No. 332

A TILTING TABLE

Another practical workshop accessory from Mike Cox

MODEL ENGINEERS' WORKSHOP

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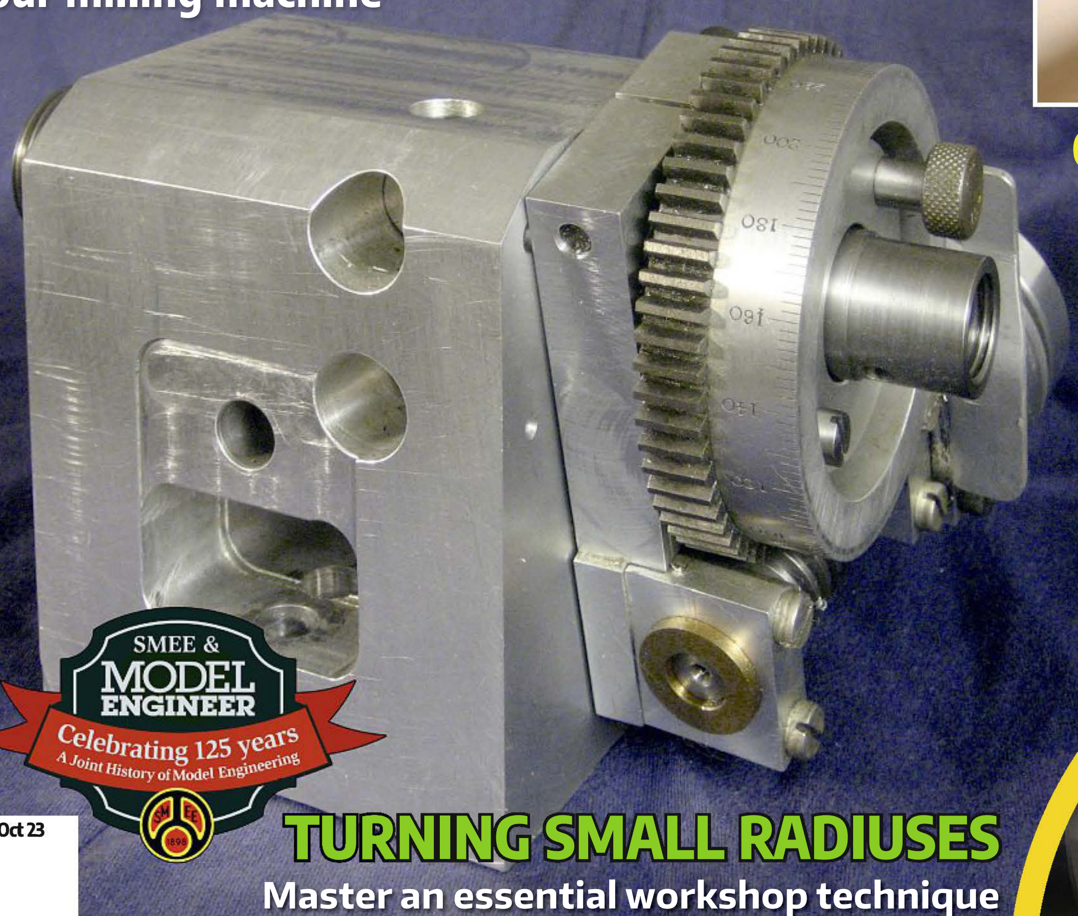

A Compact Dividing Head

Make this robust and accurate dividing head for your milling machine

CARRIAGE DIAL FOR AN EMCO MAXIMAT

Graham Meek achieves accuracy using shifted gear profiles

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TURNING SMALL RADIUSES

Master an essential workshop technique with the Artful Dodger

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MODEL ENGINEERS' WORKSHOP

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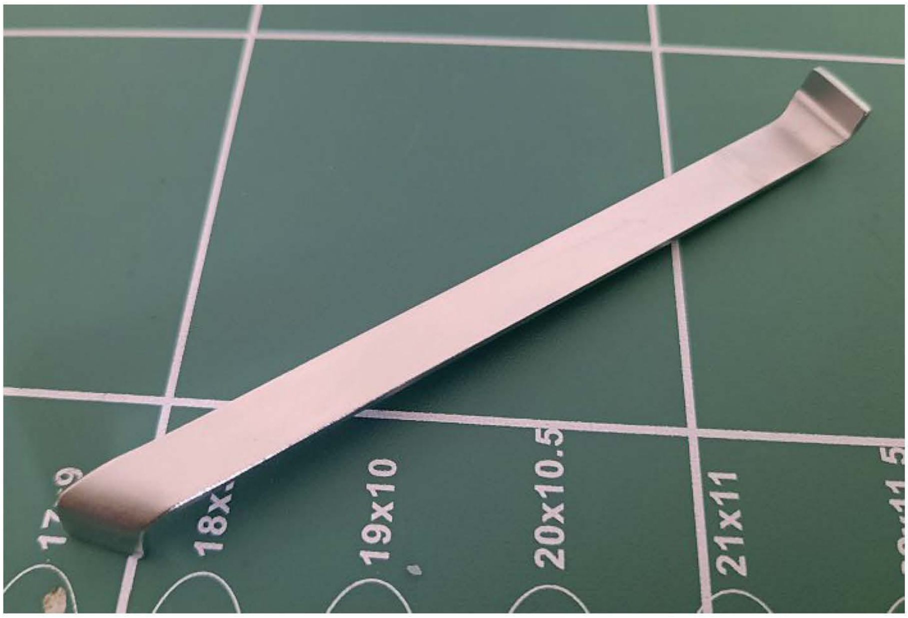
On the Editor's Bench



A Mystery Tool

I know what this 'mystery' tool is, as I bought it. In fact, I had to order it from the United States! I could have made one, but despite its simplicity, it would have needed to be bent up from a larger piece of stainless steel, a material that is a right pain to work neatly and a good smooth finish is essential. Now, I'm sure many readers will be able to guess it's basic function (no, it isn't a tire lever!) but how many of you can say exactly what the purpose of this little object is?

A Steady Hand

I was given a nice microphone, but the capsule in it had an intermittent fault. Eventually gave up on tracking it down and ordered a couple of mid-range capsules that had a similar frequency response and other properties. The first was fine and replaced the original with only minor modifications to the fixing arrangements. I didn't have an immediate use for the spare capsule but noticed that the small secondary coil had both its connections broken. Not essential for the microphone to work, this coil acts as a 'humbucker' reducing the pickup of extraneous electrical noise. It was more than a little strain on my eyesight and the steadiness of my hands, but I was pleased to be able to re-connect the coil successfully with some fine wire and a small soldering iron tip.

Briquette Cutter

My apologies to Nick Webb for accidentally crediting his 'briquette cutter' tip to somebody else in the last issue.

Neil Wyatt

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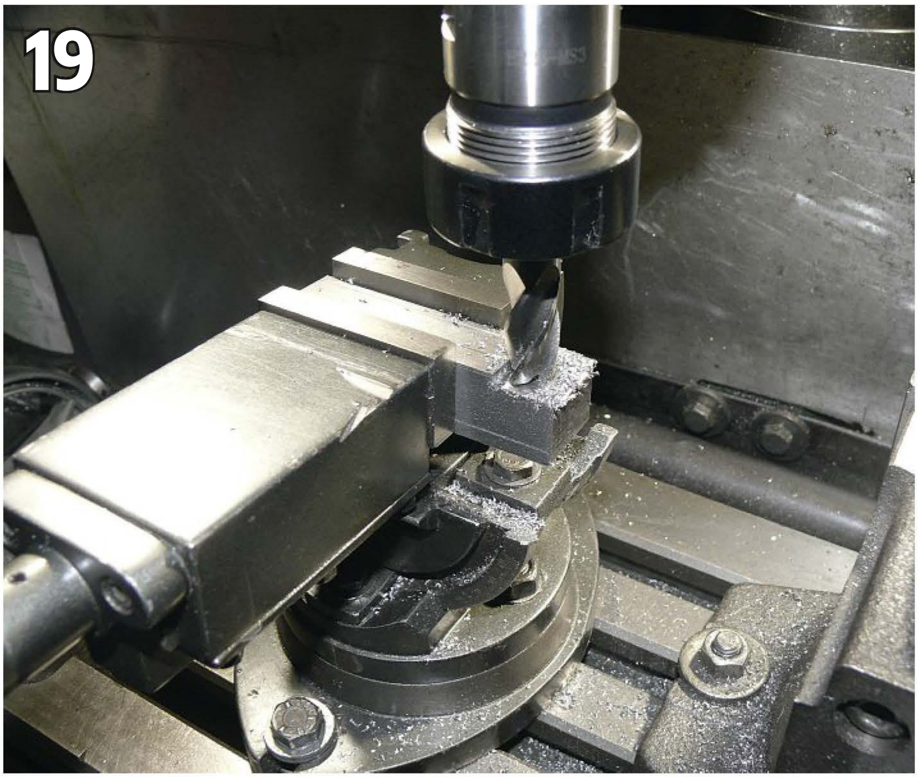
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Coming up...

in our next issue

Bernard Towers shares his design for an ER15 indexer.

Regulars

ON THE COVER

Our cover shows Chris Hallaway's Compact Dividing Head, see pages 9-15.

HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

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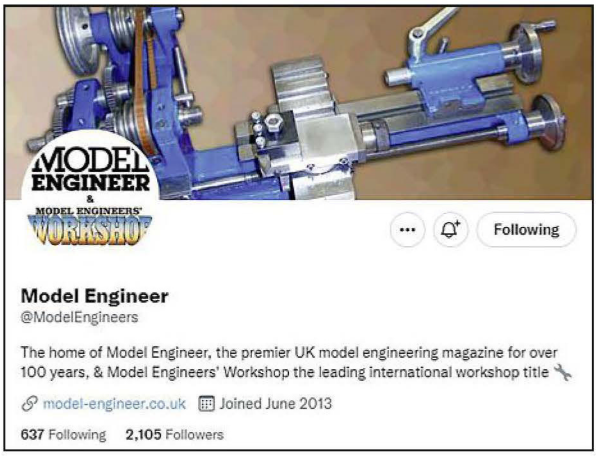


THIS MONTH'S BONUS CONTENT

Log On to The Website for Extra Content:

All the links in Jacques Maurel's article on gear design are to be found at: **www.model-engineer.co.uk/filengrene**

Other hot topics on the forum include:

Machinery's Handbook Is it worth getting a copy? By Dalboy.

All things Beaver Mill An open thread for anyone owning or working on. a Beaver Mill by Robert James 3.

Help! Excessive machine marks! Where am I going wrong? By Margaret Trelawny

Steam rocket motorcycle update. Steam rocket motorcycle course record attempt by Windy

Come and have a Chat!

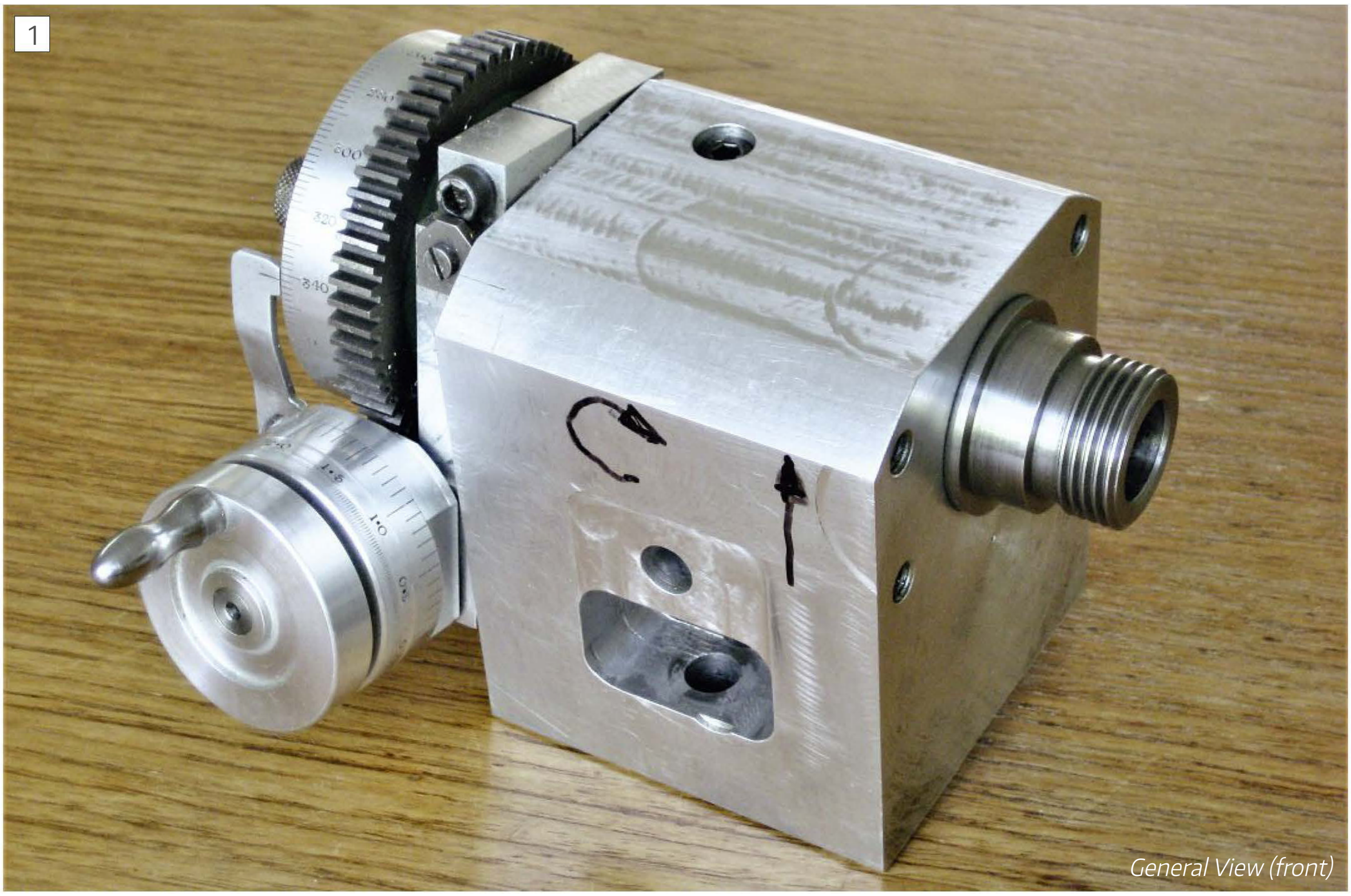
As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. Come and join us – it's free to all readers!

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

Compact Dividing Head Part 1

Chris Hallaway designed and made this Compact Dividing Head (CDH) about thirty years ago for use with hobby size milling machines.

1

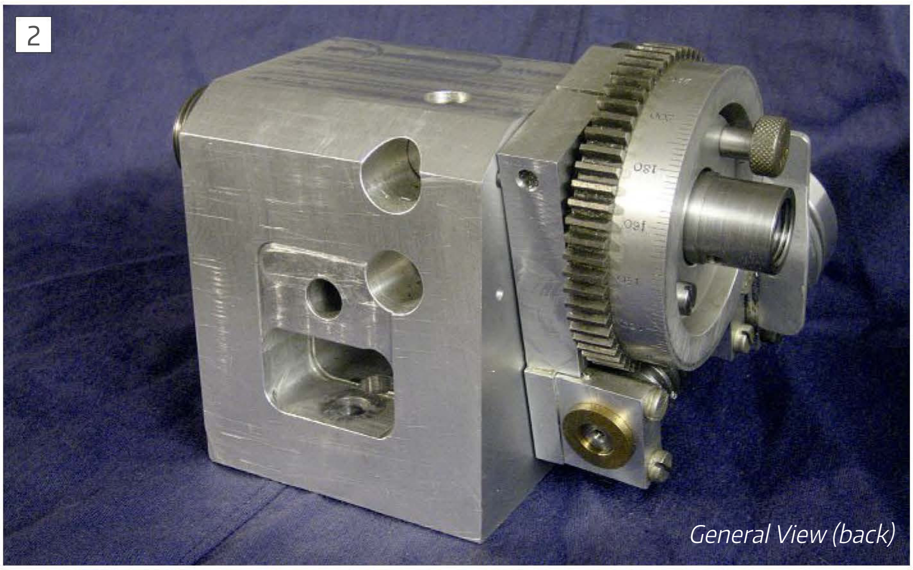


General View (front)

Smaller milling machines have limited headroom above the table, so I designed and built the compact dividing head in **photos 1** and **2**. In order to make maximum use of existing lathe accessories (3 and 4-jaw chucks, collet holder, centre, catchplate, faceplate, etc.) the spindle nose and bore must replicate those of the user's lathe, a Myford Super 7 in my case. Details for Myford 7 series lathes are shown. The mainshaft centre line is 3.1 inches above the main mounting face and so is able to accommodate a 6-inch diameter, 4-jaw chuck.

This CDH is arranged for mounting at the left-hand end of the milling

2



General View (back)

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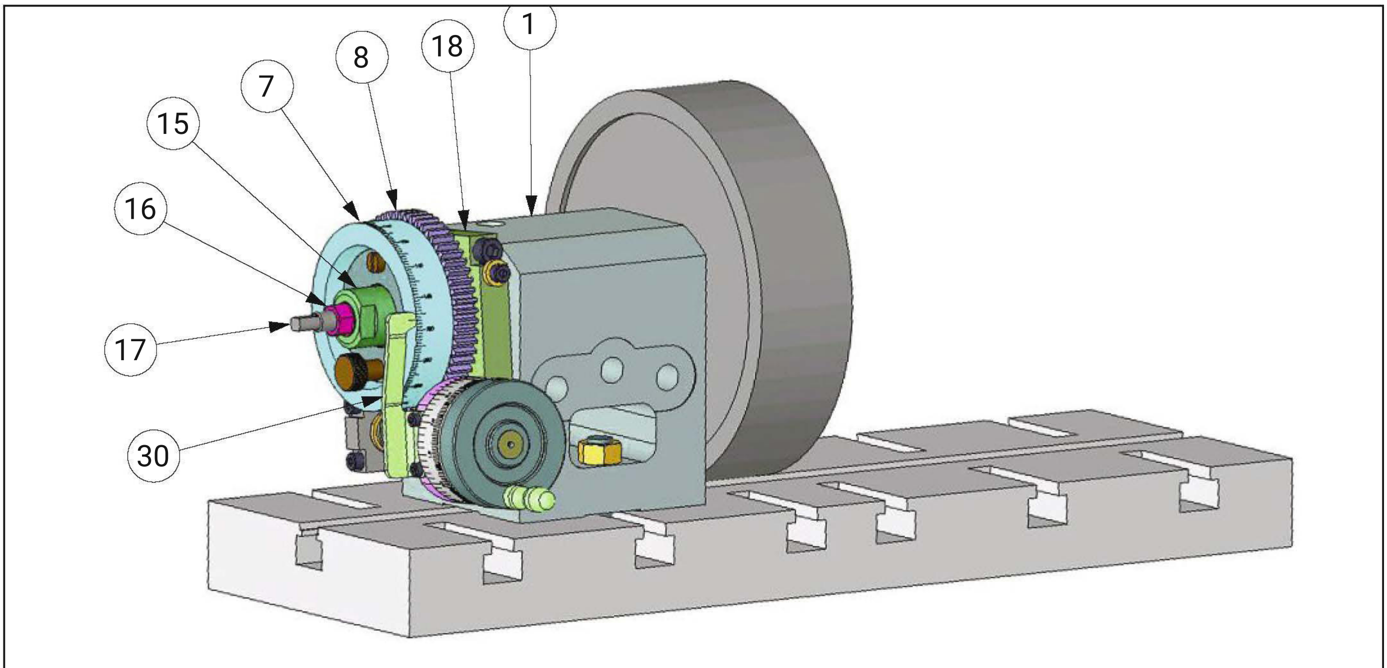


Figure 1. Mounted on Base

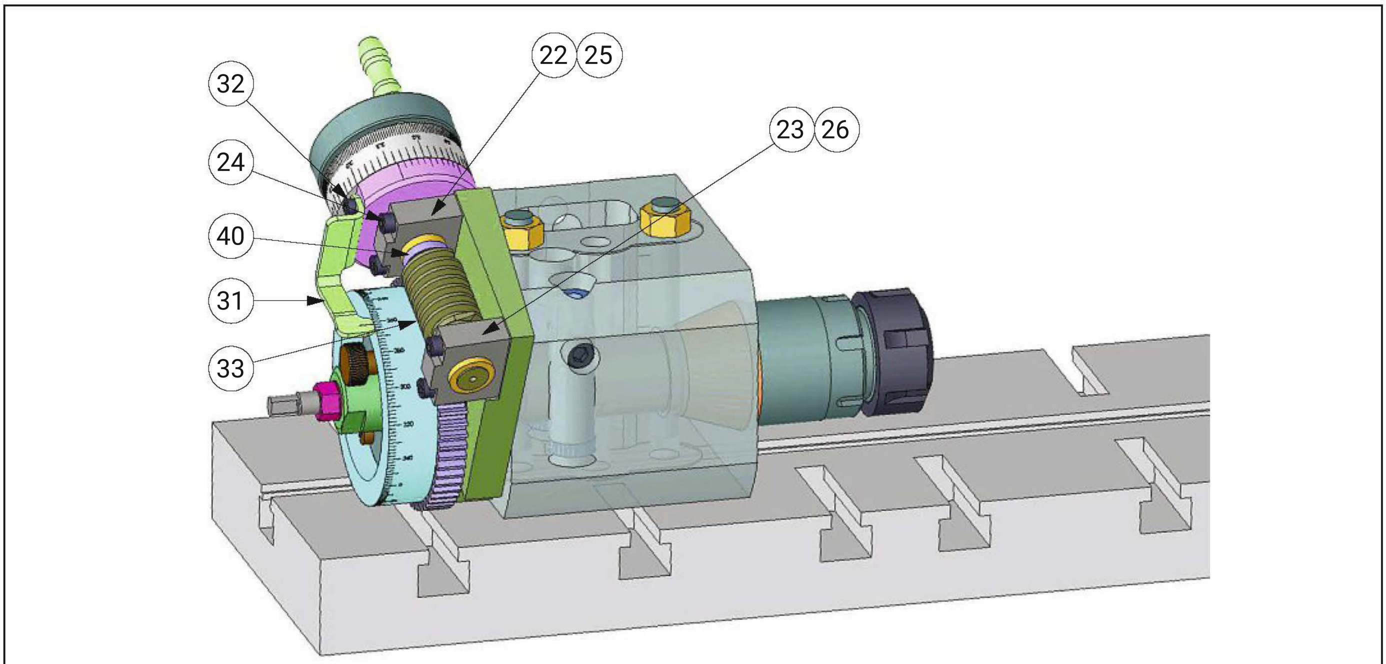


Figure 2. Mounted on Side

machine table **fig. 1,** as is usual. If vertical space is tight the CDH can be mounted on its side, **fig. 2**, which saves 1.5 inches in spindle height but which also limits the size of the workpiece and its mounting. In this position, in order to be able to read the degree scales, the wormshaft and its bracket must be repositioned through about 45 degrees and a different design of zero bracket fitted. Unfortunately, in this mode, the handwheel dial and its vernier must be read upside down.

As is usual, the mainshaft is driven by a worm and wormwheel. The wormwheel, which is the only major bought out item, is a modified Myford 60 tooth changewheel. A special tool needs to be ground to screwcut the worm profile which mates with the 20 diametral pitch (DP), 14.5 degree pressure angle (PA) wormwheel. Because the wormwheel is actually a spur gear, the mating worm has to be set at its own helix angle to the plane of the gear to obtain proper meshing. Not as good as a pukka enveloping Wormwheel but it has survived many years of amateur use without noticeable wear.

If accuracy is important for your intended use, the wormwheel should be hobbed like the genuine Myford item. Wheels indexed and cut with Brown & Sharpe cutters which produce only approximate involute forms will certainly introduce errors of tooth form and spacing and will compromise the final results.

EXAMPLE OF DIVIDING BY NUMBERS (CHADDOCK METHOD)

Number of Divisions 13

Teeth in Wormwheel 60

Division Number	Angle (degrees)	Number of Complete Turns of Handwheel	Reading of Handwheel Dial (degrees)
1	0.00	0	0.00
2	27.69	4	3.69
3	55.38	9	1.38
4	83.08	13	5.08
5	110.77	18	2.77
6	138.46	23	0.46
7	166.15	27	4.15
8	193.85	32	1.85
9	221.54	36	5.54
10	249.23	41	3.23
11	276.92	46	0.92
12	304.62	50	4.62
13	332.31	55	2.31

I am not suggesting that this Dividing Head is accurate to 2 decimal places of degrees (within 0.00009 inches on the circumference of a 1 inch circle !). However, no serious guesswork is involved in making the inputs for dividing a circle into any number of equal parts with an inaccuracy which is, in all probability, swamped by other defects in precision. The accuracy of the resulting output depends on a whole host of factors including the spacing of teeth on the 60 tooth wheel, departure of the teeth flanks from true involute form, worm pitch errors, eccentricity of various shafts and dials, success of the user in allowing for backlash, etc., etc.

Both the mainshaft and the worm shaft are fitted with friction setting dials, the latter carrying a vernier allowing angles to two places of decimal degrees to be easily dialled in. Division plates are not included in the design as, for model engineering where repetition work is infrequent, you may as well drill holes, etc. into the job itself rather than into a division plate and then into the job. Any number of equally spaced holes, faces, etc. may be set up from a table of angles calculated using a hand calculator, Microsoft Excel spreadsheet, etc. as suggested by Professor D.H. Chaddock. The **Table 1** shows an example for Thirteen equally spaced features. Because there is a degree dial on the mainshaft, there is no need to count handwheel turns noting that losing track of turns is a frequent source of difficulty in operations of this sort. A downloadable Excel spreadsheet which can calculate any number of equally spaced divisions up to 400 is referenced at the end of the article (and will be downloadable from www.model-engineer.co.uk).

