

No. 339



A THREAD INDICATOR DIAL

Paul Tiney's accessory for s pre-war Myford ML4.

MODEL ENGINEERS' WORKSHOP

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS MAY 2024 ISSUE 339 WWW.MODEL-ENGINEER.CO.UK



A CUTTING OIL DELIVERY SYSTEM

Roger Froud combines 3D printing and traditional metalworking.

GETTING THE MOST FROM A BRUSHLESS MILL

Jason Ballamy fits a powered table feed to an SX2 Mill.



A SHEET METAL PROJECT

Dave Fenner models an AEC Matador.



INSIDE THIS PACKED ISSUE:

- CONDITIONAL OPERATIONS IN MACH 3 ■ RESTORATION WORK ON THE MEDWAY QUEEN.
- ADJUSTABLE STOPS FOR YOUR MILLING MACHINE. ■ UNDERSTANDING MICRO MILLING CUTTERS.
- SCREW GAUGES COMPARED. ■ TACKLING READOUT DATA CORRUPTION.
- ROLLER CHAINS AND SPROCKETS. ■ A TO Z OF METALS – FINAL PART. ■ HOW TO GET THE MOST OUT OF FIXED STEADIES. ■ PLUS ALL YOUR REGULAR FAVOURITES!

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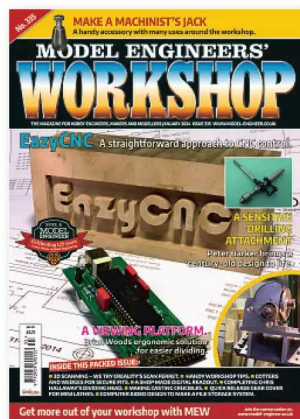
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Editor: Neil Wyatt

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GROUP HEAD OF INVESTMENT – LIFESTYLE & TRACTOR PUBLICATIONS

Mason Ponti www.talk-media.uk

INVESTMENT MANAGER

Chris Jeffery

www.talk-media.uk **DL:** 01732442144

ML: 01732445325 **E:** Chris@talk-media.uk

A: Talk Media, The Granary, Downs Court, Yalding Hill,
Yalding, Kent ME18 6AL

CUSTOMER SERVICES

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Group advertising manager: Sue Keily

Advertising: Angela Price

aprice@mortons.co.uk Tel: 01507 529411

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Sales and Distribution Manager: Carl Smith

Marketing Manager: Charlotte Park

Commercial Director: Nigel Hole

Publishing Director: Dan Savage

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On the Editor's Bench



That's Annoying!

Is there one tool that you always seem to mislay? For my it's those retractable knives I have known since childhood as 'Stanley Knives'. I think these are known across the Atlantic as 'box cutters' – presumably as they are so effective for opening cardboard boxes (and scoring the contents if you aren't careful). I am so good at losing them I seem to have more than I can count. Originally launched in 1952, the current version of the Stanley 99E has a peculiar but effective interlocking arrangement that keeps the two halves of the body aligned where the blade exits. I have several iterations of earlier designs as well as new ones. I also have some cheap clones that vary from the half-decent to barely usable, and even a few fixed blade 'copies'.

But that's not the source of my annoyance! A few days ago I fitted a brand new blade into one of my collection and after the first cut, it promptly fell out! As you'll know replacing a blade is a bit of a faff as you have to unscrew the body and then keep everything aligned as you

reassemble it, so I assumed that I'd done something wrong. Several failed attempts later I realised that the problem was actually a thin blade. Fortunately as well as many of the knives I also seem to have a few boxes of blades and one from the next box fitted fine.

I've taken a micrometer to compare the two blades and find one pack of blades are

0.44mm or 0.0175" thick. The blades from the box that refuse to stay in place are just 0.34mm or 0.0135" thick. 'Official' Stanley 1992B 'heavy duty' blades are 0.65mm or 0.0255" thick.

Well, that explains why cheap blade break so easily, with the cheapest being nearly 50% thinner, someone somewhere must be really desperate to find a way to save a few pennies on carbon steel. Still, I regularly use the 'bare' blades for model making and other purposes and they are sharp enough.

In the photo, the thinnest blades are those with two notches. The others are also third-party and about 33% too thin, but have a third notch which usefully allows you to adjust how far the blade protrudes. The moral of this story is obvious...

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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ON THE COVER

Our cover features the 3D printed pump housing for Roger Froud's automated cutting oil system. See more details on page 38 and download the files from www.model-engineer.co.uk.

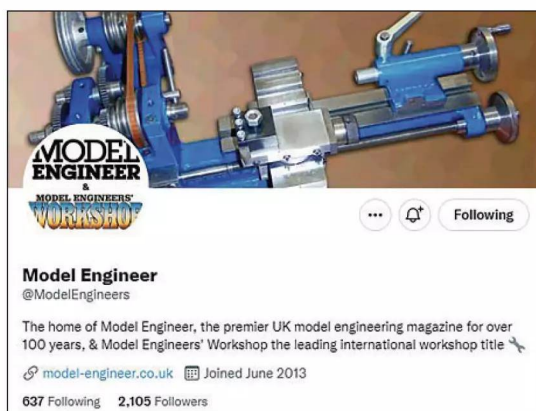


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THIS MONTH'S BONUS CONTENT

Extra Content!

We will be making the 3D print files for Roger Froud's cutting oil delivery system available for download from the forum at:

www.model-engineer.co.uk/723909/3d-printed-parts-for-roger-frouds-cutting-oil-delivery-system/

Or search the forum for 'cutting oil delivery'.

Hot topics on the forum include:

Setting up new workshop for clocks. Need advice How to get started in a horology, by bprisk.

Chinese mini lathe bearings Is a bearing change needed and how to measure any play in the spindle, by Matt T.

Proper way to make this part? How to machine a tricky to hold part, by MikeK.

Come and have a Chat!

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

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The 1960s Join us as we celebrate an ambitious decade of change by hopping on to our freshly turned out Routemaster bus. Travelling to Carnaby Street via Walmington-on-Sea, and all stops in-between, relive landmark events such as the 1966 World Cup and the first moon landing, not to mention early gigs by the Beatles and the Rolling Stones, classic television, fab fashions and more.

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A Sheet Metal Exercise

Dave Fenner built a model AEC Matador as a lock down project that involved some interesting sheet metal work.



The Finished Truck

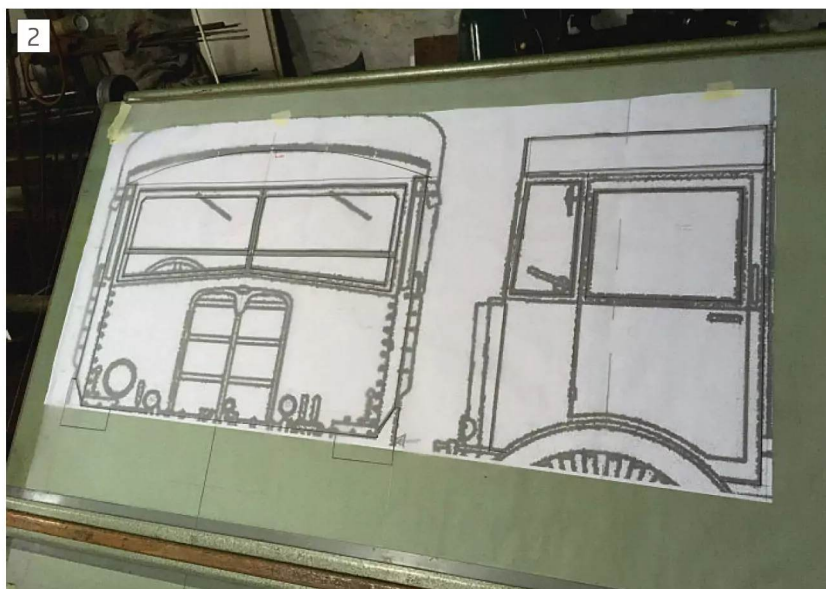
Those of us who were retired pensioners were spared the much of the financial hit experienced by many during lockdown. It did though impose severe constraints on the usual social activities. As a result there was more time to retire to the workshop. As the grandchildren were getting beyond the toddler stage it seemed fitting that one project might be aimed at amusing them. It is said that the sincerest form of flattery is imitation, and in this case, it was prompted by seeing an advert by "Ian's Electric Engines", (IEE) where the advertiser offered a set of body parts to convert a mobility scooter

into one of two lorry models, roughly quarter scale. The first was a Sentinel steam waggon, and the second an AEC Matador. The Matador was generally composed of flattish panels more suited to the facilities in my workshop. I therefore opted to produce my own interpretation of that prototype, **photo 1**. It should be noted that this article is being written sometime after a house move which forced a severe downsize of workshop space and facilities. Various items of kit employed at the time were sold off and there is a degree of reliance on photos taken at the time of build.

Scouring the Gumtree ads for a mobility scooter led to the purchase of a Kymco Mini LS, which on detailed examination proved a bit too good to cannibalise and a bit too small for the project. It was sold on. The IEE website does specify a particular make and model, the Shoprider Sovereign, so the ads were studied again, and one of these, in questionable condition, did eventually turn up about 40 miles away.

Initial Testing and Modification

The bodywork and seat were removed, and a couple of old car batteries

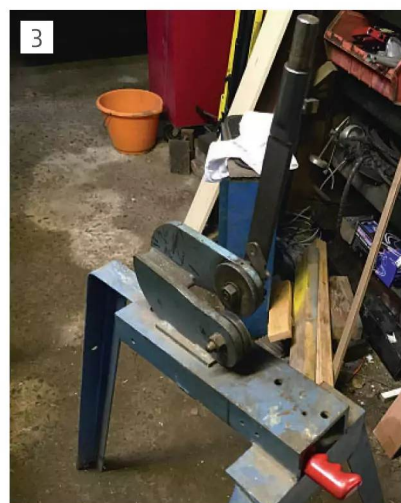


Full size print on drawing board

connected in series to give the required 24 volt power. The thing refused to go. Fortunately it was a repeat of a fault found earlier on the Kymco. Many mobility scooters have a spring loaded multi disc safety brake which is built on to the motor. When power is applied, the integral solenoid should pull back the spring pressure and release the brake. However if the thing is left unused for a period of time, especially in an

unheated shed, then mild corrosion sets in and locks the brake. The remedy is to dismantle and clean the multiple discs, using G clamps to control the release of the internal spring pressure. Once the brake was freed off, the scooter behaved as expected.

One aspect of the chassis geometry which became evident was that the front track was about two inches narrower than the rear. I suspect this is to improve manoeuvrability in confined spaces. To improve the appearance of the model, a new front axle beam was constructed from 25 x 25 x 3mm ERW square steel tube making the front and rear track equal. The steering column was shortened, as were the handlebars,



Rotary bench shear (extension handle stored in base)

these changes being made at a later stage, once the cab size and position were determined.

Bodywork Design

Although in an earlier life I did spend some time in a drawing office, I am certainly no artist, so looked on the internet for suitable outline drawings of the cab. These were then printed out at pretty small scale on A4 paper. It was then a case of working out a magnification ratio to suit the track width and wheel diameter. The A4 was then taken to our local print shop who produced the larger scale output which could be fixed to the drawing board as in **photo 2**, and used to trace off the various sheet metal parts from 18g or 1.2mm steel sheet.



Monodex cutter showing wide kerf and rolled swarf



Typical edges cut with plasma cutter



Electric shears



Sample cut using electric shears

Methods for Cutting Sheet Metal Parts in the Home workshop

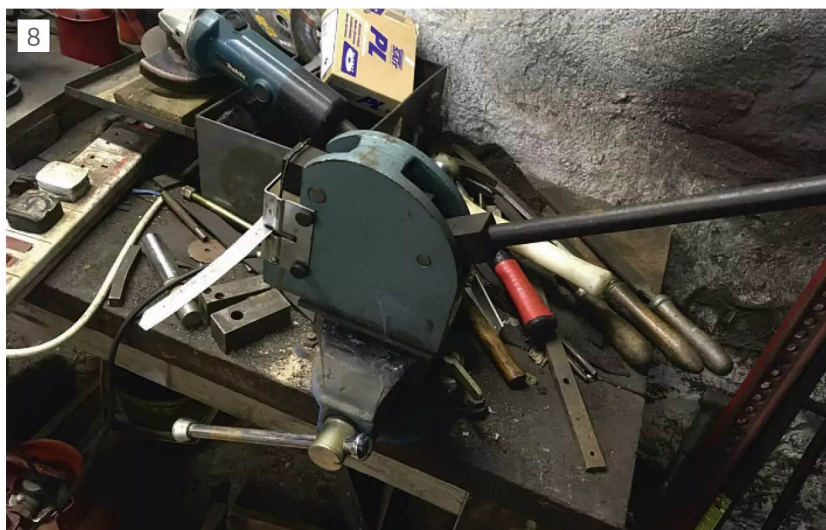
Over some forty years or so I had accumulated a reasonable array of tools (and disposed of some) for sheet metal cutting. Each has its own advantages and drawbacks:

- Treadle guillotine – this would have been ideal for cutting straight lines, pretty quiet and no dust or swarf. Unfortunately it had been sold some years earlier.
- Rotary bench shear, **photo 3**, – again good for straight lines but does cause curling plus edge distortion plus “knurl” type marking on one side of the cut.
- Tinsnips – can be hard work on the hands and cause problems similar to the rotary shear but minus the knurl effect.

- Monodex cutter – can be hard work but gives little distortion, **photo 3**. There was also a pneumatic tool with similar cutting geometry which even for 18g material proved underpowered. In either case a central curled slice is sheared away as swarf between the two cuts. It can be used for curves.
- Angle Grinder – fitted with a 1mm cutting disc will cut accurate straight lines, fairly quickly but with significant noise and dust.
- Nibbler- my nibbler was a pneumatic version which I found underpowered and prone to stalling even on 18g material. The type which attaches to an electric drill might be more powerful. The cut is near distortion free, but it's a noisy process. The swarf is produced as small sharp

crescent shaped pieces, so it is well worth cleaning up carefully afterwards. Again curved cuts are possible.

- Body Saw (Zip Saw) – this was a gadget acquired for cutting away car panels. In that application it is an effective tool. For cutting on the flat it could probably be used with a guide bar, but not tried by me. Fairly noisy, with high frequency vibration. The swarf comes off as sawdust. There are special blades for these, but it is possible to modify a broken fine tooth hacksaw blade for reuse. As it is a sawing action, the distortion is negligible.
- Jig Saw – this is basically a similar process to the zip saw, but as the speed is lower, the noise is of a lower frequency. Again, a fine-tooth blade is needed.
- Plasma Cutter – I tend to think of this as the modern version of the oxy-acetylene cutting torch. It does though require a compressor. The cut edge is melted and oxidised, but by using a guide bar, fairly accurate cuts can be achieved, as may be seen in **photo 5**, and very quickly. A light run over with an angle grinder will remove the melted/oxidised slag. General distortion is negligible.
- Bandsaw – I still have my Taiwanese 4 1/2 inch horizontal/vertical bandsaw purchased around 1980. It is frequently called upon to cut sheet material but normally has a blade of either 14tpi or 18tpi. I always remember articles in MEW by the late Bob Loader where he recommended that for thin materials a blade with at least three teeth in contact was ideal. However, cutting thin steel on the bandsaw does work very well. It is accurate, controllable, distortion free, with low vibration as the cutting force is constantly downwards. The downside is that due to the coarseness of the blades, eventually a tooth will break, followed by its neighbour. You then find yourself timing when to apply cutting pressure and when to release, in an attempt to avoid the missing teeth.
- Electric shears – These, **photo 6**, were purchased after this project so were not available to use at that time. Subsequent testing showed that it was possible to cut with reasonable accuracy and that the amount of distortion was rather less than with the roller shears. **Photograph 7** shows a sample, as cut.



After planishing, still a pronounced curve

Distortion Problems

The bodywork required a number of angle pieces measuring about 10 x 10 x 1.2mm section. These would be folded in a home brew 24-inch folder so required strips to be cut approximately 20mm wide. The angle strips would ultimately be spot or mig welded to the inside of the cab, and at least one side would be hidden. Even though the roller shears produced significant distortion, I did still choose this method on the grounds of simplicity, cleanliness and silence. The cut strips had a pronounced curl which was taken out in the vice and then the flypress. The part was then flat but displayed a pronounced curve as could be seen in **photo 8**. Another piece of kit acquired years ago for car restoration work was the shrinker/stretcher, **photo 9** and it was used to bring the strips to reasonable straightness as may be seen in **photo 10**. For readers who have not encountered these tools, they are supplied with two sets of dies, and the action either stretches or shrinks the edge of the material. The purchase was originally prompted by need to produce lengths of curved angle for locations like boot lid apertures or wheel arch edges.

Cab and Body Construction

The various components were either spot or mig welded, the choice being frequently dictated by access considerations. A sub chassis was designed to allow the two batteries to be fitted along the centre line, so that the flat bed could be hinged up.

This would then allow clearance for legs and for feet to rest on the foot boards. The material chosen for the chassis was 3/4inch x 16gauge ERW tube, principally because I had some on the shelf. The flat bed was cut from 9mm plywood, edged with plastic trim, the hinged parts being fitted with piano hinges. Cab windows were cut from 2mm perspex held in place with silicone sealer.

Lights

For the rear lights, the originals were re-used, fitted with 12 volt LED bulbs wired in series. For the front, a search on ebay came up with round LED arrays of about the right size, so two were purchased. Housings were then 3D printed to accommodate and locate these.

Radiator

After finding the correct shape on the web, this was traced then copied on to pieces of MDF, and cut out. The AEC badge was also found on line and printed out at suitable size. Aluminium mesh formed the two grilles. It was a turning job to produce a reasonable looking radiator cap from a short length of aluminium bar.

Painting and Lining

A quick check through the tins of paint left over from years of car repair yielded one of Vauxhall maroon which dated back to a Nova in the late 80's. After a coat of grey primer, this was sprayed on to the cab assembly. Black was chosen



Shrinker/Stretcher in use to straighten a narrow strip



Strip after straightening

for the chassis and lower details. Here it was applied by brush.

For the lining, I still had a tin of signwriting yellow acquired some years before, and this was applied somewhat cack handedly with a drafting bow pen. The heading photo shows the result.

Batteries

A pair of new budget mobility batteries were sourced from Tayna batteries, these being the cheapest I could find at the time. I have no connection with Tayna but am happy to report that the batteries continue to perform well after some three years or so of regular use ■

Setting And Using A Fixed Steady

David George explains the use of this essential aid for supporting long workpieces in the lathe.

Using and setting a fixed steady is fairly simple but here are some ideas and uses that are particularly useful.

The main use is to hold and support a long shaft or tube whilst turning, drilling or parting off to length. The first thing to do is fit the steady to the bed looking at the location faces and checking for swarf

and damage to both the steady and the bedways. I give the mating faces rub with a small smooth stone and after giving a wipe with a clean paper wipe followed by a lite oil smear as it is likely that it will be slid along the bed at sometime during use. The other thing is to check that the steady clamps in the correct places, for example on my M type lathe the front

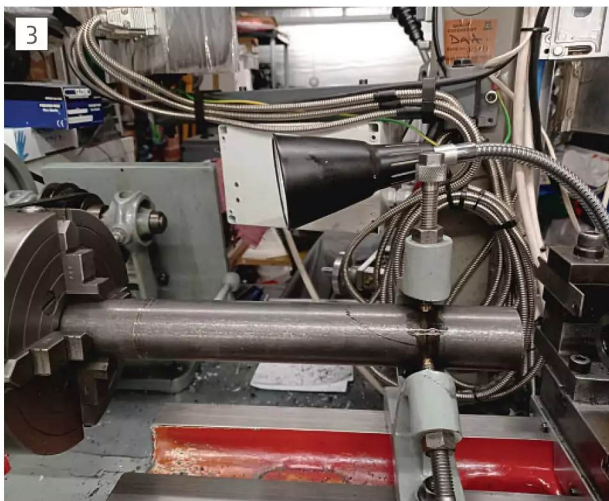
wedge clamp pulls it down and across to locate on the back of the rear of the bed and the rear clamp pulls the steady down and clamps it down as well. On other lathes it is more usual to locate the steady on the pyramid form on the top of the bed with a single clamp under the bed with a bolt through the bed casting slots, **photos 1 and 2.**



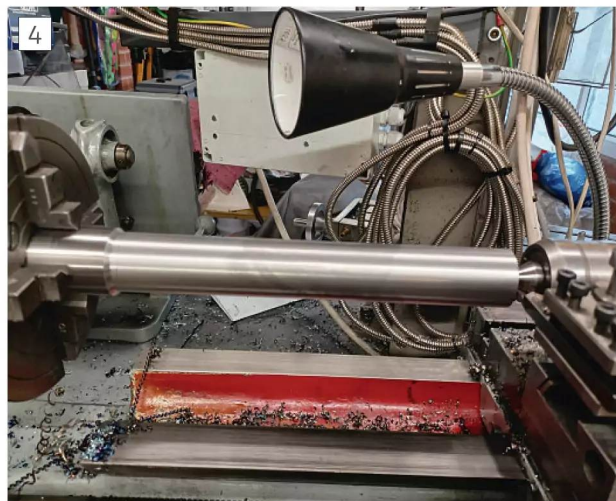
M type fixed steady.



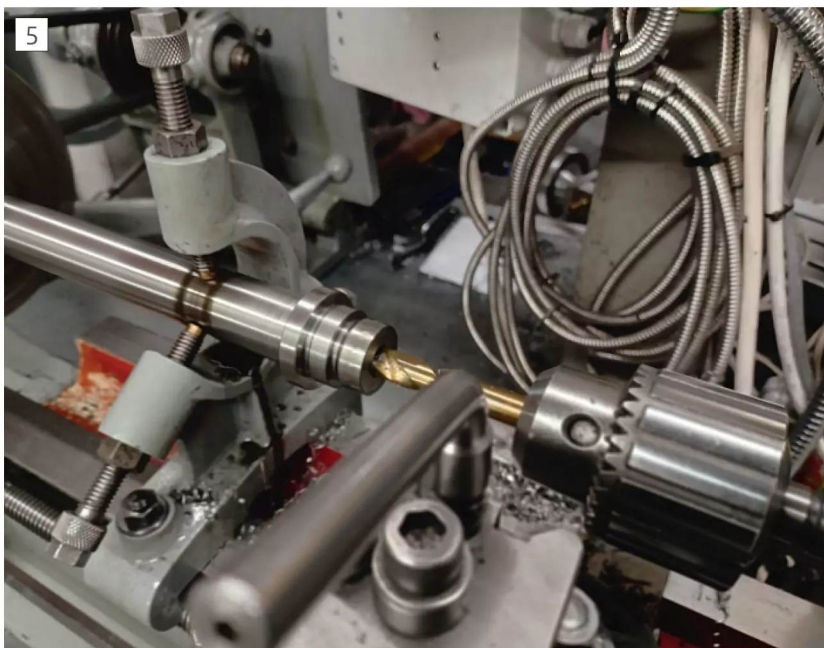
Harrison fixed steady.



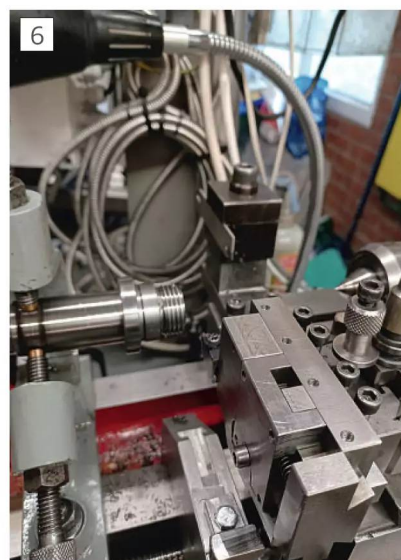
holding black bar.



skimmed black bar on centre.



drilling through solid bar.



screwcutting location thread.

If you put a short setting piece into the chuck which makes it easier to set the fingers to the correct diameter or turn a piece of the work, if possible, to the correct size. Put the steady on to bed and slide it with the fingers clear of the setting piece, slide it along and clamp it down along the setting piece length and clamp down to the bed. Then adjust the support fingers till they just touch lightly one at a time, run the lathe at a medium speed feeling the pressure on each of the three fingers till you get an even pressure on all three and with some oil on the diameter there is no excessive heat build-up. You

should then stop the lathe and release the top finger to allow the steady to be moved to the length that you need for the long piece. After moving the steady to the correct place along the bed replace the setting piece with the job in hand, tighten down the top finger lightly to the job, turn the chuck by hand feeling for tight spots or excessive friction and oil with a bed way oil. Turn on the lathe and tighten the finger slightly feeling the bar for excessive heat increase caused by overtightening then if it gets slightly warm that is all right but check regularly for heat increase especially if the turning or

drilling operation is causing the metal to warm up and expand as well. You can release the top finger slightly at any time if excessive heat build-up occurs, and stop and cool if necessary, always keep lubricating it regularly!

When I have a piece of black bar or non-concentric bar to turn, I hold it in the steady as tight as I can which may be a bit loose as it may not be exactly round. I then centre drill the end and support the bar with a revolving centre which allows me to turn a band width on the black bar to set to and use as the area for the steady to run on properly, **photos 3 and 4**. **Photographs 5 and 6** show some examples of other operations using the steady for support. ■

Getting the most out of your Brushless Mill. Part 1

Jason Ballamy follows up his series on Milling for Beginners (MEW 261 and subsequent odd numbered issues to MEW 279) with a series of linked articles focused on using brushless hobby mills.



What's included in the package

Over the next few articles, I will be looking at how to get the best out of brushless hobby mills particularly in regard to speeds and feeds. Several recent threads on Model Engineer Forum have prompted this as some of the more traditional approaches which are often based on using belt/gear driven more rigid machines don't always work so well when applied to the smaller bench top hobby type mills. To help demonstrate the optimum feed rates I was sent a power feed unit from ARC Euro Trade to fit to the SIEG SX2.7 that featured in the "milling for Beginners" Series and I will cover fitting that first.

