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# MODEL ENGINEERS' WORKSHOP

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS AUGUST 2024 ISSUE 342 WWW.MODEL-ENGINEER.CO.UK

## RECORD PERFORMANCE

A useful beginners project introducing a wide range of techniques.



## MAKING VINTAGE TRACTOR PARTS

Richard Lofting needed a fixed steady for a Myford ML10.

## A PAINT CAN TURNER

Big or small, Roger Froud's design helps keep all cans of paint fresh.

### INSIDE THIS PACKED ISSUE:

■ MAKE PAUL TINEY'S SHEET METAL ROLLERS ■ IMPROVEMENTS FOR YOUR BENCH MILLING MACHINE. ■ SUPPORTING AND STEADYING. ■ FINISHING TOUCHES FOR THE TOOL AND CUTTER GRINDER. ■ USING A MICROMILLING MACHINE. ■ REPAIRING A MACHINE LATHE. ■ EXPERIENCES WITH A DENFORD CNC LATHE. ■ MMEX 2024 – THE TALKS PROGRAMME. ■ PLUS ALL YOUR REGULAR FAVOURITES!

Aug. 24

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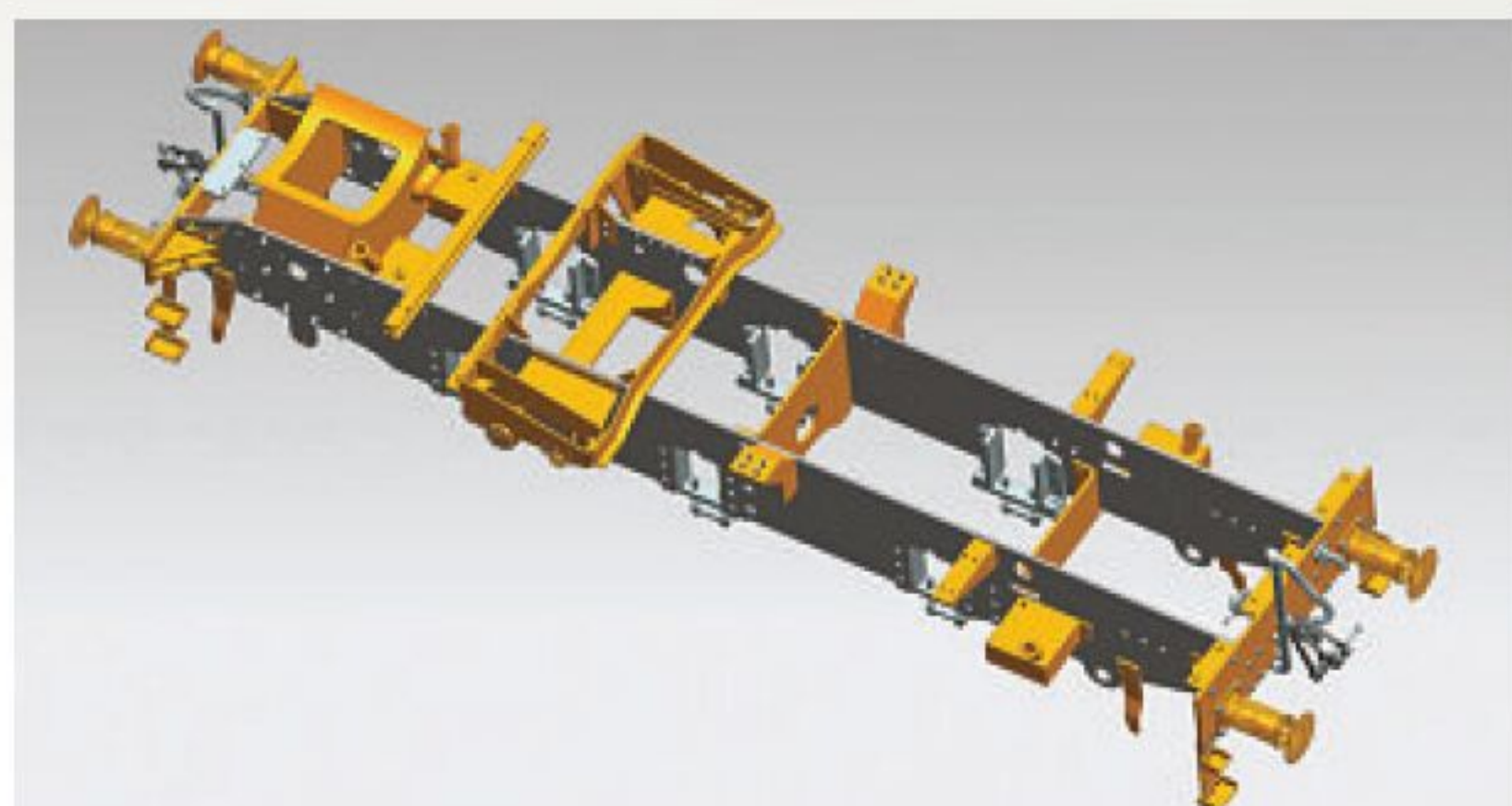


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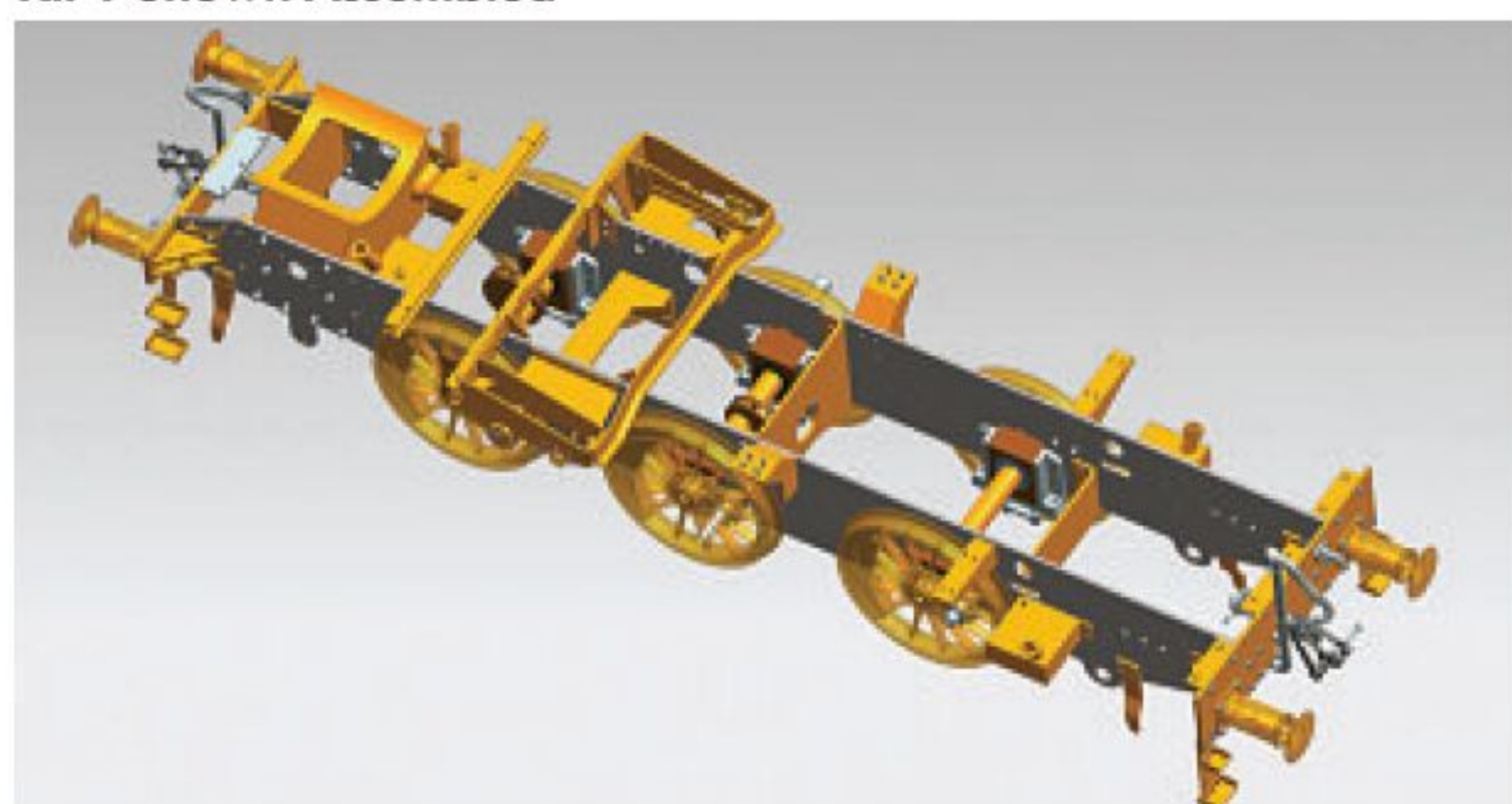
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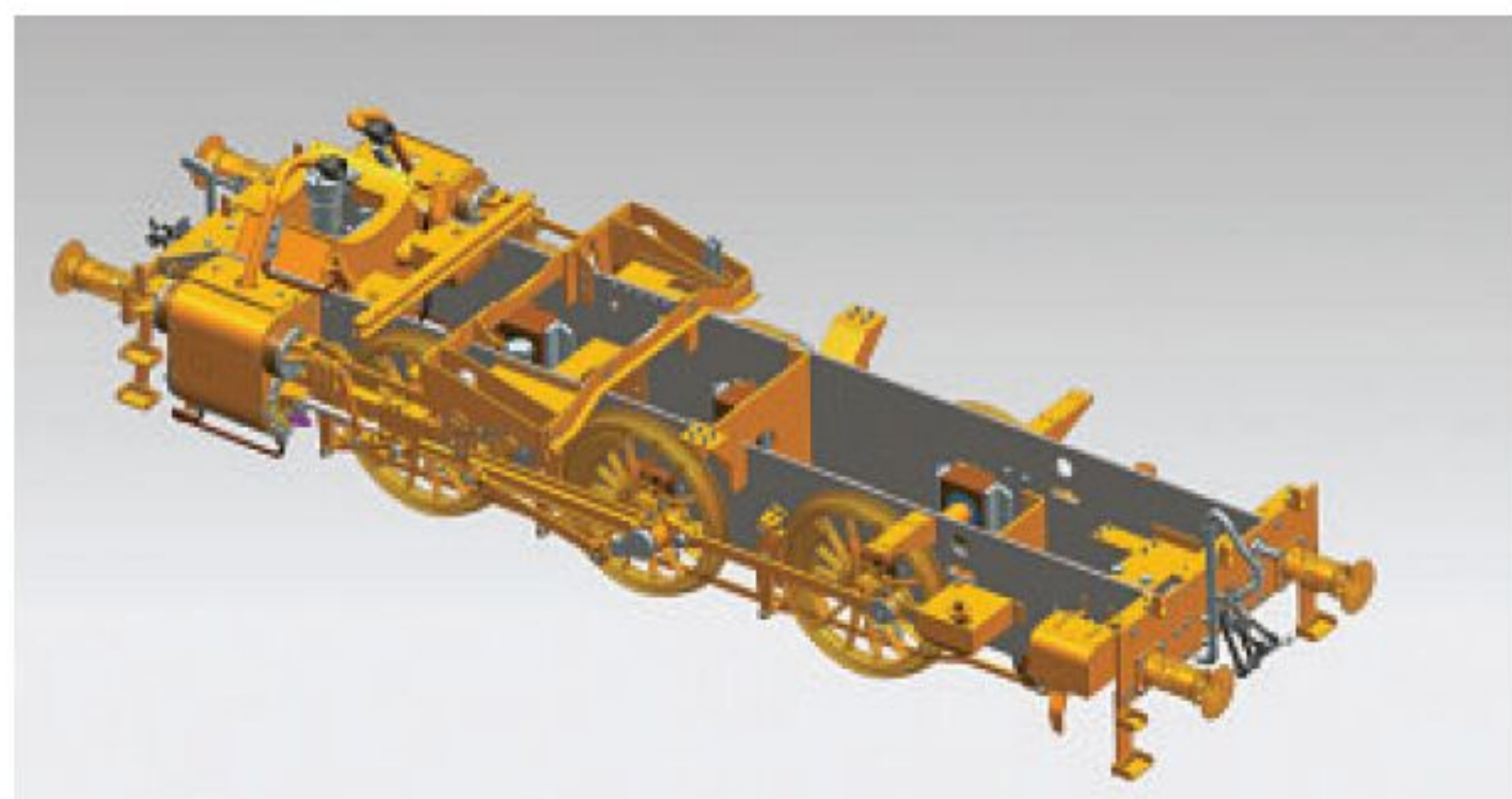
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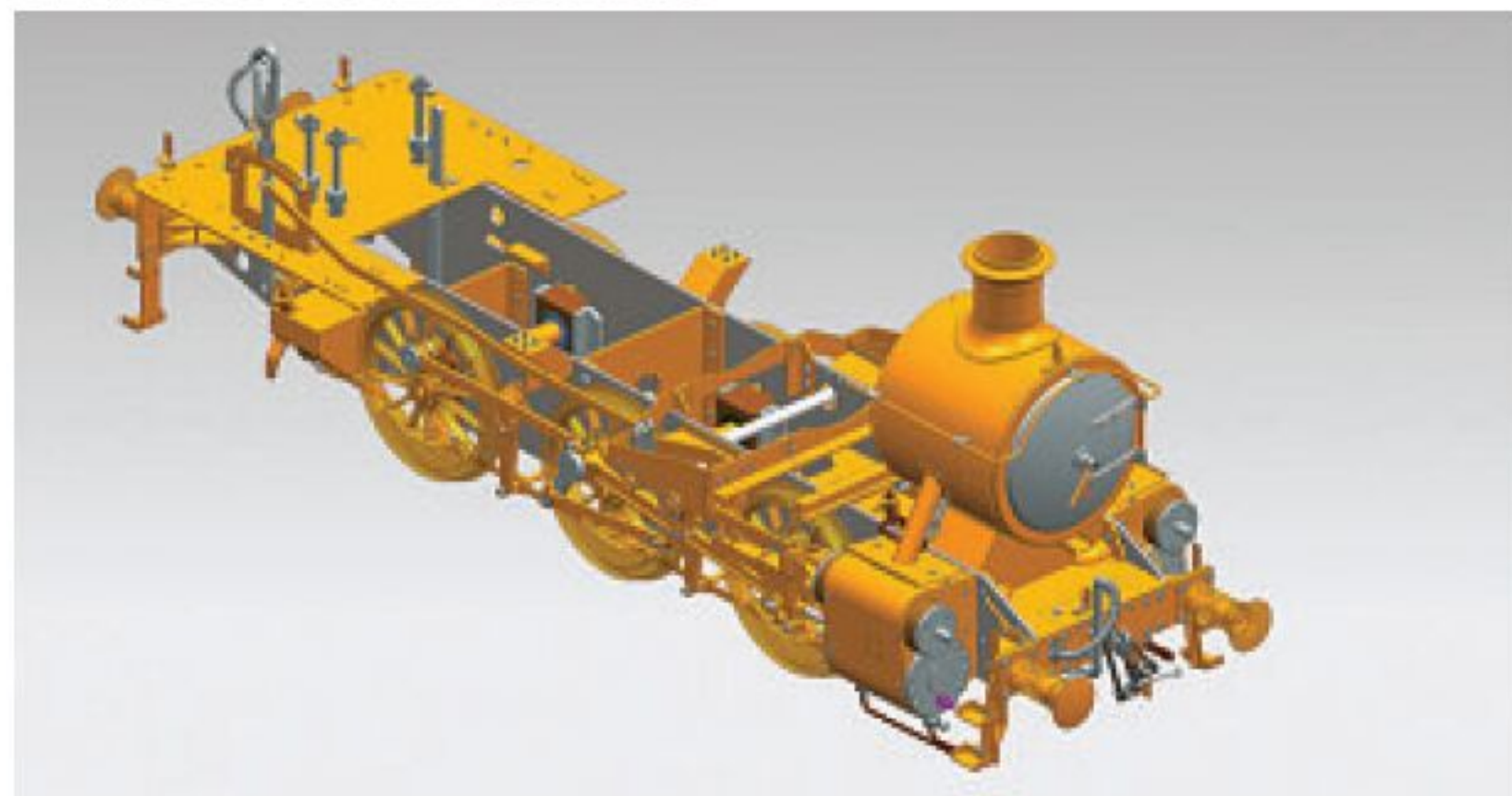
Kit 1 Shown Assembled



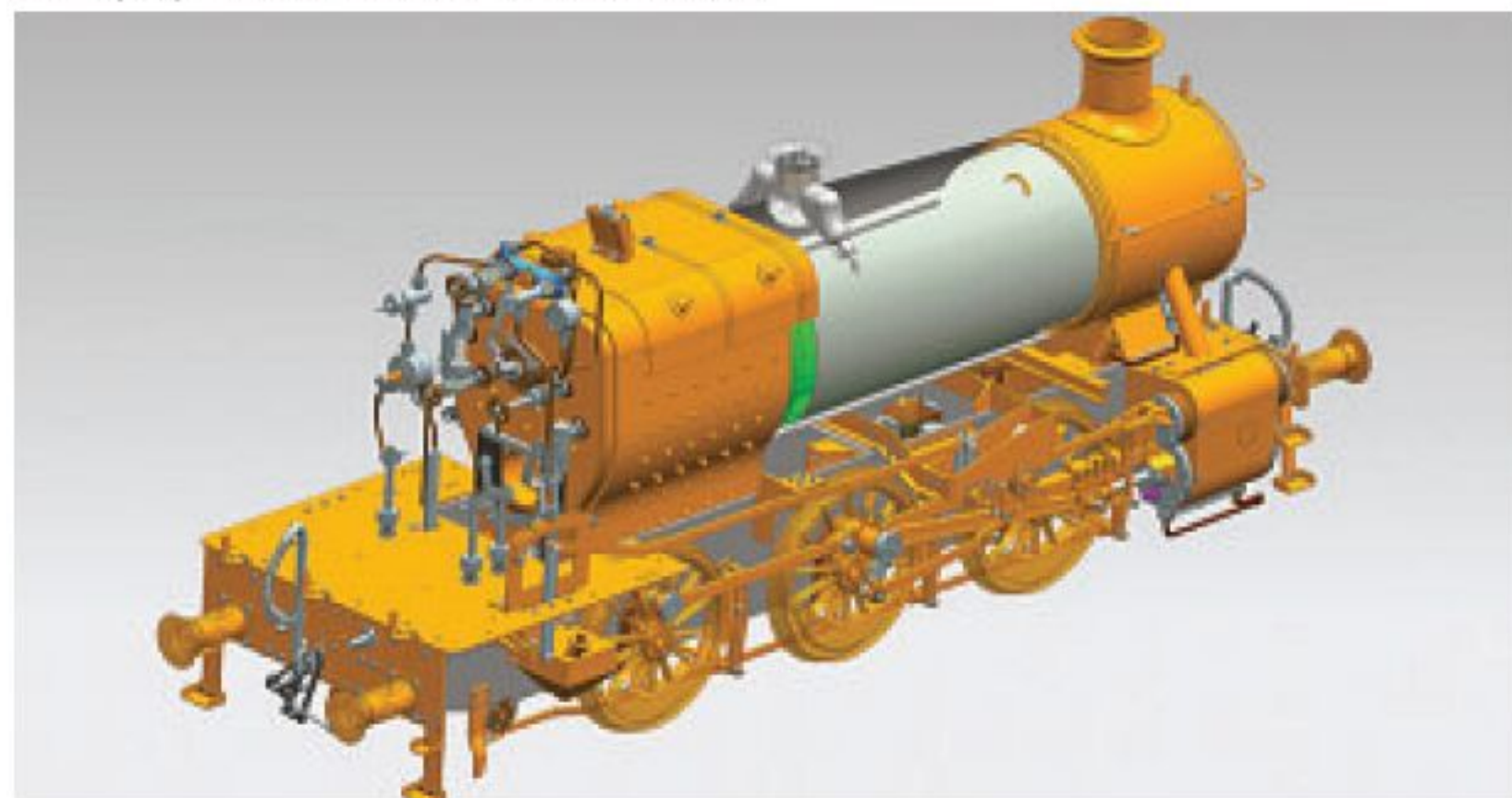
Kit 1 & 2 Shown Assembled



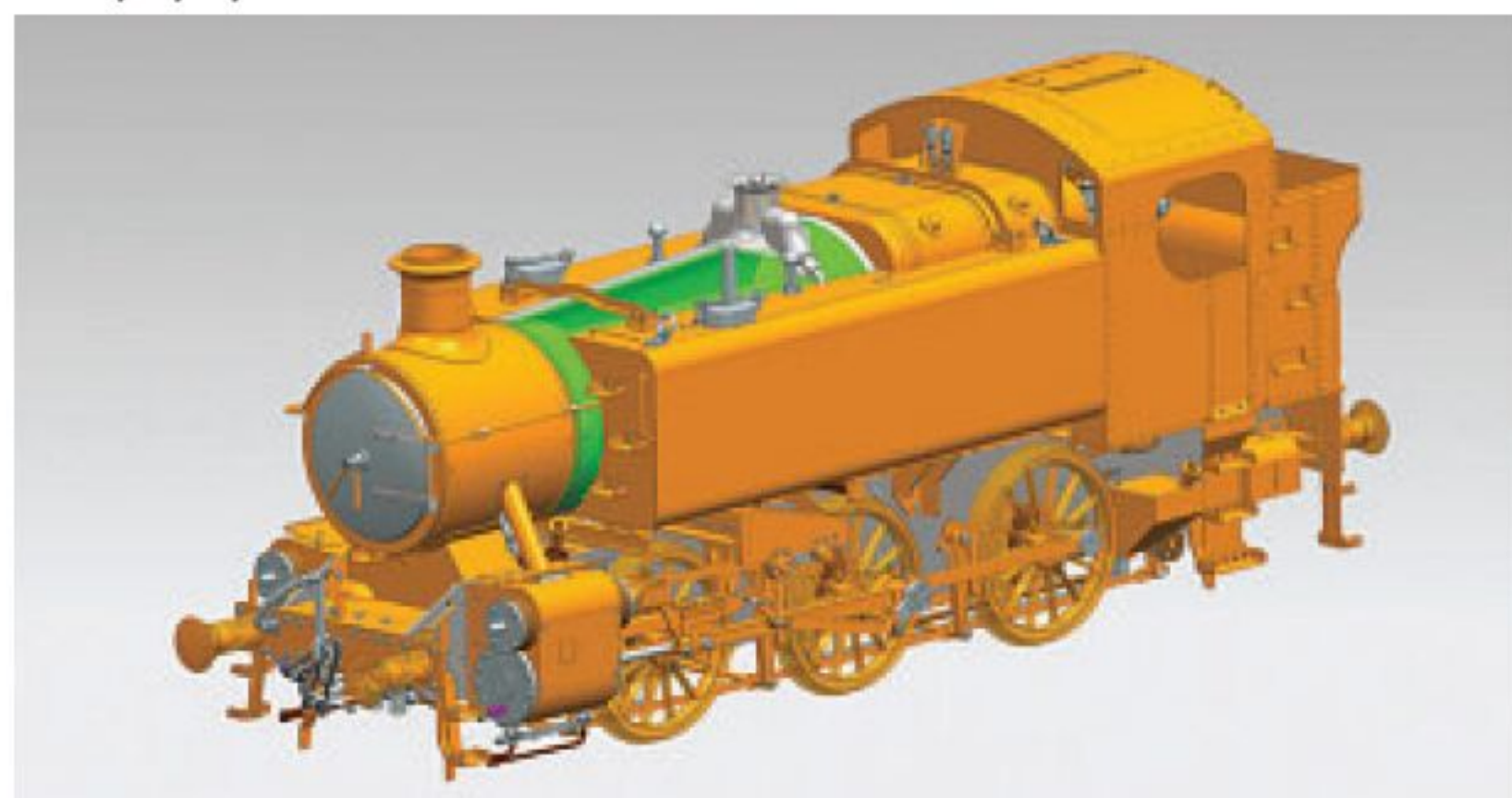
Kit 1, 2 & 3 Shown Assembled



Kit 1, 2, 3 & 4 Shown Assembled



Kit 1, 2, 3, 4 & 5 Shown Assembled



Kit 1, 2, 3, 4, 5, & 6 Shown Assembled

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## The GWR 15xx Class

All ten locomotives of the class were constructed in 1949 at Swindon and entered service on the Western Region of British Railways. They were employed on heavy shunting duties at London Paddington. Numbers 1501/2/9 were later sold to the National Coal Board for use in collieries. The 15xx was turned out in different liveries including lined black and NCB maroon.

## The 15xx Model

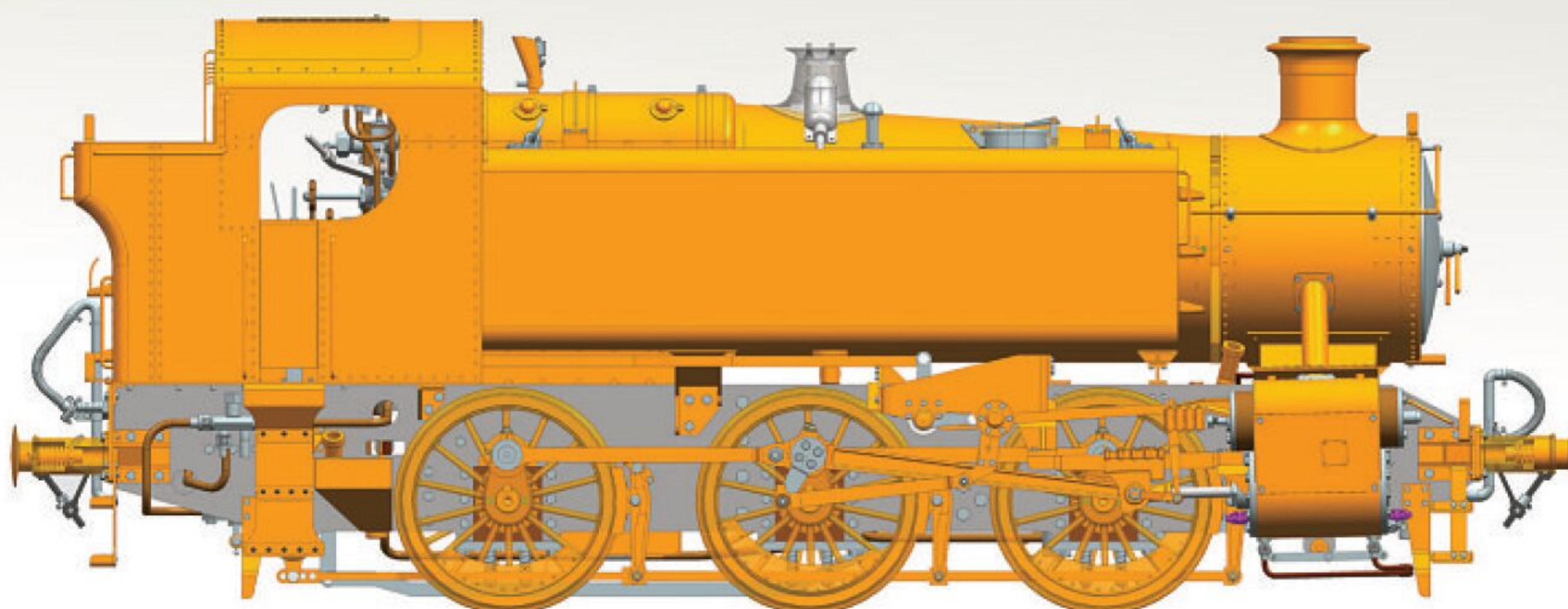
We have chosen the 15xx Class as our first fully machined, bolt-together, kit model. It is a substantial tank engine with two outside cylinders and Walschaerts valve gear. You will receive the model in a single delivery with every component required to build a complete model. The kit is divided into 6 sub-kits. See illustrations here showing the build stages. It is suitable for the novice builder who will benefit from illustrated assembly instructions and an instructional video. The kit is delivered fully painted in the livery of your choice. The model is also available ready-to-run. Boilers are silver soldered and UKCA marked. All components benefit from a 5 year warranty.

### Summary Specification

- 5" Gauge, coal-fired, live steam
- 2 outside cylinders
- Outside Walschaerts valve gear
- Stainless steel motion
- Silver soldered copper boiler
- Boiler feed by axle pump, injector and hand-pump
- Multi-element superheater
- Drain cocks
- Safety valve
- Etched brass body
- Choice of liveries
- Mechanical lubricator
- Reverser

### Approximate Dimensions

- Length 35"
- Width 10"
- Height 14"
- Weight 51kg



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## EDITORIAL

**Editor:** Neil Wyatt

**Designer:** Druck Media Pvt. Ltd.

**Publisher:** Steve O'Hara

**By post:** Model Engineers' Workshop,  
Mortons Media Group, Media Centre,  
Morton Way, Horncastle, Lincs LN9 6JR

**Tel:** 01507 529589 **Fax:** 01507 371006

**Email:** meweditor@mortons.co.uk

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## CUSTOMER SERVICES

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Monday-Friday: 8.30-5pm Answerphone 24hr

## ADVERTISING

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**Published by:** Mortons Media Group, Media Centre,  
Morton Way, Horncastle, Lincs LN9 6JR

## SUBSCRIPTION

Full subscription rates (but see page 54 for offer):  
(12 months 12 issues, inc post and packing) – UK  
£70.20. Export rates are also available – see page  
46 for more details. UK subscriptions are zero-  
rated for the purpose of Value Added Tax.

**Enquiries:** [subscriptions@mortons.co.uk](mailto:subscriptions@mortons.co.uk)

## PRINT AND DISTRIBUTIONS

Printed by: Acorn Web Offset Ltd., W. Yorkshire

Distribution by: Seymour Distribution Limited,

2 East Poultry Avenue, London, EC1A 9PT

Tel No: 020 7429 4000

## EDITORIAL CONTRIBUTIONS

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This issue was published on 19 June 2024

The next issue will be on sale 19 July 2024

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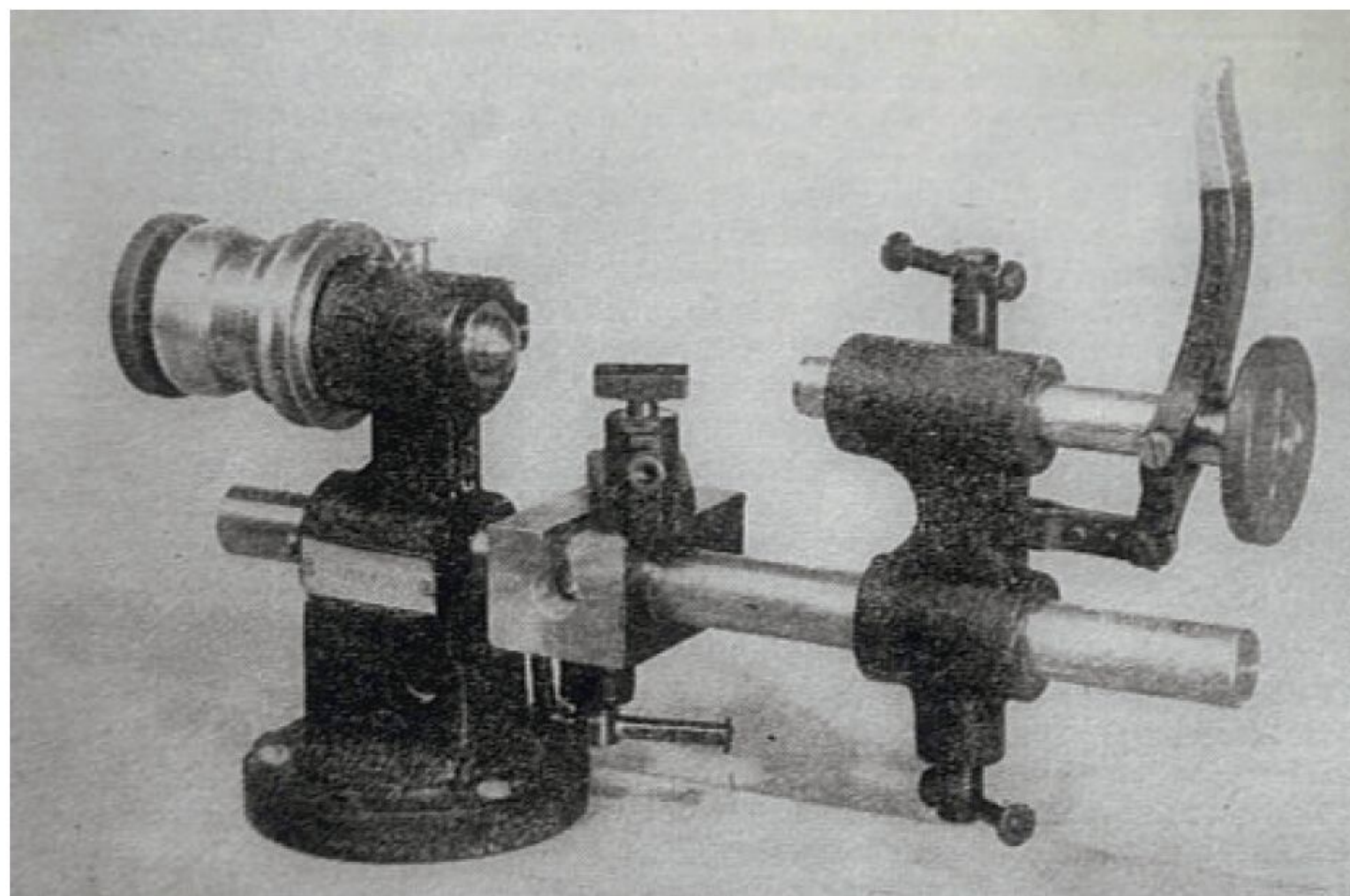
# On the Editor's Bench

I'm grateful to reader, Chris Delger, who has kindly sent me a catalogue for the 1954 Model Engineer Exhibition. I have only had it a day or two, and running to ninety-six pages plus covers I've only had the chance to have a quick skim, but there are many interesting snippets.

The exhibition was opened by the Prince of the Netherlands, Prince Bernhard of Lippe-Biesterfeld, pictured in RAF uniform. It's fascinating to look up his Wikipedia page.

Naturally the most interesting of the competition classes was 'Tools and Workshop Appliances'. Entrants were not afraid to tackle challenging projects, I will list them in full: A Turpin type universal dividing head; 0-1 inch micrometer; compound slide rest for a drilling machine; Duplex engraver, 2 1/4" instrument lathe, watchmaker's combination lathe and drilling machine (see the photo); pressure gauge calibrator and tester; modified ME jigsaw machine; 1 1/2" centre lathe; and a screwcutting dial indicator.

Another interesting competition was the Model Engineers Student's Cup, amassing a healthy twenty-seven entries. Around half of these 'sets of engineer's tools' made by, presumably, apprentices at Electro-Hydraulics Ltd. The internet shows the company were manufacturers of aircraft landing gear, forklift trucks and hydraulic mining equipment, from at least 1943 to 1964. Other tooling related entries are more unspecified engineers' tools and a surface gauge and scribe. There were also tools by A/T C. Hartland of



Sunderland, I assume A/T is air trainee, an RAF apprentice.

This is probably a good point to remind readers to make submissions for the Stevenson Trophy, head to [tinyurl.com/mr3b2z6d](https://tinyurl.com/mr3b2z6d) for details or follow the QR code.

The programme carries plenty of advertising, a standard Myford ML7 lathe, then only an eight-year-old design, with built in drive was £48 5s. That would be the equivalent of just over £1,100 in 2024, which seems a very good deal. My attention was also caught by an advert headed 'refrigeration for the home constructor'.

I shall try and remember to bring the programme along to MMEX in October, if anyone is interested in taking a look.

**Neil Wyatt**





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Taper of tailstock quill: MT3  
Motor: 1.5kw  
Weight: 230Kg

**Price: £2,782**

**W 2 Axis DRO – Price: £3,150**



**VM32LV Milling & Drilling Machine Belt drive & Brushless Motor**

**SPECIFICATION:**

Model No: AMAVM32LV (MT3) / (R8)  
Max. face milling capacity: 76mm  
Table size: 840x210mm  
T-slot size: 14mm  
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**W DRO + PF - Price: £2,948**



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# Contents

## 9 Thread Milling in the Workshop

Bob Reeve tackles a challenging machining operation, this article supports a talk to be given at MMEX in October.

## 15 A Fixed Steady for a Myford ML10

Richard Lofting made this accessory in order to machine a replacement part for a vintage tractor.

## 21 A Turntable Weight

This beginner's project from Neil Wyatt uses various machining techniques such as taper turning and knurling.

## 28 Micro-Milling – Part 6

In the final instalment of this series, Mike Tilby puts his micro-milling machine to work cutting blades for miniature turbine wheels.

## 32 Getting To Love My Denford Novaturn

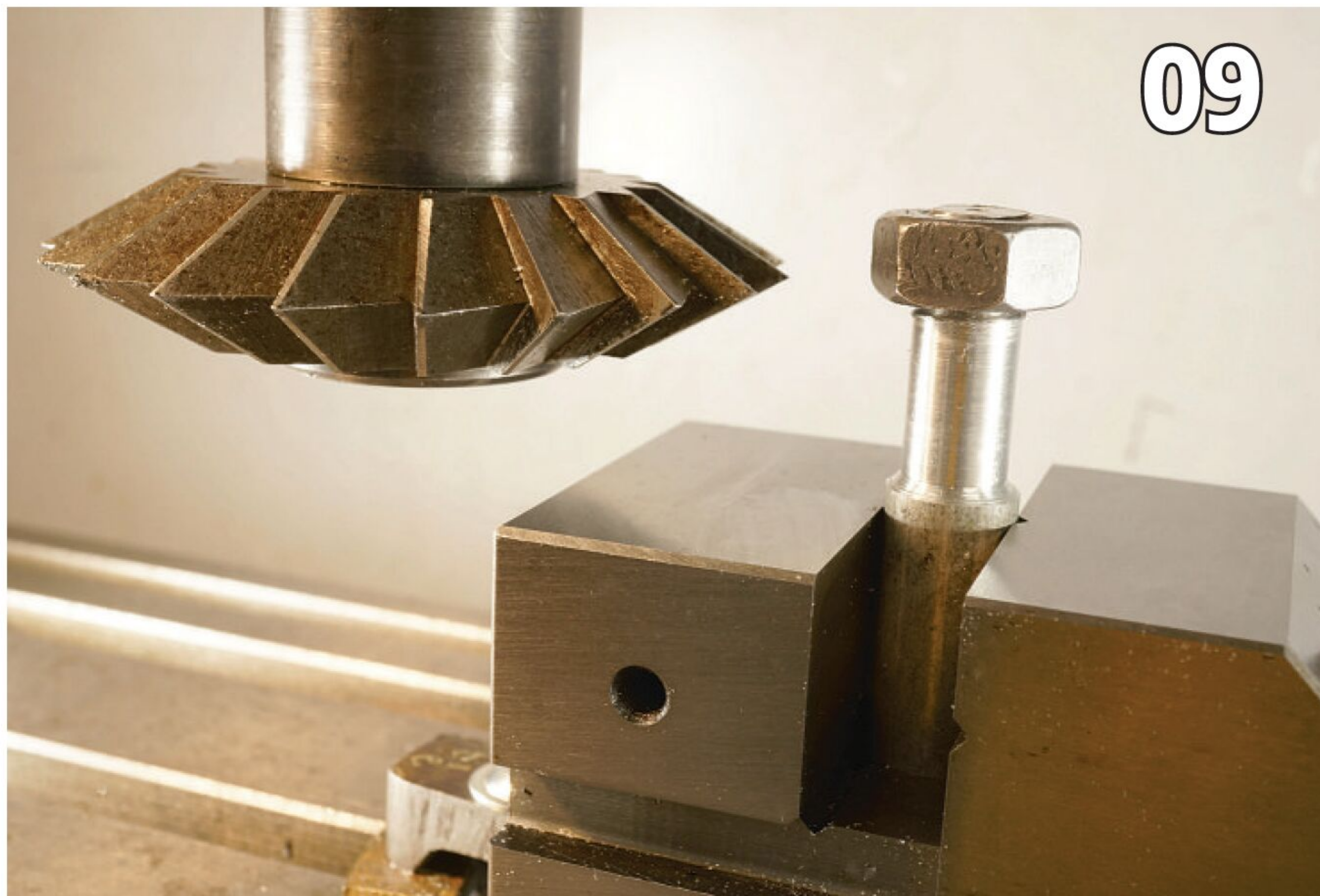
Mick Knights makes a set of toolholders for his Novaturn CNC lathe.

## 38 From the Archives

This month we revisit a vice renovation from 2001.

## 40 The PottyEngineering Cutter Grinder

Stewart Hart completes this excellent 'quick and easy' design grinder for restoring blunted milling cutters.



## 47 The Midlands Model Engineering Exhibition

Here's the timetable for the MEW Talks Programme at this October's MMEX exhibition.

## 50 A Flexible Paint Can Turner

A handy accessory for anyone who strives to achieve the best paint finishes, from Roger Froud.

## 54 Getting the most out of your Brushless Mill – Part 4

Jason Ballamy has a number of useful modifications to his SIEG SX2.7 mill.

## 60 Beginner's Workshop

Geometer looks and ways of supporting and steadying workpieces to make handwork easier.

## 61 A Sheet Metal Rolling Machine

Paul Tiney makes a straightforward but effect set of bench rolls.



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# Coming up...

## in our next issue

In our next issue Jacques Maurel explains how to carry out Vickers hardness testing.



## Regulars

### 3 On the Editor's Bench

The Editor studies the programme for a seventy year old exhibition.

### 36 Readers' Tips

Our winner this month found a way to stop his lathe coolant degrading. Send your tips to [meweditor@mortons.co.uk](mailto:meweditor@mortons.co.uk), you could win a prize.

### 48 Scribe A Line

In this month's postbag more bandsaw modifications and a mystery steam engine. We are always keen to hear from you – send the editor your thoughts at [meweditor@mortons.co.uk](mailto:meweditor@mortons.co.uk).

### 58 On the Wire

This month's round up of news from the world of hobby and full-size engineering looks at a new book on Digital Command and Control.

### 64 Readers' Classifieds

This month's collection of readers' for sale and wanted adverts. .

## ON THE COVER

*Our cover features a simple record turntable weight, an ideal beginner's project that involves a good range of machining operations as well as chemical blacking. See more details on page 21.*

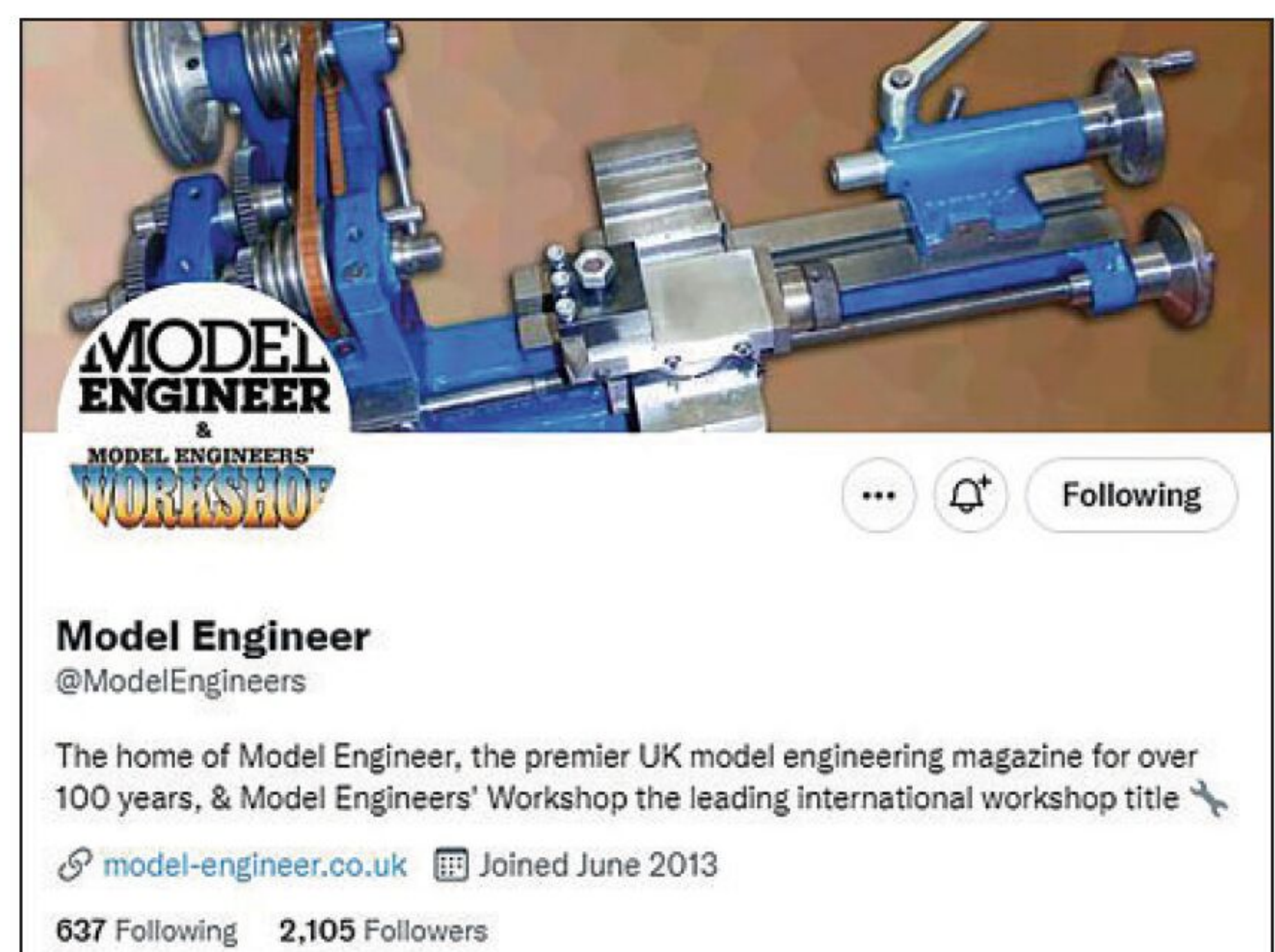


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## THIS MONTH'S BONUS CONTENT

### Extra Content!

See the videos for Jason Ballamy's Brushless Mill series:

<https://www.model-engineer.co.uk/forums/topic/getting-the-most-from-you-brushless-mill/>

Or search the forum for 'getting the most'.

### Hot topics on the forum include:

**Silicon bronze MIG brazing** Started by Speedy Builder5

An old technique brought up to date.

**Towards a better looking angle plate** Started by MikeK

It's not just about looks, a better finish aids accurate, secure clamping.

**EW Stringer Lathe Spindle Speed** Started by James Alford.

What sorts of speeds are appropriate for an vintage lathe with a spindle running in cast iron?

### Come and have a Chat!

As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. Come and join us – it's free to all readers!