The original intention was that the mainshaft would be locked in position by pulling it axially into the tapered nose bearing. This proved to be ineffective in preventing rotation so a pair of clamping bars was added to grip the centre section of the shaft **fig. 3.** The original locking

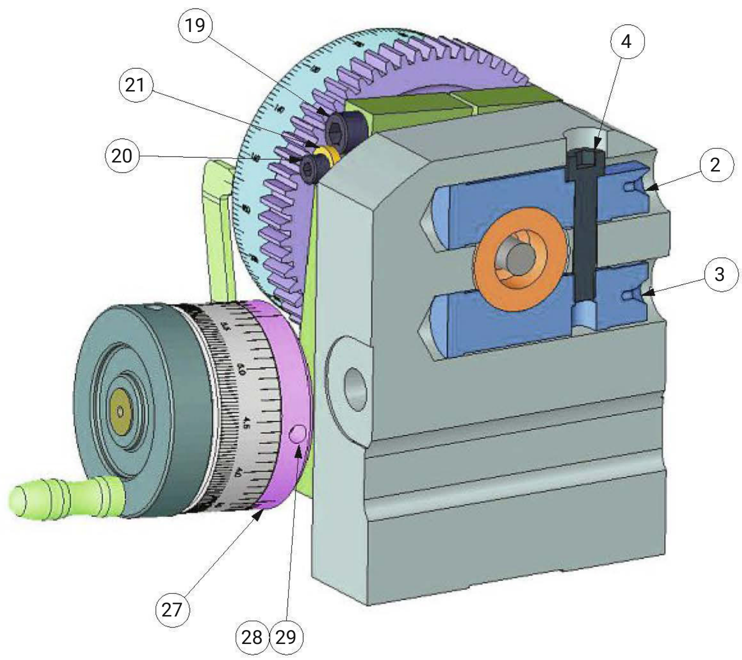


Figure 3. Cross Section through Clamping Bars

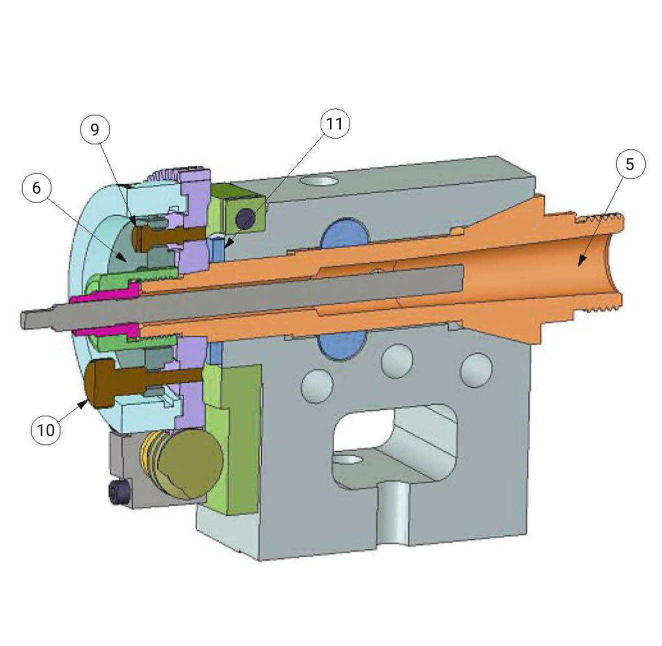


Figure 4. Cross Section, vertical through Mainshaft

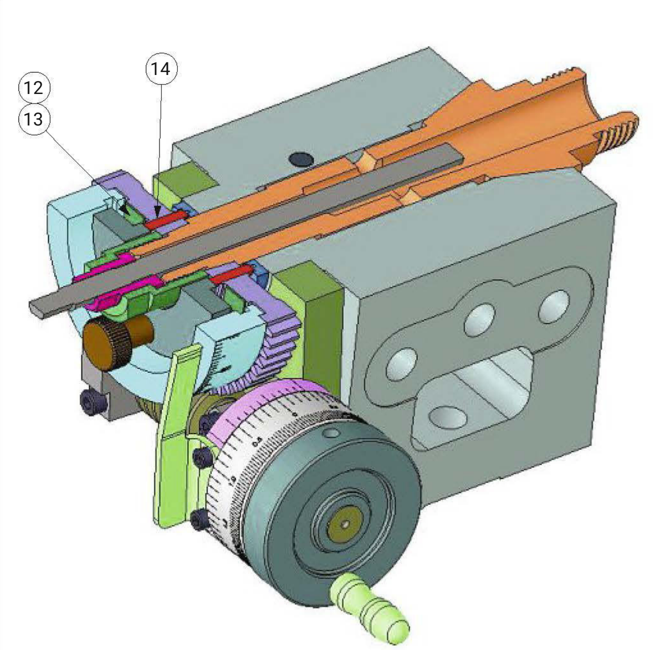
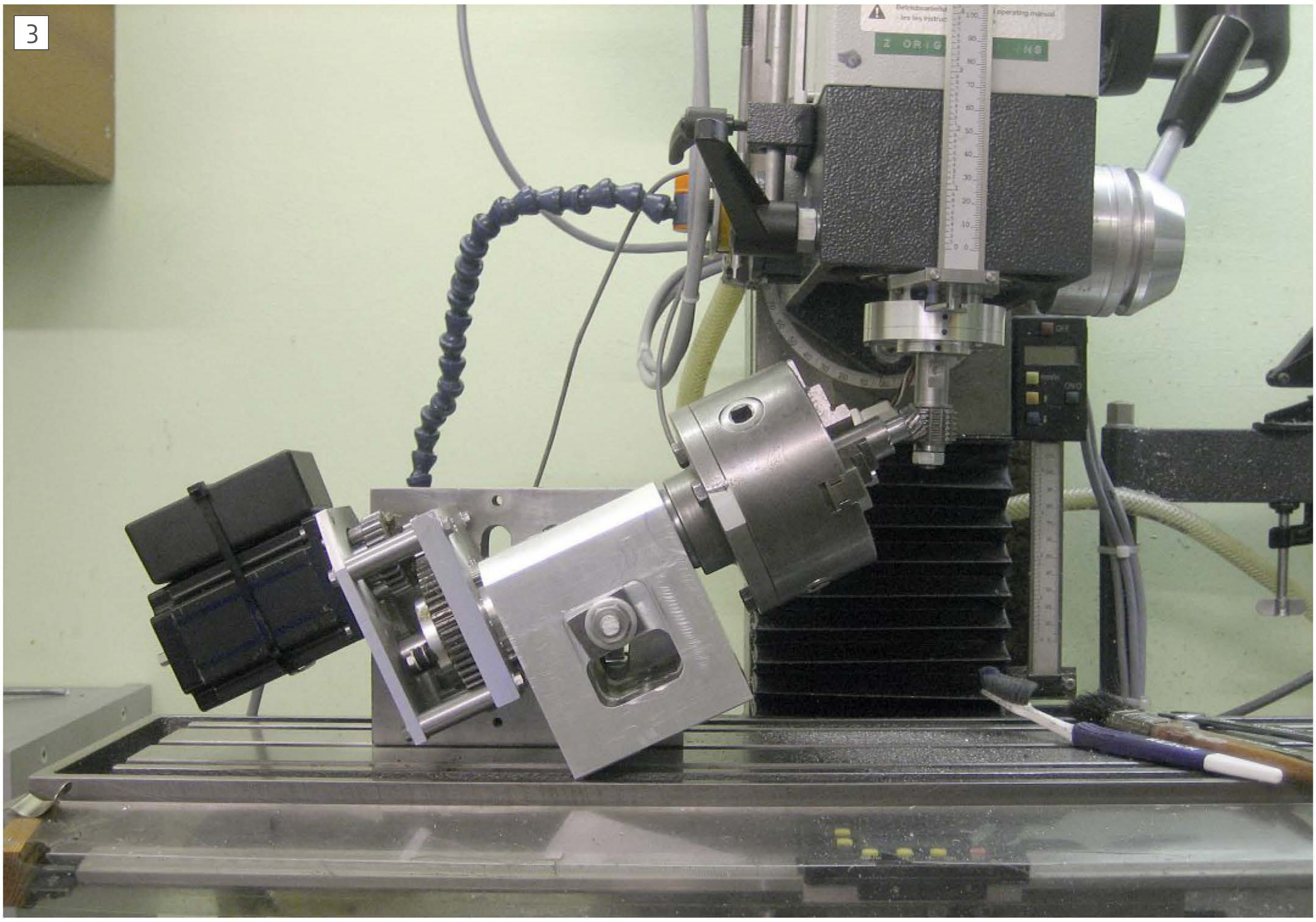


Figure 5. Cross Section, horizontal through Mainshaft



Mounted inclined on an Angle Plate

mechanism, visible in cross sections, **figs 4** and **5**, has been retained as a useful means of adjusting bearing clearance and providing braking when, for example, hobbing gears. As neither of the two locking mechanisms imposes side loads on the mainshaft they are unlikely to affect positioning accuracy.

The body was machined from 5-inch diameter forged aluminium bar and contributes to the rather low, easily

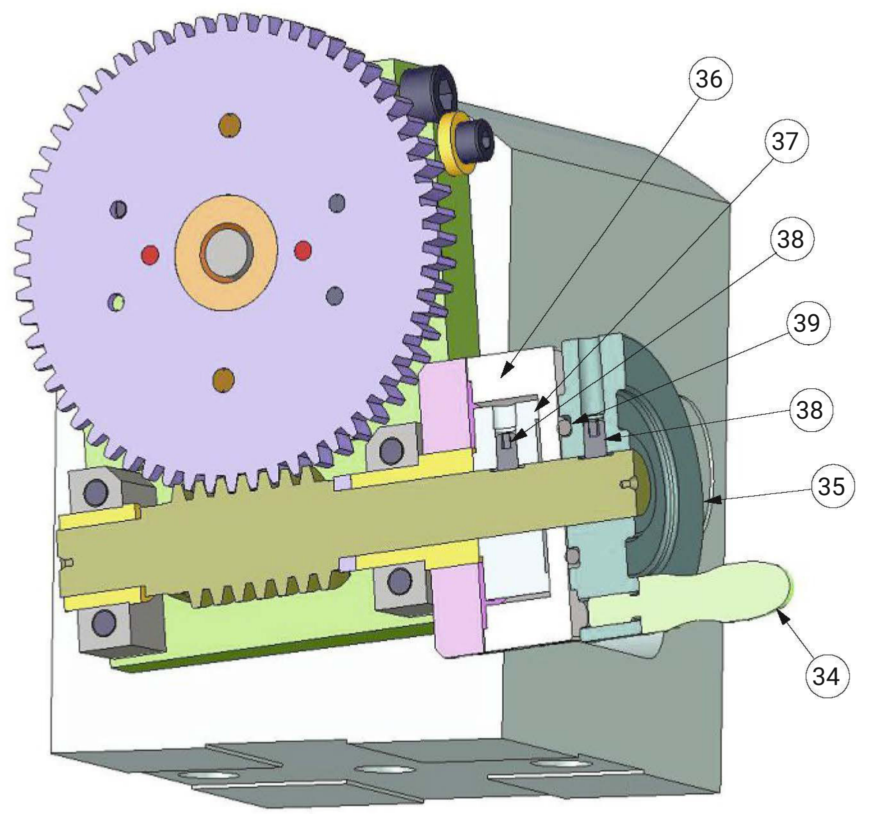


Figure 6. Cross Section through Wormshaft

Table 2 Parts List

Sub Assy	Balloon Number	Part Name	No Off	Notes
Body Assy				
	1	Body	1	3 stages
	2	Clamp Bar Upper	1	2 stages
	3	Clamp Bar Lower	1	2 stages
	4	Capscrew	1	M6 x 30
Mainshaft Assy				
	5	Mainshaft	1	-
	6	Circular Lever	1	-
	7	Wormwheel Dial	1	-
	8	Wormwheel	1	Mod. Myford 60 t. ch'gear
	9	Pivot Screw	1	-
	10	Thumbscrew	1	-
	11	Thrust Washer	1	-
	12	Capscrew	4	M3 x 6
	13	Gear Dial Retaining Plate	2	-
	14	Thrust Pin	2	-
	15	Tube Nut	1	-
	16	Drawbar Sleeve	1	-

handled overall weight of 8 lbs. It can be clamped to a milling machine table by studs, tee nuts, nuts, etc. through suitably spaced vertical holes in the lower section or, if angled mounting is required, to an angle plate via horizontal holes and bolts, **photo 3**.

All detailed parts and modifications to the 60-tooth gear were machined using my Myford Super 7 lathe and Dore-Westbury milling machine.

The drawbar, essential for retaining Morse taper 2 (MT2) mounted items against side and vibratory loads, is arranged for self ejection so impact release is unnecessary. My Dore Westbury mill can only accommodate a 5/16 BSF drawbar so all my MT2 items carry a 0.500 inch diameter, male/female adapter to get from whatever thread they came with to 5/16 BSF female. If your preferred drawbar is other than this, the Mainshaft and Drawbar Sleeve will need to be modified to suit.

It was found later that, with the addition of a stepper motor and drive, the dividing head could serve as the work holding part of a spur and helical gear hobbing set-up inspired by an article in MEW 193 by John Pace **(photo 3)**.

Making the Compact Dividing Head

At the time this dividing head was made, BA and Whitworth form fasteners were readily available. As this is much less the case now, metric fasteners have been substituted in the drawings. However as my machines and measuring equipment are inch based, drawing dimensions and turned threads conform to this old system. And I do cheat by using a full 1 - 10 by 0.1 mm set of metric drills where 1/64 inch steps in Imperial drill sets are too coarse. Most dimensions are given in inches to 3 decimal places. No particular accuracy is thereby implied.

In the light of experience and of further thought, other minor changes have been made so the drawings are showing small differences from the photographs of the original.

Several cross-sections are presented for information. This hopefully helps in sorting out what matters and what doesn't, see also **fig. 6,** enabling builders to alter parts to suit

	17	Drawbar	1	-
Wormshaft Bracket Assy				
	18	Worm Bracket	1	-
	19	Capscrew	1	M6 x 40
	20	Capscrew	1	M4 x 10
	21	Retainer	1	-
	22	Worm Bearing Block RH	1	-
	23	Worm Bearing Block LH	1	-
	24	Capscrew	4	M4 x 30
	25	Worm Bearing RH	1	-
	26	Worm Bearing LH	1	-
	27	Zero Bracket Clamp	1	-
	28	Grubscrew	1	M4 x 6
	29	Plain Nylon Plug M4	1	-
	30	Zero Bracket	1	-
	31	Zero Bracket Side	1	-
	32	Capscrew	2	M3 x 10
Wormshaft Assy				
	33	Wormshaft	1	-
	34	Handle	1	-
	35	Handwheel	1	-
	36	Handwheel Dial	1	-
	37	Handwheel Dial Collar	1	-
	38	Grubscrew	2	M4 x 6
	39	O Ring	1	BS 1806-116
	40	Wormshaft Thrust Collar	1	-

their available material, tooling and preferences. Colouring of parts in the various figures is for identification only, there is no material code or artistic impression intended.

With the exception of the spindle nose and the worm, sizes are not critical but of course where parts fit together care needs to be taken to achieve appropriate clearances. This is nothing new and is the usual procedure in model engineering. In a few places, described in the text, machining sequences need to be observed to achieve the desired results. It is suggested that major parts be made in the order given below.

Where calculations, explanations and derivations which do not directly affect dimensions would interrupt the narrative, they have been appended as figures separated from the main text.

Balloon numbers from **Table 2**, the list of parts and referenced in the figures preceed part names in what follows.

1 Body

My experience of aluminium castings produced for model engineering has been poor so, if an alternative to forged aluminium alloy as noted on the drawing, **fig. 7**, is needed, I would suggest cast iron.

Stage 1. Start by creating all 6 mutually perpendicular flat faces leaving enough on the length to clean up both ends in the lathe (the spigot on the back end is machined down later). I used an angle plate and clamps to do this because I found that my vice and not very rigid milling machine consistently produced right angles that weren't. The couple produced by tightening the vice was bending (happily not permanently !) the vice and machine table.

Drill and, where indicated, tap all the holes followed by end milling (probably from both sides) the rectangular through hole which provides access for fitting nuts to the securing studs. No spacing or size are shown for the holes which take the studs clamping the CDH to the milling machine table, angle plate, etc. as this depends on the machine in question and the selected stud size. Holes will usually be set to suit tee-slot spacing together with a centrally placed hole should angled mounting be envisaged. In the latter case, additional security would normally be provided by stops.

The eight tapped mounting holes in the front and rear faces are spaced to suit the Myford 11 inch faceplate. If you need to change their positions to suit your equipment check that you are not digging into something important. Care should also be taken to keep the shaft bore as near as possible parallel to the bottom and side mounting faces.

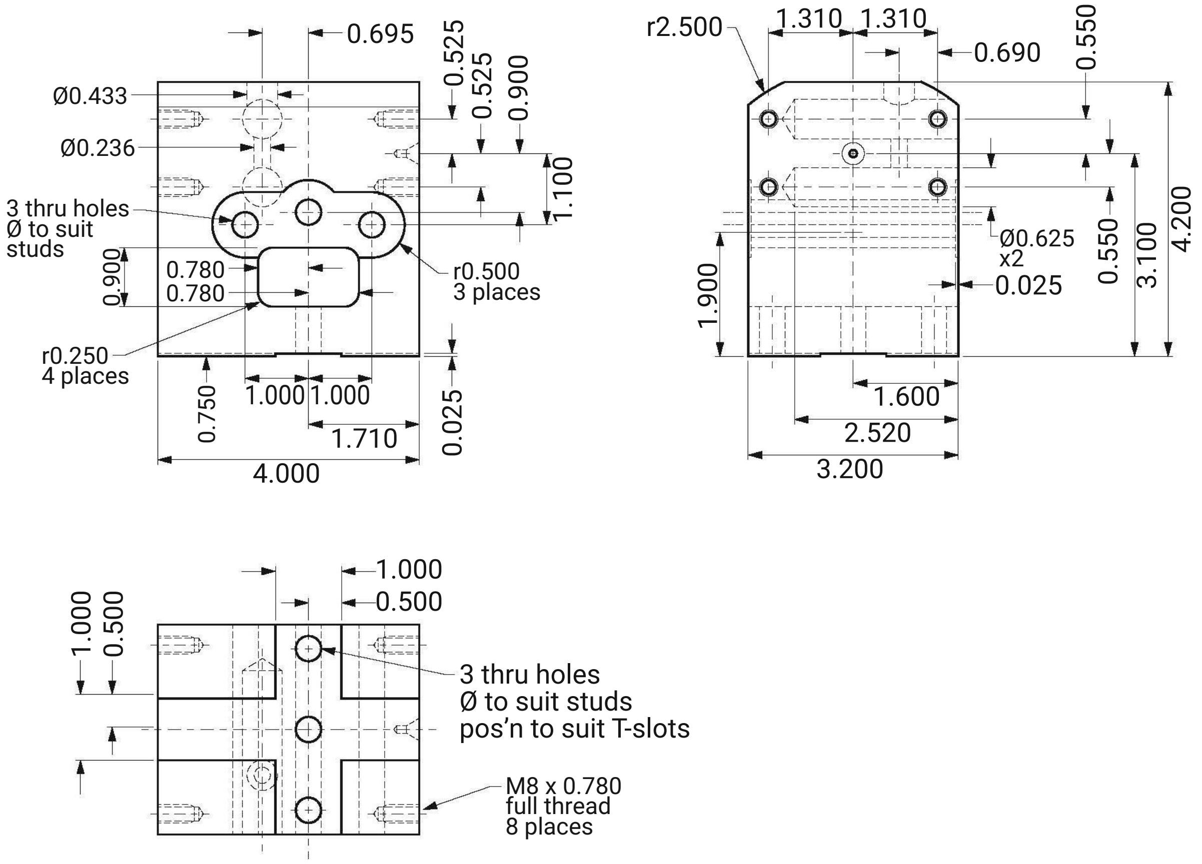
Stage 2. Bolt the back face to the faceplate and adjust so that the bore position runs true. Face and then bore from the front to drawing dimensions using the Mainshaft as a gauge. Aim to have the spigot face on the Mainshaft proud of the front face of the Body by 0.125 inches.

Fit the partially machined Clamp Bars and tighten in position with the 6 mm cap screw before boring them to a sliding fit on the 1.000 inch diameter section of the Mainshaft. Remove the Clamp Bars.

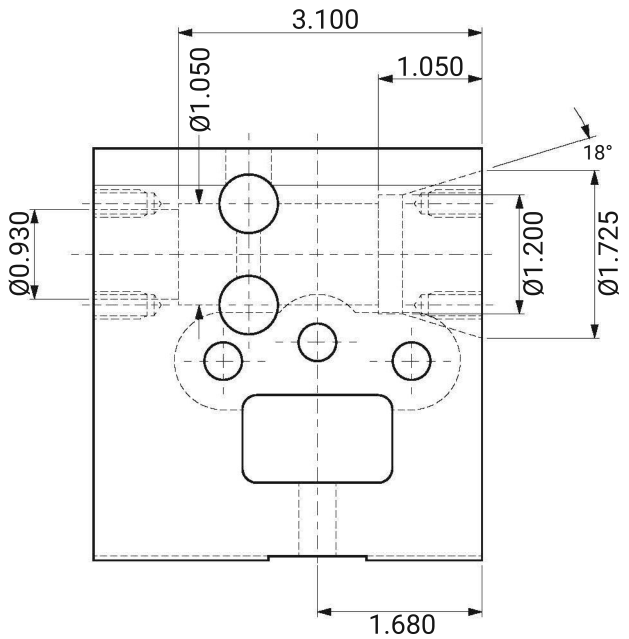
Stage 3. Now bolt the front face to the face plate and adjust so that the 0.930 inches bearing bore runs true. Face back to drawing dimensions. This will remove most of the 4 tapped holes which, together with similar items at the front, are redundant once machining is complete.

Finally enlarge the hole for the Clamp Bar capscrew to drawing dimension which will allow the Clamp Bars to self-align on the Mainshaft.

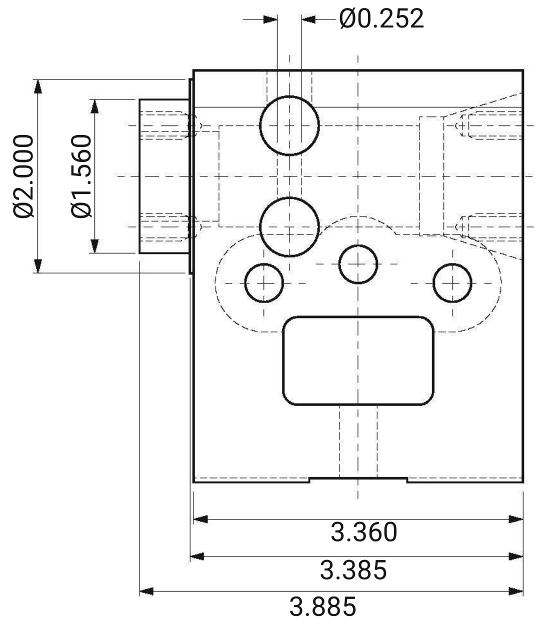
● To be continued



Part 1. Body Stage 1
Mat'l: 6082T6 or similar forged aluminium alloy



Part 1. Body Stage 2



Part 1. Body Stage 3

Figure 7. Three stages of machining the body

Tips and hints, some old, some new, some borrowed

...some engineers' blue? Brian Wood shares some useful ideas for the workshop.

I approached the Editor recently with a couple of tips for publication in MEW, completely unaware of being the winner in a previous offering that was about to be issued. I was asked nicely to accept a different method for these to be published in Scribe a Line to avoid being labelled as 'hogging the slot' to which of course I agreed.

It set me thinking though as there are several more of these considered worthy of passing on and this is the result; a mixed bag of dodges and the like to be going on with.

Tricks with woodscrews

To shift tight woodscrews that have rusted into the woodwork over the years, my father used to belt the end of the screwdriver hard to shock the grip and then **tighten** the screw slightly before undoing it in the normal way. The method helped reduce the frequent risk of 'cam-out' with slot headed screws which chews up the slot, a curse of the head design and especially disfiguring on brass screws so often used in furniture.

It works equally well on modern cross head screws and a further refinement I have found helpful is to grease screws used in outdoor projects, especially in cases where wall plugs are used. Greasing also helps when driving them home into predrilled holes in hardwood.

Distance collar for confidence in repetitive batch work.

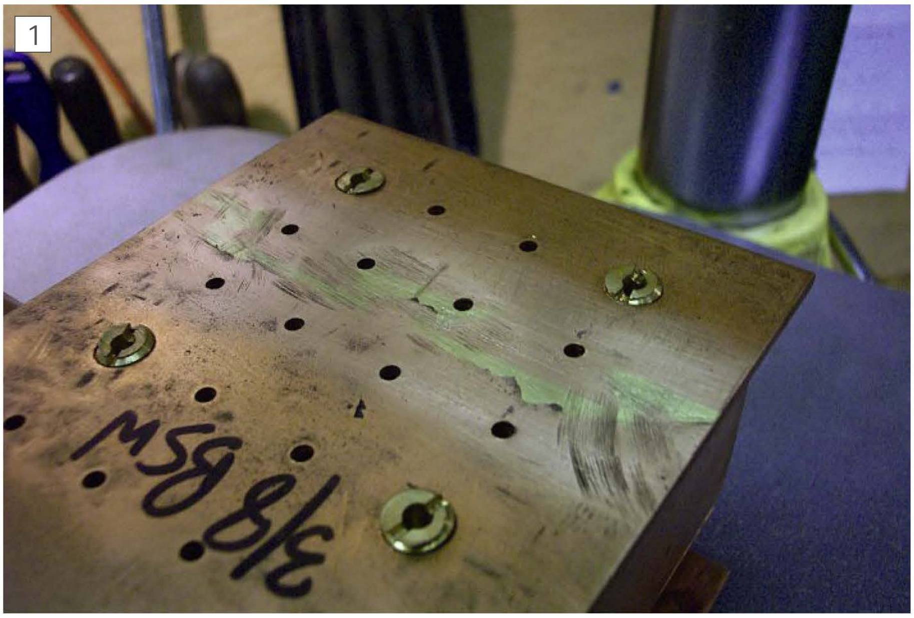
Part of what I do is commission work for local businesses. A recent furniture and glass project required a set of eight matching length support legs to be supplied in 30mm diameter stainless steel bar.

There was other work for me to do in this project, but the length required of these legs exceeded what my lathe could accommodate. A good friend offered me the use of his big Willson lathe with its large bore spindle so that I could comfortably drill and thread M10 holes for levelling features into the ends. The bars were sawn a little overlong from lengths of material from my supplier.

Without a measurement of the spindle bore beforehand to make a length stop, and to be certain they all matched for length within 1mm, I turned up a close-fitting collar with a side grip screw to function as a tooling reference stop.

Having faced one end of a bar, the collar was slid on and secured for length at the other end by ruler measurement with both the ruler and bar butted up against a solid surface. Then, with the length of the bar out of sight down the lathe spindle, I faced the end gripped in the chuck to just kiss the outer face of the collar, knowing that the bar length would be correct. To protect the collar from inadvertent machining and thus any thinning, I had previously coated the 'stop' face with a black marker pen as an indicator of impending contact.

The remaining seven bars were all machined as a batch by the same method to "*identical lengths*" as required in the brief I accepted on taking the job, using the first one for reference in each case; after which I drilled and tapped all eight with the work gripped close to the chuck in the normal way.



Angle grinder results on copper

Using an angle grinder on brazed copper and brass joints

This discovery came about by pure chance. I had extended both firebox sides on a copper boiler for a traction engine by making castellated joints and completed the joints by bronze brazing,

Small blackboards

leaving excess braze material to remove afterwards. "Try the angle grinder" I thought. The copper/braze material promptly clogged the metal cutting disc which then started to tear up the surface I was trying to smooth out.

This was of course at a weekend with suppliers closed and all I had left in the box was a partially used disc for masonry work. It was a classic case of choosing either muck or nettles, so I fitted this disc in desperation. To my surprise it proceeded to do a magnificent job if gentle strokes were used, with nothing too aggressive. There was no clogging at all.

Photograph 1 shows the result I was able to achieve. It is not perfect by any means, some of the previous disc damage is evident but it worked a lot faster than other more arduous manual methods.

Various aspects of workshop design

Small blackboards on the workshop wall. These are just redundant wall cupboards from an old Wimpey kitchen, with the doors painted in blackboard paint. They make great planning features that can be used repeatedly for notes on machining sequences, buying lists, reminders and so on.

The cupboards themselves contain masses of stuff, collectively quite heavy and keep it all clean and out of the way. They were not made to support the potential weight I would be likely to store in them, so were strengthened by strong backs cut from shuttering ply and screwed to the frames of each. The bottom edge was 'footed' into a length of Dexion slotted angle secured to the wall with the mounting leg fitted upright.

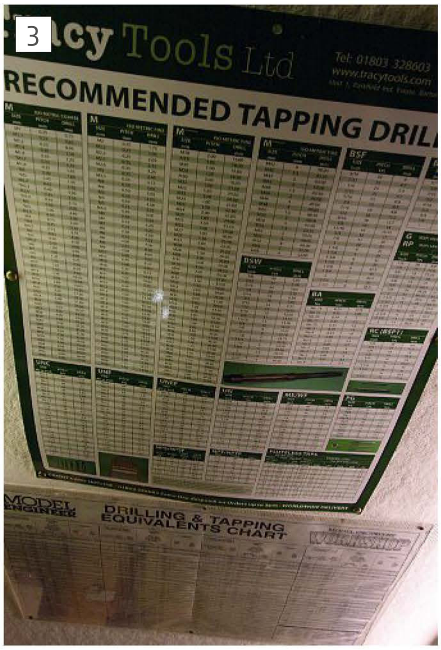
Each cupboard was screwed back through the Dexion to the wall behind. To prevent toppling, the tops were also screwed back to the block wall behind the insulation boards using the existing steel corner reinforcing plates that had been built into them.

Photograph 2 is a view of the run of fitted units. After such attention to detail in fitting them, and despite the considerable weight now contained within them, they have needed no attention at all after nearly 30 years in position.

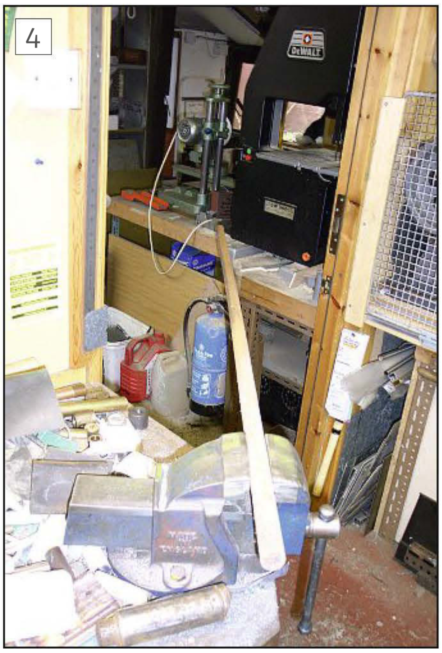
Space is at a premium in my workshop (what's new? I hear you say), something probably true of most owner's workshops and certainly so in this case. With no space left on the walls, it was all used up a long time ago, some reference charts are mounted behind Perspex sheets up on the ceiling. At least they are well lit up there!

Photograph 3 is a view of them, between the overhead strip lights. It does mean craning your neck to read them, something I can still do without falling over!

