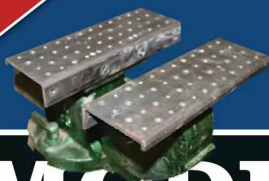


No. 341



WIDER VICE JAWS

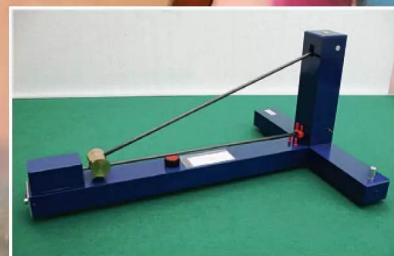
A clever design that also copes with odd-shaped workpieces.

MODEL ENGINEERS' WORKSHOP

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS JULY 2024 ISSUE 341 WWW.MODEL-ENGINEER.CO.UK

BUSY IN THE WORKSHOP

A practical example of clamping on a modified bandsaw.



FEEL THE EARTH MOVE

Mark Noel previews his talk at the Midlands Model Engineering Exhibition.

MODIFICATIONS TO A SMALL MILL

Four ways to make your benchtop mill more pleasant to use.



INSIDE THIS PACKED ISSUE:

■ AN MT2 SPINDLE FOR THE DRUMMOND/MYFORD TYPE M. ■ CONTROL SYSTEM FOR A MICROMILLING MACHINE. ■ GETTING THE MOST FROM YOUR BRUSHLESS MILL. ■ MAKING A SIMPLE TOOL AND CUTTER GRINDER. ■ CLAMPING AND WORKHOLDING. ■ REPLACING THE FEP FILM ON A RESIN PRINTER. ■ EXPERIENCES WITH S DENFORD CNC LATHE. ■ MMEX 2024 – LATEST NEWS. ■ LEFT-HANDED SCREW CUTTING. ■ PLUS ALL YOUR REGULAR FAVOURITES!

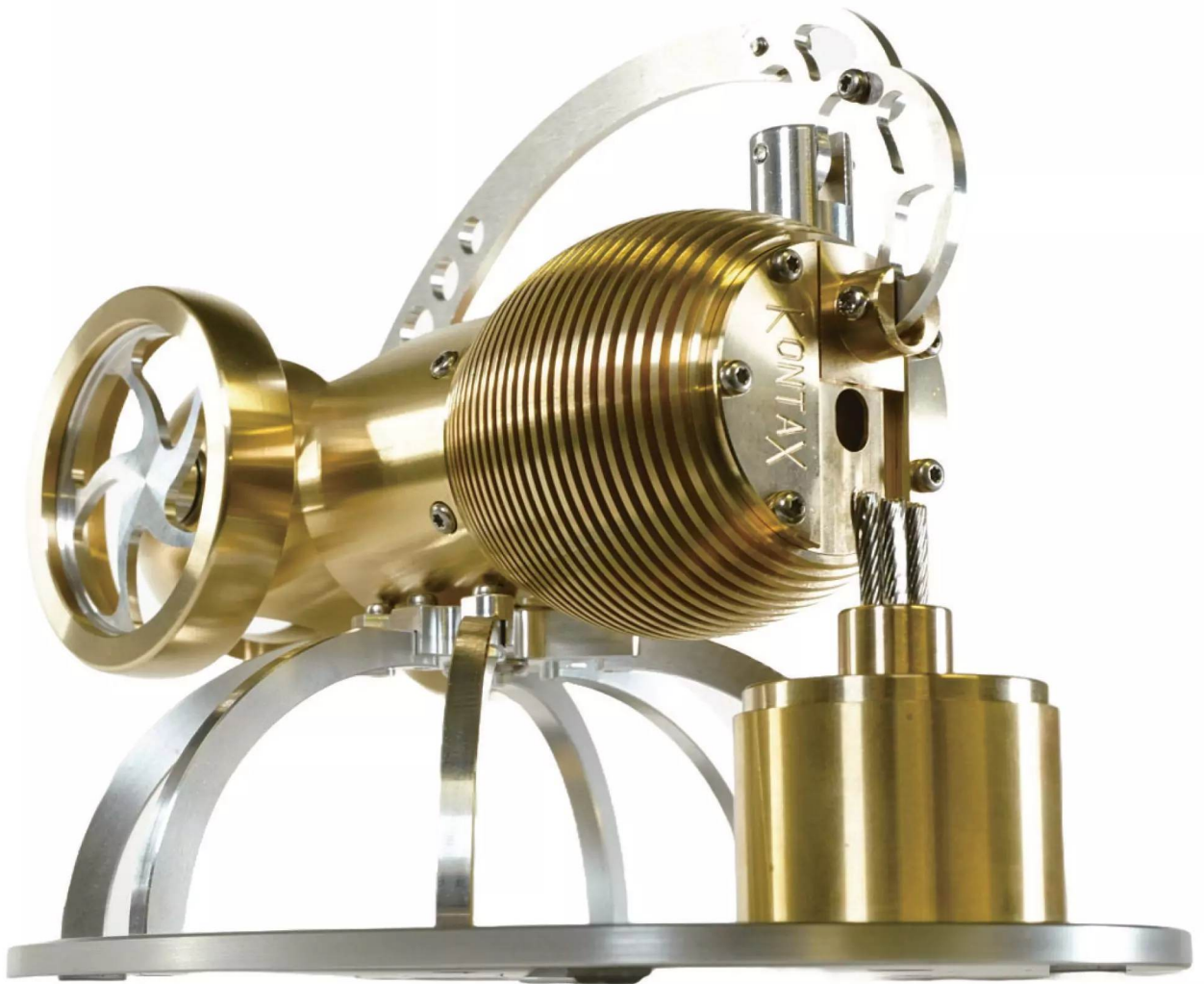
July. 24

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The next issue will be on sale 19 July 2024

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On the Editor's Bench

Busy in the Workshop

Recently a 'popular social media site' has been sending me multiple advertisements for turntable weights to keep LP records from slipping, and to help flatten out slightly warped records. I haven't bought an LP since last year, but I have a couple of hundred dating back to the early sixties, so unfortunately there are a few that could do with a bit of a 'steadying hand'. It seems more than a little profligate to buy such a thing when I have a workshop full of all the required bits, so I thought I would knock one up as the basis of an article for readers relatively new to turning. As I'm now in a part of the world where steel stockholders are less abundant (one thing I definitely miss about the West Midlands) grabbing a short end of free-cutting stainless steel is not as quick as it was. But I have a couple of feet of 2" diameter EN1a Pb, free cutting mild steel, in the workshop, I thought the exercise might also be an excuse to get some chemical blacking solution in.

I'll keep the details until the next issue when I will have space to describe some of the steps involved in more detail, but I thought some readers might find the cover photo useful, as it shows a few 'improvements' to my bandsaw. The moving jaw of the vice has the otherwise pointless redundant facing plate for the fixed jaw attached to it, this allows it to



support work very close to the blade. An M10 screw allows fine adjustment of the back of the vice so short workpieces can be gripped securely. In this case I used a v-block (with an offcut to protect it) as additional spacing. Finally, under the workpiece is a 'shelf' made of angle iron that ensures the work is supported right until the end of the cut. Here's another view that shows the shelf and packing a bit more clearly. Incidentally, the saw was used to cut its own runout groove in the shelf.

Neil Wyatt



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

SPECIFICATION:

Distance between centers: 350mm
Taper of spindle bore: MT3
Spindle bore: 20mm
Spindle speed: 50-2500rpm
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: 700x180mm
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 BRUSHLESS 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: 500x140mm
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!



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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: 840x210mm
T-slot size: 14mm
Weight: 240Kg

Price: £2,100

W DRO – Price: £2,537

W DRO + PF - Price: £2,948



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Contents

9 Milling Machine Modifications

Geoff Andrews has made several useful modifications to his Amadeal bench mill that will be of interest to all users of smaller milling machines.

15 Third Dimension: Replacing the Film on a 3D Resin Printer

Neil Wyatt explains how to successfully replace the special film on a 3D resin printer.

19 Getting the most out of your Brushless Mill - Part 3

Jason Ballamy looks at how to get the best results with different types of cutters and inserts.

24 From the Archives

A useful article with advice on cutting left-handed threads in using your lathe.

28 Micro-Milling

Mike Tilby explains how he achieved automated control of the movement of his micro-milling machine.

32 Wider Vice Jaws

Marcos Diniz makes some larger capacity vice jaws, that also provide a larger work surface with the ability to hold awkward shapes with ease.

36 Beginner's Workshop

Staying with the theme of workholding, Geometer introduces a range of clamping options for machining and handwork.



38 The Midlands Model Engineering Exhibition

More news about this October's MMEX exhibition in Warwickshire.

40 How to Build a Seismometer

Here's the fascinating background for one of the MEW Talks planned for MMEX, to be given by Mark Noel.

41 A Myford/Drummond Lathe Spindle

David George has made further improvements to his vintage Type M lathe, in this article shows readers how to make a larger capacity MT2 spindle.

50 Some Useful Gadgets for Model Making

Here are a selection of simple devices including cutters and jigs, mostly made from easily hardened tool steel.

54 The John Stevenson Trophy 2024

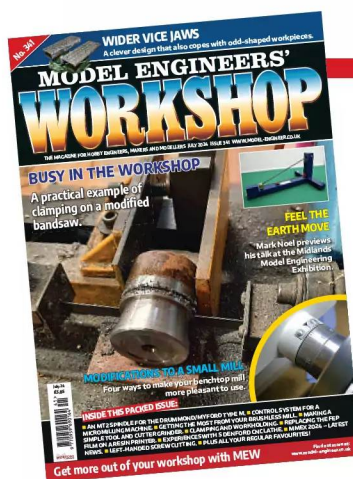
A reminder for readers to enter this year's free competition.

55 Getting To Love My Denford Novaturn

Mick Knights gets an ageing Denford CNC machine back into shape.

59 The PottyEngineering Cutter Grinder

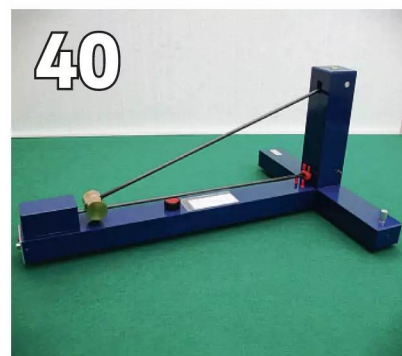
Stewart Hart continues his 'quick and easy' design grinder for restoring blunted milling cutters.



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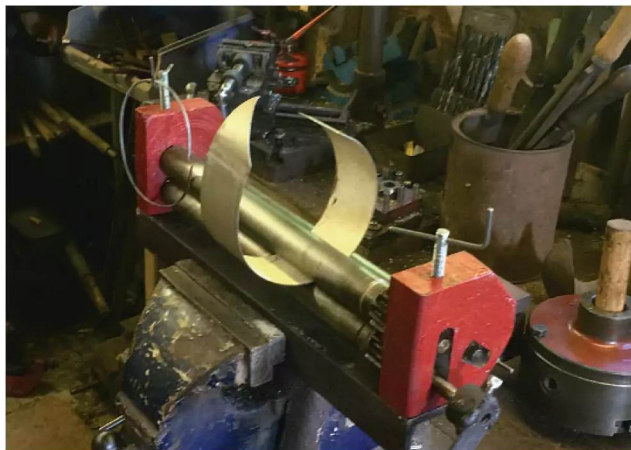
See page 24-25 for details.



Coming up...

in our next issue

In our next issue Paul Tiney explains how you can make your own sheet metal rolling machine.



Regulars

3 On the Editor's Bench

The Editor has been back in the workshop this month.

26 Readers' Tips

Our winner this month offers a quick and reliable way to mount gauges on the lathe. Send your tips to meweditor@mortons.co.uk, you could win a prize.

34 On the Wire

This month's round up of news from the world of hobby and full-size engineering.

48 Scribe A Line

In this month's postbag includes a first-hand description of thread chasing in industry. We are always keen to hear from you – send the editor your thoughts at meweditor@mortons.co.uk.

65 Readers' Classifieds

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

ON THE COVER

Our cover features modifications to the Editor's band saw, seen cutting a turned part from a mild steel bar. See more details on page 3. and download the files from www.model-engineer.co.uk.

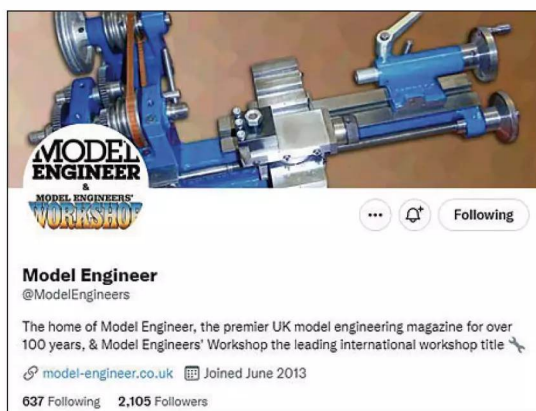


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THIS MONTH'S BONUS CONTENT

Extra Content!

See the latest videos for Jason Ballamy's article on using different types of milling cutter and the resulting surface finishes.

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

Or search the forum for 'getting the most'.

Hot topics on the forum include:

Thoughts on Detecting Pendulums! Started by SillyOldDuffer. What's the best way to ensure clean triggering of a pendulum in an electrical clock?

Fire Extinguisher for the workshop? Started by Bosun. A useful discussion of different types of fire extinguisher and their applications.

Boxford AUD metric gears Started by RRM BK. Useful information for Boxford lathe owners.

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

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AC13050	12000 BTU/h	£319.00	£382.80

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- Table travel 100x235mm
- Table Effective Size LxW: 92 x 400mm



£759.00 EXC.VAT
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Clarke MICRO MILLING & DRILLING MACHINE

- Bench mountable
- MT2 Spindle Taper
- Face mill capacity 20mm, end mill 10mm
- Table cross travel 90mm, longitudinal travel 180mm

Model	Motor	Spindle Speeds	exc.VAT	inc.VAT
CMD10	150W/230V	100-2000rpm	£549.00	£658.80
CMD300	470W/230V	0-2500rpm	£759.00	£910.80

Clarke BOLTLESS SHELVE/BENCHES

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Model	WxDxH(mm)	exc.VAT	WAS	inc.VAT
150kg	800x300x150	£39.99	£51.99	£47.98
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350 (evenly distributed) Strong 12mm (boardless) shelves

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Model	size (LxWxH) m	exc.VAT	inc.VAT
CL681212	3.6 x 3.6 x 2.5	£249.00	£298.80
CL681015	4.5 x 3 x 2.4	£279.00	£334.80
CL681216	4.5 x 3.7 x 2.5	£329.00	£394.80
CL681020	6.1 x 3.7 x 2.4	£349.00	£418.80
CL681220	6.1 x 3.7 x 2.5	£399.00	£478.80
CL681224	7.3 x 3.7 x 2.5	£499.00	£598.80
CL61432	9.7x4.3x3.65	£1099.00	£1318.80
CL61640	12x4.9x4.3	£2599.00	£3118.80

Clarke TOOL CHESTS / CABINETS

- Range of precision bench & floor presses for enthusiast, engineering & industrial applications

Model	Desc	exc.VAT	inc.VAT
CTC6800C	5 Dr chest	£349.99	£419.99
CTC6800C	9 Dr chest	£399.99	£479.99
CTC6800C	5 Dr cabinet	£149.99	£179.99
CTC6800C	8 Dr chest/cab set	£149.99	£179.99
CTC7000C	7 Dr cabinet	£179.99	£215.99
CTC1300C	13 Dr chest/cab	£189.99	£227.99

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Model	Motor (W)	exc.VAT	inc.VAT
CDP102B	350/5	£115.95	£139.14
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CDP352F	550/16	£329.00	£394.80

Clarke ARC ACTIVATED HEADSHIELDS

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- Protects to EN379
- Suitable for arc, MIG, TIG & gas welding

Model	WxDxH (mm)	exc.VAT	WAS	inc.VAT
CB8200	150	£74.99	£95.99	£89.99
CB8200	200	£94.99	£113.99	£109.99
CB8250	250	£169.95	£203.94	£199.95

Clarke BENCH BUFFERS/ POLISHERS

Model	WxDxH (mm)	exc.VAT	WAS	inc.VAT
CB8200	150	£74.99	£95.99	£89.99
CB8200	200	£94.99	£113.99	£109.99
CB8250	250	£169.95	£203.94	£199.95

Clarke SUBMERSIBLE WATER PUMPS

- Auto ON/OFF float switch on these models
- Sewage cutter pump

Model	Flow	Head	exc.VAT	inc.VAT
PSV34P	139L	8M	£49.99	£59.98
PSV64P	217L	8M	£59.99	£71.98
HIPPO 230V	85L	6M	£69.99	£83.98
PSV44P	216L	8M	£59.99	£71.98
PVP11A	258L	11.0M	£89.99	£107.98
HSC650A	290L	9.5M	£249.00	£298.80

Clarke 3-IN-1 SHEET METAL MACHINES

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Model	Bed Width	exc.VAT	inc.VAT
SBR305	305mm (12")	£299.00	£358.80
SBR610	610mm (24")	£598.00	£717.60
SBR760	760mm (30")	£699.00	£838.80

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- Sturdy lower shelf
- Durable powder coated finish

Model	WxDxH (mm)	exc.VAT	inc.VAT
CWB15000	1500x600x850	£230.33	£284.98
CWB2001P	2000x650x885	£299.00	£358.80
CWB2000D	2000x650x880	£313.00	£384.80
CWB2000	2000x650x880	£313.00	£384.80

Clarke BENCH GRINDERS

- Range of single phase motors suited to many applications
- All totally enclosed & fan ventilated for reliable long-term service

Hp	Shaft Speed	exc.VAT	inc.VAT
1/3	4 pole	£93.99	£95.98
1	2 pole	£99.99	£119.98
3/4	4 pole	£104.99	£125.99
2	2 pole	£124.99	£149.99
3	2 pole	£154.99	£185.99
4	2 pole	£189.99	£227.98

Clarke ROTARY TOOL KIT

- Kit includes:
 - Height adjustable stand • 1m flexible drive • 40 accessories

Model	Duty	Wheel Dia.	exc.VAT	inc.VAT
CB668Z	PRO	150mm	£54.99	£77.99
CB66250LW	HD	150mm	£69.99	£83.98
CB68370LW	HD	200mm	£96.99	£116.99

Clarke MMA & ARC/TIG INVERTER WELDERS

Model	Min/Max Output	Electrode Dia.	exc.VAT	inc.VAT
MMA140A	20A-140A	1.6-3.2	£104.99	£125.99
MMA200A	20A-200A	1.6-3.2	£139.99	£167.98
AT165	10A-160A	2.5/3.2/4.0	£219.99	£263.98

Clarke CLARKE DRUM FANS

- Belt sanding can be performed with the belt in the horizontal or vertical position
- Includes dust collection bag

Model	Max Air Flow	exc.VAT	inc.VAT
CAM24C	160.3 m³/min	£119.00	£142.80
CAM24110V	219 m³/min	£159.00	£190.80
CAM30C	212 m³/min	£189.00	£226.80
CAM30110V	284.8 m³/min	£219.00	£262.80
CAM36C	305.36 m³/min	£249.00	£298.80

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1	2 pole	£99.99	£119.98
3/4	4 pole	£104.99	£125.99
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4	2 pole	£189.99	£227.98

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CB66250LW	HD	150mm	£69.99	£83.98
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CB68370LW	HD	200mm	£96.99	£116.99

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AT165	10A-160A	2.5/3.2/4.0	£219.99	£263.98

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- Kit includes:
 - Height adjustable stand • 1m flexible drive • 40 accessories

Clarke CS48 BELT AND DISC SANDER

- Belt sanding can be performed with the belt in the horizontal or vertical position
- Includes dust collection bag

Model	Max Air Flow	exc.VAT	inc.VAT
CAM24C	160.3 m³/min	£119.00	£142.80
CAM24110V	219 m³/min	£159.00	£190.80
CAM30C	212 m³/min	£189.00	£226.80
CAM30110V	284.8 m³/min	£219.00	£262.80
CAM36C	305.36 m³/min	£249.00	£298.80

Clarke 18V BRUSHLESS COMBI DRILLS

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Model	WxDxH (mm)	exc.VAT	inc.VAT
CB8200	150	£74.99	£95.99
CB8200	200	£94.99	£113.99
CB8250	250	£169.95	£203.94

Clarke BENCH GRINDERS

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- All totally enclosed & fan ventilated for reliable long-term service

Model	Duty	Wheel Dia.	exc.VAT	inc.VAT
CB668Z	PRO	150mm	£54.99	£77.99
CB66250LW	HD	150mm	£69.99	£83.98
CB68370LW	HD	200mm	£96.99	£116.99

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Model	Min/Max Output	Electrode Dia.	exc.VAT	inc.VAT
MMA140A	20A-140A	1.6-3.2	£104.99	£125.99
MMA200A	20A-200A	1.6-3.2	£139.99	£167.98
AT165	10A-160A	2.5/3.2/4.0	£219.99	£263.98

Clarke ROTARY TOOL KIT

- Kit includes:
 - Height adjustable stand • 1m flexible drive • 40 accessories

Clarke CS48 BELT AND DISC SANDER

- Belt sanding can be performed with the belt in the horizontal or vertical position
- Includes dust collection bag

Model	Max Air Flow	exc.VAT	inc.VAT
CAM24C	160.3 m³/min	£119.00	£142

Milling Machine Modifications

Geoff Andrews made a number of improvements to his Amadeal model type XJ12B benchtop mill.

After I had made a number of modifications to my mini lathe (MEW issues 317, 320 and 321) and finding the limitations of using a vertical milling slide, I decided eventually to add a small milling machine into my workshop. I am very pleased that I did. The model which I chose was an Amadeal model type XJ12B. Having a brushless motor it is very quiet in operation, robustly made and a capable small machine which will do everything I expect it to handle.

This particular model is now no longer available, however, there are many models currently sold by various suppliers and of course many older models in use around the country. After using the machine for a while I decided that there were a few modifications which I would like to make.

Firstly, a feature on most larger machines is the ability to set stops to at least the longitudinal travel of the table. This clearly makes life much easier for example when taking repeat cuts to a particular length.

Secondly, this machine is a metric model, which has a 1.5mm pitch leadscrew. There are handles at both ends of the 460 x 110mm table which have calibrated dials with readings up to 75 increments per revolution. Each calibration is 0.02mm giving a travel of 1.5mm per single revolution. The cross-feed screw is the same, however, the fine down feed screw has 60 increments of a stated 0.025mm and .001". (These are the same increments shown on the mini lathe dials). It seemed odd however to work with two different feedscrew increments on the one machine.

As it happens, I am quite old fashioned and prefer to use 'thous' when working in small measurements. Years of practice



the longitudinal table stops.

means that these have a better feel for me. So with that in mind I decided to change the leadscrew dials to give 60 increments similar to the down feed. This would give metric increments of 0.025mm and .001" approximately.

Thirdly, cleaning the swarf from within the table slots is not too bad but getting all the swarf off the table is a pain so I set about a simple modification to ease this considerably.

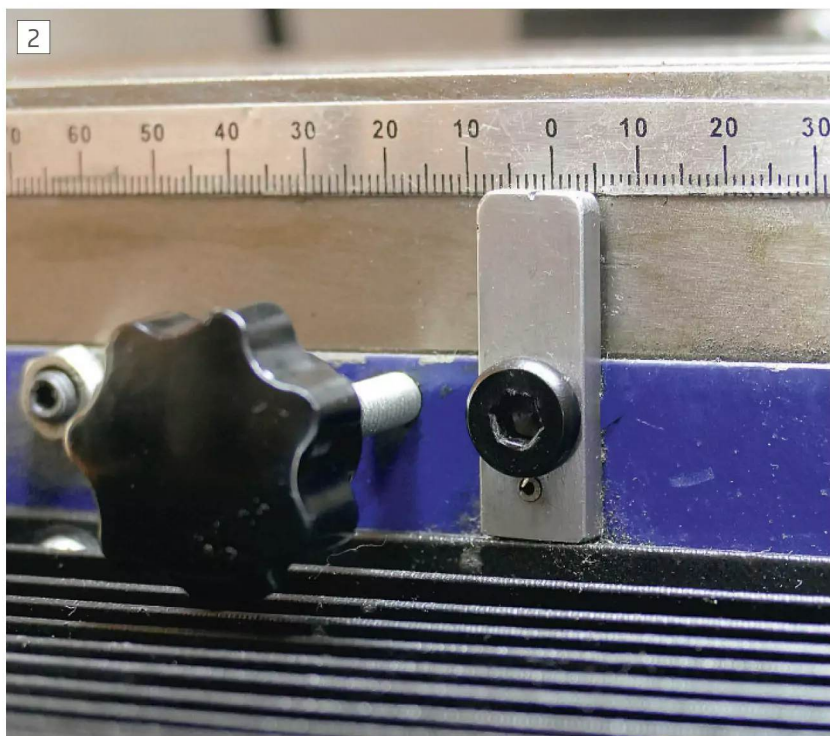
Finally, I wanted to alter the locking operation of the table for which I used some threaded knobs from my stock to replace the awkward lever screws which were fitted.

In addition these machines need to be securely fastened to a bench but in common with many people I am rather short on space in my workshop. So I needed a means to keep this heavy machine in one location to be brought forward when needed and for it to remain secure in use.

Traversing stops

Photograph 1 shows my simple table stops made from inexpensive and easily obtainable materials. The stainless-steel bar is a 420mm long kitchen door handle bought from a DIY store. This one measures 11.89mm diameter. These handles come with two short legs for fitting to a door but when these legs are unscrewed they leave two counter-bored holes. I found the diameter of the counter-bore is an easy fit for an M5 stainless steel cap screw which I used for retaining the bar to the table and looks quite fit for purpose when fitted.