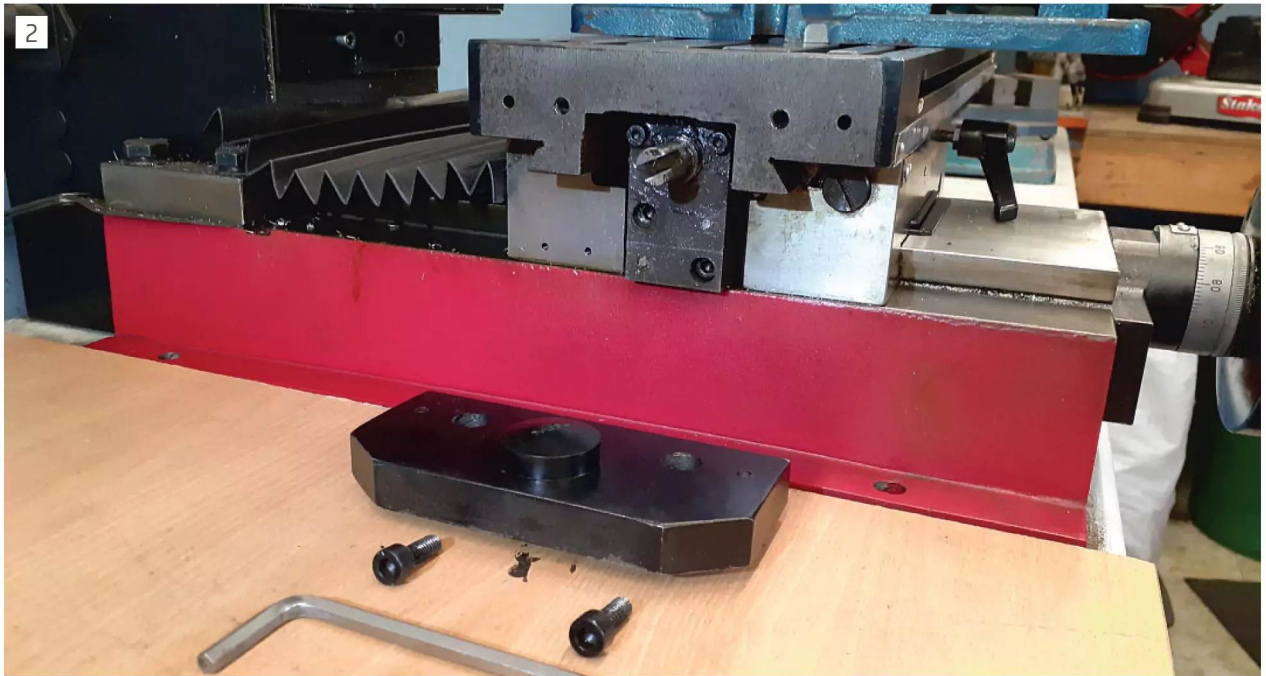
Power feed for the SX2.7 Mill

I have had a similar power feed to this one fitted to my SIEG X3 for just over seven years which was sent to me by ARC to evaluate when they were originally considering stocking this item. However some recent threads on ME forum related to feed rates when cutting with shell/face mills prompted fitting a unit to the SX2.7 mill with a standard table that I also have in the workshop.

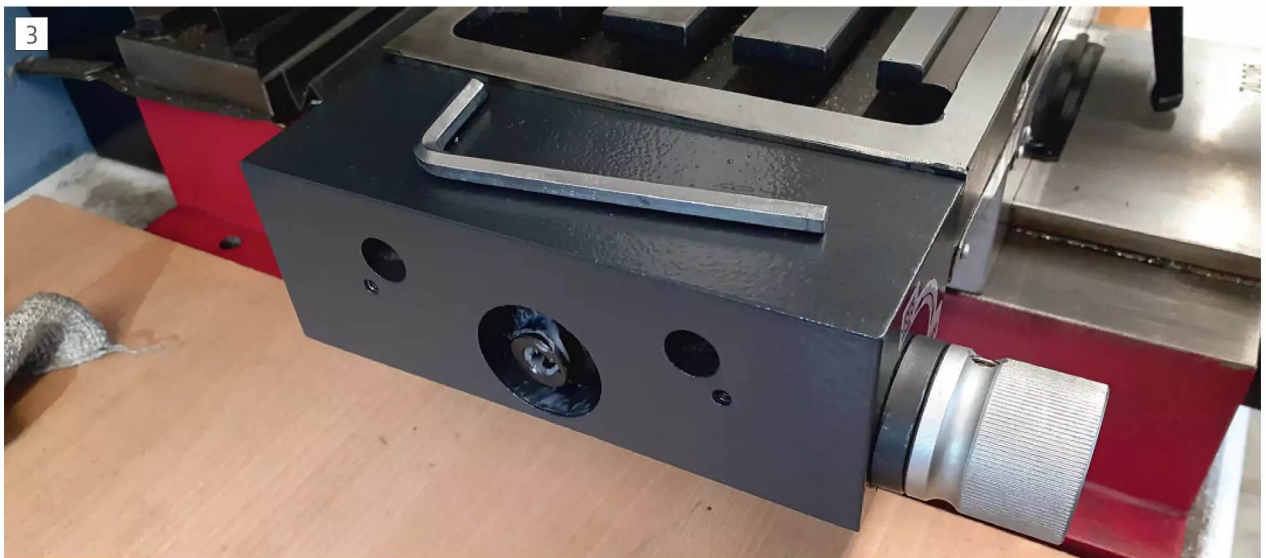
As usual a large sturdy box arrived next day from ARC Euro Trade and inside that along with some shredded cardboard packaging was a slightly smaller box containing all the necessary parts which were

individually bagged and held within rigid foam dividers.

Photograph 1 Shows the contents of the package starting in the top middle an working anti-clockwise we have: The main feed unit with variable speed knob, left/right toggle switch and two LEDs to indicate power and fault. A 240V AC to 24V DC transformer. Power lead for the transformer fitted with UK 3 pin plug top. A small enclosure with the limit switches and attached lead. Two adjustable limit stops. Selection of socket head screws needed to attach the feed to the mill. The final item is the clutch/adaptor block which varies according to which



Existing end plate removed



Clutch block fitted

mill/table combination the package is intended to fit, so make sure you order the correct one for your particular machine. The instruction booklet covers fitting the unit to the various mills within the SIEG range.

Fitting

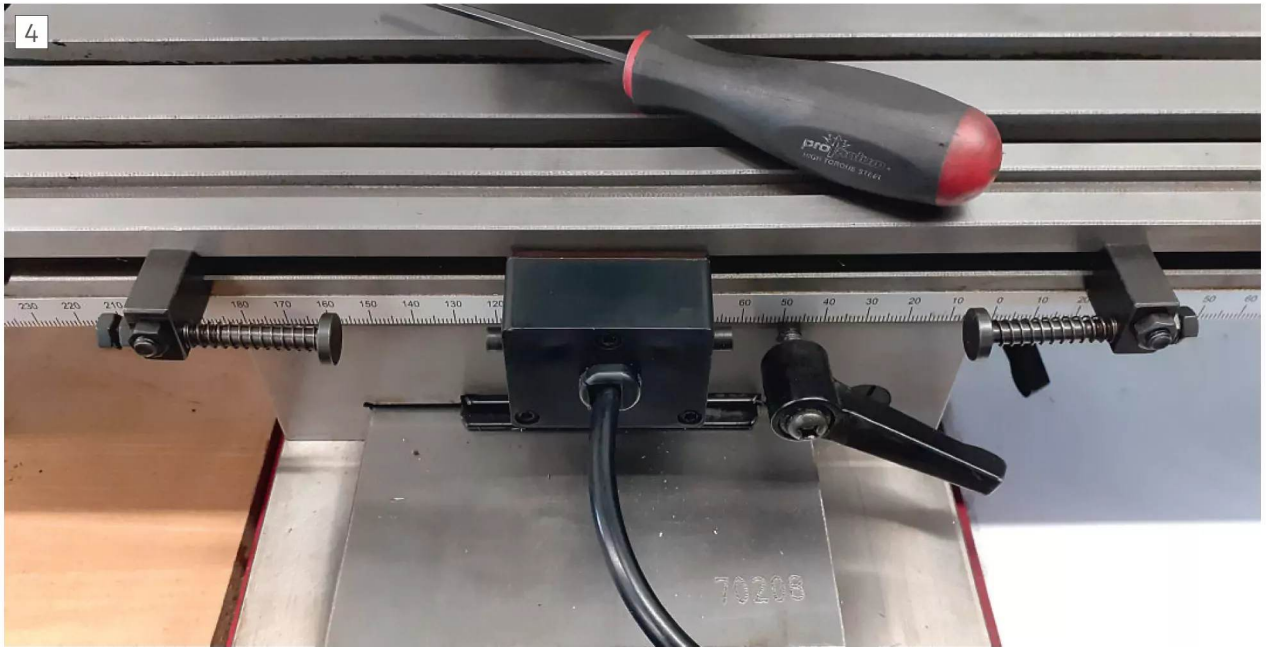
Before commencing fitment of the power feed, it is a good idea to check that the gib strips are correctly adjusted particularly checking that there is no decrease in ease of movement at the

two extremes of travel and to lubricate the ways and lead screw. Then move the table to a position just short of its maximum to the right which gets the nut close to the end of the lead screw.

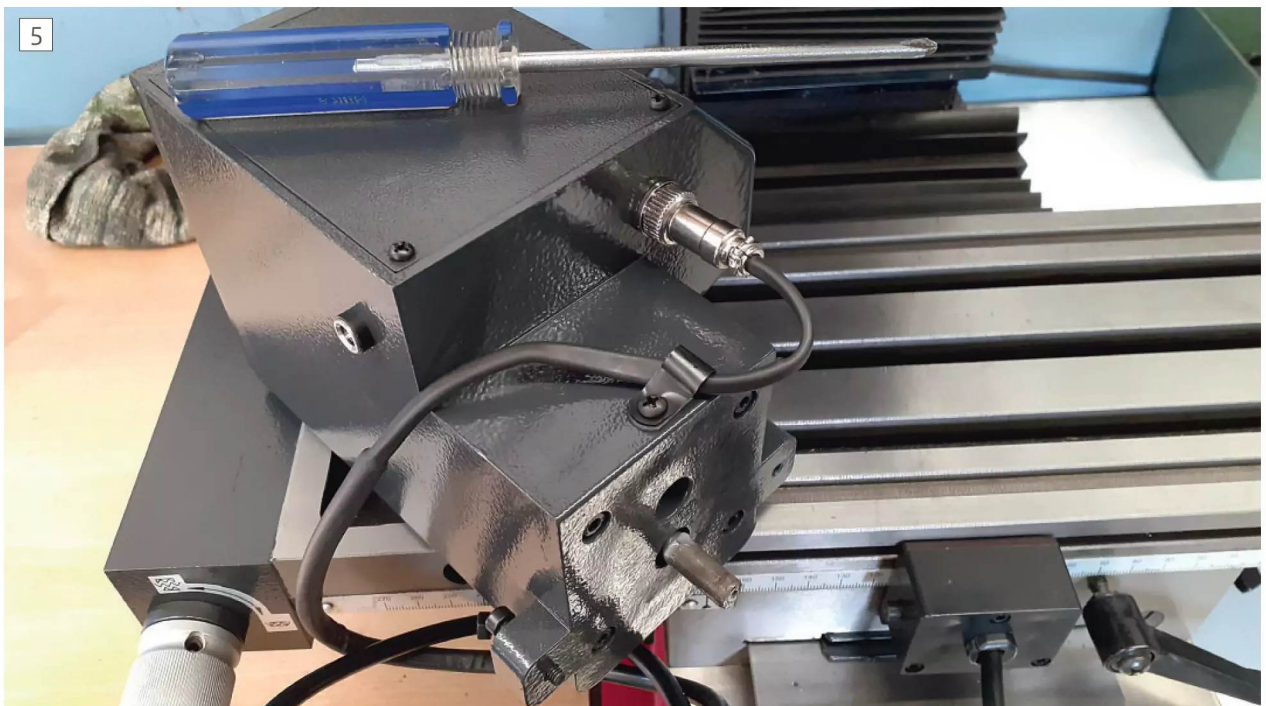
The first thing to do is to remove the existing end plate from the left-hand end of the table by unscrewing the two M6 socket head screws and then gently ease the plate away from the table. There are two location dowels that may make it a bit stiff to remove but mine came off quite easily,

photograph 2. It's also worth noting that with the end plate removed access to the two backlash adjusting screws at the top of the lead screw nut is a lot easier so they can also be adjusted now if they need it.

The clutch/adaptor block can now be screwed into place using the two longer M6 Socket head screws provided. Take care to ensure that the slot in the end of the lead screw lines up correctly with the mating male part in the clutch, you may need to turn the X axis hand



Limit switch and actuators fitted



Strain relief clip around cable

wheel back and forth as the screws draw the block into place to get the correct engagement. Before fully tightening the screws check that the hand wheel turns with a similar effort to when you started and that the block is not pulling the end of the lead screw out of line, **photo 3**.

The SX2.7 already comes with two M3 tapped holes in the front of the table

which makes for easy no drill mounting of the limit switch box using the provided screws through the backing plate that protrudes below the bottom of the box. The two adjustable stops can also be fitted to the table's front tee slot and nipped up. I find most of the time they can be left at the ends of the slot simply as a safety feature if you

forget to stop the feed but can also be positioned as required when wanting to stop the table in preset positions, **photo 4**.

Before mounting the actual feed unit connect the limit switch wire into it's socket and make sure the wire is secure through the "P" clip strain relief, **photo 5**. I also found that the two



Removing paint from threaded holes



Installation Complete

tapped holes in the clutch/adaptor block had some paint in them so quickly cleaned out the threads with an M4 tap, **photo 6**.

The completed installation can be seen in **photo 7**. The green LED indicates when there is power to the unit and the amber one when there is a fault. The fault light will tend to come on if the mains power is turned on when the speed control knob is in any position other than off, so acts as a safety feature preventing the table moving after a power cut or just unintentionally when first powered up. It is easily cleared by turning the speed control knob to the off position (fully anti-clockwise until it clicks) and then you are ready to go.

To engage the feed the clutch knob is turned 90 degrees clockwise so

that the arrow is horizontal, you will probably have to turn the x-axis hand wheel a little at the same time to get the two halves of the dog clutch to line up and fully engage. The speed knob can then be turned to the required position and the toggle switch flicked left or right depending on the direction you want the table to move. The knob needs to be turned to approximately the 10 o'clock position before the gear head motor overcomes any stiction and the table begins to move. The slowest rate therefore works out at approximately 75mm/min round to the fastest of approximately 450mm/min. See link to video at the end of this article. To return to manual feed simply turn the clutch knob anticlockwise until the arrow is vertical. In use it is still possible to use the hand wheel while

the unit is engaged but as there is a lot more resistance due to having to turn the motor as well it is best just used for small movements such as when toughing off to establish height or locate an edge rather than hand feeding a cut.

If the stops are to be used then they can be placed roughly where required by loosening the M8 nut at the front, sliding into place and tightening the nut again. Fine adjustment is then possible by altering the length of the sprung adjusters. Note that depending on the speed of travel there will be some compression of the stop adjuster and switch plunger before the unit switches off. See second video in link.

Summary

The power feed unit was very easy to fit and if my other one is anything to go by should give many years of trouble-free use. Although not something you must have or even need to use all the time once fitted, the Power feed does enable the use of higher feed rates for insert tools than it is possible to turn the hand wheel at as well as slow and steady feeds needed for things like traditional HSS fly cutters both of which result in better finishes. Or it can simply be used as a fast traverse to return a tool to the start of a cut or when clocking in long work pieces.

A small safety note, when using the power feed, it is good practice to disengage the X-axis hand wheel so that it does not spin round wildly and hit you, it also reduces vibration that can affect the finish of the work piece. In the videos that accompany this and the following articles I have removed the spring so the handle stays engaged as it gives a simple visual indication of how fast the hand wheel is rotating. ■

References

Power Feed <https://www.arceurotrade.co.uk/Catalogue/Machines-Accessories/Milling-Machines/SIEG-SX27-Mill/SX27-Mill-Accessories/Powerfeed-for-SIEG-X27-and-SX27-Mills>

Video <https://www.model-engineer.co.uk/698597/power-feed-for-the-sieg-sx2-7-mill/>

Making a Screw Thread Indicator Dial

Paul Tiney made this aid to screwcutting for his long in the tooth Myford ML4.

When it comes to screw cutting, I revert to my second lathe, (swank!) an elderly Myford ML4. A venerable old pre-war machine found at a car boot sale, complete with change wheels, for £30. Before you whisper “lucky blighter” it was some years ago when “the pound in your pocket etc.”

One of the most important aspects of screw cutting is making sure you “pick up” at the same spot every time you take a cut. There are all sorts of mathematical calculations you can make concerning the T.P.I. of your lead screw, the T.P.I. of the thread being cut, and talk of chalk marks, and hand reversing without disengaging; some, or all, of which I have

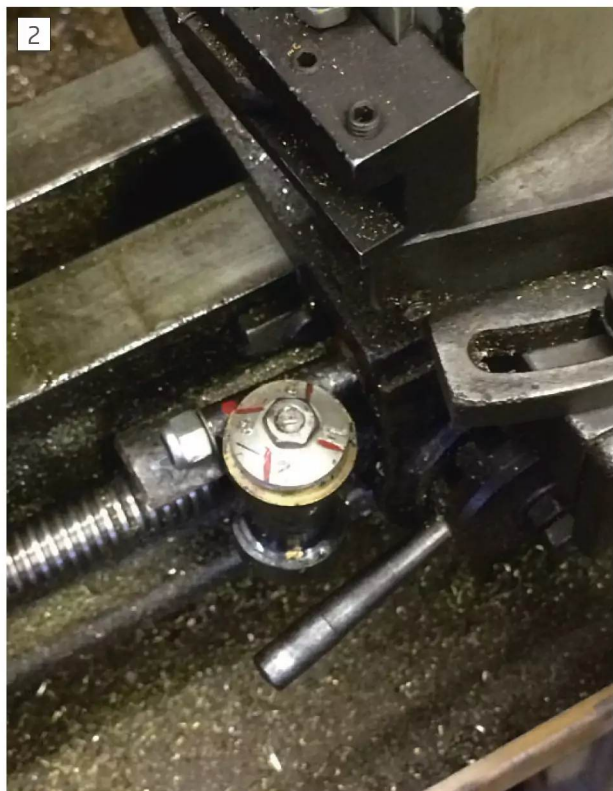
tried. However for real peace of mind a “thread indicator dial” is the answer. One attached to the carriage that can be swung into and out of mesh with the lead screw as required. Once available as an “extra equipment option” for most lathes but now only an expensive “vintage part” for mine. Therefore if I wanted one, I was going to have to make it, and so, as they say, “the die was cast”, **photos 1 and 2**. There are plenty of pictures of them in books, so overall design of the thing was very easily arrived at.

The first and most obvious problem was to obtain a gear wheel that would engage with the lead screw. This is a sort of skew gear of almost helical form

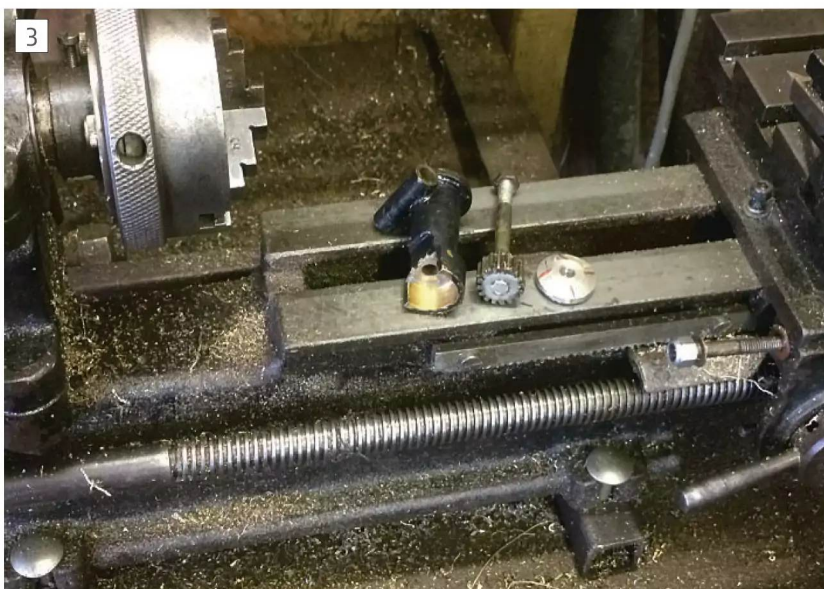
having the same pitch and form as the lead screw; in the case of my wee Myford an 8 tpi acme thread. With no gear cutting available a compromise was going to have to be arrived at, purists should look away now. I decided that an ordinary straight cut gear would do the job. Although it wouldn't engage and mesh completely it should be fine as it wasn't going to be transmitting any large drive loads. When the clasp nut on the carriage is not engaged with the lead screw the dial simply revolves, driven round by the lead screw. When the clasp nut is engaged the movement of the carriage along the lathe bed cancels out the rotation of the dial and it no longer revolves. The only load on



Fitted to carriage.



Driver's view.



Parts.



Close up of components.

the gear is that required to overcome the friction in the body of the indicator, a trifling amount.

A gear only having 8 teeth and a circumference of 1 inch was out of the question so a 16-tooth wheel with a 2

inch circumference was settled on. Off the shelf gears are mostly metric sized and of metric profiles, often made in China, as you would expect, and are readily available online. Fortunately the purveyors of these gear wheels also publish fully dimensioned specification charts and drawings in their adverts. After much deliberation and school boy geometrical calculations I placed an order for a couple of gears of 16 tooth, No1 Modulus, 18mm diameter. Oh, and they were ridiculously cheap.

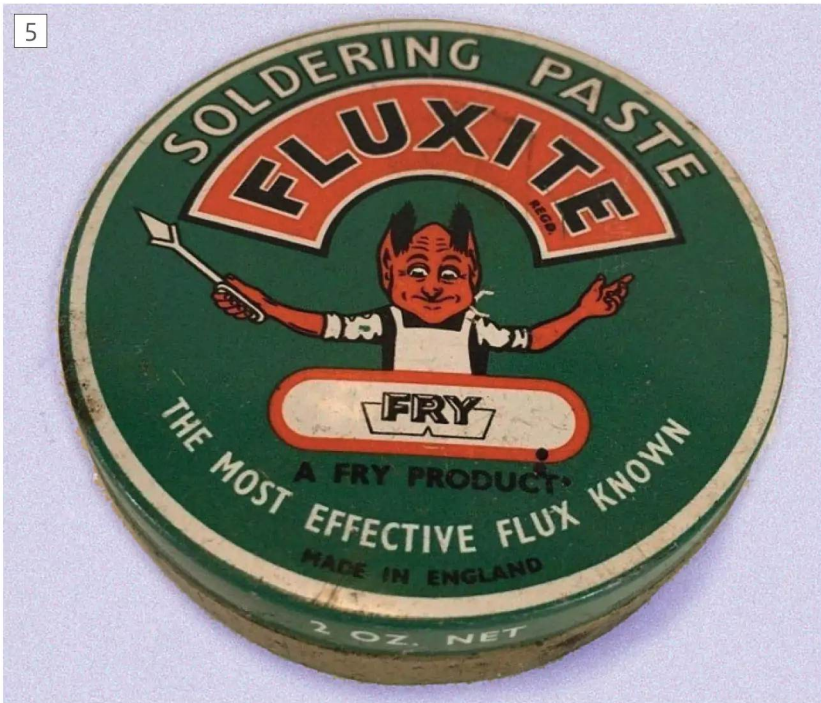
Once they had arrived and I had satisfied myself that they would do the job I got on with making the other parts, **photo 3**.

The main body was turned in brass to a satisfying profile and bored for the drive spindle. The bottom was drilled, and a boring bar used to open a hole large enough and deep enough to accommodate the gear wheel. Removing it from the lathe this lower portion had half of it cut away with a hacksaw to allow the gear to engage with the lead screw, **photo 4**.

The drive spindle was cleaned with emery and soldered into the drive gear. Soldering seems to have gone out of fashion and has now been replaced by the use of "super glues". By placing the parts to be soldered on the hot plate of my Rayburn they warm up nicely as I make my porridge in the morning. I like to use "killed spirits" (zinc dissolved in hydrochloric acid) flux for most soldering jobs except electrical and plumbing work, and if you do the same do remember to wash it all off in water afterwards. Does anyone else remember the funny Fry's Fluxite Solder Imps, **photo 5**, from the old magazine adverts? Sorry I digress, to continue...

The other end of the spindle had a thread cut on it ready to receive the dial. The dial was turned to shape from a piece of alloy and drilled and tapped to suit the spindle thread. A small portion surrounding the central tapped hole was left raised on the back of the dial to provide running clearance. It was marked using a sharp pointed tool held in the tool holder and the stop and headstock gear wheel used to index it.

A short length of brass bored and filed on the side to the profile of the main body was soldered in place for the mounting. A lock nut placed above the



Fry's Fluxite with one of the 'imps'.

dial enabled a fine degree of adjustment to be made for end float. After a trial fitting the carriage was marked, drilled

and tapped for the mounting stud or pivot. A coat of black paint and a few dabs of red finished the job, **photo 6**.



Completed.

What a joy it is to see the little dial slowly revolving until "click" the clasp nut is engaged and you watch as the cutting tool slowly advances towards the work and neatly slips into the already partly cut thread.

"But", you say, "you haven't told us how to use the thing." Correct, but there are plenty of books which will tell you, and there is sure to be a man on the web who will show you. ■

In our Next Issue

Coming up in issue 340,
June 2024

On sale 17 May 2023

Contents subject to change



Stewart Hart shares his design for the Potty Engineering Cutter Grinder, made around a selection of reasonably priced off the shelf components.



Robert Walker details a raft of useful workshop accessories, all made using 3D printing.



Michael Cox has devised a flange mounted ER collet holder for use on a lathe.

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The Midlands Model Engineering Exhibition

The Midlands Model Engineering Exhibition

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Meridienne Exhibitions look forward to welcoming you to one of the UK's largest model engineering exhibitions.

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The competition and display classes are open to all from beginner to experienced modeller. They are free to enter and all entrants receive two 1 day passes to the exhibition. If you would like to enter your work and be part

of the show, see the website for more details.

SMEE WORKSHOP - LOOKING TO THE FUTURE

Last year SMEE celebrated its joint 125th Anniversary with Model Engineer. This year SMEE wants to look more to the future and is planning to feature exhibits, including working models, demonstrations, and training that focus on what model engineers are doing today. The demonstrations will include relatively simple projects showing what newcomers to the hobby can achieve with relatively low investment and some basic training. Visitors to the SMEE stand will be able to discuss their projects with knowledgeable members and learn about the workshop facilities available at Marshall House, SMEE's headquarters, and the SMEE Training Programme.

MODEL ENGINEER AND MODEL ENGINEER'S WORKSHOP TALKS

ME and MEW will once again be hosting a series of talks covering a wide range of topics by some of their authors, with an improved auditorium and sound system. Come along and meet some of the people who help make your favourite magazines so good!

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

Make a note in your diary now and see www.midlandsmodelengineering.co.uk for all the latest information and how to enter your work. Tickets go on sale from 6th April.

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

Tickets: Adult £13.00, Senior Citizen £12.00, Child (5-14 inc) £5.00

New Airbrush Cleaning Kit

The Airbrush Company's new SOS (Save Our Spray) Emergency Cleaning Kit includes 10 key items used by our very own technician, to clean and restore airbrushes to their perfect working condition. The kit Includes:

- Premi Air Liquid Reamer Airbrush Cleaner (150ml) Aerosol
- Dental Brushes (1x white 0.35mm and 1x orange 0.45mm)
- Micro-Brushes (2x pink and 2x black)
- Measuring Cups (x2 30ml)
- Microfibre cloth (colour may vary)

They are also offering Airbrush Courses with Jason Lake:

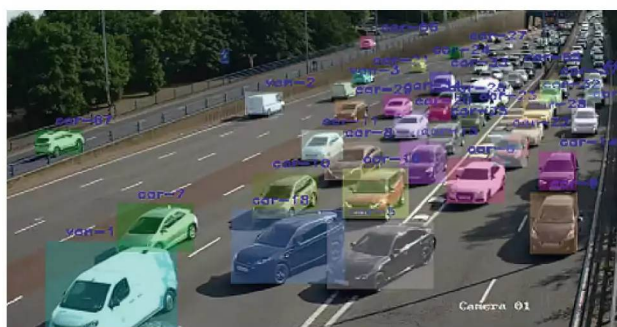


- Airbrushing for Beginners: 13th May 2024 & 9th July 2024
- Camouflage Airbrushing: 10th July 2024



- Weathering Techniques: 11th July 2024
- See www.airbrushes.com for more details.

