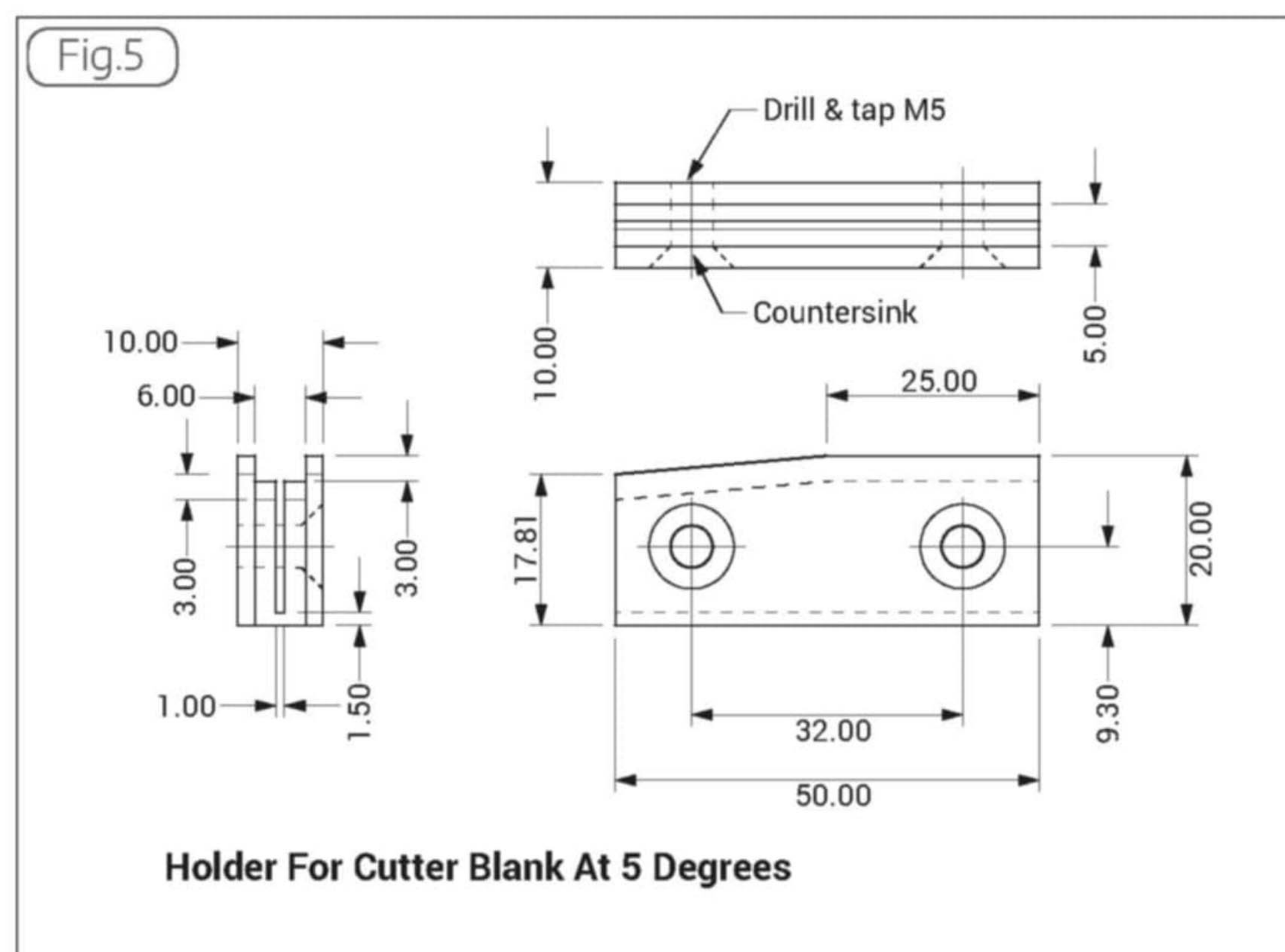
A test with this cutter on the mill on a free cutting steel blank showed that cutting was much easier than with the previous cutter without the front rake.

5.13 mm as shown earlier. If the cutter, made using a 10 degree cone drill, is displaced off centre by 1.31 mm then this gives a 5 degree top rake and also 5 degree clearance behind the cutting edge. The problem with this is that the maximum cutter thickness is reduced to only 2.57 mm. This is rather thin and there is the possibility of the cutter breaking in use. What is needed is to retain the 10 degree clearance behind the cutting edge and still having say 5 degrees of top rake. My solution for achieving this is to actually angle the the cutter blank downwards by 5 degrees and then machine the arcs using the conical drill, see **fig. 4**. Purists will argue that the arc cut will no longer be circular but elliptical but simple trigonometry shows that the ratio of the major and minor axis of the ellipse for a 5 degree tilt is $\cos 5 = 0.996$, so the error introduced by this modification is only 4 parts in 1000 which is hardly significant. It should also be born in mind that the circular arc is itself only an approximation to the true involute geometry.

To test this idea a piece of 3 mm thick gauge plate was cut 6 mm wide and this was mounted at an angle of 5 degrees down in the mill vice and the piece was then faced on the protruding edge with the cone drill and then the two arcs were cut as described above. The cutter was removed from the vice, hardened and tempered, and mounted in the 16 mm arbor with two pieces of 0.7mm packing to offset the cutter 1.4 mm from the centre. A test with this cutter on the mill on a free cutting steel blank showed that cutting was much easier than with the previous cutter without the front rake.

A special holder was designed to hold the cutter blanks accurately at 5 degrees, see **fig. 5** and **photo 11**. This just fits into the mill vice.

The final improvement was to make a new arbor, **photo 12** and **fig. 6**, to mount the cutter. This was made with an MT2 taper that would fit directly in the mill spindle. The larger diameter arbor also allowed the use of two grub screws for



securing the cutter more securely.

It should be noted that the cone drill set only covers the range 3mm to 30 mm. To make cutters for gears in the range 135 teeth and larger the arc diameter required is 46 mm which is outside the range of the cone cutters. So far, I have had no requirement to make gears with so many teeth but if I do I shall just use a fly cutter and grind a tool to give a 10 degree angle to the cutting tip.



MT2 taper cutter holder.

Conclusion

This method of making gear cutters is simple and quick. My thanks go the Ivan Law for teaching me the basics of gears and gear cutting and to John Stevenson for the idea of using conical endmills to profile the cutters. ■

Reversing a Compound Table

John Crammond makes a change of direction.

I have a floor standing 3MT pillar drill with a large 19 x 16" table which I purchased in the nineties. I used it for a long time with a six inch cross vice which was a bit rough and ready. Eventually I decided that it would be a good idea to substitute this for a proper compound table and bought one with a nicely ground 19 x 6" table which had ample travel in either direction. However to my slight annoyance I found that although the X movement was normal, the Y movement worked in reverse, in other words rotating the hand wheel clockwise brought the table towards you. Not a big problem you may say but frustrating nevertheless. I suffered this for many years until I finally resolved to do something about it. Perhaps the obvious solution would have been to machine a new feed screw and nut, but I chose to use a pair of gears to reverse the rotation of the feed screw, **photo 1**. The accompanying photos show what was involved, virtually all work being carried out on a Myford Super 7 using a 4 jaw independent chuck to machine the gearbox body. All machining was straight forward, the body being made out of 1" thick alloy plate, **photo 2**.

I cut two 30t 20 dp gears in steel, **photo 3**, which gave adequate strength and also offset the hand wheel some 1.5" to one side. Obviously, fewer teeth or smaller dp gears would reduce the offset if this is of importance. Fixing holes to attach the gearbox to the compound

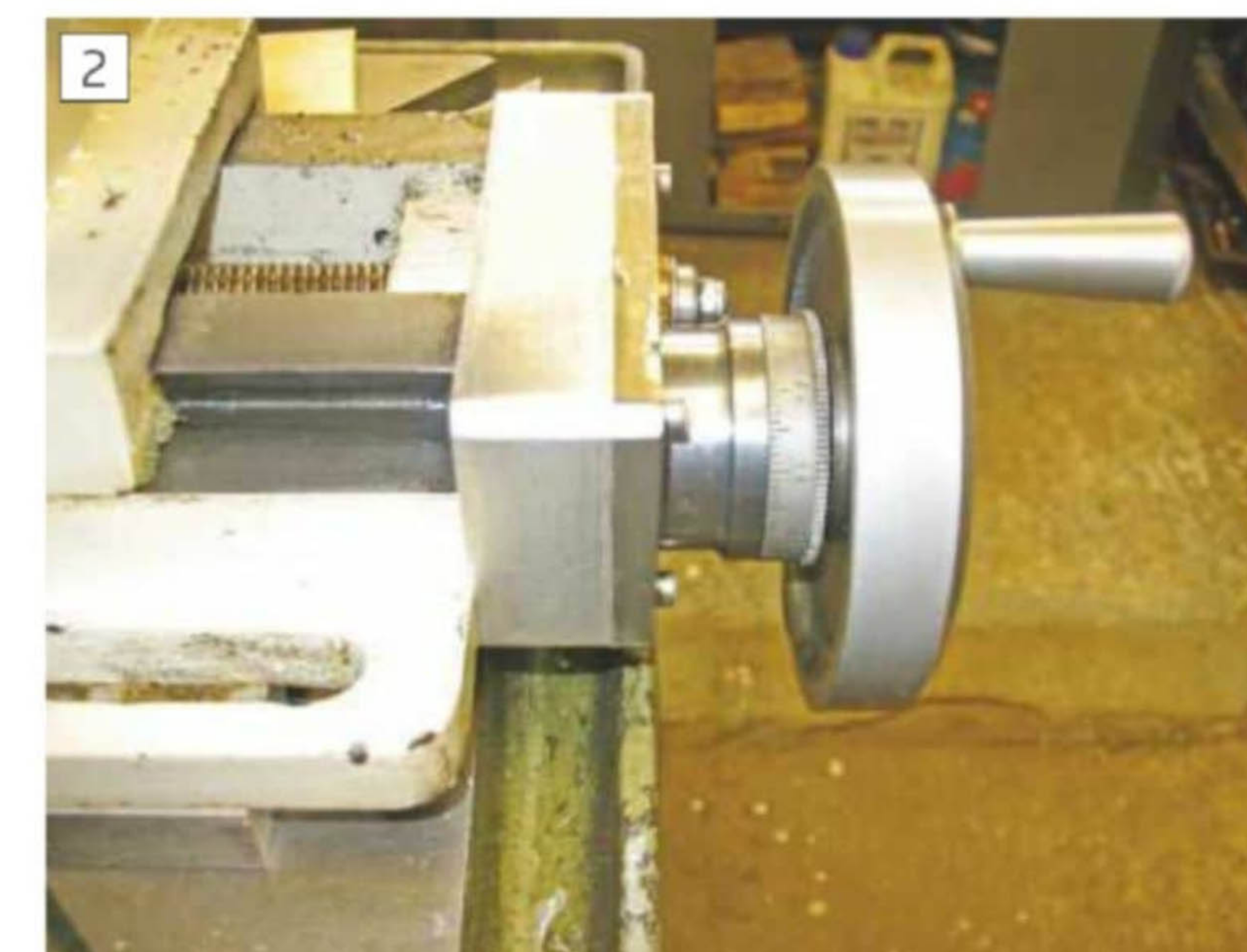


Components of the gearbox.

table were transferred from the original outer feed screw bearing. The portion of the feedscrew that originally attached to the hand wheel and also fits the outer bearing is 10mm, however, as I don't have a reamer this size (I'm an old fashioned bloke who still prefers imperial!) I decided to reduce this portion of the screw by .015" down to .375" and used this size for

both front and rear feed screw bearings on the gearbox, **photo 4**.

I disliked the thrust arrangement which originally consisted simply of the core diameter of the 10 tpi screw rubbing on the outer bearing casting. This was quite rough and I suspected that it would quickly damage the back of the alloy gearbox against which it would bear.



The body is made from 1" plate.



The two matching gears.



Gearbox assembled, note bush for feedscrew.

I therefore placed a .750" x .150" thick bronze thrust washer on the feed screw which hopefully will wear well.

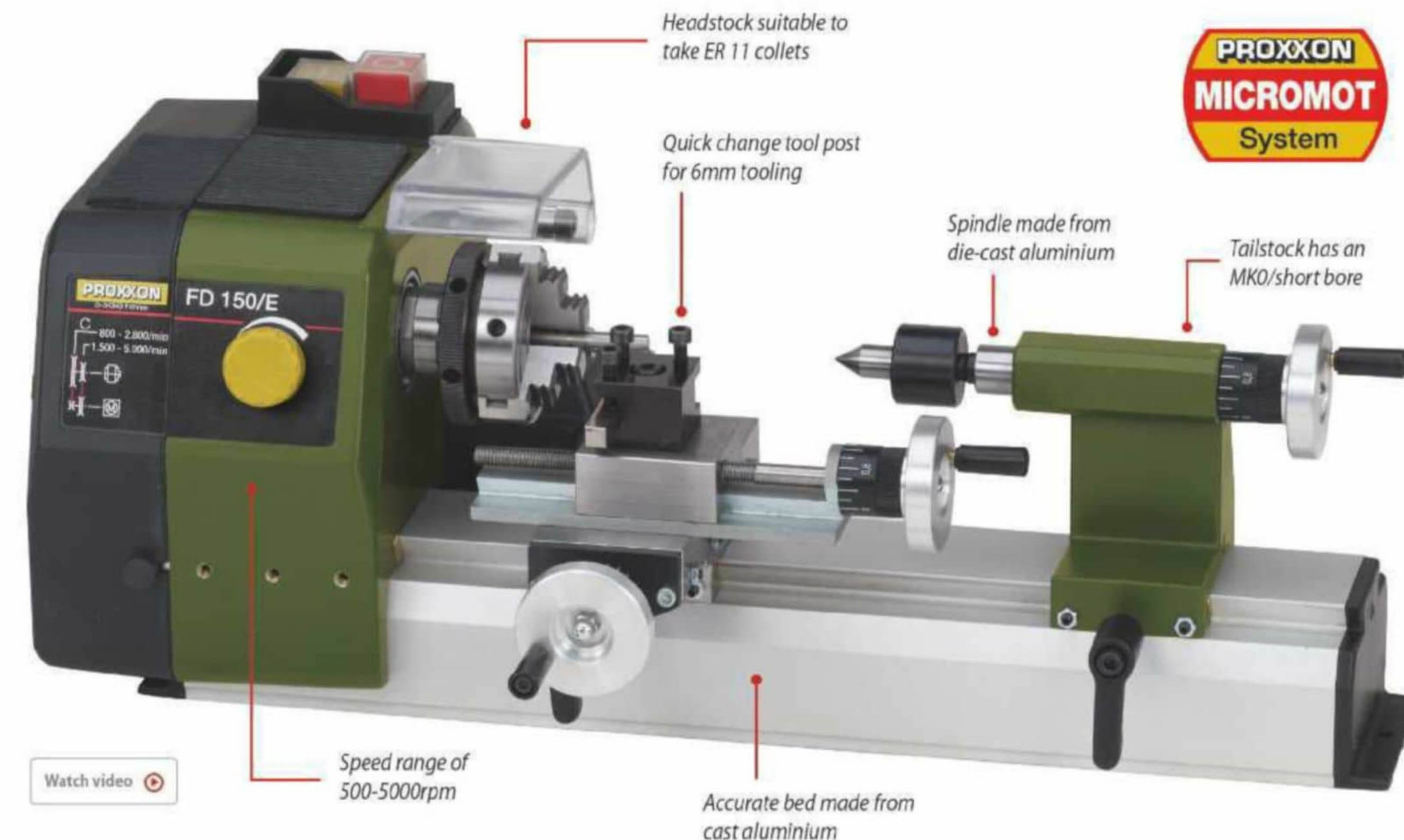
The input shaft is simple turning being careful to get front and back bearing surfaces in line. The rear bearing is .375" the front one being .437" permitting a reduction to 10mm to accommodate

the hand wheel. Gears were attached to their respective shafts with .125" square steel keys. Some of you may have seen two holes in the gear on the feed screw, these are threaded 4 BA, and are used to facilitate removal of this gear should it be necessary in the future. The outside surfaces of the gearbox and cover plate



Fitted to the table and ready for use.

were trued up in a shaping machine, all sharp edges broken, washed clean and assembled with grease to bearings and gears, **photo 5**. Everything turned very smoothly and now I don't have to think before turning the Y handle, yippee! ■



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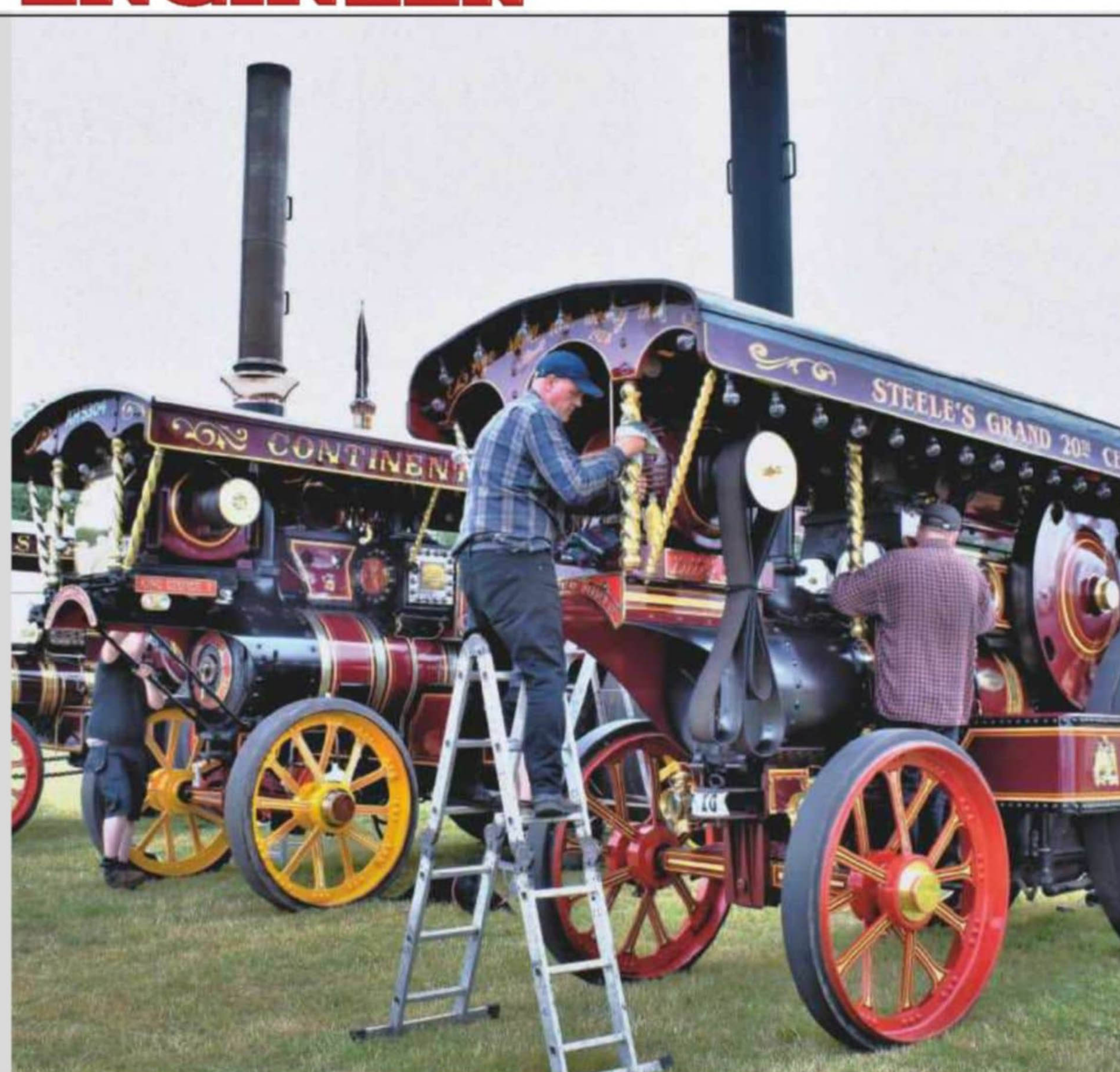
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MODEL ENGINEER

- **Poppleton**
Roger Backhouse spends a day out at the Poppleton Community Railway Nursery.
- **Beam Engine**
James Wells goes all non-parallel with his oscillating beam engine.
- **Making Tracks**
Stephen Wessel considers the challenge of laying a really permanent 'permanent way' and decides that concrete is the answer.
- **Groudle Glen**
Mark Smithers features a new-build full size Bagnall Sipat class 0-4-OST locomotive, constructed in Scarborough for the Groudle Glen Railway.
- **Welland Steam Rally**
John Arrowsmith heads for the Malvern Hills to attend this year's Welland steam rally.

Content may be subject to change.



A Boring and Milling Head Lathe Attachment

Kevin Barry contemplates some unorthodox configurations for a combined lathe and boring machine.

Model engineering is often constrained by workshop space, and innovative ways of maximising machine capability are of great importance. I worked in the engineering industry for many years and one of my many jobs was to operate a 'Dixi 75' horizontal boring machine. The versatility and capacity of this type of machine is something that most model engineers can only dream about.

I may be re-inventing the wheel here, but why don't the machine tool manufacturers think of ditching the conventional tailstock on a centre lathe and install a vertical Boring/Milling Head (BMH). This would effectively convert an ordinary centre lathe into a mini horizontal boring machine, **fig. 1**. Currently the only option provided by machine tool manufacturers is the rear mounted vertical milling head.

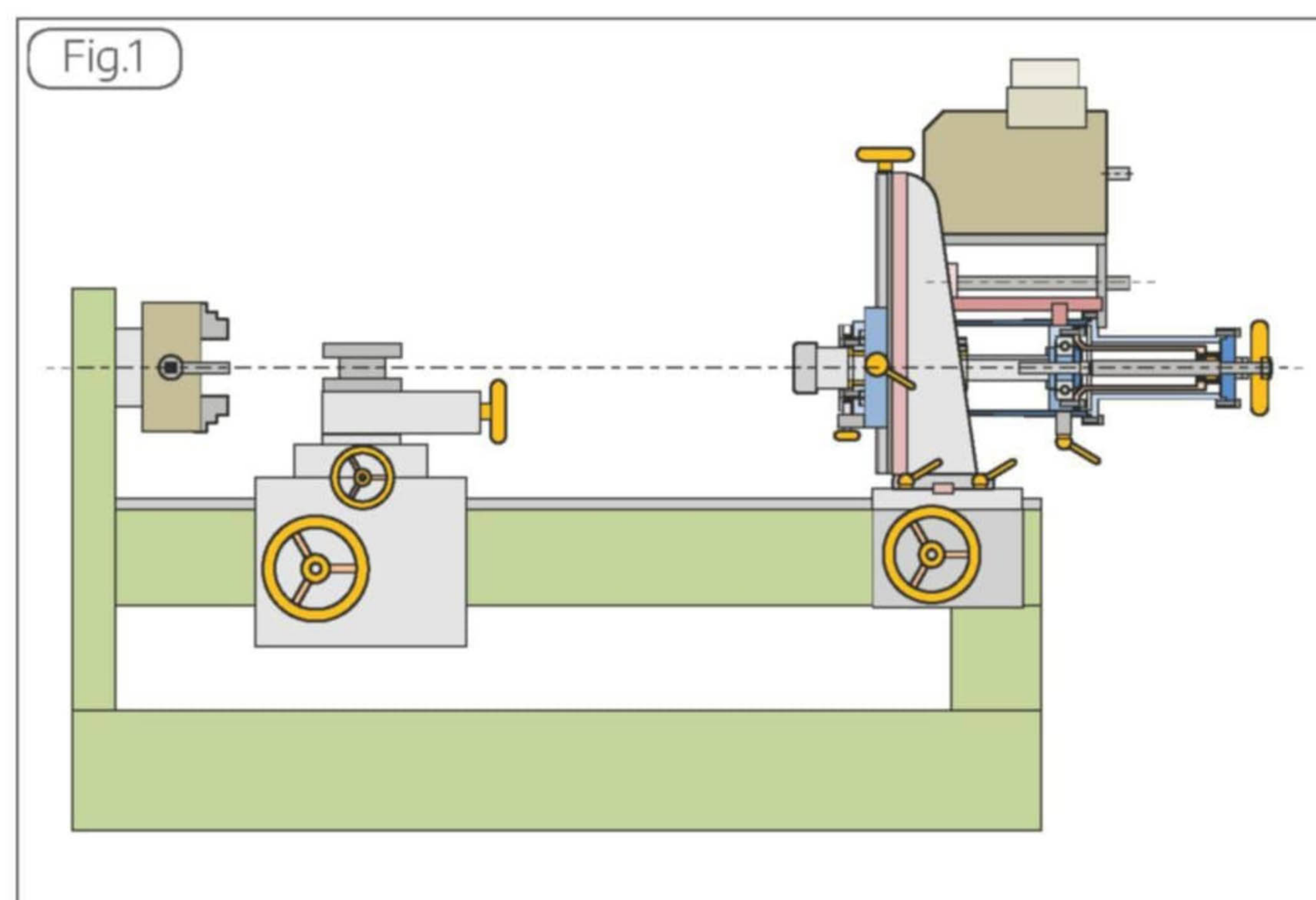
The disadvantages of the rear mounted milling head are:

- Restricted height between the workpiece and the cutter.
- Restricted throat area.
- Lack of rigidity.
- It obstructs conventional operation of the lathe.

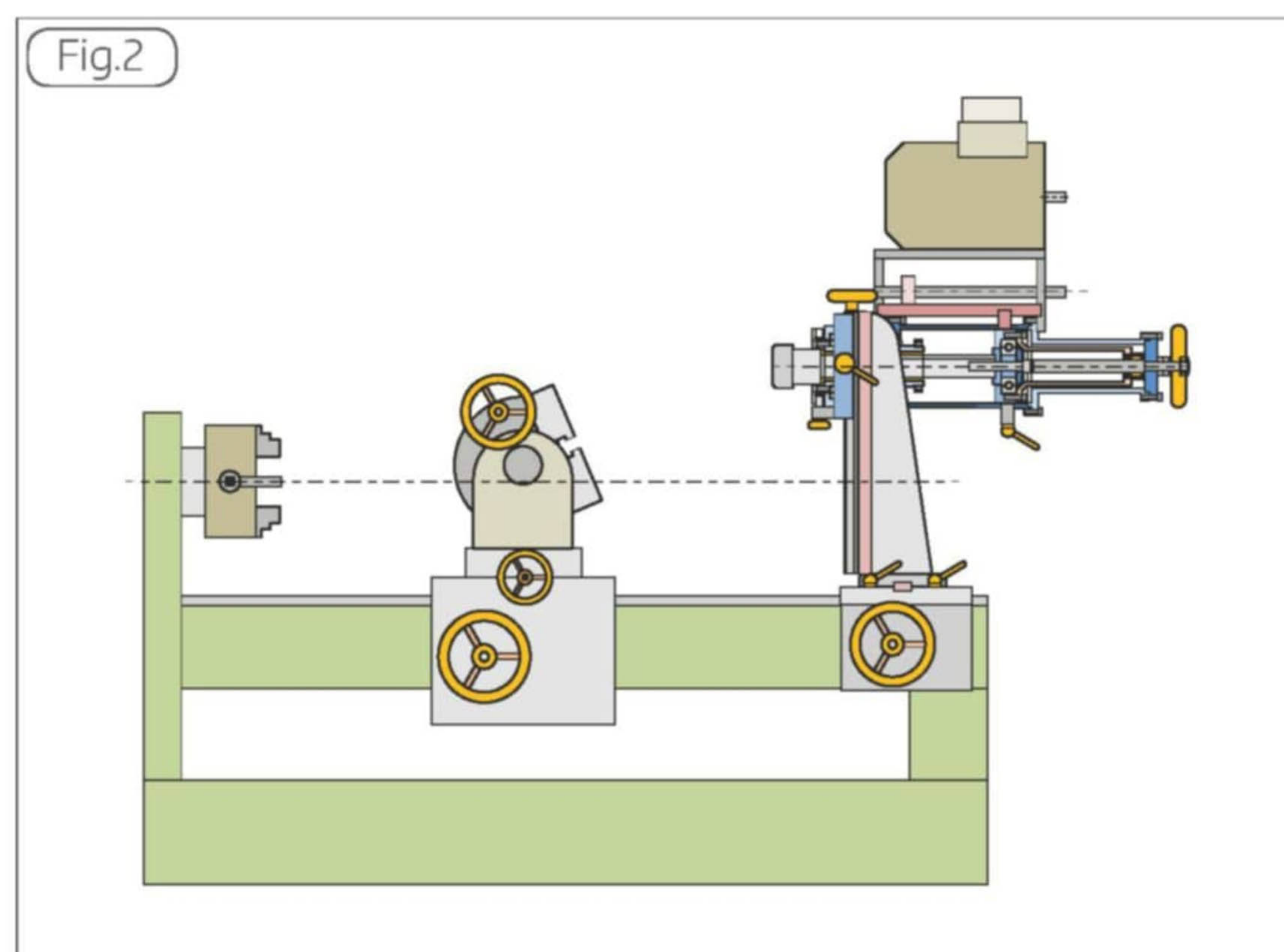
On my lathe the 'Z' axis digital read out scale covers the mounting pad for the vertical milling head, making it difficult to fit one.

The advantages of mounting a BMH are:

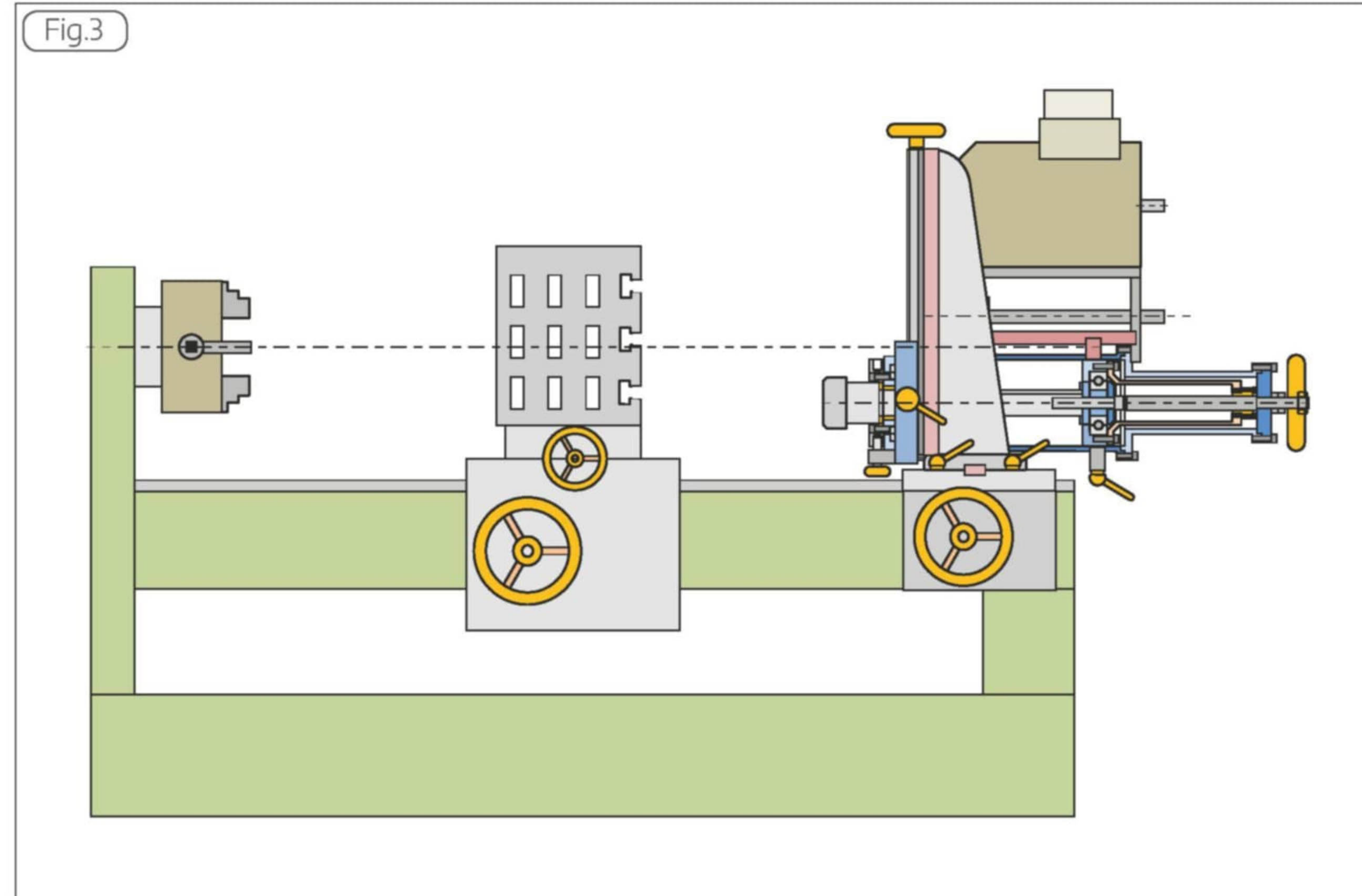
- The BMH would have the same functionality as a conventional tailstock, including offset for taper turning.
- The distance between the spindle and the workpiece is only governed by the lathe bed length. This is usually greater than that offered by a milling head attached to the back of the lathe.
- The BMH would be far more rigid as it is attached directly to the lathe bed.
- Workpieces would be clamped directly to the cross-slide on the lathe.
- Rotary tables and tilting rotary tables could also be clamped directly to the cross-slide, **fig. 2**.
- Angle plates or box-plates would enable the lathe to perform conventional milling operations, **fig. 3**.



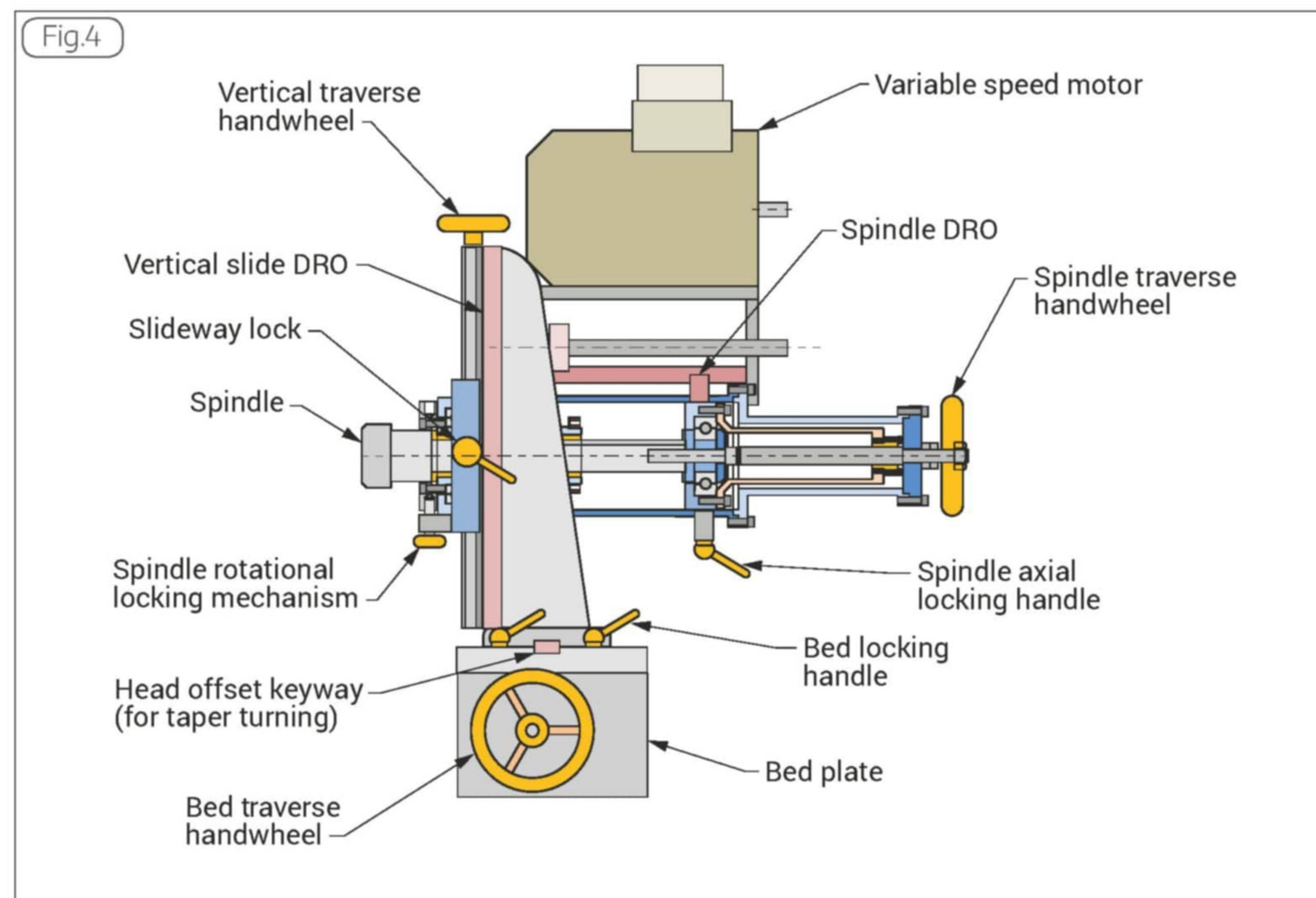
General arrangement of the BMH mounted on the lathe.



View showing a tilting rotary table mounted on the cross-slide.