The holes which were previously screwed for the legs were drilled right through at 5.5mm dia. and each fitted with an M5 x 25mm cap head screw. The edge of the table now needed threading for these screws and for me I found the optimum distance below the table top was 18mm to the centre of the screw. This position is well clear of the dovetail



Fixed Stop.



slot to remove milling chips.

slide of the table and allows visual access to the measuring tape which came already fitted to the machine table.

Positioning the first screw hole at this distance down and ensuring the two screw holes would be at equal distances from the centreline of the table I placed a centre mark. The hole was drilled with a hand drill ensuring it was level and vertical. It was then tapped M5. Then after fastening the bar to the table this

was clamped at the 18mm height at the other end and a hole drilled through the second hole in the bar into the table. Thus ensuring an accurate location. The bar needs a space between it and the table for the sliding adjustable stops and also to clear the fixed stop which will be needed to be fitted to the cross slide. To provide this space I found that an M6 'nyloc' nut to be the ideal size providing a gap of approximately 6mm.

These can clearly be seen in place in the photograph.

For the adjustable slides I used M12 'nyloc' nuts drilled out on my lathe with a 12mm drill. The nylon insert does not drill quite to this size, so it provided a nice degree of resistance to the nut sliding along the bar when it needs to be adjusted. It is for this reason that I chose to use these nuts rather than making purpose machined stops. By ensuring the 'points' of the nut are horizontal these run closely to the table to meet the fixed table stop. It also provided sufficient amount of thread for an M5 locking grub screw to be fitted into the nut. The nuts were held in a vice in the drilling machine and tapped with a piloted spindle tap holder held in the drill chuck to ensure a good alignment for the tread. I now had the basis of the sliding stops all that was needed was the fixed stop on the table.

Photograph 2 shows this fixed stop. It is a simple piece of $1\frac{1}{2} \times 3\frac{1}{16}$ " mild steel flat form stock $1\frac{1}{2}$ " long. This is fitted onto the edge of the cross slide and fitted with an M6 x 20mm cap screw. It would of course tend to twist with only one fixing point but there was insufficient space for two screws. To prevent twisting I used a small, rolled spring dowel through the stop and into the table. This has proved quite sufficient. I had also placed a mark across the top of the fixed stop to align with the measuring tape. This gives me an overall travel of 320mm between the stops. I have so far not needed to use anything near that length.

You will also see in photos 1 and 2 that the sprung lever screws often supplied with these machines to lock the table and cross slide have been replaced by a much easier to use plastic knob screw. I had something to do quite some time ago for which I needed two of these threaded knobs but of course they arrive in packs of ten. One is then left looking for something else to do with the other eight. These are threaded M6 and have a thread length of 40mm. With this length the knobs project comfortably forward of the newly fitted stop slide bar and are easily fastened or released. I have fitted a similar screw to the cross slide also which is positioned underneath the table. I now have 6 threaded knobs to find a use for.

Cleaning slot

Whilst dealing with the table, another point arose pretty quickly in using the milling machine. By its nature milling produces a large number of short sharp needles many of which settle in the table slots and are difficult to clean. While a brush run along the slot can gather these getting the accumulation of needles out of the table slots fully is difficult. So my thinking was why allow them to accumulate? **Photograph 3** was my solution.

A simple slot in the end of the table allows the chips to be swept away into a pan or wherever. To make this slot the table top was first locked into a fixed position. The handle and dial were removed and after the internal level of the slots had been marked on the inside

of the end plate of the table this was removed also.

Photograph 4 shows the end plate removed temporarily and held in a vice on the milling table where a slot was milled using the cross-slide feed. The rough corners were filed away by hand and then the end plate refitted. This is now so much easier to remove the needles and other debris from the table completely.

Moving the machine

Another factor with which I am affected and possibly many other people also is the often-limited space we have in our workshop. I have relatively little bench space left so fixing this machine in place permanently was not going to be possible. Fortunately the bench

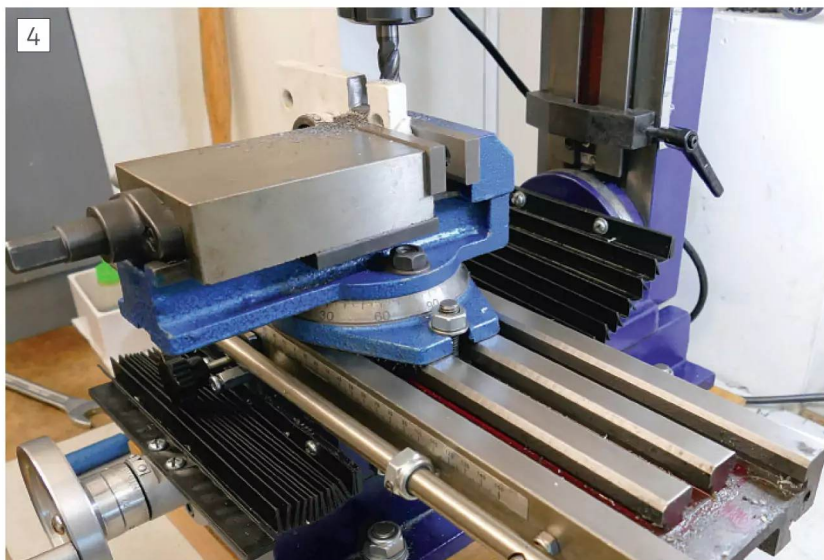
where I was to install the machine is quite deep at 900mm. The solution was mounting the machine on a timber base at the rear of the bench which could then be slid forward into position and locked in place.

To do this I mounted the machine on two layers of 15mm board (coloured brown in **photos 5** and **6**) into which the four fixing bolts for the machine are fitted. These were fastened to a third larger board (faced in white) to give the machine more stability and to provide a means of fastening the machine to my bench when needed. To prevent wear of the holes I fitted two sleeves in the lower board made from M12 bolts which were threaded into this base and having a 9mm hole drilled through. The head of these were faced to 3mm to reduce the thickness.

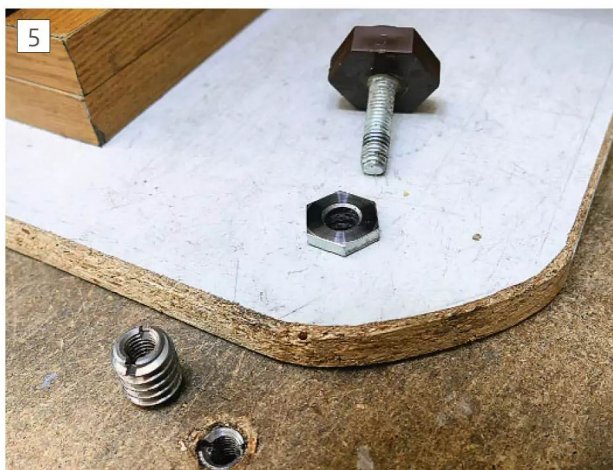
With the machine in place I drilled 9mm diameter through the sleeves into the bench. These were then opened up to 11mm and the screwed M8 socket screwed in. This is shown in photo 5 with one (of two) already in place in the bench top. These threaded sockets are a readily available item at fixings suppliers.

When in use the machine is pulled forward and the holes in the base board are lined with the threaded sockets. The M8 fixing screw is then tightened up. Only two of these are required and they do hold the machine very stable. Once finished using they are unscrewed, the machine is then pushed back into place, and I have my bench area back again.

When not in use I keep an M8 grub screw in the socket of the bench to



slotting the end plate.



M8 threaded sockets, sleeve and fixing screw.



holding down screw located.



original (left) metric 75 division dial.



replacement dial (right) 60 division dial.

prevent swarf and other rubbish getting into the fixing. A hole can just be seen in the top board which is where the fixing screw is held when not in use. These could just have easily been two of my M6 screws and I would then have only 4 left over but the M8 was also the right length so I went for them.

Micrometer dials

As mentioned I also wanted to change the odd micrometer dials from the 75

divisions of 0.020mm of the original metric dials, **photo 7**, to give a close equivalent of 0.001" for imperial dimensions. This would mean the divisions of the table would match the divisions given on the down feed dial fitted by the manufacturers.

This is not an exact conversion to imperial as 1.50mm lead screw pitch gives a travel of 0.059055" per revolution. Just less than one thou' per revolution difference. This is however no

different than any other dual dial reading dials on other machines with metric lead screws. Therefore the new dial required 60 divisions giving 0.025mm and so 0.001" per division. There are two handles and dials for the table traverse, I decided to leave the left one untouched and therefore made two new dials. One for the length traverse of the table and one for the cross feed.

Although the original dial relies upon on a simple 'o' ring internally to hold the position of the dial and to provide a resistance, it did require a bit of effort when turned. I decided to make the fit a little looser on the 'o' ring and have a grub screw to gently tighten when in position. Fortunately I had a piece of 38mm diameter aluminium bar just waiting to be turned into the new 35mm diameter dials.

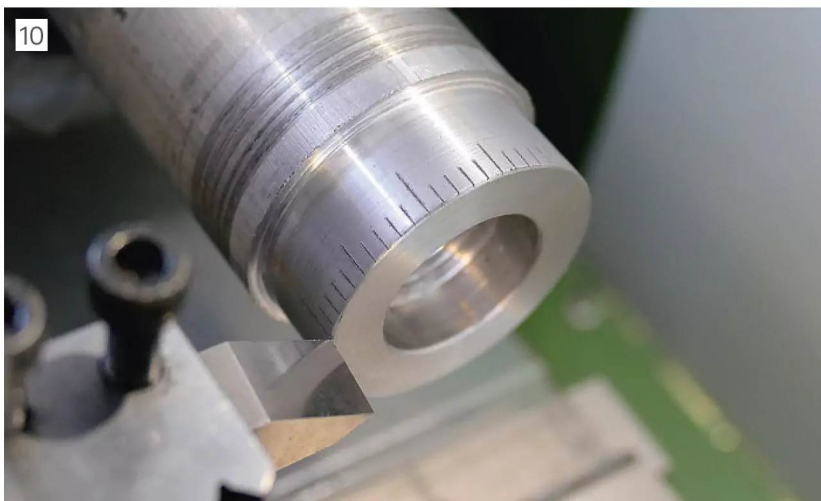
The original dials were 0.470 (11.95mm) wide with a bore of 0.787" (20.0mm) diameter. With the aluminium in my three jaw chuck I turned a 1.25" length to 35mm dia. Using a number of drills I drilled the centre to 18mm diameter and then bored to the finished 20mm 'ish' bore diameter. Although I knew the target diameter, what was important here was the 'feel' of the resistance on the 'o' ring. Therefore the final fit as achieved by lightly boring and trying the handle in the bore until it 'felt' as I wanted it.

Once happy with this the next operation was scribing the dial. In my article 'Modifications to a Mini Lathe' (MEW issue 321) I had described my simple method of using a spindle extension with change gears for making divisions on this machine, **photo 9**. This method can of course also be used to lock the lathe spindle if required.

Other lathes will of course require a different arrangement. The process of making the division marks in the dial is straightforward. By using a sharp pointed tool (a thread cutting tool in this case) on its side and raking the lathe carriage first to all sixty positions using a stop on the lathe bed. Then adjusting the bed stop slightly and increasing the length of each of the '5' position marks at each tenth division of the already marked dial. Once back to the start move five notches forward adjust the bed stop again to the full length then mark the '10' positions. I did



change gear dividing on a mini lathe.

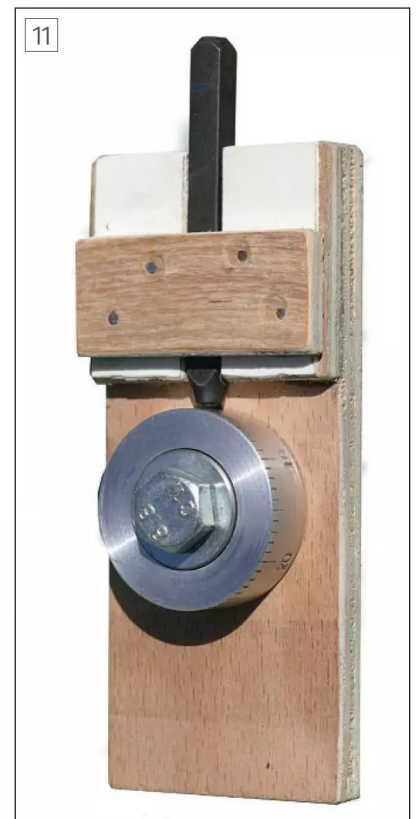


dial markings before cleaning up.

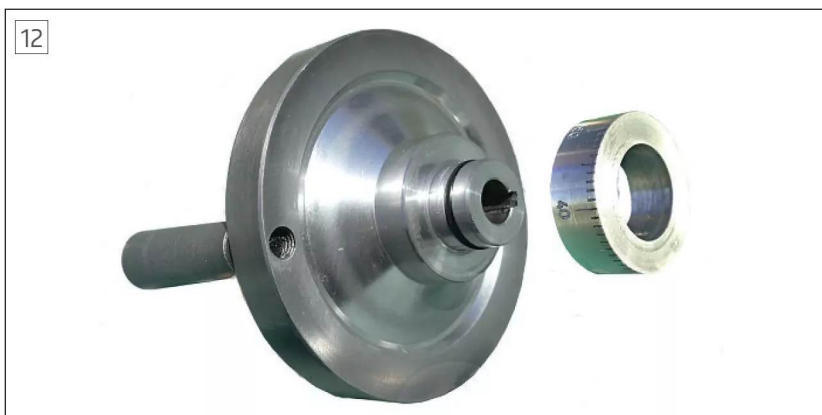
this for the first dial then parted it off to slightly over the length required so that it can be faced to length on the next stage. I then repeated the process for the second dial, **photo 10**.

To number punch the dial it is best to be removed from the lathe rather than making an arrangement for holding the dial in the lathe while it is punched, as lathe bearings are not intended to

take heavy sideways shock as occurs in punching. For this I did not anticipate making more dials so no need for a beautiful engineering solution. I made a very simple punch holder out of ply, **photo 11**. I turned a small mandrel to suit the dial bore which was then bolted into a piece of 9mm ply. Some small ply strip was pinned and glued to be a close fit on the width and depth of



simple number punch jig.



original handle with 'o' ring and new dial.

the number punch. **Photograph 12** is self-explanatory as far as construction was concerned. Holding the dial in the correct position which, as it rested on the vice jaw with a little protection underneath to prevent bruising, ensured the vice was taking the force of the strike. This ensured there was no bounce when the quite strong strike was made. This simple device worked perfectly so I kept it- one never knows it may be used again one day after all. The photo shows the original handle with 'o' ring and the finished dial.

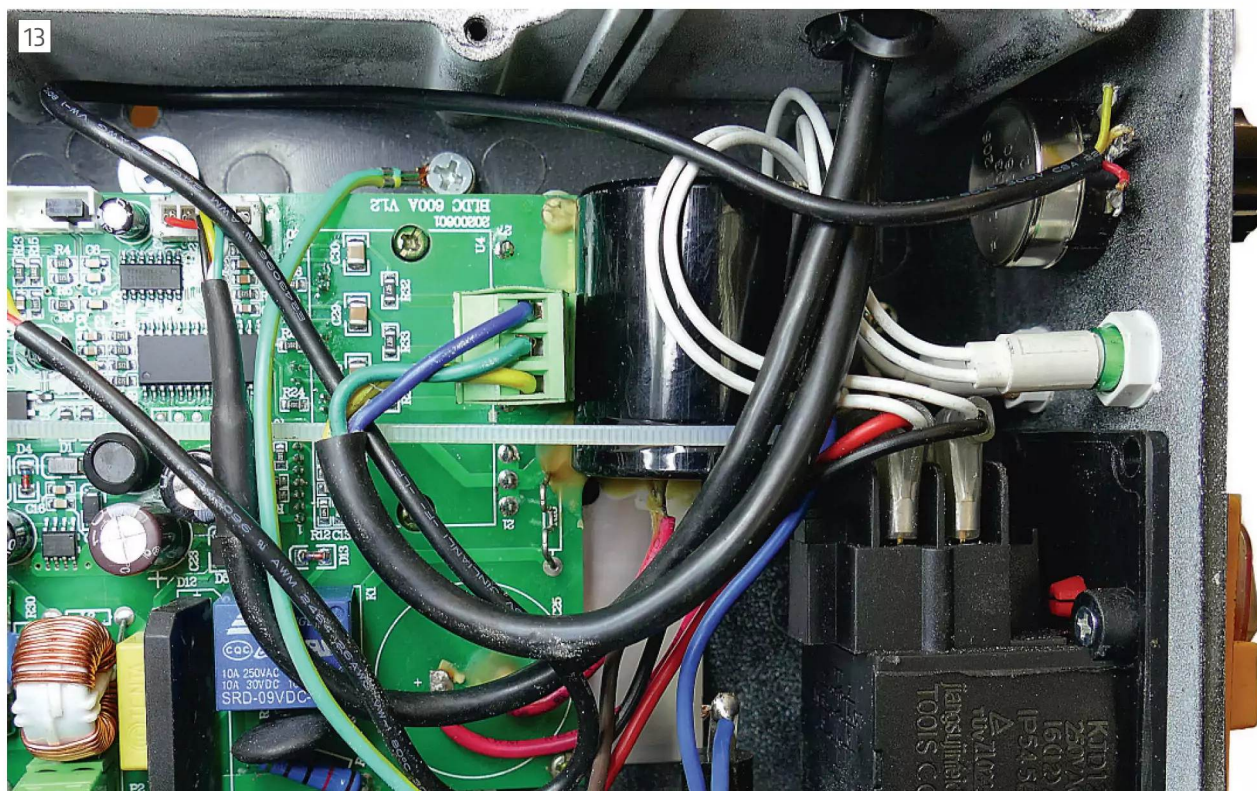
The 'O' position was placed directly under its mark. All other numbers are double, so these were placed just either side of their respective mark. In this view the division marks are away from the ply face. It is important to remember that this means that all numbers are punched upside down as seen by the user to ensure the correct orientation for when in use. To aid with this I temporarily put a small piece of tape on the side of the punch which was to be toward myself before punching. The new dials revolve more freely than the originals with a

positive resistance which are then locked with the grub screws as required.

Potentiometer

I have only had one small problem with this machine which I noticed a few months out of warranty – isn't this always the case? I found a 'dead' spot in the speed of the machine as I turned the speed control dial whilst otherwise all was working perfectly well. Obviously concerned that this may mean an expensive control board replacement I peered inside the control box (with the power disconnected). I was pleased to find that the potentiometer which I was reasonably sure had a problem was an independent unit, **photo 13**. I was able to read the manufacturer, model number and rating.

Fortunately was able to find this exact item on the internet and to find it was not a specific factory only item. A few days later the replacement potentiometer arrived. After first taking a photograph to check later that I had wired the new item correctly before switching on, to my relief all worked perfectly well now providing a smooth continuous increase in speed with no dead spots. ■



potentiometer (top right-hand corner).

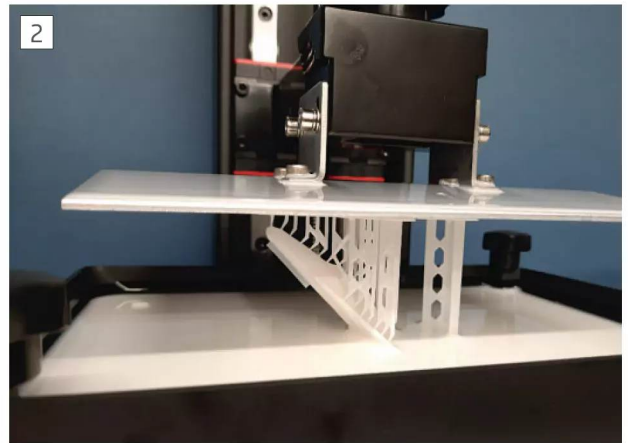
Third Dimension: Replacing the Film on a 3D Resin Printer



Neil Wyatt undertakes some routine maintenance for resin printers.



Creality Halot One Plus resin printer.



A print slowly emerges from the vat, one layer at a time.



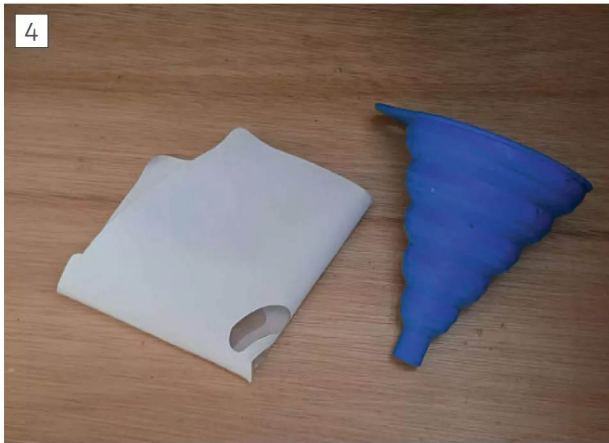
A typical plastic scraper. Do not use a metal scraper on the FEP.

It's sometimes a surprise to find that a skill tested by one of your hobbies find application in another. In this case, it was the experience of fitting a velum skin to a banjo mandolin, probably about forty years ago. Once popular instruments, there were a whole assortment of banjo-style versions of popular stringed instruments. The banjo ukulele was a rather louder version of the traditional

ukulele, and the preferred choice of George Formby.

But to return to the point in hand, 3D resin printers, **photo 1**, use a UV-transparent film (usually about 95% transmission) to seal the bottom of the printing vat, **photo 2**. The material is Fluorinated ethylene propylene (FEP) a copolymer of hexafluoropropylene and tetrafluoroethylene that is essentially a thermoplastic version of PTFE. Over

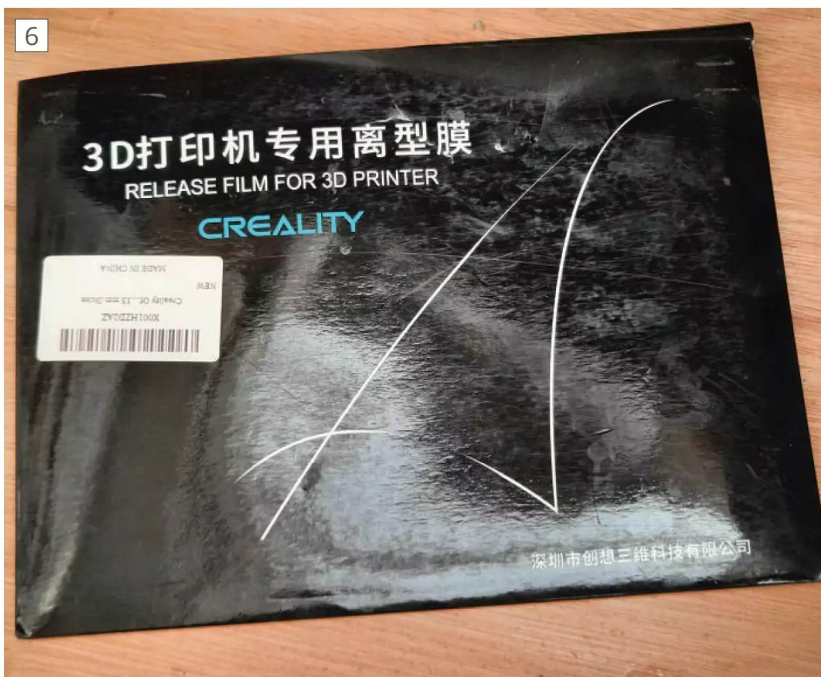
time, the FEP can pick up damage. If you have object or failed print stick to the bottom of the vat, it can be tempting to just try and prise them off, and this can stretch the film, or even nick it if you use a sharp tool. It's better to remove any such object by using the 'cleaning' function. This will print a single, thick layer of resin that can be carefully peeled off. You can either use a plastic scraper, **photo 3**, or I wear a pvc glove and use



Mesh filter paper and funnel for straining unused resin.



Vintage Reg-u-letts tin for storing screws.

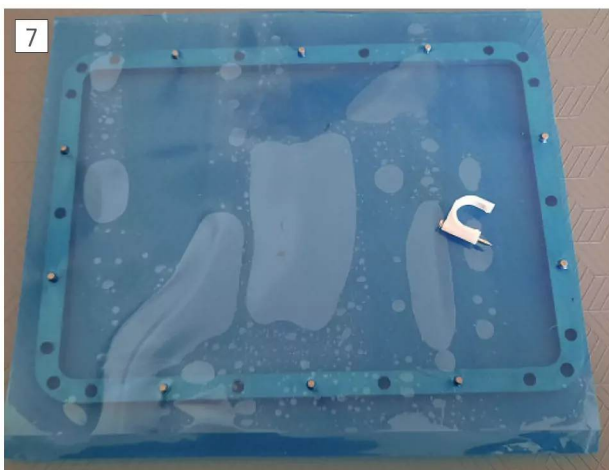


FEP fitted over pegs, protective film still in place.

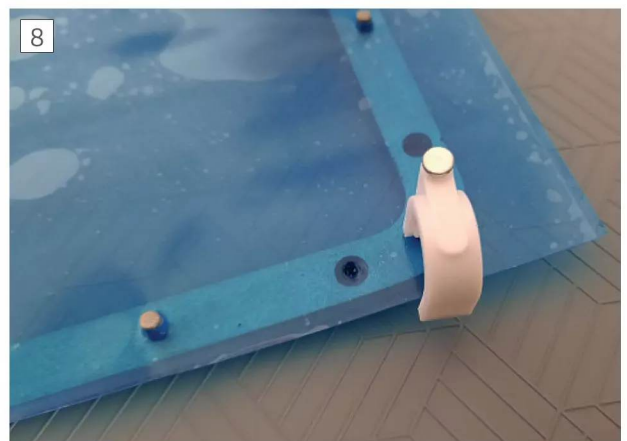
my fingernail to gently start the peel. I find PVC gloves more resistant to the resin. The FEP also gradually uses its transparency with use, so periodic replacement is required anyway.