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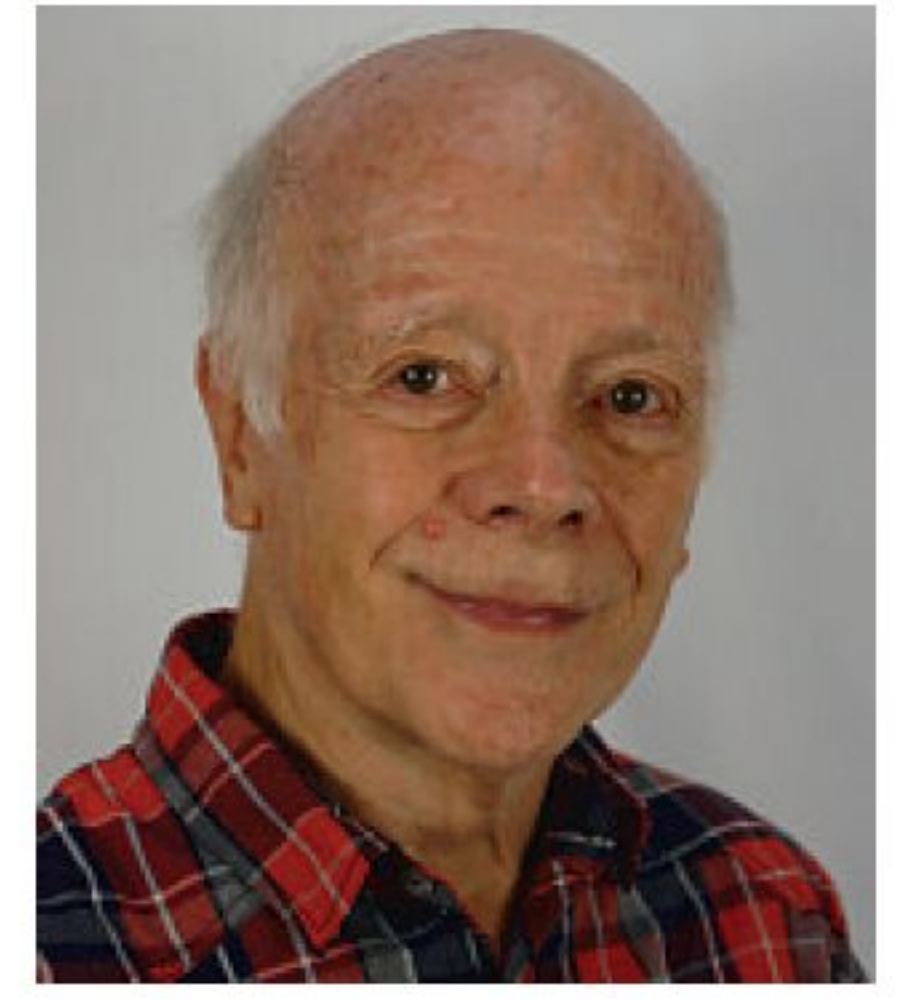
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# Thread Milling In The Workshop



**Bob Reeve investigates into the practicality of thread milling using CNC and various types of cutter.**

**M**ost Model Engineers start making screw threads using taps and dies, then progress to turned threads made on a lathe. But there are alternatives, some more practical than others. For example I remember seeing a leadscrew from a large planing machine exhibited in the Birmingham Museum of Science and Industry when it was located in Newall St. I stood in awe of this exhibit, tens of feet long, several inches in diameter and all made by hand.

Alternative thread making techniques, not so demanding on manual skills, might include thread rolling and thread whirling. I have some long high tensile bolts with Whitworth threads which I watched being rolled before carrying them back to my workshop for use on the milling table. Then there were the whirled threads I encountered as part of the Multi Role Combat Aircraft (as it was then) wing sweep mechanism. Whirled threads involve the cutter rotating around the work piece. A process used where long or very precise threads are required which might not have the common vee-form thread. In the MRCA these were essentially very robust and compact concentric, telescopic ballscrews. Their function was to reconfigure the wings in the transition from subsonic to supersonic flight and vice-versa. The loads were enormous, and the precision was superb. To my eyes, a minor triumph of engineering.

In a more down to earth moment at an SMEE zoom meeting of the Digital Group, the co-ordinator, Brian Neale asked if anyone had tried thread milling. No one had, but it sounded like an interesting challenge and the Digital Group might have both the necessary



*Sieg X3 CNC conversion.*

CNC mills and the programming skills to do it. Challenge accepted!

I already had the requisite CNC milling machine which has appeared in these pages before. **Photograph 1** shows my X3

which was converted to CNC many years ago. This machine is basically a three-axis machine to which has been added a 4<sup>th</sup> rotary axis. Note that there is no facility for tilting the head on this machine. >





Threadcutting tools & gauge.



60° Inc. milling Cutter.

First on the list of problems to be addressed was the question of the helix angle. This has always puzzled me because thread cutting in the lathe appears to take no account of the change in thread geometry caused by the helix angle of the thread. The traditional gauge in **photo 2** is used to grind the tools shown below it. I have never come across anyone tilting the tool by the helix angle to retain the exact thread form intended. The effect is small, because the helix angle is small. However, at this stage I decided not to pursue this in detail, pending discussions with fellow SMEE members who might hopefully be more knowledgeable on the subject.

I decided to put some boundaries on the threads that I might wish to explore. Starting with metric threads as being the most common (but perhaps not to model engineers). I did not anticipate milling very small diameters since the

workpiece was unlikely to be sufficiently rigid to withstand a full-frontal attack by a milling cutter. The 60° thread form presents an easy angle to generate and the pitch increment of 0.5 mm for many of the larger sizes reduced the number of variants.

My second choice was the Whitworth thread form mainly because it is a relatively coarse thread which was in common use before metrication and there are quite a few deployed in the venerable machine tools that occupy my workshop. Added to which they are becoming increasingly difficult to obtain and can be disproportionately more expensive.

I always intended to start with external threads on the grounds that it was easier to see what I was doing and there was less likelihood of crashing into the workpiece at the beginning and ends of the cut.

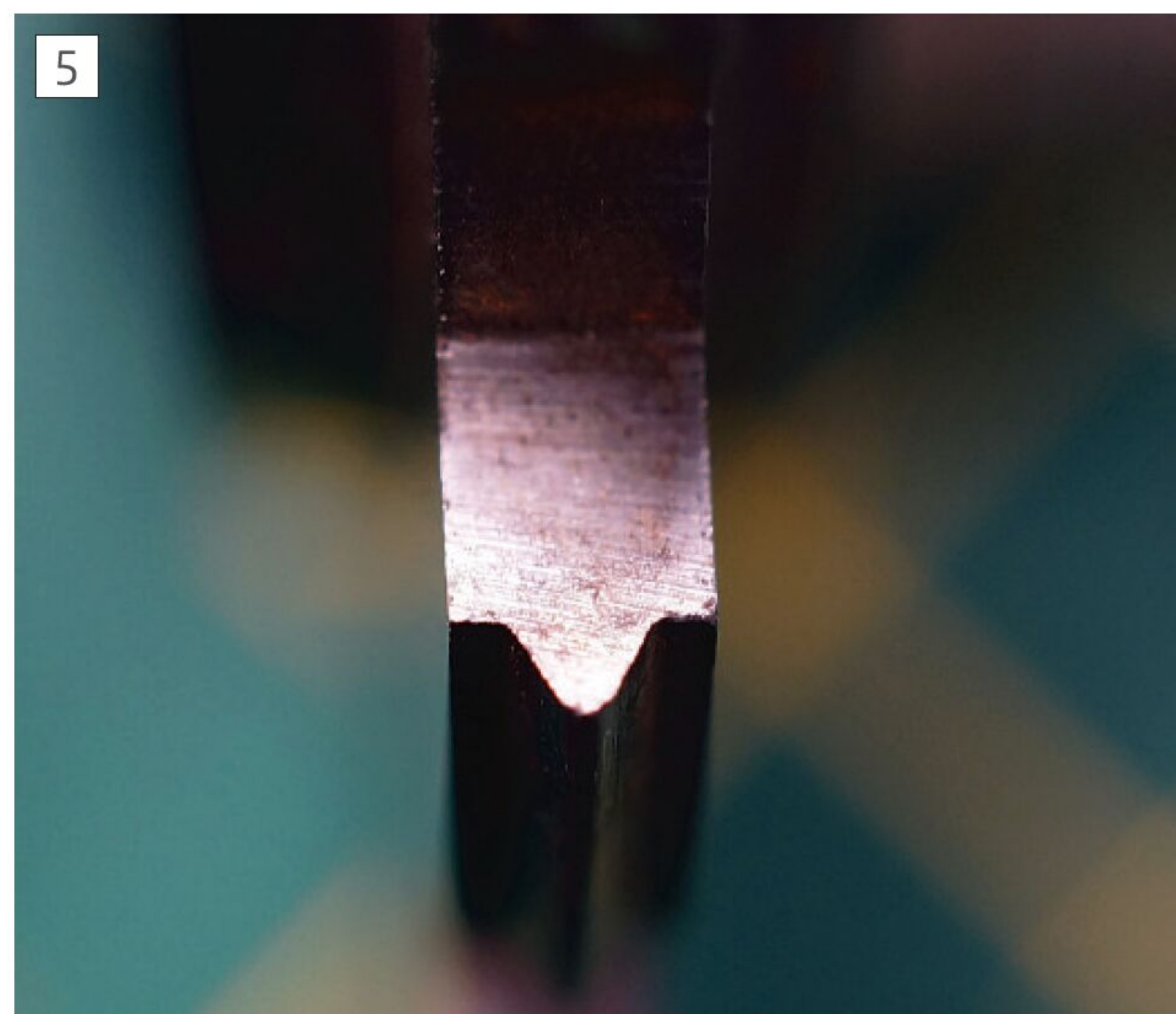
The next task was to explore what tooling was commercially available. I'm not averse to making my own tools, but I usually opt for the commercial option unless it gets prohibitively expensive or simply unavailable. Fortunately that turned out not to be the case.

I started with cutters for metric external threads. First up was a pre-owned cutter with two angled cutting faces meeting at the required 60°, **photo 3** This is not a full form cutter and will not round either the thread roots or the tips. That said, it was mine in exchange for three crispy fivers! Its condition was good, and it had not done much work so didn't need sharpening.

The next step was more ambitious; a full form cutter for a 12tpi Whitworth thread. "Full form" because it would cut the correct threadform, complete with radiused tips and roots, but only for 12tpi, **photo 4**.



Full form cutter 1/2" Whitworth.



1/2" Whit. corner radii.



Three more crispy fivers were invested. At which point I momentarily reflected on the loss of the floppy, dog-eared and dirty old fivers. Another part of our historic heritage lost to the plastic age?

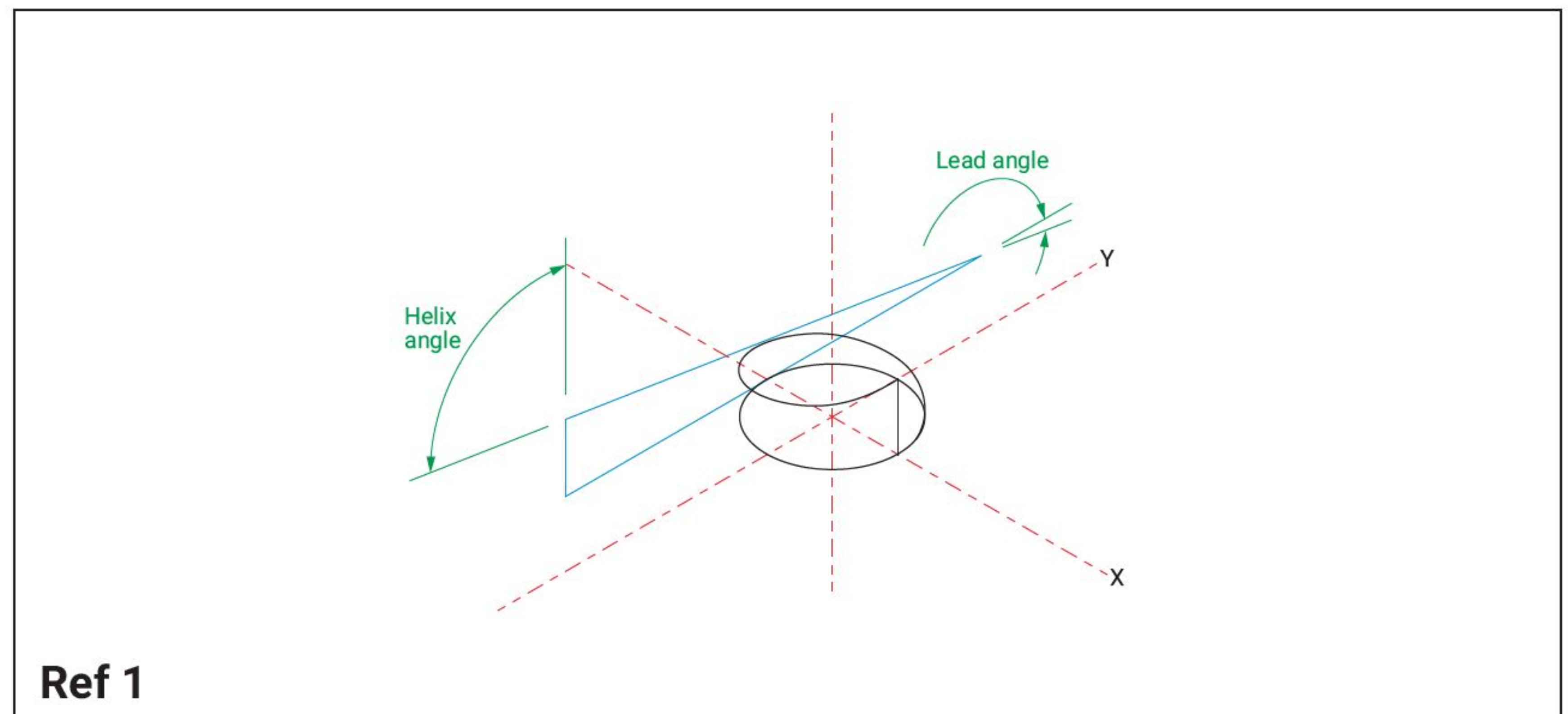
Photographing the full form capability of this cutter was something of a challenge but **photo 5** shows the details. With a tip radius for the thread root and two smaller radii on the internal corners which will provide a radius on each side of the thread crest.

It should be obvious that the cutters detailed so far were not suited to internal threads (unless of exceptionally large diameter). My choice for internal threading needed to be much smaller in diameter and would therefore have to run at much higher speeds. These turned out to be carbide tools with three ground threads so as to generate a full thread form. Needless to say three fivers would not cut it this time!

And so to the next question – to program or not to program? A sufficiently comprehensive CAM package would do the necessary, given sufficient information to define the thread details and its location. Essentially it is an exercise in spiral pocket milling. I had used a similar strategy to this for milling the ports in an inlet manifold for an automotive application. That exercise was done using the BobCAD CAM package, which was very successful, **ref. 1**. The downside was that the CAM program produced enormous files which took a long time to execute. This time I elected to manually program the thread cutting on the grounds that all that was required was a spiral path defined by the diameter, pitch and depth from a given start point.

Hopefully I might encourage a few budding programmers to have a go. However, I would point out that in my experience successful programs are rarely created in a blinding flash of inspiration. More often it requires a series of incremental improvements until success is achieved. Even then it is not perfect! To that end I have set out some of the stages that eventually led to a successful conclusion.

I use Mach 3 for the programming. This, or the later Mach 4, are free for the demonstration version, so making a start is relatively painless. In addition, the program simulators included are very usable for program development.



Ref 1

The budding programmer does not even need a CNC machine!

Milling circles or arcs can be a bit tricky, especially since complete circles linked by a helical path were required for this program. The G02 (clockwise) and G03 (anticlockwise) commands for circular interpolation are complicated by the options to use the Radius Format arc with A, B, C and R as well as the usual X, Y, Z words or alternatively, the Centre Format arc requiring all those, plus I, J, and K. So, by way of a start I programmed the centre format arc as follows:

```
%Spiral 1
G20 F100
G0 X1 Y0 Z0
M3
G3 X1 Y0 Z-0.2 I-1 J0
G3 X1 Y0 Z-0.4 I-1 J0
G3 X1 Y0 Z-0.6 I-1 J0
G3 X1 Y0 Z-0.8 I-1 J0
G3 X1 Y0 Z-1.0 I-1 J0
G3 X1 Y0 Z-1.2 I-1 J0
M05
M0
```

This has one line for each complete circle and a pitch of 0.2mm. Readers

who wish to type it into Mach 3, should find that it does indeed produce a spiral cutter path but for this trial no cutter is needed. Run the program offline. As always readers should ensure this is suitable for their CNC machine and is within their competence to use it, **fig. 1**. This is a snapshot of the program running and the first turn of the thread is highlighted; the remaining threads may be just visible "ghosted" below.

I was concerned that Mach 3 will only interpolate in one plane parallel to any two of the axes and this program appears to require interpolation involving three axes. However, after a bit of thought, I concluded that there was no interpolation required for the Z axis. As far as Mach 3 is concerned this is just a linear movement along the Z axis.

Those who typed in the program as written and got it to run might have spotted my deliberate mistake – it is a left-hand thread!

There was a further disadvantage in the centre format arc – it was not

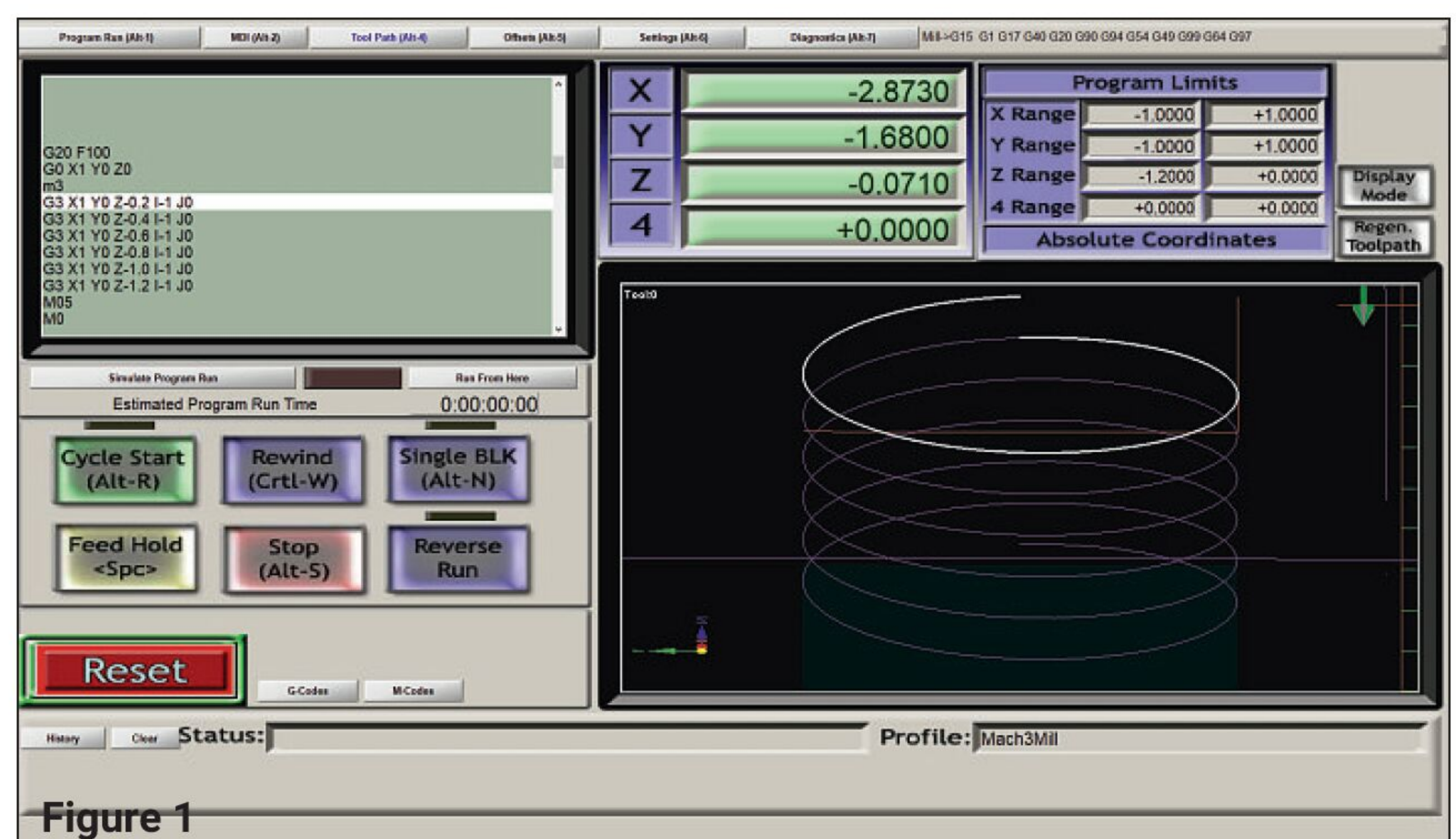
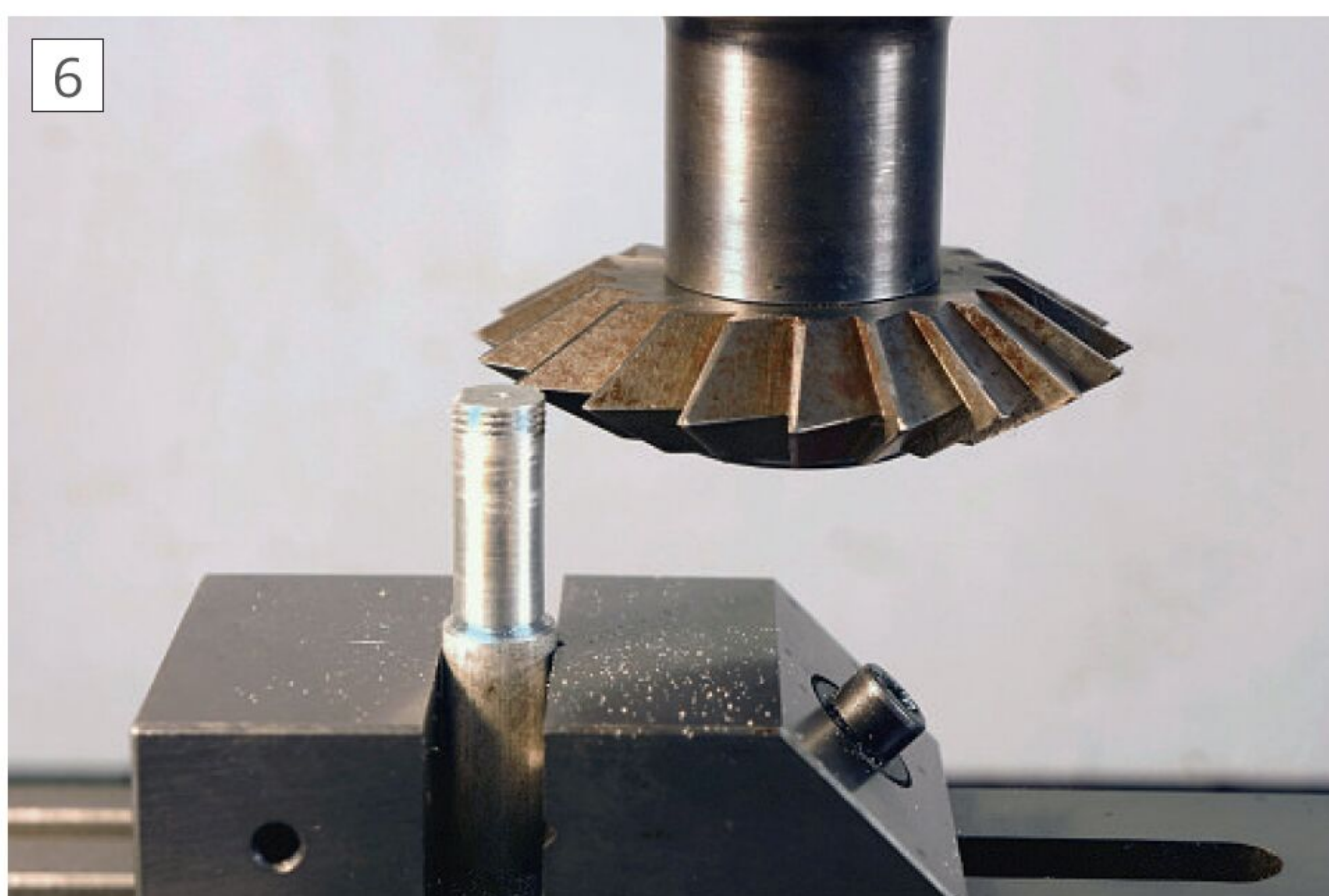
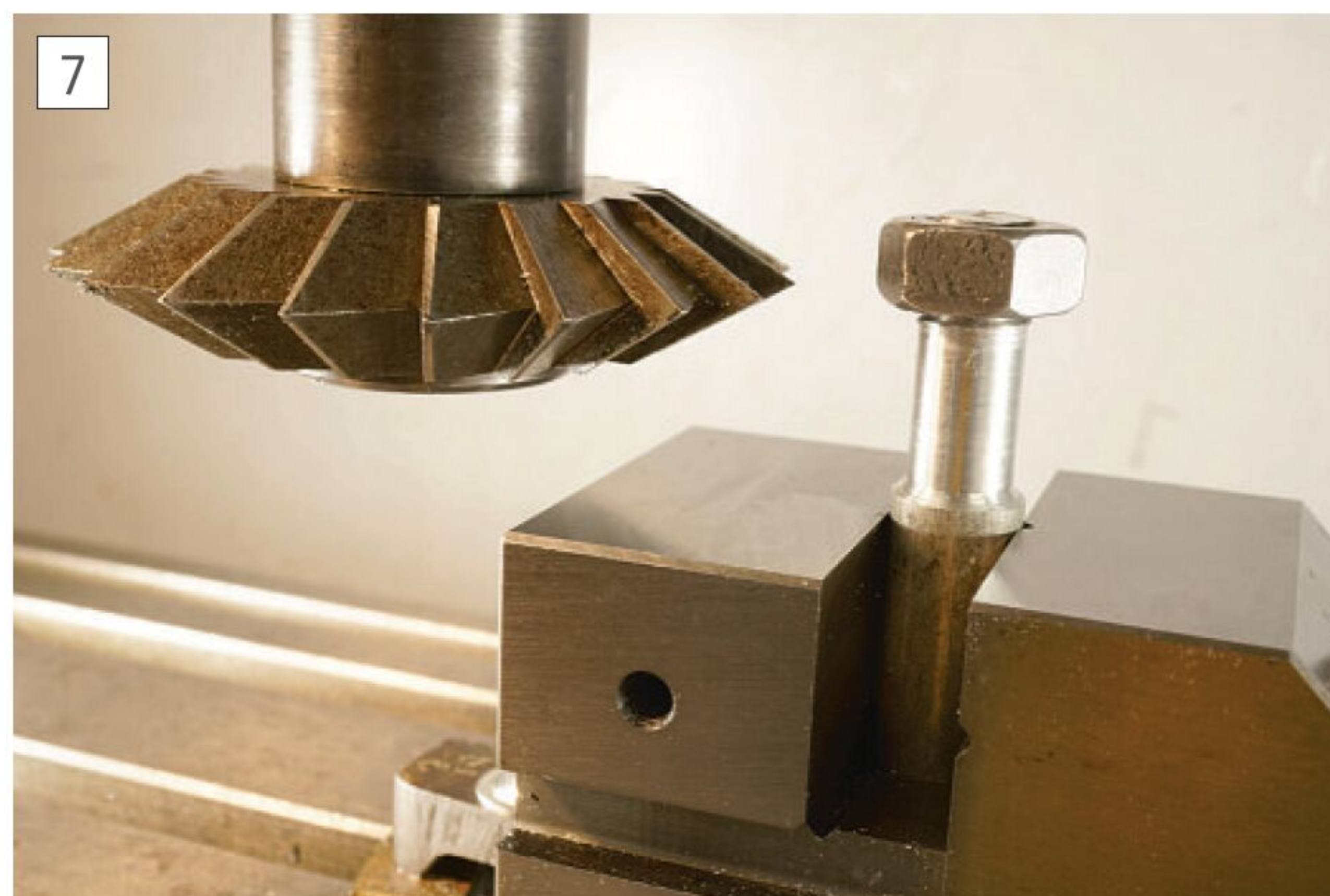


Figure 1





First trial; 1mm pitch 10mm diameter.



Successful M10 X 1.5 thread.

obvious what the radius of the thread would be.

Jumping a few iterations, my fourth attempt was a change of horses to the radius format and a right-hand thread. I have also included a more comprehensive initiation string to ensure the mill is set correctly for the start of the program. This is still a spiral development program to be run without a cutter and offline, but the previous caveat still applies.

% Spiral 4

G15 G17 G21 G40 G49 G50 G69 G80 G90

%G15 CARTESIAN CO-ORDS

%G17 XY PLANE

%G21 MILLIMETRES

%G40 CANCEL CUTTER RADIUS COMP

%G49 CANCEL TOOL LENGTH OFFSET

%G50 RESET ALL SCALE FACTORS TO

UNITY

%G69 CANCEL CO-ORD SYSTEM

ROTATION

%G80 CANCEL MOTION MODE

%G90 ABSOLUTE DISTANCE MODE

% Set workpiece vertical, centre at x=0, y=0.

G0 Z25

M3

M6 T10 S500

F100

G0 X-5 Y0 Z0

M3

G2 X5 Y0 Z-0.5 R5

G2 X-5 Y0 Z-1 R5

G2 X5 Y0 Z-1.5 R5

G2 X-5 Y0 Z-2 R5

G2 X5 Y0 Z-2.5 R5

G2 X-5 Y0 Z-3 R5

G1 X-8

G0 Z0

M30

The radius was now obvious, and the program created a right-hand thread

as it should. What was not so obvious was that there are now two lines for a complete circle and the pitch of 1mm is split between those two lines. Apparently, this is a more accurate way of programming a complete circle.

The program was more successful than I expected and with the addition of corrections for the cutter diameter it was used to cut a 10mm dia. external thread with 1 mm pitch, **photo 6**.

However, the use of such a large cutter to cut such a fine thread did seem a little disproportionate.

The thread was not to the correct depth at this stage. That refinement was to follow, and I also increased the pitch to a more proportionate 1.5mm.

With the spiral cutter path working properly, my next step was to utilise some of the more advanced features of Mach 3, starting with parameters. I found this feature most useful when I was programming the bevel gears in **ref 2** which were defined by just a few parameters.

I was once told in a maths lesson that "A parameter was a sort of fixed variable" – I didn't find that at all helpful! The parameters used here are numeric descriptions of the specific thread that was to be cut e.g. diameter, pitch and length. The real advantage being that the information relating to the current thread can all be grouped together at one location within the program; easy to locate and easy to change.

Parameters have some rules associated with them. They must be preceded by the hash symbol # followed by a real number integer e.g. #41=10 sets a 10mm dia. thread. Up to 10,320 parameters are allowed but numbers

5161 to 5246 are reserved for specific machine functions. The following program has five parameters defined, but three of them (#42, #43 & #44) are not used at this stage, they anticipate further developments. In the interests of space, the annotation of the initiation string (%G15 to %G90) has been omitted since it duplicates the previous program.

#41 is set to 10mm for the workpiece diameter, and the cutter diameter is set at 76.81mm by #45. There are also workpiece and cutter setting instructions. For manipulating parameters square brackets are normally used e.g. [#41\*#24]\*[1/2]. calculates the distance from the spindle c/l to the workpiece c/l.

This time the program could cut metal, but not much! As yet there was no incremental depth facility and the number of completed threads was fixed at three. The program was no longer gender neutral as were the "Spiral" programs. It was then specifically for external threads.

% Threadmill External 1

G15 G17 G21 G40 G49 G50 G69 G80 G90

% cancel Angle rollover: General Config..

% Set workpiece vertical, centre at x=0, y=0

% Use 60 deg. Inc. cutter.

% Set centreline of cutter at top of workpiece Z=0

#41=10 (Thread diameter)

#42=1.5 (Pitch)

#43=6 (no. of complete threads)

#44=1.0 (Thread depth)

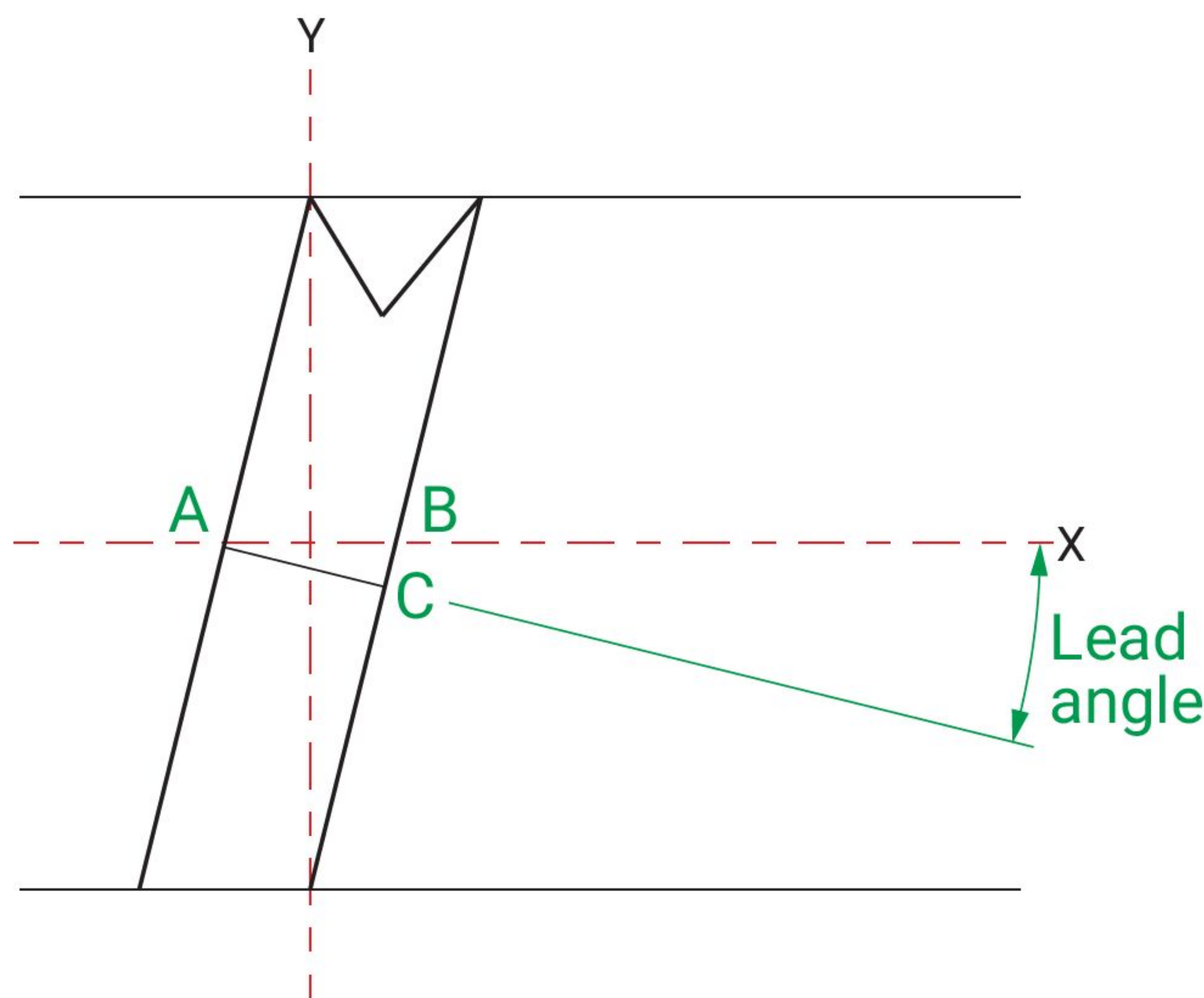
#45=76.81 (cutter dia.)

G0 Z25

F100

G0 X[[[[#41+#45]\*[1/2]]+5]\*-1] Y0 (Left of C/L 5mm clear)





Ref 2

```

G0 Z0
M3
G1 X[[[#41+#45]*[1/2]]*-1] Y0
G2 X[[[#41+#45]*[1/2]]*1] Y0 Z[#42*-0.5]
R[[#41]*[1/2]]
G2 X[[[#41+#45]*[1/2]]*-1] Y0 Z[#42*-1.0]
R[[#41]*[1/2]]
G2 X[[[#41+#45]*[1/2]]*1] Y0 Z[#42*-1.5]
R[[#41]*[1/2]]
G2 X[[[#41+#45]*[1/2]]*-1] Y0 Z[#42*-2.0]
R[[#41]*[1/2]]
G2 X[[[#41+#45]*[1/2]]*1] Y0 Z[#42*-2.5]
R[[#41]*[1/2]]
G2 X[[[#41+#45]*[1/2]]*-1] Y0 Z[#42*-3.0]
R[[#41]*[1/2]]
G1 X[[[[[#41+#45]*[1/2]]+5]*-1] Y0
G0 Z25
M05
M0

```

Another useful feature of the parameters available in Mach 3 was that they could be used as tally counters. In this case the number of threads to be cut. The tally count was incremented automatically within the program. #53 was used to track the total length of thread, incrementing by half the pitch for each half-turn of thread cut.

Subroutines were also incorporated for parts of the program which were repeated frequently. In this case the semi-circular motions and Z movement used to cut a single thread. A subroutine could be repeated as many

times as necessary. They comprise a discrete section of code, usually located after the end of the program and starting with O (capital letter O) and an identification number; in this case 100. The subroutine is called from within the program by the M98 command which also indicates which subroutine it is since there may be several, and how many times it will be called by Q[#43]. Using a parameter for this made it easy to change the program to a different thread.

```

% Threadmill External 3
G15 G17 G21 G40 G49 G50 G69 G80 G90
% cancel Angle rollover: general config
% Set workpiece vertical, centre at x=0, y=0.
% Use 60 deg inc cutter
% Set centreline of cutter V at top of workpiece Z=0
#41=10 (Thread outside diameter)
#42=1.5 (Pitch)
#43=6 (no. of complete threads)
#44=1.0 (Thread depth)
#45=76.81 (cutter dia)
% Calculate intermediates
#50= [-1*[[[#41+#45]*[1/2]]+0]] (Left OD position on X axis)
#51= [1*[[[#41+#45]*[1/2]]+0]] (Right OD position on X axis)
#52= [[#41+#45]*[1/2]] (radius for spindle + cutter)
#53= [#42/2] (Length of thread counter)

```

```

F100
G0 Z25
G0 X[#50-5] Y0 (Left of C/L 5mm clear)
G0 Z0
M3
G1 X[#50] Y0 Z0 (Touching workpiece)
M98 P100 Q[#43]
G0 X[[[#41+#45]*[1/2]]+5]*-1] Y0
G0 Z0
M05
M30
O100 (Thread Cut)
G2 X#51 Y0 Z[-1*#53] R#50 ( )
#53=[#53+#42/2]
G2 X#50 Y0 Z[-1*#53] R#51
#53=[#53+#42/2]
M99

```

The last refinement to the program might well be considered the tricky bit. This is another subroutine, this time to deal with getting the depth of thread required in three steps. I considered this necessary since for cutting fine threads, the workpiece may not have been sufficiently rigid to cut it in one pass. The unfortunate consequence was that it led to nested sub routines. In this case the number of threads subroutine is within the thread depth routine.

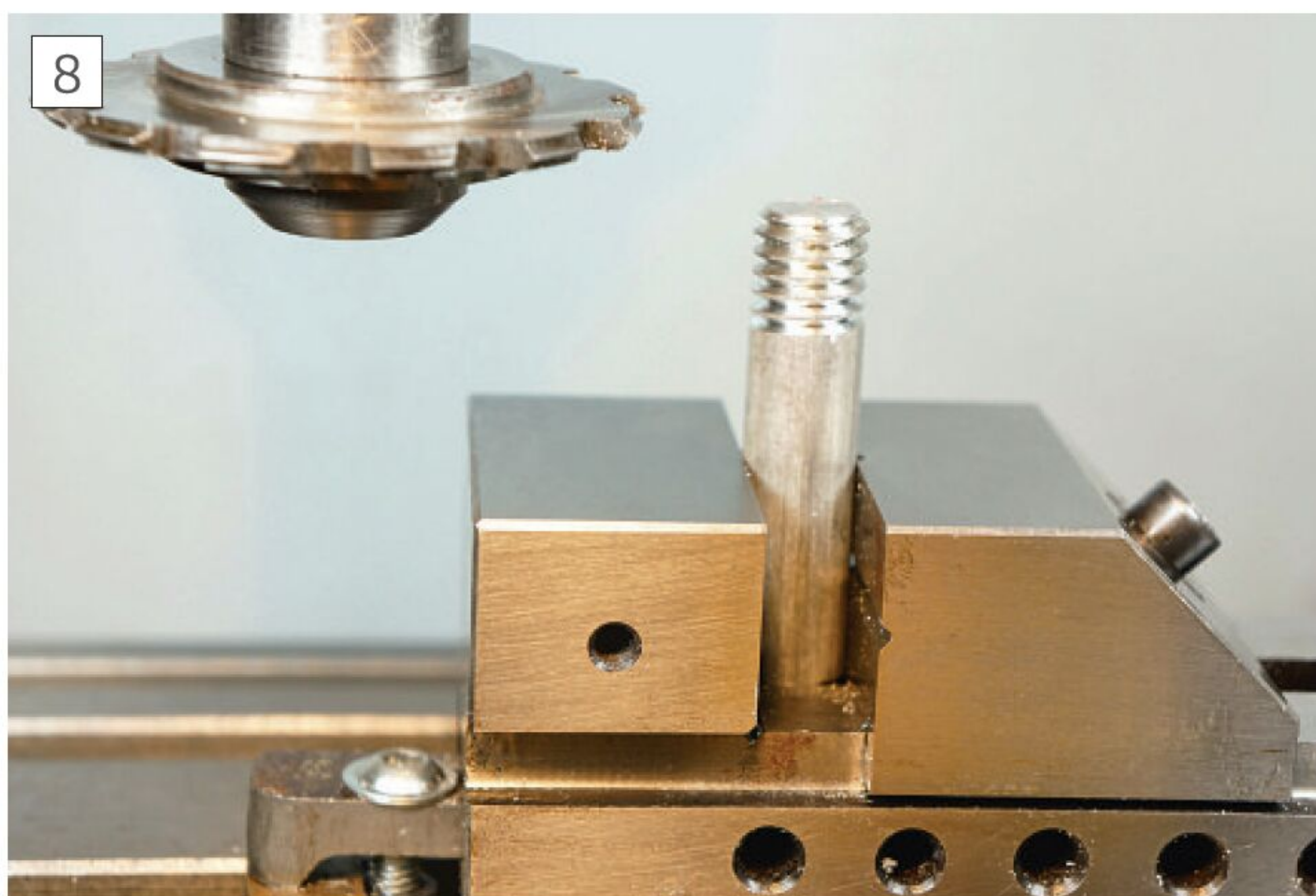
However, it was important that both subroutines were defined at the end of the program. Although it is permitted to call a subroutine from within another subroutine; it is not permitted to define a subroutine within another subroutine. That route led to some unpredictable and unwanted actions. Guess how I found out!

```

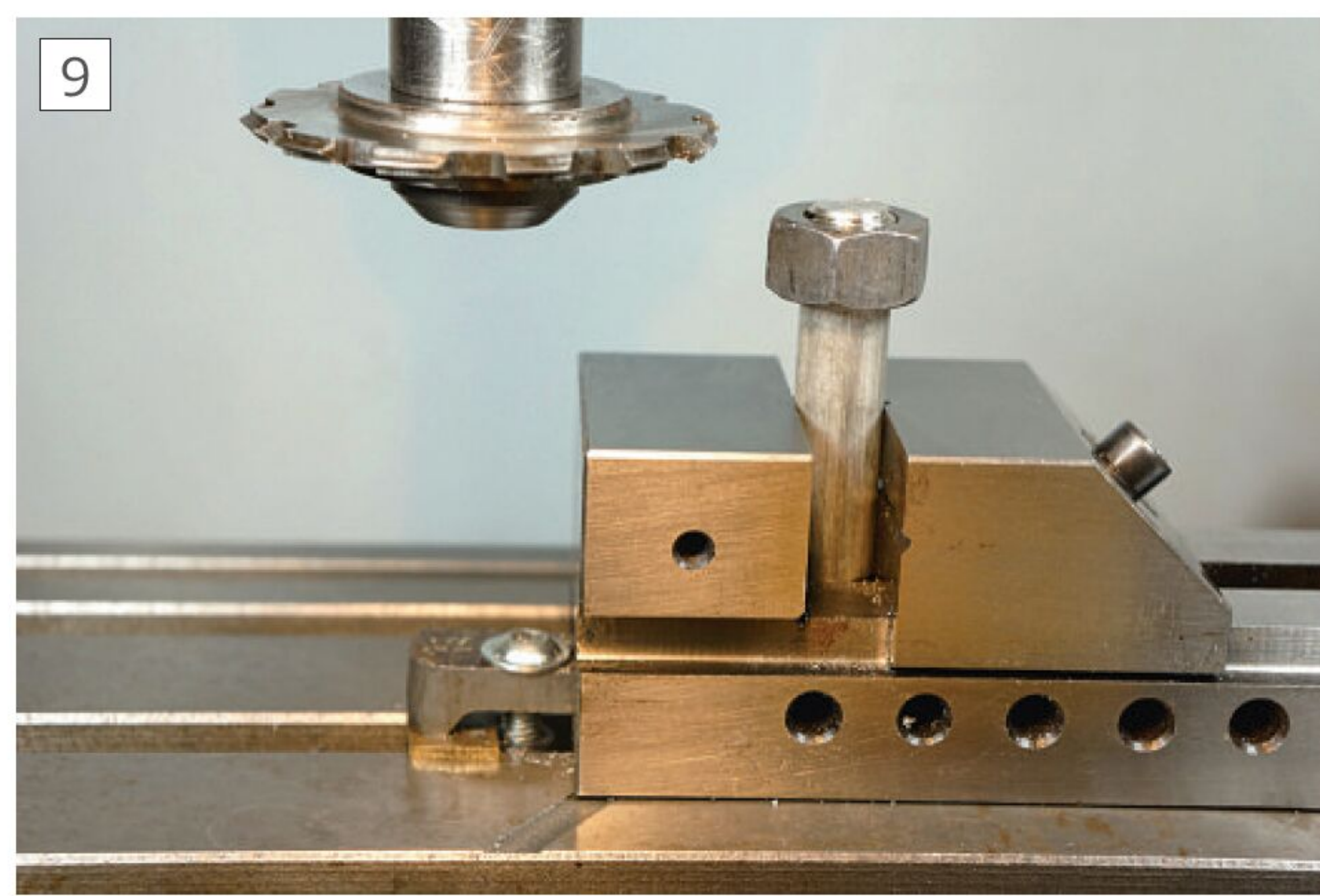
% Thread Mill External 4.2 M10
G15 G17 G21 G40 G49 G50 G69 G80 G90
#41=10 (Thread outside diameter)
#42=1.5 (Pitch)
#43=3 (no. of complete threads)
#44=1.0 (Thread depth)
#45=76.81 (cutter diameter)
% Calculate intermediates
#52= [[#41+#45]*[1/2]] (radius for workpiece + cutter)
#50= [-1*#52] (Left OD position on X axis)
#51= [1*#52] (Right OD position on X axis)
#53=0 (Thread depth)
F200
G0 Z25
G0 X[#50-5] Y0 (Left of C/L 5mm clear)
G0 Z0
M3
M98 P101 Q3 (Start of depth control)
G0 Z0
M05

```





Full form 1/2" Whitworth. Trial.



Commercial 1/2" Whitworth. nut fitted.



The two successful trials.



Carbide Internal cutter M10 X 1.5.

M30  
O101 (cut depth)  
G1 X[#50] Y0 Z0 (Touching workpiece)  
#53= [#42/2] (Current length of thread counter)  
#52=[#52-0.355\*#44] (radius for spindle +cutter)  
#51=#52  
#50=[-1\*#52]  
M98 P100 Q[#43]  
%#52=[#52-0.355\*#44] (radius for spindle +cutter)  
#50= [-1\*#52] (Left OD position on X axis)  
#51= [1\*#52] (Right OD position on X axis)  
G0 X[#50-5] Y0  
G0 Z0  
#53=0  
M99  
O100 (One Complete Thread Cut)  
G2 X#51 Y0 Z[-1\*#53] R#50 ( )  
#53=[#53+[#42/2]]  
G2 X#50 Y0 Z[-1\*#53] R#51  
#53=[#53+[#42/2]]  
M99

Note that the new subroutine O101 has the original subroutine (O100) embedded within it. The tricky bit was to ensure that the parameters that needed

to be updated, were updated at the correct point i.e. before the beginning of the subroutine, or after the end.

Because the threads produced were not fully formed, there was no radius on the crest, just as they would be if turned on the lathe. The remedy was a fine file or run the correct size split die down it – just between fingers and thumb if the size is correct, **photo 7**. To misquote an old culinary saying. "The proof of the threading is in the nutting!"