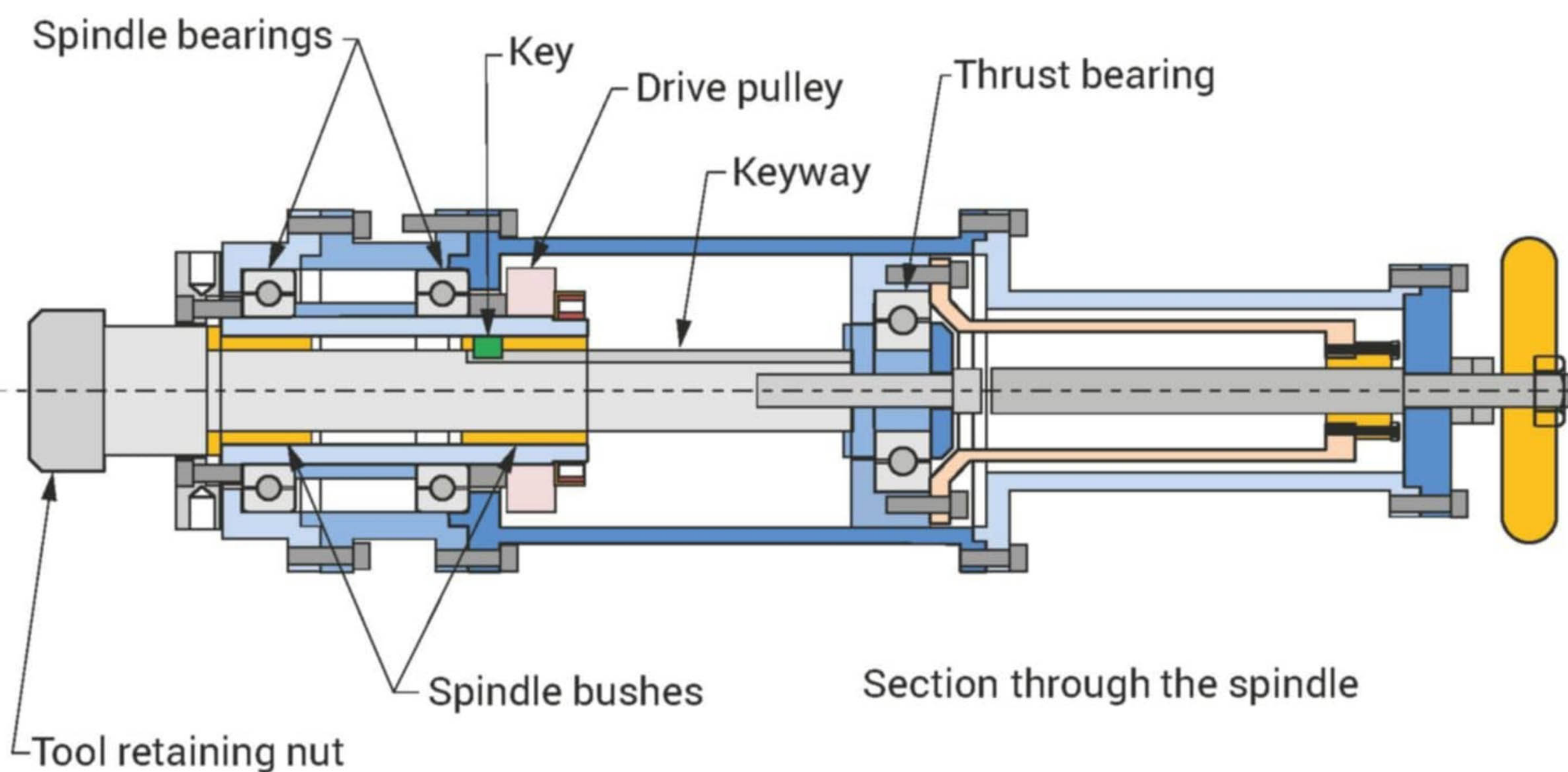


View showing a box-plate mounted on the cross-slide.



View showing the main features of the BMH.

Fig.5



Section through the spindle.

- When not in use the BMH could be moved to the end of the lathe bed and be no more restrictive than a conventional tailstock.

I have produced some preliminary sketches, (based on my 'Warco' WM250V lathe) which show what I think are the main features that could be incorporated into a practical design. The BMH is supported on a cast iron frame that is bolted directly on to a bed-plate, which in turn is attached to the 'vee and flat' on the lathe bed. The bed-plate could be supplied blank and modified to fit the bed profile of most types of centre lathe. The vertical stroke of the BMH will be dependent on the type of lathe and the design of the cast iron frame, **figs 4 and 5**.

Figure 1 shows the BMH set at the same centre height as the lathe spindle. The BMH is keyed to the bed plate and can be adjusted to bring its axis in line with the lathe. Reference points could be used to quickly reset the BMH at these positions. When set at this position the BMH will perform the same operations as a conventional tailstock.

A spindle feed mechanism could also be incorporated into the design. Obviously, the more features that are added will increase the cost.

The BMH could be moved manually along the existing rack with a hand-wheel. Another feature that could be added would be the leadscrew 'half-nut' arrangement used on the saddle of the lathe, which would allow power feed.

In fig. 4 the position of the axial spindle lock and the Digital Read-Out (DRO) scale are shown 90 degrees out of position for convenience, these would actually be in a horizontal plane. This also applies to the spindle rotational lock at the front of the spindle. The DRO scale on the BMH is shown at the front of the frame, but this would be located at the back.

Figure 6 shows a preliminary design for the frame casting. The height of the frame casting is 320mm and this would give a useable vertical movement of 200mm.

The actual configuration of the spindle nose could be changed to a Morse taper, R3 and so on. The spindle shown is to hold an ER32 collet. The spindle axial movement is controlled by a lead-screw, but this could be replaced with a rack and pinion arrangement.

Safety features would need to be incorporated into the design, such as a micro switch on the spindle rotational lock to prevent the motor being started when the lock was engaged.

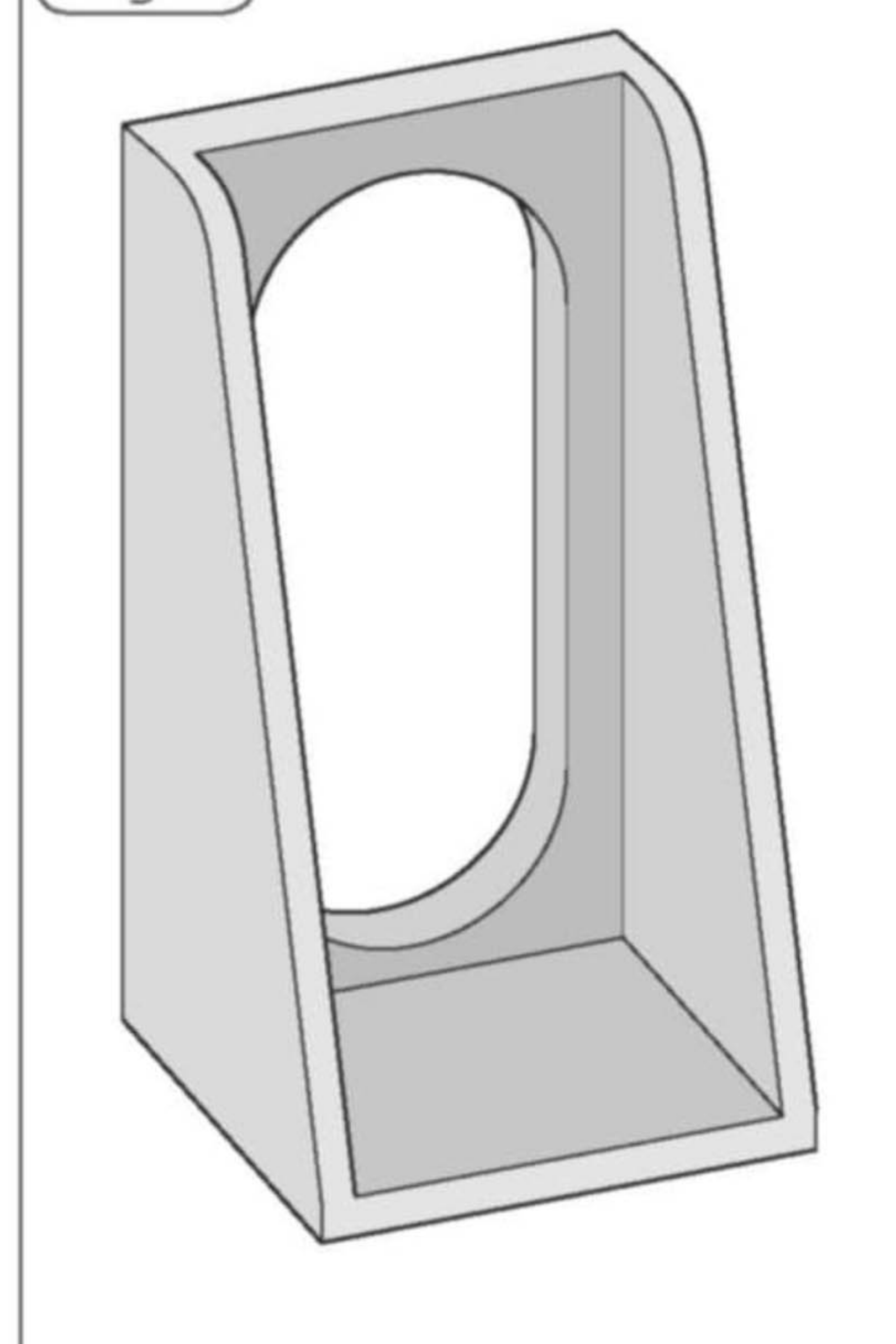
The drive train could incorporate gears with a high and low speed range. Figure 4 shows the spindle being driven by a separate electric motor, but this could be driven by the existing lathe motor through a line shaft arrangement.

A spindle feed mechanism could also be incorporated into the design. Obviously, the more features that are added will increase the cost.

I was considering making the BMH to fit my lathe, but realised it was beyond the capability of my small workshop. But I am sure that some ambitious modeller or machine tool manufacturer would be interested in such a project.

I think this type of work-head could replace the conventional milling head bolted to the back of many current lathes, and greatly increase the versatility of the lathe. ■

Fig.6



Possible design of the support frame

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

Life-sized elephant made from 29,649 batteries highlights how many end up in landfill sites



It proved to be a gruelling task - but this life-sized elephant was created using 29,649 used batteries. The installation was created to highlight the fact that 20,000 tonnes of portable cells end up in UK landfill sites every year.

To raise awareness of the issue, Duracell - which recycled 170 tonnes this year - launched a 'Big Battery Hunt' and recruited 1.3million schoolkids to hand batteries in.

Tony Diaz, an artist and sculptor at Big Stuff Design which created it, said: "It's taken 400 hours and in excess of 29,000 recycled batteries but every moment has been worth it."

"Creating this elephant has been a humbling reminder that powering change can come from anywhere."

This year the Big Battery Hunt challenged 1.3 million children from 5,800 schools around the country to pick up a Big Battery Hunt collection box and hunt for used batteries in their communities.

Beau-Jensen McCubbin, a spokesman for Hanwell Zoo said, "We are very proud to be the home of the Big Battery Hunt elephant and are very keen to continue to encourage our visitors to reduce landfill waste."

"Our environment is so fragile, and now more than ever we all need to be doing our bit to protect our planet and the incredible biodiversity that calls it home."

"We have bins in place to collect all the used batteries you can find." To visit the elephant, come along to Hanwell Zoo in the holidays from 31 July and donate used batteries of your own for recycling.

The Duracell's Big Battery Hunt initiative has been running in partnership Battery Back and We Are Futures for the last three years and is on a mission to continue to empower school children across the country and champion the importance of battery waste reduction.

New Axminster Model Engineer Series Bandsaw



The new Model Engineer Series AE1470B metal cutting bandsaw is small and simple; and its relatively light weight of 23kg makes it fairly portable. Taking up little working space, it is perfect for the home model engineer with a small workshop but is also quite suitable for small trades where metal needs to be cut on site.

The simplicity comes from having a fixed cutting speed, direct drive to the band wheels and no electronic controls, meaning there are fewer things to go wrong. Built around a strong cast alloy base and blade bow, it is quite rigid giving firm blade control. Another advantageous quality is that it is powered by a 375W induction

motor with a simple switch system and features auto-shut off when the cut is completed. The saw bow swivels to allow angle cutting up to 45°. Plus, there is a latch to hold the bow down and even a carrying handle for transportation. A UK 3-pin plug is fitted.

When coupled with a UK made Axcaliber blade, the AE1470B will provide the user with the most accurate cuts over and over again.

This is a no-nonsense bandsaw, perfect for the small workshop, giving you hassle-free working whatever the task.

At the time of going to press, the bandsaw is priced at £546.96 inc vat. For more information, please visit axminster.co.uk.

International Model Boat Show 2019

The International Model Boat Show, regarded as one of the UK's leading marine modelling exhibitions, will return to the Warwickshire Event Centre on Saturday 9th & Sunday 10th November. The show this year will be a new two-day format and will not open to visitors on the Friday.

The excellent and varied displays include everything from early warships to modern power boats – all of which will be complemented by action on the large indoor boating pool.

There will be nearly 20 specialist suppliers present, offering visitors everything they could need for their boat and modelling needs and attendees will be able to view new technologies and buy newly available products.

In addition to all the boating action, the Tamiya Truckin team will be demonstrating and driving their 1/14 scale radio controlled models on a roadway system over 80 metres square. This fantastic arena will feature radio controlled 1/14 scale trucks, plant and machinery.

The Surface Warship Association will also be celebrating their 25th anniversary at the show with a display of never before seen unique models promoting the hobby of scale model warships.

Exhibitors will once again be vying for the prestigious 'Society Shield', sponsored by the magazine "Model Boats". This is voted for by the clubs and societies themselves and will be awarded to the best club display in the show. In 2018, King Lear Model Boat Club came 1st, in 2nd place was the Lifeboat Enthusiasts Society and in 3rd position was the Bournville Radio Sailing & Model Boat Club. Who will win this year? As King Lear have won for 3 years in a row, they will have a rest year in 2019 so the competition is wide open!!!

For a full list of exhibitors and to book your discounted advance tickets before 5th November see www.modelboatshow.co.uk.



A Second Cross-Slide Leadscrew



Peter Shaw continues his occasional series of articles exploring the techniques used when making a copy of an existing item such as the cross-slide leadscrew and associated components.



Micrometer Dial Ring, Locking Pin, and Handwheel.

There is no intention to provide a blow-by-blow account of these items, merely to use them to demonstrate the thinking and procedures involved in such a project. In this particular article, we shall look at the micrometer dial ring, that is the adjustable device used on the leadscrew to determine tool travel along with the ability to set zero at any point, together with its locking device. **Photograph 1** shows the dial ring and its locking device along with the handwheel (on the left) around which the dial ring rotates.

Initial considerations

The dial ring is approximately 28mm wide and between 55mm and 65mm diameter. It is knurled around the 65mm diameter periphery at one side whilst the other side, the 55mm diameter, is engraved around the

periphery with 40 long divisions marking every 0.10mm, ie a total of 4.00mm and 40 short divisions marking the intermediate divisions of 0.05mm. The dial thus has 80 divisions in total. In addition, every tenth division has an appropriate number engraved against it, eg 0, 0.5, 1.0... 3.0, 3.5, and back to 0.

Most of the turning and boring is standard lathe work about which nothing else need be said.

Engraving and Number Stamping

To engrave the lines, it is necessary to use some sort of indexing mechanism which is capable of accurately allowing the chuck mounted dial ring to be rotated by a fixed amount of 1/40 of a turn for 40 divisions, followed by a rotation of 1/80 of a turn

and then a further 40 divisions at 1/40 of a turn. To explain this further, a maximum of 80 divisions are required consisting of 40 long divisions and a further 40 short divisions interspaced between the long divisions. If the 80 divisions are made in one complete turn, then it will be necessary to arrange for alternate lines to be longer or shorter. This can be done, but the potential for getting it wrong is quite high. Adopting the method of 40 + 40 divisions means that the 40 long divisions are all marked first and if some sort of stop is used, then equality of length is assured, whilst the second set of 40 divisions use a stop set for a different length. The reason for the 1/80 turn is to move the dial ring around by half the distance between two of the 1/40th lines.

The engraving was done by mounting a



Aluminium support and Micrometer Dial Ring.



Clamp Bolt & Nut, along with rear view of Handwheel.

tool with a V point, e.g. threading tool, on its side in the tool holder and advanced such that the point cuts a line on the workpiece whilst racking the saddle back and forth using a saddle stop to limit travel thus ensuring equality of length. To obtain the 40 + 40 divisions, I used a homemade dividing mechanism which attaches to the extreme left hand end of the mandrel and which uses a 40 tooth change wheel for the divisions. To obtain the 1/80 offset turn, the detent which engages between two teeth, has a slot in it such when the detent is rotated through 90 degrees, the detent then sits over a tooth, thus giving the required $\frac{1}{2} \times \frac{1}{40} = \frac{1}{80}$ turn.

The numbering of the ring was done by means of a 3mm number stamp set, however I thought that there may be a problem with physical support whilst wielding the hammer, eg distortion caused by the hammer blows. (Out of four of "our" suppliers, two referred to these devices as punches, whilst the other two referred to them as stamps. For this article I use the term stamp, which is what my dictionary definition would seem to favour.)

I therefore made a temporary aluminium infill which sits inside the ring and which can be clamped in the vice. **Photograph 2** shows the aluminium billet and the dial ring. To make this, I melted some scrap aluminium inside something like an old steel or tin food can, allowed the aluminium to solidify, removed the can, and then turned the billet until it just fitted inside the dial ring. The aluminium thus provided support to the steel ring whilst stamping the numbers around the outside.

Clamp Bolt & Nut

Photograph 3 shows the clamp bolt and clamp nut along with the rear of the handwheel, and it can be seen how the D shaped head of the clamp bolt is designed to lock against the cutout on the handwheel. The bolt may be made from the solid or from two parts joined

together. Making from the solid has the advantage that no joining is required but it does require a lot of turning to create the bolt shank. Making from two parts saves on the turning but then requires a means of joining the parts together permanently, such as glue, soft solder, silver solder and the like. I chose to use two parts soft soldered together, and to aid this process, the end of the shank has a reduced section for the head to sit on during soldering. The D shaped head is made after soldering by filing a flat on the periphery of the head until the flat is level with the shank.

The clamp nut poses a number of difficulties. At a little over 10mm long, it is not long enough to be securely held in a chuck for knurling, whilst making a blind thread is very difficult unless the plug tap can be persuaded to start. To overcome these difficulties, it is suggested that the following is one way to make it.

Start by selecting a length of material sufficiently long enough to be held firmly in the chuck jaws with about 30mm projecting and of a slightly larger diameter than the knurled section. By using a larger than required diameter, it is possible to use the three jaw self-centring chuck as any slight runout will not matter as it will be corrected by later turning. Face the end, use a centre drill to start a hole, and then drill & tap 15mm deep. By drilling and tapping this depth allows the taps to work correctly. Tap full depth with the taper tap, then the second tap and finally the plug tap. The drawing calls for an overall depth from the face of the nut to the point of the drilled depth of 9mm so now 6mm can be removed from the end of the work. Now turn the plain part of the nut – a little over 5mm long – to a diameter of 10.00mm. Provided there is sufficient space (if not, you will have to pull out the work to create the space), turn a diameter of about 11.5mm for a distance equivalent to the thickness of your knurl plus the thickness of the

frame of your knurling tool. On my tool that amounts to 13mm. Now make a knurl starting from the plain section. On completion of the knurl, use your parting off tool to cut off the nut at a little over 10mm from the face of the nut. To do this, set the left hand corner of the parting off tool touching the face of the nut, retract the tool, and move to the left by the desired distance plus the width of the parting off blade, and part off. And that is that, other than putting a gentle chamfer on both faces of the nut, and if desired, on the edge of the knurl in the middle of the nut.

Mistakes

When using an indexing mechanism, it is a good idea to bias the system in such a manner as to take up the inevitable slack, such bias always being in the same direction. One way of doing this is to fasten a cord to the chuck, for example by means of a peg into one of the key holes, then wrap the cord a few times around the body of the chuck and finally hang a weight on the end of the cord. When engraving the lines on the micrometer ring, I failed to make some of them deep enough, so repeated the exercise. Unfortunately, I forgot to apply the bias weight with the result that some lines are double marked.

Also, when using the number stamps, I failed to hit some of them hard enough and had to repeat the stamping. And of course, I failed to line up the stamp with the existing mark with the inevitable double marking. The moral here is to hit the stamp hard enough first time. ■

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Milling for Beginners

PART 13 - USING THE ROTARY TABLE AND THREADING

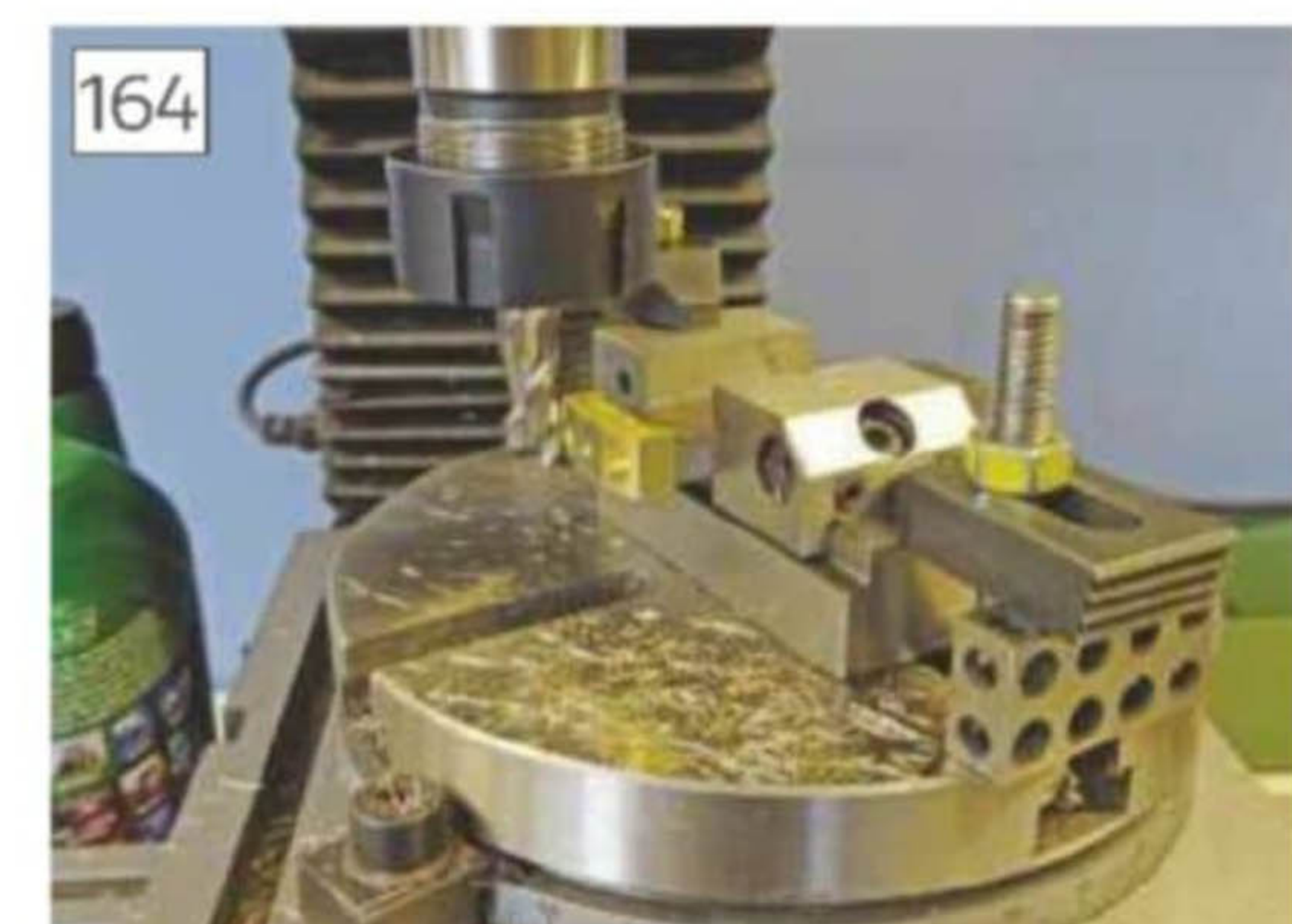
This month Jason Ballamy looks at further uses for the rotary table and also discusses threading on the mill.



Simple rounding over of an aluminium base plate

In the previous article we looked at how the rotary table can be used for indexing, this time some of the other uses that it can be put are covered below.

Most rotary tables can be mounted both horizontally and vertically which allows the axis in which the work piece is rotated to be positioned in the most appropriate position relative to the mill spindle axis and cutting tool. With some thought to mounting it is also possible to have the table's axis at an angle which further increases the possibilities of what can be done with it.



Vice used to hold small parts mounted on a sub plate



Multiple curves being cut to form a MDF template

Horizontal Use

One of the most basic uses when mounted horizontally is the rounding over of corners or the ends of parts, the work is simply held with the centre of the required radius inline with the tables axis of rotation and then the table is moved to one side and the work rotated against the cutter until the desired radius is obtained, **photo 162**. One step further to this type of use would be where several curves need to be machined on the same part in which case the work is repositioned to the next radius' centre point and a further cut taken, this



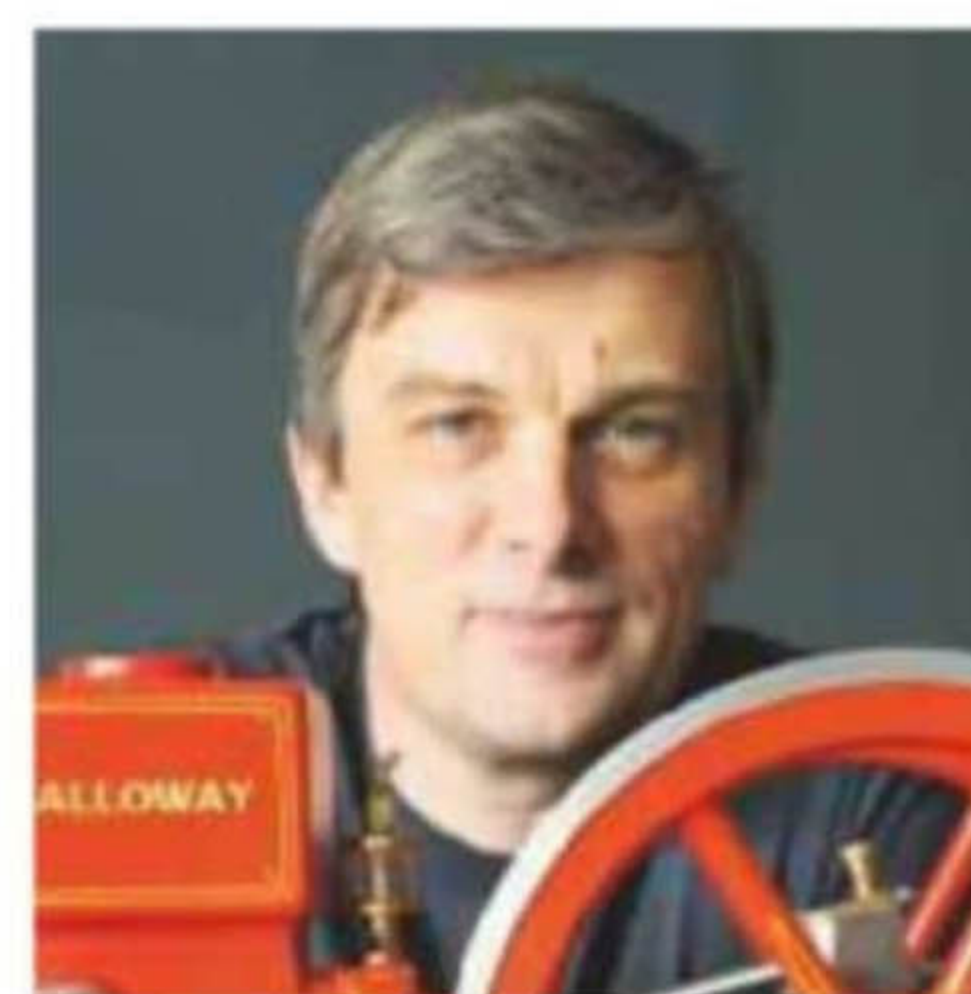
Straight and curved cuts all done at one setting

is repeated until complete, **photo 163** shows a template for an engine base being milled in this manner. Sometimes it may be necessary to mount the work onto a sub plate if the centre of the radius does not fall within the part so that it is easier to locate on the table as shown in **photo 164** where the part is screwed to a block which has the centre marked on it an this in turn is held in a vice clamped to the table.

While the work is held to the rotary table for machining the curves accuracy can be increased if other features are machined at the same time such as holes or edges which



Straight and angled cuts on the same part



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Vertically mounted for cutting radial grooves



Straight and radial cuts with tailstock support

are cut using the usual X and Y axis with the rotary tables axis being used as the datum point for setting out. The bracket shown in photo 165 had the complete profile and inner hole shaped at one setting where all the straight cuts as well as the curves were done without repositioning the work which ensures all features are true to each other. With the ability to set the rotary table at any angle you are not restricted to just milling at right angles, angled cuts can also be included as shown in **photo 166**.

Vertical use.

With the mill mounted on its edge so that the table is vertical its axis of rotation will then be at 90 degrees to that of the spindles axis. This allows features to be machines around the edge of a work piece and can be used where the feature does not extend all the way around which prevents it being turned on the lathe such as the recessed curved groove on the crankcase shown in **photo 167** that was cut with a ball nose cutter and is now having its edge chamfered.

In a similar manner the next picture of a steam cylinder has had its wall thickness reduced leaving the flanges at each end by a combination of rotary cuts to define the flanges and then cuts along the X axis at 2 degree intervals to remove the waste between, **photo 168**. In both these examples note the use of the rotary tables tailstock to help support the work which gives a more rigid setup and there is no risk of the cutting forces pushing the end of the overhanging work downwards.

Angled Use

By tilting the rotary table at an angle, it is possible to mill shapes such as tapered spigots. **Photograph 169** shows such a setup where one side of the table has been packed up on a soft aluminium rod and lightly clamped to the table so that the small cast spigot can be cleaned up and made concentric to the hole through it **photo 170**. For heavier cuts some more substantial and solid clamping is required such as that shown in **photo 171** where the rotary table was used to position the eight



Rotary table packed to slight angle



Resulting tapered cut to represent a casting's draft angle

sides of the octagonal base casting so that the sloping faces could be finish machined.

The table can also be angled across the milling table when in the vertical position which is the method often used to machine bevel gears. If the pair of gears are anything other than a 1:1 ratio then by setting the table once to say the sprocket angle and cutting in the Y direction and then cutting in the X direction for the wheel then as well as saving time resetting the table to the wheels complementary angle you will ensure that the sum of the two cuts equals 90 degrees, **photo 172**.

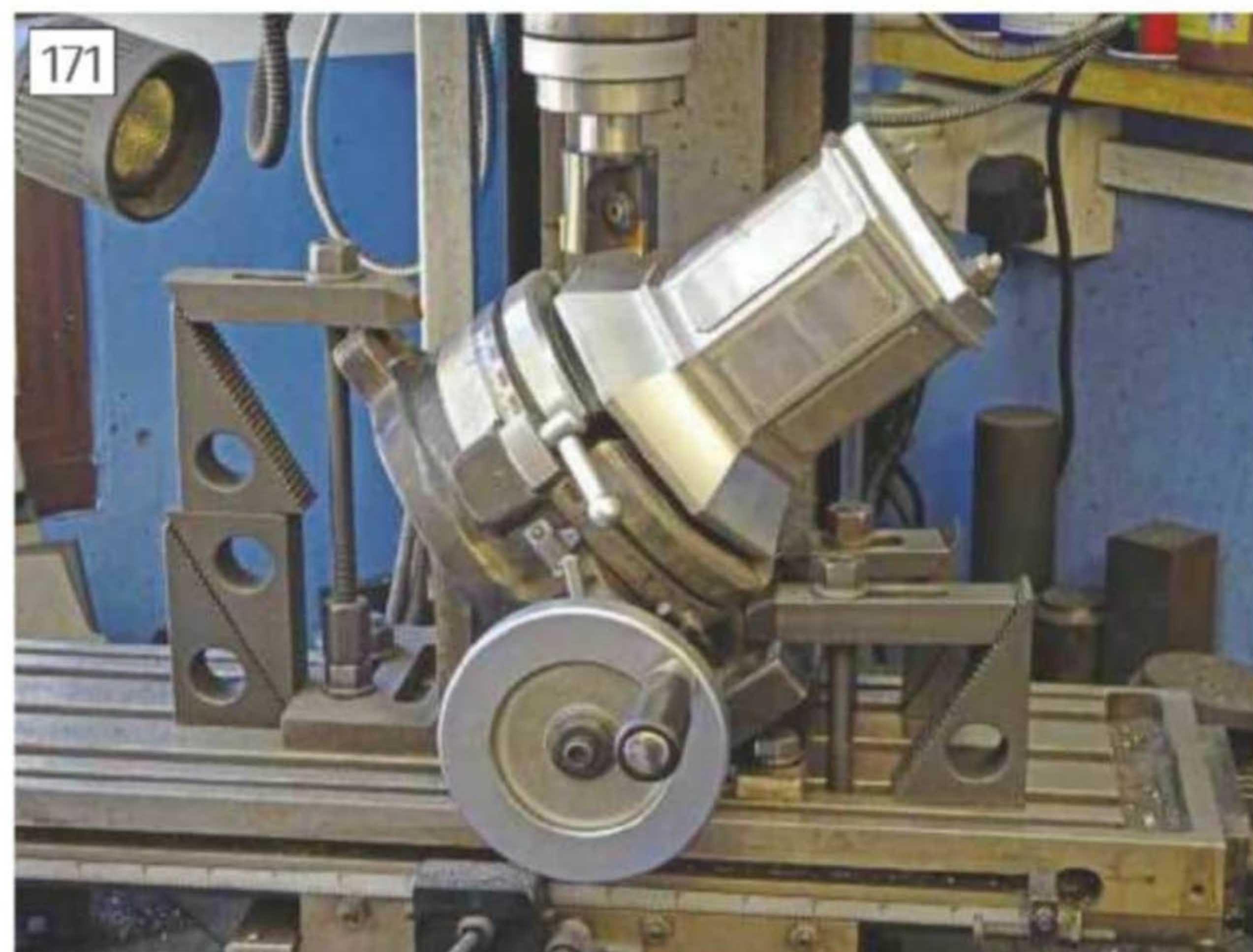
Work and Tool Positioning.

The majority of rotary tables will have a central hole with a Morse taper and it is worth making up a location peg to fit into this from a blank end arbor. Simply turn the soft blank end down to a convenient size such as 5mm or 6mm diameter if you work in metric or 1/4" if you mostly use imperial. When positioning the table horizontally place the pin into the taper and bring down the mills head and grip the pin with a collet which will place the tables axis inline with that of the spindle. You can now clamp the table down and zero the X and Y hand wheels or DRO. The pin can either be removed as you raise the head back up or if released from the collet can be left in the tapered hole and used as a pin to locate the work on, a series of bushes to fit over the pin will soon start to build up as you make them for various jobs, **photo 173**.

The pin and bushes can also be used for positioning chuck and collet back plates, the only downside being that it may not be possible to extract the pin once the tooling is in place which can limit the length of work being held as the through hole will be blocked.

As well as or instead of a tapered hole some tables have a recessed hole in the centre of the table that can be used to accept stepped location bushes or spigots on the rear of things like chuck mounting back plates such as the ARC example shown in **photo 174**.

If you have several similar parts to machine then if small they can be quickly



Heavier cuts with table mounted at a steeper angle



Table angled across the mill table to cut bevel gears



Morse taper location pin and bushes



Location recess in table and mating spigot on backplate

located if a vice fitted with a stop is used to locate then, if the part won't easily fit a vice then some form of stops held to the table will allow each part to be located in the same place. In **photo 175** two 10-20-40 blocks have been screwed together to give two way location for the batch of parts being machined.

In use always lock the tables rotation so that it does not creep during a cut unless it is a curved cut being made where the table obviously needs to turn but even then you may find you get a better finish with one or two of the clamps slightly nipped up to give some drag particularly on large diameter cuts where any backlash in the table's worm and wheel gearing becomes more exaggerated as the diameter increases.

Threading

This subject may have been better titled tapping, as the mill is seldom used for cutting external threads, at least not manually operated ones. As well as being an excellent drilling machine the mill can be used as a tapping guide simply by locating the spindle back over a previously drilled hole and using that to guide a tap thus ensuring that it enters the hole perfectly perpendicular to the surface which should



10-20-40 blocks used for repeat setups

prevent any wonky tapped holes.

There are several ways to guide a tap, you can buy sprung guides, loosely tighten a drill chuck around the shank of the tap or the method I tend to use is to make a simple male/female ended centre that can be held in a collet or drill chuck that supports the top of the tap while light pressure is applied with the quill to keep it engaged with the end of the tap. These are easily made preferably from silver steel that can be hardened or mild steel left soft will do but may need touching up once in a while. You simply turn a 60degree point on one end, which is used for taps with a

female centre hole, and the other end is drilled with a centre drill so it fits over taps without a hole. I actually have two of these one 6mm and the other 1/4" diameter as those are two sizes of collet I often find myself using so reducing the need to swap collets, **photo 176**.

When using these guides on taps without an end hole you may need to place the tap wrench on the round shank of the tap but this is no bad thing as it acts a bit like a slipper clutch and you will find that the wrench will slip before excess force can be applied, provided you don't use a massive tap wrench on very small taps. **photo 177**. In fact, for very small taps it can save breakages if a small knurled ring is used to turn the tap being held on with a cross drilled grub screw.

Machine taps

With the ability to guide the tap squarely into the hole there is little need for a traditional taper tap so making use of what have become known as "machine taps" will make the process easier and quicker. These taps come in two forms that are of interest to us - Spiral Point and Spiral Flute.

