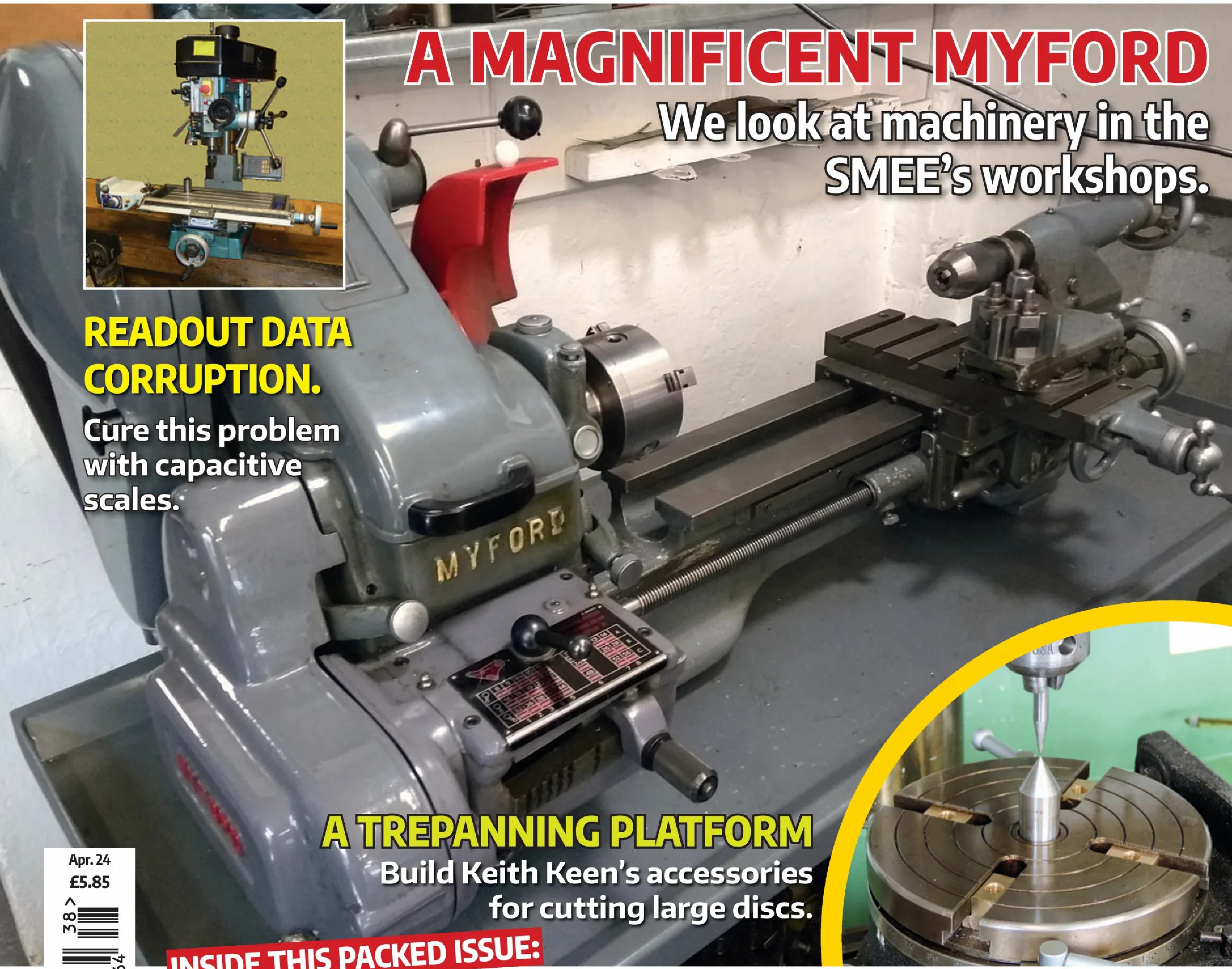
No. 338

A 3D PRINTED VERTICAL SLIDE

Print your own with a link to the STL files.

MODEL ENGINEERS' WORKSHOP

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS APRIL 2024 ISSUE 338 WWW.MODEL-ENGINEER.CO.UK



A MAGNIFICENT MYFORD

We look at machinery in the SMEE's workshops.

READOUT DATA CORRUPTION.

Cure this problem with capacitive scales.

A TREPANNING PLATFORM

Build Keith Keen's accessories for cutting large discs.

Apr. 24
£5.85

INSIDE THIS PACKED ISSUE:

- MAKE A BELL CENTRE FINDER.
- FLY PRESS TOOLING FOR ACCURATE BENDS.
- MAKING A HIGH SPEED MICRO-MILLING MACHINE.
- JOINING FLAT BELTS – HOW IT WAS DONE.
- EXTENDING WIFI RANGE TO THE WORKSHOP.
- IONISED GAS REPLACES CUTTING FLUIDS.
- FINAL SET OF PLANS FOR GRAHAM MEEK'S BORING HEAD.
- A-Z OF METALS FOR MODEL ENGINEERING – PULLOUT TWO
- PLUS ALL YOUR REGULAR FAVOURITES!

MORTONS MEDIA GROUP LTD

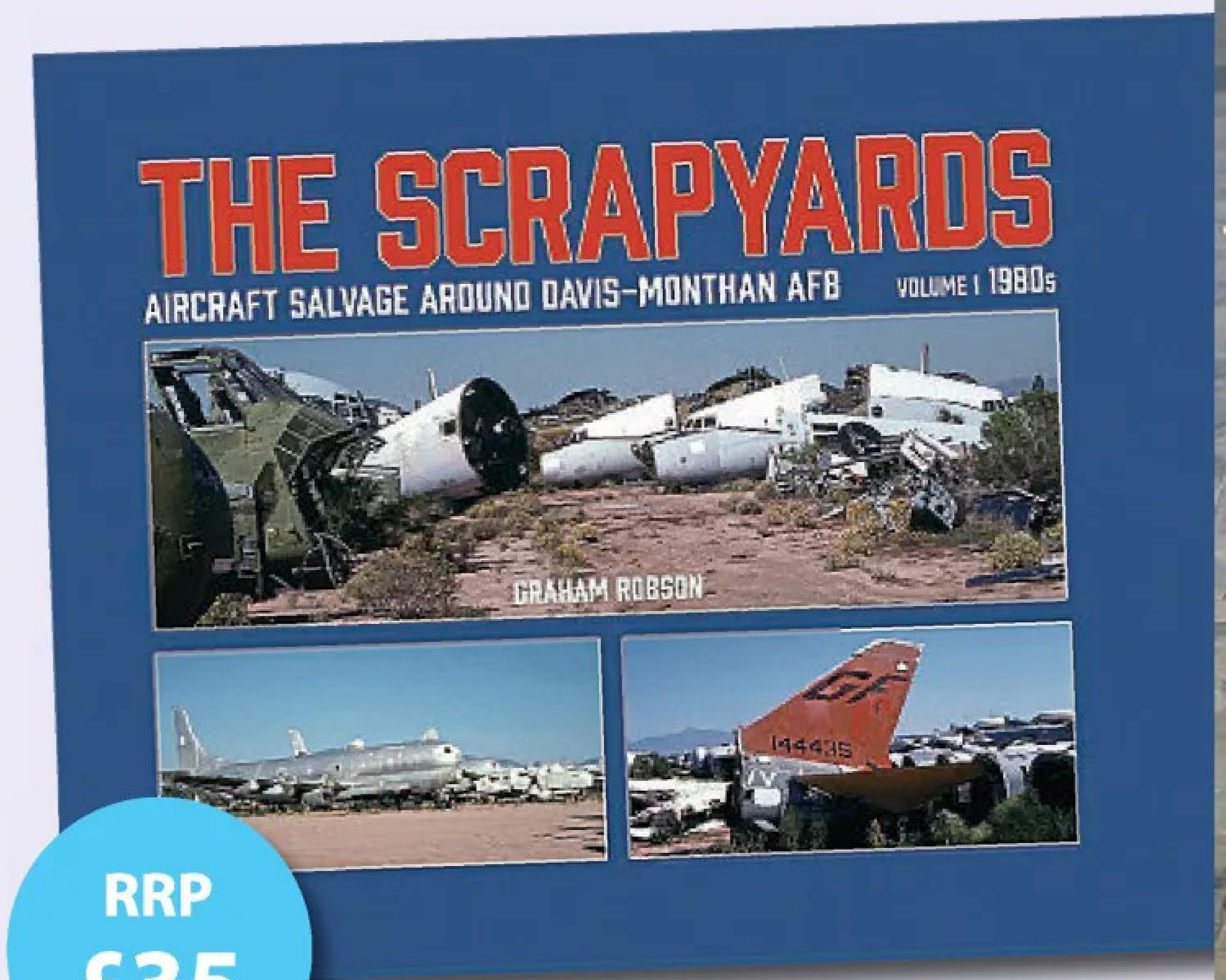
Get more out of your workshop with MEW

Join the conversation at:
www.model-engineer.co.uk

Get 20% off a selection of aviation and railway reads from Mortons Books

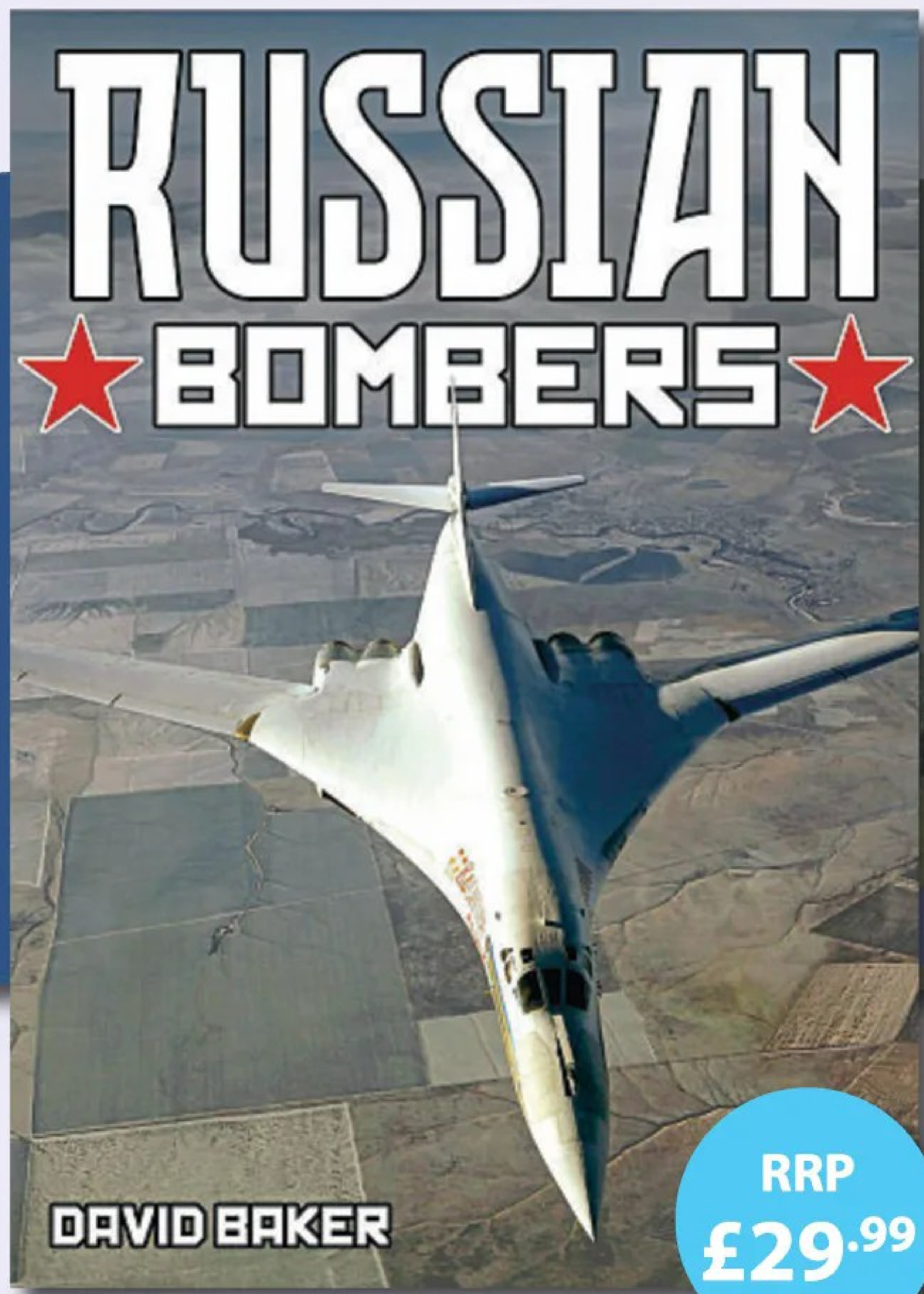
'FLASH20' for 20% off

Use code 'FLASH20' at the checkout



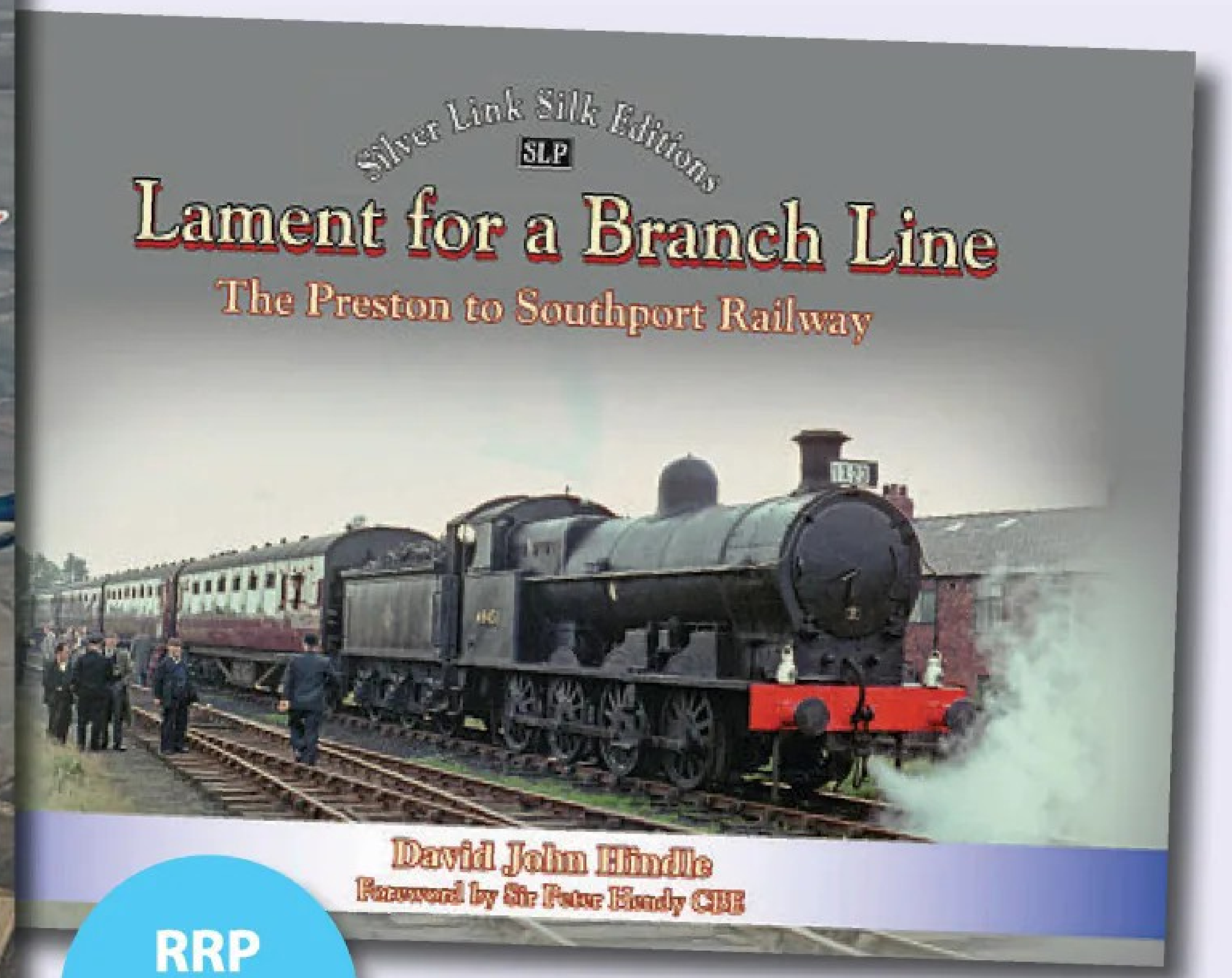
RRP £35

THE SCRAPYARDS: AIRCRAFT SALVAGE AROUND DAVIS - MONTHAN AFB VOL 1 1980s



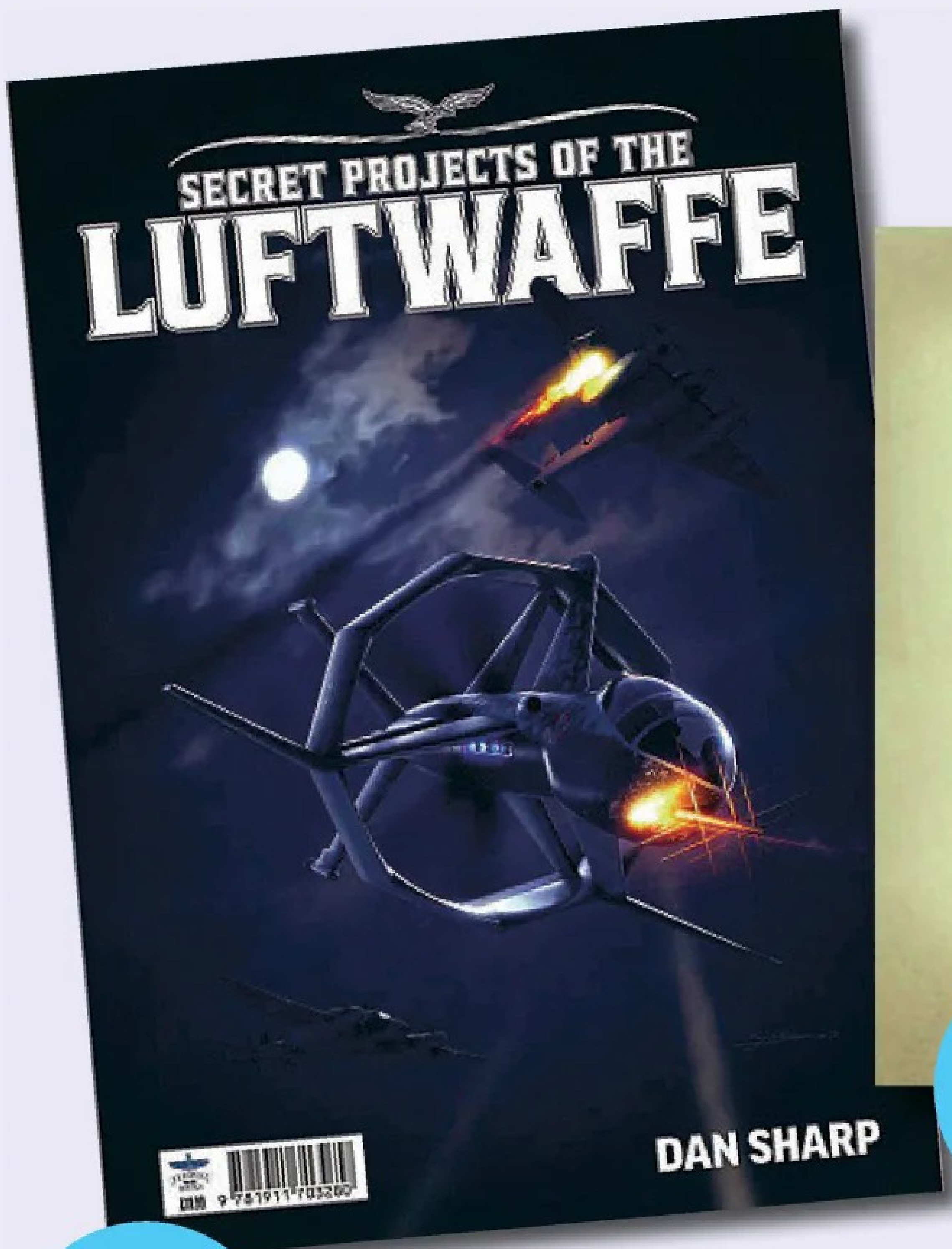
RRP £29.99

RUSSIAN BOMBERS



RRP £30

LAMENT FOR A BRANCH LINE



RRP £11.99

SECRET PROJECTS OF THE LUFTWAFFE

RRP £40

RONNY BAR PROFILES GERMAN FIGHTERS OF THE GREAT WAR VOL 2

RRP £16.99

EAGLES OF THE LUFTWAFFE: FOCKE - WULF FW200 CONDOR

MORTONS BOOKS

Excludes bookazines

ORDER NOW: www.mortonsbooks.co.uk

Tel: 01507 529529 Offer expires: 31.12.24

MODEL ENGINEERS' WORKSHOP

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
© 2024 Mortons Media ISSN0033-8923

GROUP HEAD OF INVESTMENT – LIFESTYLE & TRACTOR PUBLICATIONS
Mason Ponti www.talk-media.uk

INVESTMENT MANAGER
Chris Jeffery
www.talk-media.uk **DL:** 01732442144
ML: 01732445325 **E:** Chris@talk-media.uk
A: Talk Media, The Granary, Downs Court, Yalding Hill, Yalding, Kent ME18 6AL

CUSTOMER SERVICES
General Queries & Back Issues
01507 529529
Monday-Friday: 8.30-5pm Answerphone 24hr

ADVERTISING
Group advertising manager: Sue Keily
Advertising: Angela Price
aprice@mortons.co.uk Tel: 01507 529411
By Post: Model Engineers' Workshop advertising, Mortons Media Group, Media Centre, Morton Way, Horncastle, Lincs LN9 6JR

PUBLISHING
Sales and Distribution Manager: Carl Smith
Marketing Manager: Charlotte Park
Commercial Director: Nigel Hole
Publishing Director: Dan Savage
Published by: Mortons Media Group, Media Centre, Morton Way, Horncastle, Lincs LN9 6JR

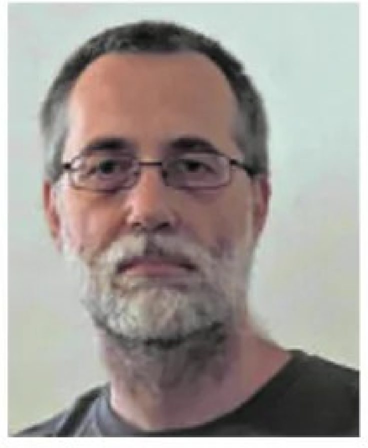
SUBSCRIPTION
Full subscription rates (but see page 54 for offer): (12 months 12 issues, inc post and packing) – UK £56.40. Export rates are also available – see page 46 for more details. UK subscriptions are zero-rated for the purpose of Value Added Tax.
Enquiries: subscriptions@mortons.co.uk

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
Accepted photographs and articles will be paid for upon publication. Items we cannot use will be returned if accompanied by a stamped addressed envelope, and recorded delivery must clearly state so and enclose sufficient postage. In common with practice on other periodicals, all material is sent or returned at the contributors own risk and neither *Model Engineers' Workshop Magazine* the editor, the staff nor Mortons Media Ltd can be held responsible for loss or damage, howsoever caused. The opinions expressed in MEW are not necessarily those of the editor or staff. This periodical must not, without the written consent of the publishers first being given, be lent, sold, hired out or otherwise disposed of in a mutilated condition or, in any unauthorised cover by way of trade or annexed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

This issue was published on 15 March 2024
The next issue will be on sale 17 April 2024

MORTONS MEDIA GROUP LTD
recycle
When you have finished with this magazine please recycle it.



On the Editor's Bench

Inverter Protection

Back in 2013 I fitted a variable frequency drive (VFD) to my Mini Lathe (a Clarke CL300M), and ever since I've felt that the VFD itself deserves rather better protection from flying swarf and the like.

The answer is obviously some sort of enclosure, and my thought was that the ideal would have plenty of room around it, combined with a louvred top for ventilation, and an open bottom for easy access for the cabling and to allow anything that does get in to drop out. It should also have a clear front so that I can see the display, which is set up to read out lathe speed and also shows any error codes, should the motor overheat or there be another issue.

I had some samples of various Perspex sheets in 100mm squares, an ideal size for the window. I put together a design in Alibre Atom 3D that would meet my requirements and look reasonably attractive, then 3D printed it on the KX1 Max, although it would have fitted on my smaller Prusa i3 clone. It's a big item, but it wasn't particularly challenging to print although a large amount of support material was needed as I printed it face up. I could have printed it face down, but that would have left a rough texture on the attachment flanges. The Perspex square was glued in place using a UV cured adhesive which essentially provides its own gasket. In the future I may add a finer grille inside the louvres, however I think it's unlikely that this is really needed.

The two pictures show the VFD in its enclosure, screwed to the wall using plasterboard plugs, and the modified controls of the lathe on the original control box. I just wish I'd got around to this sooner!

Neil Wyatt

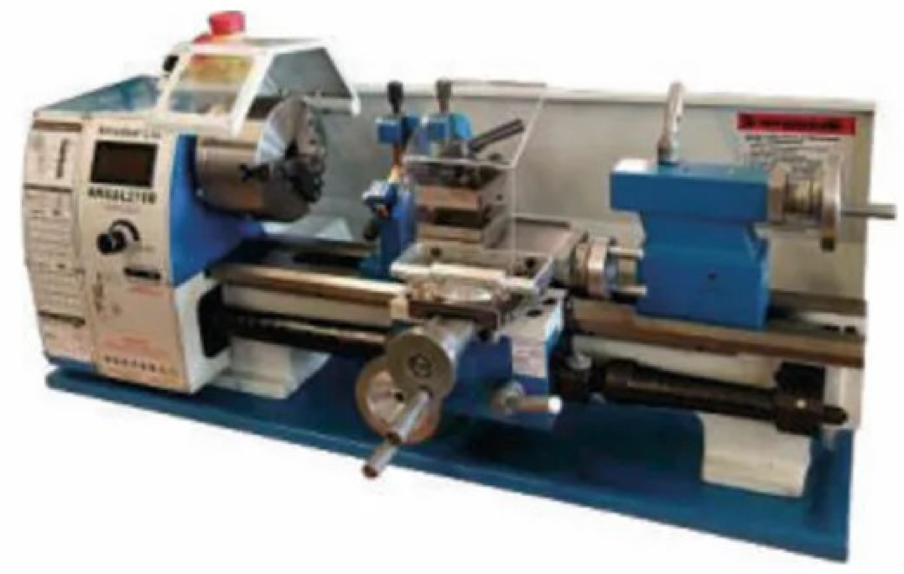
Amadeal Ltd.
Machine Tools

Call: 0208 558 4615

CJ18A Mini Lathe - 7x14 Machine with DRO & 4" Chuck

SPECIFICATION:
Distance between centers: 350mm
Taper of spindle bore: MT3
Spindle bore: 20mm
Spindle speed: 50-2500mm
Weight: 43Kg

Price: £595



AMABL210D BRUSHLESS MOTOR 8x16- LARGE 38mm spindle bore

SPECIFICATION:
Distance between centers: 400mm
Taper of spindle bore: MT5
Spindle bore: 38mm
Number of spindle speeds: Variable
Range of spindle speeds: 50~2500rpm
Weight: 65Kg

Price: £1,185

AMABL250Fx750 Lathe (10x30) Variable Speed - Power Crossfeed - Brushless Motor

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

Price: £1,904

VM25L Milling & Drilling Machine Belt drive & Brushless Motor

SPECIFICATION:
Model No: AMAVM25LV (MT3) / (R8)
Max. face milling capacity: 63mm
Table size: 700×180mm
T-slot size: 12mm
Weight: 120Kg

Price: £1,431
W DRO – Price: £1,921
W DRO + PF - Price: £2,210

XJ12-300 with BELT DRIVE and BRUSH-LESS MOTOR

SPECIFICATION:

Gas Strut
Forward Reverse Function
750W BRUSHLESS Motor
Working table size: 460mm x 112mm
Gross Weight is 80Kg

Price: £725
W 3 AXIS DRO- Price: £955

VM18 Milling Machine Belt drive & Brushless Motor

SPECIFICATION:
Model No: VM18 (MT2) / (R8)
Max. face milling capacity: 50mm
Table size: 500×140mm
T-slot size: 10mm
Weight: 80Kg

Price: £1,190
W 3 AXIS DRO - Price: £1,627

See Website for more details of these machines and many other products at incredible prices!

PayPal

www.amadeal.co.uk
| Call: 0208 558 4615 | Email: info@amadeal.co.uk |

www.AMADEAL.CO.UK

AMABL290VF Bench Lathe (11x27) - power cross feed - BRUSHLESS MOTOR

SPECIFICATION:
Distance between centers: 700mm
Taper of spindle bore: MT5
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: 840×210mm
T-slot size: 14mm
Weight: 240Kg

Price: £2,100
W DRO – Price: £2,537
W DRO + PF - Price: £2,948

Clamping Kits

Boring Head Sets

Parallel Sets

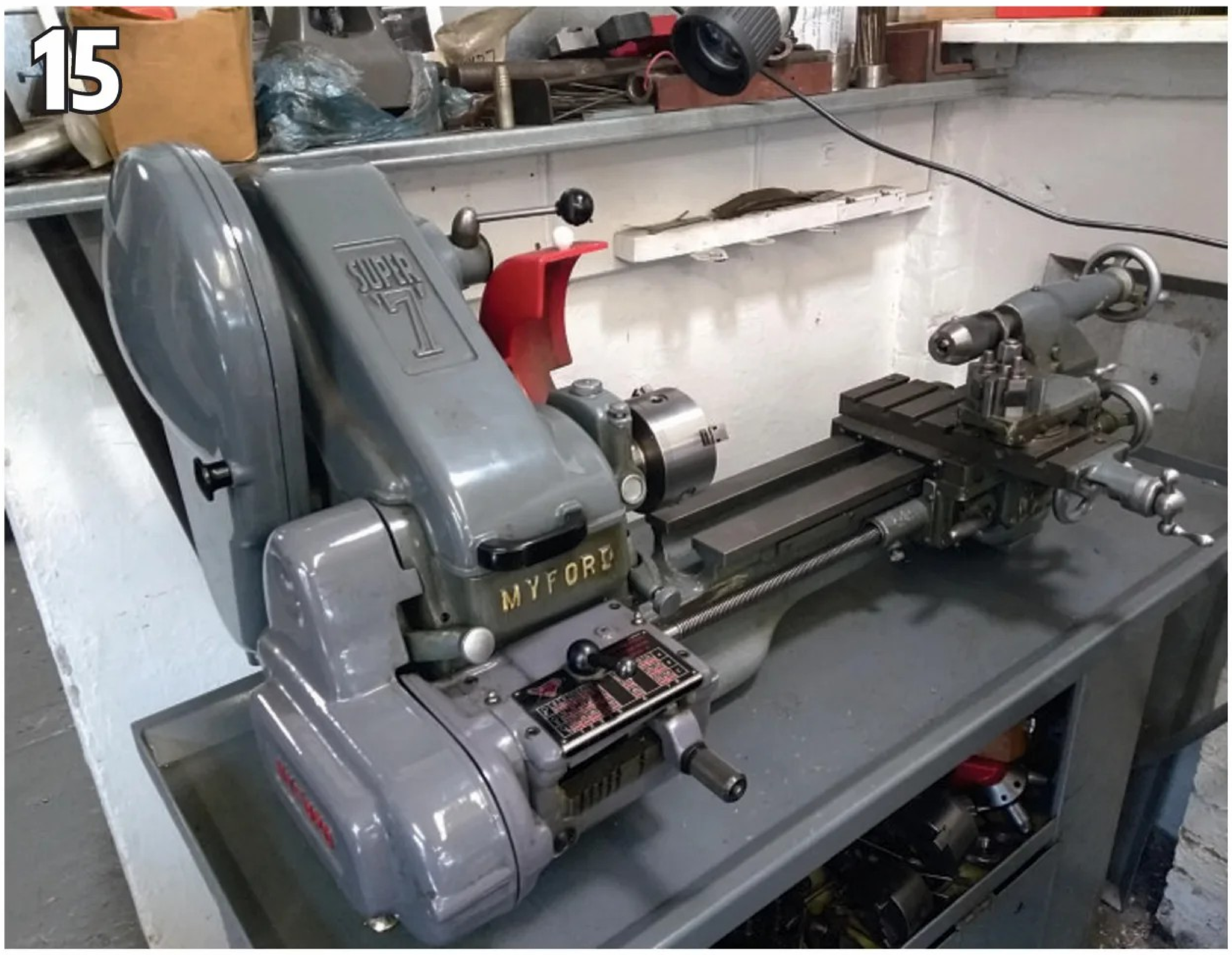
Keyway Broach Sets

Hi Spec Low Prices Why pay more?

Prices inc VAT & Free delivery to most mainland UK postcodes

We Accept

Contents



SUBSCRIBE TODAY!

GET YOUR FAVOURITE MAGAZINE FOR LESS DELIVERED TO YOUR DOOR!

See page 54-55 for details.

Coming up...
in our next issue

In our next issue Dave Fenner looks at some aspects of sheet metal work, using his lovely AEC Matador model as an example.

Regulars

ON THE COVER

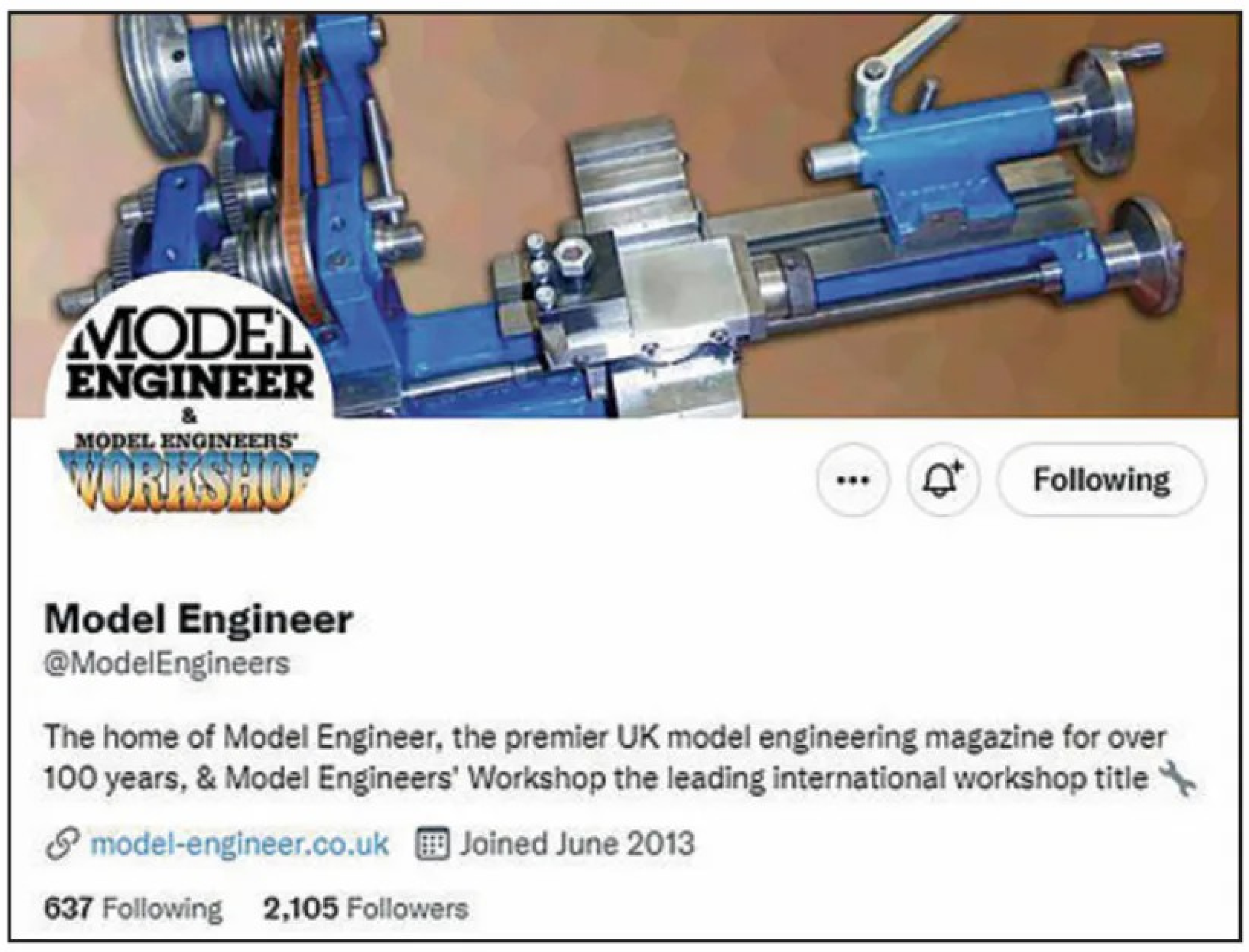
Our cover features a rather lovely Myford Super 7 lathe that lives in the workshops of the Society of Model and Experimental Engineers'. See page 15 to find out more.

HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

Visit our Website

www.model-engineer.co.uk

Why not follow us on Twitter? twitter.com/ModelEngineers hashtag #MEW



THIS MONTH'S BONUS CONTENT

The Forum has changed!

You can log on to the new forum using your existing details, you can recover your password to the email address associated with your account. I'm pleased to say that the forum is presently working faster and appears more stable than it has been since the changes.
www.model-engineer.co.uk

Hot topics on the forum include:

Rigidity problems with a homemade Myford Saw Table How to solve a problem with flexing, by Greensands.

ACME taps and Dies Looking for experiences of using these, by Vic.

Deformed plastic gear on milling machine How do I remove a damaged gear, by Bill Phinn.

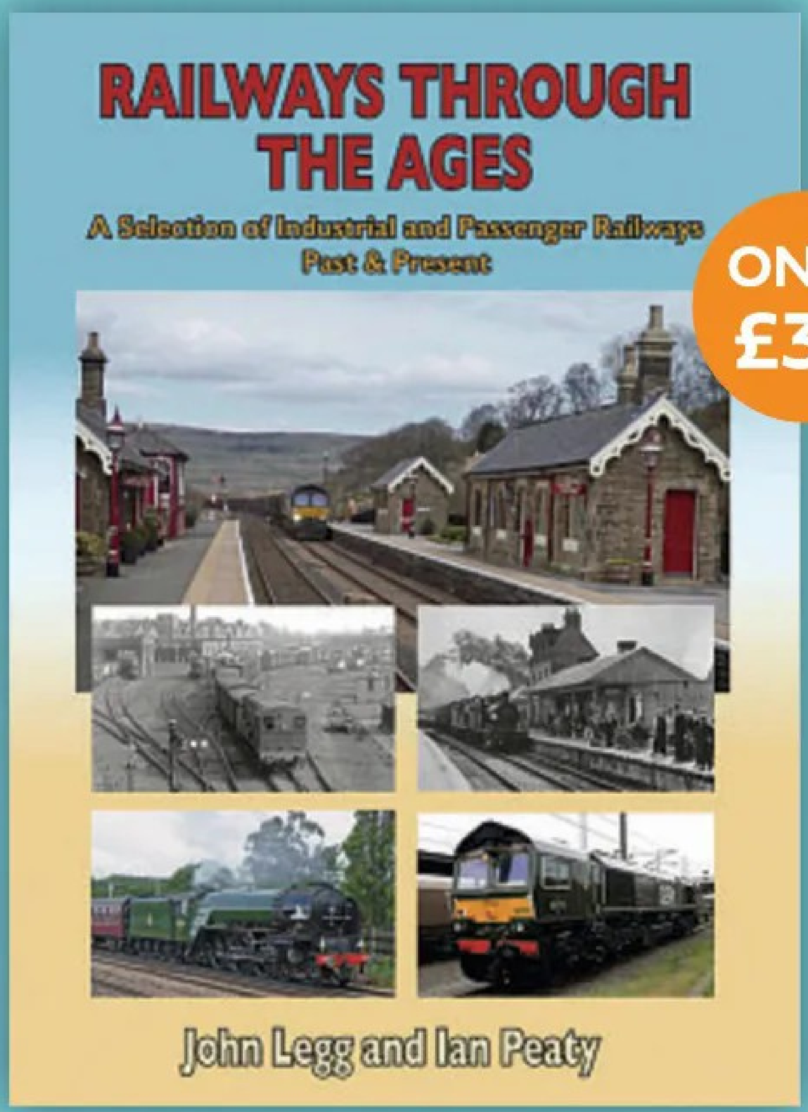
Stuart Turner Mk 814 Generator Seeking information on a wartime steam generator, by Noel Shelley.

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!

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

MORTONS BOOKS

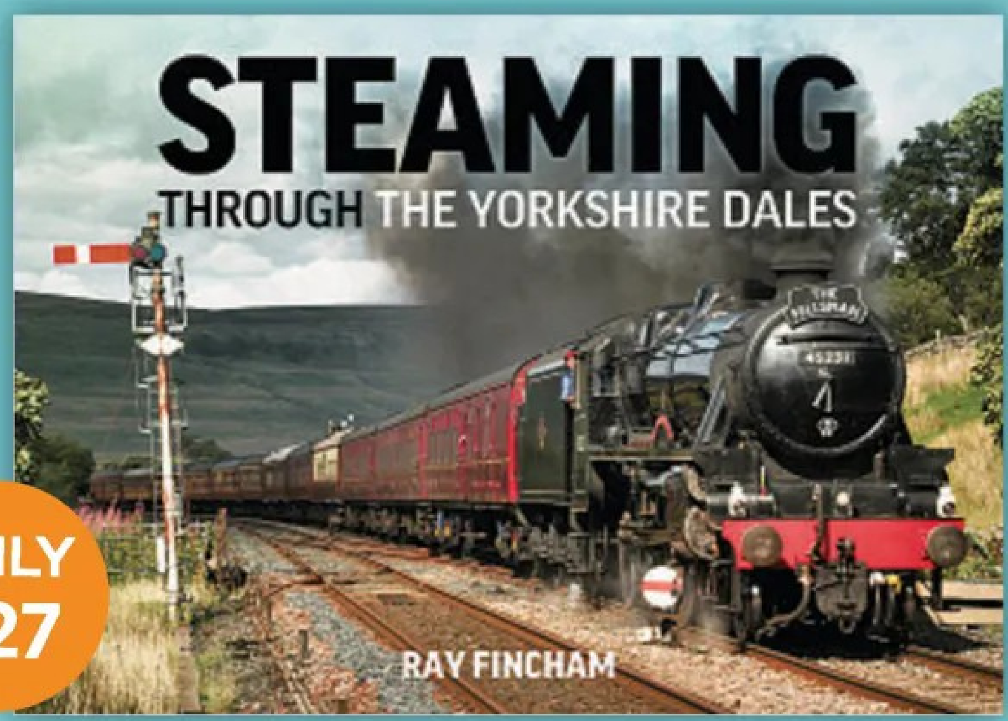


ONLY £30

Railway Through the Ages

By John Legg & Ian Peaty

Dive deep into the history of railways from their early beginnings to today. This book features a mixture of standard and narrow-gauge tracks, industrial and heritage lines, and iconic train stations.

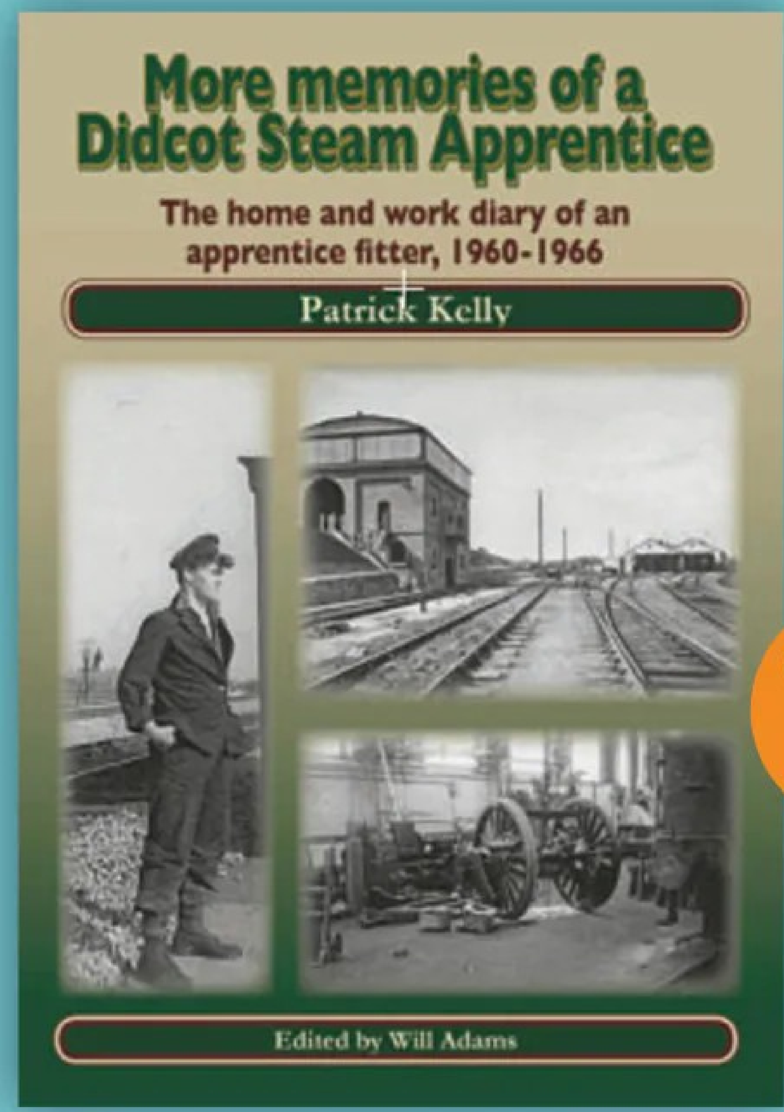


ONLY £27

Steaming Through the Yorkshire Dales

By Ray Fincham

Explore the history of the 73-mile link between Settle and Carlisle that ran through the high fells and dales of Yorkshire and Cumberland.

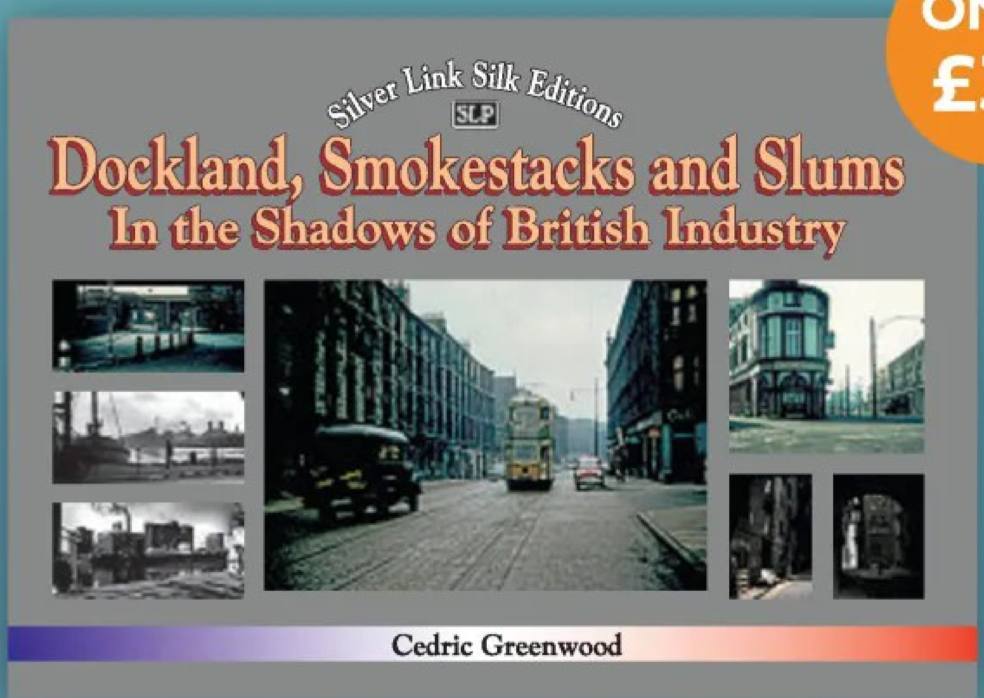


ONLY £30

More Memories of a Didcot Steam Apprentice

by Patrick Kelly

Pat Kelly's day-to-day life at Didcot shed on BR's Western Region in the dying days of steam, as a young inexperienced 15-year-old.

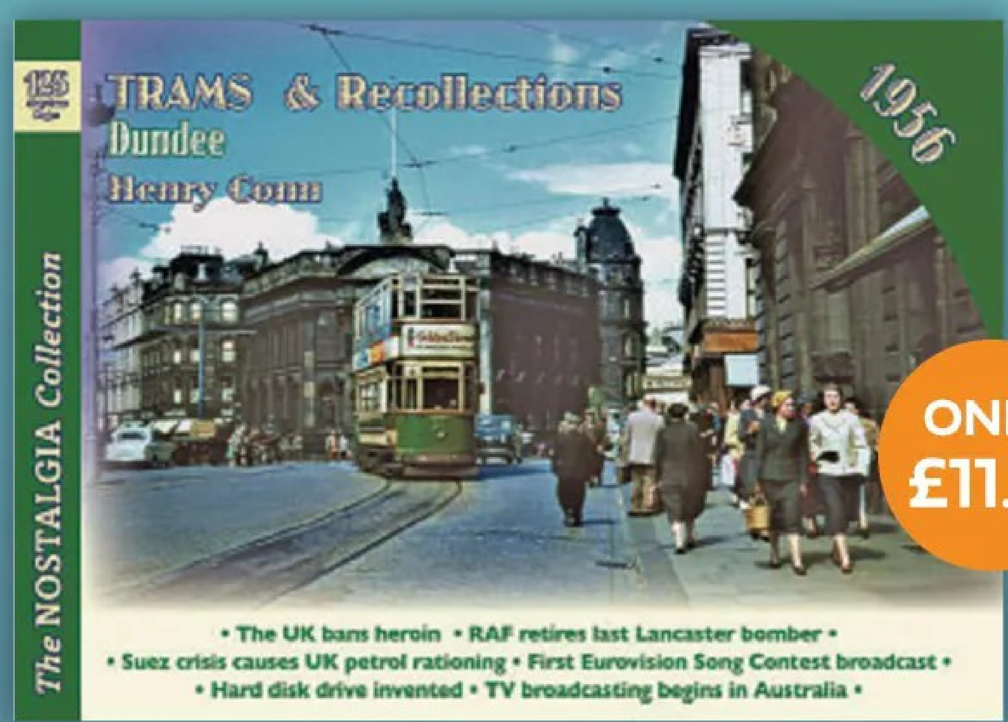


ONLY £35

Dockland, Smokestacks and Slums

by Cedric Greenwood

This book provides a photographic study of the 19th and early 20th century British industrial scene from its recovery following the Second World War to its decline in the mid-1980s.