The next trial was a 1/2" Whitworth tread of 12 tpi. At this point the parametric approach came into its own. The only change to the program was to alter the thread and cutter parameters as below:  
#41 thread dia. 12.68 (actual, 12.7 mm nominal)  
#42 pitch. 2.117 (12 tpi)  
#43 complete pitches. (Unchanged)  
#44 thread depth. 1.634 (0.053")  
#45 cutter dia. 63.9mm

This cutter was a full form profile and intended to produce a finished thread without further attention.

The result was better than expected, **photo 8**.

A commercial 1/2" Whit. nut fitted without adjustment, plus the crests and roots were visibly rounded as they should be with as full form cutter, **photo 9**.

**Photograph 10** shows both completed milled threads with the nuts removed. Note that the cessation of the thread after six complete threads is neater than with most other thread forming methods, and without needing a run-out groove.

The next stage was to attempt some internal threads. The obvious difficulty was the lack of space and the need for a cutting tool that would operate within the diameter of a tapping diameter hole.

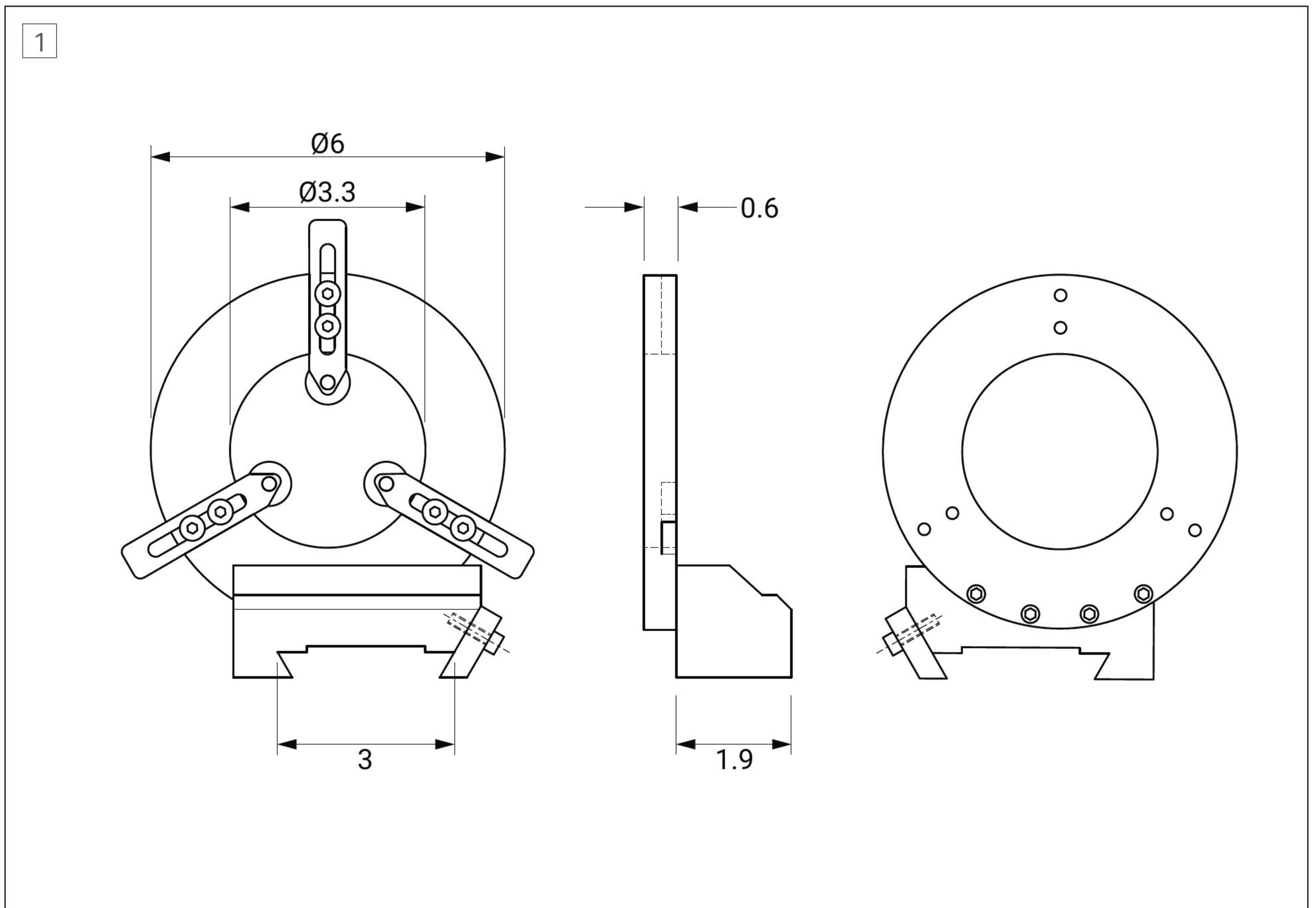
The cutters available generally look something like a tap with some threads removed, **photo 11**. However, this is misleading since these tools have no helical element to the threadform. In addition there are some variants depending on their ability to produce a full-form thread (i.e. rounded crests and roots). The one shown has three threads and will produce a full form thread but only for one particular thread; in this case M10 X 1.5.

● To be continued



# A Fixed Steady for a Myford ML10

Richard Lofting makes a steady to support long workpieces on an ML10 lathe.



The SFV 302 tractor, 5.3 litre single cylinder semi diesel.

**M**y son has a Myford ML 10 lathe, his granddad gave it to him on his twenty-first birthday, It is used regularly making or repairing parts for our vintage tractors. We have amongst others, a French made single cylinder hot bulb tractor, an SFV 302, **photo 1**, We have had it running but the fuel pump leaks, as a previous owner had fitted the wrong fuel injector, and the excess pressure required to operate it has put a crack in the bronze casting due to hydraulic action. Parts for these tractors are thin on the ground to say the least, as

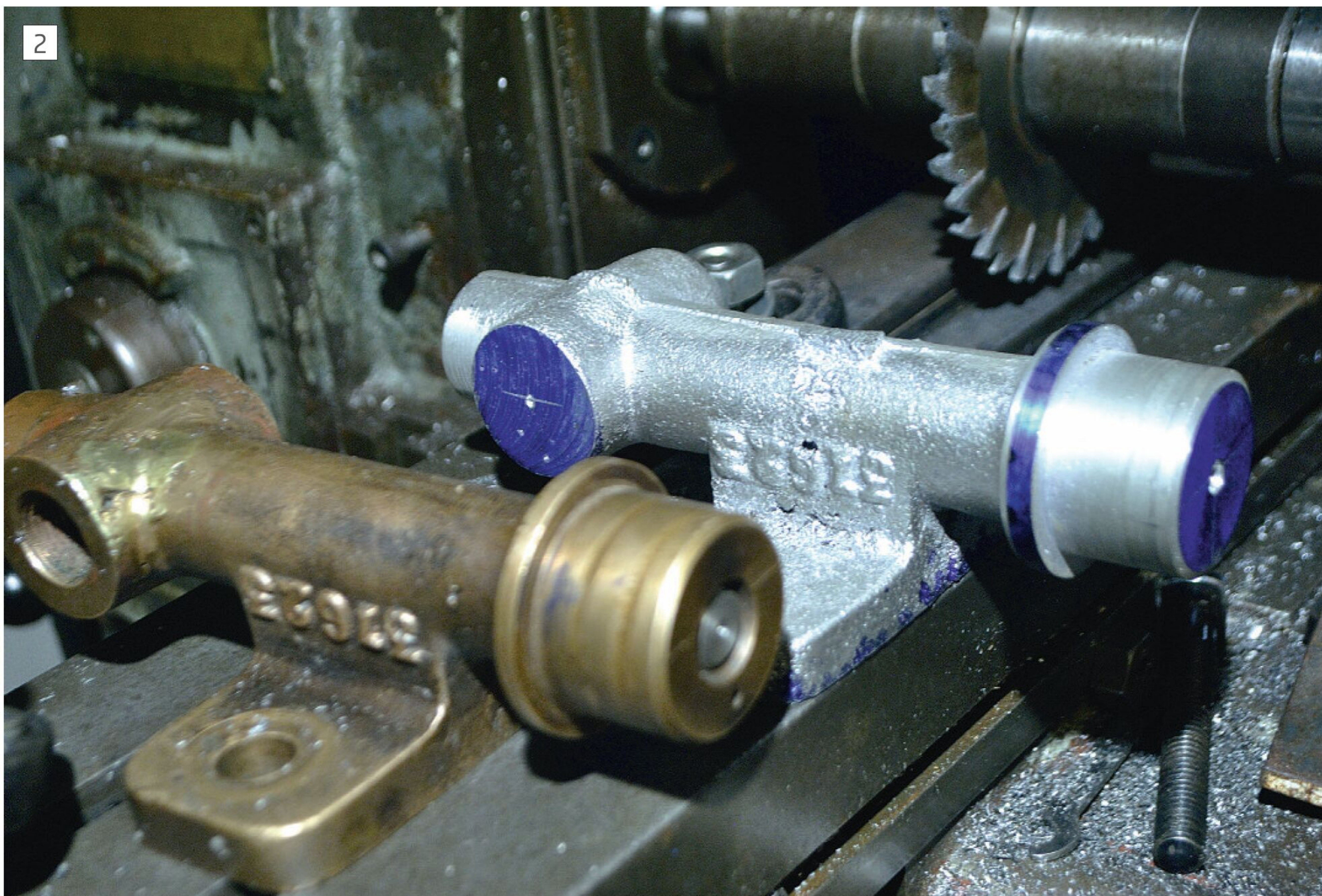
there were only a few thousand built during the late 1950s, so it is a case of making your own. I made a pattern to cast a new pump and being new to casting I started off casting the pump in aluminium alloy, for several reasons.

- 1, Aluminium melts at a lower temperature than Bronze, so slightly safer, and I can get my hands on loads of alloy castings such as water pumps etc, as my son is a mechanic for stock.
- 2, I could test and evaluate my casting technique and the pattern quickly.
- 3, I could check all the machining

operations needed on the aluminium before committing to bronze on our limited equipment.

I discovered that the pattern was ok, but it needs two ingates rather than one, so it feeds quicker, and I need to make more ventilation holes in the sand as there were a few blowholes, especially on the underside. The pump is a simple affair with one 12mm diameter piston with a 18mm x 1.5 thread at 90 degrees to the piston stroke for the one way valves and a 14mm x 1.5 thread at one end for a bleed plug, using the cracked pump with a





The original pump body with a centred rod, behind the cast alloy test pump.



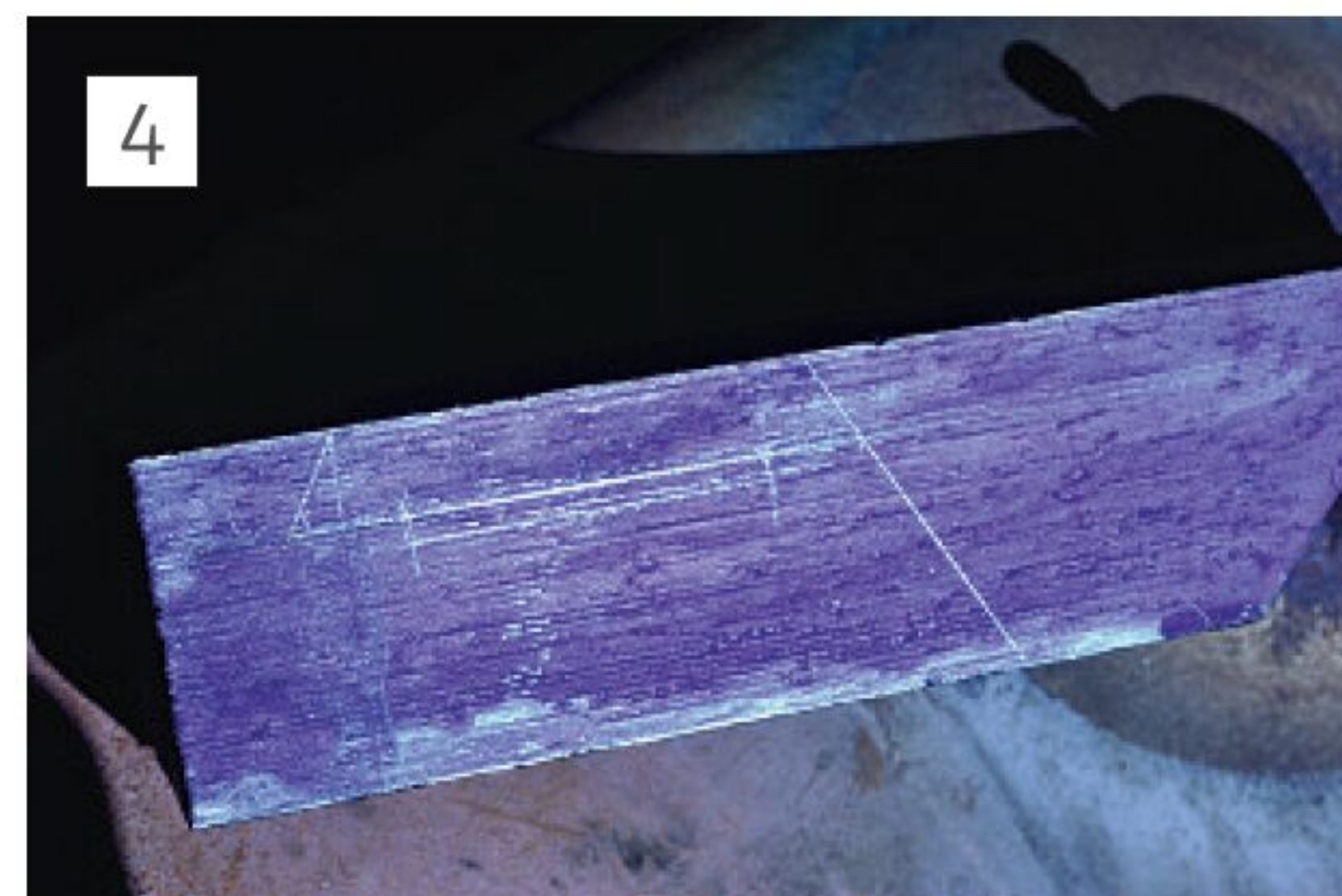
The remain of my cars crank pulley damper.

centred 12mm rod, **photo 2**, fitted in place of the piston I could transfer the centres to the casting after levelling the mounting foot in my shaper on the new casting. I had thought I could bore and ream the body for the piston on my horizontal mill, the only operation I could not do was hold the pump and

machine a groove for the 'o' ring seal. If I had a fixed steady I could use the ML10.

### The Birth Of An Idea

A few weeks previously the fan belt had snapped on my car and it destroyed the bond on the rubber in the front pulley damper, the old one sat on the scrap pile;



The 60° dovetail marked out on the base.

while drinking a cup of tea it came to me that the centre part of the old pulley was about the right diameter and had a large central hole and three bolt holes, **photo 3**, ideal for the fingers of a steady. All it needed was the outer rim removing, this was held in place with a rubber strip which I pushed off with our old Churchill screw press. After facing off in the lathe I could now see the steady taking shape.

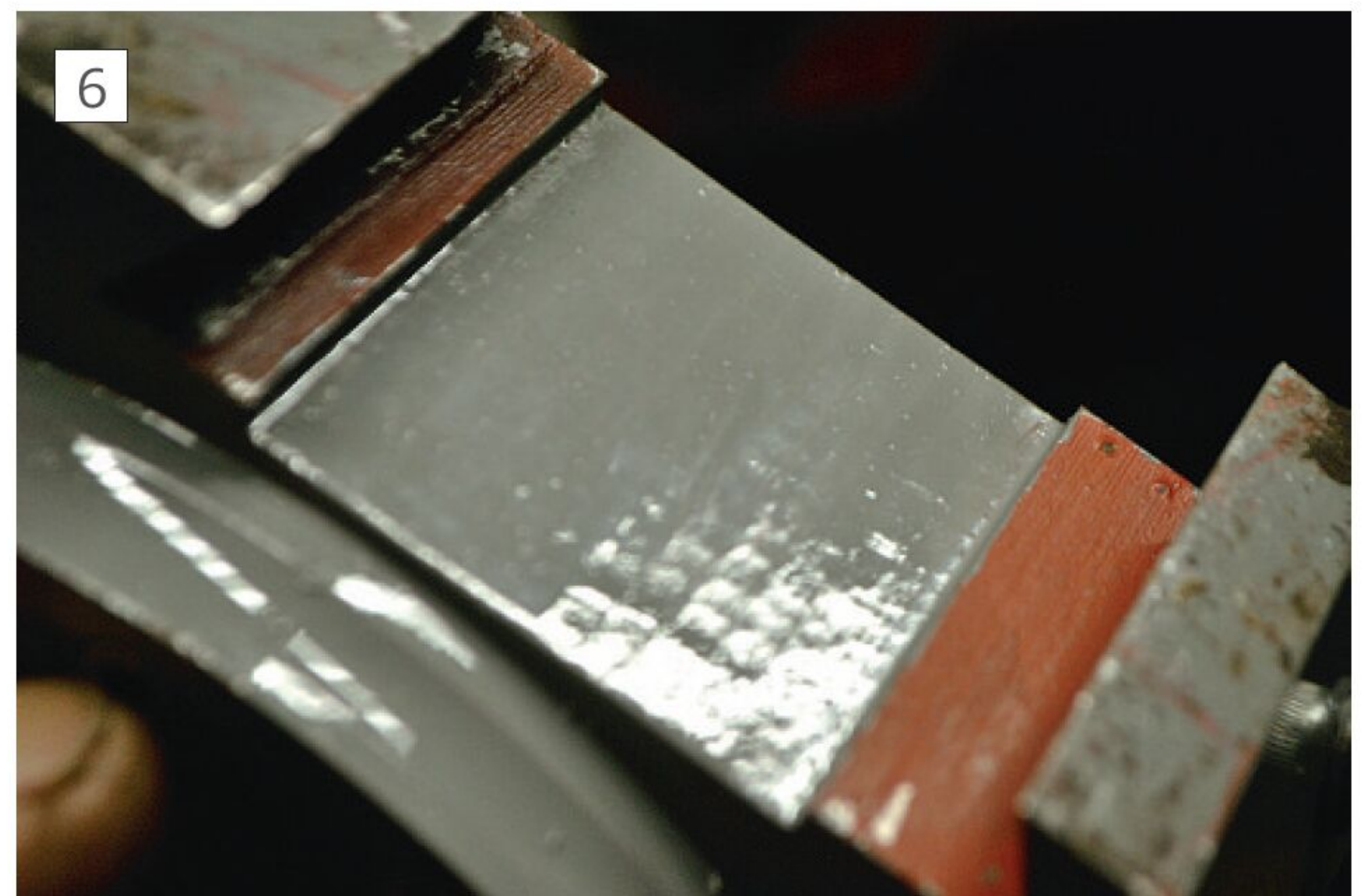
### The Base

Obviously, a fixed steady needs a base to 'fix' it to the bed of the lathe, this I made from a piece of two inch square steel that came from the base leg of a disused car lift, **photo 4**. After cleaning the

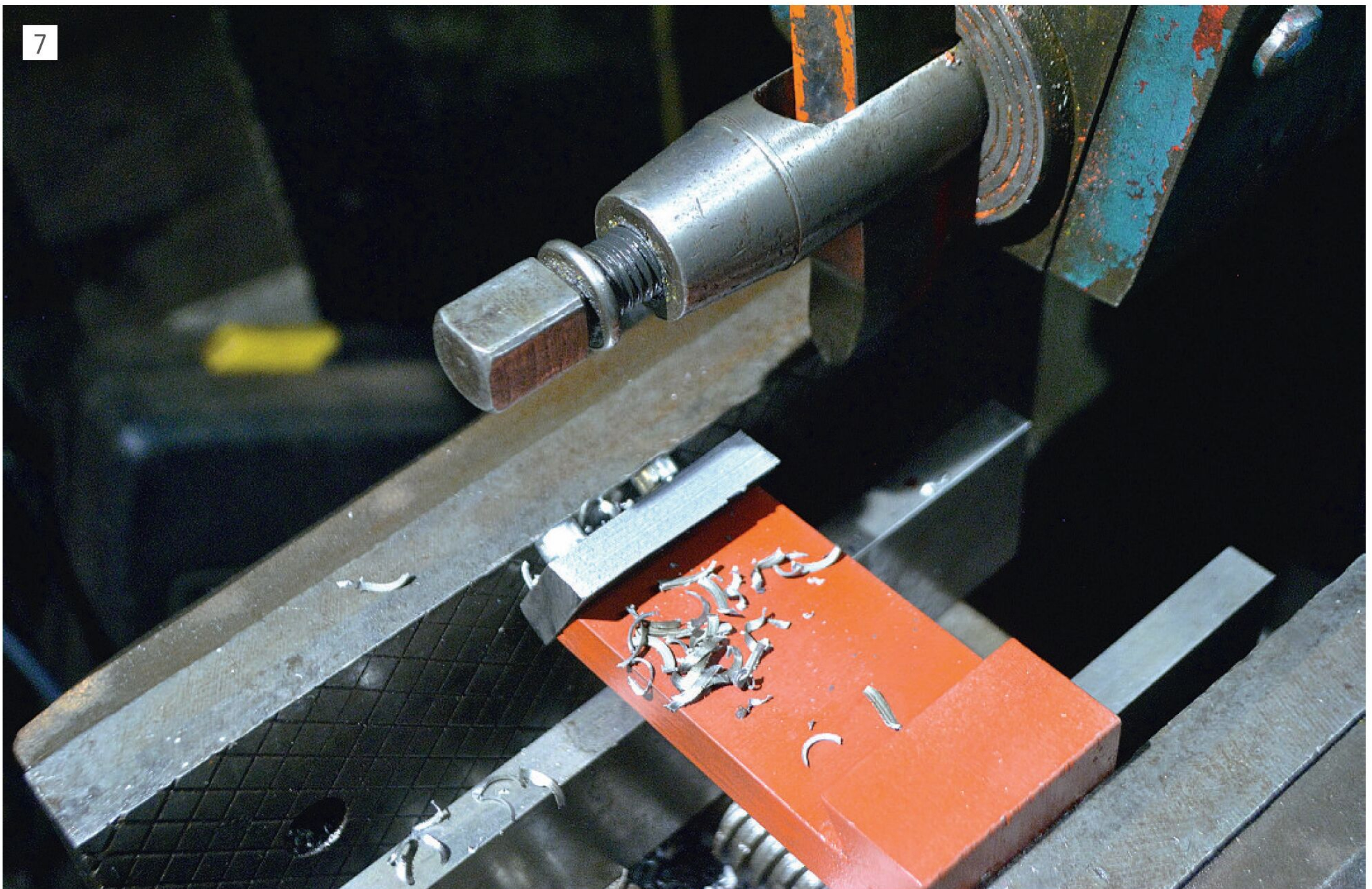




*The base more or less finished.*



*The relieved base copied from the Rodney Miller attachment.*



*Using the shaper to level the base clamp.*

faces in the shaper I marked out for the dovetail and then cut this on the shaper after grinding a tool to about 55° with the dovetail angle being 60°, **photo 5**, this was another first for me. I copied the base of the Rodney miller attachment that we have for the lathe, in that the centre of the base that contacts the lathe bed is relieved, **photo 6**. The retaining plate was made from an off cut of the gauge plate used to make the fingers. Although it didn't affect its use I leveled the bottom of the plate in the shaper,

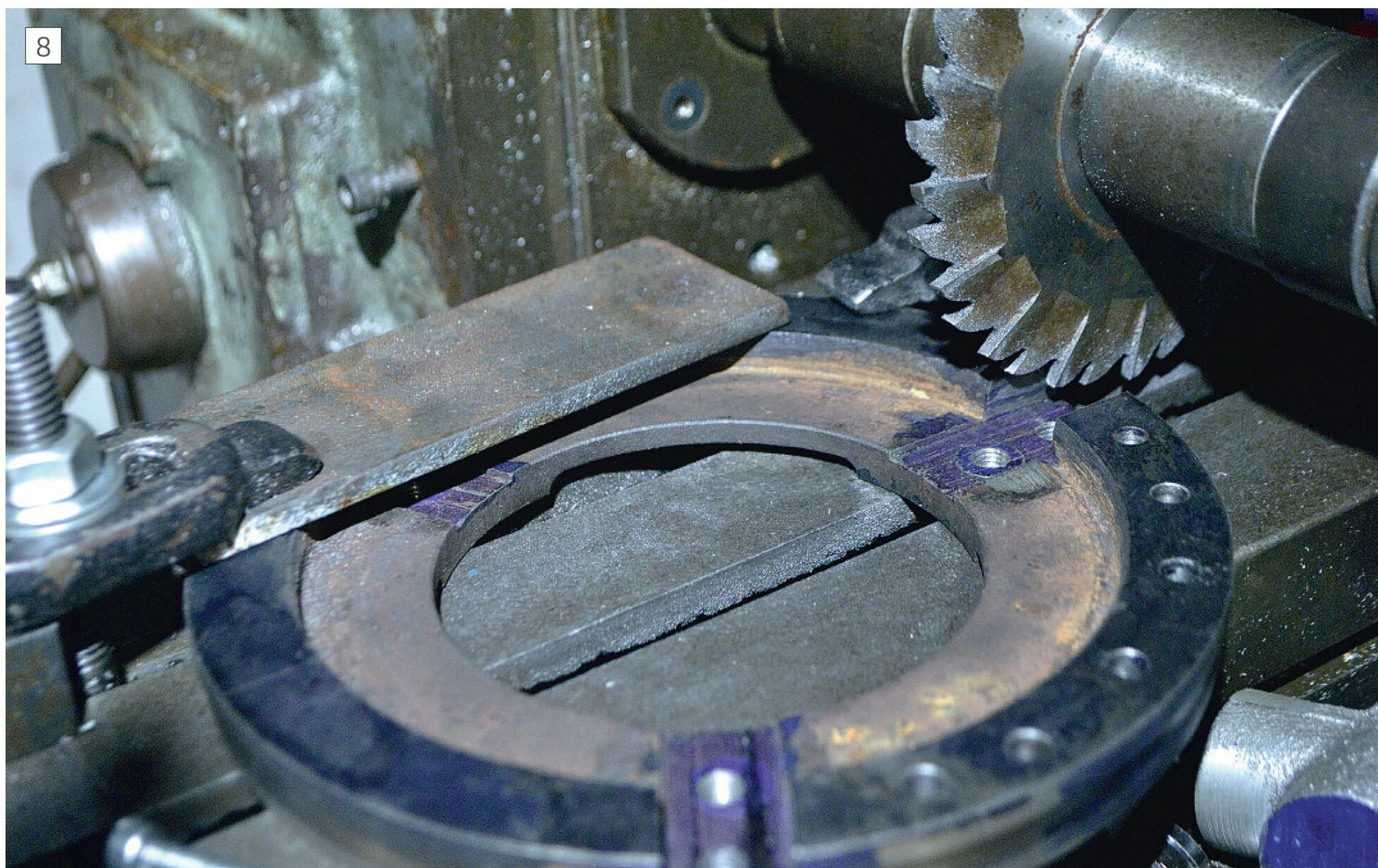
**photo 7**, so it would sit straight when not attached to the lathe. The next task was to join the two pieces together. For a previous job where the lathe was too small, I had made a Morse taper adapter so that I could fit the three-jaw chuck onto the milling machine. This also fits the lathe tailstock as they are both MT 2. By gripping the ring in the centre hole in the chuck with the base clamped to the lathe bed, I could mark the position of the two components knowing they were in the correct position. Precision

was not too important in this case as the adjustable fingers would take care of alignment when using the steady. I can hear the question 'why not use the chuck on the headstock'? I had thought of this, but with the width of the base and the body of the chuck, there was not enough room.

### Joining Together

As there is not much 'meat' at the outer edge of the ring I decided to use four M5 cap head screws and as luck would have

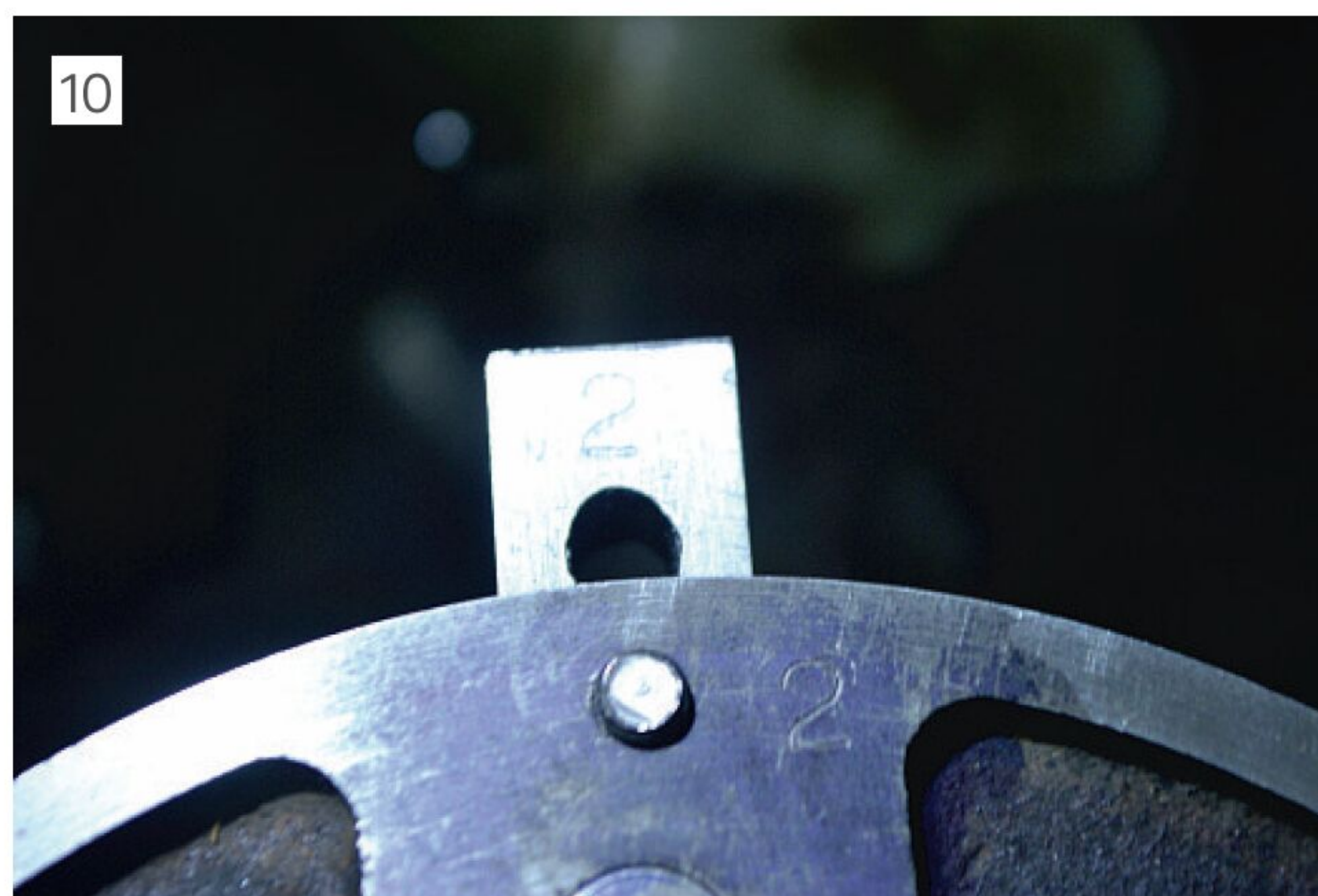




*The ring fixing holes to the lower right of picture.*



*The three fingers complete with bearings.*



*Corresponding numbers on ring and fingers.*

it, I had a counterbore for a 5mm hole as the heads were right on the edge of a ridge of the ring, **photo 8**. The other side that faced the base block was flat. I would have really liked to have set the ring in from the edge of the base, but until I finish a rotary table build it will have to suffice for now, at least it is usable as is.

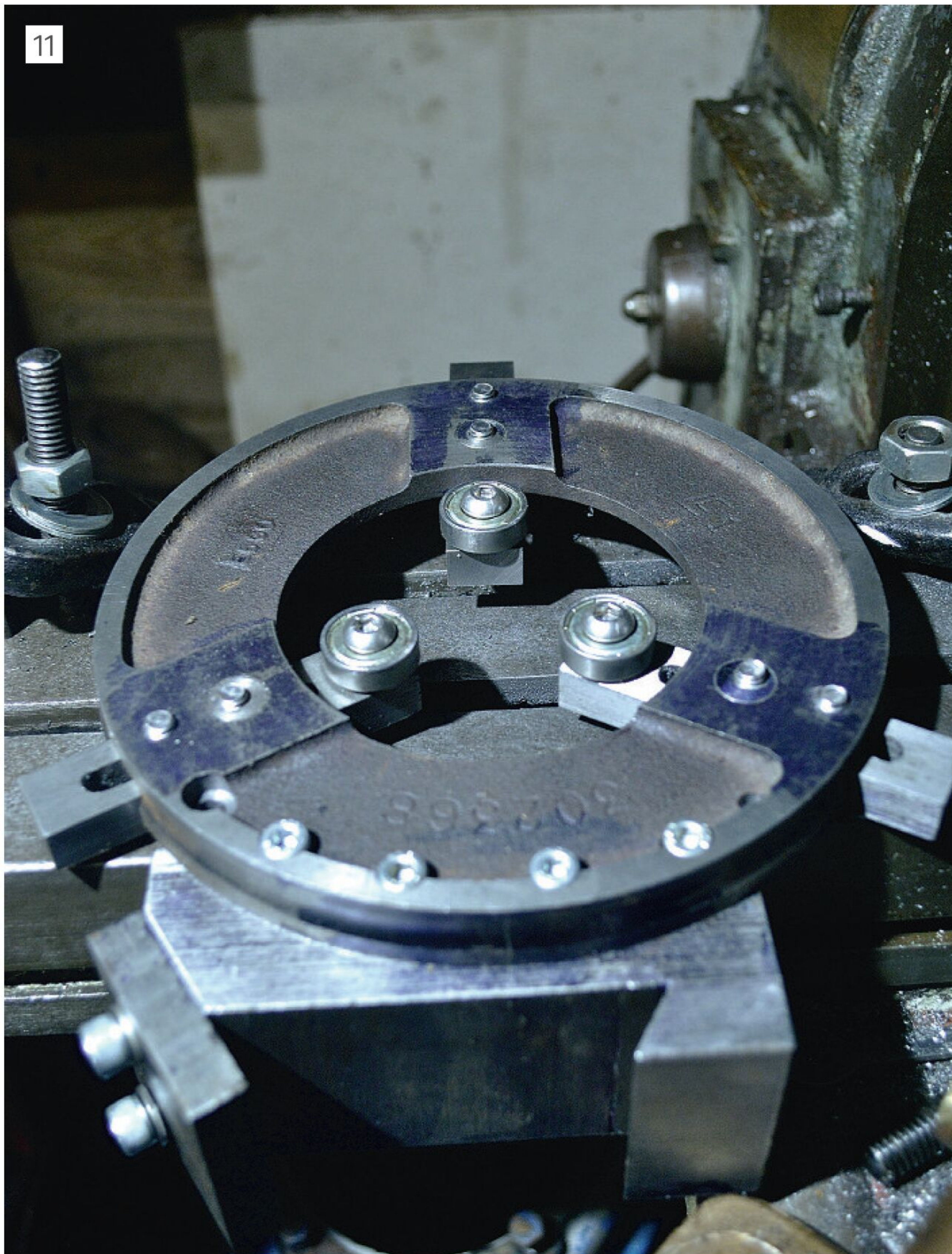
### Fingers

To make the fingers I had a length of 10mm thick gauge plate, **photo 9**, perhaps thinner would have been better,

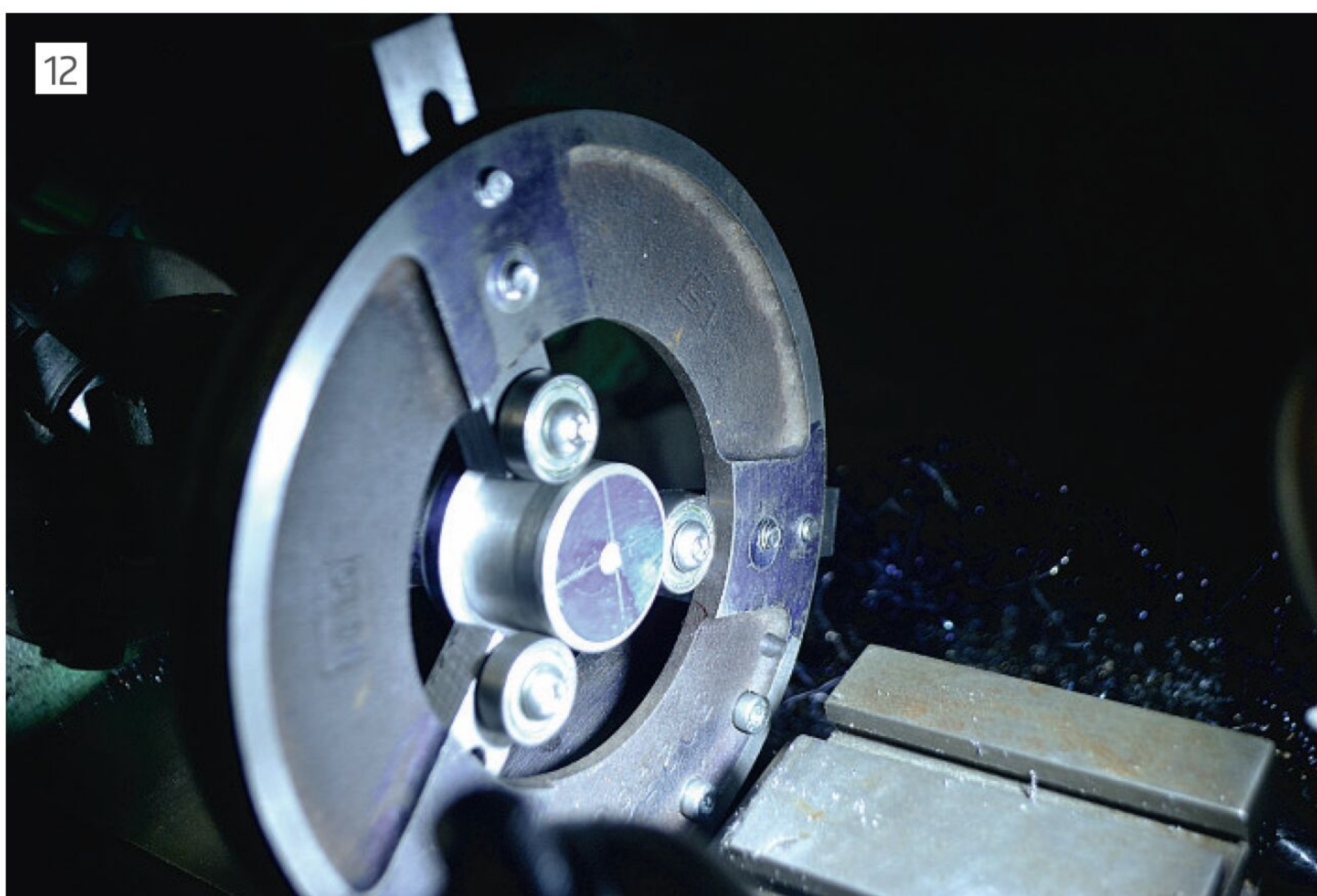
but I had it in stock. The three bearings were also in stock as I had bought a pack of ten when rebuilding the guides on my bandsaw. The holes for the bearings were drilled and tapped M6 at one end, this just left the adjustment slots. As I have not got a vertical head for my Centec mill I set up the Rodney mini miller attachment that came with the Myford. I purchased a new 6mm slot drill for £4 from a well-known internet auction site and set to on a wet afternoon. With the plate being so thick and the slot being relatively

small it took what seemed an age as I had to stop on each pass and clear the swarf from the emerging slot. So as to alleviate any future finger alignment issues, I numbered each finger and its matching slot, **photo 10**, at the business end, where the bearings are mounted. Although it didn't interfere with the operation, the square ends of the fingers overhung the bearing at the sides. So as to get them all the same I put a spot of superglue on each one and stuck them together so when taking off the mill they stayed together. I milled off the corners





All the machining done, almost ready to use.



Setting up the fixed steady with the pump held between centres.

and then rounded them on the grinder before separating them.

All that was left to do construction wise was to mill grooves in the ring for the fingers to locate, plug the three existing holes in the ring, and drill and tap for the finger attachment screws. I vaguely remember when fitting the new pulley on my car on one of the forums there was mention of there being an offset hole. Drawing out the ring to size with paper and compass as my computer printer was out of ink and drawing three lines to represent the finger centres; laying the ring on the drawing I discovered that yes indeed there is one offset hole. As the holes are a 'tad' over 11mm diameter I have turned three plugs from bar stock to fill these by interference fit. I could then drill and tap these, M6, once fitted to get them on centre line for each finger, **photo 11**. Again I wished I had finished that rotary table project that I had started as it would have been somewhat easier to align the ring on the horizontal mill to cut the three slots at 120°. As it was I marked the centre line for each finger on either side of the ring and then used the scribed lines to align the cutter before clamping down. With one face of the cutter on the centre line I then wound the y axis over half the width of the finger and cut to depth before setting the depth stop. So as not to get confused, I then wound the y axis out the width of the finger minus the width of the cutter and cut this side full depth, this just left the material in the middle which took several passes to remove, perhaps I should have used a wider cutter, but this was the only sharp one that I had at the time. A trial fit of the finger in the slot before moving confirmed that my math's was correct! That left two more slots to align and cut. I used each finger to mark for drilling and tapping as the first cut finger slot was slightly off centre, therefore I used a number punch to number the fingers and their respective slots.

### Set Up and Use

With the fixed steady finished it was time to give it a try, **photo 12**. As I said earlier the idea of the fixed steady was to be able to cut a groove in the bore of the pump to fit an o-ring seal, but once on the lathe I discovered that I had enough





*The casting set up ready to bore and ream in the fixed steady.*

room to drill and ream the bore as well. Often novices find it hard to setup work in a fixed steady. The usual way with something like a bar of material is to grip the bar in the lathe chuck and then set the fingers of the steady with the base close to the chuck and then move the steady to where it is needed for the machining operation, i.e. at the other end

of the work. In this case with a lumpy casting this was not going to be possible, **photo 13**. As I had centered each end of the pump body, I set the casting up using the tailstock centre and machined the pump spring base at the end of the casting, this gave me a good area to set the fixed steady fingers into position before removing the tailstock.

### Finishing The Job

I carried out all the operations on the alloy casting, except cutting the groove for the o-ring, **photo 14**, so I knew the fixed steady was usable. I decided to finish it off with a coat of machinery enamel, **photo 15**, all that's left to do is cast the pump in bronze. ■



*The alloy test casting fully machined.*



*The fixed steady after a coat of machinery enamel.*



# A Turntable Weight

Neil Wyatt makes a simple hifi accessory that is an ideal project for those just starting out with lathe turning. Audiophiles, please look away now.

There are uncountable accessories that a billionaire with time on their hands can spend money on, lost of money, in the hope of improving the quality of their sound system. I refer readers to the Internet where they will see arguments from those who insist speaker cables are directional to those who see anything more advanced than upgrading from a crystal pickup as snake oil. One accessory that does, almost unequivocally, improve the sound from a record turntable is a weight that slips over the centre peg. The benefits theoretically include lowering the resonance of the turntable or stopping the record from slipping (Have you ever had an LP slip when the needle goes down? Has anyone?). However tenuous some claims are, the extra mass will have some flywheel effect and steady the rotation of the turntable somewhat, but of most interest to someone like me, it will help flatten any LPs that have developed something of a warp over the decades.

A turntable weight is an ideal beginner's turning project as in essence it is just a chunky round object with a hole in the middle. If that seems beyond your current abilities, you can buy one for about £6 and upwards online – upwards to over £2,000 apparently.



*Sawing off a blank in the bandsaw.*

Anyway, here's how I made one and hopefully readers may benefit from some of the techniques I describe. Note that only one dimension is critical.

Now, some turntable weights have a central collet that grips the record spindle. I felt that a good fit is enough to dispense with this and go for the simplicity of a single part. I started with a length of 2" (~50mm) EN1a mild steel, which I cut to about 3 1/2" (~80mm) long

using my bandsaw, an indispensable tool, once you have one, **photo 1**. I secured this in the outside jaws of a self-centring chuck (it was too big to use the inside jaws). The bar had some surface rust, and I used a standard right-handed tool with the lathe's self-act to take both a facing cut across the end of the bar, **photo 2**, and a light skim along its length for about 2", **photo 3**. If you don't have automatic feed, you can take these cuts by hand.



*Facing the end of the blank with a right-hand tool.*



*Taking a skim along the surface of the bar with the same tool.*





*I prefer a spotting drill to a centre drill.*

The weight naturally needs to be no larger than a standard record lable (and can be much smaller). Height wise, anything in proportion should be OK, but my turntable has a clear lid, so I made the weight short enough to fit with this closed. The one critical dimension is the size of the central hole, which must be a close fit on the record spindle. The standard size is an imperial measurement: 9/32", that's 0.281" to the nearest 'thou' or 7.14mm. I started by using a spotting drill (a short drill with a 90-degree end) held in the lathe tailstock), these are less likely to wander than ordinary drills and more robust than centre drills, **photo 4**. I followed

this up with a 1/4" (6.35mm) drill, nice and deep – deeper than I wanted the weight to be, withdrawing the drill occasionally to help clear the swarf. I could have reamed the hole to size, but I forgot I had a 9/32" reamer, so I just finished it with a 9/32" drill. Incidentally, my 9/32" drill was missing, so I had to take a new one out of my box of spares. This was only removing 1/33" on diameter, about two-thirds of a millimetre, which is a big help with getting accurate sizing of a hole. I won't show photos of a whole succession of drills.

I wanted to recess the bottom of the weight, as this helps it sit flat and also some records have a raised circle at the

centre of the disc. To do this I used a 90-degree insert tool held sideways. It was clear the tool's body might interfere with the work, so I modified it by reducing the end of the tool shank on my belt liner, **photo 5**. This allowed me to turn a nice recess with a bevelled outer edge, without worrying that the tool shank would rub and spoil the nice crisp corner, **photo 6**.

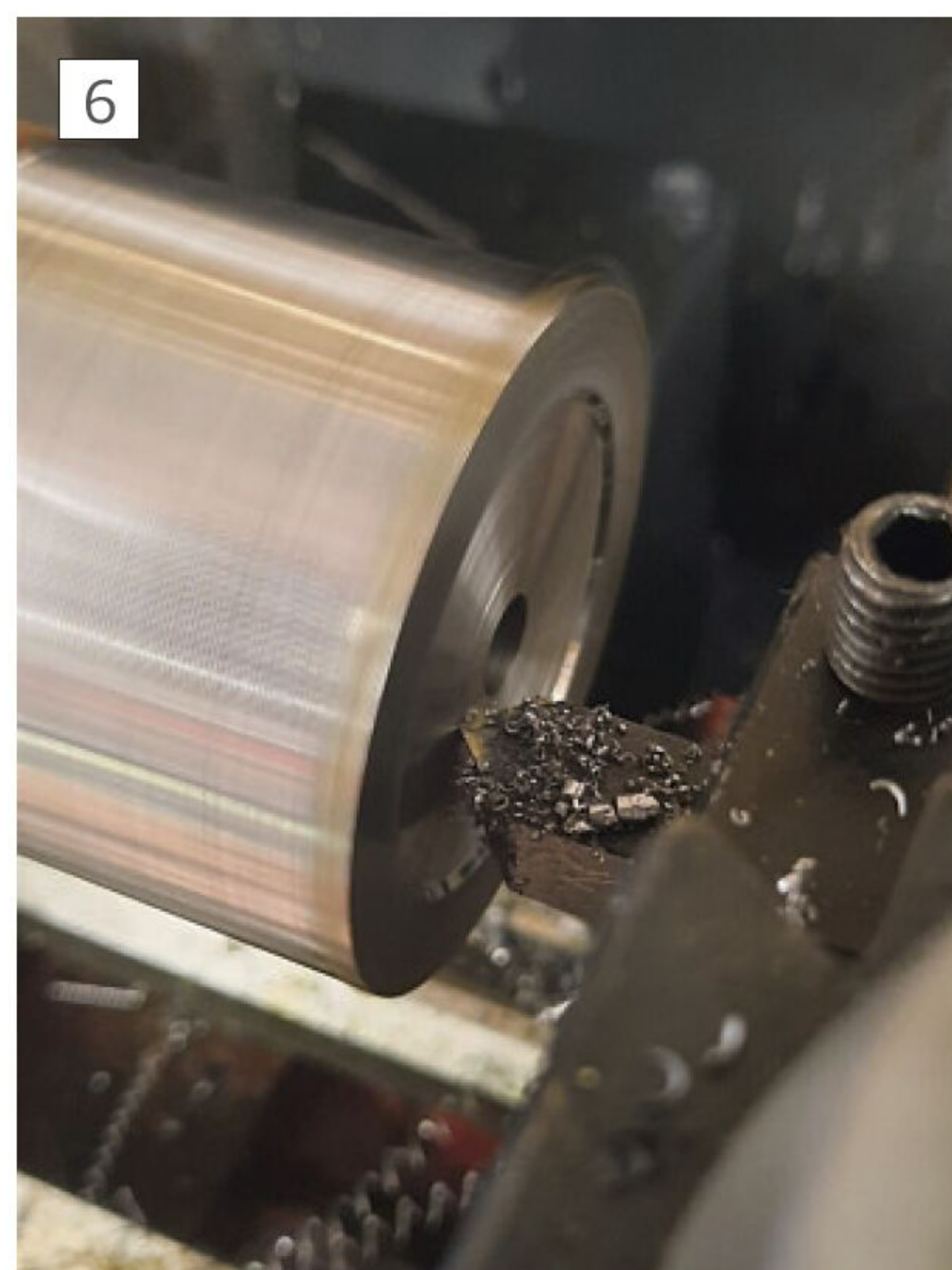
I used a proper countersinking tool, **photo 7**, to tidy up the edge of the central hole. This needs to be run quite slowly, around 100 rpm works well. If you don't have such a tool, you could just relieve the edge of the hole with a larger drill bit, or break the edges with a deburring tool.