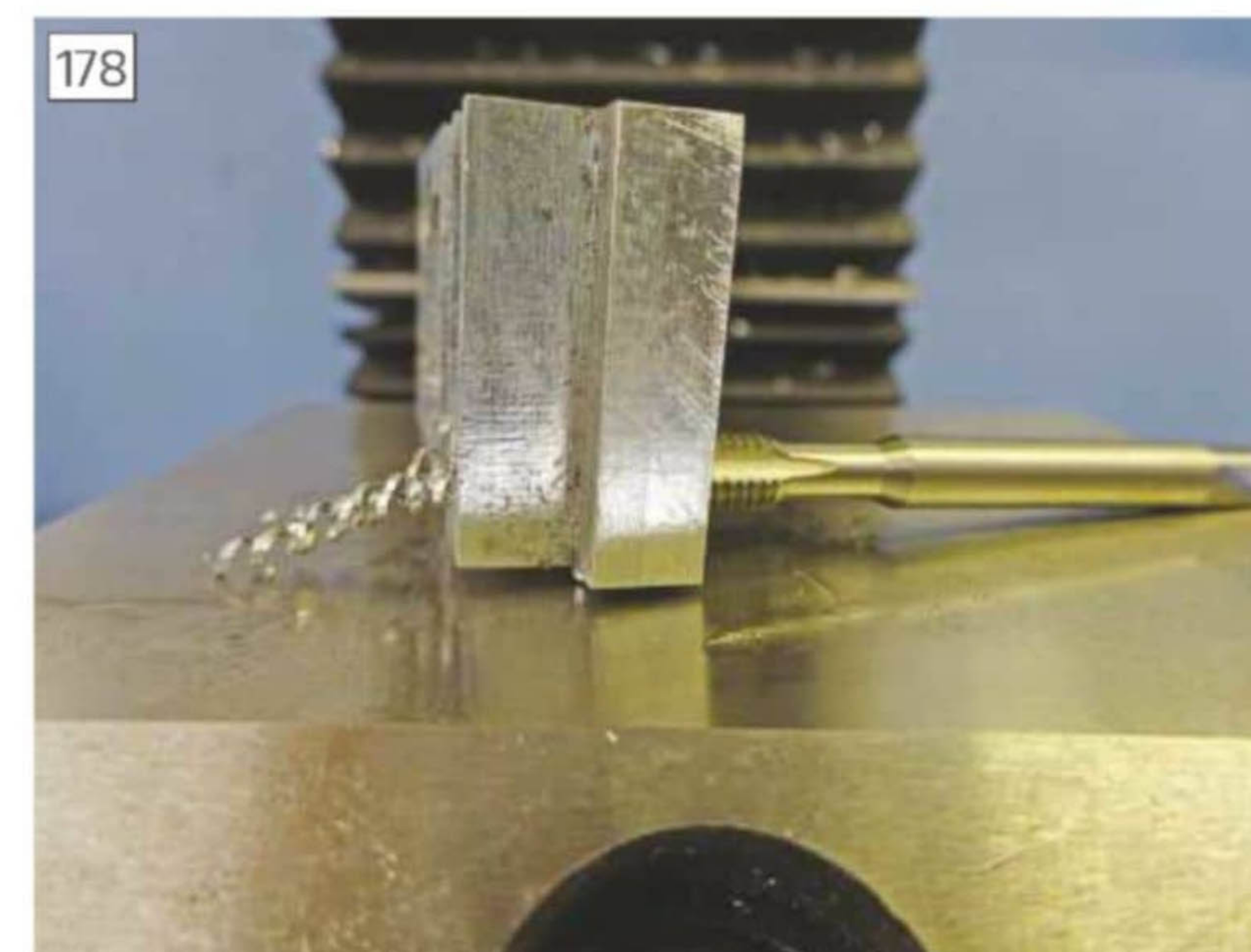
A spiral point tap actually has an angled



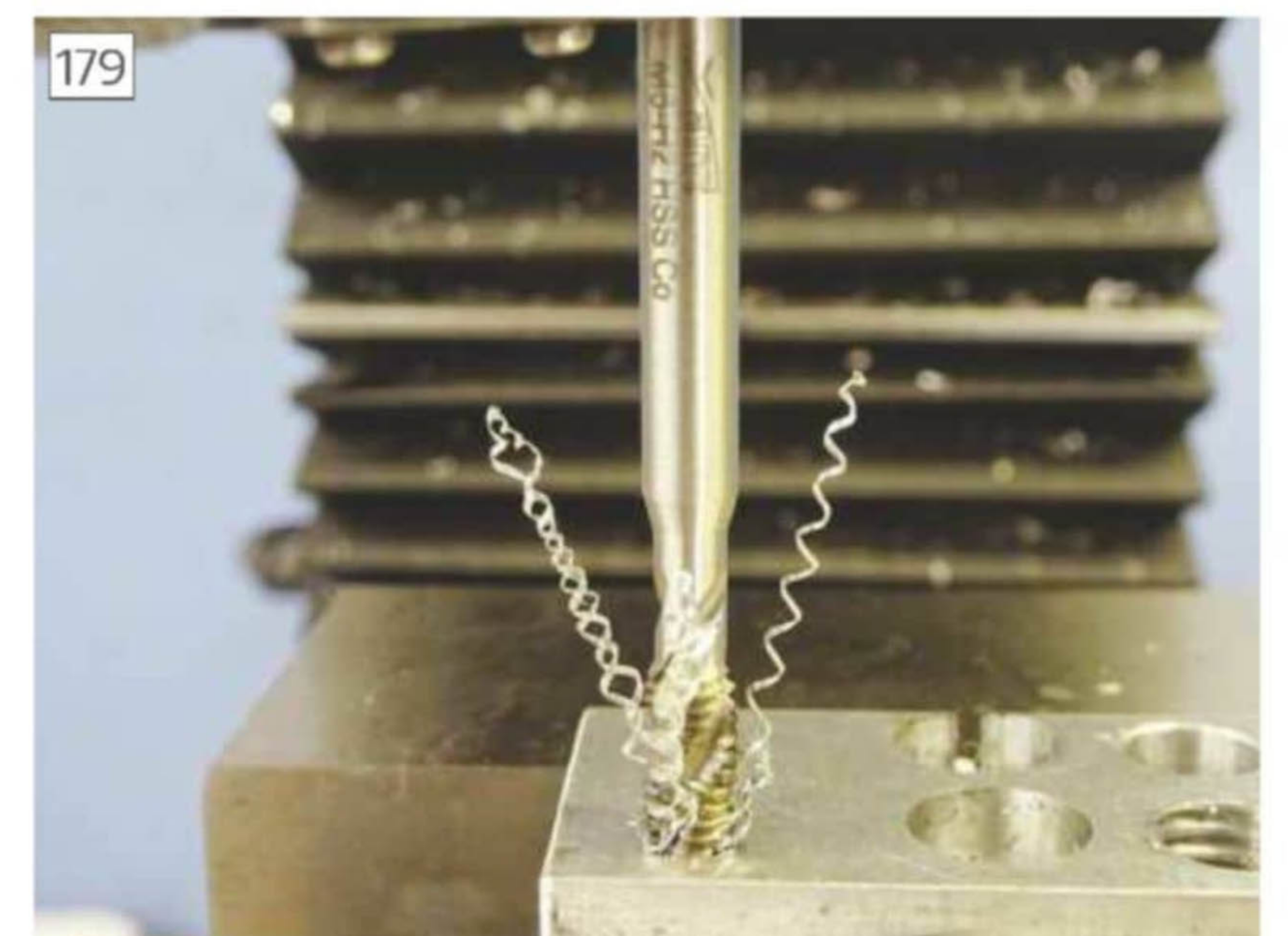
Simple homemade tap guides



Tap wrench on plain shank of tap



Swarf pushed out the bottom of hole by spiral point tap



Swarf lifted clear of the hole by spiral flute tap

face to the leading edge of each flute rather than a full left hand spiral, this angled face is designed to push the swarf ahead of the tap and out the bottom of through holes, so they are best suited to that use. Also being designed for being driven all the way in with a tapping head they do not need to be backed off every turn to break the swarf, in fact this will reduce its ability to be ejected out of the hole so should be avoided, **photo 178**. Although best suited to use on materials that produce long curls of swarf, for hobby use they will also work with crumbly materials such as the harder brasses and cast iron with the swarf just falling out the bottom of the hole.

Spiral flute taps do have the flutes shaped in a helix much like a drill bit or milling cutter which pushes the swarf up and out of the hole making them best suited to blind holes thus avoiding swarf getting packed into the bottom of the hole but they are also just as good for through holes and save time having to work through the usual taper - second - plug sequence of traditional taps. Much like the spiral point they work best with more ductile materials that produce stringy swarf and do not need backing off

but even on the more grainy metals will lift most of the chips of swarf out around the top of the hole, **photo 179**.

Machine tapping

Some bench top hobby machines have a "tapping" facility such as the Sieg SX2.7 and SX3 which activates by buttons on the end of each of the three quill feed arms that can be used to rapidly change the direction of spindle rotation from forwards to reverse and back to forwards etc. The electronics of the machines have also been set up to produce increased torque when in tapping mode, as it can put quite a load on the machine as the size and pitch of thread increases. There is also a speed limit when tapping which is not a bad thing as you do need quite fast reaction times with coarse threads that can rapidly pull the tap into the work once it is cutting. For this reason it is best to save the use of tapping mode to through holes or if used for blind holes make sure the hole has plenty of depth to allow some margin for error, if you don't hit the reverse button soon enough as unlike a tapping head the tap will not reverse itself.

Some people do machine tap on mills without the specific tapping mode

and this should be done with caution, checking the temperature of the motor if any number of holes are being tapped as it will be running slowly under possibly quite high loads. It will also load up any additional belt or gear reduction in the drive train so care should be taken, particularly on plastic geared machines, to not over load them, a slightly larger than normal tapping size hole will help here.

Which ever type of machine you are using the use of a suitable tapping and cutting fluid such as Rock Oil's "Maxcut No. 5" will make cutting easier for the machine, give a better finish and also prolong the life of your taps. ■

The items featured in this series are available from Arc Euro Trade, <http://www.arceurotrade.co.uk>, who also sell the X series of mills. See the accompanying thread on Model Engineer Forum <https://www.model-engineer.co.uk/forums/postings.asp?th=131318&dp=1> for more discussions about this series. Video Link <https://youtu.be/IDhrAfyUsTg>

Freeing a Taper



Morse taper mandrel inserted in rotary table

Laurie Leonard comes up with a solution for removing a stubborn adaptor bush

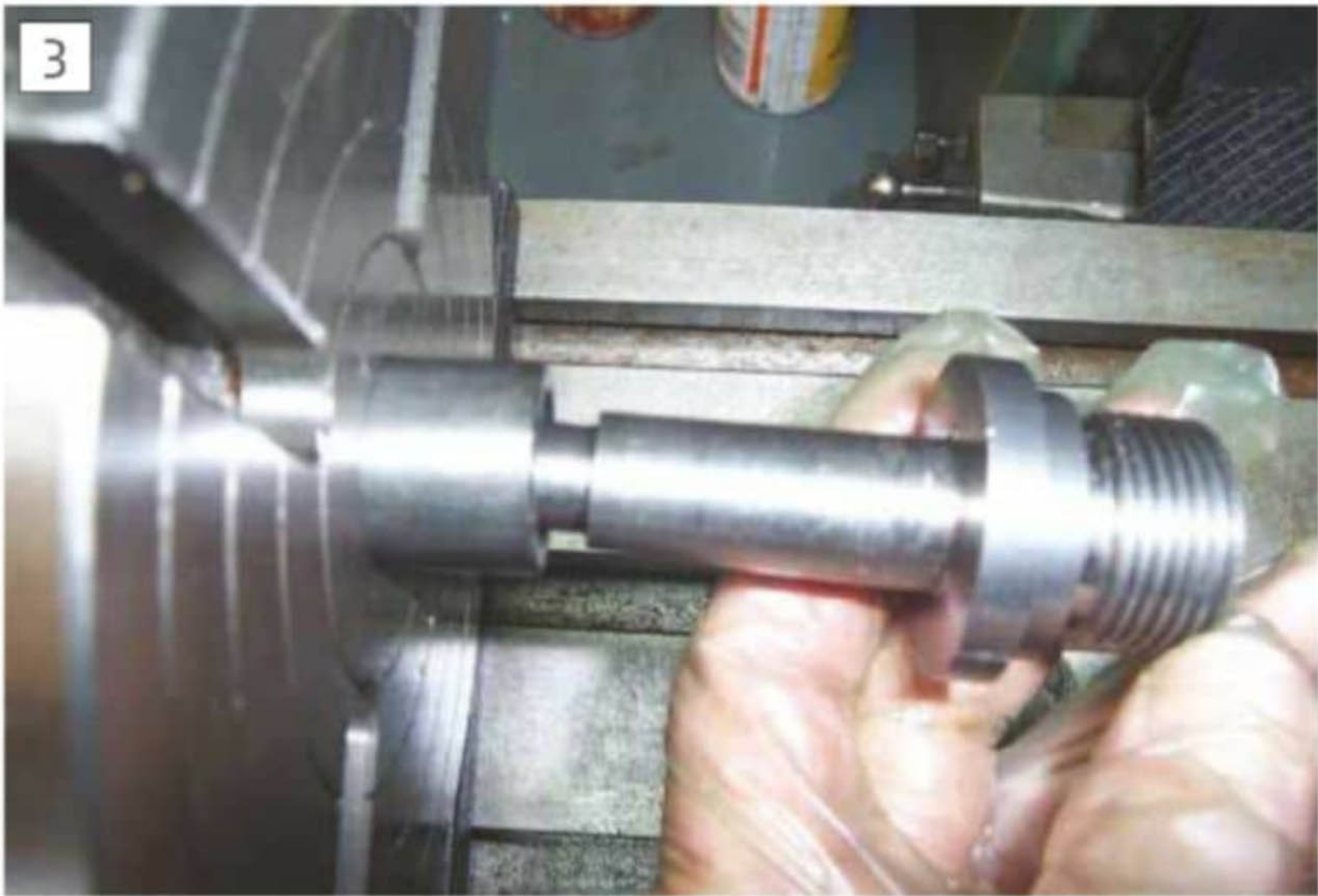
I purchased a rotary table many moons ago, and it really is brilliant when the correct application arrives and is a joy to use. Utilising a Morse taper mandrel with a Myford threaded head, **photo 1**, I can fit my lathe chucks, **photo 2**, to grip round work and of course, other shapes utilising a four jaw independent chuck. The problem arises when it is time to put everything back to bed: the mandrel ends up jammed in a bush which is a component of the table. A separator is needed.

The Separator

Photograph 3 shows the mandrel being inserted into the rotary table. The Morse



Chuck mounted on mandrel



Mandrel being inserted into the table



Mandrel and parts to fix it to the table



The small land between the bush and the threaded head of the chuck

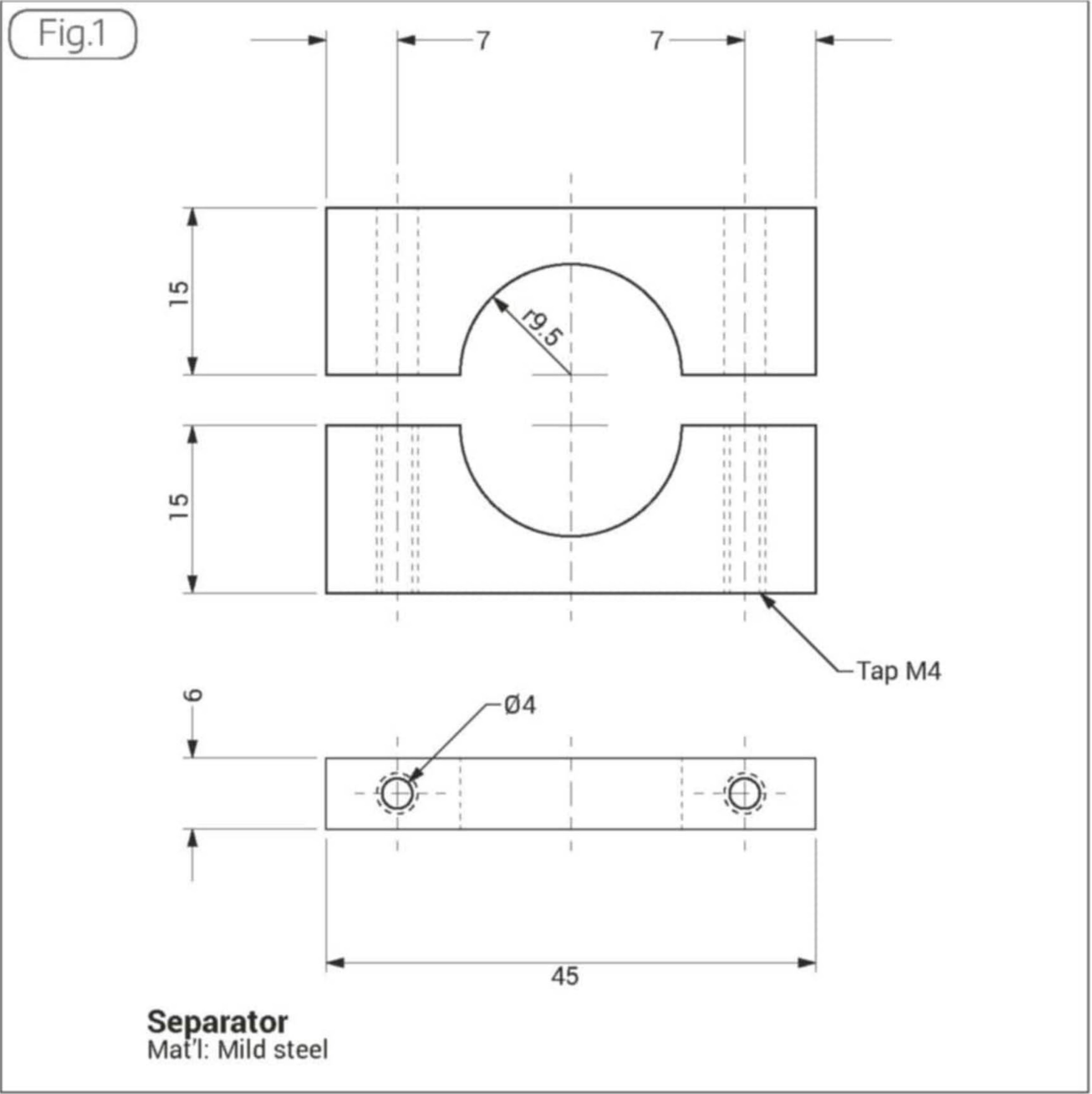


Parts of the separator

taper bush, a component of the table, about to enter the table is ground to a very high tolerance and is virtually a press fit into the parallel sided hole in the table. The bush and the mandrel are drawn into the table with an Alan screw, utilising a machined spacer, from the rear of the table. This operation also draws the mandrel taper into the corresponding taper of the bush. The screw and spacer together with the mandrel carrying the bush on the taper is shown in **photo 4**. The problem is how to remove the bush from the mandrel. **Photograph 5** shows that a small land exists between the edge of the bush and the threaded head for the chuck. This land was used to



Separator assembled around the mandrel





8
Mandrel/separator mounted on vice ready to be separated

accommodate a separator.

The separator was made from scrap (I know, it shows and this explains the extra part holes) and its parts are shown in **photo 6**, and assembled around the mandrel in **photo 7**. Rough dimensions of the separator, made to suit my Vertex 150mm table, are shown in **fig. 1** as a starting point for other applications. The extractor was simple to make. The two 45mm lengths of 15 x 4mm mild steel strip were set up together and two holes for the screws were drilled as shown in the sketch with an M4



9
Removed bush

tapping drill. The holes in one strip were opened out to 4mm and those in the other strip were tapped M4. The two strips were screwed together with M4 x 20 screws. The combined assembly was then set up on the lathe in a four jaw chuck with the centre of the 19mm diameter hole on the lathe centre line. A pilot hole was drilled and then successive drills were used to open the hole which was finally bored to size.

In use the separator is assembled around the mandrel and whole assembly is placed on the vice but not clamped in it, photo 8,

and by applying a sharp blow from a copper faced mallet on the mandrel end the taper is released. The removed bush and assembled separator are shown in **photo 9**.

Conclusion

The separator was made to solve a problem encountered whilst working on a job. It is not glamorous by any stretch of the imagination, but it worked and has continued to work as required for four years, probably longer, so can be considered a quality tool; if quality = fit for purpose. ■

In our Next Issue

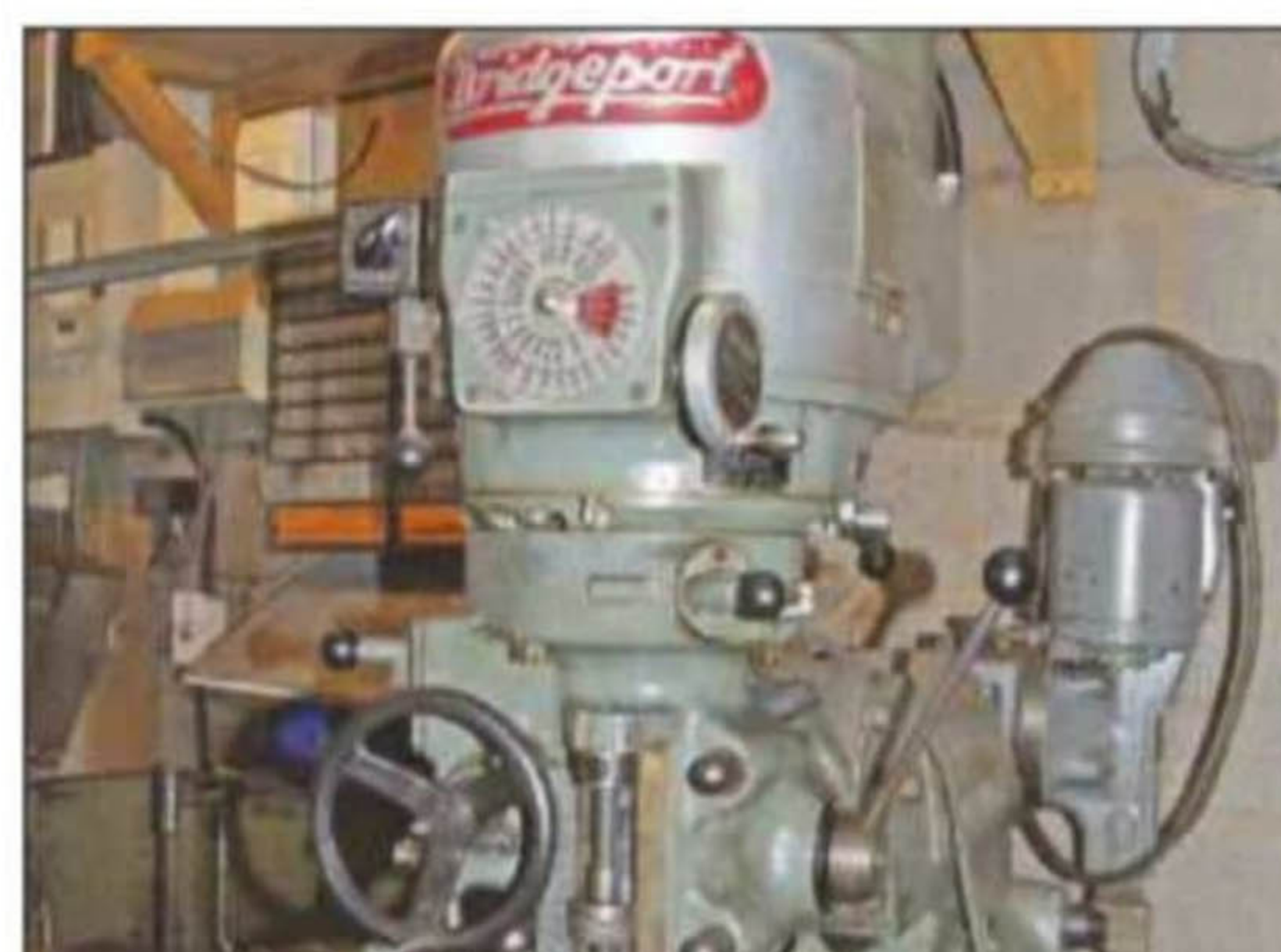
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October's issue, number 286, will have some great builds:



Mogens Kilde starts a step-by-step guide to building a Scroll Saw.



Andrew Johnston gives an introduction to his Bridgeport Mill.



Make Keith Johnson's Pointmaster jig for sharpening small drills.

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Dragon's Den or Dream Workshop?



We all have our own idea of what the 'perfect' workshop would be to meet our needs. Des Bromilow made his dream workshop a reality and documented the build for readers. Let's make a start! - Part 2.

The lining was then painted with a light cream colour paint. Why paint the lining?

- 1 - The lining material has some inherent protection against absorbing fluids by virtue of the wax and glues used in its manufacture, but I did not want to rely on that as the only source of protecting the lining. I had already chosen to place the heavily waxed side towards the external cladding as an additional layer of protection against any failing of the sarking to keep moisture away from the lining.
- 2 - I chose a light colour to allow light to bounce around the interior of the shed more. Not only does this improve lighting for working but helps overcome shadow effects caused when I start filling the shed with tools, storage, and projects.
- 3 - A light colour background wall allows a certain amount of "contrast" when examining things, I can hold something up to look at it, and the light coloured background allows me to see gaps or imperfections easier than a dark surface.

After consulting with the local paint suppliers, I chose an acrylic undercoat sealer, followed by two coats of a water based exterior grade paint. This should give me several years of service, and handle



Cover in place

the anticipated effects of coolant, or other fluids contacting the walls. By using the acrylic paints, I can easily touch up the walls in the future if needed.

This light cream paint was applied on the underside of the internal mezzanine flooring. The top is currently unpainted, but these sheets were installed "wax side up" in order to provide protection to the flooring with risk of them being slippery (if painted). The light paint on the underside is to reflect light from the task lighting fixtures which

may be fitted to individual machines.

The cable ladder the wall is covered with cream coloured colourbond sheets. Each piece is 1m in length and overlaps the exposed slot by 50mm on each side. Notches are then cut in this cover for all conduits exiting the ladder zone. The remaining cable conduits and layout will be discussed in the electrical section of this article. The cable ladder and its covers were designed to maintain a visually flat wall and provide adequate protection to the cables. The fact that the covers are magnetic and located at eye level above the machines is simply a coincidence, and the placement of magnets, holding drawings or sketches is simply a reflection of this convenient happenstance. **Photograph 17** shows these covers in place over the cable ladder.

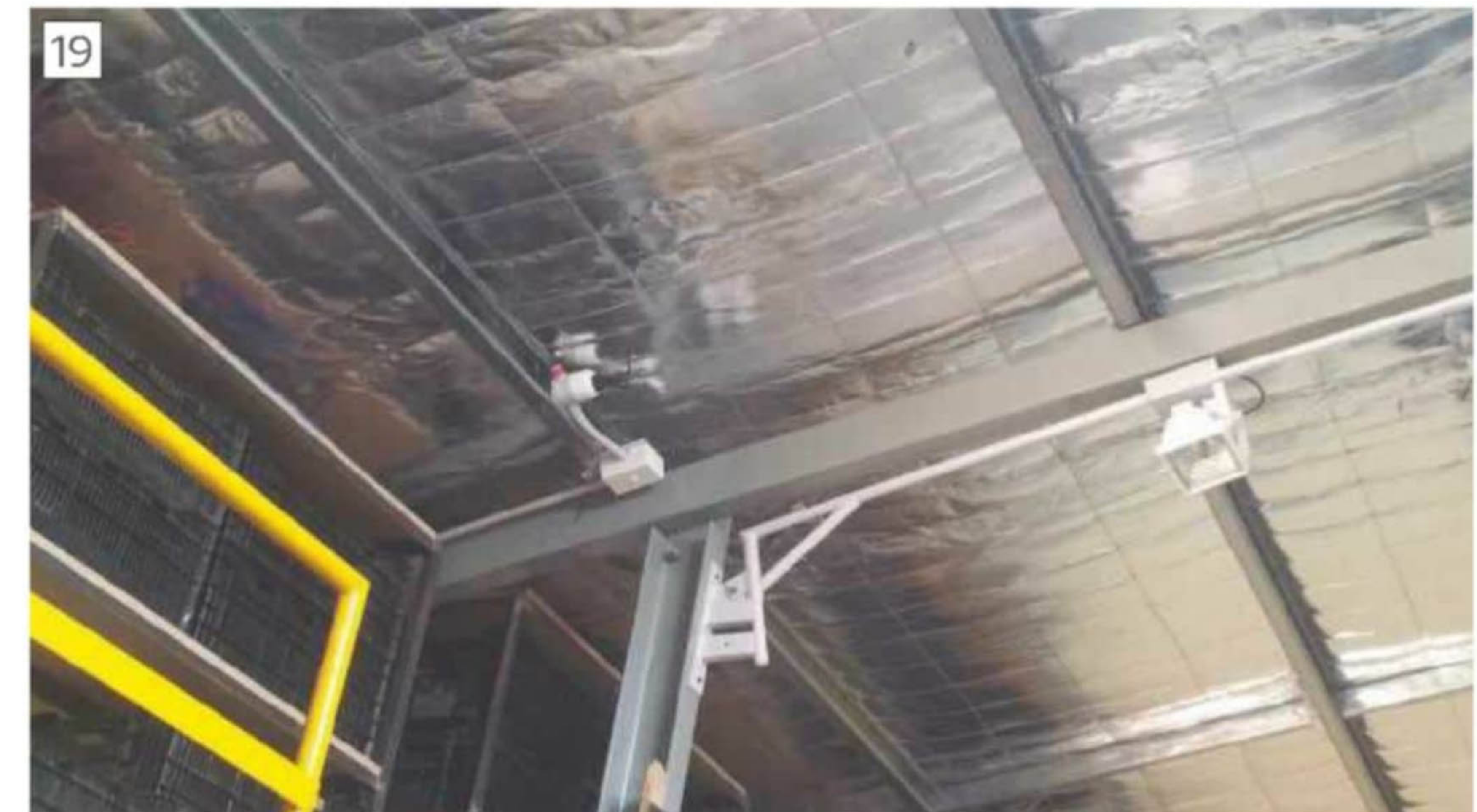
Electrical Overview

Lighting the shed was approached in a multipronged way. I wanted low cost effective lighting, and to minimise wasted energy (with related costs). This meant task lighting was a priority, and base level lighting was to be effective and inexpensive to buy and operate. Having a roof at least 4m up in the air meant I wanted a way to maintain my lights without needing scaffold, or tall ladders, for bulb replacement, or adjustments.

The lights were divided into 3 categories:

- 1- *task lighting* - the areas over work benches, machines, and under the mezzanines were fitted with individually switched banks of task lights. Each task light is 1200mm fluorescent light operating off a common switched supply. The fittings were purchased second-hand from a seller on Gumtree. The fluoro fittings allow future changeover to LED technology at a relatively manageable expense. Each fluoro fitting is held between the joists of the mezzanine by brackets made for this purpose, and the socket outlets for them are controlled by the individual bay switches mounted near them as shown in **photo 18**.
- 2 - *overall lighting* - the main workshop area is lit by "low bay" lights which are suspended from brackets made from salvage galvanised water pipe. These brackets are then bolted to the mezzanine droppers, so they are accessible from the mezzanine deck. Each bracket has a hinge so the arm of the bracket swings between the position over the floor, and the service position over the mezzanine deck. The lighting fixture on the bracket is some low cost halogen flood lights. See **photo 19** for an example of the bay lights. The bay lights in the main workshop are switched individually, whereas the two located in the welding bay are controlled as a pair. As the halogen bulbs fail, they will be replaced with LED equivalents.

The low bay light brackets located in the welding bay have a number of pieces of sheet metal attached to prevent birds roosting on the brackets - the arms have a length of fishing line strung between two small brackets to keep the taut line about 12mm above the main arm, and a strip of sheet metal with a series of cut points similar to saw teeth is located above the



Bay light



Bird deterrent

light itself and shown in **photo 20**.

The lighting brackets for the bay lighting also contain an additional arm extension on two of the sets. This extension allows a smoke alarm to be positioned just short of the ridge of the shed. One alarm is photoelectric, the other is ionizing. The alarms can be reset by swinging the lighting bracket over the mezzanine deck. Each alarm is cabled for alarm relay - ensuring that they are heard and relaying to the security system. The lights are connected to the fixed wiring of the shed by means of socket bases which are controlled by switches at ground level. The socket bases are used throughout all of the lighting setup (with one exception) which makes change-out and maintenance of the lights safe and simple. The exception to the use of socket bases in the welding bay task lighting - in this case hard wired weatherproof fittings used to maintain integrity against any rain blowing in.

- 3 - *specific lighting* - this includes the lighting for the office, storage room, mezzanines, and tank storage shed. In all cases except the office and mezzanine, the lighting is simply a fluoro fixture mounted in a bracket affixed to the roof surface. The light is

controlled from a switch at the entry point of the area, and the number of lights is designed to comply with standards for storage and non-detail work. As with the previously mentioned task lighting, the fluoro fittings permit the future change-out to LED technology at a manageable cost.

The office lighting is the same type of fluoro lighting fixtures, but more of them are installed to meet the lighting standard for detailed working. The lights are controlled in rows, with one row located over the workbench, the other row is more centrally located for general access.

Lighting circuits in the storage shed and upstairs storage room are wired for two way switching, with an indication neon in the workshop. This arrangement allows me to see if the light has been left on in those areas and switch it off remotely. As shown in **photo 21**, the upstairs storage room light is on, and the top neon is lit to indicate this.

The lighting for the mezzanine level introduced an issue and the solution may be of interest to others for future projects.

As seen in the **fig. 1** of the upper level, a typical adult standing on the mezzanine level has only a few centimetres of



Light switch



Switch with indicator light

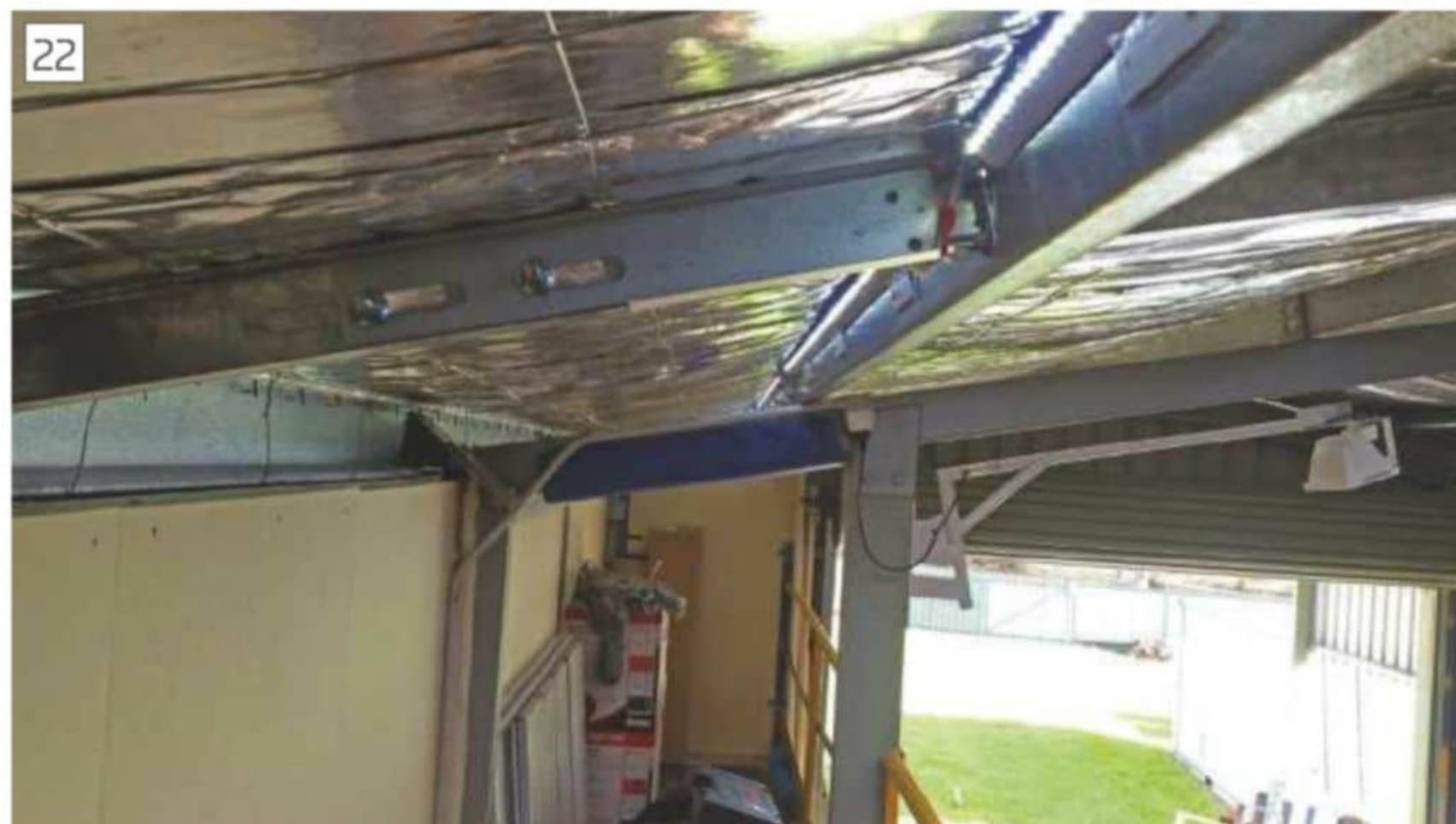
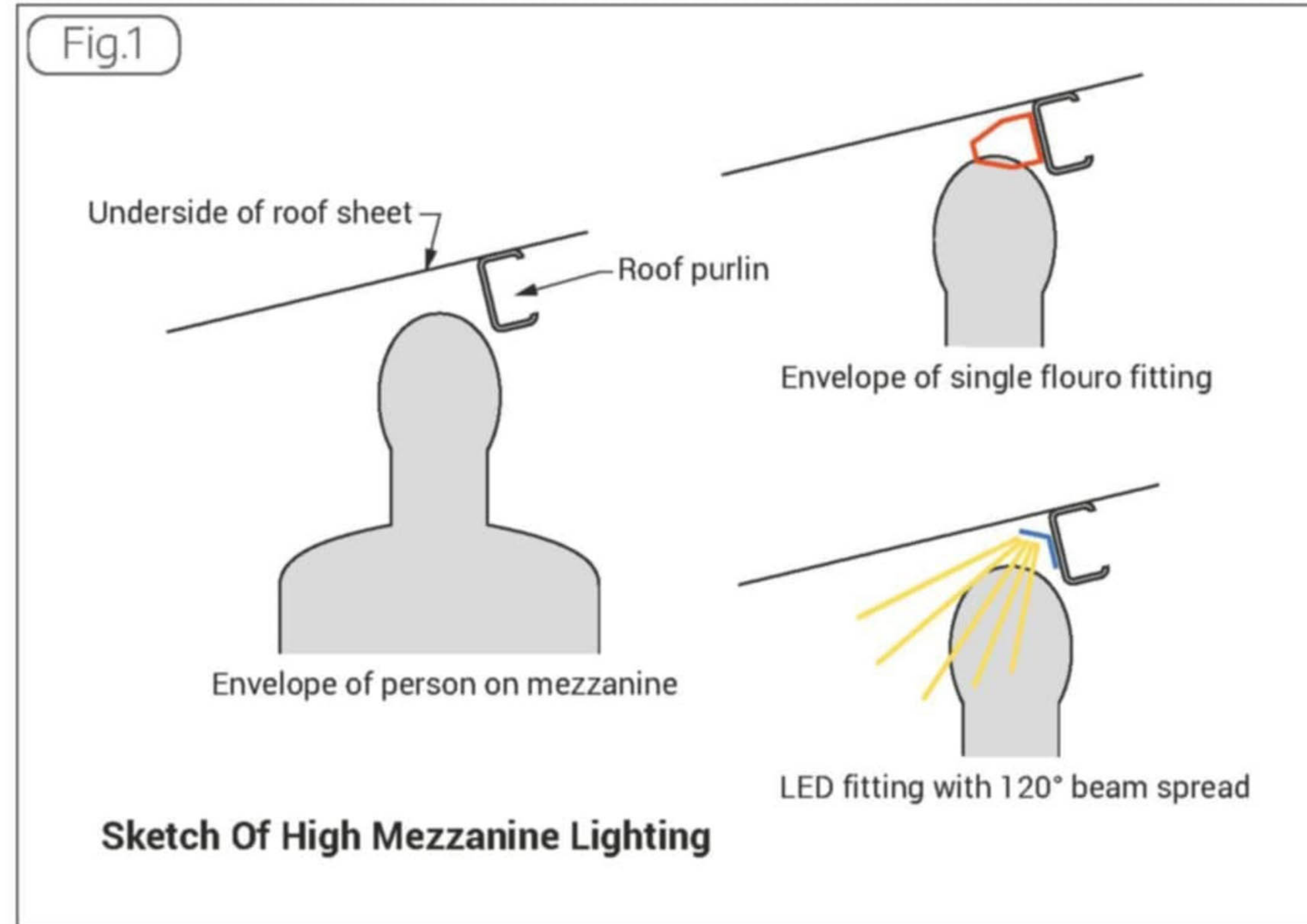
clearance between the top of their head, and the underside of the roof. The obvious mounting point for a light, the roof purlin, is too close to the head, and would either cause injury from striking, or discomfort due to walking stooped over all the time. The sketch shows that a single fluoro fitting would clash with a person's head, so an alternative lighting method needed to be found/designed.