Siting the bench vice. Unusually I chose to mount my vice at an angle on the end of the long and very cluttered bench. Having any kind of flat surface in my workshop is fatal and tends to attract



Ceiling mounted reference charts

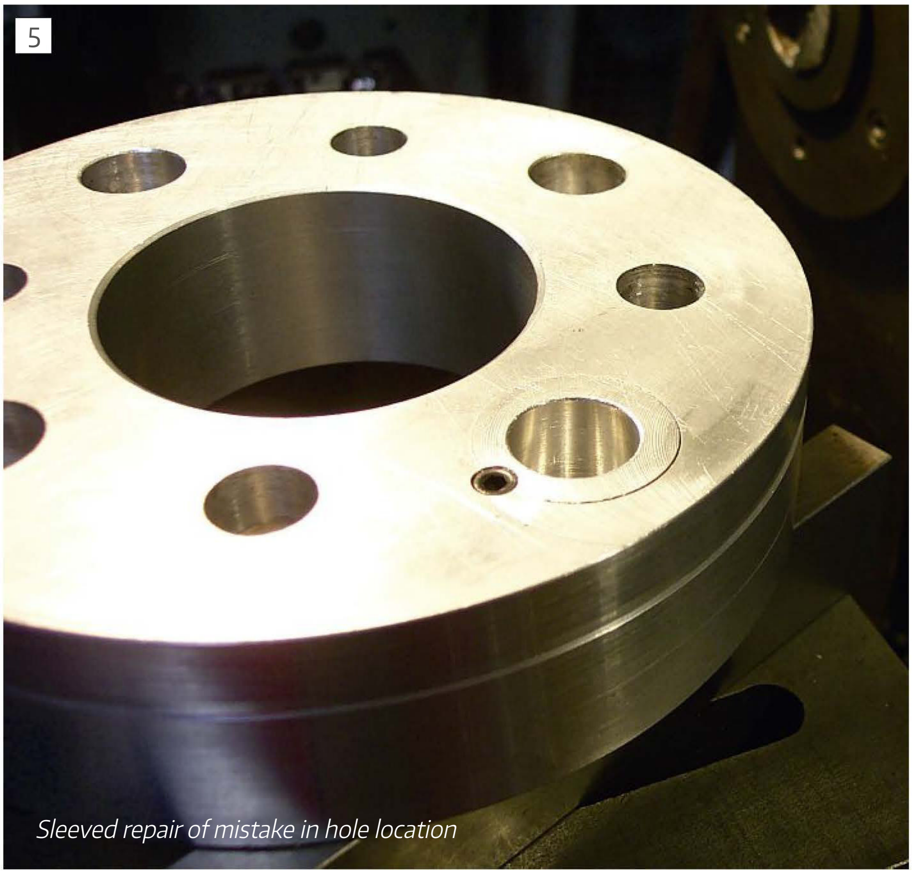


Bench vice angulation

what my wife calls junk but is in fact a valuable resource to be mined for things. **Photograph 4** shows one reason why I chose to fit the vice this way so that long work can poke out of the door rather than run along the whole front of the bench. It also allows a little more space behind the vice for a hacksaw or long file to operate into

These quick tips might be new to some readers.

- Why do some machine vices have a Vee notch ground upright in the fixed jaw? To grip round objects or



Sleeved repair of mistake in hole location

short sections of bar for drilling and mill work.

- A piece of cotton rag over an oil nipple makes sure the oil goes into the nipple rather than squirting down the outside. Ridiculous as it sounds, this dodge works remarkably well.
- Sharpen a round centre punch with it held in a power drill and rotated against the side of the grinding wheel. Best results come with the punch rotating against the direction of wheel rotation. Point angles can be easily seen as grinding proceeds and can be adjusted as necessary during the process which takes just moments to do. Automatic centre punches, stripped down to work on the hardened pin, respond well to this method.
- To saw shapes from aluminium or brass sheet, on either a metal or wood cutting machine (with a suitable blade) put a sheet of three-ply packaging cardboard beneath the sheet. It stops a lot of the ear-splitting noise made if just sawn on the table and tends to leave a cleaner cut without it rattling about.
- Fine tooth slitting saws work best at no more than 40-50 rpm while feeding them steadily into the job. Run them faster and they very quickly blunt, get hot and distort and worse still, may rupture.
- A perfectly acceptable centre punch can be made from an offcut of rebar. Being of medium hardness it will need sharpening more frequently or it can be made into a harder tool by heating to red heat, quenching in water, and tempering to a light straw colour.

Recovering from mistakes

For an over machined round object intended to fit into a hole for, say, a brazed joint, try raising the surface by knurling before assembling the joint. If you do not have a means of knurling, go around the outside diameter (O/D) with a centre punch to raise up a series of swellings around each punching. It won't centralise as well as knurling but may well be good enough to recover the situation and hold the joint together for brazing or welding.

In the alternative case where the bore has been made too large, "adding on" methods are not available, and a different approach is needed. Make a sleeve but be bold and fit a thick-walled version that can be anchored on the joint line by a locking screw to prevent later movement.

Photograph 5 shows an internally stepped sleeve, with locking feature, fitted to correct a drilling mistake (not mine) in a wheel spacer to fit a hub with different bolting PCDs.

On a similar theme, to secure a parallel locking pin across a joint that is just a little too easy a fit to grip firmly in the hole, chop a notch across it at about 45 degrees with a sharp cold chisel and then tap it home.

An old and cheap dodge to remove stubborn studs (a good example might be to remove those holding exhaust manifolds) and after soaking with penetrating oil, is to run two nuts down on the accessible thread, with a washer between them if space allows. Tighten one hard up against the other and unscrew the stud using the lower nut. The method takes up no space and avoids the cost of a stud extractor tool.

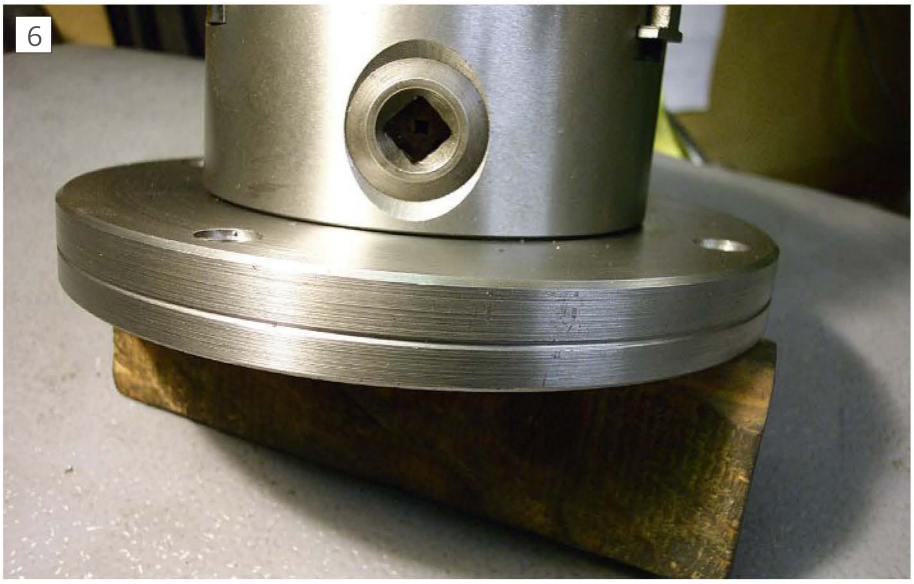
Use an old turner's trick to completely remove the slight mismatch in surface height after turning the job around in a 3-jaw lathe chuck to finish the work from the other direction. At the very least it spoils the job cosmetically and to hide the feature, use a vee pointed tool to machine a shallow groove at the point of mismatch to disguise it. If the job allows it, turn others elsewhere on the piece to reinforce the "decorative" aspect of the disguise. **Photograph 6** shows an example in the flange that has been treated this way.

I fasten housings or such things that need bolting, starting with one hole, tapped, and bolted to secure it before marking out the remainder by using a transfer punch. It ensures the job hasn't moved in the marking out process. These are such useful tools in the workshop, and they can be bought in sets of metric or imperial sizes. Being long and of precise diameters, they will reach down accurately in drilled holes.

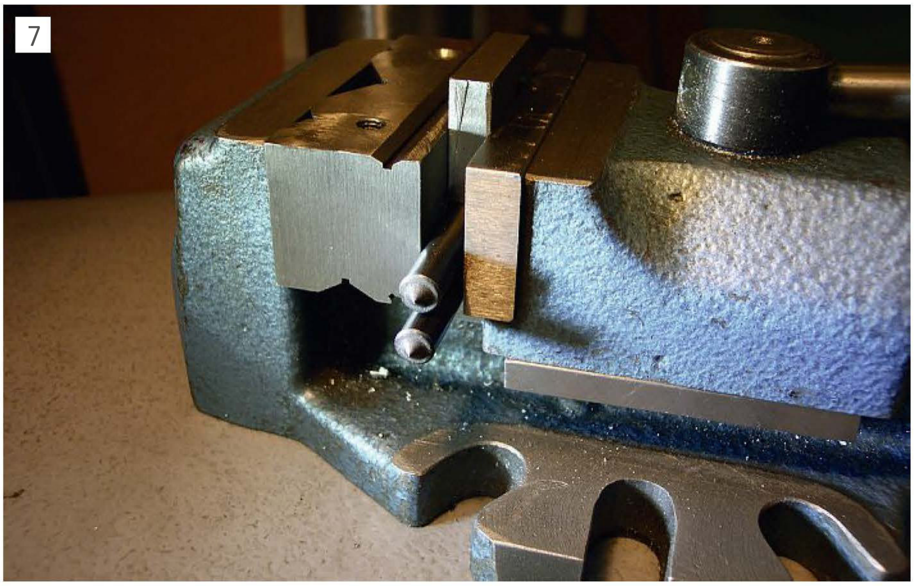
Photograph 7 shows another use for them as precision supports for low profile items that need milling work doing and are too short to get the working surface above the vice jaws when supported directly from the floor of the vice.

Some ideas learnt from YouTube professionals

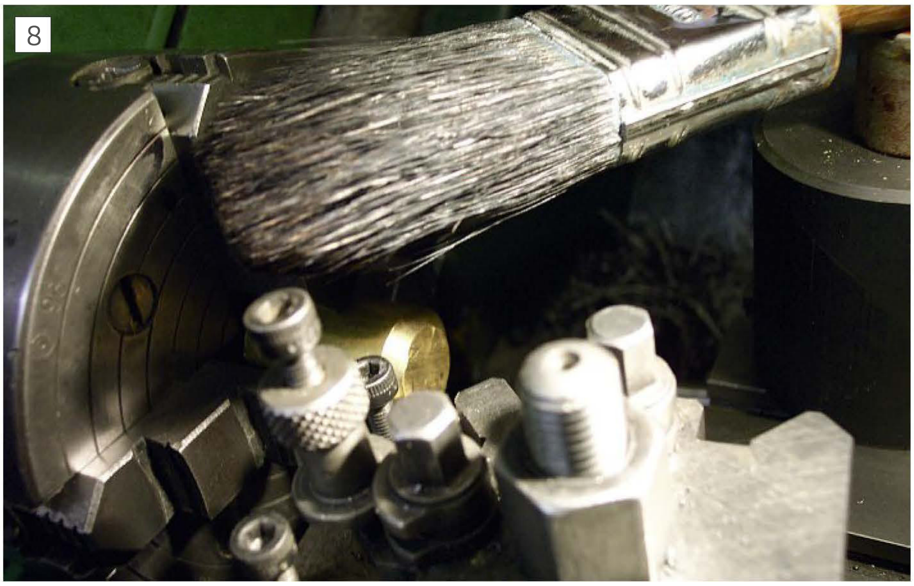
As these were demonstrated publicly on open-source material, they were clearly



An example of the vee shaped disguise



Transfer punches in use as precision spacers



Brush deflecting chip spray from brass/bronze turning work

intended to be used by others. But, even so, it is courteous to acknowledge the work of others and the first of these is from Keith Fenner of Turnwright Machine Shop in Cape Cod USA

To tame the upward spray of unpleasantly sharp brass or bronze chips on a lathe, he parks a wide paint brush on a magnetic holder to rest over the lathe tool tip to interrupt the chip path. I have reproduced his method in **photo 8.** It struck me as being especially imaginative, delightfully simple, and of negligible cost.

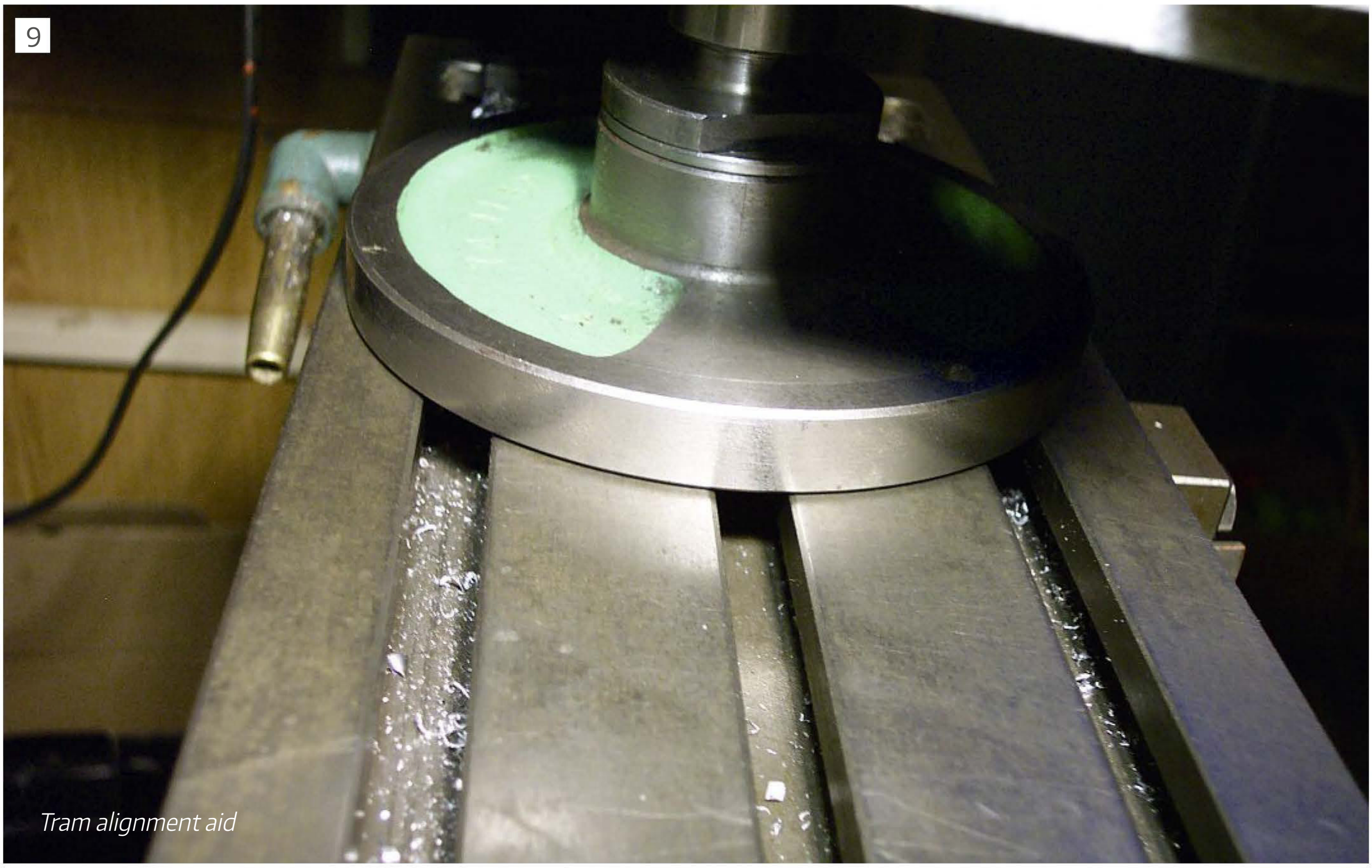
I have very recently seen the same idea in use by Adam Booth (Aborn 79) on bronze bushing. I imagine it would work well on cast iron components too to limit the spread of the dust generated in turning the stuff. It is unlikely to be useful on steel components, if the chips don't melt the brush bristles, curly swarf will probably strangle it and drag it onto the job.

From Keith Rucker of Vintage Machinery.org I would like to share two of his ideas. He was taught the first one as a trainee miller in the late 1980s by an old hand as a quick, elegantly simple, and reliable method of centring a cutter over a bar or shaft to mill out a keyway, without having to take any measurements.

He demonstrated the method on his Kearney and Trecker Model H horizontal mill, a new toy recently acquired, but he first spent some time enthusiastically describing the control features of it! A detail I liked at the time was the deployment of either one or both overarm bar supports simultaneously using a small diameter four-lobe capstan on the side of the mill, engaging them selectively with a rack cut on the underside of each bar.

On later reflection, I question the value in deploying one overarm bar. The UK equivalent would be to use one side of a dovetail overarm. I have seen another example of this model without the feature and wonder if that design has been phased out.

Despite that and without any pictures as this was a YouTube video, what follows gives a fair description of the method he demonstrated. The component was clamped down along one of the tee slots in the table and thus parallel with the table motion.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Tram alignment aid

Position the rotary cutter above the end where the keyway is to be cut, run the machine and raise the table with the knee control to just touch the job with the cutter. Traverse the job across the cutter.

The newly cut surface will of course be much narrower than that of the cutter. Raise the knee a little, take a further cut and sweep the job across the cutter again. Keep doing this in small increments of knee elevation until the freshly cut surface can be seen to be the same width as the cutter. Carefully traverse the job back and forth so that the two sides are as equal about the cutter width as you can judge. The human eye is remarkably good at making such comparisons and when you are happy with the result, lock the traverse motion.

Wind the job away and raise the table by half the keyway depth. The correct depth for a square form keyway is measured from the edge of the cut surface, not the first touch off. Now lock the knee motion, engage table feed, and cut the keyway in one pass. In a busy machine shop where time is money, this is a sufficiently accurate method for all but the most demanding work, adaptable to any shaft diameter and/or cutter width.

In another YouTube video Keith examined the perennial subject of tramming the head on a vertical mill. He demonstrated on a Bridgeport, but his method could apply equally well to other machines. He had a setting gauge which featured a thick base with a stout central bar of about ten inches or so in height fitted into it.

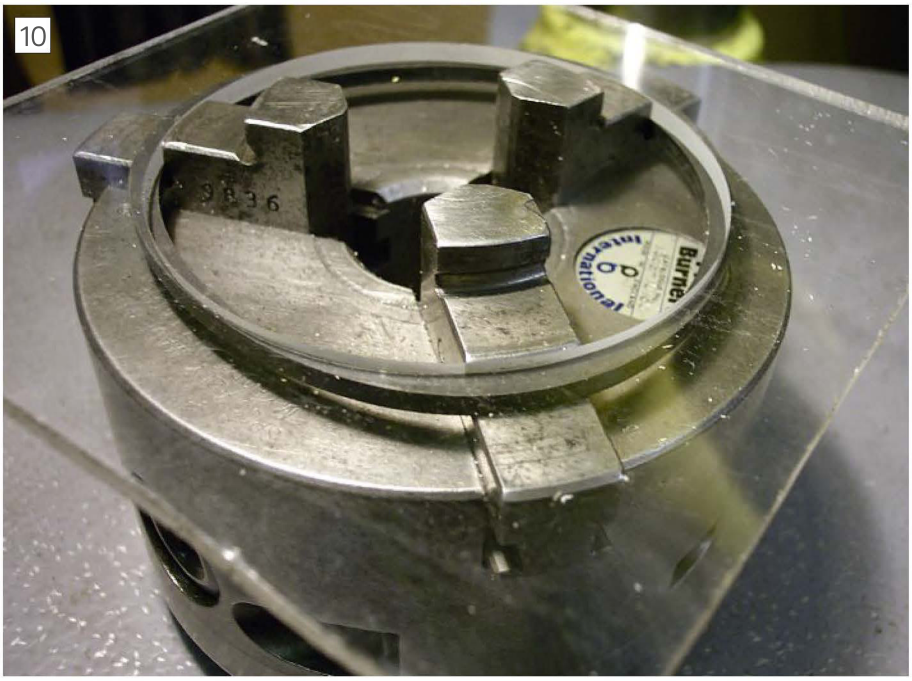
It had been made with some care and precision and he produced it from a felt lined box, as befits a gauge requiring careful storage.

In use the base sits flat on the clean table surface, the knee is raised to bring the gauge up close to the head and the vertical quill of the machine is extended down by some six to eight inches. Offer the central stalk of the gauge up to touch the quill over its length from first one side and then the front. Any discrepancy in tram alignment in the two directions is revealed with a good light shining through from the rear and can be corrected accordingly. It was quick, simple, and made a very convincing demonstration.

I realise now, without having seen this method before, it is the reciprocal of the approach I favour with a lathe face or catch plate mounted on mill spindle fitting hardware, pieces of kit most workshops will already possess. In this variation, the plate is wound down into hard contact with the clean table surface. The head can be adjusted quickly for alignment in both directions at the same time, whilst maintaining the contact pressure of the plate on the table surface.

Photograph 9 shows it in use. Here again, a good light from the rear is helpful for checking the table and plate contact to spot any gap in the joint between them. With this method you can avoid using any props at all on a mill having a large diameter quill and butt the broad end face of the spindle directly onto the table instead.

I have seen videos made by one Sheffield professional, David Wilks, of Tooltek, who made his living manufacturing long and large diameter trepanning tools that involved tilting the milling head as part of the process; he made a feature of doing just that with a Bridgeport mill. In this video he returned a deliberately mis-aligned tram back to the engraved datum marks for vertical in both directions within minutes.



To avoid crashing the tool into the chuck jaws

These tools are serious special purpose boring heads and will hog out an accurate hole down a 50-inch length of big bar in tough materials like nimonic and inconel while at the same time producing a useful length of "waste" core bar in the process. Hundredweights of chips are produced as the work proceeds.

In part two of Keith's demonstration, he went on to show the bar and twin DTI method that seems to me to be so laborious. It is also an expensive accessory to keep for occasional use and on a machine with a narrow bed it also needs a precision ground flat bar available to check for alignment across the machine bed.

Mainly out of interest I watched this part of the demonstration to see how he went about it. In real time it would take something like 20 minutes or so to include all the checking required to equate the DTI movements. I guess such adjustments would be needed each time it is used; the impression I was left with was just how fiddly it all was.

He didn't pronounce on the merits or otherwise of the two methods he had demonstrated, but I know which I prefer.

To finish, an oil filter sealing washer makes a very good spacer for any lathework butted up against the chuck jaws when gripped internally which is to be machined up to the chuck jaws. They are square edged, of precision thickness, having been stamped out from neoprene rubber sheet and will of course stretch across the chuck jaws.

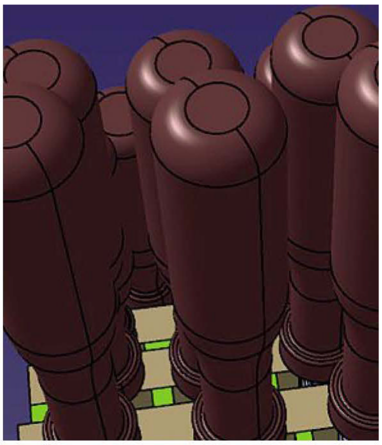
Photo 10 is a rather artificial staged set up in Perspex sheet to show the concept. An 'O' ring makes an acceptable alternative. ∎

In our Next Issue

Coming up in issue 333, November 2023

On sale 20 October 2023

Contents subject to change



Alan Bryan designs a workshop storage system for his metalworking files.

Al Hanson makes an interesting fixture for splicing quarter round timbers.

Bernard Towers describes his ER16 Indexer.

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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.**

More On Old Woodscrews

Dear Neil, please see her a picture of a wood screw. In our ancient house ('new' wing built about 1830) some of the doors are of 'Georgian' era.

This screw is from one of the door hinges. I cannot remember the year, but wood screws were first made without a point, like these, you will note it has only a very slight taper so a pilot hole would need to be drilled. It was only sometime later, sorry don't know the date, when they were able to make them with a point on so they resemble modern wood screws.

I hope this adds to the shared knowledge of the discussion.

William Waddilove, by email.

Magnetic Attraction

Dear Neil, I recently had need to make a 3 inch diameter disc with a 2 inch diameter hole in 1/4 inch Ali plate. Using the outside jaws on the chuck I needed to bring the whole piece forward of the jaws to enable a radius on the outside diameter. I have sets of printed jaw packers from e bay, but they only work on inside jaws. After several goes at using some Ali packing and it falling out, I had the idea of using the small rare earth magnets as packers. In this case I used two on each jaw and no problem with them falling out!

Keith Beaumont, by email.

Bevel Correction

Dear Neil, it looks like the gremlins got at MEW No 331. On p60 & 61 photos 15 & 18 are the same. The error is entirely mine; photo 15 should have been as attached.

Bob Reeve, by email

International Tips

Dear Neil, I've always thought it a little disappointing that the "Readers' Tips" competition is restricted to UK readers, only but is obviously implicit in the limitations of redeeming the voucher prize offered so I guess I'll just have to swallow the bitter pill that I'm a victim of the tyranny of geography. Never mind, I'll offer this tip for readers who may find it useful... want not, waste not: improve your environmental re-cycling credentials by visiting your local library, say, or even a large office complex. You will find that many these days have dedicated recycling bins for spent ink cartridges. Take a close look, they can yield some hidden treasure. Contained inside the anonymous black/grey plastic container are two very handy paddles/spiral paddles which can be re-purposed for a paint-stirrer (conveniently held in a pistol drill), say or for the other, an agitator for an electroplating or etching bath - and driven by two useful plastic gears at the end which may find use in modelling projects. The attached picture illustrates the potential. So, how do you get it out of its 'jail-cell'?

Under no circumstances must operations be performed indoors, especially not your home nor even your workshop (your second home!). Wear PPE to make sure you don't inhale the print powder or get it in your eyes. All work must be undertaken outdoors on a day with a steady wind blowing; remain up-wind at all times. Grab a hacksaw, a single-handle 'Junior' type is ideal. Start at the end with the driving gears and keep the cartridge vertical at all times. Start the hacksaw cut about an inch in from the cartridge end, the objective being to cut around the circumference, i.e. don't be a dummy and attempt a plunge-cut or else you'll 'de-capitate' the very thing you're trying to retrieve; exercise due-care. As you will observe the periphery conforms to the profile of the components inside and therefor, a continuous cut will not be possible due to the presence of at least a couple of hairpin crevices. No matter, proceed as far as you can then switch to a sharp and stiff craft knife, making a series of shallow stabbing cuts (the plastic is soft and thin) so as to join up the ends of the interrupted hacksaw cuts then carefully slicing along the perforations to break-through. Do not aggressively yank the core out (the inner components are free-running in the cartridge case, i.e. the shafts are not captive), instead slowly lift out in a series of incremental steps, tapping and shaking as you go. Once removed, a few gentle taps on the ground or even a light dusting with an air jet will dislodge any remaining black ink-powder. A few squirts with a garden hose, and, I would suggest, set aside and after finishing washing the dishes or doing the laundry, bail out the soapy, detergent-laden waste water into a bucket and give the paddles a good scrubbing down with an old toothbrush or sponge, a final rinse then leave it out in the sun to air-dry.

I hope this tip proves of use.

Andre Rousseau, New Zealand.

Thanks Andre. International tips are welcome, but Chester point out that the costs of shipping to the antipodes make vouchers from a UK business something of a 'white elephant' – Neil.

It's Not All Tooling!

Contributor Murray Lane shares some examples of long-term projects in his workshop.

Starting in issue 315, Murray lane detailed his design for a lever-feed Myford Tailstock. We don't normally cover models in MEW, but hopefully readers will excuse us for sharing these magnificent examples built over fifty years of model engineering.

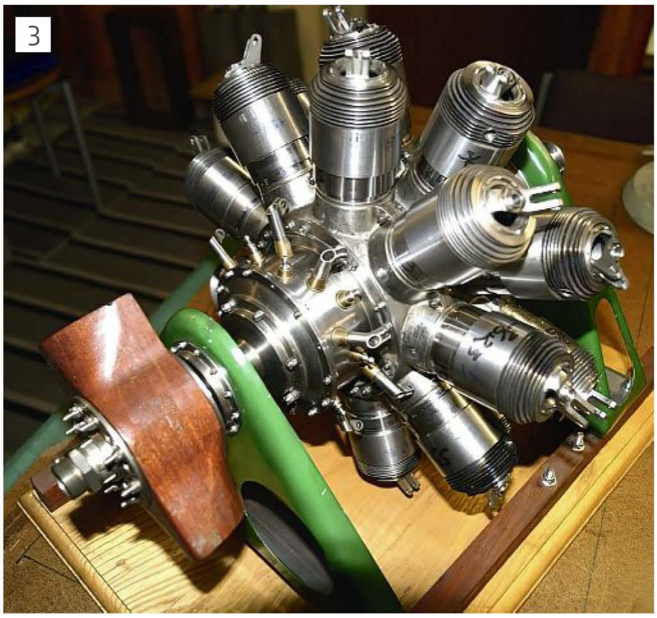
The first is a 5" gauge 4-cylinder Heisler bush locomotive of 1932, **photo 1**. The original engines were all 2 cylinders. The build time was twenty years from 1973 - 1993: It has 5 bogies all of which are connected by a geared shaft drive shaft. The model was designed and built by Murray. Although a 4 cylinder engine was drawn up it was never made. This locomotive has pulled 14 adults and a 7 ¼" locomotive up a continuous 1 in 100 grade, **photo 2**.