The next step was essentially decorative, I wanted my weight to have a knurled ridge around the top, so decided to turn a section tapered at roughly ten degrees. For this I angle the top slide, **photo 8**. Because I had to manually advance the tool I don't have any photos of the process of turning the reduced section, but essentially start where the taper will be deepest, and advance the tool a little for each cut until widest part of the taper reaches the right point. As I hand fed the tool the finish ended up a bit less perfect than the machine fed parts of the job.

On my lathe, a SIEG SC4 the slides are ground square all over, so accurately resetting the topslide after taper turning can be done by using a reference (in my case a v-block) to set it parallel to the lathe axis, **photo 9**.



*90-degree turning and chamfering tool modified for recessing the end of a bar.*



*Recessing the bar.*

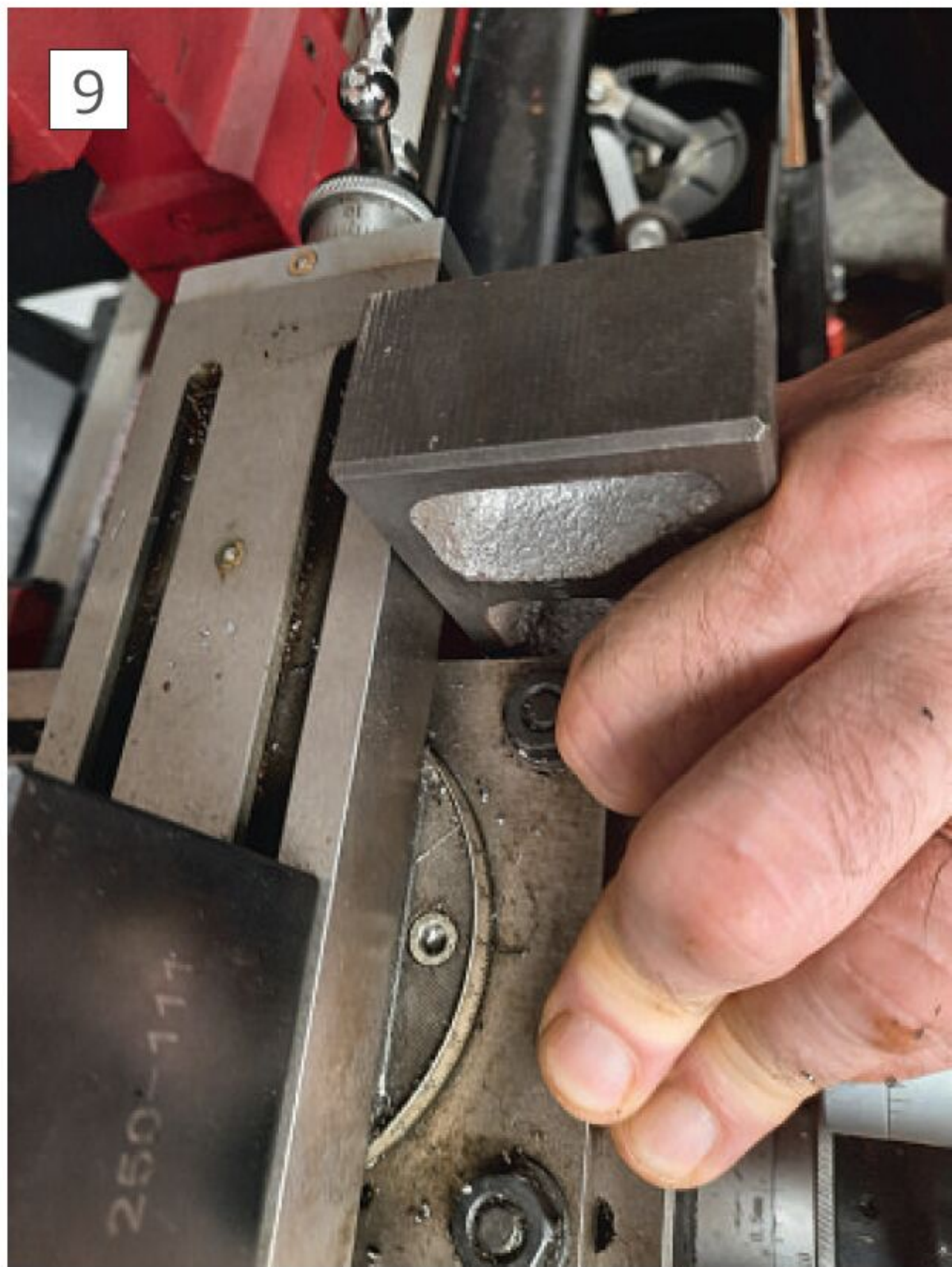


*Countersink tool.*





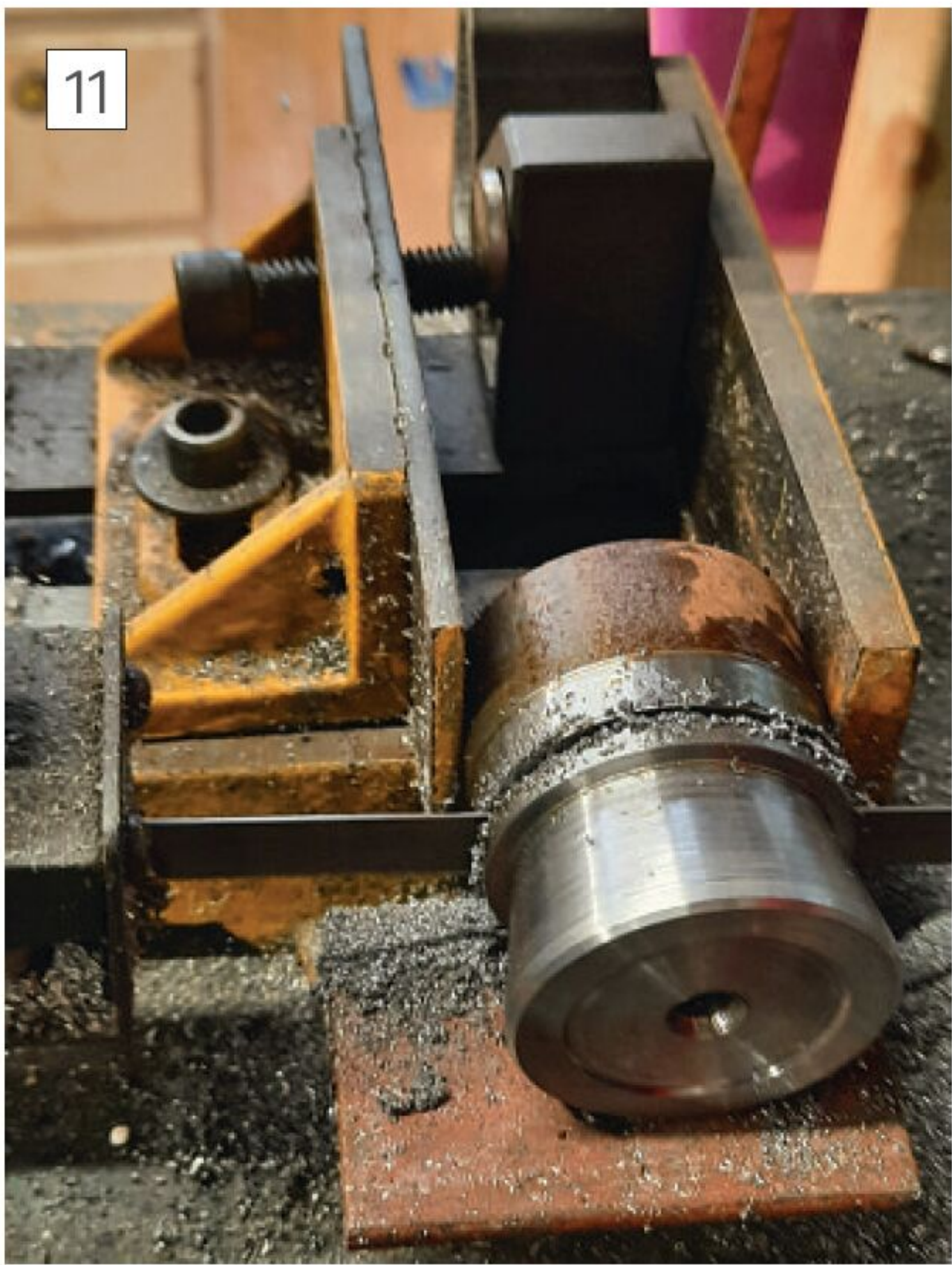
Setting the topslide for taper turning.



Resetting the top slide.



Parting off tool.



The coward's way out – cutting off in the bandsaw.



Just the lower knurl is cutting here.

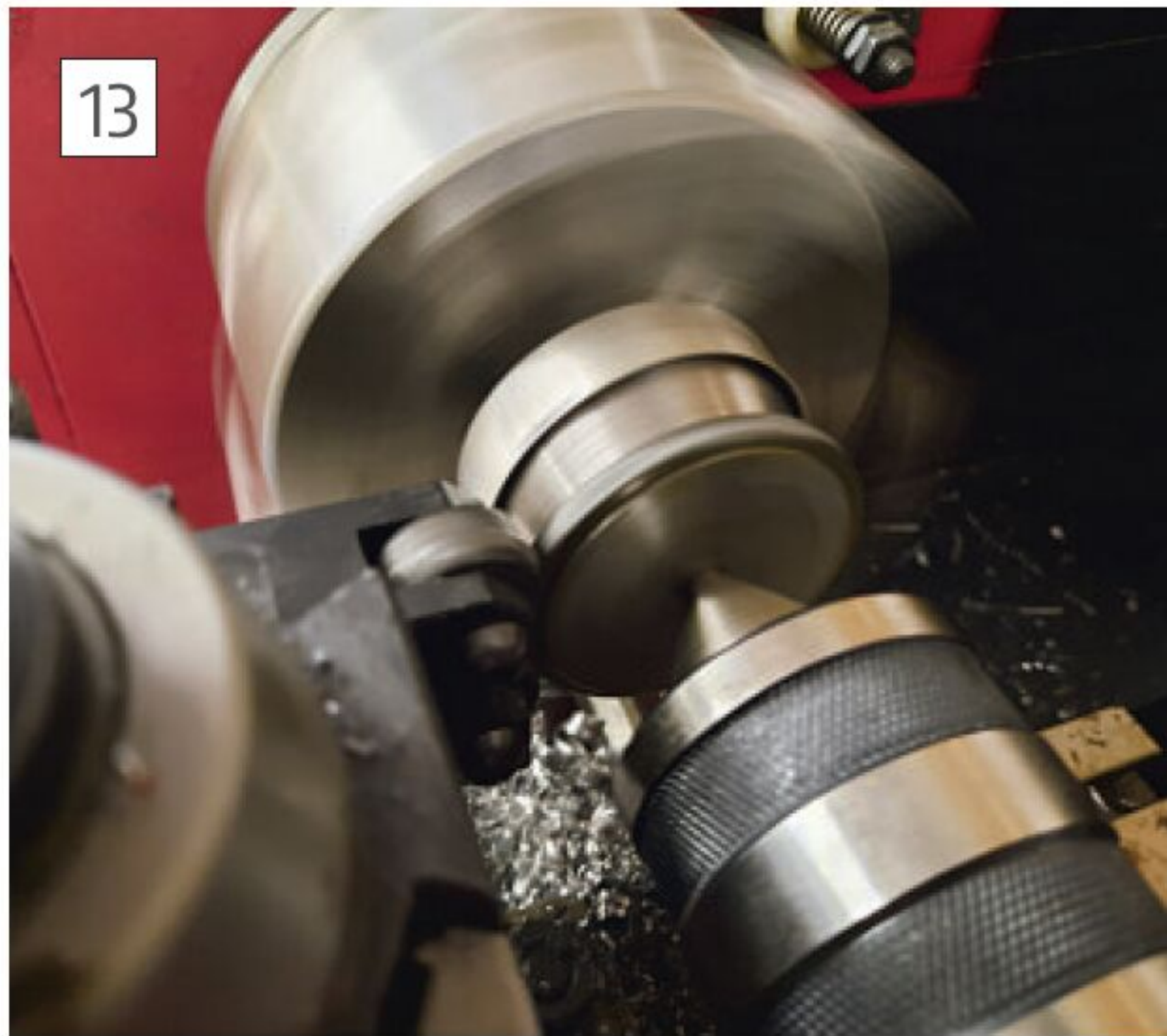
Parting off relatively large diameters can be tricky, but I decided to have a go, **photo 10**. Unfortunately I was a bit skimpy on cutting fluid and suffered a minor dig in. no damage, but discretion is the better part of valour so removed my embryo weight from the lathe and cut off the stock in the bandsaw, **photo 11**. I then replaced the reversed workpiece in the chuck, protected by a narrow strip of thin aluminium alloy sheet wrapped around the base.

The next step was knurling the raised ridge. My scissor knurl is rather small in size so instead I used a toolpost knurl that is fed in from the side. This requires a fair degree of force so I took two precautions; first I supported the work

with a live centre in the tailstock, then, I raised the knurling tool above its usual position so that only one knurl would contact the work, halving the pressure required. In **photo 12** you can see that the top knurl is not rotating, and only one diagonal cut is being made across the work. The knurl was fairly close to the chuck jaws, but I was able to (just) fit the tool under the guard. Using lots of cutting fluid, the knurl was steadily advanced into the work. Bear in mind that it's best not to cut the knurl too deep as a very sharp-topped knurl feels unpleasant to handle.

I then dropped the knurl down to the centre line and repeated the exercise, **photo 13**. I finished the edges of the

knurled section, the HS recommended way is using a strip of emery paper glued to a backing board. All that remained of the manufacture was to



Now both knurls are engaged.

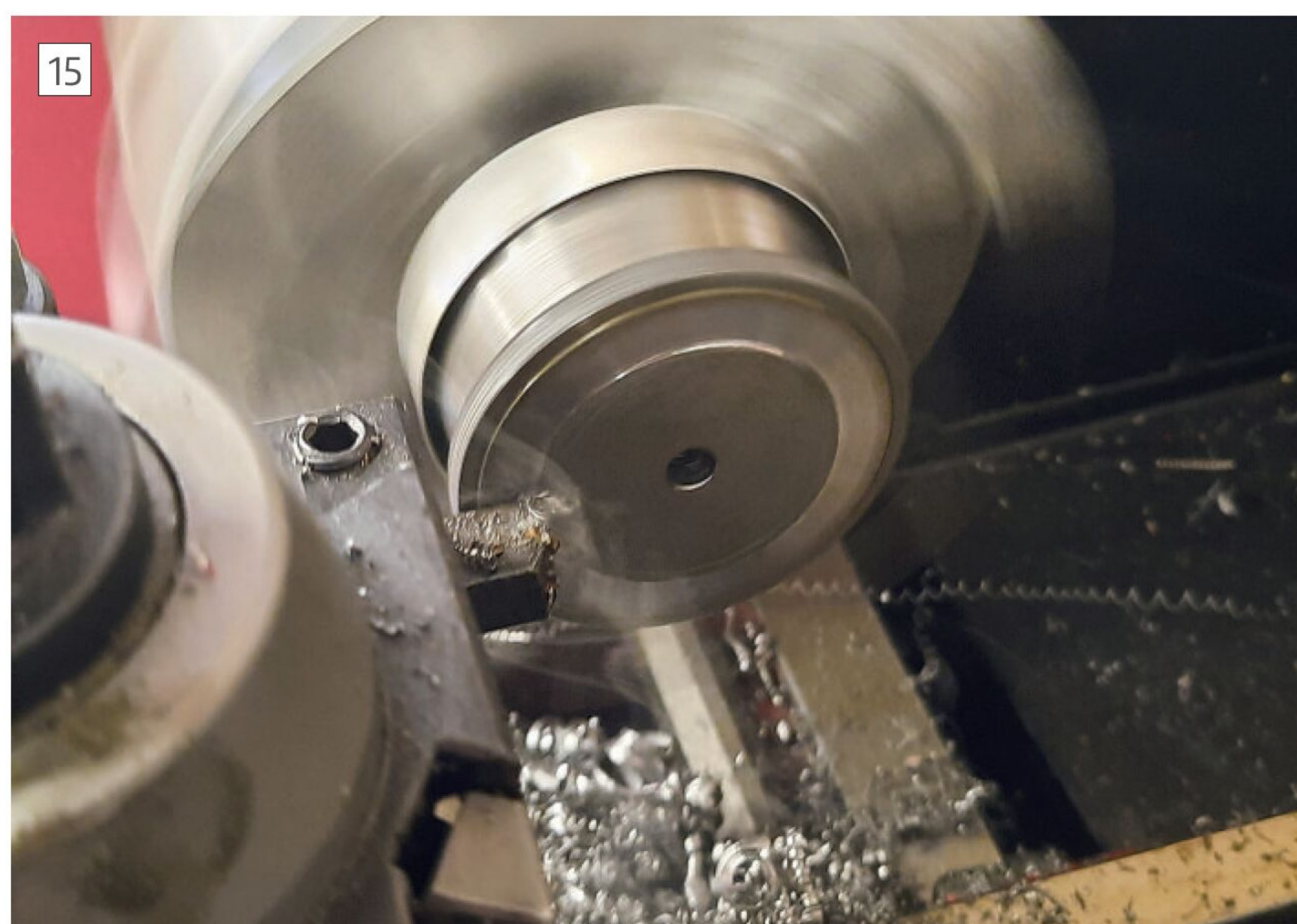




*Countersinking the top of the central hole.*

countersink the hole, **photo 14** and then face across what will be the top of the weight, **photo 15**, using power cross feed.

Now, if I had just cleaned the oil off the weight, I can guarantee that withing a few weeks or months it would have a patina of rust. I had already decided I would be blacking the weight, but rather than my usual oil blacking I decided to use chemical blacking, using a selenium-based solution obtained from the internet, **photo 16**. I discovered too late that the same supplier sells a kit with alkali degreaser and dewatering oil for just a pound extra, but it wasn't difficult to improvise. The first step is degreasing, so after using kitchen roll to remove the worst of the cutting oil, **photo 17**, and washing with ordinary washing up liquid, I put on a pair of protective gloves and put the work into a fairly weak solution of soda crystals in water. This is safer than caustic soda but is an effective degreaser to make sure you wear gloves to protect your skin.

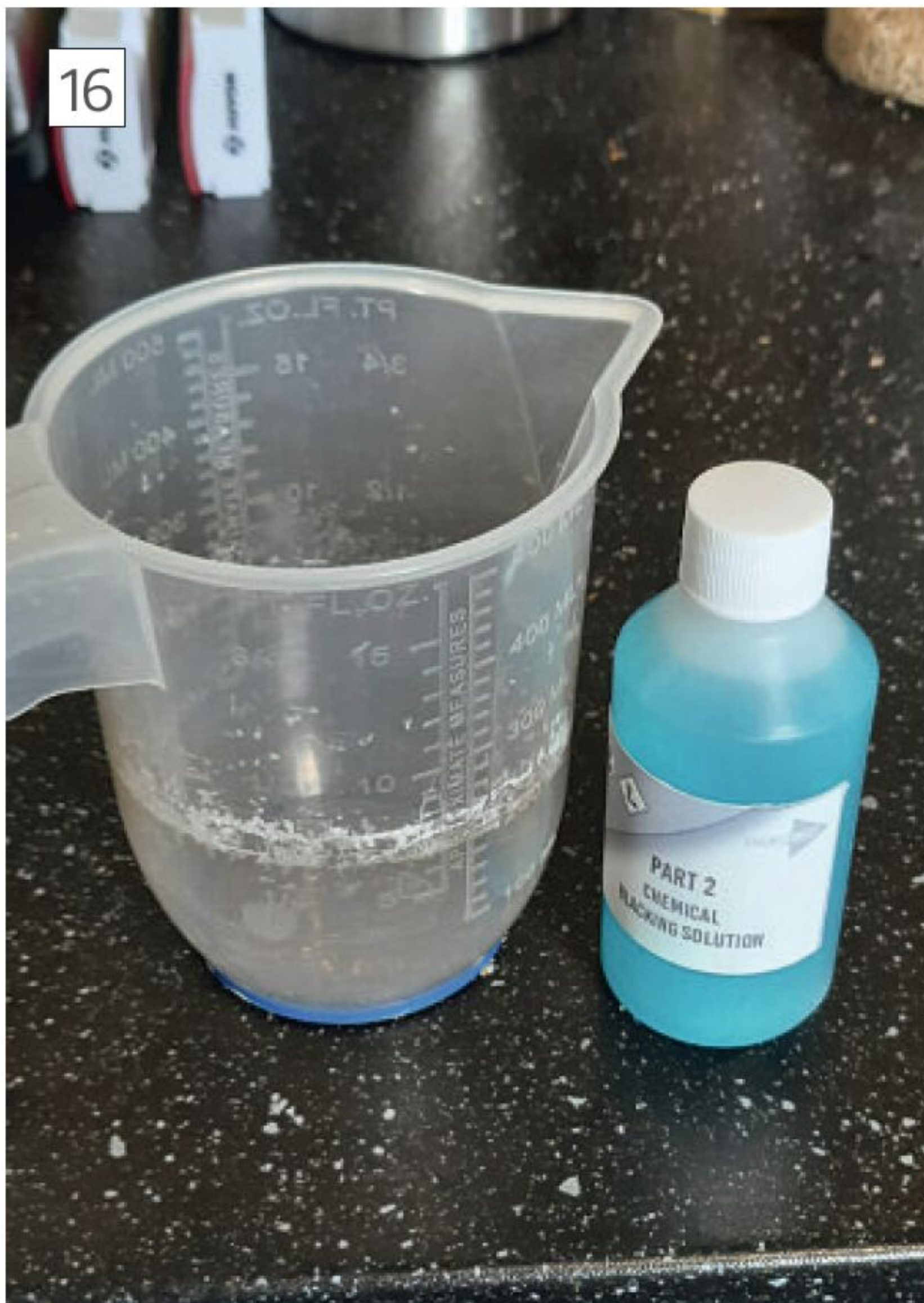


*Facing off the complete the machining operations.*

After another rinse with clean tap water, **photo 18**, the bright clean weight was put into the blacking solution, **photo 19**. Again, I kept the

gloves on, especially as the part had to be turned a few times to make sure it was blacked all over. Blacking started quickly, but the full ten minutes





Just 100ml of blacking solution can go quite a long way.



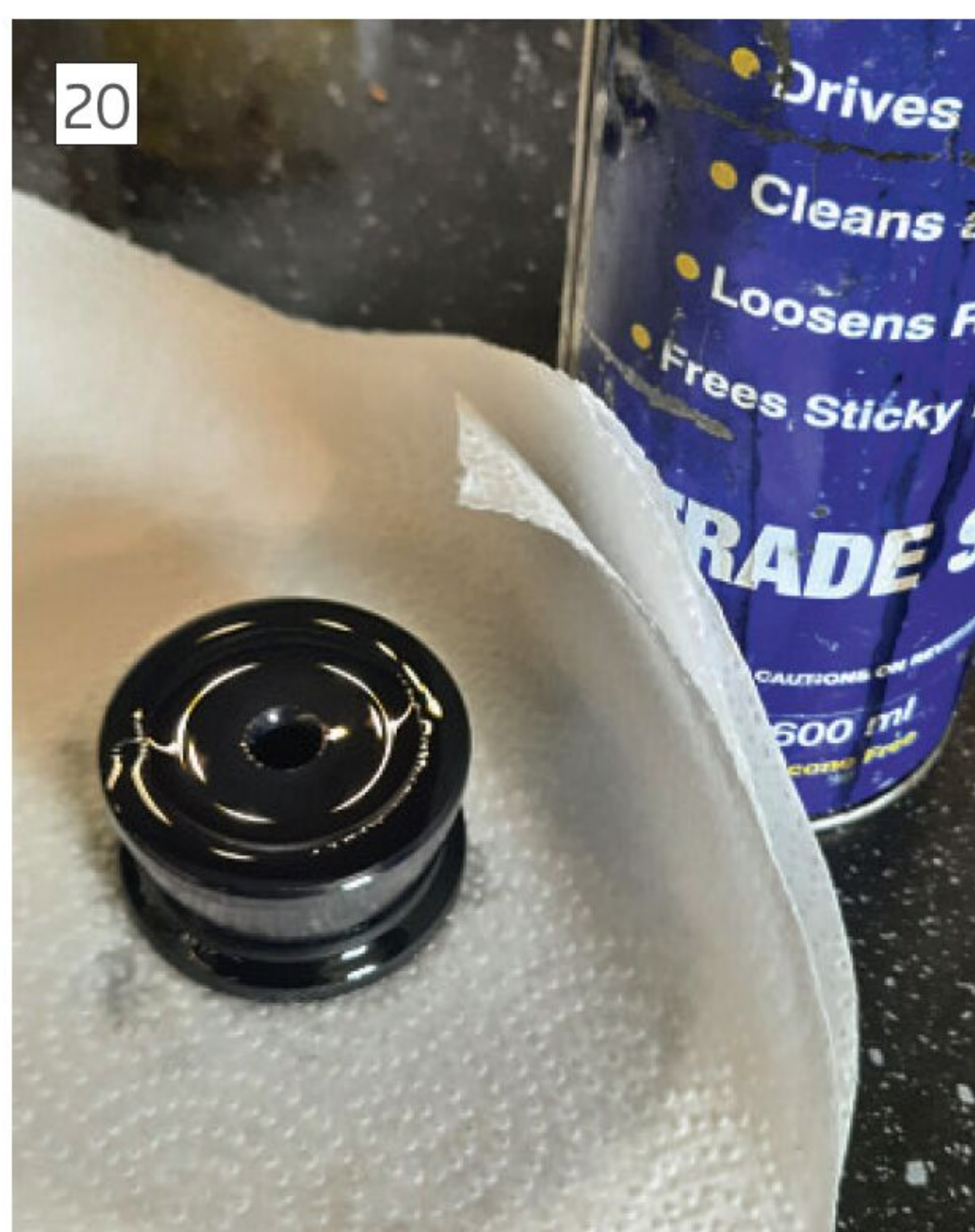
Weight before degreasing with soda crystals (washing soda).



After degreasing – shiny!

recommended saw the colour intensify and become more even. The final stage is another rinse and then dewatering, I used a good slathering of WD40, **photo 20**. Incidentally water dispersal is the original purpose of WD40, while it has many uses it isn't meant as a long-term lubricant.

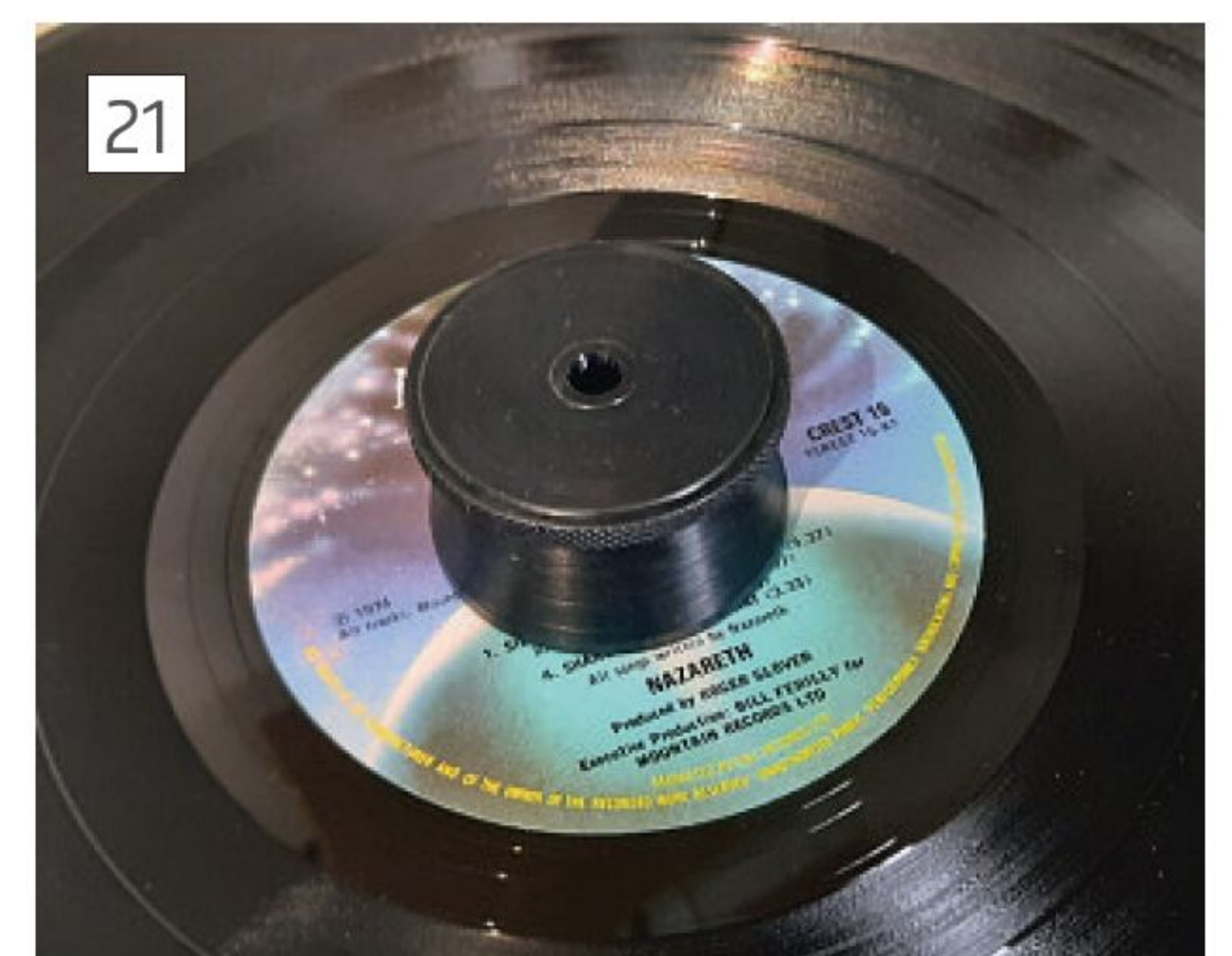
Naturally, the final test was to try out the weight on my record turntable. For the classic hifi buffs, my ancient setup is a Rotel RP-830 turntable, NAD 3130 and a pair of KEF Coda 7 speakers, which was a half decent setup some thirty odd years ago. I would like to report that the weight transformed my listening experience, giving shimmering highs and tight, well-



After a rinse, saturated with WD40.



In the blacking solution.



The finished weight in use.

defined bass with real authority. I can't say I heard any difference, but it does help keep slightly warped records flat and it feels nice in the hand. Oh, and I saved a couple of grand. ■



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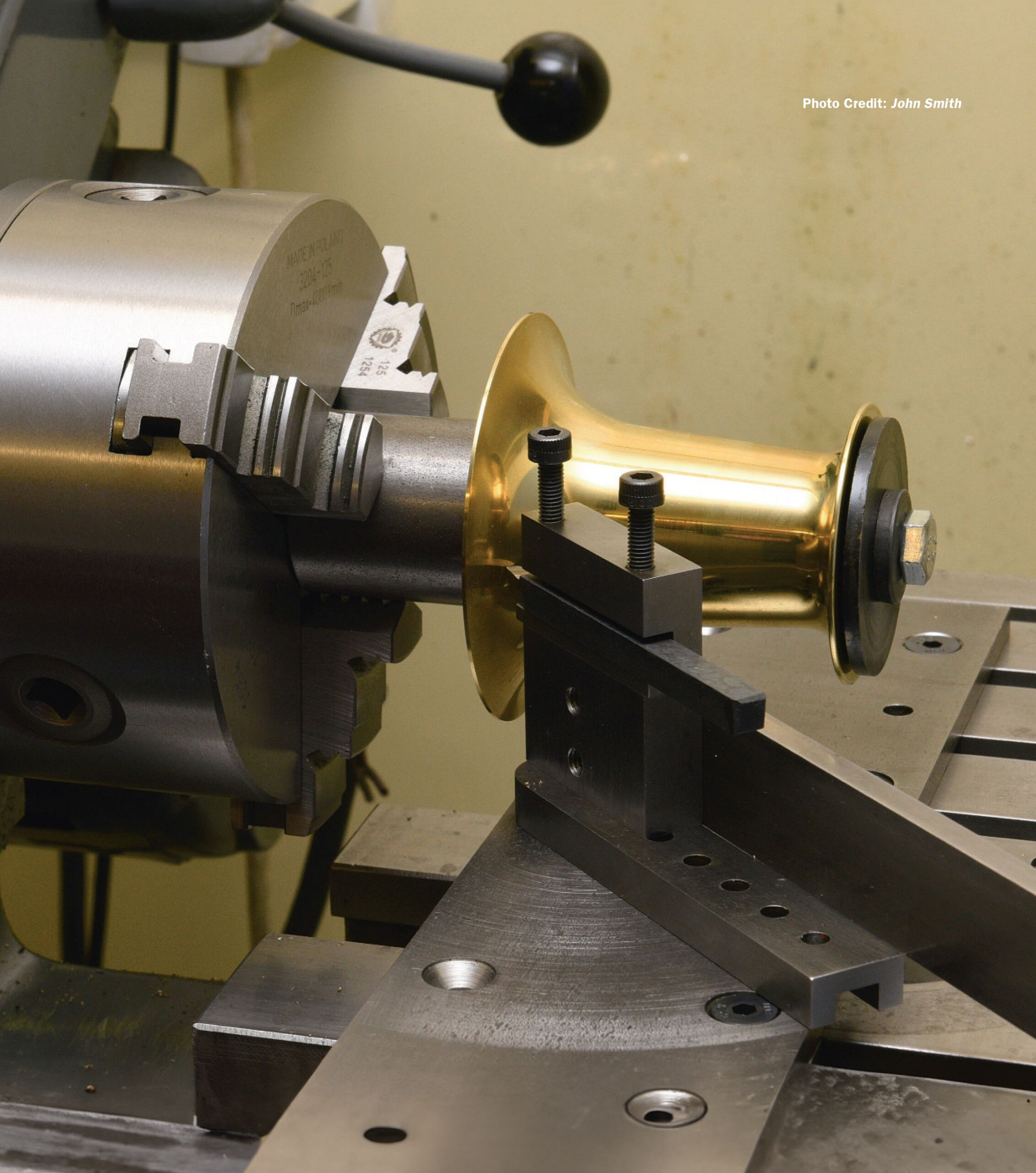
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# Micro-Milling With A Home-Made Contraption – Part 6

Mike Tilby concludes the story of his scratch built machine tool, with some further developments and examples of how he's used it.

## Defining a cutting pathway

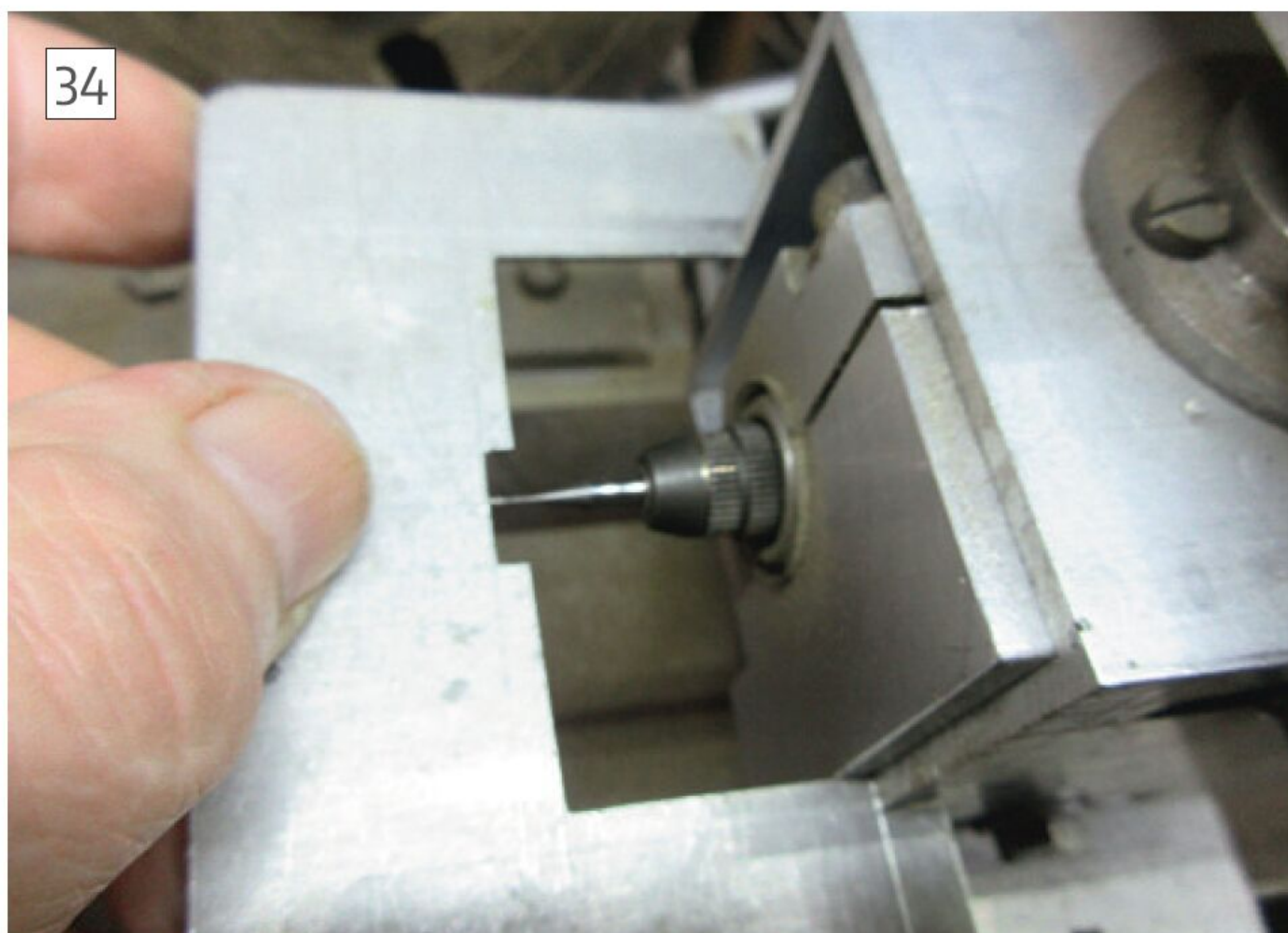
Previously it was explained that the stepper motors are controlled in a way that moves the guide-plate through a pathway that is defined as a series of straight lines between positions called waymarkers. A pathway around a new template is defined by moving the follower, under manual control, from the REF position to the position chosen for the first waymarker, such as where the follower first contacts the template. This position is then stored by pressing the appropriate pair of buttons on the control box. The follower is then moved manually to what one judges to be the next suitable position around the template and that position is stored. As explained previously, the sprung connection between the guide-plate and the template follower arm allows the follower to remain in contact with a curved edge of the template even though the guide-plate moves in a straight line. In order to check that contact with the template is actually maintained, the controls allow one to command the platform to move back along its straight line and then another command causes it to return to last position.

It can be tricky to tell if the follower is actually touching the template and so an electrical continuity detector is used, **photo 33**. The template is mounted on an electrically insulating board and has a wire that connects it to the detector. Another wire from the detector is connected to the follower arm. When contact between follower and template is lost the bright light on top of the monitor turns on and the sound that is emitted by a loudspeaker in the monitor changes from a low to a high pitch. The knobs allow adjustment of sensitivity

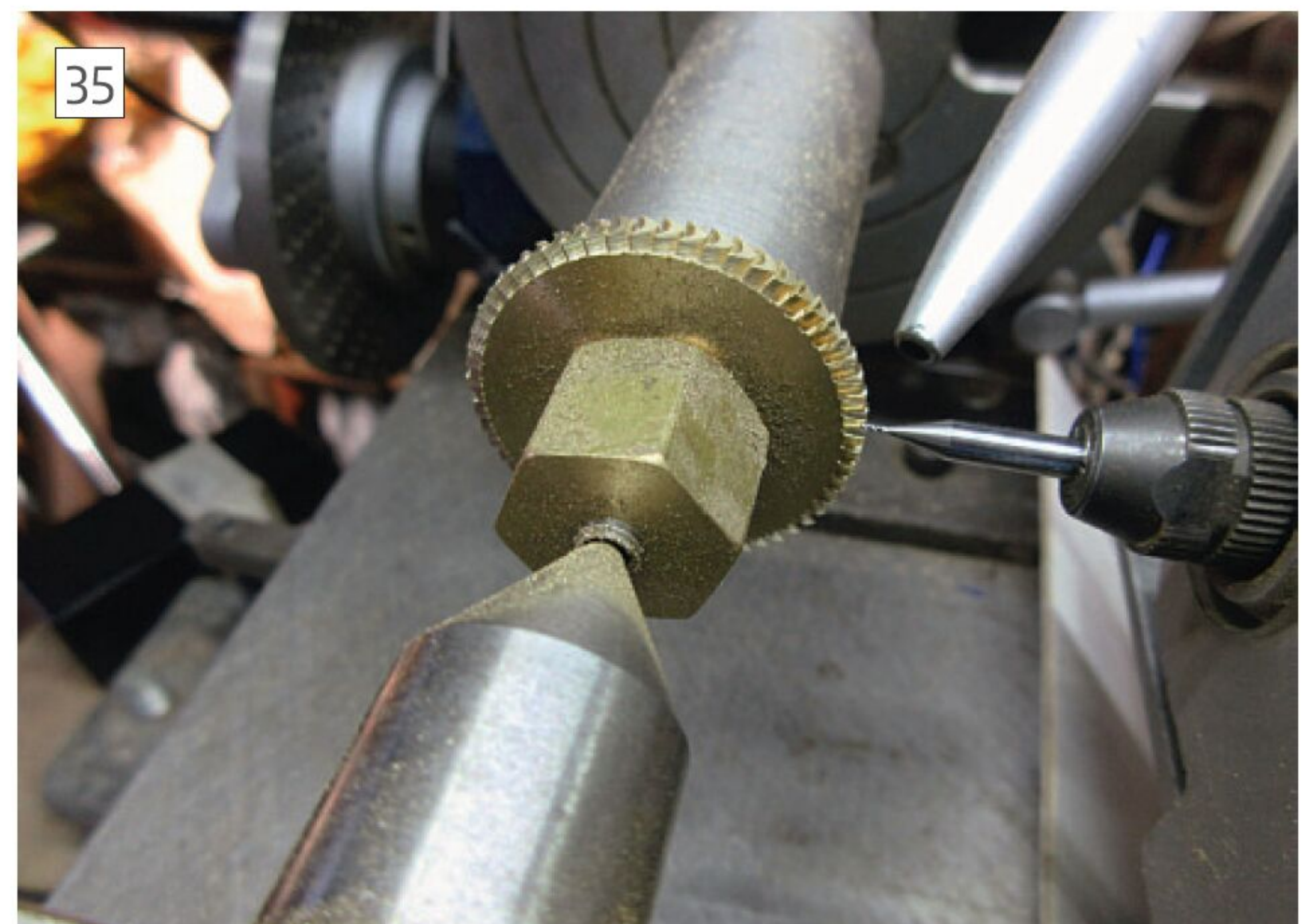


*Electrical continuity detector to detect when the follower contacts the template, or the cutter contacts the work piece. The knobs adjust detection sensitivity and volume of the sound emitted*





A simple template facilitates setting the cutter tip at the correct distance.



An air jet from the nozzle keeps the cutter free from accumulation of swarf.

of the electrical sensing circuit and the volume of the sound.

If the location of the waymarkers prove to be such that the follower loses contact with, or presses too hard against, the template then the position of one or both waymarkers can be adjusted or an additional waymarker can be inserted between them. The sequence of waymarkers that comprise a pathway can then be saved and recalled later, either to be used or to be further edited. Defining that part of a pathway where the follower passes around a sharp edge without undergoing any sudden movements requires extra care but can be achieved without too much trouble. Spending a few minutes setting up a pathway carefully is well worthwhile since it may be used several hundred times in the machining of a typical turbine disc.

### Adjustment of cutter position

When changing cutters it is important that the cutter tip is positioned 2.5" from the plane of the pivots that support the spindle. This is to accurately maintain the 10:1 ratio of the distances from the pivot point to the follower and pivot point to the cutter tip. The cutter projection is easily checked with a simple template, **photo 34**. Also it is important to correctly locate the cutter relative to the work piece. To test when the cutter touches the work piece a second electrical continuity circuit is arranged in which a second pair of wires connect to the detector box, photo 33. The box is fitted with a switch to select whether the template/follower or the

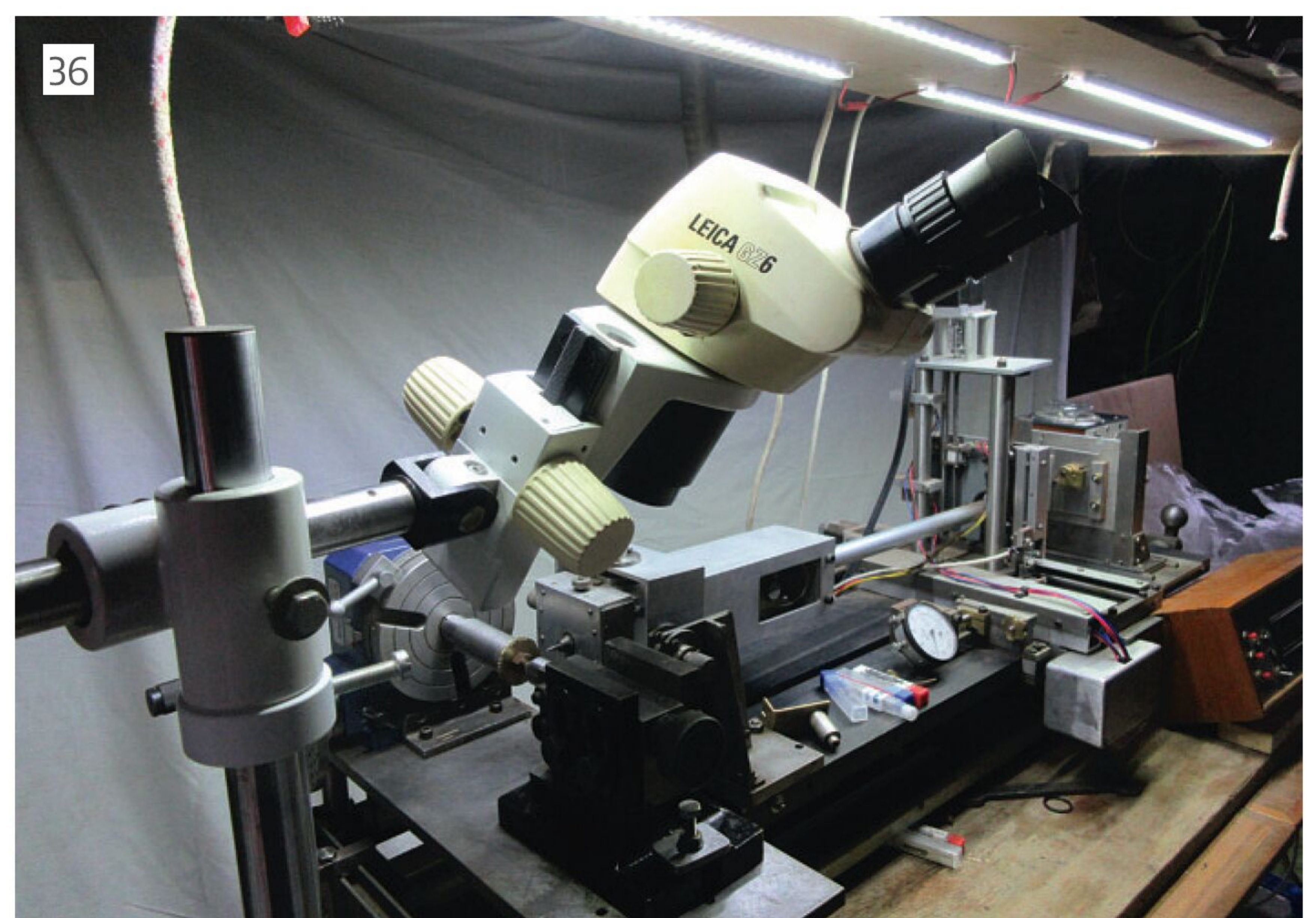
workpiece/cutter are to be analysed. The Proxxon spindle is insulated from the rest of the contraption by a thin sheet of plastic that is placed between it and the clamping block. Tungsten carbide conducts electricity sufficiently well for the electrical continuity tester to work, especially since it is possible to adjust its sensitivity.