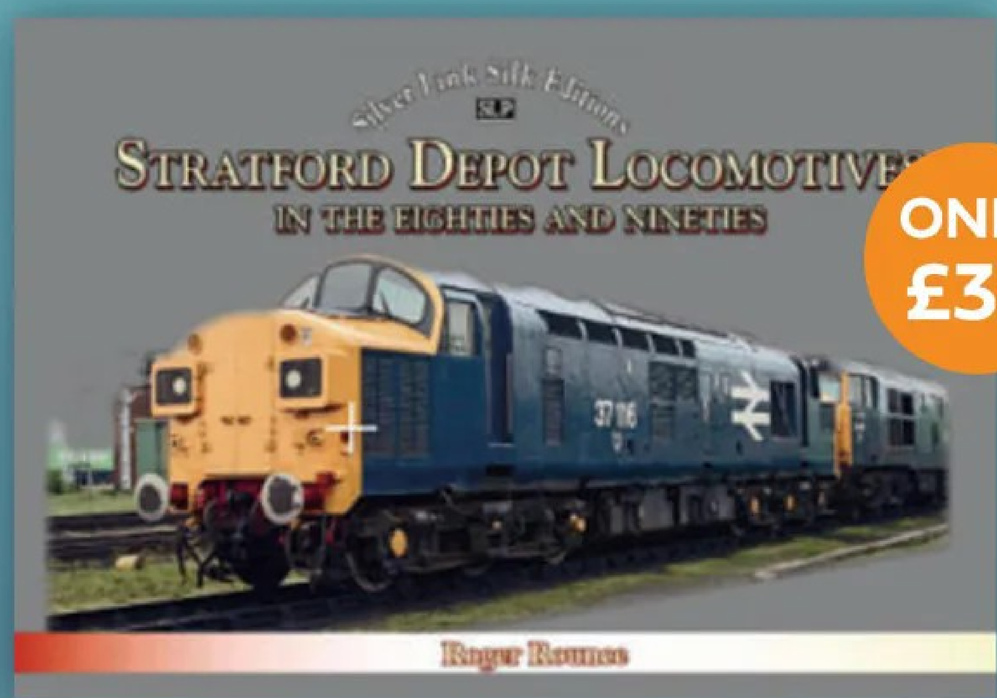


ONLY £11.99

Trams and Recollections: Dundee 1956

By Henry Conn

The third book in a series that explores the tram routes of Dundee in the 1950s.



ONLY £30

Stratford Depot Locomotives

By Roger Rounce

Photographer Roger Rounce presents a collection of his own images of diesels and electrics from the days when engines from every region could be found at Stratford TMD.

ORDER NOW: www.mortonsbooks.co.uk Or call 01507 529529

WANT TO HEAR ABOUT OUR LATEST BOOKS?

Mortons Media Group is preparing to launch a new range of non-fiction books - from railway, military and aviation history to consumer issues, hobbies, crime, and politics.

If you would like to hear more about our upcoming book releases and special offers, sign up to our newsletter.

JOIN OUR BOOK CLUB! AND RECEIVE 10% OFF!

To view the privacy policy of MMG Ltd (publisher of Mortons Books) please visit www.mortons.co.uk/privacy

Solving Data Corruption In A Digital Scale Readout Display

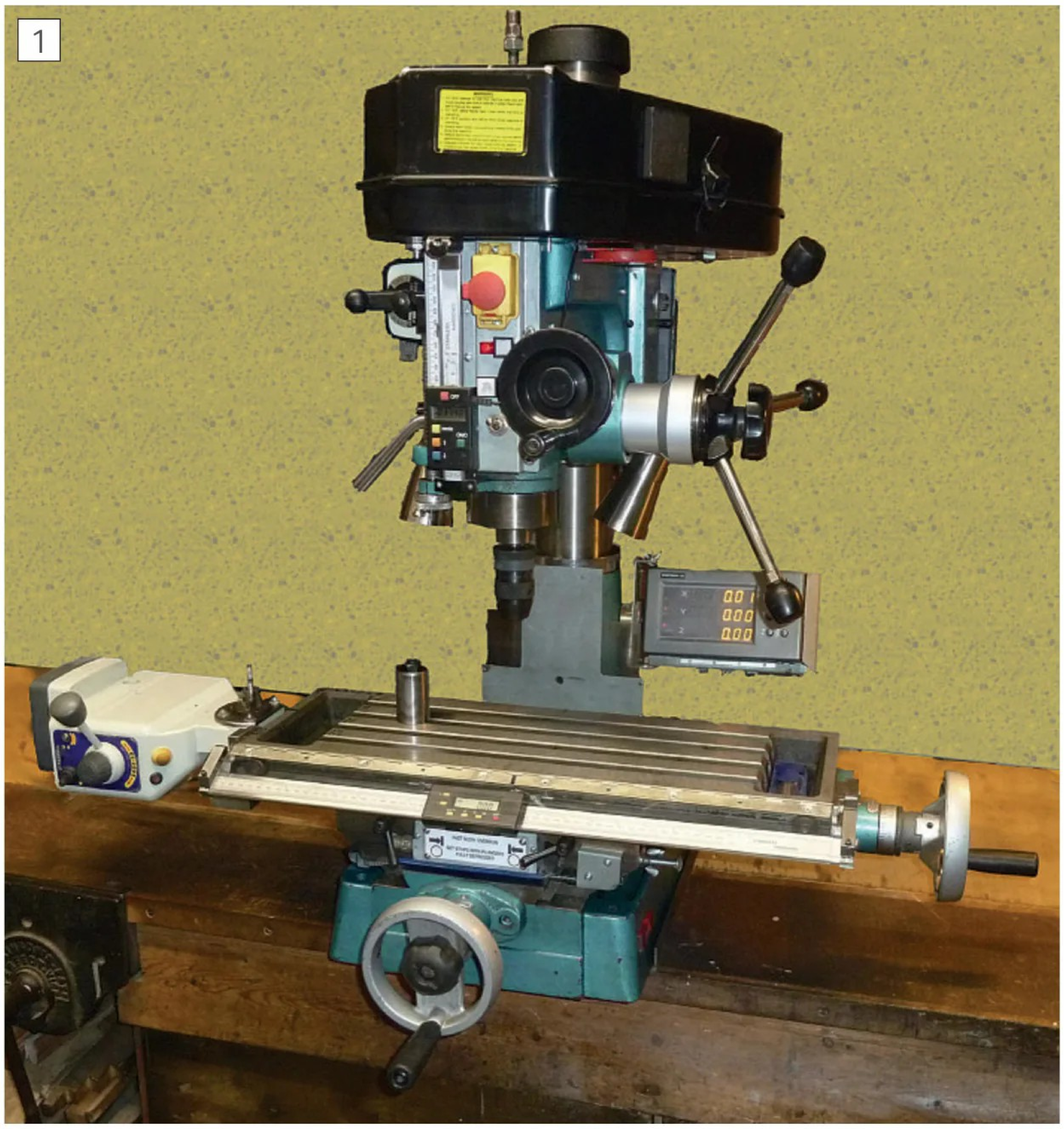
Fergus Malcolm recounts his experiences and how he solved a notorious issue with entry level digital scales.

Fitting digital scales and a readout display is clearly a priority for many milling machine owners, and this was my intention for my mill/drill. At the time, quite a few years ago, capacitive scale units were vastly cheaper than any superior alternative, so this was the route followed. Of course, it proved more challenging than expected.

Despite the undoubted utility and good value of these familiar oriental capacitive digital scales, problems can range from positional jitter, poor feel and short battery life, through to malfunction when connected to the readout (display) unit. My eventual experience has been very good after some vexing problems. With some lateral thinking and considerable work, I now have very reliable operation. Though describing how this was achieved is primarily about the electronics, it is hoped that the reasoning and methods may be of interest even to those who would be unhappy interfering with matters electrical.

Photograph 1 shows my mill/drill as it is currently. To aid clarity, the "camouflage" background of pegboard with many hand tools has been edited out.

Please note that what follows applies to the more common original type of digital scale that uses an SR44 battery. Recent scales that use a lithium battery may avoid the problems described.



Mill/Drill with Three Axis Scales and Readout Unit on Mill Column Pedestal

Measurements of scale voltage and current characteristics

In the ME Forum a couple of years ago there was a discussion about low-cost digital calipers and digital machine scales which included the comment that one example ceased to work for a very small reduction in battery voltage. It was also mentioned that connecting the data port to an external display often resulted in miscounting or other malfunctions. I suggested that if the device was powered via the data cable, a moderately increased operating voltage might reduce the susceptibility to noise. We shall see if that proved to be a useful notion.

I must admit to a vested interest, since this was the very problem with the scales I had fitted to my mill/drill if connected to the LED readout unit. Switching the motor (on or off) caused sporadic miscounting. I had followed the many suggestions on various websites about filtering techniques, but all failed to cure the problem. Sorting this out had long been a "to do", but never got high enough on the priority list to get solved. I hoped that someone else would do the spadework, but if you want something done, you need to do it yourself!

As a first step, I rounded up seven varied digital readouts (all of the SR44 battery type, and with the socket for an external readout), and got down to measuring the current over a range of

The Scale Units Measured, and the Setup to Investigate the Current Consumed

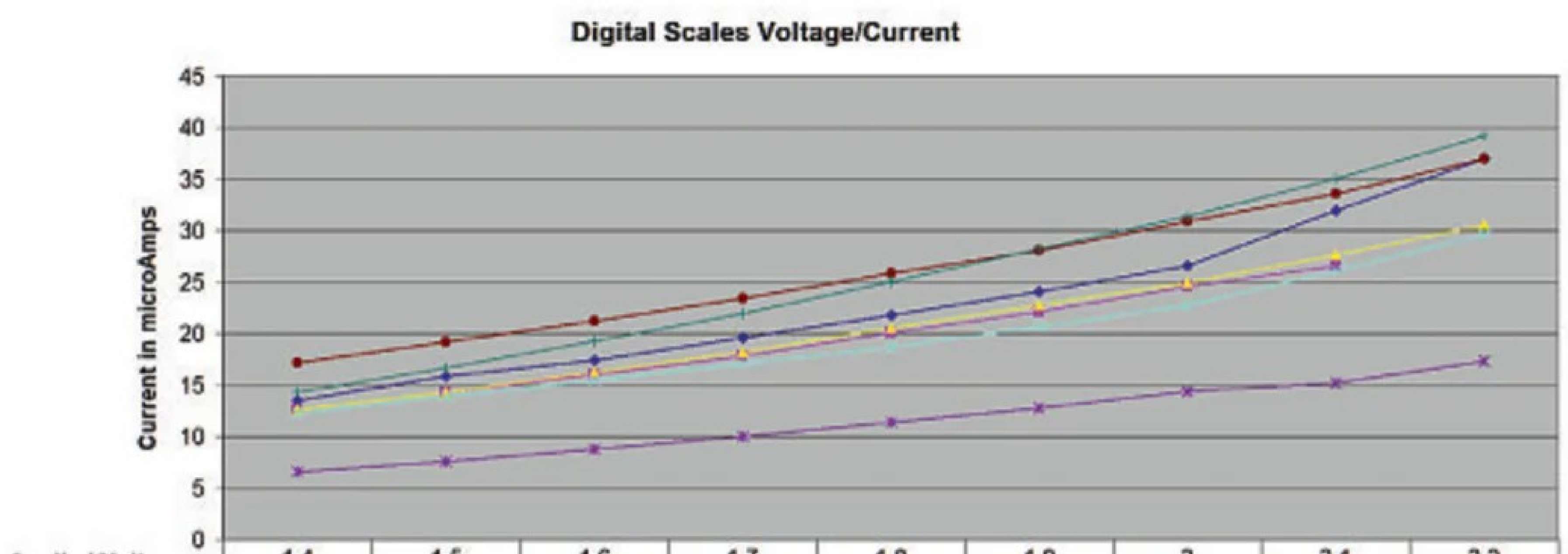
supply voltages, **photo 2**. The devices were respectively a horizontal display circuit board, replaced because the polarizer layer developed a mark that made reading difficult, an unused spare vertical display circuit board, a complete vertical scale, a recent caliper with a big window, an earlier model, and a very old caliper with a tiny display, and finally a depth gauge. The loose circuit boards needed to be placed centred on the vertical scale bar in order to function correctly.

The chip technology in these display units is likely low voltage CMOS as widely used in electronic watches and similar devices to operate from a single 1.6 volt cell and minimise the current needed. Much of this supply current is the result of charging and discharging internal stray capacitances as the data is processed. Thus, as the supply voltage is increased, the rise in current should be roughly linear. A more rapid rise could indicate exceeding a prudent limit.

For the measurements, an LM317 adjustable supply chip was used since it is easy to restrict the voltage to a safe range and also maintain the voltage constant irrespective of the current drawn. A voltage range from 1.25 volts to 2.2 volts was chosen. A very similar circuit was subsequently fitted within the LED readout unit to power the three connected scales instead of batteries.

Each device in turn was powered up using a cable with the necessary special connector. The applied voltage was measured with a digital voltmeter, with a second meter to measure current. As expected, the periodic output of positional data caused an increase in current, and such variation might interact with the digital meter sampling. While an old-fashioned moving coil micro-ammeter might have smoothed this out, the perturbations in the graphs are very minor, suggesting a small effect.

For each scale, the off current was measured for 1.5 volts applied. At 1.3 volts applied all the displays flashed, but by 1.4 volts all worked correctly. Then a series of measurements was taken every 0.1 volt from 1.4 up to 2.2 volts. These are plotted in **fig. 1**, with a further factor whether the LCD displayed properly. A liquid crystal display will be optimised for a range of voltage, and outside this, contrast can reduce or OFF segments become visible (ghosting).



Applied Voltage >	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2
Horizontal Head	13.5	15.9	17.4	19.6	21.8	24.1	26.6 (gh)	(mal) 32 (gh)	(mal) 37 (gh)
Vertical Head	12.6	14.3	16	17.8	20.1	22.1 (gh)	24.6 (gh)	26.6 (gh)	(mal) (gh)
Vertical Scale	12.6	14.3	16.3	18.2	20.6	22.8	25	27.7	30.6 (gh)
Caliper (large)	12.3	13.9	15.5	17.1	18.7	20.7	22.8	26.1	29.6
Caliper (med)	6.6	7.6	8.8	10	11.4	12.8	14.4	15.2	17.3 (gh)
Caliper (small)	17.2	19.2	21.2	23.4	25.9	28.1	30.9	33.6	37
Depth Gauge	14.3	16.7	19.3	22	25.1	28.2	31.4	35.1	39.2

Figure 1

Supply Current against Applied Voltage (Ghosting & Malfunction also shown)

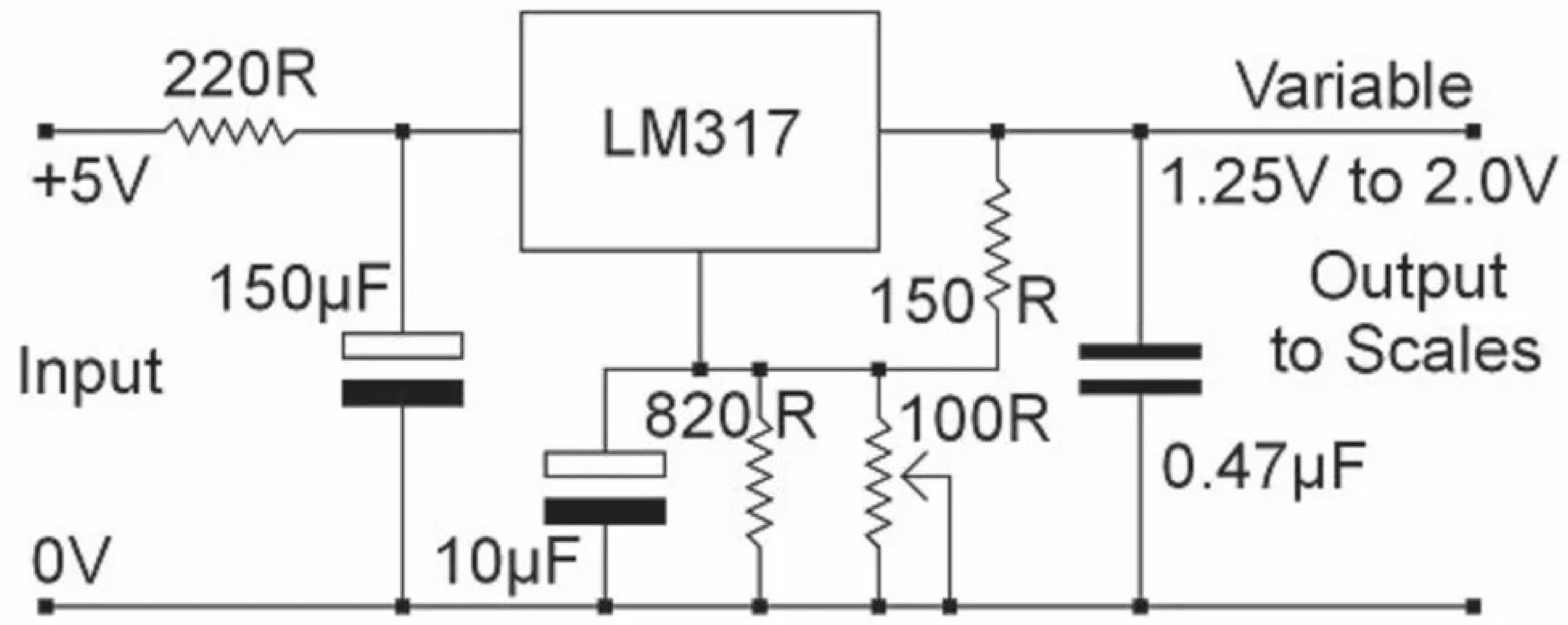


Figure 2

Regulator Circuit Diagram

Summary of results

All the scales operated from 1.4 volts up to 2.0 volts, and within this range none showed any apparent circuit malfunction. However, one scale began slight display ghosting (gh) at 1.9 and a second at 2.0 volts. Both these scales also became less stable beyond 2.0 volts (mal), with considerable upward fluctuations in the current. The others scales remained stable, but all currents curve slightly upwards above 2.0 volts. Ghosting was always slight with no possibility to misread the value but is an indication of operation beyond the design intentions.

As noted, all the units ceased working correctly somewhere between 1.4 volts and 1.3 volts. All also drew more or less the same off current as when operating, which accounts for the common mediocre battery life. The capacity of an SR44 cell is roughly 160 mAh, but this is specified for an end-of-life voltage of 1.2 volts, which is well below the minimum for operation. So a drain of 20mA will not equate to a year of battery life. Experience often seems more like three or four months.

Finally, operation up to 1.8 volts would almost certainly not result in any problem. Going to 2.0 volts might well be all right, though most likely beyond the design envelope. Beyond 2.0 volts would risk malfunction or (unlikely) damage.

Applying this

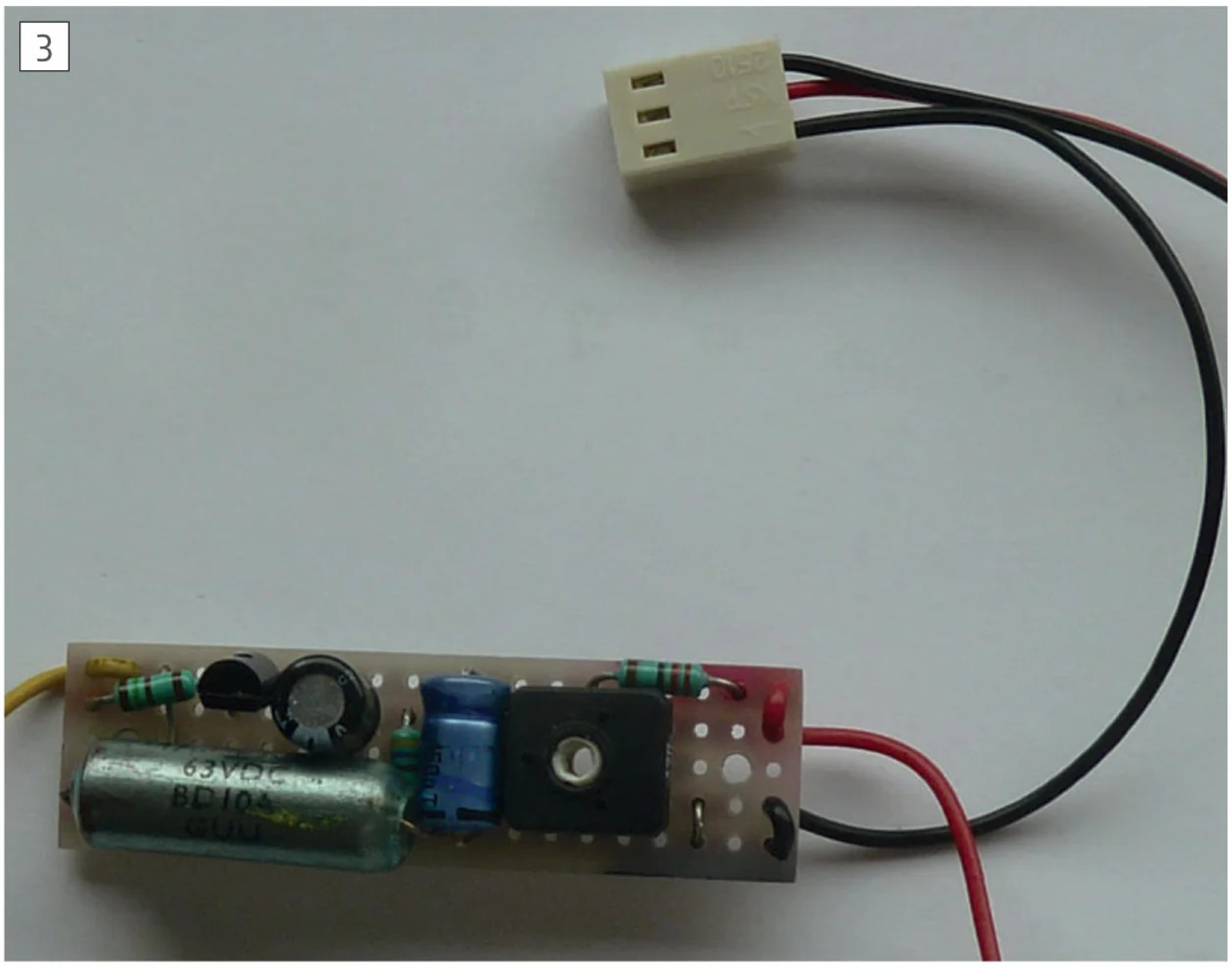
The next step was to add a variable (nominal 1.6 volt) supply to the readout unit, and a small module was made up using the same supply chip as earlier. A suitable mounting position was found, and it took little time to make it using single sided strip-board. **Figure 2** is the circuit diagram, complete with manufacturer suggested optional components, and **photo 3** is the assembly. It runs from the readout 5-volt supply, and mounts inside the top wall with Allen key access for voltage adjustment.

Does a higher voltage solve data corruption?

With the variable supply in place and connected to the scales (the data cables already had the necessary supply wires), the operating voltage was increased to 2 volts. Sadly, this was insufficient to reduce data corruption on power switching. The next section will describe a better-focused approach to the problem.

Interfacing a three-axis led readout unit with digital scales

What follows applies to the original type of "Chinese" scales, and the saga covers a period of about 15 years. Over



Regulator Module

Limit switch arrangement.

that time, better technologies have become affordable, and these days I would choose differently. Nonetheless operation is now excellent, and the narrative may be of interest and perhaps helpful to anyone experiencing similar difficulties.

For my Mill/Drill, I initially bought X and Y capacitive Digital Scales, and indeed I described fitting these in MEW 128 (August 2007). I then added a Z scale, and later I bought the 3-axis LED readout unit. While all three scales worked perfectly well in isolation, connecting them to the LED readout was immediately problematical. With new batteries in the scales correct operation was sometimes achieved, but mostly the displayed positions were liable to corruption when the mill spindle motor was switched on or off. Trying many configurations of filter components and snubbers (admittedly in a fairly unfocused way) failed to improve matters.

Since care had been taken that the data windows of the scales were easily legible, the LED readout unit was simply put aside to be investigated "sometime". In due course an Align X axis power feed was fitted. As the mounting position for the supplied (rather primitive) limit switch block was already occupied by the X axis scale, an alternative home brewed limit unit was made, **photo 4**. This incorporated improvements, including enough over-travel for fast slew to come to a stop! All this worked fine. Indeed things might never have progressed further, but about the time of the forum discussion the main spindle on/off switch disintegrated. The opportunity was taken to include a zero volt release breaker as well as lighting for the work area, so while in the mood I had a further try to fix the corruption of the LED readout. Clearly, more than simply increasing the voltage would be necessary.

Finding a good mounting place for the readout unit

The placement of the LED readout unit affects the wiring configuration, and thus electrical filtering arrangements. This unit has a plastic case with built-in magnets for attachment "somewhere", but irrespective of where it was adhered to existing metalwork, it was both in the way and awkward to read. It is surprising how long it takes to identify a solution which with hindsight is quite self evident, but at last the obvious mounting arrangement was found – a folding mounting tray of sheet steel. This has proved most satisfactory, with the data easily read from the natural working position without having to peer half way up the wall. It folds for protection when other use is made of the bench surface.

Interference suppression considerations

Figure 3 is a simplified electrical connection schematic as intended by the makers, though showing only a single scale unit rather than all three. The motor windings (top left) connect to mains, and so does the 5V power supply for the Readout unit. The mill/drill metalwork is shown outlined in green, and so are the scale bars and

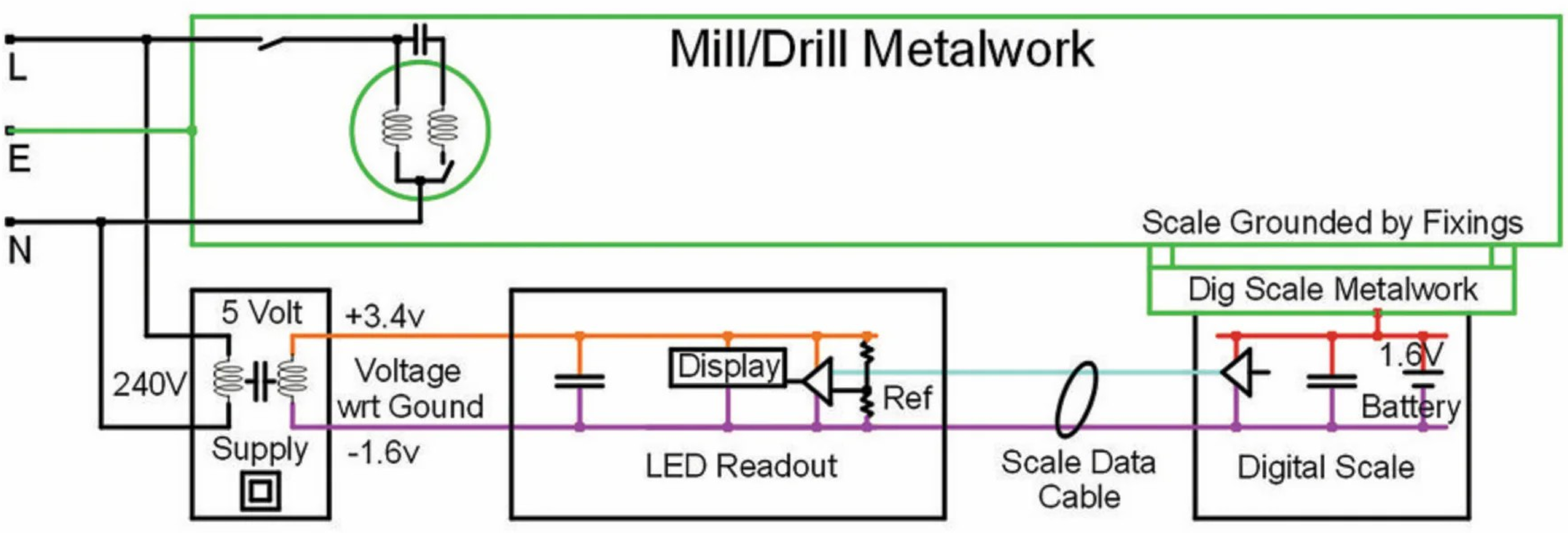


Figure 3

Schematic Circuit Diagram of Relevant Wiring, Unmodified as Supplied

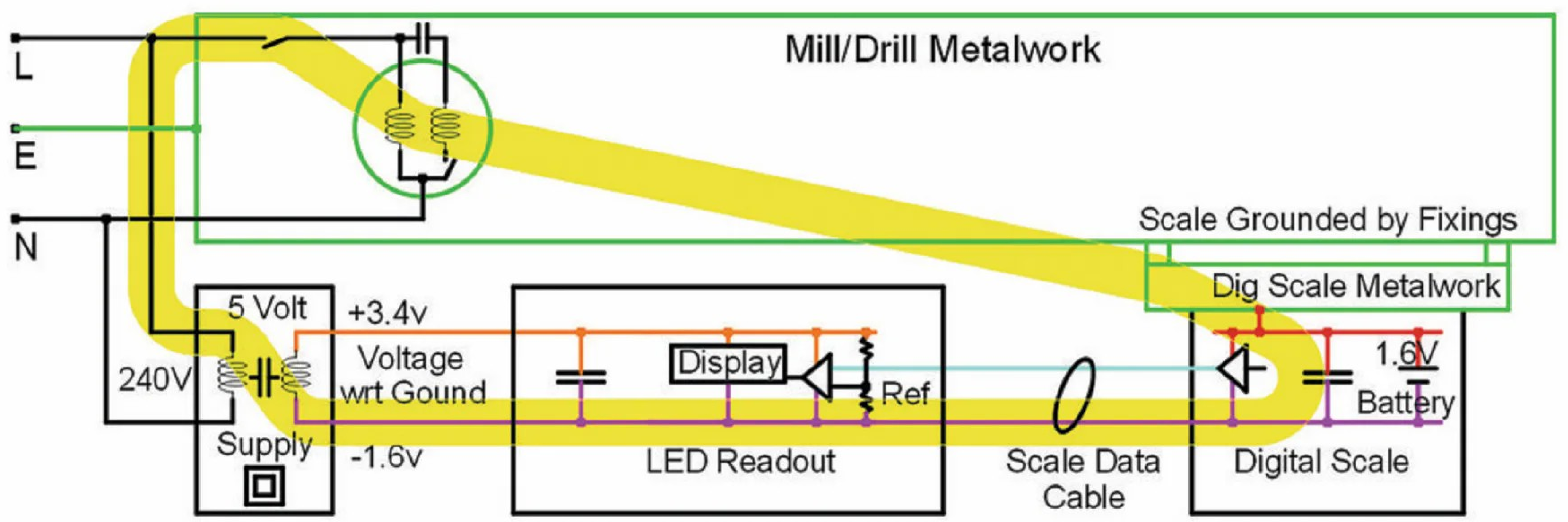


Figure 4

Original Schematic with Potential Noise Path Indicated

heads whose fixings connect them to the structure. Thereby the 1.6V cell positives are intrinsically frame connected, so that the 5V supply lines of the LED readout sit at +3.4V (orange) and –1.6V (mauve) with respect to metal work ground. The scale (battery) positive rail is shown red but is of course thus grounded. Also note that with all three scales present, the batteries are inevitably connected together in parallel via the positive connections to structure and by the negative return wires to the readout unit.

This arrangement contains a considerable design flaw. The 5-volt supply for the readout is a typical double insulated wall-wart. The negative wire in each data cable is also the signal reference. But with the positive (battery) rail of each scale inseparably connected to the metalwork, this referencing "floats" with respect to the machine ground. This imperfect configuration is, to say the least, an unhelpful factor in the interference problems. In contrast the recent 3-volt lithium cell powered scale units seem to have the battery negative grounded.

As many of us will know, a mechanical switch does not provide a single clean instantaneous contact action. Rather, "contact bounce" causes a series of on/off transitions having fast edges and consequential over-voltage spikes, and typically lasting several milli-seconds overall. Switching the 240-volt motor thus results in electrical noise (interference) of high amplitude and wide frequency spectrum, with ample potential to upset inadequate electronics. It is common to connect "snubber" components across the switch contacts to mitigate this but was ineffective on the motor mains switch. The start winding centrifugal switch might also have contributed, but only at on, and since data corruption also occurred switching off was not investigated.

The large noise voltage that appears across the switch contacts can be regarded as an emf (electro-motive force) that will drive a corresponding current to circulate in any attached closed loop wiring path. The motor and the scale circuits may seem electrically separate, but at the high frequencies and voltages involved, continuous metal is not necessary since small capacitive and inductive strays can conspire to form parts of the path. The yellow band in **fig. 4** is a guess at ›

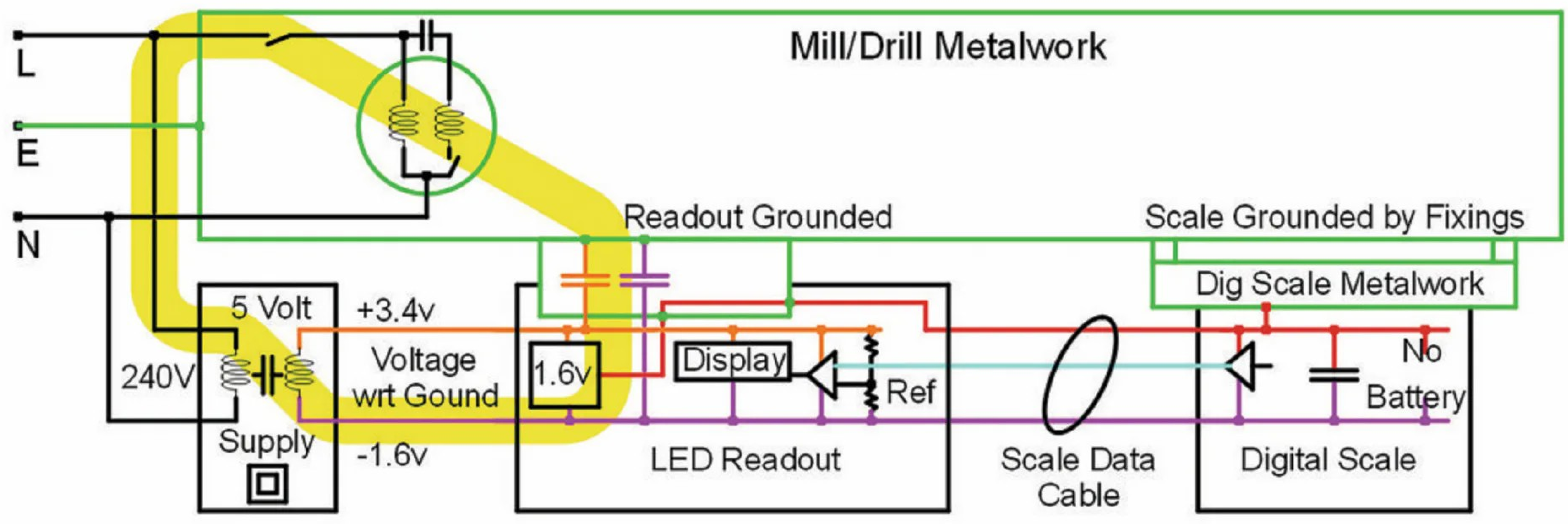


Figure 5

Revised Schematic with Grounded Decoupling within Readout

a likely route for noise currents. This path for the noise currents includes the negative wire of the scale cable, so that resultant spurious voltage spikes may add to or subtract from the data signals to corrupt the display. Here lies the key to improvement.

The 5-volt wall wart for the readout measures about 100pf from primary to secondary, at first sight insufficient to transmit much noise. However, series resonance with parasitic inductances in the path is unavoidable and has the un-intuitive characteristic of zero impedance at resonance. Large interference currents can flow, limited only by the minimal resistance of the wires.

Wiring inductance also affects sensitivity to noise. A noise current in a wire induces a spurious voltage proportional to the inductance multiplied by the rate of change of the current. Short wires have less inductance, thinner wires more, and a conductive ground plane (a wide conduction surface) would minimise effects. However, the machine structure can provide a similar function to a dedicated electrical ground plane. The thin wire in the data cables can be presumed to collect sufficient induced noise voltage to swamp the inputs of the readout. Time to find a pencil and a large envelope.

The plan is to redirect or "short circuit" the electrical noise from the offending data cables by means of a much lower impedance path. Its impedance at interference frequencies must be much less than that of the data cable route, with decoupling capacitors of similarly low impedance over the complete frequency spectrum of the noise. It is unlikely a dedicated ground plane would be significantly better than the main metal structure, though the whole path must be low impedance. Where necessary, bridging with a wide braided earth strap, for example to the mounting tray had been planned. However everything turned out adequately good without this. The capacitor values were chosen to be effective down to 50Hz just in case, and the need to bypass with small high frequency capacitors had been expected, but again this was not found necessary.

Physically, the hardware to achieve this consists of the sheet steel tray to which the LED readout unit adheres with its magnets. Within the readout unit, a thin brass plate is added to mount and connect the capacitors, and to connect to the tray through the attachment screw. The tray mounts to the column by a two-axis swivel. Obviously, the button cells are not required, with the 1.6 volt scale supply derived from the 5 volts for the display unit.

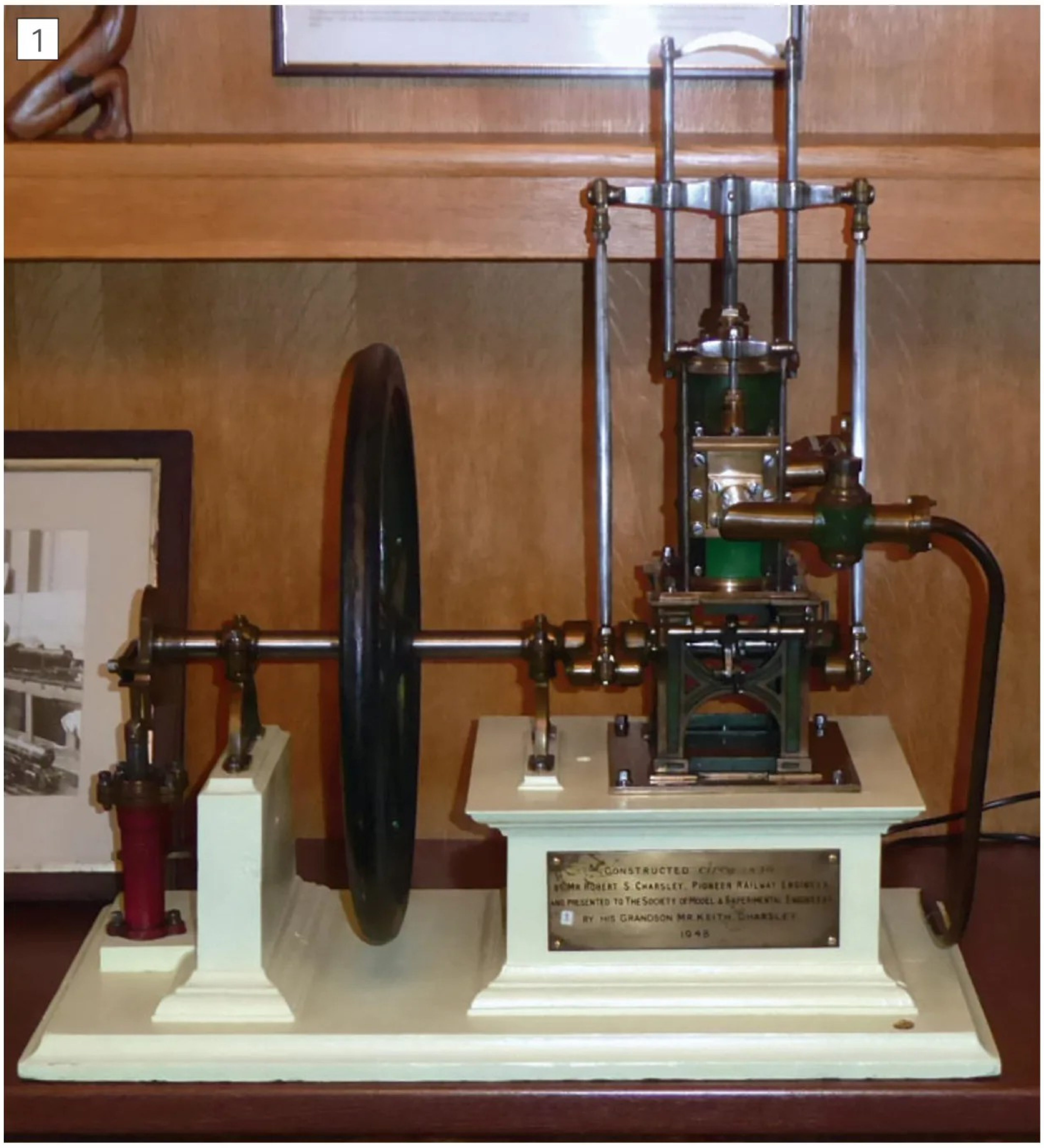
Figure 5 shows the revised arrangement with the readout directly grounded (at the interference frequencies) to the metalwork. Following the yellow path this time illustrates how the data cables no longer carry the main noise current. As a simplistic indication of numbers, 1 metre of the 0.4mm wire like the data cables has an inductance of roughly 1700nH, whereas a 100mm path of 5mm diameter would be only 30nH. Notice that whereas originally a very short data cable might perhaps reduce susceptibility, there is now no harm in a long cable (always provided it does not collect radiated interference!). You can also see why in the original configuration, clip-on inductor cores fitted to the data cables would if anything have made matters worse.

In the final part of this article, I will look at the practical implementation of my improvements, and some further steps taken to achieve a high level of reliability.

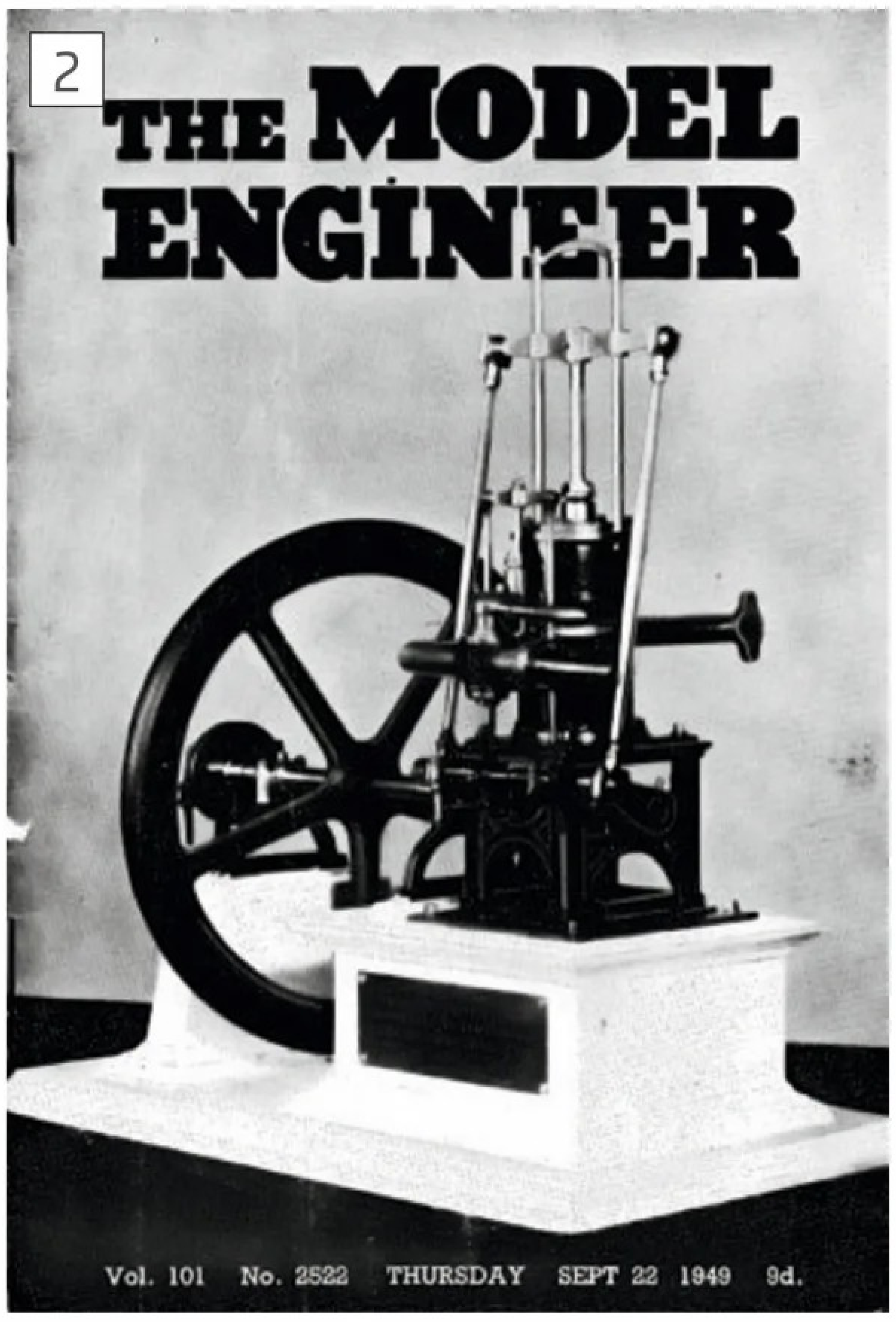
● To be continued

A Visit to the SMEE at Marshall House.

The Editor paid a visit to the home of the Society of Model and Experimental Engineers.



Engine built by Robert Charsley, a pioneer railway engineer. It was built around 1830 and conserved by Allen Berman in 2022.

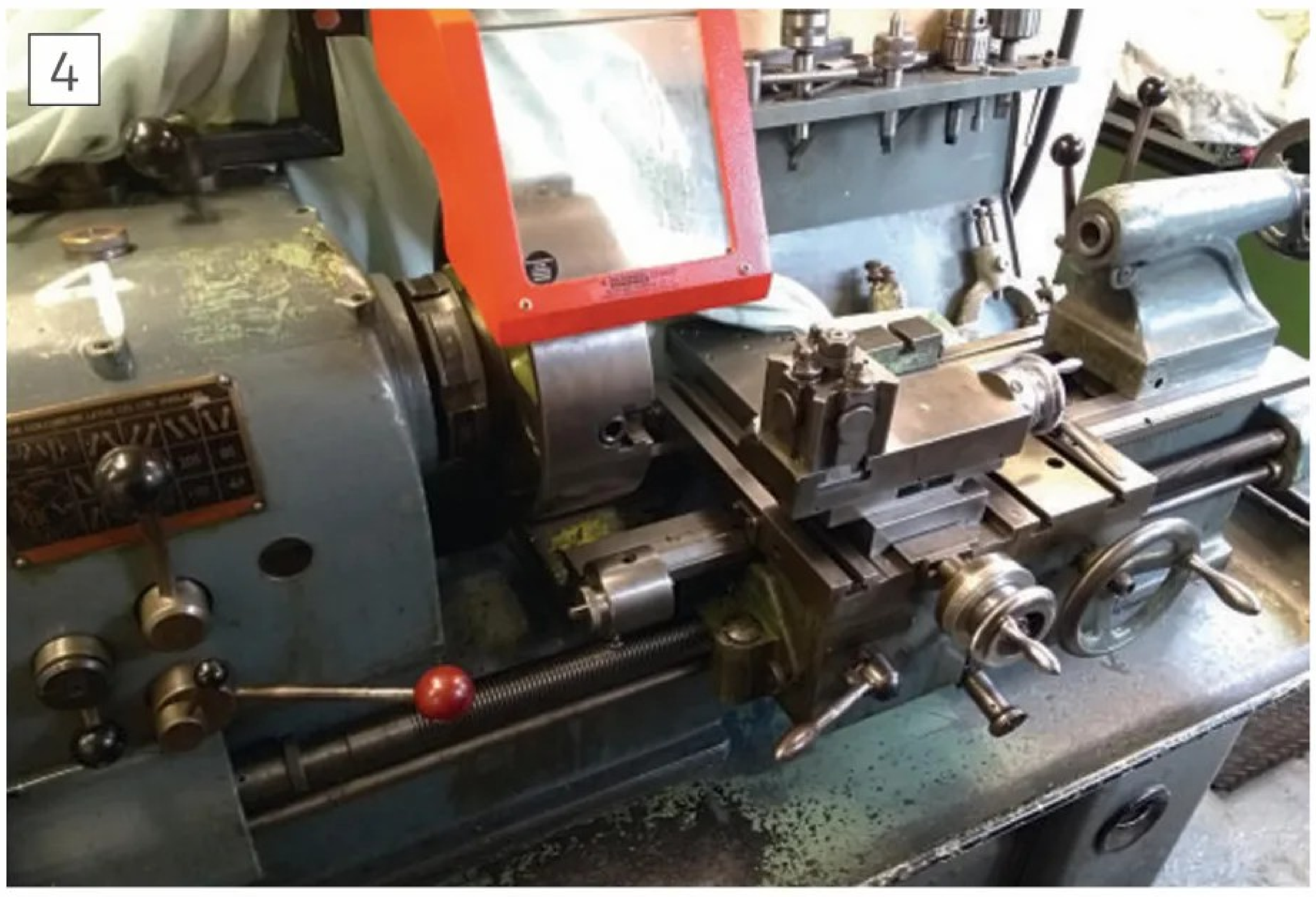


The engine was featured on the cover of Model Engineer in 1949.

Last month I introduced readers to the headquarters of the SMEE, Marshall House, to conclude this month I'm going to share photos of some of the machinery in the society's workshops. Before I do this, I'd like to thank SMEE Vice Chairman Elliot Hirst, who got in touch with a few thoughts. First the loco by 'Uncle' Jim Crebbin in the Lecture Room is actually Aldington, later known as Conversion, not Cosmo Bonsor – the latter normally lives safe in a box and appeared at MMEX last year. Also, the Maudsley Type Table engine was built by Robert S Charsley, **photo 1**. In 2022. this engine was restored to proper working condition by SMEE Chairman, Allen Berman, **photo 2**. He took a 'conservation' approach cleaning and restoring parts where possible and avoiding irreversible repairs, minimising damage to original parts or finish on the model (if only 'The Repair Shop' would treat some of its rarer projects like this!) One particular concern was the risk of damaging threaded fasteners – the model was bult many years before Whitworth define thread-forms! Now, let's take a look at some machinery.

The standout machine is the original prototype Myford Super 7 lathe, **photo 3**, which was presented to the society by Chris Moore, then chairman

The original prototype Myford Super 7 lathe.



The large Colchester Lathe.

Another fine Super 7.

Bridgeport milling machine.