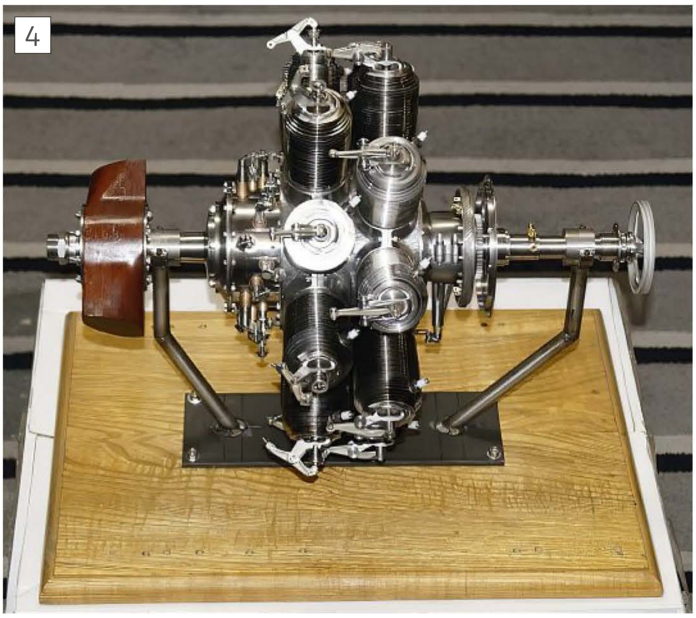
The second model is a 1/3 scale 18-cylinder Gnome Monosoupape rotary aero engine (1913). Only one experimental engine was built which may never have been run.

The build time so far is 30 years to date 1993 – 2023. It is 324mm in diameter and weighs 13 kg which includes the stand Murray designed and built the model with with very little information, but it is an exact replica in all aspects. **Photograph 3** shows progress around 2017, while **photo 4** shows the state of play a few months ago; when Murray estimated it would take another 6 months to complete, hopefully before the end of 2023.


1
Heisler bush locomotive.


2
Another view of the 1932 loco.


3
The Gnome Monosoupape in 2017.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In 2023, the engine is virtually complete.

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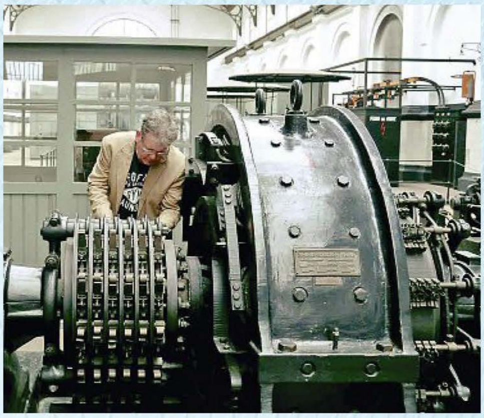

New product promotion, AV550 550W motor / inverter for the Myford Super 7. Call for details!

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Company Profile – WARCO


Tim Ede

Warco (also known in the past as Warren Machine Tools, after its founder Roger Warren), is a machine tools company and UK brand that many of us are familiar with. Established way back in 1975 (when Rubik's Cubes and bellbottom flares were all the rage!), they have been providing lathes, mills, drills and much more to keen hobbyists who want high quality and good value machines in their home workshops. We found out more about some of the people behind the scenes at Warco and asked them about their home projects too.


Twin Stromberg carburettor and manifold refurbishment.


Russ with the Warco super major milling machine.

Tim Ede, Technical Sales Manager, photo 1.

When did you join Warco?

I joined in June 2022, taking over from the previous owner Roger in the sales and technical support role.

What's your own background?

I had a 4 year fully indentured apprenticeship from age 16, then worked in aerospace and mod manufacturing where quality and reliability of supply were of key importance. I've worked with a specialist CNC miller and turner, 3-4 axis, horizontal and vertical machining and grinding. I've also worked as shop floor supervisor, business manager, managing director, sales manager, production manager, owned my own business for 10 years.

Describe a typical day at work for you.

I'm usually speaking to customers, supporting them with technical advice and product choice, dealing with any faults and queries of quality, as well as building quotations and processing orders and payments. I work closely with the purchasing team to ensure we have continued availability/supply of our most popular products from the Warco factory – I never want to let customers down.

When we were based in Chiddingfold, Surrey, I would regularly be meeting customers and supporting them with further technical advice in our showroom. Now that we've moved down the road to a brilliant new facility in Passfield, I still meet customers, but it's by appointment only until the new showroom opens in January '24.

I also visit commercial and industrial customers and educational facilities (like technical colleges and universities) to discuss full install packages and support from start to finish.

What's the best part of your job?

I love supporting customers with making the right product choice for their unique set of needs, and generally helping them any way possible.

What's so special about Warco machines and do you have a personal favourite?

I think what's really special about Warco is its wide range of product choice and the technical support available to customers. Our competitors may have similar products, but they don't have such a wide range, or anything like our level of support and aftercare. My personal favourite is the WM290v. Its all-round spec and size is perfect for so many applications, from light industry to model making and hobbyist – it's crazy value for what you get!

So this is a personal hobby for you too. What equipment do you have in your home workshop?
I have a Warco wm18 mill, linisher, welder, Warco grinders, Warco 2b12pillar drill, many more power tools, air compressor and air tools, and me!

How much time do you spend in your home workshop?
I'll be in there anything from two to six hours per week.

What are some of your home workshop projects?
The refurbishment of Hillman imp, including a full engine rebuild and carburettors, **photo 2**.

Russ Tyson, Engineer, photo 3.

When did you join Warco?
May, 2021

Describe a typical day at work for you.
A typical day for me at Warco will be in the workshop, and usually involves making something, modding something or fixing something! I can be making parts from scratch, maybe modding a machine to have a DRO system or a power feed, or any specific modifications requested by our customers. I also fix old Warco machines that we've bought from customers to sell on as part of our part-exchange scheme and second-hand offering. Usually old machines are still in good working condition but just need some tweaks.

Can you give an example of what you might make from scratch?
A usual part to make would be base plates for the lathes to fit rear tool posts and milling slides, made from a technical drawing. I also make a lot of brackets and spacers to fit my DRO systems as well.

What's the best part of your job?
The variety! Nearly every day has a new challenge! Also, I get to do my hobby every day by manufacturing items on the lathe and milling machine.

What's so special about Warco machines and do you have a personal favourite?
I have followed Warco and their machines for over 20 years, and I have visited many Warco open days and shows. I have always liked the fact we are a UK company, still going after all these years, supplying like-minded individuals. My personal favourite is my GH1322 lathe in the Warco workshop. It's such a nice lathe to use and ergonomically correct for me.

You say this is your hobby too. What equipment do you have in your home workshop?
I have a full-blown workshop at home which covers most of my model engineering needs. I have a mill (Warco Minor - 1996 year), lathe (Harrison 140 - 1965 year), a power hacksaw (Warco - 1982 year - vintage!), a Warco sander and grinder and various other gadgets and gizmos!

4

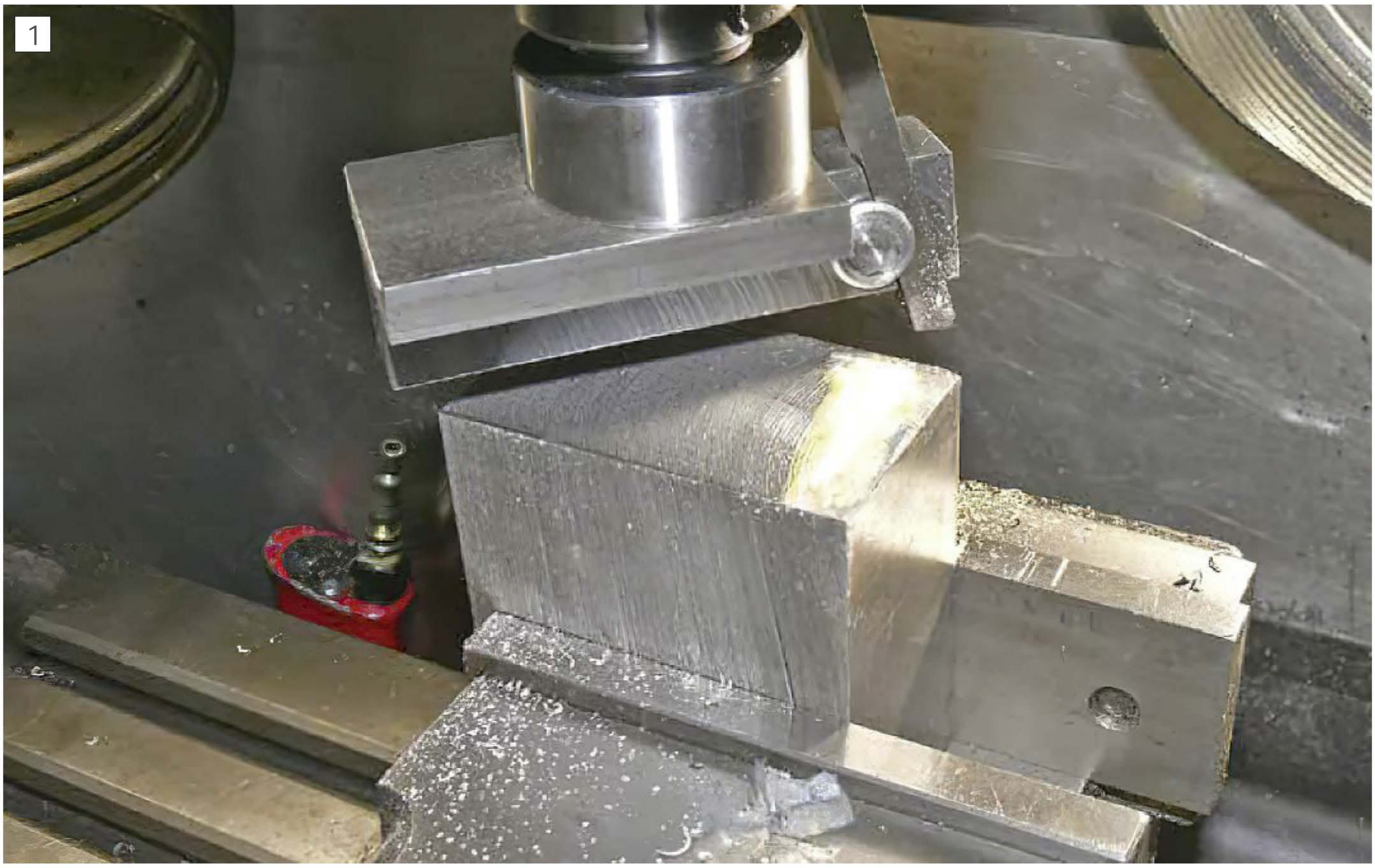
Russ's traction engine.

How much time do you spend in your home workshop?
As much time as possible! In reality I try to balance my home life with my young family, so that means probably one or two hours a night through the week and up to eight hours across a weekend (maybe a little less than this in the cold months!)

What are some of your home workshop projects?
I am currently working on a scratch built 1.5" scale traction engine based on the Minnie engine, **photo 4**. I also like making pens from various materials including stainless steel, brass, aluminium, bronze and titanium. I really enjoy modifying motorcycles as well, including a full nut and bolt rebuild on a Honda CB400/4, a Honda VFR 400RR, and a Triumph Daytona T595. I'm currently about to start a Triumph Trident 750.

Improving A Tangential Flycutter

Howard Lewis described several versions of a tangential flycutter in MEW number 316. Since then he made a number of improvements.



Mk 4 tangential flycutter in use.

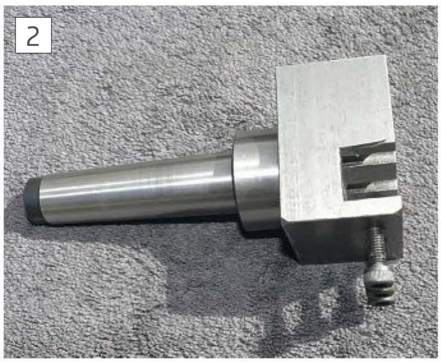
The performance of the mk4 tangential flycutter, **photo 1,** was still not as good as was desired, so further thought was given to the matter.

In the interests of simplifying machining, the mk. 4 tool holder had been made with a full-length trapezoidal shank. It seemed very likely that this was a feature which could allow the holder to tip and upset the intended tool geometry.

Since this was effectively a right-hand tangential turning tool for a lathe, possibly a left-hand version would solve the problem?

Work was put in hand to produce a left hand toolholder, but by milling at compound angles, machining just a short distance at the end of the holder shank to a trapezium shape.

This would entail widening the slot in the tool holder block, to accommodate a full ¾'' (19mm) square shank. So the block was milled to widen the slot. This thinned the end wall, but still left a thickness of ¼'', which would still provide an acceptable an acceptable thread engagement of just over one diameter for the M6 clamp screws, **photo 2**.

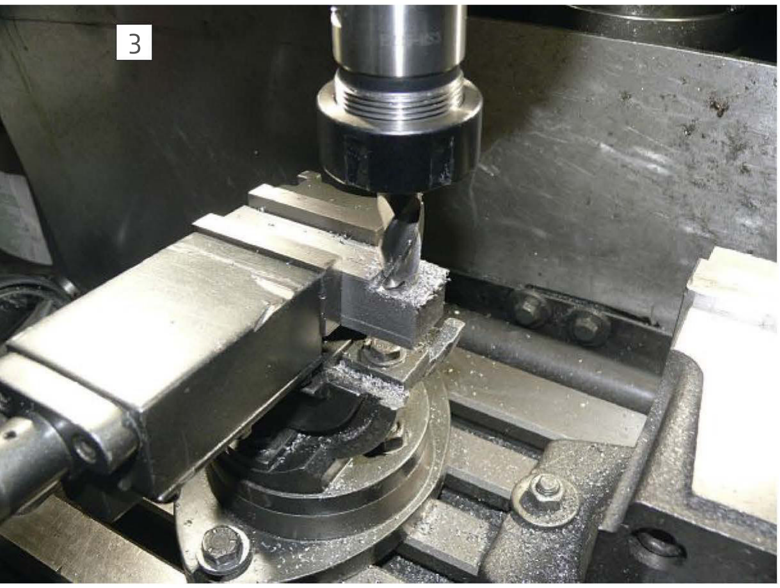


Widened slot in tool holder block.

Toolbit holder

Once made, it soon became apparent that using a left-hand tool holder, with a square shank which was only trapezoidal at the end, was not the solution, since the toolbit could not be mounted in such a way as to produce the required tool geometry, whilst maintaining the requirement to keep the cutting edge on the centre of rotation.

So another, but modified, right hand toolbit holder was made up. Again, the



Milling the angled flats.

Staged picture of centring the tool holder.

Drilling clamp screw hole.

Milling the slot for the toolbit.

raw material for the toolbit holder was ¾" square bar. This was clamped in the vice, which had been inclined at 12 degrees so that two opposite faces could be machined to produce a trapezoidal section tool shank, **photo 3**.

This time the trapezoidal section was only 7/8" (22mm) long, to provide clearance around the hole for the clamp screw and its nut.

Having produced the shortened angled flat, it was centred under the mill for the hole for the clamp screw to be drilled. Absolute positional precision was not required so it was done as shown in the staged **photo 4.**

Staged after the M6 clearance hole had been drilled, **photo 5**, because I omitted to take the picture before!

According to my calculations, the hole should be drilled 0.454" (11.53mm) from the end. The vice was then rotated by 12 degrees in preparation for milling the slot for the toolbit.

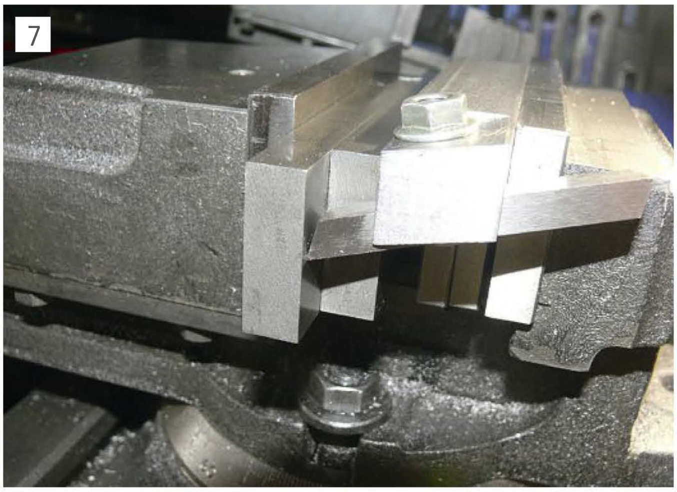
The mill table was repositioned by the crude method of adjusting its position in both axes until the drill could be used as dowel that entered the hole quite freely. This was then used mas a datum from which to offset the ¼" end mill to ensure that the slot would break into the hole. In this way, a flat on the clamp screw would bear against the toolbit, preventing rotation whilst the clamp nut was being tightened.

Care needs to be taken to ensure that the slot is milled on the correct face of the holder! **Photograph 6.**

Having completed the machining satisfactorily, the hole and all edges, were lightly deburred, ready for assembly of the complete tool.

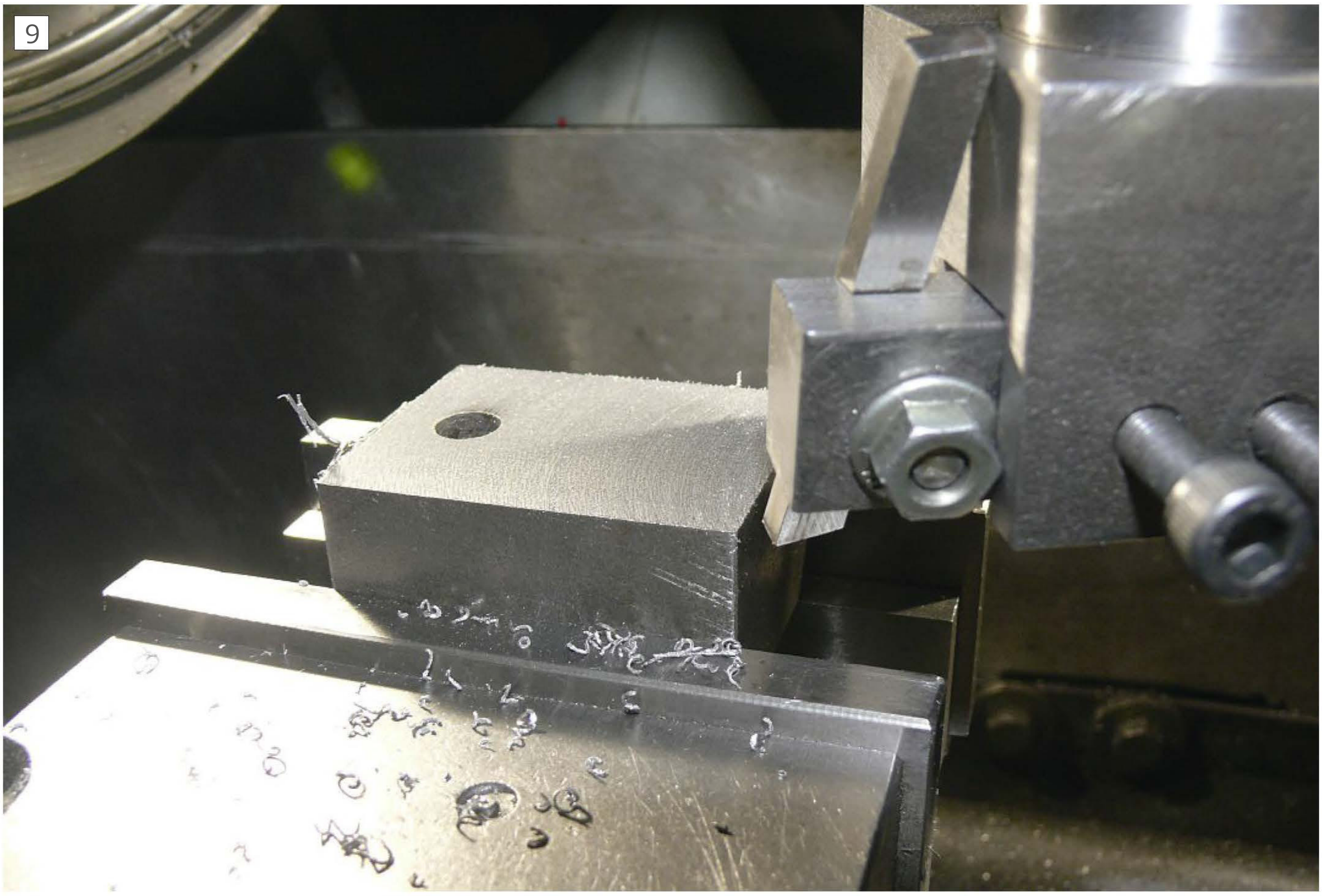
Setting the toolbit

Again, because of the angle at which the toolbit is set, the protrusion from the holder will affect the position of the cutting edge from the centreline if the arbor. As before, to set the cutting edge of the toolbit close on the centreline of the arbor it was set by resting the shank on a 10mm parallel, with the tool bearing against another 10mm parallel, whist clamped in a vice. 10mm was the chosen protrusion to maximise rigidity. This was calculated to bring the cutting edge of the toolbit ›

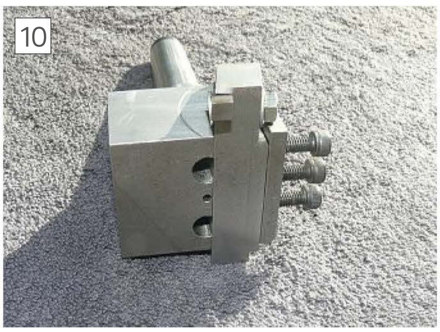


Using a parallel to set toolbit protrusion.

The mk. 5 tangential flycutter toolbit holder.



The mk. 5 flycutter in use.



Mk 5 tangential flycutter.

0.081'' ahead of the toolholder, **photo 7**. The completed, and set, toolbit holder is shown in **photo 8.**

The assembled flycutter was then tested. It was set to minimum radius, (1.75'' or 44.5mm) and with the mill running at minimum speed (90 rpm) a trial cut, made with a depth of cut of 0.005'' (0.125mm) and a slow manual feed. It was apparent that the cutting action was improved, since much smaller burrs, which soon fell off, were produced, in addition to an improved surface finish, **photo 9.**

Increasing the speed to 170 rpm, which effectively decreased the feed per rev, produced an even better surface finish. The final complete tangential flycutter mk. 5, is shown, ready for use, is shown in **photo 10**. ■

Introducing Multi-Tools

Stub Mandrel gives a brief introduction to these handy devices.

This lightweight lithium-battery powered multi-tool from Dremel is an example of recent innovation in multi-tools.

Multi-tools live in an interesting area between machine tools and hand tools. These tools are basically a hand-held powered spindle, usually with variable speed, and fitted with a collet. The multi-tool name reflects the bewildering array of different fittings that can be used with them.

Typified by the Dremel brand they are available in a wide range of styles and sizes from slender low-voltage versions to hefty mains-powered types. A new generation of high power lithium battery powered multi-tools has recently come to market, allowing their use in inaccessible places, **photo 1**. Some of the larger mains-operated versions come with a flexible drive to a slender hand-held unit, allowing the combination of high power with the ability to be used for delicate tasks. Even small multi tools can have considerable torque, so take care to hold the workpiece securely and keep a good grip of the tool. Move the toolbit steadily across the work and avoid excess pressure or staying in the same spot too long.

Accessories

When you buy a multi-tool it will probably come with a selection of different tools, usually with 1/8 inch (3.2mm) shanks. Examples of different tasks these tools are well suited to are:

Metal Cutting

Various types of cut-off wheels are available. The very thin, brown carbide wheels are excellent for cutting small, hard wires but are rather fragile and it's not unusual to get through several on a larger cutting task. That said, the ability to cut hard materials in inaccessible places is probably the greatest benefit a multi-tool brings to any workshop. More robust fibreglass reinforced wheels, **photo 2**, can be used for jobs like cutting through seized-on bearing

Reinforced cutting discs are thicker but more robust than the brown carbide type.

Polishing compound and 'mops'.

races or even rough-shaping and cutting high-speed steel tools.

Drilling

Tiny carbide drills with 1/8" shanks are often included in sets of accessories and are excellent for drilling printed circuit boards, but must be used with some form of drill-press accessory – they are far to fragile to be used hand-held. In contrast, many people have had more success using a small chuck (they screw onto the end of the spindle in place of the collet closer) to hole small diameter HSS drills. Down to diameters around 1mm it is possible to use HSS drills hand-held with care.

Cleaning and Polishing

Most accessory sets contain a variety of brushes and felt polishing mops and points (which often fit on a screw-ended 'mandrel', **photo 3**. Brushes can be steel, brass or various types of plastic,

Steel and brass brushes. Nylon brushes are suitable for more delicate materials.

photo 4, and you need to choose the right one to suit the material you are working -beware of using steel brushes on aluminium alloys as they can embed small steel particles that later rust and spoil the job. Felts are best used with polishing compound, this is often supplied in small containers but you can also get excellent results on many metals and hard plastics by using automotive chrome polish.

Grindstones

Although many accessory sets include an assortment of different coloured grindstones, these are often not as useful as they look. Generally speaking, they aren't up to larger sharpening tasks which are better carried out by taking the work to a bench grinder, but they can be useful for things like removing moulding marks from castings. Ideally

Using a venerable 'Woolworths' multi-tool and diamond files to tidy up iron castings.

Rotary rasps and diamond coated burrs.

a set will indicate what materials each colour of stone is best for, but if you have to experiment unsuitable stones will reveal themselves by rapidly losing their shape.

Sanding Drums

Aluminium oxide sanding drums are intended for use with wood, but they are actually really effective on steel, cast iron and aluminium alloys, both for cleaning up castings and for blending corners into neat curves. If you run the tool nice and fast and don't force it the drums are surprisingly long-lived and often more effective than grind stones as they have a coarser grit-size and cut faster.

Burrs and Rasps

Photograph 5 shows a selection of these tools. The coarse metal rasps are best used on wood and soft plastics -with care as they can remove material at a startling rate! In contrast, diamond studded points can be used for delicate work on hard materials, even engraving glass. One particularly useful task for such burrs is cleaning up fine details on iron castings, **photo 6**.■

Multi-tool Safety

Being hand-held, it is easy to break tools in these machines – cut off wheels and drills in particular, but also brushes can throw wires in unexpected directions and even small grinding stones can shatter if they are damaged. It is therefore essential to wear good quality eye protection when using any multi-tool. Use a face mask when doing any task that will produce dust and ensure you have good ventilation. Finally, some multi-tools can run very fast – always check that you do not exceed the maximum safe speed for any tool.

Squaring the Circle

Graham Meek makes some custom gears to solve a handwheel conundrum.

I took delivery of my Emco Maximat Super 11 in 1986. At that time this was only one of two lathes in the model engineering world that came with a handwheel dial as standard. The other being the Myford 254 lathe. Having this luxury was something I had grown up with in industry, but the 19mm per revolution graduation was a bit of a disappointment. Nonetheless I soon became used to some quick mental arithmetic to get all those desired dimensions above 19mm that I wanted. There had always been an intention to remedy this shortfall but somehow, I never seemed to get around to it. Matters came to a head thirty years later when a series of mental arithmetic mistakes, which resulted in several scrapped components forced my hand.

Thinking to myself, things would be a lot simpler if this was a whole number, or even 25mm per revolution. Preliminary sketches soon showed that the 25mm dial version was going to need a dial nearly as big as the Emco handwheel, so no more work was done on this design. This was a pity because this would have made an ideal base for a 1'' dial version for those readers with an Imperial versions of this lathe. The next design route was to make the new dial read 20mm. This would mean a simple reduction with-in the dial which had a 19 to 20 ratio, or numbers thereof.