It is important the film is an excellent seal, as leaking resin could damage the display that prints each layer of the printed object. Just like the banjo mandolin skin, the film has to be stretched over an inner frame (the sides of the vat) and held in place by a screw-tightened outer frame.

The first step is to drain any remaining resin from the VAT, it can be poured back into its original container, usually resin is supplied with mesh-insert filter papers specifically for this purpose, **photo 4**. Wear latex or PVC gloves and keep them on while handling anything contaminated with resin. You can clean out the vat with ordinary kitchen roll, using a little isopropyl alcohol to complete the process. Wearing gloves



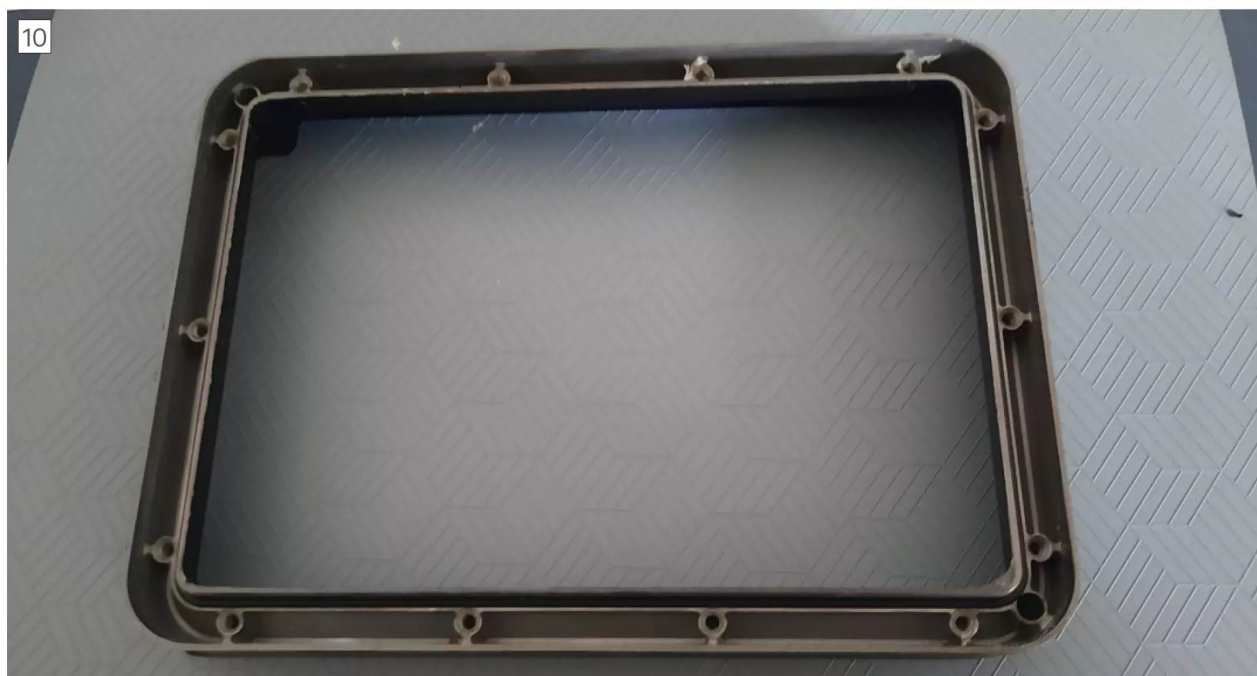
Piercing screw holes.



Protective film removed and trimmed to size (the film could be left larger than this).



Underside of vat after cleaning.



First six screws engaged, but not yet tightened up.

in case any leftover resin is present, unscrew the FEP retaining frame (whatever I am dismantling, I store screws in a magnetic tray or a small tin, **photo 5**). Remove and dispose of the old FEP, then complete cleaning the frame and vat.

It is important to get the correct size of FEP (or larger) as some of the 'compatible' films sold on line are actually undersize, and this makes

fitting almost impossible. For the Halot One Plus, the film size is 150mm by 200mm, **photo 6**. Film is supplied with a protective layer on both sides, leave this on for the initial stages of fitting. Start off by fitting the FEP over the pegs on the frame, **photo 7**. A cable clip provides a handy tool for starting holes in the FEP, which should be pulled taught but without stretching at this stage. The next step is to go around

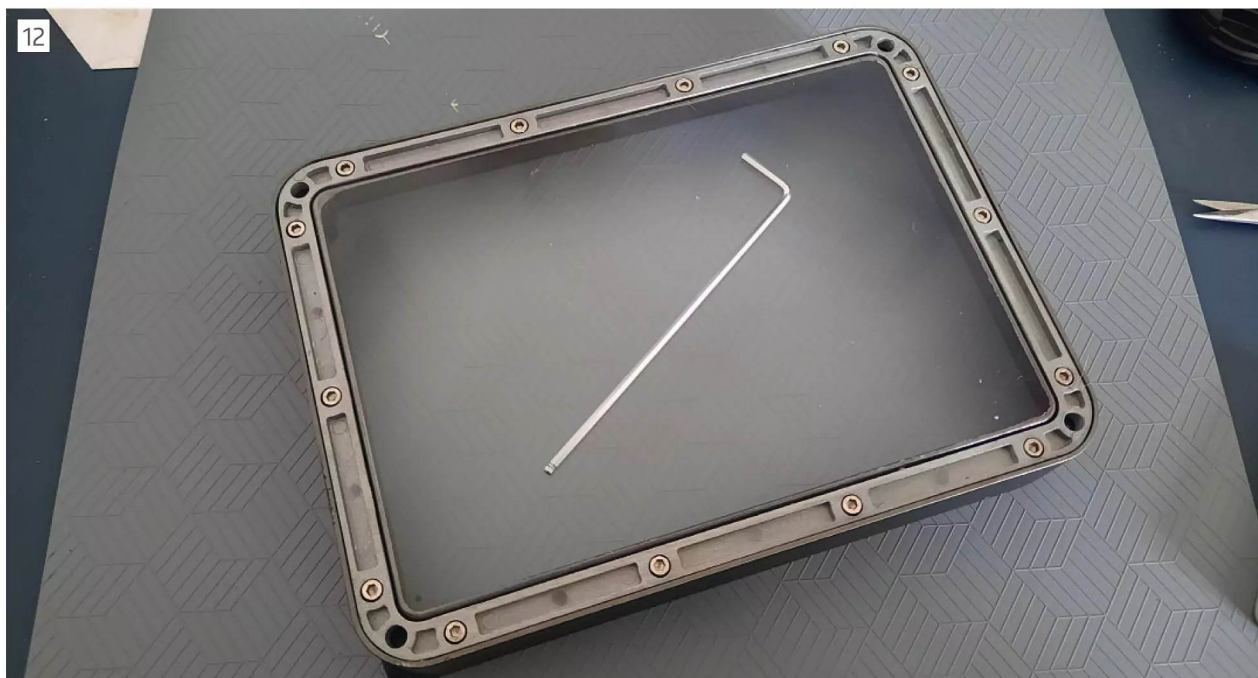
the frame, making a perforation aligned with each of the screw holes, **photo 8**.

Once this is done, you can remove and discard the protective film and replace it on the frame, at this stage you can trim it to the outside of the frame, **photo 9**, you may wish to leave a slightly larger margin if you are cautious. Check the vat is clean without any projections that could pierce the FEP, **photo 10**.





11
All screws fitted and gradually tightened to secure and stretch the FEP.



12
XXXXXXXXXXXXX

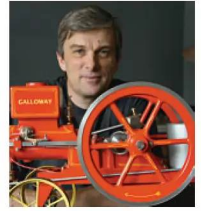
Position the frame with the FEP on the underside of the vat, and start fitting the screws starting with opposing holes, **photo 11**, and only tightening them enough to gently grip the film. Adding more screws, 'zig zagging' around the perimeter of the frame. Once you have all the screws in place, tighten them up a couple of a turns at a time, aiming to

keep the pressure evenly applied and avoiding distorting the frame.

The final result should be securely snugged down, and be taught, in close contact with the lower rim of the vat and free of creases **photo 12**. You should test for leaks with water, but if you have taken the tightening process steadily you should have no problems.

It is good practice to level the printing platform before replacing the vat. This is done by loosening the platform fixing screws and lowering it onto thin card without the vat in place. Holding the platform down firmly, retighten the screws, then raise the platform. You can now replace the vat on the printer, refill it and you can start printing again. ■

Getting the most out of your Brushless Mill. Part 3



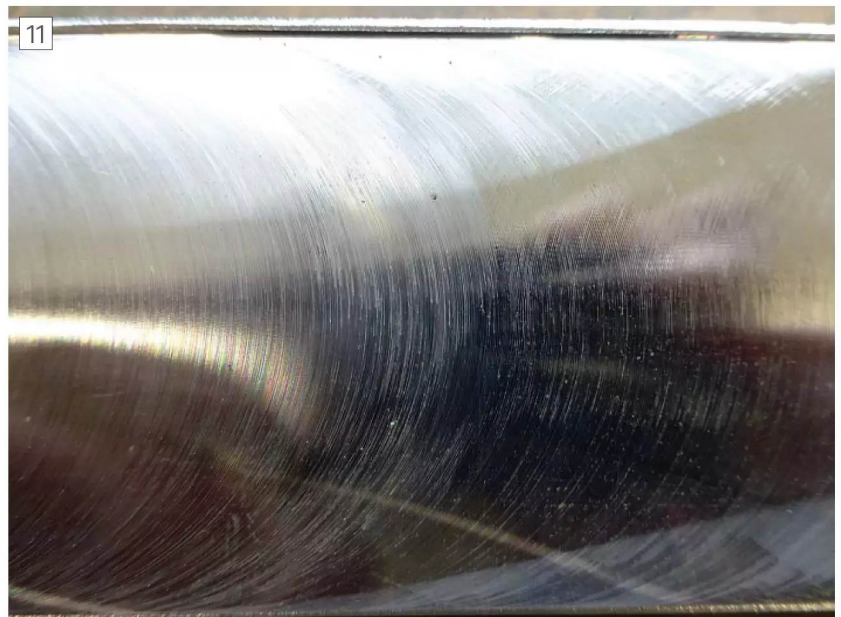
Jason Ballamy looks in more detail at using different types of cutting insert on your mill.

In the previous instalment I showed how a change in approach from the traditional to one of using shallow but fast cuts can improve how face/shell mills perform on hobby size machines. This time I will show how a change of insert can further improve finish, speed up the machining time and also put less load onto a lighter machine.

Insert Types

Although there are many styles of insert for the vast array of holders on the market, they can generally be divided into two main types: Those that are designed for cutting ferrous metals such as steel and iron and those designed to cut aluminium and other non-ferrous metals. The ones for ferrous tend to have a blunter cutting edge as they are moulded from powder and then just coated and can usually be distinguished by having a gold/bronze colour but also can be grey. Depending on their exact intended material use some can be "blunter" than others. The inserts for non-ferrous on the other hand are much sharper which is often a result of grinding, polishing or lapping after the initial shape has been moulded and they tend to have a bright polished appearance.

The codes used to distinguish these two main types of inserts are not a clear cut as they are for lathe turning inserts so you may find the third letter in the code does not always signify what purpose they are intended for. Some manufacturers tend to suffix the shape/size code with one that relates to the intended material such as H01 for the polished inserts for aluminium.



Close up of steel cut with APMT "Moulded" inserts

It is the sharpness of these non-ferrous inserts that can be taken advantage of on a lighter constructed and less powerful hobby machine as for the same given size of cut they do not load the machine as much as the ferrous inserts do. This not only puts less strain on the motor and drive train but as the cutter is less likely to be forced off the surface as the machine flexes the resulting cut is likely to be more accurate and have a better finish.

This sharpness also makes it possible to increase the feed rate when using these cutters and still not load the machine as much as it would taking a similar depth but slower feed with non-ferrous inserts. As an example

although I was able to cut at 450mm/min feed with the ferrous inserts I could hear the machine was being loaded quite a lot so a feed of 300mm/min would be about as fast as I would want to go for general use. However the machine sounded far happier cutting at 450mm/feed with the non-ferrous inserts.

Photograph 11 is a close up of the finish from a general purpose APMT insert and although it has quite a bright reflective look when you examine it closely there is some tearing of the surface, and the back edge of the cutter left a more pronounced mark which suggests the machine was flexing with the load of the leading edge cut.



Close up of steel cut with APKT "Polished" inserts



Back-to-back APMT & APKT cuts to steel.

Photograph 12 is a close up of the finish from a polished APKT non-ferrous insert which is far more uniform with no signs of the surface being torn as the sharper cutting edge cuts rather than pushes the material out of the way. There is also very little sign that the back edge was cutting suggesting less load is being created that may flex the cutter away from the work. **Photograph 13** shows the two surfaces back to back.

The final photo related to the insert face/shell milling cutters, **photo 14**, gives an idea of the type of finish the non-ferrous APKT inserts will give on a range of materials commonly used in the home workshop. All samples are approximately 50mm wide and were

cut using a five-insert 50mm diameter cutter running at 2000rpm, feed rate of 450mm/min and a depth of cut of 0.5mm. All were cut dry with the exception of the aluminium which had a small amount of paraffin brushed onto the surface, which helps prevent a build-up of material on the tip of the insert.

From left to right the samples are 6082-T6 aluminium. 070M20 (EN3) steel. CZ121 Brass and GR17 cast iron. The following link will take you to a YouTube video of these pieces being cut and should better show the finish obtained. The QR code will take you to a page on the forum with links to all the videos for this series.

youtu.be/mipbeyK0lj4



In summary, the figures below can be taken as a starting point when using insert face and shell mill cutters on a bench top hobby machine, they can be further tweaked depending on the actual machine and type/size of cut. See the previous part of this article on how to work out the rpm and feed rate for a specific cutter using the parameters below.

Steel & Iron with APMT or other moulded type inserts 200-250 m/min cutting speed and a chip load of 0.02mm to 0.03mm per insert. Depth of cut 0.5mm.

Steel & Iron with APKT or other polished non-ferrous insert 225-275m/min cutting speed and a chip load of 0.025mm to 0.035mm per insert. Depth of cut 0.5mm.

Aluminium and other non-ferrous metals with APKT or other polished non-ferrous insert 300-350m/min cutting speed and a chip load of 0.04-0.05mm per insert. Cutting depth of 0.5mm.

Solid milling cutters

In much the same way as face mills the traditional approach with "slot drills" and "end mills" was to run fairly slowly and remove a reasonable amount of material per pass which was fine on a heavy full-size machine but is not always the best option with the smaller bench top machines. For these a look at how CNC machining methods make use of lighter cuts but with the tool running faster can get the job done in the same or even less time.

The faster running is often due to using solid carbide cutters which have a much faster cutting speed - typically three times that of HSS and that is an option for home use as the difference in cost between the two materials certainly in the smaller diameters is not that great. However even sticking with HSS, if the diameters are kept small then the hobby mill can still be run at or around



Finish on assorted metals cut with APKT "non-ferrous" inserts

its maximum spindle speed without over speeding the cutting tool.

HSS Cutters

The old rule of thumb was to use $\frac{1}{4}$ the cutter's diameter per pass (sideways) but reducing this to $\frac{1}{10}$ cutter diameter or $0.1D$ reduces the load when using the side of the cutter and that can be combined with using a vertical depth equal to the cutter diameter or $1D$.

If we take cutting steel as a starting point then a 6mm diameter coated HSS tool can be run at a speed of up to 2500rpm, not all hobby machines will run at those speeds so using 2000rpm as an example and the same formulas

that were used for the face mills, then feed rates can be worked out as follows.

For a side cut of 6mm vertical depth and 0.6mm horizontal depth a good starting chip load would be 0.035mm which will give a good finish and not overload the machine. So the feed rate is $0.035 \times 2000 = 70\text{mm per flute}$. Therefore depending on what cutter you are using, a three-flute cutter can be fed at 210mm/min or a four-flute at 280mm/min.

Photograph 15 shows a piece of steel that has had a 6mm x 0.6mm cut taken at a feed rate of 200mm using a three-flute coated HSS cutter that gave a good finish, minimal burrs to the

edges and clean good size chips, the cut was done dry.

The following video shows cuts being made in steel both slower and faster than these figures which illustrates there is some flexibility and why I have said to take them as a starting point and adjust to suit your particular machine.

I have also included a couple of cuts with a 10mm diameter 3-flute cutter firstly using the same $10 \times 1\text{mm}$ ($1D \times 0.1D$) with a reduced feed rate of 120mm/min (0.02mm chip load) and then a shallower cut of $10 \times 0.5\text{mm}$ ($1D \times 0.5D$) feed at 180mm/min (0.03mm chip load) somewhere between the two will be a good compromise between getting the job done, good finish and not straining the machine.

Lastly some cuts in other materials, all cutting parameters are given in the videos on-screen captions. For Aluminium and other non-ferrous metals it is better to use an uncoated cutter to reduce the risk of the aluminium sticking and building up on the cutting edge. The sideways depth of cut can be increased with these materials from the 10% used on steel to around 15-20%, so typically 1mm sideways for our 6mm diameter cutter. Due to the faster removal rates on the non-ferrous metals it is also a good idea to purchase the ones designed specifically for them which have a higher helix angle that



Typical finish from a side cut on steel



Clean edges and swarf produced by a sharp cutter



Burrs and crumbly swarf resulting from a blunt cutter

removes the large amount of swarf that is generated better than the standard helix angled cutters do.

youtu.be/vBvUA78KCHE

For a slot, the chip load is best reduced slightly so start with 0.025mm, cut width will be the full 6mm diameter of the cutter and vertical depth per pass of around 0.15D. So the feed rate will be $0.025 \times 2000 = 50\text{mm}$ per flute. Note that 4-flute cutters are not really suited to cutting slots as they can cut oversize if the cutter deflects. This reduced number of flutes will need to be taken into account, a 2-flute cutter can be fed at 100mm/min or a 3-flute cutter feed at 150mm/min.

The vertical height should not be too low as that will simply wear the very corners of the flutes and quickly blunt them which becomes costly, aim for at least 1mm depth which won't unduly load the mill or risk chatter. Only reducing this for very small diameter cutters that are not as strong.

Non-ferrous metals can have both a higher chip load and the cutter run faster, a starting point for a 2 Flute 6mm Aluminium specific cutter would be 20-25% of its diameter as the depth and a chip load of 0.04mm to 0.06mm per flute. The following video shows some slots being cut in various metals

youtu.be/KZksrHuPnPQ

Solid carbide cutters

Although probably not the best choice to start learning on, as they are a bit more delicate and can easily be damaged by mishandling, solid carbide cutters do have some advantages over HSS. Firstly they can be run faster, typically three times as fast which will mean that if you have a need for a larger diameter cutter the mill can still be run within its higher speed ranges to get the most out of it. Also if you have a machine that has a higher top spindle speed than the usual 2-2.5K rpm, such as an SX3.5 then full use can be made of its 5000rpm top speed.

A carbide cutter is also less flexible than one of the same size made from HSS, so longer side cuts can be made, which is good if you want to do full depth profile cuts to get a better finish than a series of step downs may produce. If you don't have a machine that can take advantage of their higher speed, then increasing the depth of cut that their stiffness allows will reduce cutting times.

Lastly, they are harder wearing so although the initial purchase price may be a bit higher if looked after that can more than be made up for by the greater amount of cutting, they can do before becoming blunt. Their hardness is also useful on some of the more difficult to cut materials such as chilled iron castings that may take the edge straight off an HSS cutter, but the carbide will manage to cut it.

A cutter is not for life

Cutters will get blunt and when they do it is best to replace or possibly sharpen them rather than carry on using one that is past its best. Not only will a blunt cutter put more load on the machine it will give a poorer finish. Two tell tail signs that a cutter has started to lose its edge are larger burrs along the edges of the cut and the swarf coming off as crumbs or dust. If you look at the videos, you will see the swarf is all coming off in large chips and there is very little in the way of burrs. Compare **photos 16** and **17** where 16 has been cut with a sharp cutter and 17 shows the results of using a blunt one.

● To be continued

Readers' Tips



Quick-Mount DTI

TIP OF
THE MONTH
WINNER!



This month's winner is Mike Hurley from the West Midlands, who recommends a way of speeding up using a dial test indicator.

This is nothing particularly clever or innovative, just something that saves me masses of time on occasions.

Simply a sturdy fabricated bracket with attached (plunger type) DTI that engages into a spare QCTP holder.

When setting a 4 jaw chuck or simply testing runout it is the matter of seconds to fit without all the fiddling about with magnetic stands and trying to ensure the tip is at centre height. Most useful 30 minute 'quick' job I've ever thrown together!

Mike Hurley

Editor's note: Following last month's article by Jacques Maurel, I received some comment that a 'dial test indicator' has a swinging arm and a 'dial gauge' has a plunger. A review of what manufacturers and sellers call these items suggests 'plunger type dial test indicator' is now probably more common than dial gauge.

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

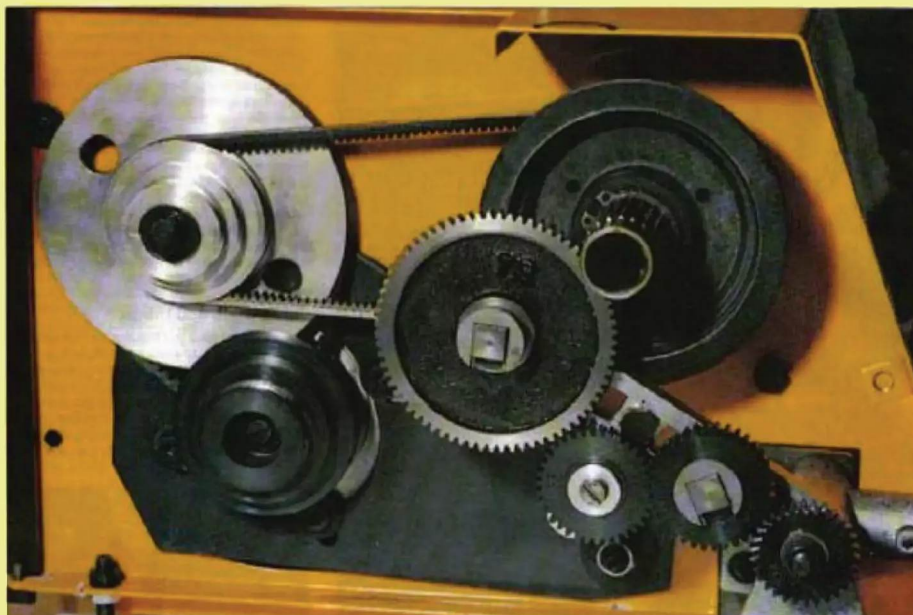
Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 600 words and a picture or drawing. Don't forget to include your address! Every month we'll choose a winner for the *Tip of the Month* will win **£30 in 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.

From the Archives

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

Issue 20, November/December 1995, featured a 'perfect' workshop on the cover, as well as reviewing an article on clamping. We've decided to reprint a useful article of cutting left-hand threads by Joe Briffa.



The bracket and quadrant in place.

CUTTING LEFT HAND THREADS

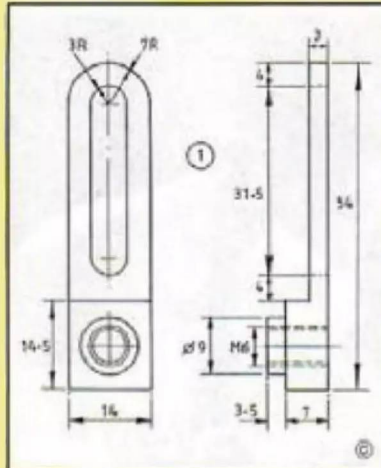


The finished parts.

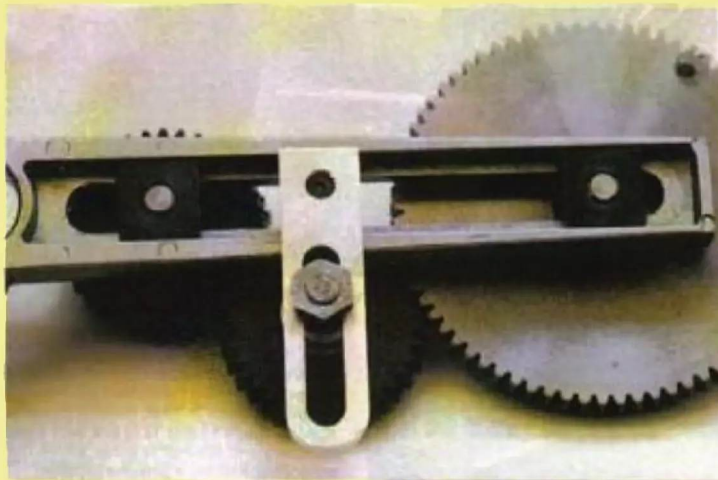
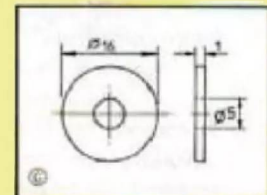
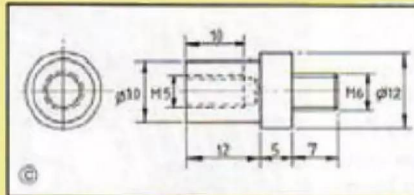
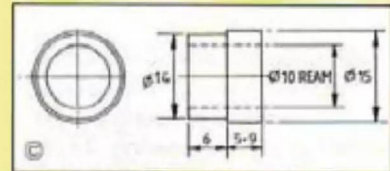
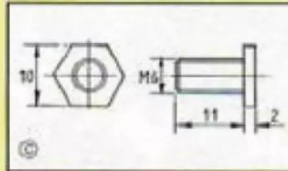
Cutting a left hand thread is not a frequent requirement for most readers; however, if a need occurs then it is probable that particularly on smaller lathes, this may be found an impossible task. Joe Briffa of Malta has overcome the problem on his Emco Compact 5 lathe, the method is likely to be applicable to many other small machines

When I started building the *Matador 60* using the Emco Compact 5 lathe all went well until I came to cut a screw thread on the front housing. The instructions called for a 1.5 in. dia. 24 TPI L.H. thread. I was stuck; the Compact 5, although a very versatile lathe, could not cope with L.H. threads, and I had no access to a lathe that could. I had two options: either find a place where I could have it done for me; or come up with some sort of gadget that could turn my Compact 5 into a L.H. thread cutting lathe. I opted for the latter.