Finalists named in hunt for new ways to tackle hazards on National Highways' roads



Nine innovative new ideas which could help manage hazards on motorways and major A roads have been selected by National Highways to receive up to £90,000 funding to develop their concepts and improve safety. It follows the launch of a competition by National Highways to find new ways to help protect road users by better managing hazards.

The winning ideas include using 3D radar technology to predict weather-related road hazards, AI road monitoring technology that can be used by traffic control centres, traffic officers or in inspector vehicles and virtual reality training courses for drivers.

National Highways is working with Connected Places Catapult on the Hazard Protection on Roads Accelerator. The shortlisted organisations will now get funding of £15,000 to £30,000 to design their trials. The projects will then be whittled down to five and those projects awarded up to £60,000 to deliver their trials.

Hazards might include potholes and subsidence, flooding and extreme weather, obstructions, unsafe driving behaviour and incidents on the road network.

The nine projects being taken forward are:

- **Esitu Solutions** (based in Nottingham): Esitu Solutions will be developing a virtual reality training course as a downloadable app for the Meta Quest headset to promote safer and more considerate driving
- **VESOS**, (Devon): VESOS developed TeCall to harvest eCall data automatically sent after collisions. TeCall fuses other hazard alerts, adds vehicle make and model, propulsion and can identify if vulnerable drivers are on board
- **PRAM** (Dublin): An integrated solution that predicts weather-related and surface condition hazards on the network and is based on 3D radar technology widely used in the automotive industry
- **VivaCity** (London): VivaCity's sensors provide data on interactions between road users, enabling a proactive response to an increased rate of near misses
- **Roadside Technologies** (Chesterfield): Roadside Technologies is developing an automated hazardous object detection solution using the latest in sensing technology, to improve road user safety and enable smoother journeys through temporary work zones on roads.
- **CrossTech** (Wiltshire): CrossTech has developed a stopped vehicle detection verification system. The

platform builds on the automated computer vision inspection platform from the rail industry, called Hubble.

- **Route Reports** (London): A video analytics-based road monitoring device that can be fitted to any National Highways vehicle in order to automatically detect hazards.

- **TransPix**, (Hull): TransPix uses video analytics and computer vision technology to improve road and workplace safety by detecting complex behaviours and hazards

- **Valerann**, (London): Valerann's AI real-time road data analytics platform fuses data from a broad range of data sources to deliver road traffic situation insights and accidents risk modelling, improving road traffic authorities' situational awareness and empowering them to take accurate, actionable and timely decisions

The competition particularly targeted small or medium enterprises that may not have worked with National Highways before and could have, as yet undiscovered, innovation gems to share around dealing with hazards.

All nine finalists will be guided through a bespoke programme tailored to their requirements offering coaching and mentoring, business development opportunities and technical and procurement support.

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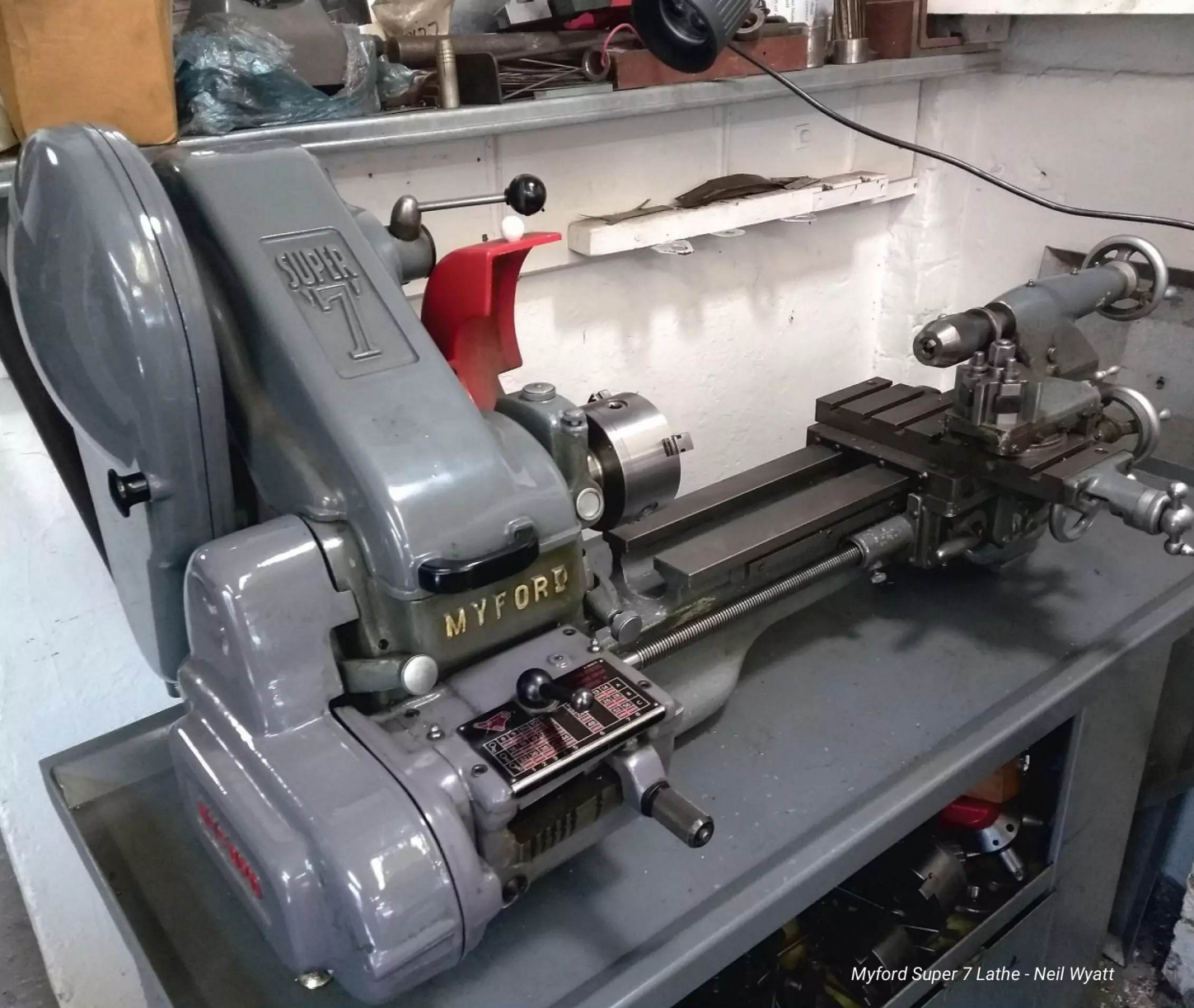
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Readers' Tips

A datum for Accurate Boring

TIP OF
THE MONTH
WINNER!



This month's winner is John McLaughlin from Leeds, who has found an interesting way of boring a hole to an exact depth with a boring head.

The graduations on my tailstock spindle are too coarse for accurate use and access to use a dial gauge was impossible. I selected the largest hexagon key which would fit in the 'side' hole of the boring head, filed a flat near the top for the dial gauge to read from and successfully bored with complete accuracy.

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

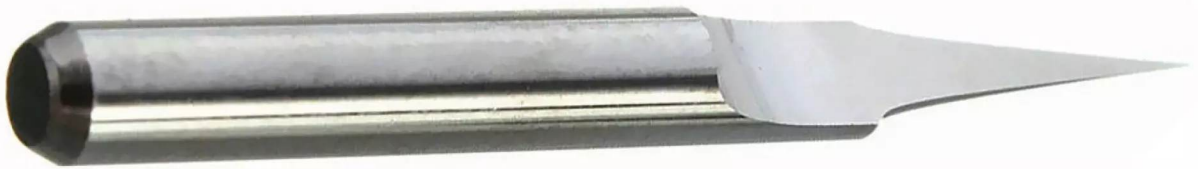
Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 600 words and a picture or drawing. Don't forget to include your address! Every month we'll choose a winner for the *Tip of the Month* will win **£30 in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

Micro-Milling With A Home-Made Contraption Part 3

Mike Tilby continues with a discussion of micro-milling cutters themselves.

11



A typical pointed engraving cutter.

Cutters for machining fine details in a work-piece seem to be sold under the headings of either 'engraving cutters' or 'micro-milling cutters'. The former include a wide variety of shapes but seem to be mainly designed for cutting only shallow grooves and many are shaped simply as pointed D-bits as shown in **photo 11**. I have no experience of using these but assume that the simple tapering shape of such cutters makes them relatively robust. That pointed shape seems unsuitable for most micro-milling tasks, other than engraving, although in the 1950s Prof. Chaddock, ref. 13, used home-made D-bit type cutters with a short parallel section and a flat end, **fig. 8**. He ground the ends of pieces of 1/8 in. diameter high speed tool steel down to 0.030 ins. while they were held in his spindle, and this would have ensured the cutters ran true. He was able to cut turbine blades in a particularly tough grade of steel, although he could only cut two blades at a time before having to re-sharpen the cutters. I don't know how feasible it would be to make cutters of this type much thinner than 0.03 ins (0.76 mm). These days cutters are available commercially down to less than 0.1 mm diameter.

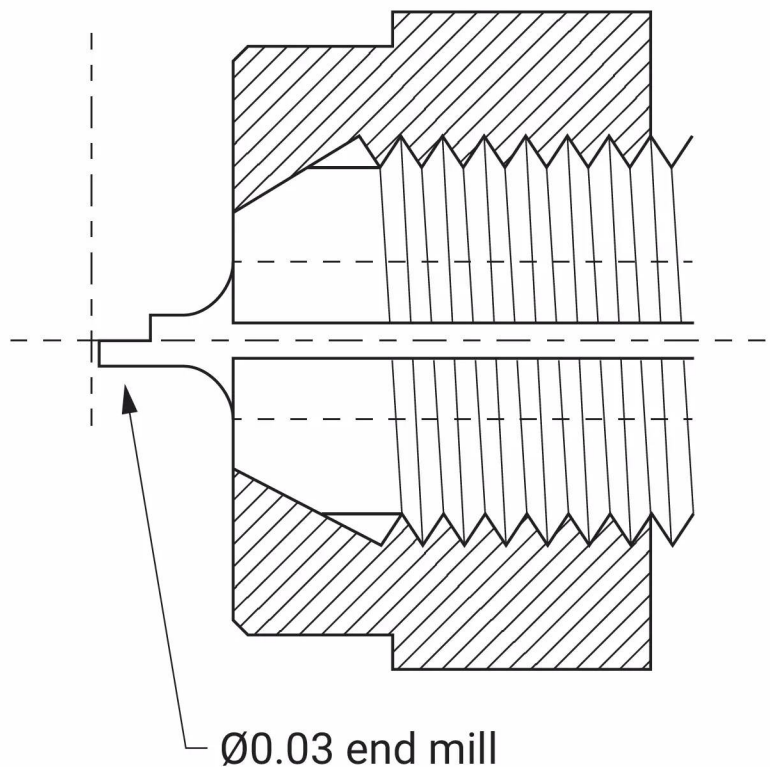


Figure 8

Prof. Chaddock's homemade milling cutter (ref. 13 in previous instalment).

What are generally advertised as micro-milling cutters are shaped more like typical end mills with either flat or rounded ends. Although most are now made from tungsten carbide, I have seen very small HSS cutters on sale (I'd very much like to know how all these microscopic cutters are made).

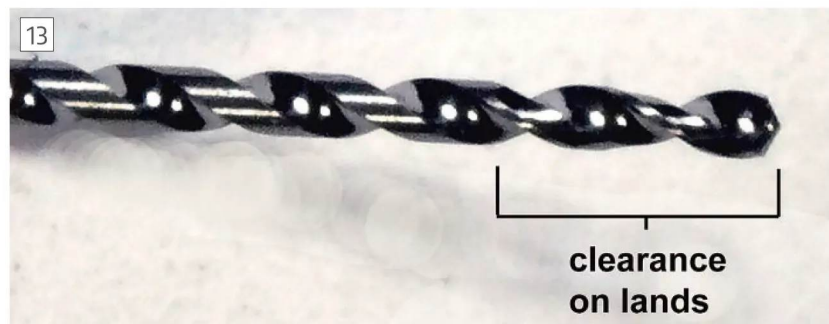
Many micro-mill cutters are sold by well-known large tool manufacturers and one can pay a lot of money for something which will break at the slightest mishandling or machining error. However, several years ago when I started this project there were also quite frequent adverts for very cheap

cutters online. More recently there seem to be fewer examples of such items for sale. As shown below, such cheap tools are of the wrong type to give good finishes, but they are very useful for learning how to use such fine tooling and for making roughing-out cuts, which is when I assume breakages are most likely to occur. The better more expensive cutters can then be kept for finishing. Some cheap cutters that I've bought direct from China have been poorly described and have arrived broken due to inadequate packaging. The best way to buy them is in plastic boxes, each containing ten cutters, **photo 12**. From time-to-time UK-based sellers have them in stock. If purchasing such items it is important to avoid buying the wrong type of cutter, but it can be difficult to identify exactly the type of cheap cutter that is being advertised. This is because the photos and descriptions of the tiny tools are often unclear. Many are advertised as milling/drilling cutters and these generally have a pointed tip with two flutes like a twist drill. The ability to make side-ways milling cuts is due to the clearance on the lands but such clearance generally only extends a short distance up from the tip. For most of their length there is no visible clearance, see **photo 13**. These seem to be aimed at drilling and milling printed circuit boards. At the start of this venture I bought some of these before realising what they were like. After removing the point with a diamond hone I made use of them for milling brass. They might suffice for some tasks in the absence of anything better, but the result was a poor finish, and I would not choose to use them again.

The Proxxon IB/E spindle has a maximum collet capacity of 0.125 inches (3.125 mm) and many cutters seem to be available with that shank



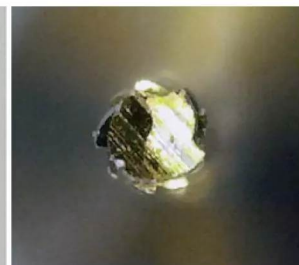
Box of cheap 0.5 mm diameter milling cutters purchased via eBay.



A typical tungsten carbide drill / engraving cutter in which the lands are given clearance relief only in the lower few mm. Diameter = 0.5 mm. This and subsequent images were taken using an Andonstar ADSM-201 HDMI digital microscope.



Toothed tungsten carbide milling cutter, 0.6 mm diameter, yellow-coated



diameter. Cutters with shank diameter of 3 or 4 mm also seem to be commonly available. Sometimes the cheap cutters have special surface treatments which give the tools improved wear resistance etc. The types of cutters that I have mainly used are all made from tungsten carbide and are of the following types.

Toothed milling cutters

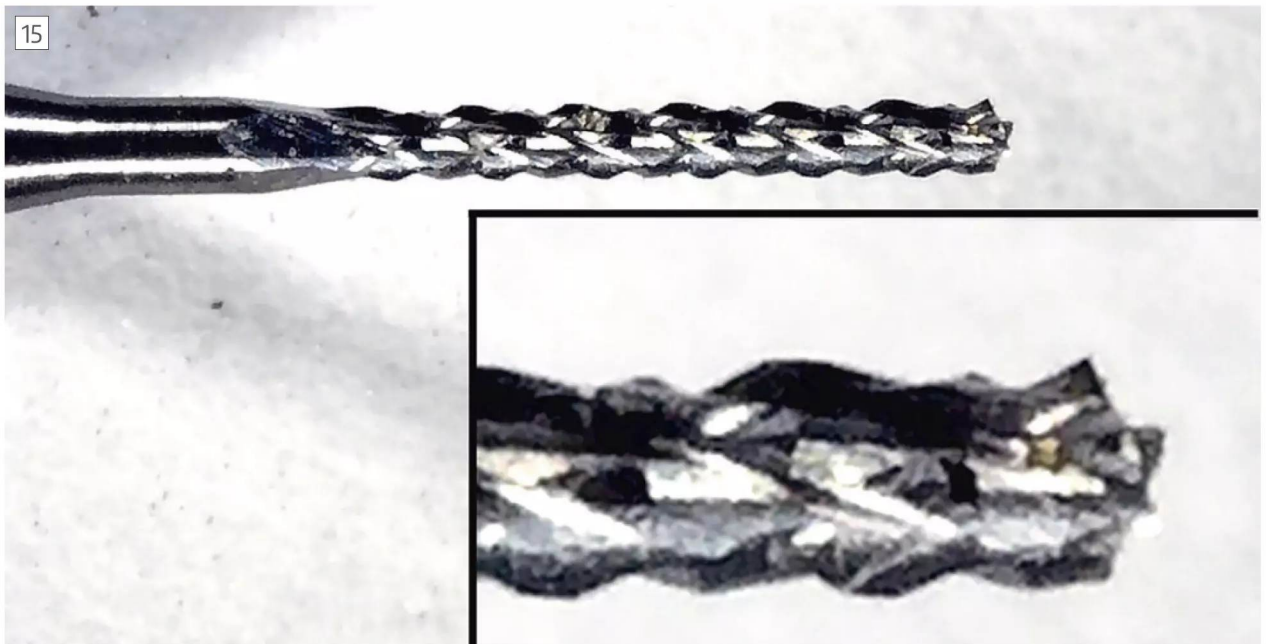
These seem to be miniature versions of the larger toothed roughing or corn-cob type cutters. I gather that they are commonly used on composite materials, but I find they can work well for cutting brass and they have proved very useful. I have purchased these with at least two different styles of teeth as well as different types of coating.

Photographs 14 and 15 show fish-tail type cutters. The ends of these carry two points. I have found this type of cutter works well on brass.

Photograph 16 shows a blue-coated cutter which has an almost straight cutting edge across its end. I find that these cutters break very easily when machining brass. I do not know if this is due to the design of their ends or some aspect of the style of teeth. I have not yet tried shortening this type of cutter (see below).

A disadvantage of these cheap toothed cutters is that they leave a poor surface finish (see below). I have only seen them for sale online where they could sometimes be bought for about £12 for a box of ten.

These cutters are very long relative to their diameter and that probably explains why they have invariably broken after machining a dozen or so turbine blades. I have shortened some of these cutters by passing them through a suitably sized hole in a piece of metal and snapping off the protruding section. The resulting irregular end was then squared using a fine diamond file. Such shortened cutters have lasted for cutting over a hundred blades, but please remember that my experience so far has been with a steady very slow electronically controlled rate of cutter movement. I have also successfully used this style of cutter in just 0.4 mm (0.016 inch) diameter.



Toothed tungsten carbide milling cutter 0.5 mm diameter non-coated.



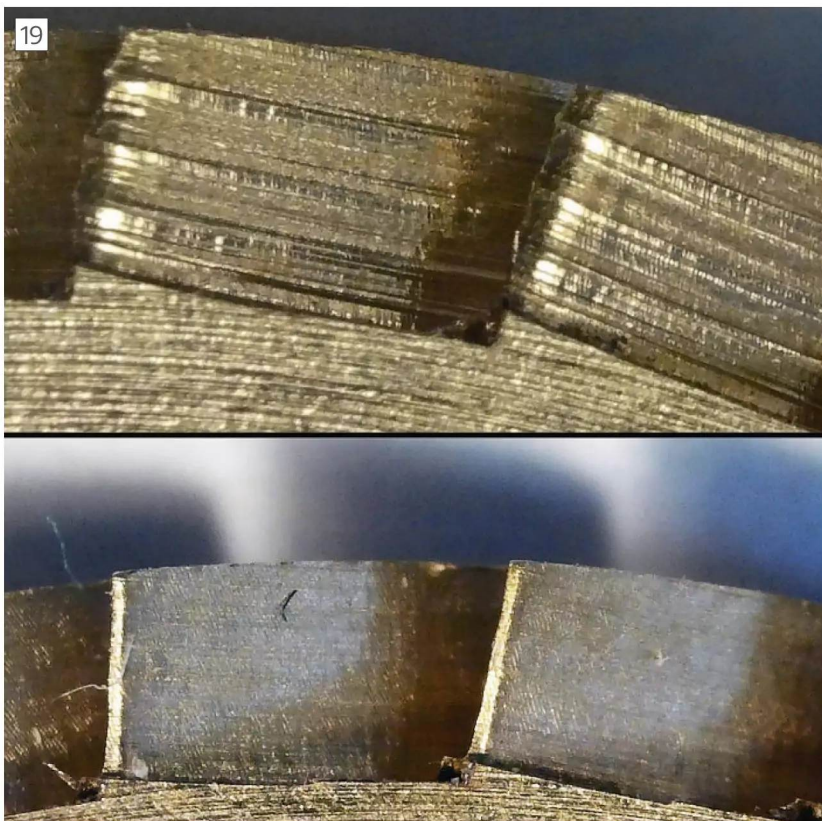
Toothed tungsten carbide milling cutter, 0.5 mm diameter blue nano-coated.



Four-flute square ended Accupro milling cutter, 0.5 mm diameter x 1.5 mm.



Two-flute ball-nosed Accupro milling cutter, 0.5 mm diameter



Upper panel shows turbine blades as cut using a 0.5 mm diameter toothed cutter. Lower panel shows similar blades after finishing with a 0.5 mm diameter four-fluted Accupro cutter. Blades are 0.06 inches high.

End mills with two, three or four flutes

These are miniature versions of typical larger-sized end mills, see **photos 17** and **18**. They are generally shorter than the toothed cutters mentioned above and are also more expensive. I have only found them in the catalogues of major tool companies such as 'MSC Industrial supply'. Prices range from about £7 up to over £30 each.

Cutter performance

As is to be expected, the corn-cob type cutters leave a grooved surface, **photos 19** and **20**. The appearance of the surface finish of small items is greatly affected by the nature of the lighting since it can accentuate or mask surface irregularities. However, these photographs do faithfully reflect the appearance of the blades as viewed under a stereo microscope. The obvious grooves are not very deep and can be removed by taking finish cuts about 0.002 inches deep with a 4-fluted cutter of the type shown in photo 17.

The contraption again - cutting a slot versus cutting round a blade

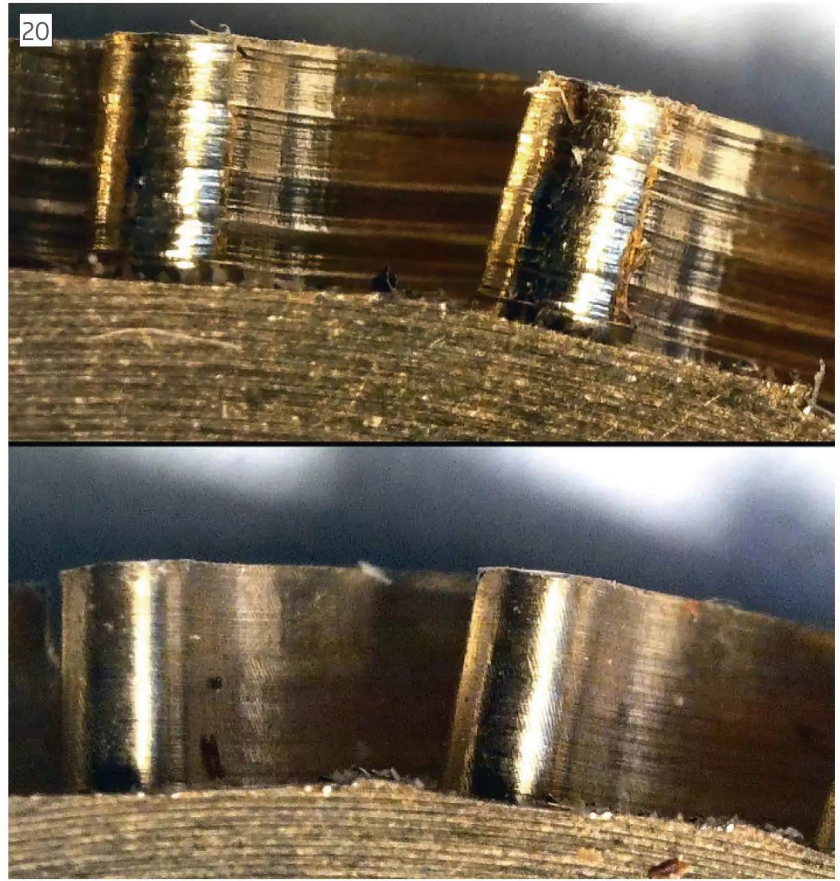
Prof. Chaddock's device was made to machine only basic impulse blades which could be created simply by cutting a series of inter-blade slots of constant width. In that arrangement the mid-point of each of the gaps between blades was aligned with the axis of the machine, **fig. 9A**. However, I wanted to have more freedom in the shape of blade to be cut. This meant being able to cut all around each blade rather than simply cutting a slot. Therefore, so far, I have been using the contraption in a manner whereby the axis of each blade rather than the centre of each gap is aligned with the machine's axis, **fig. 9B**.

In Prof. Chaddock's arrangement, with the inter-blade gap aligned to the axis of the machine, the tilting spindle results in the blade thickness tending to increase slightly towards the tip (**fig. 9A**). In contrast, with the blade-centred alignment the blades tend to decrease in thickness slightly towards their tips (**fig. 9B**). This difference is probably not functionally significant in a small

model although in theory, decreasing thickness towards blade tip is more favourable and better resembles the design of full-size turbine blades.

The change from cutting constant width grooves to cutting around a blade has major implications for the design of a template and how it is used. In Prof. Chaddock's design, the width of gaps between adjacent blades is determined simply by the diameter of the cutter and the thickness of each blade is determined by the number of blades into which the disc is divided. In his design the width of the slot in the template was not critical so long as the follower on the end of the spindle fitted it without being loose. In my contraption the template is a ten-fold enlarged version of the whole blade rather than just the shape of the slot. This means that the template follower must be moved around the outside of the template while taking care to ensure it remains pressed against the template's edge all the time. Also, for any template, the result of the milling operation depends on the diameter of both the cutter and the template follower since it is important that the follower is held the correct distance away from the template so that the cutter leaves the equivalent sized shape to form the turbine blade.

The template followers in the contraption are ball races that are exactly ten-fold larger in diameter than the cutter in use. This ensures that the axis of the spindle is the correct distance from the template, so a correctly sized turbine blade is formed. The followers are each mounted on a tapered holder which fit in a matching socket on the end of the arm. This means it should be possible to change followers without upsetting the alignment of the machine. In practice I have never needed to do this. However, I do use a series of rings that fit around a basic follower. These rings are used to position the follower (and hence the cutter) slightly further away from the finished blade profile so as to leave an over-sized blade. Initial cuts (as in photos 19 and 20) are with a 0.5 mm diameter toothed cutter, with a ring that is 0.020 inch thick on the 5 mm diameter follower. The resulting blades are thus 0.002 inch over-sized



Upper panel shows turbine blades as cut using a 0.5 mm diameter toothed cutter. Lower panel shows similar blades after finishing with a 0.5 mm diameter four-fluted Accupro cutter. Blades are 0.06 inches high.