However, that was until I decided to check the actual carriage movement for one complete turn of the dial. I was a little surprised to find that the actual distance travelled was 18.97mm. Given the countless thousands of jobs completed, many on a commercial basis, this error had never once scrapped a component. Even when the dial had

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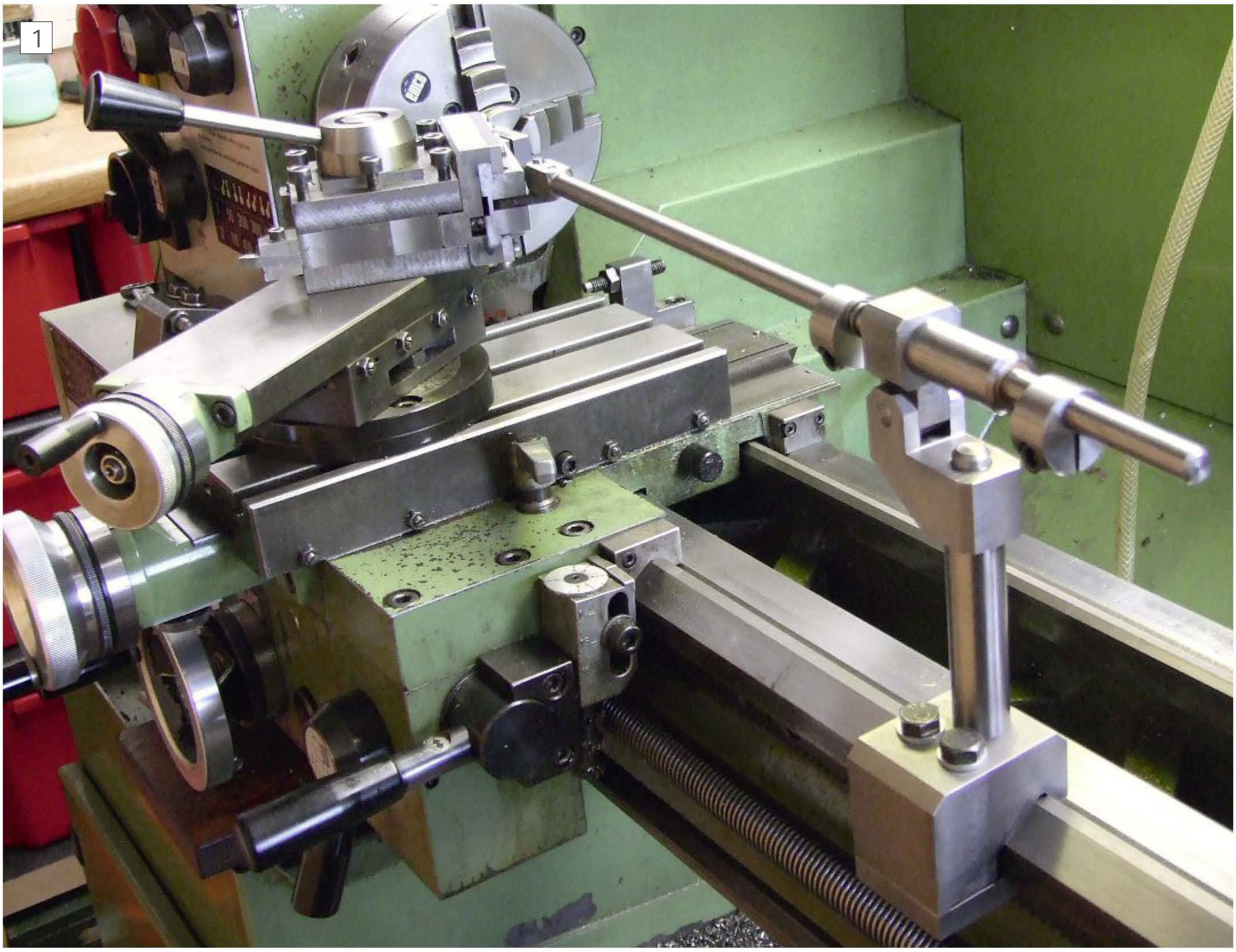

Carriage handwheel and dial just visible.

been used to measure off lengths involving multiple turns. It did somewhat put a "stone in the ashes" as regards my simple 19 to 20 ratio though. Of course, I could have just left it at that, but the opportunity to get it right was beckoning and I do so love a challenge.

The existing dial sits directly on the handwheel boss, with the face of the dial in close proximity to the apron wall. This can just be made out in **photo 1**. Although this photograph was originally taken to show my version of Jacques Maurel's quick retracting screw cutting attachment. In the Emco design the handwheel is used to transmit the drive via a woodruff key set into the pinion shaft and any end float is eliminated via a Symonds, or Nyloc nut on the exposed end of that shaft. The dial is free to rotate on the handwheel boss, but a semi-circular spring set into an undercut in the handwheel boss, provides friction on the dial which means it is possible to zero the dial at any point and the dial will stay put. That is provided attention is paid to the end float. Slight up and down movements of the handwheel during travel can cause the dial to rub the apron wall if the end float is too great. This rubbing can alter the dial as I had found out once to my cost. It was in this space that I also wanted to incorporate a radial ball bearing race to eliminate this slight up and down movement brought on by 30 years of wear. There was never going to be an easy way to incorporate all that I wanted to in the existing envelope. This was beginning to feel as though I was trying to "square the circle", i.e. trying to do a very difficult or impossible task. Finally, I managed to square the circle as can be seen in **photo 2**.

Eventually after many permutations I found that a 37-tooth gear driving a 39-tooth gear gave me a near perfect ratio. The theoretical distance moved for one revolution of the dial would give 19.995mm of travel, somewhat nearer than the standard set-up. The only problem with this ratio was the need to mesh both gears using a common idler gear. The reader will see from the General Assembly, (GA), that these gears are co-axial. Two standard gears could never mesh with one idler. The only solution is to increase or reduce the PCD of one of the gears. Given the design constraints, reducing the 39-tooth was not really an option, the only alternative was to increase the 37-tooth gear.

The problem is that this is only usually done in industry with the use of a gear Hobbing machine, or unless you own a Jacobs gear hobber. As I do not possess any form of gear hobbing machine, this needed a different approach. I have always been comfortable drawing gear tooth profiles for standard gears and making my own single point gear cutters from these drawings. However, where to start with an increased PCD gear was something I was not familiar with. The time was ripe for a perusal through Machinery's Handbook, (or

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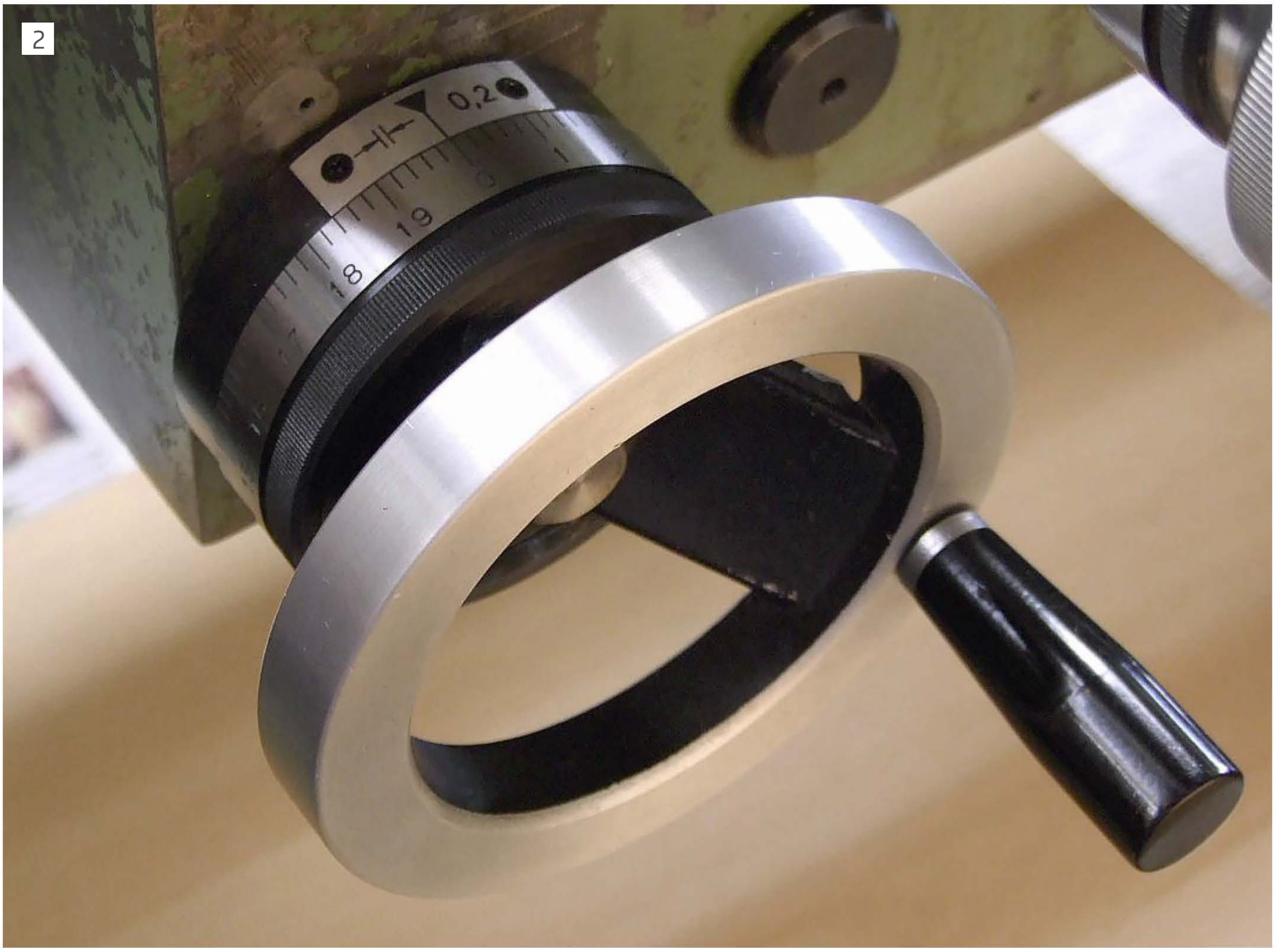


Handwheel with new dial.

the 'Engineers Bible'). Sure enough, in the "Gearing" chapter, under a section headed, "Circular thickness of tooth when outside diameter has been enlarged", page 677 of the Fifteenth Edition. I found what I was looking for. This section gives the formula:-

$t = p/2 + e \tan\varnothing$

Where, t = Tooth thickness, (at new PCD)
p = Pitch diameter of standard gear
e = Amount the outside diameter is increased over standard gear.
$\varnothing$ = Pressure angle

Using the above formula, it is possible to draw the required gear and those with AutoCad or similar will find it dead easy.

Perhaps with the Editor's indulgence a few simple notes on how I draw these might be welcome, as this is not something I have seen in article form, but I am always ready to be corrected. The first thing to do is to draw the PCD of the new gear, **fig. 1**. Which is the same as the 39-tooth gear, using the "Circle" command. Which in this instance because I chose 32 DP for my gears is 1.2188" or as I choose to work in metric units this becomes 30.95mm. This circle is drawn as well, as a circle on the same centre for the outside diameter, (OD), which again is the same as the 39-tooth gear. After conversion this should be 32.53mm but I ignored the 0.03 as it is insignificant, and it makes for a simple OD of 32.5mm. A vertical line or vector from the circle centre to the OD is drawn next, (I usually work with the Ortho "on", this ensures automatic verticals and horizontals). A further vector is needed in the top right quadrant, (or approximately where 1 o'clock should be). This can be easily achieved using the "rotate" command on the drawing package and rotating our already drawn vector. The angle to move through is the pressure angle chosen, (PA). Which in this instance is 20 degrees and this is a minus quantity otherwise the vector will rotate anti-clockwise, instead of clockwise. Next draw another vertical vector to the OD from the circle centre to replace the one just moved.

The next thing required is the "base circle" size, **fig. 2**. A point on this circle forms the basis of the gear tooth "Flank" radius.

Again this can be found in Machinery's handbook and it is:-

$Bc = p\cos\varnothing$

Where, Bc = Base circle
p = Pitch Circle Diameter
$\varnothing$ = Pressure angle

This is not how it is written in my edition of Machinery's, I have purposely altered this formula to keep some form of continuity going in this article and thereby avoid confusion. Also the PCD in this case is for a standard 37 tooth 32 DP gear. If the PCD of the 39-tooth gear is used it will cause fouling. As basically we would be drawing a 39-tooth form, but there would be only 37 of them, if that makes sense. I have drawn this to show the difference, **drawing 1**. The reader will see the two extreme corners of the 37-tooth gear foul, this is because the teeth are further apart. The product of the above equation in this instance is 27.58mm. A circle is now drawn on the same centre with this diameter. Where the 1 o'clock, or PA vector crosses the base circle is the centre of the gear tooth flank radius. The length of this radius is the distance from this intersection, to the intersection of the vertical vector with the PCD. A circle is now drawn with this radius, which is 5.35mm. This is also the radius of the cutter needed to make the single point gear cutter, ie 10.70mm diameter. This is not an easy cutter size, but more on this later. The gear tooth form does look odd, but this is basically the same part of the involute curve used on the standard 37-tooth gear. It is that in this instance the curve being used is a little further away from the Base circle than it would be for a standard 37-tooth gear.

Using the "Offset" command the Whole depth of the gear tooth can be determined, this will give what is known as the "Root" diameter, **fig. 3**. This is the total of the "addendum", the part of the gear tooth above the PCD and the "Dedendum", the part of the gear tooth below the PCD. On DP tooth forms the addendum on a gear is 1/DP and the dedendum is 1.157/DP. The dedendum is always a slightly larger dimension. The reason being there needs to be clearance for the OD of the mating gear tooth, the provision of a radius at the root flank intersection for strength and some space to allow debris or excess lubricant to go. metric or MOD, (short for module), gears are easier in my opinion in that the addendum is equal to the module and the dedendum is equal to the module times 1.157.
So for these DP gears the whole depth = 2.157/DP.

The product of this ratio will be in Imperial units, so to get to a metric dimension divide by 0.03937 and this gives a dimension of 1.71mm, but again I am going to ignore the 0.01mm, so the offset command is for 1.7mm. Selecting the OD and biasing to the inside of the OD circle, the root diameter will appear. Using the "trim" command select the OD and root diameters. Remove all of the flank radius circle except for the portion that passes through the PCD on the vertical vector.

At this intersection draw a circle that represents the tooth thickness, t, **fig. 4**. I have added an enlarged view if this drawn at five times full size, (5xFS). From the above formula for the tooth thickness this gear works out at 1.19mm. Draw a further line from where this circle cuts the PCD on the lefthand side of the vertical vector to the circle centre. Measure the angle between this line and the vertical vector, (2.22 degrees, two decimal places are plenty accurate enough for this measurement). Make a note of this angle and select the rotate command. Select the flank radius as the entity to rotate, select the circle centre as the rotation point. The angle to rotate through is that noted. The flank radius will then move to its new position at the tooth thickness circle and PCD intersection, **fig. 5**.

Using the "erase" tool remove the last line drawn, the PA vector and the base circle. These will only get in the way shortly. Alternatively the reader might like to use the "copy" command and copy the whole view before deleting the above. That way there is always a drawing of the original path preserved for future reference. Using the "mirror" command select the flank radius and mirror about the two ends of the vertical vector. This command usually asks if the source is to be deleted, yes or no, press N and enter. The opposite flank of the gear tooth appears as if by magic, **fig. 6**. Then using the "array" command and selecting a "polar array" select the two flank radii. Next select the circle centre as the polar origin and enter the number of arrays, 37. Do a

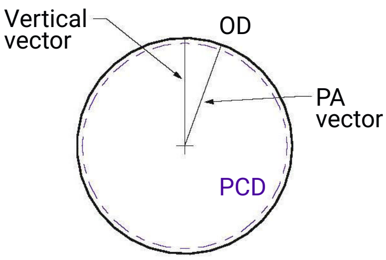


Fig.1

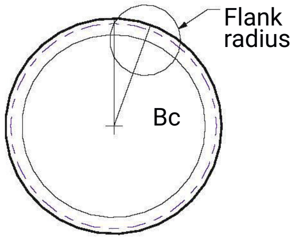


Fig.2

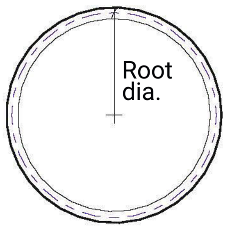


Fig.3

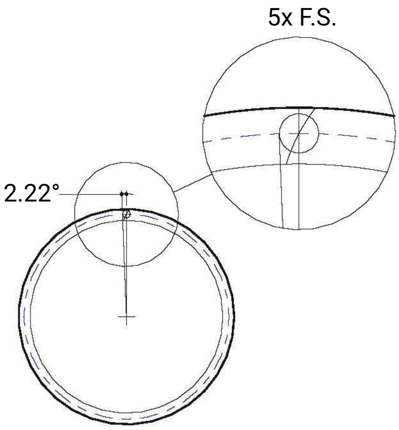


Fig.4

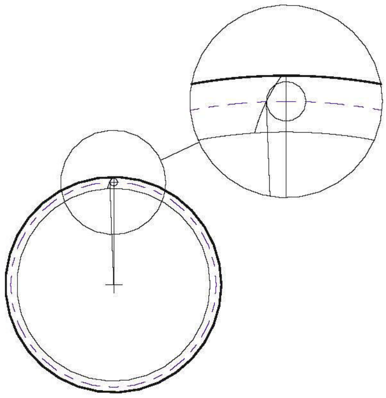


Fig.5

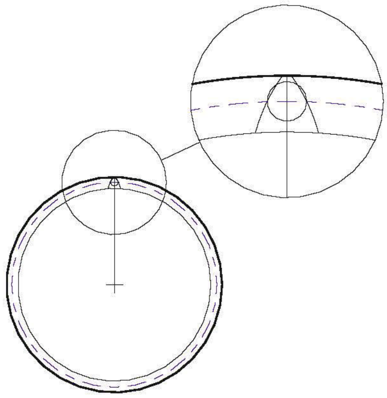


Fig.6

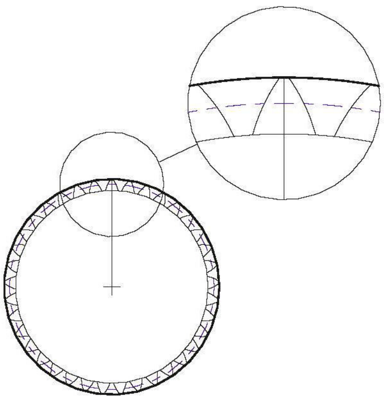


Fig.7

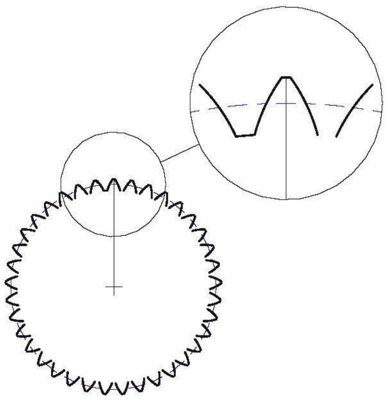


Fig.8

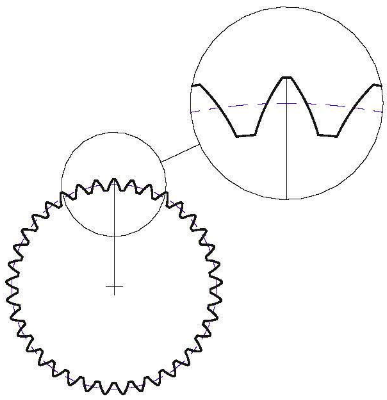


Fig.9

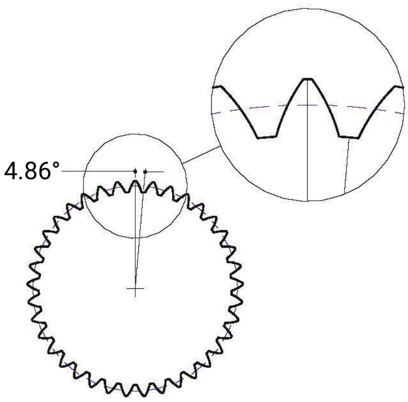


Fig.10

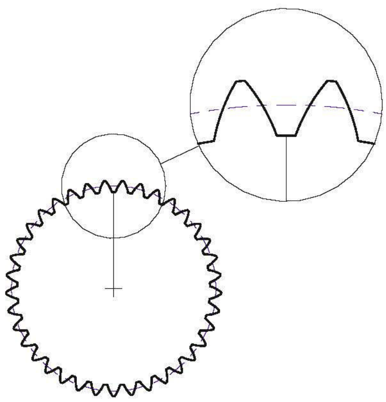


Fig.11

"preview" to make sure the whole of the circle has been filled. If it has not filled the whole circle, check the "angle of fill box" this should be 360 degrees. Once satisfied with the preview it is a simple enter keystroke for the teeth to become permanent, **fig. 7**. Using the trim command select three adjacent flank radii. Click to remove all of the root diameter except that portion between the two adjacent flanks. Use the same approach on the OD leaving just the portion between the other two flank radii, fig. 8. Using the polar array command and just selecting the portions of these remaining diameters and doing a 37 array again, the gear will then complete itself, **fig. 9.**

In order to acquire the profile for the flycutter it will be necessary to get a tooth space on the vertical vector where there is currently a tooth profile. This is easily done by drawing a line from the "midpoint" of a root portion of one of the adjacent gear teeth on the right-hand side of the vertical vector to the circle centre, **fig. 10**. A slight deviation, to get the midpoint either "tune" the cursor settings, or by entering "mid" in keystrokes, plus "enter" before selecting the line. Measure the resultant angle, (4.86 degrees) and again make a note. If a rotate command is now done selecting the whole gear as the entities and the circle centre as the origin. Entering the noted angle and pressing enter should see the whole gear rotate and the last line drawn become the new vertical vector, **fig. 11**. Erase the old vertical vector this will serve no purpose from now on.

Again using the copy command select the new vertical vector, the two flank radii straddling this line, the PCD and the portion of root diameter connecting the two flank radii. Move these copied items to a fresh part of the drawing **fig. 12**. Now draw a vertical line from the end of the vector, the length is immaterial. This represents the cutter centre-line. Using the offset command, offset this line either side by 1.6mm. Which is near enough for a ⅛" square tool blank. Select these two new lines with the "extend" command and then click on the exposed ends of the flank radii in turn. Using the trim command select the two flank radii and trim off the portion of the "toolbit" that is in fresh air as well as the PCD. The original vector can now be erased. Because the flank radius is an awkward size now would be a good time to make this more manageable. Mark the flank radius centre using the "centremark" button. Draw a line from the PCD line on the flank to the flank radius centre mark. At the PCD end of this line draw a circle 10.50mm diameter. Erase the two flank radii. Where the 10.50mm circle crosses the line from the PCD to

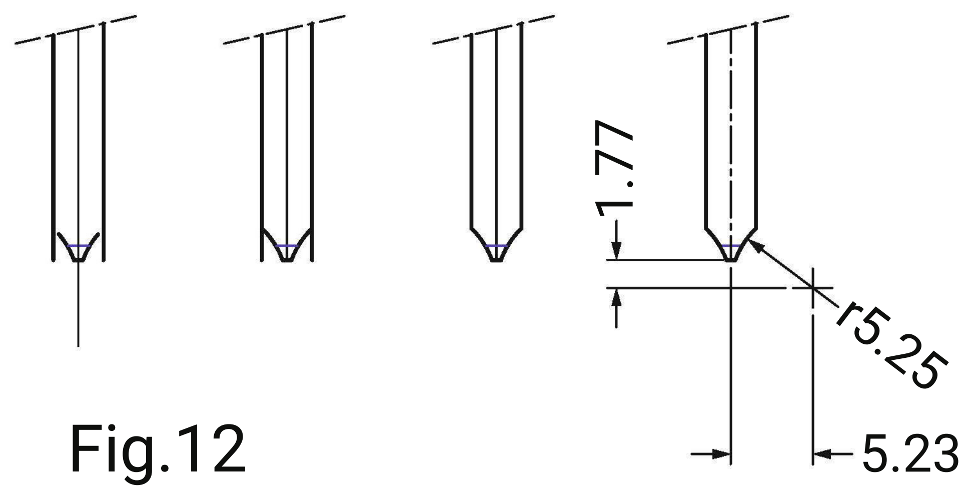
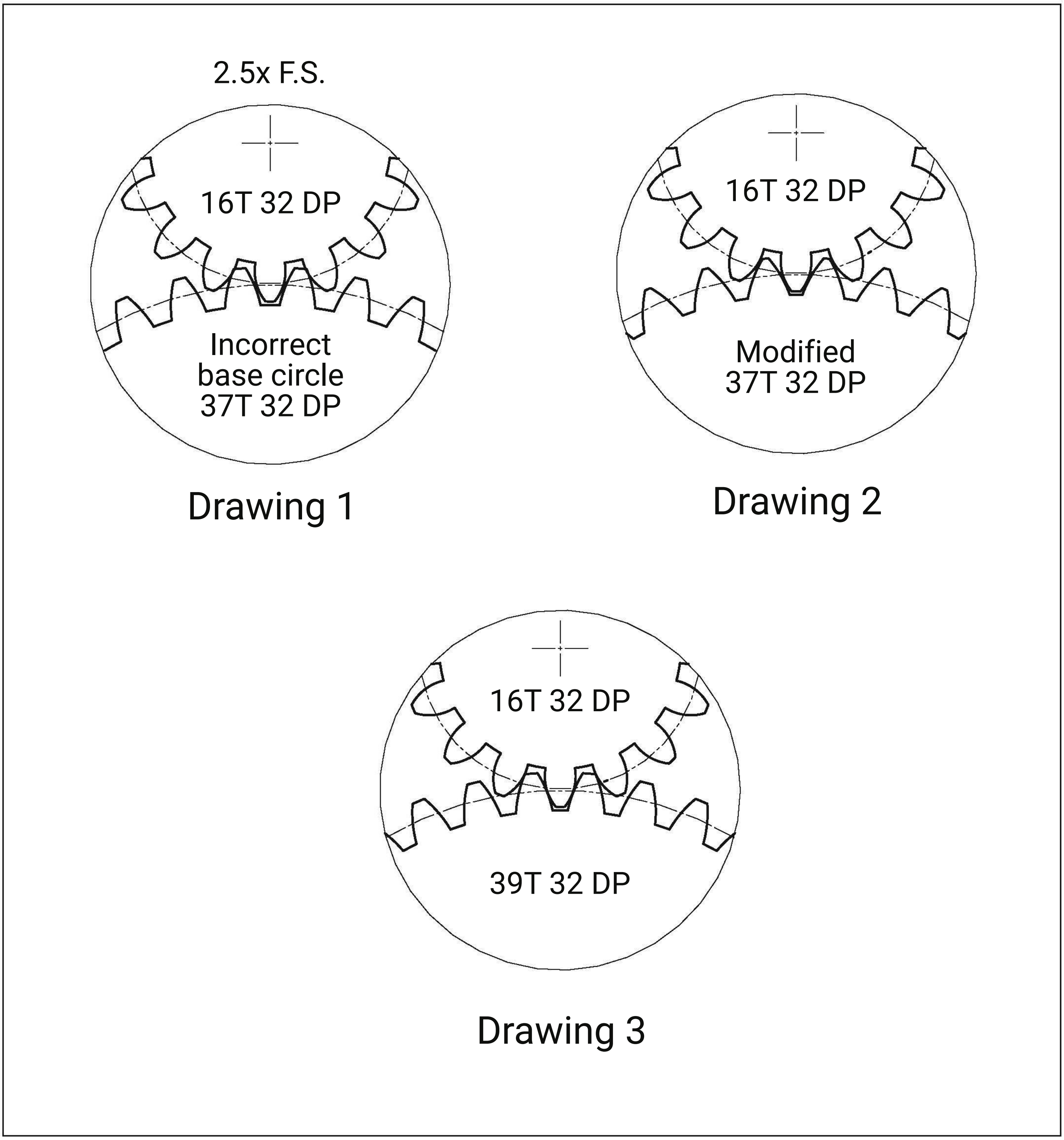


Fig.12



the centre mark draw another circle 10.50mm diameter. Erase the first 10.50mm circle, the line joining the PCD to the centre mark as well as the centre mark. Using the extend tool select the 10.50mm circle and extend the root diameter towards this circle as well as the side of the tool bit. With the trim tool select the side of the tool bit and the root diameter. Trim the circle away outside these lines. Using the mirror function select the new flank radius and mirror this about the tool bit centre line. To complete this view the root diameter and tool bit side need extending to the new flank radius. Choose a new layer for dimensions and dimension the radius. This should automatically insert the radius centre mark. If not use the centremark button. Working from this centre mark insert the coordinates from here to the centre-line of the toolbit and to the end of the toolbit. My drawings of the flycutter profiles for each gear gives the general idea. These dimensions will be needed for making the cutter which I shall explain a little later on.

This concludes how I draw my gears and it has worked faultlessly for me over the years. This may not be the approved method, but like arithmetic we all have different ways of arriving at the answer. **Drawings 2** and **3** give an enlarged view of the gears in mesh.

● To be continued

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

Ferrozinc Relaunched

HMG Paints, a manufacturer of high-quality coatings and paints, has announced the relaunch of Ferrozinc, a revolutionary water-based rust converter. With its exceptional performance and ease of use, Ferrozinc is a go-to solution for rust conversion in areas where shot blasting, or complete rust removal is impractical or impossible.

"Ferrozinc has been a popular product for our customers for a number of years and we're proud to introduce the new 250ml size" commented James Burton of HMG. "It's such a handy product for users in a number of industries from decorators and industrial applicators to agricultural and classic vehicle restoration."

Traditionally, rust removal has been a laborious and time-consuming process, involving hours of wire brushing or the use of strong acidic chemicals that pose significant safety hazards. With HMG's Ferrozinc rust converter, however, this arduous task becomes a thing of the past. This is the perfect solution to anyone working in the decorative or industrial markets, and even classic car enthusiasts!

Users only need to remove loose debris and poorly adhered surface rust, followed by a degreasing step to eliminate any contamination that may interfere with the chemical reaction. Afterward, a thin coat of Ferrozinc is applied to the rusted area, and within 30 minutes, the surface transforms into a black/navy colour, indicating the successful rust conversion. Any excess product can be easily wiped off, and after just +3 hours, the treated surface is ready to be overcoated with the user's preferred coating system.