Strip LED lighting was looked at, with the idea of attaching it directly to the roof purlin, however the LEDs only have a 120 degree illumination angle, this means that the beam illuminating the shelving would stop approximately 400mm above the floor, and not illuminate the floor of the mezzanine at all. If the LED was angled further from the roof purlin, the beam would cover the entire shelving unit, and the floor of the mezzanine. The calculated angle was determined to be 30 degrees as a minimum.

To implement this angled LED strip light, some lengths of 30x3 mild steel flat bar were cut to length, and some affixing tabs were welded on at a 45 degree angle. By using a piece of 30x30x3 equal angle (tipped on the open face) as the jig, the tabs were all welded on at the same consistent angle.

Once the welding was complete, the welds were ground back to ensure a flat surface, and then steel was primed and then painted with a light coloured gloss enamel. This was done to ensure a smooth surface for the LED strips adhesive backing to grip well, and transfer heat into the steel mounting. LED strips dissipate around 5W per linear meter, so some form of heat sink is usually necessary to promote a long life of the LED strip. The mezzanine floors in the main workshop represent twelve lengths of 1.8m, so each side needs to dissipate approximately 60W via the mounting strips. This same power rating is the minimum rating for the AC to 12VDC power supply which runs the light strip. **Photograph 22** displays the mezzanine lights bars in use.

All of the task lights for the upper and



Mezzanine light

lower mezzanines, plus the six low-bay lights are controlled via a set of master switches, as well as the individual switches for each light/section. This means that at the end of a day, I can switch them all off

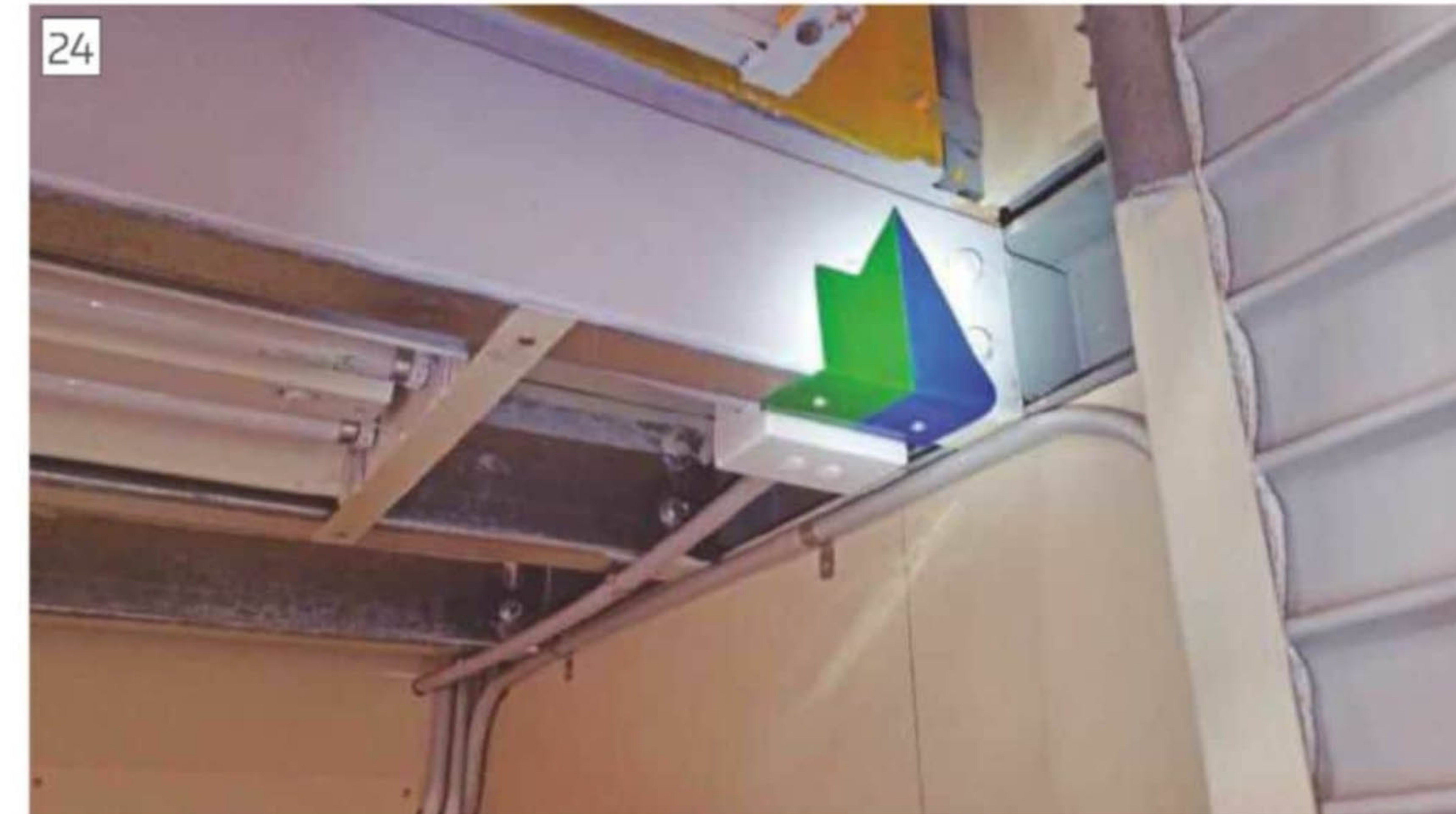
by activating only two switches, instead of walking around the shed turning each one off individually.

All cables (lights and power) are concealed within conduit, or within the covers of the walls via the lining, or the ducting covers. This is in line with common industrial practise and conforms to the highest interpretation of the relevant electrical standards. The conduit not only adds protection to the cables, but also marks their location, so holes can be drilled into walls without fear of striking a hidden cable.

As mentioned previously, the lighting circuits within the workshop area (including the welding bay) are controlled by two master switches, however each bay also has its own switch. Each low-bay light has its own switch, and each mezzanine light has a two way switching arrangement. This means there are a number of switches located on the underside of the mezzanine floor for switching various lights. A labelling scheme was needed so people knew which switch to operate.



Switch labels



More labels

A simple graphical system was devised and fabricated. The geometric shape told a person what kind of light it was, the colour told them where it was.

A triangle was chosen to represent a "point source" of light ... the overhead low bay lights are point sources of light, whereas a rectangle was chosen to show that the light was presented as a strip (ie fluoros or LED strips).

Pieces of salvaged thermo plastic were cut and heat bent to form the labels.

The colours chosen for the paint demonstrate the level location of the light source - blue is the colour of the sky, and therefore overhead, whereas green is the colour of the grass, and represents the ground floor. Examples of these are shown in **photos 23** and **24**.

The signs were spray painted and left to dry before being affixed to the same mezzanine beam which supports the light switches. There was one switch plate controlling two light circuits, in that case

the colours and shapes were both shown in the same order as the switches in the plate - therefore maintaining accurate representation of the switch layout.

Power Points and Safety Systems

Electrically this shed is patterned on a few industrial ideas, and some bitter experience.

The shed was designed with ample electrical capacity - the cable which supplies the shed is capable of current exceeding 85A per phase. This was done so I have an upgrade path in the future, and fewer voltage dips on startup. The switchboard was designed with plenty of spare capacity - several spare pole positions for additional circuits, and easy for an electrician to work in. **Photograph 25** shows the completed switchboard, with the full set of breakers in place.

The number of circuits (with separate RCD breakers) is higher than most sheds. This was done to prevent a fault in one part

of the shed dropping power to everything. The main workshop has six circuits supplying the general purpose outlet (GPO) - aka "power points", aka "power outlets", and these GPOs are separated from the circuits for the 3-phase, and welding outlets. Lighting is split for the same reasons - this prevents a fault in one fitting taking out all lighting in the shed, and this is the intent of the electrical standard I'm complying with.

A safety feature I borrowed from my old high school manual arts dept was the use of emergency stops (e-stops), also known as LOS (Lock Off Stops). There are a number of e-stop boxes dotted around the shed which interlock a contactor in the switchboard. The e-stop shown in **photo 26** is in the "healthy state" as evidenced by the lit green neon in the top RHS corner. The contactor controls power to one half of the board, which includes 3-phase and welding outlets, and GPOs in the workshop. This means that I can be standing at the door of the shed, see something going wrong at the other side of the shed, and interrupt power to every machine in the workshop. The same safety circuit also doubles as a NVR (no volt release) for the same circuits. This means that if the power from the street drops, the machines cannot restart automatically when the power is restored. Given I sometimes have "learners" in my shed, this feature is for their safety, and my peace of mind. The reset for this e-stop/contacter circuit is key controlled, making the circuit an effective safety feature, and able to be locked out when I am not around by simply removing the key, and tapping one of the e-stops as I walk out of the shed. Each e-stop has two neon indicators on it, Green to say that the switch is healthy, and red to indicate that it has been activated. The e-stops are wired in a sequence, and if the contactor does not pull in, it is simply



Main switchboard



E-stop live



E-stop tripped

a case of looking around the shed in the correct direction to see where the tripped e-stop is (or damaged cable) located. All e-stops are labelled and require a positive twist action to reset. The e-stop shown in **photo 27** is in the "tripped" state and would need to be reset before the contactor could be reclosed and power restored to the GPO circuits.

There are 3 outlets for 3-phase power in the shed- they are positioned along the "metalworking side" and expected to be used for the milling machine, lathe, and one spare outlet. The position of the outlets also permitted the construction of a 15m 3-phase extension lead which could reach any part of the shed footprint. The 3-phase power means I can use industry surplus machines (often cheaper than single phase machines), and the lead means I can rent a machine and use it in the welding bay if necessary. This permits the rental of 3-phase equipment to be used for one-off specialised work.

The 3-phase outlets are RCD protected, and individually protected for overload.

The single phase general power outlets (GPOs) are spaced around the shed at a regular interval and spread across the circuits. The GPOs are all double points, and will be used for machines, accessories, and whatever else is needed. There are some single phase 15A GPOs fitted - each has its own breaker in accordance with the applicable electrical standard, and are positioned for use supplying plasma cutters, welders, and other future machines (rental or otherwise).

Other GPOs are provided in the office area (concentrated in the office wall above and below the bench, with other sockets spaced around the office to support communications equipment, etc. A single 15A GPO and circuit was installed in the office for a possible future air-conditioner should it prove necessary.

The mezzanine levels each have a small number of GPOs fitted - mostly for driving an electric winch used for lifting things to that level, plus for anything else which may need power up there - this means I don't



Cable ladder with cables in place



'Story sticks'

have to have an extension lead draped over handrails, or through doorways.

This may seem like an excessive number of GPOs, but I've never heard someone complain about too many places to plug in, and the cost of installation during construction is considerably cheaper than a later addition or extension to existing circuits.



C1509 trunk

Cable Ladder and Conduits.

Given the amount of cabling in the design, I chose to place cable ladder in the long walls of the shed to form electrical trunkways. These ladders were made up by cutting some 50 x 50 x 4mm galvanised mesh into strips and bending the edges of the strip to add some stiffness to the strip. The installed ladder is shown in **photo 28**. I accomplished the bends by clamping the mesh between two large landscaping planks, and bending the edges through with a hammer. The finished strips were then welded together to form the required lengths, and attachment brackets folded up from pieces of galvanised sheet. A "story stick" was used to position the ladder (and conduit cover anchor strips) to the frame of the shed before cladding was commenced. Example story sticks are shown in **photo 29** including the stick used to install the ladder.

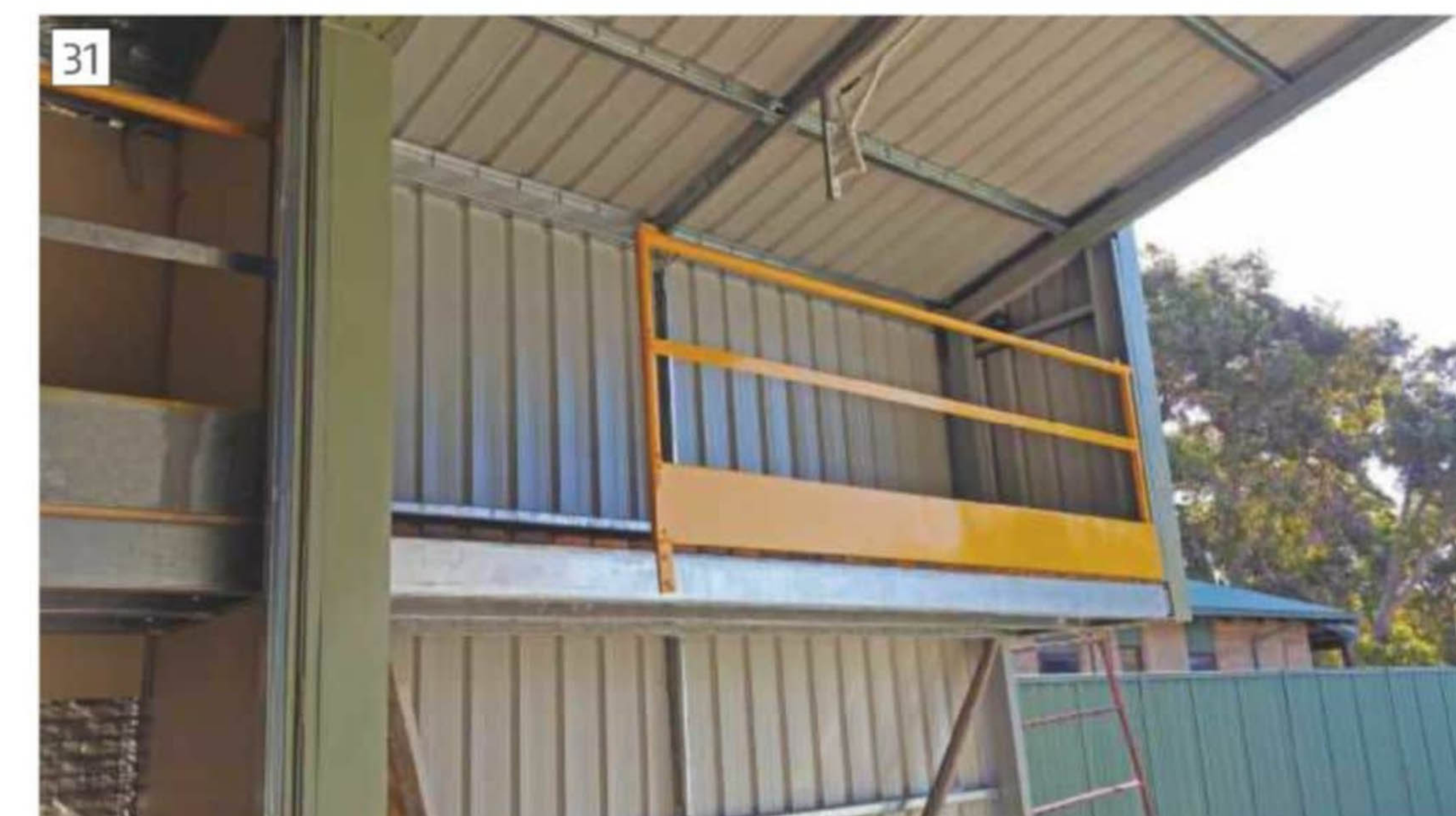
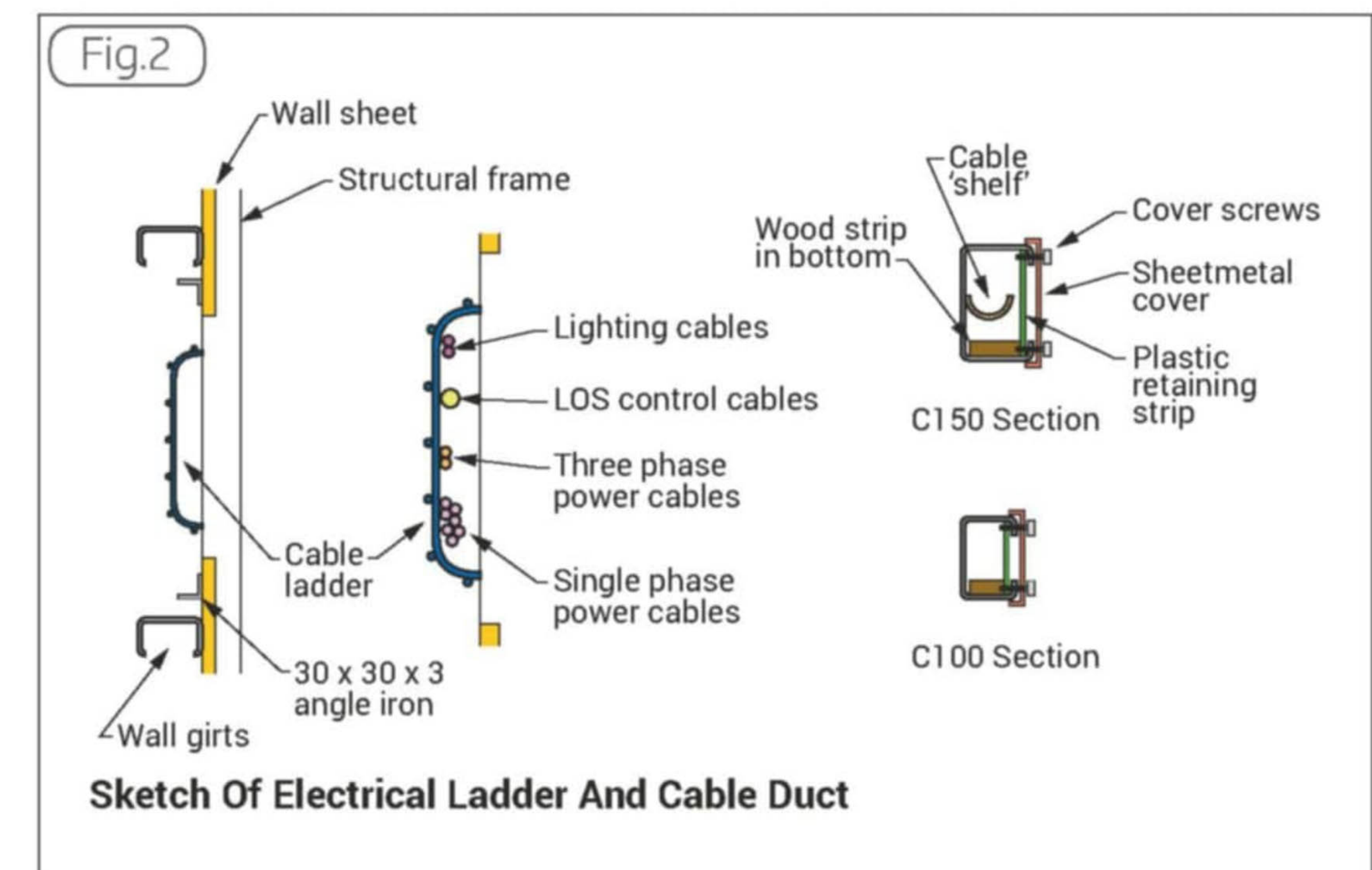
The cables are routed from the Switchboard to the ladders through cable conduits made from roll form purlins (C form) which is screwed to the wall. The conduit is completed by means of a folded metal cover which screws to the conduit to enclose the trunk. Cables simply lay inside

the trunking, retained by the periodic placement of strips of plastic to stop them falling out if the lid is removed.

This style of trunking is very strong, and quite versatile. The cost involved was cheaper than running a series of plastic conduits, or metal tubes. The C150 trunk is shown in **photo 30** and explained in **fig. 2**.

In order to increase cooling of the cables (reduce derating effects), some spacers were made and fitted inside the cable conduit to stop all of the cables simply laying in the floor of the ducting.

All cable ducting and ladders are connected as part of the electrical equipotential bond system. This connection is done via cable clamps on the ladder, and screw/lug connections on the ducting, and main structure of the shed. The equipotential bond system is part of the electrical safety of the shed, guaranteeing a low resistance path for any faults so they



Mezzanine handrails

are detected so the residual current devices operate. This equipotential system was tested to the earthing standard as part of the commissioning of the shed. A high resistance here can be as dangerous as a high resistance in the earthing circuit.

The shed will be used for a lot of differing work, metalwork, woodwork, electronics, etc. This means that access to information is also needed. A pair of communications conduits were installed as part of the construction to permit the use of data, telephone, and other systems. The conduits were laid with "sweep bends" deliberately, so optical fibre could be used as a connectivity means. Pre-terminated multimode optical fibre is relatively inexpensive from a number of sources and provides a degree of immunity to electrical interference which long electrical cables are susceptible to.

Several sets of copper (Cat 5e) cables can also be used for data, phone and alarm cabling. The installation of an Intercom is still to be determined as required or not, but the cables will support it if needed.

Once data is available within the shed via copper or fibre, a reconfigured surplus

ADSL router can be easily used to provide WiFi, VoIP, or cabled connections for most devices.

The office is cabled for internet, and home network, access so data can be accessed from other home computers, internet, and access to the house printer. Over time, I see an increasing need for connectivity in the shed, as much for accessing and sharing information, as also for the type of things we build or use there. An obvious example is to design an object on a computer in the house and store the completed design files on a shared network drive. The computer in the shed can be used to retrieve the design files from that network drive, and then output the file to a 3D printer, or CNC machine located in the shed.

As with all aspects of this shed, it has been relatively easy to add extra conduit, or capacity during construction, than face the future cost and disruption of adding it later.

Handrails

The mezzanines present a real danger for people accessing them. The height of the mezzanine level exceeds 2m - fatalities

occur in falls less than that too regularly within the building industry, plus other industries. All countries have a Standard for handrails, and I applied the relevant one for my jurisdiction. The handrails are required to withstand a lateral force of 30kg and meet a minimum height. The handrails I built and fitted to the mezzanines meet those standards. During the design, it was decided to place only a single access point for each mezzanine. This meant that each opening would need a gate (or door) and all other parts of the mezzanines could be barricaded properly. The handrails were welded up and fitted to the mezzanines and painted in the requisite traditional high visibility colour as shown in **photo 31**.

Access to the mezzanines is accomplished through a portable ladder. This ladder was designed and built to provide access for people and materials. The ladder is moved from one position to another via a pallet jack. Materials are moved from one level to the next using the ladder, or a lifting arrangement. To aid in this, one section of mezzanine handrail in each of the main workshop sides was made removable. A stiffener was designed and fitted to the roof structure to aid in lifting the handrail section away when removed, and to aid with lifting items up to the mezzanine level. A small mains-powered winch (100 Kg) is used for this purpose, and for supporting the lift out handrail during removal/reinstatement.

Readers should be aware that Des is in Australia, and that regulations and practice for electrical installations vary a lot between different countries.

●To be continued

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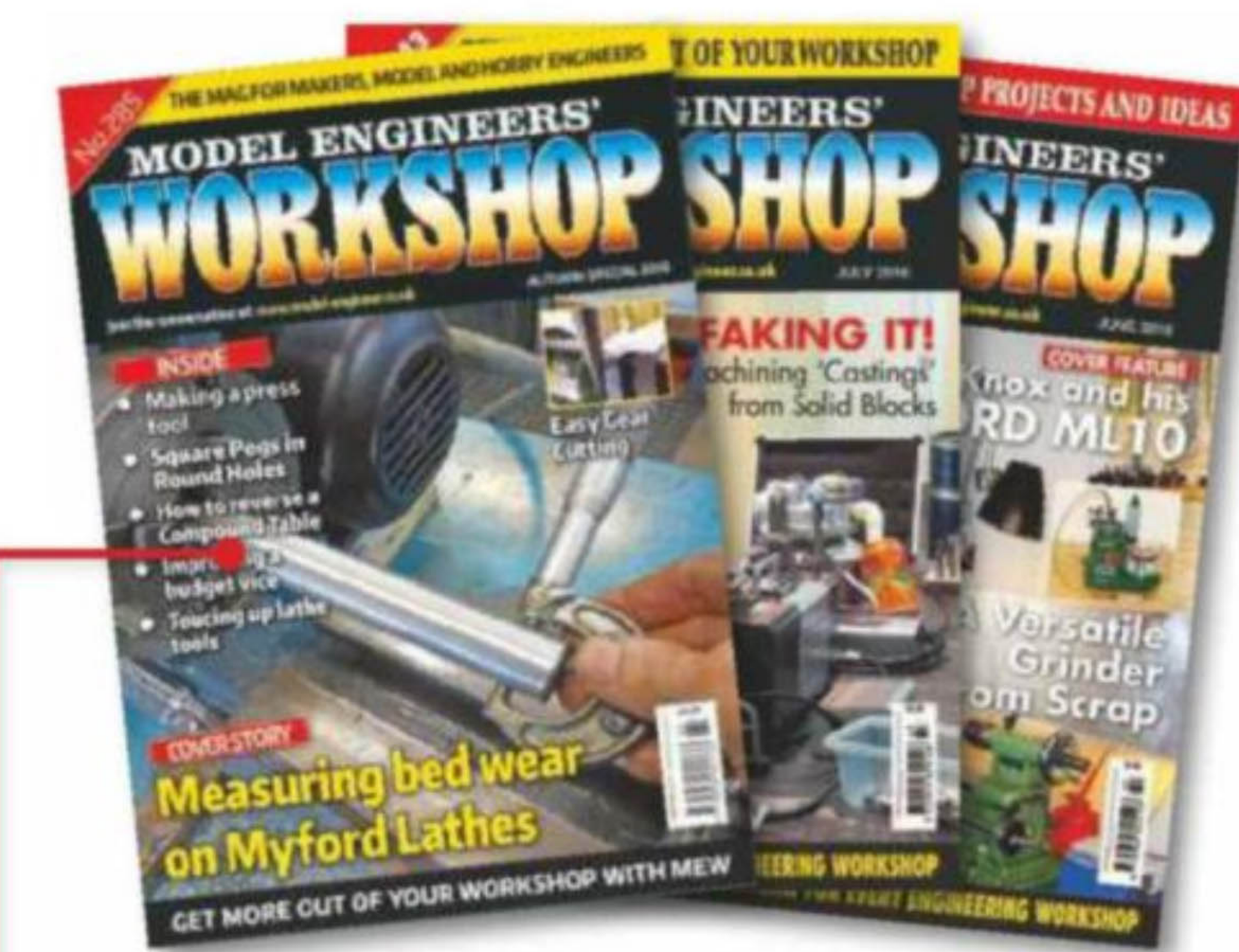
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A Cutting Tool Clean-Up Procedure

Ron Wright describes his approach to quickly putting an edge back on lathe tools.

All cutting tools gradually lose their edges whilst working which inevitably leads to, sometimes imperceptible, reductions in surface finish and dimensional accuracy, so it is very useful to have some simple system available by which sharp edges can be easily restored quickly and with minimal effort, especially for lathe tools.

The procedure described below is for just this purpose; note it is not intended to shape a tool from a blank but only to sharpen up faces and edges which have become blunt.

The machine shown in **photo 1** is just a simple belt sander with an adjustable table, and **photos 2, 3** and **4** show the top, front and side faces of a carbon steel lathe tool being held against the belt with the table set at appropriate angles.

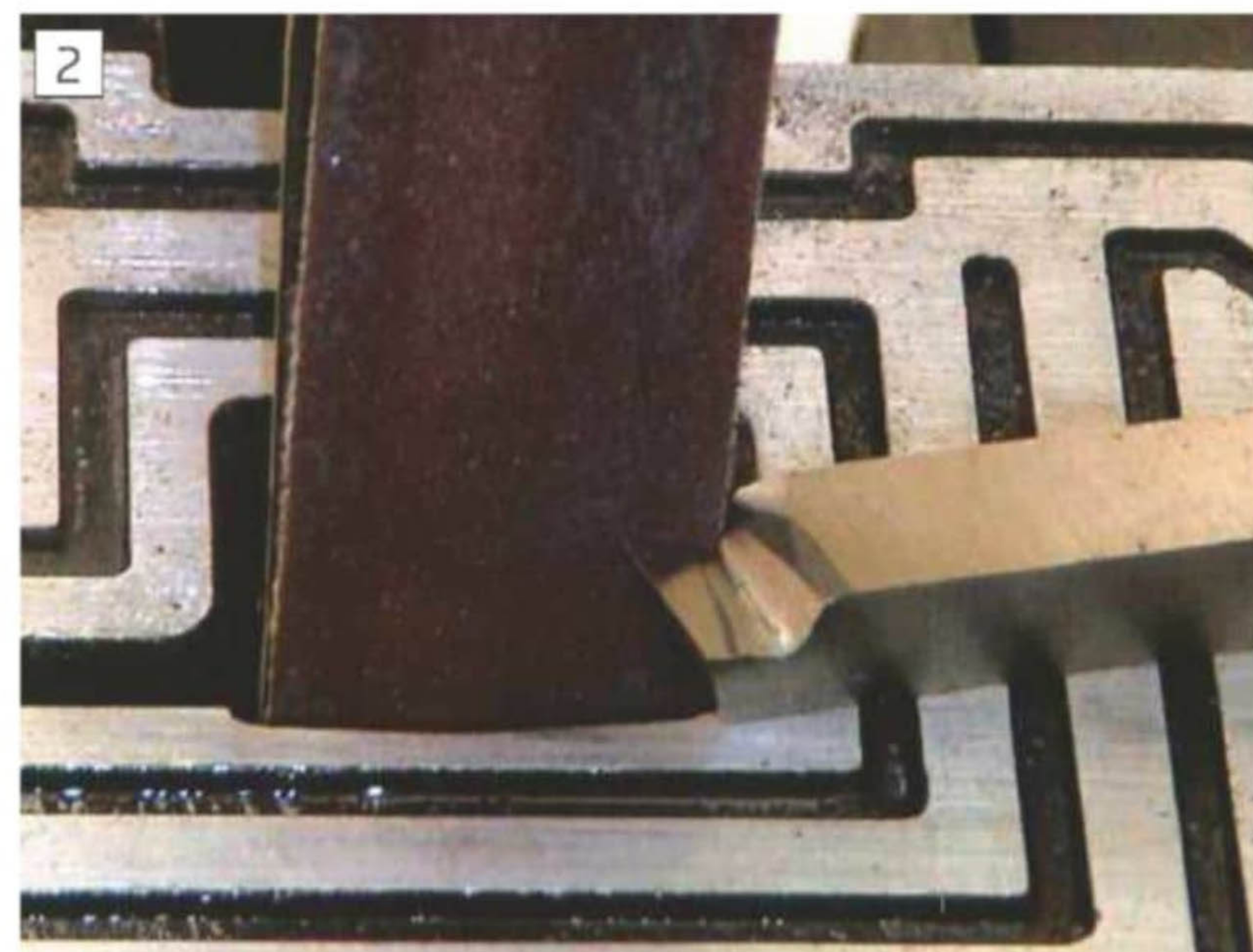
Three-in-one oil was used on the tool and it is only necessary to hold it gently against the belt to produce a good flat finish, and an example of this is shown in **photo 5**.

In use on free cutting mild steel of about 25mm diameter a very fine satin finish was produced, using the tool with its cutting point sharp and not stoned to small radius.

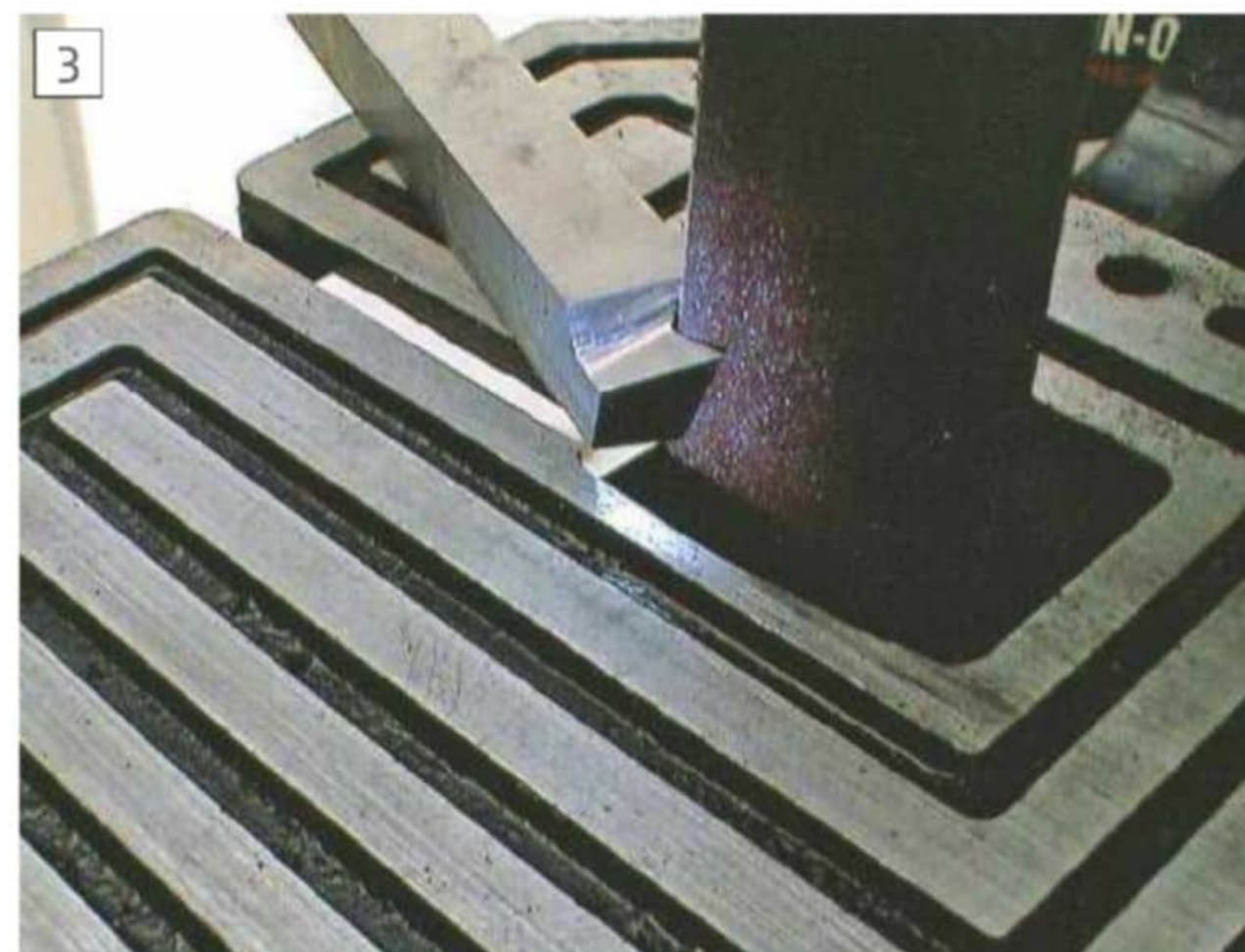
The table angles were not set to any specific figures and instead the tool face was simply held against the belt and the table adjusted to support the tool shank, but it would obviously be possible to use angular setting plates for this purpose as shown in **photo 6** which would probably be more accurate. ■



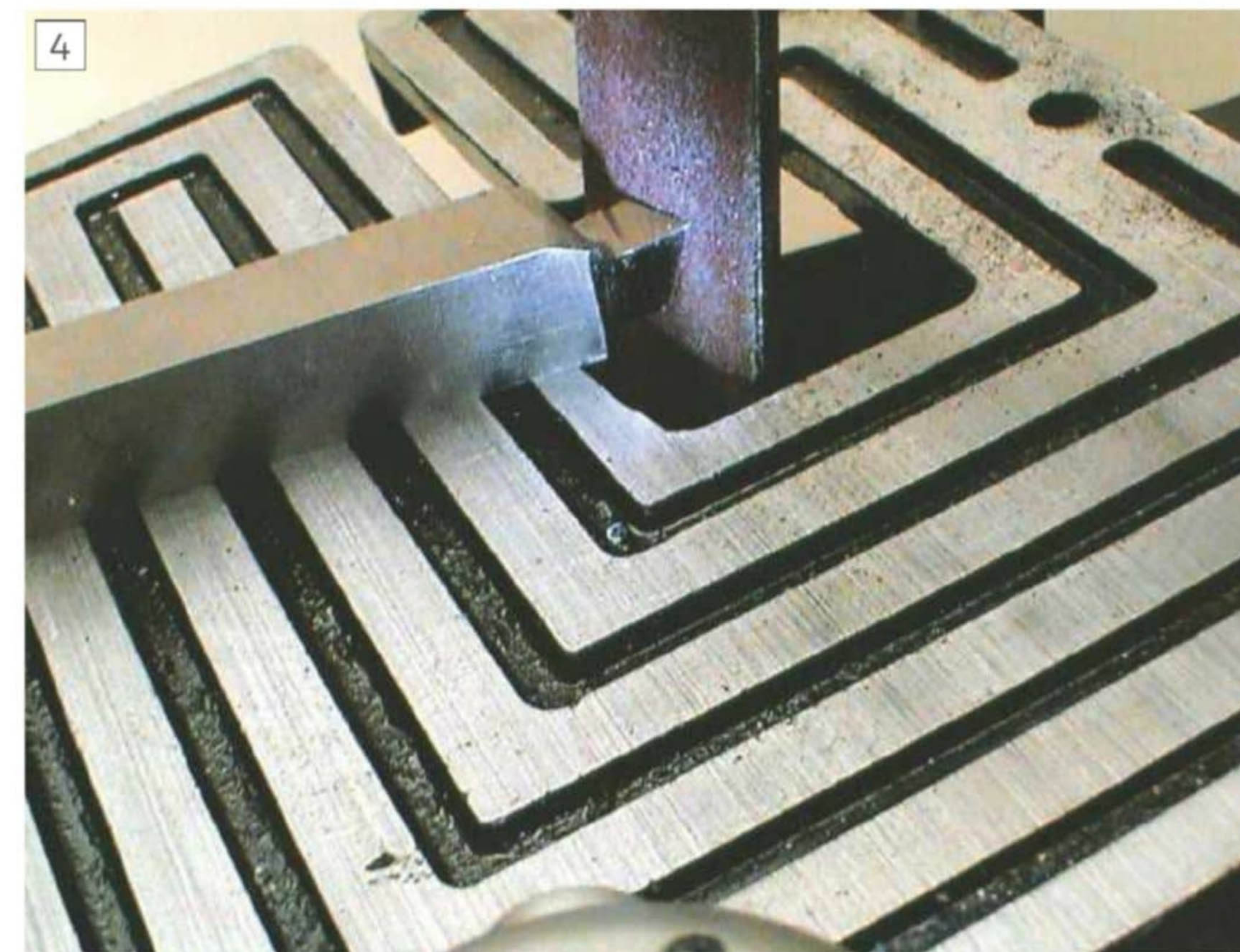
The belt sanding machine.