### Further developments

Three changes to how the contraption is used have greatly improved the process of cutting turbine blades. The first was finding a way to keep the groove being cut free of accumulated swarf. The fact that the face of the work piece is vertical helps the situation but there is still a problem because the surface

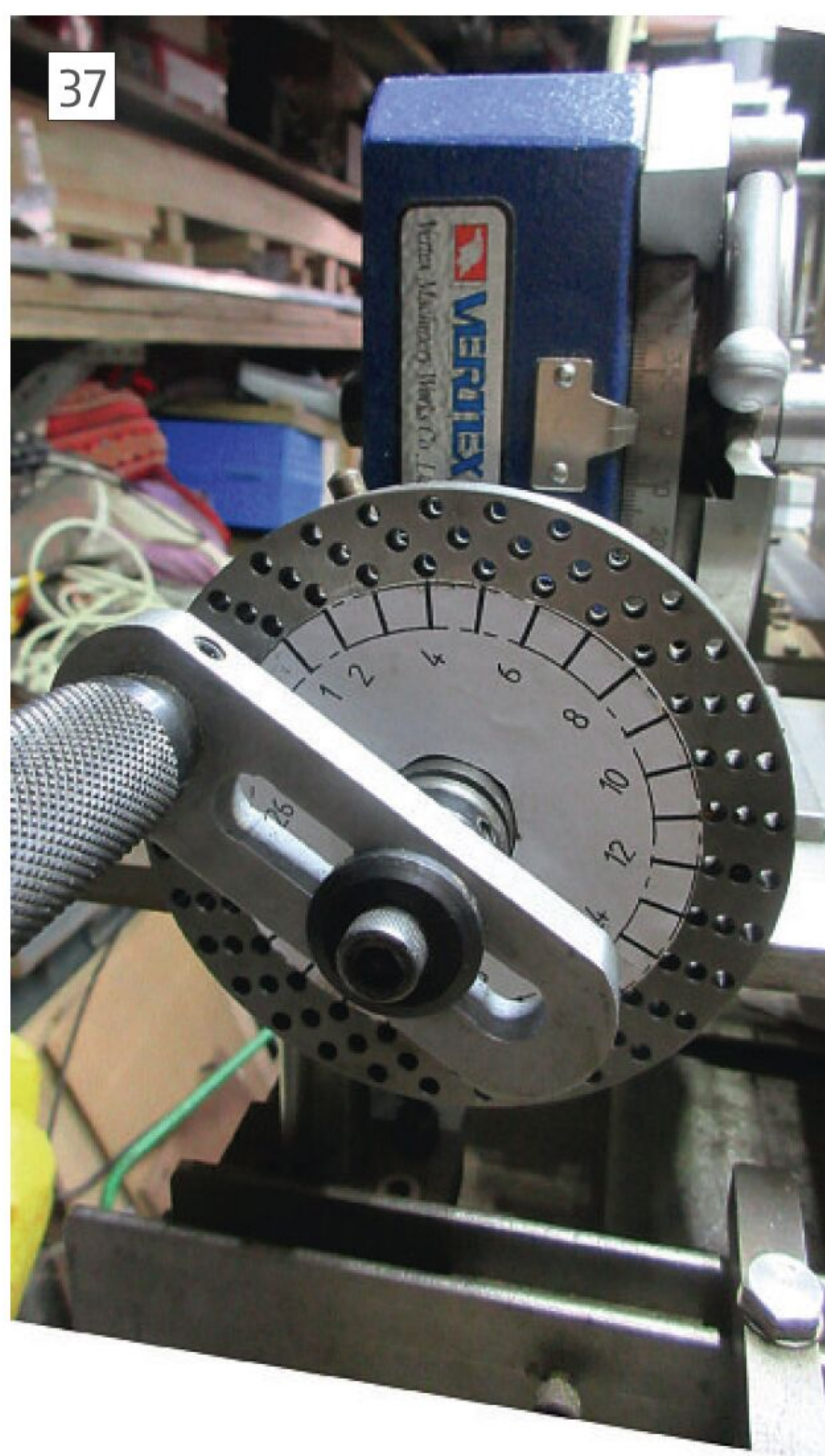
speed of the very narrow cutters is not sufficient to fling the swarf out of the way and they can easily break if they become clogged up. Since I have no plans to machine anything other than brass and related alloys there was no need to add the complication of a stream of cutting fluid which would also entail arrangements to contain the fluid. Instead, a jet of compressed air has been found to work very well and that is delivered from a type ET60 aerator pump (made by Charles Austen Pumps Ltd) via a nozzle, **photo 35**, which is actually the end from a ball point pen.

The second very useful addition to the contraption has been the binocular microscope, **photo 36**. This was a second-hand unit that had originally



Leica stereo-microscope mounted to enable viewing of the cutting process.





*Use of a labelled division plate to reliably position the turbine disc*

come from the micro-electronics industry. It was supplied by the very helpful company [micro-science.co.uk/](http://micro-science.co.uk/). It has a long working distance and has revolutionised my ability to monitor what is going on at the cutter. Also it enables me to keep my head clear of the swarf blowing around near the work area.

The third innovation is the adoption of a new (to me) way of using the division plate and rotary table. Using a division plate rather than direct indexing with a gear wheel etc allows fine adjustment of the number of divisions so as to give an optimal blade pitch. However, in moving through over 50 blade positions it is very tedious and error prone to rely on the sector arms supplied with the dividing plates. This is especially important since the cutting procedure entails returning to each blade position more than once in order to complete all the machining steps. I eventually dispensed with the sector arms and printed a circle of numbered marks that could be stuck, using photo-mount type adhesive, inside the ring of holes that were in use, **photo 37**. These numbers in combination with the degrees marked on the rotary table allow very clear



*First product made using the contraption were slots cut in the periphery of a tapered disc tapered disc when the disc is inserted into a matching taper a casing ring of the turbine. This nozzle is 0.027 in. wide at its outlet.*

and unique identification of every position. This approach is helped by use of a spreadsheet to work out all the positions so that a table of blade positions can be printed in which each position is identified by the number of degrees from the zero position and by the hole number.

### Use so far

Design and construction of this contraption became a project in its own right and having developed it to a state where it can be put to good use one can see ways in which it could be improved. However, it seemed about time to actually start using the thing. The first actual components to be machined were a number of fine nozzle slots for the planned turbine, **photo 38**. In fact these were cut very early on in the development of the equipment at a time when I was only using what now seem totally inappropriate cutters of the type known as engraving drills that were illustrated in photo 13. A diamond hone was used to remove the point but the finish on the sides of the slot were very poor, and I shall not be using such cutters again.

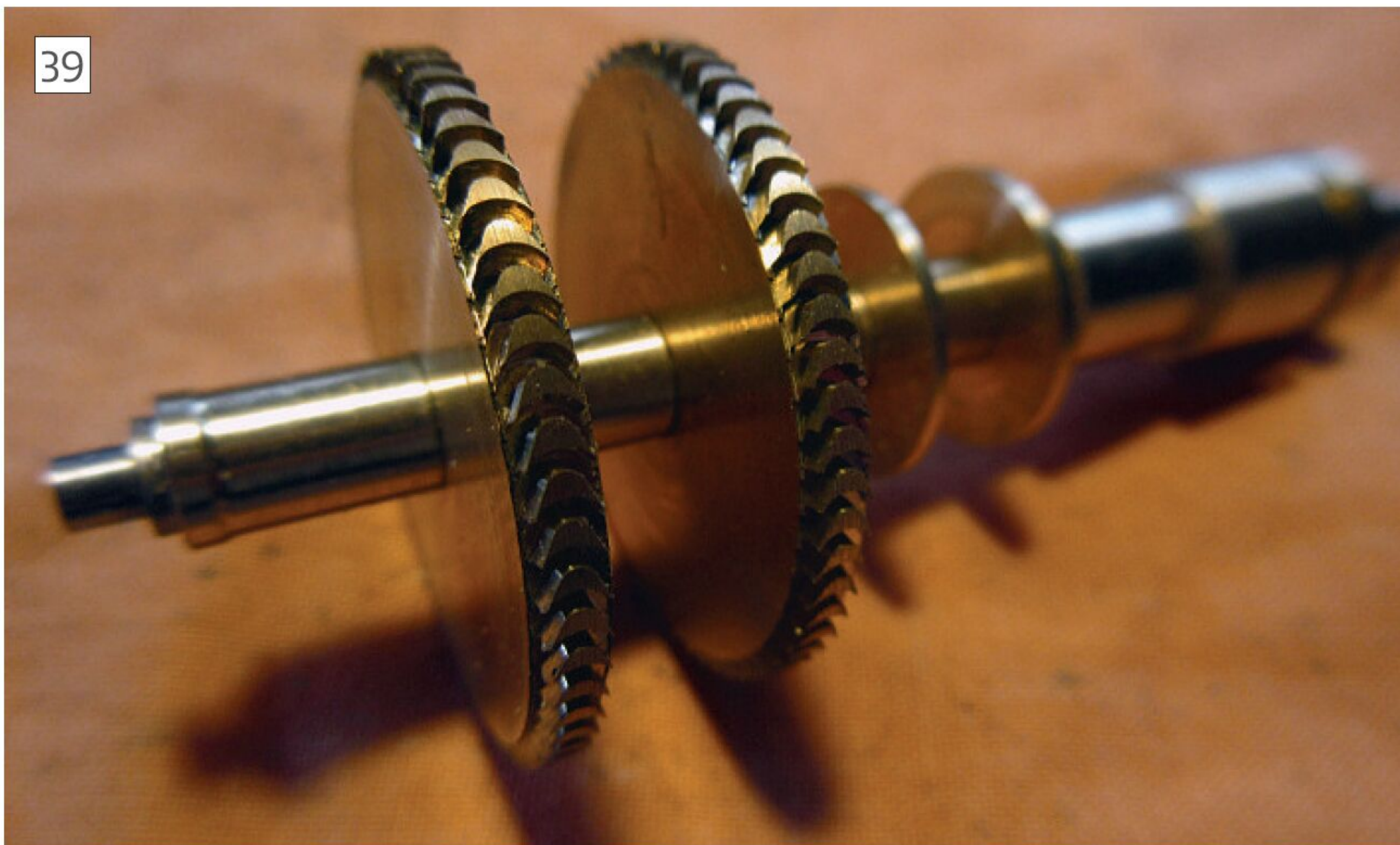
A considerable number of trial turbine blades had been cut but the main test of the contraption's overall utility was only to come from using it in earnest to cut the blades for a complete turbine disc. Only then would practical difficulties associated with aspects such as cutter life, repeated use etc become apparent. So far three full discs have been machined. Each has fifty-eight blades of a conventional

impulse shape designed with the ratio between blade pitch and blade width to match recommendations from text books on turbine design, **photo 39**. As described earlier, each blade was first roughed out using a toothed cutter 0.5 mm diameter. Four cuts at increasing depths 0.020, 0.035, 0.050 and 0.058 inch relative to the periphery of the disc were carried out for each blade before indexing the disc round to the next position. At this stage each blade was machined to be 2 thou over-size all round by placing a steel ring over the 5mm diameter template follower, as described previously. An alternative strategy would have been to make a second slightly larger template. But, apart from the extra work involved, that would risk introducing errors when attempting to accurately position the second template. After all fifty-eight blades had been roughed out a 0.5 mm diameter four-flute Accupro cutter was used to finish the blades with the follower ring removed. Three of these lighter cuts were performed per blade with depths (relative to the disc periphery) of 0.025, 0.045 and 0.060 inch.

When I started using the contraption I assumed that it would be best to use the highest spindle speed possible. However, I later realised that at 20,000 rpm with the maximum rate of cutter movement possible with the un-damped stepper motors and lead screws, the cutter was probably passing over the same piece of surface several times before sufficient lateral movement had taken place to cause it to actually remove any more



39



*Turbine discs .125 in. O.D., each with 58 blades cut with the contraption using cutters 0.5 mm in diameter.*

metal. This would mean that for many rotations the cutter was just rubbing and that would lead to blunting of the cutting edges. Also, the vibrations caused by the high rpm rubbing might lead to fatigue fracture of the milling cutter, especially with the cheap long cutters. I then reduced the spindle speed to its minimum which is 5,000 rpm.

This gave just as good performance as the 20,000 rpm and could have helped extend the life of the cutters. It has been possible to perform the four roughing cuts on each of over one hundred turbine blades using just one of the cheap shortened toothed cutters, 0.5 mm in diameter. The three finishing cuts have been performed on each of

about 150 blades using the same 0.5 mm diameter Accupro four-fluted cutter.

### Conclusion

I guess this can be called a scratch-built machine since ready made components could have been used in several places. I very much doubt anyone else will be so 'eccentric' as to build a similar contraption to this but I hope the articles might provide ideas that are useful for other people's projects. If anybody would like further details on any aspect, I'll be very happy to help as much as possible (please send queries via the editor).

### Acknowledgement

I thank Peter Gale for providing much helpful discussion and advice on many topics, especially on electronics and for designing the circuit for the continuity tester.

### References

The following reference should have appeared in an earlier instalment:

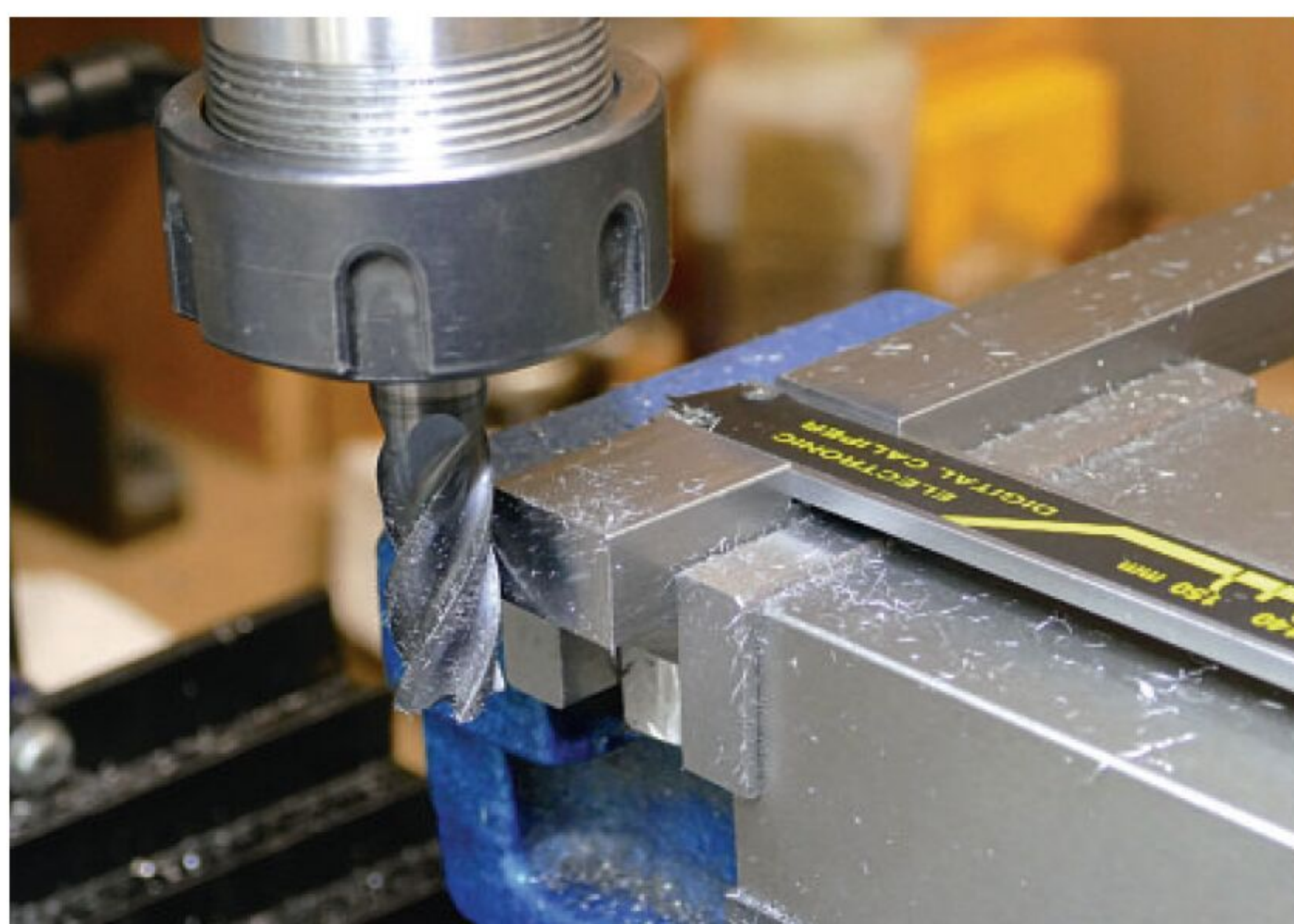
16. Tilby, M.J. (2019) An electronically controlled boiler - part 3 SMEE Journal 27 (1): 14 – 20. ■

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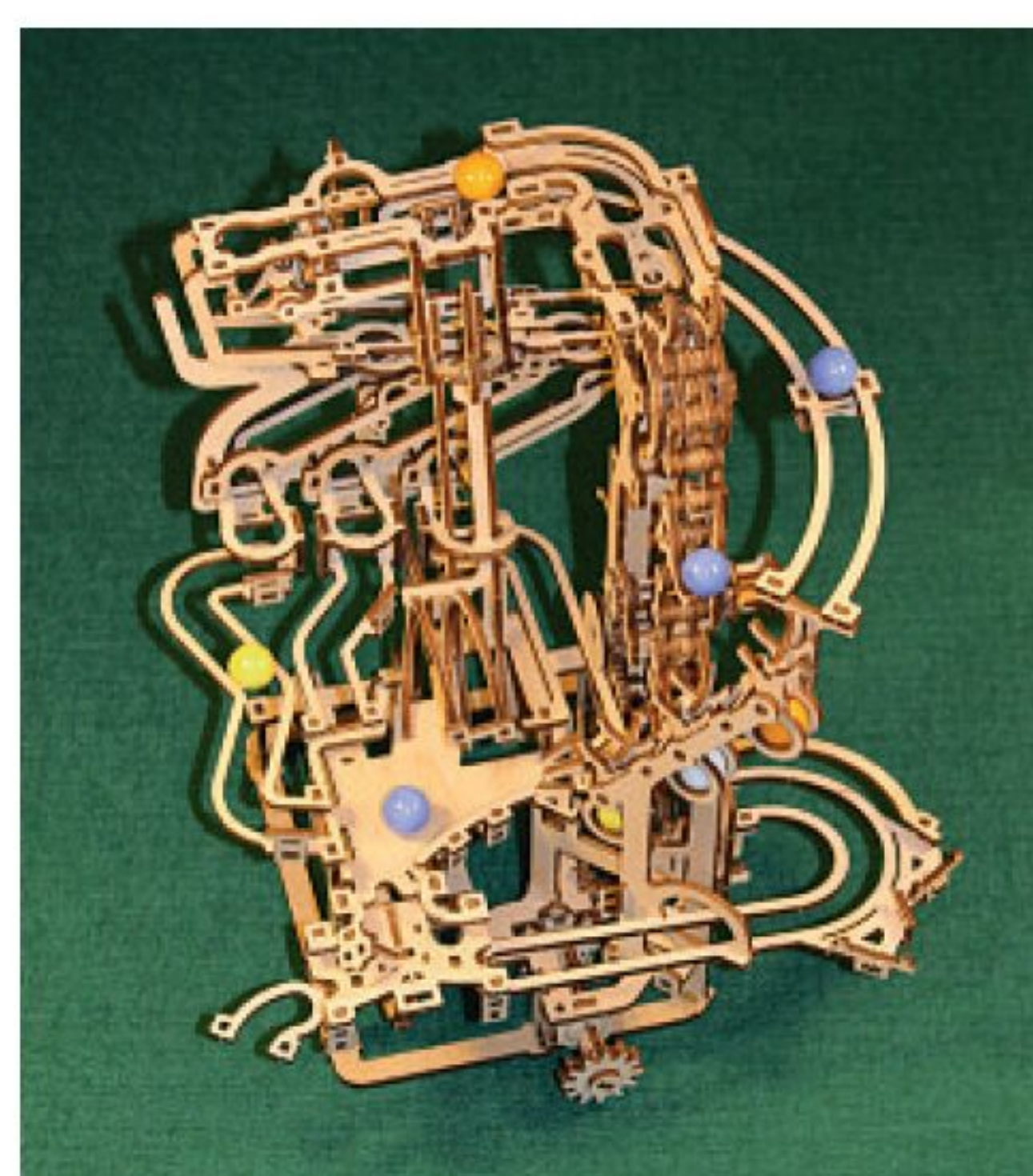
**Coming up in issue 343,  
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**Geoff Andrews** details a useful modification to a digital caliper.



**Mark Noel** looks for an entertaining diversion while his new workshop is being completed.



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# Learning to love my Denford NovaTurn, Part 2

Mick Knights makes quick change toolholders for his Denford Novaturn CNC lathe.

**H**appily we can now move on to the actual operating of the Novaturn lathe, a place where I feel decidedly more comfortable, and the Denford service engineer can now check his emails without the fear and trepidation of finding another request for help with IT problems from yours truly!

Hopefully by writing this detailed look at the operation and setting of my Novaturn it will be of interest to readers not yet acquainted with CNC turning and who may feel reluctant in getting involved with the black art through lack of information of what might be involved. It may also help readers who have decided to get involved with CNC turning and have not yet made up their minds on which machine best suits their needs, and so may help them in making a decision on what machine to acquire.

Being a training lathe there are several extra layers of health and safety features that go a long way to ensuring that inexperienced operators can't crash the machine or be in danger of injury from flying swarf. Now I do not advocate the removal of any of these features if young or inexperienced operators are to use the machine. In my workshop I'm reasonably confident that only one older person, who should know better, will be using this particular machine. As there is no coolant pump with this machine, (something I'll probably get round to in due course,) coolant has to be brushed onto the work piece, or in the case of drilled holes squirted directly up the resulting hole from an oil can. All this of course means the guard has to be raised when the spindle is rotating, to achieve this the guard fail safe switch has to be bypassed.

Although I can find no mention of it in the User's manual, but there seems to be a limit switch that stops the saddle travel 20mm before a standard cutting tool mounted in the tool post, or auto



*Aluminium spacer ring.*



*Chuck mounted 20 mm. forward from original position.*





*The start of my tool library*

tool change carousel reaches the chuck jaws, this is all well and good and of course will prevent any over enthusiastic programmer crashing into the chuck. The problem with this for me is parting small diameters when the parting blade needs to be as close to the chuck jaws as possible in order for the jaws to give maximum support to the bar stock. Now any readers who can remember part one of this discussion may also recall that electronics is not my strongest suit and so a mechanical solution was required. The easiest method to bring the chuck closer to the tool post is by making a spacing ring. To digress slightly, the lathe came with a very nice Pratt three-inch chuck, the only problem was that the hard jaws were missing. A set of genuine Pratt hard jaws are £120.0, while a brand-new three-inch chuck from Cromwell was £65.0. No prizes for guessing which route I took. Back to the spacing ring. Needless to say the two registers, spacer to spindle and spacer to chuck need to be completely concentric and a snug positive location to their respective mating registers, **photos 12 and 13**.

This would be as good a time as any to discuss tooling and the investment required. No hand ground tools and that includes brazed carbide, should be used on CNC machine tools, as the whole object of the exercise is accurate repeatability and this is only achieved by using inserted tooling, plus of course any radial forms required can be generated rather than using form tools.

Once a tool library has been assembled and their individual Z and X axis offset positions established against the reference tool (T01) position then even one off machining is quick and easy with just the Z axis offset of the reference tool, T01, needing to be zeroed on any new work piece, as all the other established tool offsets, being set from the reference tool position, will pick up the new Z axis absolute zero position, while all the X axis offsets will remain unchanged as they are established using the centre of the spindle as their absolute zero positions. **Photograph 14** shows my tool library, the only tool missing is an internal screw cutting holder, which I'll leave until I have a component that requires one.

Depending on the type of tool change system mounted on individual machines only a few tools are required for machining a wide range of work pieces. My machine has a manual tool change, while other Nova Turn machines have an eight-position automatic tool changer (ATC). There are pluses and minuses to both systems, but both really only require eight tools permanently set to be able to produce most work pieces, these are:

- T01 Finish turn
- T02 Centre spotting drill.
- T03 Rough turn.
- T04 Drill.
- T05 External screw cutting.
- T06 Boring bar.
- T07 Groove and parting (dog bone style insert)
- T08 Internal screw cutting.

All internal tooling used on ATC turrets have even numbered positions as you can see from the above tooling list. CAD/CAM generated part programs will mirror this system, so therefore manual tool changing machines should also follow this numbering system if CAD/CAM generated part programs are to be used. It is simple process to edit a CAD/





*Initial machining of the tool holding blocks.*



*Four tool holders.*

CAM generated part program to reflect different tool numbers and their offsets if using a manual tool change, but on an ATC the even tool positions on the turret will have bores rather than rectangular locating slots in order to accept front facing tooling such as drills and boring bars. Internal tooling mounted on an ATC doesn't necessarily have to follow the positions as I've given them, as other factors such as work piece clearance while the turret is indexing may be a consideration. If the internal tooling has to be repositioned, then the tool positions allocated in a CAD/CAM generated part program will have to be edited to reflect the change, for example T02 may have to become T04. Of course this is where the manual tool change system comes into its own as there are no limitations to the number of tools that can be permanently set and called on when required.

Now anyone who has been involved with machining for any length of time,

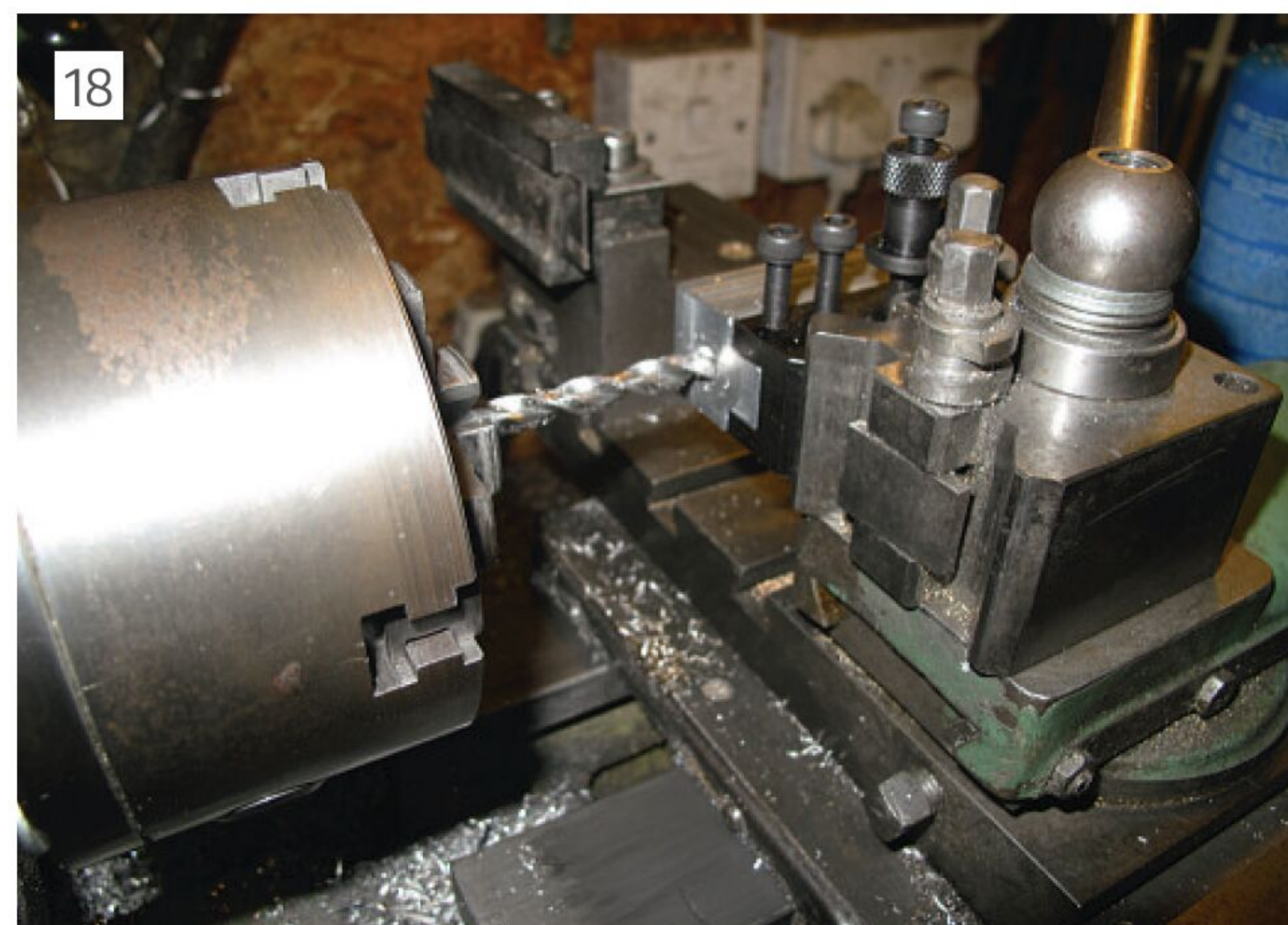
be it model engineering or industrial, will be aware that tool holders and inserts can carry a hefty price tag. It was only a few years ago that cheaper tooling, that is, not from an established manufacturer, could well have been produced from inferior materials and the inserts could also be problematic. This happily is no longer the case. Over the past ten years or so far eastern, and especially Chinese tooling has become inexpensive and more than good enough for everyday use in the hobby, and indeed industrial workshops and I can thoroughly recommend them, after all it's the insert that does the work and the holders being ISO standard and now being produced from the correct tensile steels, will accept different styles and grades of specialist insert from more established manufacturers should the need arise. I sourced all the tooling for the lathe via the internet. A few quick examples, I sourced a ER16 external

screw cutting holder on a 16mm shank, for £14 which included postage. A set of seven tool holders on 12mm shanks was £45 including post, all holders came with a general-purpose grade insert. As the lathe didn't come with a tailstock, I needed a system of holding drills, so rather than using a small drill chuck which I would have had to adapt to be held in a quick-change tool holder, I bought an ER16 collet holder mounted on a 16mm diameter shank and a set of eight collets for £22, anyway, I'm sure you get the general idea.

All twist drills and centre spotting drill need to be mounted in the manual tool post, so suitable tool holders need to be produced. As they will not be subject to a particularly hard-working life they can easily be made from aluminium. To ensure that all the bores are parallel to the tool holders they were machined in situ using the manual lathe as a horizontal borer. The centre heights



*Setting the tool post square to the spindle.*



*Pilot drilling.*





Turning the bore parallel.



Finished size.

between the Novaturn and the Myford are different so this will entail positioning the bores centrally in the tool blocks for initial machining and then adjusting the centre height on the Novaturn later. Scratching through my 'it'll be useful one day' box I found a couple of pieces of rectangular aluminium, although any suitable section that allows the machining of a securing lug and leaves a decent amount of material around the bore would be perfectly okay. First operation was to mill the 12mm wide

securing lug, **photo 15**.

I then split them to produce four tool blocks, **photo 16**. For obvious reason the machined bore needs to be parallel to the quick-change holder, a quick method of setting the tool post square to the spindle is to gently clamp a try square in the lathe chuck and set the tool post to it, this initial setting can subsequently be checked using a DTI, **photo 17**. After the centre is established the first block is pilot drilled, the bore can then be opened up using ascending

drill diameters, **photo 18**. Unfortunately my boring head is mounted on a No. 3 morse shank, while the lathe spindle only accepts a No. 2, so to ensure the bore is completely parallel the drilled hole was opened up until a boring bar mounted in the chuck could take a cleaning cut to completely true up the bore, **photo 19**. The bore was sized to 16mm using a machine reamer, **photo 20**. Finally, the finished tool holders and their respective tooling are shown in **photo 21**.

● To be continued



Four completed tool holders.



# Readers' Tips



## Rotten Eggs (and how to avoid them).



**This month's winner is John Lawmon from Oxfordshire, who doesn't enjoy the smell of old cutting fluid.**

About six years ago the coolant sump for my newly acquired surface grinder started to smell of rotten eggs. A little research found that bacteria feasting anaerobically on the iron particles were responsible for the smell. Once that discovery was made it was obvious that if the sump could be aerated with oxygen the anaerobic bacteria would die. A fish tank pump quickly followed, and the smell has not returned since installing the pump over five years ago. I have now extended the concept to my flood coolant metallurgical chop saw which was experiencing a similar problem.

The attached images show the front of my grinder and the sump at the rear with two fish tank pumps.

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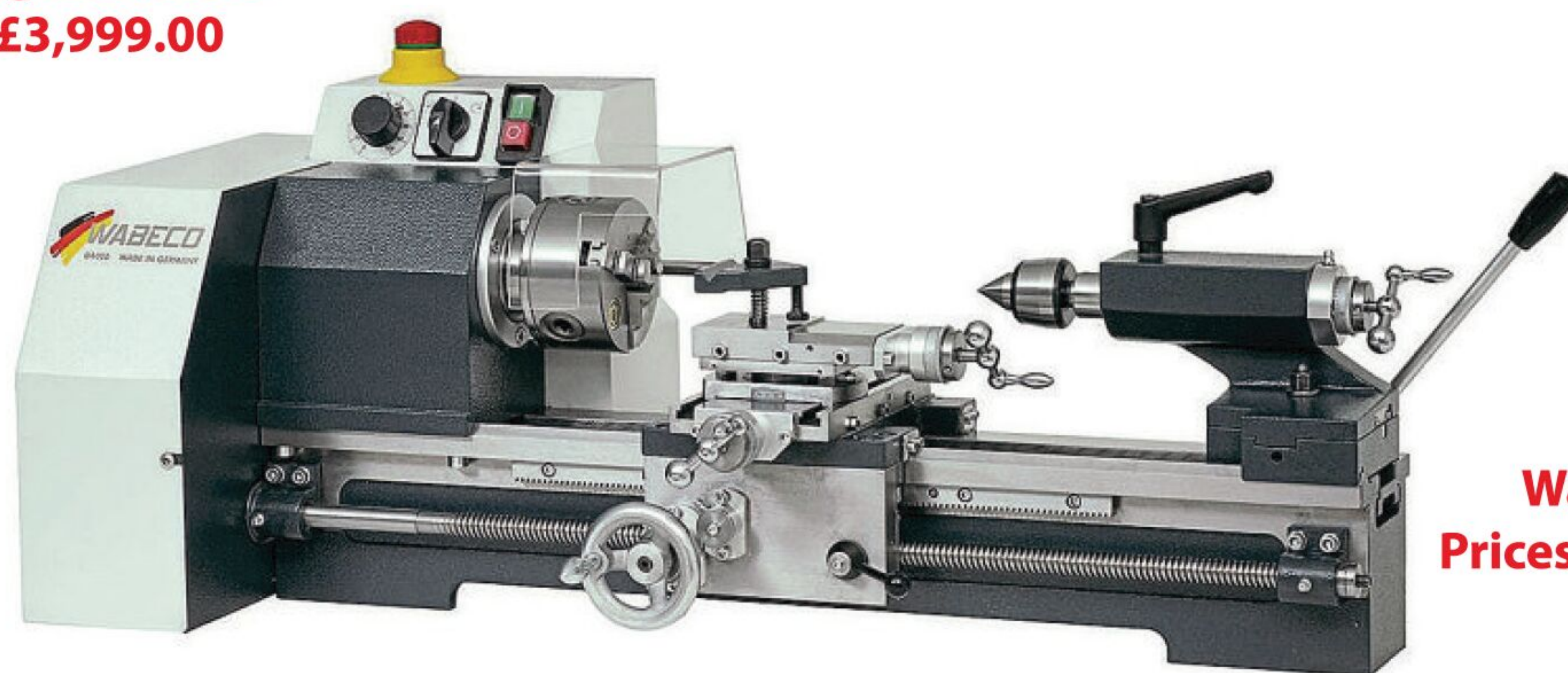
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# From the Archives

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

Issue 78, November/December 2021, featured a this neatly executed repair of a damaged vice by Victor Elsendorn. Note that the vice was cast steel rather than cast iron, making it easier to weld successfully.

## RENOVATING A MACHINE VICE



1. The components of the machine vice, showing the generally poor condition

Some years ago I bought an old pillar drill, and although the machine was in a reasonable state it came with a machine vice which had been very badly treated (Photo. 1). Apart from the poor overall appearance, the biggest problem was that the bottom of the vice looked like the surface of the moon (Photo. 2). Even the jaws of the vice were heavily damaged. I stored the vice away, waiting for a more convenient time to attend to it or to make a decision on scrapping. I recently reworked a grinding machine, this being a very time consuming but fascinating job. I am sure that most of you will have the



2. The badly damaged areas with their moon-like craters

same feeling when such a project is ready; you urgently need a job to do to test out the new machine, so I decided to use the vice as the first job for the grinder.

After disassembling the vice and making a careful inspection, it became clear that the biggest problem areas were the bottom slide surfaces, the right hand side being less damaged than the left. I decided to add new material to the right hand side by welding and, for the left, to mill out a section and to insert a blank of mild steel (Photo. 3).



3. Machining the recess for the insert

Victor Elsendorn of Sassenheim, The Netherlands, describes the renovation of a damaged machine vice during which two restoration methods were used, providing an opportunity to compare their effectiveness

### The welding process

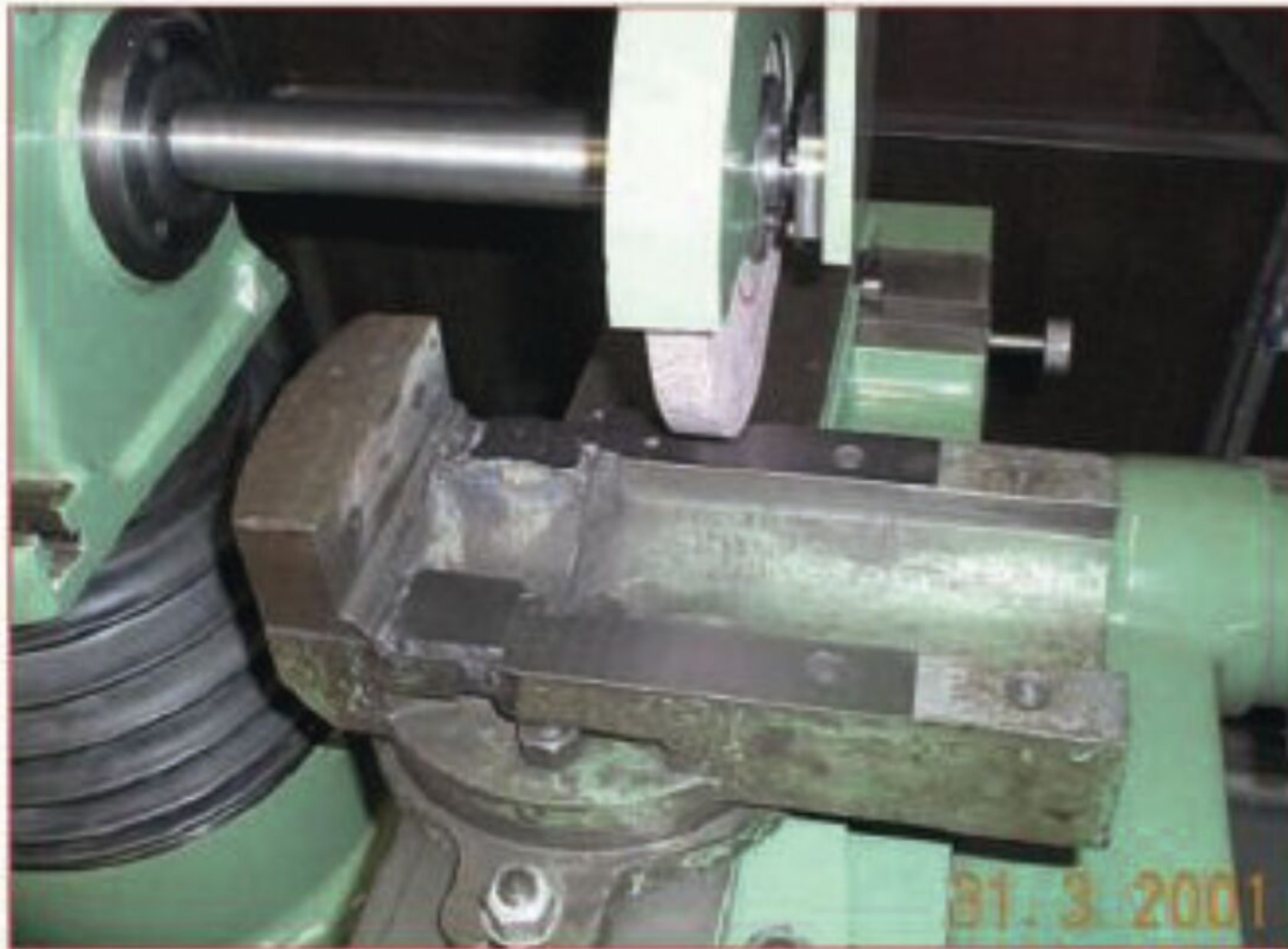
Reinstatement of material by welding is, in principle, a straightforward process, but there is always a risk of introducing unacceptable stresses in the casting, as a result of which the vice body could break. To minimise this risk I started with short welds, by so doing causing the casting to heat up slowly, thus preventing tension building in local areas. It takes some time to add enough material, and what appears to be difficult is to make a neat square surface. However, with the help of a small angle grinder, the result was very acceptable, having added enough material to allow for subsequent surface grinding.

### The replacement process

The left hand side was milled out, another straightforward job. The recess was made less deep than the blank that was added, in order to allow for surface grinding. The insert was attached by welding along its bottom







4. Surface grinding the restored areas. The welded insert can be seen on the slide nearest the camera

sides, although fixing with Loctite could have been an alternative solution (Photo. 4).

### Surface grinding

When both sliding strips had been filled, the grinding process could start. The vice was mounted on the grinding machine, and with light strokes over the total vice width, the sliding strips were both ground. This process took some time, but the result was really good, resulting in a very nice looking and perfectly straight surface (Photo. 5).

The vice was rebuilt and the top surfaces of the jaws were ground. By doing it in this way, I could make sure that these surfaces were parallel with the slides.

### Painting

I am sure that most of you know how to do this, but a few remarks could be worthwhile. I use a chemical paint stripper, the advantage being that this remover gets rid of oil and dirt, as well as the old paint. I used standard metal primer followed by filler on the small scratches and holes. As a final coating a 'high solid' paint in a more or less standard machine green colour Ral. 6011. The result can be seen in Photos. 6 and 7.

### Conclusion

By comparing these two methods of repairing damage, it can be concluded that both methods are very effective, but the welding method is more appropriate for restoring small areas than for replacing large sections. Note that the welding process creates a new alloy out of the existing cast steel and the welding stick material and, because of the relative high percentage of carbon in the cast steel, the new alloy will be hard. The only way to machine this material is by grinding, so if you don't have a surface grinder, it would be better to use the other method, since milling can then be used to clean up the surface.



November/December 2001



5. The appearance after re-grinding



6. The refurbished components after repainting



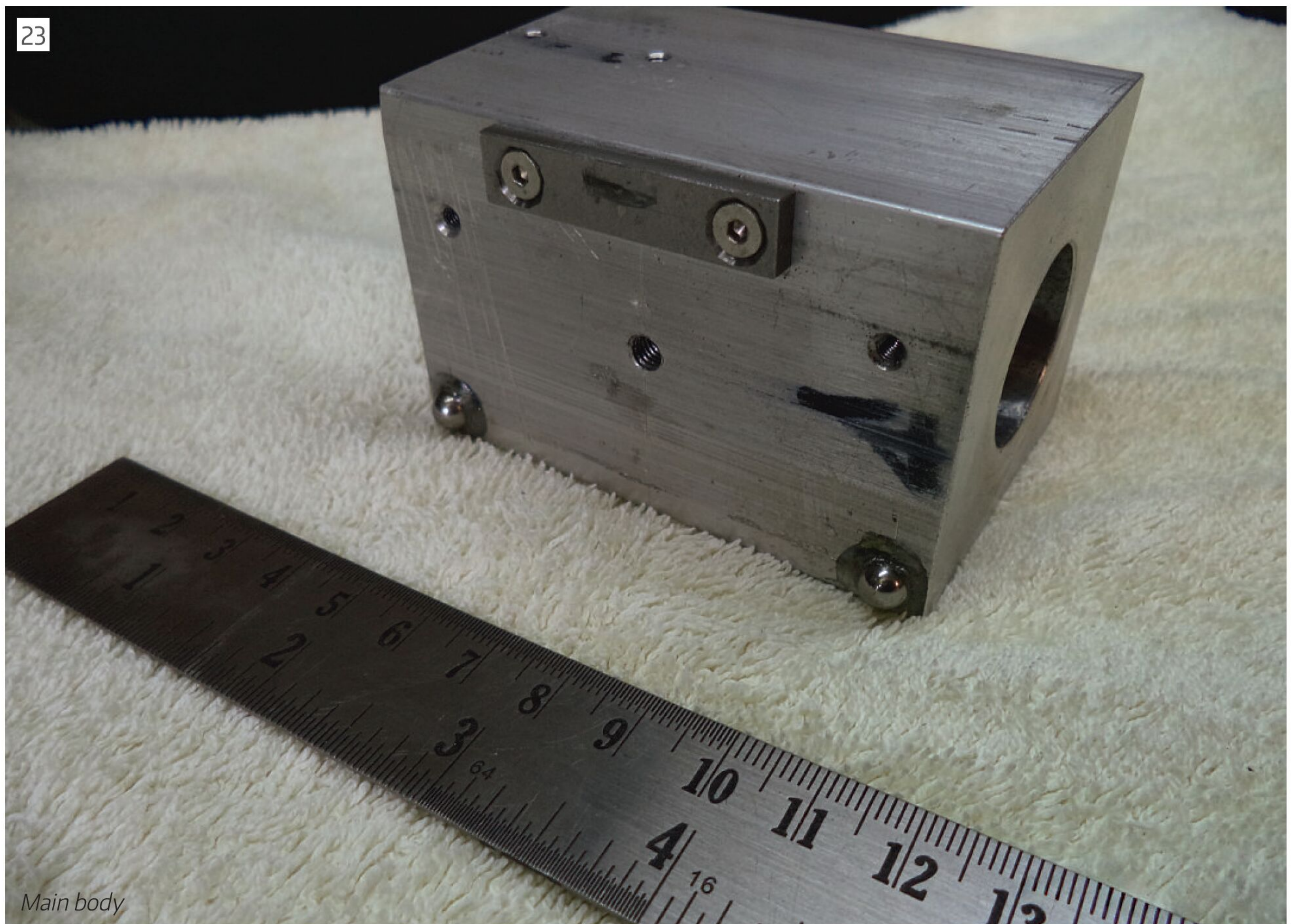
7. Now reassembled, the old vice is a handsome addition to the workshop



# The PottyEngineering Cutter Grinder Part 3



Stewart Hart continues his 'quick and easy' grinder build, featuring two more full pages of plans.