What I needed was some sort of contraption that would move the saddle away from the main spindle as the spindle revolved counter clockwise. By introducing another gear in the gear train, the leadscrew was made to revolve in the same direction as the main spindle. The



All dimensions in mm



The assembled parts.

bracket shown was the result. Now L.H. threads are no problem with the Compact 5.

Construction

The bracket 1 is quite straightforward. I made this from Dural, as it takes very little stress. The bracket is threaded M6, the square part is inserted into the quadrant slot and secured by means of bolt 2. Once it is decided on a particular thread that it is wished to cut, choose a gear that will fit into the gear train. The number of teeth on

Materials list

- 1) Bracket - Dural. Make to suit leath. dimensions shown are for an Emco Compact 5.
- 2) Bolt - 10mm hexagon mild steel (although any other size with a larger diameter is also suitable).
- 3) Gear spindle - Silver steel.
- 4) Gear spacer - Silver steel.
- 5) Washer - Aluminium.
- 6) 5mm - Cheese head screw.
- 7) 6mm - nut.



Above: Rear view of the bracket fitted to the quadrant.

Left: A 24 TPI L.H. thread which was screwcut using the attachment.



the gear is not important since this is an idler gear. The bracket is then secured by tightening the bolt. For final adjustment, to mesh the idler gear with the gear train adjust the gear spindle 3. This is done after first inserting the spacer 4 and then the gear. The gear is then secured with the M5 bolt and washer 5.

Make the gear spacer a push fit for the gear and a free fit on the gear spindle.



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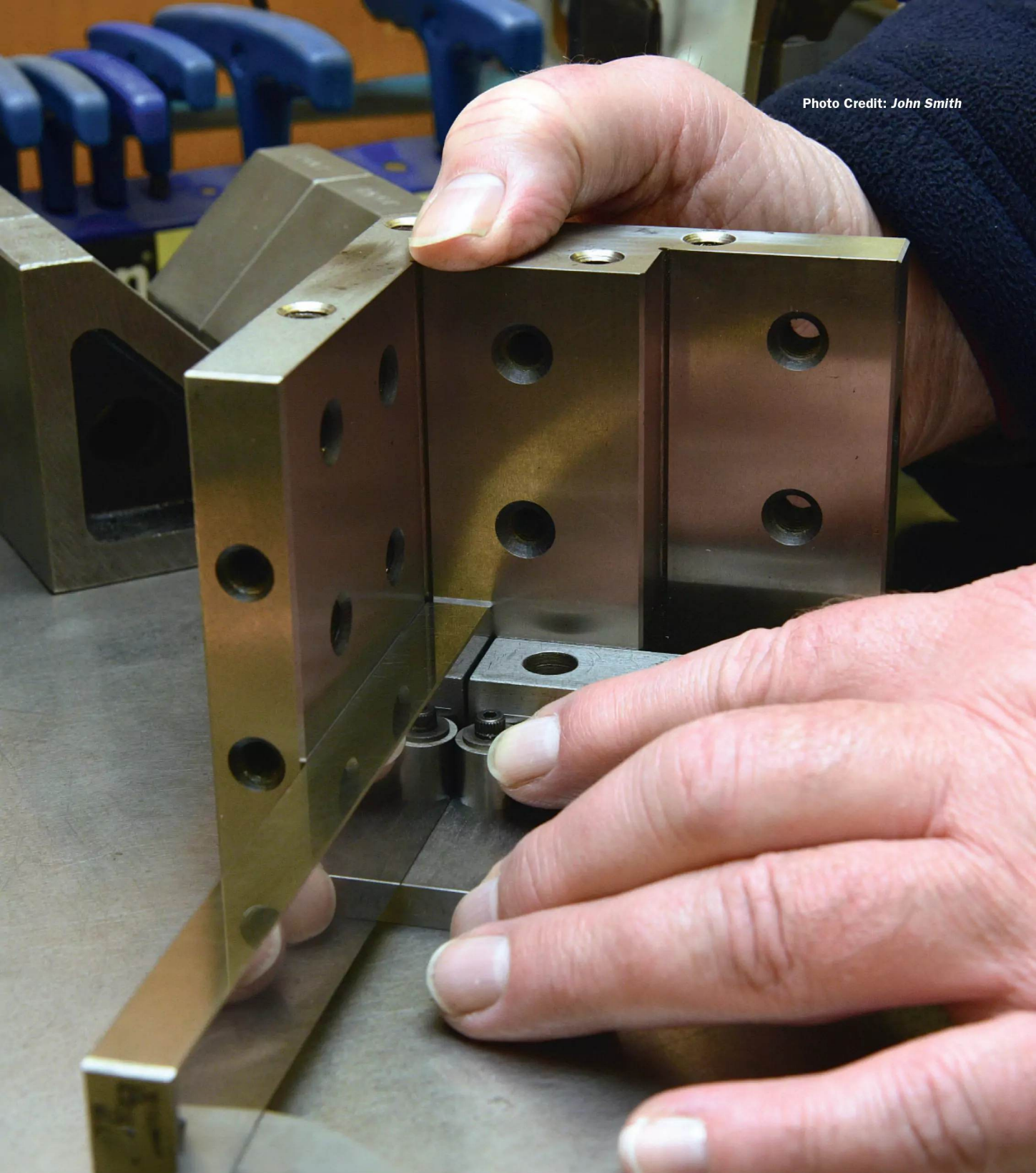
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Micro-Milling With A Home-Made Contraption Part 5

Mike Tilby describes the control of automatic movement for his scratch built machine tool.

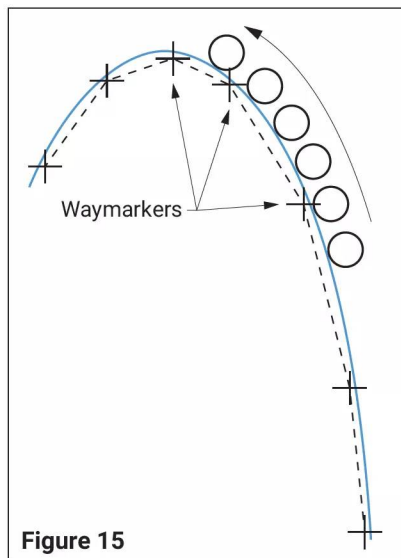
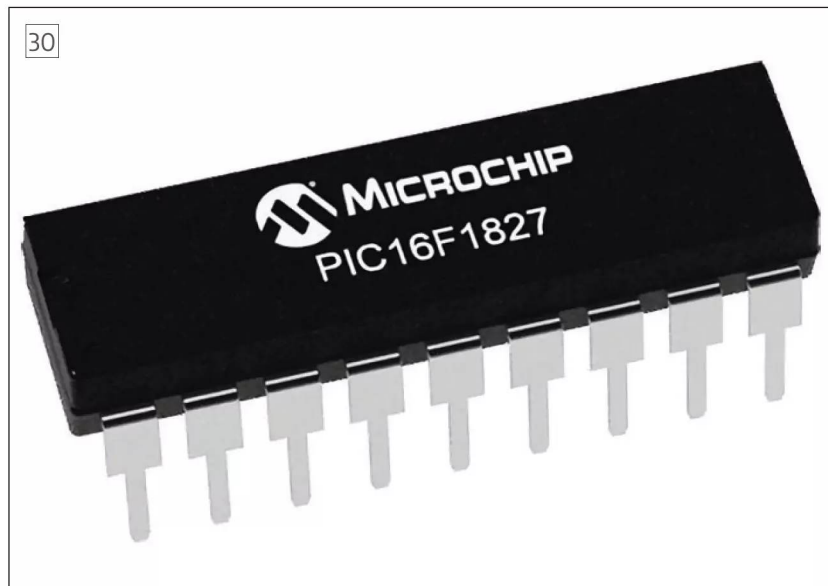


Figure 15
Straight line paths between waymarkers while the follower traces a curved path.

As described in the previous issue, the follower arm of the micro-milling contraption is attached to the motorised guide-plate via two springs plus a link. The guide-plate moves in a series of straight lines that approximate to the shape of the template while the follower on the end of the lever is held against the edge of the template, **fig. 15**.

Positions of the guide-plate are defined as the number of steps moved by the X and Y stepper motors from a reproducible reference point (**REF**) which is defined by the lower and right-hand optical limit sensors of the slides. As described previously, the sensors used enable position to be detected with a reproducibility within two thousandths of an inch which is more than adequate for holding the follower against the template. A typical cutting operation entails moving the guide plate from REF, all around the template and it ends



A PIC 16F1827 micro-controller.

with the option of automated return to REF. This whole movement is called a 'pathway' and is defined by a series of XY coordinates. It is convenient to have a name for the positions defined by these coordinates and I call them 'waymarkers'. To achieve a flexible control system the following features were desired:

- To recall a selected pathway from memory and either edit it or run the cutting program.
- To easily define the series of waymarkers that make up a pathway.
- To store several pathways in some sort of memory.
- To indicate when the follower loses contact with the template.

To achieve the above features it was necessary to devise numerous subsidiary processes. For example, to edit a pathway it was necessary to be able to:

- Retrieve an existing pathway or start editing a new one.

- Move the guide-plate manually while keeping track of the coordinates of its current position.

- Move the guide-plate automatically along the straight path between two waymarkers in order to assess if contact was maintained with the template.

- Adjust the position of an existing waymarker.
- Insert or delete a waymarker at a chosen point in a pathway
- Save a pathway with the same or a new identity.

The above example hopefully illustrates how a large number of user commands soon accumulated when designing controls that provide a useful degree of flexibility in the operation of the contraption. Options for all these commands were written into the programs loaded into the various microcontrollers that are at the heart of the control system.

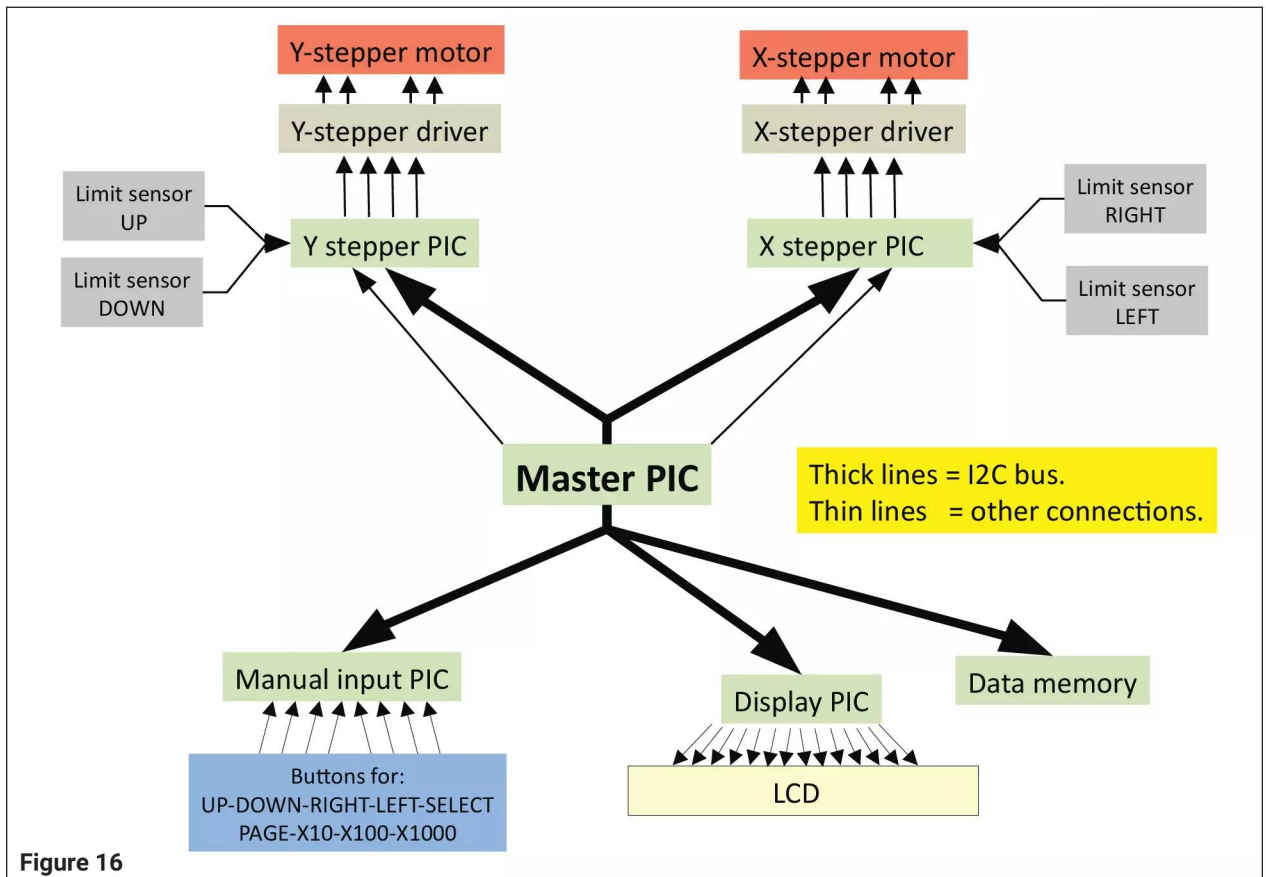


Figure 16

Connections between main components of the control system.

Microcontrollers

I have no idea how much readers of these articles know about microcontrollers so I'll play safe and give a brief outline which can be skipped if it is not needed.

Each microcontroller can be thought of as a miniature very simple computer. The programs are known as 'firmware' rather than 'software' because they are stored in a semi-permanent manner within the microcontrollers. Also, the programs work by directly controlling processes within the specific microcontrollers being used. This is in contrast to computer 'software' which is more often loaded, as and when required, into a computer's memory from some sort of storage device and it can often work on a wide range of devices. Unlike commonly used computers, microcontrollers are designed to interact directly with other equipment such as sensors and transistors. Also, they do not require any extensive boot-up procedures and so the system is available for use

immediately after switching on. The microcontrollers I used are one of a very wide range of such devices that are generally known as Peripheral Interface Controllers (PICs) which is the name given to microcontrollers made by the company Microchip. The PICs used in this project are relatively cheap simple 18-pin devices which look rather unimpressive, **photo 30**. They belong to a class of devices known as mid-range PICs because there are other classes which are simpler and others that are far more complex. Nevertheless, the devices used here (all are type PIC16F1827) have a wide range of capabilities which require a 400-page data sheet to define in a concise manner and a 680 page manual for a more detailed description of the class.

Like many such devices, the PICs used in this project can communicate with each other via two wires known as an I2C bus. One PIC (the master PIC) is in charge of the bus, and it can send and receive messages to and from so-called slave PICs. Slave PICs only send data when

prompted to do so by the master and each has a unique address so the master can send a message specifically to any one of them.

Structure of the control system

The control system for the contraption contains five PIC16F1827 devices interconnected via an I2C bus. The 'master PIC' carries out most of the calculations needed to move the guide-plate in the correct manner, **fig. 16**. This master sends commands to two slave PICs, each of which controls a stepper motor. Some commands are via the I2C bus, such as "move to REF". However, movement of the stepper motors half-step at a time is triggered by a dedicated one-wire connection between the 'master PIC' and each of the two 'motor control PICs'. This is to avoid timing delays associated with commands sent via the I2C bus. The 'motor control PICs' also receive signals from the optical sensors which limit the movements of the slides (as described earlier).



The main electronics case housing the power supply and circuit boards for the master PIC and for PICs that control the stepper motors. The small block set into the left-hand end of the case is a removable memory device.

The 'master PIC' and the two 'motor control PICs' are each on their own circuit board which are all housed in the main electronics case, **photo 31**. The user interacts with the controls via a number of buttons on the semi-portable control box, **photo 32**, which is housed in the wooden case from an old radio. These buttons are connected to another slave PIC (the 'input PIC') which works out what the button presses mean and then sends the result to the master PIC. The fifth PIC controls the text that is shown on a 4-line liquid crystal display (LCD), **photo 32**. The text that is displayed and the functions of the buttons depend on the context, determined by previous button presses and the state of ongoing movements. The 'master PIC' sends to the 'display PIC' information about the current state of play together with any values that need to be shown. The display PIC then works out what text should be shown on the screen for that particular context and converts any numerical values into a form that us humans can easily read. The user (i.e. me) sees various options and data such as the current XY coordinates of the guide-plate.

There is one more item attached to the I2C bus and that is a memory device to or from which the waymarkers making

up pathways can be saved or retrieved. This memory device is removable and is housed in a small metal box which is located in its socket at the left-hand end of the case in **photo 31**. The device holds 8 Kbytes of data which seems incredibly small in comparison with what is commonly used in today's electronic consumer products. However, as we'll see, 8,000 bytes is sufficient capacity to store over 50 cutting pathways for this contraption.

Waymarker values

For the lead-screws to turn by one rotation it takes 400 half-steps of their stepper motors. So, with a 20 tpi leadscrew 8,000 half-steps are required per inch of movement of each slide. Since the maximum possible movements are no more than 6 inches, the maximum possible number of half-steps to be moved from the zero position is 48,000.

In PICs, as in most digital devices, values are stored in bytes of memory where each single byte can hold a value between 0 and 255. However, if two bytes are used together to hold a value then that value can be between zero and 65,535 which is more than the maximum possible number of steps. So, each waymarker requires four bytes of memory, two for each of the X and Y values.

It is convenient to use a maximum of thirty-one waymarkers in a pathway and so far this has proved to be more than enough. Thus, each pathway can be stored in 4 x 31 bytes plus another 4 bytes for additional data, making a total of 128 bytes.

Organisation of commands

Operations are divided into the following five basic pages which are selected by pressing the 'page' switch in combination with the right or left button, **photo 32**.

1. Initial page with option to move to and so define the REF position.
2. Manually control XY movements;
3. Retrieve or save a chosen pathway;
4. Perform a cutting operation;
5. Create a new pathway or edit an existing one.

Within each page, one can adjust values and implement commands by pressing combinations of one of the four direction buttons or the selection button on the right with buttons 1, 2 or 3 on the left. For example, when moving the XY head manually, pressing a direction button once moves a motor one step. Pressing the same button at the same time as pressing buttons 1, 2 or 3 moves the motor 10, 100 or 1000 steps respectively.



Semi-portable control and display box. The most important switches are indicated. Those on the left modify the effects of the action switches which are the buttons on the right. (sel. = select). The 'arrow buttons' are used to move the XY-head, to adjust values, to change page or to select an action from a list of options, depending on context and what other switches are pressed.

A saved pathway includes data to define what happens after the final waymarker is reached. Movement can either halt at that point or it can automatically return to and reset the REF position. In the latter case, when making repeated cuts at increasing depths, after adjusting the cutter depth, all that has to be done is press the appropriate buttons (press buttons 1 and SELECT simultaneously) to start the next cut.

I found the process of building and programming the control system using

these fairly simple microcontrollers to be very satisfying but if starting again I would probably do things differently. The limited program memory size of the PIC16F1827 would make it difficult to add very many more functions in addition to what are already programmed. When this project was started my knowledge of cnc control and electronics in general was even more rudimentary than it is now. It was only after the contraption was largely completed that I joined SMEE and

found a group of helpful people with much relevant expertise. I gather that devices such as Raspberry Pi nanos would probably be a much better choice. One of these could replace the master PIC and probably also the input and display PICs. However, I think I would still use the current PICs to control the stepper motors.

In the next issue I will conclude this short series with some examples of how I have used the machine.

● To be continued

In our Next Issue

Coming up in issue 342,
August 2024

On sale 19 July 2024

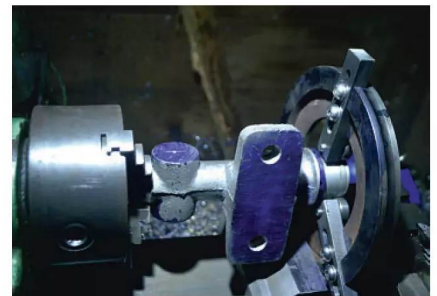
Contents subject to change



Roger Froud makes a paint can turner using 3D printed parts.



Paul Tiney explains how to make a sheet metal rolling machine.



Richard Lofting makes a fixed steady for his son's Myford ML10 lathe.

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

Wide Vice Jaws



Marcos Diniz increases the capacity and flexibility of a bench vice.

I must have got the idea from somewhere: a magazine, the net, somewhere. I know I didn't invent it. But it looked very interesting and seemed to have a lot of potential. So, I decided to make a pair.

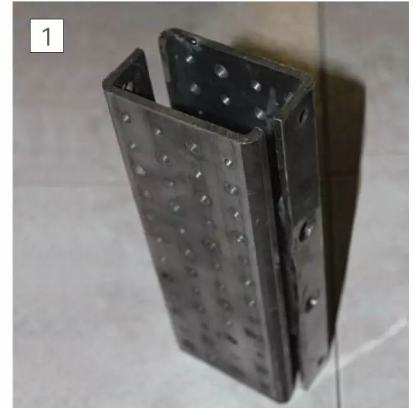
To begin with, steel angle is available in lots of sizes, but anything as wide as what is needed here is also unnecessarily heavy. So I decided to pay a visit to my usual steel source and as luck would have it, found a piece of 90 x 50mm tube about 240mm long, wall 5mm thick. Close enough to what I had in mind. The

ends were cut at anything but right angles, but I decided that didn't really matter.

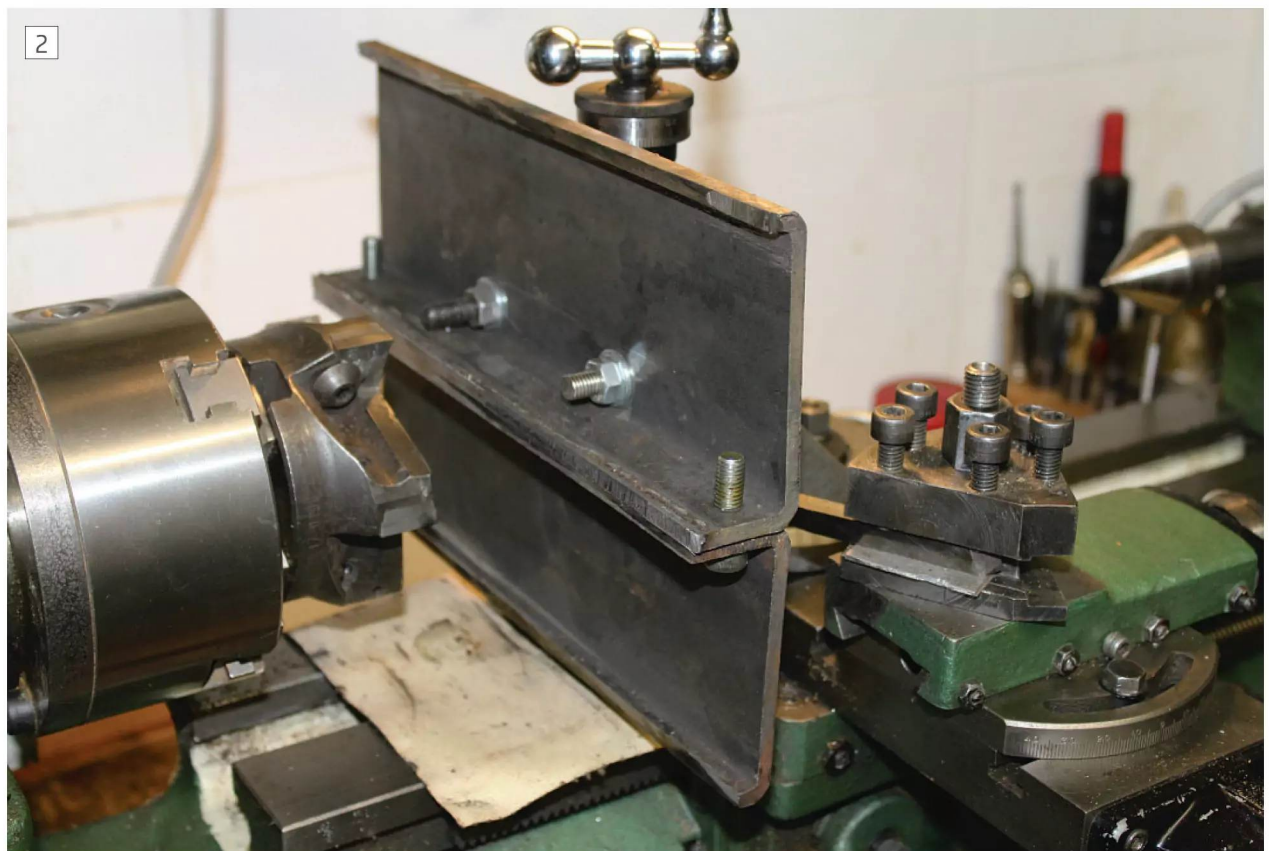
So I duly bought it, got it to the workshop, grabbed the angle grinder and cut it in two pieces as in **photo 1**.