Ferrozinc's water-based formulation not only provides excellent rust conversion properties but also ensures a low odour, making it a more pleasant and user-friendly option compared to solvent-based alternatives.

Ferrozinc is available in 250ml, 1 Litre or 5 Litres and can be purchased direct from HMG's website or their nationwide distributor network. If you require further information, contact marketing@hmgpaint.com.

2024 Midlands Garden Rail Show

The 2024 Midlands Garden Rail Show will take place on Saturday 2nd & Sunday 3rd March again at the Warwickshire Event Centre.

This event attracts nearly 2,000 enthusiasts from all over the UK and offers visitors the opportunity to see layouts in the larger gauges and scales including Gauge 1, O Gauge, G Scale and more.

Once visitors have been inspired to build their own layout, they can visit nearly forty specialist suppliers at the show who are more than happy to guide them in the right direction of the best product to purchase.

To see more information on exhibitors attending and to book tickets see www.midlandsgardenrailshow.co.uk

THE MODEL RAIL SHOW FOR LARGER GAUGES

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Tales from the Workshop

James C. "Uncle Jim" Crebbin

1

Mr. James C. Crebbin in his workshop overhauling his model locomotive 'Aldington'.

In 1950 an obituary by J Nevil Maskelyne in Model Engineer marked the passing of one of the 'small number of distinguished enthusiasts who got together, early in 1898, for the purpose of founding the Society of Model and Experimental Engineers. James C. Crebbin, **photo 1**, was probably the last surviving member of a group that played a seminal role in establishing our hobby, along with Percival Marshall, who founded our sister magazine Model Engineer magazine in the same year.

'Uncle Jim' Crebbin as he was widely known was tireless in promoting and supporting the hobby of model engineering and made friends in societies across the UK and around the world. Like many of us, he was not an engineer by profession, but he was fascinated by steam locomotives. Over a lifetime in the hobby he made many freelance designs, being more interested in innovation and experimentation than making true to scale models.

In 1903 he completed the loco 'Cosmo Bonsor', named for his friend, a brewer, politician and highly successful railway businessman. This was a 4 ½" gauge Atlantic with four compound cylinders, **photo 2**. In fact, he named most of his locos after railway managers who were amongst his personal friends. He knew many people on the railways from drivers and firemen to great designers such as G. J. Churchward and Sir Nigel Gresley.

This is only the briefest of recaps of his life; more detail can be found in Roger Backhouse's book 'The remarkable Jim Crebbin and his experimental locomotives' and Anne Hatherill's briefer document 'James Charles Crebbin: an extraordinary model engineer'.

2

Cosmo Bonsor in the 1920s (Anne Hatherill/SMEE).

A Tilting Milling Table

Mike Cox explains how to make this useful sub-table for use with a tilting vice.

On one occasion I wanted to machine a vee groove in a piece of steel. The piece had a number of projections on the back that made it difficult to clamp securely in my tilting vice due to the narrow jaws. I ended up making several special packing pieces to get a stable clamping in the vice jaws and was able to mill the vee groove. After I had finished the job, I started thinking how much easier the job would have been if I had a tilting table with tee slots. With a few clamps and some jacking screws in the workpiece it would have been very easy to set up.

I started to think about making a tilting table from scratch. I even started to draw up a tilting mechanism and it suddenly occurred to me that I already had the tilting mechanism in the tilting vice and all I really needed was a tee slot table that could be clamped in it.

The finished table mounted in the tilting vice is shown in **photo 1**.

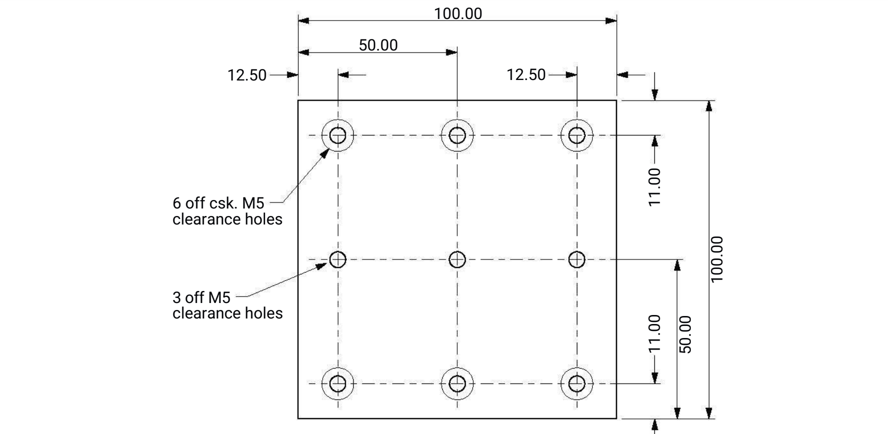
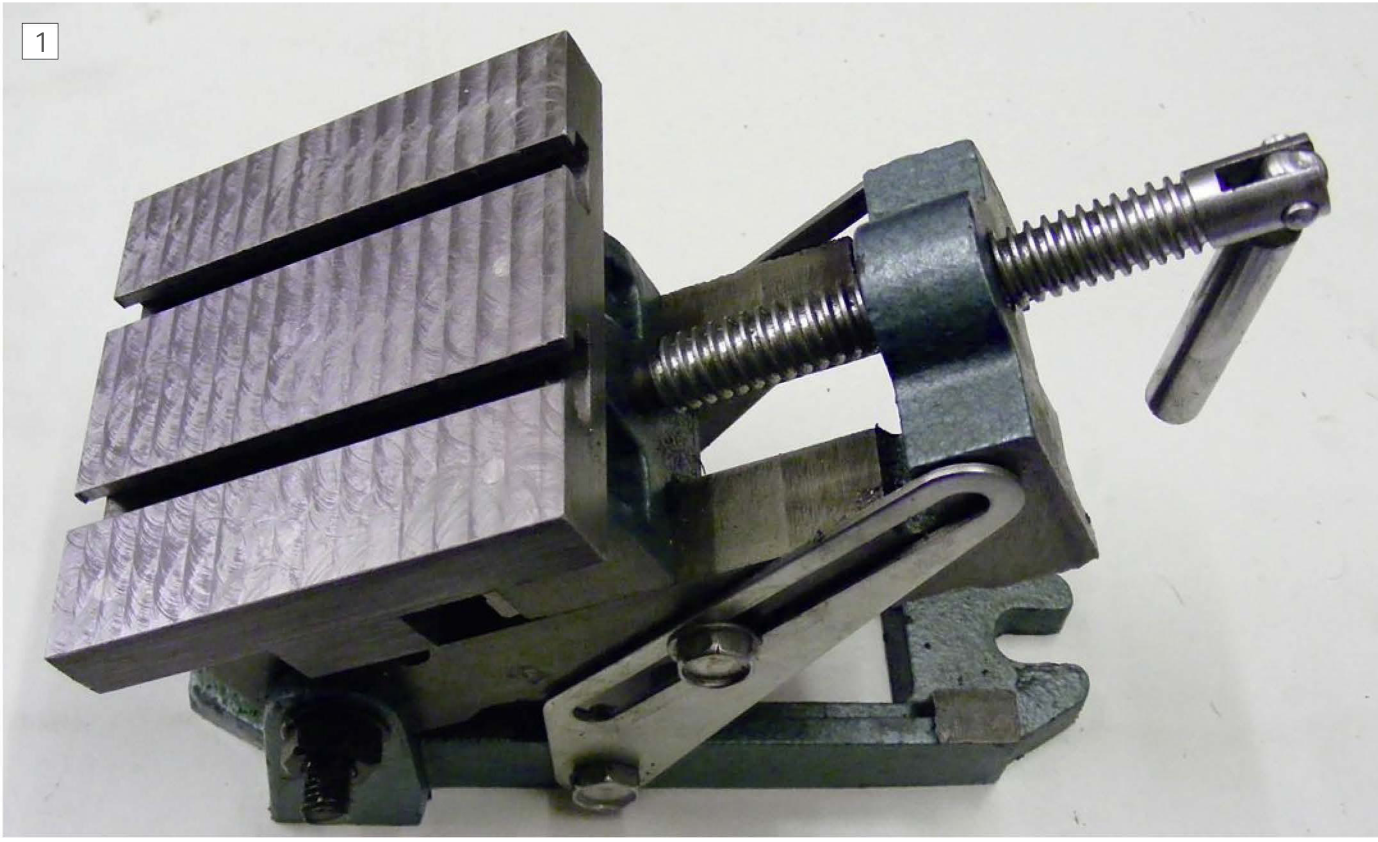


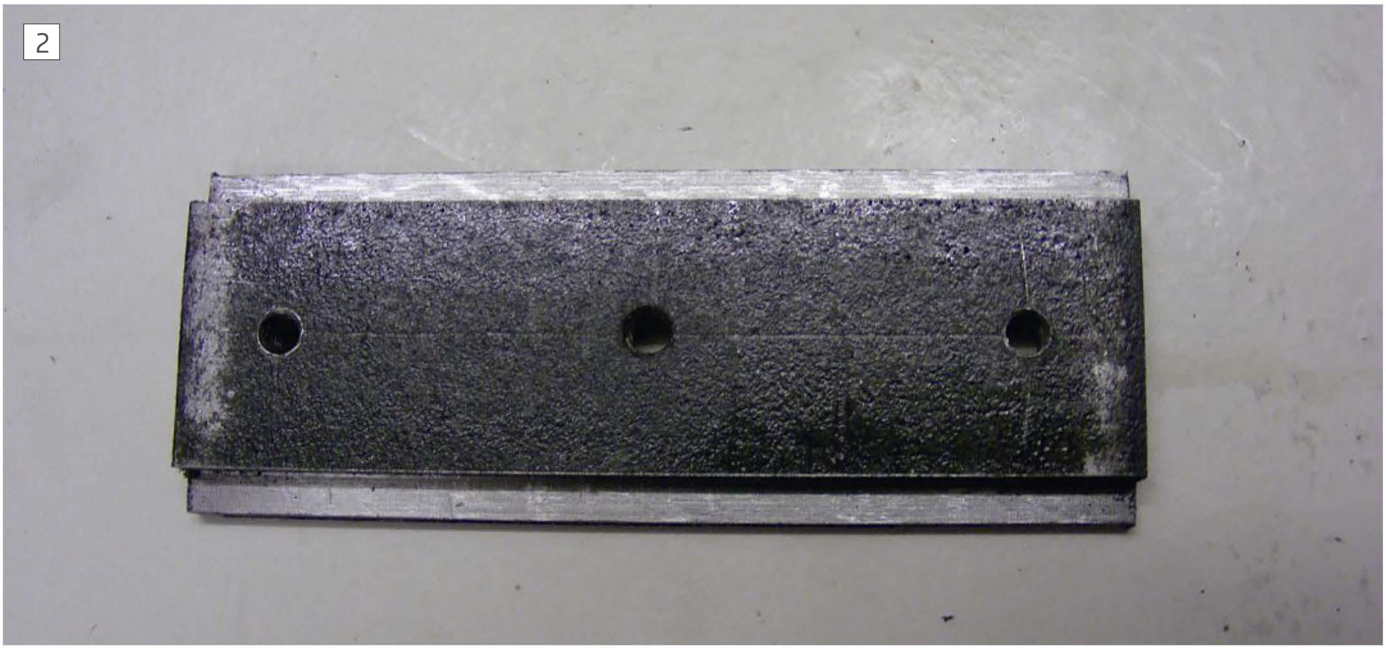
Fig 1. The Base Plate
Mat'l: 6mm steel plate

The base plate

The base plate, **fig. 1**, was made from a 100mm square of 6mm steel cut from a 100 x 6mm bar of EN3 steel. The piece



The table mounted on a tilting vice.



Underside of the central tee bar.

was cut slightly oversize, and the cut edges were squared up on the mill. This was carefully marked out as shown in fig. 1 and hole positions centre punched. The holes were drilled out with a 5mm drill.

The tee bars

The tee bars, **fig. 2**, were made from 10mm thick steel bar. Unfortunately I only had some 150 x 100 hot rolled bar available, so I used this for the bars. For the central bar I cut of a 39mm wide slice from the bar with the bandsaw and I removed 24mm from each end. This was set it up in the mill vice. After careful levelling the edge of the bar was cleaned up using an 12mm end mill. The bar was turned around in the vice and carefully levelled again and aligned with the mill table axis. The bar was machined to the required width of 37mm. The cutter height was set to cut a 5mm rebate in the edge of the bar. Taking small cuts a 5mm deep rebate was then machined. The bar was turned over again and a 5mm rebate cut on the other edge. The holes were not drilled in the tee bar at this stage. The finished tee bar is shown in **photo 2**.

The two tee bars for the edge of the table were made in a similar fashion starting from a 26mm slice of material cut from the hot rolled bar. These were trimmed up in the mill adjusted to the correct width and a 5 x 5 rebate cut from one edge. Two of these edge tee bars were made.

The vice grip bar

The vice grip bar, **fig. 3**, was a 100mm length cut from some 12 x 25mm bar stock. The holes were not made at this stage.

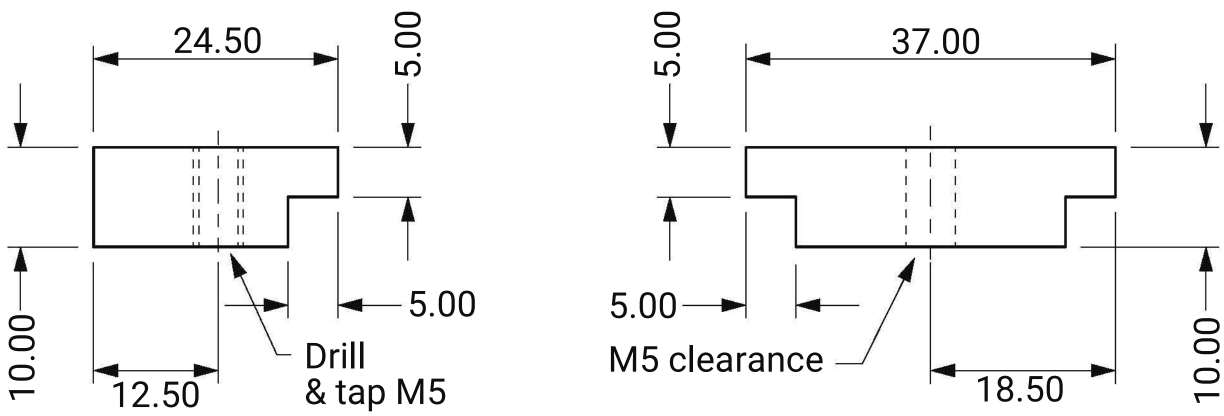


Fig 2. The Tee Bars
Mat'l: 10mm steel x 100mm

Assembly

The critical part of making the table is assembly process as it is important for the tee slot bars to be parallel with each other and with the edge of the plate. Before starting the assembly, I made up a 7mm wide spacer bar by cutting a slice from the 9mm offcut from the hot rolled 10mm bar and then milling it down to 7mm on both faces. The components are assembled together as shown in **fig 4**.

The base plate was set up vertically on a surface plate with the holes that are 12.5mm from the edge parallel to the surface plate. I used a 90 degree welding magnet to hold the plate vertical. One of the side tee bars was then placed next to the base plate and clamped to it using small toolmakers clamps ensuring that the edge of the baseplate and the edge of the bar were parallel. The assembly was then removed from the base plate and the hole positions in the base plate spotted through onto the tee bar with a 5mm transfer punch. The edge and the bar were marked with a felt tip

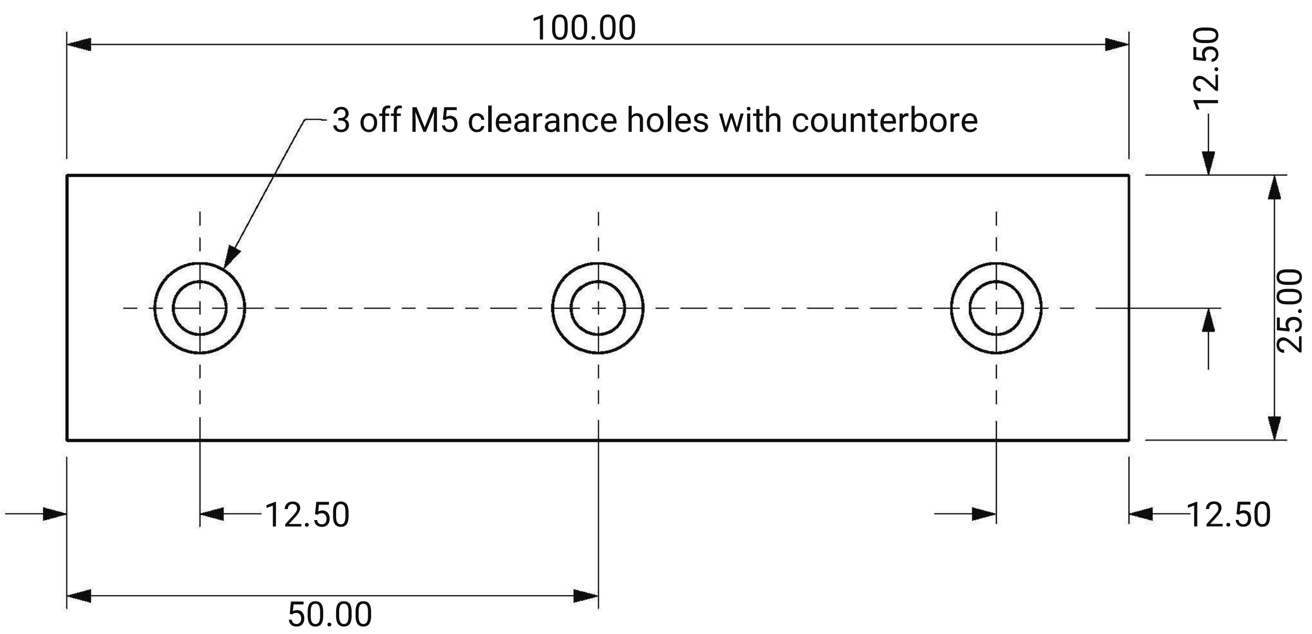


Fig 3. The Vice Grip Bar
Mat'l: 12mm x 25mm steel bar

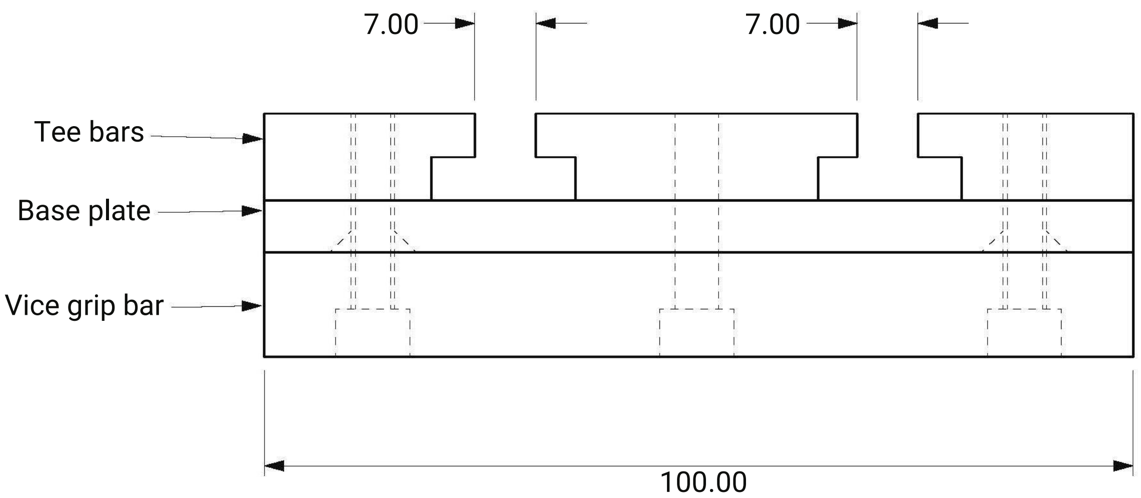


Fig 4. Assembly

Upper surface of the table after milling.

Underside of the table showing the vice grip bar.

marker to ensure that they would be assembled back together in the right orientation. The tee bar was removed, centre punched at the spotted locations and then drilled out with a 4.2mm tapping drill. The holes were tapped M5. After cleaning up the tapped holes the tee bar was attached to the plate using temporary M5 socket head screws. After checking that the two edges were parallel the assembly was returned to the surface plate and the middle tee bar was placed above the first tee bar with the 7mm spacer bar between to ensure the correct spacing and that the middle bar was parallel to the first bar. The middle bar was clamped in position and the assembly removed and the holes in the base plate spotted through to the tee bar. The tee bar was then drilled tapped and fixed to the base plate. This procedure was then repeated with the last tee bar.

The vice grip bar was marked out, drilled and counter bored to accept 30mm socket head screws. The temporary screws were removed from the middle position of each tee bar and the vice grip bar was attached using 30mm socket head screws.

The temporary screws were removed from the outer edge of each of the tee bars and the holes on the base plate side were countersunk to accept 20mm countersunk screws. These screws were inserted and tightened down securely.

Finishing

The assembled tee slot table was fixed in bench vice using the vice grip bar and the screws protruding from the tee bars were cut off using a fine hacksaw.

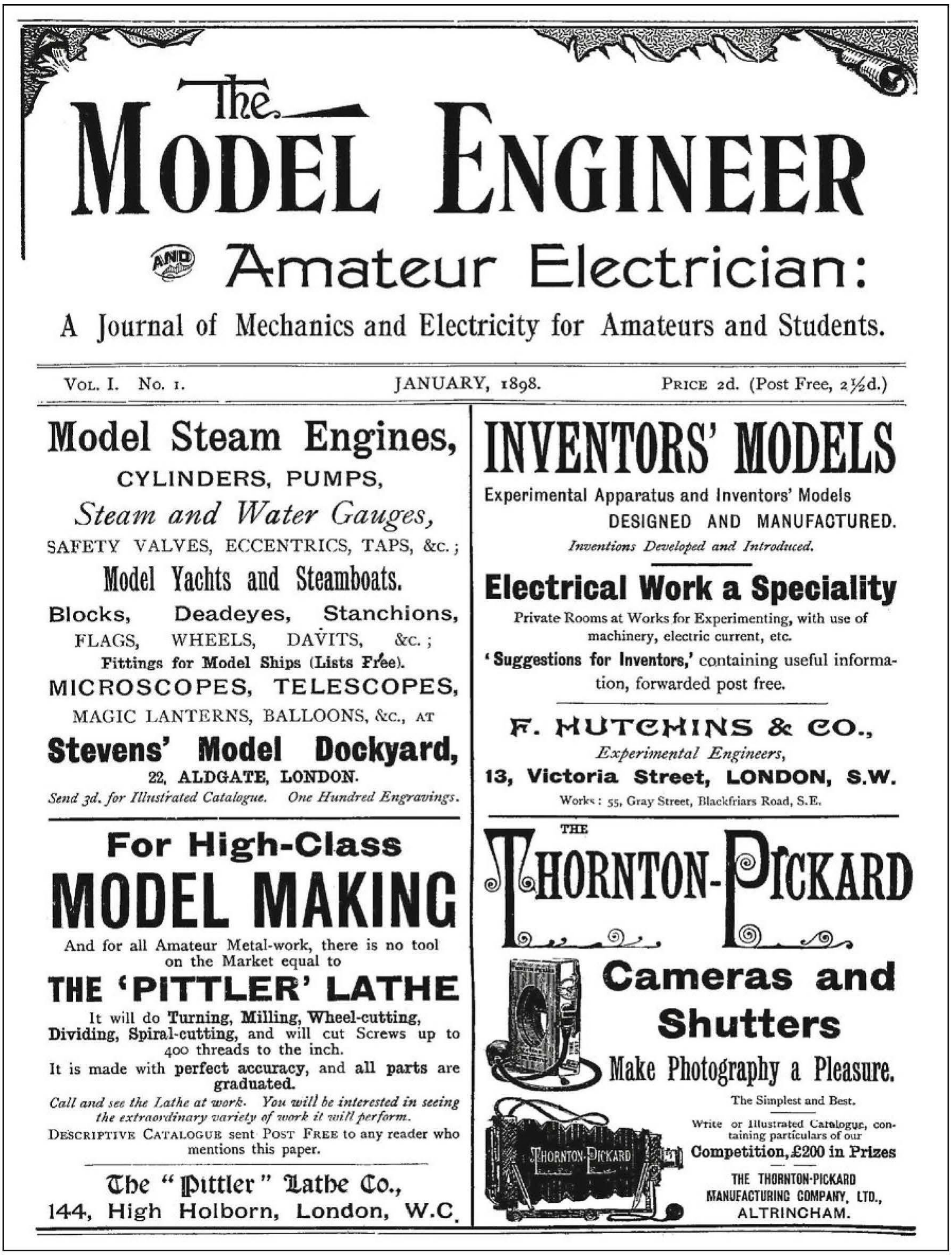
The table was next mounted in the standard mill (not tilting) vice and tapped down with a hammer to ensure that it was well seated on the jaws. Using an end mill the edges of the table were cleaned up. The top surface was then milled to ensure that it was completely flat all over. I did this using a carbide tipped milling cutter. This quickly removed the black mill scale from the hot rolled bar and levelled the surface but the finish was not very good. The top of the finished table is shown in **photo 3**. As a final attempt to improve the finish I rubbed the surface gently on abrasive paper stuck down on a granite tile. In retrospect it would probably have been better to use a more machinable steel than hot rolled steel for the tee bars as this would have given a better surface finish. **Photograph 4** shows the vice grip bar on the underside of the table.

Conclusion.

I have used the table on several occasions mounted in my tilting vice and it has proved effective and stable. ▮

From the Model Engineer Archive

To celebrate 125 years of Model Engineer magazine and the Society of Model and Experimental Engineers, each issue in 2023 features fascinating historic content from Model Engineer relevant to workshops, tools or techniques. This month we present something a little different. It's the cover of the very first issue and the first page of Percival Marshall's introduction to his new publication, Volume 1, Issue 1, from January 1898.



The MODEL ENGINEER and Amateur Electrician:

A Journal of Mechanics and Electricity for Amateurs and Students.

VOL. I. No. 1. JANUARY, 1898. PRICE 2d. (Post Free, 2½d.)

THE

Model Engineer

AND

Amateur Electrician.

A JOURNAL OF MECHANICS AND ELECTRICITY FOR AMATEURS AND STUDENTS.

EDITED BY PERCIVAL MARSHALL.

VOL. I. No. 1. JANUARY, 1898. PRICE TWOPENCE.

To Our Readers.

IN the first number of a new journal it is the usual practice for the Editor to put before his readers a more or less extensive outline of the programme which it is his intention to fulfil, and also to give some explanation as to why the publication of such a journal has been decided upon. It is in accordance with this time-honoured custom that we set ourselves the task of penning these introductory lines, in which we give, first of all,

Our Reason for Starting

THE MODEL ENGINEER AND AMATEUR ELECTRICIAN. It is simply that there is at present no journal in this country which is exclusively devoted to mechanics and electricity from the amateur's point of view, and the army of workers whose tastes lie in this direction has grown so large that there is a distinct want for a publication which shall make their interests its especial care. It is our aim to supply this want, and if the reader will look carefully through the pages of this, our first, issue, he will gain a good idea of the manner in which we hope to achieve the desired end. THE MODEL ENGINEER AND AMATEUR ELECTRICIAN will be essentially practical in character, but the contents will be so arranged that

All Amateur Mechanics,

from the least skilful to the most advanced, will find something of interest and assistance in every number. Lathe-work in all its branches, tools and tool-making, model-engine designing and making, pattern-making, brass and iron founding, forging, and sheet-metal working, are all matters which are within our province to discuss, and original and instructive articles on these subjects by experienced writers will appear within our pages. Good illustrations and clear working drawings will form a regular feature of the journal, and everything that is possible to make it an acceptable companion to model engineers will be done.

Electrical matters

will be dealt with in a particularly complete and attractive fashion, and it is our intention to cater more thoroughly for the wants of amateur electricians than has yet been done by any other journal. The construction of electrical appliances requires considerable skill in the manipulation of metal-working tools, and therefore the mechanical portion of our paper should be of practical benefit to model engineers and electricians alike. In selecting matter for publication, we shall accordingly give first consideration to articles having interest for the many, though we shall by no means neglect the requirements of the few. We want all amateur mechanics to regard this journal as *their* journal, and to make use of our columns to help each other by giving hints and helpful suggestions on workshop matters, and by the discussion of such practical points as may call for the expression of various opinions.