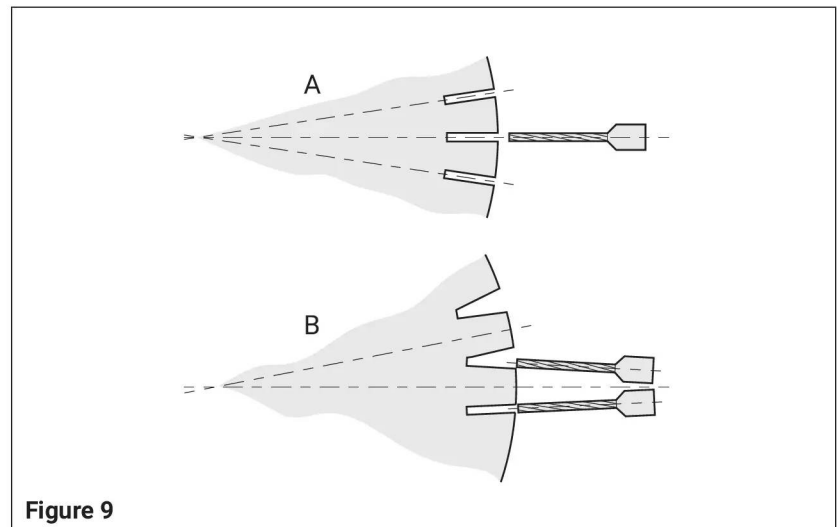


Figure 9

Diagrams to illustrate in an exaggerated way: A. Cutting plain grooves, as in Prof. Chaddock's device. B: Cutting around each blade.

all round. Then the ring is removed (or replaced with a thinner ring) in order to make finishing cuts with a 4-flute 0.5 mm cutter.

Acknowledgement

I am very grateful for the helpful comments on a draft version of this article made by the late Joerg Hugel. ■

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. These 'Quick Release Backstops' by Alan Cambridge appeared in **MEW 39**, December 1996. The ingenious captive dowel/cam operated by an offset screw could find applications in other projects..



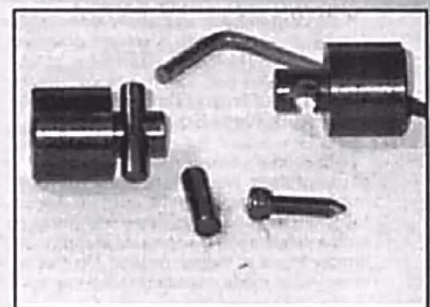
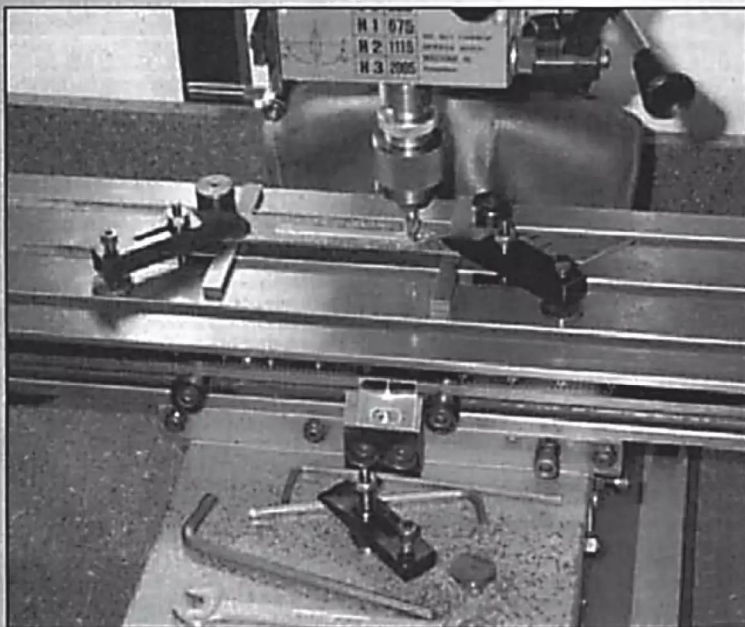
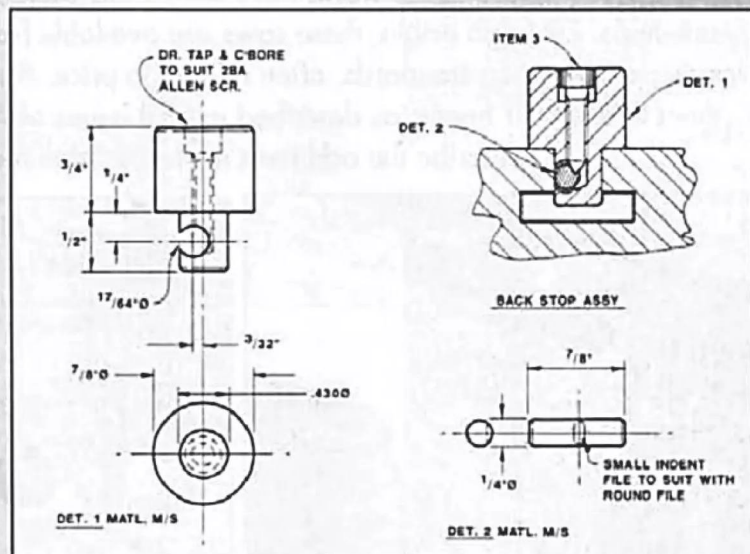
Work setting probably accounts for the majority of the time we spend on our workshop projects, so ideas for items which will speed things up are always welcome. Alan Cambridge describes some quick release work stops which are simple to make and fix.

How many times do you clamp some form of backstop, perhaps with tee nuts into the tee slots, only to find that you have to move them again to get a better layout of work clamps and packing? The quickly made stops shown in the drawing and photographs can be moved at will, without disturbing the remainder of the set-up. They provide a firmly clamped, positive stop, against which work can be located with repeatability.

The clamp bar (Detail 2) ensures that they self-align, presenting the same face to the work each time, but you do, of course, have to see that both bars are kept to the same tee slot face to ensure this alignment.

A half turn of the Allen key is all that is required to secure or remove the stops, and this also ensures that the bar is held captive in the body when removed from the machine.

The dimensions shown suit a VHM milling machine, but obviously the principle could be adapted to match any size of tee slot.



An A to Z of Metals – R to Z

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

Reduction

A chemical reaction in which an atom gains one or more electrons.

Refractory

Heat resistant, as a firebrick.

Refractory materials may or may not be good insulators.

Rehardening

If carbon steel tools are overheated (by being forced to work too hard, or being ground too fiercely), they will lose their temper, become soft and blunt. Such tools can be rehardened, but first they must be annealed. There is a risk of burning out the surface carbon through the various cycles of reheating required. To avoid this wind a few turns of soft iron wire wound around tool and coat it with a paste of ground chalk.

Rockwell hardness test

To determine the Rockwell hardness of a metal sample a hard ball bearing or a diamond stylus is pressed into a sample under great pressure, sustained for several seconds. The size of the resulting depression is used to calculate the hardness of the sample as a Rockwell number, the higher the number the harder the material. There are several Rockwell ranges, using different loads and penetrators, only numbers from the same scale are directly comparable unless a conversion table is used.

Rust

A bright orange hydrated ferric oxide of iron, commonly produced by its corrosion in damp conditions. The susceptibility of different irons and steels to rust varies considerably, with some types being effectively rust proof, some just developing a hard, resistant surface layer, and some rapidly losing their surface integrity. Rust has

considerably greater volume than the original iron, and removal of even a thick coating of rust using agents such as weak acids can reveal surprisingly little surface damage. It is possible to convert rust into magnetite or iron phosphate by electrolytic or chemical means and recover rusted items virtually to their original dimensions, although they will show dark staining.

Sand casting

A common method of casting metals by using a mould made by packing greensand around a pattern.

Scale

Surface oxides and other contamination on hot worked steel (black mild steel) or metal that has been heat-treated. It may be removed mechanically or through the use of a pickle.

Seasoning

The practice of ageing cast iron by leaving it out of doors for a considerable period to subject it to changes of temperature with the weather and time of day. Seasoned castings are more dimensionally stable than 'green' castings.

Sheet metal

Metal supplied as relatively thin flat plates rather than the form of shaped bars or castings. The thickness of sheet metal may be quoted in imperial or metric measurements or in standard wire gauges. High quality thin metal sheet is referred to as shim stock. Sheet metal may be supplied in varying degrees of hardness making it suitable for different purposes.

Shim stock

Thin sheet metal to an accurate thickness and good surface finish, typically used for

making spacers to allow fine adjustment of assembled parts.

Shot

Small metal pellets.

Shot blasting

A technique for mechanically cleaning metals by spraying them with metal pellets under pressure. Shot-peening is a variant used for surface hardening of metals.

Shot-peening

A technique for surface hardening metal by shot-blasting it with small, hard metal pellets.

Shrinkage

The amount by which a casting decreases in size on cooling. Patterns for castings should be made oversize to allow for cooling (noting that cavities will also shrink). The amount of shrinkage depends on the metal, being quite small for cast iron and much greater for aluminium alloys, for example. Pattern rules are available that allow for such shrinkage.

Silicon mould casting

A technique for producing multiple items in low melting point metals using re-usable moulds formed of silicon rubber.

Silver brazing

A term sometimes used to describe silver soldering to highlight the difference with the use of lower temperature silver bearing soft solders.

Silver soldering

Hard soldering using a molten filler metal with a significant silver content. Silver soldering requires the parts to be joined to be well fitting, with a

suitable small gap to allow the solder to flow into it by capillary action. A suitable flux should be used to prevent oxidation of the surfaces to be joined. Following brazing the flux and the work in general can be cleaned off with a suitable pickle. Not to be confused with the use of lower melting point soft solders with a more modest silver content.

Silver steel

A high-carbon steel suitable for hardening and tempering in water or brine, normally available precision ground to within tight tolerances. Silver steel is ideal for the manufacture of small cutting tools, as it is easily worked and hardened without special equipment.

Silversmith

A craftsman skilled in the working of precious metals, particularly in the context of jewellery, tableware and the like.

Sintering

A process resembling casting, but where the mould is filled with a powder that is then subjected to heat and pressure to cause the particles to fuse and make a solid part. Sintered parts are typically porous; an example would be sintered bronze oilite bearings.

Skin

A thin, tough layer on the surface of a casting, not to be confused with a case. Even well annealed castings can have a tough skin and it is not a defect. It is often most easily removed by taking a deep enough cut to reach the softer material beneath, as light or rubbing cuts can rapidly blunt tools. Even machinists who normally prefer HSS tooling often find it useful to have some carbide tooling just for cleaning up castings in this way.

Slag

Non-metallic waste material, such as oxides and impurities that separate out from metal or alloy during smelting.

Smelting

The process of melting metal in order to refine it and/or cast it.

Soaking

The process of keeping a metal at prolonged high temperature, as in the malleablising of iron.

Soft solder

Filler metals with relatively low melting points for metal joining. Typically containing chiefly low melting point metals such as tin, lead and bismuth, soft solders are literally softer and weaker than hard solders.

Soft soldering

The joining of metals using a molten filler metal with a relatively low melting point (typically below 300°C). The most usual soft solders are lead/tin alloys such as the 60/40 solder used for electrical work in the past, and which is an excellent general-purpose solder that wets and joins most copper and steel alloys well. Recent regulations now mean that slightly higher melting point lead-free solders must be used for electrical purposes. Other readily available soft solders include a 99%tin 1% copper solder principally meant for potable water supplies. Soft solders must be used with a flux to clean off, and prevent the formation of, surface oxides. For electronic work various mild fluxes are necessary (as through cleaning is not always practical). For other work more aggressive fluxes can be used, but the risk of corrosion if cleaning is not complete should be borne in mind.

Soldering

The joining of metals using a different filler metal with a lower melting point. Contrast soft soldering with hard soldering.

Soldering iron

A heating tool used for soft soldering. Large copper irons heated by a blowtorch or other heat source are now rare. Small gas-heated irons, often suitable for detail work are easy to obtain, as are heavy-duty bits that fit directly on gas torches. Most modern soldering irons are electrically heated. These may range from the very small (12 watt) to the large (300 watt or more). Electric irons generally have replaceable bits. Typically, smaller bits

and irons are used for electronic and detail work, larger items may be used for soft soldering items such as sheet brass fabrications.

Solid solution

A combination of one element 'dissolved' throughout another element, though remaining in the solid state.

Solidus

The temperature at which a cooling non-eutectic liquid mixture will become wholly solid. Between the solidus and the liquidus the mixture will be a pasty combination of solid crystals and liquid.

Steel

The generic name for alloys of iron (other than cast iron). Plain steels contain only iron and carbon, typically from 0.1 (mild steel) to 2% (carbon steel). Stainless steels contain various other metals to give them corrosion resisting properties. High speed steels may contain large amounts of other metals and have the property of retaining their hardness at high temperatures making them ideal for cutting tools. Other alloy steels have a huge range of properties from machineability through ductility to high strength, depending on their constituents.

Step brazing

When fabricating complex structures in several stages it is possible to use the technique of step brazing. Essentially the process depends on using a series of filler metals of different melting points at each stage, so that the heating for later stages does not result in the melting of earlier joints.

Stick welder

Informal term for an MMA or 'arc' welder.

Sulphur

A soft, yellow mineral with a low melting point. It is sometimes added to steels to increase their machineability (e.g. EN1A).

Surface treatments

Various techniques for treating tools

and parts to produce a hard outer case while leaving the inside tougher and less brittle. Traditionally case hardening has been used and is a process that can be used in the home workshop. Nitriding and coating with titanium nitride are techniques that are less practical on this scale.

Swage

A tool for bending and stretching metal; the process of bending metal into shape. An example could be swaging the end of a section of pipe so it can fit over a second piece.

Swarf

The waste material removed when cutting metal. It ranges from powder like iron filings produced when machining cast iron, through granular chips from free cutting steel and brass, to long curls produced by tougher materials. Care must be taken to avoid injury from flying or whirling swarf. When clearing long pieces use a metal rod to avoid fingers being pulled into machinery. When milling at high speed with a low depth of cut it is possible to produce swarf in the form of very tiny, sharp needles that should be treated with extreme care.

Sweating

A process for joining parts by soldering to fine tolerances. The faces to be joined are tinned and then wiped while the solder is still fluid, leaving a very thin film. The two parts are then clamped together and heated until the solder melts. This leaves a fine joint on cooling. The strength of such joints is often greater than one made with a significant fillet of solder.

Tarnish

Surface discolouration of metal without significant dimensional change due to oxidation or chemical attack, usually reversible by polishing.

Tempering

The controlled reduction of the hardness of a material to make it less brittle, increasing its toughness and aiming for a compromise state which suits its application. In the US tempering is often informally used to refer to hardening, and drawing is

used to refer to the process known as tempering in the UK.

Tempering colours

When carbon steels are heated in the presence of oxygen, a thin oxide film of a thickness related to the temperature forms on the surface. The colour of this film indicates the maximum temperature reached over a broad range which usefully corresponds to that required for tempering hardened steel for various purposes. For example, springs can be tempered by heating until they show a dark blue colour, whilst many cutting tools only need to be heated until they take on a dark straw colour.

Tin

A soft pale grey metal. Used to produce a corrosion resistant plating and in alloys such as bronze and soft solder. Lead free plumbers' (not electricians') solder is 99% tin with a little copper added. Tin foil has been superseded by aluminium foil, but tin plate is still available.

Tin plate

Thin sheet steel with a thin layer of corrosion resistant tin plating. Before the universal availability for plastics, tin plate was much used for toys and tins and is still use for making tin cans from which usable sheets can sometimes be recovered. It is easily cut to shape and solders well.

Tinning

Coating a metals surface with soft solder, prior to sweating a joint, or to make it easier to join other parts to it by soft soldering.

Tool steel

A general term high-carbon steel used for the making of cutting tools. In its annealed state it can be easily worked, but when hardened and suitably tempered it make durable tools. It is often used for hand tools such as files and chisels where the usage does not involve high temperature that could draw the temper of the tool. Historically it was used for many tools such as drills and lathe bits which today are almost universally made of heat resistant materials such as HSS and tungsten carbide. Examples of tool

steels available to the model engineer are silver steel and gauge plate.

Toughness

A measure of a materials ability to withstand loads and resist wear. There is no fixed measure of toughness, as it depends on the application and covers various properties of a material. Materials that combine different properties, such as case-hardened steel or composites, are often particularly tough.

Troostite

A tough form of carbon steel formed by the tempering of hard martensite at temperatures from about 150 to 400°C.

Tungsten

A hard, grey metal; used in the manufacture of alloy steels.

Tungsten carbide

A very hard substance that can be used to mould cutting tools in complex shapes by the process of sintering.

Ultimate tensile strength (UTS)

The maximum stress that a material can take under tension. Defined as the highest point on the stress-strain curve. This is the most often quoted property relating to the strengths of materials and can be useful when comparing them. It is not the whole story; for example, paxolin has almost as great an UTS as cast iron, but is much more flexible and their applications are very different. A more useful property is the yield strength of a material. This defines the stress at which it is permanently deformed, and hence the point at which a component is likely to fail to function properly, if not break completely.

Unhardened

In an annealed or relatively soft and easily machined condition.

Vanadium

The hardest metallic element; used in alloy steels. Vanadium steel is hard strong and tough. It hardens very deeply and has good impact resistance. It is hard to machine, but is often used for forged tools.

Vickers hardness test

To determine the Vickers hardness of a metal sample a pyramidal diamond stylus is pressed into a sample under great pressure, sustained for several seconds. The size of the resulting depression is used to calculate the hardness of the sample.

Vickers number

A number indicating the hardness of a material, the higher the number the harder the material. A range of different steels might have numbers across the range 120 to 280; copper might range from 50 to 100 depending on its condition; brasses from 80 to 140; and bronzes as high as 160.

Volatile Corrosion Inhibitor (VCI)

An organic compound that slowly evaporates and (when used in a suitably small and enclosed space) offers a degree of protection against rust. Typically a tin of VCI will protect a space of a few cubic feet for a year or more.

Weld

The joining of metals by fusing them together, if filler metal is used it is normally of similar composition to the materials being welded (in contrast to soldering and brazing).

Welding rods

Filler metal rods for welding. MMA rods (known as 'sticks') are coated in flux, but rods for gas welding usually only have a thin copper coating to protect them from corrosion.

Welding torch

A type of gas torch that uses both a fuel gas (such as propane or acetylene) and oxygen to obtain very high

temperature flames for welding metal through local fusion. Such torches require many safety precautions and considerable skill in use. They can be used for many other purposes including brazing and heat treatment.

Wet

The action of a liquid overcoming surface tension and spreading across a surface. One of the functions of a flux is to encourage solders and brazes to wet the metal being joined.

White iron

Cast iron that has been rapidly cooled, so that almost all of the carbon in it is in the form of iron carbide (cementite), a very hard material in common with other carbides. It is a very hard, brittle, intractable material, but can be readily ground to give hard wearing surfaces. The use of chills allows areas of white cast iron to be deliberately created where bearing surfaces are needed.

Wilkinson, John,

Inventor of an improved process of steel making, by burning out all the carbon then adding as much as was needed, supposedly a solution suggested by his young daughter.

Work hardening

The hardening of metals caused by cold working, often accompanied by a degree of embrittlement. As a metal is subjected to shock loads or deformation, the crystals within its structure move and 'lock' together reducing its ductility. It can be used to advantage, for example when a copper pressure vessel in the annealed condition is first stressed it is able to deform, reducing stress concentrations. This process also

causes some work hardening, making it more resistant to future deformation. Another example would be beating brass strip with a hammer to harden it and make it more suitable for use as a spring. Work hardening can cause problems during machining, for example some stainless steels work harden so rapidly that a brief pause while drilling can be enough to render the metal hard enough to blunt the drill bit. Work hardening of most metals can be reversed by annealing.

Wrought iron

Very pure iron produced by the process of puddling which effectively burns out all of the carbon. Wrought iron is a durable but relatively soft metal that is easily worked, although stringy inclusions of slag can rapidly wear tools. Wrought iron is no longer produced on an industrial scale.

Y-alloy

The aluminium alloy LM14.

Young's modulus

The modulus of elasticity of a material.

Zinc

A soft, greyish metal of little use for engineering purposes in its pure form, but a component of brass and also used to galvanize steel as a method of rust protection.

Zinc Chloride

A chemical compound that has considerable efficacy as a flux (see killed spirits), particularly for soft soldering. It is, however, very corrosive and should always be completely cleaned off the workpiece, and should never be used for electrical work.

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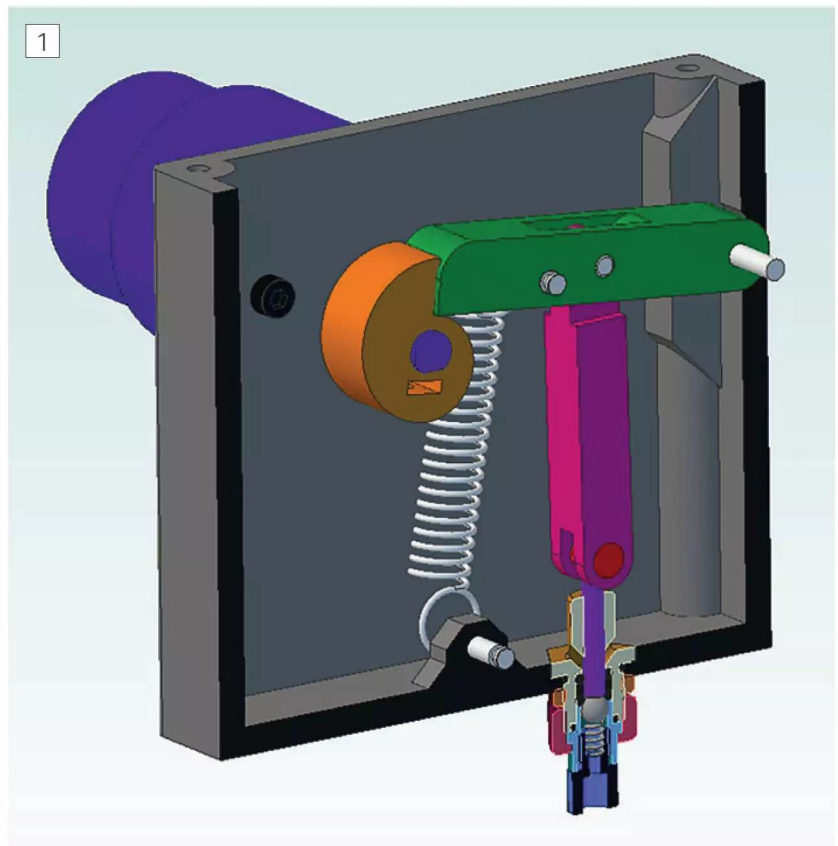
A Novel Cutting Oil Delivery System

Roger Froud's cutting oil system was designed for milling machines, but is adaptable for lathes as well.

Most machining operations benefit from some sort of lubrication and cooling in the form of soluble oil or neat cutting oil. This reduces the generation of heat through friction, and for commercial purposes the tool is flooded to maximise the removal of heat. This is fairly easy to do on a lathe, but not as simple on a milling machine in a home workshop, unless you have an enclosure that catches the excess and returns it to a sump. Even then, machines have a nasty habit of leaking, and experience shows that you still need to sit the machine in an oil tight tray if you don't want to be paddling in it.

The Denford Mill in my workshop has been converted to CNC, and that's often left quietly running unattended for many hours. Until recently, that's been running dry, with the exception of the occasional drop of cutting oil applied from a bottle. Obviously, this is far from ideal, and it can run into trouble when machining more difficult materials. Running slowly reduces the need for large quantities of cutting oil, but even a small amount makes a world of difference.

Lack of space in my workshop means it's impractical to use flood coolant because there's simply not enough room for an enclosure. Mist lubrication systems are great and can easily be set up using a pneumatic lubricator to deliver cutting oil one drop at a time. However, these require a continuous supply of compressed air, which is noisy and expensive. I need to keep noise down to an absolute minimum since I sometimes run the machine overnight. My machine is used not only for my hobby, but for commercial work too.



Sectioned pump general arrangement.

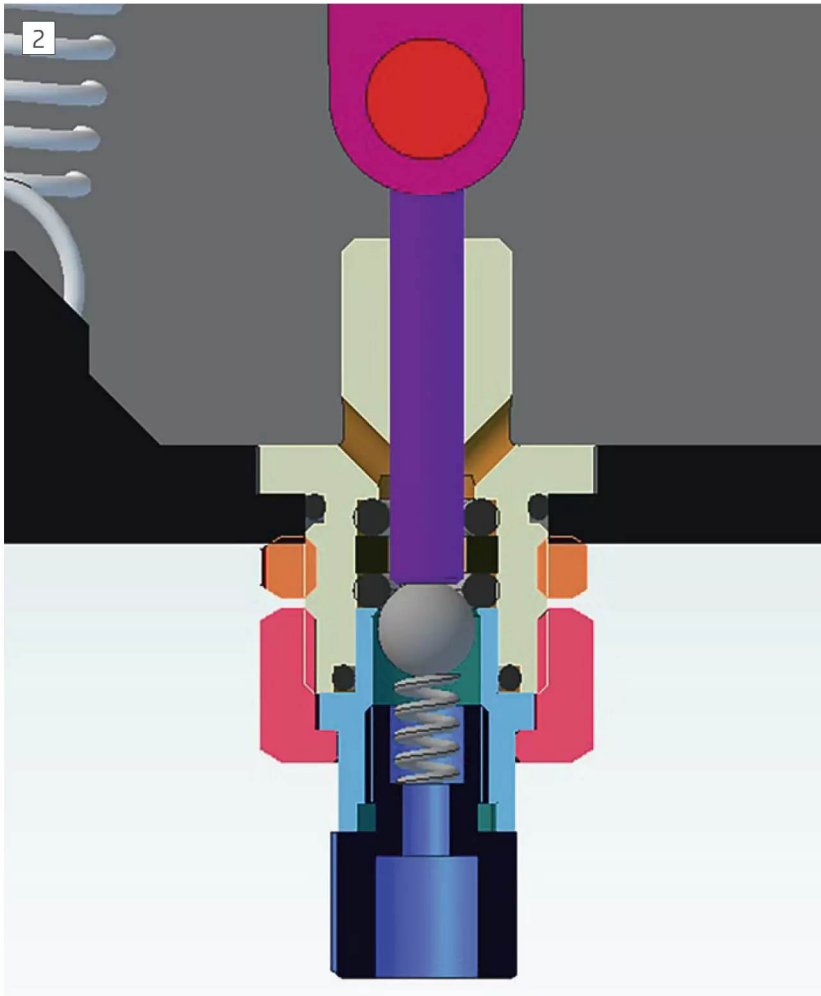
The solution I settled on is simple, reliable, and doesn't suffer from any of the shortcomings of the aforementioned systems.