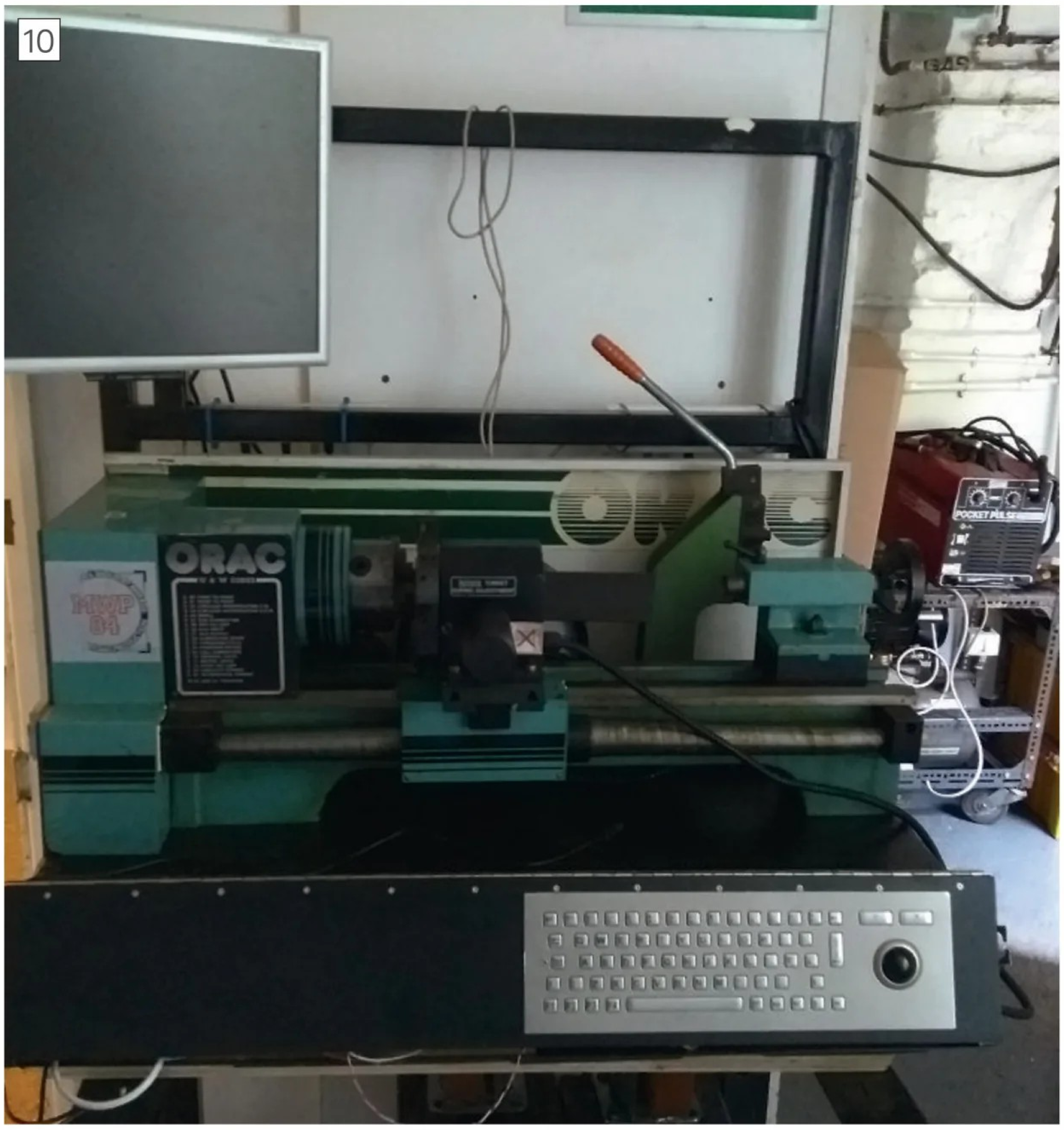
Tool and cutter grinders.

Surface grinder.

of Myford Limited. Naturally this lathe is not in regular use! Other lathes that get plenty of use included a Colchester Chipmaster, **photo 4**, and a Super 7, **photo 5,** at the time of my visit. The Colchester has now been replaced by the second Super 7. Theres is also a much larger Tong lathe that comes into its own when making large flywheels. Without exception everything is beautifully maintained and adjusted, it's a pleasure just to 'twiddle the knobs' and enjoy the smooth actions on these machines!

Milling machines include a sizeable Bridgeport, **photo 6**. For readers unfamiliar with such a machine, it is what is called a 'turret mill', providing great flexibility. The powered table can move up and down, as well as in the X and Y directions, while the head can be tilted as well as up and down moved back and forth. This machine has been very popular in toolrooms for many years particularly in the UK

Corona high speed drilling machine.

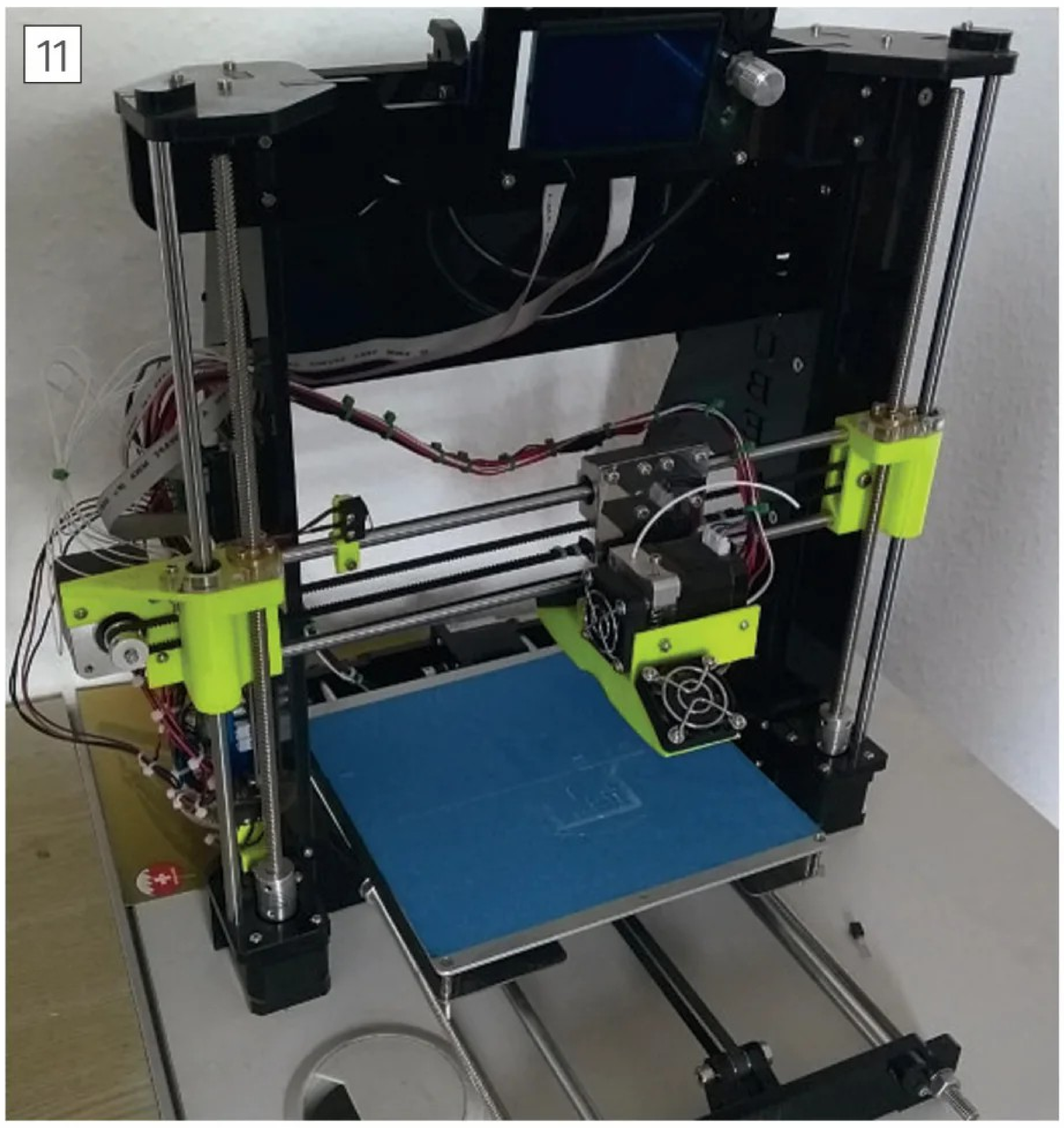


Denford ORAC CNC lathe.

and the USA. More than a quarter of a million have been built. The workshops also have several tool and cutter grinders and a Jones & Shipman 540 surface grinder, **photos 7** and **8**. These machines have dust extraction and can be used to finish cutters and parts to a very high level of accuracy.

The bench drill in **photo 9** not only looks rather old fashioned but has very strange proportions. This is because it is a specialist machine, a Pollard Corona 9FX, designed for drilling very small holes at very high speeds – from 2,700 to 18,000 rpm. These machines were produced with up to four heads for use in a production environment, and normally there would be a jig set up on the fixed table to allow rapid and repeatable drilling. The feed arrangement claims to have an automatic backlash eliminator and the machine would originally have had a woven silk belt – I wonder where one would source a replacement these days?

As you would expect from a society of ‘experimental’ engineers, the SMEE has been interested in the latest technologies from its earliest days. The Denford ORAC CNC lathe was an example of such a machine from the 1980s, **photo 10**. These were produced ›



Early example of a 3D printer.

Cutting tools and hand tools easily to hand.

A selection of measuring tools.

Some of the items currently in storage.

in the years following the BBC science fiction series Blake's Seven, so it's hard not to speculate where the machine's name came from! Cutting edge forty years ago, this machine had become outdated, and has now moved on. Another example of the early adoption of new technology is the 3D printer in **photo 11**. 3D printing has been eagerly adopted by many SMEE members, along with wire cutting edm and spark erosion.

Obviously, any good workshop has a wide selection of hand tools and measuring equipment. **Photographs 13** and **14** show two examples of how such things are stored and organised neatly in the workshops. I should explain that all SMEE members are able to use the workshops, which have regular opening times during the week and on Sundays. While the south-London location does impose some practical issues on members from further afield, it's not unknown for members from further afield to 'stock up' some tricky jobs and then spend a day or two in the capital to carry out the work on the SMEE's machines – perhaps with advice and assistance from other members. The workshops are also used for the SMEE's excellent beginners' courses, including the 'Polly Course' which takes a novice through the building of a small steam engine. These courses run each year – watch out for news of these in future issues.

To conclude, I'll just share photo 17, this is an example of one of the storage rooms in the upper levels of Marshall House. In these boxes are examples of works by many different model engineers from over the last 125 years and before. The society's members aim to conserve all of these items, some by the work of its own volunteers and some in partnership with colleges specialising in engineering and conservation.

Even if you can't easily access Marshall House, joining the SMEE can add an exciting extra dimension to your hobby, introducing you to new ideas and fellow hobby engineers through its journal, meetings and online events. To find out more about membership visit www.sm-ee.co.uk.

More simple yet effective fly press tooling

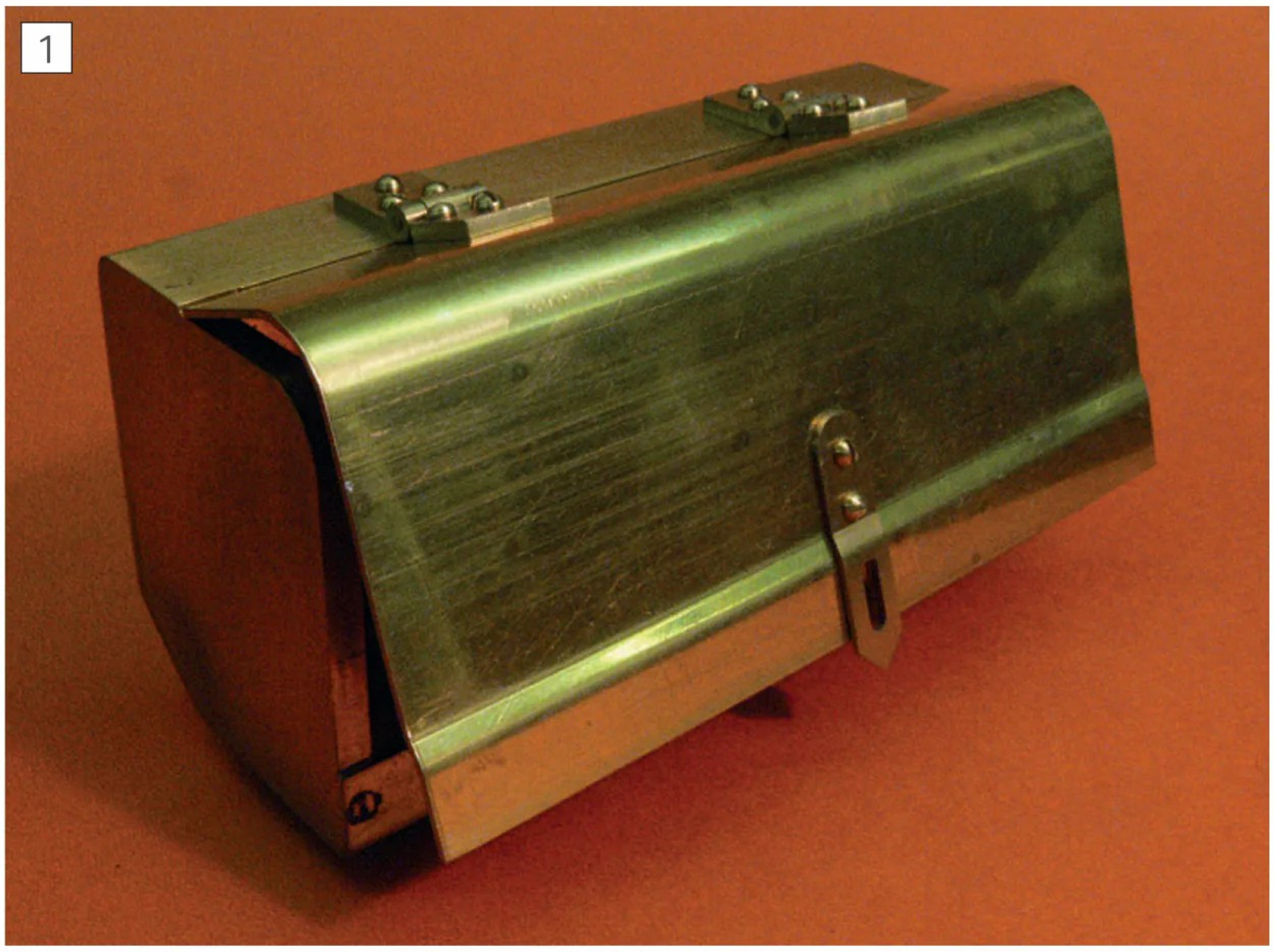
Following on from an article over a decade ago, the late John Smith continued to find that the fly press performed an essential role in his workshop

"The past is a foreign country; they do things differently there." This phrase came to mind when standing in the Great Western Railway drawing office last week looking up at the vaulted roof. Yes, it's still there, now an English Heritage reference library. I visited to breathe in the ambience of the office where *Stars*, *Castles* and *Kings* were designed. The beams supporting the roof purlins are made from broad gauge bridge rail, bent at the works in 1904 to the desired radius. Could UK engineering shops today replicate this feat?

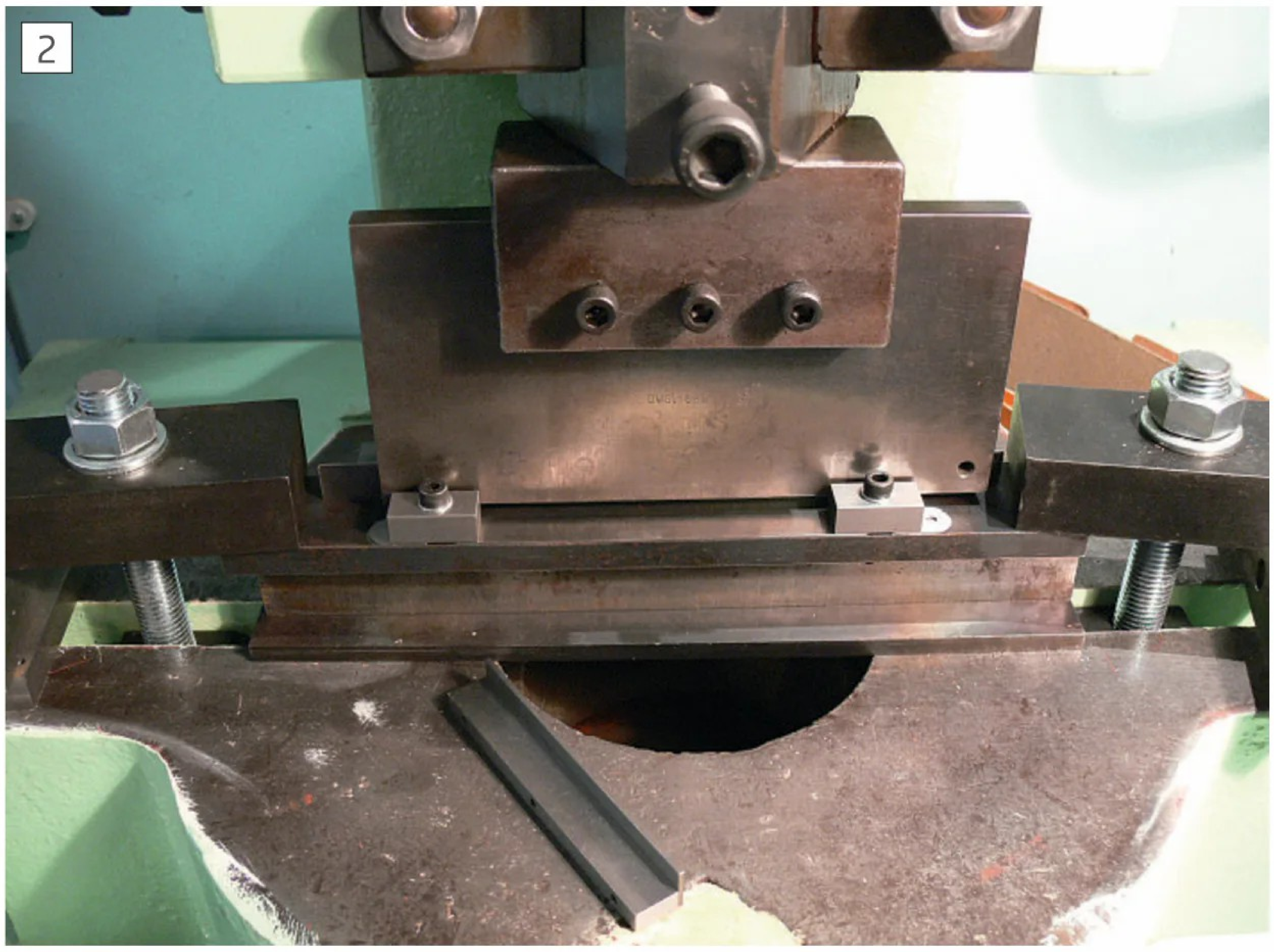
Since my last article on the fly press (MEW 211) I have made several press tools and dies which have worked really well and I hope that they give you a few ideas for your own projects. I'll let pictures tell most of the story.

The first is a simple tool and die for putting a joggle into a piece of sheet material. **Photograph 1** shows one of the pair of toolboxes made recently for my 7¼" gauge GWR 1400 class locomotive. All the bends were made using the press, the joggles using the set-up shown in **photo 2**. A strip of metal of thickness appropriate to the joggle required is clamped down tightly to a thick bottom plate to form the die. The work-piece is placed onto this strip and clamped down firmly using the bar shown in the foreground and a pair of toolmaker's clamps. The tool is a simple piece of mild steel rectangular bar. Guides behind the tool prevent the tool from being forced backwards when it is brought down onto the work-piece. I hope this shows how easy it is to "cobble" a really effective press tool.

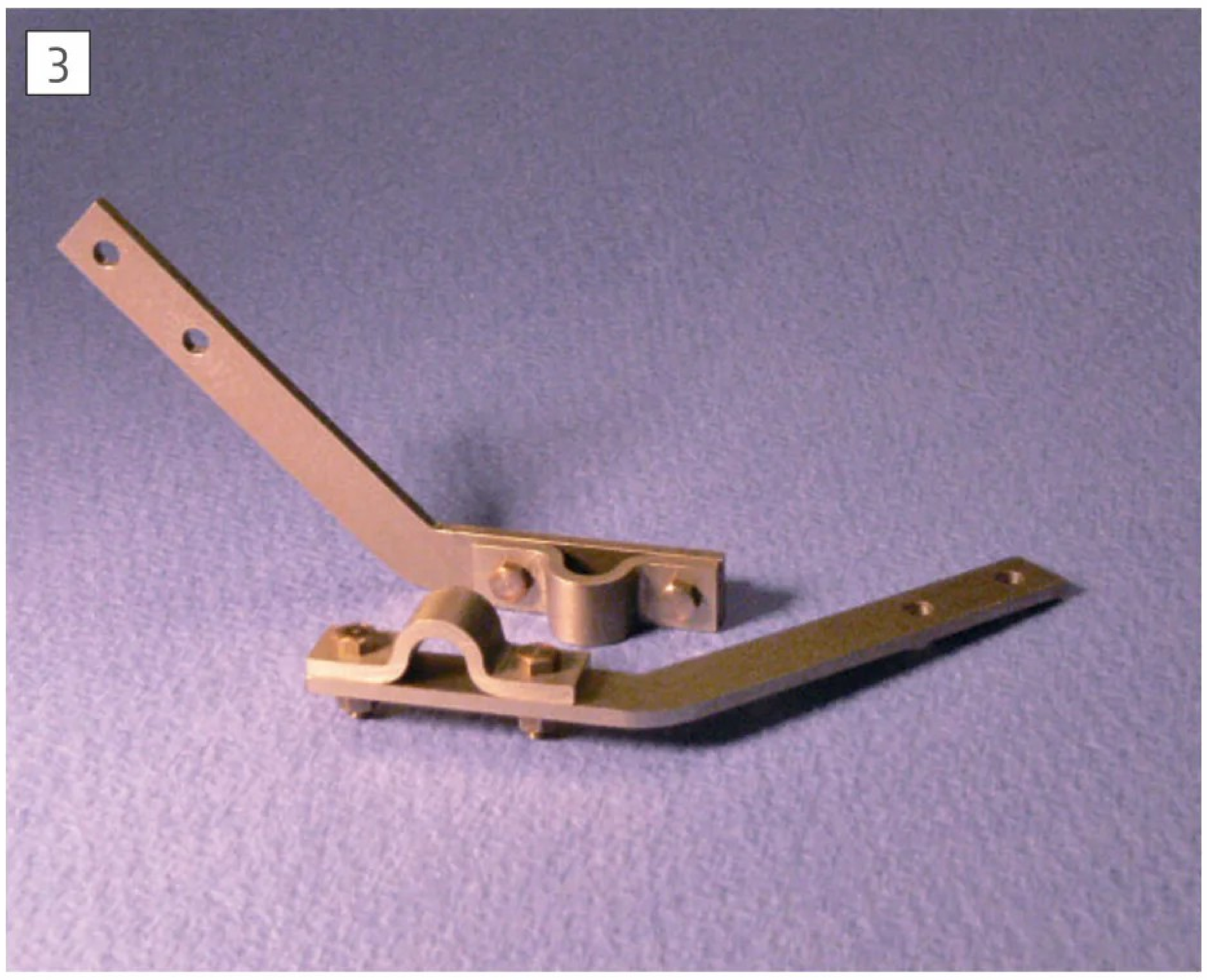
(It might be helpful if I just mention how the toolbox hinges were made. I used 1/16" diameter taper pins as hinge


1

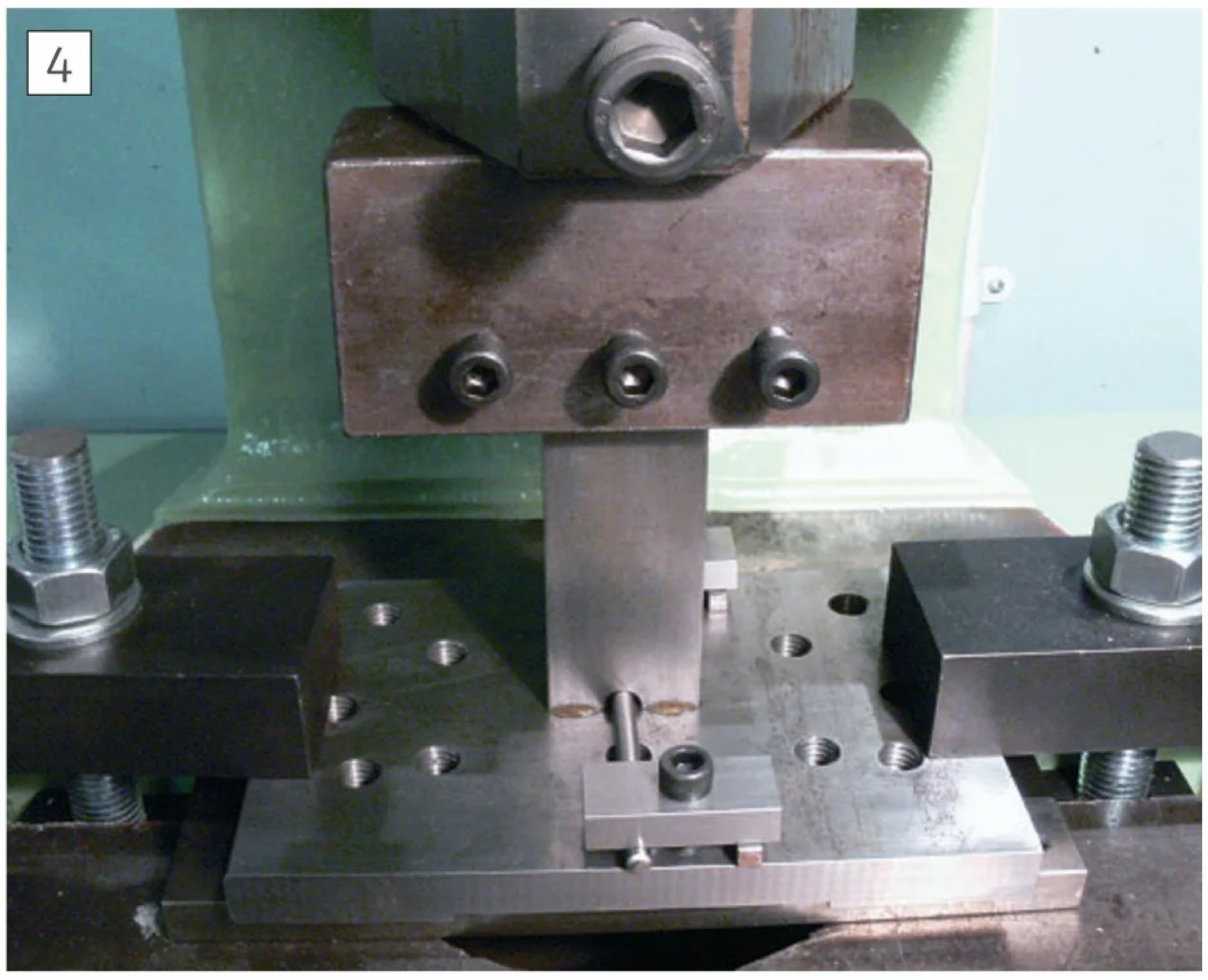
A 1400 class toolbox.


2

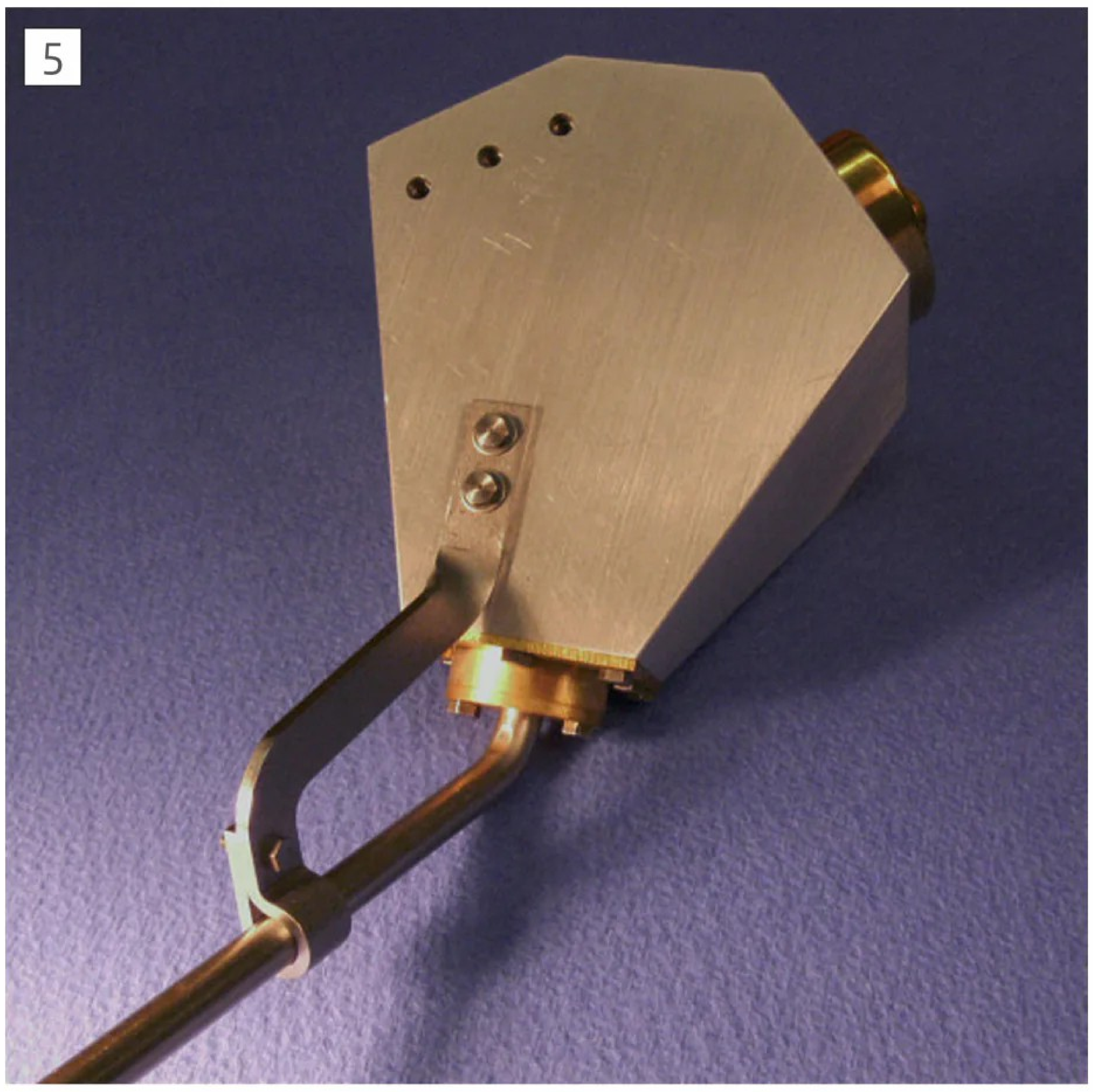
Joggle Tool & Die.



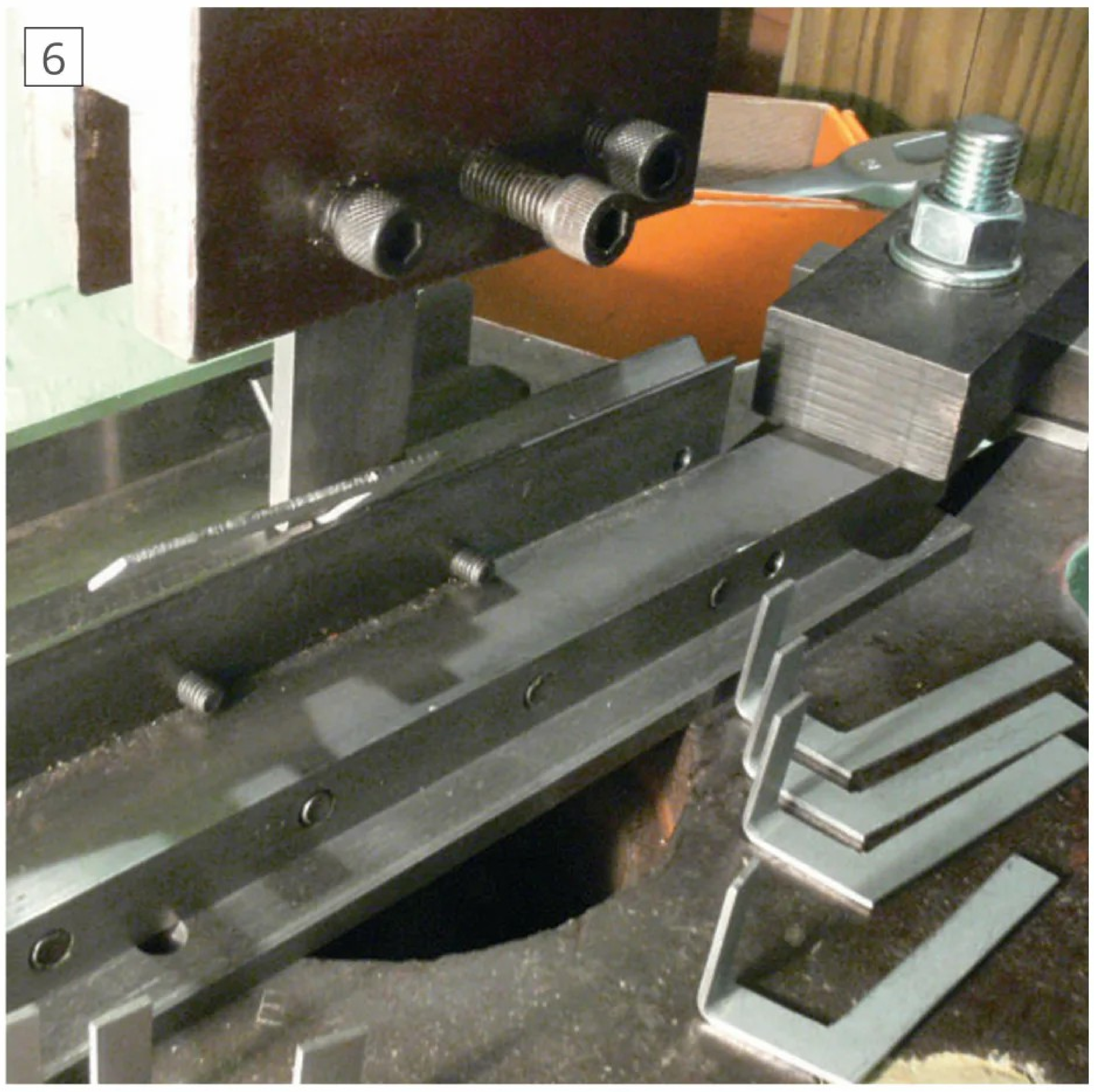
Front Sandbox Pipe Stays.



Tool for Front Sandbox Pipe Clamps.



Rear Sandbox Pipe Stay.



First Operation.

pins. If you ream both halves of a hinge together with a taper pin reamer and then open out one half of the hinge just a little more, the pin can be pressed home tightly into one half of the hinge while the other half rotates freely.)

Another tool/die duo was made to produce the 'clamps' of the front sandbox pipe stays shown in **photo 3** from 1/16" cold reduced mild steel sheet. This is the steel of choice for presswork; bright mild steel will simply shear in the press unless heated to red heat. I bring back small quantities of Imperial sheet whenever I visit the US!

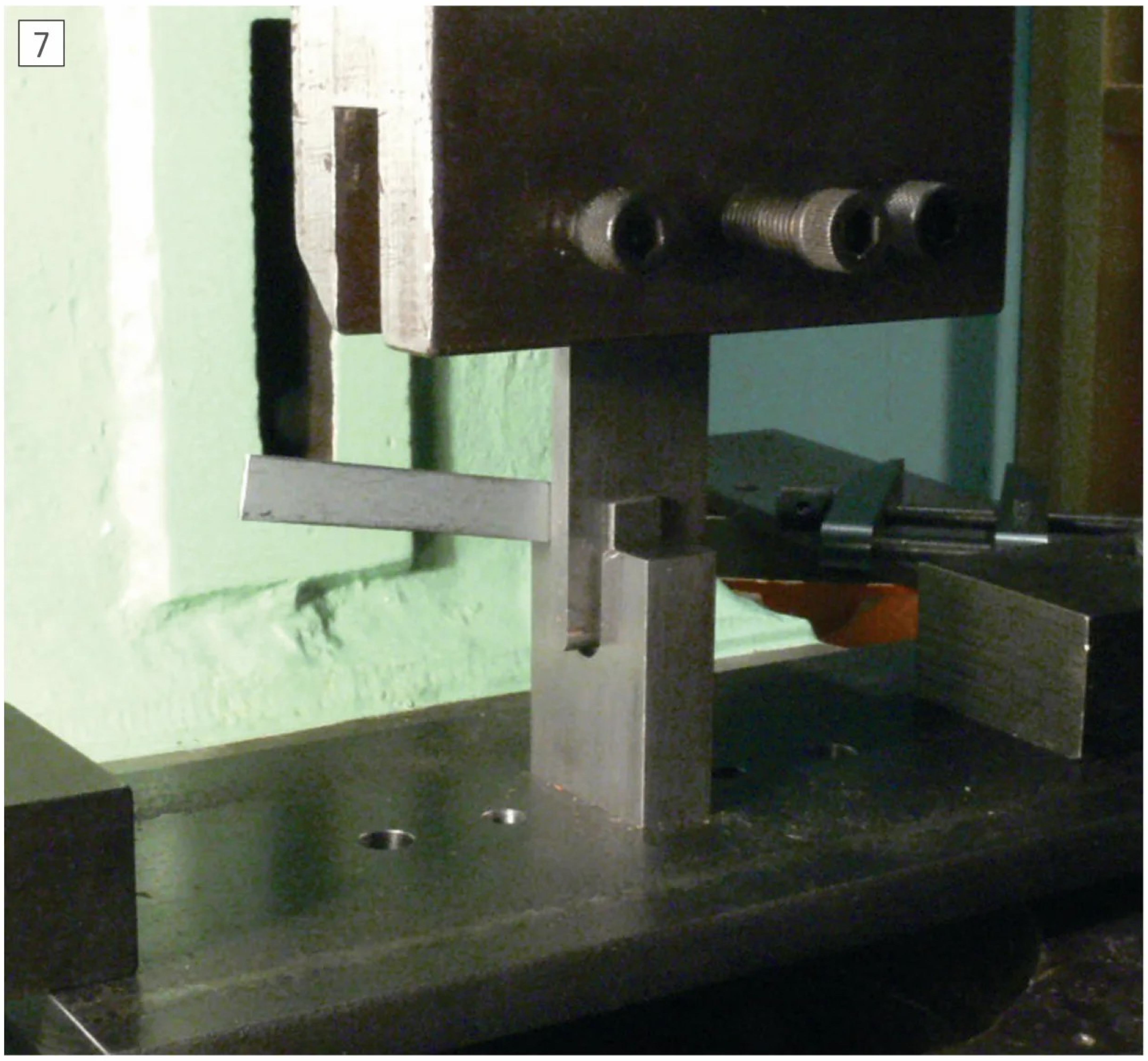
The set-up is shown in **photo 4**. The die consists of a length of 3/16" diameter silver steel rod clamped down to a thick bottom plate. The tool is a piece of mild steel with a 5/16" wide slot formed with a slot drill. I found it best to use rough-sawn blanks and to mill the sides of the clamps after forming. The results were outstanding; the clamps fit the 3/16" pipe perfectly. Note that the edges of the slot in the tool must be rounded to provide small bend radii, otherwise the blanks will shear. A little grease applied to each blank helps the metal to 'flow'.

Finally, a rear sandbox pipe stay can be seen in **photo 5**. These are a little more complex to make. I'm sure that the full-size stays would have been made by blacksmiths in the Swindon works at red heat using some very heavy hammers and a lot of perspiration and noise. Thankfully, the fly press makes light work of the model stays, but three press operations are needed.

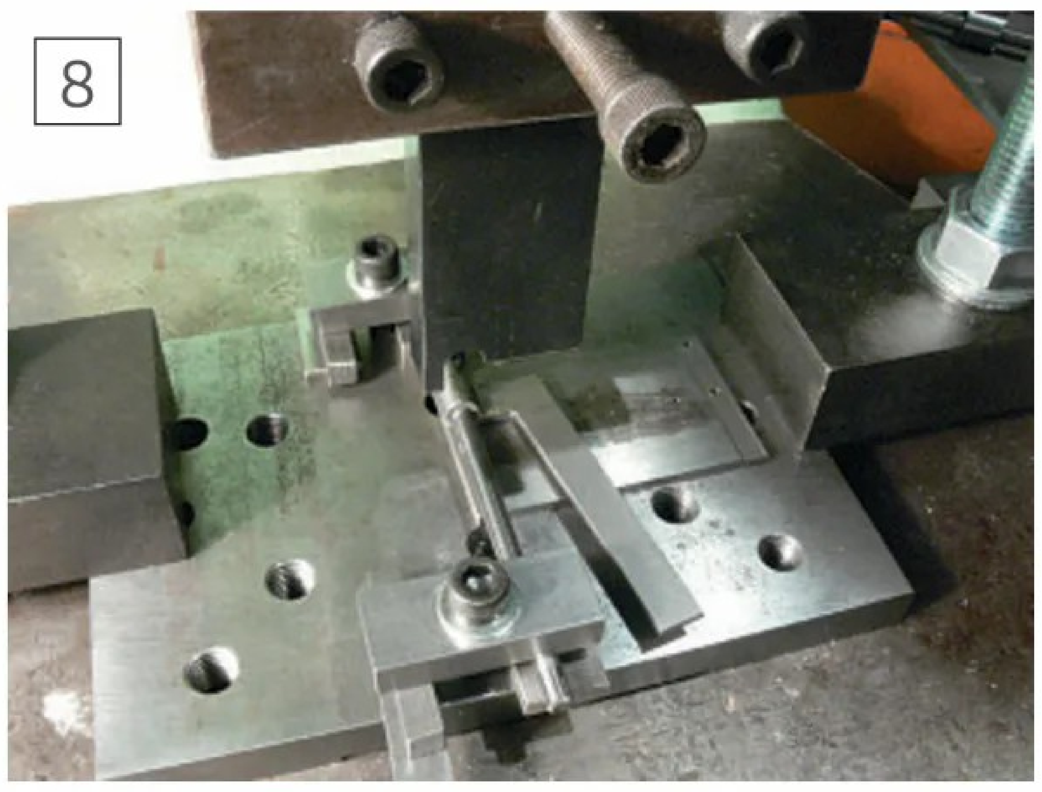
The first operation, **photo 6**, is to put a 3/32" radius 90º bend into the rough-sawn blanks using a 90º V die and a tool made from a piece of 1" x 3/16" steel with a length of 3/16" silver steel rod, silver-soldered into a V at one end.

The second operation, **photo 7**, uses the same tool to push the blank into a 5/16" slot, producing a 180º bend of 3/32" radius.

The third operation is shown in **photo 8**. The trick is to make the tool



Second Operation.



Third Operation.

and the die as simply as possible so that when they come together the metal has no choice other than to 'flow' into the shape you want. It's very satisfying and every blank comes out exactly the same!

The sandbox "pipes" were made from 303 Stainless steel rod, drilled in the lathe at one end to look like pipe before bending in the press using a 120° die. The sandboxes themselves were all milled out of solid aluminium as my soldering skills were not equal to making them out of brass sheet. ■

MODEL ENGINEER

NEXT ISSUE

Pre-order your copy today!

Visit www.classicmagazines.co.uk

or call 01507 529 529

Contents subject to change.

Camshaft Grinder
Gerard Dean explains how he ground the crankshafts for his 1450cc V12 motorcycle engine.

Bradford Challenge
Bradford Model Engineering Society invites entries for a fun competition to design a racing engine that goes fast and manages to stay on the track for two laps.

Steam Engine
Ron Fitzgerald explores the history of hydraulic engines – engines powered by gravity by means of a head of water.

American Locomotives
David Rollinson traces the development of the classic 4-4-0 American locomotive.

Williamson Engine
Ray Griffin completes his Williamson engine by making the crosshead and crankshaft, paints it and runs it for the first time.

The Next Issue of Model Engineer is issue 4739, March 22 2024

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.**

3D printing Experiences

Hi Neil, for hobby machinists and for those of us who are older the often included 3D printed examples of unrelated objects are of little interest or indeed have doubtful relevance to whatever is going on in the workshop.
With the falling prices of a basic FDM machine, I purchased a Creality Ender 3 S1 about a year ago and have already pushed a Kg of PLA filament through it.
As a long time 3D modelling user I find I can create a model quickly and have it in the printer in 10 mins or so, leaving it to chug away while I go on with something else or leave it to print overnight. For those not already adept at 3D modelling a further barrier for capitalizing on printing is also there.
Modelling and printing jigs, fixtures and prototypes before committing to metal I've found is really useful, a quick and dirty printed ER32 collet for some hex bar worked surprisingly well as an example.
A recent quite complex sample part from a vendor resin printed was as good as an investment casting and early in my FDM foray a printed and painted pattern for conventional bronze casting was easily produced with compensation for draft and shrinkage easily completed in the modelling program.
The photo shows a painted FDM pattern for Klinger type sight glass on left and resultant casting after machining centre right
An interesting occasional page for MEW could showcase model engineering related jigs, fixtures and other parts produced by readers.

Paul Zeusche, by email.

The Universal Pillar Tool

Hi Neil, I have been reading about the universal pillar tool. Many years ago I bought the book by GHT because I intended to make the tool, several years ago I saw an article about the tool and the person used gas fittings to make the arms ,can you please tell me what number issue it was in, your help will be greatly appreciated.

Tony Swinfield, via our Website.

Hi Tony, the index for MEW, updated regularly by David Frith, shows that Issue 139, March 2008, featured 'A Pillar Tool from Scrap' by Jim Whetren – this may be the article you seek. The latest indexes are linked here : https://www.model-engineer.co.uk/forums/topic/latest-mew-index/ or use the QR code.

Another Mystery Tool

Dear Neil, the Mystery Tool featured in **MEW 337** is a hand microtome. It is used to cut thin sections of animal or more commonly plant tissue to be mounted on glass slides and viewed through the microscope. The tissue could be embedded in paraffin wax through a laborious process of fixation and dehydration or particularly with fresh plant material held between slices of raw carrot cut to fit the holder. A sharp razor held flush to the flat top of the device is then used to shave thin slices from the block, after each cut the block being advanced by turning the calibrated micrometer dial on the base of the device. Each division of the micrometer would advance the block 10 µm so very thin sections could be cut. Many Old Hands would dispense with the hand microtome and simply wedge a bit of leaf in a block of carrot and quickly run off a load of perfect sections using a wet Gillette 7-o-clock double sided safety razorblade while tyro's were fiddling about carving a block of carrot to fit the microtome.

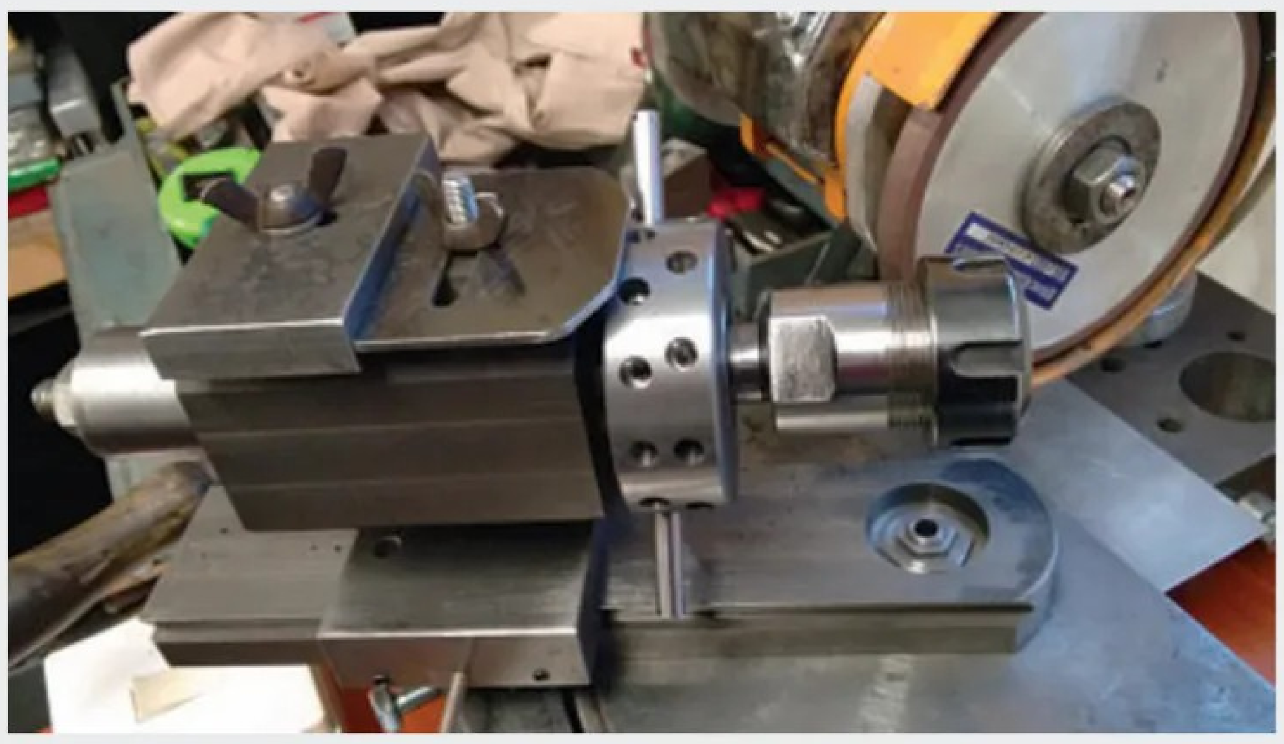
Bob Cannon, by email.

Philip George's Machine.

Dear Neil, I believe I have one of these machines (**MEW 337**), in its original format as a surface grinder. I attach the pictures of the maker's labels and the model I have is a 'Superior'!! Apologies for the angle of the maker's name plate but my replacement motor obscures it.

Paul Chapman, Middlesex.

Taps and Tap sharpening by Jacques Maurel



Hello Neil, I have just commissioned an attachment for my tool and cutter grinder based on the above series by Jacques in MEW (Photo attached). I am very impressed with the performance of the system and would be most grateful if you could pass my thanks on to Jacques for an innovative method and an excellent description.

So far I have ground drills, centre drills and spotting drills and will shortly be moving on to taps and dies. My incarnation of the device uses the sliding head of the Stent cutter grinder and as a consequence the cams are about 50% larger than in Jacques drawings, but the principle is excellent and so simple in operation.

Martin Johnson, by email

Thanks Martin, it's always good to hear readers' feedback on making the tools we feature in MEW – Neil.