## Main Body Part 3

From a piece of 2" square by 85mm long aluminium alloy, using a four-jaw chuck locate on the centre of the square, face off and drill and bore 25mm to a close sliding fit on the ER32 collet holder. Turn round in the chuck and face off to length. Mark out and drill and tap as required. Try and get the depth of the two 90-degree countersinks exactly the same and secure a 1/4" stainless steel ball bearing in each of the countersinks with two-part epoxy resin to act as a pivot point for the cam tilt action, **photo 23**.

## Cam Holder Part 5

This is made from 2" square box section steel tube, orientate it so that the welded seam will be at the bottom well out of the way of the holes you will be drilling in it. Cut to length mark and drill holes as required and silver solder in place the brass bush that will take the cam. The cam spring needs to be reasonably strong to hold the main body in place, I just hunted through my spring box until I found one that was suitable, a spare axle spring from a 5" gauge model locomotive would be just the ticket, **photo 24**.

The rest of the parts are mainly simple turning and milling jobs and don't need any explanation. The design of the guide rest, part 13, may need fine tuning to suit your particular set up, see **photos 25 and 26**. I made a secondary riser base plate to clamp the base plate to lift the fixture slightly higher on the table in order to give more room to tilt the grinding spindle, but again this will depend on your particular set up.

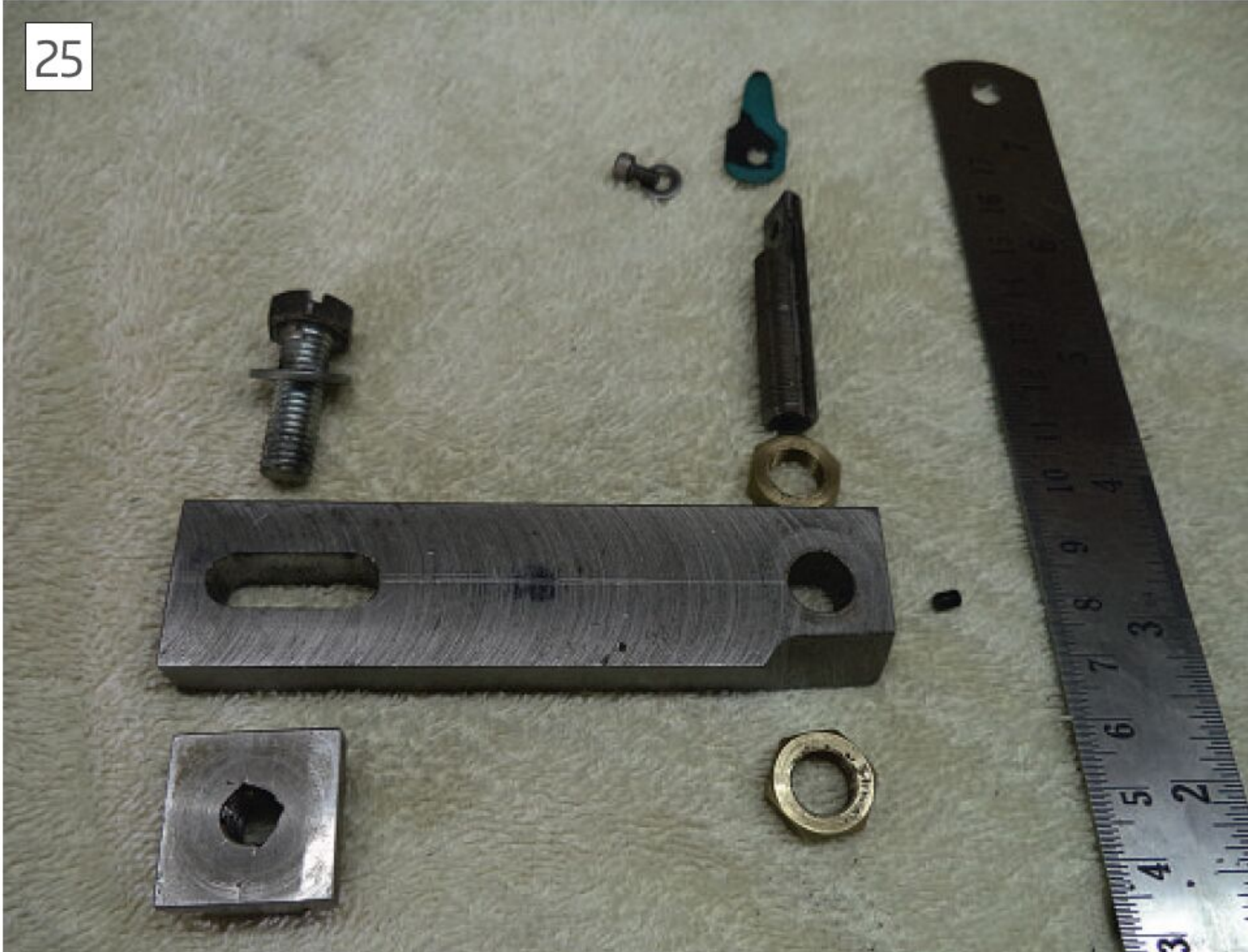
## End Mill and Slot Drill Geometry.

At this point it may be useful explain a





Cam holder.



Guide rest exploded out.

little about the geometry of end mills and slot drills, and to introduce some of the terms used. In an industrial context this is a very technical and competitive subject with competing suppliers vying to sell their product to customers by convincing them that their product will cut faster and last longer and be more cost effective than their competitors. But a lot of this bumf can be cut out in a model engineering context, what we want is a basic no-frills high-speed steel cutter that will do the job. **Sketch 1** and **Table 1** show the basic geometry of an end mill greatly simplified and features exaggerated for clarity, it's best to study this sketch with an end mill in your hand this way it will all start to make sense.

The gash or recess is to give clearance at the centre of the cutter.

End mills generally have three or more flutes and are used to cut along the x and y axis, Slot drills have two to three

flutes and have an end tooth geometry that allows them to cut in the z or vertical axis the same as a drill, they can also cut in the x and y axis the same as an end mill, **photo 27** shows the difference

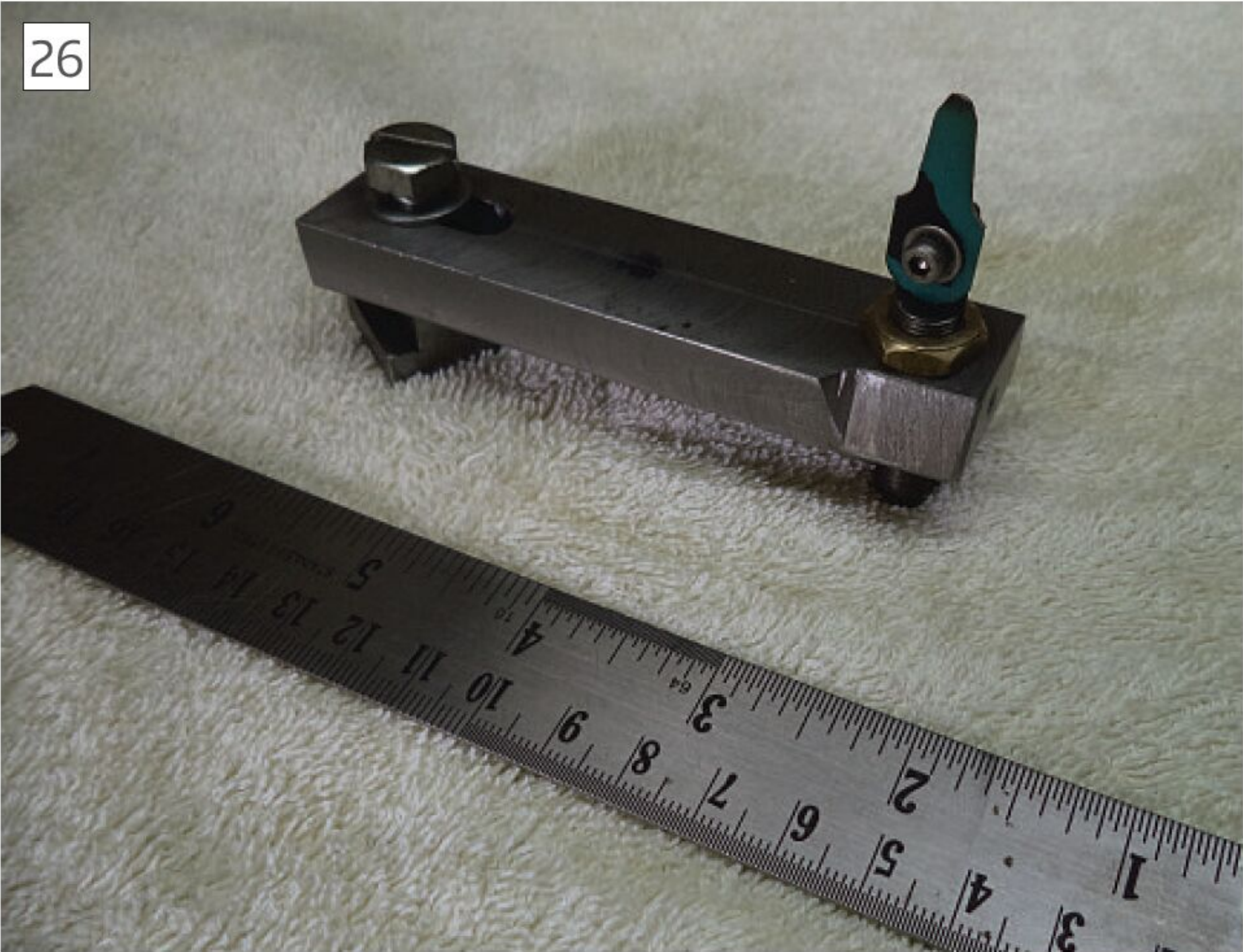
Using the Fixture

To sharpen the end faces of an end mill the cam needs to be locked up by tightening the two M4 cap screws and the index collar needs to be slid forward so that it butts up against the main body so that you have minimal end float on the ER holder. Slew the fixture round

about 1 degree to form the concave in the face of the end mill. Tighten the collet onto the mill so that teeth are level with the table, if using a cup wheel tilt the grinding head back about 5 degrees, set the centre stop, then gently approach the wheel until you just start to see sparks, grind across the face of the cutter, and repeat at this setting for all the teeth using the indexer, increase the cut and repeat until you've taken the worn edge off the cutter, then go round again with a light final cut. If the cutter was heavily worn or this was the

Table 1:- Clearance angles for general purpose work

|                         |              |
|-------------------------|--------------|
| Edge Primary Angle:-    | 3-5 degrees  |
| Edge Secondary Angle:-  | 15 degrees   |
| Flute Primary Angle:-   | 3-5 degrees  |
| Flute Secondary Angle:- | 15 degrees   |
| Concave Angle:-         | 1/2-1 degree |

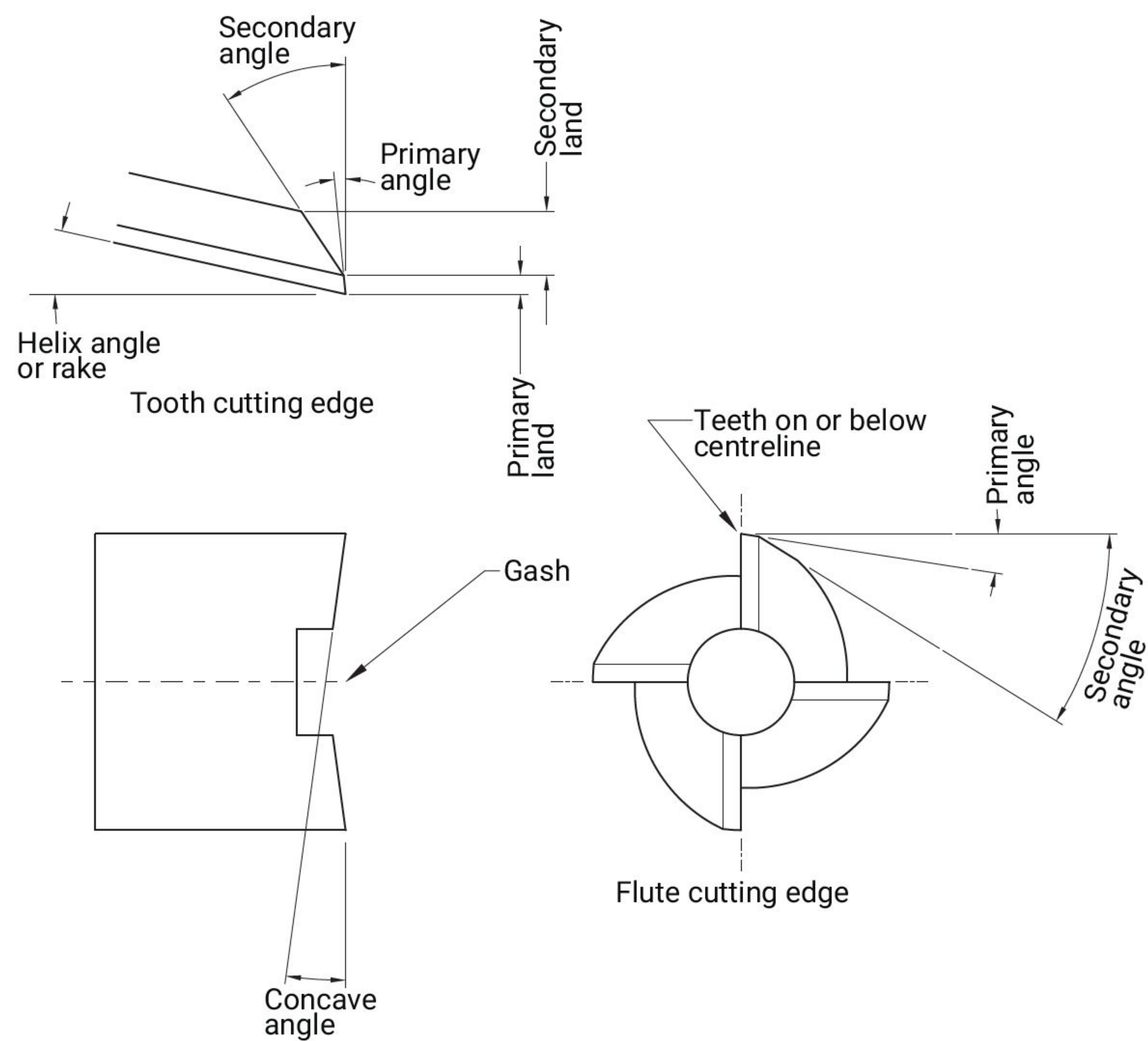


Guide rest assembly.



From left to right: end mill, two flute slot drill, three flute slot drill.

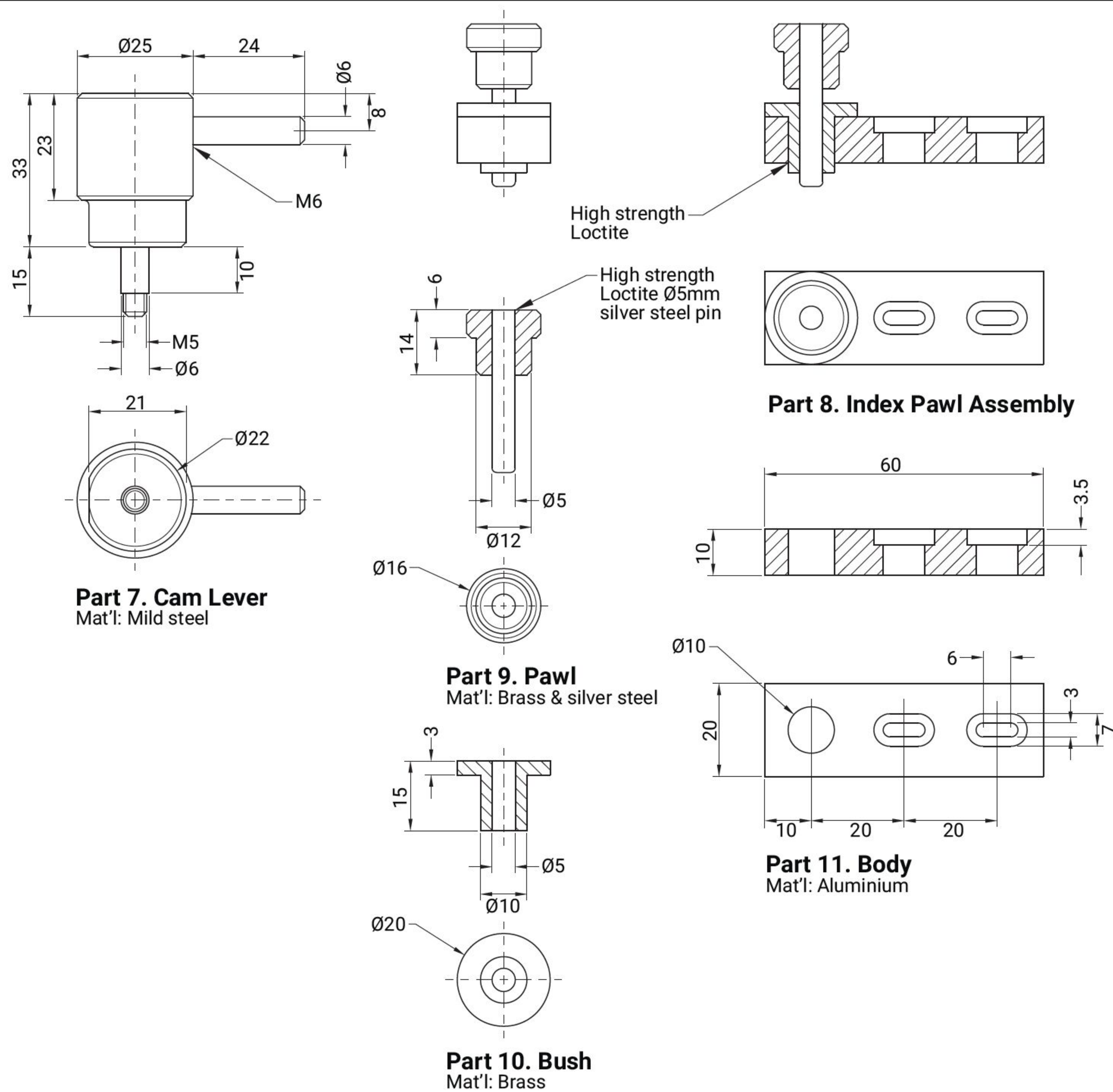




### Sketch 1

### Sketch 1. End Mill Main Features

Greatly simplified with features exaggerated for clarity



### Figure 5



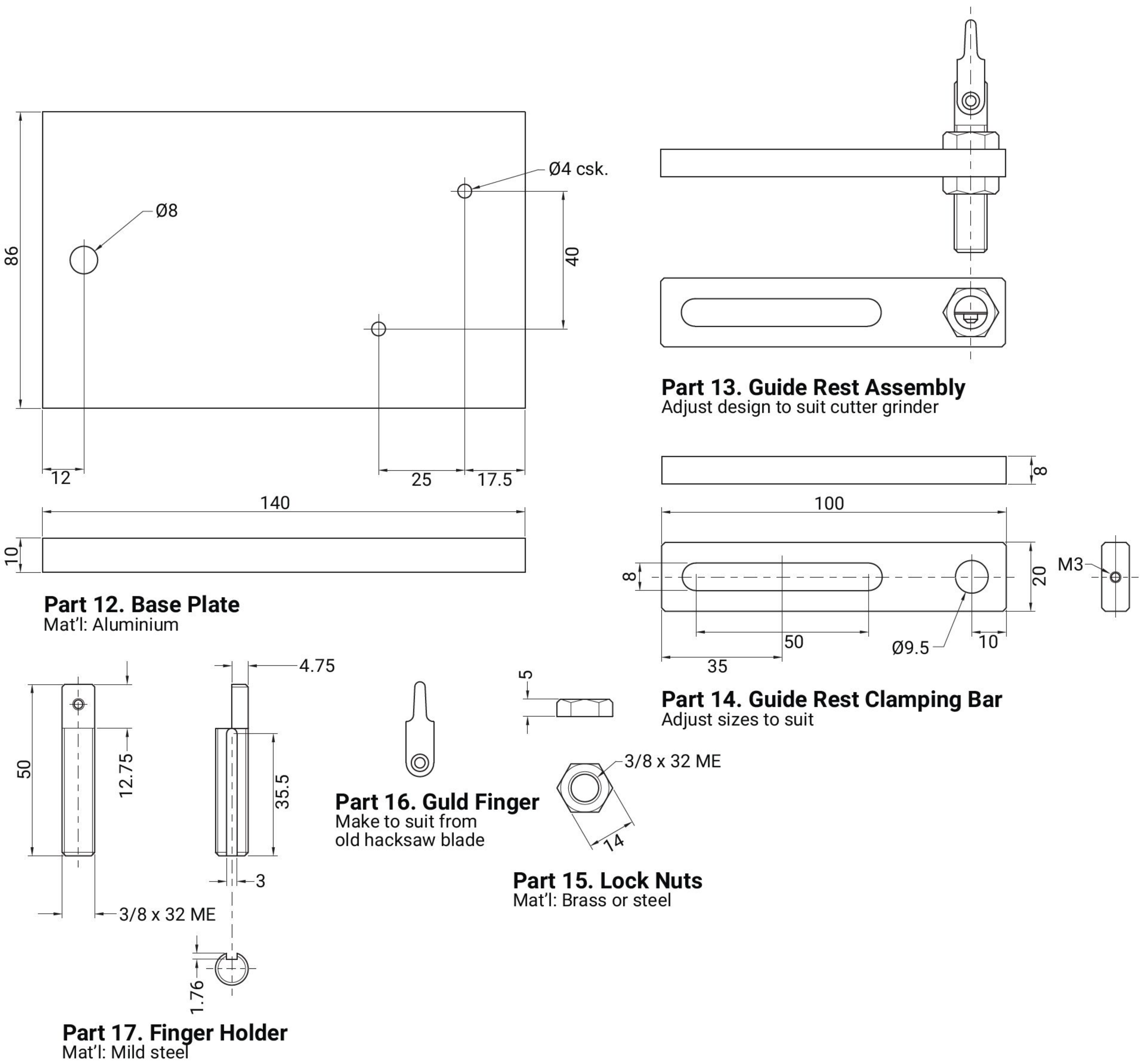


Figure 6



28

*Set up for grinding end mill  
primary clearance.*



29

*Set up for grinding end mill  
secondary clearance.*







Grinding secondary gash.



Grinding primary gash.



Gashed end mill.



Set up for grinding flutes.

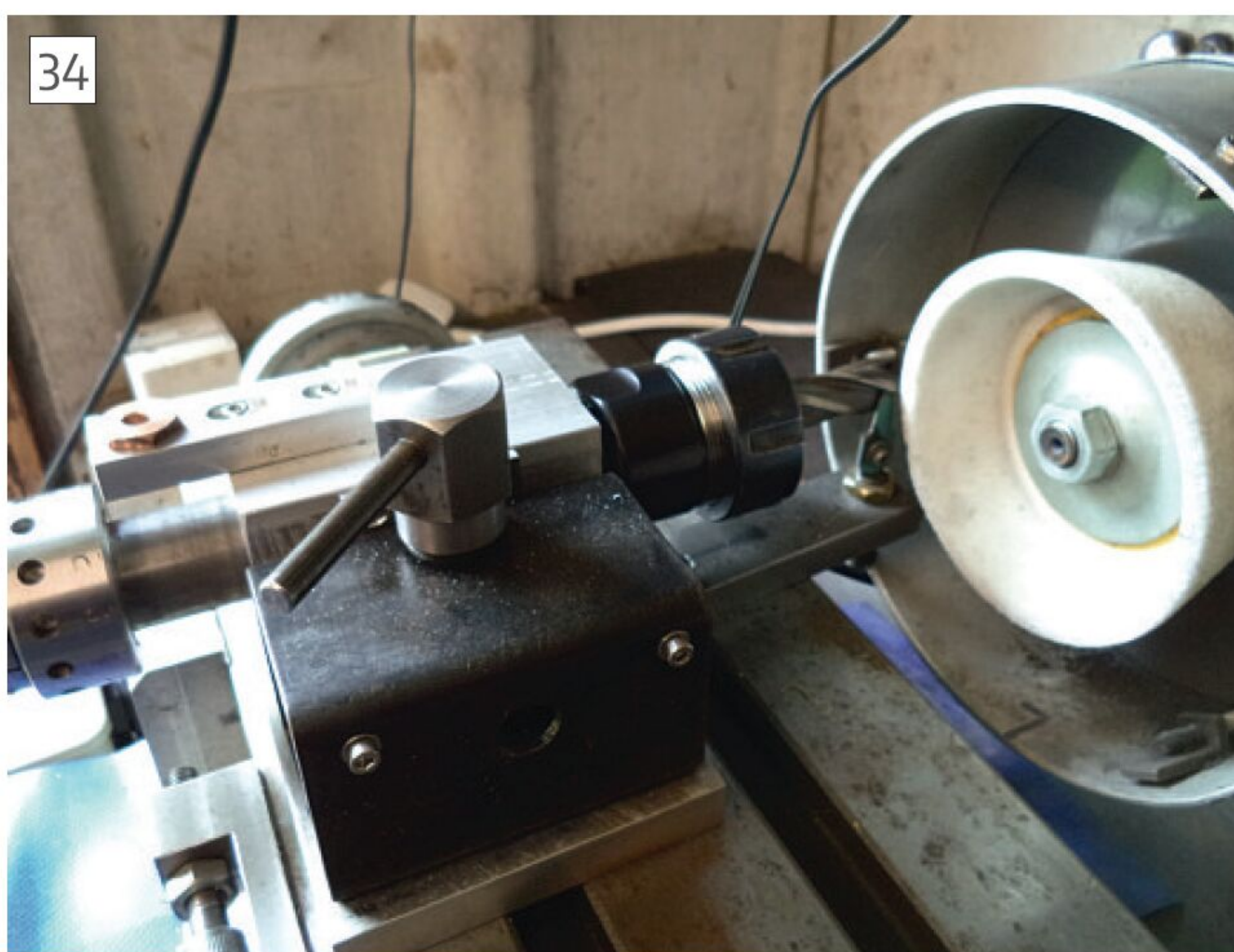
second or third regrind you may have to add some secondary clearance, to do this simply tilt the head back to about 15 degree and grind the clearance, **photos 28 and 29.**

Cutters that have been reground a number of times will start to lose the gash or recess this has to be regained by using a gashing wheel to gash across the centre of the cutter. For this I used a blue wheel with the fixture slewed round finishing off with an elastic cutting off wheel, **photos 30, 31 and 32.**

To sharpen the outside edge of the flutes the cam is unlocked, and the index collar is clamped in the back position to allow the ER holder to slide forward, the cutter itself now becomes the indexer on the guide finger. The clearance angle is set by positioning the cutter below the centre line of the grinding wheel. With a tooth resting on the guide slowly advance to cutter onto the wheel until you start to get a spark, then gently advance the cutter along the edge of the wheel at the same time keeping it in contact with the guide finger at the end of the cut activate the cam to lift the cutter off the wheel, return the cutter to the start position engage another tooth on the guide activate the cam to put the cut on and advance the cutter across the wheel again repeat for each tooth, put more cut on and keep repeating until you have sharpened the cutter. As can you no doubt imagine this is a process that takes a little practice but with perseverance you can get good results, **photos 33 and 34.**

I have also used the cutter grinder to sharpen slitting saws using a fixture similar to the one in Harold Hall's book, >





Set up for grinding flutes.



Grinding slitting saw.

**photo 35**, this is a very simple device and doesn't need any explanation other than the photographs.

This project slowly evolved over a number of years starting as a vague idea and slowly developing as parts

and inspiration came my way, until I eventually gained a real useful bit of kit that has proven to be very flexible, it should be possible to use it with all of fixtures covered in Harold Hall's book - I have no excuse now for using blunt

tools. At some point in the future, I'll buy a dished grinding wheel as I think that will be better for gashing cutters and I may explore the possibility stretching out the concept into other grinding applications. ■

## MODEL ENGINEER NEXT ISSUE

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*Contents subject to change.*

### Motor Van

Ashley Best adds other types of road vehicles to his collection of tram models.

Leufortin Ian Bayliss makes a start on his 7/8ths G scale internal combustion locomotive by making all the fasteners he will need.

### Jungle Railway

Colin Standish clears a patch of jungle in Phuket and builds his own garden railway.

### Dividing

Mike Joseph describes his approach to the problem of crossing out the wheels for his clock project.

### Learning to Drive

Mitch Barnes decides there is more to life than simply looking at his models and attends a boiler management course so that he can learn to drive them.

**The Next Issue of Model Engineer is issue 4747, July 26 2024**

[www.model-engineer.co.uk](http://www.model-engineer.co.uk)



# THE MIDLANDS MODEL ENGINEERING EXHIBITION

Thursday 17<sup>th</sup> to Sunday 20<sup>th</sup> October 2024 at Warwickshire Event Centre

Opening Times are Thursday – Saturday 10am – 4.30pm. Sunday 10am – 4pm.

Tickets cost Adult £13.00, Senior Citizen £12.00, Child (5-14 inclusive) £5.00

A full list of confirmed exhibitors to date is available at

[www.midlandsmodelengineering.co.uk](http://www.midlandsmodelengineering.co.uk) as well as the competition entry form

and advance tickets.



## The Stevenson Trophy

At this year's exhibition, the **John Stevenson Trophy** will be awarded in association with Model Engineers' Workshop and the [www.model-engineer.co.uk](http://www.model-engineer.co.uk) website.

This competition is awarded for excellence in practical and useful workshop equipment. For more information on the competition and how to enter your work visit [www.model-engineer.co.uk](http://www.model-engineer.co.uk). Note that the competition is held online so you don't need to get your entries to the exhibition.



## The Model Engineers' Workshop Talks Programme

Following the successful and well attended talks at last year's exhibition, MEW is pleased to host the talks at MMEX this October. I'm pleased to say that we will have an upgraded sound system, and that the organisers will be ensuring the lecture area is better soundproofed to address the issues with background noise last year.

Last month we previewed Mark Noel's talk on building a seismometer, and readers following Bob Reeve's short series on thread milling will be able to find out more. By popular demand Noel Shelly returns with a presentation on foundrywork. Malcolm High and Roger Froud will be giving talks on contrasting aspects of 3D printing; Malcolm will also be looking at the tricky world of Li-Ion batteries. Brazing can be a challenge, but Shaun Meakin aims to make the task easier for you. Finally, MEW Editor, Neil Wyatt, will share some of the more unusual and challenging workshop tasks he's undertaken in his ten years as editor.

| Day                        | 11.15am             |                                                      | 1.00pm                                       |                                                 | 2.15pm              |                                             |
|----------------------------|---------------------|------------------------------------------------------|----------------------------------------------|-------------------------------------------------|---------------------|---------------------------------------------|
| <b>Thursday 17 October</b> |                     |                                                      | <b>Roger Froud</b>                           | 3D Printing for the Home Workshop               | <b>Noel Shelley</b> | Casting and Foundrywork for Beginners       |
| <b>Friday 18 October</b>   | <b>Malcolm High</b> | lithium Ion batteries, a history and how to use them | <b>Brian Neale</b>                           | CNC for the model loco builder                  | <b>Shaun Meakin</b> | Brazing made easier – not easy!             |
| <b>Saturday 19 October</b> | <b>Bob Reeve</b>    | Thread milling.                                      | <b>Malcolm High</b>                          | 3D printing is it for you? – a beginners guide. | <b>Mark Noel</b>    | Hear the Earth – how to build a seismometer |
| <b>Sunday 20 October</b>   | <b>Neil Wyatt</b>   | (Mis)adventures in a Model Engineer's Workshop       | <b>Presentation of Awards 2.00pm onwards</b> |                                                 |                     |                                             |



# Scribe a line

YOUR CHANCE TO TALK TO US!

---

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

## Bandsaw Modifications

Dear Neil, I bought the July issue of MEW as front cover illustrated clamping on a modified bandsaw. However the only source of information was the two pictures, one on the cover and one on page 3.

As the owner of a similar bandsaw I would have liked more information on how the modification was made. I am at a loss to know why the jaws as supplied are of unequal length as if the saw is used to cut an angle, then it moves away from the shortest jaw.

**Steve Wagstaff, by email**

*Hi Steve, the modifications were covered in more detail all the way back in issue 238 in 2016. If you access the indexes, via the forum, many other authors have detailed their approaches over the years. Neil*

## More Bandsaw Modifications

Dear Neil, tanks for putting my article in this month's magazine it looks great to me. I would also just attach a picture of my band saw vice with modified jaw, great minds think alike. I will also add the extra support to my saw as it is a no brainer when you see yours.

**David Geroge, by email**





## Online Indexes

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

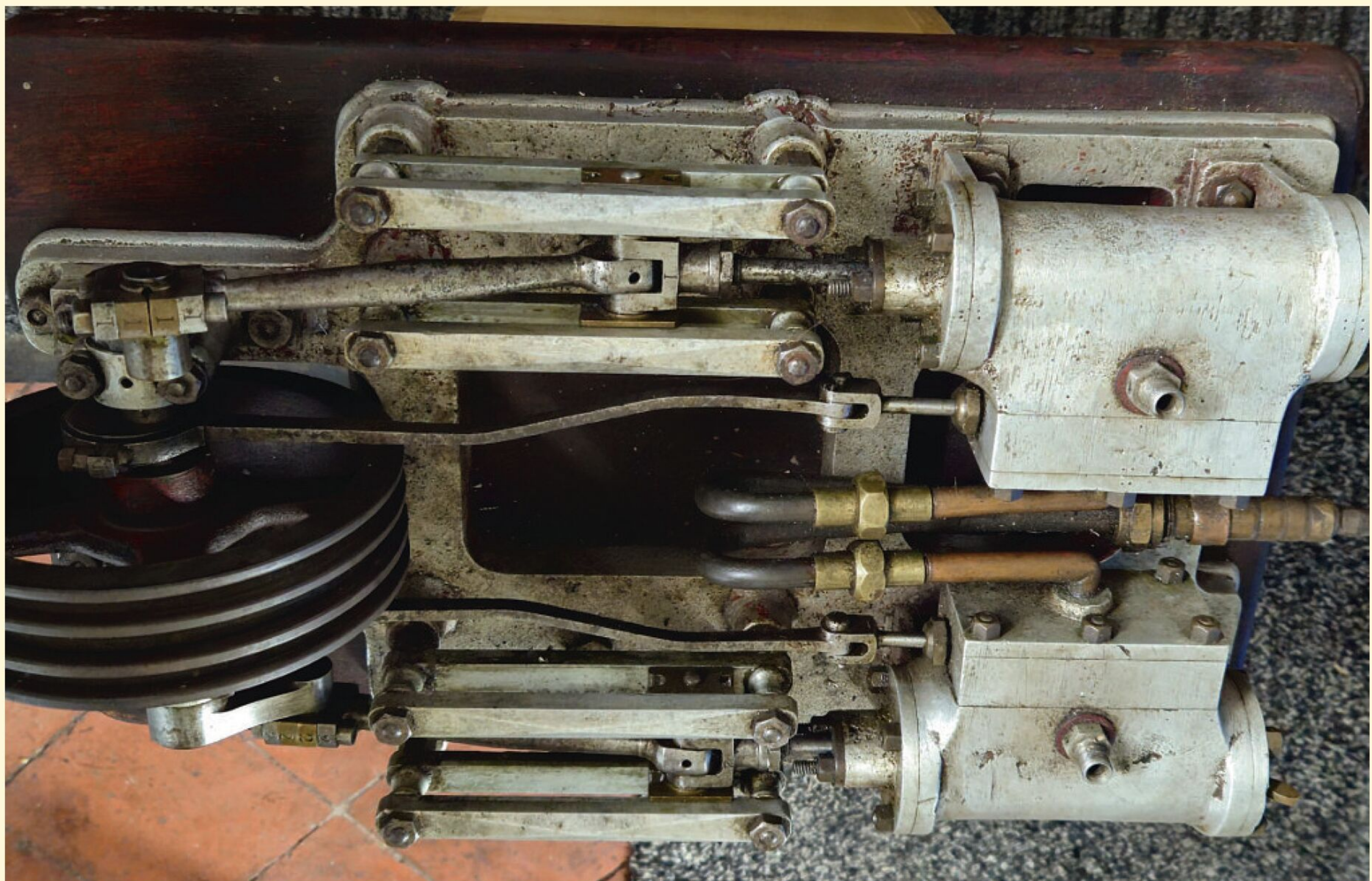
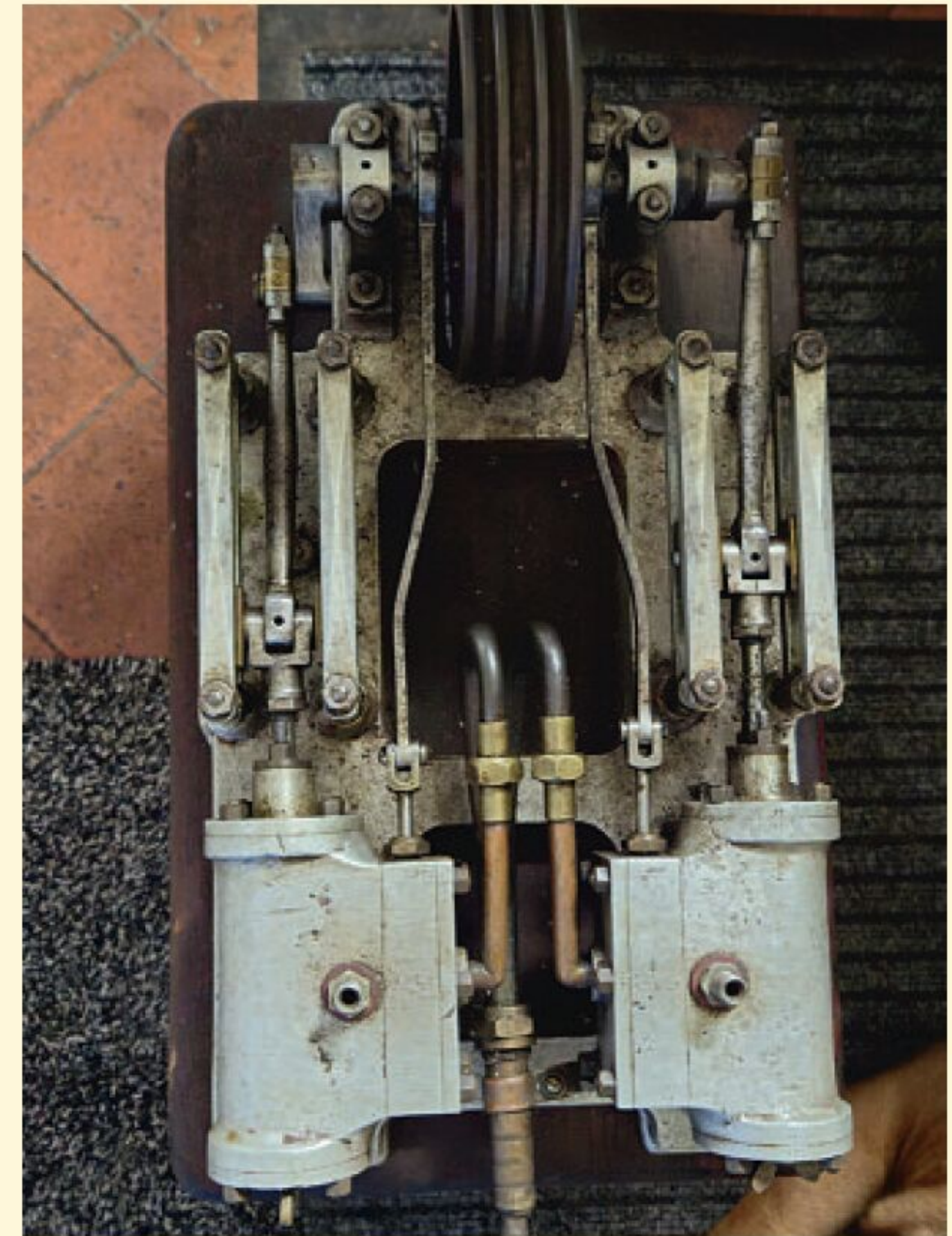
If you prefer the paper indexes, don't worry, David will be producing these in the future, carrying on Barry Chamberlain's sterling work..



## Mystery Engine

Dear Neil, further to our conversation other day I have attached some photos for you to look at. The model engine I have had for years, but I'm not sure what it is. Can any readers shed any light on this?

**Leighton McGrory, by email**





# A Flexible Paint Can Turner

Roger Froud has devised a useful device for keeping paint in tip top condition during a project. We include a link for downloading files for making or modifying the design yourself.



The prototype.

Painting something like a Locomotive can be frustrating at the best of times. Things don't always go well, and you sometimes need to strip off the paint and start again. You mix up however much paint you think you're going to need but end up with quite a lot left over. You don't want to waste it but leaving it for more than a few days can see it forming a skin and ending up getting wasted.

Someone suggested that I should make a simple mechanism to keep rolling any cans or jars, so that their contents wouldn't spoil as quickly, so that's what I decided to do.

The design is based on a cheap geared motor type, **fig. 1**, that's readily available from the internet at a reasonable price. You can get them in a variety of DC voltages with speeds down to a mere 3.5 rpm. You only need a very slow speed for this to be effective. Just make a note of the size of the end of the motor and

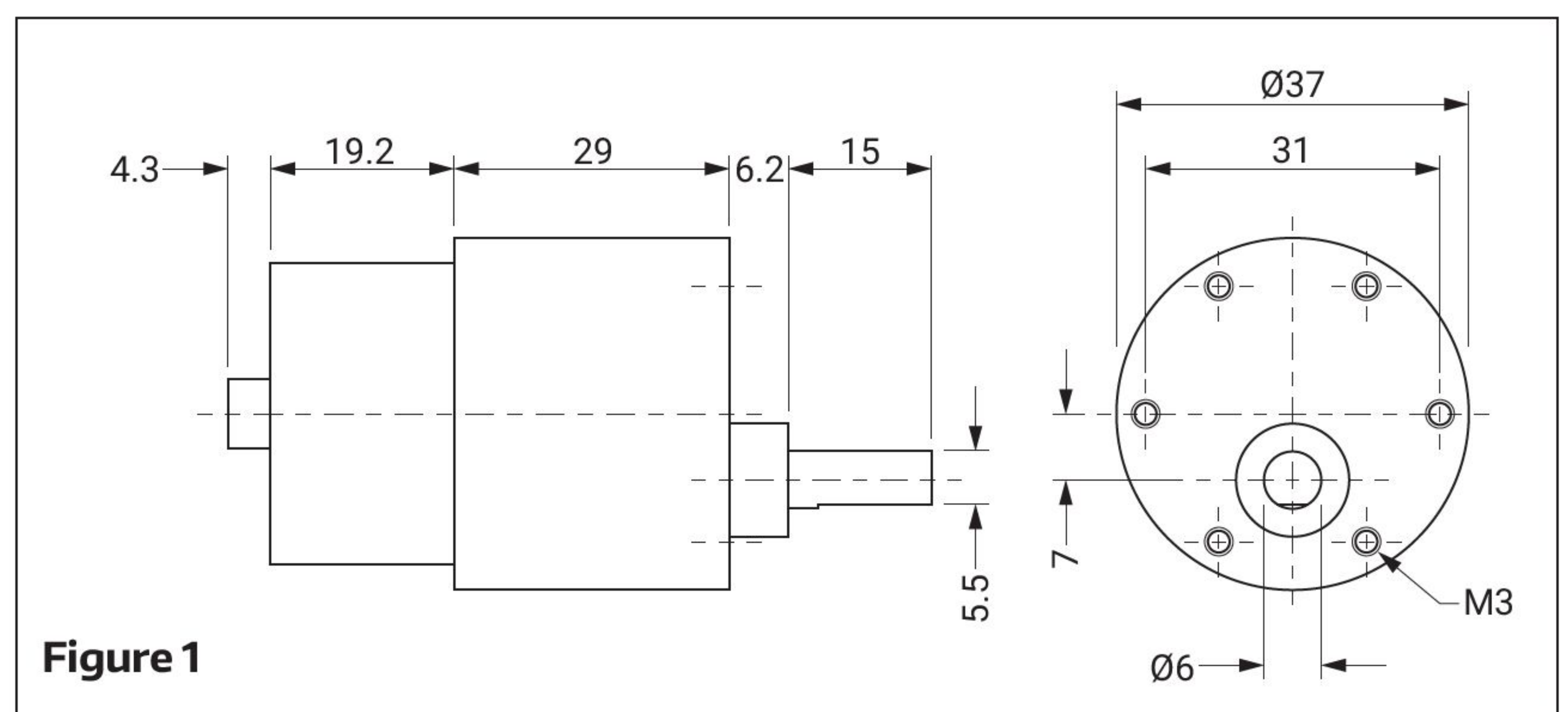


Figure 1

adjust the cover to suit. I've made a small hole in the Motor cover to take a grommet. The cable is tied in a knot inside to prevent it pulling through. A cheap DC plug in power supply can be found on eBay too.

The motor is secured by two M3 x 15 Cap screws. Don't do these up too tight, the threads aren't that deep.

I wanted to be able to use this with all

sizes of cans and jars, but that posed a problem with the spacing of the rollers. Too large a gap and the smallest ones would fall through, and too small and the large cans would be unstable. I also wanted to be able to put multiple ones on at the same time, because I was using primer and at least two colours of enamel at the same time.

I could have made multiple machines





End view showing bearings.



The 3D printed parts and geared motor.