In essence, the system is nothing more than a simplified Ewins type steam oil lubrication pump which is activated by a snail cam and spring mechanism. The motor driven cam can be driven at different speeds to adjust the delivery interval of each squirt of oil.

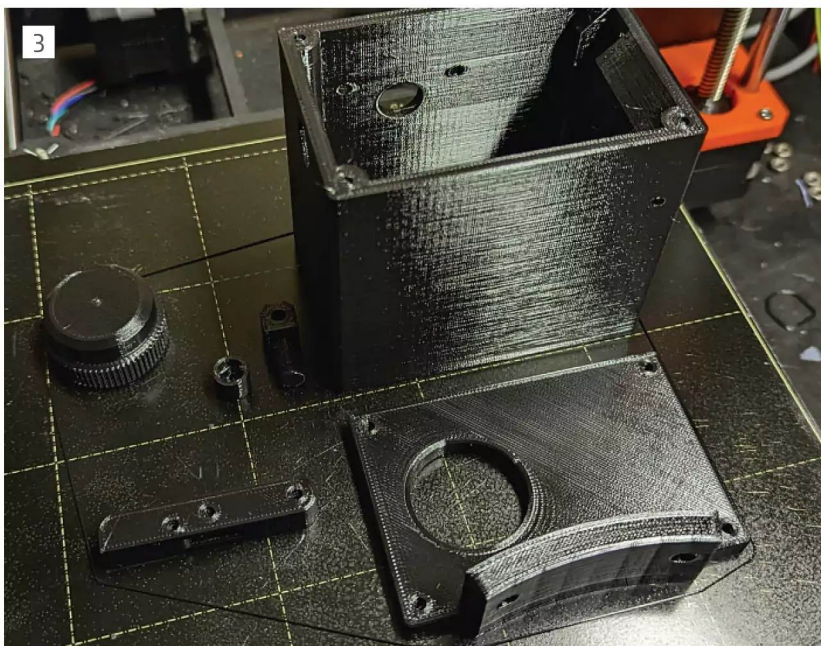
The bulk of the parts have been 3D printed, which is a lot simpler than

making all of the parts individually. The design was optimised with 3D printing in mind, but it wouldn't be that difficult to make something similar using conventional construction methods.

Below is a sectioned general view of the assembly, **photo 1**. The geared motor turns slowly anti-clockwise, lifting the Green arm against two tension springs. The lift is 8mm, so with the 2:1 reduction that gives 4mm stroke on the 4mm pump rod. The cam follower drops off the highest



Sectioned pump mechanism.



3D printed parts on printer.

point and all of the energy stored in the springs is transferred onto the pump rod.

The sectioned view of the pump is a modified Ewins design, with the unnecessary additional spacer being removed. You can change the amount of oil delivered by changing the length of the plunger. You don't need to change the thickness of spacers.

I haven't supplied detailed drawings for the pump element because it's all metric, with metric fine threads that most people won't have taps and dies for. You can use the original published Ewins design or draw up your own variant, it's a very simple device.

The pump ram is connected to the 3D printed arm using a round barrel with a tapped hole across the diameter to take the pump ram, **photo 2**.

My version has an M5 female thread at the bottom so that I can use a 4mm pneumatic push fitting that has an M5 thread.

The 3D printed parts can be found on Thingiverse.com (they will also be available on www.model-engineer.co.uk) if you want to print them, or the dimensions on the GA can be used to make a more conventional version. I've provided both the .stl and .stp files in the download so you can import the various 3D printed parts into your CAD package. That way you can get all of the dimensions and can modify the parts if they aren't to your liking. Fusion360 is free for hobby and non-commercial users, and that will open these files.

Photograph 3 shows most of the parts printed in PETG. The lid has a curved mount that matches the radius of the column on the mill. The two parts to the left of the reservoir are the mount and retainer for the blunt syringe needle. There is an additional cover for the motor which isn't shown here.

Figure 1 is a sectioned view to show the general arrangement. None of this is set in stone, it's just to give a flavour of the proportions you need.

The geared motor is a very common design that you can buy online for a very reasonable price. This one is a 12V 7RPM version which is about right for giving the maximum delivery that I need. Some have different gearbox dimensions, but the majority have the

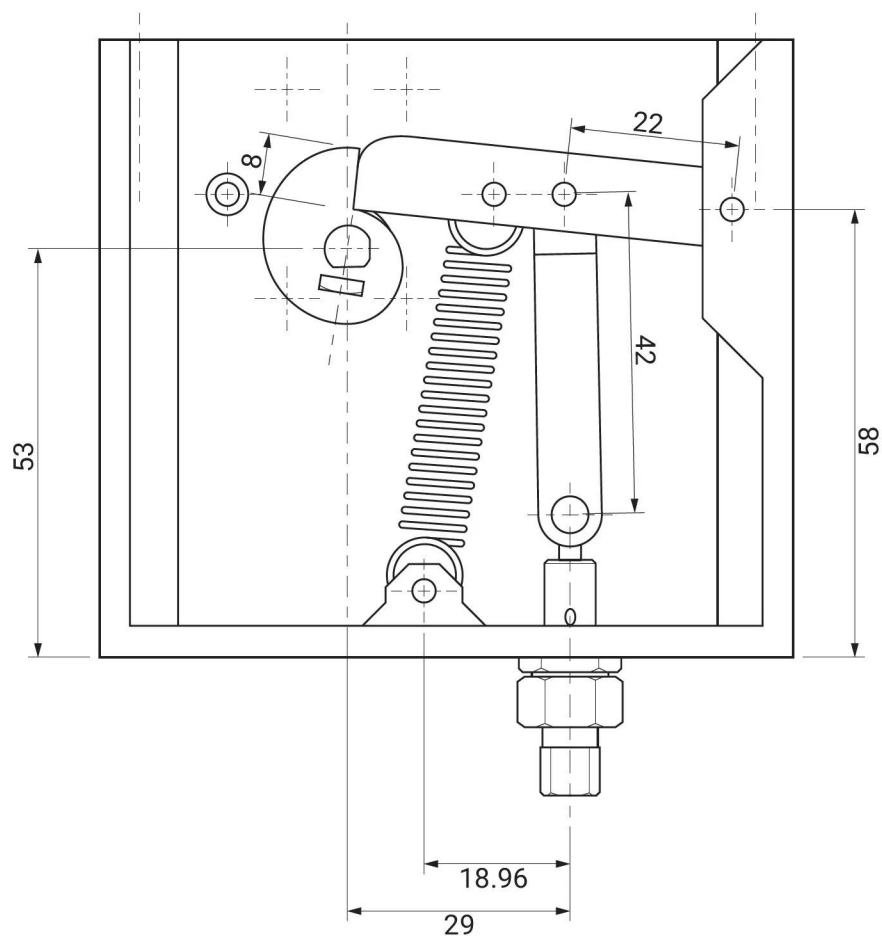


Figure 1

General arrangement.

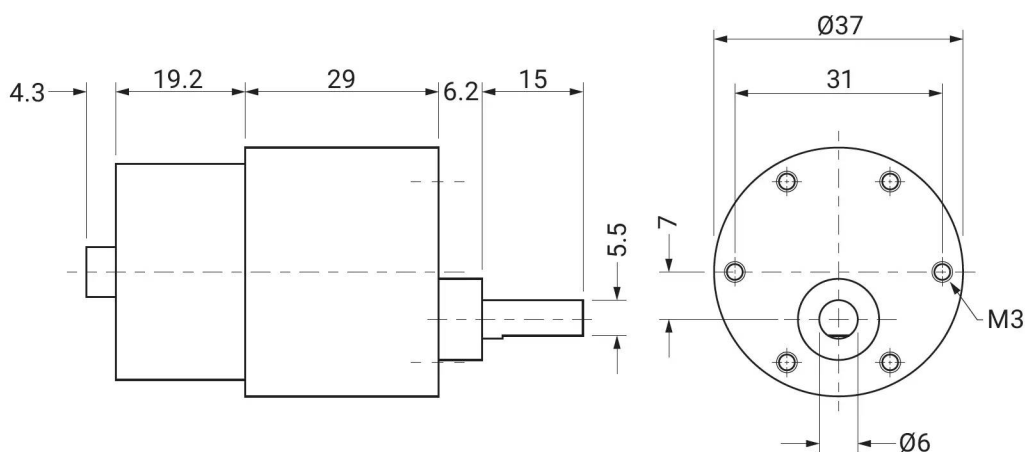
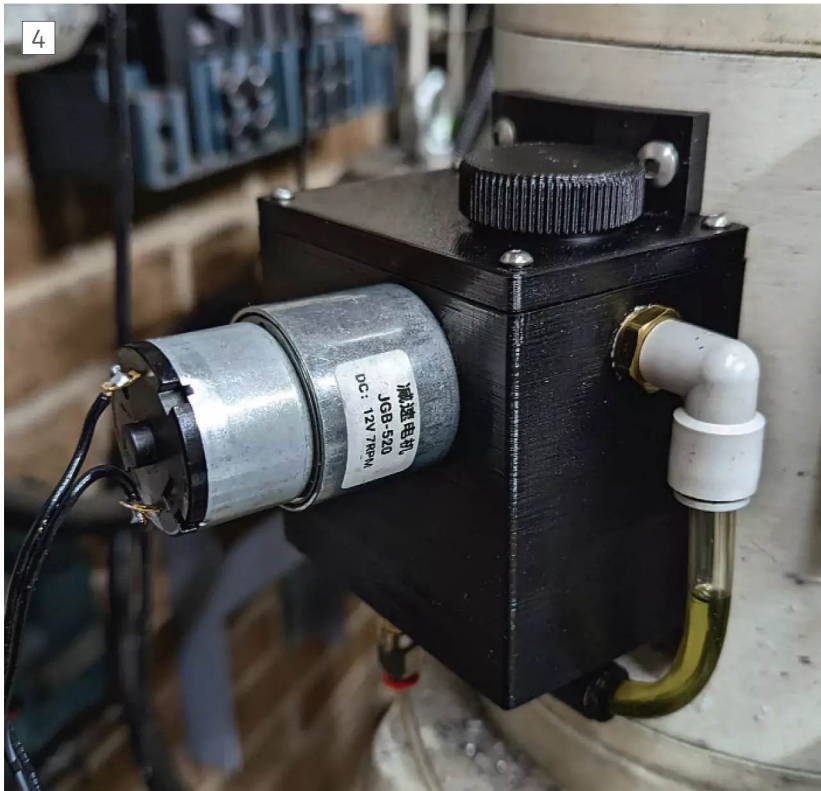


Figure 2

Geared motor.

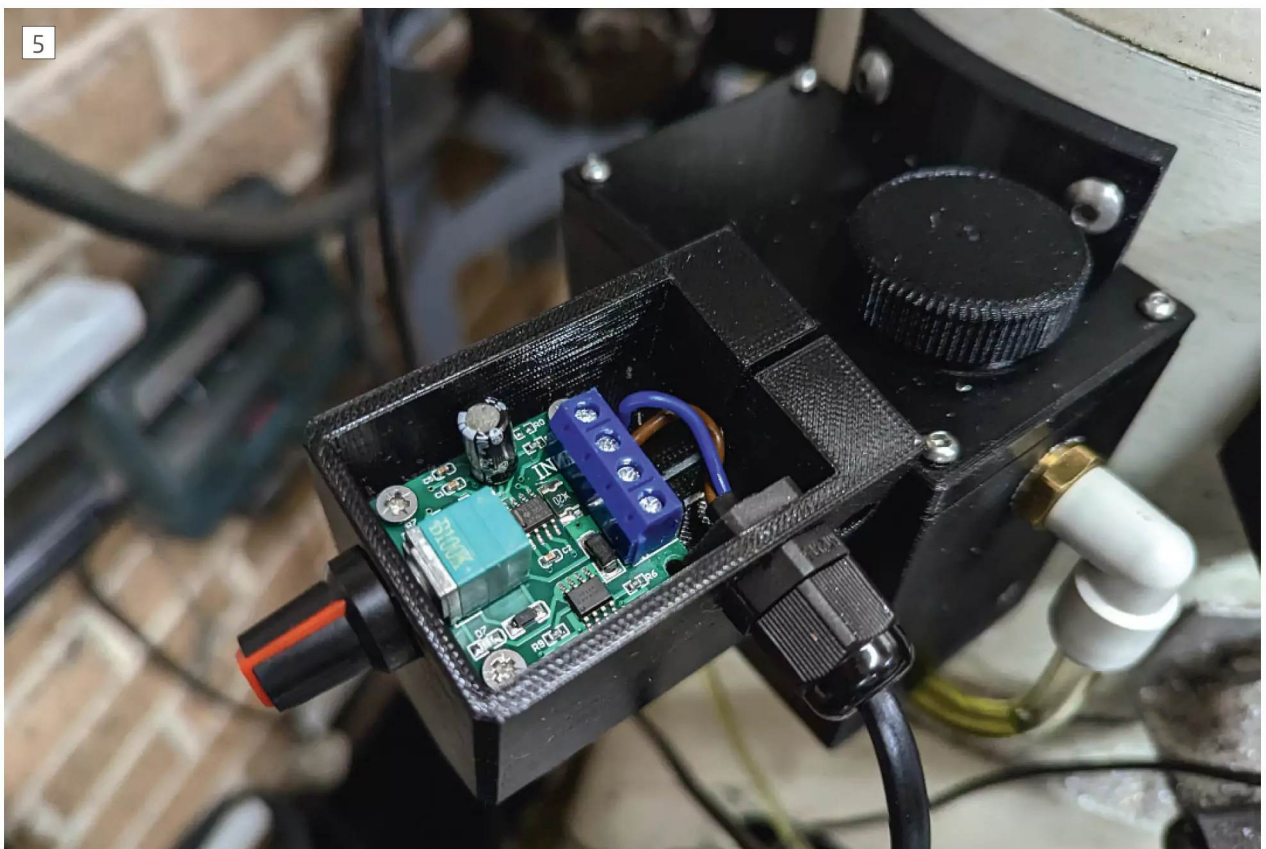


Assembly without motor cover.

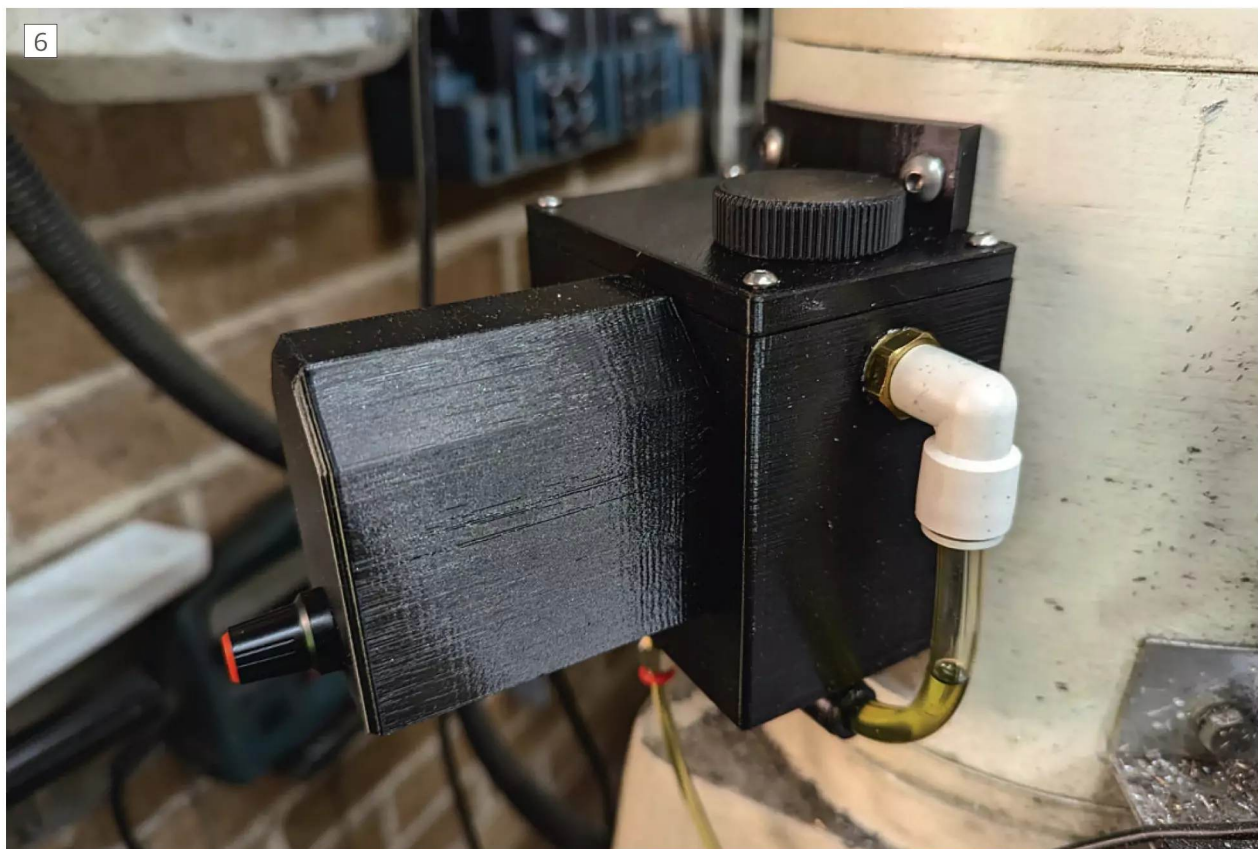
same fixing holes and output shaft details, **fig. 2**.

The motor is held on by just two of the possible six M3 screws, **photo 4**. The oil level arrangement is just two 1/4" BSP elbows that take clear 6mm pneumatic tube. The holes are plain as printed and need tapping. Fusion360 allows you to model functioning threads, so you might want to do that instead. Alibre Design that I use doesn't have this function, so you have to create the thread profile yourself. I didn't think it was worth the effort for a thread that I rarely use.

The motor cover also serves to hold the speed controller, which is another cheap item, **photo 5**. There's a cutout for an M5 square nut which clamps the split body onto the outside of the motor. It can be wired up and then turned around and clamped in position. The bottom is left open since it's only a low voltage item. Obviously, this is one of many possible options for mounting a speed controller and switch. In any case, the motor terminals need insulating since they can accumulate swarf thrown from the job.



Assembly with speed controller.



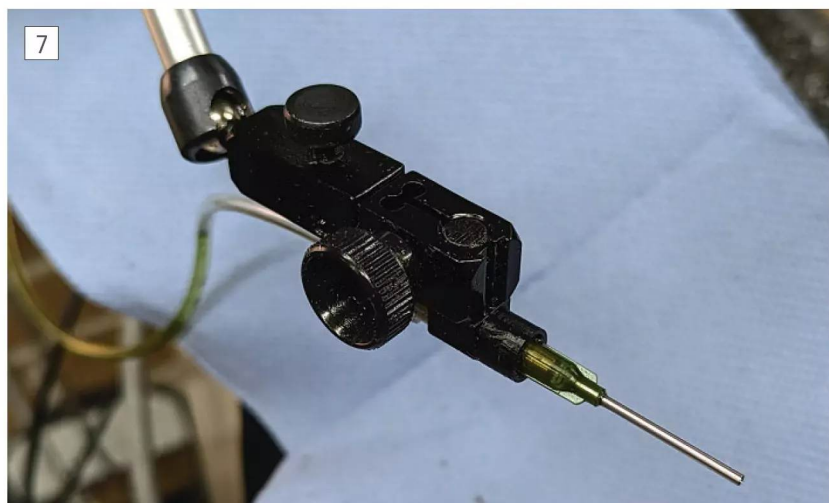
Complete assembly.

Here's how that all looks when it's ready for use, **photo 6**. It's not going to win a beauty contest, but it is functional.

I wanted the delivery system to be as flexible as possible, so a cheap magnetic DTI base was chosen because it has a fine adjustment arrangement on the end. The mill column spacer is a mild steel one i made when the machine was converted to CNC. That provides the ideal surface for the magnetic DTI base to attach firmly to.

The nozzle assembly, **photo 7**, can be used as shown, or the needle part can be turned through any angle if it's necessary to avoid clamps and such like.

Photograph 8 shows the nozzle mount which was 3d printed. The M5 thread takes a pneumatic fitting for 4mm hose on one side and the brass tapered adaptor on the other. You can buy a variety of blunt syringe needles to suit the cutting oil viscosity. I'm using a fairly thick cutting oil (EXOL EXCELCUT 427) so the 14 gauge (Dark Green) size is about right. You can google 'syringe needle size chart' to see what the



Nozzle assembly.

options are. If the needle is too small for the viscosity of the oil, it will just dribble out the end while the hose swells and releases like a bladder. If you don't want to 3D print that, here's the drawing so it can be made in metal, **fig. 3**.

The blunt needle pushes onto the brass tapered adaptor in **fig 4**, but would pop off due to the high oil pressure.

There's a 3D printed retainer for that. The printed retainer looks like **fig. 5**, but you could make one that uses two pins inserted from the side to engage with the ramps on the Needle.

I've used a clear pneumatic hose for the delivery so that I can see if there are any air bubbles. The pump delivers high pressure pulses which need a solid

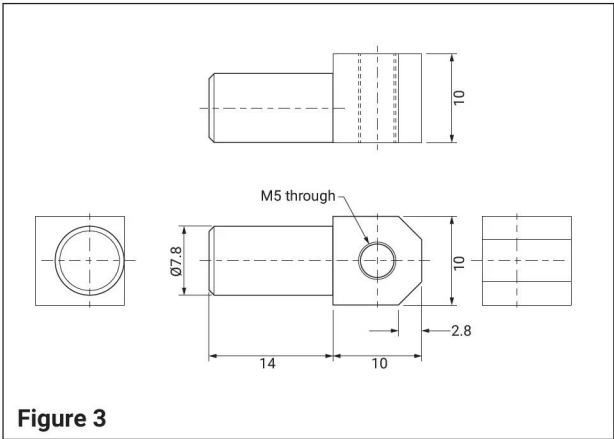


Figure 3

Nozzle mount.

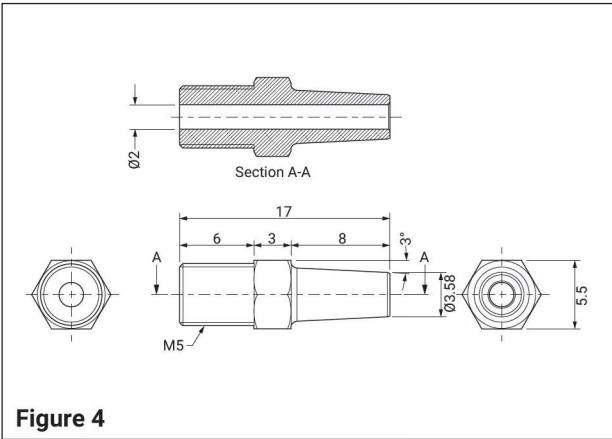


Figure 4

Tapered needle mount.

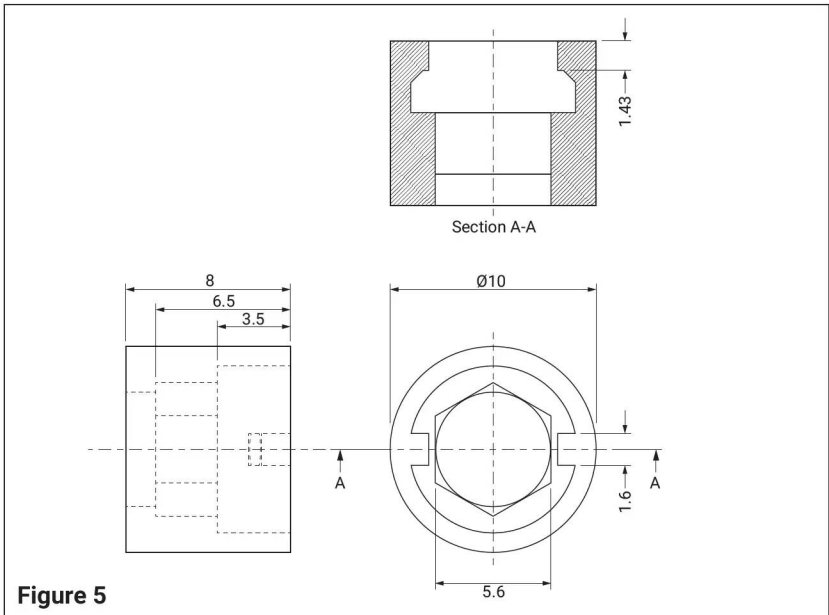


Figure 5

Needle retainer.

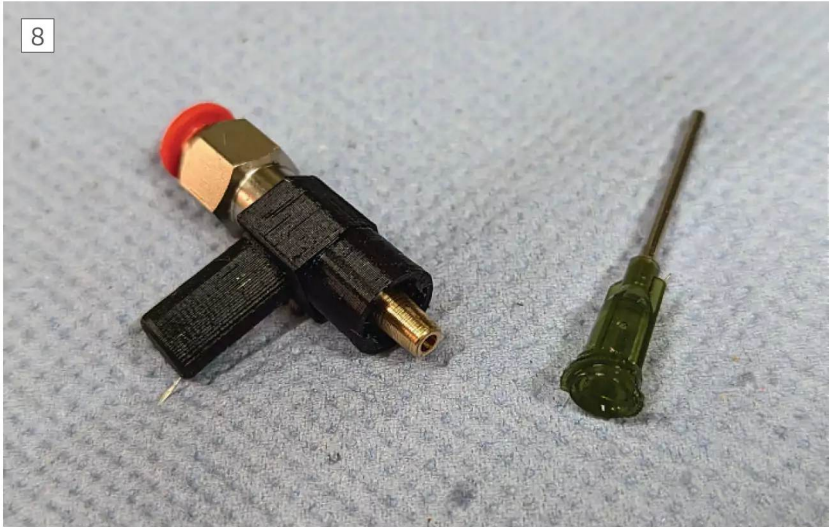
column of oil for it to eject out of the needle. You can't use a really soft tube, it needs to be suitable for 100 PSI to be rigid enough. You may need to prime the tube with oil using a syringe because it takes a very long time to fill it using the pump alone.

The system is powered by a cheap 12v power supply which I switched through a relay such that the power is only on when the spindle is running. The DC motor speed control has a switched rotary knob so it can be turned off if you don't want to use the system.

In use, the shot of oil travels around 100mm with the setup as it is now. This allows the needle to be set up well clear of the job and any swarf that's coming off the cutter. I usually aim the needle at the top of the flutes and let it find its way down to the cutting edges. That way it still gets lubricated even when the cutter goes deeper into the work and swarf builds up.

The single shot delivery volume can be changed by changing the length of the pump ram or altering the throw of the snail cam. The frequency of the delivery pulses as the slowest speed seems to be adequate, but you could reduce the volume of the pump per stroke and use a motor with a different gearbox if you prefer.

The range of delivery volumes seems to suit the differing work I do, from tiny PCB cutters to large face mills. If you're using high chip loads, you might run into issues with smoke from vapourised neat oil. However, you're going to get that if you apply it with a brush anyway. Like all matters in Engineering, it's a compromise. ■



Nozzle assembly parts.