Small CNC Lathes suitable for a Model Engineer

Dear Neil, do you have any contact details for manufacturers and suppliers of CNC lathes / machining centres suitable for model engineers. I would be interested in a such a machine in a size between a Unimat 3 and Myford Super 7, both of which I have. It doesn't need to be a new machine, but must be in good 'nick', i.e. accurate. Thus far, all I've managed to find is a 'CNC ready' Proxxon lathe which just has two stepper motors fitted where the hand wheels would normally go, i.e. no control system. I abhor terms like 'CNC ready' and 'DCC ready', as they are misleading. After all, they don't usually sell cars with the tag line 'Engine ready'!

Brian Jones, Lincolnshire

Thread Chasers

Dear Neil, I enjoy reading the Model Engineers Workshop every month.

Issue 333 has an old article on how to make thread chasers. I have been a metal worker for 65 years but have never seen a thread chaser. How would you use one and why? Is the item still in the lathe? Is the lathe running? Is some form of tool rest used? Are we likely to loose an arm in this process?

Do we need a different one for every thread pitch and for every different diameter? Perhaps someone could write an article to enlighten me?

Neil Bromilow, Albany, Western Australia

Hi Robin, the answer isn't simple. Some die chasers, like the split nut are just used to 'tidy up' a damaged thread by winding them on and back off. Others can be used in the lathe instead of a single point tool for thread cutting, and with skill some can be used on a holder to finish a thread freehand, starting with a guiding groove. I think some people can even do it without a guide. There's more to it than just this... would any readers like to offer an article? – Neil.

MODEL ENGINEERS' WORKSHOP

SUBSCRIBE AND SAVE

Enjoy 12 months for just £50

SAVE 30%

PRINT ONLY

Quarterly direct debit for £14

1 year direct debit for £50

1 year credit/debit card for £54

PRINT + DIGITAL

Quarterly direct debit for £17*

1 year direct debit for £65*

DIGITAL ONLY

1 year direct debit for £37*

1 year credit/debit card for £41*

**Any digital subscription package includes access to the online archive.*

GREAT REASONS TO SUBSCRIBE

> Free UK delivery to your door or instant download to your device > Great Savings on the shop price > Never miss an issue > Receive your issue before it goes on sale in the shop

Myford Super 7 Lathe - Neil Wyatt

www.classicmagazines.co.uk/**MEWDPS**

01507 529529 and quote **MEWDPS**

Lines open Mondaty to Friday 8.30am – 5.00pm GMT

Offer ends December 31, 2024. Subscriptions will start with the next available issue. Direct Debit payments will continue on the agreed plan unless you tell us otherwise.
To view the privacy policy for MMG Ltd (publisher of Model Engineers' Workshop), please visit www.mortons.co.uk/privacy

Please visit www.classicmagazines.co.uk/terms for full terms & conditions.

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 of 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

By GEOMETER

Belt fasteners

FOR LIGHT FLAT belt drives, as may be used in small workshops, commercial types of fastener are usually too large and heavy, fitting badly on the curvature of small pulleys and tending to weaken the belts at positions where they are joined. Generally, better results are obtained-particularly with leather belts-by employing a chamfered and stitched joint or a type of small hinge which can be made to suit any width of belt.

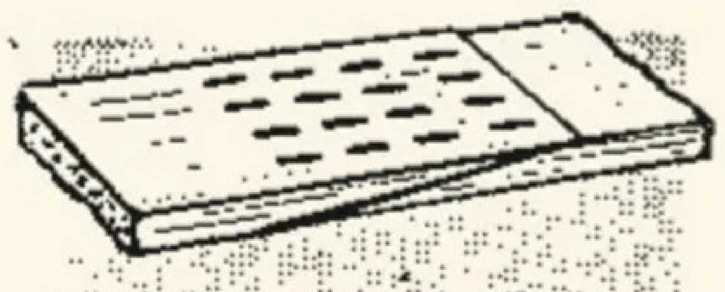
If time permits, much of the initial stretch can be taken out of a leather belt by attaching to a beam and hanging a weight on the end for several days. If height is wanting or the belt is long it can pass over the beam, packed to avoid sharp edges, and support a pair of weights.

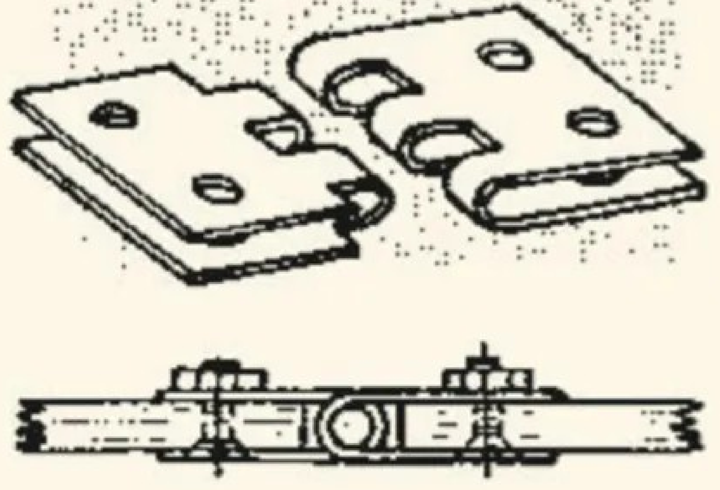
The belt being ready to be joined, pulley adjustment should be let right back and the belt wrapped round and cut so that when joined it will run slightly tight. It is a good plan to lap the belt before cutting, particularly if the pulleys are at fixed centres, placing a small piece of steel plate each side and gripping the joint with self-locking pliers. This should be done in the middle of a run with the tension checked, adjusting as required. Two marks, one each side of the joint at a measured distance, then provide means of verifying the length when the belt is removed to make the joint.

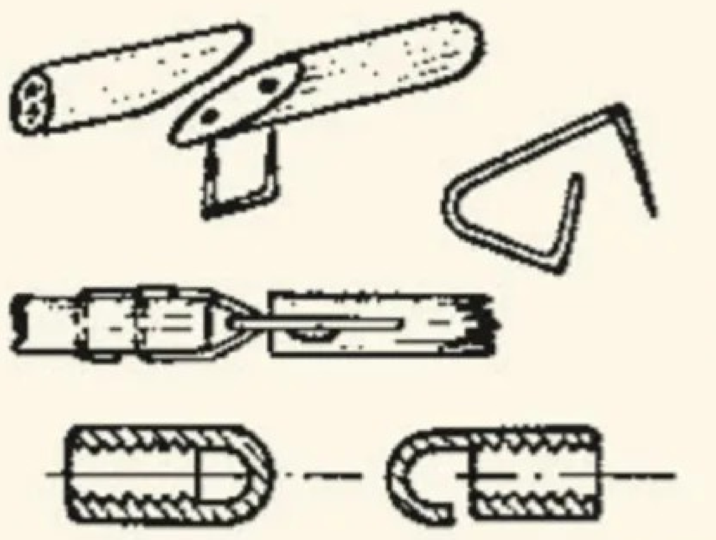
Making various joints

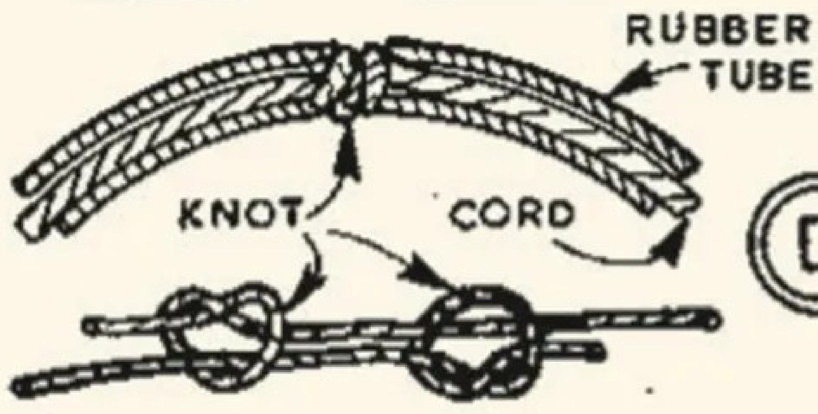
For the type of joint at *A*, chamfering can be done with a sharp knife, the faces coated with leather adhesive and the joint squeezed in the vice. When adhering it can be stitched with strong thread, lightly scoring the leather with a knife for the stitches to lie flush.

For most small belts a hinged fastener, B, is strongly recommended. Construction is by folding sheet steel over a piece of metal slightly thinner than the belt. Gripped in the vice each piece is filed to make lugs fitting into those of the other. Held by pliers hinge pieces and metal are drilled right through and deeply


A


B


C



D

countersunk on the underside-for screw heads to lie flush. Each piece is fitted with two screws, shallow nuts on the outside, and the screws lightly riveted. A piece of round rod, burred each end, makes the hinge pin. One advantage of such a fastener is the belt can be shortened by as little as 1/2 in.

A round belt may be joined by butting its ends and driving a type of small staple through. Alternatively, the ends may be chamferred, C (top), coated with adhesive, a staple fitted and the joint bound with thread.

Again, two staples with long legs can be passed through the belt and turned, C (centre.) The end of each staple projects as an eye and the second is fitted linked into the first.

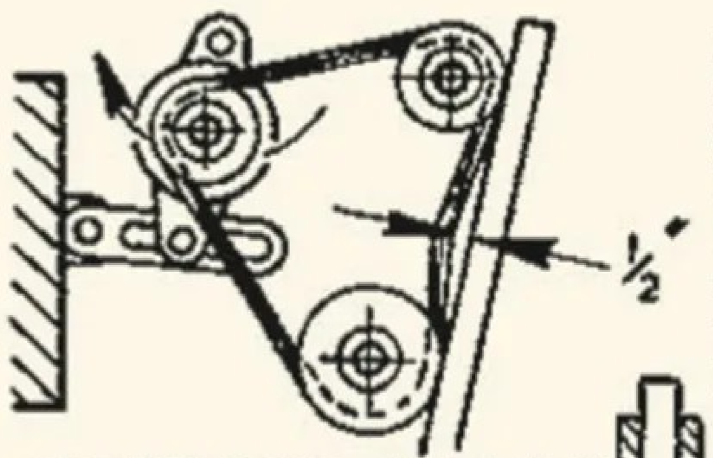
A common fastener is the screw on hook and eye, C (bottom), made by drilling short pieces of rod not quite through, tapping, then filing the blind ends each side until an eye is made, one being cut through to form a hook.

A round belt, but to run on vee pulleys, was once made in an emergency as at *D*. Ordinary rubber (gas) tubing was used, a strong cord passed through the centre, the tubing pushed back and the cord tied with the knot shown. The ends of the tubing were then bound.

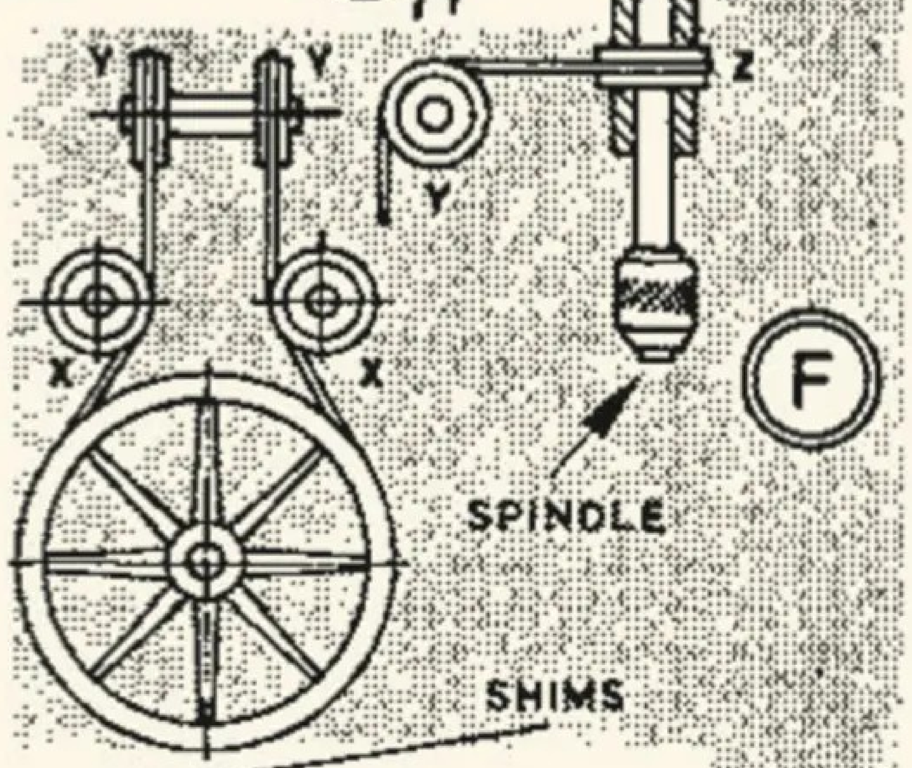
Common means of tightening belts are varying the centres of shafts, as when an electric motor has slotted feet, or is mounted on a plate with slotted holes, or by a third (jockey) pulley. This can be mounted on a swinging bracket and with a slotted link, *E*, as is the case for car auxiliary drives,. where the dynamo furnishes the third pulley. From the straight on the longest run correct belt tension is about 1/2 in. push down.

Adapting jockey pulleys a round belt can be directed as desired, F. Pulleys X constrain the belt from the large driving wheel in line with pulley Y taking the drive to pulley Z on the vertical spindle-a type of drive which can be used on a small drilling machine.

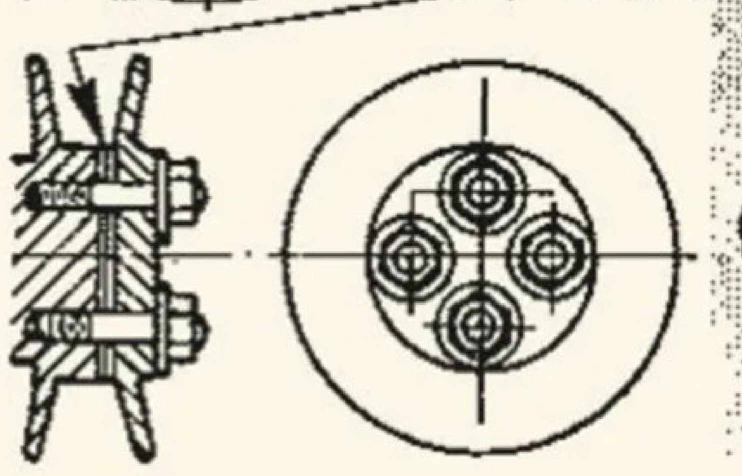
On a vee pulley the diameter can be varied by shims between the flanges, G, as is done on Fiat 500 cars, shims being extracted to tighten the belt. The most famous example of this principle was the Rudge Multi motorcycle on which both engine and rear wheel pulleys could be varied while riding to provide an intinitely-variable drive. ❑



E



F



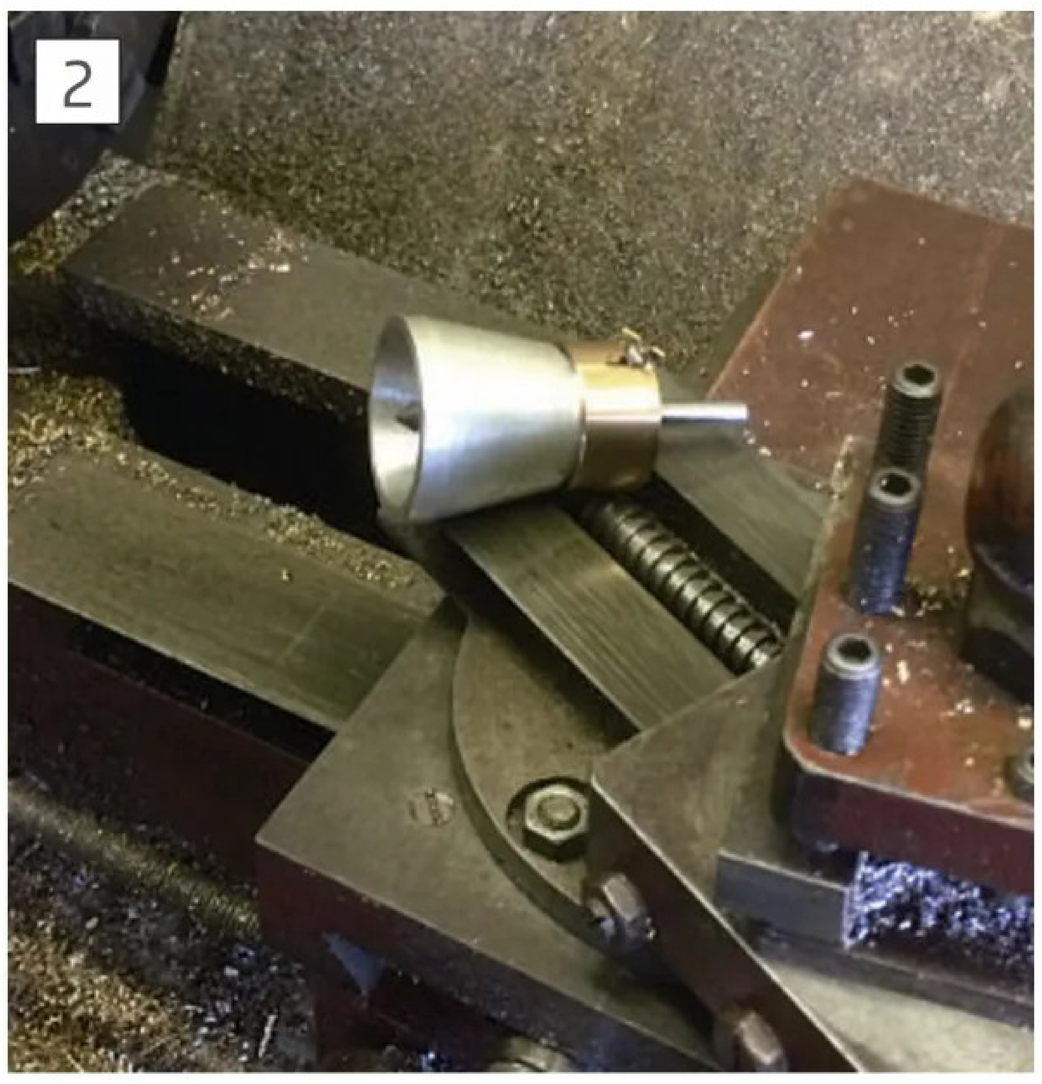
G

A Bell Centre Finder

If you don't have this essential workshop accessory already, follow Paul Tiney's guide and you will wonder how you coped without it.

1

Finished item

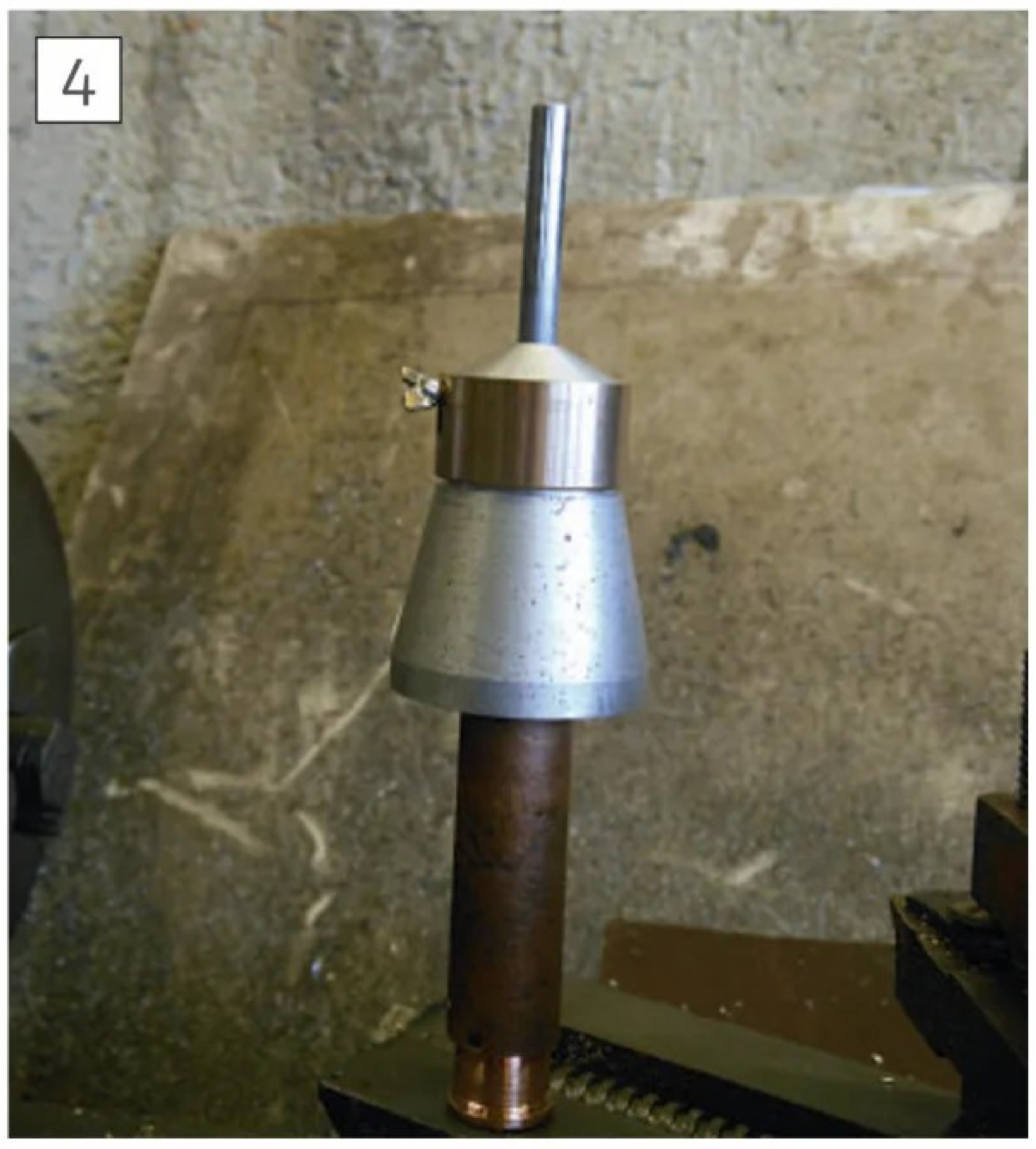


2

View from side

3

Component parts



4

Centring bar stock

It all started with a left over off-cut of ¼ inch silver steel rod. If put in the "come-in-handy" draw it would languish there for twelve months or more until the day came when it would be found to be just too short to be used for the project then in need of it. I therefore felt it needed using up.

Older readers will I am sure remember an item called a "bell centre finder", a hand tool for spotting the centre on the end of bar stock. Fairly accurate, simple to use and speedy in operation. Since a picture "tells a thousand words" I refer you to **photo 1**, **2** and **3** for illustration. To use, the hollow bell is placed on the end of the piece of bar and because of the internal taper it self-centres itself. The punch is then tapped to mark the centre. Note "tapped". It is a centre finder and marker only, **photo 4**. Once

›


Centring hole. Brass ring ensures finder is kept vertical.

marked you can then play at Thor with his mighty hammer and use a proper centre punch. (Thor as in ancient god not the hide faced mallet).

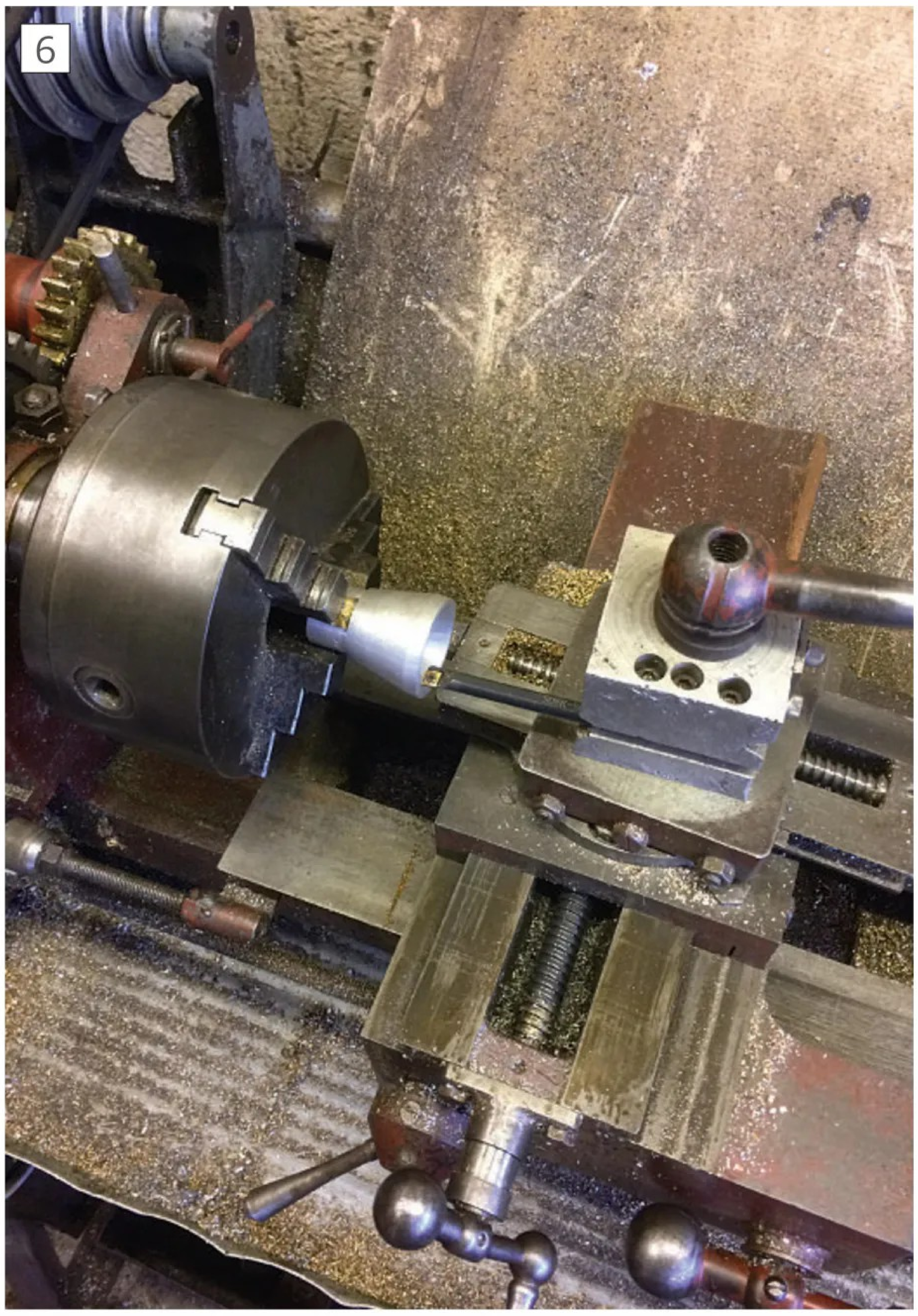
You will also see that the "handle" of the bell has a brass collar surrounding it and that it is finished to a blunt taper point. If the punch is slipped out and reversed and this tapered end placed in a hole it will be found that the taper also self-centres and the punch will "spot through" to the other side, so marking, for instance from the large clearance hole, the centre for a smaller tapping drill. The loose collar is used to support and ensure the tool is held square to the surface, **photo 5.**

As with my other suggested projects no dimensions or materials are specified; only you know what your scrap box contains. I used an off cut of alloy bar for the main body, a brass bush from a motorcycle gearbox for the collar, and the silver steel for the silver steel for punch has already been spoken of.

Before we go very much further can I just suggest that for those who are new to this sport please read through carefully and get things clear in your mind before you start so that you "know what he's on about" Old hands will just be muttering "wouldn't do it like that."

Construction

1. Start with the collar. First bore the collar to a convenient size. This needs to be of an internal diameter that you can easily measure as it will dictate the dimension of the "handle" later.
2. Now chuck the material you are going to use for the main body in the lathe. A three jaw is fine. Turn the "handle" to the bore of the collar. Aim for a smooth sliding fit with no shake. Take your time, measure, and take light cuts. Remember you can take it off, but you can't put it back on
3. Swing and set the compound (top) slide over towards the back of the lathe. Now, using the compound feed screw, cut the blunt taper on the "handle" end. Keep the point fairly blunt so that it will sit on the edge of any hole but not pass right through it.
4. Take the material out of the chuck and reverse it, gripping the "handle". Don't grip all the full length of the handle but leave enough protruding to give clearance for a lathe tool. Three small pieces of brass shim stuck to the chuck jaws with a blob of grease will prevent marking the surface of the "handle". You should be aware that un-chucking and re-chucking in a three jaw usually results in some small out of true running, but sometimes "needs must" as they say. To reduce the error and help mitigate the problem try to put the work

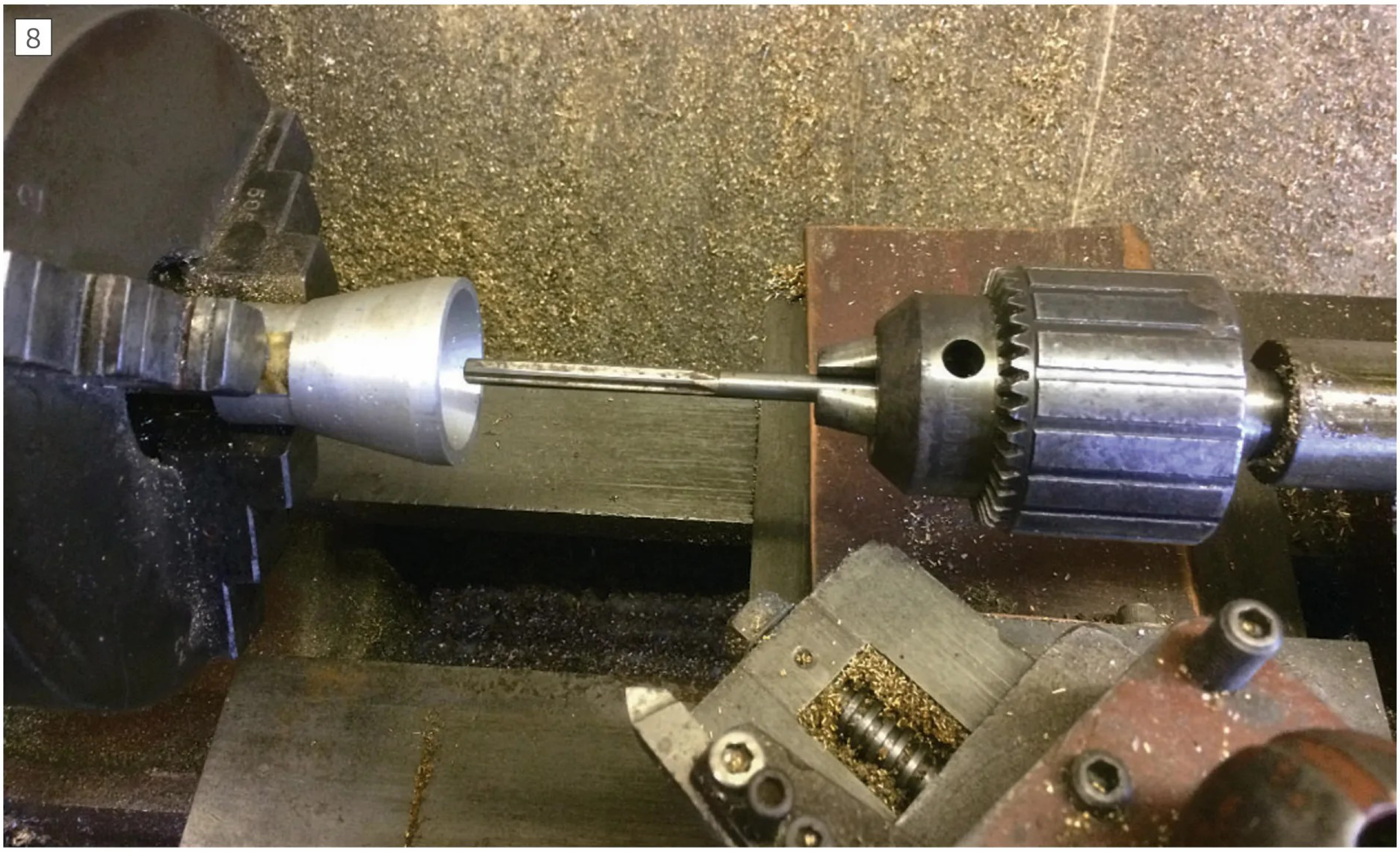


Boring internal taper. Note brass shim under chuck jaw.

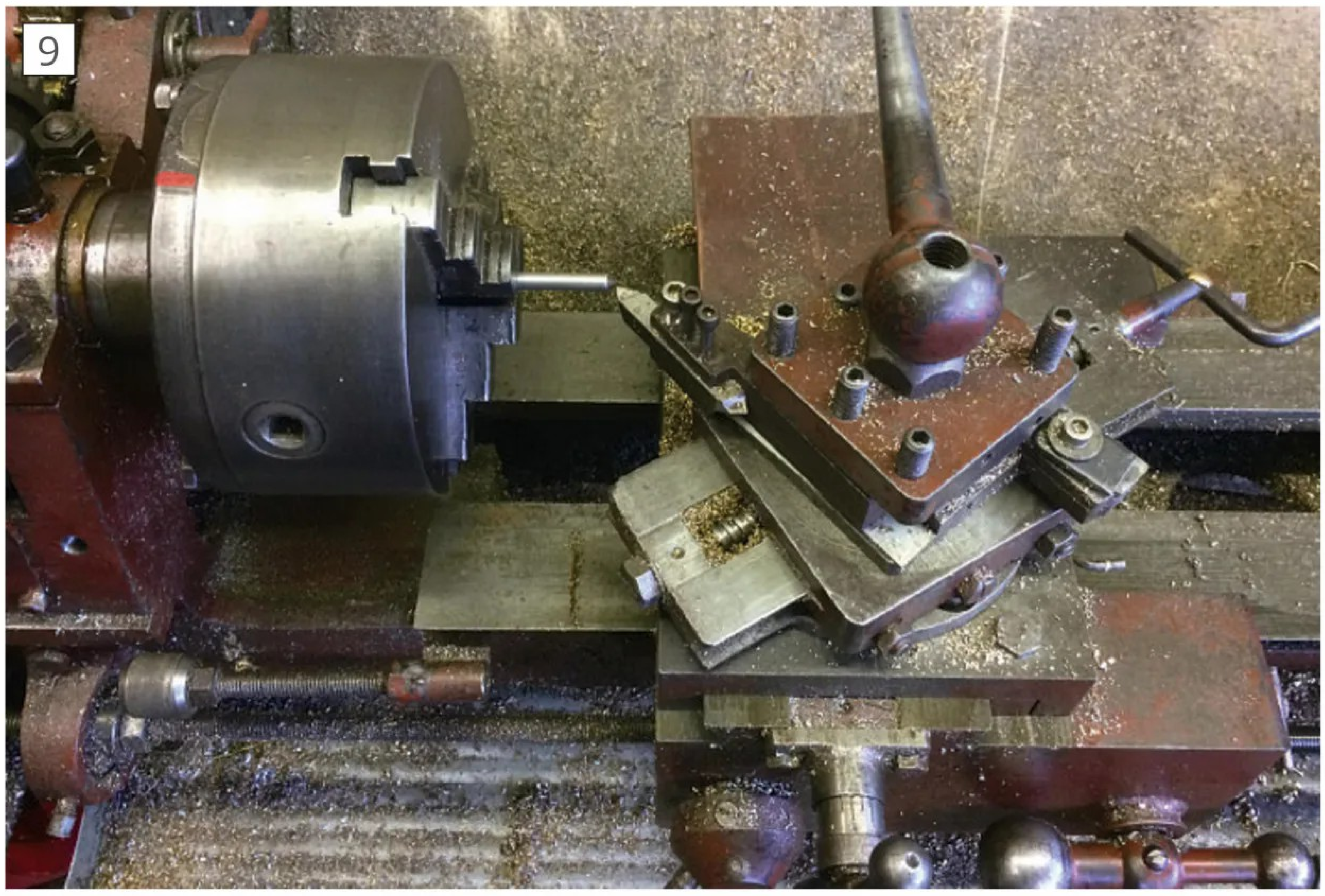
Cutting external taper

back in the chuck orientated in the same place from which it was removed. i.e. mark the work and mark the corresponding jaw. I have a small spot of red paint on the chuck backing plate and by keeping it uppermost a pencil or marker pen dot on the work aids in getting things back together.

5. Centre drill the work and then whiz a drill right the way through. For drill size see step 10.
6. Enlarge the hole to a size that will allow you to introduce a boring bar. Make the depth approx. half the depth of your proposed finished bell.
7. Mount the boring bar. Swing the compound slide round, handle towards you, and set to half the internal angle of the finished bell. This will be a compromise governed by the dimensions of the material you have available and the largest bar that you expect to find the centre of. In my case the internal angle was approximately 60 degrees and the depth about 1.125 inches in old money.
8. Using the compound slide for the feed and the cross slide to control depth of cut begin making the internal taper. Note that you will be winding the cross slide out not in to make the depth of cut and just winding the compound back and forwards to take the cut, **photo 6**.
9. Remove the boring bar, but do not slacken or alter the angle of the compound slide. Replace the boring bar with your normal tool bit Now we begin to make the external taper to the bell. Run the carriage up towards the chuck and using a normal lathe cutting tool begin the external taper by cutting off the square shoulder and slowly extending the length of cut. This is do using the cross slide to increase the cut and again the compound to provide the feed. Move the carriage as necessary for positioning but don't alter the compound slide. Continue until you are satisfied with the appearance, **photo 7**. This outside dimension and shape have no influence on the operational use of the finished tool and is done for the satisfying quantity of swarf it produces, the appearance and because it may be something new to you.
10. The size of the central pin hole is dependent on the size of silver steel you have and also if you also have a reamer to match. If you don't have a reamer, get a new or at least an unworn drill the same size as your silver steel. Use plenty of cutting fluid/suds and a slow feed. If you do have a reamer the initial drilled hole needs to be slightly smaller (0.010 – 0.015" or 0.3-0.4mm should be about right). Then mount the reamer in your drill chuck, slide the tail stock up to the work and rotating the lathe chuck by hand slowly introduce the reamer by pushing the tail stock along by hand, ›



Reaming hole



Putting point on pin. Note red dot on chuck backing plate

photo 8. The use of all this "hand work" on this delicate operation is to enable you to "feel" the process as it proceeds. Later once you have done it a few times, well.

11. Happy now with the smooth fit of the silver steel in the hole the work can now be removed from the lathe and placed in a spot where you can look and admire it.

12. Chuck the silver steel rod, set over the compound slide and put a point on the end of the rod, **photo 9**. All this moving the compound slide and using it to provide the feed should by now be becoming familiar. Don't make a fine taper spear point, but a blunt point, perhaps 60 to 90 degrees.

13. To help preserve the point the silver steel needs to be heat treated. To do this heat the business end to a temperature of 750 – 800 degrees or a cherry red colour and quench in water. The point is now very hard and will probably shatter if struck. To temper the tip and make it usable it has to be heat treated again. Clean and polish the tip with emery. Now gently warm the end again but watch the colours that appear. When the point becomes a very light straw, approximately 150 degrees, quench again. By playing the torch flame just back from the tip as the metal absorbs the heat you will be able to watch as the colours, and therefore the temperature, run up towards the point. If you had made the point over sharp the heat and colours would rush up the point before you had a chance to react and quench.

14. I drilled and tapped a small hole in the side of the "handle" on mine to take a screw, this was done simply keep all the component parts together when the tool was not in use. ▮

Best Of British Magazine finds exciting new home at Mortons Media

Best of British Magazine, the nation's favourite nostalgia magazine, has joined the stable of titles at leading publisher and events company Mortons Media Group.

The magazine, which covers every aspect of life from the 1930s through to the present day, becomes the 25th regular title in the Lincolnshire-based publisher's portfolio of publications.

"We are delighted to welcome Best of British Magazine into the Mortons Media Group family," said Mortons' publishing director Dan Savage.

"Best of British has a rich legacy, and we are committed to building on that foundation, delivering engaging content to their readers and creating new opportunities for advertisers."

The UK's premier nostalgia and heritage magazine, Best of British celebrates classic entertainment, transport, food and drink, and the great British countryside.

Regular features include Treasures in the Attic – a look at recently uncovered antiques and collectables, Postcard from... which casts a spotlight on a British town or city to visit or stay in, and Window on the Past – a compilation of archive images and memories from The Francis Frith Collection. As well as a lively six-page Postbag, readers are able share their stories in our Yesterday Remembered memoir section, while Doctor Who star Colin Baker writes about his personal connection to some the issue's themes.

Features in the March issue include a celebration 60 years of Radio Caroline, a visit to Beaumanor Hall – Bletchley Park's unknown other half, a chat with the Hovis boy, the history of the London Cigarette Card Company, a look at a British radio hoax that predates Orson Welles' The War of the Worlds, and an interview with John Lloyd, the man behind Not the Nine O'clock News, Spitting Image, Blackadder and QI.

Over the past 12 months we've looked at the origins of Slade's Merry Xmas Everybody, gone on the trail of the real-life Dick Whittington, looked back on 100 years of the Shipping Forecast and 180 years of Nelson's Column, uncovered the history of Bentley Cars, and celebrated 70 years of Quatermass, the golden age of motocross, and the record-breaking InterCity 125.

We've also featured interviews with the stars of classic TV, film and music including Randall & Hopkirk (Deceased)'s Annette Andre, Blue Peter's Sarah Greene, Last of the Summer Wine's Sarah Thomas, Doctor Who's Janet Fielding, The Bill/Carry On's Larry Dann, Carry On's Jacki Piper, Grange Hill/EastEnder's Gary Hailes and Return of the Saint's Ian Ogilvy.

"The acquisition by Mortons Media is an exciting chapter for Best of British," said the title's editor Steve Stabler. *"We believe that this partnership will strengthen the magazine's position within the market and ensure its continued growth. We are confident that Mortons Media Group is the ideal custodian for this beloved publication."*

The next issue of *Best of British* published by Mortons Media Group will be the April issue, on sale March 28, 2024.

Readers' Tips

CHESTER MACHINE TOOLS

TIP OF THE MONTH WINNER!

Extending WiFi Range

This month's winner is Ian Richmond, who recommends a way for getting a wifi signal around old or large houses. (Thanks also to Richard Taunton for the first photo).

The writer of the article on resin printers suffered from wifi range limitations to his workshop (August 23 issue).

My house rambles with the router at one end. Wifi is not working in some rooms.

I use AV600 Powerline adaptors or similar. These are mains plugs with an ethernet port and come in pairs. One is plugged into a mains socket near to the router and linked to it with an ethernet cable. In the workshop the other plug is again plugged into a mains socket and linked to your PC with an ethernet cable.

The technology uses the house ring main cable and spurs to pass signals from plug to plug. Wifi is not being used. I use two pairs to link a HD TV and a PC.

We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'. Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 600 words and a picture or drawing. Don't forget to include your address! Every month we'll choose a winner for the *Tip of the Month* will win **£30 in gift vouchers from Chester Machine Tools**. Visit **www.chesterhobbystore.com** to plan how to spend yours!

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

An A to Z of Metals – G to P.

This short series by Neil Wyatt aims to clarify some of the technical terms you are likely to come across in Model Engineers Workshop and elsewhere, with the focus on terms relating to metals and their properties. It uses material from his Model Engineers Workshop Dictionary.

Galvanising
The coating of steel components with zinc, originally by electrolosis (i.e. Galvanic or electrical action), but now also used to refer top a hot-dip process. Due to the typically poor surface finish it is rarely used by model engineers.

Gauge plate
An oil-hardening high-carbon steel that is available as precision ground flats. It can be used for making form tools. It is also ideal for the making of small flat parts that need to be wear resistant such as elements of locomotive valve gear. The precise hardening requirements of gauge plate vary by manufacturer, but generally it requires a somewhat higher temperature than silver steel. It should also be quenched in clean oil, not water or brine, taking due precautions against the ignition of the hot oil.

Gilding
Any of many techniques for applying a very thin layer of gold to an object.

Gilding metal
A brass that is 95% copper and 5% zinc that has great ductility when annealed and is therefore much used for spinning.

Grain size
The mean size of individual crystals in a metal.

Grain structure
The mechanical properties of metals depend on their microscopic structure. Typically a metal is comprised of crystal grains of one or more compositions. The relative hardness and arrangement of these grains confer the metal with properties such as toughness and ductility. Work hardening occurs as a direct result of changes in the grain structure, where the grains physically move into new arrangements and 'lock together'.

Greensand
A mixture of damp sand and clay used for making moulds for metal casting. Named from the greensand of the Weald in Sussex (an area that was one of the centres of the pre-industrial revolution iron industry), a friable sandstone that weathers to produce such material.

Grey cast iron
A shock-resistant form of cast iron that is easily cast into intricate shapes. It machines well because the carbon it contains is in the form of inclusions of graphite, which acts to lubricate the cutting tool and the surrounding iron matrix is relatively low in carbon and well annealed. The free graphite can make machining cast iron a rather dirty task.

Hardening
The strengthening of metal by heat treatment or cold working. When carbon steel is heated above its critical point (typically 700-800°c) all the carbon in it goes into solid solution and forms austentite. As it is quenched more and more rapidly the layers of pearlite formed in the steel get ever finer. Eventually a point is reached, with a very fast quench, where angular crystals of martensite are formed. If quenching is too fast some austentite may remain; this will gradually convert into martensite by a process of ageing, possibly creating internal stresses and causing dimensional changes as the grain structure realigns itself. Martensite is extremely hard but brittle, and to be of practical use hardening must be followed by tempering. The hardening colours of steel can be used to judge its temperature sufficiently accurately for hardening.

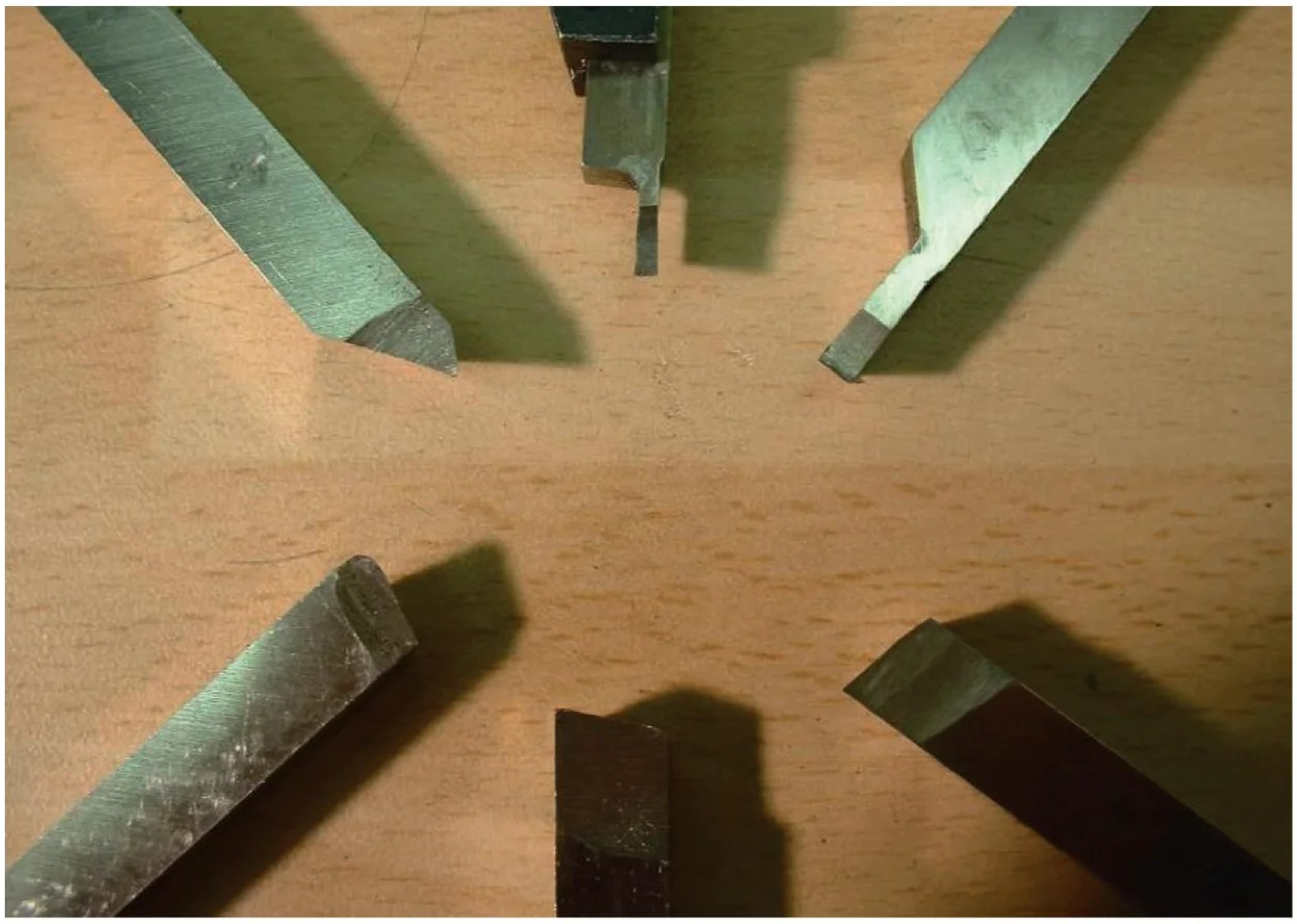
Hardness
A measure of the resistance of a metal to penetration, and hence indicative of its resistance to wear, damage or deformation. Hardness may be measured by a number of tests such as the Vickers and Brinell hardness tests. It is also possible to judge hardness comparatively using a hardness gauge. Steels show a close relation between hardness and tensile strength, though this is not true of many other materials.

Heat treatment
The alteration of the physical properties of a metal by the controlled application of heat. Heat treatment is used to harden, anneal, normalise or temper metals.

High carbon steel
Carbon steel with a greater carbon content that the carbon-iron eutectic.

High Speed Steel (HSS)
High speed steel, a wide range of alloy steels that show good resistance to wear and do not soften appreciably at even elevated working temperatures. It is now the commonest material for the manufacture of cutting tools, having displaced carbon steel in this role, although it tends to be softer, it tends to have longer working life. HSS can be readily ground so tools can be made from pre-hardened blanks. Annealed HSS can be worked by normal processes, but the resulting tools require hardening by rapid quenching in an air blast from white heat.

›



set, the wax pattern is melted out, the mould further heated to drive off any moisture, and the casting made.

Hydrogen embrittlement
A reduction in ductility of metals caused by the adsorption of hydrogen, for example during welding or electrolysis.

Hypereutectic steel
Carbon steels with more than 0.83% of carbon, they tend to be harder to machine in the unhardened state than lower carbon steels. See eutectic steel.

Induction furnace
A furnace that heats a metal charge by inducing powerful eddy currents in it, rather than by the conduction of heat from an conventional heater element.

Induction hardening
The hardening of parts of the surface of a steel or cast iron component by locally heating it by powerful induced electrical currents, followed by quenching.

Investment casting
A metal casting process involving the use of a ceramic shell formed around a pattern of wax or other material that is melted or burnt away before the metal is cast.