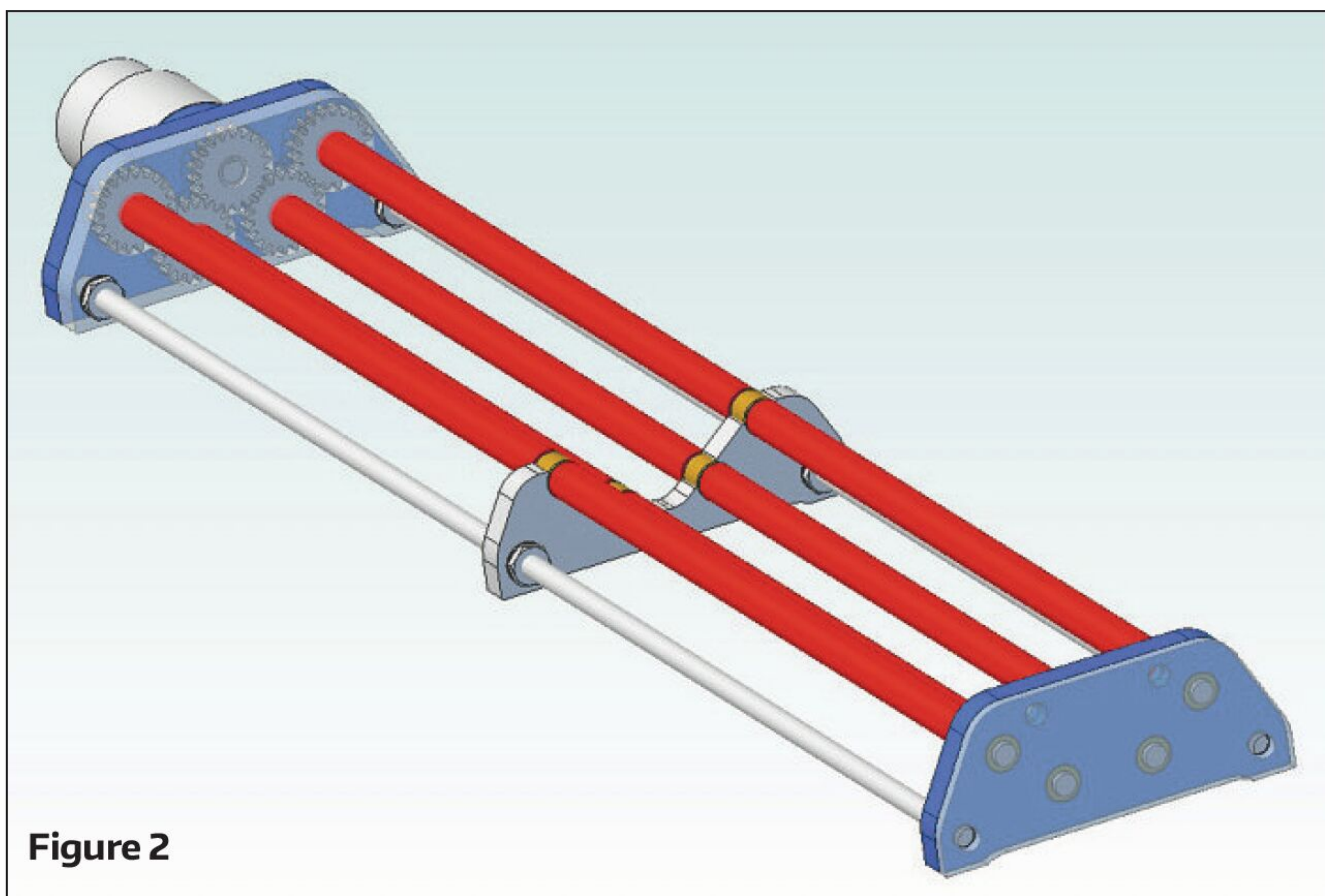


Figure 2

that took one or two cans or jars but thought it would be more economical and convenient to make one long one that could do the job.

The design uses as many 3D printed parts as possible, so that it would be quick and easy to make. The parts have been printed from PLA, but you could use PETG or even ASA if you're going to leave it in direct sunlight.

The prototype was a short version

to check that it was a practical design, **photo 1**. I made some brass bushes for the bearings and used 6mm mild steel rod for the rollers, **photo 2**. The gears were the same design I've used on several projects. The main drive gear has a flat on it which engages with the flat on the motor drive shaft. The rest are a press fit, which turns out to be more than adequate. That solves a problem, because you don't really want a flat

where the bearing is at the end of the shaft.

Plain bearings are ok for a short unit, and plastic ones would probably be better than brass. However, for a longer machine, I was concerned that the slender rods wouldn't be that straight, and they might bind. I also thought that a larger can or several smaller ones would cause them to bend, which isn't ideal.

The solution was to make an intermediate support bearing mount that was slender enough to allow for cans to bridge wherever the gap happened to be. By using silicone vacuum hose with an ID of 6mm, the OD was larger than those of the bearings. By shopping around on eBay, I managed to find some 6mm x 10mm x 8mm Needle roller bearings for a very reasonable price and decided to swap the plain bearings for those throughout.

**Figure 2** is how that looks, with the Silicone tube covered rollers and centre bearing support, with the gear cover made transparent to show the arrangement. I haven't bothered meshing the gears correctly on the 3D model.

All of the printed parts and the motor for the long version are shown in **photo 3** ➤





*The full-length version.*



*Stocked with various different sizes of paint container.*

and the assembled device is in **photo 4**.

Obviously, the bottom rollers rotate in the opposite direction to the top ones, and that would preclude specific diameters from being used if they happen to touch both sets of rollers. So far, I haven't found any cans or jars that do that. Of course, you could opt to remove the bottom rollers and just make the gears to be idlers, running on a short length of rod. The Gear cover plate would prevent the gears from coming out of mesh.

You can see that there's no problem with the large can spanning the centre bearing support, **photo 5**. I've used M6 full nuts at the motor end, but half nuts elsewhere which I thought was more elegant.

This version uses a one metre length of M6 studding that's been cut in half. This assembly sits nicely on the side of the bench, taking up very little room. The small cans with a larger diameter top compared to the bottom, tend to want to ride up before settling down against another can. You could leave off the Silicone sleeve on the bottom rollers if you want, that would solve the problem

which I didn't see on the prototype.

Within reason, you can make this as long as you like. There's nothing stopping you from making it using a full 1 metre length of M6 studding, but you may need two or more intermediate bearing supports. The geared motor is more than capable of turning a considerable load. The gear cover wasn't part of the original design, but I found that items managed to find their way into the gears which jammed it up and sheared off the flat in the drive gear.

All of the files can be downloaded from the Model Engineer forum at <https://tinyurl.com/3d6wfvfb> (or you can use the QR code). I've included the .stp files so you can load them into your CAD program and make any changes or copy the parts to make your own version. Fusion360 is free for hobby users, so it won't cost anything to do that. Obviously, you could make a much bigger one with more idler gears and rollers if you're using large cans and jars.

It looks complicated, with lots of parts that would be a nightmare to machine but are trivial to 3d print. Once you have a 3D printer, you realise that it's



so much more than a substitute for making conventional shapes. All of these parts can be printed without supports because they've been designed with that in mind. In particular, the M3 holes use a technique pioneered by Prusa where a hole can be created in an overhanging part. This is done by first printing a slot, followed by a square, then an octagon and finally the circle. Ok, it doesn't give a flat bottom to the hole, but it doesn't matter. It's worth taking the time to look at some of these clever ideas, there are some very smart people out there who can make our lives much easier. ■



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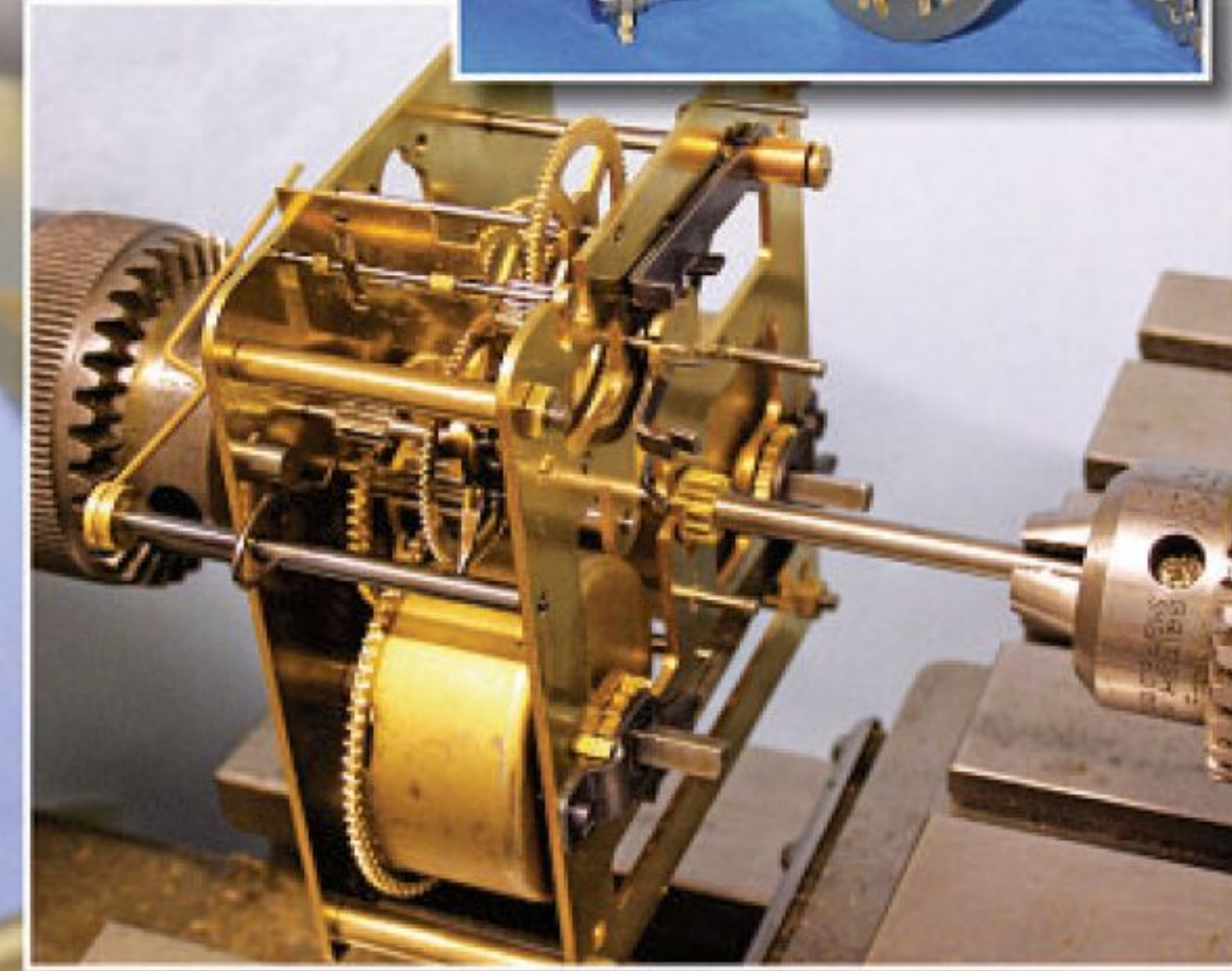
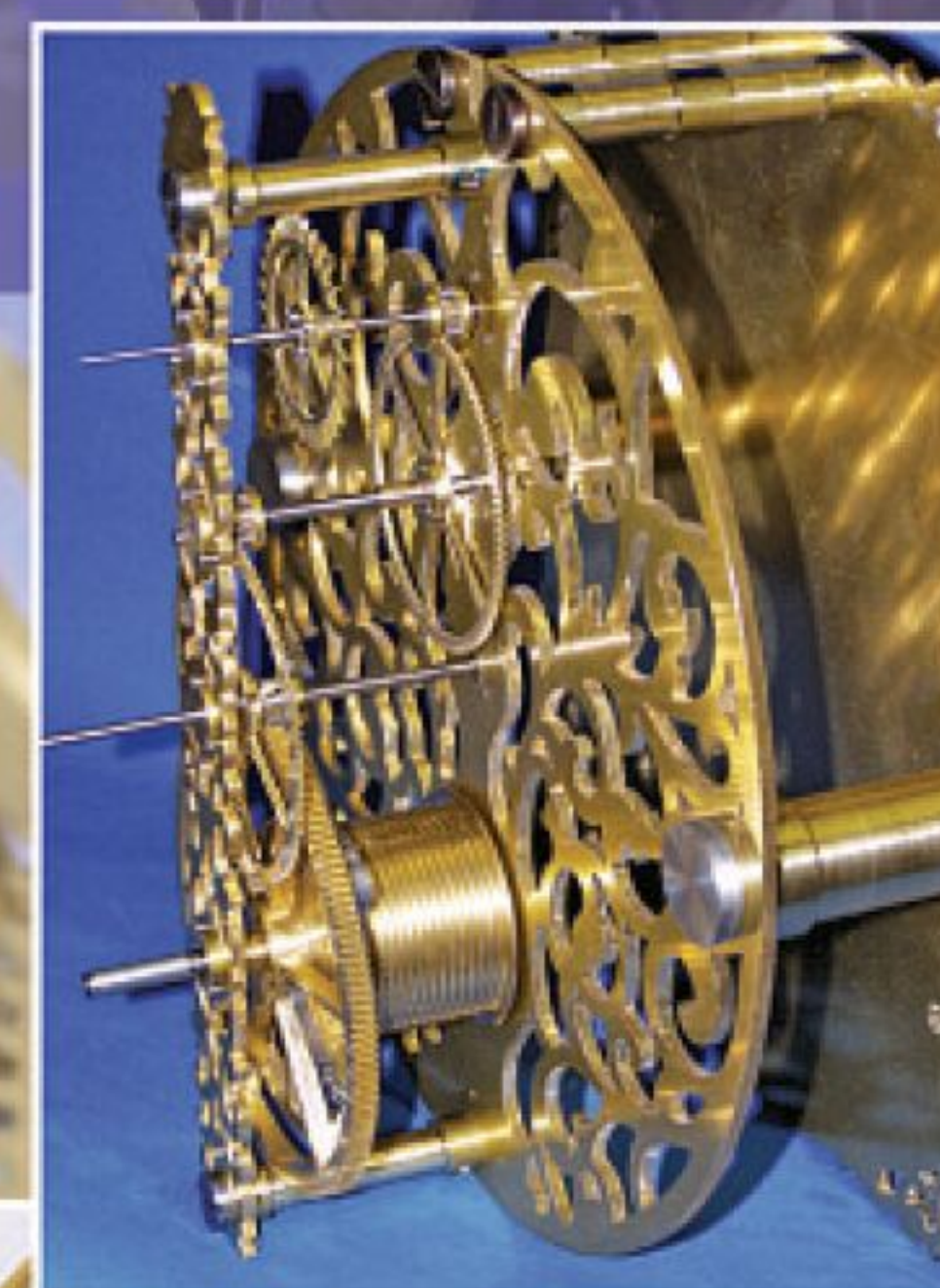
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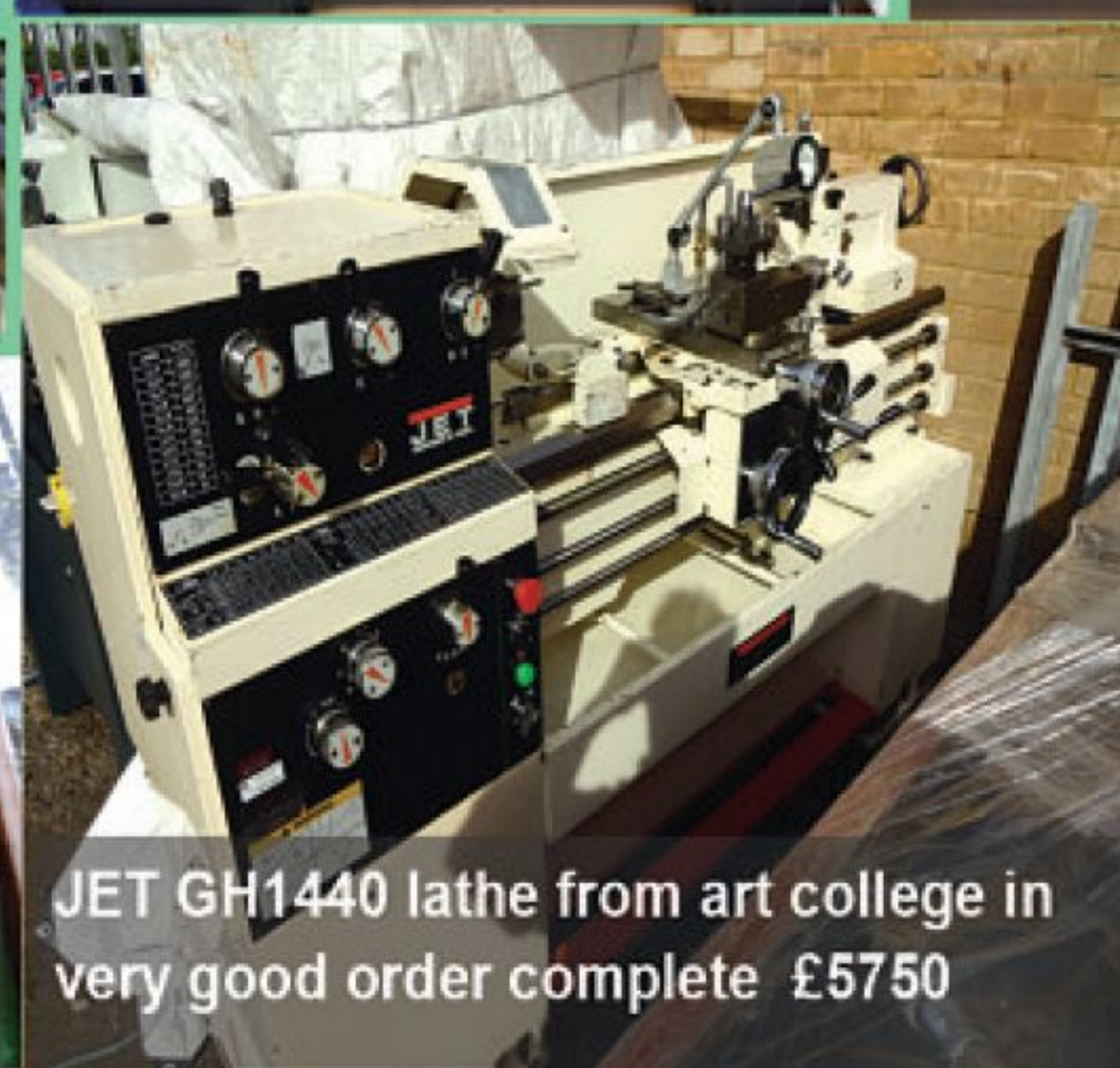
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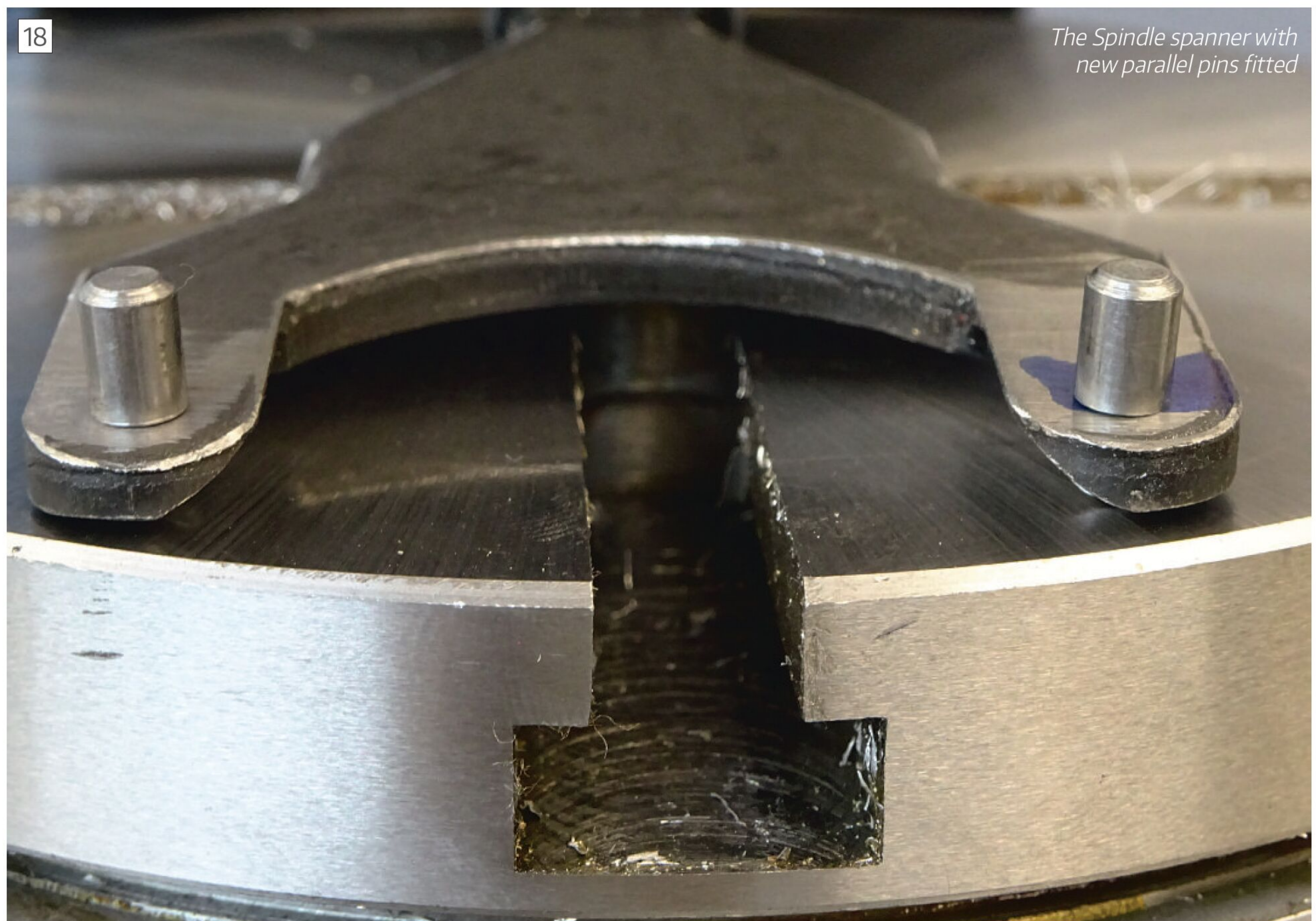




# Getting the most out of your Brushless Mill. Part 4



Jason Ballamy details some modifications you can make to enhance the usability of your mill.



*The Spindle spanner with new parallel pins fitted*

Since getting the SIEG SX2.7 at the start of the Milling for Beginners series (starts in MEW 261) I have found during use a few items that could be improved upon. Some of these are specific to the SX2.7, others could be applied to any machine.

## Spindle Spanner

The supplied pin spanner that is used to hold the spindle while either

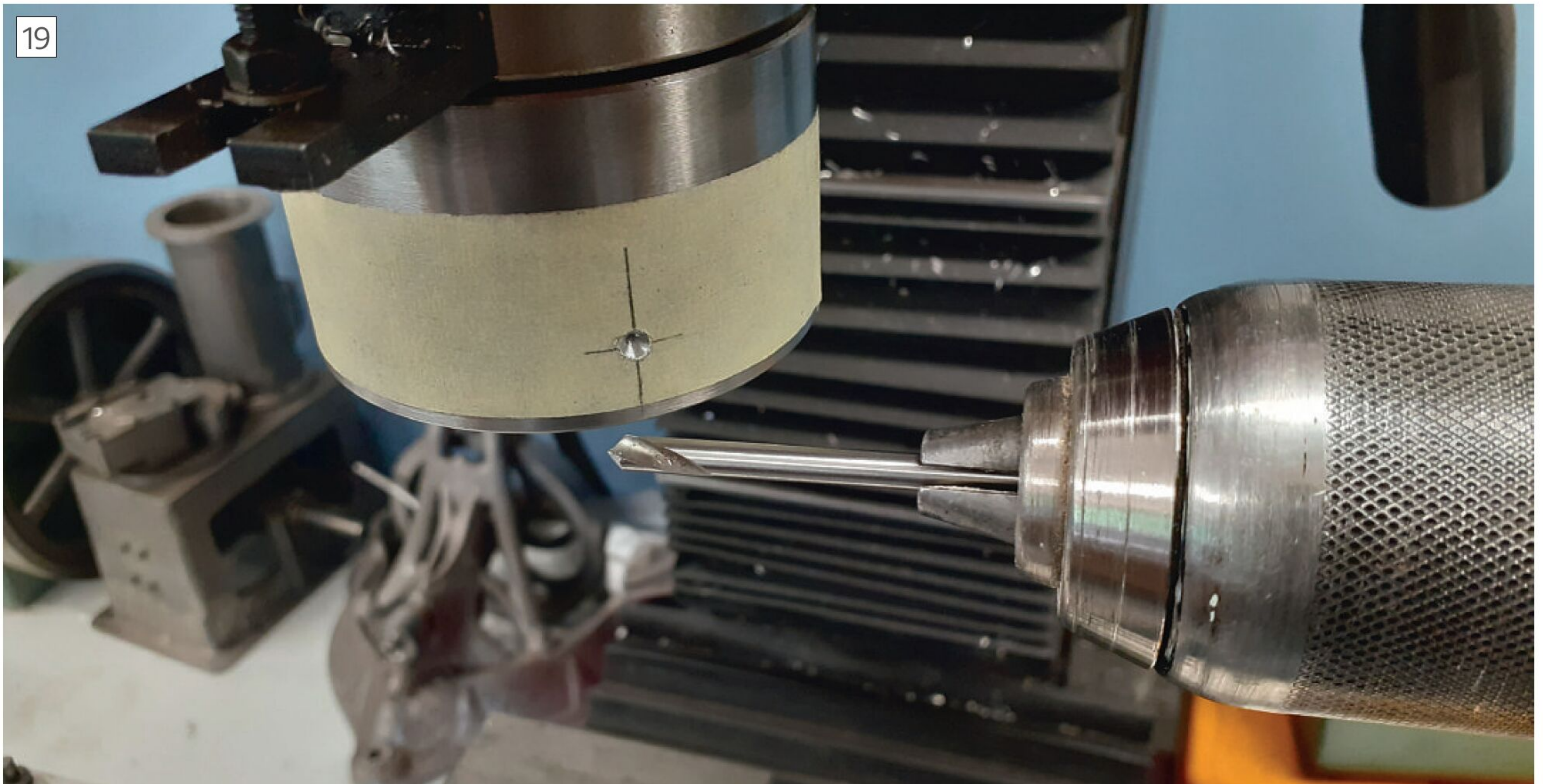
tightening/loosening tooling or releasing/tightening the drawbar has tapered pins which I found tended to easily ramp out of the holes when being used.

My remedy for this was to file off the back of the pins where they had been peined over so that they were flush with the spanner body and then drive the pins out of the holes with a parallel punch. New pins with parallel sides can

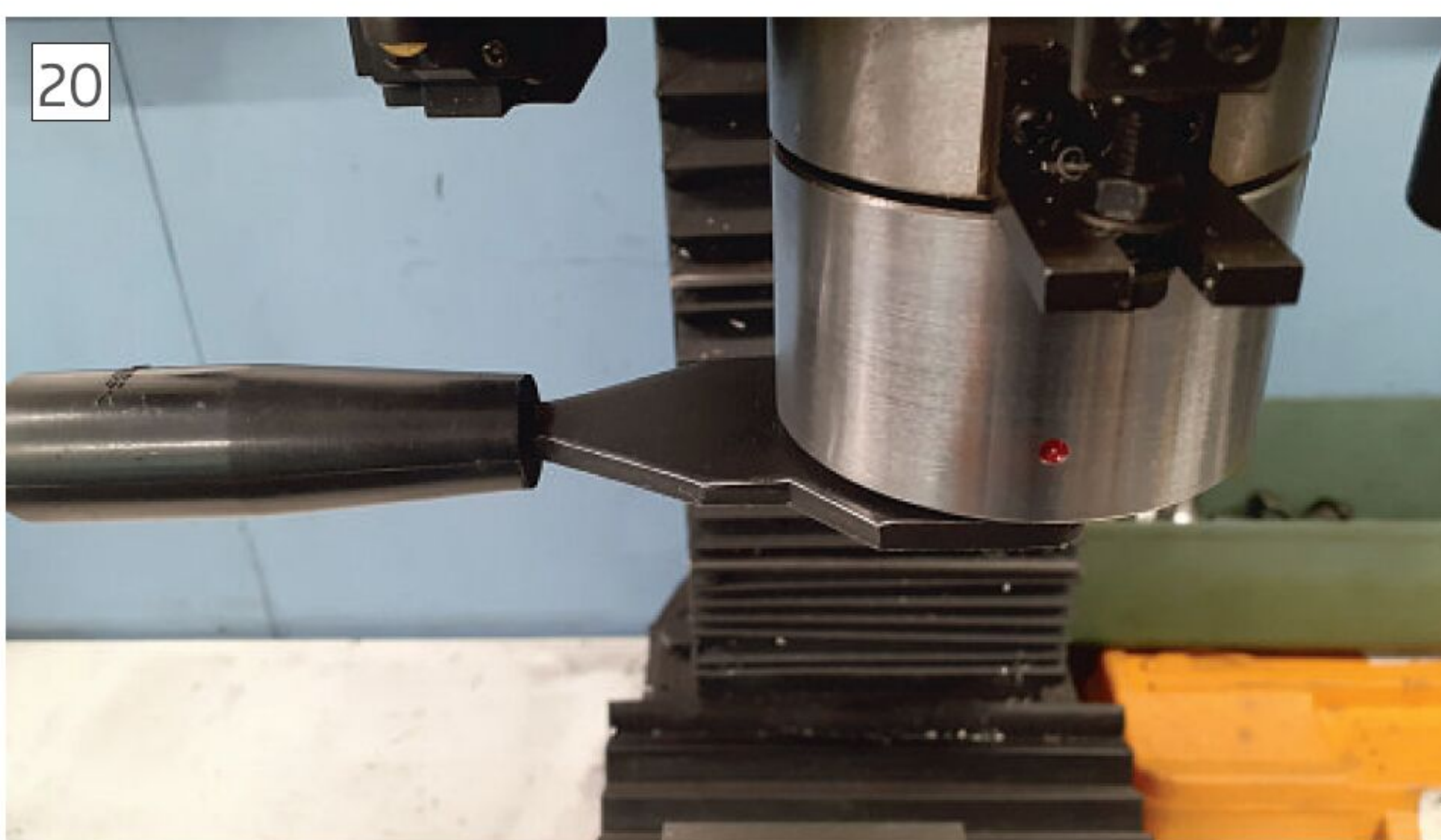
then be turned up from 5mm diameter round bar, a chamfer put on the edge and their spigots sized to fit the holes in the spanner and about 1mm longer than the spanners thickness.

Push the pins into the holes and with the end of the pin resting on something solid use a ball pein hammer to lightly pein over the ends much like you would a rivet but just enough to hold them in place, **photo 18**.





Marking out and Drilling holes



Completed holes filled with paint are easy to see



Draw bar spacer ring in place

### Spindle Spanner Hole Location

A related item is the need to either feel about to find the holes in the end of the spindle or bend down and look up to see where they are every time you want to use the spanner. I got over this by marking out their positions on the side of the spindle, if you use some masking tape and pencil there is no need scribe on the metal. I then used a spot drill in my cordless drill to form two conical recesses which were then filled with a bit of paint to make them easy to see. I can now offer up the spanner in approximately the right location and it soon finds its way into the holes. **photos 19 and 20.**

### Draw Bar Auto Release

On the SX2.7 the hold of the R8 taper can be released by unwinding the drawbar

until it contacts the black metal cap at the top of the head at which point resistance can be felt and turning the key a little more will "Pop" the tooling out of the taper.

I found that the point at which the taper released was very close to where the drawbar completely screwed out of the tooling's thread. This not only risks the tooling dropping as it is released but all the force is being taken by less than one turn of thread as very little is engaged.

My remedy for this was to turn up a simple spacer ring, the OD to match that of the drawbar's flange and the OD to be a close but sliding fit on the hex socket head above the drawbar's flange and 8mm long, **photo 21.** A drawing for this can be found under the "Workshop" heading on the ME Website. With the

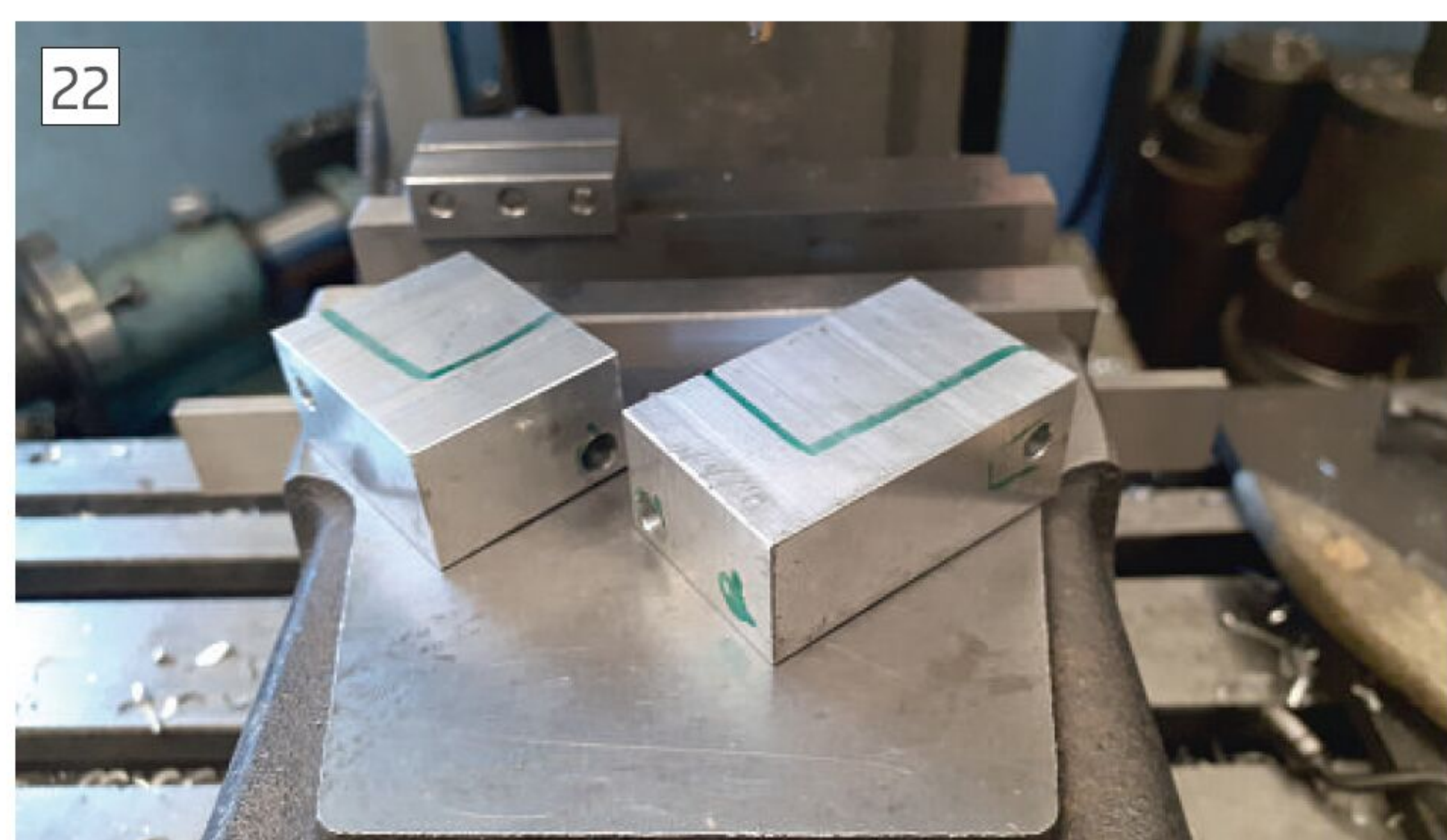
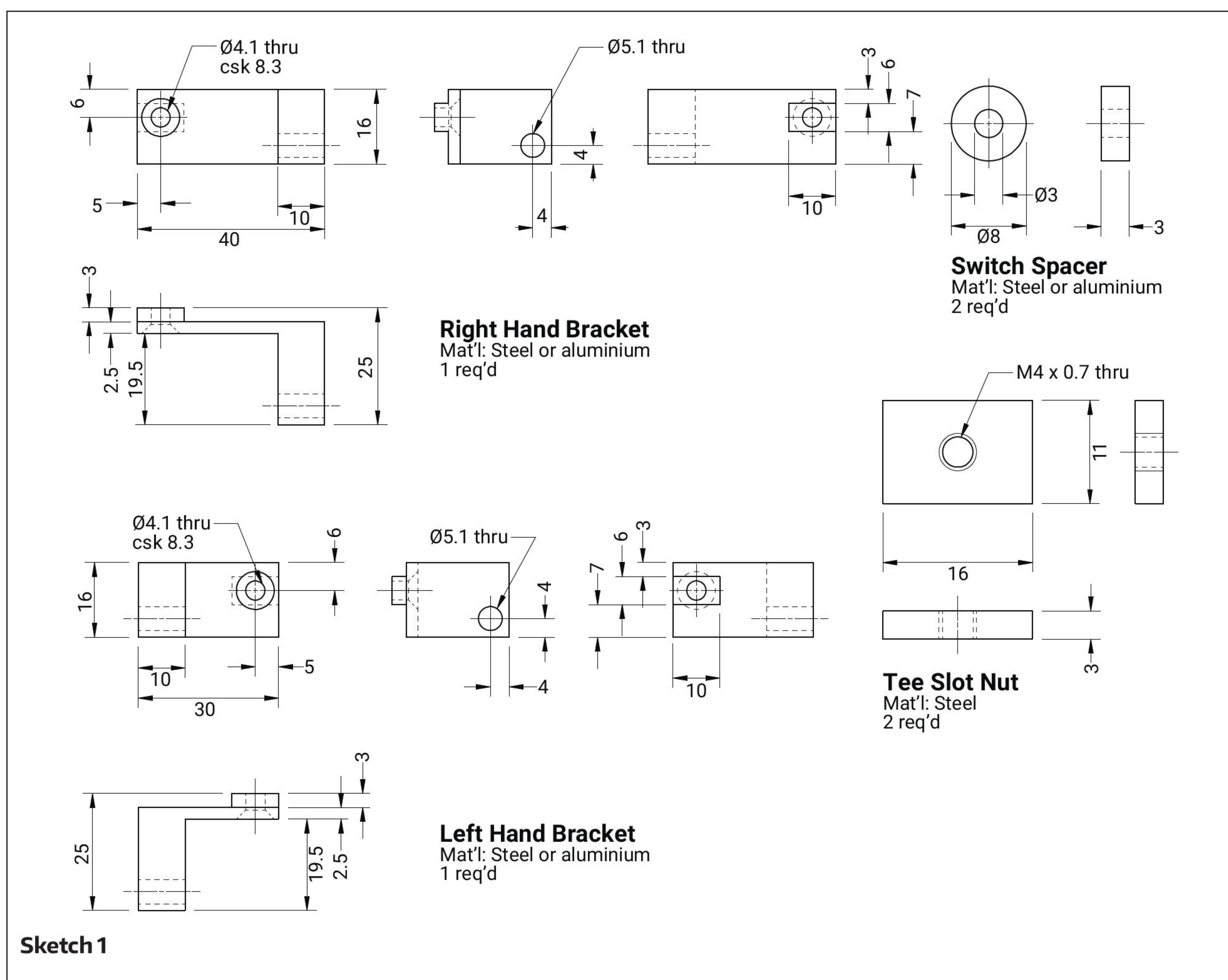
ring in place the drawbar will release the taper after approximately three turns of the hex key.

### X-Axis hand wheel Spring

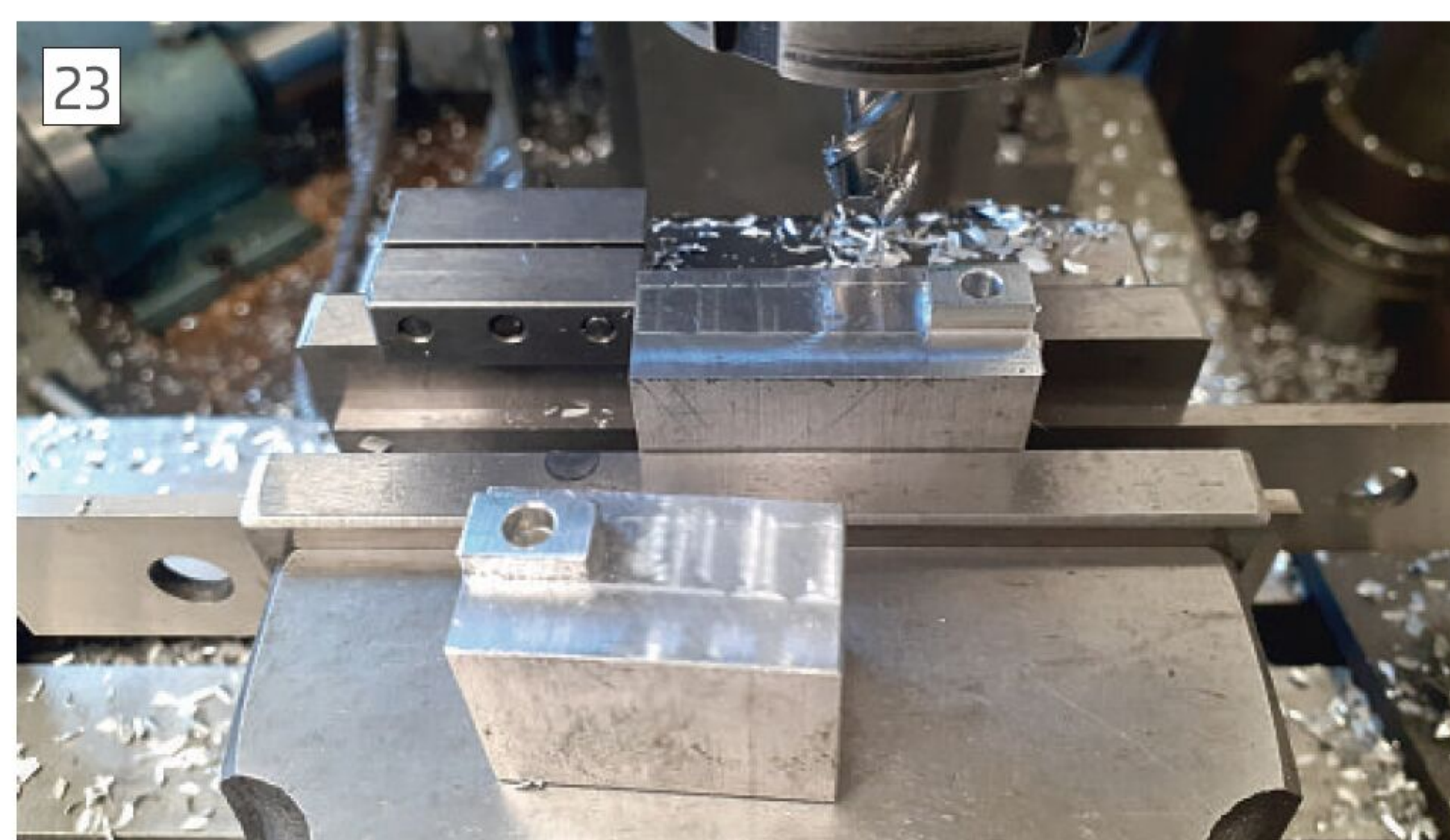
As a safety feature the X-Axis hand wheel comes fitted with a spring to keep the dog clutch drive disengaged, which is only needed if using power feed where the handle can fly round at a fair speed and could give you a knock. Having to push against this spring when feeding or putting on a cut makes it hard to feel how much effort is being put into moving the work against the cutter or to just sneak up on a cut or when touching off against an edge.

Luckily the spring is easily removed which makes use of the hand wheel a lot more comfortable and the spring can be put somewhere safe until you get round





machined blocks with holes drilled and features marked



Milling the table side of the bracket

to thinking of refitting it when a power feed is added to the mill.

### Extending Power Feed Stops

The SX2.7 that I have is one of the earlier models where the tee slot in the front of the table stops about 50mm in from the ends rather than the newer ones where it runs full length. Therefore, when I fitted the limit stops for the SIEG power

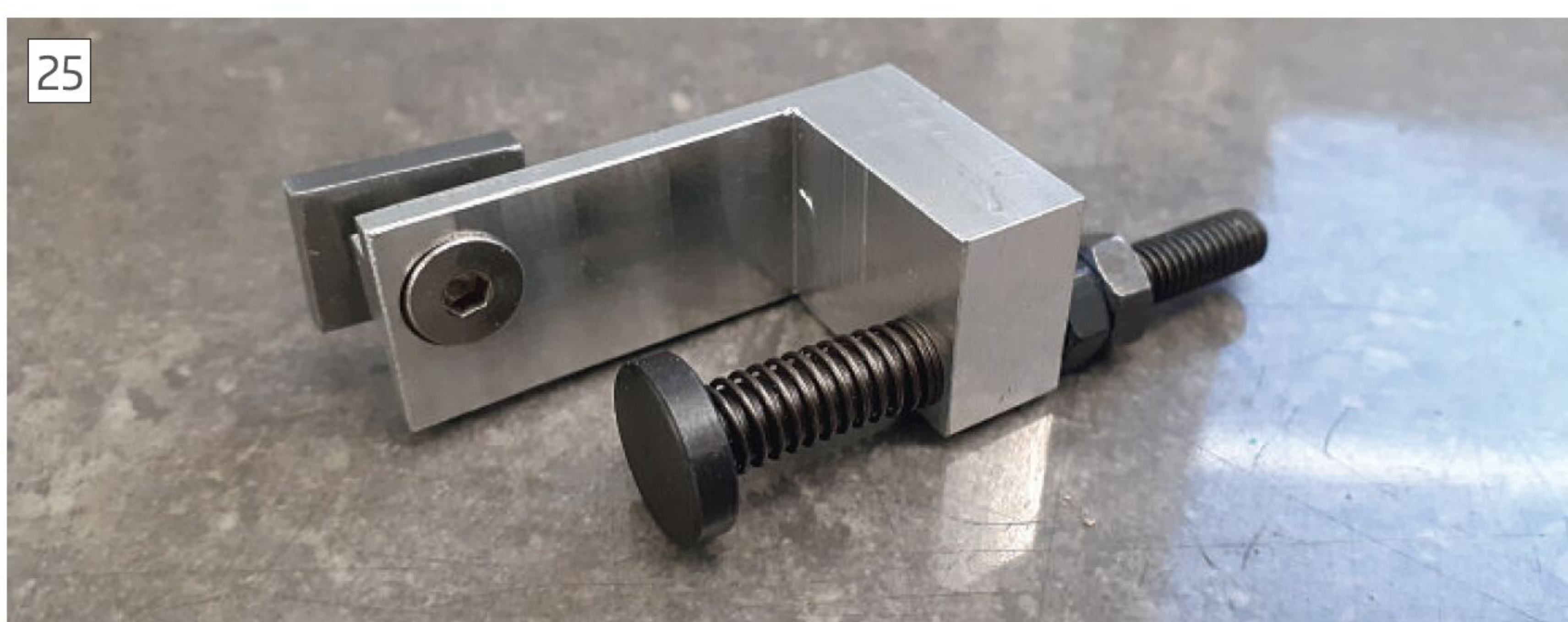
feed unit I lost about 50mm of possible X axis Travel as the stops could not be mounted at the points where the table runs out of travel and caused it to stop short.

**Figure 1.** shows the parts that I made to regain the full length of travel which are basically handed "L" shaped replacements for the supplied straight stop brackets, new tee nuts and a pair

of spacers to move the switch box out allowing the leg of the new L bracket to pass behind. The existing stop screws, springs and nuts are reused.

Start by milling two rectangular blocks to the respective overall sizes, I used 6082 aluminium, but mild steel could also be used. It is worth roughly marking the positions of the holes and milled features as the opposite handing of the





Assembled right hand bracket

parts can get a bit confusing. Then drill the various holes, I made use of a vice stop to save having to locate the holes more times than needed, **photo 22**.

The small, raised area that fits into the tee slot can be milled next, touch the end of the tool off on the top of the block, move clear and lower 3mm then lock the

height and all the cuts can then be done at the one height setting, **photo 23**.