I needed a reference edge, so I machined it so that, when fitted to the vice, the jaws would be in the same plane, **photo 2**.

I then marked the holes, drilled and tapped them alternately M6 and M8. Dull stuff, that took me hours! In the meanwhile I kept pulling my own leg, as I often do, about the time I was



Split tube.



Cleaning up the cut material.

wasting to make something I would never use.

(The last time I did this was about my lead mallet. And not more than half an hour after I got it to the workshop (I did the melting in the kitchen, by permission of my peach of a wife) it started its work-life and has been busy ever since.)

When finished and screwed in place, the jaws look like **photo 3**.

Basically, what we have is a couple of sub-tables and the means to decide how far apart you want them. I confess that the jaws took longer to be put to use than the mallet, but there were some instances, such as **photo 4**.

And... early this year, I had to repair a soap dish I bought in Kenya about thirty years ago. It's made of "soap-stone" (talcum) the softest stone on Earth, and all irregular, hell-on-wheels to hold. I know, I could just throw it in the dust bin, but where's the fun in that? Besides, I happen to like the thing, elephants and all. In came the jaws with a fanfare! Gluing was easy, **photo 5**.

The very soft "sub-jaws" are wine corks (I'll bet you know where to get some) glued to pieces of threaded rod. Then I had to remove the excess glue, with a chisel, and I can't imagine any other simple way to do that safely. **Photograph 6** doesn't show it, but there's a thick slab of cork under the dish, for support.

All things considered, I think it's fully worth the work it took to make. ■



The tapped surfaces.



Using as a sub-table for a smaller vice.



Soap dish held using cork stops.



Underside of dish.

Chang'e-2 Samples the Far Side of the Moon

China's Chang'e-6 touched down on the far side of the moon on Sunday 2 June, and collected samples from this rarely explored terrain for the first time in human history, the China National Space Administration (CNSA) announced. Supported by the Queqiao-2 relay satellite, the lander-ascender combination of the Chang'e-6 probe successfully landed at the designated landing area in the South Pole-Aitken Basin (SPA).

The terrain on the far side of the moon is more rugged than the near side, with fewer continuous flat areas. However, the landing site in the Apollo

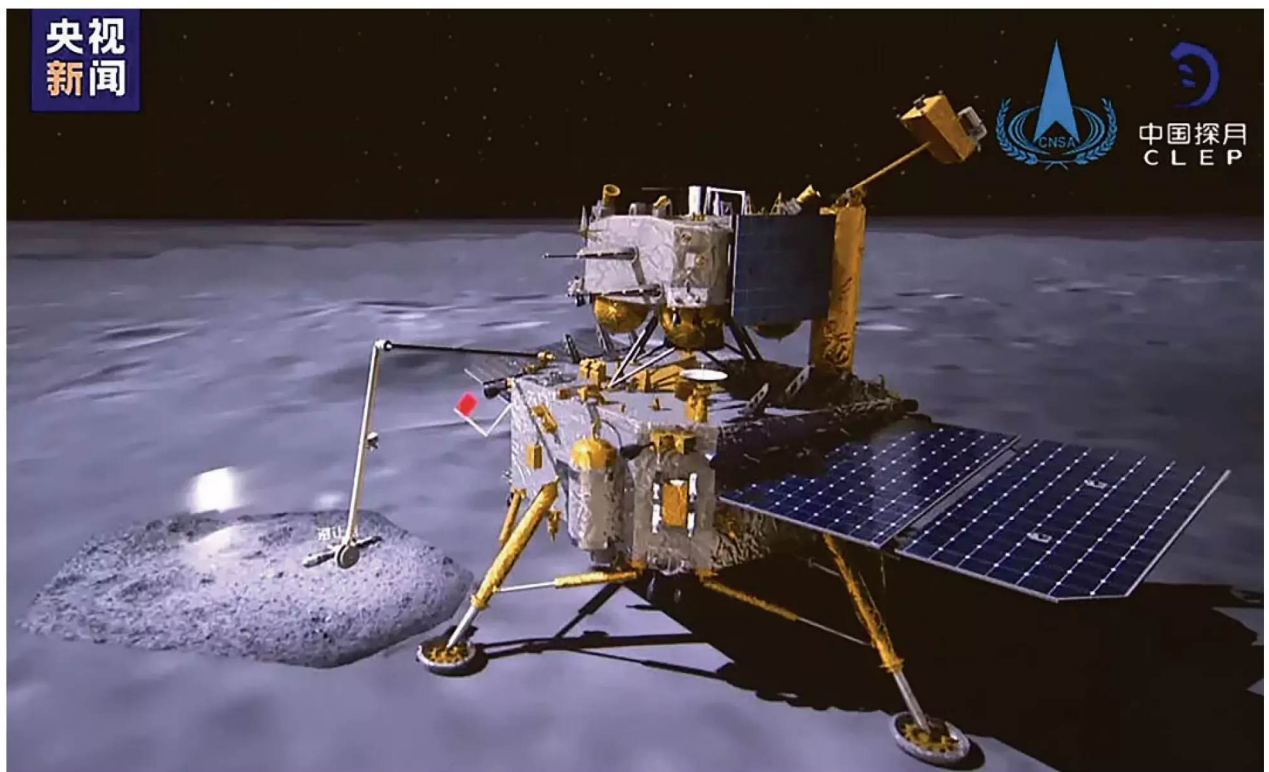
Basin region of SPA is relatively flatter than other areas on the far side, which is conducive to landing.

The lander is equipped with multiple sensors, including microwave, laser and optical imaging sensors which can measure distance and speed, and identify obstacles on the lunar surface. To prevent interference to optical sensors by lunar dust during landing, the lander is also equipped with gamma-ray sensors to accurately measure the height through particle rays, ensuring that the engine could be shut down on time and the lander then touch down smoothly on the lunar surface.

At the same time, the landing legs play their role as buffers, absorbing the impact energy of landing and ensuring the safety of the equipment on the lander.

After the landing, the probe was scheduled to complete sampling within two days. It has adopted two methods of moon sampling, which include using a drill to collect subsurface samples and grabbing samples on the surface with a robotic arm.

Chang'e-6 ascender separated from the lander and lifted off from the South Pole-Aitken Basin on the moon at 7:38 a.m. Beijing Time on June 4. It is carrying lunar samples gathered during the previous two days. After about six minutes, it entered the targeted orbit and began several orbital manoeuvres in the next step of the sample return process. Picture credit:CSNA.



Biogas Liquefaction

In France, SUBLIME Energie is revolutionizing commercial biogas production with a unique technology: biogas liquefaction. By efficiently transporting and pooling biogas produced by multiple farms, this technology reduces initial investments and operating costs. Therefore, it opens access to untapped biomass resources, increases the resilience of farms, and provides a decarbonization pathway for the agricultural and transport sectors. SUBLIME Energie democratizes biogas production for isolated or small farms and creates local supply chains for biomethane and bioCO₂.

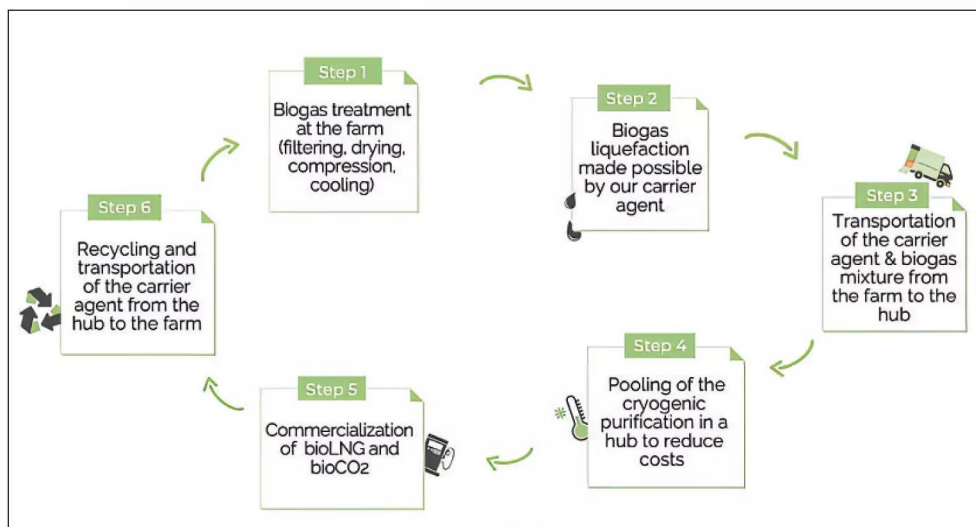
Over 80% of biomass is held by farmers, yet biogas sector development is hindered by the limited profitability of traditional technologies and the mismatch between potential biogas production sites and their consumption locations. Co-generation, the oldest method, has limited profitability due to low engine efficiency. Biomethane injection into gas networks, on the other hand, involves costly purification and connection steps requiring high flow rates. This excludes small or remote farms which represent an estimated additional potential of nearly 26 TWh of renewable energy by 2050. Liquefaction

addresses these challenges by offering a third pathway suitable for low flow rates, making these positive-impact units profitable.

The technology is based on an innovative biogas liquefaction process directly on the farm. By introducing a carrier agent into the biogas, the company overcomes technical constraints related to mixture crystallization.

By capturing methane (CH₄)—a greenhouse gas 80 times more potent than CO₂ over 20 years—from livestock effluents, SUBLIME Energie helps decarbonize the agricultural sector,

which is responsible for 25% of global GHG emissions. The methane is transformed into bioGNV, a mature fuel for heavy-duty mobility, reducing greenhouse emissions by 85% over the fuel's lifecycle compared to diesel. This substitution could prevent 270,000 tons of CO₂ annually by 2030. The fuel offers up to 1,500 km range for trucks and is suitable for agricultural machinery, especially tractors, enabling a full day's work.



New Lifecolor Airbrush Thinner for acrylic paints.

A new and improved formula significantly helps the fluidity of colours and prevents clogging inside the airbrush. With the right pressure/dilution combination, the new thinner supersedes the old one.

To offer a lower retail price than the 250ml size, Lifecolor has also introduced 100ml jars. This size will be included with a practical dropper dispenser. The thinner is available from Airbrushes.com for £7.10 per bottle.

Please note: the old style Lifecolor 250ml Thinners are available until stocks last.



BEGINNERS WORKSHOP

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

Beginner's Workshop

Clamping and holding

IN NUMEROUS operations-drilling, filing, assembling, etc.-clamping is advantageous even if not strictly necessary. It can free both hands for the operation, prevent movement where parts have to be kept in alignment, and save broken drills and damaged fingers where otherwise there would be a want of control, as on machine drills.

If components have to be heated, as in soldering, brazing and welding, clamping and careful aligning when cold are usually essential; and where there is a tendency to heating, as in grinding, it can be useful when components are too small to clamp them to something which is larger and easier to manipulate.

Two components which have to be filed (or planed if they are wood) can be held together in the vice to bring them to the same shape or outline; then, when convenient, portions can

be left projecting from the vice jaws on which a clamp can be fitted when necessary to remove for examination. This obviates movement and the necessity for time-wasting re-alignment. Similarly, on long flexible parts, clamps and temporary stiffening pieces eliminate vibration.

In assembly work, where weight or awkwardness may have to be contended with, simple clamped stops, which may be no more than blocks or short pieces of angle iron, can act as rests or means of alignment until bolts or screws can be entered. Again, clamps admit of parts being temporarily set for alignment to be checked before vital holes are drilled.

Clamping devices

The common C-clamp or G-clamp, *A*, is made in various sizes and designs. Types which are no more than pieces of flat steel bent U-shape and fitted with a screw, may be used for light clamping-since under force they spring and open; and types in which the body is of cast iron can be broken, if they are small, by using too much pressure. Consequently, the best clamps of this type have reinforced bodies of steel or malleable cast iron.

Important factors in efficiency of such a clamp are straightness of screw and body-the screw turning without wobble centrally on to the jaw. A bent screw wobbles the clamp in tightening; and with malaligned screw and jaw the clamp tends to twist off.

For edge-grip clamping within their jaw opening (about 3/4 in.), self-locking or toggle action pliers are equally suitable as C-clamps and they are quicker and easier to use; and if the need is for a firm hold on flat material, without clamping, the most suitable tools are parallel-jaw pliers, *B*.

For a firm well-regulated hold on metal, thin wood, etc., classic clamps are the toolmaker's pattern, *C*, these having a clamping screw and a support, or reaction screw, by means of which latter the jaws must be kept parallel in use. Toolmaker's vee-blocks, *D*, also have clamps for securing round material for checking, marking-off or drilling.

Work which would be marked by clamps or self-locking pliers can be protected by using smooth strip metal to distribute the pressure, with or

without soft material like paper or cardboard.

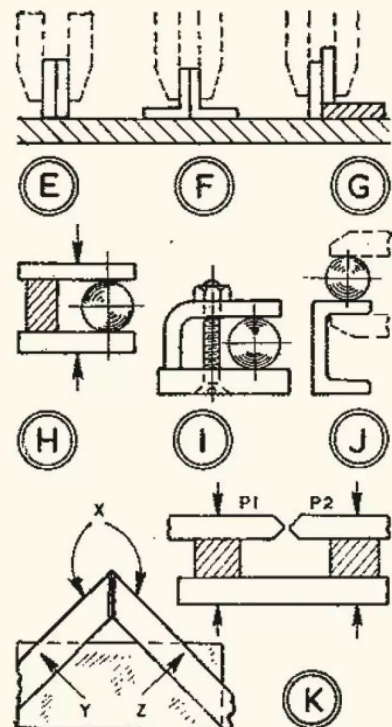
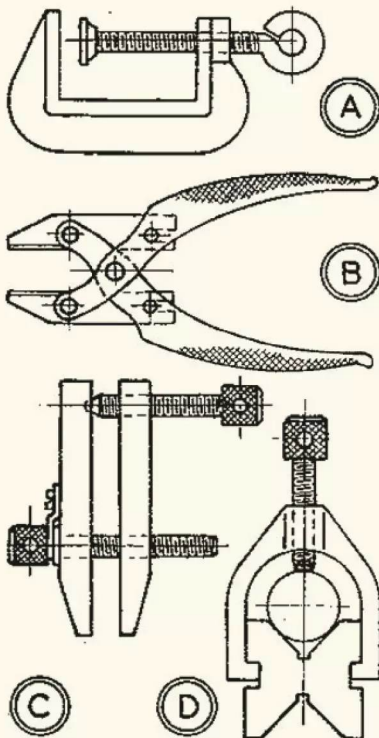
Conversely, where there is a tendency for clamps or pliers to slip, particularly on metal, a firmer hold obtained using soft material-hardwood, or emery cloth folded abrasive outwards. Short sections broken off small worn-out files also prevent slip.

Edges or faces needing to be flush, alignment can be effected through a flat surface, like the slide of a vice or lathe bed, *E* and *F*, and should a step be necessary, as when clamping two strips, packing of suitable thickness can be used under one, *G*.

Gripping round material

Difficulties in gripping round material can be overcome using a bar and block for the clamp *H*; or a small clamp can be made to take a counter-sunk screw-useful when drilling, *I*. On the drilling machine table, a length of steel channel often provides easy clamping, *J*.

In soldering or welding, where heat would be lost in the mountings, methods at *K* can be used-material such as *P1*, *P2* being packed up or, as at *X* overhung from the mounting plate and clamped *Y*.



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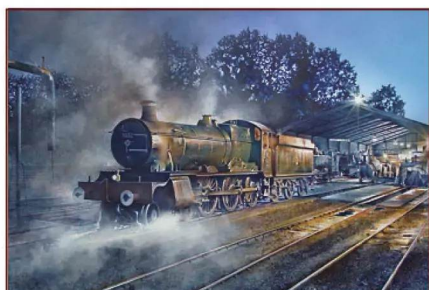
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The Midlands Model Engineering Exhibition

Thursday 17th to Sunday 20th October 2024 at Warwickshire Event Centre



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The Show for Model Engineers

Meridienne Exhibitions look forward to welcoming you to one of the UK's largest model engineering exhibitions, the Midlands Model Engineering Exhibition, taking place from Thursday 17th to Sunday 20th October 2024.

There will be **over 30 clubs and societies** present displaying hundreds of exhibits covering a wide range of modelling skills.

There will also be **nearly 40 of the leading model engineering specialist trade suppliers**, all waiting to meet you and provide everything you need for your modelling activities.

The Society of Model and Experimental Engineers (SMEE) will be presenting some **practical workshops** again this year which will focus on a beginner's project Elmers No 19. Over the duration of the exhibition the team plan to make multiple sets of the parts and build a number of running examples as the show progresses. This

is the model in more detail. <https://www.journeymans-workshop.uk/elmer19.php>

For the more experienced model engineer there will also be demonstrations of more complex techniques as well as a range of their famous models on display and a chance to meet the members and learn about

their training courses, programme of meetings and membership.

The **competition and display entries** are now open, and the entry form can also be downloaded from the website.

At this year's exhibition, the **John Stevenson Trophy** will be awarded in association with Model Engineers'



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Class 5 Stationary Engines
Class 6 Steam Road Vehicles (static)
Class 7 Machine Tools & Workshop Equipment
Class 8 Internal Combustion Engines
Class 9 Horological, Scientific & Automata
Class 10 Marine Models – Scale (over 50% scratch built)
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Workshop and the www.model-engineer.co.uk website.

This competition is awarded for excellence in practical and useful workshop equipment. For more information on the competition and how to enter your work see www.model-engineer.co.uk.

The **Association of Helicopter Aerosports** will be at the exhibition with an indoor static display, simulator, and outdoor flying demonstrations! The static display will cover various types and sizes R/C helicopters and the simulator will allow visitors to have a go at flying R/C helicopters. Weather permitting the AHA will also have an outdoor flying demonstration of scale model helicopters. Models included in the flying demonstrations are a 1/8 scale MH-65 Dauphin, a 1/7 scale Bell UH-1B Iroquois (Huey) and a 1/8 scale Westland Lynx HMA Mk8.

The **lecture program** is also shaping up and the full schedule will be announced soon!

This unique exhibition is the result of a tremendous amount of effort by many hundreds of modellers and other enthusiasts.

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

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

A full list of confirmed exhibitors to date is available at www.midlandsmodelengineering.co.uk as well as the competition entry form and advance tickets.



How to Build a Seismometer ...

Mark Noel will be giving a talk on this topic during the Midlands Model Engineering Exhibition in October. Here is a taster of what he plans to present.

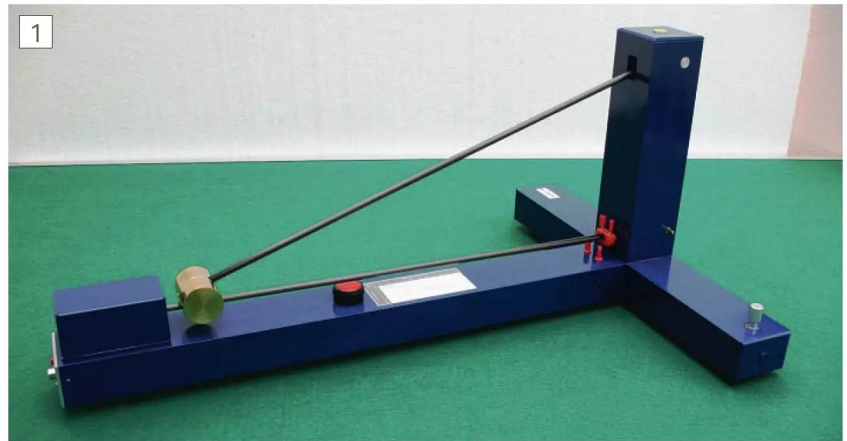
The ground is constantly rolling beneath your feet. Can you feel it? Last night there was a bump and even stronger rolling. Did you feel *that*?

Of course you felt nothing at all, and that is because the movements are microscopic, at the most microns in scale and often much smaller. However, if you could make an instrument that can detect these movements then a window into our planet is opened, providing clues to the source of earthquakes and the structure of the core, mantle and crust upon which we live. Such an instrument is called a 'seismometer', in other words a machine to detect and record seismic waves. From my home on the Isle of Man I have recorded hundreds of 'signals' from earthquakes around the globe, mostly from the Pacific rim where tectonic plates grow, collide or are sliding beneath continents, such as along the coast of South America.

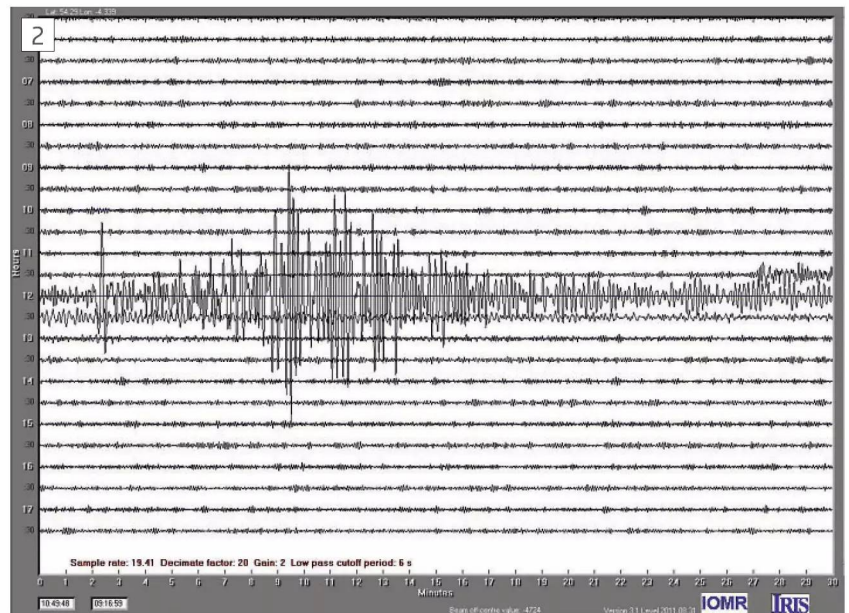
Building a successful seismometer presents a number of challenges all of which are within the capability of hobby engineers with a modest grasp of electronics. The first challenge is constructing a sensor which can resolve movements of less than a micron, and preferably down to several nanometres – that's a few millionths of a millimetre. You may be surprised to learn that this is actually quite easy as I will outline in my talk.

The second challenge is creating the mechanics that are stable, form the basis for housing your sensor and which enable these tiny Earth movements to be detected. This will be another key topic in my talk – but be assured it is *not* impossible!

Here is a photograph of the first instrument I constructed. It is a special



My first home-built seismometer.



Record of an earthquake that occurred near the Pacific island of Vanuatu, detected by my instrument on the Isle of Man.

type of pendulum that picks up horizontal seismic movements and also imperceptible ground tilt. Some quite unexpected results came from the

tilt data – and something that may be completely new to science. Wait to hear the rest of this story when we meet at my lecture in October!

David George makes as Morse Taper No2 spindle for his M Type Myford/ Drummond Lathe. Originally designed in 1902, in 1924 after a design update it was named the M-Type. In 1940 Myford took over manufacturing, introducing a number of improvements and the lathe continued to be produced until 1950.

old spindle and using Alibre which I have been using for some time now, a drawing was done, **figs 1** and **2**. The next problem was what material to make it from and EN24T seemed to me the obvious material to use as it is a

Figure 1

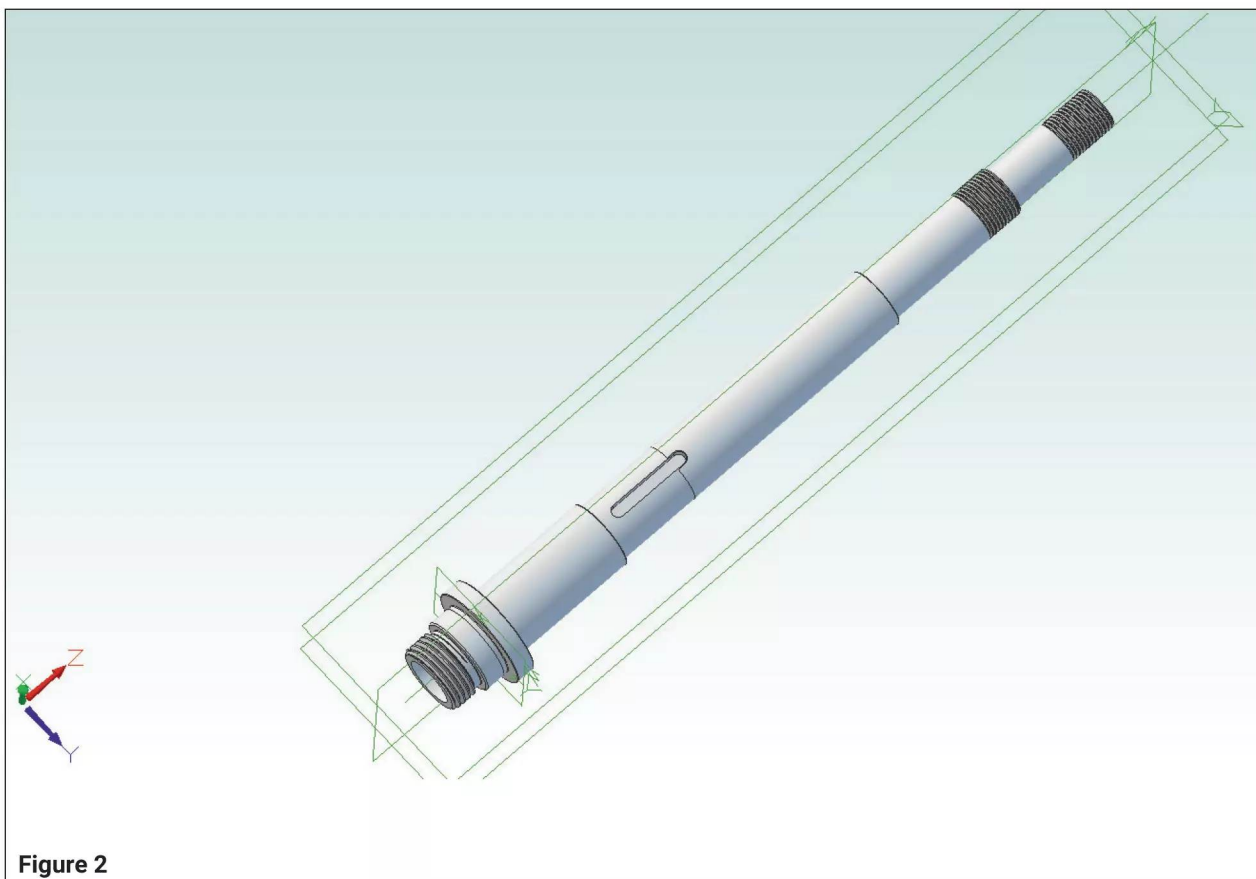


Figure 2



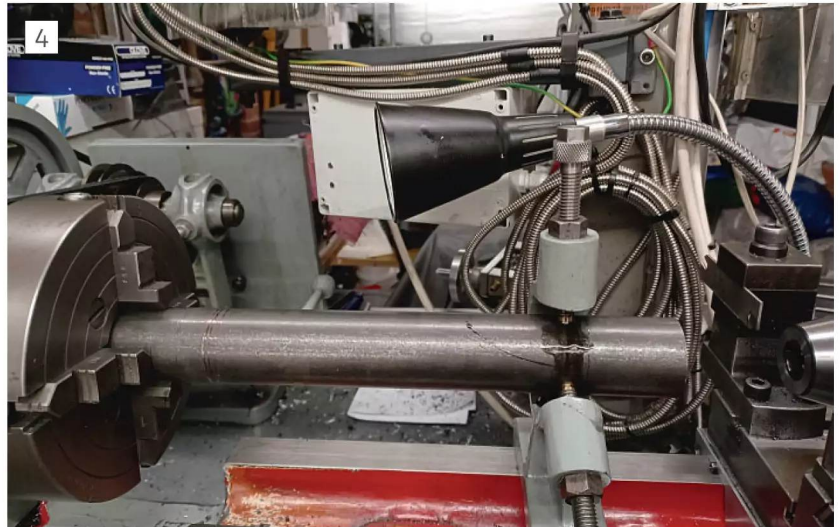
Machining dummy bar.