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.

Different Approach to Inverter Protection

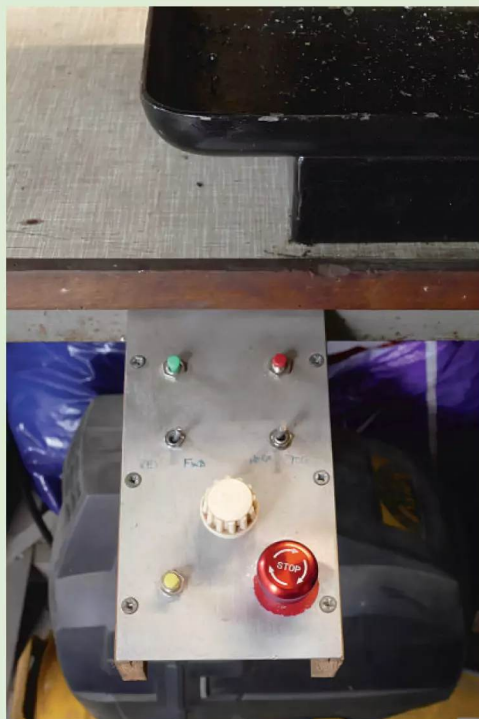
Dear Neil, your latest editorial (MEW 338) made me realise just how many talents the model engineering community possesses with the ability to find their own solution to a problem and then the skills to manufacture the solution using what was available to that person both in materials and tools

Faced with the problem of how to keep our inverters safe and clean you used your skills with 3-D printing to produce an enclosure. I took an entirely different approach to the same problem by mounting

the inverter on one of the workshop's power distribution boards some distance from the lathe, see my first photo, and using my electrical and electronic skills to produce a remote-control panel, the working prototype being shown in the second photo. Apart from the emergency stop button this was built entirely from what happened to be in my "spares" boxes (I have many!) and may, one day, be rebuilt

into a more elegant unit but since it has been working well for many years and only operates from 24V there is no immediate need for any great protection.

I would be cautious about putting an enclosure, however well ventilated, around my 1kW inverter. The pulley block on my lathe is built for A-section vee-belts, which limits the minimum size of pulley I can fit to the 550W motor. I am already at that minimum size and using the largest of the mandrel pulleys. This gives me 835 rpm on the mandrel for 50 Hz from the inverter and so I spend a lot of running time with the frequency below



20 Hz. At this frequency the motor presents a "difficult" electrical load to the inverter and its cooling fan runs continuously; any lower frequency for more than a few minutes and the inverter overheats and trips out. Using the back gears isn't really an option as the old cast iron gear wheels are so noisy at anything above screw cutting speed that ear protection is essential - not the most comfortable way to work.

Chris Gardiner, Chelmsford



And Another Approach

Hi Neil, I refer you to Issue 162, in which I did much the same thing. The disadvantage of mine, since overcome, was the tedium of accessing the inverter via the transparent panel. I now have a remote controller above the headstock giving stop/start/speed etc. I've checked the enclosure for ingress of swarf occasionally. Clean as a whistle. We all claim our own is best. So can I claim the Elegance prize?



James Perry, by email

Low Dropout Regulators

Hi Neil, I hope you are well and flooded with articles. The write up on batteries in the Chinese scales (Fergus Malcolm, MEW 338) was interesting and duplicated some of my experiments and findings. Could you pass on to Fergus to look at the AMS1117 low drop out 'three legged regulator'.

These are available in 1.2V, 1.5V, 1.8V and other versions. You can also get a ready-made PCB module on the net, but it is only the regulator and two caps. My experiments have been successful by simply adding the regulator module close to the scales.

Here is a related search link for my blog <https://altrish.co.uk/?s=regulator>

On page 23 Brian Jones requested advice for a small CNC mill. One option would be to look at the Sherline products, excellent quality and very well supported. If he wants something significantly bigger then the Tormach PCNC440 is an option. A lovely machine but I'm biased.

Alan Pezula, by email.

Painting Etched Plates

Dear Neil, my question relates to etched nameplates, specifically paints to be used in filling the background and then polishing the surface of the nameplate to remove any paint and take the metal from the matt to a shiny finish whilst maintaining a gloss on the paint.

Can you recommend a paint which can be purchased in small quantities in a variety of colours and sets hard enough that it will polish at the same time as the brass of the nameplate?

Any help and advise you care to proffer would be greatly appreciated.

Many thanks for a great magazine. The EasyCNC articles have really inspired me to look more closely at CNC and the Universal Pillar Tool (should Part IV have read "Part III ?) but enjoy all the more practical articles. Less sure about things like "The Dictionary" started in MEW 337 or the reprints of "Beginner's Workshop" of long ago.

However overall, I would say, keep up the good work.

Derrick Ardron, by email

Hi Derrick, I use Humbrol gloss enamels for anything like this. They will take a light polish and are much harder than acrylics. It helps to finish the metal nicely before painting, so you only need to use a very light polish with, say, Brasso wadding. A layer of cellulose lacquer can be used to keep a plate shiny long-term – Neil.



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..



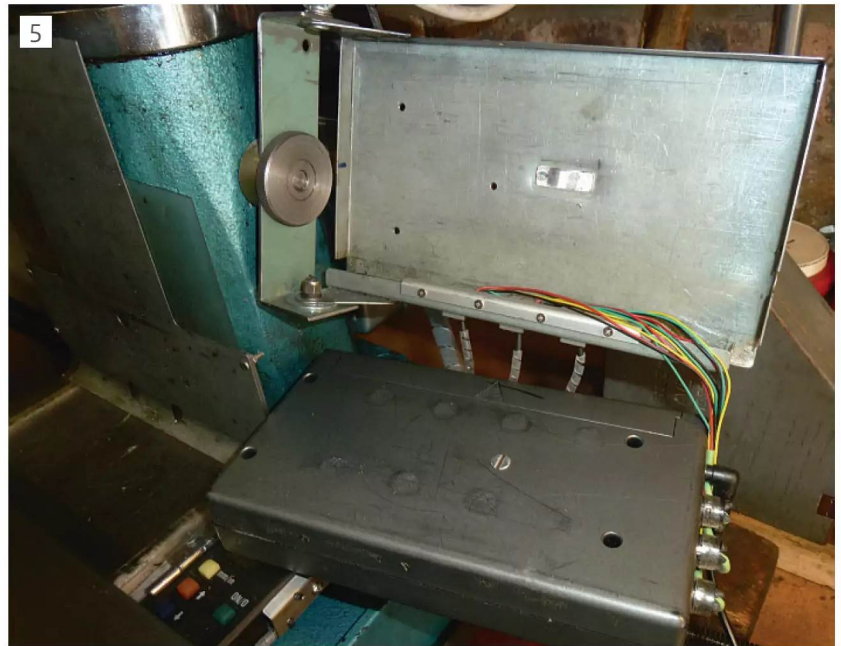
Solving Data Corruption In A Digital Scale Readout Display

Fergus Macolm follows up his approach to reducing corruption problems with digital scales by describing how he put his ideas into practice.

Some idea of the mechanical build will have been gleaned already, but here is a bit more detail. Once the LED readout mounting position had been decided, the sheet steel tray was fabricated. The tray attaches to the pedestal by a simple two axis adjustable mounting, fixed to the column by an M10 stud, see next paragraph.

Photograph 5 shows the assembly, and as will no doubt be appreciated, making the readout unit easily removable ensures that this will rarely be necessary. So in conjunction with the magnetic mounting, a flat contact (rather than a screwed connection) was used at the all-important grounding point. Pure tin solder on the contact surfaces provides a reliable connection, and indeed tin plating is used successfully for many low-cost connectors.

The mounting to the column may be of interest. Fixing to the structure should be sturdy and also provide a low impedance electrical path. Rather than bracketry or a hose clip round the column, a direct screw connection into the metalwork seemed appropriate. But making such an attachment to the base of the column has to cope with the tapered face and the non uniform surface. How to machine a



Tray, and the Back Face of the LED Readout Box

location recess with fixing thread? It was time for a crafty bodge.

A 20mm diameter hole saw was capable of making a suitable recess, **fig. 6**. Firstly, the wall of the column was drilled through horizontally (by eye) and tapped M10. An M10 guide bolt was fitted, through bored

1/4 inch diameter and with the corners reduced to clear inside the hole saw. This was used to pilot the hole saw to cut a concentric shallow recess in the column. To provide a clean(ish) recess, the residual ragged up-stand was removed with a small chisel.

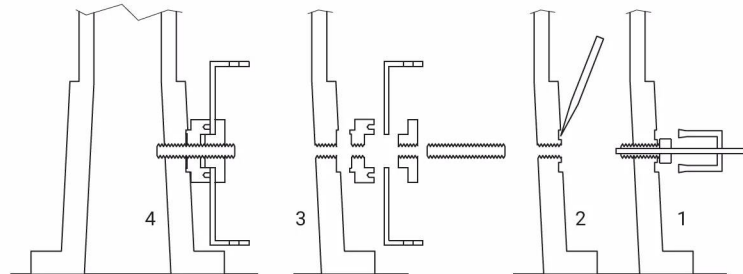
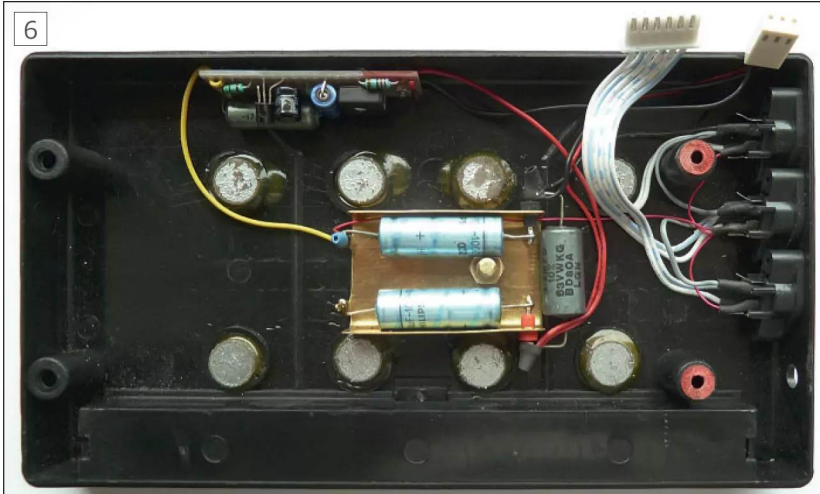


Figure 6

Making the Mounting on the Mill Column Base (without another bigger Mill)



Capacitor Plate and Regulator Board in the Base of the Readout Unit



Apron (with X Axis Scale Removed)

The interface to mount the tray is a brass bush which sits in the hole saw track and is threaded M10 to locknut the fixing stud. The other face is machined to provide location for the knurled clamping wheel for the tray. Note that paint was cleared from the contacting surfaces. While perhaps of greater electrical impedance than heavy copper braid, in practice the arrangement has proved entirely adequate.

Electrical component mounting

The grounding plate carrying the decoupling capacitors mounts in the centre of the base, see **photo 6**. The brass fixing screw also provides the

grounding path, and the method of mounting and connecting the capacitors is obvious. An additional connector was necessary to supply 5 volts and return for the small regulator circuit board which supplies the 1.6v to the scale connectors via the additional thin red link wires. The direct low impedance grounding path provided by the plate is fairly obvious.

Management of the scale data cables

The original DIN plug connections on the right-hand side were in the way and very vulnerable. Retaining only their pins, wiring was run to RJ11 sockets under the unit, and the tray formed to suit.



Y Axis Cable Guidance

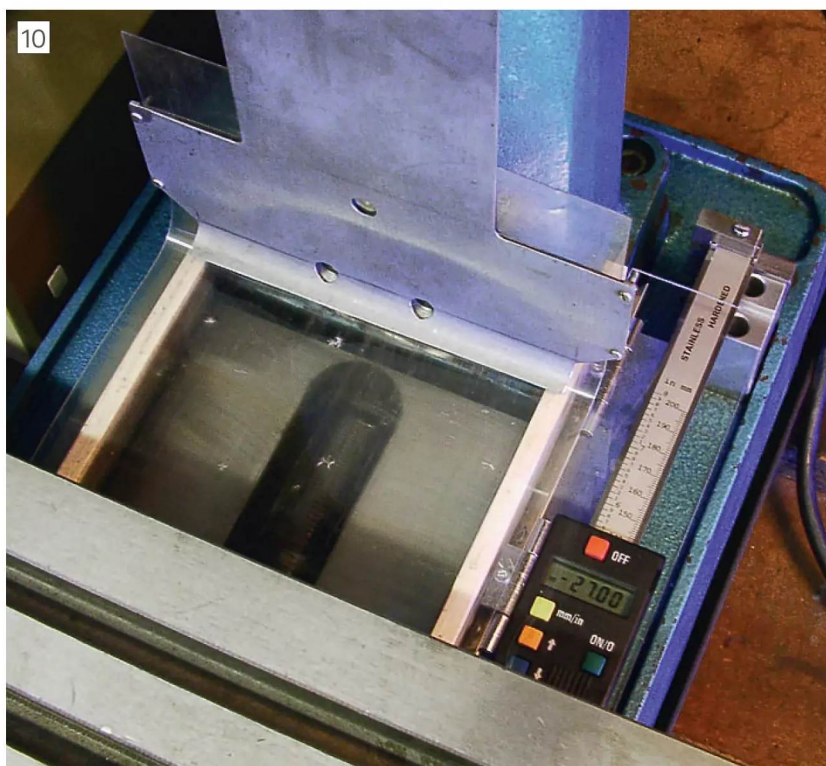
New cables that were already fitted with these plugs were obtained, resulting in a neater and safer configuration. However, when they were fitted to the mill, it was impossible to prevent these data cables from twisting, kinking and tangling. An initial thought was fitting them inside armoured flexible conduit as often used for machine electrics, but this is clumsy on a small machine. Threading the cables through rubber tubing was another possibility and would give protection from oil that may embrittle insulation, but would itself need to be oil resistant. However, having plenty of small diameter "Spirap", this proved to greatly improve the lay of the cable, though not affording much protection. Neither does it offer protection from oil, but guide troughs help keep cable runs away from contamination.

Photograph 7 shows the apron area, without the X axis scale which clips into the central slot below the tension spring with the "anvil" and anti-backlash plunger just visible. Both X and Y cables are routed to the lower left corner of the apron, where they enter a narrow U channel clear of the base (only the Y cable is present in this photo). The apron area is "very busy", but none of the functions had to be compromised in the final design. For example, the adjustable travel stops are accessible just above the bar of the scale, and are both moved and tightened using an allen key.

As **photo 8** shows, the cables are clamped as high as possible on the



9 Z Cable with Sheet Steel Guide



10 Revised Y Axis Swarf Guard

column pedestal and arranged to drape into the channel to provide for Y traverse. An electrical box at the rear stows excess length. Similarly, **photo 9**,

the Z cable is kept high and formed into a loop in the well-protected space between head and motor to allow for vertical and rotary movements. For cable

guides, thin sheet steel fabrications have been made. The method I use is to cut the sheet using a DeWalt hobby bandsaw intended for wood, but excellent for this task with either 24tpi or 32tpi metal blade. The cut is marked as a thin pencil line, and it is not difficult to cut even a complex profile to a fraction of a millimetre. A smear of wax over the pencil lines gives

just enough lubrication to extend blade life without contaminating the pulleys. Held clamped between off cuts of chipboard, the cut edges are then finished and deburred with a smooth file. This method eliminates distortion, at least until you come to make folds.

Results

I set the voltage for the scales at 1.6 volts and connected up everything on the mill/drill. Obviously, the scales must be without batteries. After verifying satisfactory communication and correct operation, I was gratified to note no corruption when switching the spindle motor. After many start/stop cycles I became increasingly confident the problem was solved. Extended use has confirmed this.

What of sensitivity to supply voltage? I included the ability to adjust the voltage, and as 1.4V was previously found to be about the minimum necessary for functioning, I started there. Operation was perfect! So while a higher voltage might be hoped to reduce noise susceptibility, correct configuration is key. A higher voltage not being necessary, I still set the supply to 1.7V. In engineering, extra margin does no harm even if you have no idea for what!

Conclusions

The correct configuration is much more satisfactory than a plethora of trial-and-error fixes. A web search suggested capacitors were needed in place of the batteries for remotely powering the scales. These were bought, but in fact have not been required. Operation is as good as hoped, with no corruption. There is the same 0.01mm jitter as other low-cost digital callipers (genuine Mitotoyo devices seem better in this respect), but this is quite commensurate with the modest capabilities of the mill/drill. Critically, use of the machine is transformed. The positioning of

the readout is ideal to view while simultaneously keeping a weather eye on the actual machining, and the bright yellow characters provide excellent immediate legibility.

Design considerations and miscellaneous musings

This Mill/Drill is a Clarke round column metric machine of typical Taiwanese pattern. A round section maximises stiffness for a given mass of material, and rigidity seems adequate for the spindle capacity. In the final configuration with three axis readout and X axis power feed, the mill is a much-valued asset in the workshop. It has become the default for jobs such as drilling groups of holes in metal sheet or even in wood because of the quick single pass process. Again, the power feed takes much tedium out of fly cutting and similar extended cuts.

I originally wondered if the lead screws were merely 10 TPI, but they agree accurately (2.5mm per turn) with the digital readouts. As well as fitting digital scales, my article in MEW 128 described a worthwhile improvement. The Y-axis travel was increased by about 15mm by lengthening the slot for the lead screw nut in the base casting, which also better centred the travel. This in turn required a much more compact swarf guard, and a design using 0.5mm polycarbonate film sliding through a curved slot has proved excellent, **photo 10**. It was expected that spring assistance would be necessary, but surprisingly it slides smoothly, rejects swarf, and does not stick or ruck. Alignment did need to be fairly precise. However, twenty years accumulated wear and hot swarf does now mean the polycarbonate film will soon need replacement.

A flexible approach

Nearly all features of the present project as already described turned out satisfactory at first attempt, but in an evolving project such as this it is well worth making reasonable allowance for revision. The capacitor plate is a case in point since it was easy to change or add components without spoiling the configuration. In the same way, a regulated power supply to eliminate the scale button cells was decided before it was clear the voltage was not at all

critical. In the event, a simple potential divider would have been good enough and incorporated on the capacitor plate, but the assured adequacy of the regulated supply was the safe choice.

About snubbers

The term snubber refers to a device to control energy surges, commonly in electrical or hydraulic systems. In the present case of an induction motor being switched off or on, some of the energy is converted to voltage spikes. Inductance has the property to continue the previous current, but disconnection removes the path, which results in the high voltage that the snubber is used to manage. For switching AC mains, this usually takes the form of a capacitor and a resistor in series. A simple capacitor across the switch contacts might absorb much of the voltage spike at break but unfortunately when the contacts made, the discharge current would cause accumulating contact damage. Hence the series resistor, and the component values are chosen as a compromise between voltage suppression, limiting the contact erosion, damping resonances and controlling the spectrum of interference. It is unlikely everything can be optimised.

Scale mountings for ease of use

The original placement of the scales was chosen to offer good intrinsic protection, but also give clear direct visibility of their display windows. All three scales can be quickly detached and replaced without loss of alignment by snapping into backlash free spring-loaded mountings or by means of hand tightened screws. This allows easy removal for cleaning or for large or rough work. The Y scale lies partially in a tunnel through the saddle casting for protection, but there is still visibility of the window and convenient access to the buttons. Both X and Y scales are protected by polycarbonate flaps, the X one quickly removable by loosening four screws.

Rejected possibility: electronic motor switching

You may gather that I have had limited success with optimising snubber characteristics. Contact bounce can be avoided by using a triac (semiconductor)

with electronic control. This usually includes zero crossing circuitry so that switching is always at the point where the AC voltage passes through zero, reducing the interference generated. The start winding would also require similar electronic management. Unfortunately, other switching such as an emergency stop button or adjacent machines would still very likely corrupt the display. It did not seem worth the considerable effort when not all eventualities could be addressed.

REJECTED POSSIBILITY: ELECTRICAL ISOLATION OF SCALES

Since the scale metalwork is irretrievably connected to the positive supply rail, wholly insulating each scale from the mill/drill structure was considered to allow the negative line to be connected to structure. This was rejected as requiring a lot of work, prone to short-circuit, and with no convincing guarantee of success.

Rejected possibility: greater voltage swing data transmission

A dependable method for data connections in a noisy environment is two-wire differential transmission similar to RS422, but this would be complicated to add. Easier but less certain would be to step up the transmitted data signal voltages by interposing level conversion buffers at each end. It was expected that level-shifting ICs would be available, but nothing appropriate was found, due once again to the awkward scale grounding configuration. A discrete component design was then explored but was found too big and too complicated. The idea was abandoned.

Existing modification - spindle lock

Soon after purchase, a spindle lock was made. This works in conjunction with the rotary forward/stop/reverse switch, which was modified with a cam to provide a safety interlock. The locking pin can be pushed up to engage with a hole in the rim of the spindle pulley, but only when the switch is at STOP. Selecting either ON position pushes the pin out of engagement.

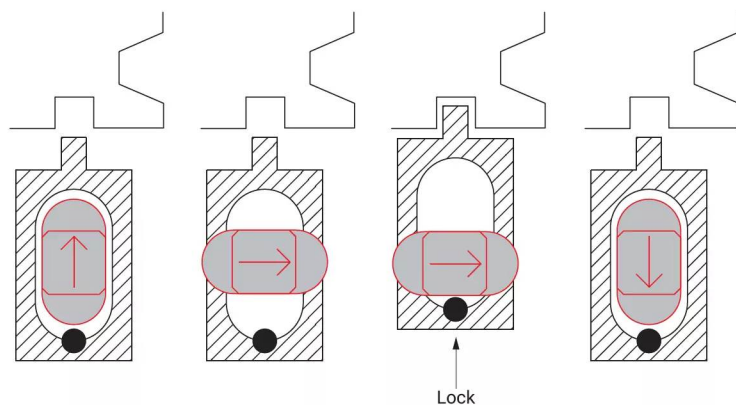
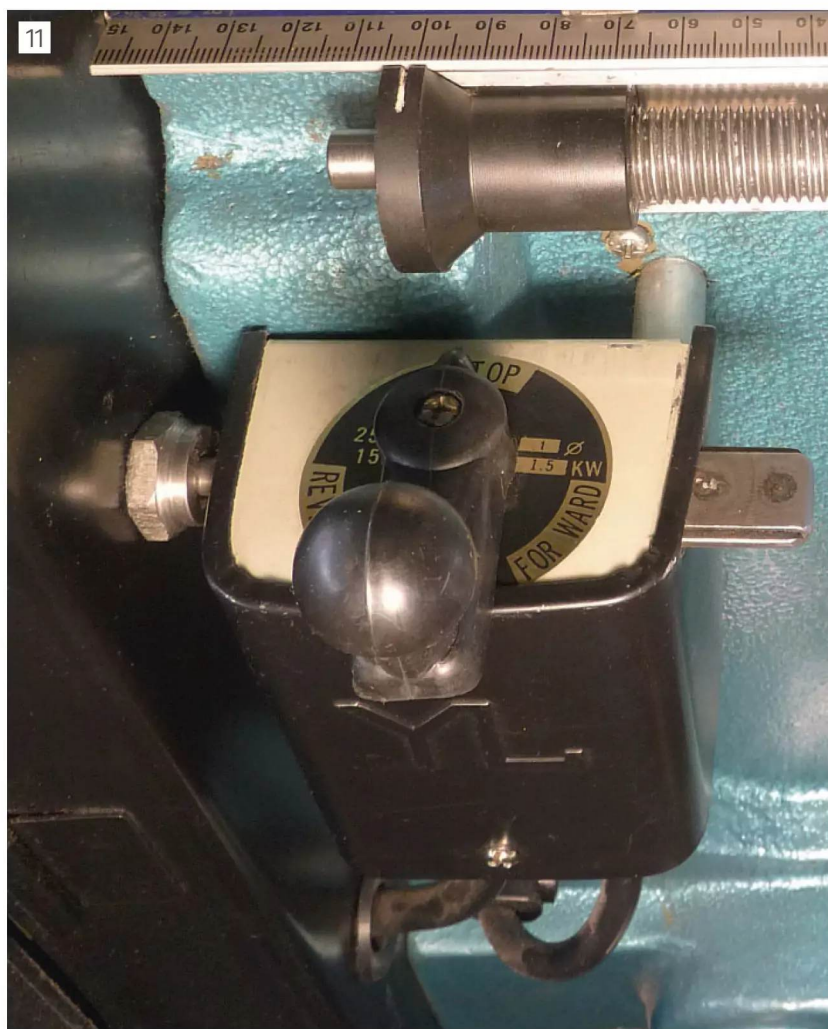


Figure 7

Spindle Lock Concept



Reversing Switch with Spindle Lock Tab

Figure 7 shows the concept, and **photo 11** the switch with the operating tab for the spindle lock. Modifications to electrical items do, of course, need special care to preserve the integrity of

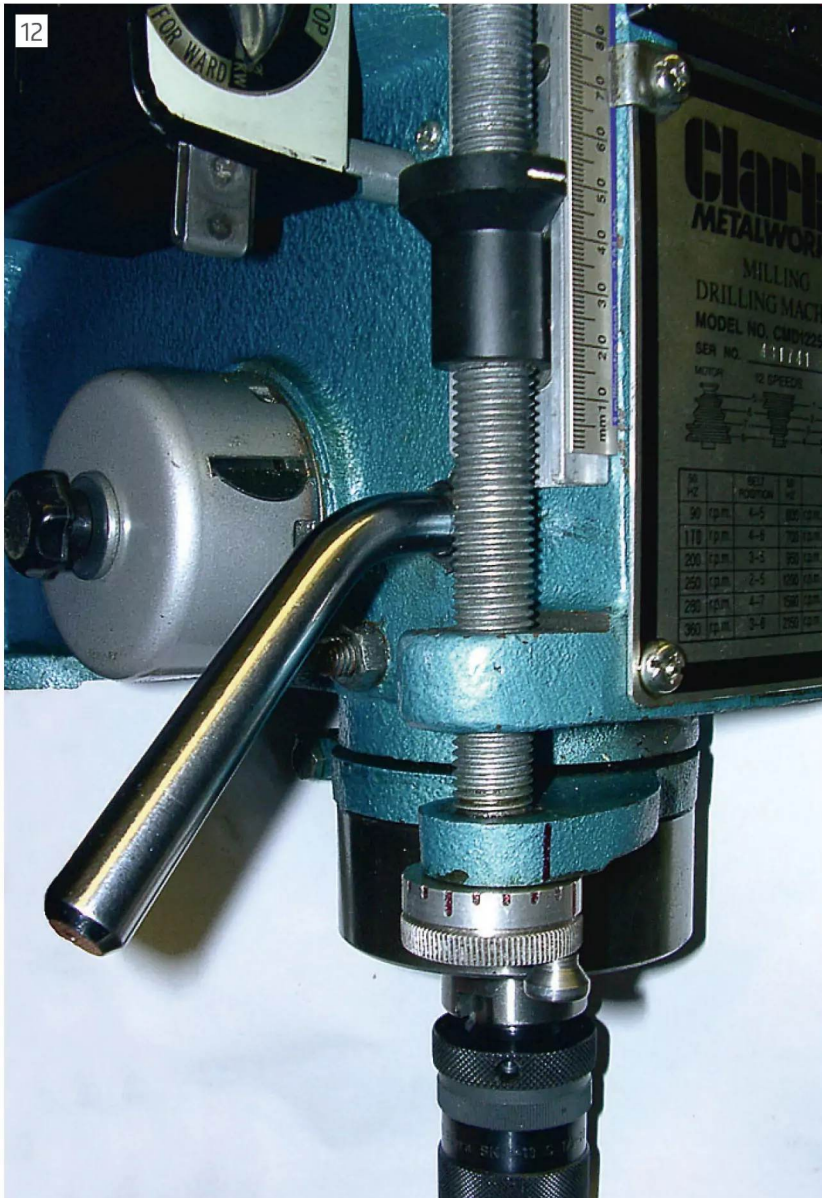
the insulation. In this case, there was just room for the extra mechanism between the front panel and the existing detent plate, thus avoiding proximity to any live switch contacts or wiring.