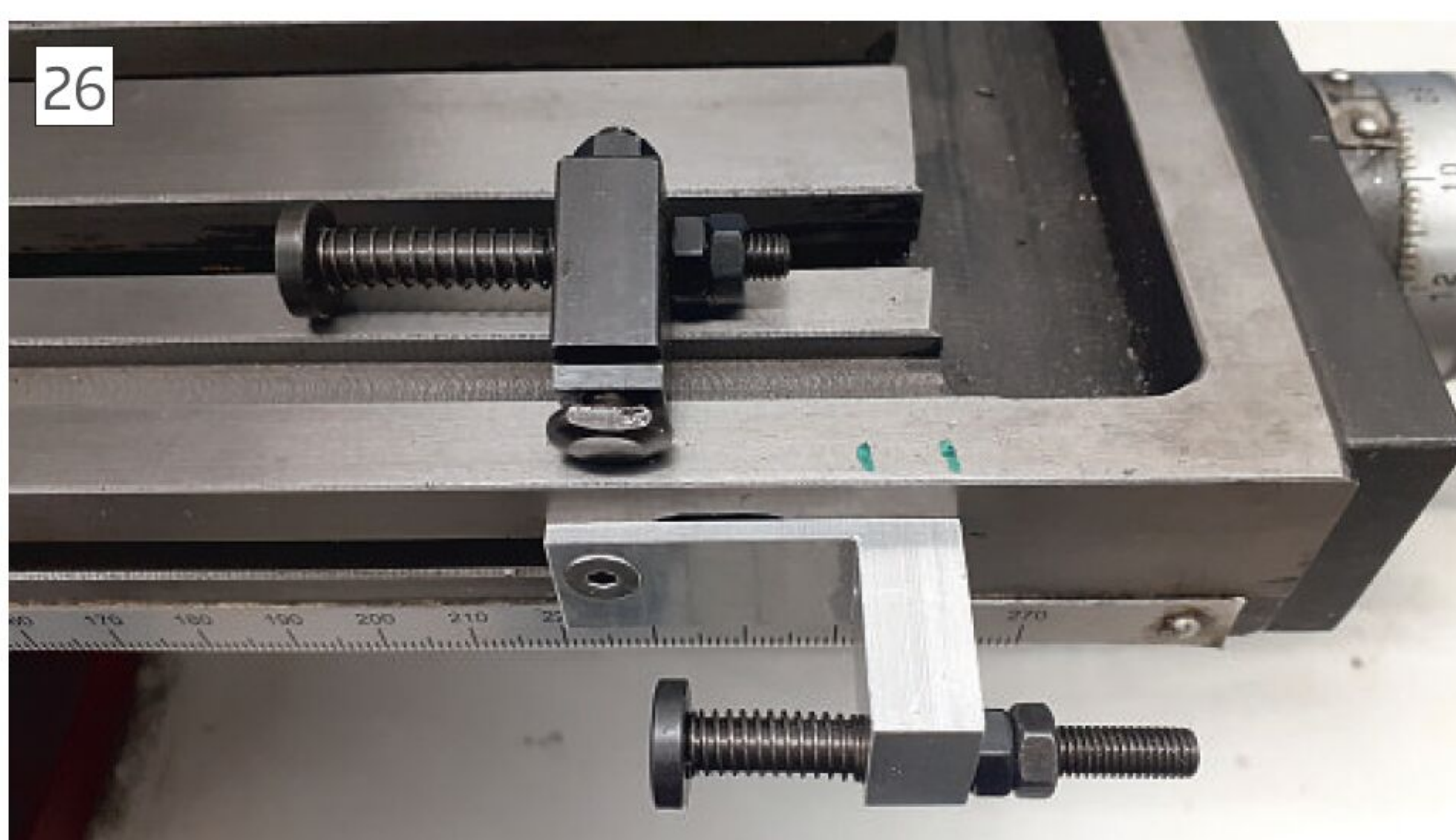
Turning the blocks the opposite way up in the vice the remaining material can be milled away to form the "L" shape. As it was aluminium I used one of the cutters designed for non-ferrous and aluminium and took full depth passes

of 19.5mm stepping over 1mm per pass that gets the job done quite quickly and makes use of all the flutes that you have paid for rather than just wearing them towards the end **photo 24**.

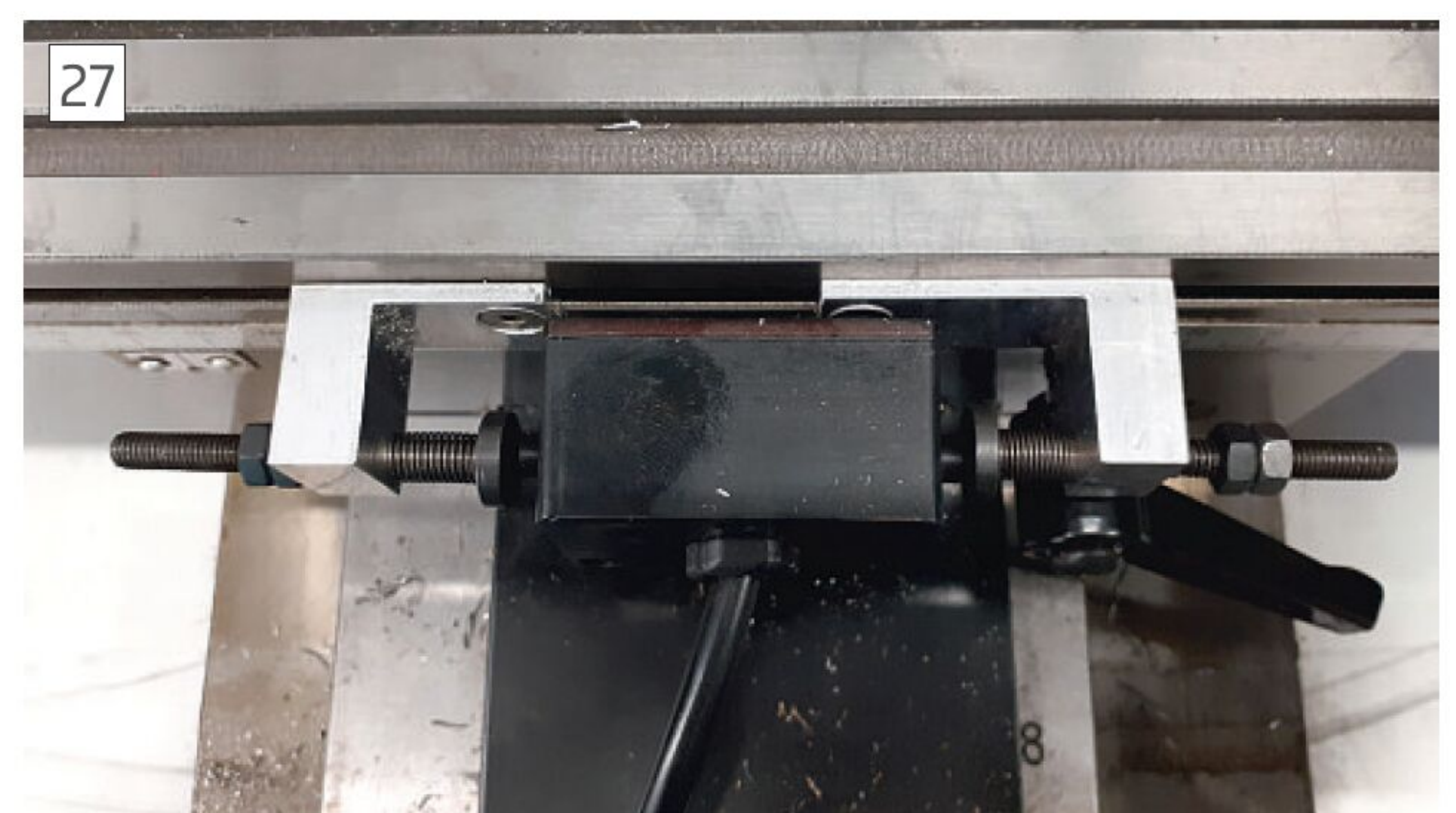
The last job is to countersink the M4 clearance hole and ease all the external corners with a file. The tee nuts and spacer rings are simple parts that should not really need any explanation.

**Photograph 25** shows the assembled right-hand bracket. **Photograph 26** shows the original bracket laid where it would have fitted to show the extra travel that the new bracket has gained, approximately 30mm on the right and 20mm on the left hand one. Lastly **photo 27** illustrates how the spacers allow the new brackets to pass behind the power feed's switch box.

● To be continued



New and old brackets showing regained table travel



Spacer ring allow brackets to pass behind switch box



### DCC for Railway Modellers

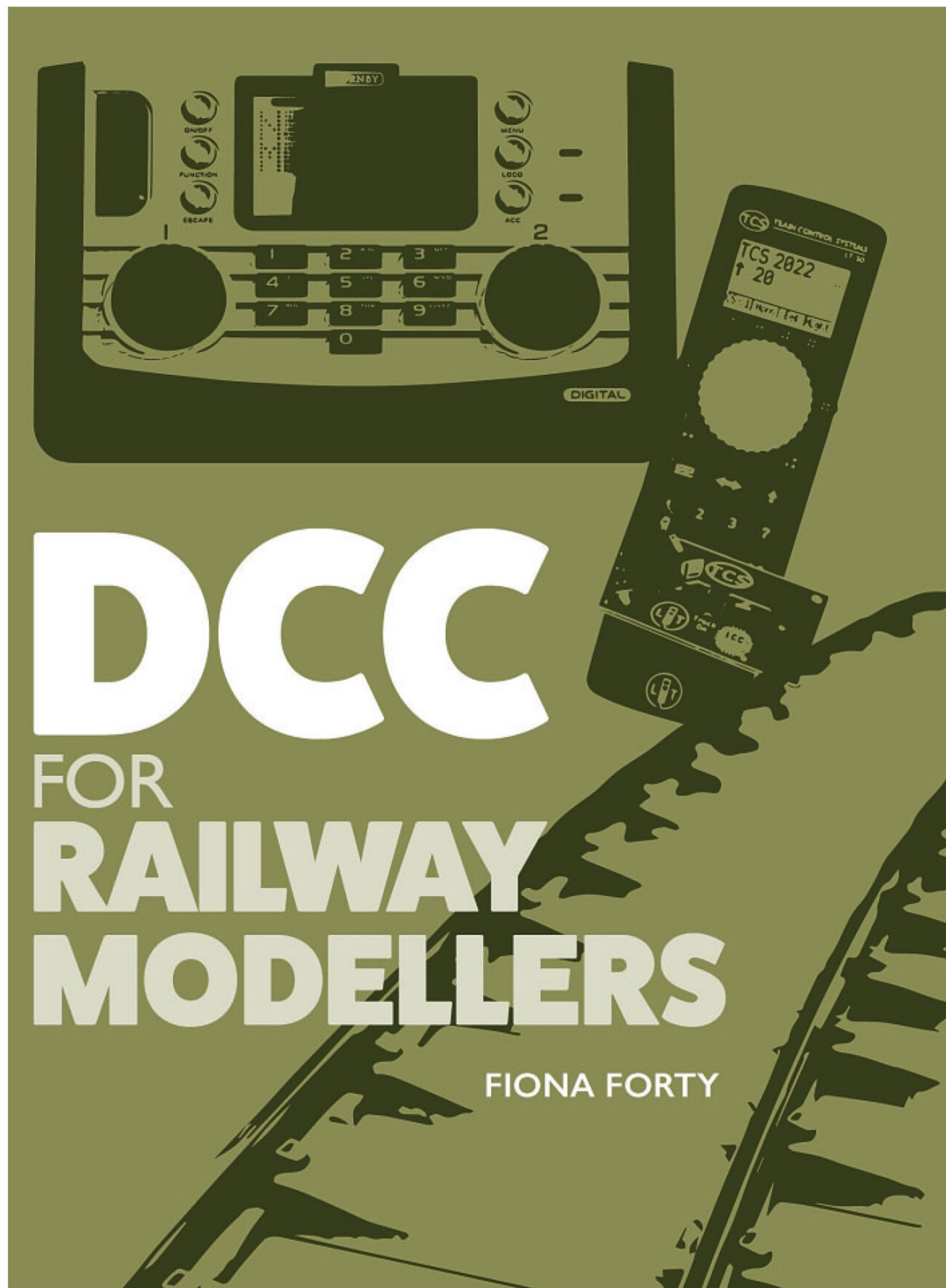
Many readers of MEW are model railway enthusiasts, and they may well find this book interesting and informative. DCC is 'digital command and control' – systems that allow the independent control of multiple locomotives on the same track. The book starts with a fascinating section on the history of DCC, which surprisingly has a history back to a Lionel system in the 1940s that used frequency control to operate two locos. From the 1960s things got ever more sophisticated and today DCC is a sophisticated system whose protocol is defined by the National Model Railroad Association.

The book explains DCC in detail and also shatters many misconceptions about the systems. It then moves onto the practicalities of track design and wiring; along the way there are brief interludes recapping background issues such as how gauge and scale relate. A chapter deals with electronic soldering; this chapter is perhaps a little repetitive, but it does get the facts across for soldering newbies. It then goes on to cover DCC locomotive maintenance, including looking after the running gear of model locos.

The second half of the book takes a deep dive into DCC systems, covering the systems themselves, and then carefully unpicking the incredible sophistication (and complexity) of locomotive decoders. A detailed chapter on fitting decoders is well illustrated with practical examples and also looks at programming decoders. Final chapters cover accessory decoders and troubleshooting.

The book has 160 pages and is fully illustrated in colour. Although some of the diagrams are low resolution, they are clear and easy to understand.

DCC for Railway Modellers is written

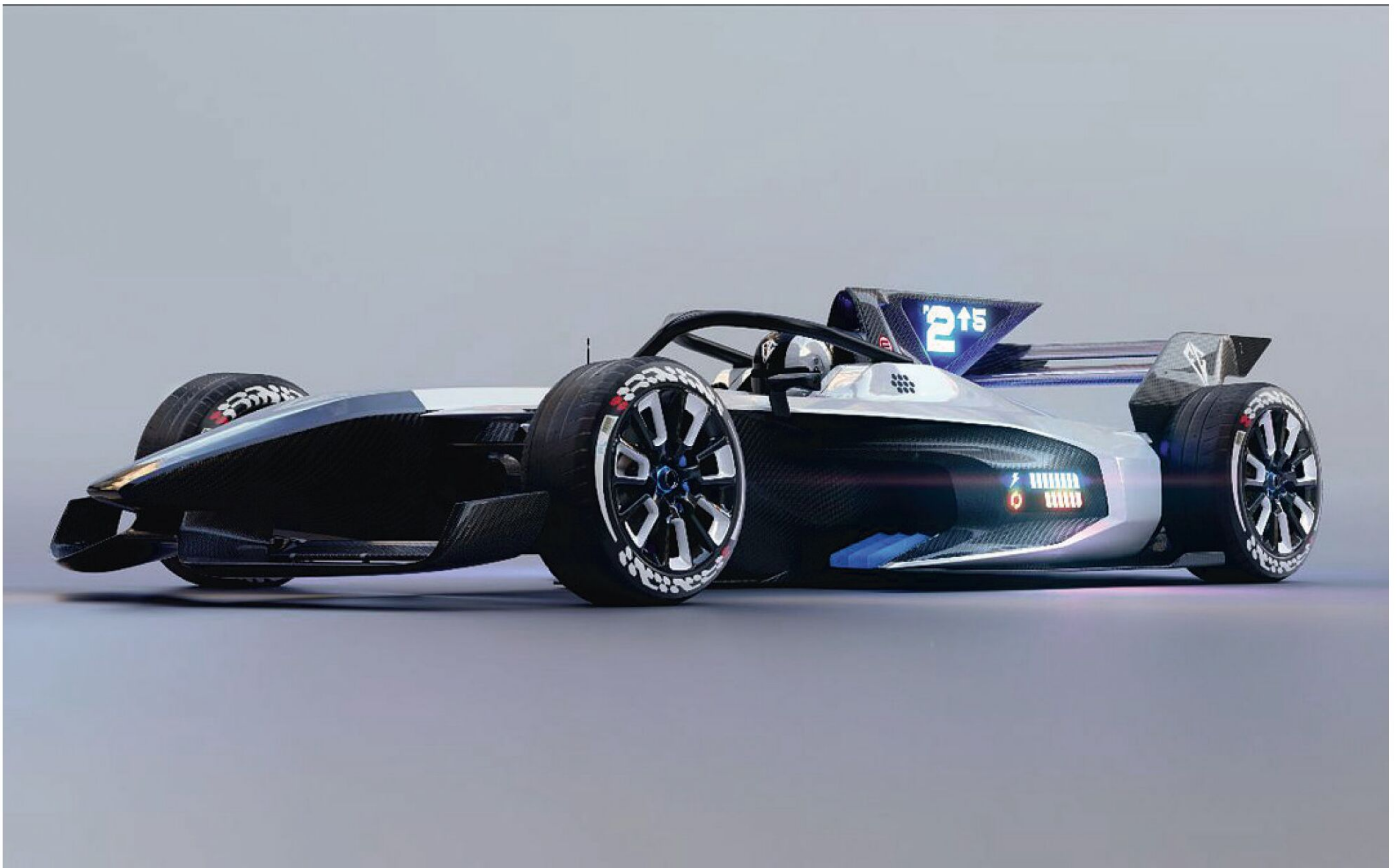


by Fiona Forty, who with her husband, Andy, has been training people for many years on subjects relating to digital command and control, as well as general issues relating to model railways. Fiona runs DCC Supplies a specialist business

dealing with all things relating to DCC.

DCC for Railways Modellers costs £19.99 and is published by the Crowood Press. It is available from [www.crowood.com](http://www.crowood.com), online retailers and local bookshops.





## FG Series reveals the world's first all-electric dual-Championship race car, the FG-Twin

The exciting all-electric championship, FG Series, has revealed the design of the dual-power single-seater race car ahead of its inaugural season in 2025.

Daniel Simon, a world-renowned automotive designer and futurist who is best known for his vehicle designs in *Tron Legacy*, *Oblivion* and *Top Gun Maverick*, worked closely with the Founders of FG Series Dilbagh Gill and Nick Heidfeld to ensure the car will be a torchbearer for championing electric and accessible motorsport, two key elements in the FG Series ethos.

Breaking the mould of previous single-seater categories, the FG-Twin is a modular race car, offering an all-electric powertrain with both rear-wheel and four-wheel drive. The pioneering model has the ability to run the front and rear axle at 350kW of peak power and offers two different performance levels

for the FG1 and FG2 championships. Alongside the different power levels, the purpose designed easy change system allows for quick adjustments to the hardware, creating a seamless transition and tailored racing experiences for drivers competing in the two FG Series Championship levels.

FG2 is the entry-level for the series, operating the FG-Twin car on the lower power setting and is geared towards training drivers on their path to professional racing. FG1 will perform the FG-Twin cars' greater power level, making it the pinnacle of the FG Series racing ladder. Devised for more experienced professional drivers, FG1 provides higher performance capabilities, increased downforce and greater freedom for setting up the car.

Thanks to its groundbreaking design, the FG-Twin race car will be used by

multiple drivers over the same race weekend. This pioneering feature will help drive affordability for teams and drivers. Lowering one of motorsports' biggest entry barriers – cost of participation – is a core part of FG Series' mission. The global coverage through regional championships, the strategic positioning as a support series to other major motorsport events and its unique sporting formats, FG Series is set to become the pathway for the next generation of motorsport talent aiming to compete on the right racetracks and in front of the right audiences.

FG Series' sustainable edge also sets it apart from other series. Using the same car for both championships is a unique way to reduce the series' carbon footprint through both energy demands and impact of transportation.



## BEGINNERS WORKSHOP

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

# Beginner's Workshop

## SUPPORTING AND STEADYING

By Geometer

**T**HERE ARE TIMES when even the simplest operation would be greatly facilitated if one had a third hand. In some instances, of course, work cannot proceed unless assistance is available or means are devised to enable one to work single handed. This is especially pertinent when long or weighty material has to be mounted with one end in the vice, or a pedestal or bench drilling machine is employed for parts which are extensive or overhanging.

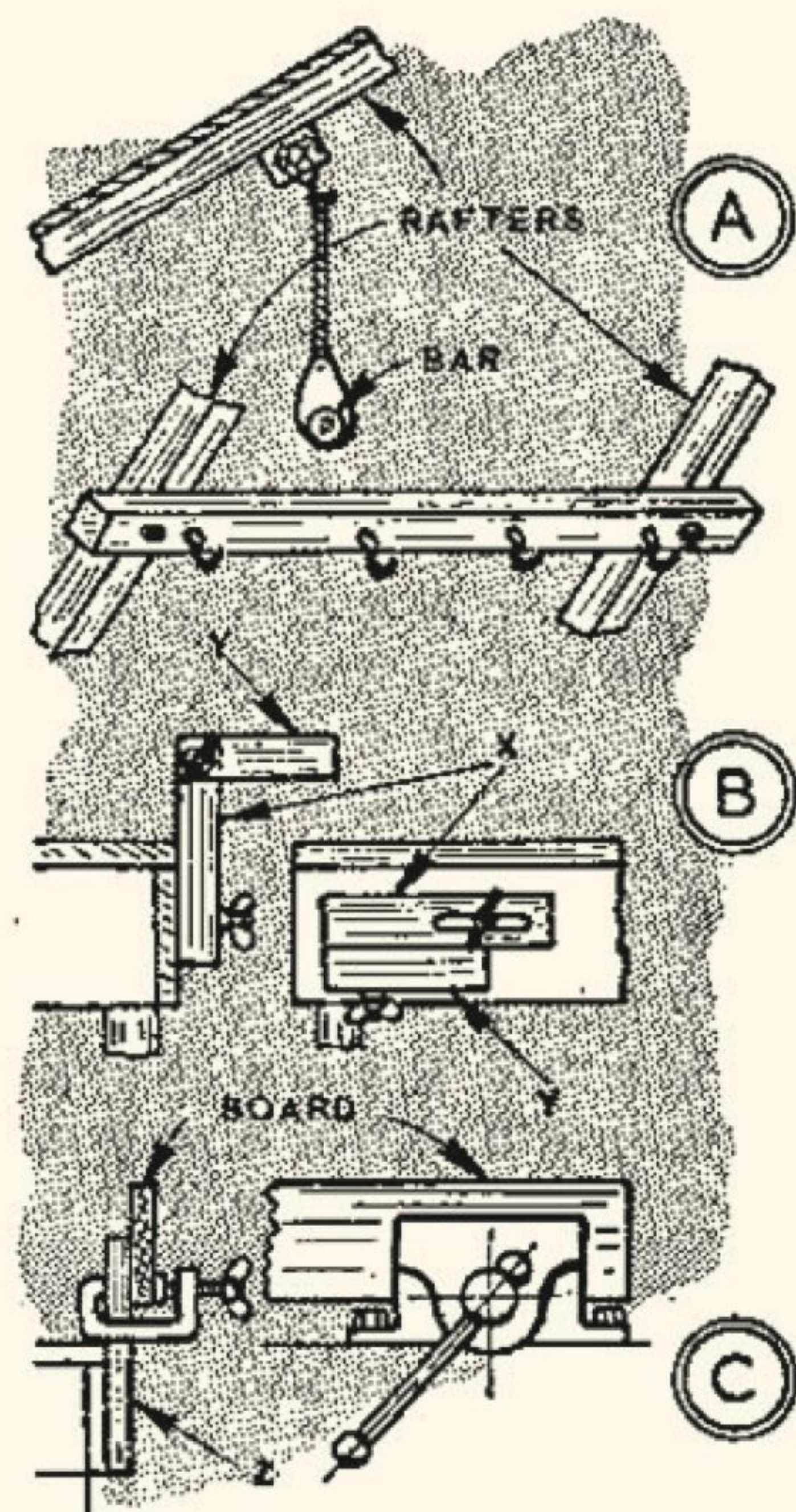
Ordinarily, gripping material in the vice presents no problem. It can be held with one hand while the vice is tightened with the other. If it is heavy but short and needs to be mounted centrally at a certain height out of the vice jaws, a piece of wood or similar packing can be laid in the jaws on the slide and the material rested on this while the vice is tightened.

Again, should such a piece of material be no longer than a comfortable arm's reach, one can still hold the distant end and operate the vice handle oneself. Beyond this length, however, the distant end must be supported in some manner.

Nor is it a question only of initial mounting, for often the support must be maintained. A piece of heavy steel bar, for example, will twist in the vice and descend when let go—or if extremely heavy pressure is applied the vice may be unnecessarily strained—and lighter material, like a board, may have to be gripped so hard that the vice jaws leave marks.

In a low building it is generally convenient to support from the roof via a cord or piece of light chain. To find the spot where the support needs to be, the material is placed one end in the vice jaws, the other on the floor, then a plumb-line (a weight on a string) carried up from the floor to the roof where a bent nail or screw hook can be placed in a nearby rafter.

If cord is used it should be tied to a wire ring or loop in which the material rests as cord alone grips the material, which then proves more difficult to move along. If chain is used it can be looped round the



material and a bolt passed through the links—which also affords a means of height adjustment. Should the support line come between rafters a member can be fixed across them, when, if desired, a number of hooks can be fitted, A.

### Bench supports

Brackets or supports attached to the bench are other means of maintaining the distant end of material level with vice jaws. The type at B is compact, adjustable, folds down to the bench when not in use and may be constructed either from light angle iron or wood about 1-1/2 in. square.

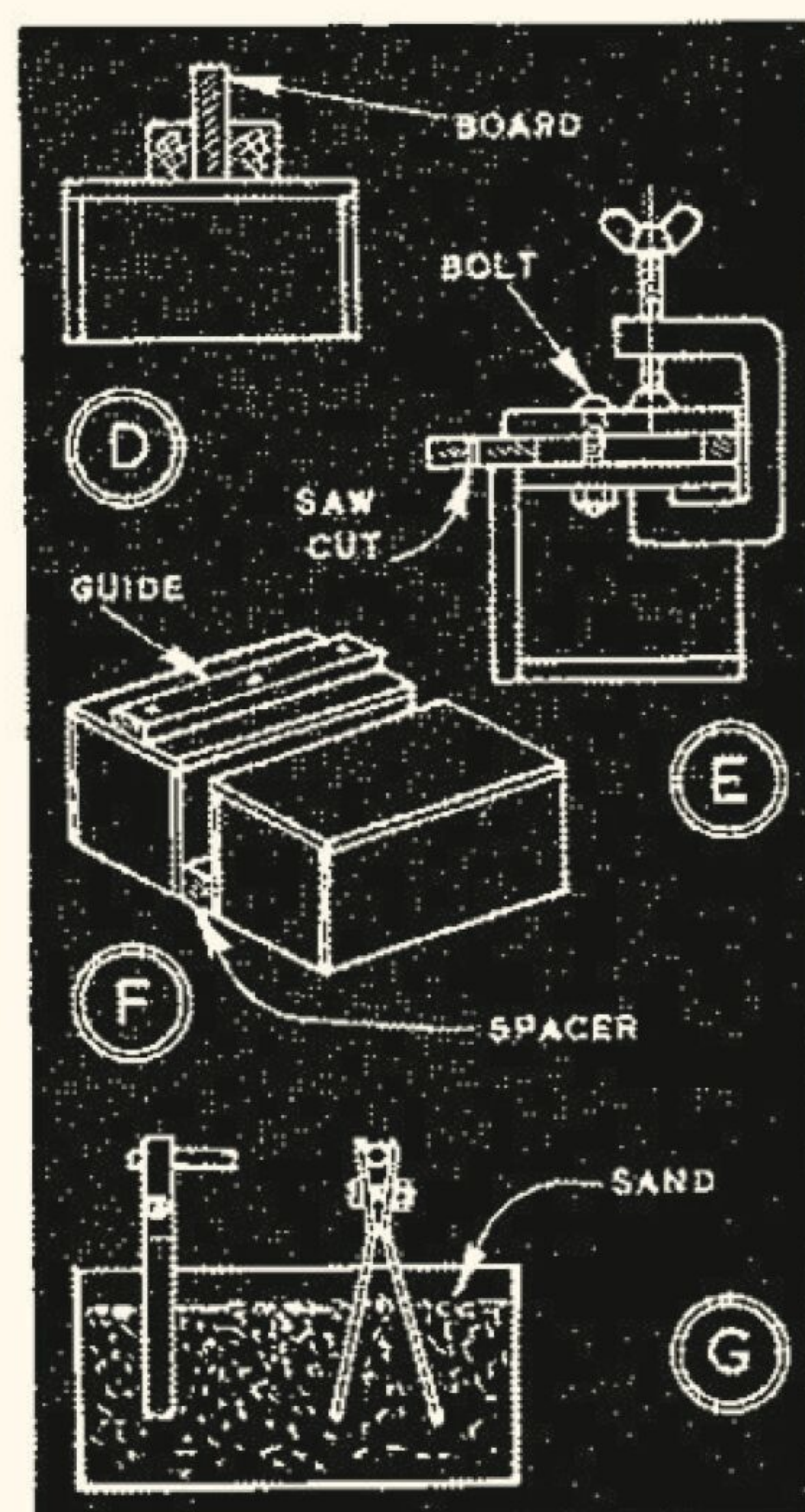
Part x swings up and may be slotted to set for height while part y turns out horizontally. Fixing can be by bolts and wing nuts.

Support for the distant end of a board when planing the edge may be provided, C, by attaching a strip of wood, z, vertically to the front of the bench, then gripping the board with a clamp. Should such a mounting be impracticable, however, alternative means of mounting are inverted boxes

on the floor with pieces of square or similar wood nailed or screwed to the bottom. These form a channel in which the board can be placed vertically, D. Endwise movement of the board, under plane pressure, is prevented by a crossblock at the end of the channel.

Boxes also provide support when strip sawing or splitting boards. For a narrow strip, clamping to the side of a box is convenient, E, when a bolt may be used instead of a clamp. For cutting down a length two boxes may be spaced, F, one having a nailed-on guide to align the board while the saw, passing down the marked line, is kept central between the boxes.

Support of a different nature to hold small parts in alignment for soldering, brazing, etc., may be provided as G. The parts may be laid or clipped on strip metal supports and these pressed into sand in a box or held while sand is packed round them—a method avoiding strain.





# A Sheet Metal Rolling Machine



**Paul Tiney makes a set of bending rollers for manipulating sheet metal into accurate curves.**

**M**ost, if not all, of us have stood bashing a sheet of thin gauge metal around an off cut of bar, a drain pipe, or even thought of using the milk saucepan “looks about the right size”. We have probably also promised ourselves that the next time we have cause to bend a nice curve we shall use a set of home-made rollers. Rollers which never get made. Well this winter “plans were laid”. Forsaking my full-size drawing board I pulled out the small A3 size one, sat in my chair, put another tot of embalming fluid in the glass, and settled to get something down on paper.

The operation of these things is pretty straight forward. Two rotating rollers, geared together, pull the sheet metal between them and a third adjustable roller bends it. A glance at an old tool catalogue will give the general layout, until one notices that there seems to be differences of opinion about just where the third roller should be located. Since I intended to make my machine bench vice mounting the rolled sheet had to exit upwards and away from the vice, therefore the adjustable roller had to “push up” from behind and below, **photo 2**.

The sharp eyed amongst you will see that the finished item has certain design differences to the plan as drawn. This is called development, though is more often in the form of “Oh, doing that will make life easier”.

Overall shape of the thing settled it now came to deciding on the specifics, and this says more about me than it should. Because the A3 drawing board is equipped with drawing aids which are all marked in metric, in a break from tradition, all dimensions are therefore in metric, all that is except the length, “about a foot should be long enough” and so 12 inches is the capacity of the machine.

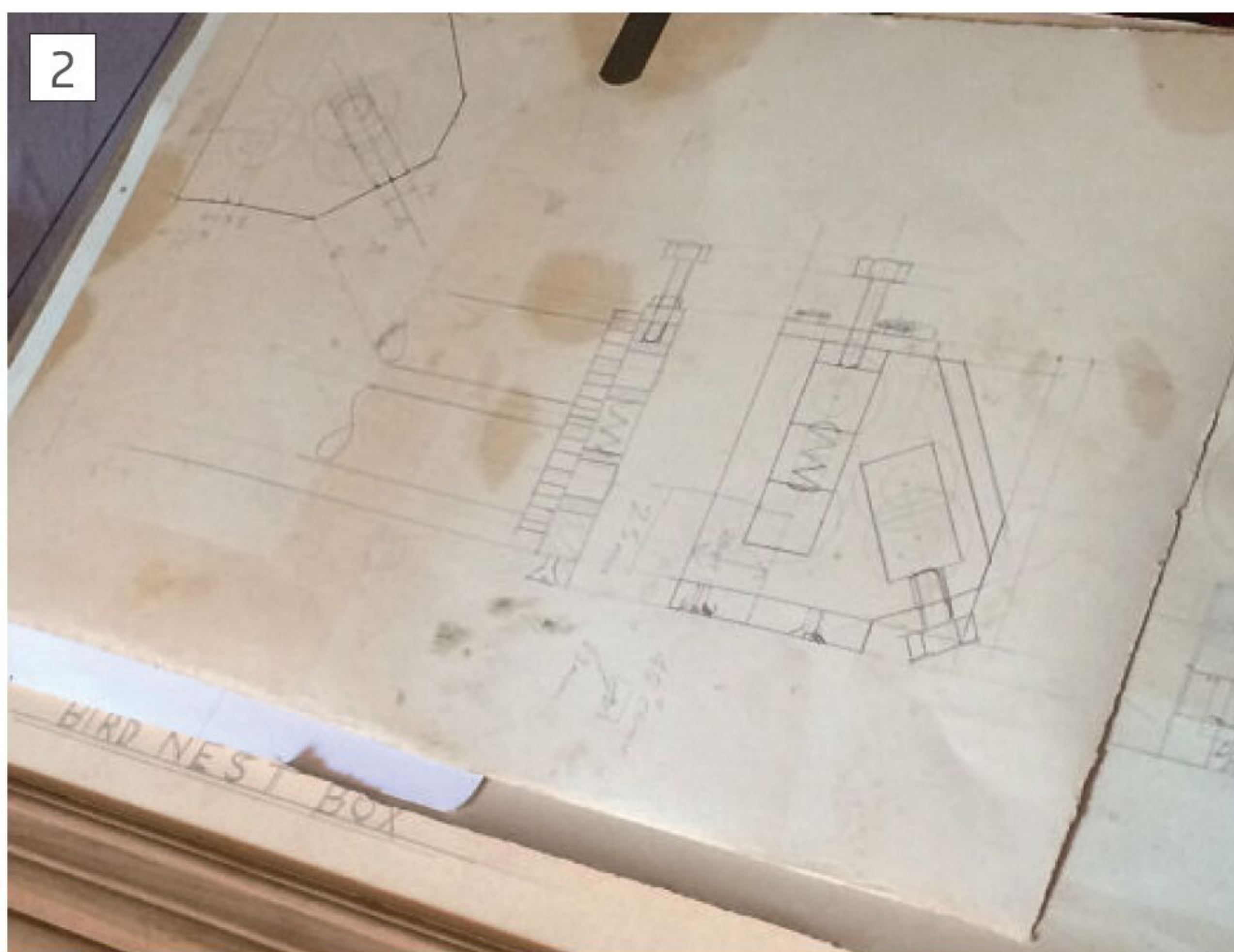
Each roller has a gear wheel attached



to it so that when meshed together each will revolve and draw the sheet metal between them. The rollers, and hence the gears also, can be moved apart to accommodate different thicknesses of material. The limit of capacity is reached when the gears no longer mesh sufficiently well to be driven. The radius of each roller has therefore to be half the distance between the centres of the two gears when they are meshed

together. This position is near enough the point of drive between the gears, the spot between the addendum and the dedendum. All we now need to find is a gear wheel with nice deep teeth to provide lots of meshing capacity with an addendum/dedendum dimension that is the same as an off the shelf stock steel bar. “Simples” as the twelve-year-olds say, and in fact it is. Purveyors of gear wheels publish fully dimensioned





General assembly drawing.



Patterns and box.



Marking out.

drawings and all one has to do is look for the gear that best fits the bill. "Ah here it is, a 2.5M, 12 tooth gear, outside diameter 35mm, with a tooth depth of 5.625mm. Call it 5 for running clearance, 5 from 35 gives 30, so a bar of 30mm diameter should do".

Once I had the dimensions of the gears and rollers I could begin to plot their positions and the position of the movable third "forming" roller. Once this was down on paper I could then draw and dimension the end support pieces. The gear wheels as supplied came with an 8mm centre bored hole. I therefore decided that this would be the size of the support spindles at the end of each roller. Instead of reducing the diameter of the roller to suit, horrid task, repeated six times, I would bore an 8mm hole 1 inch deep, sorry 25mm, in the end of each roller. Into these I would slip a piece of stock 8mm bar, slide the gear onto that and then solder the whole jolly lot together. "What" I hear you say, "no woodruff or key way, not even a shear pin?" The driving power comes via your arm not an electric motor so let's see if the solder is going to hold first. If it does it will certainly speed the job on. (and it has so far). I suppose there are "super glues" which would also work, but we are very much of the "old school" here. The rollers are hardly likely to bend and the 8mm "pins" in the ends are both well and closely supported. The gears drive the rollers by being fixed (soldered) to both the pins in the roller ends but also to the face of the roller. Plain flanged brass bushes at each end for bearings would do as we shan't be turning the handle





Positioning end support using pointer mounted in lathe chuck.

very fast.

Some of you may criticise the long pre-amble explanation, and you could well be right to do so, but I sometimes find reading the “why” as interesting as the “how”.

As I intended to sand cast the two end support pieces in aluminium alloy I cut and shaped two wooden pattens, **photo 3**. The casting was carried out using an open mould, the alloy provided by two old car engine inlet manifolds. Once cooled and brushed off they were each mounted in the lathe four jaw chuck and

faced. I then fitted my vertical slide and machined three of the edges square

I now had two alloy blocks on which all the critical faces matched. I now marked out on the faces where the various slots were going to fall, the dimensions being taken from my drawn design. I don't have a cast iron surface plate but I do have a piece of plate glass, boxed and framed, with a green baize cloth beneath. Plate glass is made by floating the molten glass onto a bath of tin or lead. Picture glass is rolled and not actually that flat and so is really not that suitable. A word

of warning here concerning marking out, a very little Prussian Blue goes a very long way, and it can also be particularly attracted to hands, fingers, and soft furnishings, **photo 4**.

The centres at the end of each of the slots were marked and centre popped preparatory to drilling. Since the lathe is not designed as a milling machine and is not constructed with quite the same rigidity, I try to resist taking the heavy cuts that would be normal fare for a milling machine. This can result in taking lots of small passes back and forwards and can seem to be never-ending, the more so if also having to concentrate on the running length. By drilling a hole the same diameter as the width of the slot I could just run the end mill into fresh air at the end of each pass.

As my vertical slide was not large enough, I had to use an angle plate mounted on the cross slide, and all cuts would be taken using the cross slide feed. If the angle plate looks home-made it is, an offcut piece of RSJ. With a pointer mounted in the lathe chuck and an eye glass, by tracking the cross slide back and forwards, and gentle taps from the vernier persuader (hammer) I was able to set the work on the angle plate before finally tightening up the clamping bolts, **photos 5** and **6**. After what seemed like an age of milling, I had two alloy support end pieces, each having two slots. It was now just a case of drilling and tapping the four holes for the adjusting screws. All done in a twinkling of an eye and with no breakages.

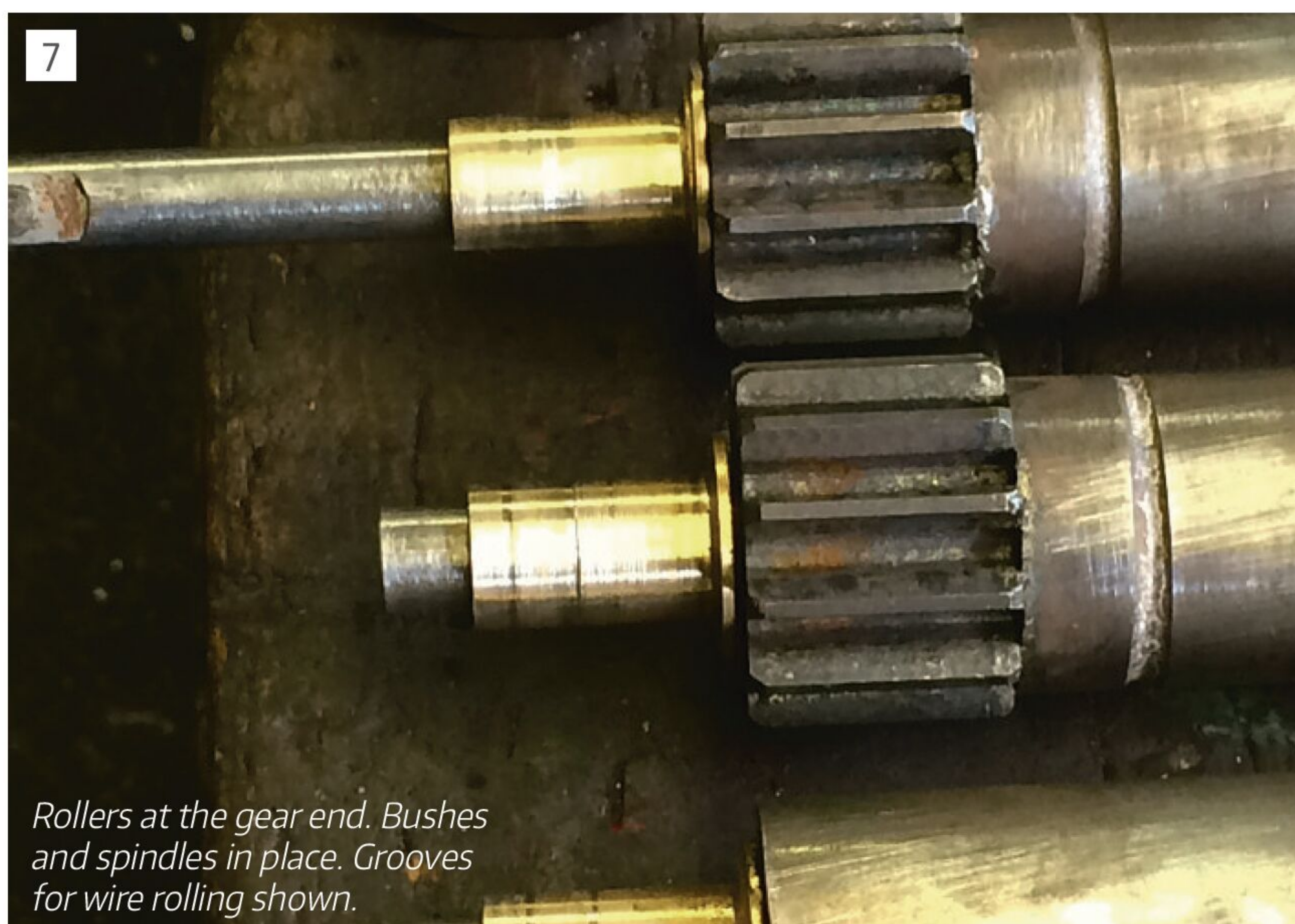
My metre of 30mm steel bar was cut into the three lengths need, two the same and the forming roller longer by the width of the gears. Centres were marked and dotted on each of the ends. Each was in turn chucked, a steady fixed, and holes drilled in the ends an inch or 25mm deep to take the 8mm supporting pins or spindles. As an aside I have always been a bit confused when it comes to “spindles” and “axles” I used to believe that spindles spun and axles didn't, but it seems to have now become a clouded issue so far as terminology is concerned. Comments would be welcome.

Before removing the two main feed rollers I set a revolving centre in the tailstock and ran it into the drilled 8mm hole. Then at the chuck end of the



Milling the end support slots.





Rollers at the gear end. Bushes and spindles in place. Grooves for wire rolling shown.



End support with bushes and adjusting screws.



All the bits.

roller using a tool that I had ground to a rounded tip I cut a groove in each of the rollers. This would enable thin sections of round wire or bar to be fed between the rollers, in much the same way as flat sheet metal can, and curves and rings be produced, **photo 7**.

The six brass bushes were knocked up one evening and suddenly the “assembly area” seemed to contain all the requisite component parts, **photos 8 and 9**.

As mentioned before, I soldered the spindle pins in the ends of the rollers, and while all was still warm sweated the gears to the roller ends and ran a bit of solder down between the spindle and the gear for good measure. If it all holds up, all well and good, and if not, it is an easily job to take apart drive pins can be fitted. But so far all has been fine.

The whole kit and caboodle was now bench assembled and held together using a sash clamp before being carefully set in place on a length of heavy angle iron that had been clamped in the vice. Once all had been positioned and marked holes were drilled in the angle iron and corresponding holes drilled and tapped in the alloy end pieces. After greasing anything that moved and daubing with paint anything that didn't, it was ready for assembly the next day. Two springs were inserted between the roller bushes to hold them apart and to aid the adjusting screw. The crank handle is held by a pinch bolt tightening down to a flat machined on the roller drive pin, **photo 10**. ■



Assembled before finishing.



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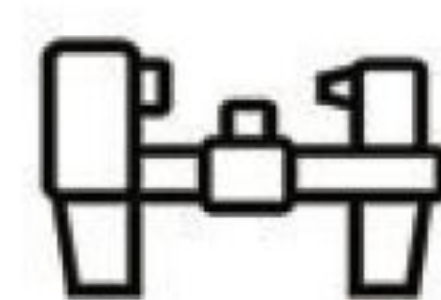
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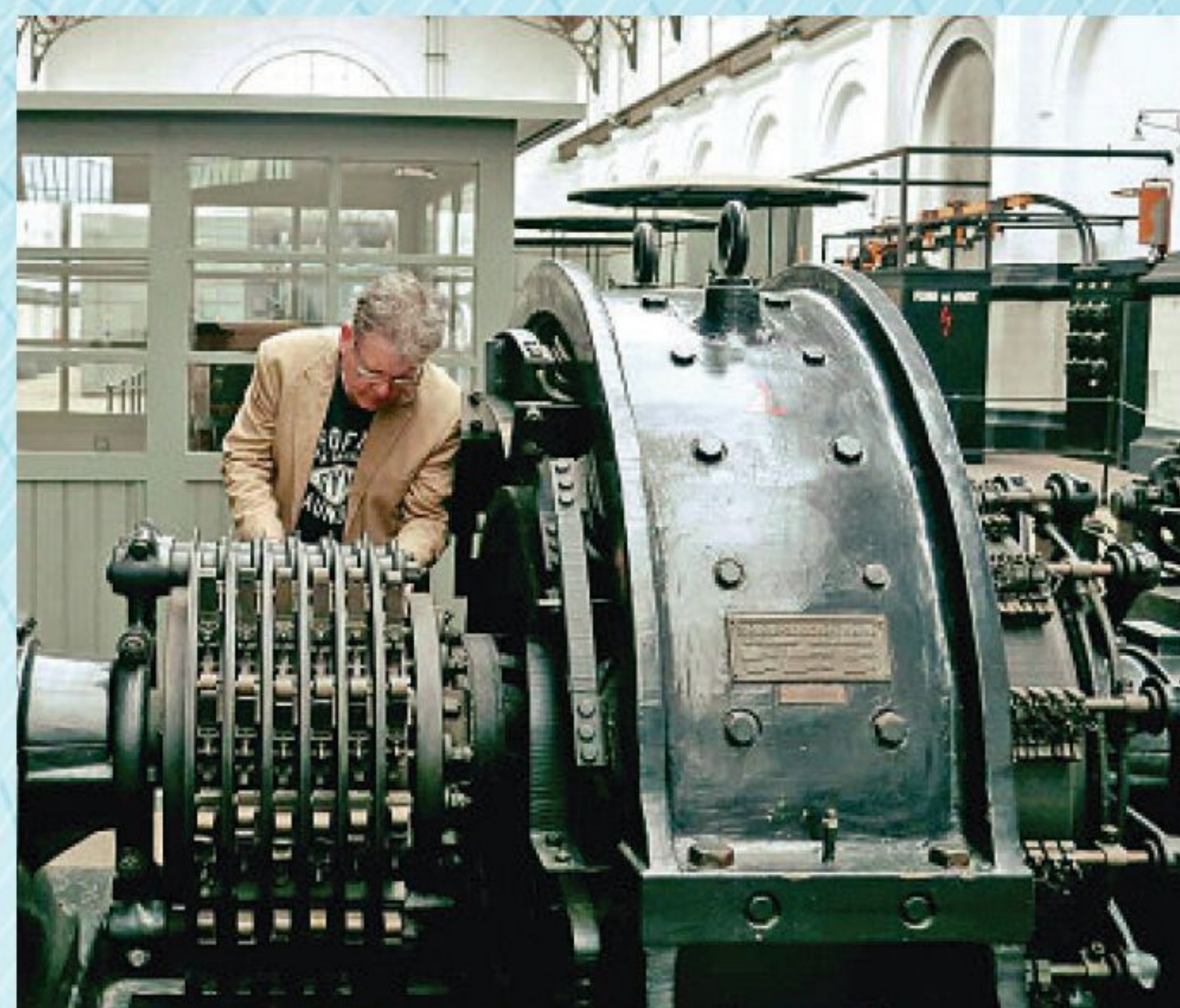
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