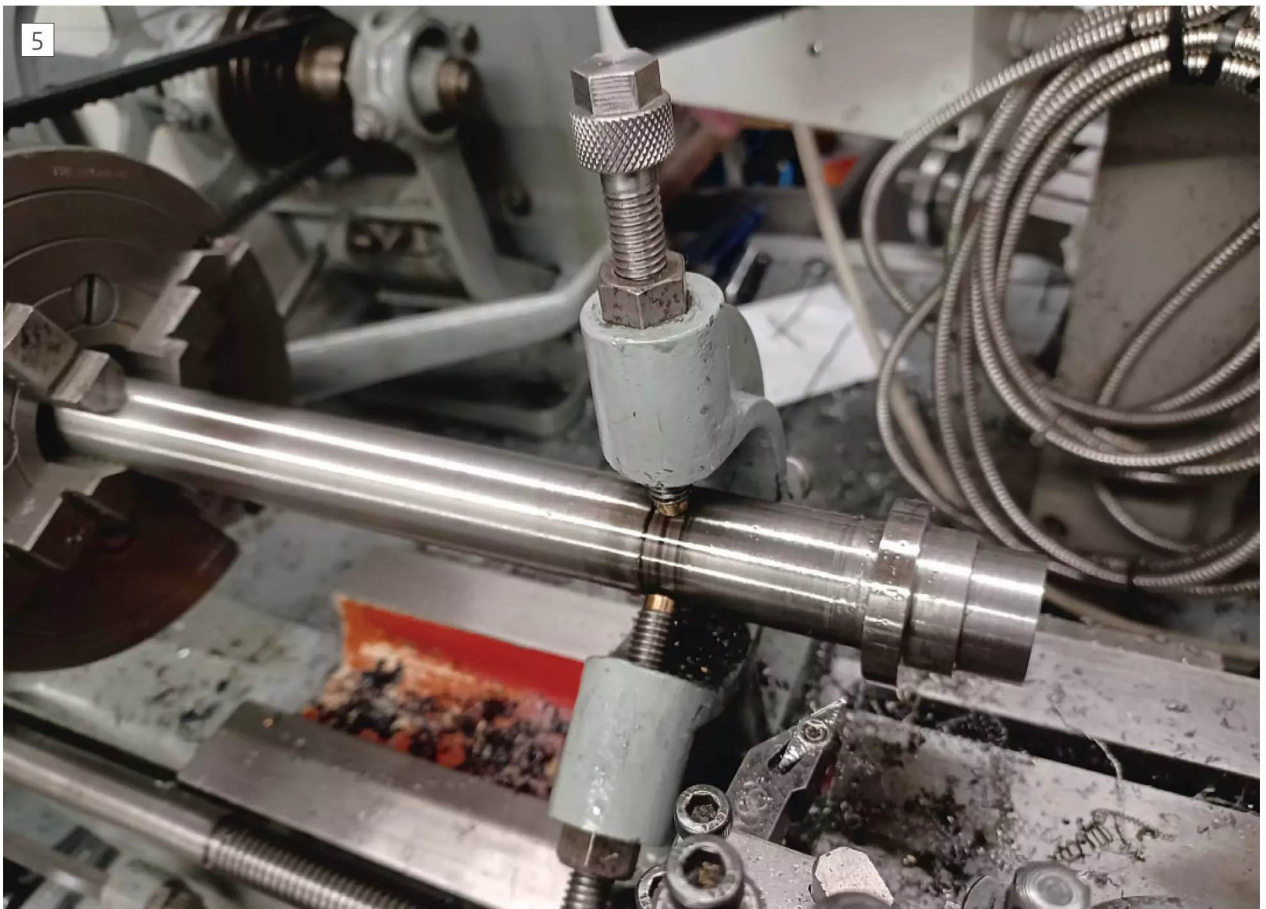
Testing screw threads.



Finished test nuts and dummy bar.



Setting up fixed steady.



Finish turning ends.

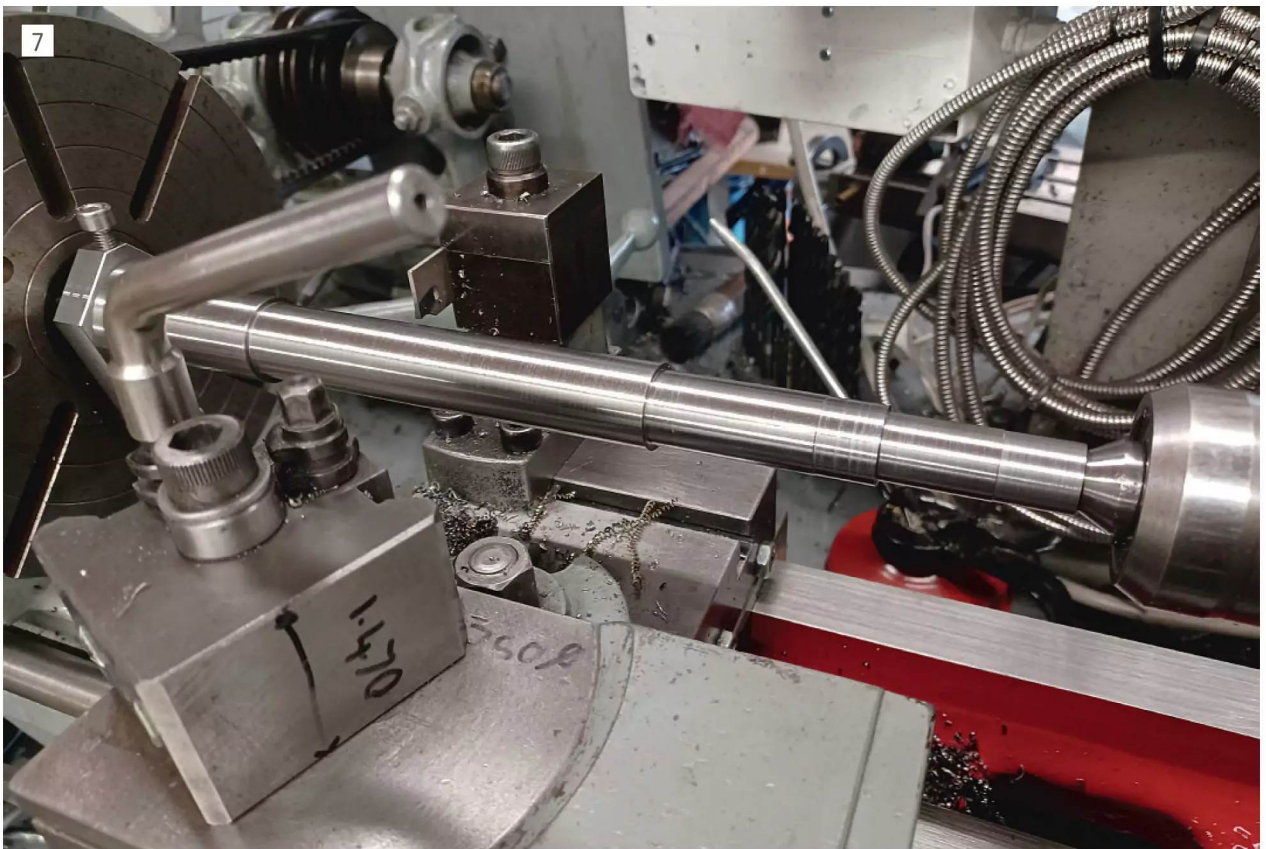
stable pre-toughened chromium steel which works well with bronze bearings. The next thing was to make some standard nuts and threaded bars with which to check the new spindle and to check the new nuts in turn to make

sure the parts were interchangeable. A dummy bar was turned, and screw cut firstly using my new screw cutting holder and the correct form Whitworth inserts which made it easier to get the size right, **photo 1**. Secondly after

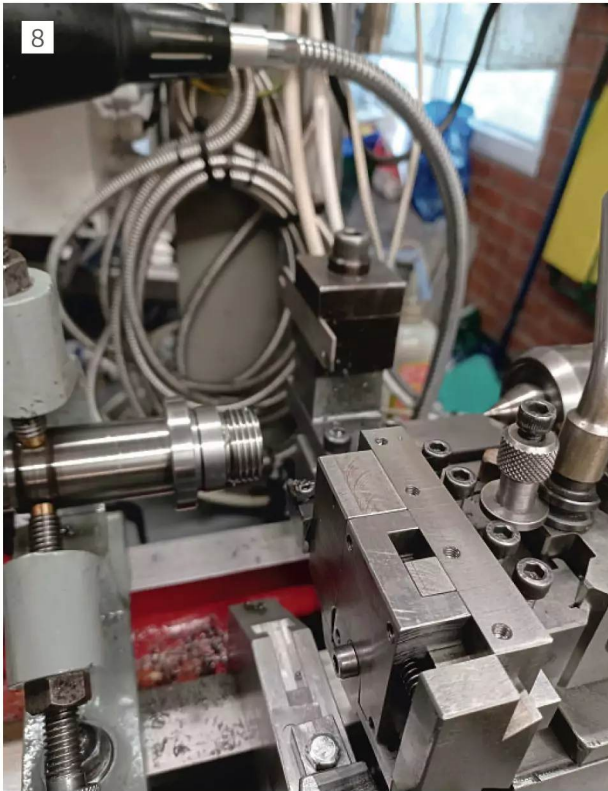
checking the threads with the original nut for fit, **photo 2**, I made some nuts to fit the dummy bar as I couldn't use the original nuts when screw cutting the new parts as they were on the lathe in use, **photos 3**.



Drilling the spindle.



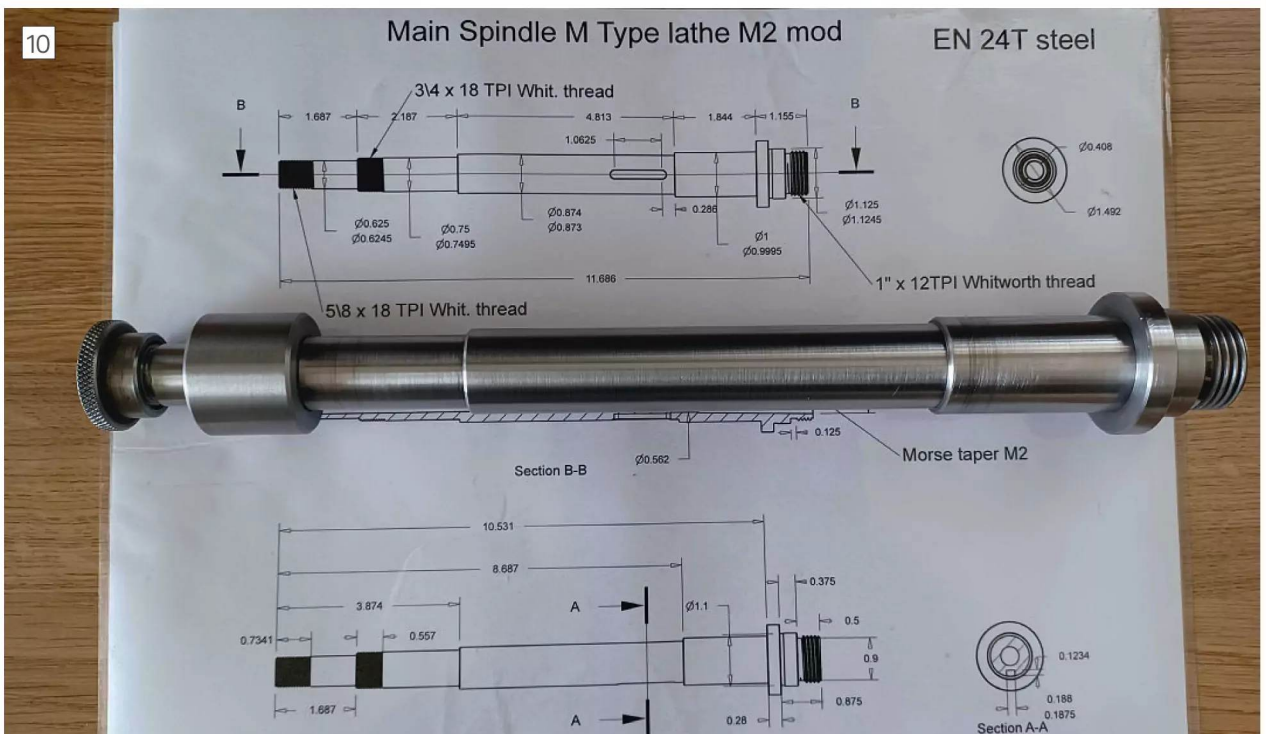
Machining spindle between centres.



Thread cutting spindle.



Testing with a chuck backplate.

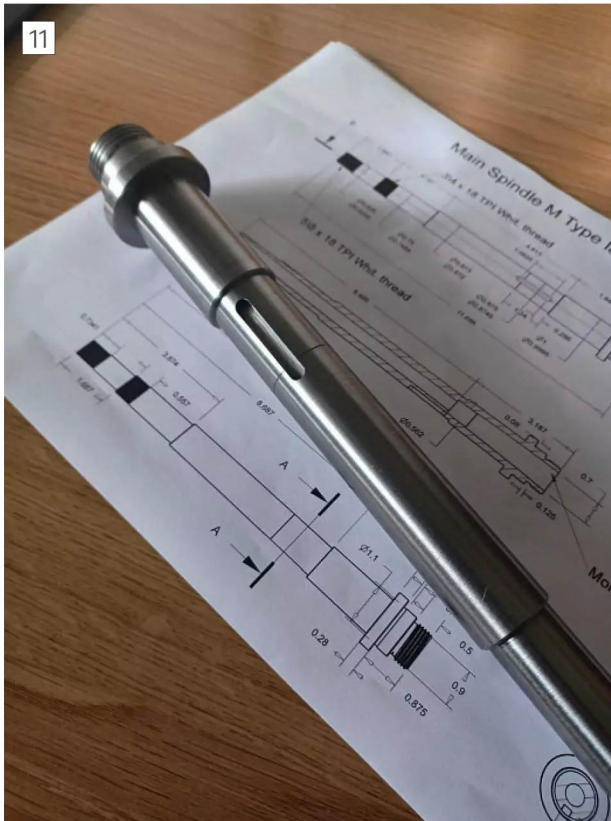


Turning complete.

The bar of EN24T had arrived from M-machine materials and it was a little over length so the first job was to mount

it on the lathe with the fixed steady, **photo 4**, and part the excess material off, face and centre both ends, **photo 5**.

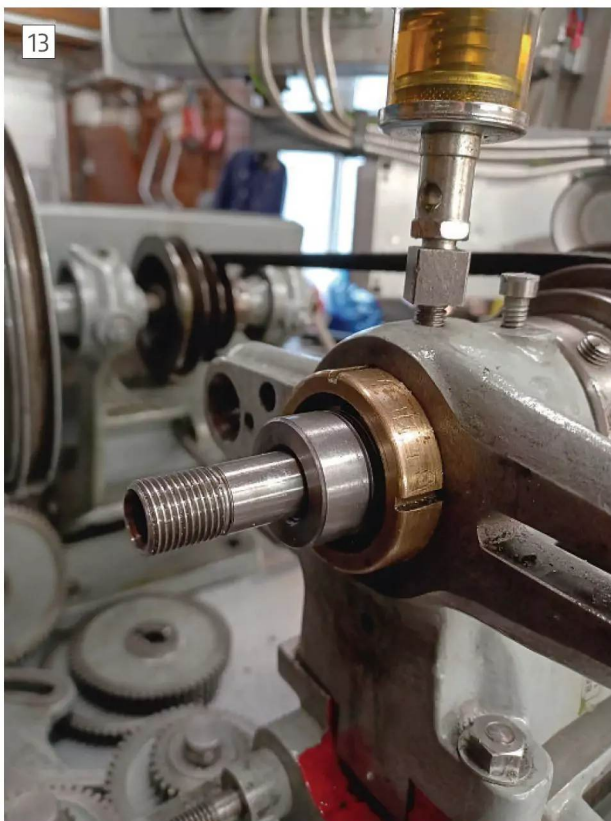
This allowed me to rough out the spindle with either between centres or use the fixed steady.



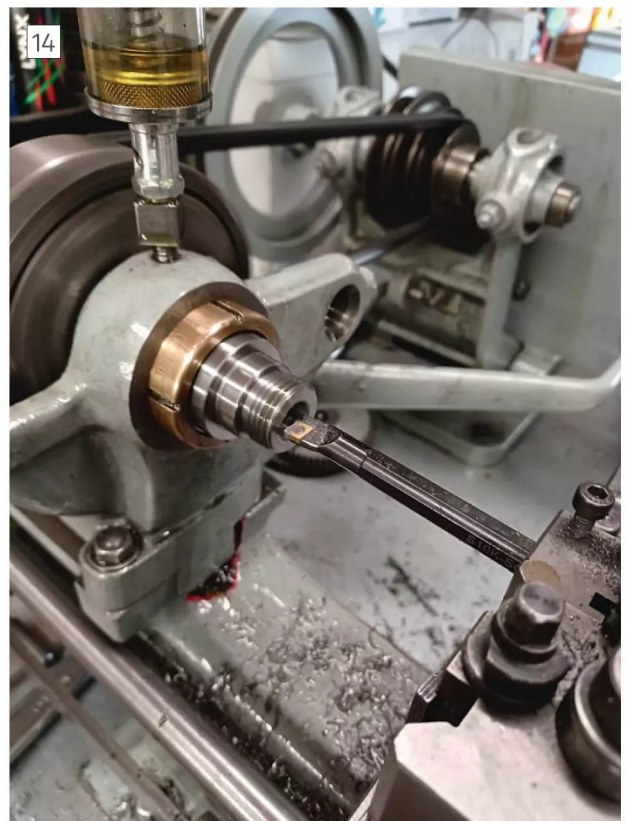
Bull gear keyway.



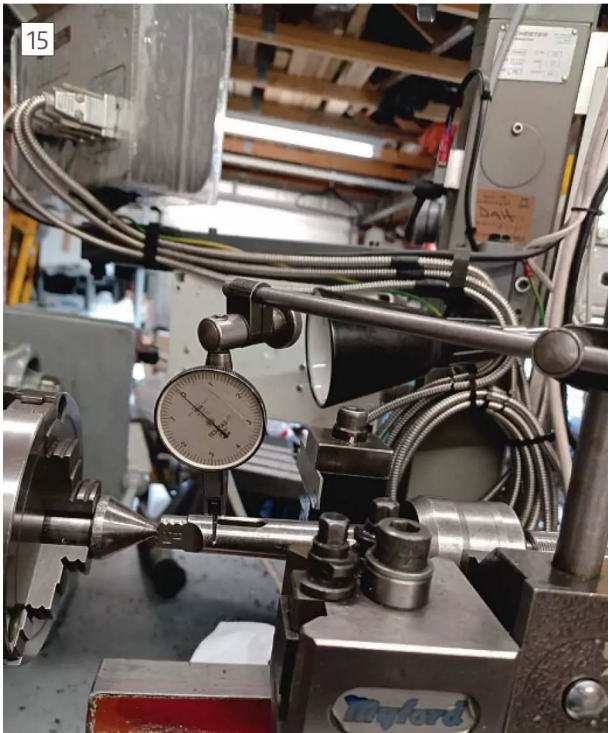
Bull gear fitted.



Running in new spindle.



Boring square bottomed hole.



Setting taper angle.



Testing runout of new morse taper.



Testing for fit with engineers' blue.

I used my 4-jaw chuck for most of the main turning operations as I could true up the spindle fairly easily and knew all was going to run true at both ends, except when I finished the diameters on the bearing and location diameters right at the end. This then became just a long turning job roughing out and finishing the outside diameters except for the bore and morse taper. When drilling the through hole I had a drill which would drill just over half way through of the correct diameter, but I had to drill through a smaller size first

to make it easier to drill the correct size through. In order to get the longer drill in and because of the combination of bed length and job length, I had to remove the tailstock, feed the long drill down the already short drilled hole, **photo 6**, and then replace the tailstock to then continue to drill the longer hole. This was repeated from both ends till they met in the middle. Also in order to get the hole running true I bored the hole from each end as deep as I could get, leaving only 10 thou in to finish with the drill which made the drill run true to get a perfect meet up in the middle. The outside was roughed out between centres, leaving 0.015" on diameters, to ensure the diameters all ran true, **photo 7**. The lengths were finished ready to screw cut the threads for the two spindle threads and back plate thread.

The threads were cut next using the pre-made nuts and a backplate from a chuck to check the threads for fit and size, **photos 8 and 9**. The diameters were next finished to size between centres with a new tipped cutter and given a slight polish in places to ensure size and smooth finish with some wet and dry paper, **photo 10**.

The next operation was to mill the bull gear drive keyway, **photo 11** and file and

polish the key to fit both the shaft and gear, **photo 12**.

The new spindle was fitted to the lathe and after a short run in and adjustment of the bearings and thrust pressure it ran very well, **photo 13**.

The morse taper was the last operation that I had to do and that was done in situ to remove any set up errors as was suggested on the forum. I started by drilling the parallel portion to depth then finishing to diameter and square out the bottom with a boring bar, **photo 14**. I mounted a morse taper sleeve between centres and using a finger dial indicator, on centre height, set the taper for boring the final taper, **photo 15**.

The taper cut well and after fitting an arbour into the spindle there was only 0.0001" deflection on the readout, **photo 16**, and the sleeve had a faint but even colour after blueing the spindle bore with engineers' blue, **photo 17**.

I have used the new spindle for quite a long time over the next few months with no problems and it is so much better that I can fit my milling collet set to hold jobs now and smaller diameters will pass down the spindle further into the morse taper area as well as the spindle bore is slightly larger size than the original. ■

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.

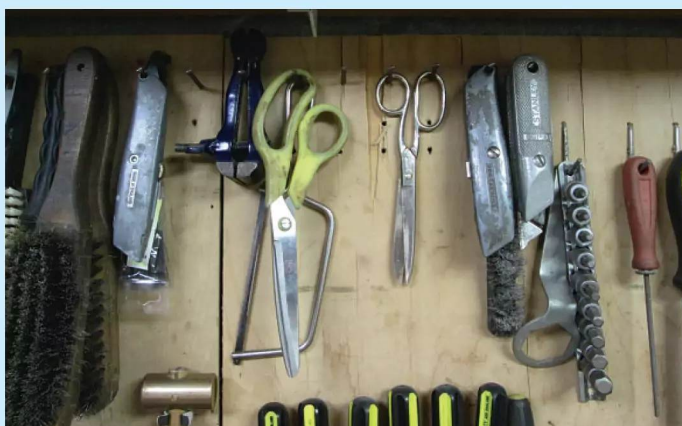
Stanley Knives

Dear Neil, I was interested in your comments on the "Stanley" knife in the May issue of MEW.

I like them and have a collection, see photos, of various types but mostly use the retracting blade type for safety reasons. I also have a scar, see photo, to show what they can do. I was doing something that I knew I should not do, cutting the edge off a piece of wood for a model boat. I thought "if the knife slips it will get me" so I put my right arm, I am left-handed, under the table out of harm's way. Wrong! As predicted the knife did slip, my whole body swung round exposing the "sheltered" arm and the knife slashed my wrist. NOT the vein but with the amount of blood I was in a real panic. This was in the mid-60s, and the local GP put four stitches in it.