Existing modification - self ejecting differential thread drawbar

Another early modification was a somewhat unusual auto ejecting drawbar. This can be regarded as an experiment that was sufficiently successful to still be in use today. The mill/drill spindle is MT3, and as I already had several arbors with 3/8 Whitworth drawbar threads, I standardised on that. This thread is 16 TPI or 1.5875 mm pitch and used differentially in conjunction with a M10 thread of 1.5 mm pitch gives 0.0875 mm per turn, so high leverage is available. **Figure 8** shows how this is implemented.

It is easier to operate than to describe. Viewed from above and turning the drawbar clockwise, the net motion pulls the arbor up, 16 TPI being coarser than M10. First with the taper faces not yet in contact, the drawbar is screwed down fully into the arbor. Then, with the arbor allowed to rotate, the drawbar is screwed back up anti-clock until the taper contacts and stops turning. A further six turns are now applied (which unscrews the 3/8 thread). The arbor is lightly tightened by hand to seat the taper, then finally the drawbar is tightened about three turns clockwise, fully clamping it. For removal, the drawbar is simply screwed anti-clockwise until the taper comes free, and the arbor is then unscrewed by hand.

Although this has always worked reliably, I have considered replacing it. The worry is that ejection takes several turns of considerable force, during which



Quick Action Depth Stop

both threads are rotating under high load. In practice there has been little wear, but it feels less than ideal.

Existing modification – a better depth stop

The original “pillar drill” type depth stop was dreadful, and soon in a fit of exasperation was replaced with the design in **photo 12**. This operates in “distance to go” mode, and thus (before switching on) the drill or cutter is lowered to touch the surface, and the depth of the hole set directly on the scale. Alternatively, the drill is let down to the required depth, and the handle

rotated to screw the black “stop nut” fully down.

The existing depth stop mounting plate on the quill was found to have a suitable bore to be the outer of a plain bearing. By using M16 thread, each turn is 2mm with dial divisions at 0.1mm. These divisions do not synchronise with the ruler divisions but are useful for fine adjustment. Graphited nylon is used for the moving stop nut and is free running despite the rather uneven screwed rod. Setting is rapid and precise using the small handle, and despite now having a Z axis scale readout is still much used,

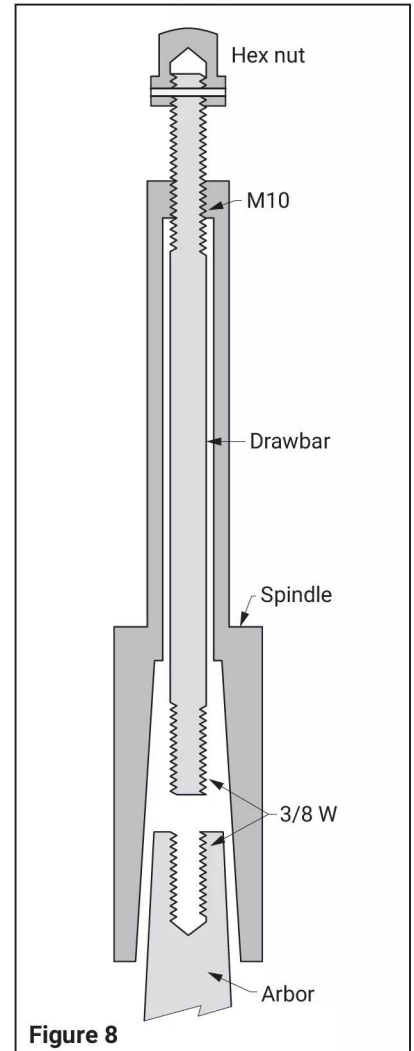


Figure 8

Self Ejecting Drawbar

particularly for peace of mind when working to critical depth.

Existing modification – align power x feed

I had toyed with a windscreen motor power feed, but a special offer of the Align unit was too good to miss. While the “Bridgeport” version uses bevel gears to fit neatly below the spindle, there is insufficient clearance below the mill/drill table. Therefore this “afterthought” adaptation sticks straight out well beyond the table, bad enough, but the supplied mounting proved unsatisfactory for stable gear mesh with the leadscrew. The clamping screws tightened against the considerable draw angle of the table casting, and mesh was easily displaced. A different mounting was designed to



Mounting of Align Power Feed Unit to Ensure Accurate Gear Meshing

maintain accuracy, **photo 13**, clamped by the wing nut for quick removal and replacement. Operation of the controls is indicated. The clutch centre position disengages the motor to allow normal manual operation by the lead screw hand wheel.

The Align unit works pretty well. The drive speed can be varied over an adequate range, roughly from 0.25mm per second up to 7.5mm per second, though unfortunately "feed per rev" is not readily deduced. The speed does vary slightly with loading, and also cyclically with rotation of the internal

plastic reduction gear. A replacement for this proved no better, though neither had measurable run out at the periphery nor any other obvious defect. While occasionally there is some patterning, a satisfactory finish is readily achieved. A fast slew button takes the effort out of long table traverses. When the limit stops were redesigned, a small buzzer was fitted to sound when a stop is reached, and this facilitates other activities when making long slow cuts.

To sum up

Sorting out the data corruption of the digital scale readout was a matter of carefully thinking things through. I had anticipated the cure would be finding appropriate suppression for the motor switching, but this turned out to be irrelevant. It merely needed the filter plate, its components and the correct disposition of the wiring to exclude harmful coupling of interference. Making the readout system less susceptible to interference has the important benefit

that sensitivity to externally generated interference will be similarly reduced.

The readout display is now dependable, and this has transformed the usefulness of the mill/drill. It is now the first choice for several tasks previously done by other means, for example using a table of coordinates to directly set out hole positions or to run machining coordinates. Another timesaver is quickly recovering the datum when changing the height of the round column in conjunction with the ball race edge finder recently described in MEW.

During more than twenty years ownership of the mill/drill, quite a few minor improvements have been made. Though each has been simple, the machine has progressively become more agreeable to operate. My use these days is sporadic, and I rarely do major projects anymore, but it is a great benefit to be able to quickly modify, improve or make from scratch items that would otherwise be difficult or time consuming to obtain. ■

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Contents subject to change.

Butterside Down

Steve Goodbody devises an effective solution to the problem of 3 inch Allchin Ruby Swann's lacklustre draughting.

Northampton

We visit the Northampton Society of Model Engineers.

Propane Burner

Graham Astbury converts a burner design by T.E. Haynes to run on propane rather than town gas.

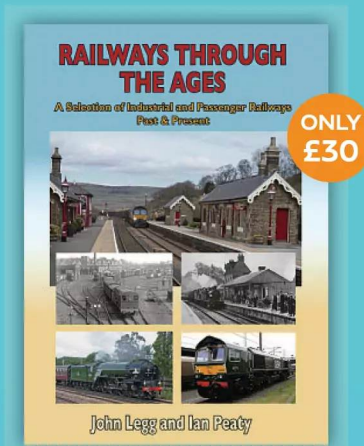
Federation AGM

John Arrowsmith travels to the Boscombe Down Aviation Museum, host to this year's Federation of Model Engineering Society's AGM.

A Cautionary Tale

Chris Rayward discovers the hard way that you need to know the composition of a non-ferrous alloy before trying to silver solder it.

The Next Issue of Model Engineer is issue 4740, April 19 2024

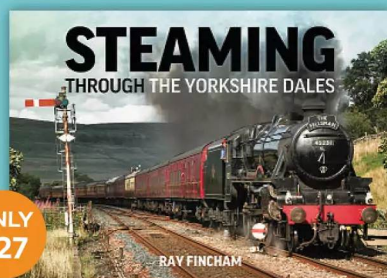


Railway Through the Ages

By John Legg & Ian Peaty

Dive deep into the history of railways from their early beginnings to today.

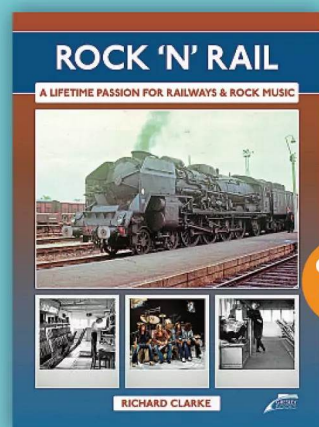
This book features a mixture of standard and narrow-gauge tracks, industrial and heritage lines, and iconic train stations.



Steaming Through the Yorkshire Dales

By Ray Fincham

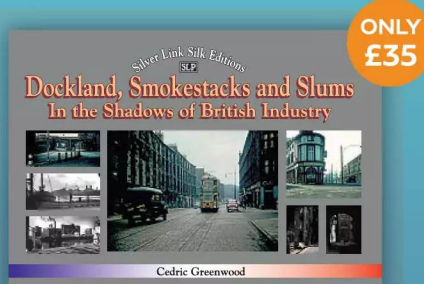
Explore the history of the 73-mile link between Settle and Carlisle that ran through the high fells and dales of Yorkshire and Cumberland.



Rock 'n' Rail

By Richard Clarke

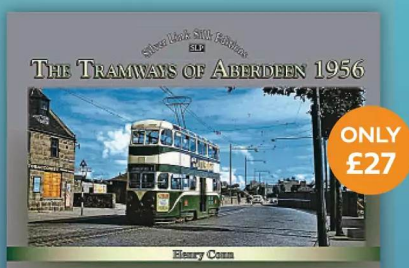
Rock 'n' Rail chronicles the changing scene of the rail industry from steam to privatisation – and the music industry from ballad through pop to rock.



Dockland, Smokestacks and Slums

by Cedric Greenwood

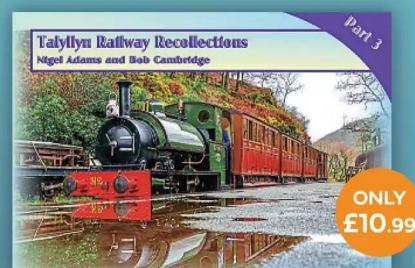
This book provides a photographic study of the 19th and early 20th century British industrial scene from its recovery following the Second World War to its decline in the mid-1980s.



The Tramways of Aberdeen 1956

By Henry Conn

This is the second book in a series that features the wonderful views of David and John Clarke taken in the year 1956.



Talyllyn Railway Recollections Part 3

By Nigel Adams & Bob Cambridge

The Talyllyn Railway is a remarkable survivor from a long past industrial age. Since 1865, it carried slate, then passengers. Enthusiasts saved it, volunteers maintain it. Enjoy its scenic, nostalgic journey in this book.

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Screw Cutting Gauges – A Comparative Review

The Editor takes a look at a couple of small pieces of metal.

On the forum at www.model-engineer.co.uk there has been some discussion on getting eth depth and form of lathe-cut screw threads right. An aid to getting this right are screwcutting gauges.

For those who may be unfamiliar with screwcutting gauges, they are rectangular metal templates, with various notches cut out to help with grinding and aligning tools for screwcutting. The v-notches are sized to suit 60° metric threads, 55° imperial threads and 47.5° BA threads. A special notch allows tools for 14.5° Acme threads to be checked as well. Alignment is done by placing one side of the gauge against the work, and offering the tool tip up to a notch on the opposite side.

The M&W gauge, **photo 1**, is thinner and is slightly smaller in its length and width than the economy, **photo 2**, but the measurement notches appear to be the same sizes on both gauges. It's hard to be definitive about what material they are made of. The M&W is discoloured in patches, which *may* be a bit of surface tarnish, suggesting a carbon steel Whilst the economy version looks like stainless

steel. A discrete scratch test showed the M&W is significantly softer than the economy version.

The M&W's markings appear to be etched or laser engraved, while the economy gauge has very clear stamped markings. The M&W markings are fainter and harder to read at a distance. The M&W one has the maker's name and No.200 which the other does not.

The edges of the M&W gauge don't feel as 'sharp' but they are both well finished. it may just be that the M&W gauge is older and has worn through contact with other tools.

The import is noticeably heavier and this makes it a little more pleasant/positive to handle. The slight extra thickness may help alignment when offering up to a sharp tool.

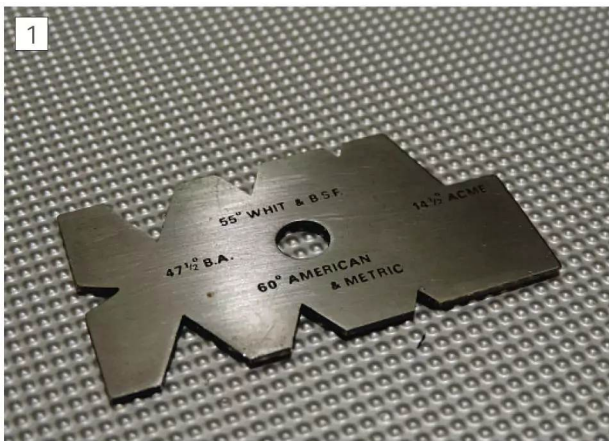
The both have a hole in the middle of exactly the same size. The arrangement of notches is identical, but as mentioned above the imported one is larger and the notches are therefore slightly further apart.

I can't see or feel any difference in the accuracy of the notches comparing the two gauges one against the other.

There is one difference that does put the M&W tool ahead. It has small slits at the bottom of the v-notches and the acme notch has a 'square' corner. The imported gauge has a slight radius in all internal corners.

In many ways the economy gauge appears superior – its markings are easier to read, it has a bit more thickness, has a bit more weight, appears to be of stainless or less easily tarnished steel and it is noticeably harder. In contrast the M&W is smaller (with the same size notches) which makes it a little handier to use. But the main difference is the little notches in the vees. This means that out of these two, only the M&W gauge can be used reliably on a pointed tool that hasn't had the end slightly stoned, which is exactly what you need when you are grinding a tool to match the template. This means the M&W wins by a clear head.

Naturally other 'economy' gauges may have notches or at least more cleanly cut corners, but I would say that if you want to grind your own screwcutting tools, rather than just set them, look for the little slots at the bottom of the V notches.

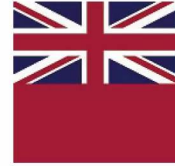


The Economy gauge has clearer markings and is made of a harder steel.



The Moore and Wright screwcutting gauge, note the tiny slots at the tip of each notch.

Rebuilding Medway Queen's the paddle box fascia



To mark the paddle steamer's centenary in 2024, Richard Halton takes a look at one of the 'workshop' tasks undertaken by the Medway Queen Preservation Society's volunteers.



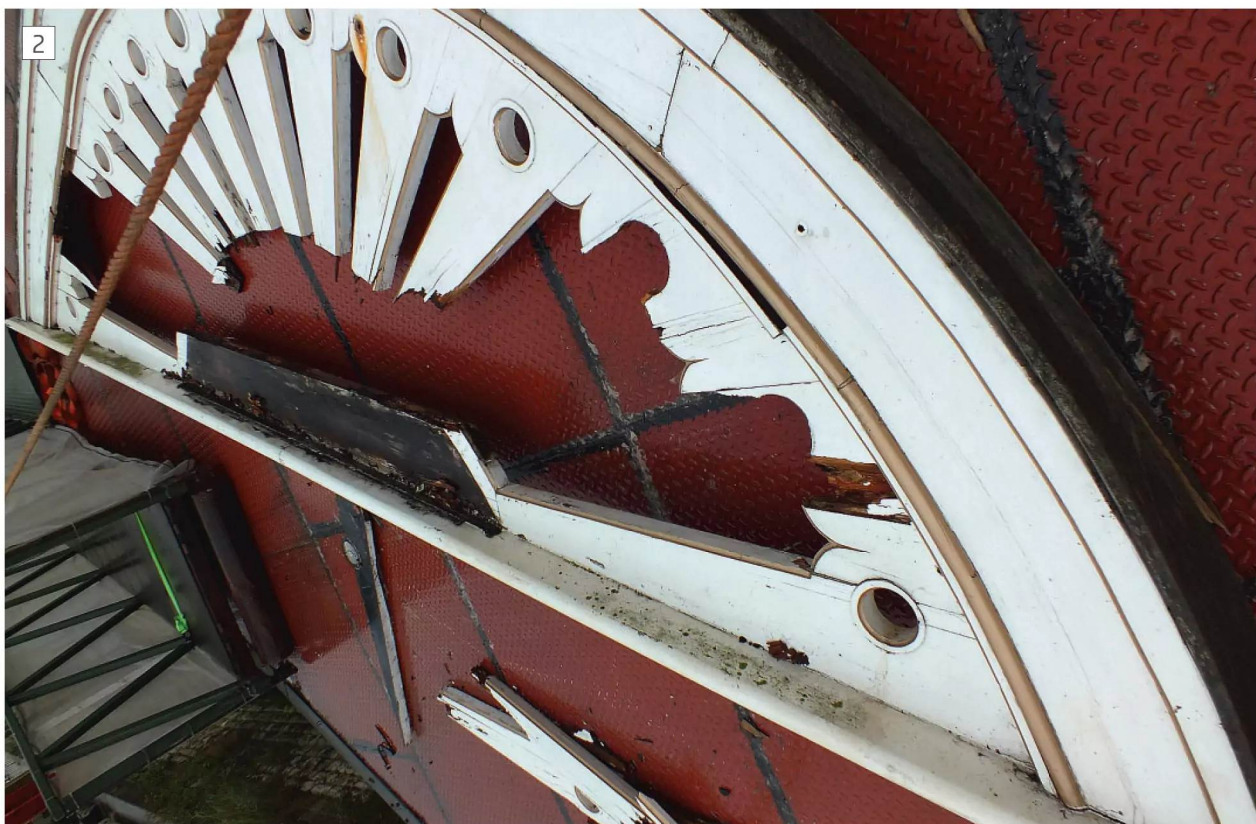
Medway Queen.

The paddle steamer, Medway Queen, **photo 1**, is preserved in static condition at Gillingham Pier, Kent, where restoration work continues. In 2021 she was towed to EAPL's yard in Ramsgate for hull maintenance. We knew that both paddle box fascias would need remedial

work and planned this for when she returned. When work started on the starboard paddle wheel, they found that the fascia was in a worse condition than expected and for the safety of the EAPL crew it was agreed to remove it. Where Medway Queen is moored the starboard side receives little direct

sun and does not dry out quickly after rain. The wood deteriorates as a result. Timber paddle fascias have always been replaced from time to time and even in her static role PS Medway Queen's have been replaced several times.

The ship returned to Medway in January '22. It was obvious that the



The damage was obvious, Mick Appleyard.



Lofting, Bob Wilde.

starboard fascia was beyond repair, **photo 2**. All of the MQ workshop crew were involved at some point in the reconstruction of the fascia. Ron Vant was the Project Lead, assisted by Bob Wilde. The following account

of the project was adapted from their account of the work, published by MQPS in 2023 and on sale at www.medwayqueen.co.uk. We have drawings showing the design of the paddle box fascias, but each drawing

showed a different set of dimensions, and none matched the current fascia. The team decided to go back to basics and employed "lofting" techniques. They placed the remains of the fascia on the workshop floor and drew



The main spokes, Bob Wilde.



Router in action, Bob Wilde.

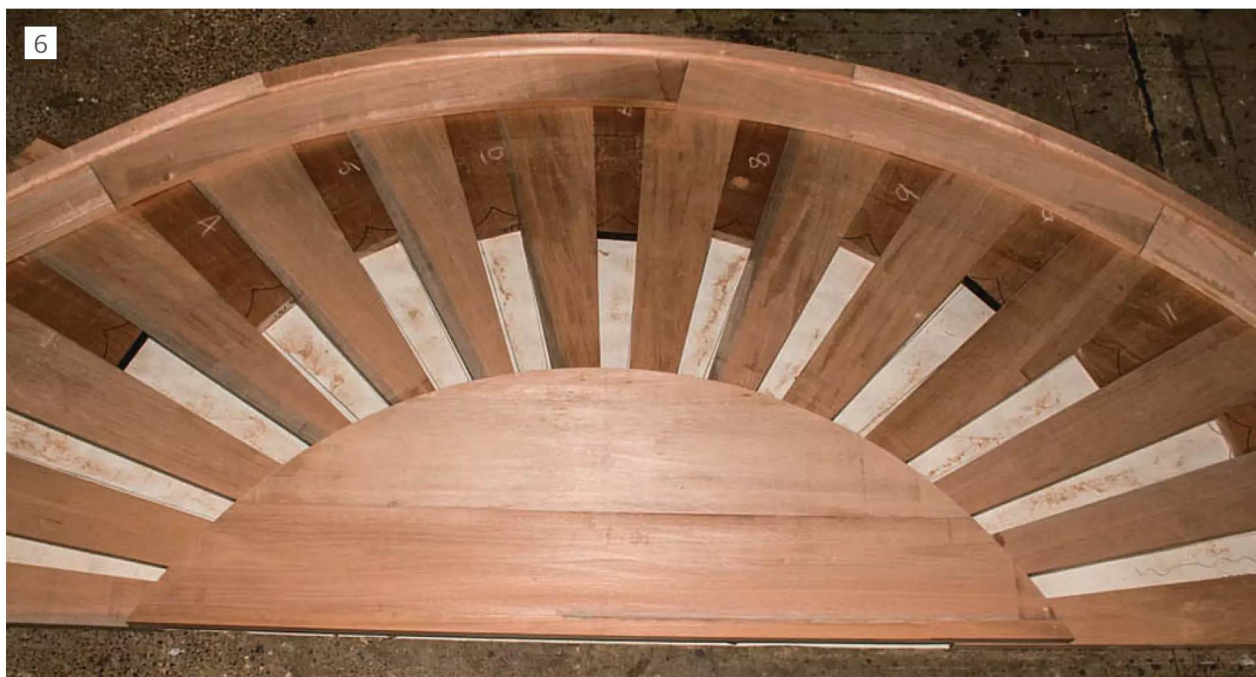
around all the remaining pieces with chalk, **photo 3**. This was transferred to a full-size paper template made up from lengths of lining paper taped together. They then made a full-size model using hardboard and battens, which was placed against the paddle sponson as a size check.

Ron drew up a cutting list and a local supplier gave us a competitive quote for the supply of Meranti hardwood. This would be for rough sawn timber, giving a dramatic cost saving. The workshop has a circular saw and a planer to take the sawn pieces down to the exact size required and give each surface a smooth finish. There is also a bench router for cutting detailed shapes and a spindle moulder, plus a variety of routers, joint-cutters and hand tools. The wood would also need preservative and paint. Advice was sought from Brewers Decorator Center (Gillingham) who generously supplied the preservative and paint free of charge,

Cutting to size.

A local wood carver was persuaded to carve a replacement shield for the centre piece, which could be mounted on the semi-circular board which had survived the weather. There would also be a larger hub semi-circle, constructed in sections due to timber available. In simple terms the fascia has this semi-circular hub and an arched top shape, which had to be manufactured in sections. See illustrations. This is covered by boards bent to fit the curve. The team started by cutting timber for the long "spokes" of the fascia fan, **photo 4**. The width at the top was wider than the available timber so they had to join an additional piece at the top with 'slip tongue' joints. This gave us fourteen pieces shaped like a square 'P'. Next, they cut the thirteen shorter spacer pieces to length. These were sawn to a fixed angle using a jig on the circular saw. Laying the parts on the paper template the individual angle to be cut was determined for each spoke. A long straight edge was clamped to each spoke to guide the circular saw.

For the smaller boards there are two different shapes. The first one has a half round detail on the top, shaped on the spindle moulder, the second has the detail cut using the bench router, **photo 5**. Having cut the spokes, they



Major parts laid out, Bob Wilde.

needed to add detail; curved V shapes on the end of the shorter spokes (band saw) and a 5" diameter hole in each of the long spokes to house the decorative collars. A curve was cut on the narrow end of each long spoke to match the curve of the hub board. The radius was consistent, but each spoke had to be individually cut as they meet it at different angles. The boards were laid out on the floor and care was taken to ensure everything was positioned correctly. Using the hub as a template the position of the curve was drawn on every long spoke and a template made to guide the router.

Assembly.

The top curved board assembly was laid face down on the benches and the spokes and infill pieces were laid in position, **photo 6**. These included the long spokes and the shorter, infill, spokes. Blocks were used to maintain the level as the curved board is around 50mm thick. The half round board was placed on the bench, again supported by blocks to ensure it was level. Registration marks were made on each spoke, to help with the alignment. The top of each spoke was then shaped to fit the curve of the curved board. A hand saw was used to remove any significant excess and then finish

it using an electric planer until the curve of the top edge of the spokes matched the curve. The long spokes were connected to the half round board using zip bolts to pull them together.

The top edge boards of the fascia needed to be steam-bent to shape. Once the steam tank was full of steam, they loaded the wood into it. The team was split between those handling the board when it came out of the steamer and who would bend the wood and the rest would apply clamps to hold it in place. The first piece was about 2.7m long. This was to be central on the top of the paddle sponson so that joins would not be so obvious. The end of the first board was against the top edge and gently, but quickly, bent around the curve of the top of the paddle box fascia and the clamps were then applied. Then it was drilled and screwed to the curved top board of the fascia. Other edge boards followed the same procedure.

Painting.

The first two coats were a preservative. Although hardwood was used, we needed this to last as long as possible. Next came three coats of primer undercoat, followed on the back of the fascia by three coats of satin black. After turning the assembly over, using

the forklift with a boom attachment. Two coats of preservative, then three coats of primer undercoat were applied. Finally, three coats of satin white. The routed edges of the spokes, the edge of the wide curved board, and the top of the collars on each long spoke were highlighted in gold. The small, curved board had the scroll work and new crest attached and was added to the main assembly. The "Medway Queen" name board was also attached.

Installation.

In April 2023 we completed the work on the fascia. It weighs around $\frac{3}{4}$ ton, so care was needed, and the workshop crew worked together on a detailed plan and risk assessment. The boom was fitted to the forklift once more and straps positioned around the fascia, ensuring that the balance was even. We needed to slide the new paddle box fascia between a few structures on the edge of the quay adjacent to the ship and the paddle wheel. We started the lift and moved it out of the workshop and onto the quay.