Iron
A moderately hard, silver-grey metal that readily alloys with carbon. Virtually pure iron is known as wrought iron, is relatively corrosion resistant, ductile and is no longer a common engineering material. Cast iron contains high amounts of carbon, often as graphite. Steels contain controlled amounts of carbon and often other elements alloyed with iron, and come in many different types with hugely different properties.

Iron carbide (FeC3)
Cementite.

Iron filings
The very fine, dust like swarf produced when machining cast iron.

Lead (lĕd)
A heavy, grey metal with a low melting point and high density. The heaviest of the commonly encountered metals. Lead and its compounds are poisonous. When added to metals in small quantities it can improve its machineability.

LM14
An aluminium alloy of moderate strength and hardness often used for casting, but also relatively easily machined. Also known as Y-alloy.

Lost wax casting
A process for the production of complex and detailed castings using a disposable pattern made of wax. The wax pattern is assembled and finished to a high standard and then embedded in a mould material appropriate to the metal to be used. Once the mould has set, the wax pattern is melted out, the mould further heated to drive off any moisture, and the casting made.

Machineability
A property of a material that lends itself to working with cutting tools. It is possible to make relative assessments of how well different materials can be machined. For example, brass is generally more easily machined than mild steel, whilst carbon steel is tougher. Generally, metals with high machinability cut freely, reducing chip size and the cutting forces required and improving the surface finish without materially reducing the other desirable properties of the material. Metals may have elements such as lead, sulphur and phosphorus added to make them more easily machined; such materials are described as free cutting. Some materials are known for their poor machinability, such as many bronzes that ten to 'grab' cutters. Stainless steels are notoriously hard to machine because of their rapid work-hardening, but free-machining alloys are available which have far better machineability.

Magnetite
A naturally occurring mixture of ferrous and ferric oxide, a hard iron ore with magnetic properties.

Malleability
The readiness of a material to be deformed. Malleable metals may be beaten or spun into shape without cracking. A malleable material may nonetheless work harden, and may need to be annealed a number of times as it is worked into shape. See ductility.

Malleable Cast Iron
An easily machined and relatively soft form of grey cast iron. Despite the name it cannot be wrought into different shapes when cold, but it is more resistant to fracture than common cast iron.

Malleableising
The process of converting hard white cast iron to grey cast iron by prolonged annealing causing carbon combined in cementite to concentrate as particles of free graphite.

Manganese
A metal used in the production of alloy steels. Manganese steel has increased strength and toughness.

Manganese bronze
Strictly a brass with a high zinc content together with small amounts of manganese and other metals. It is very strong and resistant to corrosion.

Martensite
An extremely hard form of carbon steel, created by rapidly quenching it when in the austentitic state. The exact hardness depends on the amount of carbon in the steel, and varies from 460 to 710 Brinell. Martensite is extremely brittle and it must be tempered before use by re-heating it and allowing it to partially convert to softer, but tougher forms.

Meehanite
A proprietary form of cast iron with an easily machined fine texture obtained by prolonged heat treatment. It is available as lengths of continuously cast bar with a thin 'skin'. In some cases, machining parts from solid Meehanite (or other cast irons with similar properties) is a viable alternative to using castings.

Metal
Elements characterised by relatively loosely bound outer electrons, which therefore tend to make them good conductors of electricity and heat, and liable to form positively charged ions in chemical reactions. Most metals are solids at room temperature, have fair to high strength and are easily alloyed with each other to obtain materials with different properties.

Mild steel
A plain steel with less than .25% carbon. Mild steel is cheap and readily available in all sorts of shapes and sizes, the down side is that it does not have the tensile strength or hardness of other steels. It is therefore an excellent raw material for components that are not heavily stressed. Bright drawn mild steel is sized by drawing through a succession of dies. If it is machined asymmetrically it has a tendency to distort as due to internal stress, but this can be overcome by normalising prior to machining. Black mild steel is hot rolled to size and has a poor surface finish, but it has low internal stress. Precision ground mild steel is bright drawn mild steel that is ground to a very accurate diameter.

Molybdenum
A metal used in the production of alloy steels. Molybdenum steels are strong, but remain ductile and can be easily worked even when very hard.

Monel Metal
A tough, bright, corrosion resistant alloy of two parts nickel to one of copper. It is smelted directly from a mixed ore naturally of these proportions.

Mould
A receptacle used to form molten metal into a useful shape, typically made of greensand. The mould is normally made by packing slightly damp moulding sand around a pattern. For some metals with lower melting points moulds of silicone or other metals (diecasting) may be used.

Muntz metal
A bright, hard brass of about 60% copper, 40% zinc originally developed as a replacement for copper for plating the hulls of wooden ships.

Music wire
The proper name for piano wire, stiff, hardened and tempered wire with considerable spring usually produced to standard wire gauge sizes.

Necking
An effect of a material being stressed beyond its yield point (if it has one) there is sudden increase in strain shown as elongation and thinning of the material (forming a narrow neck), often accompanied by a temporary reduction in stress. This can be clearly seen in an screw that has overstressed to the point of stretching, but without breaking. Because necking is accompanied by a decrease in cross section (and often by work hardening leading to brittleness) any affected parts should be discarded and the reasons for the overloading of the component investigated.

Nickel
A greyish metal with excellent corrosion resistance and high electrical conductivity. When nearly pure and in the annealed condition it is ductile and can be spun. When added as a component of nickel steels it increases their hardness and strength without reducing their ductility. It also allows hardening at lower temperatures, reducing problems of distortion.

Nickel silver
An alloy of about 55% copper with about 20% each of nickel and zinc. It solders well and is much used in the construction of small models from plate. It resists corrosion and resembles steel so can be used as an alternative to steel for making bright parts.

Nimonic
A tough, temperature resistant alloy typically used for the blades of gas turbines and other demanding applications.

Nitriding
A process of case hardening where nitrogen, not carbon, is introduced into the surface of the material. This involves the use of ammonia or other nitrogen rich material and is generally impractical in a home workshop.

Normalising
A way of relieving the tension steel by heating it to a red heat and allowing it to cool, distinct from annealing it does not necessarily affect the hardness of the material. It is always wise to normalise bright drawn mild steel if it is to be machined assymetrically, as it usually has high levels of internal stresses and can distort when machined. Black mild steel is sized when red hot and is less likely to distort.

Oil tempering
Tempering by heating in a temperature controlled oil bath.

Oil-hardening
A process for rapidly hardening suitable metals (typically some high-carbon steels) by quenching them from a high temperature in hot oil (with due safety precautions). Oil is a less drastic ›

quench than water or brine and less likely to cause distortion.

Oroide
A non-technical term for a gold-coloured brass.

Overheated
A metal is overheated if it is raised to a temperature where it develops a poor grain structure, but not actually burnt. It can be recovered by suitable heat treatment, such as normalising.

Oxidation
1. A chemical reaction in which an atom gives up one or more electrons.
2. A chemical reaction in which an element or substance combines with oxygen, as when a substance burns. Oxidation is the main process involved in metal corrosion. Most metals react readily with oxygen to form their oxide, with the rusting of iron and steel being the classic example. Metals that resist oxidation may simply be less reactive, such as copper which only forms its black oxide when heated strongly in air, or they may be very reactive but form a thin resistant layer of surface oxide, such as aluminium or chromium. Many other compounds are prone to oxidisation, such as plant based oils that degrade after long exposure to air.

Pattern
An object in the shape it is desired to make a casting, often made of wood, and used to make a mould. Patterns need to be made slightly oversize to allow for shrinkage of the metal casting, and to have a slight taper (draft) on their vertical walls to allow their easy extraction from the mould.

Pattern rule
A rule graduated oversize, so that a pattern constructed using it will automatically incorporate a shrinkage allowance.

Pearlite
The typical annealed form of carbon steel (Brinell hardness about 240), comprising hard crystals of cementite layered with rather more crystals of much softer ferrite. On heating above its decalescence point (700-800°c, depending on carbon content) pearlite changes into a solid solution of carbon in iron (austentite). Rapid cooling of austentite prevents these steels reverting to pearlite 'freezing' it in the form of very hard martensite (see hardening). Similarly hardened carbon steels can be annealed into the pearlite form by heating to above 800°c and allowing it to cool very slowly.

Peening
A process for surface hardening metals with repeated small blows, through a process of localised work-hardening. Traditionally a ball pien hammer is used, but other methods including shot-peening may be used.

Permanent deformation
A change in the size or shape of a component, the result of it being stressed beyond its yield point due to the application of external loads, that will not disappear when the load is removed.

Pewter
A fairly soft, dark coloured alloy, historically of tin and lead but latterly replaced by lead free alloys with similar properties and colour.

PGMS
Precision Ground Mild Steel.

Phosphor bronze
A copper alloy with high levels of phosphorus, characterised by high strength and wear resistance it is an excellent bearing material. It has a tendency to grab drills an reamers if care is not taken.

Phosphorus
A highly flammable element used in a many alloys, notably phosphor bronze.

Pickle
An acid bath for cleaning metal

Pickling
The process of cleaning metal by immersing it in an acid bath, often to clean of scale, spent flux and surface oxide after brazing or heat treatment. Many people use strong solutions of inorganic acids. A solution of citric acid (available in bulk from home brewer's suppliers) makes an excellent pickle and is far less risky to use. For small pieces of work household limescale removers also make an effective pickle. In the past the metal was often immersed as soon as its had faded from red hot to black, causing the acid to boil and spit, but aside from the hazards this approach can cause unnecessary strains on the work.

Plain steel
A steel which is comprised solely of iron and carbon, with any other elements only being present as impurities. Plain steels contain only iron and carbon, typically from 0.1 (mild steel) to 2% (carbon steel). Contrast with alloy steels.

Plate
A flat thin sheet of metal. A thin coating of metal over an object.

Precision ground mild steel
Mild steel ground accurately to size. PGMS is cheaper and possibly superior to silver steel for purposes such as shafts and axles that are not to be hardened.

Preheating
The practice of gently and evenly heating an object to an elevated temperature prior the application of more intense heat for hardening, brazing or some other process. The purpose may be to minimise distortion or internal stress or simply to make a procedure easier or more efficient.

● To be continued


MAXITRAK.COM
The best of model rail and road.
Tel: 01580 893030 Email: info@maxitrak.com
5" E.M Baldwin
Painted Kit
From £2,375
Complete Garden Railway
Discount Available!
5" Wren
Painted Kit
From
£4,995
5" Planet
Painted Kit £1,395
Ready to Run
£1,495
10-11 Larkstore Park, Lodge Road, Staplehurst, Kent, TN12 0QY
MAIDSTONE
ENGINEERING
SUPPLIES
01580 890066
MAIDSTONE-ENGINEERING.COM
info@maidstone-engineering.com
One stop model
engineering shop
Leading suppliers of fittings,
fixings, brass, copper, bronze, steel,
plastics, taps, dies, drills, machine tools,
BA nuts and bolts
Browse our website or visit us at
10-11 Larkstore Park, Lodge Road,
Staplehurst, Kent, TN12 0QY
New
Copper
TIG Welded
Boilers


HOME AND WORKSHOP MACHINERY
144 Maidstone Road, Foots Cray, Sidcup, Kent, DA14 5HS
Tel: 020 8300 9070 - evenings 01959 532199
website: www.homeandworkshop.co.uk
email: sales@homeandworkshop.co.uk
visit our eBay store! Over 7500 items available; link on website;
homeandworkshopmachinery
Check out our eBay store!
Chester Cub630 6 complete with lots of tooling £2950
3 1/2" Britannia class 4-6-2 rolling chassis and castings + completed tender and part built cab, modelled on 70054 Dornoch Firth (LSBC) check out our website for more pictures £1150
Colchester Bantam 2000 lathe (long bed) metric leadscrew, Dickson post £4950
Stanier precision vice 55mm jaw New / New Zealand £195
Myford Super 7B centre lathe; hardened bed,3 jaw chuck, Dickson tooling £4500
Harrison L5, M250, M300 / Colchester Student 1200 / 1800 lathe change wheels + A&S 1ES milling machine table gears
Wadkin wood lathe 6" centre height x 32" centres + 14" rear face plate on the rear end + 6 3/4" 3 jaw chuck £1150
Creuson Morrisflex 240V 8" polisher buffers £825 each
COLCHESTER Triumph 2000 lathe 7 1/2" x 50" bed held in stores section so very little work + taper turning attachment £9750
Myford gearbox unused £1000
Please phone 0208 300 9070 to check availability.
Distance no problem – Pallets leaving daily!– prices exclusive of VAT
Just a small selection of our current stock photographed!
Worldwide Shipping

On the

Wire

NEWS from the World of **Engineering**

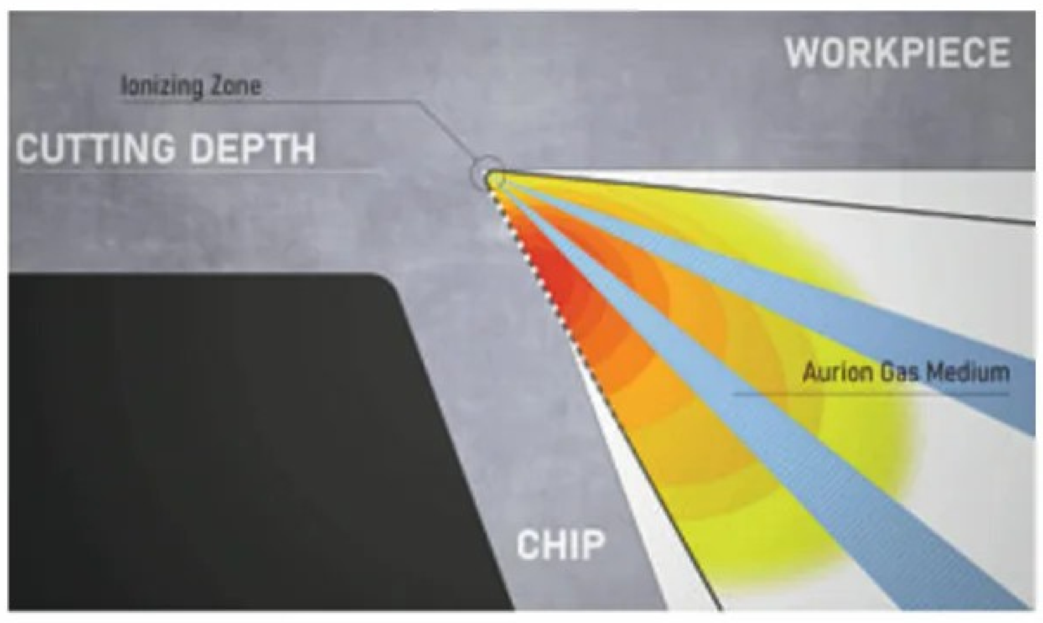
Ionized Air as an Alternative to Cutting Fluids

Disposal of used cutting fluids causes significant environmental contamination. Global annual consumption of cutting fluids is estimated to exceed 2 billion liters - although the actual amount of cutting fluids waste is assumed to be up to 10 times higher, as most fluids are diluted before their use. Cutting fluid treatment and their release to the environment leads to significant oxygen depletion and nutrient destruction in surface waters.

Aurion technology uses ionized air which generates an electrochemical process resulting in electron loss and atomic level transformation of the Aurion gas medium at the cutting surface. The electrochemical process acts as a dry lubricant in the cutting process, penetrating the cutting zone and optimising the interaction between the tool edge and the workpiece. This process accelerates oxide layer formation and significantly reduces the friction, thermal stress and tool wear.

The Aurion system consists of three components - ionizer, controller and air-cooling unit. The system is connected to the factory compressed air network and machinery CNC. There is no need for any special safety precautions as ionized air pressure remains at 2 - 3 bar and temperature in the -10°C to +10°C during machining operations.

Thousands of validation runs have proven that Aurion technology delivers at least the same machining quality and performance as cutting fluids – measured by cutting speed, tool life



and surface quality. Ionized clean air is safe for its operators and the relevant machinery and meets the highest standards for workpiece residuals.

Aurion technology is suitable for all machining applications and materials. It is easy to integrate to both existing and new machines, either by using the external piping to the cutting zone or by using existing coolant channels in standard toolholders and tools.

Gloucestershire Vintage & Country Extravaganza

The Gloucestershire Vintage & Country Extravaganza will make a welcome return to South Cerney Airfield, near Cirencester, on 2-4 August 2024. The show has grown considerably from its humble beginnings in 1975 on a football field in Stonehouse, and is now among the largest events of its kind in the country run entirely by volunteers. Now after nearly 50 years, it's regarded as one of the biggest and best steam, vintage and countryside events in the UK, celebrating all modes of vintage transport.

The Gloucestershire Vintage & Country Extravaganza will once again boast a huge array of vintage transport, from buses and coaches, classic cars and motorcycles all the way through to pushbikes, vintage caravans and much more! There are three live arenas that are an integral part of the educational aspect of the show, and feature demonstrations, vehicle parades and commentary.

A major star of the show is the magnificent steam section, which is packed with 30 miniature steam engines, 70 stationary engines and 60 full-size steam engines of all descriptions. For many visitors, seeing the fabulous line-up of showmans' engines, with their gleaming, twisted brass, really is a highlight. The 'Demonstration Arena' puts the mighty machines to the test, and there's even the opportunity to drive one. Also, don't miss the grand parade of miniature steam in the Alec Tanner arena, and be sure to check out the steamrollers in action.

Every mode of vintage transport is represented, and in motion – from

a huge display of heavy haulage commercial and industrial trucks, mixed with classic plant and machinery, to more than 160 military machines, American auto trucks and ex-emergency services vehicles. You might even get a bit wet from the fire-tender demonstrations!

Advance tickets available until Thursday 1 August. Visit: www.glosvintageextravaganza.co.uk

Magnetic Lifters

Readers struggling to move heavy chucks and other items safely, even with a workshop crane, may be interested in this new product from Eclipse.

Eclipse Magnetics is delighted to announce the launch of Ultralift E, a new choice in high performance lifting and handling. Ultralift E utilises the latest magnetic technology and manufacturing techniques to provide safe, efficient, accurate and cost-effective steel lifting.

Designed with safety uppermost in mind, a combination of permanent magnetic technology and an integral locking device on the handle ensures the load cannot be released while in mid-lift. Ultralift E's 3 to 1 working load limit safety factor means customers can rest assured that the load is secure.

Ultralift E also offers a wealth of other benefits, such as single person operation, single-face contact, instant engagement and non-marking of load, increased lift efficiency, optimised storage space, and zero running costs. We also offer a Service Care & Maintenance Package to help you maintain your lifter using our own in-house fully trained engineers to help you achieve the correct annual certification requirements helping to protect your investment.

To find out more, visit www.eclipsemagnetics.com/products/lifting-and-handling/ultralift-e/

New supply system for methanol improves safety and saves energy at sea

The Danish company Eltronic FuelTech is now the first in the industry to offer equipment for supplying fuel from tanks to engines on methanol-powered ships. This can save shipping companies both money as well as energy while enhancing safety.

The naming of Laura Mærsk, A.P. Moller-Maersk's first container ship that can sail on green methanol, marked the start of more sustainable shipping. In the wake of this, the Danish engineering company Eltronic FuelTech has now launched a new supply system – a so-called Low-flashpoint Fuel Supply system (LFSS) – for this particular vessel.

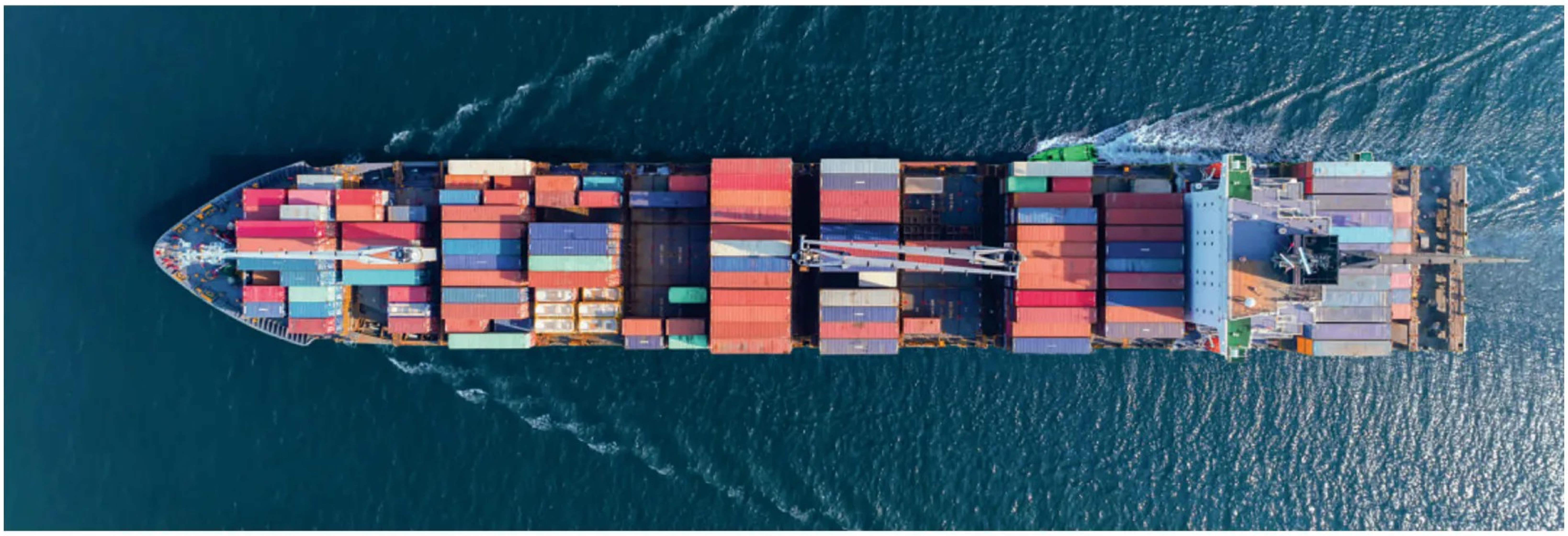
"Embracing green methanol as a fuel has been increasing markedly in recent years, and with the new LFSS system, we can make a significant contribution to the green transition of the shipping industry. In the past, several suppliers were required to put together a complete fuel supply system all the way from the fuel tank to the engine, but the fact that we can now supply the entire system brings multiple benefits," says Louise Andreasen, CEO at Eltronic FuelTech.

While most other supply systems on the market use two pumps to pump the methanol around, Eltronic FuelTech has managed to create an LFSS with only one pump, thereby saving considerable energy. In addition, it is now possible to adjust the pump depending on the engine load, so that only the right amount of methanol is supplied to the engine, something which has not been possible until now.

This means that if a ship is sailing slowly, the pump automatically adjusts to the load, so that it only runs at 60% of full power for example. With other systems, unnecessarily large quantities of methanol are pumped around the system, which clearly affects electricity consumption, especially on large ships.

With the biggest engines on container ships, for example, the pumps usually use more than 100,000 kWh a year pumping the methanol from the fuel tanks to the engine. With our new supply system, we expect to be able to cut consumption by up to 40%.

In addition to developing systems for a ship's main engines, Eltronic FuelTech has also developed a compact combined system to supply the ship's auxiliary engines with fuel from the tanks.



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. This interesting short article by former editor Dave Fenner appeared in **MEW 105**, April 2005. Look out for an interesting new article from Dave about sheet metal work in the next issue.

INCONCLUSIVE EXPERIMENTS

Dave Fenner reports partial success with manufacturing trials

Background

I mentioned in a recent editorial note that in making the centre electrodes for Bentley spark plugs, I had eventually resorted to machining from solid, taking the material down from 0.25in. dia. to 0.0625in dia. in one pass, then drawing the material further out for a second bite. A 10BA thread was cut with a tailstock mounted die, and the head diameter of 0.165in. turned before parting off. Using the dead length collet chuck accessory in the Myford Super Seven concentricity was assured, even though the bar was moved and re-clamped. This method follows the practice that would be adopted on industrial sliding head CNC lathes. A finished spark plug is shown in photo1.

As this was going to take a fair bit of time, I felt it might be worthwhile investigating whether other methods might work, and two avenues were indeed explored. In each case a degree of success was achieved, and I believe that with further perseverance, viable production methods would result, which might also be applied to other components having a long slim section and a larger diameter head. I should perhaps add that I had earlier searched many hardware stores to see if a common or garden nail of appropriate size could be found.

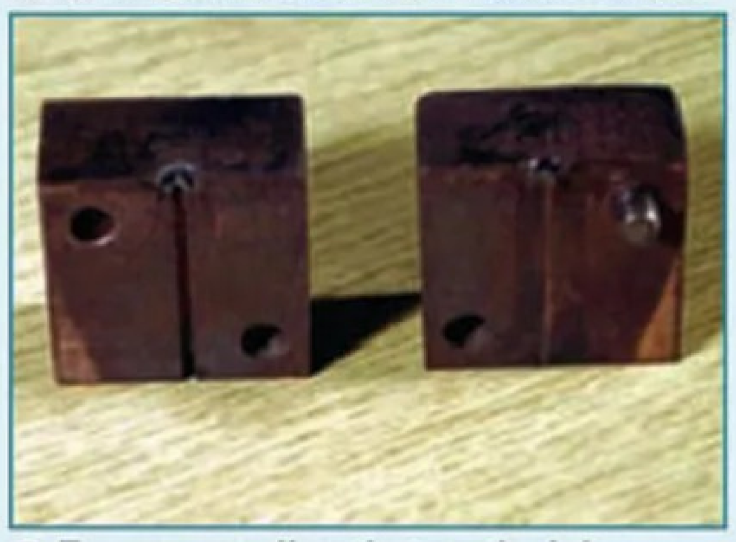
1. Completed spark plug showing centre electrode in place.

Casting method

It had occurred that it might be possible to produce the large diameter head by melting down a length of 0.0625in. dia. wire. For the experiments, lengths of ordinary welding rod were used, the heat being applied by a TIG torch set on very low power. It is likely that the same effect could be achieved by either an oxy acetylene flame, or one of the old twin carbon arc torches powered from a stick welding set.

Some means had to be devised to hold the wire, to give shape to the head and to make the earth connection. My solution was the pair of copper dies shown in **photo 2**. A groove was machined in one half only, and for simplicity, this was cut to a rectangular shape 0.0625in. wide, and a few thou less in depth so that when clamped together the wire would be tightly held in position. A recess of about $\frac{3}{16}$ diameter and $\frac{1}{16}$in. deep was then machined on the top surface to coincide with the wire centreline. On the basis that the larger diameter has an area of nine times the smaller, trials proceeded with about half an inch of wire protruding, as in **photo 3**. The method then adopted was to locate the dies in a small vice with the earth lead connected, then melt down the wire with the torch (held in the left hand), and finally quickly smack with a small hammer (right hand).

A number of parts were knocked out using this system, but subsequent machining of the head threw up a flaw, in that a significant proportion suffered blowholes. Discussions with my friendly metallurgy guru, Jim Brown have since suggested that it could be better to shape the recess more like a hemisphere, and thus improve the flow of molten metal

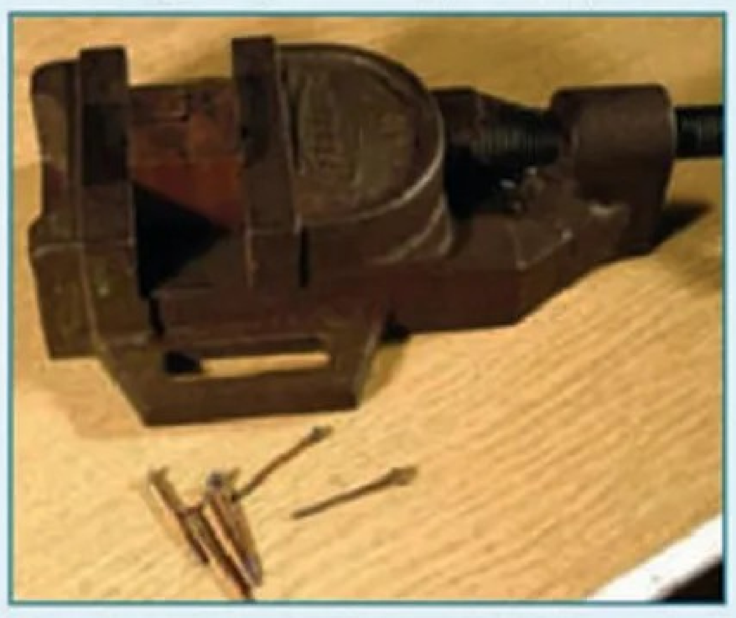


2. Two copper dies, that on the left features the location groove.

Welding method

A second line of thought was to make the disc for the head by punching out from sheet steel and then to weld this on to the wire. The punch parts in the Roper-Witney device each feature a small spike probably intended to locate on a centre punch mark. Centre punching heavily and then punching out the blank yielded a disc with a depressed centre, which in turn could be located on the end of the wire. The same copper dies were used for wire location again, ensuring good electrical contact. However, this time they were used inverted (the recess being unnecessary) and clamped by a G clamp, with a piece of perforated cardboard being used as an insulator under the disc. The assembly was then manipulated between the electrodes of an automotive spot welder, set (after one or two abortive efforts) to minimum current and just one pulse. A satisfactory joint was achieved, but the combination of force and plasticity meant that the end of the wire deformed sideways as in **photo 4**. I believe that with more time spent developing a restraining jig-cum-insulator, this system could well have borne fruit.

For the future, should any reader continue these lines of experiment, I should be extremely interested to hear of the outcomes.



3. Wire clamped in dies ready for application of welding torch.

4. Spot welded assembly has deformed sideways.

Micro-milling with a home-made contraption

Mike Tilby describes the construction of a scratch built machine tool for high-speed milling.

"*One of the attractive features of model engineering as a hobby is the comparative lack of competitiveness as a result of which no one is obliged to please anyone but himself. Long may it continue.*" (Geo. H. Thomas, **Ref. 7**)

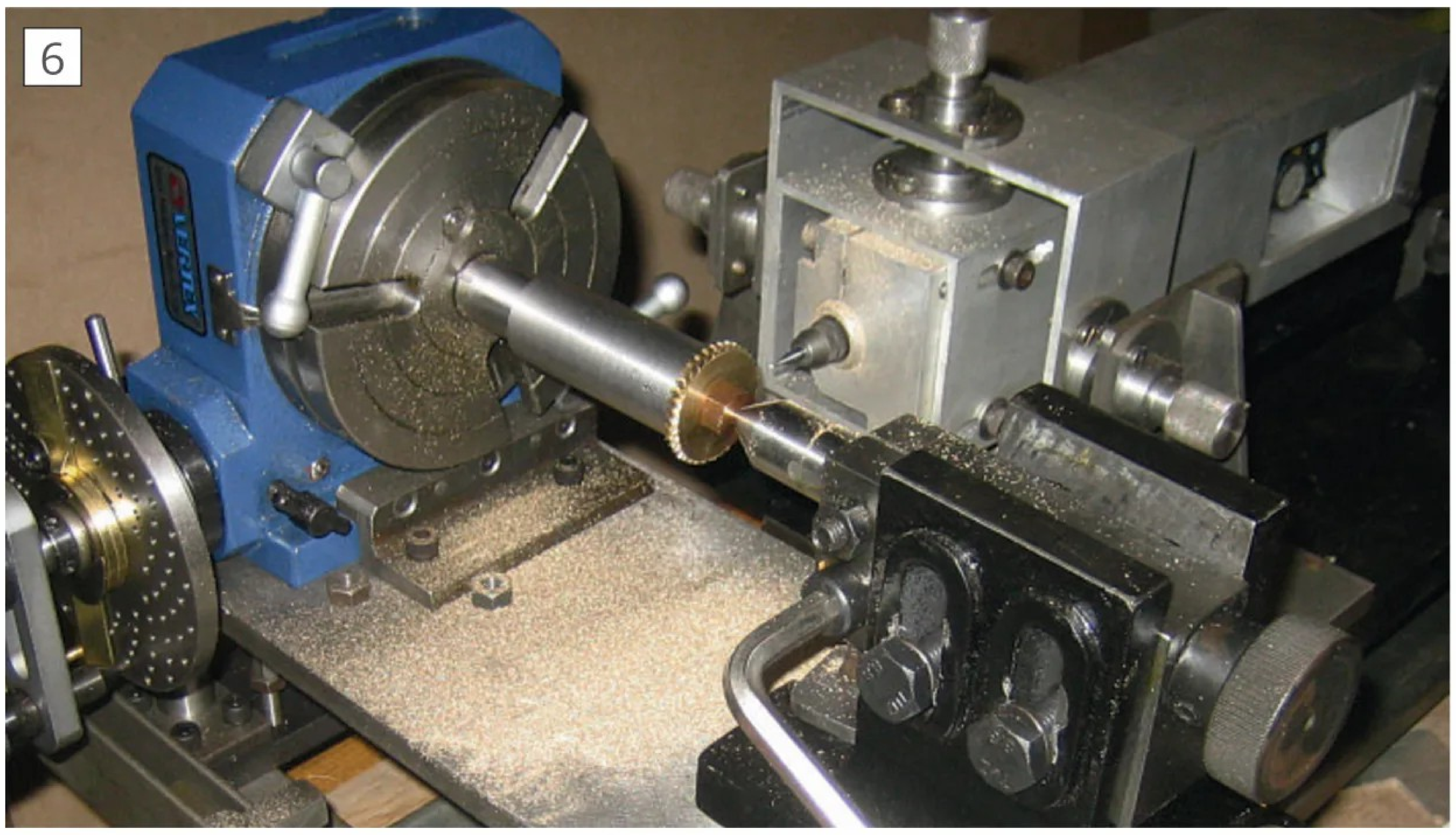
The above words greatly pleased me when I came upon them recently in '*The model engineers workshop manual*' since I feel that this philosophy is particularly apt for the present project. It has already been explained why micro-milling was important for my aim of building a miniature steam turbine. As will be discussed later, four-axis cnc micro-milling would undoubtedly have been the best way to cut turbine blades and, after building this equipment, I saw that it was possible to buy on Ebay, for just a few hundred pounds, a new four-axis cnc micro-milling machine with a 25,000 rpm water-cooled spindle. However, at least for the example that I saw, it seems one would have to accept dependence on an out-dated PC operating system (which might not be compatible with modern CAM applications) and possible difficulty in obtaining spare parts, advice, etc from China. Also, in many ways a ready-made machine would not have given the same satisfaction as the contraption about to be described.

How to generate the blade profiles

As far as I am aware, the first published description of properly shaped miniature turbine blades appeared in the 1940s and was by SMEE member Mr Elkin (**ref. 8**). He used a Taylor-Taylor and Hobson pantographic engraving machine. He gave no details but I assume he used equipment similar to that shown in **photo 5. (**For details of these tools see **refs. 9** and **10**). They are

5

Taylor Hobson type CXL pantographic engraver. (Photo courtesy of David Knight who has an interesting web-site: http://g3ynh.info/index.html)



Front end of the micro-milling contraption showing the Proxxon IB/E fitted in a Carden mount.

mostly large floor-standing machines although a bench-mounted version was also produced (See **ref. 11**) and, in their day, they were quite expensive. The milling spindle of the example shown in photo 5 was belt driven at up to 15,000 rpm. Movement of the spindle was controlled by a stylus which was moved by the operator over a drawing or template laid on the platform on the upper right of the machine, as shown in a video (**ref. 12**). The stylus is connected to the spindle by a set of levers that form a classic pantograph. Adjustment of the effective length of the levers allows the cutter movement to be reduced, relative to the movement of the stylus, by a variable factor of up to about thirty. I thought about the possibility of a home-made version of such a machine but the large number of pivoted arms and levers together with the need for the motorised spindle to be held rigidly while moving in two dimensions made this seem too much of a challenge.

Prof. Chaddock was inspired by the turbines built by Mr. Elkin but he did not have the use of a pantographic engraver, so he devised his own much simpler and less ‘clunky’ blade milling device (photo 3 in Part 1 and **ref. 13**). In this, the single ball race in which the milling spindle rotated was of the spherical type and that allowed the orientation of the shaft to be changed. The bearing, **fig. 3**, was located 1.125 in. from the tip of the cutter which was held in a collet chuck on one end of the shaft. The other end of the shaft (the tail) was 11.25 in. from the bearing and was terminated by a small spigot. Thus, any movement of the tail-end was reflected in movement by the cutter tip, except the cutter movement was ten-fold smaller in extent and in the opposite direction to the tail’s movement. Prof. Chaddock made a template in which there was a groove with a width that matched the diameter of the spigot on the tail of the spindle. The groove was shaped to give the desired form of the gap between the miniature turbine blades but it was ten-fold larger. This template was mounted so that the tail-end of the spindle could be moved by hand around the groove to cause the cutter to move across the edge of the turbine disc so as to cut the gap between adjacent blades.

CNC

As is to be expected, industrial micro-milling machines are invariably computer numerically controlled and are often equipped for more than the minimum three-axis movement. Despite using very small cutters, machines of this class need to be well built in order to ensure accuracy. Also they must be able to move the slides through extremely small and precise distances. This means that good stepper-motor powered ball-screws seem to be the minimum standard acceptable and more precise techniques for moving the work table and measuring its position have been widely adopted with movement in some machines being driven by linear motors coupled with accurate sensing of position. Sometimes slides move on air lubricated slide-ways rather than rolling bearings. Links to examples of micro-milling machines of this class are given as **ref. 14**.

The design choice

I considered the possibility of constructing a conventional three-axis mill based around the Proxxon IB/E

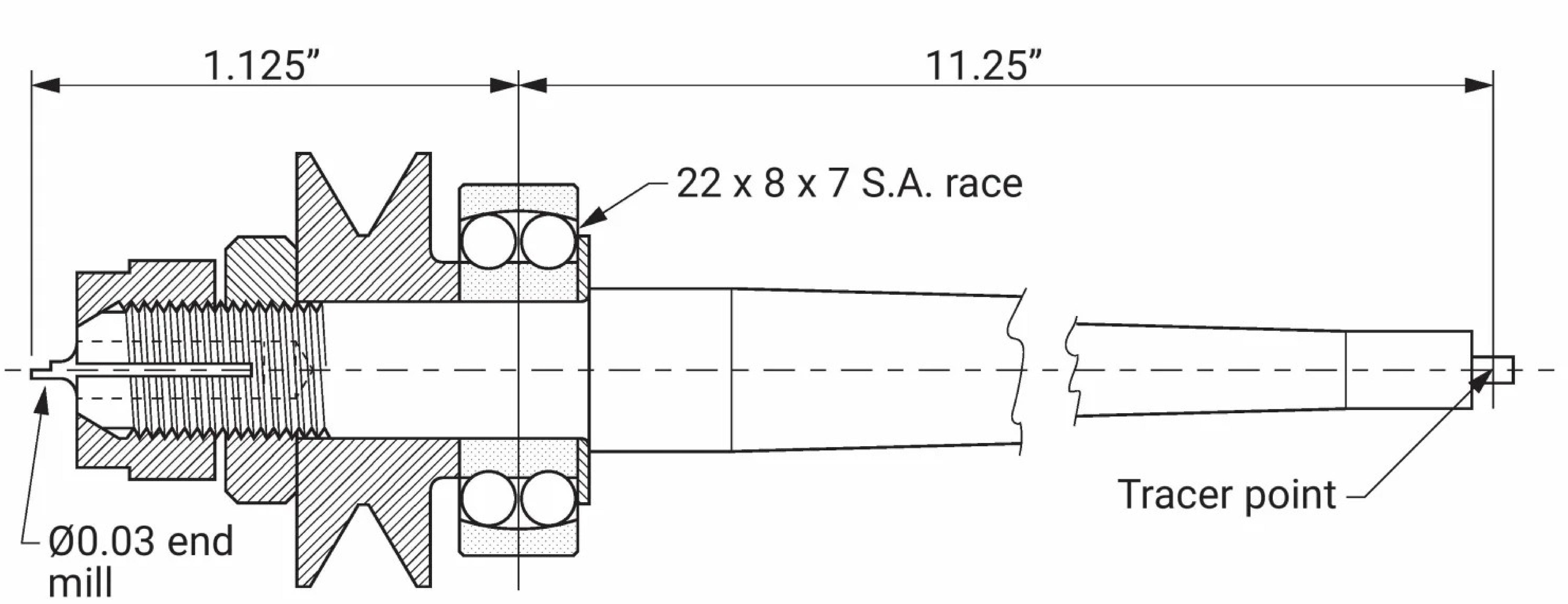


Figure 3

Prof. Chaddock’s blade cutting milling spindle. (From Ref. 13)

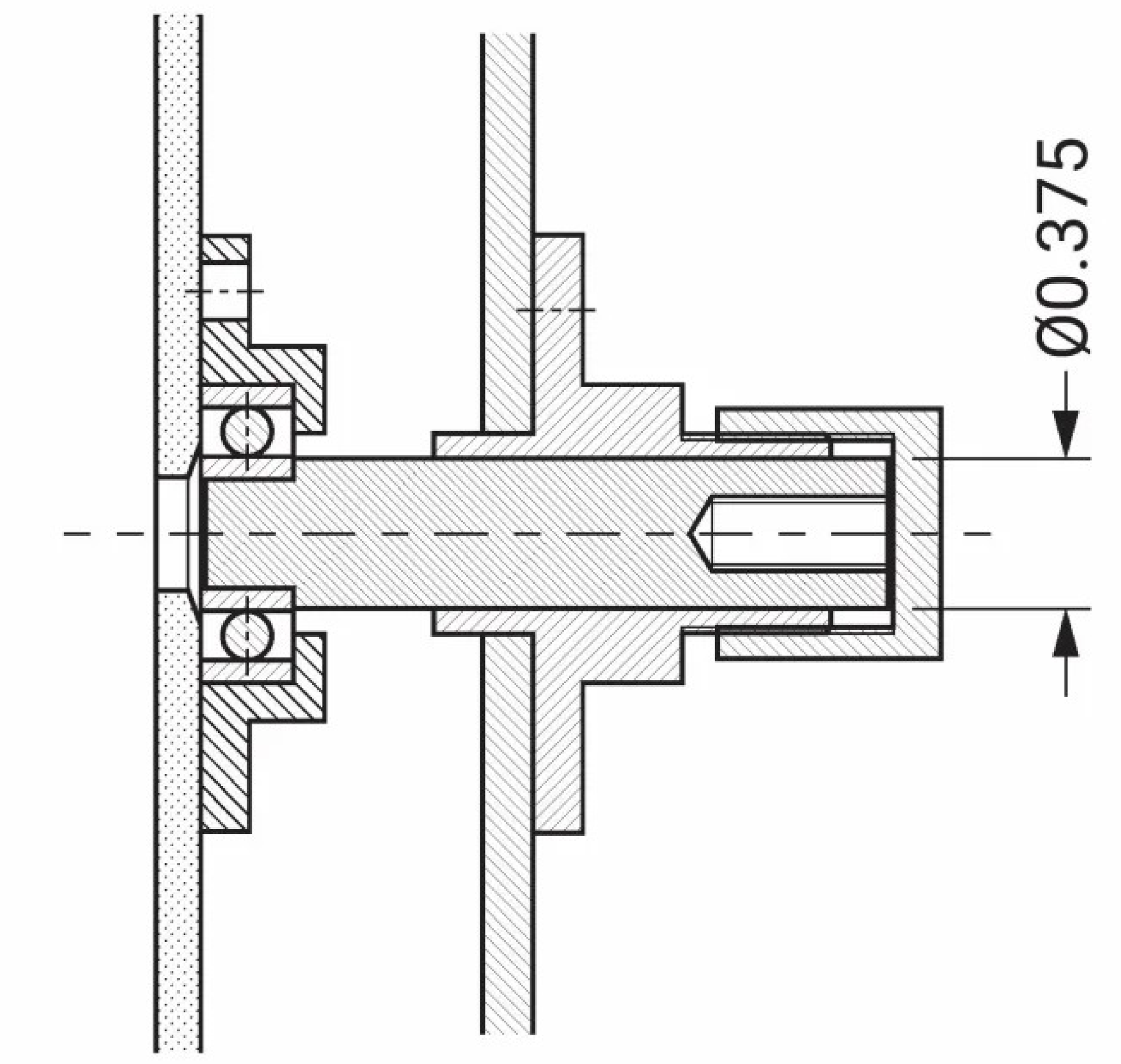


Figure 4

Bearing for the gimbals of the Carden mount.

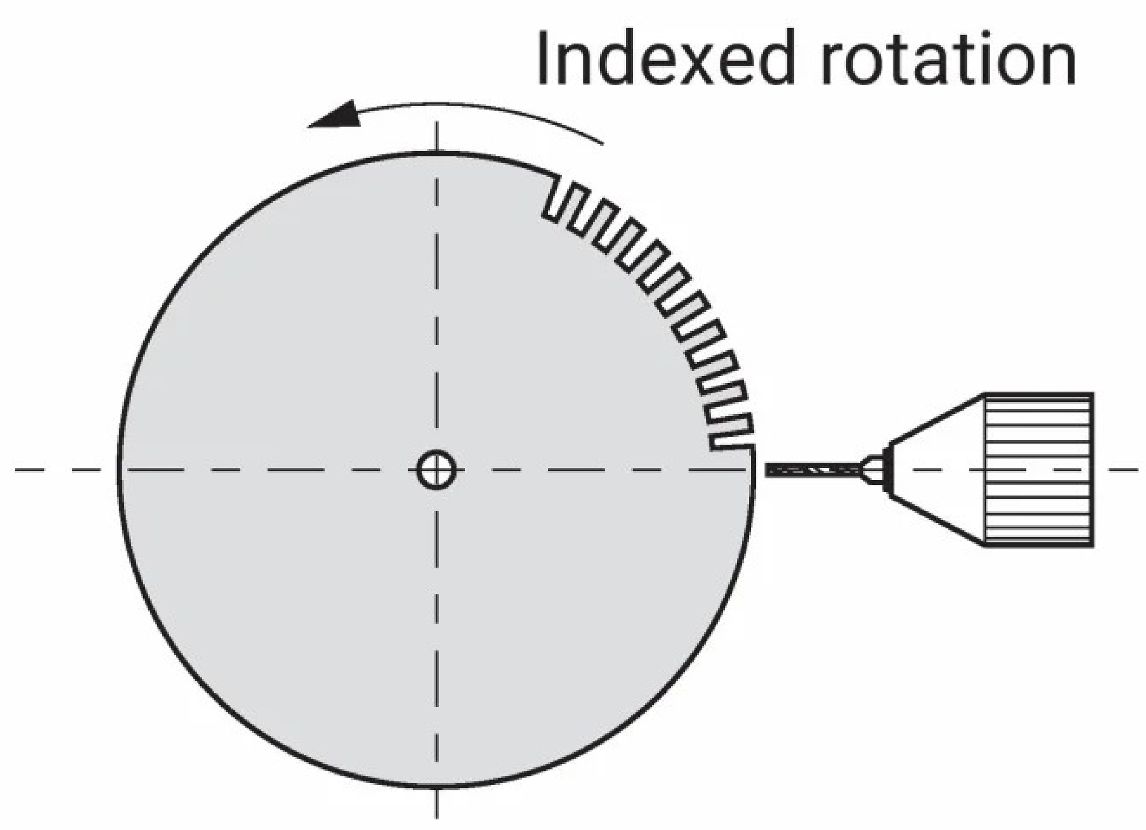


Figure 5

Cutting blades in the periphery of a rotor disc.

which I had chosen as the spindle to be used, as described earlier. In this arrangement, each axis would require fine feed ball screws and some type of hardened rail with linear bearings. When I started the project, I had very little idea about which of the numerous types and qualities of these components would be appropriate. (Since then I joined SMEE where plenty of advice about the use of these types of components is available via on-line meetings etc). Also, I felt uncertain that such a machine would have sufficient resolution to produce smoothly curved blades just 0.08 inch wide. Furthermore, being experimental, the project could entail a lot of dismantling for modifications, and I was unhappy about the prospect of losing balls from the linear bearings and ball-screws. Finally, I did not like the idea of being unable to easily adjust the length of the hardened parts. On top of all this there was another challenge – namely the need to obtain a fairly sophisticated cnc programme and the associated electronics to control the stepper motors. I say it would need to be sophisticated because the profiles of turbine blades are essentially nothing but a collection of curves. These can be complex, and they should merge together without any sharp change in tangent at the junctions. I had read that machining smooth complex curves was one of the more difficult aspects of cnc programming and I knew that companies building full size steam turbines use specialised programs for generation of blade shapes. More recently I have learnt that cnc programs that are available affordably to hobbyists have become much more sophisticated over recent years but, by then, my project had already started along its own untrodden path.

All the above-mentioned factors indicated to me that to build a cnc mill would entail a considerable investment in hardware, software and learning. Also, if the turbine project for which it was needed proved unsuccessful, the micro-mill would get abandoned since I could not foresee many other applications where I would use it. Another very important factor was that I am happier when I can minimise dependence upon specialised commercial components. Instead I prefer the freedom of making my own bits and pieces - within limits of course - especially if I can make use of items collected over the years because they "might come in handy".

The plan

As outlined above, in Professor Chaddock's blade-milling device the cutter was moved by tilting the spindle. This seemed to me a beautifully simple and mechanically robust way to generate very small blade profiles. The machine that eventually evolved in my shed comprised a Proxxon IB/E mounted inside a length of square aluminium tube (material with an outside width of 2.5 inches and 0.125 inches wall thickness proved suitable). The neck of the Proxxon was gripped in a clamp that was attached to the inside of the tube by screws that passed through slots to allow its position in the tube to be adjusted, **photo 6**.

The aluminium tube was surrounded by a short length of a larger square aluminium tube (external width 100 mm). It was suspended in the middle of this by a pair of vertical gimbals. The outer tube was itself suspended on a pair of horizontal gimbals which were attached to a pair of vertical supports fixed to a base plate. The gimbals consist of ball races mounted in holders, **fig. 4**. The knurled caps on the pivots allow fine adjustment to ensure there is no side play in the bearings. So long as the two pairs of gimbals are in the same plane then the assembly acts as if it pivots at a single central point. This arrangement is sometimes called a Cardan mount (named after a 16th century Italian polymath called Gerulamo Cardano). It is equivalent to the joints at each end of a Cardan shaft. The main feature for this project is that it allows the orientation of the spindle to be changed in a manner equivalent to the spherical bearing in Professor Chaddock's blade milling device.

This way of moving the cutter is simple and robust but it has disadvantages. However, before describing its pros and cons, it is probably worth saying that I was encouraged to adopt this design by the thought that: "if it was good enough for Prof. Chaddock then it should certainly be O.K. for me!"