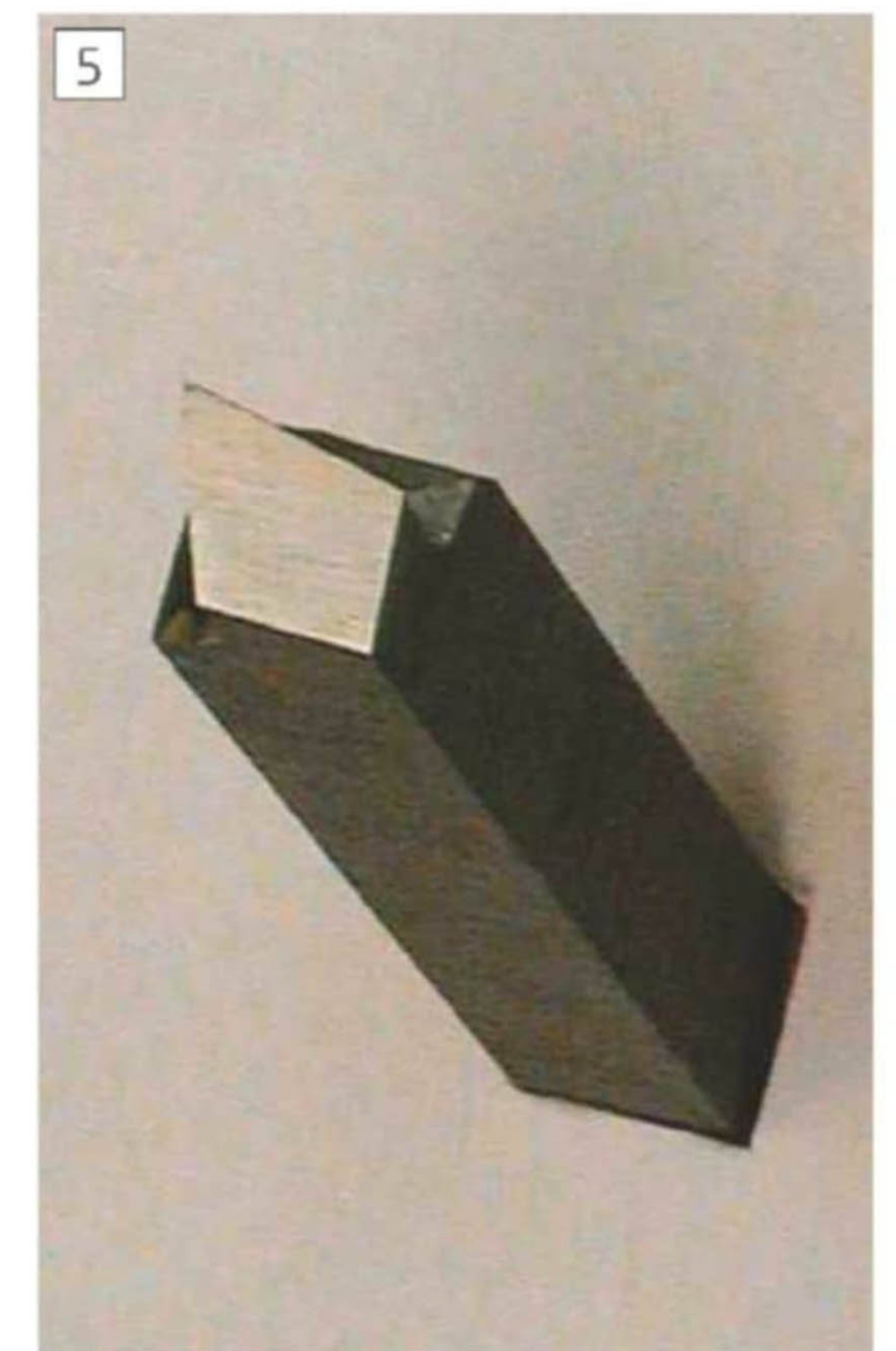
Touching up a left hand lathe tool.



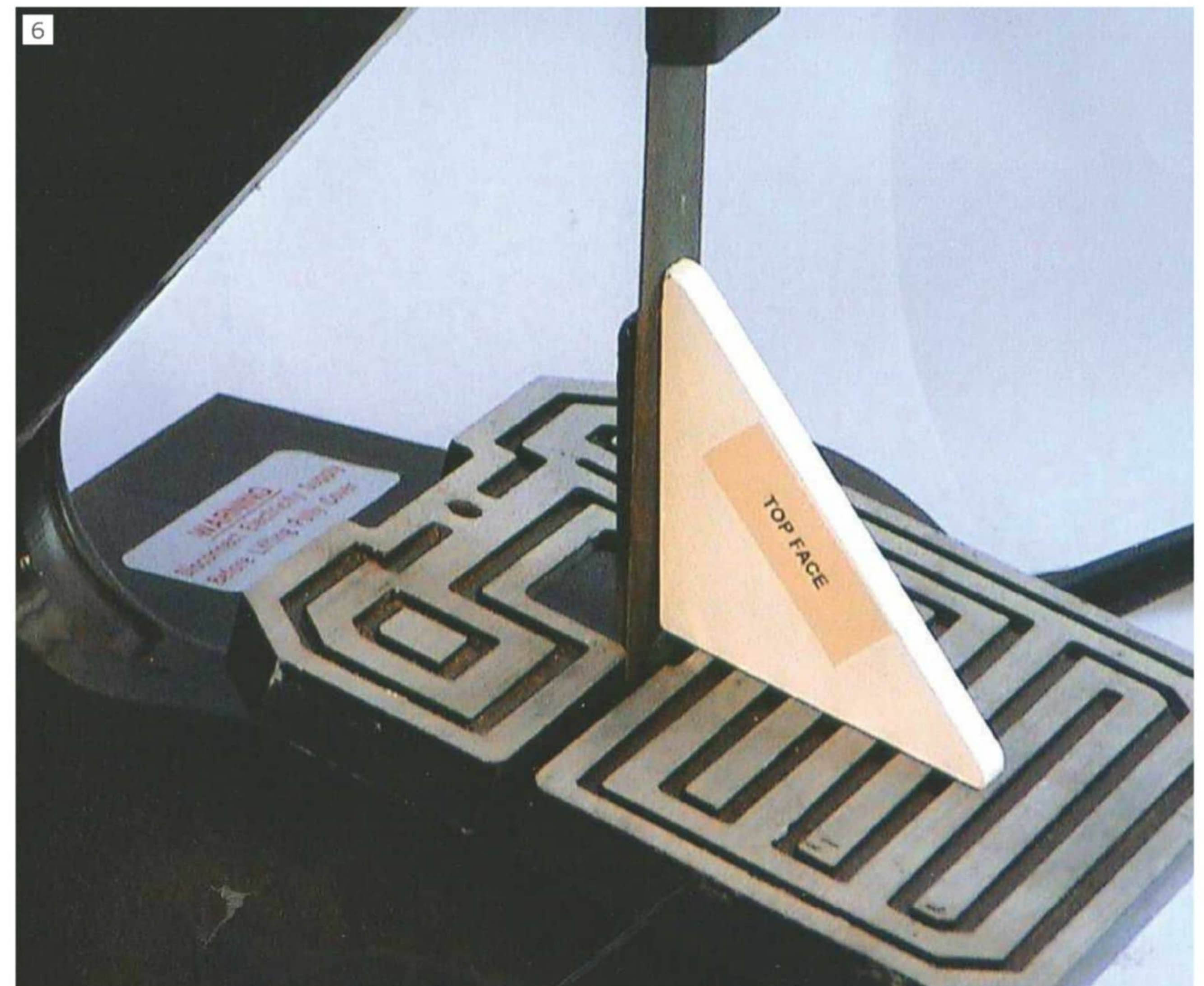
And a right hand tool.



Tidying the end of a knife tool.



Polish left by the sander.



Setting the table to 90 degrees using a template.

Readers' Tips



MT Buttons for easier taper removal

TIP OF
THE MONTH
WINNER!



This month our lucky winner of £30 in Chester gift vouchers is **Laurence Pepper**.

Over the years I have been frustrated by the fact that some of the No 2 MT centres I use are too short to self eject from the tailstock. The problem was exacerbated when I fitted a digital readout to the tailstock. The collar around the barrel, which held the arm of the digital calliper I cut down to make the DRO, reduced the return of the barrel still more. I therefore decided to make all my No 2 MT centres self eject by using super glue to fix brass buttons of the appropriate length to the ends of the short No 2 morse tapers.

Fortunately, a few years ago I purchased a No 2 MT half centre with a screw in the end, enabling me to find the optimum length. By pushing the half centre into a MT2 to MT4 sleeve I was then able to measure the required off set and make brass buttons of the appropriate size. The photos show the Morse taper sleeve being used to measure the off set, and brass buttons glued to a selection of Morse tapers.

Laurence Pepper

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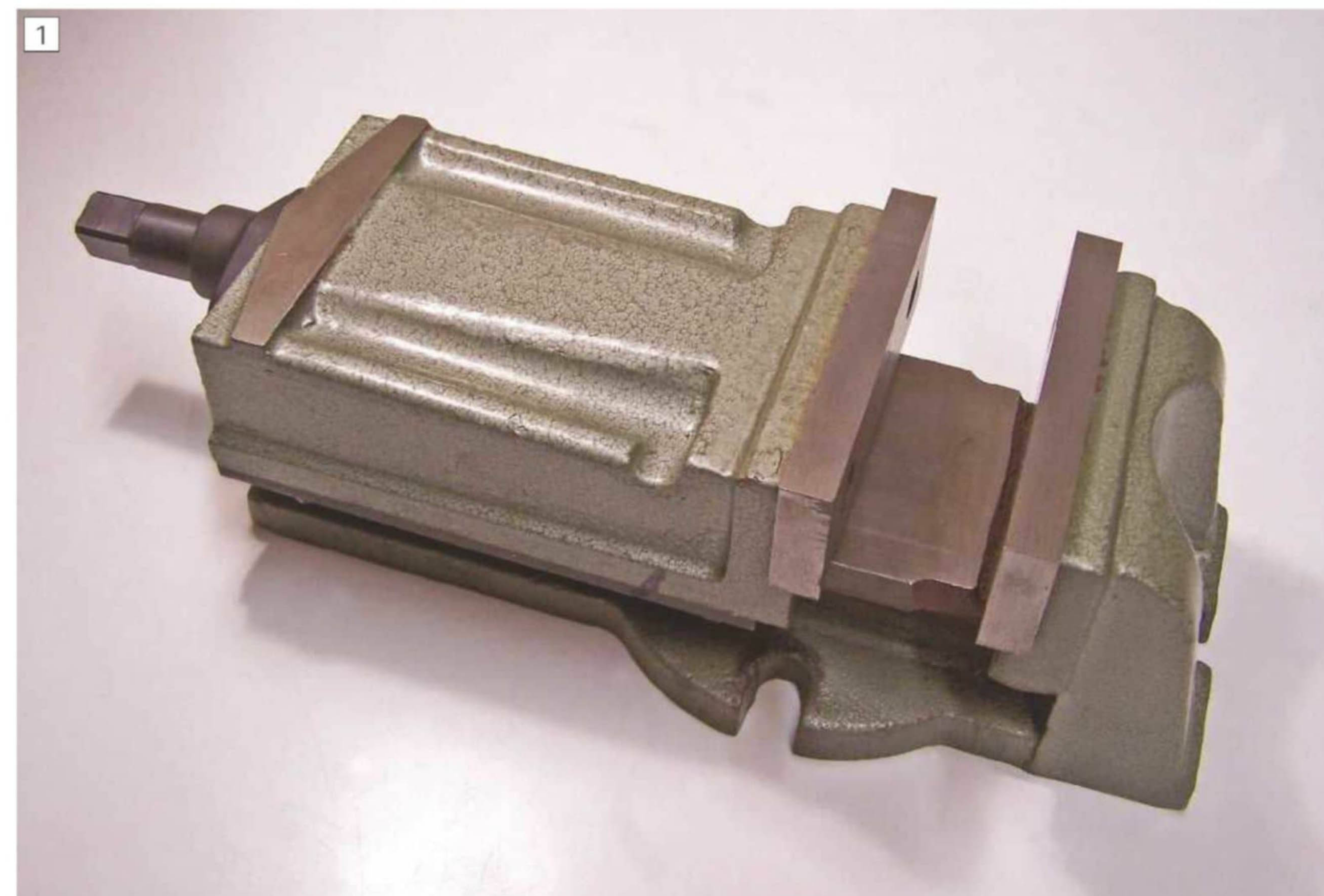
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Improving an Inexpensive Milling Machine Vice



R. Finch fits lubrication points to a low cost milling vice



The vice in its original state

When I purchased a milling machine at the Doncaster exhibition in 2016, I was offered a free milling machine vice to go with it as an Exhibition offer. This is a low cost vice made somewhere in China, and the only information concerning it was in the instruction leaflet. This described it as a "Model Q12100 Milling Machine Vice", **photo 1**. The maintenance instructions were extremely limited and suggested that if it needed lubricating it should be dismantled and lubricant applied. The instructions did not give any clue as to what

required lubrication; the grade of lubricant to be used; or how to apply it. Clearly it was a "do your own thing" type of instruction.

I found that the vice screw could be turned by the fingers for most of its travel, but as the moving jaw approached the fixed jaw it became stiff and I needed to use the square key provided. Clearly some form of lubrication was required. I decided to dismantle the vice and investigate. Please note that all the dimensions that I have used apply to the 100mm size of vice, similar makes are available but may not have the same dimensions. The principles

will, however, apply to all the sizes of vice; you will just have to change the dimensions to suit your own vice if you choose to modify yours.

Dismantling the vice

The screw retainer was removed first which allowed the screw to be unscrewed and removed. I marked the top of the retainer so that I could replace it in the same position as it was supplied. This proved to be a most sensible move, as I later found out. The reason for the lack of smoothness in rotating the screw was now apparent.

...the holes are almost, but not quite, symmetrical so it was a good job that I marked each component as I dismantled it.

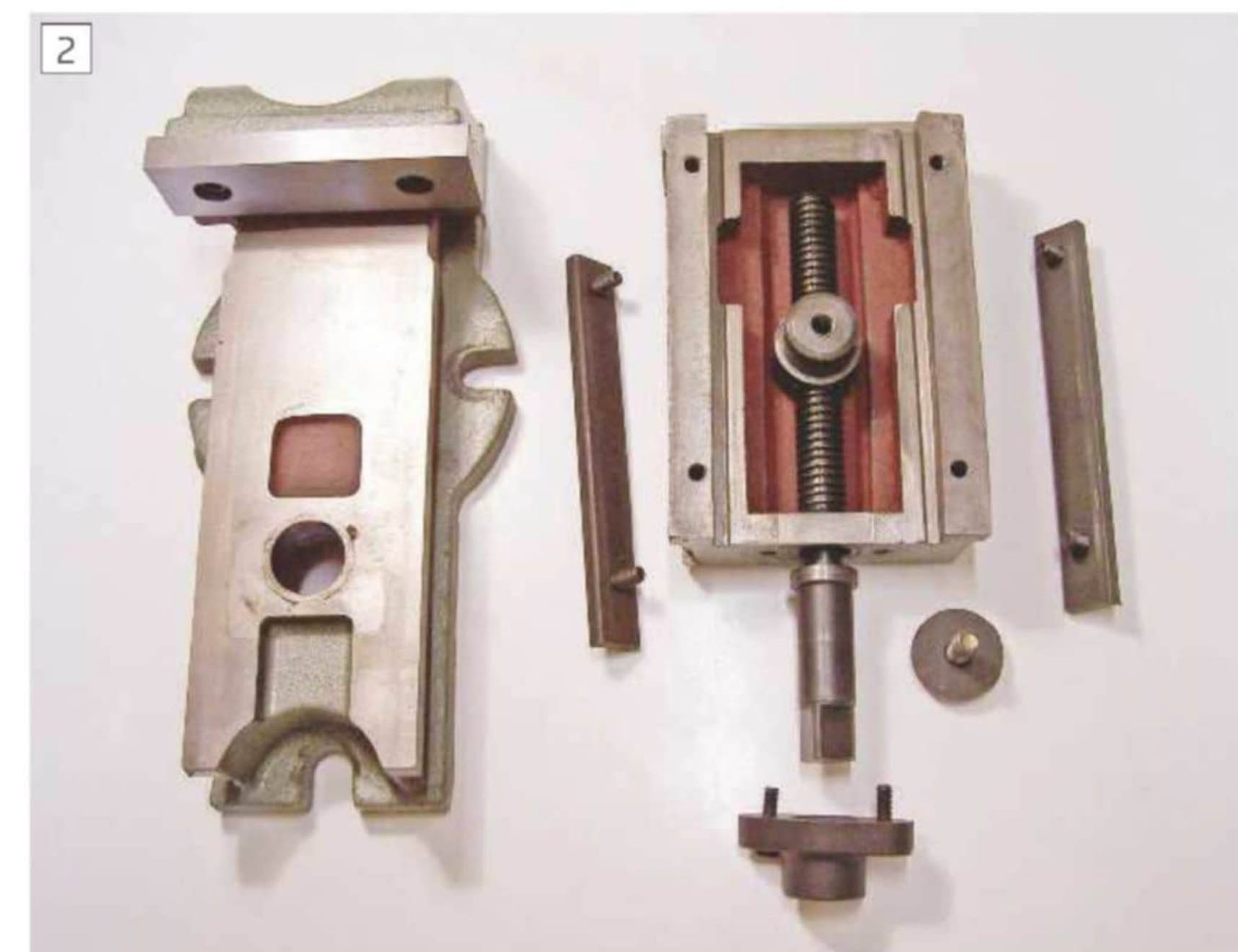
In the original assembly, there was some fine swarf and debris trapped in the screw retainer socket and there was not any lubricant at all. The guide strips were then taken off to allow the sliding jaw to be removed and this revealed the nut fitted to the screw, **photo 2**. The nut is fitted into the circular hole in the base of the vice and secured in place with an M8 machine screw, **photo 3**. The main nut and the screw thread did have some grease on them.

The screw retainer

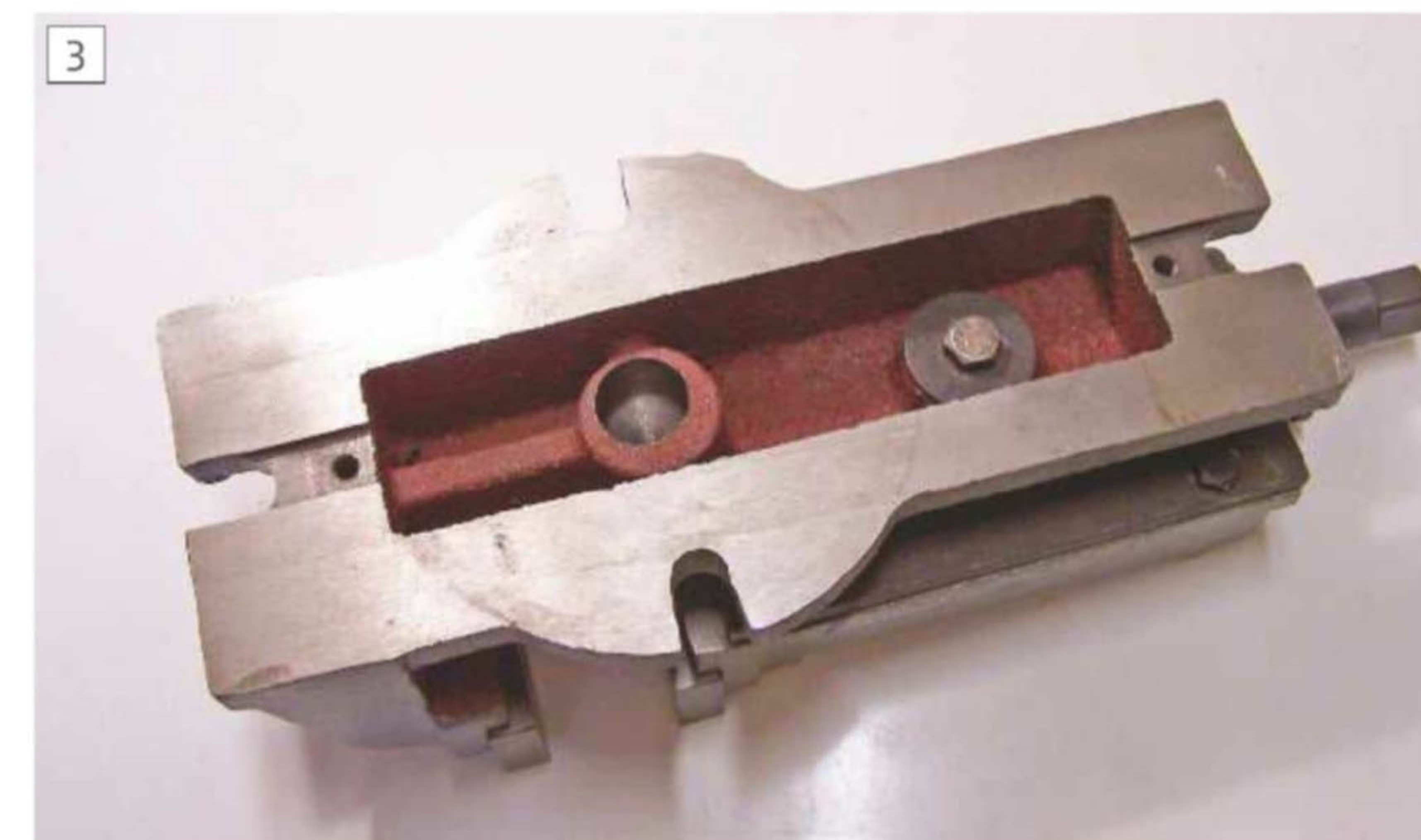
The first modification was to provide a grease nipple to inject grease into the screw retainer to lubricate the thrust face of the screw. This simply involved drilling a 5mm diameter hole through the wall of the retainer at 19mm from the end of the flange and tapping M6 for a grease nipple. The 19mm dimension was chosen as this allows the full length of the grease nipple thread to be accommodated within the wall of the screw retainer and yet allow free passage of the grease. This is shown in **fig. 1** with the installed nipple shown in **photo 4** and assembled onto the screw in **photo 5**. Make sure that you remove any cast iron dust from the hole before proceeding. I found out that the retainer could only be fitted satisfactorily one way up – the holes are almost, but not quite, symmetrical so it was a good job that I marked each component as I dismantled it.

The main nut

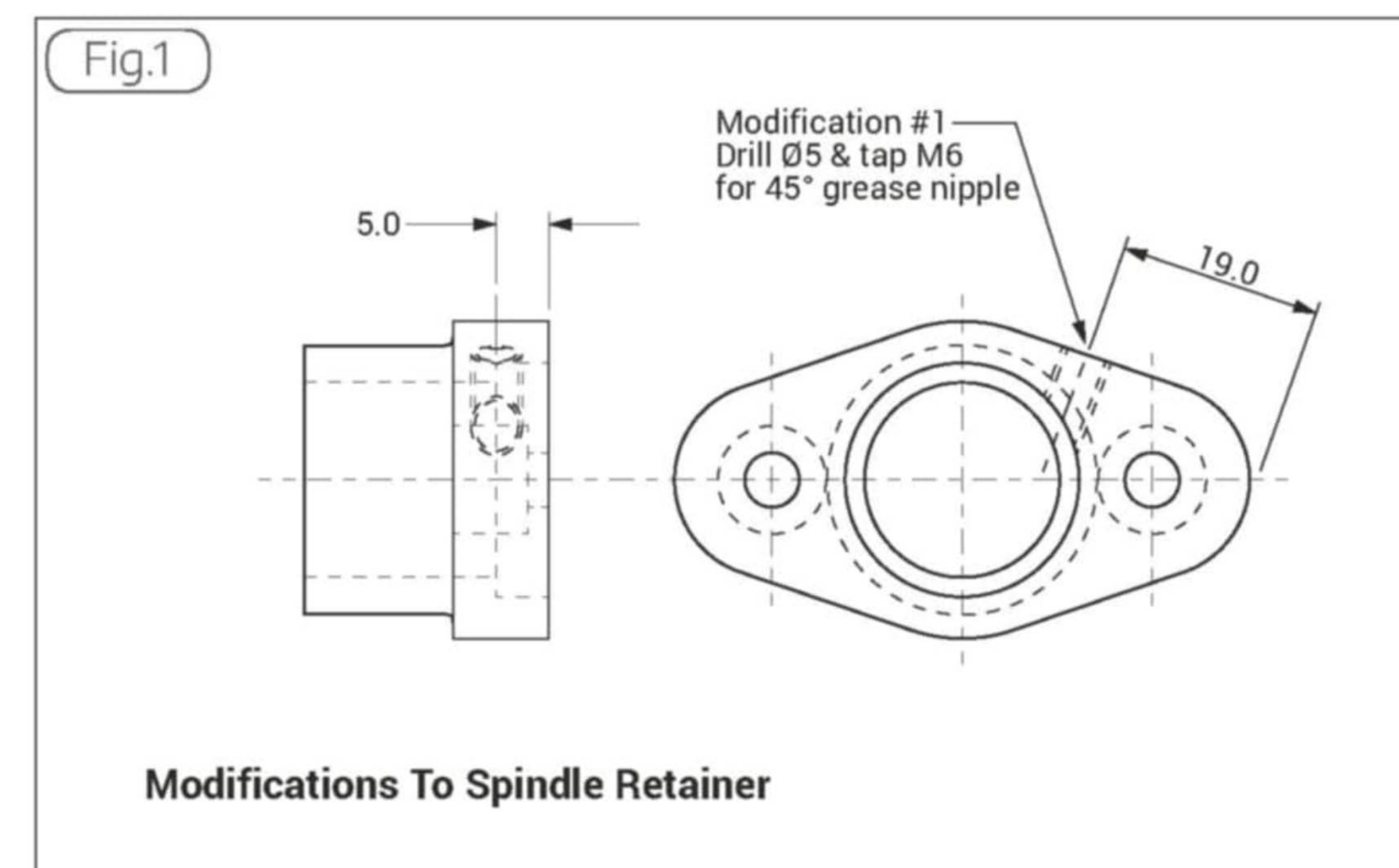
The nut is secured into the base by a M8 x 25 bolt. Whilst there was a small amount of grease already applied to the screw, it would have been better if there were a method of injecting grease directly into the nut. Rather than have to dismantle the vice every time a bit of lubricant was required, I decided to fit a grease nipple to the vice to enable the nut to be lubricated. The nut itself is always concealed by the sliding jaw, so a direct fitting on the top was not possible. Looking at the underside, **photo 3**, it would have been possible to fit a grease nipple directly into the head of the machine screw by drilling a 2mm hole down the screw, opening up and tapping M6, and then drilling through into the nut's main thread at the bottom



The vice dismantled showing all the components



The underside of the vice showing the machine screw securing the main nut



The drilling details for the grease nipple location

of the M8 thread. However, this would mean that the vice would have to be lifted up and inverted to grease it. As the vice is fitted with a rotary base, I did not particularly want to have to remove the vice from the base and re-set it parallel to the milling machine each time I lubricated the nut. The graduations on the base are rather poorly marked and the fiducial line is not marked on properly either!

Drilling the base

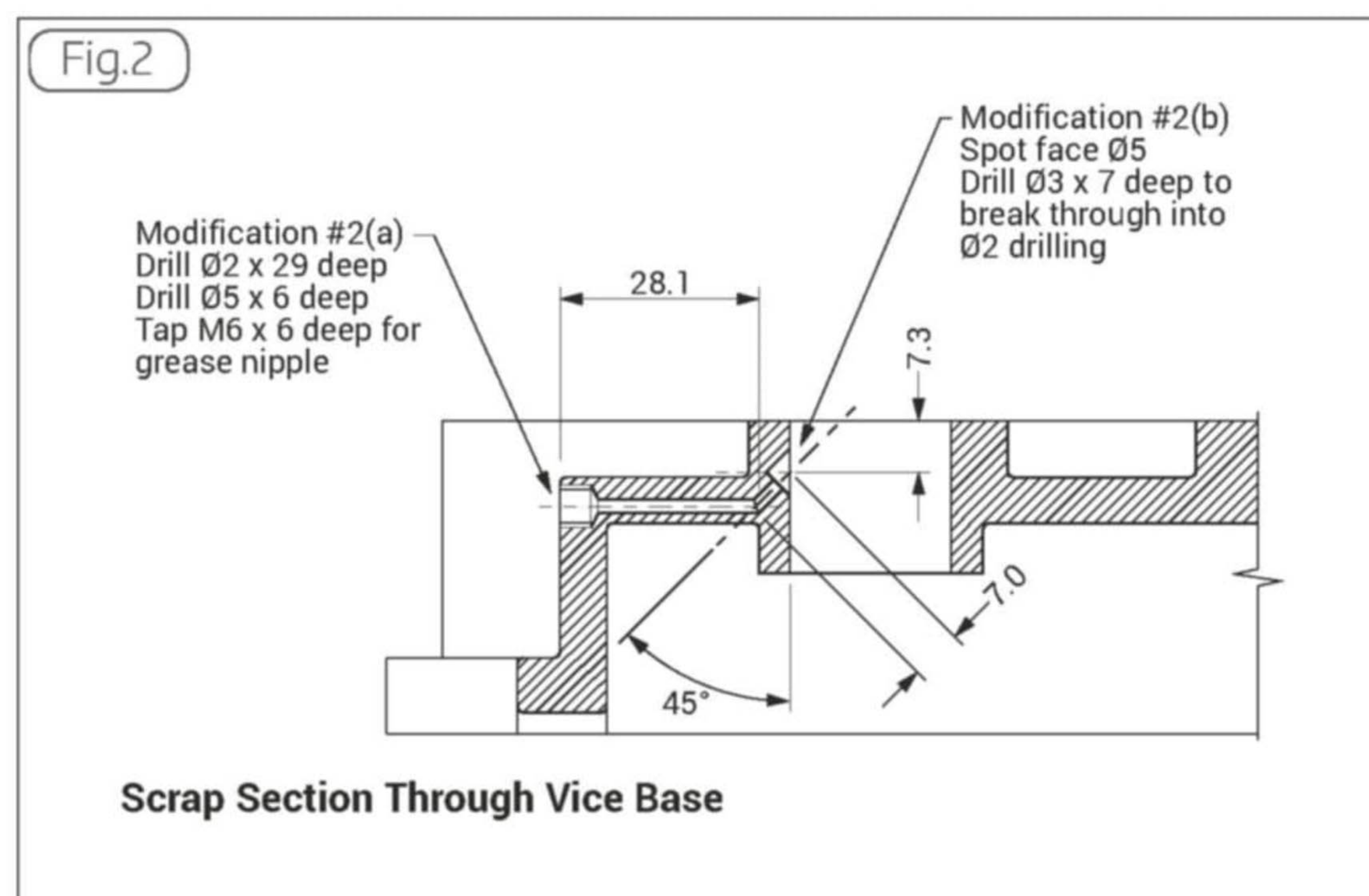
I looked at the base of the vice and measured the wall thicknesses of the casting so as to be able to draw a cross-section of the vice where the main nut is secured. I decided that by carefully drilling from both ends, I could make a passage from the end of the base into the locating hole for the main nut. By drilling the main nut, I could then make a similar small passage for the grease to go directly into the nut. The cross-section with the two passages drawn in is shown in **fig. 2**.

The 2mm diameter drilled passage, shown as modification number 2(a) in fig. 2, is drilled sufficiently far as to be within reach of the main hole used to secure the nut. The diameter is small as the casting thickness here is only about 6mm, so the hole has to be small and accurately drilled. As the depth is 29mm, the hole is very deep for its diameter and great care was needed to keep the drill on track by repeatedly withdrawing the drill to clear the drilling debris. Take your time to avoid breaking the drill! Fortunately, the cast iron of which the base is made drills very easily and I did not encounter any hard spots. The hole is then opened up to 5mm for a depth of 6mm and tapped M6 for the grease nipple. Make sure that you clear out any cast iron dust left after drilling. The hole cannot be drilled directly into the hole for the nut spigot, as it would break through too low down to feed the grease – hence the next part of the modification.

Drilling the angled hole

Drilling the angled hole for modification 2(b) was slightly more involved. I first set the vice base up at 45 degrees and used a pointed rod in the chuck to locate the edge of the large hole for the vice nut, **photo 6**. Note the use of soft aluminium packers to

Fortunately, the cast iron of which the base is made drills very easily and I did not encounter any hard spots



The cross-sectional drawing of the base casting with the holes drawn in



The grease nipple fitted to the screw retainer



The screw retainer assembled onto the screw



The set-up for drilling the angle hole



Setting the milling chuck centre line to the edge of the hole



The spotted mark ready for drilling

prevent the vice being marked and the fact that I had to remove the milling machine guard to get the angle vice in. The use of the pointed rod is quite accurate enough here, as all that is being done is locating the centre-line of the chuck over the edge of the hole shown in close-up in **photo 7**. I now moved the milling table 5mm to the right so that the centre of the spindle would line up with a point 7.1mm down the bore.

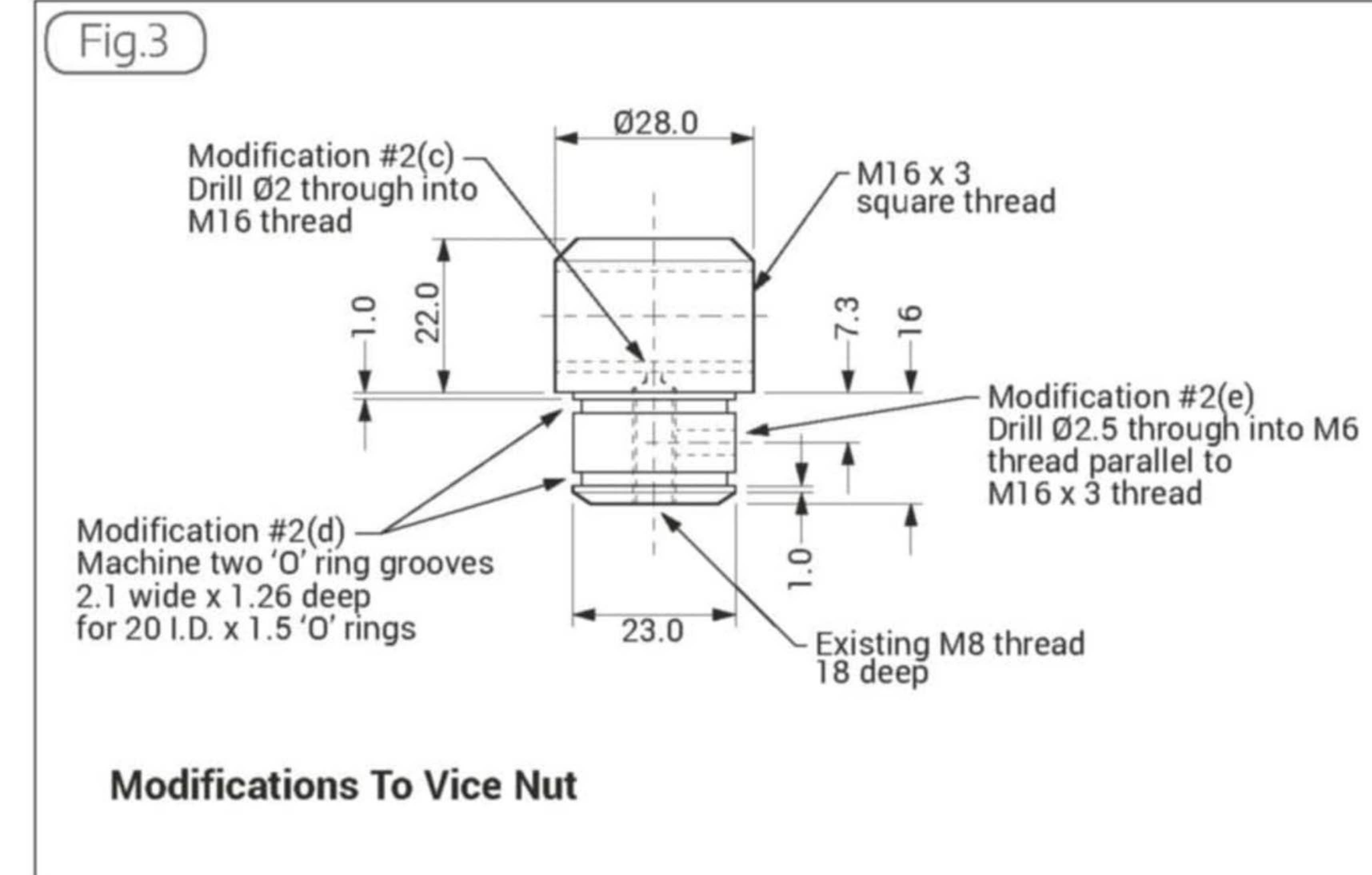
The 7.1mm dimension is calculated from the modifications to the nut, to be described later. Moving the table 5mm means that the dimension down the bore moves by:

$$5 / \cos(45^\circ) \text{ mm or } 5 / 0.7072 = 7.071 \text{ mm}$$

Say 7.1mm. Once in position, I replaced the pointer with a 5mm slot drill and fed that down until a flat surface had been generated. The slot drill was replaced by a 5mm spotting drill and a small dimple made for the main drill to enter without skating about all over the place, **photo 8**. I drilled 3mm diameter exactly 7mm deep at which point I felt it break into the 2mm hole drilled from the end. Make sure that you clean out any cast iron dust left behind after the machining and drilling. I used a 3mm drill to make sure that the two drilled holes actually met, as if they didn't which one would you drill deeper? If your drilling is as inaccurate as mine, it still gives a chance that the two holes will meet. This reminds me of when I went to Austria on a coach tour. The guide said that when the local authority were planning the road tunnel through which we were driving, the American contractors said that they would drill from both ends and meet within half an inch. The British contractors said that they would start from both ends and meet within 6mm. The Austrian contractors said that they too would drill from both ends and when they had finished, there would be two tunnels...