The fascia had to be threaded between the quayside obstacles and lowered into position. It was then secured by team members working inside the paddle box. As far as we know they all successfully extricated themselves afterwards! ■

Conditional Statements in Mach 3

John McPhee offers a way to implement conditional statements for those who write their own machining programmes. Some basic knowledge of how to understand and edit G-Code is assumed.

For those hobbyists amongst us who prefer stepper motors on our leadscrews instead of handles then MACH3 is probably the most common CNC system used. Any user of MACH3 software who writes their own G Code programs will at some point want to make a decision within the part program dependant on certain conditions and want to control what the program does next. In many languages this is a standard function known as If () then Goto () or If () then Goto () Else (). At first, second and third look through the MACH3 programming manual this is apparently impossible. But that's not so.

I realized that since subroutine label calls can be the result of an expression evaluated at run-time, we can use maths to effect conditional execution of the part program. Consequently a main program or a subroutine can have a decision-making bit of G Code in it that subsequently calls more subroutines. Here is a way of doing so.

Firstly allocate three-part program parameters to be used repeatedly as temporary stores each time a decision is made. The following program is highlighted, with information text in brackets.

Let's say:- **#102 = 0 #103 = 0 #104 = 0**

Now for an example another parameter in the program could be (Make a decision:- enter 0 for doing something, enter 1 for doing something else):

#018 = 0 or #018 = 1

And you would select two subroutines to run as an outcome so:

Subroutine 50 is executed for doing something when #018 = 1

Subroutine 51 is executed for doing something else when #018 = 0

The G code in your part program would look like this. The resulting parameter #104 can only ever be 0 or 1.

(This sets the argument for deciding which subroutine to run)

#102 = #018

(This decides if 102 is -ve or 0 then #103 is = 0 if 102 is +ve then #103 is a positive number)

#103 = [#102 + ABS[#102]]

(if #103 = 0 then #104 = 0 if 103 is not zero #104 = 1)

#104 = [1 XOR #103]

(if #104 = 0 run subroutine 50 if #104 = 1 run subroutine 51)

M98 P [#104 + 50]

The "50" can be substituted for the first of any consecutive pair of subroutines.

This is a slightly upside down result since a value of zero in parameter #018 results in the addition of one, and a value of one in parameter #018 results in the addition of zero to the chosen subroutine pair. You soon get used to it.

Or you could alternatively say for the last line of the G Code.

(if #104 = 0 run subroutine 0 if #104 = 1 run subroutine 50)

M98 P [#104 * 50]

This would result in:

Subroutine 0 is executed for doing something else program i.e. #018 = 1

Subroutine 50 is executed for doing something program i.e. #018 = 0

The advantage of using multiply is that Subroutine zero could be left empty and would be a constant "do nothing" routine for every decision made. This equates to an If () then Goto () where using the addition method gives you If () then Goto () Else (). In fact any equation could be used to determine the call and I'm sure some creative formula could be developed.

So now you can control G Code flow into two different subroutines to do different things dependant on a part program parameter. That was a simple example of If () then Goto () Else (). The argument parameter (#018) was declared as either zero or one, in reality it can be any equation resulting in a value for testing and can be a dynamic value in the program.

i.e. a counter, result of a probed axis position, etc.

Also bear in mind that subroutines can be nested, and you realise that really complicated part programs can be created. Sometimes the decision-making calculations are a bit convoluted, it's simply a case of making the maths equation evaluate the logic that you're trying to achieve. I have one program that engraves a Celtic pattern dependant on a string of numbers relating to shapes where the subroutines nest many many times.

As an example the following figures show the documentation for a program I wrote that cuts slots. **Figure 1** shows the definition of the slot to be cut, any parameters over thirty are calculated within the subroutine itself and do not need declared. **Figure 2** shows examples of slot patterns that can be cut. **Figure 3** shows the flow diagram of the G Code. **Photo 1** shows an application of the slotting program. I'm sure if you write G Code you can appreciate the time saved in programming.

Below is the G Code used for generating slots, this would go into a part program in your c:/Mach3/GCode folder. The G code for actually executing the cuts is in the subroutine program and should never need to be modified. The last line M98..... runs the subroutine that should be put in the c:/Mach3/Subroutines folder on your PC.

% tooling

#001 = 010 (Enter tool number)

#002 = 4.0 (Enter tool diameter)

#003 = 2000 (Enter spindle speed)

% feedrates

#004 = 1000 (Enter non cutting feedrate)

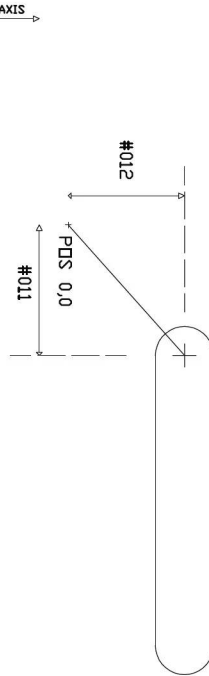
#005 = 500 (Enter cutting feedrate)

#006 = 250 (Enter finishing feedrate)

#007 = 100 (Enter z axis down feedrate)

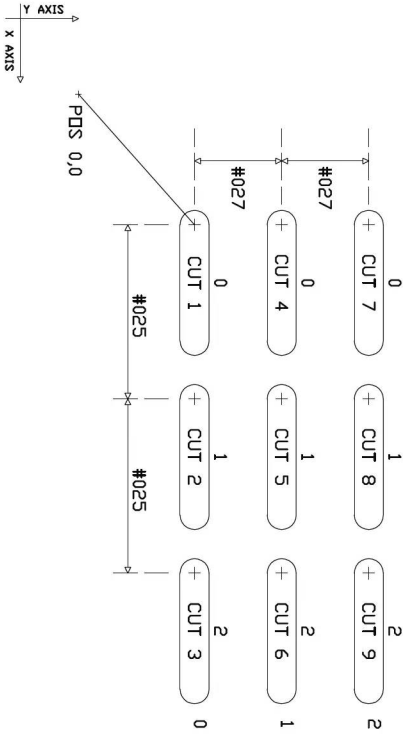
VARIABLES

#018 = 0 (0 = SINGLE SLOT 1 = MULTIPLE SLOTS)
 #019 = 0 (0 = RECTANGULAR 1 = ROTARY SLOTS)



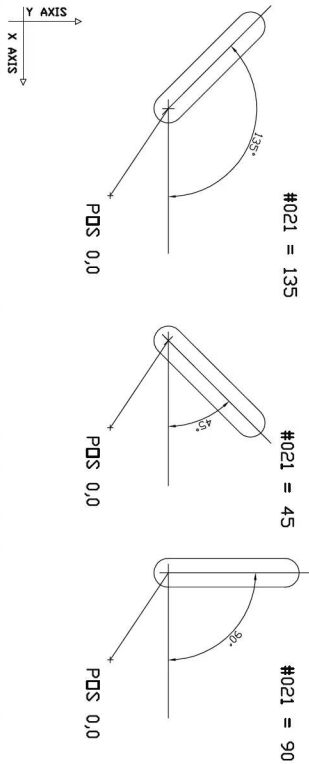
VARIABLES

#018 = 1 (0 = SINGLE SLOT 1 = MULTIPLE SLOTS)
 #019 = 0 (0 = RECTANGULAR 1 = ROTARY SLOTS)
 #024 = 3 X AXIS ARRAY QUANTITY = 3
 #026 = 3 Y AXIS ARRAY QUANTITY = 3



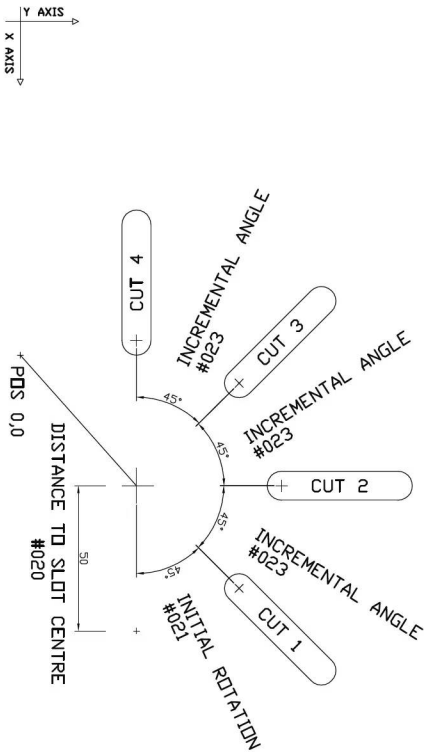
VARIABLES

#018 = 0 (0 = SINGLE SLOT 1 = MULTIPLE SLOTS)
 #019 = 1 (0 = RECTANGULAR 1 = ROTARY SLOTS)
 #021 = INITIAL ANGLE OF ROTATION

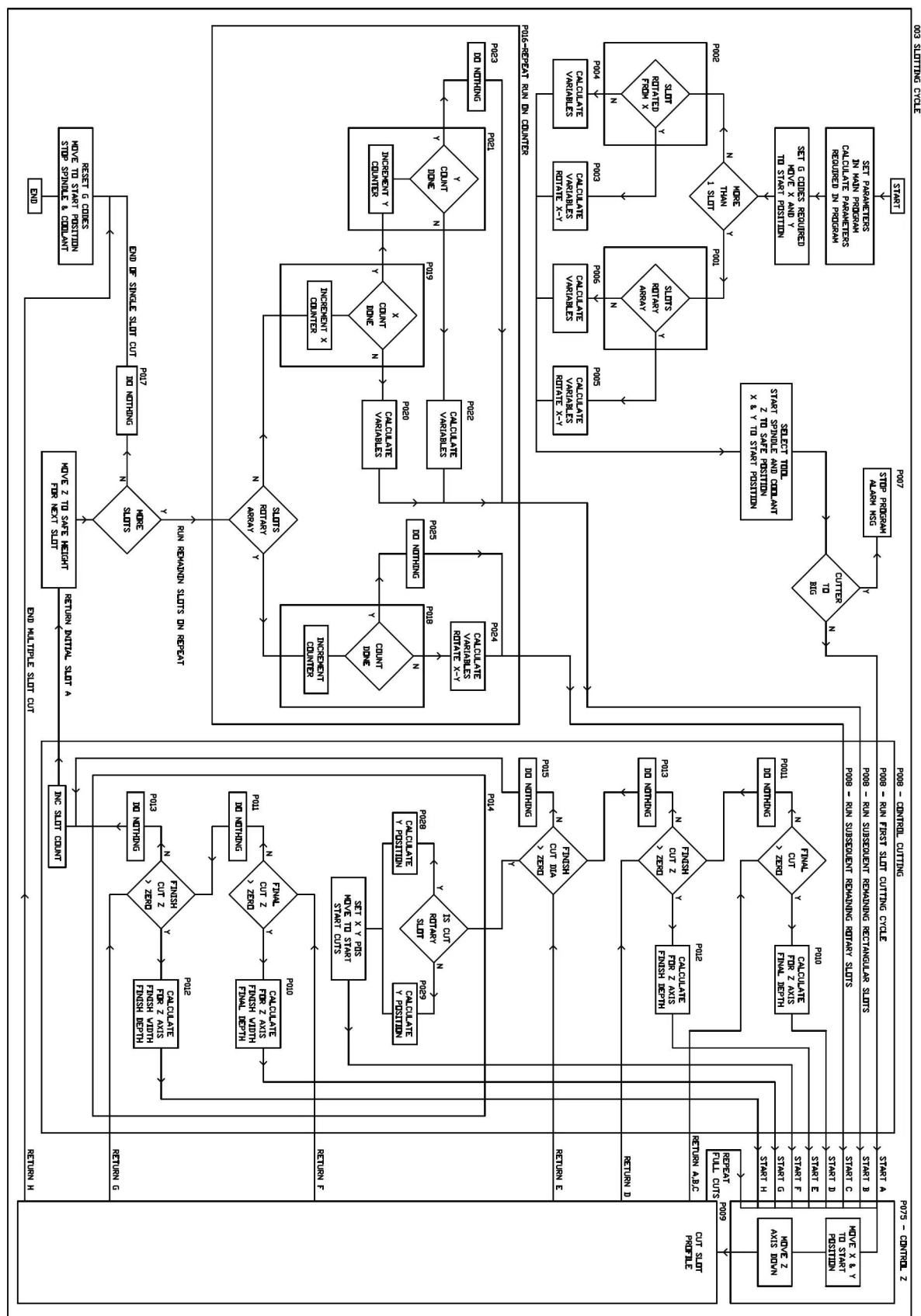


VARIABLES

#018 = 1 (0 = SINGLE SLOT 1 = MULTIPLE SLOTS)
 #019 = 1 (0 = RECTANGULAR 1 = ROTARY SLOTS)
 #022 = 4 NUMBER OF SLOTS TO CUT



Slot layout parameters



% cutting dimensions

#008 = 1.0 (Enter cutting depth per pass)
 #009 = 0.3 (Enter z axis finishing cut depth)
 #010 = 0.2 (Enter x-y axis finishing cut depth)

% slot positions

#011 = 0.0 (Enter x axis starting offset)
 #012 = 0.0 (Enter y axis starting offset)
 #013 = 0.0 (Enter z axis start cutting height)
 #014 = 5.0 (Enter z axis safe start and end position)

% slot dimensions

#015 = 15 (Enter x slot length)
 #016 = 6 (Enter y slot width)
 #017 = 2.0 (Enter Z slot depth)

% configure slots to cut

#018 = 1 (Enter 0 for single slot Enter 1 for multiple slots)

#019 = 1 (Enter 0 for rectangular slots Enter 1 for rotary slots)

% rotary slot

#020 = 10 (Enter distance from centre of array to slot start centre)
 #021 = 45 (Enter initial slot rotation angle from x axis)

% rotary array

#022 = 4 (Enter number of rotary array slots to be cut)
 #023 = 45 (enter angle between slots)

% rectangular array

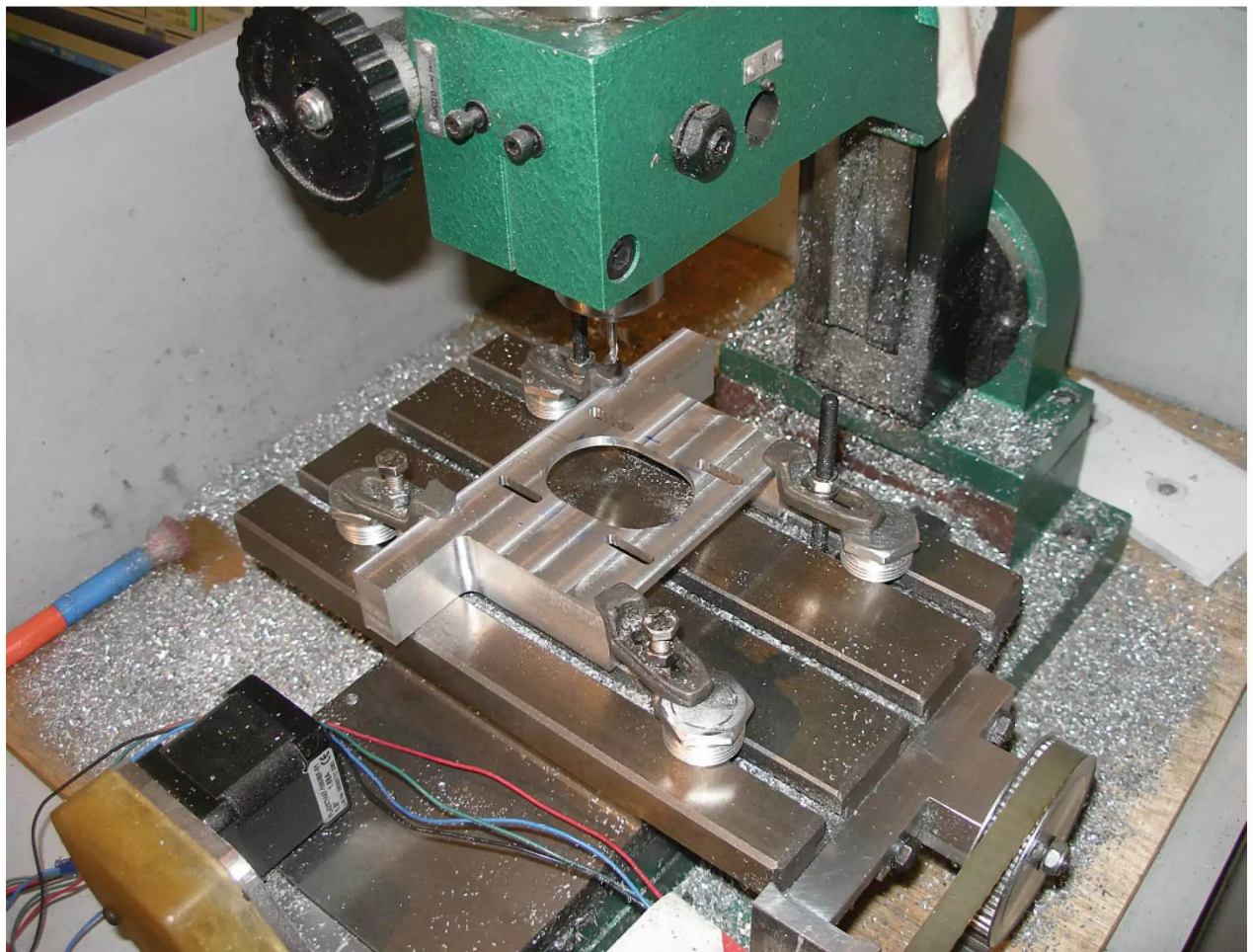
#024 = 2 (Enter x array quantity)
 #025 = 30 (Enter X array spacing)
 #026 = 3 (Enter y array quantity)
 #027 = 20 (Enter y array spacing)

M98 (003_slotting_cycle.tap)

Decisions can be made in MACH3 and this enables new programming

options previously not known about by many users. This also opens the gates to using Mach3 on specialist machines. In my slotting program, once the initial programming time has been made, it subsequently saves loads of time when developing G Code for components. Because the program itself is quite long and re-typing it would be a pain in the backside, I will make the documentation available for download on the MEW website along with a little subroutine test program.

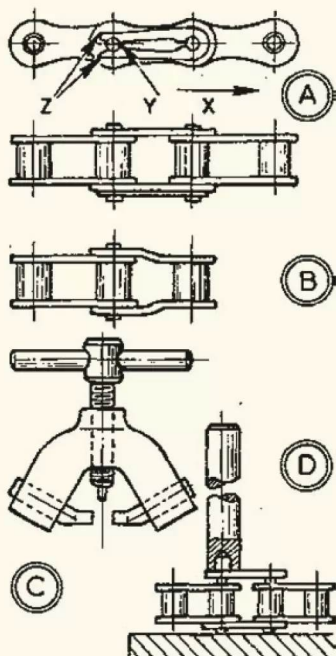
I hope this is of some help to those of us who prefer motors on our lead screws instead of handles. Happy programming. ■



X3 motor bracket slots

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.



PRESENT-DAY DEMAND being for simple drives, the choice often falls on roller chains and sprockets and, of numerous applications, those on cycles, motorcycles and cars-camshaft drives-are perhaps the most common.

Not least of the virtues of chains and sprockets is their high "mechanical efficiency" -power transmission with small friction loss-which is particularly valuable on pedal cycles. Drive, moreover, is non slip and, unlike gears, does not demand precise centre distances between shafts. Often too, chains and sprockets are more silent than gears and will withstand more abuse on open drives.

A typical roller chain, A, consists of links with rollers and links with pins. Those with rollers each comprise two sideplates in which bushes are pressed for the roller to turn on the outside and for the pins of the other links to find a bearing inside. Links with pins consist merely of a pair of sideplates and pins.

When assembled a chain is permanent, but it can be opened or shortened by pressing the pins out of a sideplate. Often to permit removal a chain has a spring link, A, this having longer pins than the others, a sideplate to push on, and a clip to fit in grooves in the pins. A tapped link is sometimes used on cycle chains; this has a threaded sideplate taking a small screw secured by a lock-nut. A

chain being permanently riveted, as on a car camshaft drive, both sprockets are drawn evenly to effect removal.

In applications where a chain of standard links is too long and it is impracticable to shorten to the extent of a whole link of two rollers? a special "half link" or cranked link, B can be used. This should not be dismantled more than illustrated. Four rollers are removed from the chain, and three inserted, shortening it by one.

The clip of a spring link, A, should be fitted with the closed end to the direction of travel, X-any contact pushing the clip on. Removal is best effected with the link on the sprocket, using square-nosed pliers, getting a grip on the pin at Y, on the legs at Z, and holding a finger over the clip to prevent it springing away.

For dismantling, a chain punch, C, is necessary for sideplates cannot be

satisfactorily prised off nor pins tapped out. The punch jaws grip round a roller and the screw forces the pin back.

To assemble, links should be on a flat metal surface, the sideplate tapped on, then driven down with a hollow punch, D-a piece of rod drilled to clear the end of the pin. Afterwards the link should move freely. Old and new links should not be used together in a chain or it will run tight and loose.

There are various tests for wear in a chain. On a large sprocket it can be pulled at the mid point of the wrap round and should not lift away to any noticeable extent. Removed, a chain can be held sideways, E, when considerable "bowing" indicates wear. Play can be felt in the individual links and the sum of wear-lengthening-can be seen by laying or hanging new and old chain side by side.

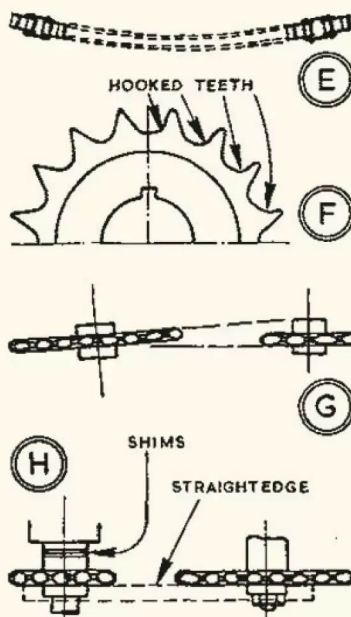
On sprockets, observation should be made for "hooked" teeth, F, those on the left of the centre line being correct unworn shape.

Cleaning and adjusting

Cleaning can be done with paraffin and a brush, and for lubrication grease or oil can be used-cycle oil for cycle chains, engine oil for motorcycles. On occasion, the latter are immersed for a few minutes in a tin of warm grease, then hung up to drain.

In adjusting chains, sprockets should be turned several times to check there are no tight spots, and at the tightest spot the chain should just be free. On a motorcycle a tight primary chain can cause the clutch to drag.

Where there is possibility of misalignment, G (as on a back wheel) care should be taken to adjust evenly and squarely with the line of the chain and sprockets "sighted" -or, if possible, a straightedge placed along. This latter method is employed on car camshaft drives, H, where the crankshaft sprocket may require to be shimmed out level with the other.



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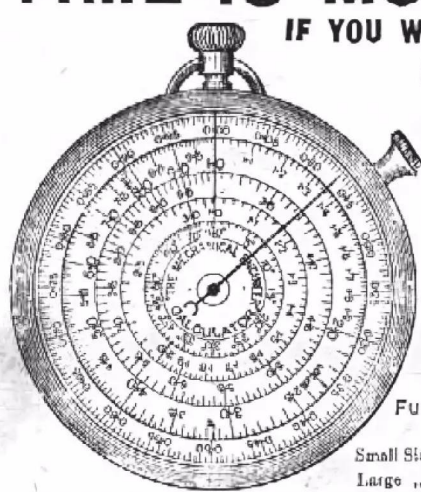
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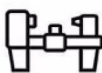
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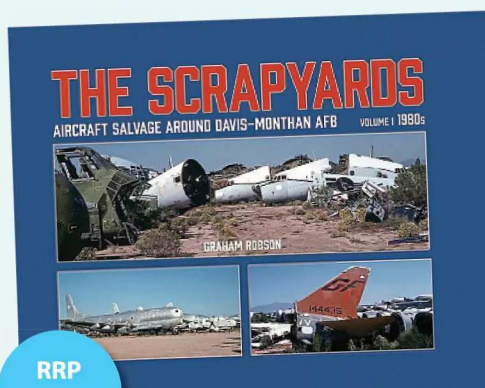
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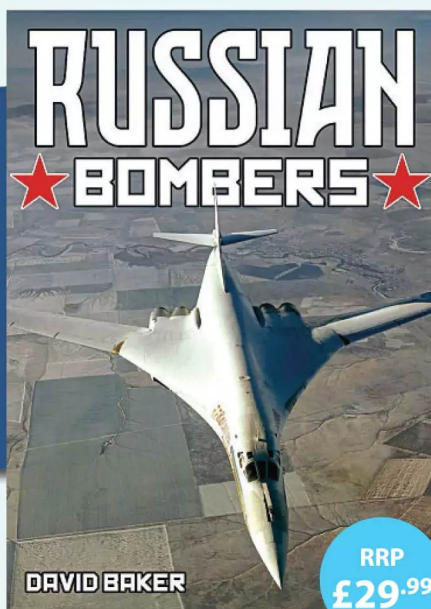
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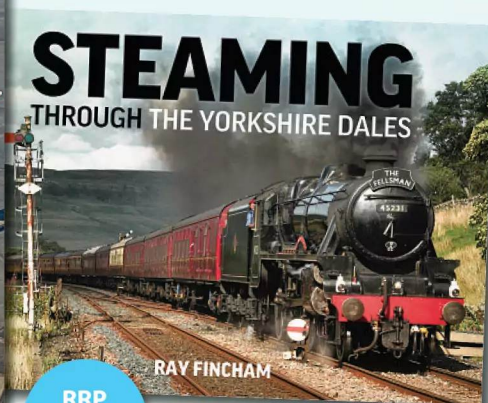
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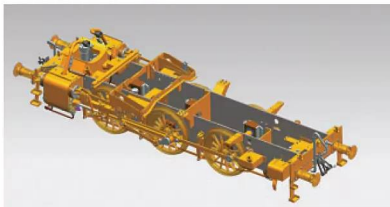
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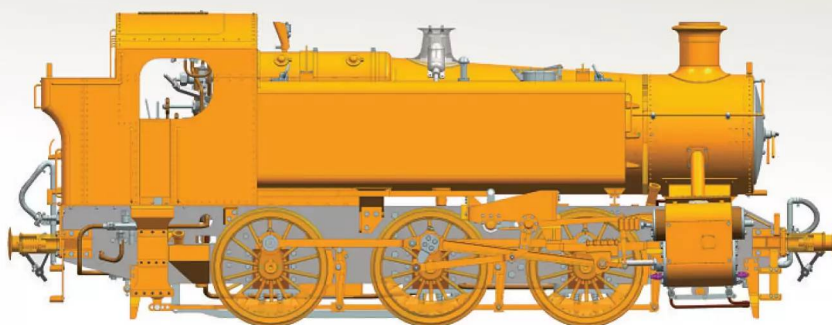
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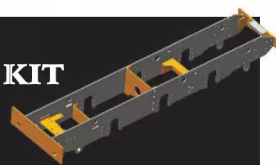
Summary Specification

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

Approximate Dimensions

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

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