The overall procedure involves holding the plain turbine disc in an indexing device so that the edge of the disc faces the end of the cutter, and the centre of the disc is aligned with the centre line of the horizontal milling spindle. **fig. 5**. Moving the cutter across the edge of

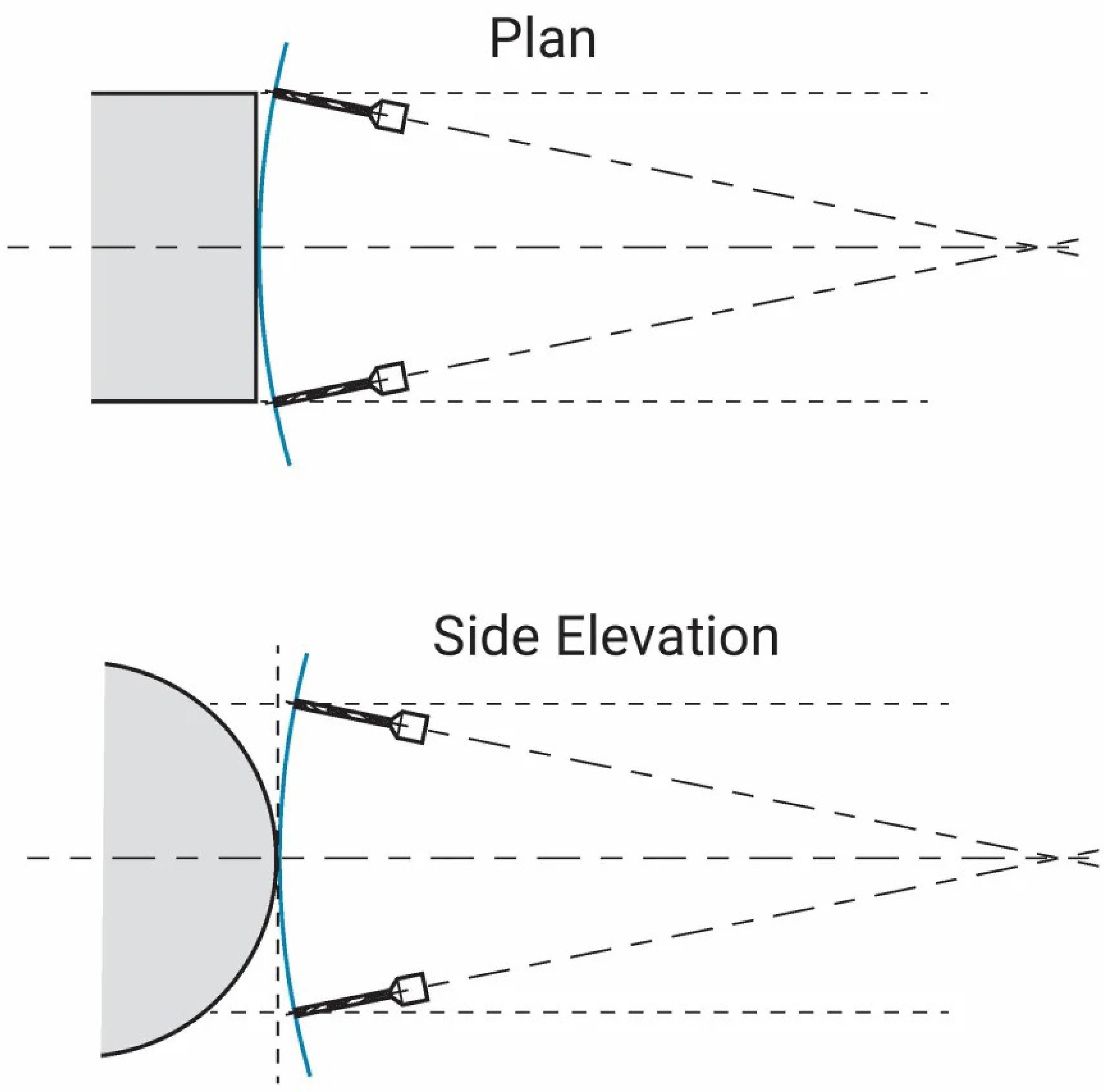


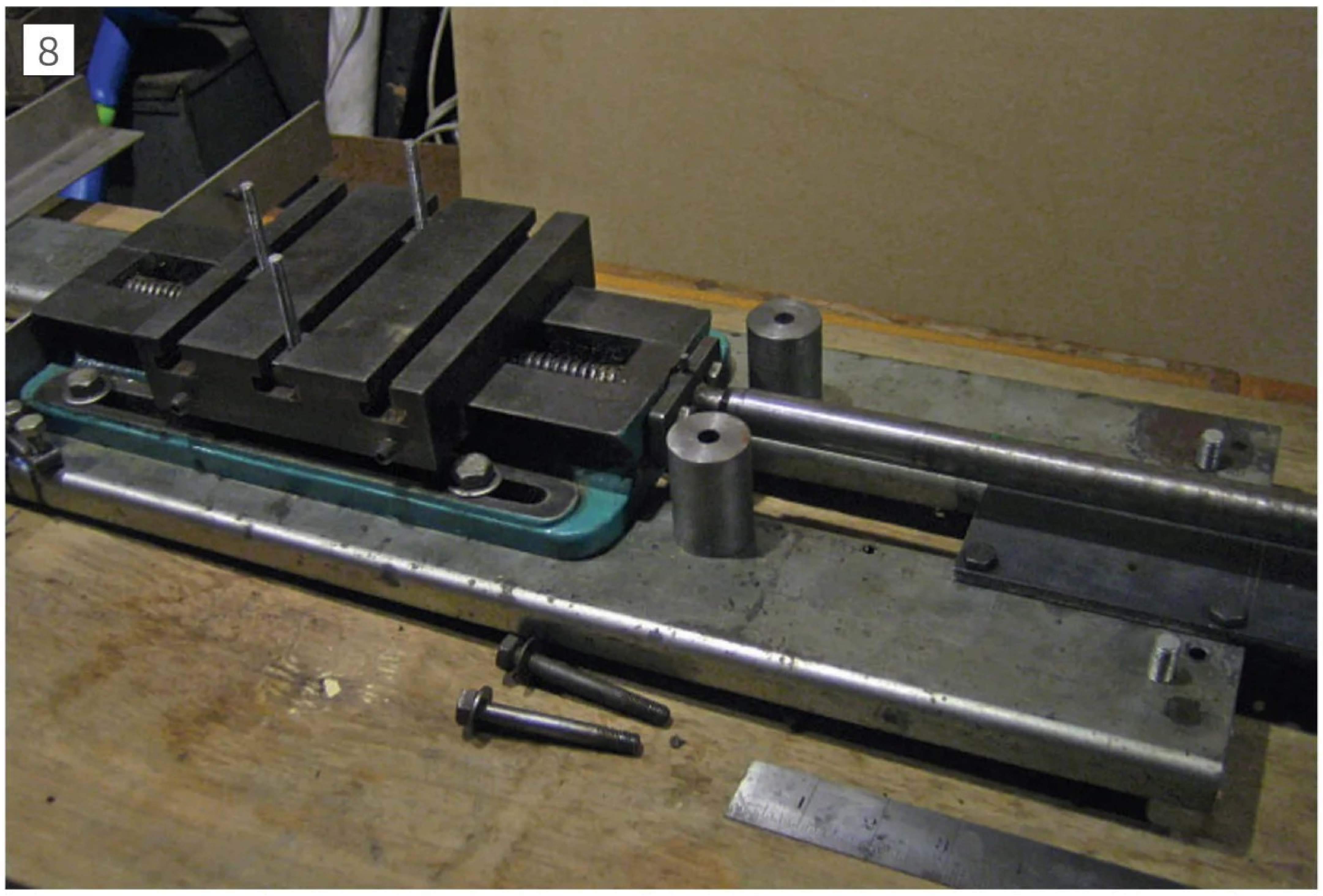
Figure 6

Curvature errors (exaggerated) due to the tilting spindle. Plan view shows curvature of cutter path during movement horizontally across the edge of a turbine disc. The side elevation shows how the curvature of the disc adds to the problem as the cutter is moved vertically. The horizontal dashed lines show the maximum extent of movement of the cutter.

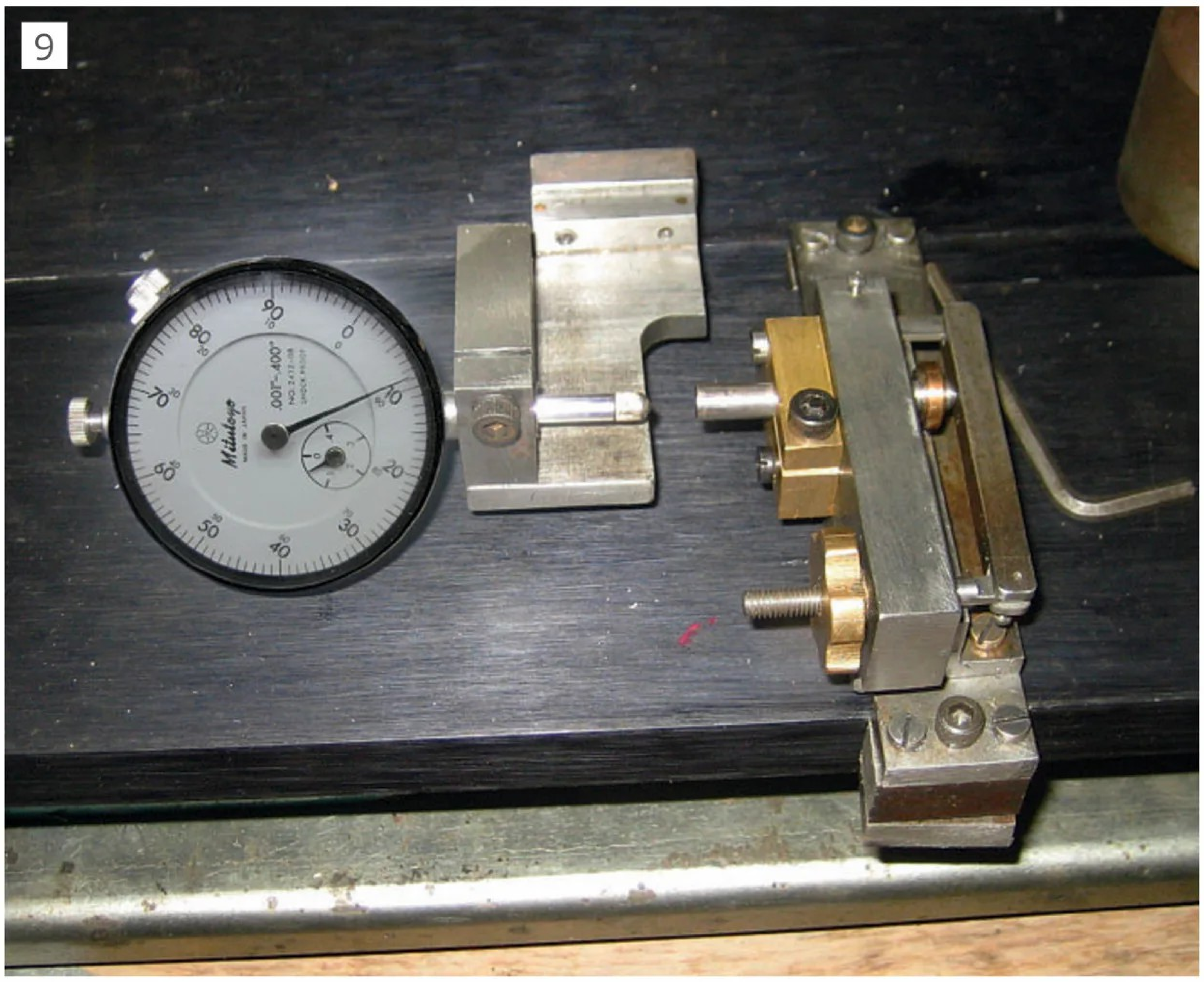
the disc results in the cutting of suitably shaped slots in the disc so as to leave the blades. The disc is indexed round to each position in turn and the blade-cutting procedure repeated.

Of course, a disadvantage of the tilting spindle design is that as the cutter tilts away from the centre line of the device the angle of the cutter changes relative to the centre-line of the blade being cut. Also, the tip of the cutter follows a path that maps on a spherical surface, and it cannot produce a flat surface. However, when cutting small items these errors are very small. In **fig. 6** the effect of this curvature is exaggerated so it can be seen more clearly. The importance of these effects depends on the type of item being created. For turbine blades, so long as the width and height of the blades are small relative to the distance between the cutter and the spindle's pivot point, the errors will not be significant and, in any case, flat surfaces are rarely found in turbine blades. Furthermore, as will be

Template holder near the end of the two hollow aluminium planks forming the platform that carries the milling spindle.


8

The main slide mounted on inverted steel U-section showing the two steel pillars for supporting the dial gauge holder.



9

Dial gauge for measuring movement of the main slide, supported on the pillars shown in Photo 8.

described in the next episode, a slight tilting of the cutter axis could actually be advantageous. An alternative approach would use a conventional basic XY type of control for the spindle movement. That would give a parallel-sided blade but if the disc is rotated blade-by-blade, both methods give poor geometry at the base of the inter-blade gap. The ideal approach would be to use a milling machine with four axis control where the rotor disc can be rotated in a way that is synchronised with the XYZ movement. I am greatly impressed when seeing such machines in operation (at the Parsons/Siemens factory and on videos such as in **ref. 15**) but my brain gives up at just thinking about how to programme a machine to carry out such complicated synchronised movements. However, if I ever fit a stepper motor to the indexing head of the contraption, I might try a simplified approximation of this procedure.

Axial movement

The pivoted spindle provides the means to move the milling cutter around a blade profile but some means is needed to adjust the depth of cut into the edge of the rotor disc. This could be achieved either by moving the workpiece or by moving the spindle, together with its Carden mount and the template. My choice of design was determined by the materials I had available which had mostly been accumulated over several years from discarded equipment where I used to work. The spindle support and the template holder were mounted on a pair of black anodised aluminium hollow planks, **photo 7**. These were held 0.5 inches apart by suitable spacers. These planks were attached to a large heavy slide, **photo 8**, that had been salvaged from a scrapyard by my Dad over fifty years earlier. An extension was fitted to the handle of the slide so it could be operated from beyond the end of the planks. The slide was bolted to a pair of heavy U-section steel strips each three inches wide.

It is important to control the depth of cut accurately and that was achieved using the dial gauge shown in **photo 9**. This is fixed to a support that passes through the gap between the two aluminium planks. Beneath the planks the support is fixed to a bar which is bolted to the two steel pillars visible in photo 8. The plunger of the dial gauge can press against an anvil attached to the planks. This is finely adjustable via the screw and can be locked in position by the socket headed screw in the brass clamping block.

Tilting spindle design

My version of the Chaddock tilting spindle machine was designed so that the distance between tip of the cutter and the plane of the gimbals in which the spindle pivots, was about 2.2 times larger than in Prof. Chaddock's device (i.e. 2.5 inches instead of 1.125 inches). The increased distance means that, for the same maximum width of the machined part, the angle through which the spindle tilts is 2.2 times smaller and the degree of curvature of the cutter

›

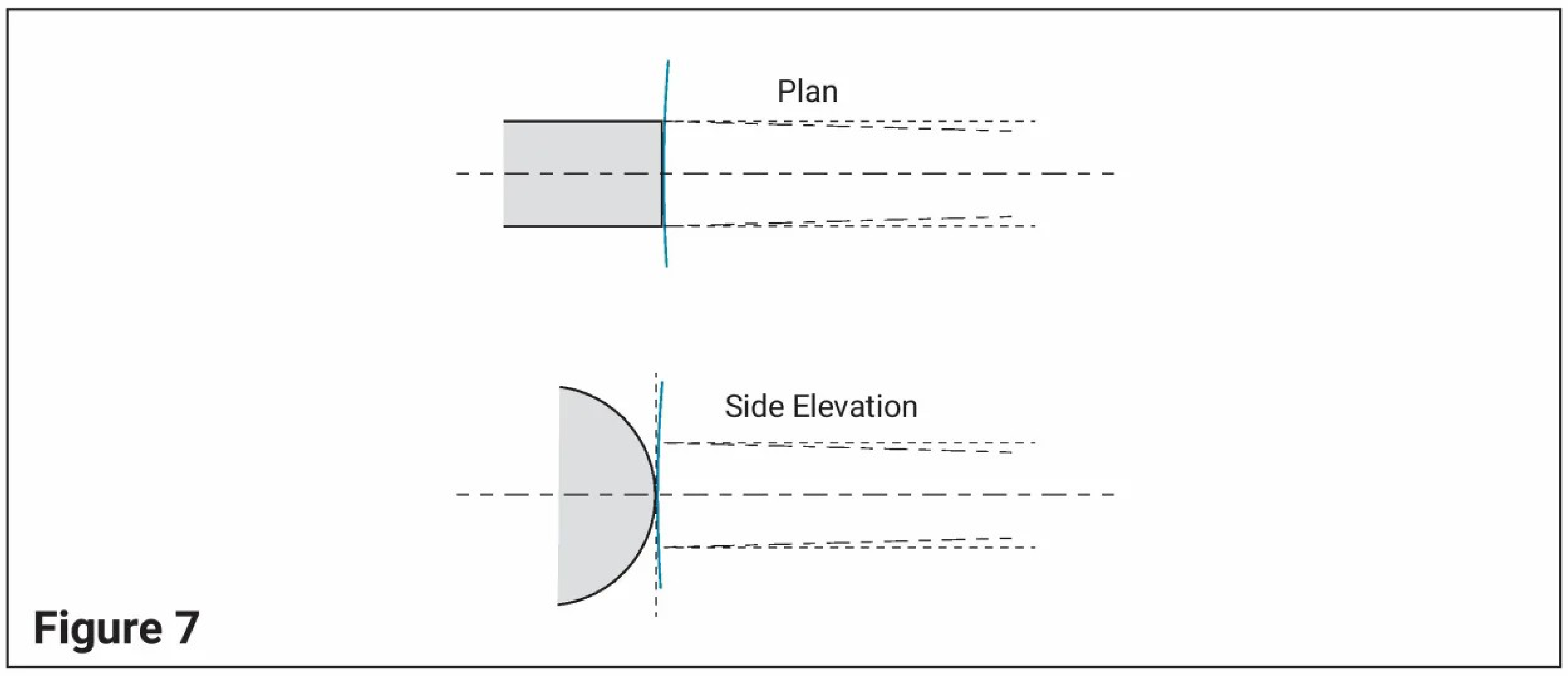
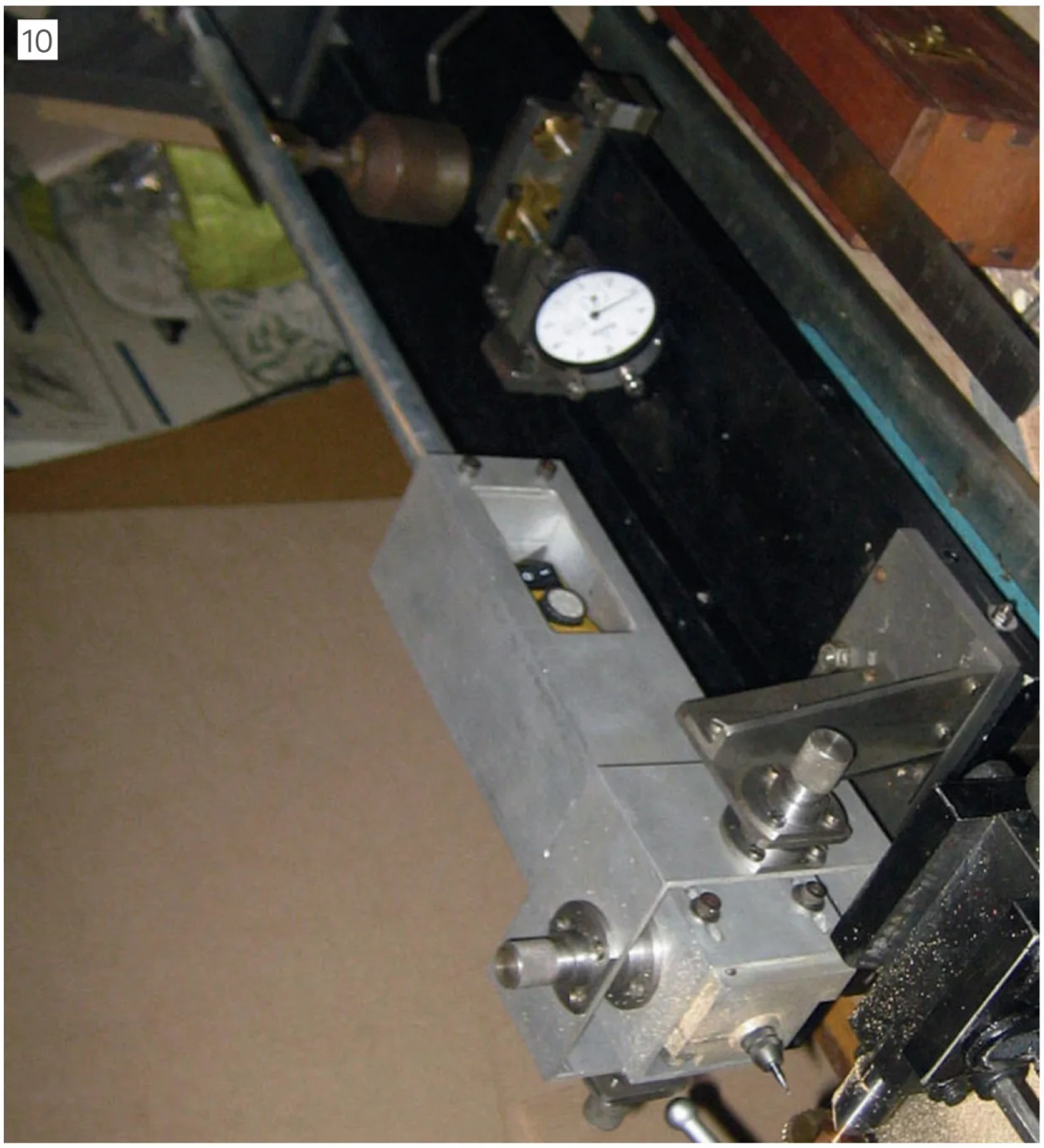


Figure 7

Actual curvature errors drawn to scale for a typical turbine disc. The horizontal dashed lines show the typical maximum extent of movement of the cutter.



10

The rigid tubular arm between the housing for the Proxxon IB/E and the template follower. The arm is being temporarily supported on a stand.

path 2.2 times less noticeable. **Figure 7** shows the geometry drawn to scale for my contraption machining a blade with a width of 0.125 inches, which is significantly wider than the maximum I expect to make. Basic trigonometry indicates that the angle to give this width is 1.4 degrees either side of the axis. At this angle the maximum departure of the cutter tip from a straight line is 0.0008 inches. However, as shown in the diagram, when the cutter is tilted vertically the curvature of the turbine disc must also be taken into account. As a result, when tilted up by the same 1.4 degrees (i.e. cutter tip is 0.0625 inch above the centre line) the tip of the cutter is about 0.0038 inches further from the periphery of the disc compared to when the spindle is horizontal. The extra error would be the same even if XY lead screws were used to move the spindle instead of the tilting arrangement. As discussed above, the best method would be to use a machine that rotates the work piece at the same time as moving along the other axes.

Of course, if the template is to remain 10-fold larger than the final blade, the increase in distance between cutter and pivot plane means that the distance between the pivot plane and the template also has to increase 2.5-fold and without any loss of rigidity. This was not a problem since the square aluminium tube in which the Proxxon IB/E is housed is quite large and it was simple to attach to it a rigid steel tube on which the template follower is fixed, **photo 10**. In fact the extra length was needed so as to accommodate the electronically controlled attachment for moving the spindle around the template automatically, but we'll come onto that later.

● To be continued

References

7. Thomas, Geo.H. (1984 / 1992) The model engineers workshop manual ed. by W.A. Bennett. TEE Publishing, Hinckley. (p.26).
8. Elkin, W.H. (1947) Small impulse turbines. SMEE Journal 73: 613–638.
9. Knight, D. Taylor-Hobson CXL: http://g3ynh.info/workshop/th_cxl.html
10. http://www.lathes.co.uk/taylor-hobson-engravers/
11. https://www.youtube.com/watch?v=h_tVygO0vOY
12. https://www.youtube.com/watch?v=3FoqyFENzz8
13. Chaddock, D. H. (1950-51). An experimental steam turbine plant - Part 1. Model Engineer 103 (2587): 966 -969.
14. https://www.imes-icore.de/eng/premium-1010-micro-cnc-milling-machine.html
https://emco.co.uk/products/premium-1010-micro/
https://www.kern-microtechnik.com/wp-content/uploads/2019/09/MicroHD_engl.pdf
15. https://www.youtube.com/watch?v=xZOiNdkJ8SU
https://www.youtube.com/watch?v=6ujgpNMQ2zY
https://www.youtube.com/watch?v=bLiYL7U7rvs

A New Boring and Facing Head. Part 3

Graham Meek presents his latest design for an advanced boring and facing head. There are six sheets of figures accompanying the series, and two appear in each instalment.

Using these increased PCD gears also introduced another problem. A standard 0.5 MOD worm will not mesh with these gears. To get around this the worm also needs to have a larger pitch due to the greater distance between the gear teeth, plus the effect of the helix angle. A standard 0.5 MOD worm has a pitch of 1.5708mm, but the worm to mesh with the 10-tooth helical gear needs to have a pitch of 1.729mm. Trying to set-up a gear train to cut this pitch on my Maximat Super 11 proved at the time to be a fruitless exercise and in the end I settled for a standard 1.75mm pitch, but cutting the worm slightly deeper. This introduces a pitch error of approximately + 0.02mm. This does produce an error in the actual distance moved by the tool slide with regard to the indicated dial reading. Using Slip gauges it was found that over 20 turns of the dial, (1mm actual movement on the tool slide), the slips actually measured 1.01mm. Thus over 20 turns the tool slide the error would produce a hole 0.2mm larger. However it has to be remembered that the boring head is only usually used to remove rather small amounts from a bore. Most of the material being removed by drilling prior to boring. Therefore this large error is unlikely to cause any concern. This does however mean that the graduated divisions are removing slightly more per division. To quantify the extra amount, this is 0.01 / 400, (400 comes from twenty turns of the dial and twenty divisions per turn), this equates to 2.5 X 10^{-5} more per division. However those readers wishing to cut something nearer the exact pitch can get a very close approximation by setting up a 46 DP gear train, if their lathe has this facility. This gives a pitch of 1.735mm, which is larger by 6 X 10^{-3}. This being just a third of the original pitch error when using the standard 1.75mm pitch, this should yield about one third of the above 2.5 X 10^{-5} error. I have digressed on purpose in showing these errors to highlight how far these things can be taken for no real gain other than a theoretically exercise. To get all these errors into perspective, the accuracy of any boring head is only as good as the sharpness of the tool removing the metal and the temperature environment in which the machining is being carried out, especially as some of these errors are approaching the coefficients of linear expansion per degree C for metals.

The worm gear was originally intended to be made entirely from phosphor bronze, but initial testing showed that this material was not up to the duty that the slipping ball bearing clutch was imposing. Subsequently the worm gear was made into a composite component with the upper portion with the drilled holes and dial friction spring being made from silver steel, (or drill rod). This was the reason why the Emco dial friction spring was abandoned. Please note that the drilled holes are shown on the drawing as being spot faced. This ensures the ball bearing has a continuous ring of contact around each hole. Rather than two points of contact on the extremity of the diameter when the holes are not spot faced. The spot faces also have a further benefit in that any damage caused around the hole during use will not affect the bearing surface. With the worm still being made from phosphor bronze, the two items were pressed together. The press fit allowance does not want to be overdone or the silver steel / drill rod ring will close-in the bore of the worm gear. The parts can be secured with Loctite Retainer if this is preferred but the spring section to supply the friction for the dial needs to be raised slightly in order to stop the Loctite adhering to this portion as well. Do not be overzealous when raising the spring section, it is far better to do this in stages, such that the dial will just slide with the least amount of force. The spring section is cut into the silver steel in such a way that the dial moves more easily with the numbers on the dial ascending, than it does with the numbers descending. This dial movement also ensures the backlash in the system is also eliminated during setting. While holding the feed ring the amount of effort to move the dial should not trip the feed ring clutch. That is not to say this clutch should be set such that if it were on a cordless drill, it would drive home woodscrews. A high setting on the clutch will put an enormous strain on the gear train, feedscrew, etc, before the clutch slips when the stop is contacted. This strain is to be avoided in the interests of safety. On this note I would also like to urge the constructor to use some form of stop bar for the torque bar to impinge against when using the facing facility. Far better for the stop bar to bend and the machine stall than it is to lose one or more fingers in the event of something catastrophic going wrong.

While we are discussing the dial and feed ring settings there is another adjustment that was added after the initial boring head trials. When using the boring head on my Clayton Timber Wagon conversion it was noticed that the dial would always counter-rotate as the spindle was set in motion. The

Arbor and modified 3mm Woodruff key.

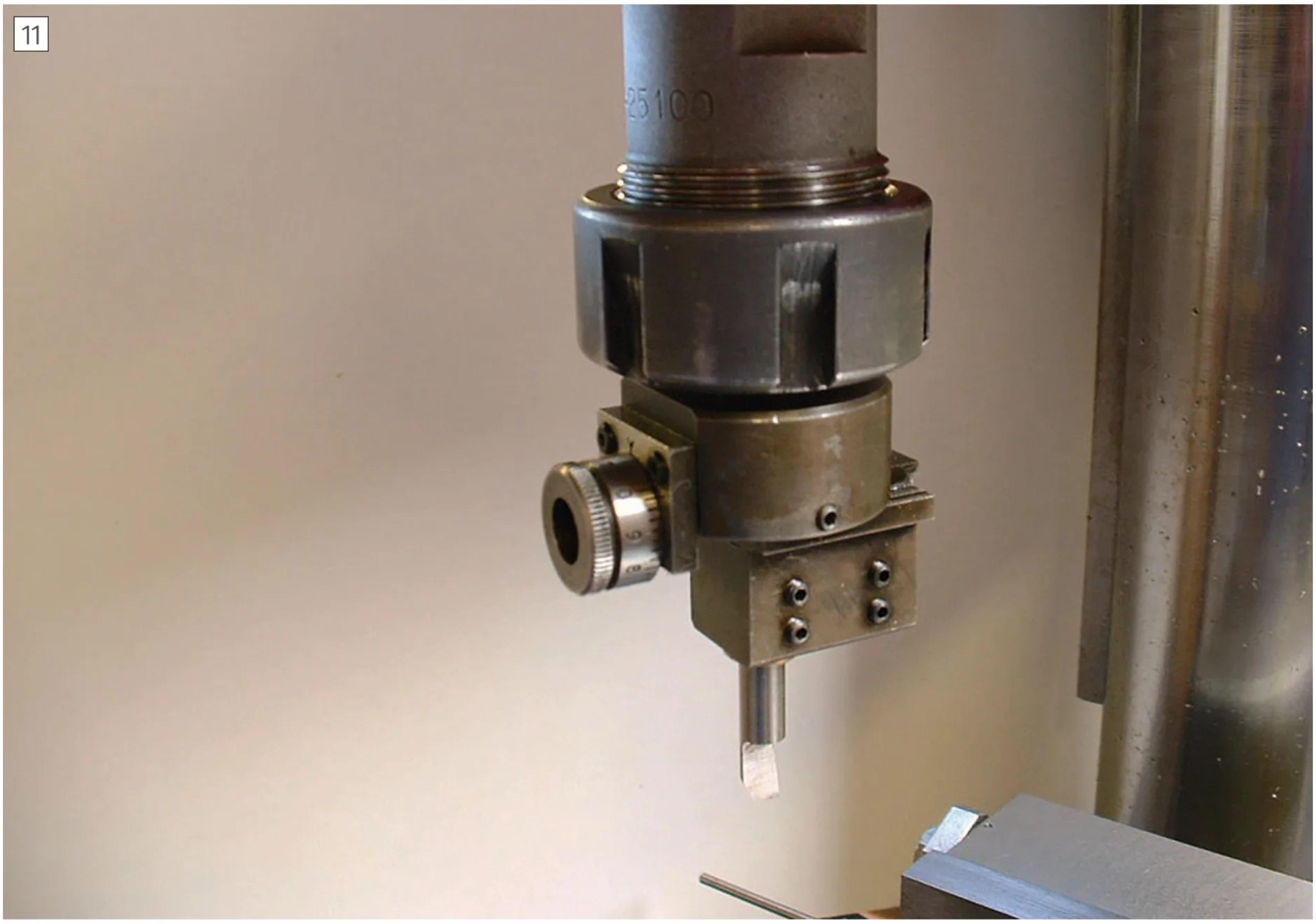
counter rotation was merely due to the backlash in the system. This is due to the moments of inertia as the spindle starts. The dial is free to rotate on the boring head. As the machine starts the body moves instantaneously but the dial momentarily stays still. Until the backlash has been taken up, then this too rotates. However the rotation of the dial is in the opposite direction to which the feed is normally applied. When the spindle stops the dial is in a different position. This is not a problem if you know this is what is happening and remember the last setting but can be annoying if like me your short-term memory plays tricks. To overcome this a Tufnol adjustable pad was added to apply a slight amount of friction to the dial. This is adjusted only until the added drag of the Tufnol pad is felt. Moving the dial to and fro slightly it should be possible to detect the clearance between the pad and the counterbore that the pad sits in. If this adjustment is overdone it has a knock-on effect, in that the dial friction spring needs a higher setting and then the feed clutch needs to be set higher. Therefore I would advise getting the dial and the feed ring sorted out first as I did and attend to the Tufnol pad last. It is possible to access this adjustment without any dismantling. Ensuring the underside face of the dial and Tufnol pad are free from oil or grease on assembly is another key point.

While I have shown a No 2 Morse taper arbor **photo 10**, this is by no means mandatory. One requirement of the arbor is that it needs to be a good fit in the main body, any slop here will not be good for rigidity or bore finish. Practice on a stub end of material to get the size just right. A plain parallel shank on a boring head of this size is quite satisfactory. Provided this can be held in something like an R8 collet where there would be minimal overhang. Holding the boring head in a collet, in a Morse taper collet holder is greatly increasing the overhang and asking for vibration problems while boring. Plus this arrangement is seriously reducing the spindle nose to table work envelope, something that might be important one day. I did make a half size plain version of the Emco boring head to hold in my ESX 25 collet holder. **Photograph 11** is included to show how the overhang of the boring tool in this set-up is well within the length of a standard 16mm shank end mill held in the same collet chuck and is therefore not being compromised on the rigidity front.

Assembly of the boring head is fairly straightforward. There are few points to watch out for which might catch out the unwary. The 10 and 11 tooth gears are designed to be assembled with 0.1mm of end float in the scalloped bush. To ensure this happens the 3mm silver steel axle needs to have a shallow undercut at the 2.5mm junction. A definite undercut 0.05mm deep with a narrow 0.5mm wide parting type tool is to be preferred to just plunging in with a knife tool. If the knife tool has any hint of a radius, which it should have, then this radius needs to be below the 2.5mm diameter in order to ensure the gear abuts a square face. By which time the trailing edge of the knife tool is producing a nice, inverted cone on the 2.5mm diameter and reducing the available location surface. This little axle also needs the two 2.5mm diameter portions to be concentric as well as a good fit in the gears. Turning these axles in a collet will ensure the concentricity requirement and turning the diameter such that the gear will just start to go on the shaft will look after the fit. If no collet is available, then a split bush in the 4-jaw chuck is the next best substitute. The gears are finally pressed home using a small arbor press with a trace of Loctite Retainer, just for good measure. Some lithium based grease should be used to lubricate the scalloped bush before pressing on the second Colpos 90 gear. The two stub axles that carry the 11 tooth steel idler gears are secured in the main body with Loctite Retainer. The two gears are retained on the axle with 2mm "E Clips", they are not really needed as the endplate keeps these gears in check once assembled. However without the E clip these gears have a nasty habit of slipping off the axle onto the floor during the assembly phase. I leave the choice of fitting them up to the constructor, but one word of caution if they are fitted. The E clip needs to be oriented as shown in the photograph otherwise the endplate will trap the E clip and lock up the gear.

In order to assemble the selector ring bush a special spanner is required to tighten the bush. However prior to this the two M3x6 cheese head screws need to be inserted into the endplate along with the small spring and the 3/32" steel ball for the selector mechanism. Some grease will be found handy to hold the spring and the ball in place, as well as some light oil on the bush. Hold the spanner initially to screw in the bush. When it comes to tightening the bush be sure to keep pressure on the special spanner to ensure this does not slip out of engagement and ruin your work, as well as your chances of undoing the bush. It will be found easier to hold the endplate in the bench vice while performing this task. This bush does not need to be done up that

11



Half size boring head.

tight, just merely locked in position. Fitting the feedscrew and setting the axial play is best attended to next. The outside diameter of the countersunk threaded collar needs to be matched to the constructor's micrometer spanner. As does the hole in the side of the collar. The ones shown are for a Mitutoyo micrometer.

The modified countersunk M4 screw provides the locking medium after the adjustment is deemed satisfactory. Be sure to check that the countersunk screw is locking up on the collar and not the end feedscrew, or the adjustment will move. The axle that holds the 13-tooth tumbler gear is retained in the selector ring with Loctite. The gear remains captive by use of a circlip groove, but this time there is no commercial circlip. Instead there is a disc of Delrin 0.5mm wide and with a 2.85mm hole drilled in the centre. This disc is pressed over the end of the shaft, I found a BA box spanner ideal for applying pressure whilst doing this. The disc then drops into the undercut, fit this item only when the constructor is satisfied with the freedom of the set-up. Before the end plate can be assembled it is necessary to fit the arbor as the arbor securing Allen screw is hidden beneath this plate. Lubricate the worm with light machine oil, but do not over do the lubrication, and do not forget to slip onto the arbor the 31.75mm diameter washer before offering up the worm feed ring and dial assembly. The 3mm wide Woodruff key needs to be reduced by 2mm on the overall length as the standard key will foul the worm if left unmodified. These keys can be troublesome but a small centre-pop on one side will usually be sufficient to keep them in place during assembly. This key does not want to be a permanent fit as it may be required to remove it one day. There is not a lot of room to get a stubborn key out in this instance.

The tool slide has a small pin in the underside to restrict the slide travel, this can be secured with a drop of Loctite retainer once the slide has been checked to see that this pin does not foul the bottom of the groove in the main body. The phosphor bronze feedscrew nut is slipped into the tool slide after applying some grease to the thread. Details for adjusting the slide are contained in the above articles and book. The M5 slide locking screw in the main body has a 4mm ball bearing between it and the gib, this greatly reduces the amount of effort needed to lock the slide and the ball ensures the pressure is applied centrally to the gib.

The feedscrew is now threaded into the feedscrew nut until the endplate retaining screws are about to engage the threads in the main body. These need gentle coaxing into the threads, a couple of turns each at a time until they are just nipped up. Using the 2.5mm Allen key bring the tool slide up against the endplate. Release the cheese head screws and centralise the endplate with reference to the flat on the main body. If the dimensions have been adhered to then a faint witness line should be visible each side of the endplate. A gap exists between the dial and the endplate when ›

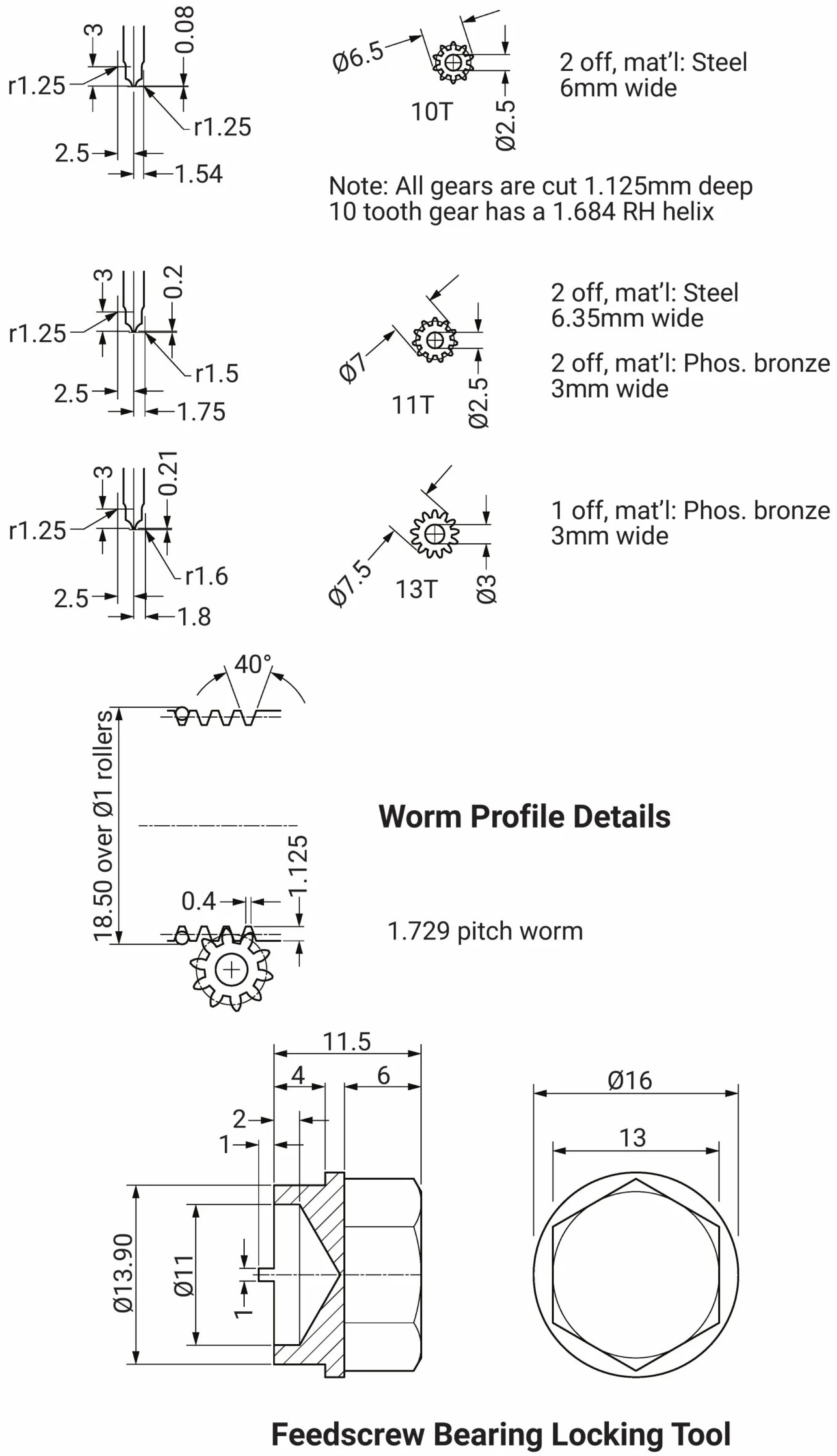

3
0.08
r1.25
r1.25
2.5
1.54
Ø6.5
10T
Ø2.5
2 off, mat'l: Steel
6mm wide
Note: All gears are cut 1.125mm deep
10 tooth gear has a 1.684 RH helix
3
0.2
r1.25
r1.5
2.5
1.75
Ø7
11T
Ø2.5
2 off, mat'l: Steel
6.35mm wide
2 off, mat'l: Phos. bronze
3mm wide
3
0.21
r1.25
r1.6
2.5
1.8
Ø7.5
13T
Ø3
1 off, mat'l: Phos. bronze
3mm wide
40°
18.50 over Ø1 rollers
Worm Profile Details
1.125
0.4
1.729 pitch worm
11.5
4
6
2
1
Ø13.90
Ø11
1
Ø16
13
Feedscrew Bearing Locking Tool

Figure 5

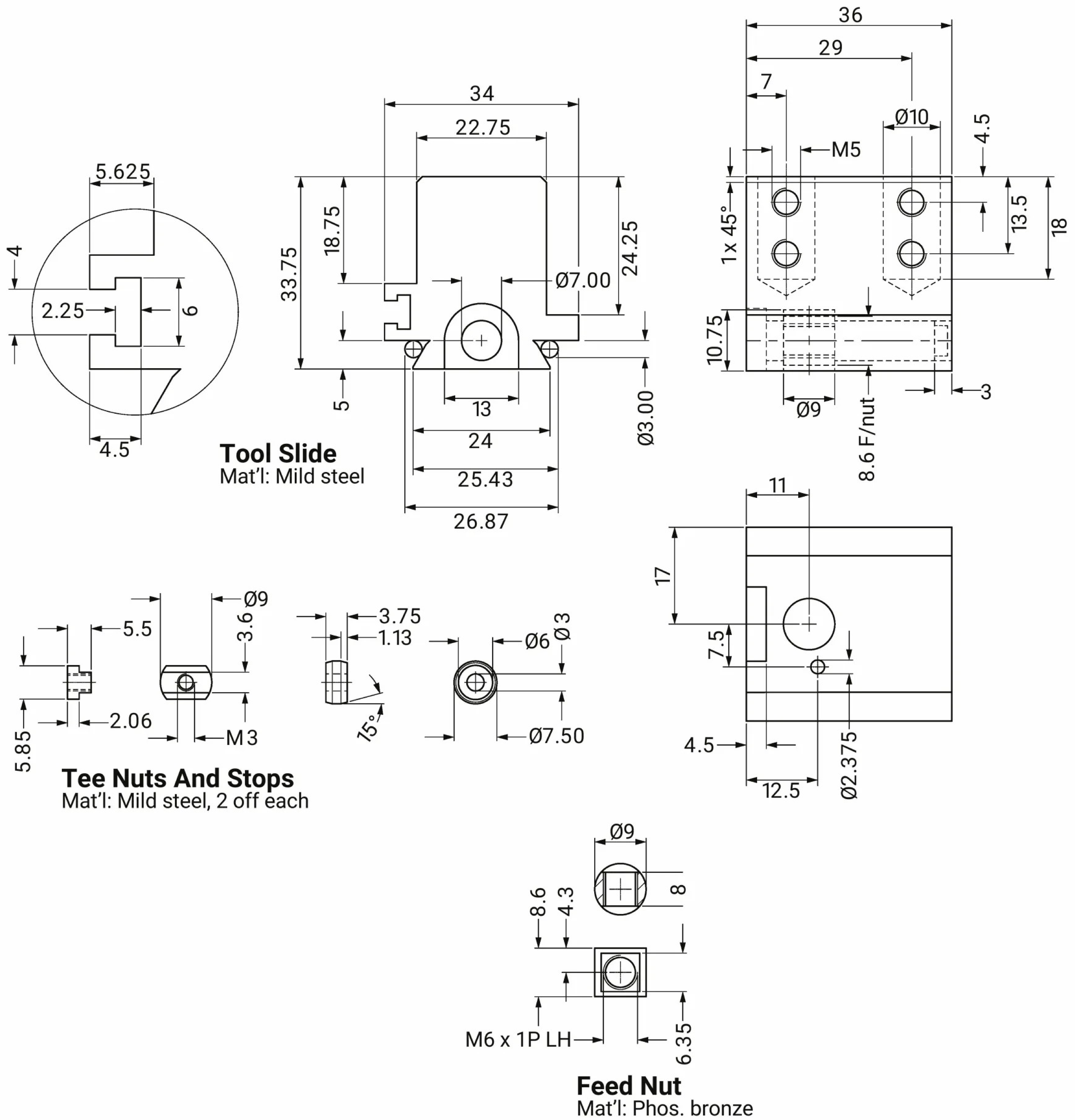
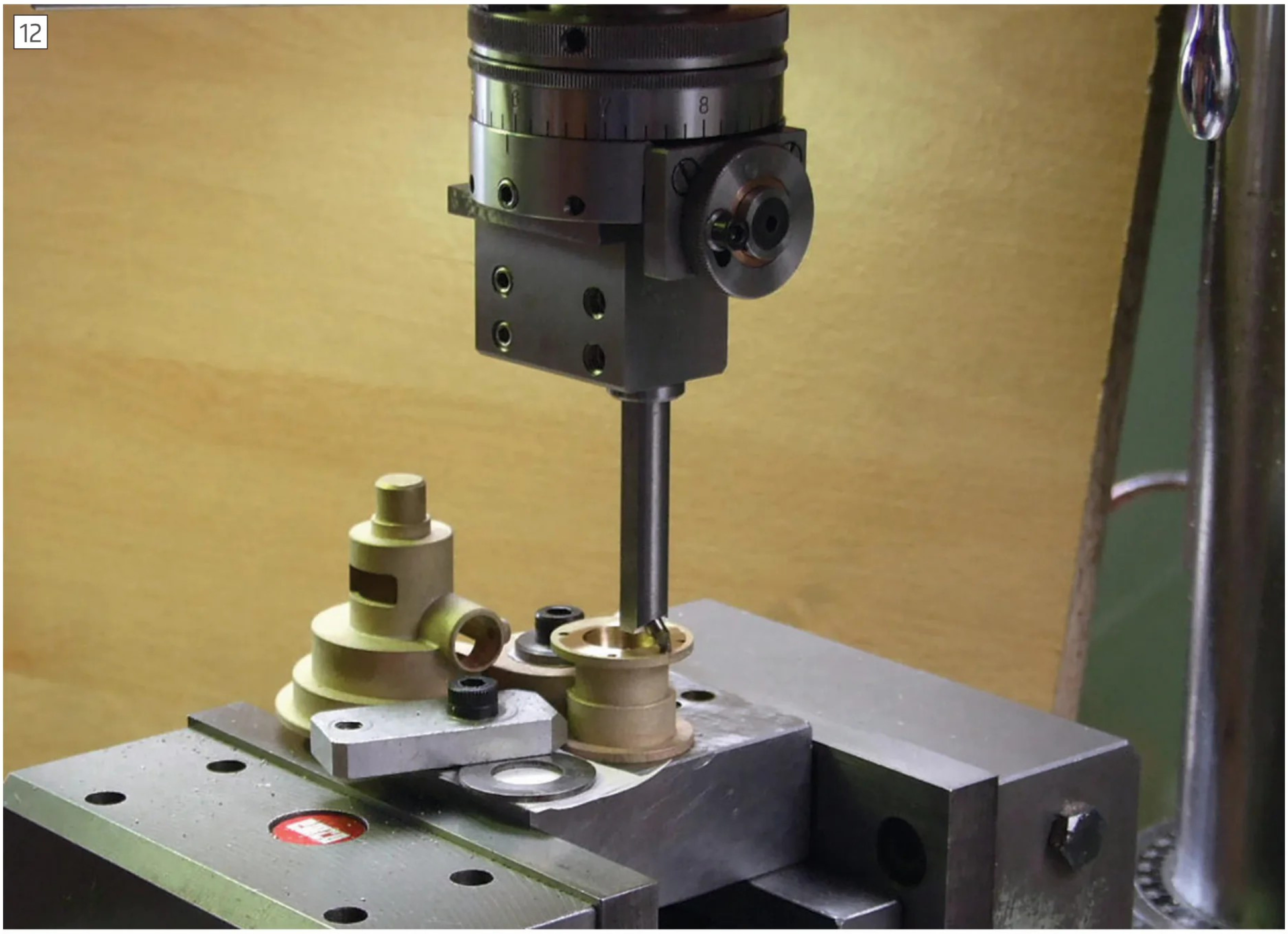

Tool Slide
Mat'l: Mild steel
Tee Nuts And Stops
Mat'l: Mild steel, 2 off each
Feed Nut
Mat'l: Phos. bronze
36
29
7
Ø10
M5
4.5
1 x 45°
13.5
18
10.75
Ø9
3
8.6 F/nut
34
22.75
33.75
18.75
24.25
Ø7.00
5
13
24
25.43
26.87
Ø3.00
5.625
4
2.25
6
4.5
11
17
7.5
4.5
12.5
Ø2.375
5.5
Ø9
3.6
2.06
M3
5.85
3.75
1.13
15°
Ø6
Ø3
Ø7.50
Ø9
8.6
4.3
8
M6 x 1P LH
6.35

Figure 6



Facing the Clayton transfer case mounting face, using my new boring head in facing mode.

this is assembled onto the main body. The design gap is 0.65mm, using feeler blades of this dimension set the plate vertically. As the 13-tooth gear protrudes above the endplate this needs to be out of the neutral position otherwise a false setting may be made. Nip the cheese head screws up and check to see if the tumbler gear will go easily from one direction to the other. It may be found the gear teeth meet "end on" and will not permit engagement. Rotate the feed ring while trying to engage that particular feed direction and it should drop in. If there is any difficulty engaging either direction increase the feeler blade setting in 0.05mm increments until the selector will easily go from one direction to the other. Record this setting for future reference, the setting on my head is 0.85, so do not be worried if the measured setting starts to go above 0.75mm. After all this is setting is directly related to the position of the feedscrew hole in the endplate in relation to this edge to start with. Now try your handy work the feed ring should be silky smooth with no hint of tightness and irrespective of which feed direction is selected the feed ring should not show any resistance in either direction. Finally be sure to tighten the two cheese head screws. When all the checks are complete the last thing to do now is put the boring and facing head to work **photo 12**.