We invite Correspondence

from our readers on any subject which comes within our scope, and shall be particularly pleased to receive descriptions of models, whether mechanical or electrical, which our readers have made, and also to have particulars and sketches of any special workshop tools or appliances which they may have devised. For our own part, we shall be happy to give such information and assistance as lies in our power, and to this end have inaugurated

A Postal Query and Reply Department,

of which our readers are invited to avail themselves to the full. We have gathered around us a staff of experts in the various subjects to which our journal is devoted, and their knowledge and experience may be drawn upon by readers as explained elsewhere in this issue. It should be particularly noted that by this system a reader can obtain a reply to any reasonable question within the space of two or three days, thus entirely obviating the vexatious delays which are so frequently experienced by amateurs who turn to the columns of a paper when they want helping out of a difficulty. To encourage a healthy spirit of rivalry amongst our readers we have arranged a series of

Prize Competitions,

full particulars of which are given on the next page. The

Model Engineers' Workshop and Model Engineer at the Midlands Model Engineering Exhibition

More news about the Society of Model an Experimental Engineers at the forthcoming exhibition at Warwickshire Event Centre Thursday 12th to Sunday 15th October 2023

As regular readers will be aware, Model Engineers' Workshop and its sister publication Model Engineer are teaming up with the Society of Model and Experimental Engineers to celebrate our joint 125th birthday in 2023. To mark the occasion we will be attending the Midlands Model Engineering Exhibition, organised by Meridienne Exhibitions.

News from Meridienne

We look forward to welcoming you to the 2023 Midlands Model Engineering Exhibition, sponsored by Engineering in Miniature – One of The Premier Modelling Events in the UK.

We will have hundreds of models on display including locomotives, rolling stock, traction, stationary and hot air engines, boats, along with workshop equipment and clocks – virtually every interest will be represented. There will be over a thousand models on display for your enjoyment on nearly 30 club and society stands as well as the competition and display classes and outside steamers.

This year we have the newly completed 10¼ inch gauge LNER P2 built by John Wilks - "Cock O' The North" on display for your enjoyment.

There will also be a full complement of specialist suppliers with nearly 40 companies being represented so, in addition to viewing the model displays, you'll be able to purchase virtually anything you might need for your modelling activities.

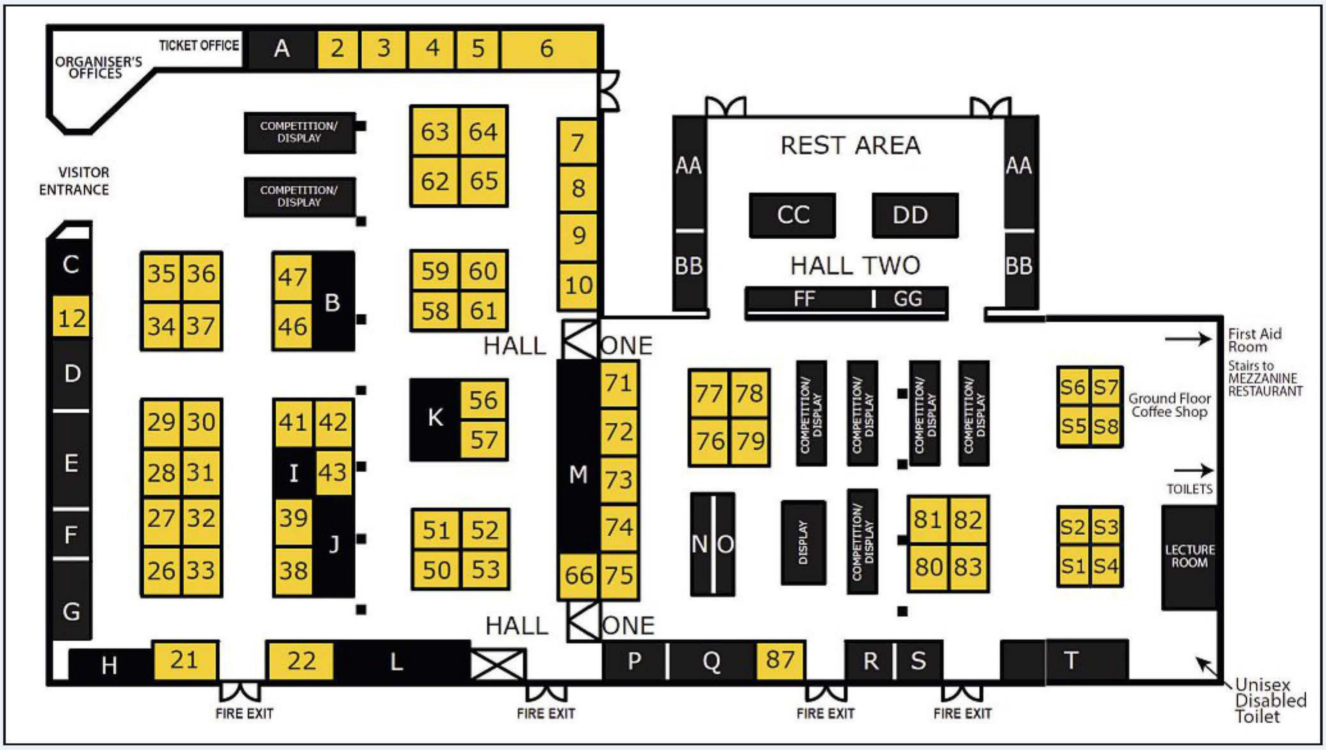
This year we will see the return of our lectures which will be presented by Model Engineer and Model Engineers' Workshop to celebrate their joint 125th anniversary with The Society of Model and Experimental Engineers. SMEE will be having a super-sized stand featuring models and tools from across its history. There will also be live demonstrations of 3D printing by MEW Editor, Neil Wyatt daily.

See our website to book tickets, for full competition details or further details of the show and exhibitors present.

We hope that you will join us and enjoy the exhibition, meet old friends and make new acquaintances.

The Meridienne Team

Specialist Suppliers at the Exhibition



ABBOTS MODEL ENGINEERING
Stand: 6

AEROSPACE SURPLUS TOOLS
Stands: 50+51

ALUTIGHT/PERMAGRIT
Stand: 59

ARISTOCRAFT COACHES/ TRAIN4RAIL
Stand: 83

BB ENGINEERING SUPPLIES
Stands: S1+S2

BEUGLER PAINT PINSTRIPING TOOLS
Stand: S6

BLACKGATES ENGINEERING
Stands: 81+82

BRUSHES 4 MODELS
Stand: S8

COLLEGE ENGINEERING SUPPLY
Stand: 22

CMD Engineering
Stand: 37

CuP ALLOYS (METAL JOINING)
Stand: 2

THE ENGINEERS EMPORIUM/L.A. SERVICES
Stands: 58+61

GLOFORCE
Stand: 60

HJH TOOLING
Stand: 56

HOME AND WORKSHOP MACHINERY
Stands: 78+79

JB CUTTING TOOLS
Stands: 42+43

KEITH ROBINSON ENGINEERING TOOLS
Stand: 36

KONTAX ENGINGEERING
Stand: 57

LIVE STEAM MODELS
Stand: 53

MAMOD
Stand: S5

MINIATURE RAILWAY WORKSHOP
Stand: 6

MODEL ENGINEERS LASER
Stand: 80

MODEL ENGINEER & MODEL ENGINEERS WORKSHOP – MORTONS MEDIA GROUP
Stand: 66

MYFORD
Stands: 38+39

NOGGIN END METALS
Stand: 63

PNP RAILWAYS
Stand: 21

POLLY MODEL ENGINEERING
Stands: 7-10

POWER CAPACITORS (TRANSWAVE CONVERTERS)
Stand: 41

RDG TOOLS
Stands: 26-33 + 34+35

SOLDERS & FLUXES
Stand: S3

STUART MODELS
Stands: 46+47

TEE PUBLISHING
Stands: 3-5

THE CRAFTLIGHT COMPANY
Stand: S7

TRACY TOOLS
Stands: 73-75

TURBOTRADE UK
Stand: 62

WALKER MIDGLEY INSURANCE BROKERS
Stand: 12

Myford Super 7 Lathe - Neil Wyatt

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

Beginner's Workshop

By Geometer

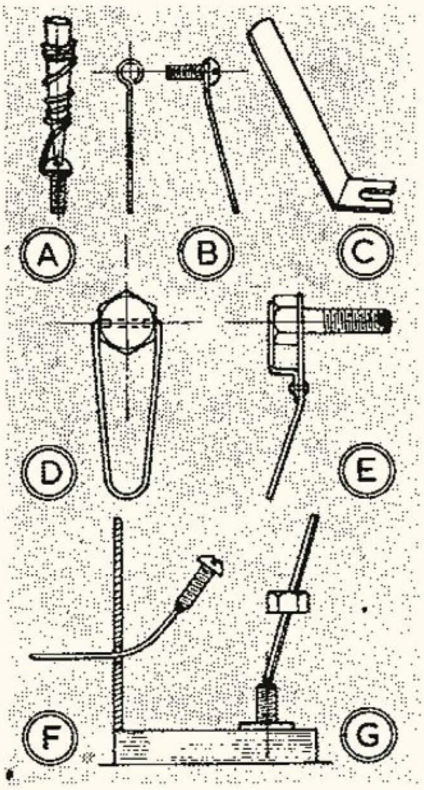
SIMPLE SCREW ASSEMBLY

OCCASIONALLY in assembly work, only familiarity with some " dodge " or other enables a screw, bolt, or nut to be fitted without a great deal of frustration and loss of time. Much the same is true if a screw or small component is dropped in an inaccessible position.

Small screws and components can be handled effectively with tweezers, and medium-sized ones with long thin-jawed pliers; and there are various means of maintaining screws on screwdrivers.

If the screw slot and screwdriver blade are both good, and the screw is to be pushed into a horizontal or overhead hole, it can be done by simply placing the screw on the blade. If the hole is substantially downwards, however, the screw will fall off unless held in some manner. To do this, the screwdriver blade can be magnetised for a steel screw, or alternatively a small blob of thick grease or Plasticine used-as for a brass screw. Some screwdrivers have a type of sliding "jaw " which can be pushed down the blade to hold the screw.

With a good screw slot, an ordinary thin rubber band can be looped one end through the other round the blade, twisted tight, then the free end passed over the screw shank *A*. Where the difficulty is mainly in fitting a screw in a hole, or maintaining it in alignment for screwdriver to be used, it can be done as *B*, employing a wire loop, and pulling it off when the screw has started. Another idea, where the hole is downwards, is to slot a piece of thin steel, C, for the screw to lie in. This method is also effective for driving in tacks and small nails without damage to fingers.

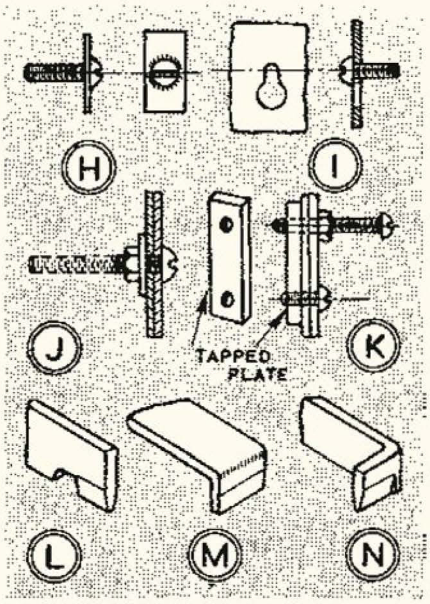


Other methods

Bolts and nuts can often be fitted by placing them in tubular box spanners, or in socket spanners with long shanks. A bolt or setscrew which is one of a number with the head drilled for a common locking wire, can be manipulated and fitted with a type of wire tweezers, D, bent from thin rod or wire. A slotted holder, a development of that at C, is as *E*, where a short strip of sheet steel is riveted on to hold the bolt in the slot. The hexagon can then be turned with an open spanner.

Occasionally, it is required to fit a screw in from the back of some panel or sheet metal work and a nut and washer outside. The wire loop method *B* may be practicable. But if the position is really inaccessible, a wire can. be pushed through the hole from the front, out to where the screw can be fitted, this soldered on the end and pulled into place, *F*. The wire can be broken off and the thread cleaned up with the screw shank gripped by thin-jawed pliers.

On an inaccessible stud, a nut can sometimes be fitted by sliding down a wire, then flicking round with a screwdriver to start it until a cranked spanner can be used, G.



A screw fitted to the rear of a panel can be prevented from turning by soldering or brazing on a plate *H* to abut against an edge. Where there is no access at all to the rear of a panel, a hole can be drilled off-position to pass the screw head, then a slot filed to bring the screw into position I. The hole being made large enough (or wide and the metal kinked), the screw can be fitted with a plate *H* to cover the slot and prevent turning.

Rotation can also be prevented in initial fitting, which may be all that' is necessary, by using a long screw, gripping the shank with pliers for the nut to be tightened, then snipping off and filing smooth, J. A tapped plate, *K,* enables screws to be fitted from outside. If not soldered, it can- be guided into position with a wire. For badly-placed screws, various types of " round the corner " screwdriver can be bought or made from strip steel, case hardened, *L*, *N*. ❑

Artful Dodge #12 –
Turning small convex and concave radii

Essential reading for beginners and valuable to old hands, this series by the late John Smith shares some of his wealth of skill and experience from over half a century in hobby engineering.

Radius gauges.

A selection of round nosed lathe tools.

A set of radius gauges is extremely useful when there are radii to be cut. Imperial, **photo 1**, and metric sets are available, and they can often be found online.

Small concave radii, such as that at the root of a wheel flange, can be produced easily by grinding a carbide-tipped or HSS round-nosed lathe tool to the desired radius. Recently, tools with replaceable circular carbide tips have become available but you will be very fortunate if you are able to find a tip with the exact radius to be cut. A selection of useful lathe tools is shown in **photo 2**.

The lathe will complain when a profile tool cuts along an extended edge. This can be minimised by either using the lowest back gear speed or by turning the lathe by pulling the belt by hand. For lathes without convenient access to the belt, a lathe spindle handle (also shown in photo 2) works well, provided that you have access to someone to turn the handle while you feed the tool.

For concave radii larger than around 1/8" or 3mm radius, it is hard to find a suitable round nosed tool. They can be made - there is one in **photo 3** – but a simple concave radius-turning attachment will produce a better

A large internal radius tool and several external form tools.

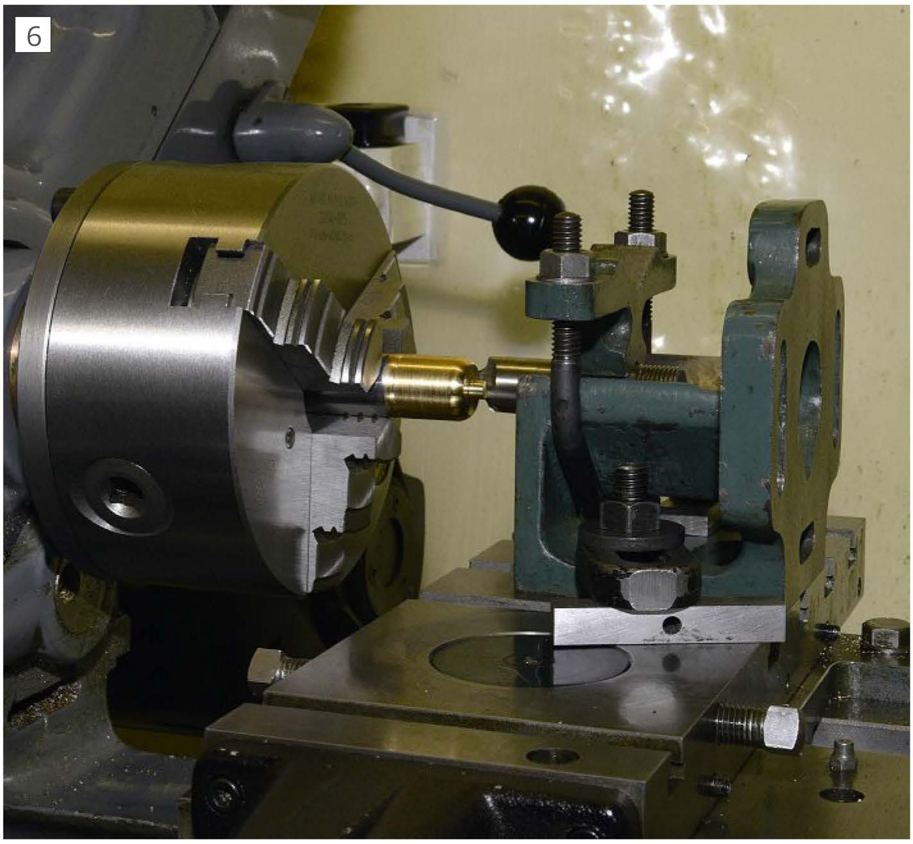
Radius turning attachment for small radiuses.

result. My first such attachment is shown in **photo 4**. It is basically a tool-post made from square bright mild steel bar, which can hold round-nosed tools made from ¼" diameter HSS tool blanks. If you have access to a local engineering firm with a wire-erosion machine, they will be able to cut a square hole; this would make it a little easier to make suitable round-nosed tools. This tool is very useful where space is limited.

A 3/8" bolt is glued into the base of the tool-post with high strength retainer, the unthreaded portion of which acts as the pivot bearing of the tool. The pivot fits into a reamed hole in a ¼" thick mild steel plate which is bolted to the cross-slide. A little grease is applied. The Nyloc nut is nipped tight, but not so tight as to prevent the tool-post from being rotated by hand using a 5/8" A/F spanner working on the flats milled in the tool-post. This tool will cut concave radii from just over 1/8" to 1/2" diameters, producing a good finish.

I used to make tools for turning small convex radii – for example for turning the outer profile of a locomotive wheel flange - from 1/8" thick gauge plate by drilling (at an angle of 5-10° to provide front relief) a hole of diameter twice the radius needed, sawing and grinding at least half of the hole away, and then

Corner rounding endmills.



Using a rounding endmill behind the work (lathe run in reverse).

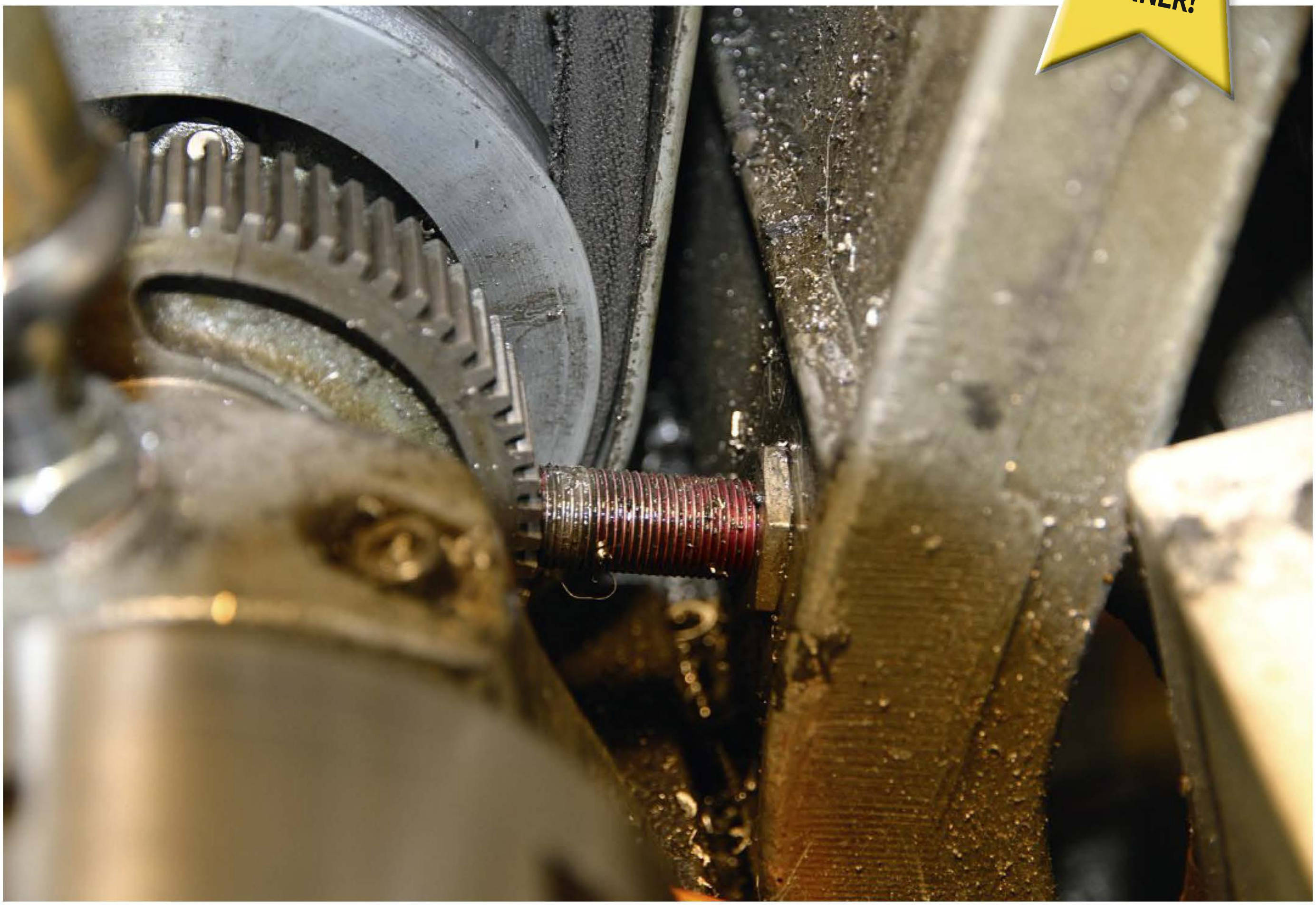
hardening the tool, also in photo 3. The tools were never totally convincing. They did the job, if set a little below centre height, but they did not cut very well.

I now use corner-rounding milling cutters, **photo 5**. These are made from high-speed steel, HSSCO or carbide, are very accurately ground, and they cut any metal beautifully. They are available in a wide range of Imperial and metric sizes. Small cutters can be easily held in a Dickson-type tool-holder designed for circular tools, while large cutters which will not fit a tool-holder can be held in a V-block bolted to the cross-slide with some packing to bring the cutting edge to centre height. The axis of the tool needs to be at 90° to the lathe spindle. Alternatively, you can mount the tool parallel to the lathe centre-line and cut the rear of the workpiece with the lathe running in reverse, **photo 6,** note that the chuck should be stud mounted or if thread mounted, locked so it can't unscrew when the lathe is run in reverse. ▮

Readers' Tips

Hall Effect Gear Tooth Sensor.

TIP OF THE MONTH WINNER!



This month's winner is Keith Fisk of New Zealand with a suggestion for a reliable device for a lathe speed sensor.
From time to time, as in MEW 325, I see articles published for lathe speed sensors. All the designs I recall seeing have either a magnet fitted to the outboard end of the headstock spindle and a proximity sensor, or a slotted disk with an optical sensor.

Several years ago I fitted a VFD to my Myford ML7 (Tri-leva) and made my own tacho. I took a slightly different approach and used a Hall Effect gear tooth sensor aimed at the bull gear – no additional magnet or slotted disk required.

Hall Effect gear tooth sensors are commonly used in the automotive industry and are available in many form factors providing options for mounting. The photograph shows my arrangement.

The datasheets for gear tooth sensors usually specify a low carbon steel gear and a tooth geometry for optimum performance however mine has been totally reliable sensing the Myford gear.

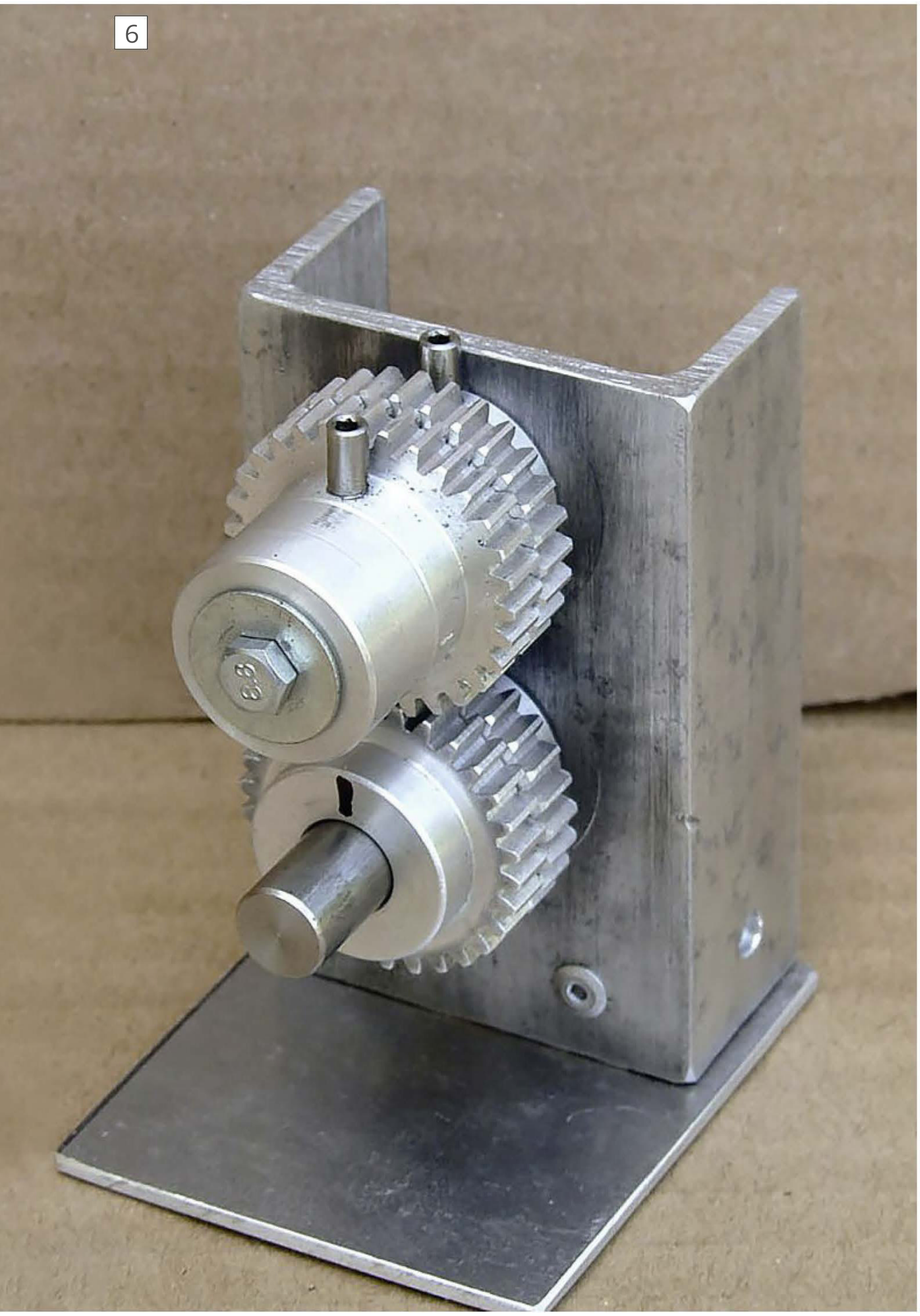
We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'.
Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 600 words and a picture or drawing. Don't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

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

"Filengrène" – Software for Gear Design Part 2

To help you with gear design, with neither calculations nor charts, Jacques Maurel proposes you use this free software designed for industrial use.

6



Mismatched gears that run at the same speed?

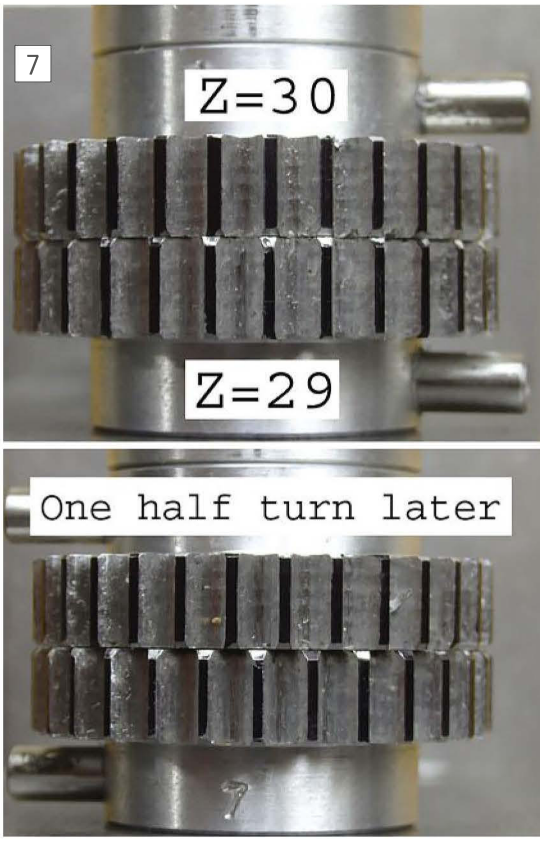
Let's resume making the Ferguson's Paradox device.

The screws are not shown on fig 2, but they are described in the part list with the ISO designation for shape and material.

Another puzzling gear set can be made, using a gearset having 29 teeth for each gear (profile shifted) associated with the gearset having 30 teeth for each gear (same module m= 1 for all the gears) see **photo 6**, all the gears are running at the same speed but the gears teeth seem to move one aside the others, see **photo 7** giving a side view.