I have also had trouble with thin blades emerging from the split in the knife handle when under pressure and the retracting blade not quite retracting leaving a very small bit of blade sticking out and biting me.

Laurie Leonard, by email.



Online Indexes

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

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



Thread Chasers

Dear Neil, Many years ago I worked for a pneumatic fittings company in the development department. Next door was the prototype shop where brass was turned by hand on overhead belt driven lathes.

The tools were very much like wood turning gouges with long wooden handles which rested on a fixed rest in front of the work to be turned. Likewise the thread chasers were fitted into long wooden handles and again used by hand to cut threads.

There was a slight taper run in at where the start of the

thread would be. The skill is to move right to left at a rate that continues as the thread is cut (a slowish lathe rotation speed helps). Like most skills the scrap gets less as more practice is made and the operators rarely made any.

Thread chasers as shown in MEW340 are still available (although you probably have to search hard) and I have a small selection which I use to cut threads on wood (mainly beech).

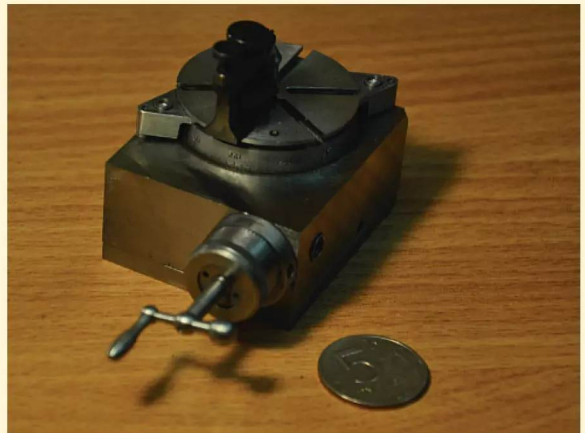
Bernard J Greatrix, by email

Clock and Watchmaking Tools

Dear Neil, my friend Valery repairs clocks, from modern hand clocks to Victorian grandfather clocks, and I made an instrument for him. I will need his help in describing the technology. I am sending you a video description of what Valery and I have done over several years. He told me what devices he needed, and I made them. The Bulldog eccentric head is designed for the automatic winding mechanism of

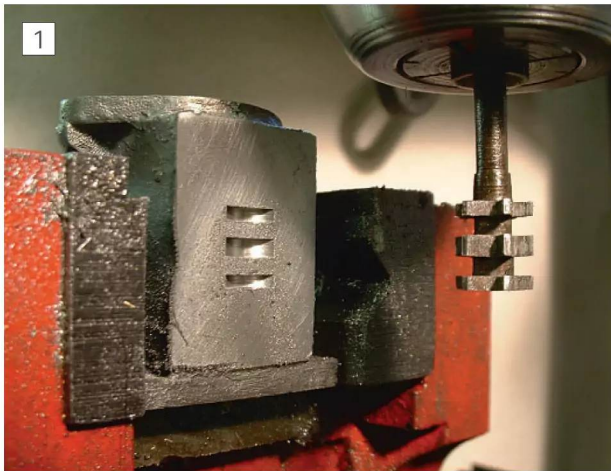
hand watches. A tooth is cut on the tail, displaced by a given amount. When Valery does a full cycle, he promises to film everything in more detail. Thank you for your interest in our work.

Mikhail Chernyshev, by email.



Some Useful Gadgets for Model Making

Silver steel and gauge plate are hardenable steels that can have a multitude of uses for making jigs and custom tools, they are used to make several of the useful gadgets featured below.



Three gang cutter with valve ports.



Milling the cutting teeth.



Port milling in progress.



Tapping cylinder face with a guide.

In **photo 1** you can see a three-gang cutter for making accurately spaced steam ports. This is actually made following a description by LBSC that appeared in an old issue of *Model Engineer*. It is made by turning a blank with three discs from silver steel to the correct spacings for the valve ports. The choice of diameter has to be a bit of a compromise, the small

the diameter, the better the ports are formed, but too-small a diameter and the central column cannot be a large enough diameter. I would suggest aiming for a diameter of about 1.25 times the port width. I drew up a sketch in CAD that shows a 15mm diameter cutter could have a 6mm central column and happily cut a 12mm wide port to a depth of about 4mm.

The cutting teeth are very carefully formed by milling away segments, **photo 2**. Aim to leave a small 'witness' at the tip of each cutting tooth, this can then be carefully filed back by hand to create a small amount of relief to ensure free cutting.

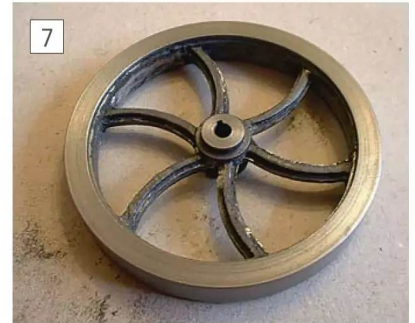
The tool is hardened by heating to read heat and holding it there for about a minute (the section is quite small),



Typical key on a model.



Keyway filing guide.



Flywheel with hand-filed keyway.



Flange drilling jigs.



Typical fitting in the guide.

before quenching in water. Before use the tool needs to be tempered so it is not too fragile, in this case by heating it gently until it turned a pale straw colour. The cutter needs to be run at a relatively low speed and feed rate to avoid overheating, but works very well, **photo 3**.

While we are thinking of engine cylinders, one tricky task can be making a neat job of tapping lots of small diameter blind holes, such as for mounting the valve chest. A simple 'top hat' guide drilled to be a sliding fit for the tap, **photo 4**, is an excellent aid and guarantees a square thread while minimising the risk of breaking an expensive tap in an expensive casting. Any material can be used to make the guide, even plastic, the one featured is aluminium alloy.

An awkward task when making scale model steam engines is cutting internal keyways, **photo 5**. It's fine



Making an oval flange.



Filing buttons.



Finished crank.



Cylinder base made using filing buttons.



Simple form tool.



Brass balls made with the form tool.

if you have a proper set of keyway broaches, but these are not readily available in very small sizes and can be very expensive for what may be a single-use item. The 'top hat' guide shown in **photo 6** is a cheap and easily made alternative, just turn it a close fit in the flywheel and mill the slot using the same size milling cutter you use to make the keyway in the shaft. Ideally, make the guide from silver steel and harden and temper it to blue, to give a robust file guide for making the slot with a small file, **photo 7**.

If you make your own pipe fittings and valves for your models, you will need a way to drill evenly spaced holes around a flange. Once again, hardened and tempered silver-steel jigs are an easy solution that helps ensure flanges are both neatly drilled and that they match up, **photo 8**. The flanges at both ends of the part in **photo 9** were drilled before the oval end was shaped.

A different flange piece is shown in **photo 10**, in this case it is being roughed to an oval shape using a very simple jig – screwed to the end of a piece of cast iron bar. The outer curves are turned down, then the ends can be shaped by eye.

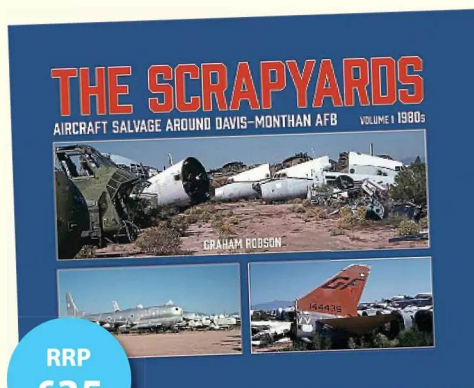
Another use for silver steel jigs is making circular filing buttons. These are simply thick washers turned and drilled to size, hardened but not tempered. In **photo 11** you can see three pairs of buttons being used to help shape a steel crank, the real left button obviously didn't harden fully as it has been partly filed away. Following filing to shape, one of the holes in the crank was plugged with a piece of matching steel hammered in, then it was polished to a high finish, **photo 12**. Similar buttons could have been used to shape the ends of the flanges in **photo 10**, held by screws through the fixing holes. **Photograph 13** shows an unusual cylinder base shaped using filing buttons.

Where hardenable too steel comes into its own, is, as with the port cutter, for making custom tooling. **Photograph 14** shows a simple form tool, made by drilling a hole in a piece of gauge plate, then trimming it to size. Unlike silver steel, gauge plate is hardened by quenching in oil, I use a small metal tin with vegetable oil in. The lid can be used to control smoke and extinguish any flames, but always do oil hardening outside for safety's sake. The tool is held flat with its upper edge at lathe centre height, and used very gently at a modest speed to avoid chatter. The two governor balls in **photo 15** were made using this form tool. Pilot drilling the balls before shaping them, but not drilling all the way though where the stem will be until after the balls are parted off helps ensure the balls don't 'part company' too soon. ■

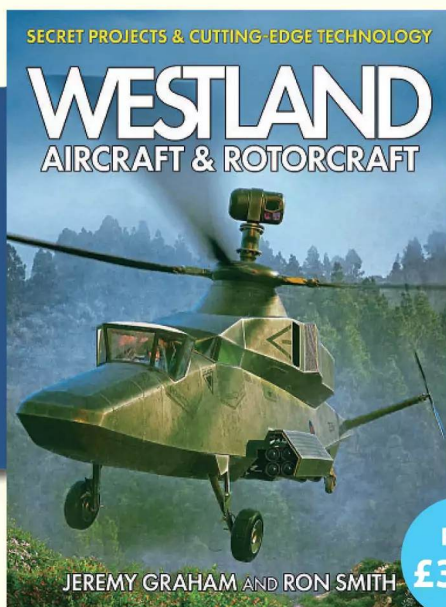
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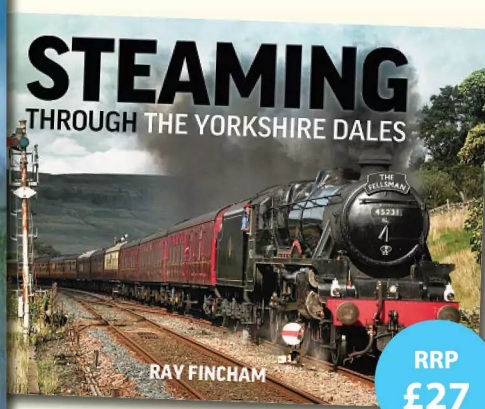
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The John Stevenson Trophy 2024

Readers are invited to enter the workshop competition that puts practicality and function ahead of appearance.



Our apologies for any confusion from the wrong date on last month's announcement, we are reprinting the basic information here to remind readers you have about six weeks to put in your entries.

Funded by many donations in his memory, the Stevenson Cup was first awarded in 2018 in memory of the late John Stevenson. The cup is engraved "John Stevenson, 1948 – 2017. Remembered by his many friends" with "Awarded for Excellence in Practical and Useful Workshop Equipment" on the plinth.

The John Stevenson Trophy is presented for just that, a well-made and usable piece of tooling, a modification to a machine or an accessory for a tool where the fact it works well is more important than making it look good. Unlike judged trophies, we decided on a different approach to reflect John's

reticence about traditional competitions. After a call for nominations, a small panel of judges selected a shortlist, on which there was an online vote.

Because of the disruptions caused by Covid and the interruptions to exhibitions where we can present the trophy, it has been held bi-annually for the last few years. The most recent winner was Bernard Towers for his well-made and practical indexer. He received the trophy at last year's Midlands Model Engineering Exhibition.

Once again, the competition is open to all Model Engineers Workshop readers and Model Engineer forum members, who may enter their own work. We encourage entries of items published in MEW but unpublished items can be entered.

A short list will then be prepared by the organisers, so that award of the cup can be judged by a popular vote. Voting

will be via a poll on the forum and open to all.

The winner will be announced online and in the magazine.

To enter, send four good photographs of your entry with up to 500 words of description by email to meweditor@mortons.co.uk no later than **22 July 2024**.

The rules of the competition can be found on the forum www.model-wmengineer.co.uk follow the link below or use the QR code: <https://tinyurl.com/mr3b2z6d>



Getting to love my Denford Novaturn, part 1

Mick Knights describes his adventures in CNC control.

Not too long ago, I bought a Denford Novaturn, the small bench top cnc lathe that I had always wanted, but until that time I hadn't had the space for, also that I was looking forward to sharing my experiences of getting to grips with the control and producing some interesting work pieces.

To be completely honest I don't actually need a small cnc lathe as my Myford Super7 has done everything I've ever asked of it over the nine years I've owned it, but at my time of life the word need is often replaced by 'want'. Well as things turned out the title of this piece could well have been 'Be Careful What You Wish For' as things haven't exactly gone as planned and if the chaos theory is correct there must have been a particularly large butterfly having a prolonged flap in the Brazilian rainforest!

For readers unacquainted with the black art of cnc I will be explaining the basics of cnc turning along with a look at suitable tooling for a small cnc lathe and my own learning curve with the Denford QuickTurn 2D Design software, which was my first experience of using CAD/CAM and although it turned out not to be that difficult I had to pretty much learn how it works by the time honoured method of pressing keys to see what happens, as I couldn't find any step by step instruction in the online manuals, but all of this will have to wait till part two.

The price and availability of a modern CAD/CAM supported cnc bench top training lathe is now coming within the reach of the home machinist and if the machine has come from a school or college there's a good chance that it wouldn't have had a hard-working life. All cnc controlled machines will differ slightly from one to the another, but the basic processes remain the same, so I hope by recounting my experiences with this particular model and control any



The original set up including the ancient and sizeable PC.

readers contemplating adding a small cnc lathe to their workshop equipment may be able to avoid some of the pitfalls I encountered along the way.

But before we embark on the machining there are some control issues to discuss, so before I start relating my cautionary tale of woe, it's important to point out that what follows is my own unique personnel experience, coupled with a fair slice of bad luck and is in no way a criticism of the machine or software, this is hopefully more of an honest appraisal of my own limitations when it comes to IT, as Denford are a well-respected manufacturer of light industrial and cnc training machines and they wouldn't be where they are today in the worldwide market place if their products and after sales service were not top notch, also as this discussion progresses you'll realise that their service engineers are fully prepared to go the extra mile in order to get your pre-owned machine running, but, as with all pre-owned purchases, especially cnc machine tools, it's very much a case of buyer beware when purchasing

a machine unseen, as any after sales warranty would have long expired and as I know to my cost when I was trying to find a locally based cnc service engineer to come and have a look at the situation I found myself in, industrial cnc service engineers are very reluctant to get involved with cnc machine tools in a domestic situation.

I had been looking out for a Novaturn for a while, as I've long held the view that if a piece of kit looks right then there's a pretty good chance that it is. But don't let the size fool you, this is a weighty machine as it took three of us to lift it out of my van and on to a sack barrow ready to get it to my shed, I feel there's very little danger of it vibrating across the bench top! I bought the machine, **photo 1**, as a package from a well-known on line auction site, where the purchase included the lathe, control and a PC with the appropriate Denford software installed. The package was advertised as ready to run, and in fairness to the vendor, when it arrived it was. If the software operating licence that was loaded on the computer



A bit of a tangle. Laptop to control cable.

was correct then the machine was commissioned to a school in Wales back in 1997 making the machine and control almost twenty years old, but the lathe was in a very clean condition with no apparent sign of any machining mishaps.

After some initial hiccups trying to work out if the control software (VRTurn) did operate in conjunction with the dedicated CAD/CAM software of the Quickturn 2D Design, which without the benefit of one to one instruction, which would have been the case when the machine was originally purchased, was not immediately obvious, I wrote a simple part program and established the offset value of T01 (tool number one) and prepared to cut some metal. It's at this point where things started to go south.

I feel I must briefly recount my own history in regard to cnc machining. In the 1980's, in order to learn cnc theory and practice I initially took a three-year evening course at my local college for a City and Guilds qualification, as in those days and being in your late thirties, you were considered, by most employers and manufacturers of cnc machine tools, to be too old to be able to understand or even operate the new technology. Later, when I ran my own small workshop the first three axis cnc machine tools I owned and operated were Bridgeport series one milling machines, which had paper punch tape readers and so all programming and editing was via a Teletype. The first PC I used to write a cnc program on was a green screen Amstrad which would only accept a hundred lines of programming. Having been involved with cnc machines and hand written programming for many years I'm quite happy to operate most two and three axis machines, as the only aspect that will be different from machine to machine is the control and some subtle differences in how the program is constructed, while the basic approach to the machining will be

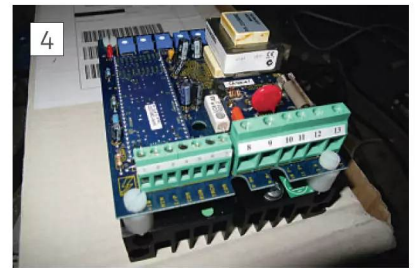


The control card with the direct cable from the laptop connected.

the same. In all that time that I've been involved with cnc machining I've always considered the PC to be just another tool and I have never fully understood the magic that makes it all work, this will probably go some way to explaining the initial problems I encountered in trying to solve a set of ongoing computer related situations, while my electronic diagnostic skills are practically non-existent. In the past when I was directly employed, I'd always had the luxury of a maintenance engineer to sort out any control or computer related issues, and when I ran a small workshop I had neither the time or the expertise to tackle control problems and so I relied on a call out service engineer to sort things out.

I should also mention that the PC that came with the package was a bit on the ancient side, very big, extremely heavy and it ran Windows XP which was prone to crashing at the most inconvenient moments.

So back to the machining. With the tool offset stored in the Denford VRTurn (Virtual Reality Turning) software I initiated cycle start and started to turn metal. When I checked the finished turned diameter, I was surprised to find it measured 1mm above programmed size. The quickest method of rectifying this is to change the X axis offset value of T01 to compensate for the error, which is the route I took. Again the finished diameter differed from programmed, so I decided to physically reset the offsets against a freshly turned diameter. For any readers unfamiliar with cnc turning, a test diameter can be quickly produced by starting the spindle and moving the cutting tool towards the work piece by using the 'jog' control enabling a small depth of cut to be taken in order to establish a diameter, which can then be measured and the value stored as the X offset value for that particular tool. I will cover this in a little more detail in



The new drive card in all its glory.

part two. Anyway to cut a long story short I reset the X offset value of T01 a total of six times and on each occasion the readout recorded a totally different value across a band of 60mm both in the positive and negative quadrants, clearly something was very wrong, so in order to establish if the error was due to mechanical, software or a computer related issue I decided to uninstall the version of VRTurn (V1:45) that was loaded on the computer and install the free to download V1:43 version to see if that had any effect on the problem so it could be excluded from the equation as far as the mechanical side of things were concerned the slides were fully oiled and moving smoothly.

The individual software license that was initially issued to a specific individual or institution which allowed them to use the Denford software to operate the machine is called the Flash code. This consists of lines of text, along with numbers and symbols which must be pasted at the bottom of the VRTurn. Ini. program file. This operating licence system has now been replaced by an embedded SecKey, which I can only assume is to bypass this easier method of obtaining an operating licence. With the older style Flash code there must be no deviation from the code as it appears as text when pasting it into the VRTurn. Ini. file, as this will result in the failure of the software package to function. The chap I'd bought the package from had sent me an email with the Flash code, so I was reasonably happy to paste the code directly from the email and into the appropriate program file in order to open the software, but unfortunately the software had other ideas. In similar computer related situations it's usually my IT skills that are identified as the root cause of any malfunction, so I asked a friend to check it all out. He uninstalled and reinstalled the downloaded

software, with exactly the same result. To add to the mix the version that I had uninstalled, for reasons best known to itself, when reinstalled wouldn't now connect to the machine control. I got back to the chap I'd bought the package from who told me the code was good and that perhaps I should try a different clean computer that had not run the VRTurn software before. For the sake of brevity and to avoid readers succumbing to slumber, the story now moves on to computer number three. All three computers I've tried had different Windows operating systems and all encountered the same problem of not being able to open the software let alone connect the control to the machine, also at this point there had been an unreconcilable parting of the ways with the vendor, so I'm now completely on my own and there's still no connection to the lathe. On the plus side I could now confidently navigate my way through all the program files and set the machine parameters in my sleep.

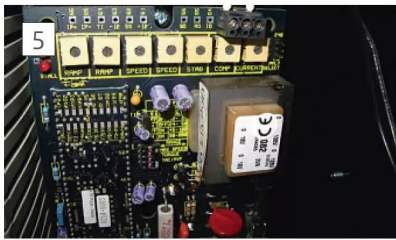
The Denford users forum is full of friendly members who were only too happy to respond to my posts, sadly none of them had the faintest idea what the problem was or how to solve it, but for a few weeks I had some very pleasant online conversations. Finally the moderator, who is also one of their service engineers, took pity on me and we started to try and get to the bottom of the problem by PM emails. It took several weeks until we had exhausted all the obvious questions and answers, when he asked me to email him the Flash code. To be sure he had the code as it was presented to me, I copied the vendors email to him. When he got back it was to tell me that he couldn't get the flash code to open his version of the VRTurn software and so the only way forward was to purchase my own licence at a cost of £240.0 This is where the fun really begins!

As the first ancient computer, which ran Windows XP, had actually run the original software plus the fact that it had operated the machine and in spite of its tenancy to crash for no apparent reason I decided to load it with the latest version of the software (V1:47) that came with my SecKey single user licence. Everything went smoothly and I managed to get the control screen up. The only problem was that every time I clicked on the tool

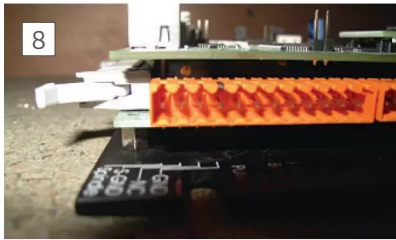
profile box on the main control screen the screen pixilated, and the software froze. The only way I could get out of this was to close the computer down. This occurred five times before I decided to try computer number two. I bought this unit from the same well known online auction site on the recommendation of the original vendor. This unit ran a commercial version of Vista. The tool profile window worked fine with this unit, but the problem here centred on the Mint file. The Denford software is generic, which means you have to select the correct Mint file for your lathe in order for the control to run your machine, this is achieved by entering 'set up' and selecting machine parameters, then the correct Mint file can be selected from a menu, all quite straight forward, but when I tried to connect to the lathe the screen displayed the reason why the control wouldn't talk to the machine was, the Mint file I had selected didn't exist. No matter how many times I uninstalled and reinstalled the software the Mint file failed to register. Don't worry if this doesn't make an awful lot of sense at the moment, I'll be explaining the machine set up in part two. On to computer number three, my trusty old laptop, which runs the even trustier Windows7. But with the software installed on this unit the Mint file menu was completely empty, which of course meant I couldn't select any file let alone the correct one. On this occasion after several attempts at uninstalling and reinstalling the software the Mint file menu became active and at last, I could get the main control screen up, but sadly still no connection to the machine control, so as all the software elements seemed to be active I decided to make the laptop the computer of choice to go forward. Now while I fully appreciate that the average five-year-old could sort out any of these problems, I was left more than a little perplexed. I also had the added problem that the laptop had a USB port, while the other two units had serial ports and so I couldn't use the original VGA to parallel signal cable that had connected the original computer to the control, so I used a USB to VGA which then connected to the old VGA to parallel signal cable, **photo 2**. There was no choice really but to contact the Denford service engineer again for advice. Initially the cable connection was the main suspect,

so I sent all the cables to Denfords so they could be checked, all turned out to be working, the only untested connection was the controls' internal cable which connects the parallel input to the main control card. The suggested way forward now was to replace the smaller of the two control cards, which had a VGA connection, to one with a USB B connector, which would allow me to connect directly from USB port on the laptop to control card using a single cable, thus also avoiding the control's internal signal cable, **photo 3**. But even with this system in place there was still no connection between computer and control. Denford's service engineer did say that if he was on site he could identify the problem very quickly. The only fly in that particular ointment was that he was in Yorkshire while I was on the south coast and the call out rate was £95.0 an hour, including travelling time!

The next thing to try was for the engineer to take control of my laptop with the free to use 'Team Viewer' software. This was clever stuff, but even after twenty-five minutes of tweaking the software on the laptop there was still no connection to the control, but on the plus side all the settings on the laptop that I had established, com port and machine parameters etc. thankfully turned out to be correct. There is a quick check to establish if the computer is connecting to the control and this is by using the Denford easy upgrader, which is part of the software package, pins and ports can also be accessed via this component, but when we tried to use this software no link between the computer and machine could be established. A slightly baffled service engineer then wanted me to send both the small and large control cards complete with its heat sink back to Denfords so he could check them out. I'm unsure what was found but once returned and re-installed in the control cabinet my laptop was again taken over to check it all out again. This time the engineer was convinced that the machine was running as everything going on in the computer said it was, when fact it wasn't, but on this occasion the easy upgrader had detected a connection between the computer and the machine, which was progress. On visually checking out the control drive card (Sprint 1200) an led light that should



The six adjustable pots on the original drive card.



Side view of low speed pot adjusting screw.

have been illuminated wasn't and so a new drive card was required. This in fact was a spectacular own goal, for when the service engineer asked me to send him a particular card to check I misunderstood which card he was indicating and tried to remove the drive card, which didn't want to be removed. To my cost I now know that the drive card cannot be removed unless it is removed still attached to its heat sink. On the plus side I saved myself £40.0 by buying a drive card direct from the manufactures, but it still cost £180.0, **photo 4**. When I installed the new drive card and connected to the machine the spindle immediately started to rotate, the only problem now was the spindle encoder said it was revolving at 4000 rpm while the top speed is only supposed to be 3500 rpm. When I emailed my by now personal service engineer I found that I hadn't exactly helped the situation as I had installed the new drive card without transferring six small control pot settings from the old card to the new one. It was a straight forward job to set all six adjustment pots on the new card to the same visual settings as the old one. (photo 5) This did help, but only by reducing the spindle speed from 4000 rpm to 2000 rpm which was the constant speed over the whole 0 to 3500 rpm variable speed range. Time for a third computer take over session, but the situation still couldn't be rectified, the main suspect now was a component on the main control card that might have blown as a direct result of the drive card



Larger bottom control card and low speed pot.