Addendum.

Since writing the above article I have been annoyed that I could not produce a worm which was nearer to the desired pitch on my metric version of the Emco Maximat Super 11. During a session whiling away the long winter nights working out screwcutting trains on the Maximat for the commonly used BA pitches for items required on my steam wagon. I started trying different gear permutations to achieve the so far elusive 1.729mm pitch. I know there are probably a dozen or so apps to do this, but I like the mental agility needed to sort this out longhand. I eventually reached a train which gives a plus error of 0.002mm. This is about 10% of the original error when using a 1.75mm pitch and better than the 46 DP train. Having recently made a new worm to verify my calculations, I could not find any measurable error over the working range of the boring head. This new worm is also much smoother in operation and was well worth the additional work.

The Maximat gear train has a 50-tooth gear on the inboard position of output shaft from the headstock, this drives a 120-tooth idler gear on the first changewheel stud. This in turn meshes with a 60-tooth gear, which is inboard on the second changewheel stud coupled to a 45-tooth gear (outboard on this changewheel stud). This in turn is driving a 65-tooth gear on the outboard end of the input shaft to the screwcutting gearbox. The box itself needs to be set at B5. Just for reference, at this setting this gives a straight through drive through the gearbox to the leadscrew. ▮

MODEL ENGINEERS' WORKSHOP

BACK ISSUES

£5.75 EACH
(inc p&p)
For EU and ROW, please see www.classicmagazines.co.uk

Whether it's recent releases or vintage copies, step back in time and browse through the ages with the *Model Engineers Workshop* back issue collection.

AVAILABLE TO ORDER TODAY AT CLASSIC MAGAZINES.CO.UK

AUGUST 2023
- Accurate Tapping
- Cutting Gaskets
- 3D Printer Review

SEPTEMBER 2023
- Getting the Angles Right
- A Tailstock Boring Adaptor
- Setting up a Lathe to turn parallel

OCTOBER 2023
- A compact Dividing Head
- Carriage Dial for an EMCO Maximat
- Turning small Radiuses

NOVEMBER 2023
- Artful Dodges
- Rocket Man
- Servicing a DTI

DECEMBER 2023
- The Universal Pillar Tool
- MMEX 2023
- Making Internal Gears

JANUARY 2024
- EazyCNC – A straightforward approach to CNC control
- A sensitive drilling attachment
- A viewing platform

FEBRUARY 2024
- A boring and facing head
- Optimum TU2004V Lathe
- Make a tailstock Steady

MARCH 2024
- Micro Milling
- Churchill CUB 111 Lathe
- The Umpelby Engine

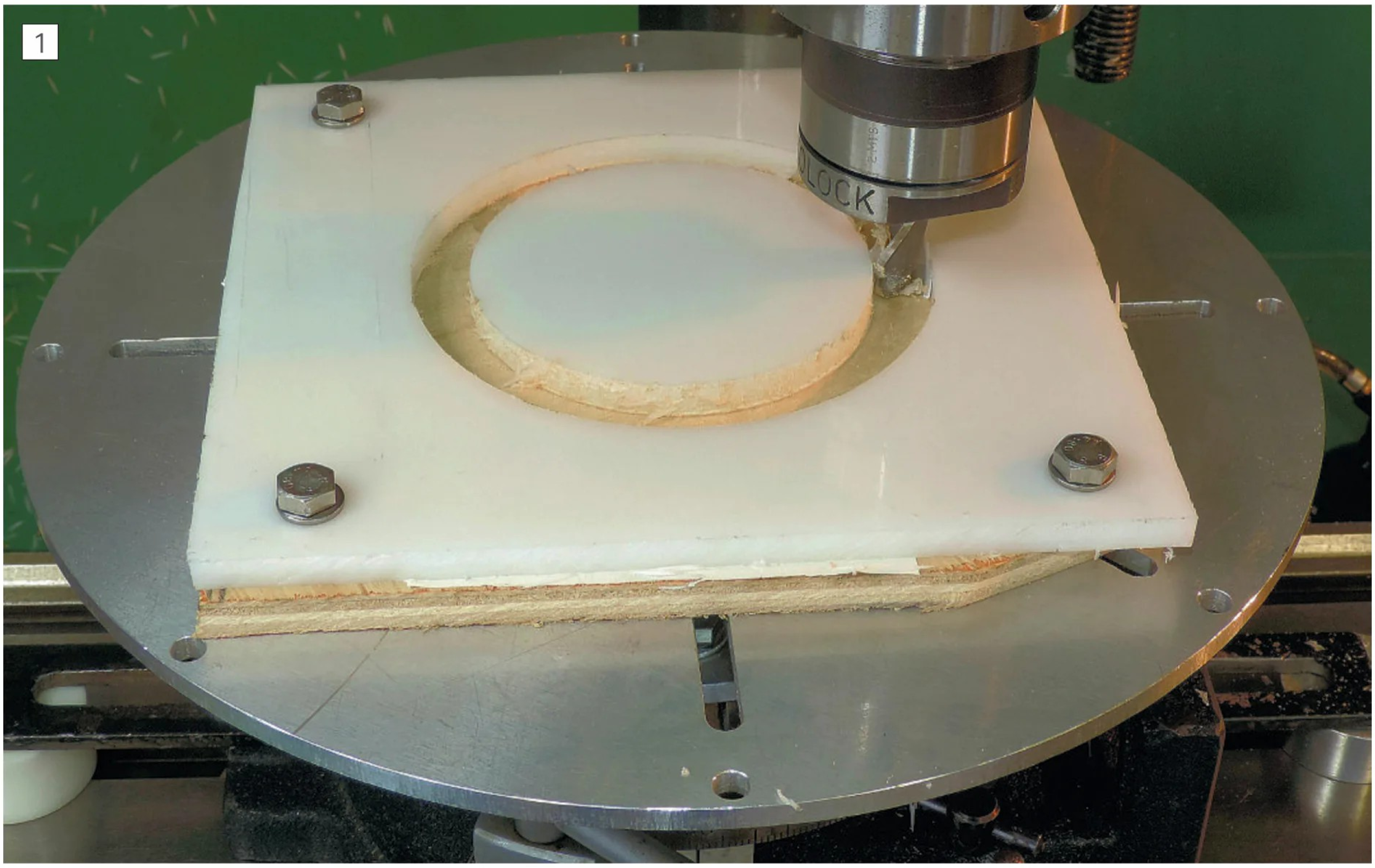
OTHER ISSUES ALSO AVAILABLE – ORDER YOUR BACK ISSUES NOW!

2 EASY WAYS TO ORDER

CALL: 01507 529529 **ONLINE:** www.classicmagazines.co.uk/issue/mew

Producing Discs Without Holes in the Centre

Keith Keen has devised a trepanning arrangement for cutting out discs from sheet material.

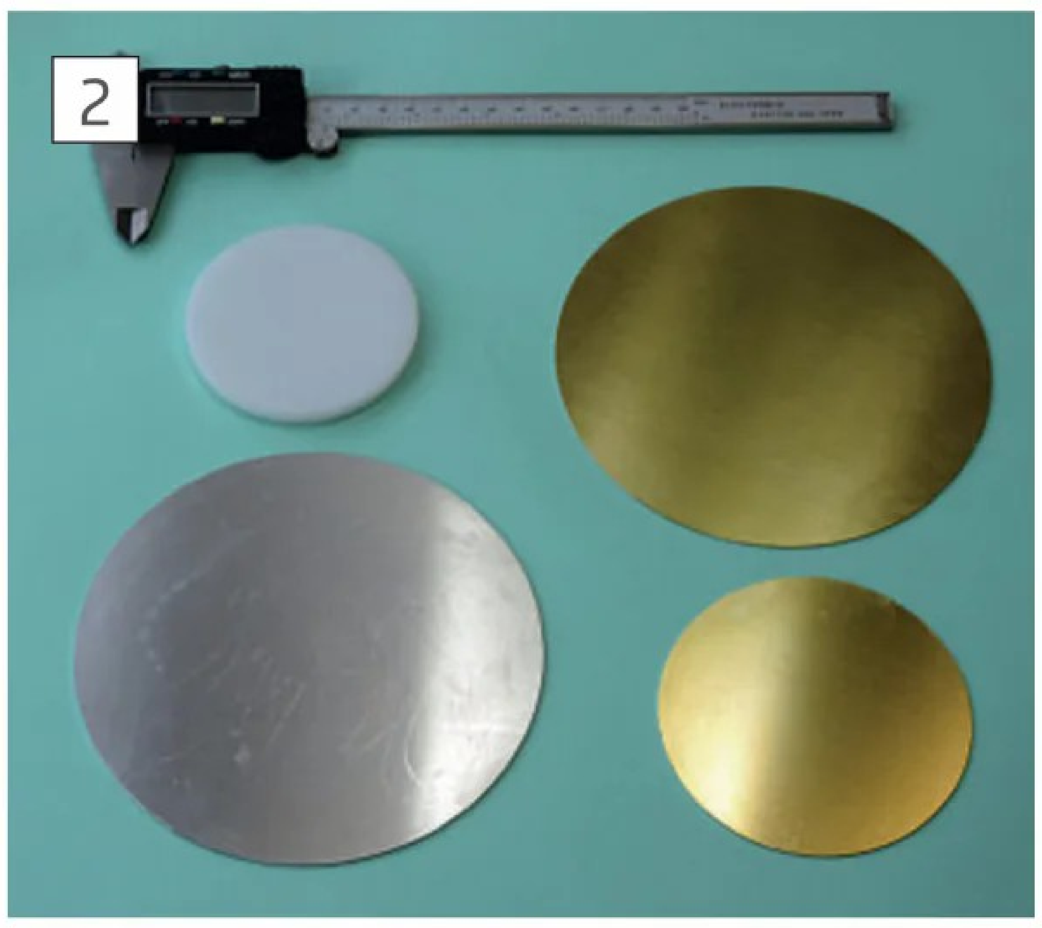


Trepanning an acetal disc with a slot drill in a milling machine, using a platform on a rotary table.

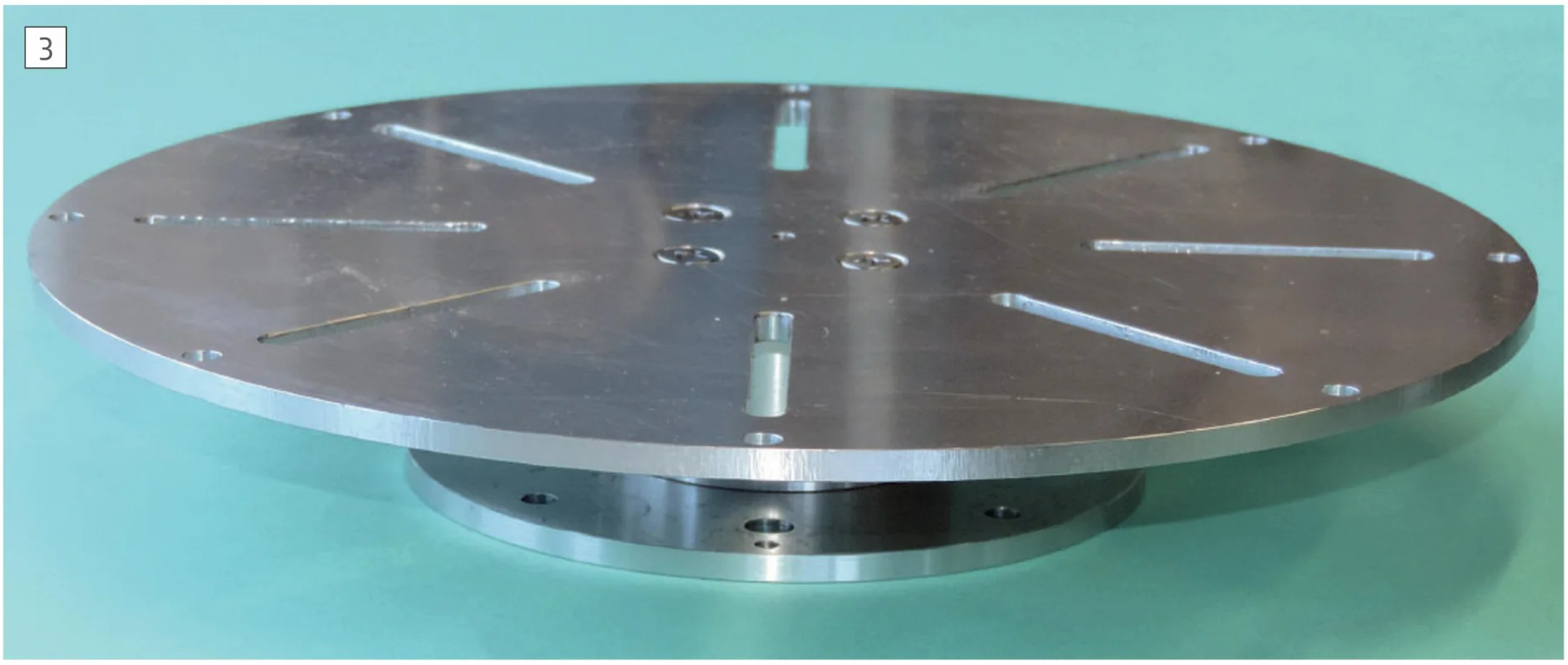
It is an easy enough task to machine a disc of some required diameter from sheet material, if you know it will need or can have some holes in it. It is just a matter of roughly cutting out a piece of the sheet to a larger approximate circle, drilling the holes (maybe just a centre hole), mounting the roughed-out disc in the lathe with some sort of mandrel or holding device using the drilled hole or holes, and turning the disc to the required diameter. But if the disc has to be hole free, it is a more difficult matter.

What I wanted was some sort of arrangement whereby I could machine discs of up to about 200mm diameter from metal or plastic sheet material of up to maybe 10mm thickness, with a precision of the order of +/- 0.05mm on diameter. The only way to do this, as far as I could see, was by some sort of trepanning technique.

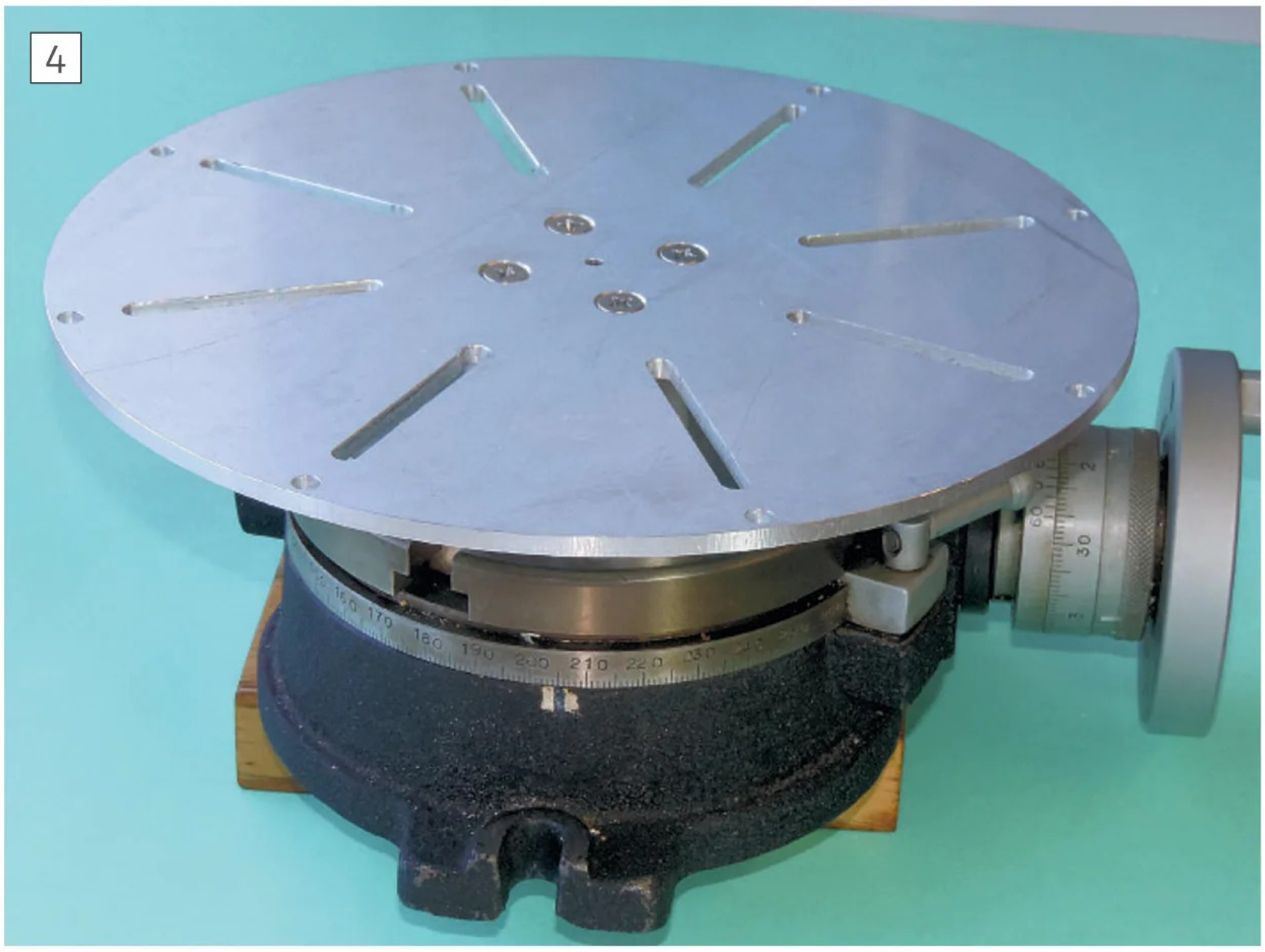
I could not find much information on trepanning methods appropriate for a small workshop. There are, of course, holesaws available, the sort of things you find in DIY stores, but they only come in certain fixed sizes and they are mostly intended for cutting wood. So I devised an arrangement for use in a milling machine using a rotating platform on a rotary table and with a slot drill to cut an annular slot in a piece of the required sheet material. **Photograph 1** shows a 80mm acetal disc being machined out using the trepanning arrangement, and **photo 2** shows some of the hole free discs that have been produced in this way. These are: 150 and 100mm brass



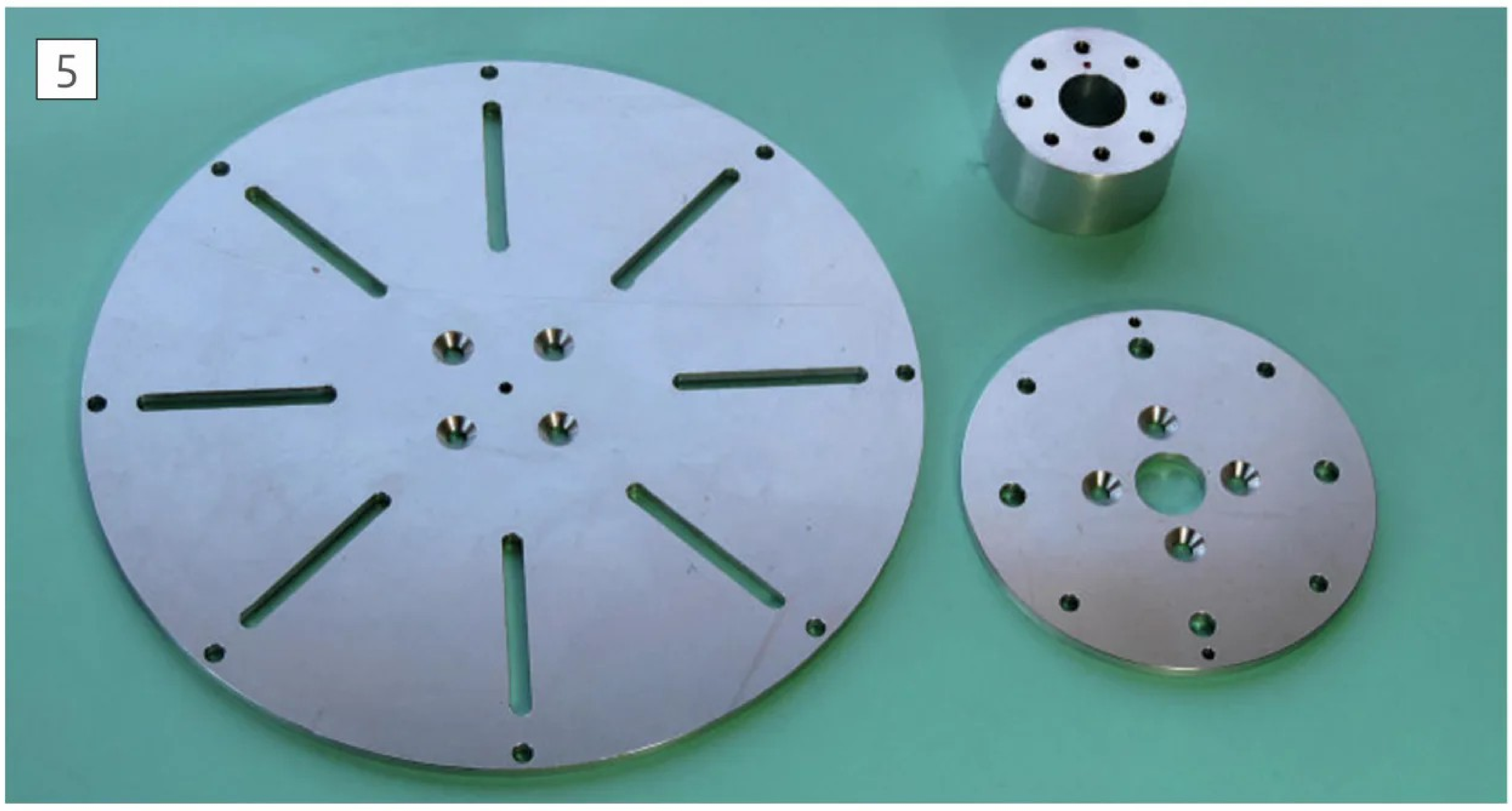
Some trepanned discs.



The trepanning platform.



The trepanning platform on a rotary table.



The trepanning platform parts.

discs 0.9mm thick, a 150mm aluminium disc 1.2mm thick, and a 80mm acetal disc 6.2mm thick.

The Trepanning Arrangement

The trepanning platform shown in **photo 3** is the main part of the trepanning arrangement. This has a top plate similar to a lathe faceplate, a bottom flange which mates with a rotary table, and a centrepiece which goes between the top plate and the bottom flange.

Photograph 4 shows the platform mounted on a rotary table, and **photo 5** shows the trepanning platform parts.

The top plate and the bottom flange have countersunk holes for M6 countersink screws to join the parts together with flush surfaces, as can be seen in photo 3. The bottom flange has four 8.2mm holes on PCD 100 for short M8 setscrews which attach the platform to the rotary table, which has T-nuts in the table slots. In addition to the platform parts shown, a set of four brass T-nuts, threaded M8 and with a good fit in the rotary table slots, were also made.

Using the Trepanning Platform

The first step in carrying out a trepanning operation with this arrangement is to set the centre of rotation of the rotary table to (0,0) coordinates on the milling table. My rotary table has a 2MT tapered centre hole which is convenient for housing

Setting the milling table to the centre of the rotary table.

a 2MT lathe dead centre, as shown in **photo 6**. The pointed end of the dead centre can then be aligned with a plane pointer (mine was made from a piece of silver steel rod) in the milling machine drill chuck, to set the (0,0) milling table position. Having done that, the lathe dead centre can be conveniently left in place when the trepanning platform is screwed to the rotary table T-nuts, because the centrepiece and the bottom flange have 22mm central holes in them so that the dead centre can fit within the platform assembly. Note that it is not necessary for the platform itself to be precisely coaxially aligned with the (0,0) setting - the important thing is for the centre of rotation (of the rotary table) to be aligned.

To carry out the trepanning, a piece of the required sheet material is screwed to the trepanning platform with a plywood backing piece, with strong double sided adhesive tape (such as carpet tape) between the sheet material and the plywood backing. The purpose of the adhesive tape is to prevent movement of the trepanned disc at the final breakthrough of the annular slot cutting in the sheet material.

The milling table is clamped in the Y axis direction and then moved in the X axis direction by a distance equal to the required disc radius plus half the diameter of the slot drill which is to be used with an appropriate rotation speed, to cut the annular slot. The milling table is clamped in the X axis direction, and slot drill milling is then carried out by rotating the rotary table in the direction for upcut milling on the outside of the disc. Photograph 1 shows the setup.

A very important point is that eye protection is essential when this milling is carried out because the swarf flies everywhere. Gloves are also a good idea to protect from sometimes hot pieces of swarf.

Trepanning Platform Parts Description

Figures 1, 2 and **3** give details of the trepanning platform parts shown in photo 5. The parts were all made from ordinary 6082 aluminium alloy. The top plate and the bottom flange were made from 5mm thick sheet, and the centrepiece was made from a small length of 2.5-inch diameter round bar.

Machining the platform parts shown in the figures using the lathe and milling machine was quite straightforward. With the centrepiece,

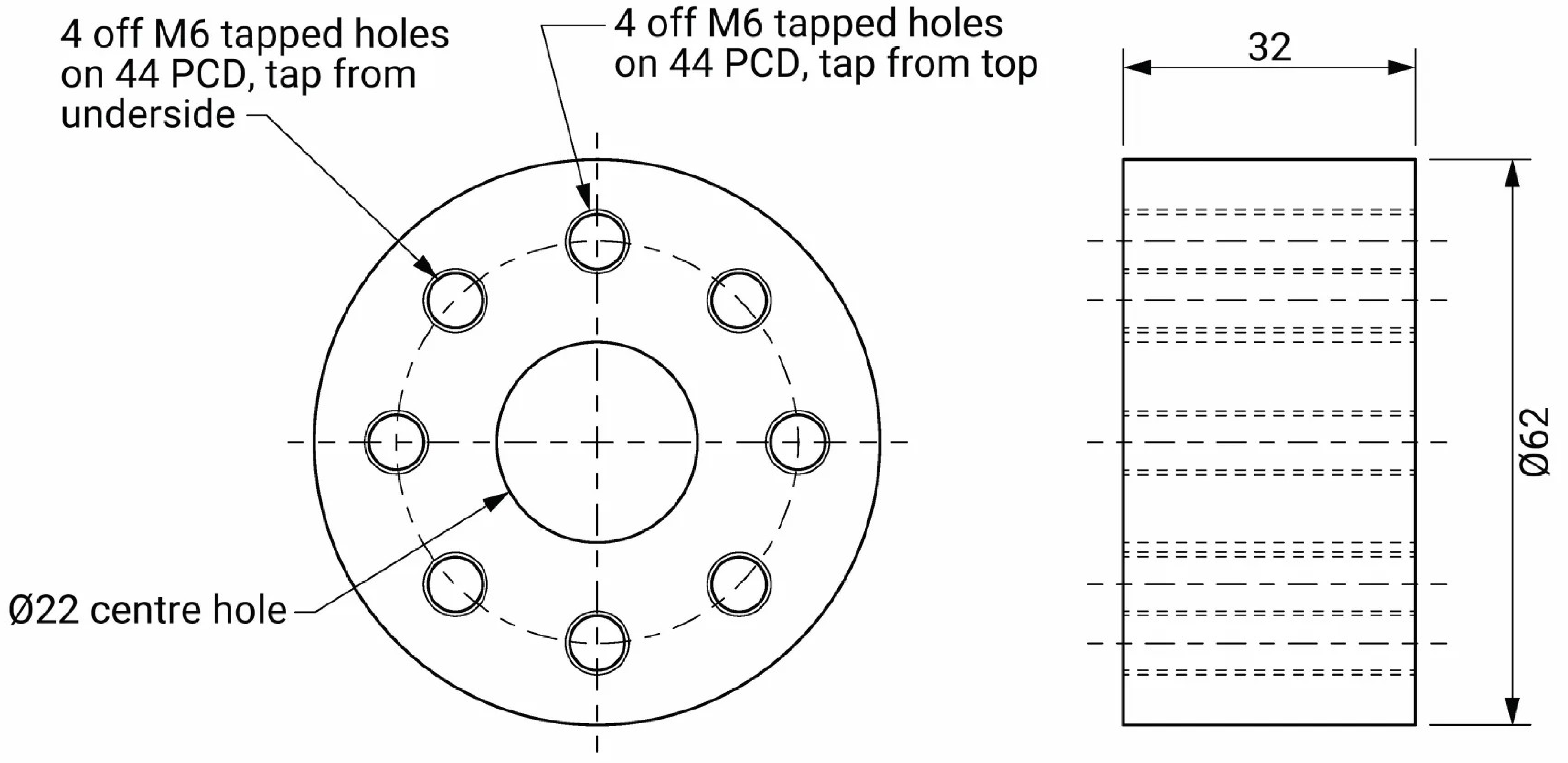


Fig. 1 Centre Piece
Mat'l: Aluminium alloy

Figure 1

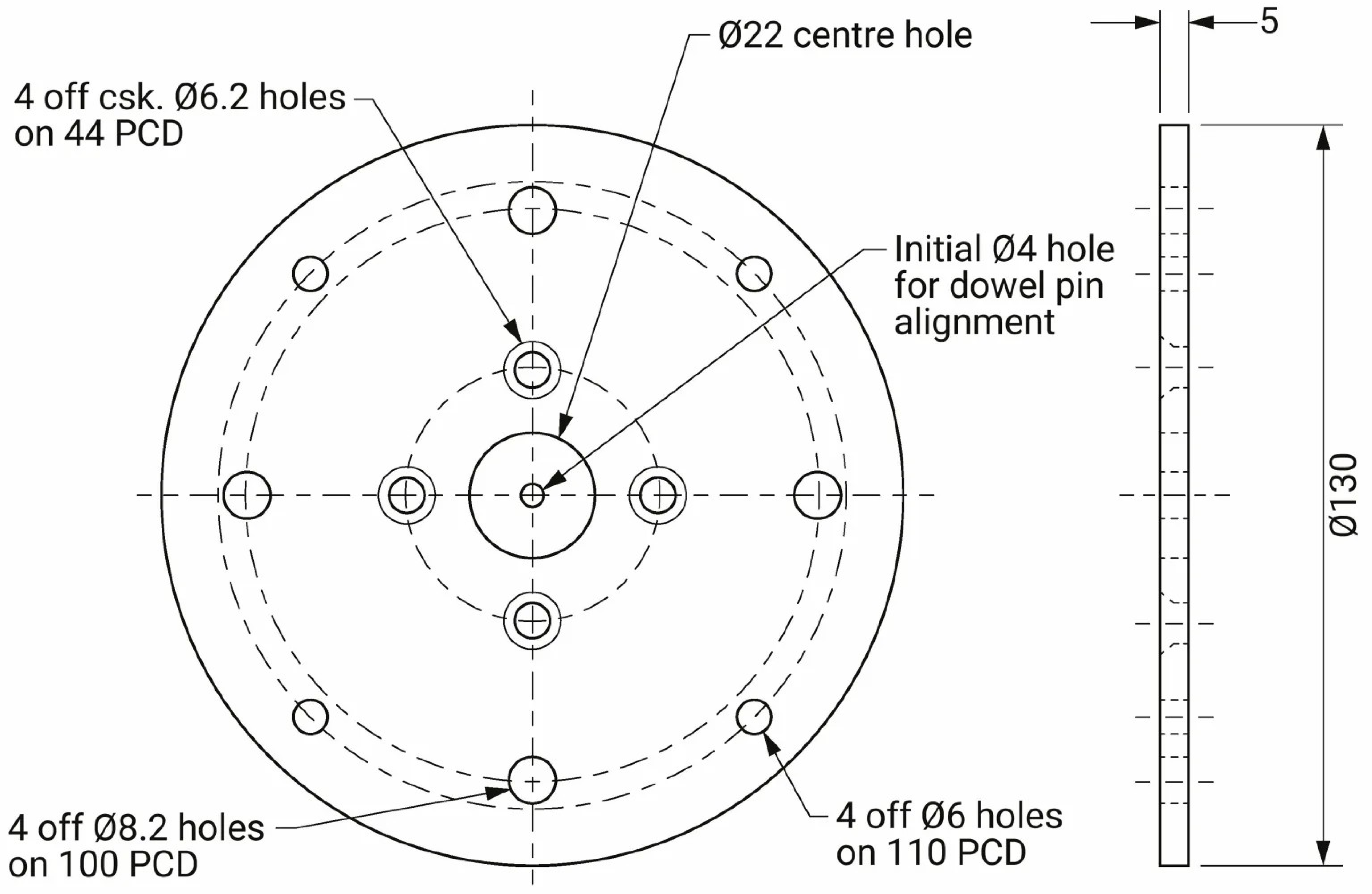


Fig. 2 Bottom Flange
Mat'l: Aluminium alloy

Figure 2

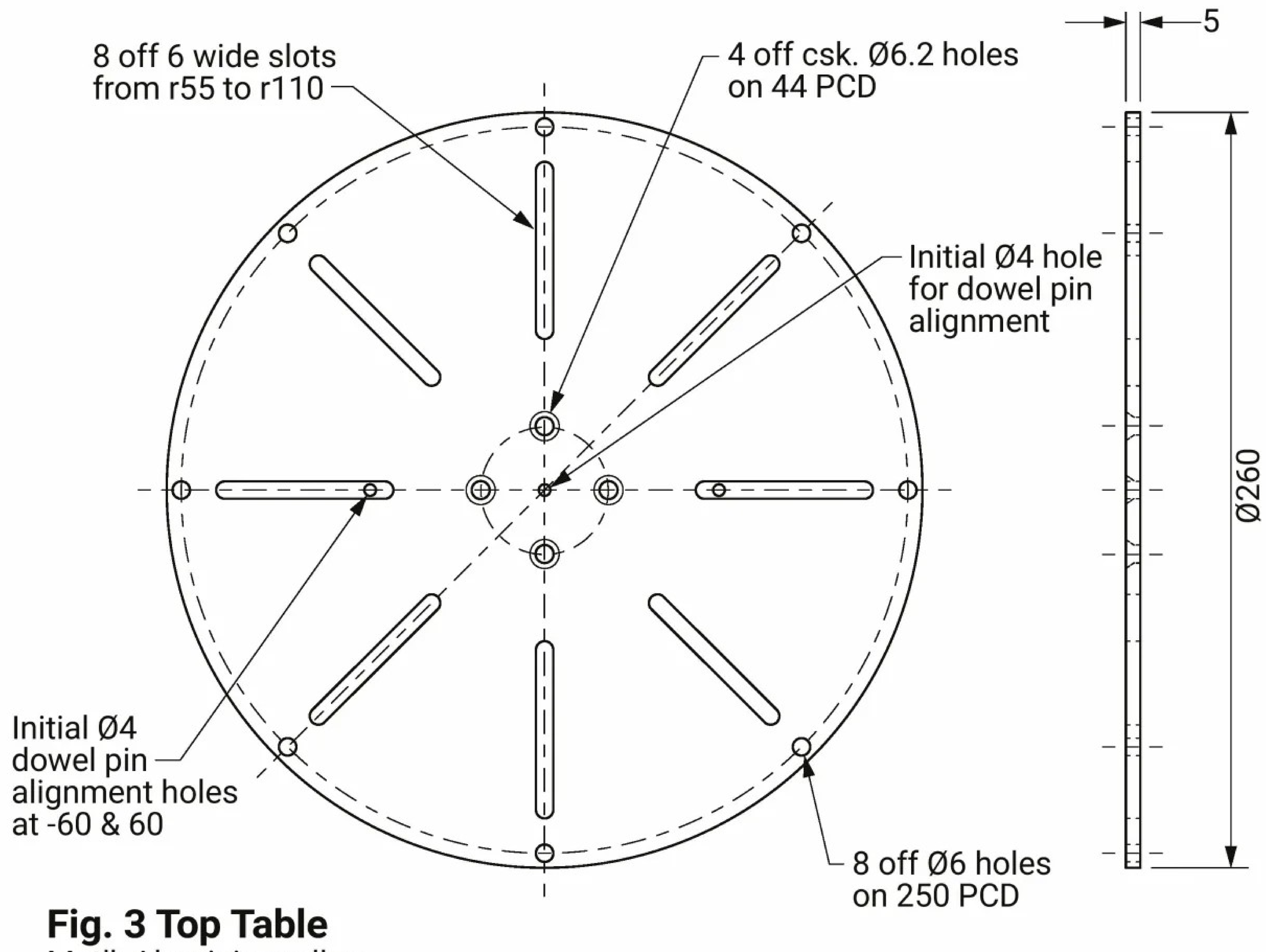


Figure 3

the M6 tapped holes on PCD 44 were drilled 5mm as an equally spaced set of eight on one side, and then tapped M6 in sets of four from that side and then the other side, because the taps that were available were not long enough to go right through the 32mm length of the workpiece.

The circular plates shown in figs 2 and 3 were initially drilled with 4mm positioning holes for alignments using 4mm diameter dowel pins in lathe and milling machine drill chucks. With the top table, three 4mm dowel pin alignment holes were initially drilled with spacings of 60mm, so that this large plate could be axially rotated through 180º and accurately realigned to overcome the available working area limitations on the milling table.

Another Use

Another use for the trepanning assembly is that, if there is sufficient space available over the lathe bed, the assembly with the bottom flange removed can be held in a lathe chuck to serve as a faceplate. ▮

In our Next Issue

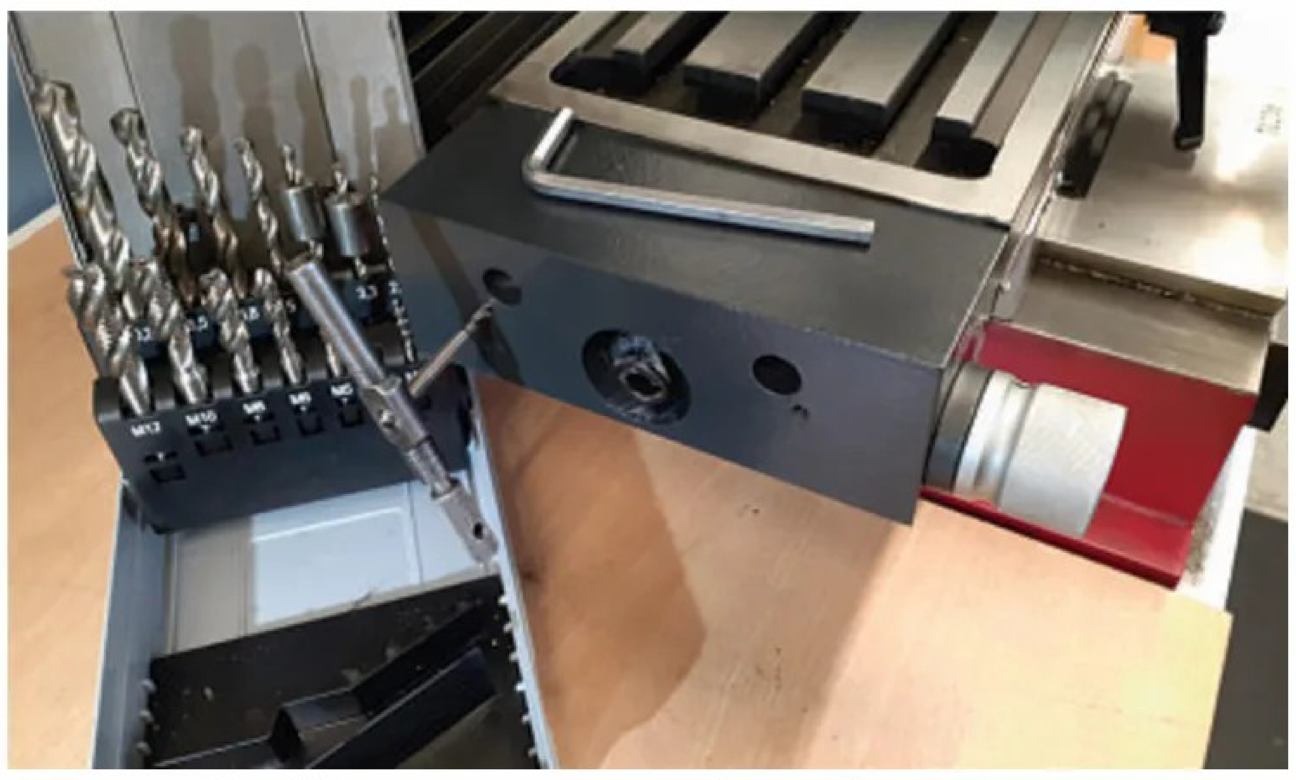
Coming up in issue 339, May 2024

On sale 12 May 2024

Contents subject to change

Dave Fenner offers some useful guidance on sheet metal work, using a model AEC Matador as an example.

David George explains how to set up and use a fixed steady on your lathe.



Jason Ballamy on getting the most out of your brushless Milling Machine.

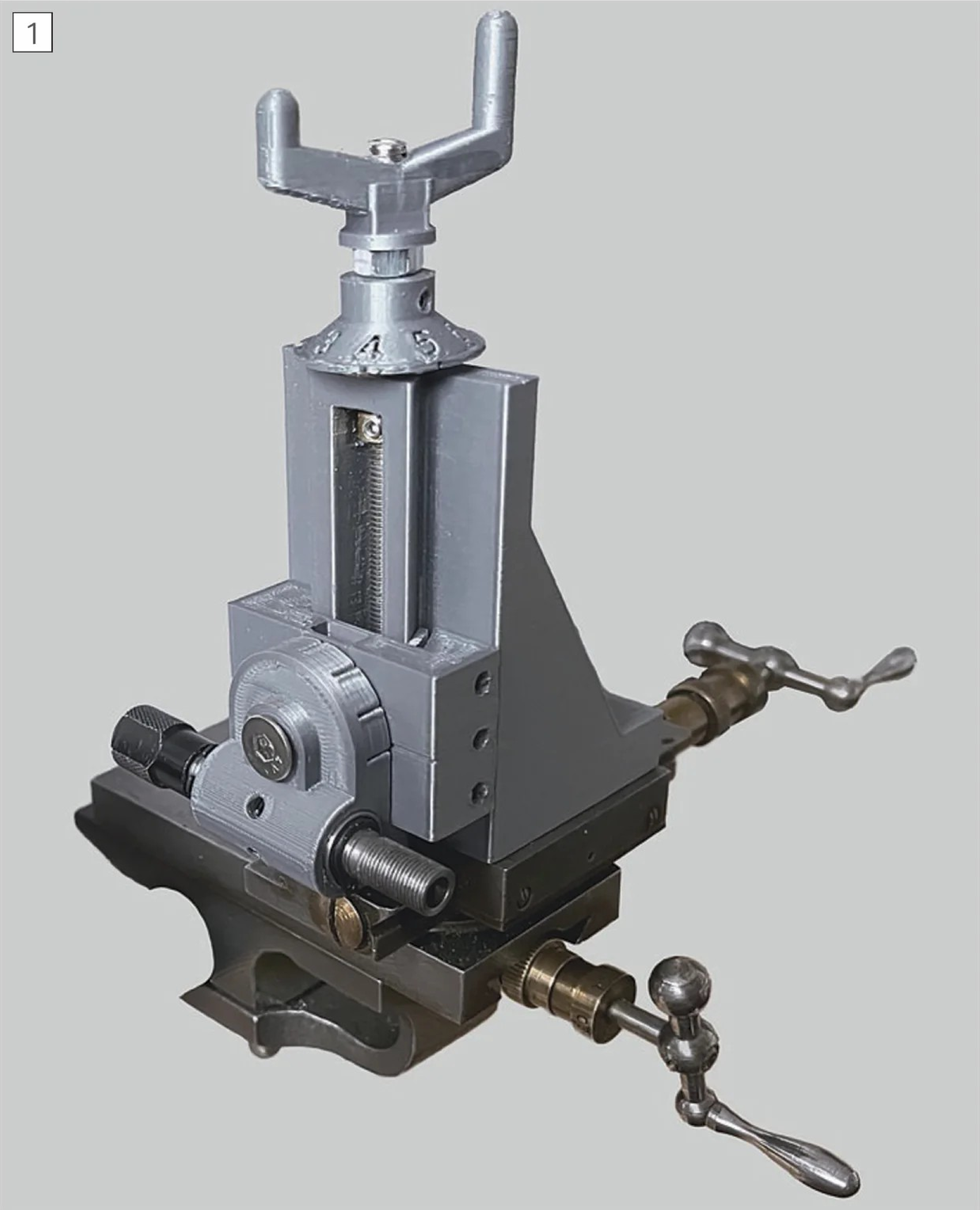
To pre-order your next copy of MEW visit www.classicmagazines.co.uk or call 01507 529 529

DON'T MISS THIS GREAT ISSUE-SEE PAGE 54-55 FOR OUR LATEST SUBSCRIPTION OFFER

A 3D printed Watchmaker's Vertical Slide.

Adrian Rawson demonstrates a surprising application for 3D printing.

1



Vertical slide mounted on compound slide.

Having found a need for a vertical slide to fit the compound slide on my watchmaker's lathe and seen their rarity and price, I decided to have a go at making my own, **photo 1**.

I found a Chinese version on sale that looked like a reasonable starting point. So, I proceeded to draw some plans with the idea that the design must include a spindle that could be driven by a rotary tool flexible drive. This seemed like a bright idea as it would obviate the need for pulleys and belts.

I noticed that the Chinese pulley version had a reversible spindle which allowed for the driven end to be chosen dependent on its orientation. I came to the decision to make my spindle double ended and consequently fixed.

Drawing the plans brought out a few issues which I felt might benefit from a plastic model. So, I captured the design in CAD and printed it out. I was so impressed with the results that I decided to add the spindle and test its capabilities. After a few adjustments and remakes I came to the conclusion that this plastic version was a viable tool worth consideration by anyone needing a 3rd axis with a driven spindle. It may not last forever but, let's face it, it's easy to reproduce.

The design **fig.1** is my best attempt at technical drawing so may leave something to be desired. However, it shows all the measurements of the finished plastic model and could therefore be used as a basis for CAD capture.

There are quite a few parts that still have to be made in metal once the plastic components are printed. My 3D printer is a Zmorph Fab which comes with Voxelizer software for slicing. Although it is highly configurable I pretty much do what it suggests, so no particular advice here except go for high density particularly where holes are to be tapped.

Upright

The design as shown, **photo 2**, is specific to my compound slide's mount and as

2

Upright.