Modifying the main nut

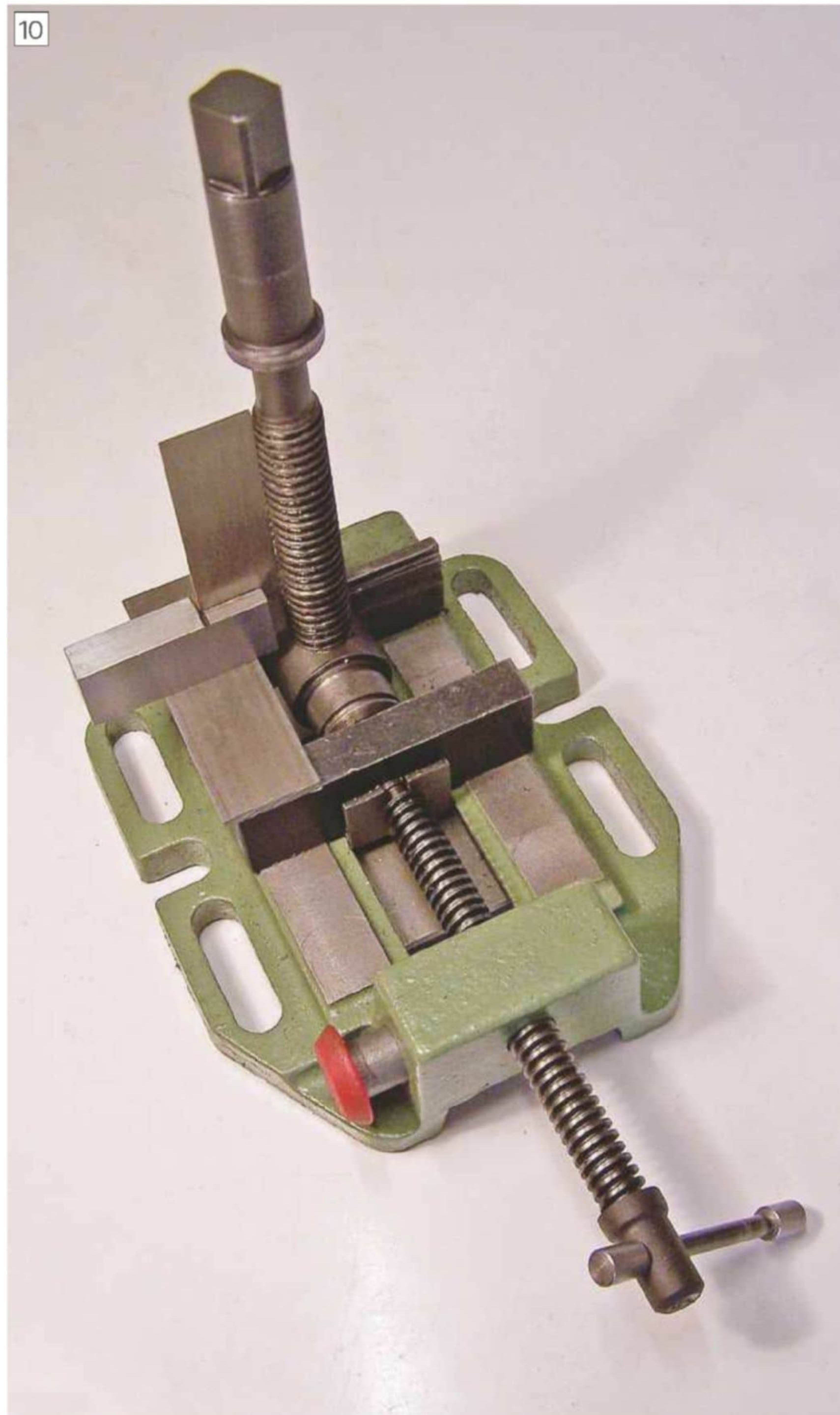
Once the hole has been made through from the bore of the hole which holds



The modifications to the main nut



The two o-ring grooves machined into the spigot

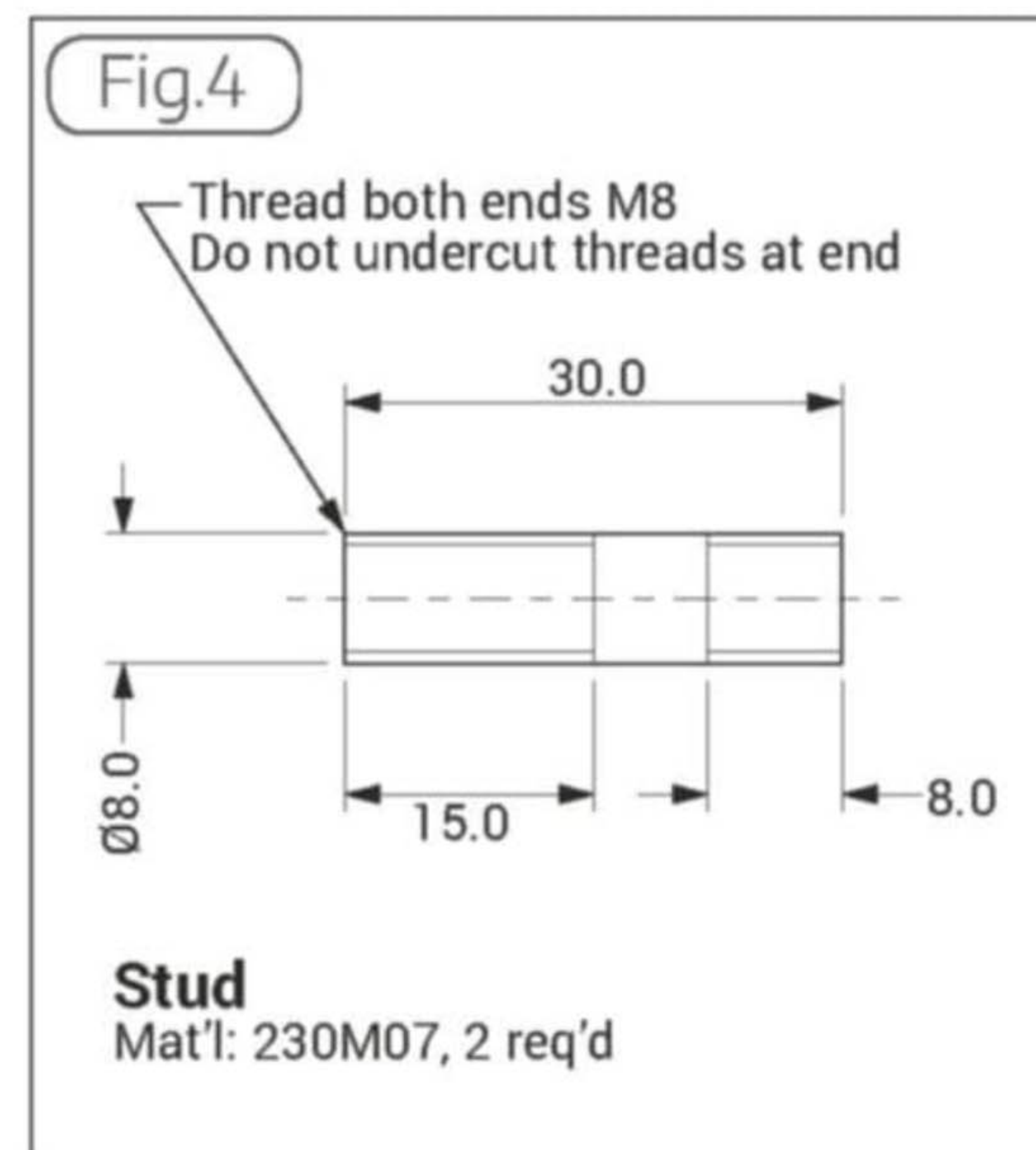


Setting the main screw vertical

the main nut, it is time to modify the nut itself. There are three separate modifications to undertake. The first, modification, 2(c) in **figure 3** is to chuck the nut accurately with the spigot running true and the M8 thread pointing towards the lathe tailstock. I used the four jaw chuck for this. Firstly, drill down from the bottom of the M8 thread into the thread for the main screw, which is a 16mm diameter 3mm pitch square thread, using a 2mm diameter drill, fig. 3. Take care when doing this as there is only about

2mm of material to drill, and if the drill goes into the square thread too quickly it is likely to break the tip off the drill. Slow and steady wins the day.

Once this has been done, it is necessary to machine the two o-ring grooves, modification 2(d). I decided to use o-rings to make sure that there was a reasonable seal between the nut spigot and the hole in the base so that the grease would go into the nut and not squeeze down the gap between the not-so-well matched hole and spigot. The o-ring grooves need



The replacement M8 stud



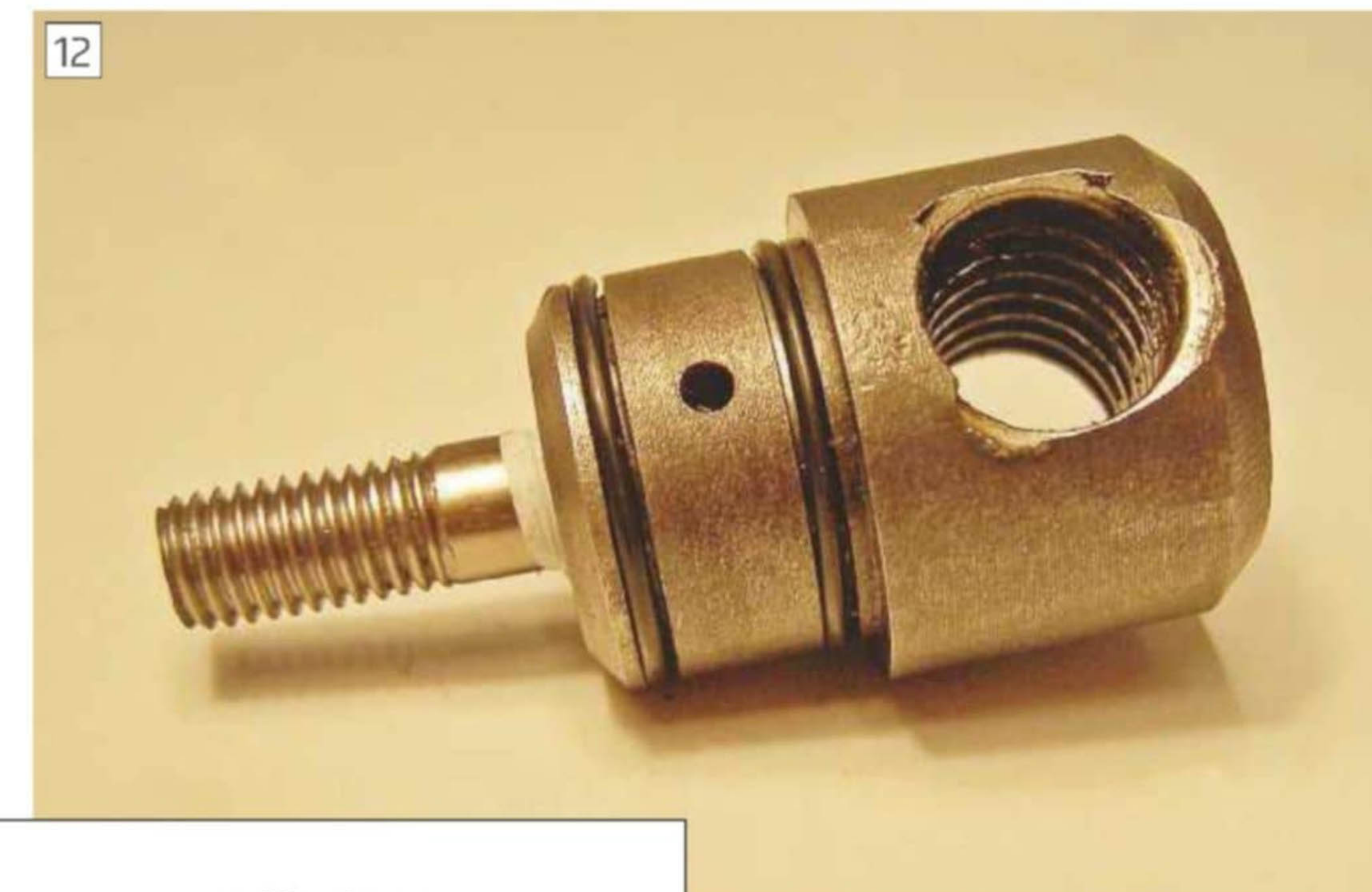
The 2.5mm hole to allow the grease through

to be machined 1.26mm deep and 2.1mm wide to fit in a standard 20mm internal diameter (i.d.) by 1.5mm section ring, **photo 9**. If you use an imperial sized o-ring, then you will have to decide on the right size grooves to machine. I would guess that a 29/32nds inch o.d. ring by 1/16th inch section would be satisfactory, but you would have to check. Remember to remove any sharp edges on the grooves to prevent the o-rings being cut as they are installed.

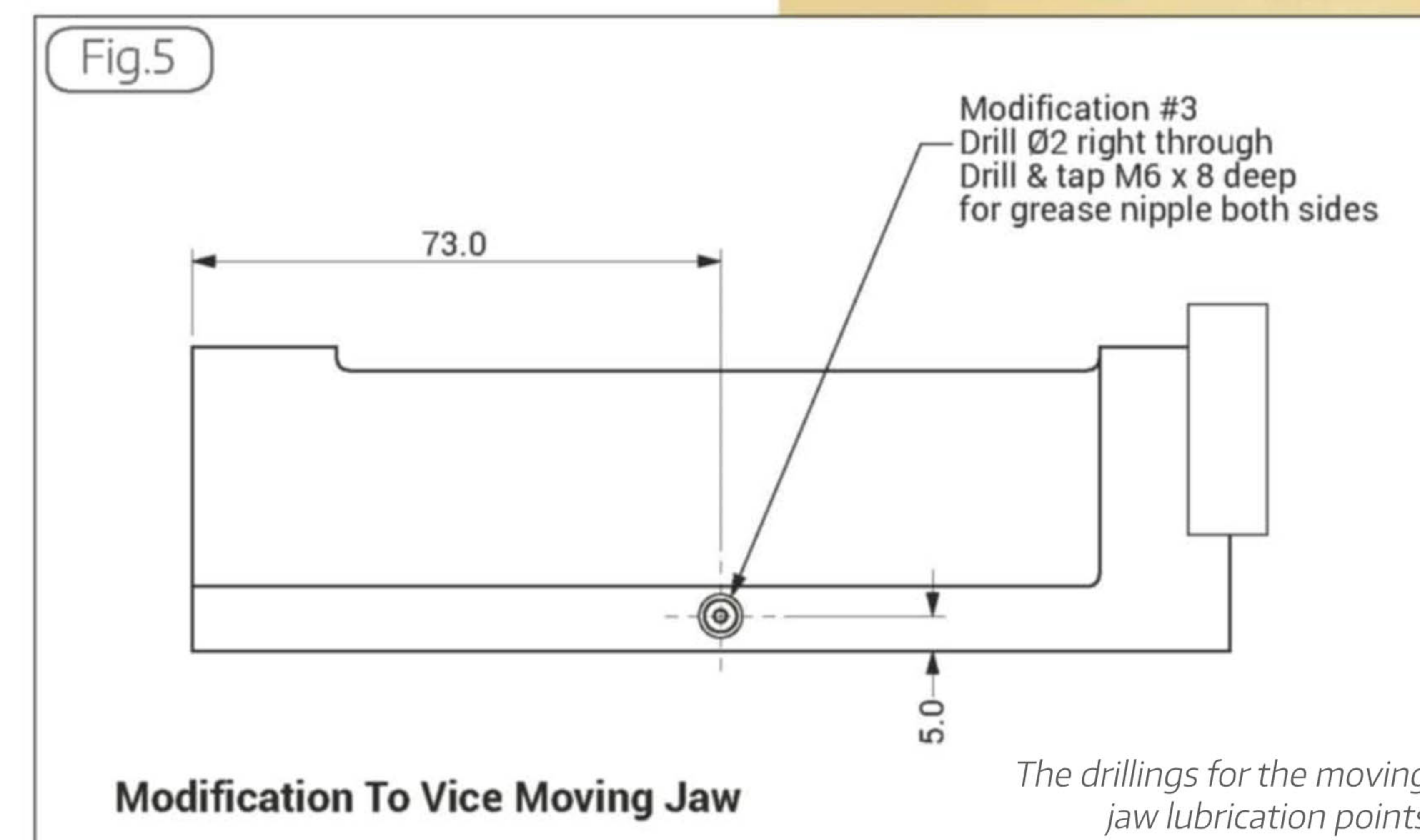
Having made the two grooves, remove the nut from the chuck and grip it in the drill vice ready for drilling the 2.5mm hole through to the M8 thread, modification #2(e). Make sure that the hole is truly parallel with the main 16mm vice thread by putting the vice screw into the nut and setting it square, **photo 10**. Note the small piece of steel flat to allow the stock of the square to sit parallel to the drilling machine vice jaws. Drill the 2.5mm diameter hole until it breaks into the M8 thread. This hole should be exactly halfway between the two o-ring grooves and should also be opposite the hole in the vice body which breaks into the hole taking the nut's spigot. It would be best to check before drilling that the hole in the spigot will be opposite the hole in the base so that the grease gets through. Adjust the dimension if necessary, **photo 11**.

The stud

As the tapped hole in the spigot is now connected to the grease passageway, there is the potential for grease to seep past the M8 screw securing the main vice nut into the base. I decided to try to minimise this by replacing the machine screw with a stud and nut. By using a plain section on the stud, the threads are not cut to the full depth at the end of the thread, so by using a couple of turns of PTFE thread sealing tape on the 8mm long thread, a seal can be effected. This is a slight botch using PTFE tape on parallel threads, but here the seal is where the thread runs out. It is essential not to undercut the threads as this will remove the point at which the thread will seal, **fig. 4**. Once the stud is screwed in, the



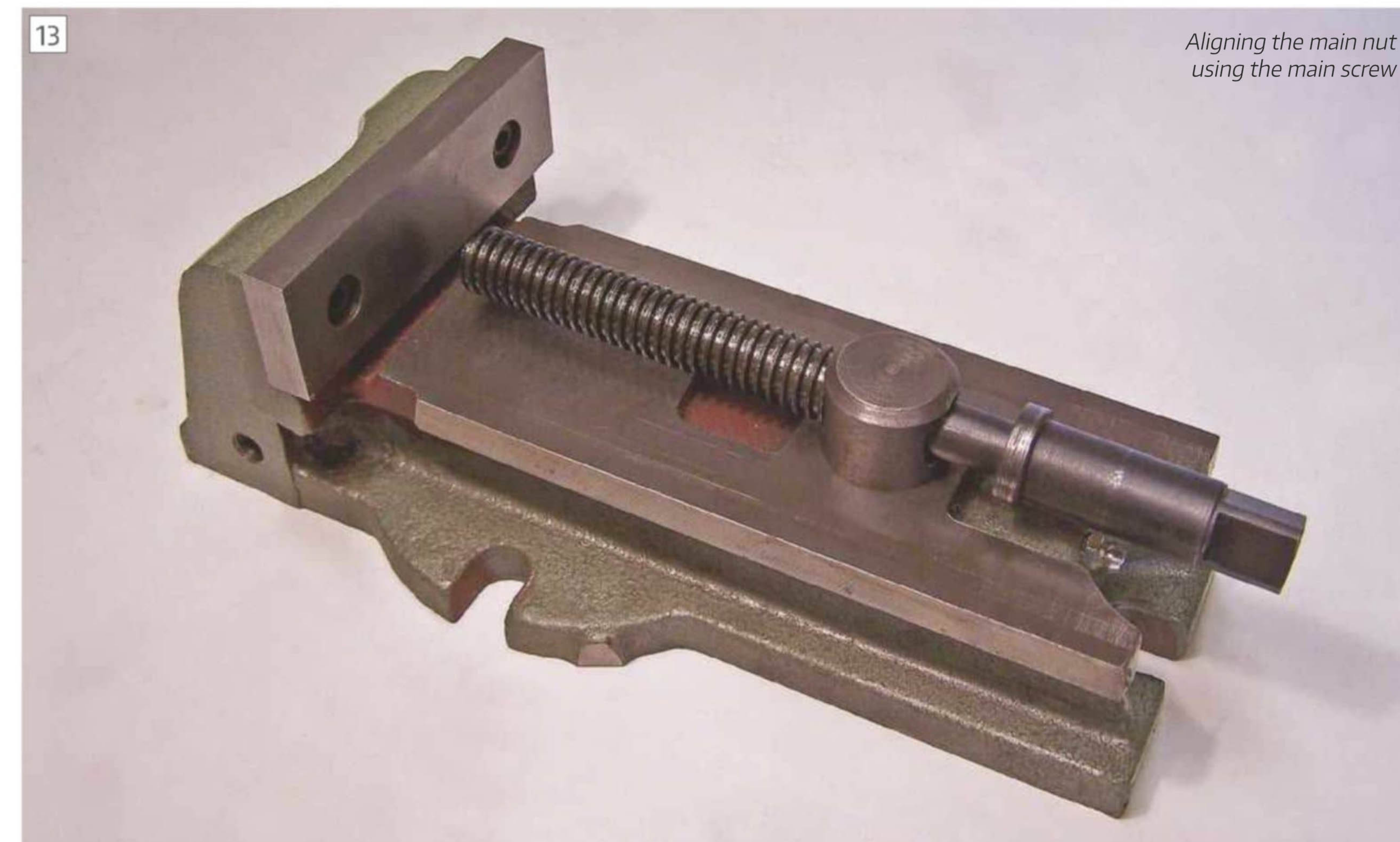
The stud sealed with PTFE tape and the o-rings fitted



Modification To Vice Moving Jaw

The drillings for the moving jaw lubrication points

tape should seal it to an adequate extent. Once the stud has been screwed in, the o-rings can be slipped on last to avoid the risk of damage whilst screwing the stud in, **photo 12**. The main vice nut can now be replaced onto the base and aligned using the main screw. Make sure that the 2.5mm diameter grease hole is pointing towards the hole in the base! I just nipped up the M8 nut on the bottom to hold the vice nut whilst I aligned it using the main screw, **photo 13**. Once aligned, the nut underneath can then be tightened fully, **photo 14**.



Aligning the main nut using the main screw

Slideway lubrication

Before I completed the re-assembly, I thought that it might also be advisable to add lubrication points to the slides. This is a simple job of drilling a 2mm hole through each side of the sliding jaw, opening up to 5mm for 8mm depth and tapping M6 for a grease nipple, **photo 15**. The location of these holes is not critical along the length but should be in a position that will make the distance from the grease nipple to the open ends of the slide about equal. The drawing in **fig. 5** shows where I drilled them. The 5mm dimension is to make the nipple halfway up the side of the slide on the vice base. After this, clear the holes of cast iron dust and re-assemble the vice, **photo 16**.

Choice of lubricants

There were no specific instructions regarding which type of lubricant to use on the vice. Since the main screw has a high load on it whilst it is being tightened, a grease would be more appropriate than an oil. The type that I chose is a National Lubricating Grease Institute (NLGI) Grade 2 lithium based grease which is common for automotive use. For the slides, these are not really under a heavy load whilst moving, so I chose to use standard ISO VG 68 slideway lubricant for this, which is the same grade that I use on the lathe slideways. Of course, you can choose whatever grade you like, as I think that it is not really critical as long as there is some lubricant present. Readers who do not read the words in the article but just look at the pictures will notice that in photo 16, the grease nipple for lubricating the screw is a 45 degree one, whereas the one shown in photo 5 is a straight one. This confirms my lack of foresight in that I didn't quite think out how to put the grease gun onto the nipple when the vice was reassembled, as the straight nipple was not quite long enough to clear the top of the moving jaw when installed.

Conclusions

Was this modification worth it? It has certainly made the vice much easier to operate with no stiff places as the screw is turned. It may be a little over the top to make such modifications, but at least it is quite easy to flush out any debris that gets onto the slideways. It also means that the main screw and nut can be lubricated without dismantling. For the time taken to carry out the actual work, it was probably only three or four times as long as it takes to remove the vice from the milling machine, dismantle it, lubricate and re-assemble, and then relocate it on the machine table. Thinking how to drill the holes probably occupied much more time, but at least the thinking could be done at a time that didn't occupy valuable workshop minutes. ■



The M8 nut securing the main vice nut



The slideway lubrication points on the moving jaw



The finished vice re-assembled

Assessing Myford Bed and Saddle Wear



How do you tell if that old lathe bed is due for a regrind? Pete Barker gets out the micrometers and dial indicator.

The axiom "If you can't measure it, you can't manage it" nowhere rings truer than in machine-tool reconditioning. The bed of the scruffy old Myford ML7 lathe my son and I rescued from a garage sale had score marks, hacksaw cuts, hammer dents and worse all over it. "Needs a regrind" was the consensus, offered with knowing nods. But did it really? Appearances can be deceptive.

The first step in assessing its true state was to clean it down, then gently run a fine flat file over the dents, bumps and scores on the shears, or ways. A 10-inch flat mill saw file is perfect for this. It takes down the displaced metal that rises up around every dent and removes the burrs from the edges of marks where careless use such as a hacksaw instead of a parting tool has left its traces. Use long strokes and try to keep it even all over the ways. A quick finish off by rubbing an oilstone along the ways smooths things out without removing measurable amounts of metal. We applied a light frosting to the way surfaces with a hand scraper for oil retention, but this is not really necessary.

Measuring the shears

Most wear will be on the front shear of the bed because it takes most of the load under cutting forces. But both shears are



Measuring front shear thickness.

measured along their full length at intervals and measurements recorded so there is no confusion. Both the width and thickness of each shear needs to be measured along its full length.



Bed Wear. Measuring the width of the front shear at the unworn right-hand end.

First, use a 0-1" micrometer to measure the vertical thickness of each shear, **photo 1**. Start by measuring the thickness at the virtually unworn end, the far right, then work toward the headstock, writing the figures on the bed in felt pen as you go. This gives a good visual picture of just where the wear has occurred, and how much, and is less distracting than picking up a notebook repeatedly while trying to make repeated accurate measurements. Most wear will be found in the final six to twelve inches at the left-hand end of the bed, so measure at smaller intervals along here. It can be assumed that most if not all the measured wear is on the top surface as the bottom surface has a small working clearance between it and the lift plates on the carriage, whereas the top surface is in direct contact with carriage way surfaces. Write the felt pen readings down in your notebook and then erase the felt pen from the bed, ready for the width measurements.

Now we repeat the process but using a 1" to 2" micrometer to measure the width of each shear at intervals along its length, **photos 2 and 3**. This measurement is more critical because the carriage is guided in the horizontal plane by the rear vertical surface

of the front shear on earlier Myfords, pre-1972, and by the rear vertical surface of the rear shear on the later model machines, the so-called "wide guide" models.

Most of the wear is usually found on the load-bearing vertical surfaces mentioned, with a much lesser degree of metal missing from the front vertical surface of the front shear where the gib strip is located.

Alternatives and checking

A couple of simple methods can be used to double check our measurements - always a good idea - or if you do not have large micrometers and the like. On the earlier narrow guide models like ours, the rear vertical surface of the rear shear is machined at the factory but has nothing bearing on it in operation. So, after 60 years of use, it is in pristine condition, making it a perfect reference surface. If you have a large enough



Dial indicator mounted on sled to compare the distance between the two outside vertical shear surfaces.



A long steel rule and feeler gauges can be used in a pinch to assess bed wear, or to confirm our micrometer readings.



Unworn rear vertical surface provides a reference for measurement on narrow guide models.

micrometer, or digital calliper, or even a pair of old-fashioned friction-joint callipers and feeler gauges, **photo 4**, a measurement can be taken from the very back of the back shear to the front of the front shear. By comparing the unworn right-hand end of the bed to the high-wear area at the left, we can assess the condition of that front surface. Ours was found to have very little wear. In the case of the wide-guide models we can also assess load-bearing rear shear surface this way too, compared with the relatively little-worn front surface.

Another check is to use a dial indicator mounted on a "sled" that slides along the rear shear. A handy sled can be made using the base of a common marking gauge. Most have two small round pins that can be tapped down with a hammer, **photo 5**, until they protrude enough to register on the vertical surface of the shear as the base is slid along the horizontal surface. You always wondered what those pins were for, didn't you? Now you know. The dial indicator is



Pins on the marking gauge base follow the rear vertical surface.

Wear is measured at intervals along the shear and recorded.

attached and set to read on the surface to be tested, **photo 6**. Both vertical surfaces and the horizontal surface of the front shear can be checked this way, as can the front vertical surface of the rear shear.

A further simple, but not so accurate, check can be made using a three-foot steel ruler laid along the shear with a feeler gauge used to find and measure any low spots, **photo 7**. That's all there is to basic bed wear measurement. Having confirmed our initial measurements written in our notebook, we are now in a position to assess whether that expensive regrind is really necessary.

Bed Wear: How much is too much?

The Myford factory booklet "Pre-Owned Lathes: A Guide to Inspecting Before You

Buy" states maximum allowable bed wear to be .005" on the thickness of each shear from one end to the other, as measured in photo 1.

Myford's maximum allowable wear in the horizontal width as measured in photo 2 is less at .003". This measurement is more critical because the tool path follows directly the path of this measurement in the horizontal plane. A .003" curve in the vertical shear surface could theoretically result in a .006" variation in diameter of the job being turned. In practice it will most often be less because the wear is often fairly even along the commonly used section of the bed. But longer jobs will suffer the full inaccuracy as the carriage travels from worn to unworn bed sections.

If like us, you have a bed that is on the threshold, all is not lost. Our bed measured at .004" wear in the vertical plane and .003" in the horizontal on the front shear. So just under the limit on the less critical shear thickness but right on the allowable limit on the all-important shear width. However, if you are fortunate enough to own a pre-1972 narrow guide model, it is possible to convert it to the later style of wide guide which will then track along that unworn rear vertical surface of the rear shear. This means you can get away without regrinding the bed, saving considerable expense. A future article will describe exactly how to do this conversion, where we can delve into it in detail.

On our example, I am not at all worried about the .004" of wear on the top surface of the shear. It affects only the vertical position of the carriage. If the tool bit drops by .004" height as it traverses the worn section, the difference in the machined diameter will not be measureable in the home workshop. The surface of the job at the point the tool contacts it is so close to vertical that tool height does not affect it drastically. Subsequent turning tests on the rebuilt and wide-guide-converted lathe have confirmed this, with a six-



Unworn strips to the left of the two scored contact areas provide references to measure wear.

inch-long turning test piece showing no measureable taper, well within Myford's check-sheet tolerance of .0008". No regrind necessary.

Assessing the saddle

The lathe's bed is only half the story. The mating component, the saddle is just as important. First thing to look at is the pair of horizontal surfaces that run on the tops of the two bed shears. They will be scored from swarf ingress over the years, but actual wear can be measured against the quarter-inch wide unworn strip seen at the left of each bearing surface in **photo 8**. This step can be measure accurately with a depth micrometer or digital calliper, or roughly with a feeler gauge and running

a finger over the top of it. Ours measured out at .002" wear here, not very much. If it were more, we would be looking at paying to have the surfaces milled back flat. But in this case that would be wasted money and effort when the surfaces will be mating with the worn bed ways. A quick deburring with a flat file was deemed sufficient here. A quick check with a thin smear of bearing blue on the bed ways showed passable contact over the pair of surfaces with no sign of warp or twist.

However, and it's a big however, most of the wear on these saddles seems to commonly take place on the short vertical surface marked with felt pen in **photo 9**. It's the surface that bears on that critical vertical rear surface of the front shear on

the narrow guide models. In this instance, measurement with a feeler gauge and finger against the unworn strip at the top in the picture revealed .020" wear at one end and .005" at the other.

This much wear here is unacceptable. It will cause the saddle to tilt around out of square with the lathe's longitudinal axis. This in turn will cause any facing jobs to have a dished shape roughly concurrent with the wear, so an expected .020" dish over say a 6" diameter. The usual tolerance here is 0 to .001" concave over the length of travel of the cross slide.

Rectification is a matter of two choices. You can remachine the surface in a milling machine and attach a packing strip to the surface to make up the lost metal. Or if you have no milling machine, you can make the wide-guide conversion mentioned above so the unworn long vertical surface at the rear in photo 9 bears on the unworn rear vertical surface of the rear bed shear. A future article will provide full how-to details on the conversion.

Conclusion

Measuring wear on the bed and carriage is a simple matter with basic micrometers and other simple tools. Maximum allowable bed wear before regrinding is officially .005" in the vertical plane and .003" in the



Most saddle wear was found on the marked vertical surface and measured with a feeler gauge against the unworn strip at the top.

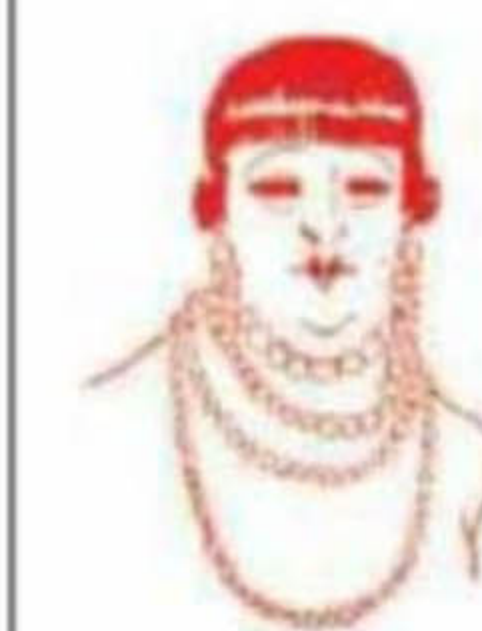
more-critical horizontal.

Wear on the saddle has been found more pronounced on the vertical guide surface than the horizontal. Unfortunately, this surface is the most critical, affecting the lathe's ability to face a job correctly.

Fortunately, though, in many cases both an excessively worn bed and saddle can be salvaged through a wide-guide conversion, to be described in an upcoming article. ■



Result! Zero taper measureable over a six-inch test cut without regrinding the bed after a bit of work.



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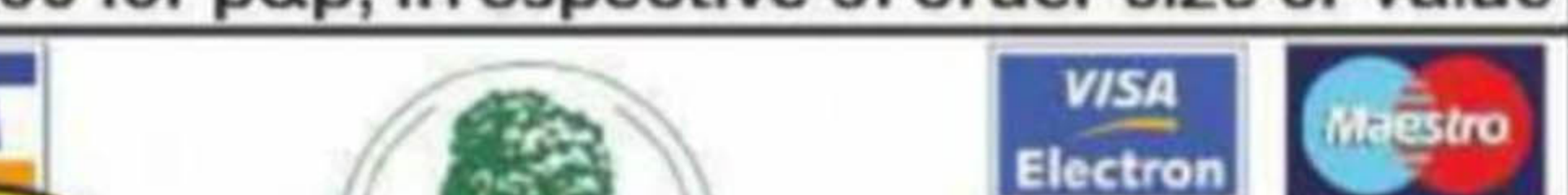
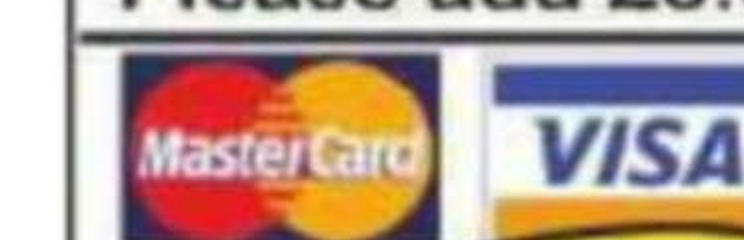
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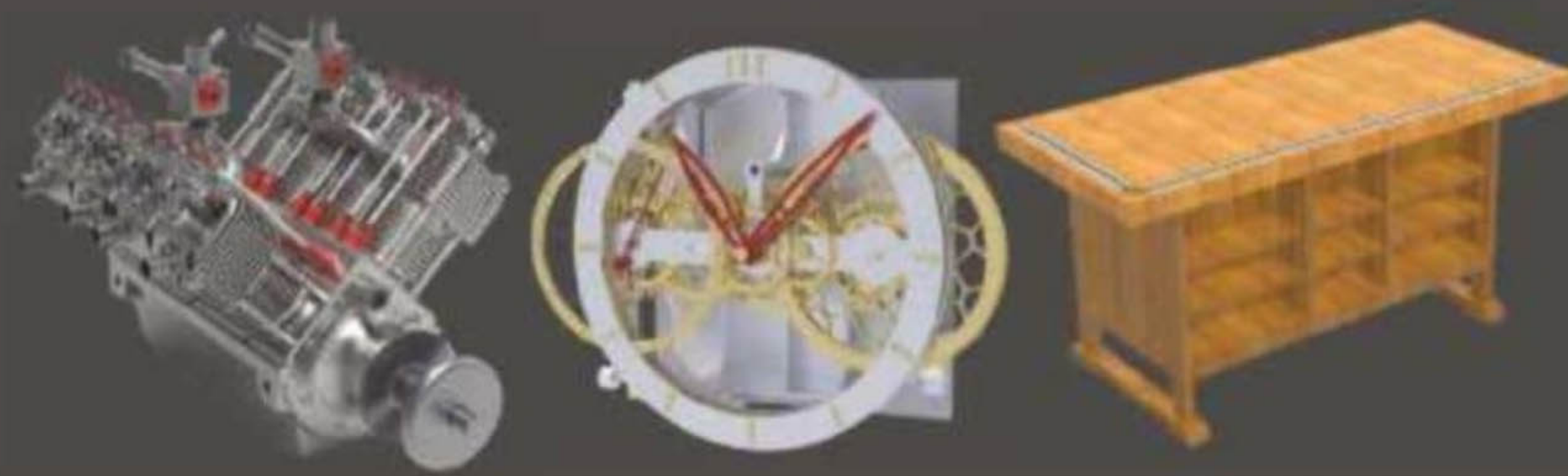


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A Workshop Press

Will Doggett introduces a short series on making a workshop press tool.