The control cabinet

being installed without the correct pot settings, another spectacular own goal, and so the control card went back to be tested, where a fault was identified and rectified. With the control card replaced the spindle behaved itself with the top speed values between programmed and spindle encoder being roughly equal, but when testing the lower speed range the spindle stopped rotating when the programmed speed was showing 500 rpm. Time for some low end spindle speed calibration.

Once again Denford's service engineer gave me all the information required to accurately calibrate the spindle in order to get the program speed in sync with the spindle encoder. The spindle speed over ride pot on the actual machine has to be adjusted until the override value is showing 100% on the control screen. The top speed of 3500 rpm is easy to set just by adjusting the 'high speed' pot on the drive card until both the program and spindle encoder speed on the screen readouts are identical, although a 10% variation between the two is acceptable. Setting the low-end speed range is a completely different matter. A few months before I had been scratching around in the bottom of the control cabinet trying to locate a screw I'd dropped, when I discovered a dentist's mirror, which at the time I thought was a bit odd, now I realise that someone else had most properly been trying to set the low-speed range, a possible indication that the control has



Small card replaced.



Pot spinners and dentists mirror.

history. As I subsequently discovered the dentist's mirror is an essential piece of kit in order to locate the incredibly small adjusting screw in the slow speed pot that a cunning designer had hidden underneath the smaller control card.

Photograph 6 shows the main control card with the smaller card removed, the low speed adjusting pot is the small blue upstanding block in the bottom right hand corner. **Photograph 7** has the smaller card replaced and so successfully obscuring the adjusting screw.

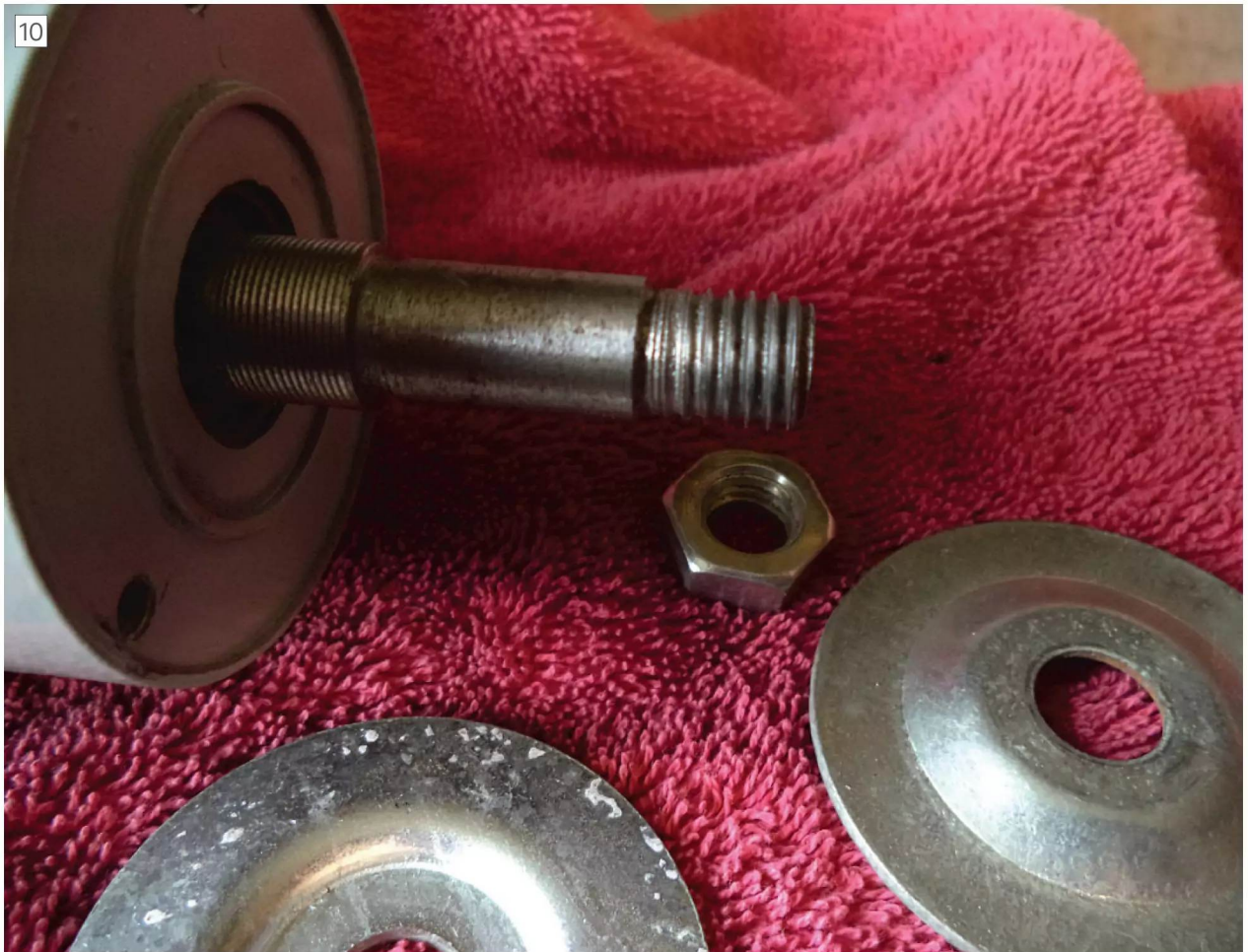
Photograph 8 is a side view of the top and bottom control cards. If you look closely, you can just make out the small brass adjusting screw. Now imagine the card back in the control cabinet and yourself on the floor trying to get a tiny screwdriver blade to engage with said brass screw, **photo 9**. Who said design engineers don't have a sense of humour! The service engineer kindly sent me a couple of little screw drivers, or pot spinners, that they use to calibrate the spindle speed, which certainly helped, but the process is not an easy one as the adjusting screw is super sensitive and just fiddling the screwdriver until it locates in the screw slot can change the spindle speed by a couple of hundred rpm, **photo 10**. When I finally achieved a 10% variation between the program and actual spindle low speed revolutions, I was very happy to call it a day and get back to something I do know a little bit about, metal removal.

● To be continued

The PottyEngineering Cutter Grinder Part 2



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



Grinder spindle for mounting wheels with washers.

As an initial test I planned to use the blue grit 8" grinding wheel that the grinder came supplied with, but I was far from happy how this ran on the spindle, to my mind it had far too much wobble. From Harold Hall's book he mounted the complete grinder on the cross slide of his lathe and running the motor and using the lathes compound slide he trued up and reduced the diameter of the spindle, I wanted to avoid this if possible.

Inspection of how the grinding wheel interfaced with the spindle indicated the possible cause of the problem, the spindle is $\frac{1}{2}$ " diameter that matches the bore of the grinding wheel but the remainder of the shaft is only $\frac{5}{8}$ " diameter only giving a small face for the mounting washer to pull up against, on top of this the pressed steel mounting washer is far from flat so it's not surprising that the wheel fails to tighten down square onto the spindle,

photo 10. The solution was simple, I made a 1" diameter collar a tight push fit on the $\frac{5}{8}$ " diameter held in place with a M3 grub screw this gave a nice wide face for the mounting washers to pull up square to, and this took most of the wobble from the wheel, **photo 11.**

To mount a grinding wheel safely you must first check that the wheel has no cracks or chips and the maximum speed for the wheel. You must also use mounting washers of equal diameter



Modification to improved wheel mounting.



Diamond for dressing wheel.

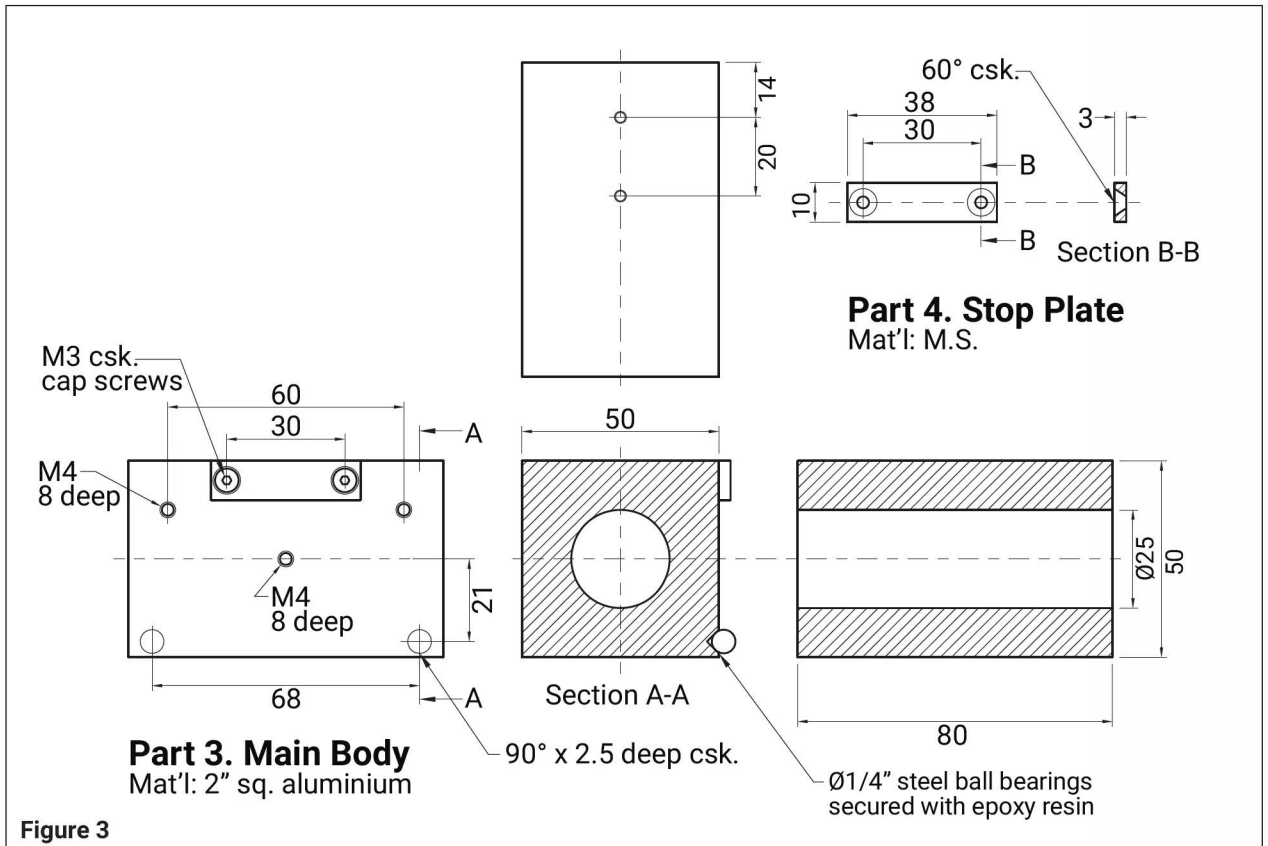


Figure 3

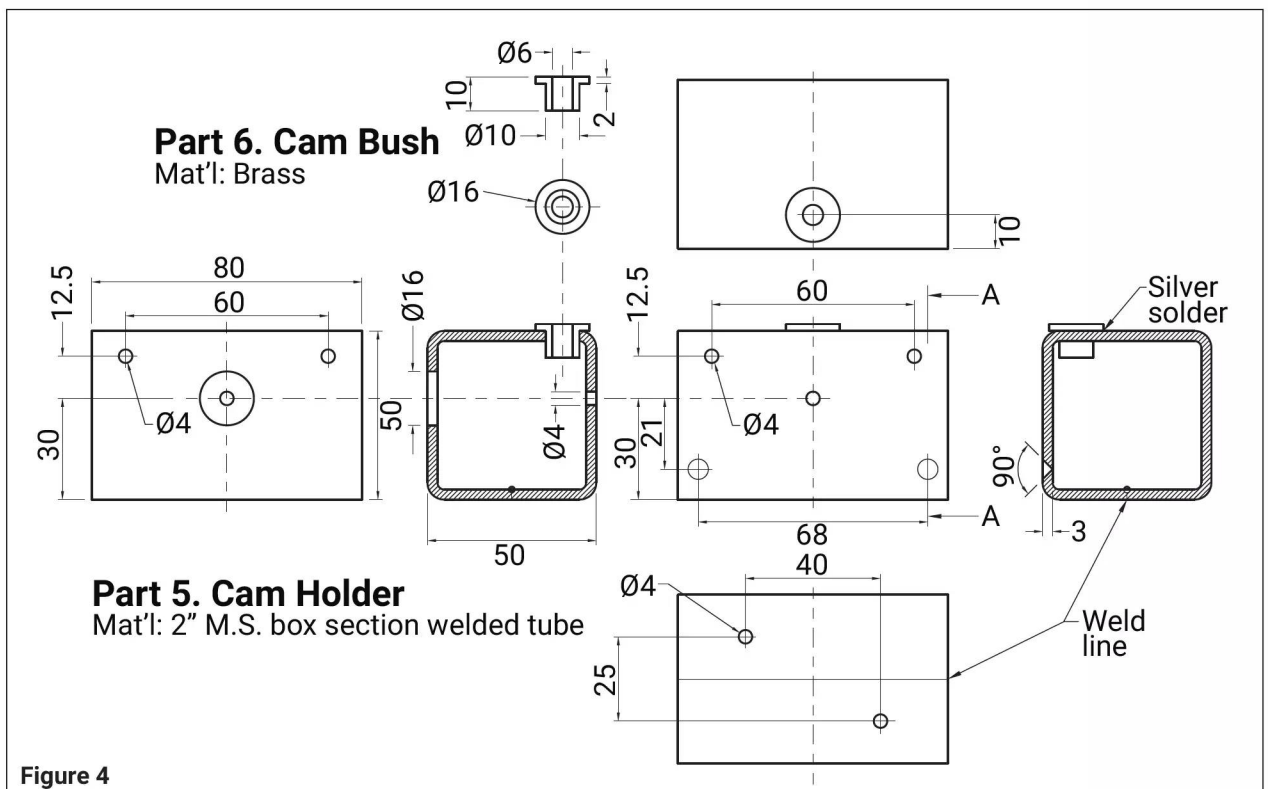


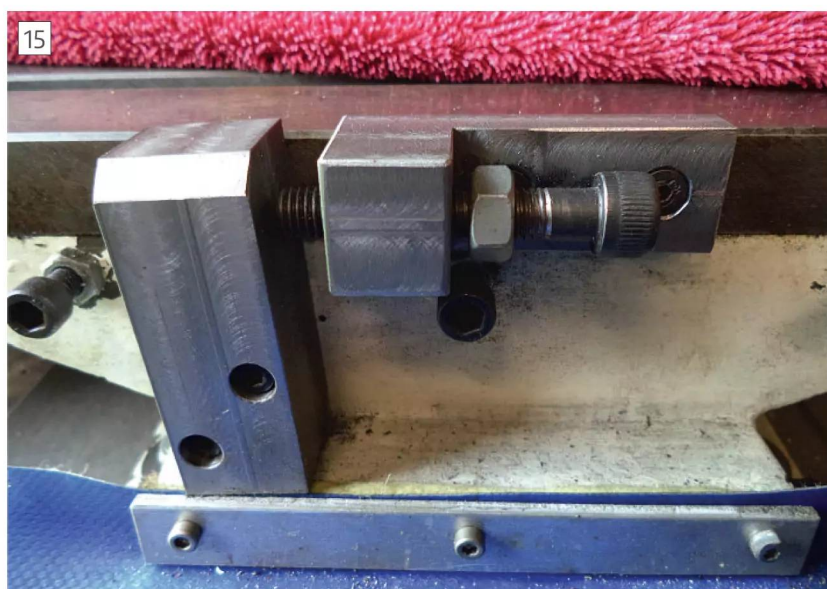
Figure 4



Selection of reground end mills.



Finish before and after regrind.



Stop fitted to table.

and use paper blotter washers to prevent the wheel spinning between the mounting washers, it must also run in the correct direction to prevent it coming loose.

To dress the face and side of the wheel a diamond was gripped in a suitable ER32 collet in the Stevenson block this gave a more than satisfactory result, **photo 12**.

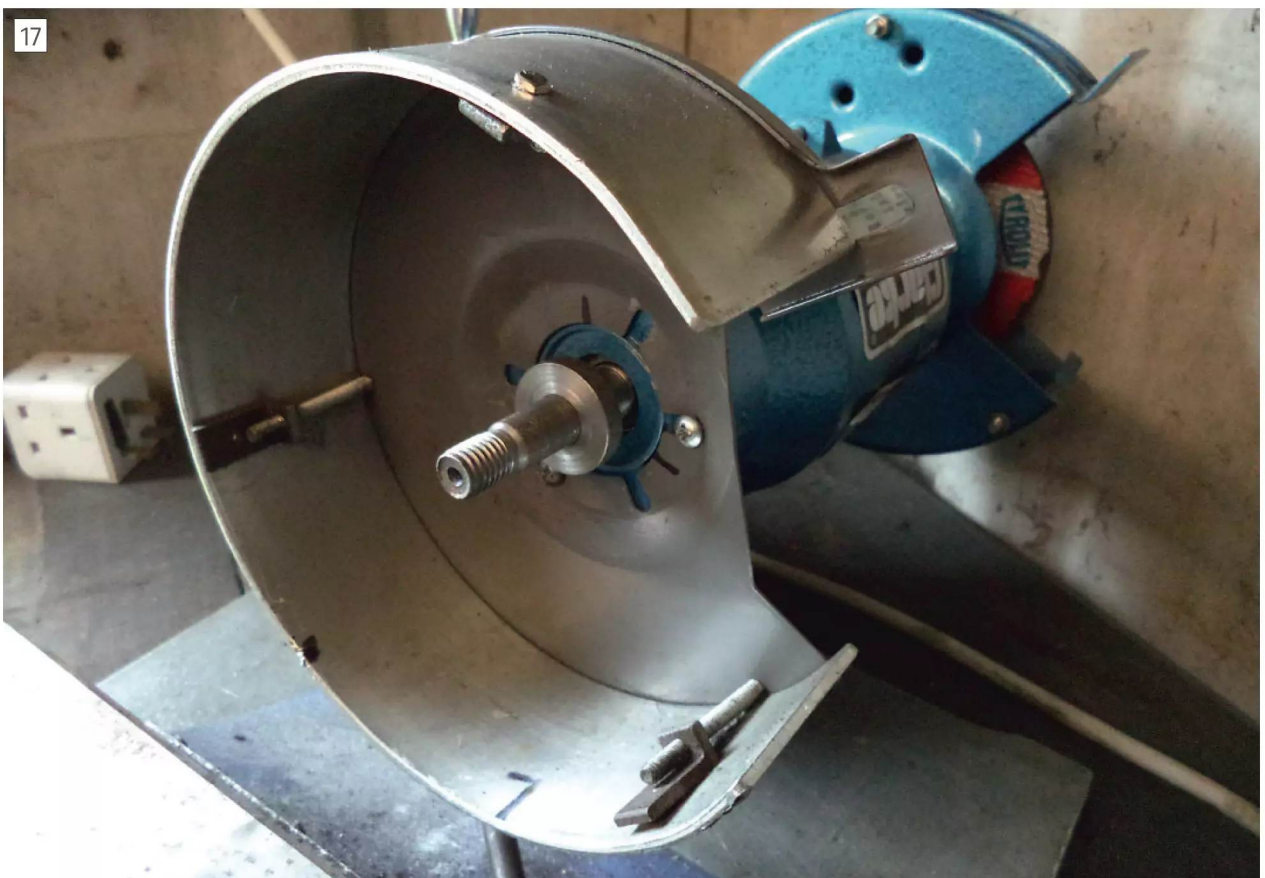
I was now ready to give the set up a test run, and I was delighted how well it worked, I soon had a selection of nice sharp end mills, **photos 13 and 14**. However, the test run showed up the need for a table stop to prevent running past the centre of the cutter with the wheel and catching the tooth on the other side of the cutter. This was simply remedied by drilling and tapping into the X/Y table and fitting a stop, **photo 15**, and while I was at it, I fitted some felt wipes and plastic covers on the slide ways to protect them from the grinding dust. I was content with this arrangement for quite a time, with some of my end mills being sharpened a number of times, and I even had a few club members round making use of the kit to sharpen their stock of cutters. One even made his own version of the cutter grinder.

With use however a number of shortcomings became apparent. The blue grit wheel was a bit on the hard side and tended to glaze and burn the cutter and had limited movement when it came to grinding secondary clearance, what was needed was a softer white grit cupped wheel. But a major fault with the system was the fact that it was not completely idiot proof, if you forgot to close the toggle clamp to lock the Stevenson index block in place, the cutter would dig into the wheel, a stomach-churning experience. After a number of such near misses, I decided it was time to implement some improvements.

A supply of suitable white grit cupped wheels was obtained from an internet auction site, and a pair of suitable mounting washers made, a modification to the wheel guard was also required as the cupped wheels were a lot wider than the wheels supplied, this modification consisted of a semicircular piece of aluminium held onto the existing guard back plate with some extended clamps, **photos 16 and 17**.



Cup wheel and washers.



Modification to guard for cup wheel.



ER32 straight shank collet holder.



Parts for end mill sharpening fixture.



End mill sharpening fixture.



Boring the index ring.



Slitting index ring to make pinch clamp.

The only way I could think of to make the system idiot proof was to do away with the Stevenson index block system and to replace them with a bespoke end mill sharpening fixture, to this end I trawled through my books and searched the internet for ideas, in the end I came up with a design that drew inspiration from a number of sources: Harold Hall, Professor

Chadwick, Philip Duclos and a little bit of "pottyengineering".

It is based around a 25mm diameter by 150mm long, a ER32 straight shank collet holder, this came off an internet auction site from a company based in Hong Kong it cost less than £25 including postage and is first class quality, I could hardly have bought the material to make my own at that price, so to buy in made sense. This is mounted in a 2" square aluminium holder with a twelve-division indexing arrangement. Twelve divisions will cater for 2,3,4 and 6 flute cutters. The holder is linked to a spring-loaded cam arrangement made from 2" square box section steel tube that is used to sharpen the flutes of the cutter (more about this later).

See **photos 18,19** and **20**, and the general arrangement drawing. The manufacture of this fixture should pose no real problems to an

experienced machinist, but I will go into some of the detail and features with a few of the parts.

Index Ring Part 2

This is made from piece of 45mm diameter by 35mm long mild steel. Face and turn up the 44mm outside diameters and rough out the bore, swop it round in the chuck and face to length and turn the 36mm diameter, and finish the 25mm bore to a nice sliding fit on the ER32 collet holder, swap it round again and transfer over to the spin indexer or dividing head and drill the 12 index holes. Then using a slot drill mill a flat to give a platform to start the tapping drill to drill and tap M3 for the pinch bolt, open up half of the depth to 3.2 mm dia. Using a slitting saw cut half way through the diameter, then slit this through axially to form the pinch clamp, **photos 21** and **22**.

● To be continued

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T. 01205 290312, Near Boston, Lincs.

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E. geoffwarner129@gmail.com

T. 07964 756762. Nottingham.

Models

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on-board shipping (i.e. I pay shipping costs) to a port of your choice.

E. vapour2@yahoo.com.

T. (USA) 570-484-8360. Scotia, Pennsylvania.

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E. derekrgoddard@btopenworld.com. Witney, Oxfordshire.

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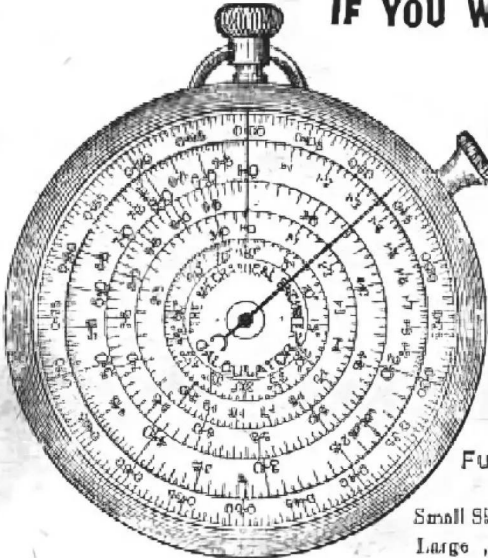
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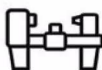
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Summary Specification



Approx length 80"

- | | | | |
|---|----------------------------|---------------------------------|-----------------------------|
| • Stainless steel motion | • Choice of liveries | • Piston Valves | • Superheater |
| • Boiler feed by axle pump, injector, hand pump | • Painted and ready-to-run | • Walschaerts valve gear | • Reverse |
| • Etched brass body with rivet detail | • Coal-fired live steam | • Drain cocks | Approx Dimensions: |
| • 4 Safety valves | • 5" gauge | • Mechanical Lubricator | • (L) 80"x (W) 10"x (H) 14" |
| | • 4 Cylinder | • Silver soldered copper boiler | • Weight: 116 kg |

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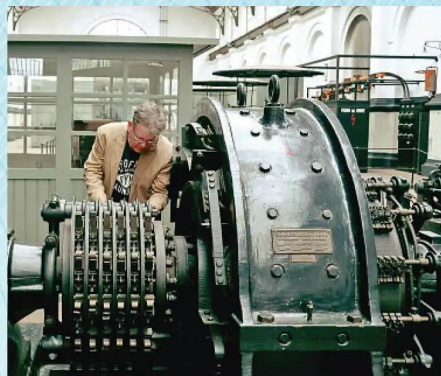
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