›

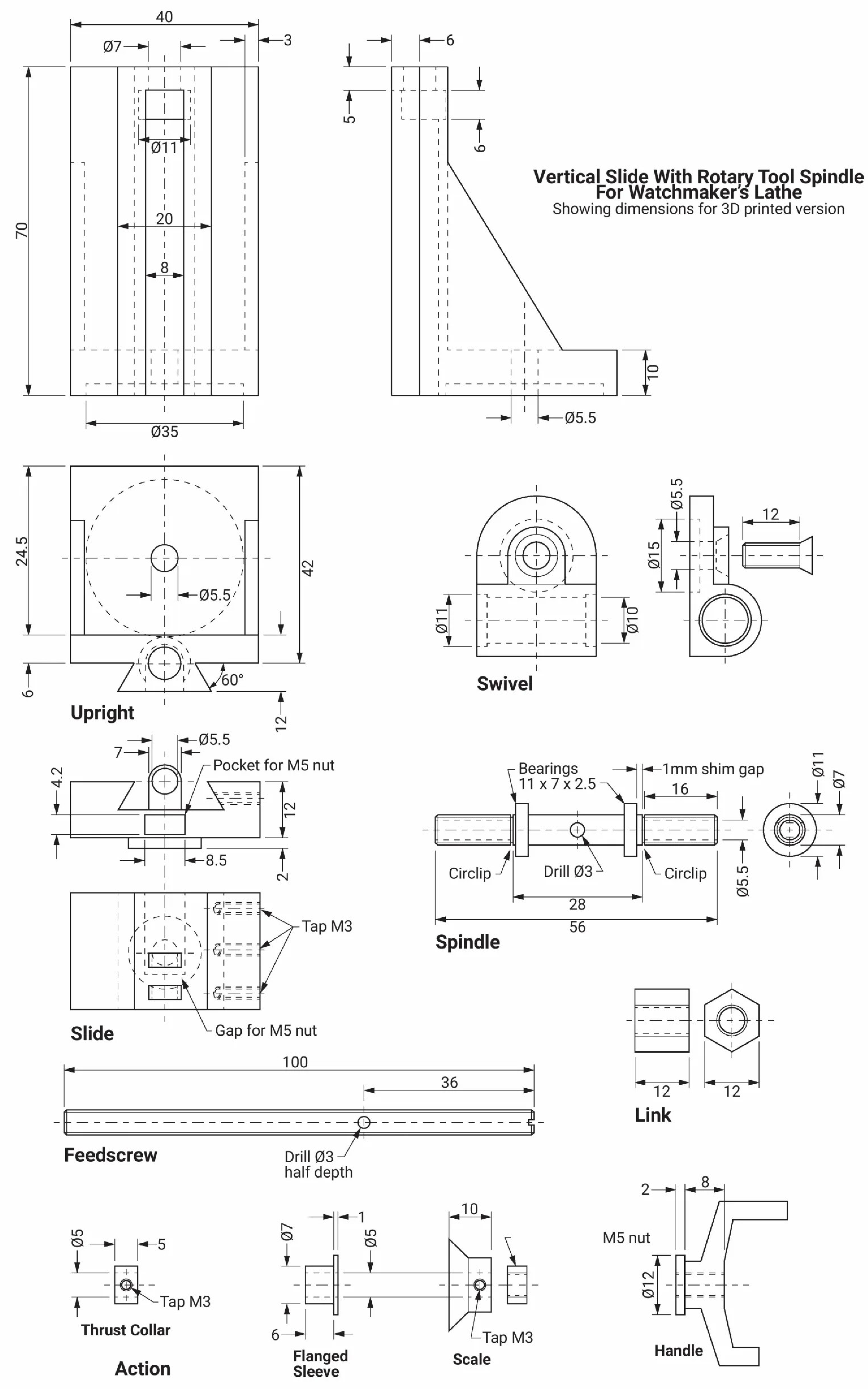
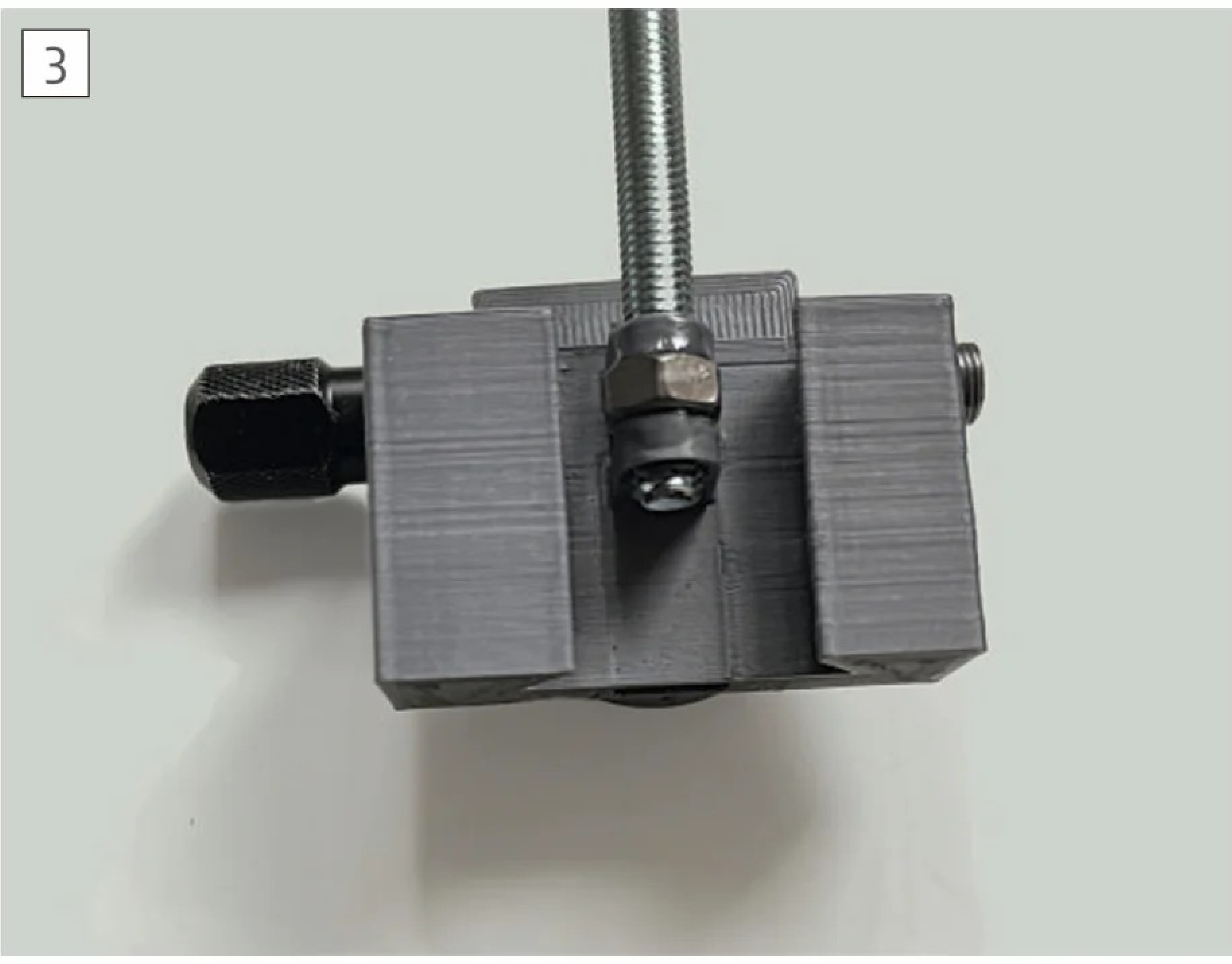
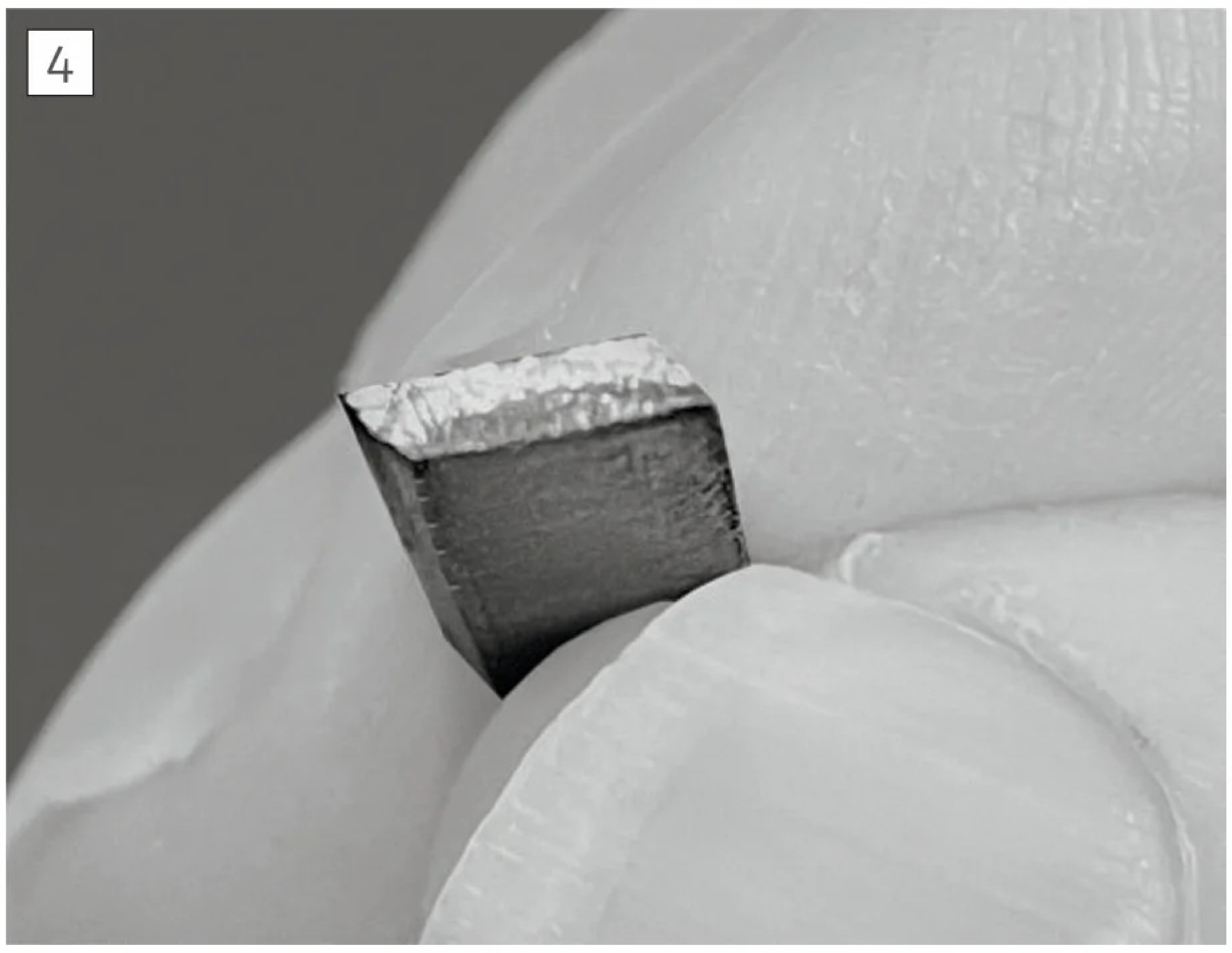

Vertical Slide With Rotary Tool Spindle
For Watchmaker's Lathe
Showing dimensions for 3D printed version
40
Ø7
3
6
5
6
Ø11
70
20
8
10
Ø35
Ø5.5
24.5
Ø5.5
42
6
60°
12
Upright
Swivel
Ø5.5
12
Ø15
Ø11
Ø10
Ø5.5
7
4.2
Pocket for M5 nut
12
8.5
2
Bearings
11 x 7 x 2.5
1mm shim gap
16
Ø11
Ø7
Circlip
Drill Ø3
Circlip
Ø5.5
28
56
Spindle
Tap M3
Slide
Gap for M5 nut
Link
12
12
100
36
Feedscrew
Drill Ø3
half depth
2
8
M5 nut
Ø12
Handle
Ø5
5
Tap M3
Thrust Collar
Action
Ø7
1
Ø5
6
Flanged
Sleeve
10
Tap M3
Scale

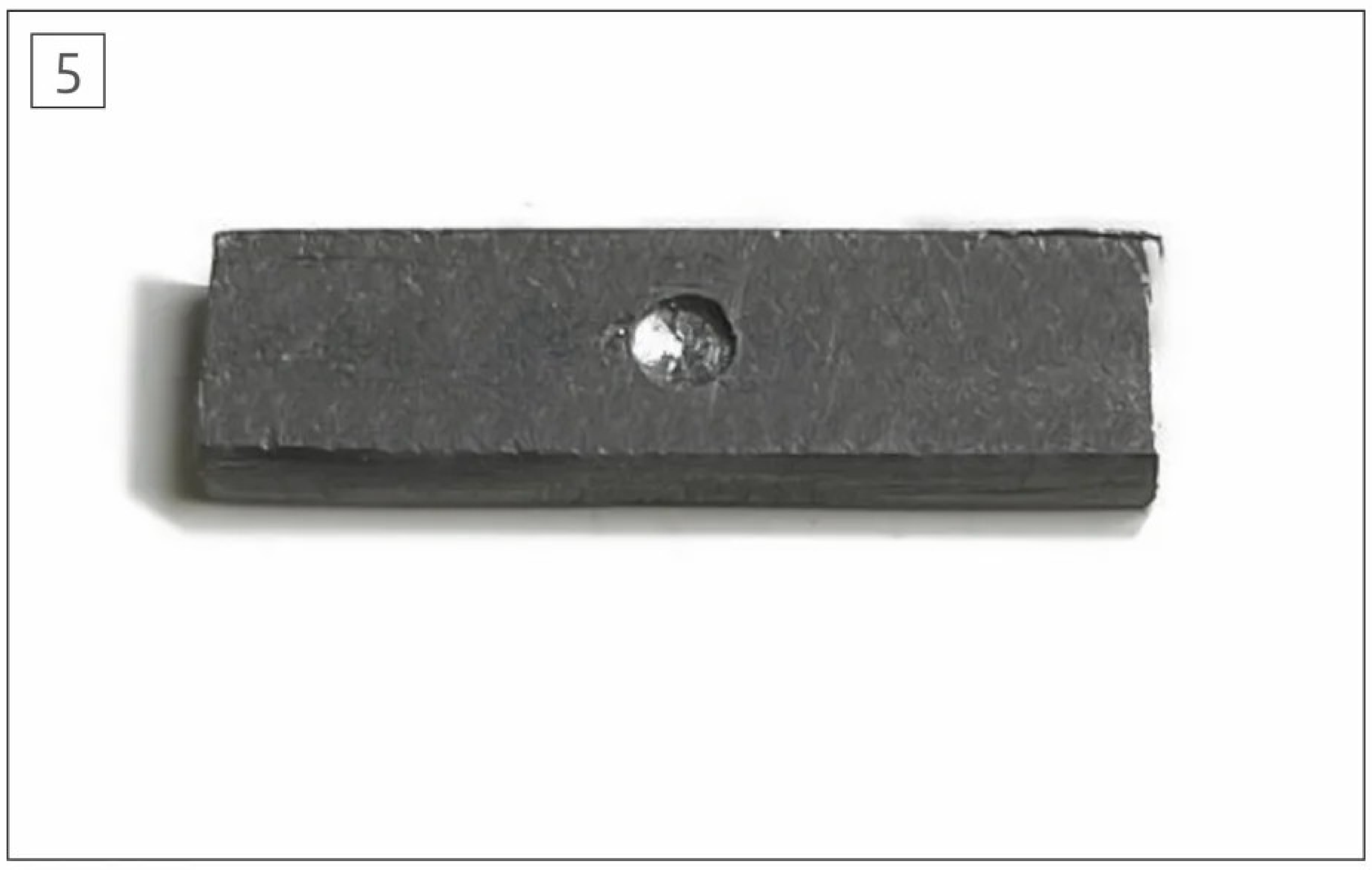
Figure 1



Slide nut.



Gib Strip profile.



Gib strip locator.

Swivel locator.

such may not fit others out there. The drawings show the recess and central 5mm fixing point used. This type of mount facilitates easy 90-degree rotation of the slide for drilling or milling activities. The first upright I made was only 50mm high. When I mounted the finished article for an initial feasibility trial, I realised it wasn't tall enough to accommodate the full swing of the lathe plus any tooling. A couple of hours later I had a 70mm version. Mistakes are easily rectified in printed plastic.

Slide

This runs up and down the upright's dovetail and carries the swiveling spindle. There are two M5 nuts required on the slide, one for the action of the feed screw and another to hold the swivel in place. The feed screw nut must be glued in place so that it can't twist, **photo 3**. I held this central to its mount with an M5 bolt while I applied a few drops of superglue. Care is required not to glue the bolt into the nut during this process as it must be removed to make way for the feed screw.

A pocket in the slide holds a similar nut for holding the swivel. This is simply dropped in place, no glue required.

The dovetails are set off centre to accommodate a gib strip for slide adjustment. This is achieved by three M3 grub screws. The slide must be carefully tapped to accept these. The ones I used were 5mm long, but longer would be better as there would be more thread engagement. The middle one probably isn't necessary as the slide never extends beyond the reach of the upright but may be used as a convenient slide lock. I made a couple of gib strips from aluminium and steel. Neither proved better than the other so it's a matter of what you have that's about 1.5mm thick and rigid. This must be profiled to fit snugly into the dovetail, **photo 4**. I also drilled an indent into the gib strip to locate the central grub screw, **photo 5**. This is necessary to stop it being pulled from the slide. All three would normally have locating slots, but in this miniature slide I got away with one.

Swivel

This is fixed to the slide by a 5mm countersunk bolt which tightens it against a circular mount on the slide. This locates in a corresponding depression on the swivel, **photo 6**. I tried making this locator slightly tapered so that it might seat more precisely but found that plastic doesn't lend itself to such accuracy at this scale. In the event I found that it was necessary to file it to a best fit, particularly as it wasn't perfectly round due to being printed vertically

The swivel has marks set at 30, 60 and 90 degrees which align with a horizontal mark on the slide. This is for indication only and lacks the accuracy achievable with a steel version. Offset from the centre is the spindle housing which has two centre holes for aligning the hole in the shaft. This is used to lock the shaft with a bar during tightening and loosening the chuck and link. These aren't shown in fig 1.

Spindle

This is made from a 56mm length of 7mm silver steel rod. It doesn't have to be silver steel but it's what I had available. Stainless steel would probably be better for its antirust quality. Both ends of the rod are threaded for 12mm at a pitch of 40 TPI and drilled 4.5mm to a minimum depth of 14mm, **photo 7**. This satisfies the requirements of a standard rotary tool chuck. Forming the thread on silver steel must be carried out slowly and with a sharp tool, and the resulting thread may stand proud of the original 7mm. I found it necessary to run a fine file over it, whilst spinning in the lathe, to allow the 7mm inside diameter miniature bearings to slide over the thread and onto the spindle shaft. Two slots to match circlips used are cut 28mm apart. This leaves 1mm of shim space to take out any end float on the spindle. In my case the bearings were such a snug fit that there was no end float to take out. I tapped the bearings into place with a short length of 10mm brass tube with a 7mm internal diameter. Once one bearing is in place on the shaft it can be seated in the spindle housing passing the shaft through to accept the other bearing. Tapping the other bearing onto the shaft until it seats snuggly in the spindle housing tightens everything up. I made sure that the bearing seats were clean and round by hand turning an 11mm end mill in them to remove any printing inaccuracies, **photo 8**, shows the complete assembly with the rotary tool chuck mounted on the spindle. After trying the spindle under load I found that the bearings did creep a bit which introduced some end float, so I shimmed the shaft with a 1mm brass washer.

Action and Feed screw

The feed screw is a length of 5mm stainless threaded rod. My 50mm high version used a simple bolt but the extra length required by the 70mm version needed a length of rod. The design doesn't prevent the use of something better of course as long as it's 5mm in diameter. This standard M5 screw has a pitch of 0.8mm so the scale is marked off 0 to 7 to indicate a movement of 0.1mm per graduation. The stainless rod is drilled half way through, 36mm from one end, to locate the thrust collar grub screw. It's important that this grub screw doesn't protrude from the collar to a point where it catches the channel in the upright's body. So the ability to sink it into the bar is important. The shortest grub screw I had was 3mm and needed sinking. I made the thrust collar out of brass. This collar rides against the flanged sleeve, also from brass. The flange acts as a bearing surface for the graduated wheel and protrudes 1mm through the upright for the collar to ride against. It is necessary to superglue this flanged sleeve in place to stop it sliding in the upright and producing backlash. The scale wheel is tapped for a 3mm grub screw so that it can be locked in place. I initially centre tapped this wheel 5mm so that it could be wound onto the feed screw and locked against the handle, which is also threaded. Then I placed an M5 nut on the end of the feed screw to hold everything tight. I found that the tapped wheel didn't ride flat against the flange when adjusted tightly to reduce backlash. This was due to the lack of concentricity in the tapped thread. So I ended up drilling a 5mm clearance hole instead and relying on the grub screw to hold it in place. This meant that the handle needed something to lock against so I moved the M5 nut to be below it.

Assembly

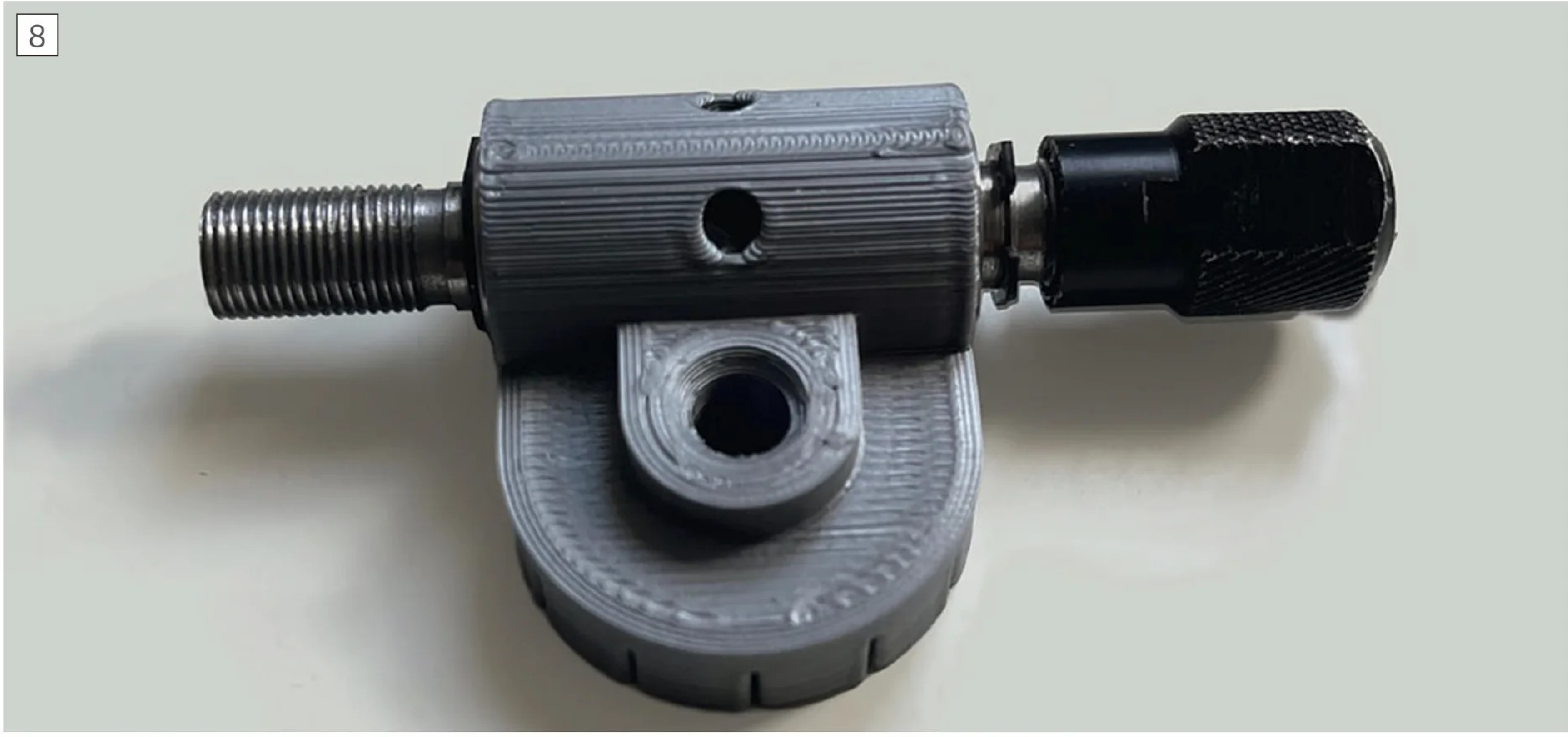
Assuming that the spindle has already been constructed as described, the feed screw action must be assembled. The collar is located on the feed screw with a grub screw, making sure it finds the predrilled hole. The flanged sleeve is glued in place before passing the feed screw up through it. The scale wheel is then slid onto the feed screw followed by an M5 nut. Finally the handle is wound on and locked against the nut. The scale wheel can be locked in place later.

It is now time to wind the slide assembly onto the upright by inserting it with the feed nut end last. But before doing this give all the sliding surfaces including the gib strip a spray with dry PTFE lubricant. This will make everything super slippy. Once you get the feed screw to engage with the feed nut the slide can be wound up the dovetail and the gib strip slid into place ready for adjustment.

The centre grub screw must be wound in to locate the indent in the gib strip to stop it sliding out. Now the other two

7

Spindle shaft.

8

Swivel assembly.

9

Link.

grub screws can be wound in to find the best compromise between slide and sideways movement. I found that sideways movement was very easily eliminated taking care to only just pull the grub screws up against the gib strip.

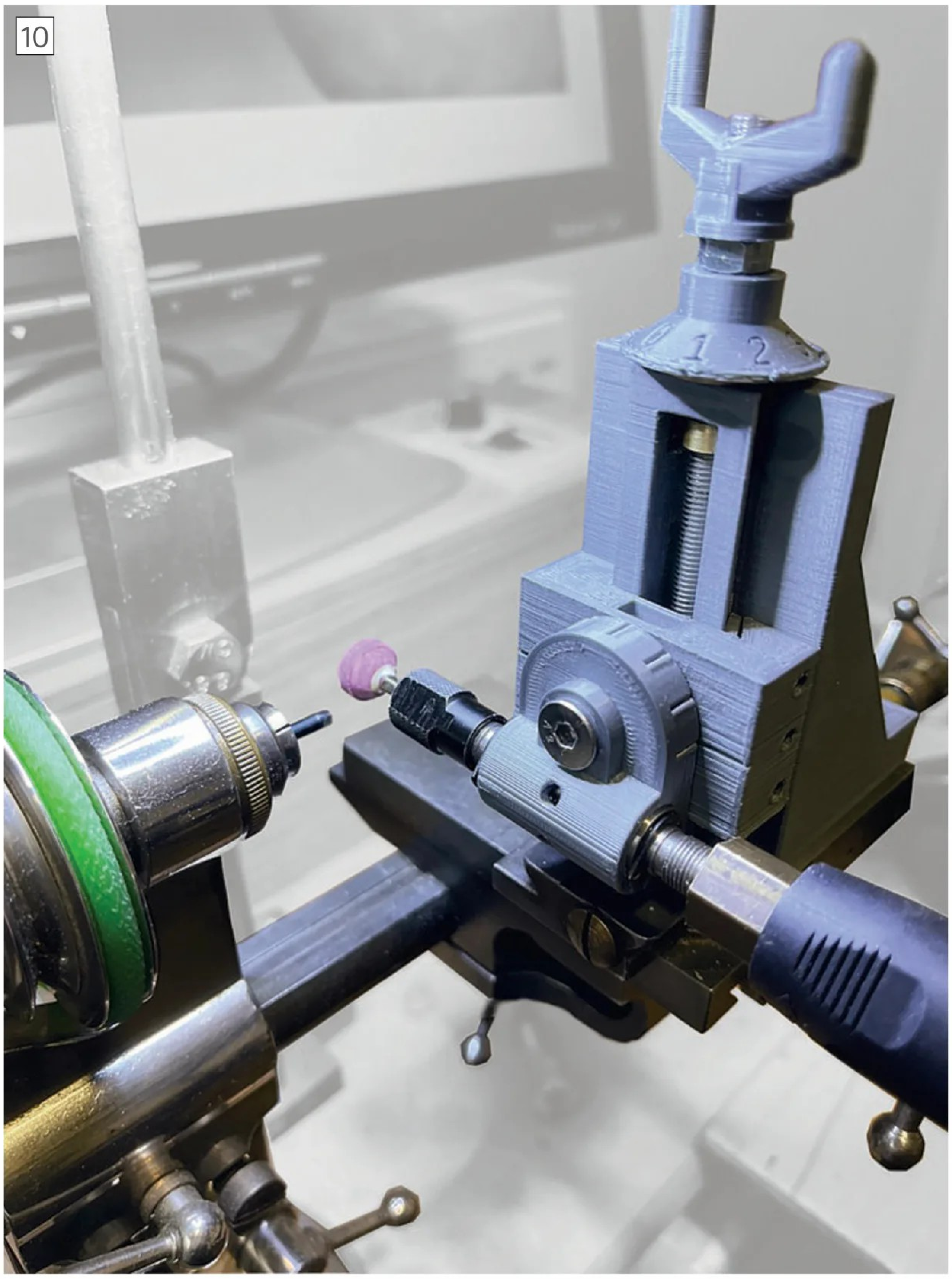
To reduce the backlash in the feed screw pull the scale wheel tight against the flange and tighten the grub screw.

Link

This is a long nut to enable the rotary tool's flexible drive to connect to the spindle. If the chuck is removed from the flexible drive the revealed thread is the same as the spindles, so all that is needed is a threaded sleeve to connect them together. I used a 12mm long piece of half inch hexagonal brass bar to make the link, and having read that the thread is 9/32 x 40 TPI, I bought a tap. However, this produced an unsatisfactory result. Unfortunately 9/32 inch is 7.144mm so if I hadn't had to file the thread back to a bit under 7mm to allow the bearings to pass over it would probably have worked. So I resorted to cutting an internal thread on the lathe, **photo 9**, using a tool ground from a broken tap.

In use

I wanted this device so that I might try cutting some clock wheels and do some off-centre drilling. But I have yet to try it in anger. However as my main concern was its rigidity, I tried grinding a square ›



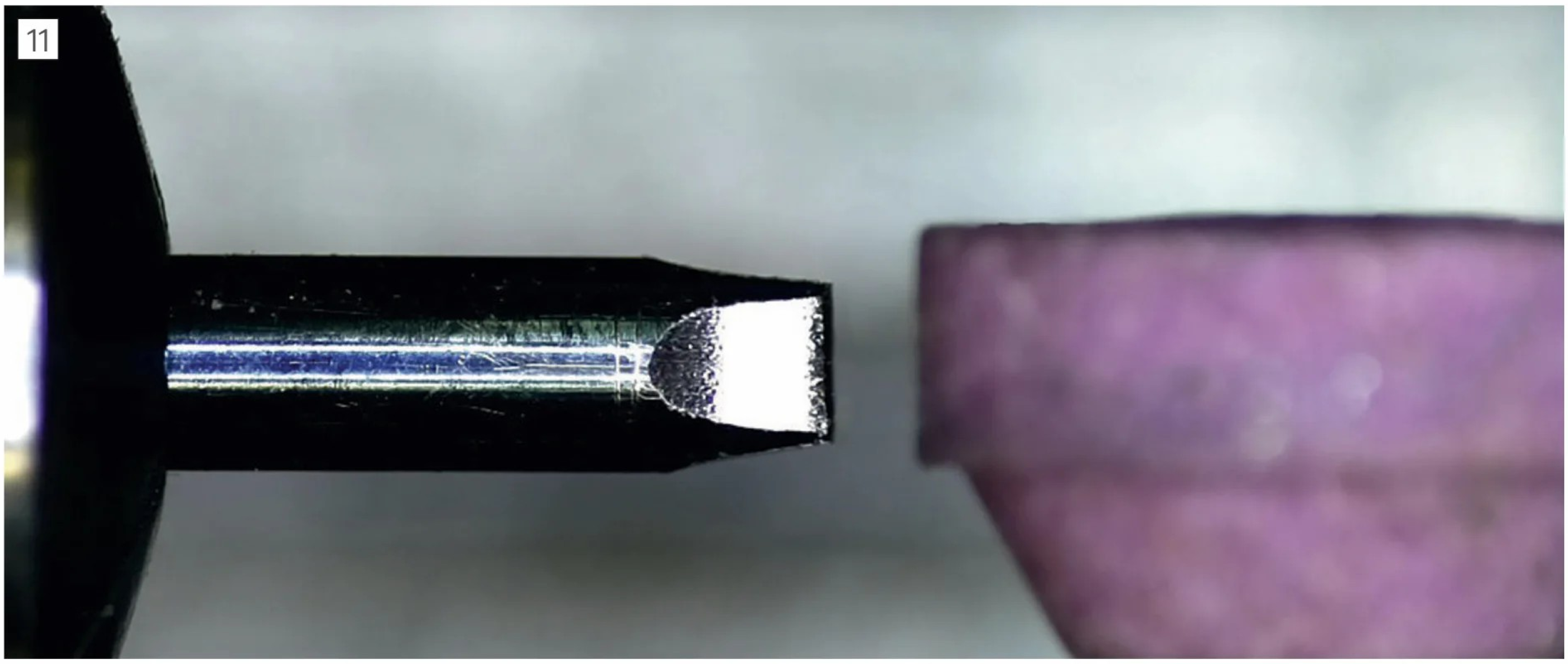
Grinding set up.

end on a 3mm blue steel shaft using the dividing wheel on the lathe to fix the shaft at 90-degree intervals. The set up is shown in **photo 10**. With the results under magnification shown in **photo 11**. The angle of the grinding wheel shown is slightly different to that used during actual grinding. However there was no sign that anything had lost its way during the process, and everything remained rigid.

The problem yet to be solved is some kind of support for the rotary tool's flexible drive. I ended up supporting it with one hand during the trials so as not to load the swivel unnecessarily.

In conclusion

I set out to make steel version but after modelling the design in plastic and discovering its capabilities I thought it worth sharing. If you already posses a reasonable 3D printer and a reel of PLA then it's a simple thing to make the plastic components from the STL files available for download on my website ahrprojects.co.uk. The small brass components could be made on a watchmaker's lathe but to screw cut the spindle and link something more capable is required. I've tried to provide enough information to enable CAD capture and hence modification of the design. I think the first modification I would make is the handle and scale wheel which would be much crisper in steel or brass. I can't see the plastic versions lasting forever. ▮



Ground steel.

FREE PRIVATE ADVERTS

MODEL ENGINEER — MODEL ENGINEERS' WORKSHOP

Save a stamp! You can now place your classified ads by email. Don't waste time scanning the form, just send the text of your ad, maximum 35 words, **meweditor@mortons.co.uk,** together with your full name and address, a telephone number, whether it's a for sale or wanted and stating that you accept the terms and conditions for placing classified ads – see below. Please note, we do not publish full addresses or website links to protect your and other readers' security.

Tools and Machinery

- Axminster bench milling/drilling machine. Including drill chuck, angle vice, swivel vice, collets, various drills, side and face cutter, tee nut set, holding set and shell cutter with arbor, boring cutters. Buyer to collect £650.
T. 01443 405385/07974446321 Pontypridd.

- Chester Milling Machine vertical bench top, very heavy, £450.
T. 07796 628908. Wolverhampton.

- Stent tool and cutter grinder complete and functional but not been used for a few years so would benefit from a strip down and clean up. Best offer over £100.
T. 01425 476837. Ringwood.

- New Engineers Bevel Square complete in presentation case £25. A Brand-new Boxed set of micrometers one to six inch with additional Anvils for the two to six-inch Mic's £75. A Metabo Drill stand similar? in appearance to the current series about the Universal Pillar Tool. £15. Photos by E-mail. All plus postage. **T. 07905 783031**

Parts and Materials

- Complete Castings for LMS Jubilee 5"G to Tony Allcock design plus Model Engineers Laser LMS 4000 tender body. Tender chassis part built. Offers over £1,200. **T. 07470 584651.**

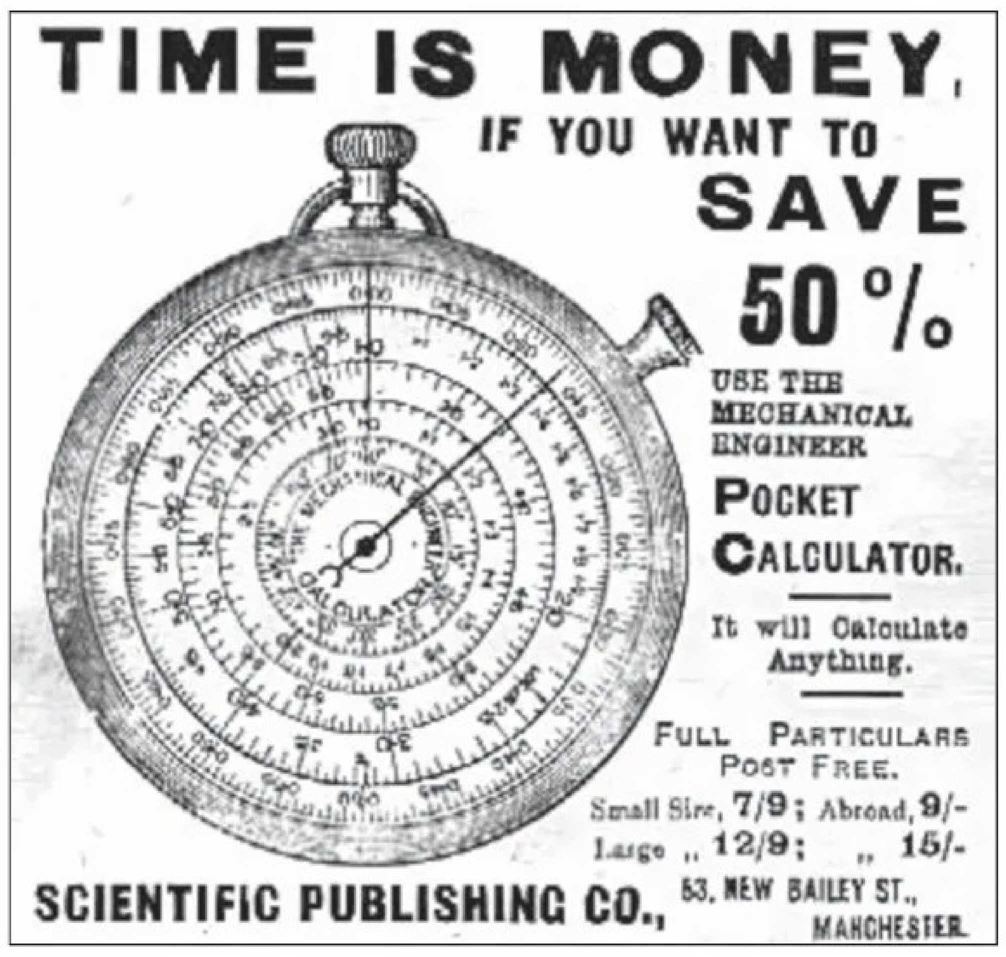
Magazines, Books and Plans

- Model Engineer, 1987 to 2023 in yearly boxes, free must be collected Devon. **T. 01626 332700. Newton Abbot.**

- 3" Marshall 7NHP Traction Engine Drawings - set of 18 sheets approx. A0 size also 2" Fowler 7NHP Traction Engine Drawings - set of 16 sheets approx. A0 size. £25 each set plus P+P.
T. 01933 460647. Wellingborough.

Wanted

- Boley Watchmakers Lathe, Lathe chuck and tailstock chuck for above.
T. 01443 686111. Mid Glamorgan, South Wales.



YOUR FREE ADVERTISEMENT (Max 36 words plus phone & town - please write clearly)

❑ WANTED ❑ FOR SALE

Phone:	Date:	Town:
		Please use nearest well known town

Adverts will be published in Model Engineer and Model Engineers' Workshop.

The information below will not appear in the advert.

Name ....

Address ....

....

....

.... Postcode..............................

Mobile .... D.O.B..............................

Email address..

Do you subscribe to Model Engineer ❑ Model Engineers' Workshop ❑

Please post to:
ME/MEW FREE ADS, c/o Neil Wyatt, Mortons Media Centre, Morton Way, Horncastle, Lincolnshire, LN9 6JR
Or email to: meweditor@mortons.co.uk

Photocopies of this form are acceptable.

Adverts will be placed as soon as space is available.

Terms and Conditions:
PLEASE NOTE: this page is for private advertisers only. Do not submit this form if you are a trade advertiser. If you wish to place a trade advert please email Angela Price at aprice@mortons.co.uk

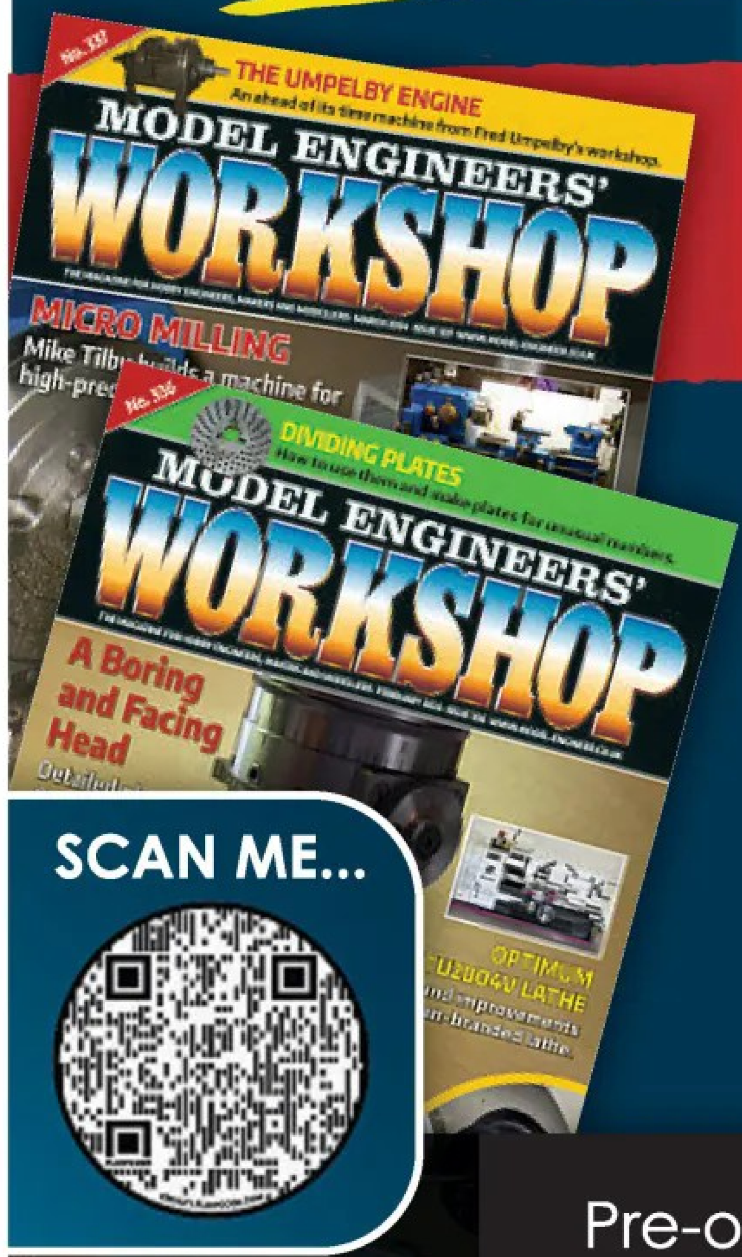
By supplying your email/ address/ telephone/ mobile number you agree to receive communications via email/ telephone/ post from Mortons Ltd. and other relevant 3rd parties. Please tick here if you DO NOT wish to receive communications from Mortons Ltd: Email ❑ Phone ❑ Post ❑
or other relevant 3rd parties: Email ❑ Phone ❑ Post ❑

To advertise please contact Mason Ponti
Email: mason@talk-media.uk
Tel: 01732 442144

M-MACHINE
Unit 6 Forge Way, Cleveland Trading Estate
Darlington, Co. Durham. DL1 2PJ
Metals for Model Makers
Contact us for Copper, Brass, Aluminium, Steel, Phosphor Bronze, etc.
PHONE & FAX 01325 381300
e-mail: sales@m-machine.co.uk
www.m-machine-metals.co.uk

Thinking of Selling your Engineering Machinery?
and want it handled in a quick, professional no fuss manner?
Contact David Anchell
Quillstar (Nottingham)
Established 1980.
Tel: 07779432060
Email: david@quillstar.co.uk

GUARANTEE YOUR COPY
PRE-ORDER YOUR NEXT ISSUE

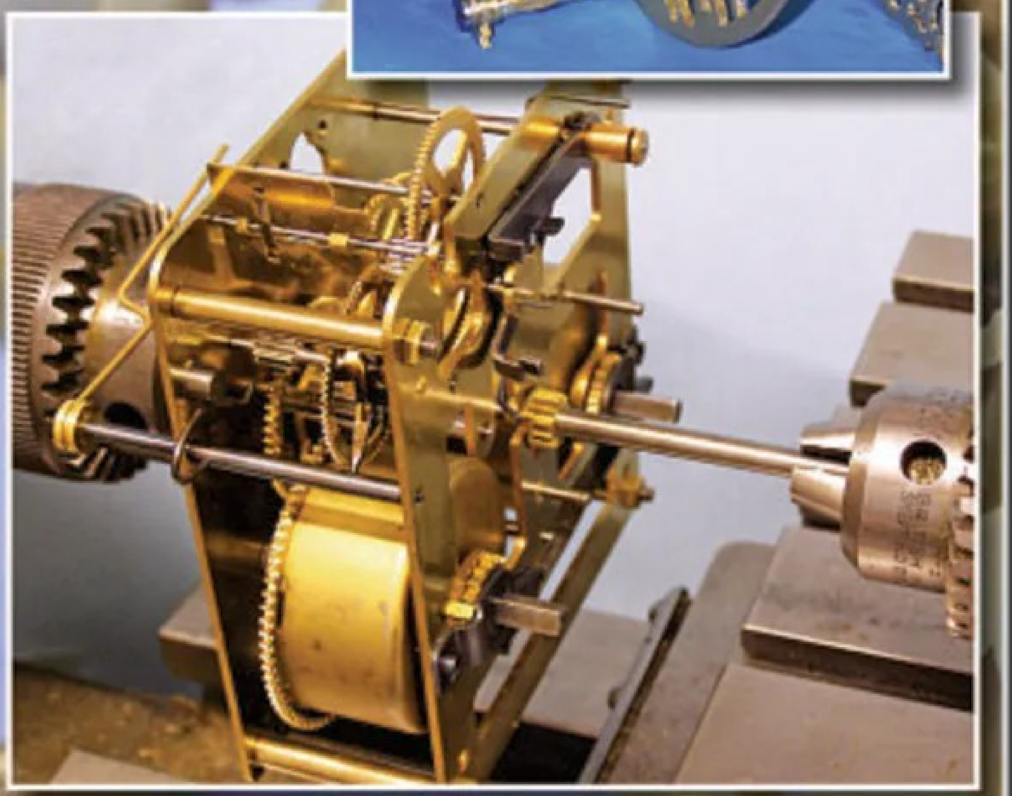


3 GREAT REASONS
- Delivered straight to your door
- Free postage and packaging
- Buy direct from the publisher

SCAN ME...
Pre-order today:
www.classicmagazines.co.uk/issue/preorder

webuyanyworkshop.com
Re-homing model engineers' workshops across the UK
It's never easy selling a workshop that has been carefully established over a lifetime. I will buy your workshop so you don't have to worry about finding a new home for much loved workshop equipment and tools.
Please email photos to
andrew@webuyanyworkshop.com
Or to discuss selling your workshop, please call me on **07918 145419**
All equipment considered: Myford, Warco, Chester, classic British brands etc
Polly steam locomotives also purchased, especially those needing a bit of 'TLC'

CLOCK CONSTRUCTION & REPAIR
Books by:
John Wilding MBE FBHI, E. J. Tyler, John G. Wright, Eric Woof, John Tyler and others.



SPRINGS
BEARINGS
FRAMES
DIALS etc.
FREE Catalogue
Telephone: +44 (0) 1420 487747
www.ritetimepublishing.com

J A Alcock & Son Courses

Craft Your Own Mechanical Clock Movement
Introduction to Practical Clock Servicing

3 East Workshops, Harley Foundation Studios,
Welbeck, Worksop, S80 3LW
(Workshop visits by appointment only)

For more information including additional courses run by J A Alcock & Son please see our website
Tel: 01909 488 866 Web: www.sortyourclock.co.uk

All courses taught by a Fellow of the British Horological Institute

Find us on
@sortyourclock
THE HARLEY FOUNDATION

To advertise please contact Mason Ponti • Email: mason@talk-media.uk • Tel: 01732 442144

Be a part of making things possible

REMAP is a charity which connects volunteer inventors with local people with disabilities to help them achieve greater independence and enjoyment of life's opportunities. Our REMAP volunteers operate throughout England, Scotland and Wales. We have over 60 volunteer-led branches that support their local communities throughout England, Scotland and Wales.

COME AND JOIN US...

- Make a significant difference to somebody's life in your local area.
- Enjoy the opportunity to meet other, like-minded people.
- Receive recognition for the skills and experience you bring to your branch and the people we help.



Find out more www.remap.org.uk

Charity no: 1137666 | Scotland: SC050584

WE ARE THE EXCLUSIVE UK DISTRIBUTOR FOR

WABECO

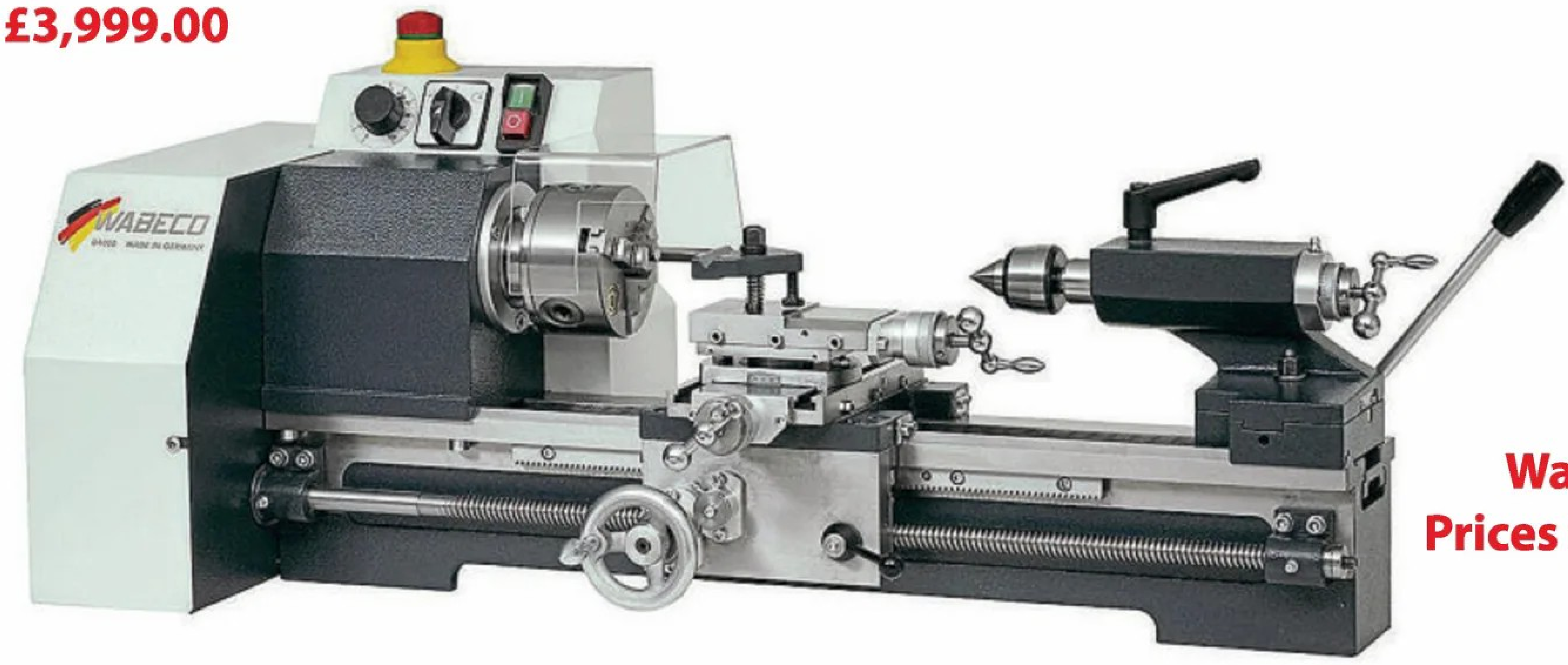
MACHINE MANUFACTURER since 1885

5 YEARS WARRANTY

On selected machines

Wabeco drilling stands
Prices from £165.00

Wabeco milling machines
Prices from £3,999.00



Wabeco lathes
Prices from £3,995.00

Prices include VAT & Delivery Mainland UK

We offer a complete range of quality, precision machines for the discerning engineer.

Developed and manufactured in Germany, Wabeco products guarantee the highest quality standards. Whether your milling or drilling with Wabeco, you're sure to get the best results possible.

Emco distributes a wide range of machine tools, CNC machines, lathes, drills, printers, routers, 3D scanners and waterjet cutters for industrial and educational use.

Visit **emco.co.uk** to see the full range of new and secondhand machines or call us on **02392 637 100** for more details.

isel WABECO MACHINE MANUFACTURE SINCE 1885

Emco Education Ltd, Unit 4, Hayling Billy Business Centre, Furniss Way, Hayling Island, Hampshire, United Kingdom PO11 0ED sales@emco.co.uk

emco UK DISTRIBUTOR