The concept

A press is not the first piece of equipment that a workshop needs as things like a bench vice and other hand tool will take priority, then there are machines, e.g. a bench drill (or floor standing), a lathe, a mill, etc., so the workshop press is fairly low on most peoples list of requirements for their workshop.

The most obvious press is an arbour press and the humble bench vice falls into this category, although a limited one, as it can be used to press bearings and with an adapter, known as a magnetic vice mounted brake, can even bend thin plate if required to do so.

Having said all that, I have always wanted a small press for my workshop as using the vice method is a bit fiddly for general workshop duties. I wanted a press for bearing pressing, possibly using it for punching holes with the right tooling, to use broaches and possibly straightening things as I have used a press for this in the past.

The other requirements were that it had to be smaller than the normal size of press, also I wanted it to be easily dismantled when not in use and as light as possible, so that it can be stored.

To this end I started looking around various web sites with a view to buying one, the problem was none of the sites that I visited had what I wanted so I decided to make my own.

I had two bottle jacks under the bench that I had acquired some years ago, one



Finished press

was a 1.5 ton and the other a 5000kg jack, this is about 5 tons. The smaller one was discounted as I thought it was under powered, as it were. The 5000kg I thought would be the answer for my press as I was not looking for a lot of pressure, but more than 1.5 ton, just enough to push bearings in and out etc. but with some power to spare.

The thought process

The first thing was how to mount the jack. It had to stay in a vertical position, that much was obvious, as the pump is at the bottom as is the oil but I wanted it to act as a ram. It was at this point I thought why not fix the jack's ram to a top cross frame and fix another ram on a piece of steel plate and

attach this to the bottom of the jack. This could then push down onto a base bed plate that is fixed to the side rails below.

The table would be supported by the side frames with holes drilled in them at intervals, this in turn would have moveable pins to give adjustment for the different sizes and heights of the things I was going to be working on.

The new idea is shown in the very rough sketch 1, with text added, this was to give me the idea of what I was trying to do as it makes more sense when drawn on paper.

Note the sketch doesn't show the ram guide as this was an afterthought and was added to the main sketch later.

The jack that I was going to use is



The jack

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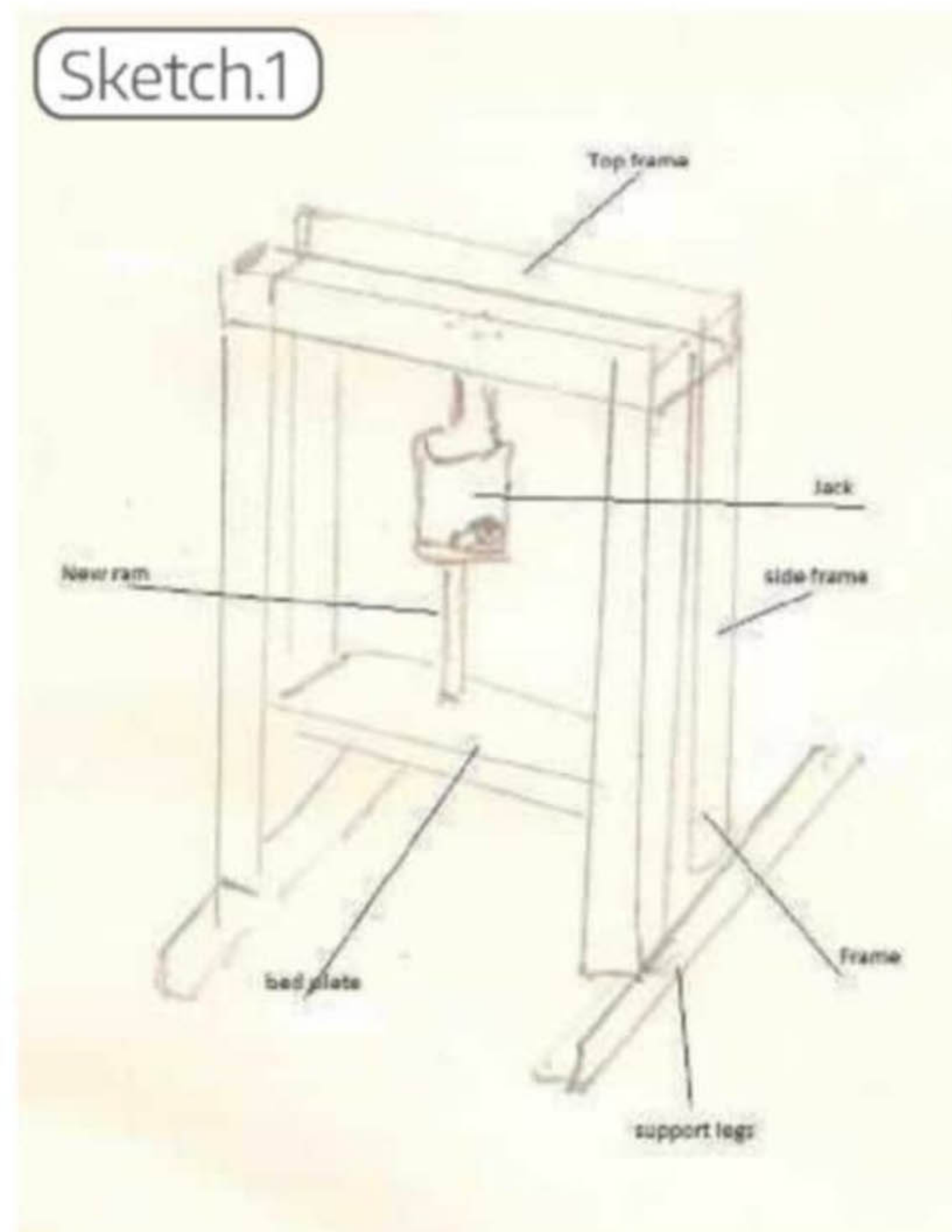
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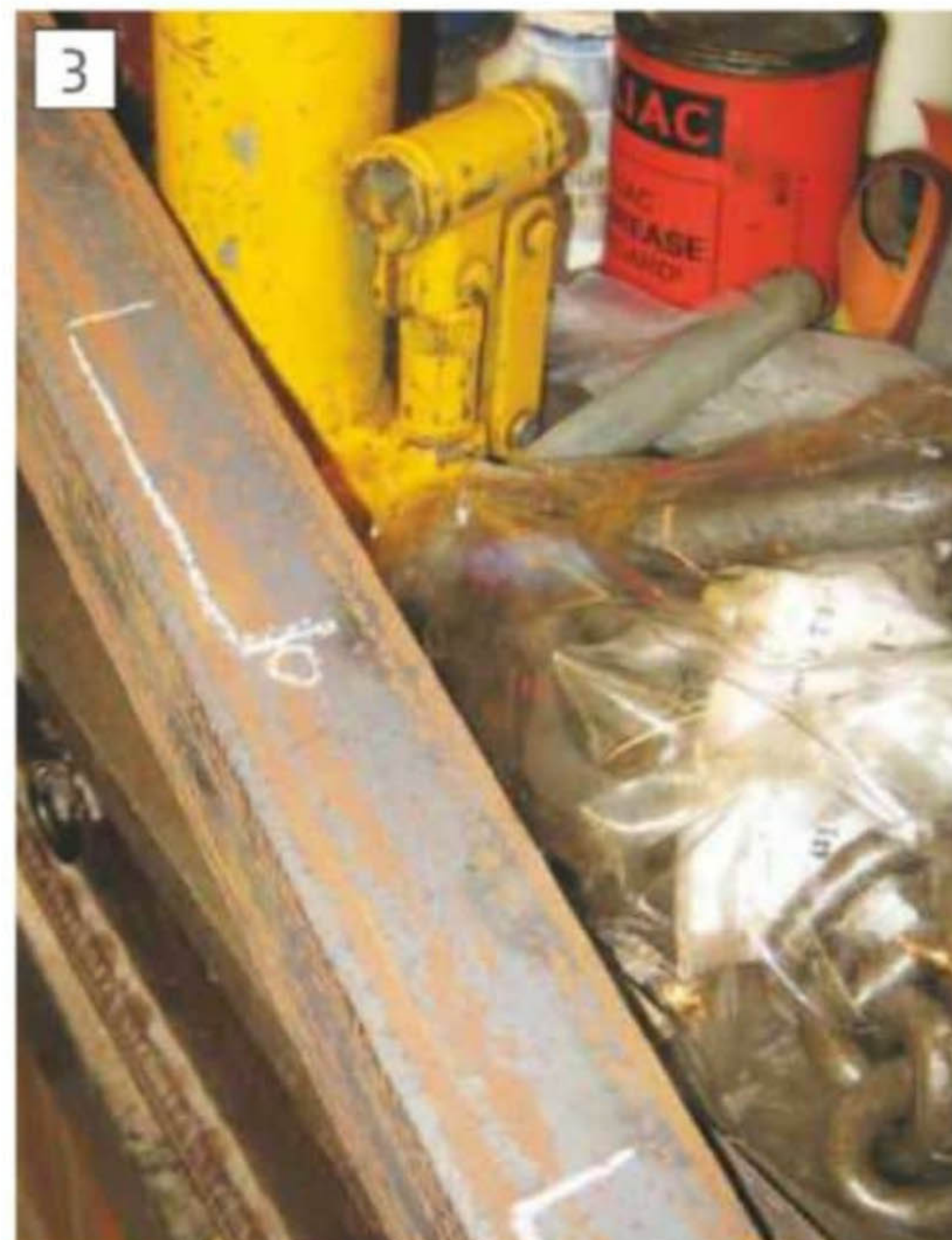
shown in **photo 2**. In the closed position it is 215 mm or approximately 8 1/2 inches high and when fully extended 370 mm or approximately 14 1/2 inches high, this gives a working stroke of 150mm or 6 inches. So, I had the dimensions of the jack, I had a basic idea of how to work out the general dimensions so I could now begin preparations for making the press. The general idea was coming together.

I apologize for using both metric and imperial measurements in this article but most of the material is in imperial sizes and it is stock sizes and readily available. The dimensions are not that critical as long as the parts fit together.

Incidentally the trampoline springs were advertised in imperial!

The first thing I did was to mark out the general dimensions to scale on a piece of paper starting with the size of the jack. This was so that I could work out the finished height of the side rails. With this information I could work out the top support size and the table dimensions to make the press look balanced in proportions.

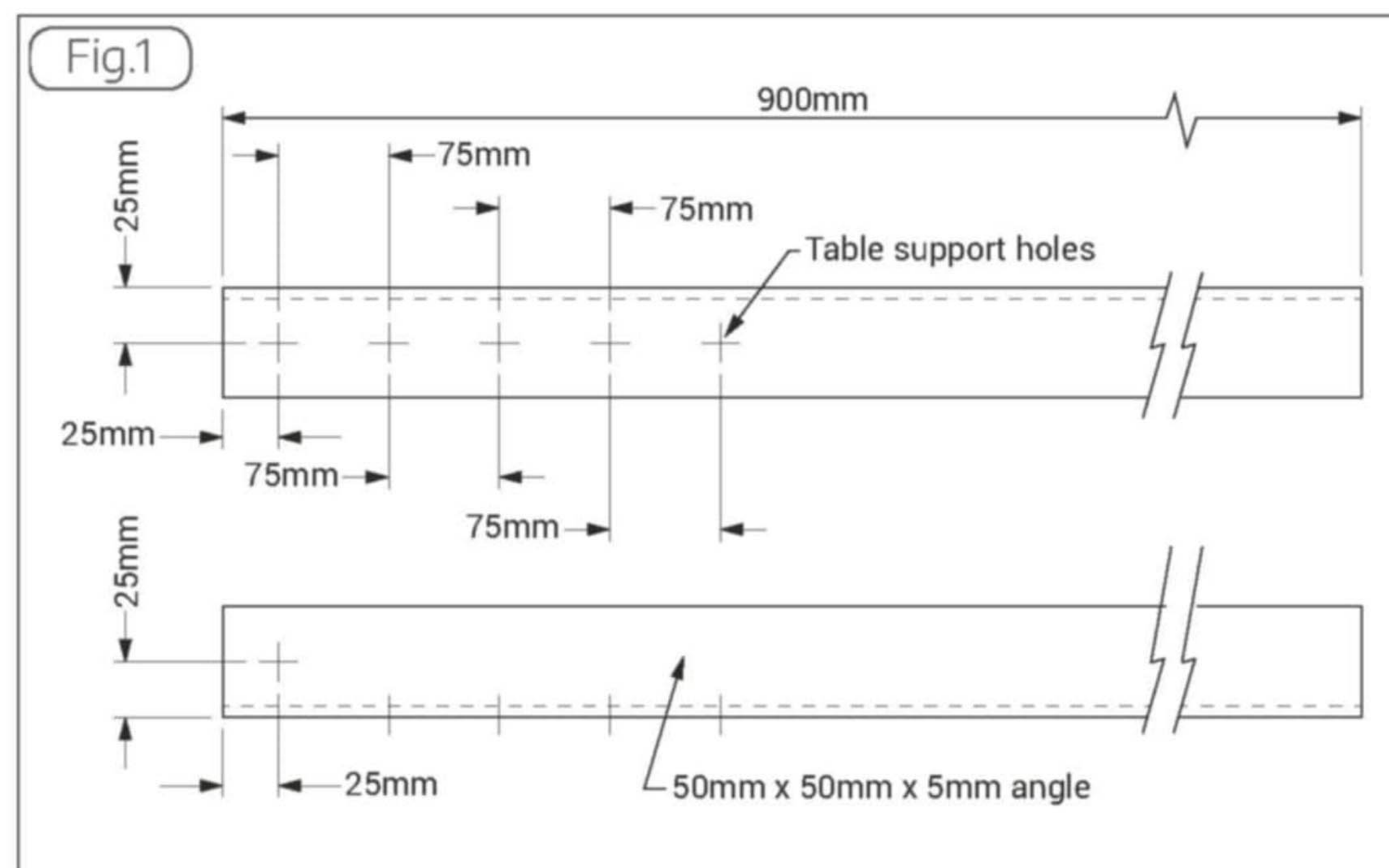
At first, I thought I would use angle for the side rails and some large channel 5 x



The angle roughly mark out



The angles the right length



2 1/2" for the top and the press base bed plate. There was a problem using this large channel – it would give a nice large base frame which is good, but too large and heavy making it difficult to move up and down and as I am trying to keep the weight

down this was not good idea.

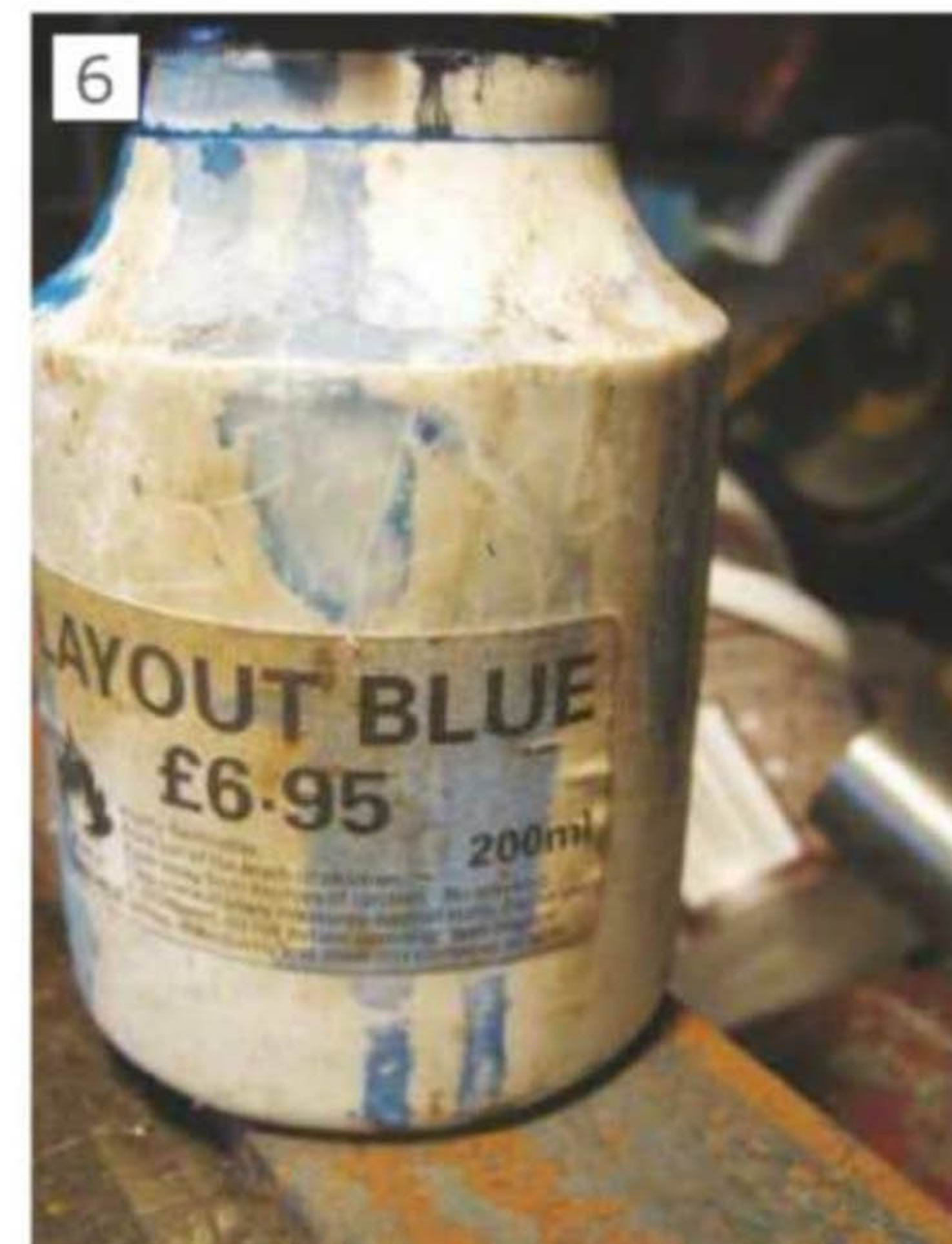
The compromise was to use some smaller channel, 4 x 2 x 1/4" for the table the detail of this and how I made the base frame I will explain later. Suffice to say the new arrangement gives a larger table area to work with but a lighter one.

The top rail that the jack pushes against would also be made from this channel. The ram guide was made with two pieces of 50 x 50 x 5mm angle welded together to form a box section, with a hole in the centre to guide the ram. The use of angle was to reduce the weight, I was going to use some of the channel, but this made the guide heavier than necessary. The ram guide was a necessary after thought as without it there was nothing to align the ram.

The side rails were still made from 50 x 50 x 5mm angle, and to stop the press from falling over it was also used for the



Angles mark out with layout blue



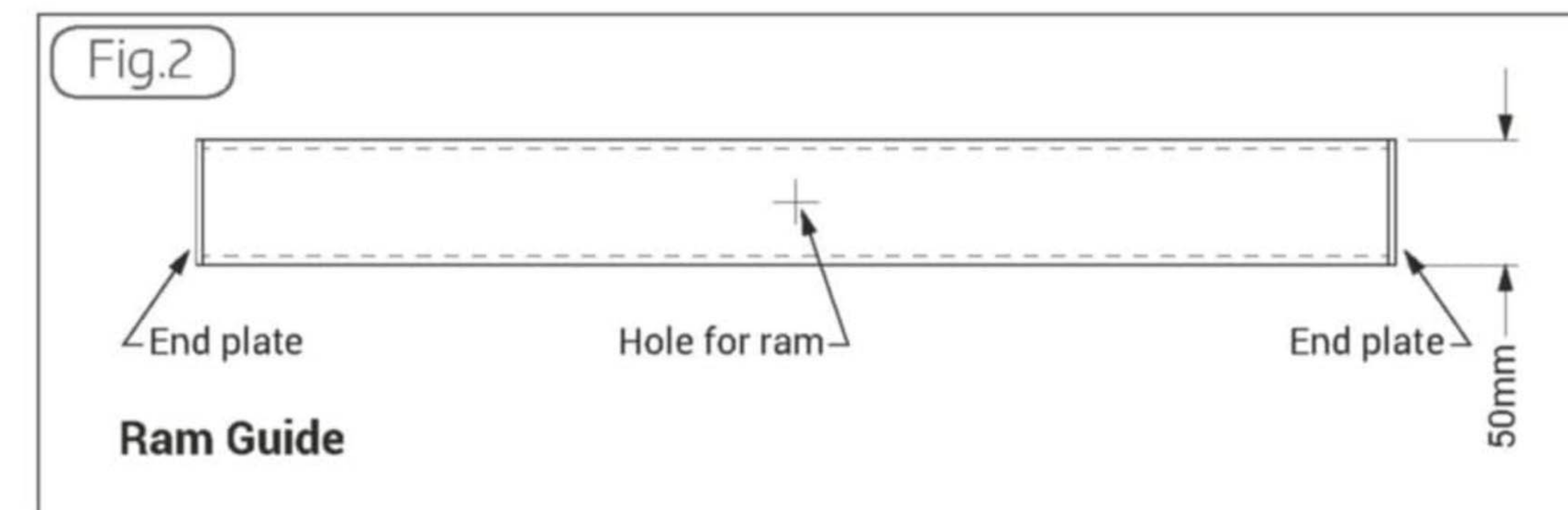
Layout blue bottle



Drilling the side rails



First channel cut



supports to hold the frame upright.

The jack has a bottom plate that is attached to the bottom of it. The ram was 1 1/4" diameter mild steel, as this was the only material near to the right size I had, this is also fixed to the bottom plate.

To return the jack back to the upper position I would be using some 8 1/2 inch trampoline springs attached to the jack bottom plate and to the top rail.

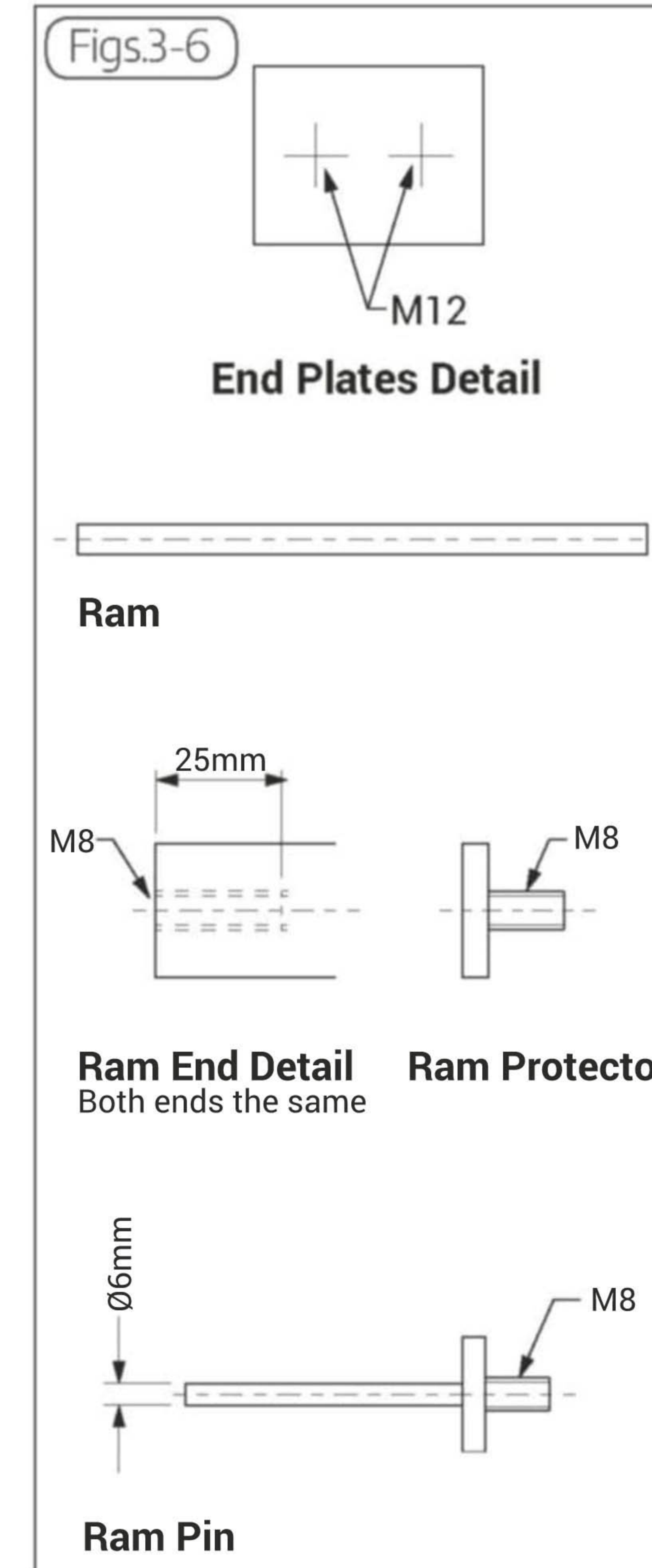
Having got the dimensions from the drawing and the holes positions I marked them out with chalk on one of the angles to check that the paper version translated to the full size version, and it did, **photo 3**. So now I could start to cut steel.

The main frame

The four 50 x 50 x 5mm angles **fig 1** were already the right length at 3ft or 914mm, **photo 4** so now they were ready to be worked on. They were painted with layout blue, **photo 5**.

The bottle of layout blue or marking out blue in **photo 6** is a very thin paint like substance and is painted on, usually, bright steel so the making lines can be seen more easily. It is not to be confused with engineers blue also known as micrometer blue, photo 17, which is more like a thick paste and used with a very thin coat on components to check for the fit between two pieces of metal such as tapers, scraping bearings or getting a plate flat. It is guaranteed to get on your hands and is difficult to remove.

Layout or marking blue has now been superseded for most people as they use felt-tip pens, which are ok on small areas.



Other types of marking out material that I have used over the years are marking white this was a bit like modern emulsion but dried a lot faster. It was put on with a brush and also available in yellow. These were mainly used on hot rolled steel and steelwork and sand castings, but the fastest method for these is blackboard chalk - rub it on and mark out.

Next they were marked out for the base frame support holes and the side support holes in pairs. It was done this way because they are handed and it is all too easy to get distracted when marking out, they were then centre punched and drilled with a 13mm drill. **Photograph 7** shows the second hole being drilled, the reason for the hole spacing being 75mm is that this works with the jack stroke.

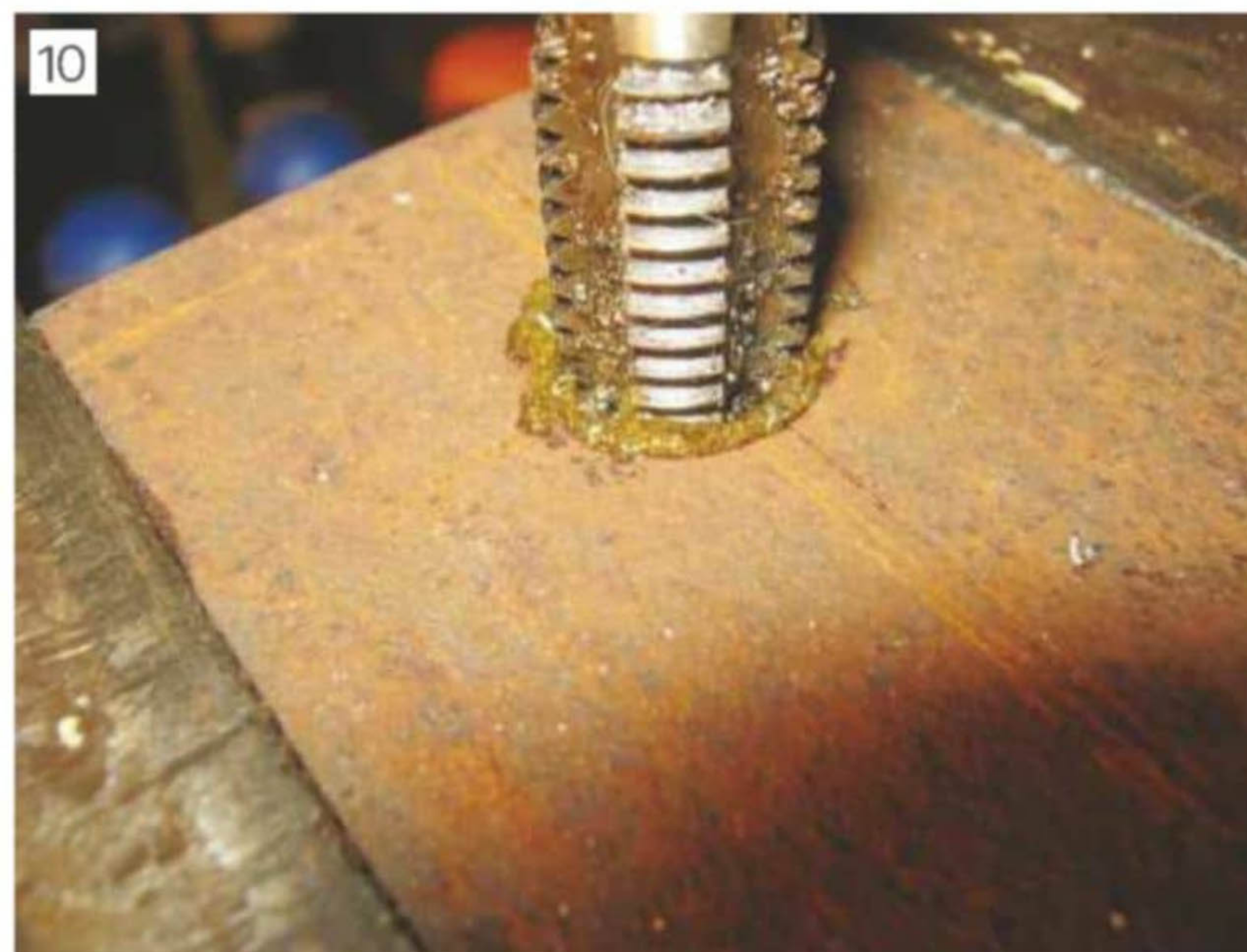
I used my mill/drill to drill the holes, this is the first time I have used it as a drill, I have not needed to use it before as I have a Meddings drill in the workshop that I use most of the time.

The drilling was done before assembly as it would be difficult to hold the frame and drill the holes on the drilling machine after they were welded together with the top channel and all this would be too heavy to handle safely and accurately.

After drilling the side rails a piece of 4 x 2 x 1/4" channel was put in the bandsaw and



End plates drilling



Tapping the end plates



Ram guide tack welded



The end plate fitted



Centre drilling the ram support

cut to a length of 18 inches, this was going to be the top channel, fig 7 (for the jack to work against) shown in **photo 8**.

The next operation for the bandsaw was to cut the two base bed plate channels these were also cut from the same channel but 18 1/2 inches long.

The different length for the base bed plate channels was because the top and the ram guide fit inside the upright angles and the bed plate channel run right across on the outside of the support angles to their outer edges.

The ram guide

Two pieces of 50x50 angle, **fig 2**, were cut to length 17 1/2". The two angles for the ram guide are welded together to form the box section which fits inside the open webs of the side rails to guide the ram.

A flat was cut 75mm long, **fig 3**, and is welded on both ends of the angle box section after they were drilled, **photo 9**, and tapped with two M12 holes in both pieces, **photo 10**. This was for the bolts to hold the box section in place on the inside of the support rails.

This is the ram guide has a 1 1/4" (31.78mm) hole in the centre. The only drill I had near to the right size to drill the



hole was 33mm in diameter, this was a bit larger than ideal. I think it will be alright, but it will give a galloping fit.

In the millwright's shop where I was an apprentice, some of the work we did was machining for the foundry fitters as they did not have machines in their workshop, as it was right in the foundry and the sand would have played havoc with them.

The first job I did for the foundry was a bearing for a roller track I made it a running fit as requested it was returned that day and I was told it was too tight for the foundry. I said no, it is a free running on the shaft. Yes came the reply but this is the foundry, we need a Galloping fit. I said why? The answer I got was to allow for the something sand! This was a play on limits and fits for engineers.

I made four spacer rings, used to keep

the box section central in the side rails. The outer diameter is 15mm to fit the slot in the side rail and they are drilled 12mm for the bolts.

The other part required for the top channel is a jack register ring, tack welded to the centre of the top channel to locate the top of the jack. This was turned from a piece of 50 mm diameter steel and bored to fit the top section of the jack; the finished piece is 10mm deep.

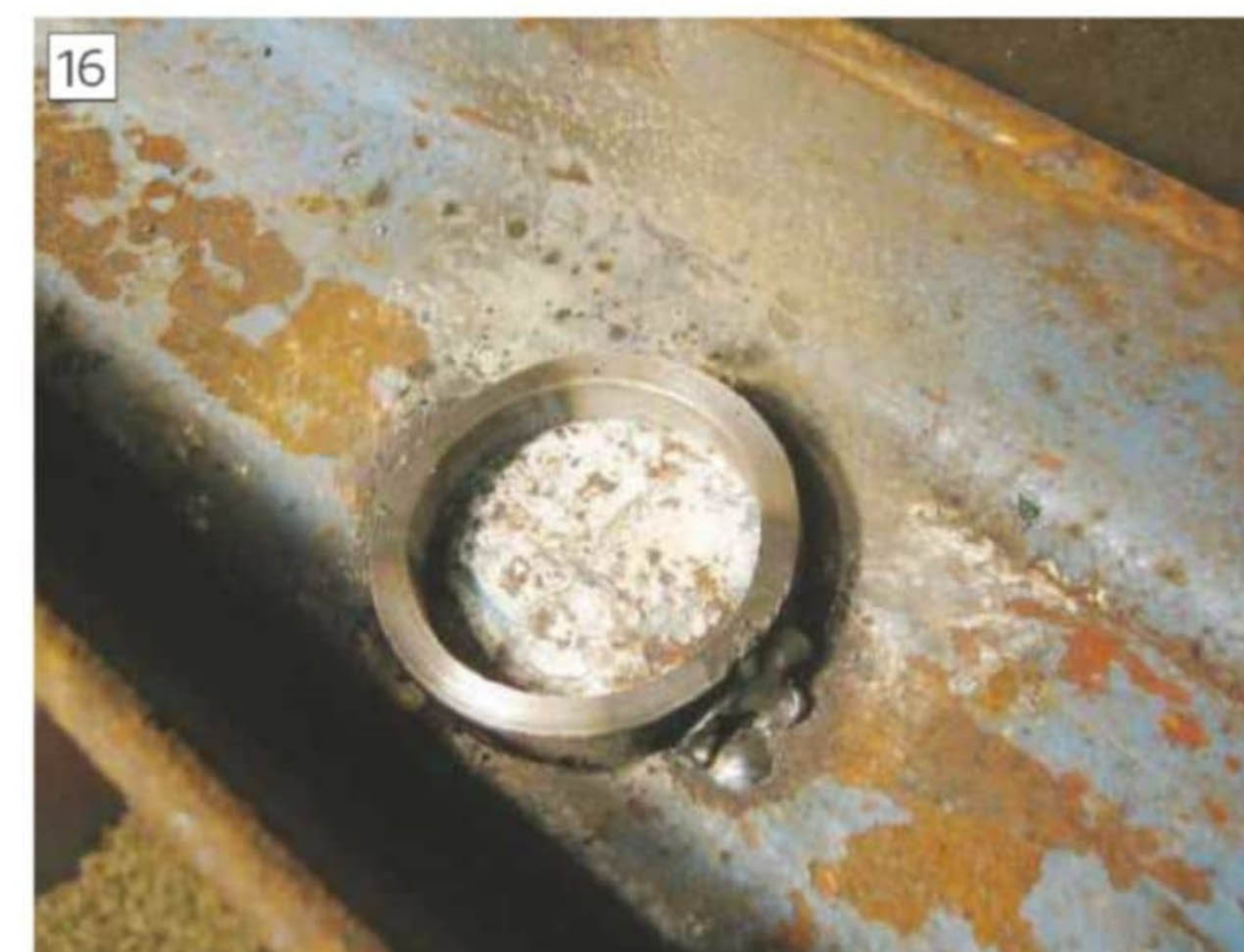
Because there was a gap of about 15mm between the side rail angles when fixed to the top channel two pieces of steel were welded in the gap at the bottom of the rails. This was done to help with stability at the bottom of the rails and to stop them spreading when the frame is stored, as the support angles are removed. All the welding was



Start of drilling with 33mm drill



Testing the ram fit



The jack location ring tack welded



Engineers blue

done outside on a dry day as I don't like welding in the workshop.

The box section ram guide

The first parts of the guide, **fig. 7**, to be welded were the box section angles with its fixing flats on both ends. As you can see I only used big tack welds to hold it all together as there is no load on this part, **photo 11**. The photo also shows the marking out for the centre hole. The end for the box section with fixing plate is shown in **photo 12**.

The box section was then drilled, this I did on the mill as it was big enough to hold the 33mm drill which has an MT3 taper, if I didn't have a mill then I would have used the lathe with the drill held in the headstock's morse taper and the box section fixed to the cross slide on packing. The Meddings drill doesn't have a MT3 taper.

The box section was held in the machine vice with the part to be drilled hanging out over the edge of the vice and supported on small adjustable wedges on the bed of the mill.

The first operation was to line up the centre drill, held in a drill chuck, with the centre punch mark, **photo 13**.

Then the bed clamps were tightened, and the hole was started with the centre drill, the chuck holding the centre drill was then removed without moving the machine head or the vice.

The 33mm drill was then put in the mill and the hole was then drilled right through the two parts of the box using the z mill wheel to push the drill through. **Photograph 14** shows the drill starting to remove metal.

Photograph 15 is the finished hole with ram inserted for a test fit, this shows the clearance the ram has in the hole. At this stage I was not certain if it would be a problem, if it was then I could open up the hole with a boring bar and make a bush to give a better fit.

The box section looks a lot better after I ran a power file over it, but I didn't photograph it.

The jack register ring was tack welded in place, the finished ring and top channel are shown in **photo 16**.

The next job was to weld the side rails with the spacer pieces at the bottom and the top rail channel at the top, the completed welded frame is shown in **photo 18**.

Note about welding the top channel:



The welded frame

This is the bit that counts in terms of strength if your welding is not up to scratch, get somebody that can weld to do it for you.

Support legs

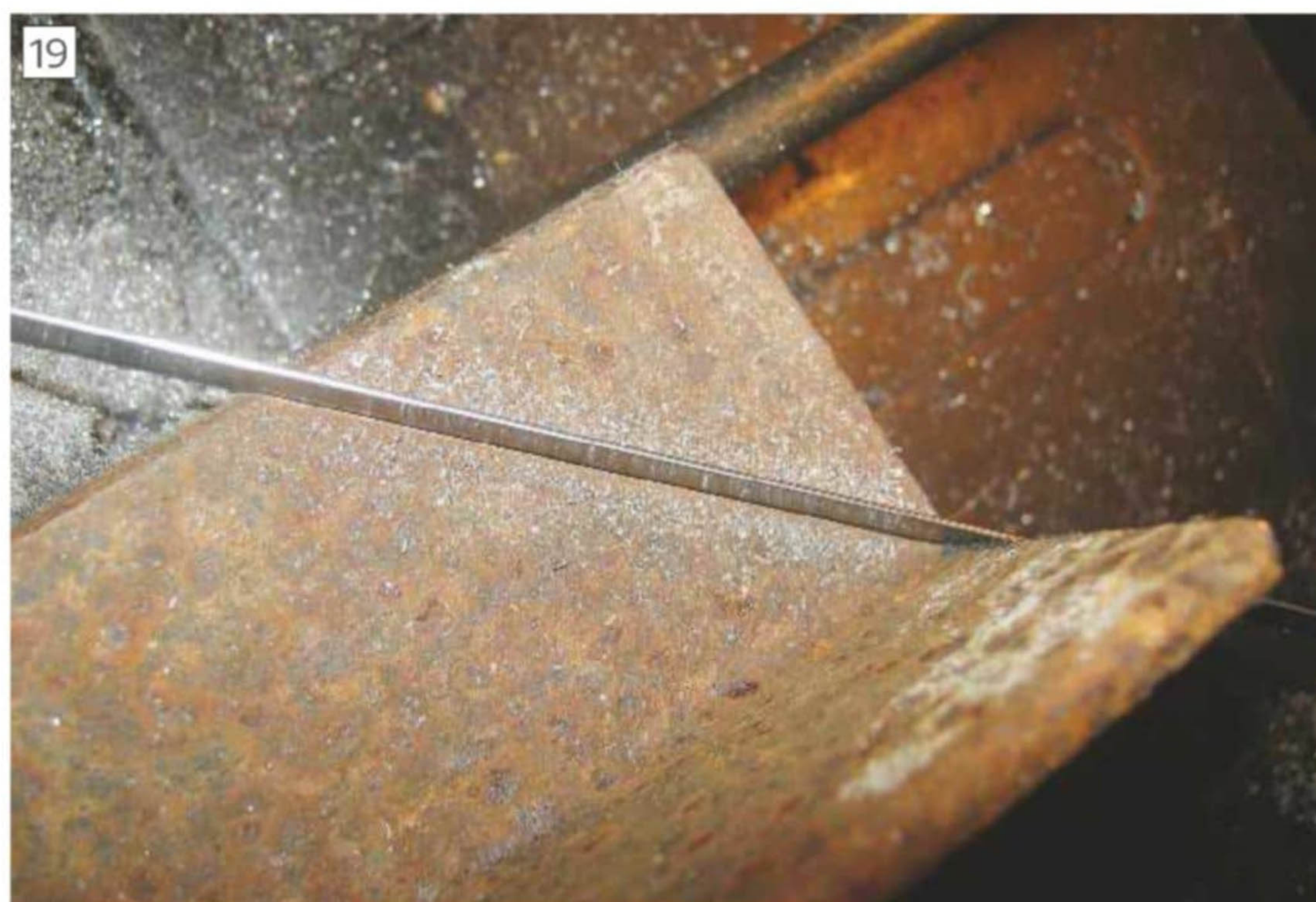
The next parts to be cut on the bandsaw were the support legs, they were cut to 545mm – about 21½” long from 50 x 50mm angle.

The parts of the angle that are vertical on the ends were cut at 45 degrees, this gives a better finish. **Photograph 19** shows the cut being made on the bandsaw. **Photograph 20** shows the finished cut, after this the fixing holes were drilled on the same face of the angles, **photo 21** shows the hole as drilled with chalk on the angle to help with marking out.

The ram plate

The ram plate, **fig 8**, is the piece of material that fits between the jack, to which it is clamped, and the ram screwed to the underside. The jack ram return springs are also attached to it at the sides.

To make the ram plate I used a piece of aluminium plate that was in the scrap box, it came from a redundant saw table shown **photo 22**. **Photograph 23** shows the jack



The support angle cut

in relation to the plate.

The size and shape of the ram plate is not important as it is there just to hold the ram and the return springs to the jack so ant sensible shape and size will be ok.

●To be continued



The finished cut



A fixing hole with chalk



The ram plate



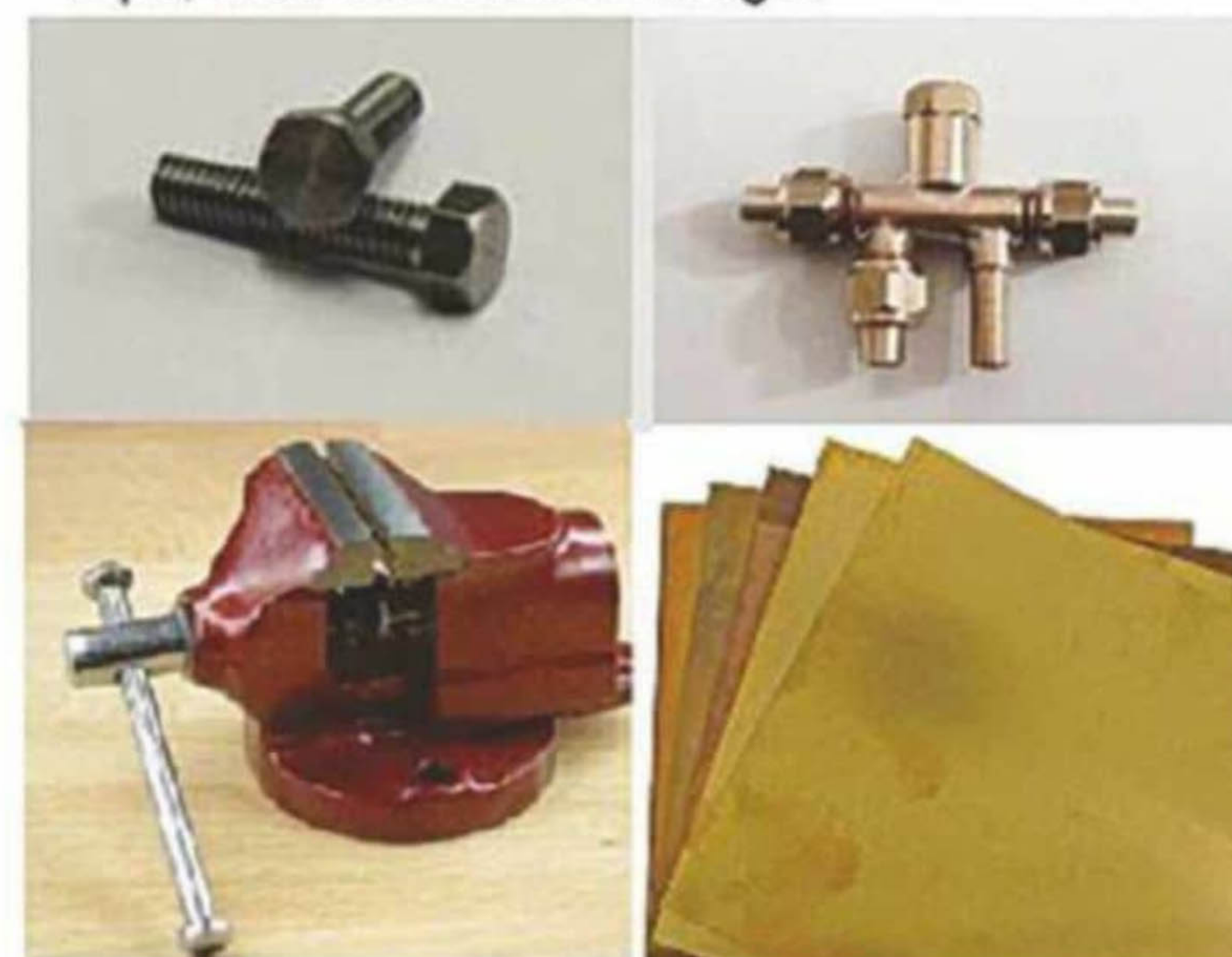
The ram plate with jack

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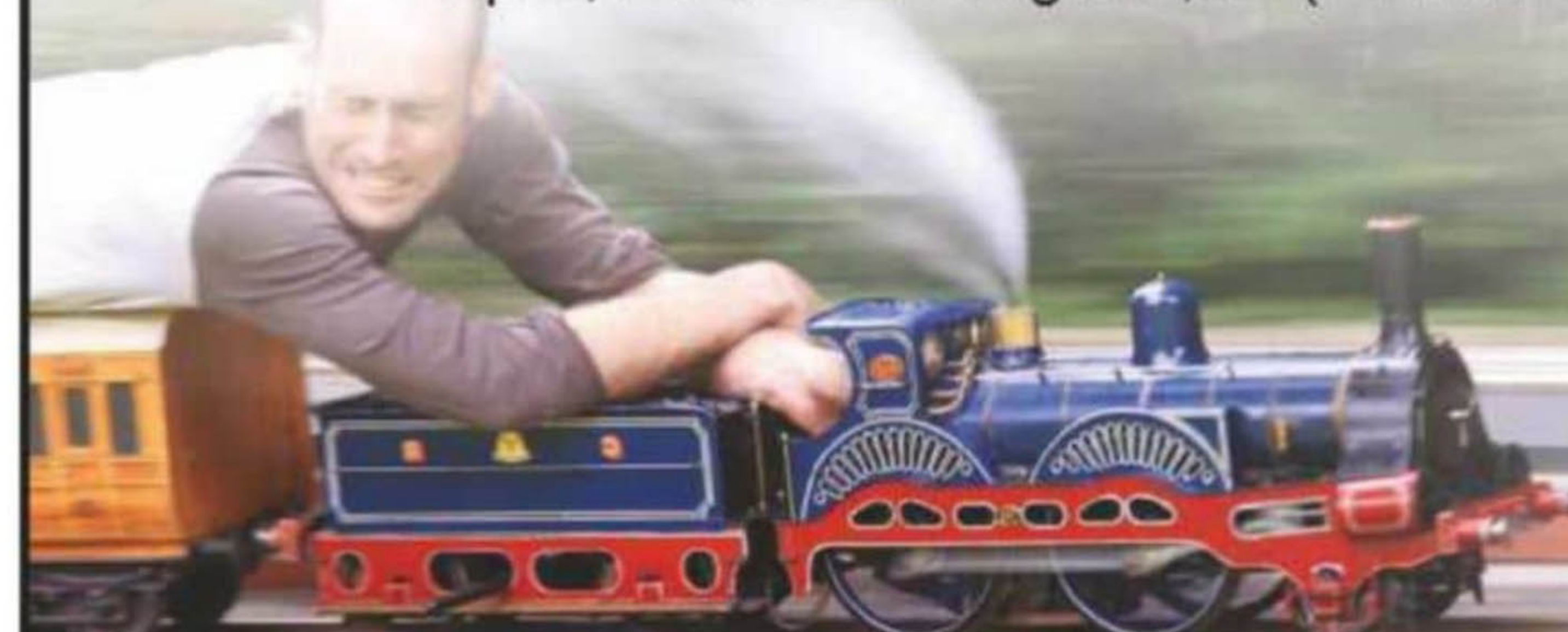
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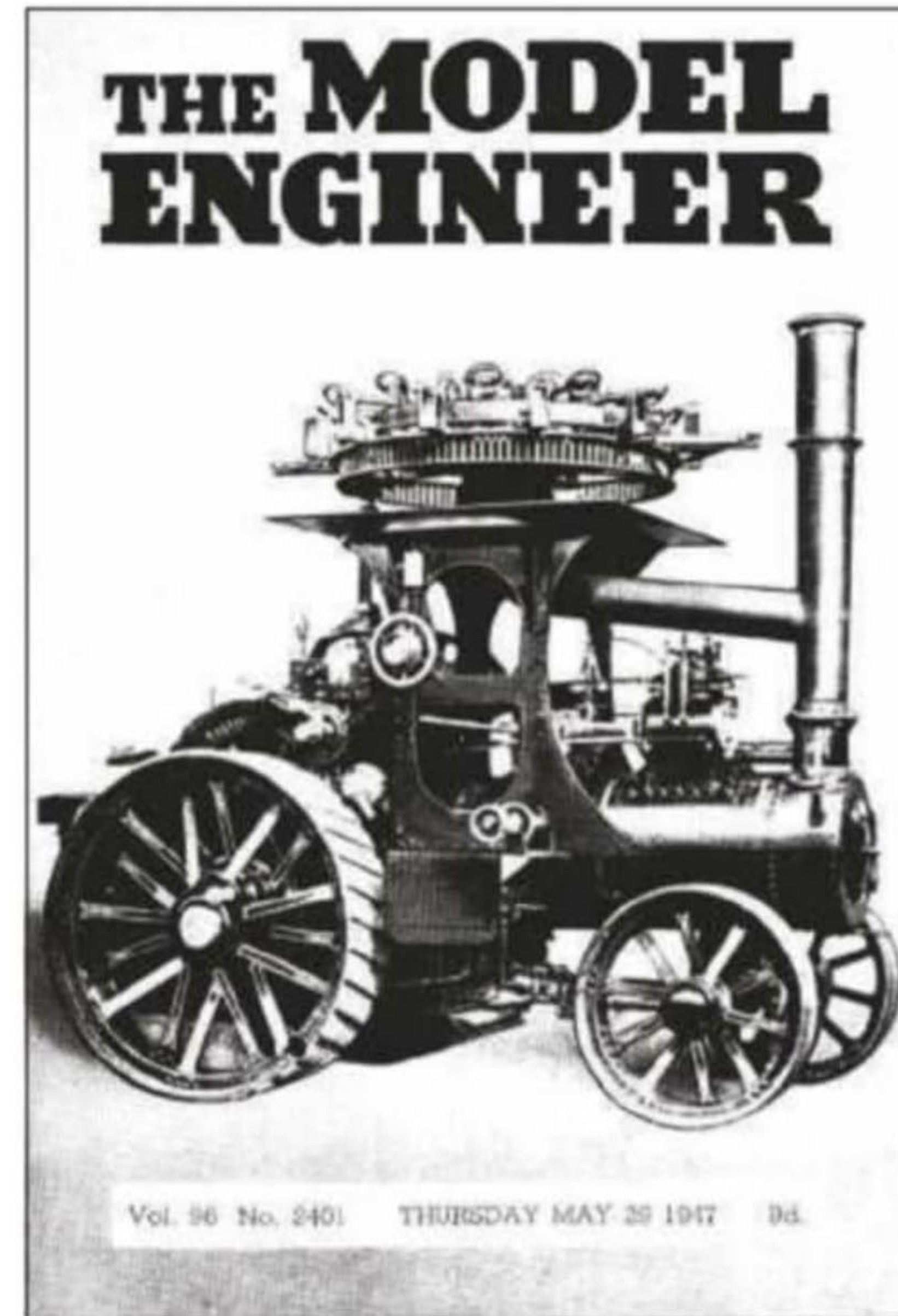
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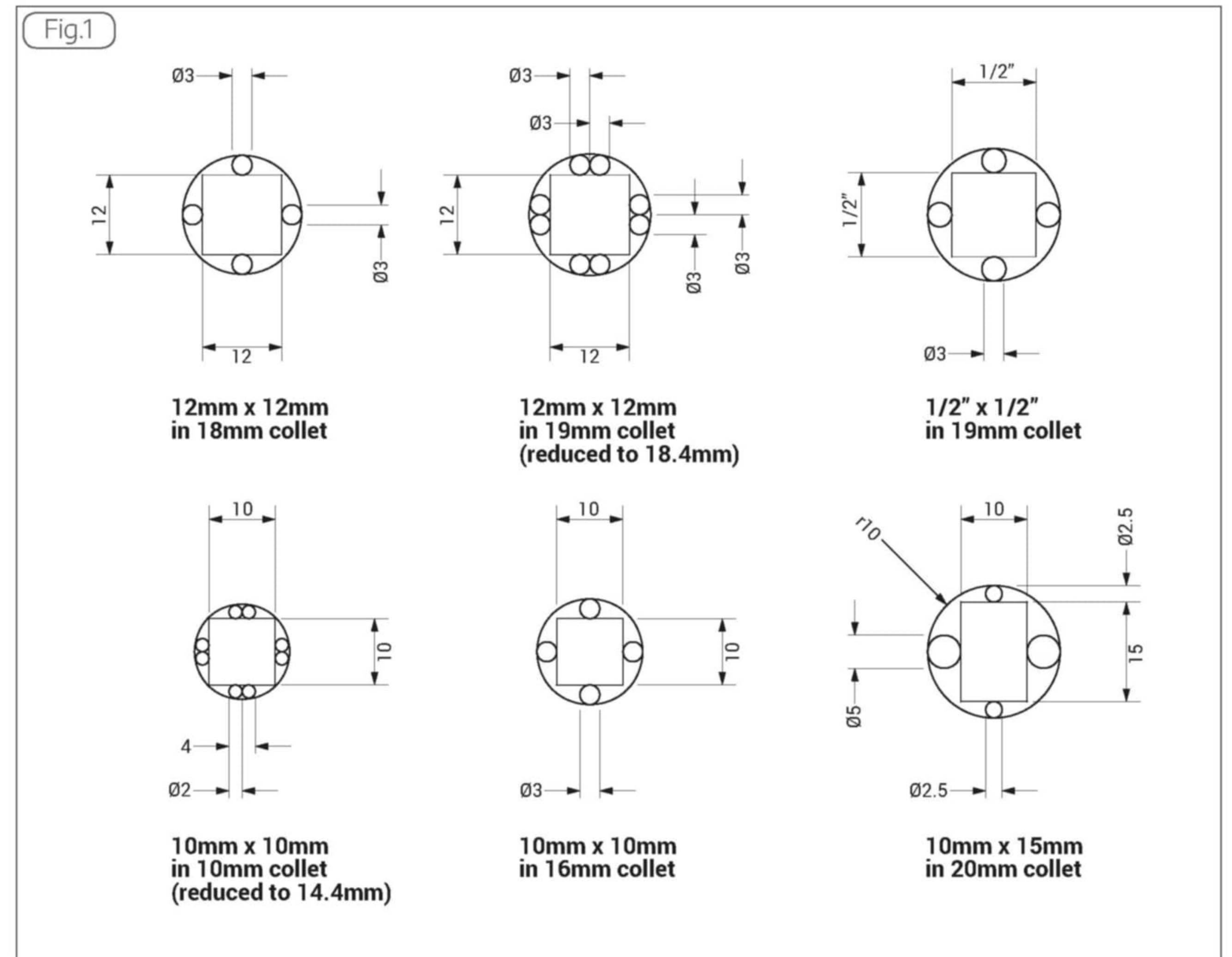
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Fitting a square peg in a round hole

John Hinkley tries a way of holding square stock in a collet



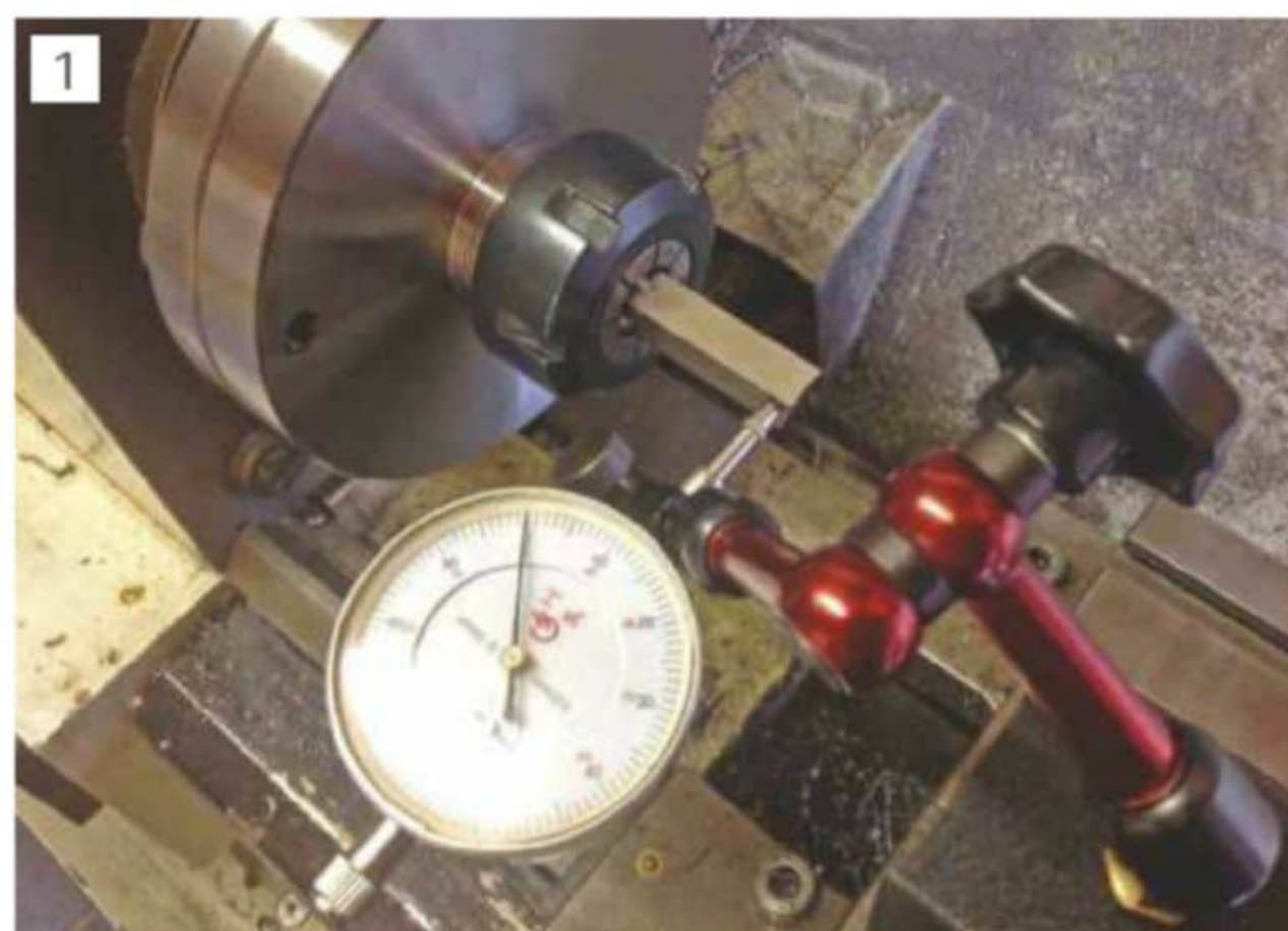
How many times have you wanted to turn a piece of square stock in the lathe? If you are anything like me, not often! But when you do need to, you'll need some means of holding the stock true and parallel to the lathe spindle. The easy way out, for those with 5C collets and the like and a means to hold them, would be to buy a suitably shaped collet. I don't possess a 5C system - all my collets have been standardised between the lathe and mill with the ER25 and ER32 systems for both.

Taking my cue from Archimedes, I took a long soak in the bath and I came up with the idea expressed in this article. Bear in

mind I am not by any means advocating this as a method to hold square stock in collets on a regular basis but suggest it as a temporary measure for a one-off set-up. Using, in my case, an ER32 collet chuck, it has a maximum collet capacity of 20mm in diameter. A get-out-of-jail card, if you will.

A few minutes spent using a CAD program and adjusting the size of the stock, collet and rods and I came up with the examples shown in **fig. 1**. That done, it was off to the garage to test the theory. Having cut several lengths of silver steel of the required diameter to 50mm, the length of the appropriate collet, I then trial-

Taking my cue from Archimedes, I took a long soak in the bath and I came up with the idea expressed in this article.



The general setup, dial gauge reads 0.00mm.



Closer to the collet, gauge reads 0.01mm.

assembled the arrangement in a chuck as shown in **photo 1**. In the example shown, I have used a piece of 10mm x 10mm HS tool steel, in order to measure the parallelism of the set-up. **Photograph 2** shows that there is a difference of less than 0.01mm in the measurement of the stock. Other set-ups showed a similar level of accuracy, although some care is required to ensure

that the rods are set parallel (or as near so as possible) and bear on the clamping parts of the collet, rather than the gaps between. In some instances, the collet either needed to be squeezed down to clamp the work or be "persuaded" to accept a slight over-stretching to accommodate the stock and silver steel. Fortunately, the ER collets are fairly forgiving in both these respects. It

should be borne in mind that, unless you use a collet chuck of the type shown in the photograph, with a through bore, the length of stock and the retaining pieces will be limited. However, I anticipate that use of this method will be restricted to small work pieces, anyway. ■

Theasby's Wrinkles

Making a Flexible Coupler

Geoff Theasby, G8BMI, makes a special connector.

In making a transmitting radio aerial tuner, a 'Transmatch', I needed two insulated flexible couplers, but only had one. This takes the form of a plastic ring, with two full width arms set at right angles, therefore not in contact, but

supported by the ring, each bearing a boss with a grub screw. Thus, insulation is achieved, together with a degree of angular misalignment for adjustment. They are ideal for use when both elements of a variable capacitor are 'live' and

subject to 'hand capacity' effects. These couplers are rarer than hens' teeth these days, and the only ones easily available at a good price were all metal. They have a spiral groove cut into them, making, in effect, a very stiff, broad, flat spring. If I



Expo drill in toolpost zz Flex cplg 4



Nearly finished... (In lathe) zz Flex cplg



Diamond saw in mill zz Flex cplg 3

made some from Acetyl, or Nylon, then my objective would be fulfilled.

I have a lathe, milling machine and drill press, so it was theoretically easy. I needed some way of cutting a spiral in a piece of material held in the lathe chuck. On reflection, it would be easier if I cut, not a spiral, but a series of cuts through to the central bore at 120 degree intervals, but not meeting, around a short piece of rod, inspired by a strain relief on a coaxial plug.

In the toolpost of the lathe I mounted a 12 volt mini-drill, held in a longitudinally split piece of 38 mm OD plastic drainpipe, fastened with M3 csk machine screws to a parallel length of aluminium 10 mm square bar, and clamped by a Jubilee clip at each end. The mini drill was supplied from a speed control unit I built myself. With a miniature circular saw blade, slitting saw or cut off disc in the mini drill, I can move the running drill sideways or back and forth, and thus cut narrow transverse grooves in the rod. Bingo! (I can also drill holes at any p.c.d. (pitch circle diameter) on a disc held in the chuck, but that's another subject) From the faced end, move x mm to the left,

(x being dependent on your cross slide leadscrew) make a slot, move x mm left. Repeat, slot, add x mm, and again. Rotate chuck 1/3 of a turn, repeat 1 mm along, in between original slots. Rotate 1/3rd, repeat again. None of these slots should link up, except to the bore, **photos 1, 2**.

If you have to reduce the diameter of the rod, do this before cutting the slots, as the finished item is weakened in shear and may break. I speak from experience! Mine was bored 7mm for a 1/4 inch shaft.

The couplers could be made on a vertical mill, as this would not limit the size of the cutting disc, as the lathe-fitted drill does. A rotary table would help, but



Slitting saw in mill zz Flex cplg 2

Readers without access to such machinery can produce similar items using only a power drill, vice and Junior hacksaw if careful.

the indexing of the work is not critical, just cut slots roughly every 120 degrees, by lowering the head between cuts.

I tried using both a slitting saw and a diamond-coated cut-off disc, **photo 3**. Both did the job well, but the saw was faster. Then return to the lathe to deburr. In this photograph, it is supported on the bore drill, as it proved to be as relaxed as a newt, **photo 4**. Mark 2 and Mk 3 followed, at a greater spacing, and in a different material. Finally, cross drill, 5 mm in from the rear edge by 2.5 mm and tap 3mm for a grub screw or t-wain to grip the shaft. It is good practice to fit another grub screw at right angles to the first.

Readers without access to such machinery can produce similar items using only a power drill, vice and Junior hacksaw, if careful.

Results: it worked very well. This example had four slots cut over a length of 25mm, with two more lots of four at every 120 degrees, interleaved but not connecting. Yours may differ depending on the space you have available. I made a Mk 2 version in 12mm nylon, and a Mk 3 in 12 mm acrylic. ■

These couplers are rarer than hen's teeth these days, and the only ones easily available at a good price were all metal.

Scribe a line

YOUR CHANCE TO TALK TO US!

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

Deep Hole Drill Fracture

Dear Neil, thank you for your excellent magazine. I was interested in the article by Brian Wood describing his efforts in drilling a deep hole.

But when I spied the photo of the fracture surface, Figure 8, I was taken back to my occupation (I am now retired), Failure Analysis, or in the modern vernacular Forensic Engineering.

This image shows what looks like a rotating bending fatigue failure. The crack origins appear to lie around the circumference roughly from the right hand side, extending around to the lower bottom of the item, where there is a ratcheted appearance. I have attached a grab of the image 8 and added some arrows and text. Unfortunately, the image is not sharp on the other side of the item, so it is hard to see detail. Of course, I would like to get it under a microscope, but that is not likely to happen. The ratcheted appearance shows that there were many places where cracking commenced, and then, as the cracks grew into the body they merged onto a common plane. The location of the origins of cracking might be located around a change of section, a circumferential groove or some sort of damage, I cannot really tell from the article. The edge of the item appears to be rough. The cracking then proceeded across the item until failure occurred.

The description in the article says that the failure is a rapid brittle fracture.

Now I could start preaching here, but what is meant in the article is that the fracture happened quickly. Brittle fractures happen very quickly (instantaneously), upon the load reaching a critical level, without much sensible deformation. And it is certain that inappropriate heating of some materials can produce brittleness. Fatigue fractures, on the other hand are the result of repeated applications of load, during which time a crack grows, usually from some defect or stress concentration in the item. The crack starts tiny and then grows each time the load is cycled. So, in a rotating bar, with a bend or some other way of producing a cycle of load per revolution, the crack will grow until failure occurs. In this case the impact loads may have also contributed. It might be said that the



action of cold bending and straightening of a bar will leave residual stresses in the bar. Also, local heating and cooling may leave such stresses.

Residual stresses act with the applied stresses to enhance or reduce the effect. This is used to good effect with shot peening for example.

If the rotating rate and impacts per revolution of the drill are considered, then the number of cycles which the rod was subject to would be able to be estimated.

And microscopic examination of the fracture usually reveals striation markings which are produced by the applied load cycles. And if you are fortunate the number of striations can be related to the number of load cycles. QED.

In a proper failure analysis, one would examine all of the items involved and attempt to measure the important dimensions in the object, in an attempt to do some stress analysis so that rational explanations might be made.

Noel Goldsmith, Australia

A Gear Cutting Machine



Dear Neil, I'm sending this message on behalf of my father-in-law, Mike Kovacich, who is a machinist and reader of your magazine. He's been cutting gears for over 40 years.

He's built a gear cutter/hobbing machine based on your blueprints, and he made some modifications that he wanted to share. The pictures show 35 pitch, 65 teeth chain sprocket. It takes 3 cuts to get to depth.

Mike doesn't have an e-mail account, but I'm happy to pass on any questions or comments to him.

Ted Wendt, by email.

Machining a Shallow Groove

Dear Neil, I like cracking little problems and thought this one might interest our readers.

I needed to machine a circular segmental chase along one side of a half inch square steel bar to be a snug fit on an inch and three-quarters O/D brass tube for silver soldering. Don't ask what for, it's Classified or Intellectual Property or something.

My first attempt was to set the piece eccentric in the four jaw chuck and bore the chase, but combined deflection of piece and tool produced a rough result which needed a lot of arduous hand finishing and even then, was not satisfactory. I looked at my little vertical mill and reflected that I had never used the tilting head facility so why not give it a go to machine said groove to a 7/8th inch radius. Unfortunately, my sense of geometry, conic sections and angular projections had deserted me so I couldn't calculate the angle to tilt the head to generate it. I tried three runs with small increases of tilt each time until an ad-hoc gauge indicated success. Pictures are worth a thousand words so please look.



Peter Peters, Dorset.

More Deep Drilling

Dear Neil, with reference to your issue 283 cover story - drilling a long hole through a church wall.

I recall many years ago watching a team drilling long holes into a rock face at the side of a road to insert 'rock anchors'. They used a drill, which eventually was resin fixed into the rock.

It appeared to be a hollow tube with a helical outer thread and by its very nature was not used a second time, but I doubt that it couldn't. Being consumable the team had dozens lying around, many of them many meters long, so I expect they are freely available to buy.

Just a thought should the project come up again.

Bernard J Greatrix, by email

Dewhurst Alternative



Dear Neil, Like Glyn Davies, my single-phase Super 7 was also fitted with a MEM contactor and a Dewhurst reversing switch, which fairly rapidly burned out although seldom used for reversing.

A friendly electrician suggested that a much better and far cheaper solution was to fit a 250 v, 10A "ON-OFF-ON" double pole changeover latching toggle switch in place of the Dewhurst and that it could be fitted to the front cover of the MEM contactor.

I followed his advice and fitted the switch some 35 years ago and have had trouble free operation ever since.

In use, select the motor direction before starting. To reverse, switch off the motor and let it come to complete standstill before switching over and re-starting.

A word of caution- ensure that the switch is in one of the "ON" positions ; do not use a switch with a centre "OFF" position as this isolates the start winding and the motor will not start but cause the run winding to make a distressing and ultimately destructive buzz!

I do have inverters on most of my other machines, but the Myford is very well set up so I am reluctant to disturb it and am happy to use it with ancient technology!

Attached is a wiring diagram and some pics to show the layout.

Peter Sanderson

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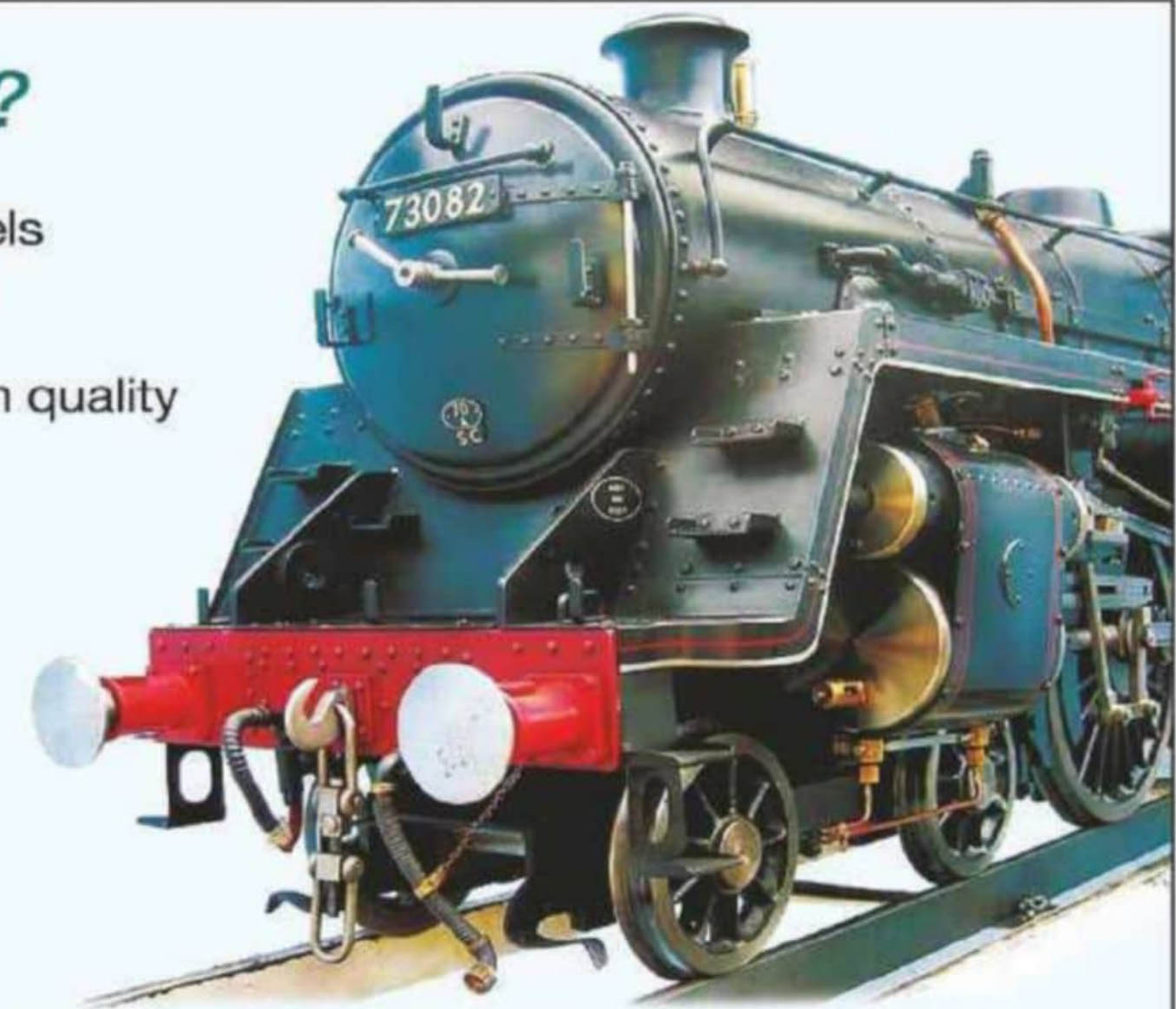
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