Details for the two new 29 teeth wheels: da =32.1; Wk = 14.06 ; x = 0.55

7



Demonstrating the mismatch.

A left click on "?" in the bottom menu shows you the cutting rack and pinion definition, see **fig. 3**.

- The x values given are calculated for the sliding condition optimization.
- It's worth to strike their ref number on each pinion to ease the set up.

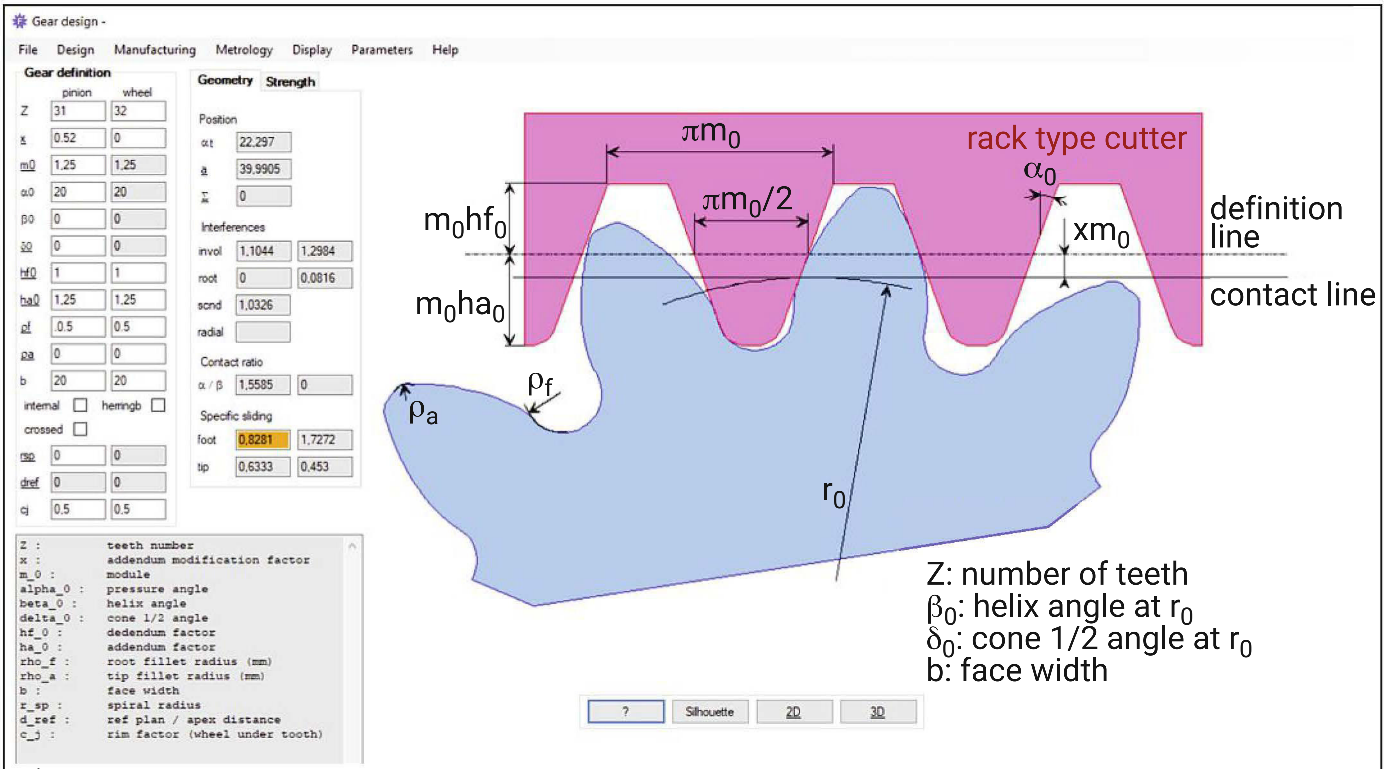
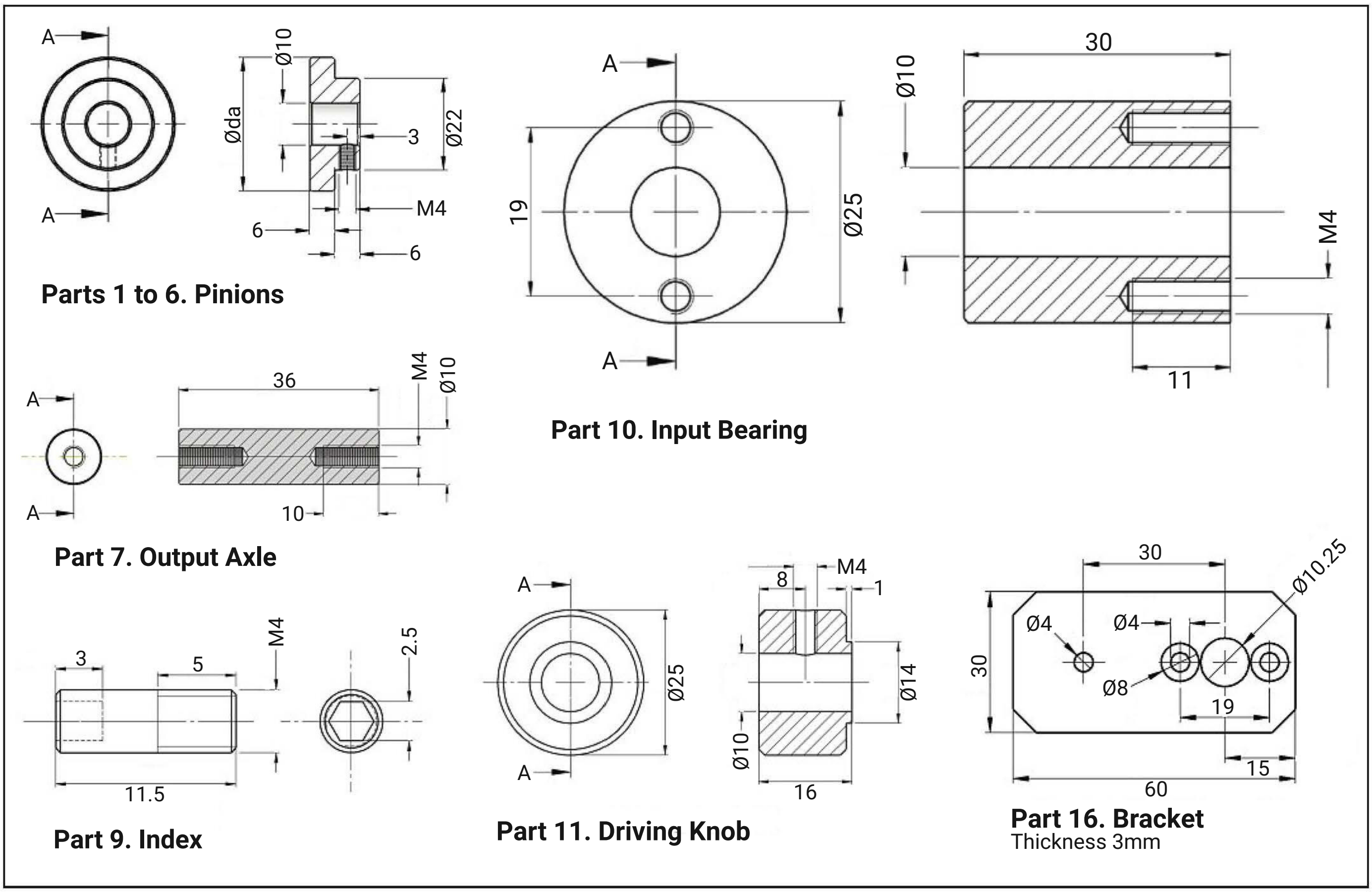


Figure 3.

Parts list:

Ref	Nbr	Name	Material	Remarks
1	1	Wheel Z = 30; m = 1	dural	da = 32 ; Wk = 10.75 ; x = 0
2	1	Idem part 1		
3	1	Wheel Z = 29; m = 1	dural	da = 31.54 ; Wk = 10.92 ; x = 0.27
4	1	Pinion Z = 30; m = 1	dural	da = 32.51 ; Wk = 10.93 ; x = 0.26
5	1	Wheel Z = 31; m = 1	dural	da = 32.49 ; Wk = 7.64 ; x = -0.253
6	1	Pinion Z = 30; m = 1	dural	Da = 31.57 ; Wk = 7.65 ; x = -0.214
7	1	Output axle	CRS	diam 10mm
8	1	Input axle	CRS	diam 10mm; 85mm
9	3	Index	CRS	diam 4mm
10	1	Input bearing	Dural	Diam 25mm
11	1	Driving knob	Dural	
12	1	Grub screw Hc M4-6	8-8	
13	1	Screw H M4-12	4-6	Galvanized
14	2	Screw F/90 M4-12	4-6	Galvanized
15	3	Grub screw Hc M4-6	8-8	
16	1	Bracket	Dural	
17	1	Screw H M4-12	4-6	Galvanized
18	1	Large washer diam M4	MS	Galvanized



Increasing gear strength:

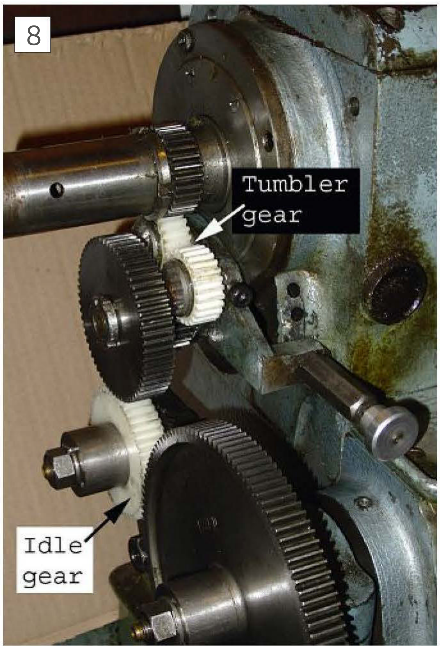
I wanted to make my lathe more silent, so use plastic gears between two metallic ones as far as possible, **photos 8, 9** and **10**, two are set in the tumbler reverse (Z1 = Z2 = 25; m = 1.25; 13mm wide), one idle in the rear quadrant (Z3 = 51; m = 1.25; 15mm wide), the travelling swing arm idle of the Norton gear box (Z4 = 32; m = 1.25; 9mm wide) and the driving gear of the self-act shaft (Z = 34; m = 1.5; 12mm wide).

They are standard gears (x = 0), unless the travelling idle gear transmitting the greatest torque (as meshing with the travelling output pinion set directly on the lead screw shaft, having also 32 teeth) and being only 9mm wide. I decided to use Z = 31 teeth with a profile shifting of 0.52 (by fiddling with the software to keep the same centre distance given by the older gear having 32 teeth). Look at the screen shot, **photo 11,** showing this gearset.

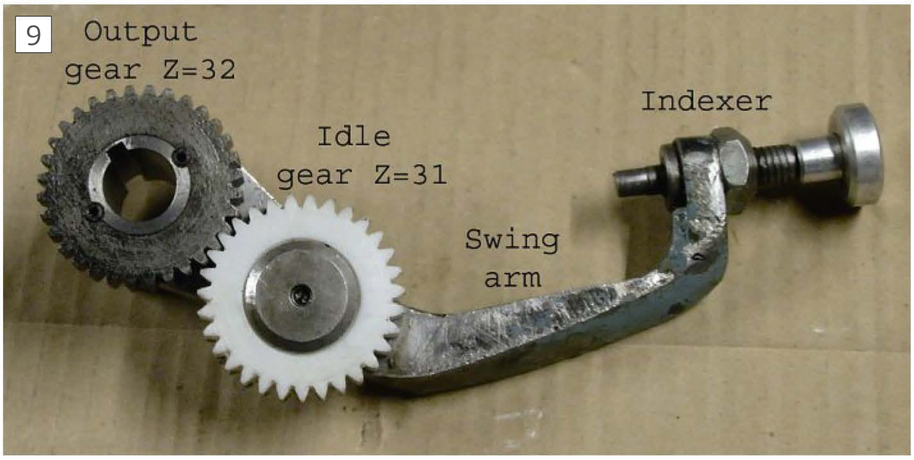
We are now interested in the strength results: left click the "strength" table (to replace the "geometry" one). Fill the boxes E = 2900 MPa (N/mm2) and v = 0.35 (Poisson's ratio, no unit) for the pinion made of POM; the wheel's values are already the steel ones. The torque is 5N.m, **appendix 1**.

Results

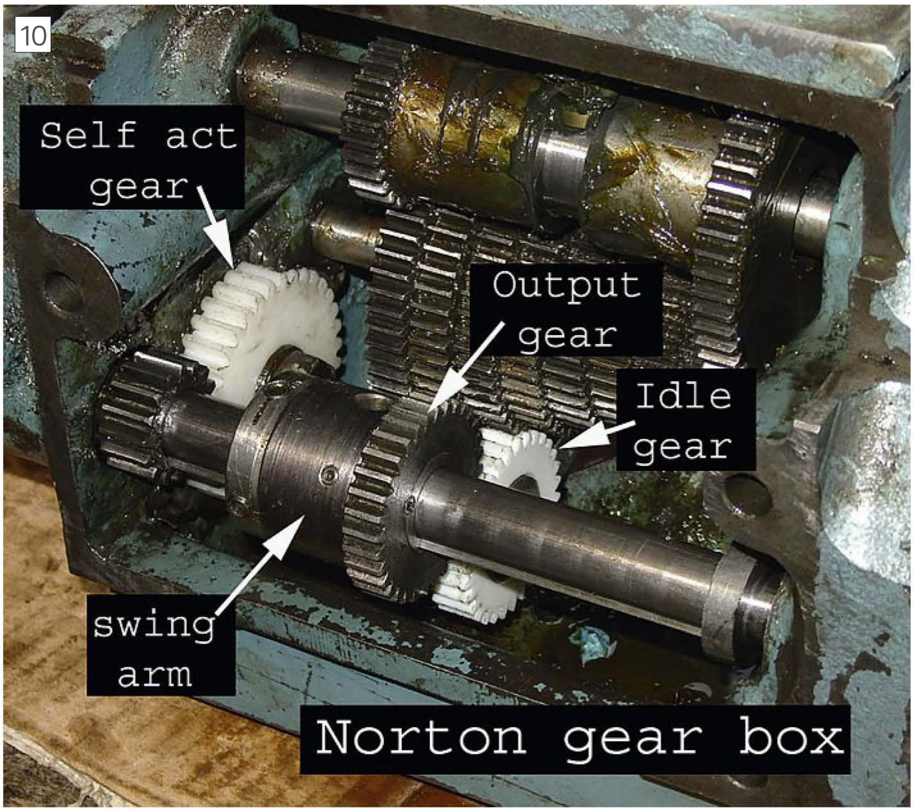
Root stress: pinion 61.16 MPa (maximum bending stress value 110 MPa for POM,



Plastic idlers for tumbler reverse.



Tumbler reverse removed from lathe.



Plastic idlers in the lathe's Norton gearbox.

so a 9 N.m maxi torque could be applied) ; wheel 136.23 MPa (maximum value 240 for mild steel).

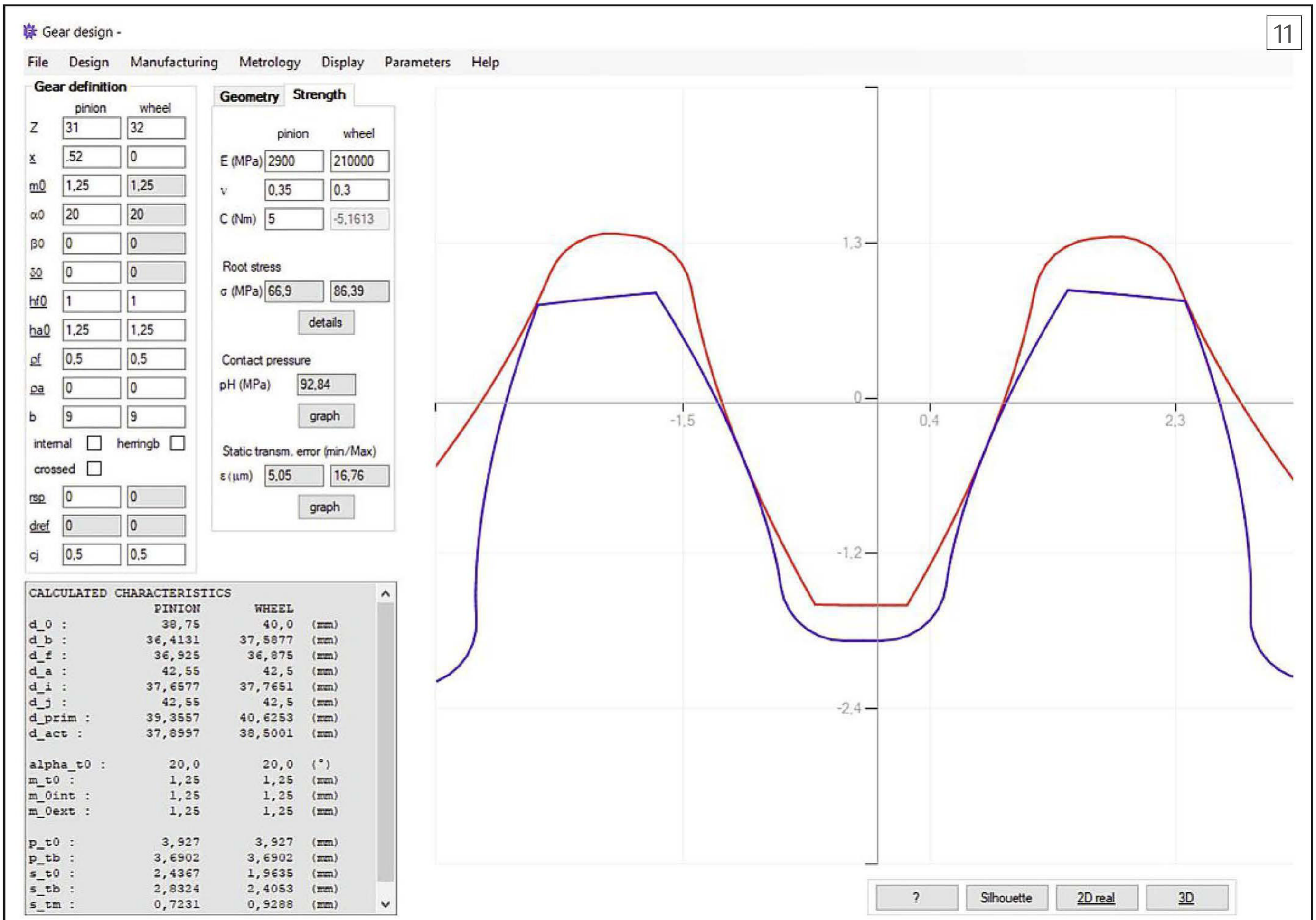
By making the same study with standard gears (x = 0) it's possible to know the strength improvement given by the profile shifting, about 20% here.

For a silent running, it's also necessary to check and adjust the indexers for no play.

It's worth it for an idle pinion to have a number of teeth odd to the mating wheels to even the teeth wear, so 51 teeth meshing with 60 and 120 mating ones in the rear quadrant. I used 31 teeth for the Norton gear box travelling idler.

I use POM (acetal) or PETP (arnite) plastic being stronger and stiffer than PA6 (nylon). It's possible to use fibreglass loaded plastics (this doubles the strength) but I thought they could be abrasive for my hob.

To protect the gear (Norton idle one), I've calculated and set a plastic shearing pin, **appendix 2** for the calculations).



Design for stronger gears with 'stubbier' teeth.

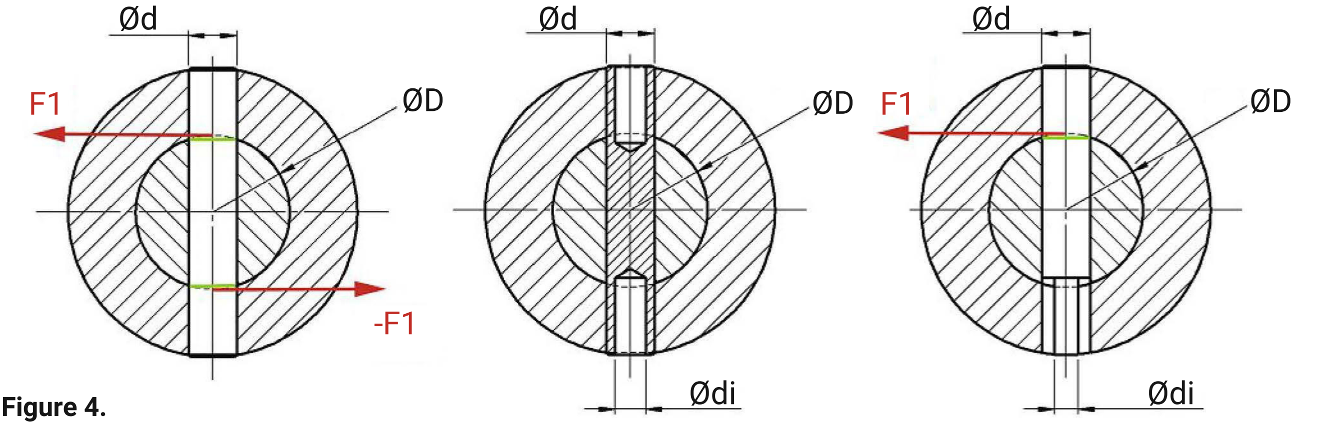


Figure 4.

Next month I will explain addendum modification, which will make it easier to understand what some of the figure above mean.

Appendix 1 – Calculating Torque to be applied to the lead screw:

Relation between: T torque (Nm.); Axial force F (N); lead screw pitch p (m); efficiency n (no unit).

T = F x p/(2 x π x n) Values : F = 1500N; p = 4mm; n = 0.2 (estimation from: steel trapezoidal screw on bronze half nut, and axial friction on cast iron, lubricated contacts).

T=1500x0.004/(2 x π x 0.2) = 4.77 N.m

I used 5N.m for gear calculation**.**

Appendix 2 – Shear pin calculation: see fig. 4

Relation between: shaft diameter D (m); pin diameter d (mm); pin material breaking shearing stress Tr (N/mm2); breaking torque Tr (N.m).

For a plain pin (fig. 4 left):

Tr = D. (0.25. π). d². Tr

But if this plain pin is too strong for our needs, a hole must be drilled inside (fig. 4 centre), diameter di(mm), to weaken it, the new relation is:

Tr = D. (0.25 π). (d²–di²). Tr

It's also possible to use a "half pin" see fig. 4 right**.** The "di" diameter part is only to give the right axial position for the pin in its bore.

An experiment was made using a 5mm diameter PA6 pin set on a 16 mm diameter shaft with a torque wrench, **note 2**), I found Tr = 63 N/mm² for this material.

We want the pin to break at Tr = 9 N.m, the shaft diameter being 15mm. A plain 5mm diameter pin can withstand 18.55 N.m so a half pin can do the job, and this was the solution I used as it's easier to make than the drilled pin.

For a drilled pin, the hole diameter "di" would be:

di = [d²– {Tr/(0.25 . π . D. Tr)}]$^{0.5}$ = [5²– {9/(0.25x0.015xπx63)}]$^{0.5}$= 3.6 mm

An experiment was made using a ring dynamometer set between the saddle and the lathe headstock, **photo 12**, the clasp nut closed and

Using a ring dynamometer to measure spindle torque.

the spindle then turned by hand until something was broken. The pin only was broken for an axial force of 1900 N. (so the leadscrew efficiency is about 0.134).

It's worth striking two punch dots, one on the lead screw and one on the lead screw hub to ease the removal of a broken pin see **photo 13**.

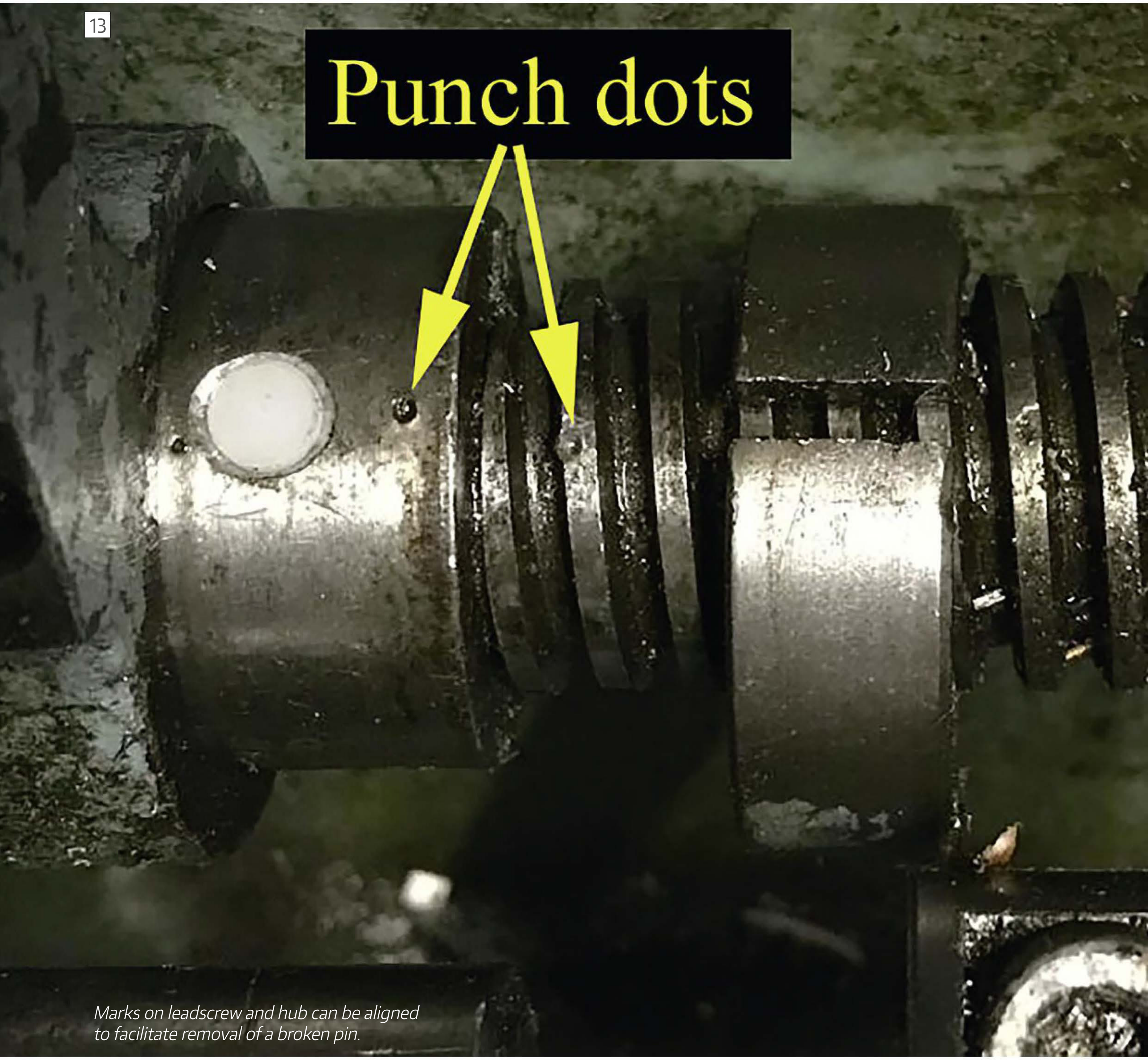
References

This link and those from the previous installment are all available at www.model-engineer.co.uk/filengrene

Ref 4 : Ferguson's paradox video: https://www.youtube.com/watch?v=wPXMDo1oLlw

Pins and bonded joints shearing video:
https://www.youtube.com/watch?v=jrSgPwcc_-o

13



Marks on leadscrew and hub can be aligned to facilitate removal of a broken pin.

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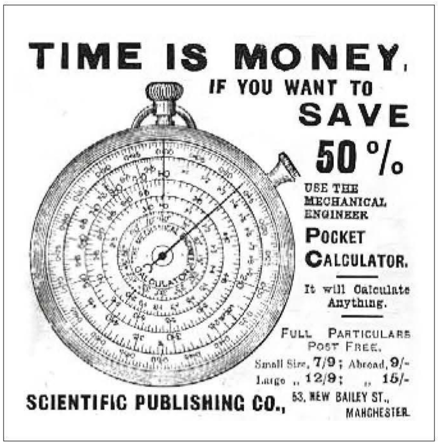
■ Axminster bench milling/drilling machine. Including drill chuck, angle vice, swivel vice, collets, various drills, side and face cutter, tee nut set, holding set and shell cutter with arbor, boring cutters. Buyer to collect. £720. **T. 07974446321/01443 405385. Maesycoed, Pontypridd.**

Parts and Materials

■ New, unused 8.5" X 12" drilling table for Fobco Star drilling machine. Bought from O'Brien's but never used. £50. **T. 07794 041638. Huddersfield.**

Wanted

■ UNE two speed motor for Unimat 3 lathe. EMCO Maire stopped production of these in 2017. **T. 07783 649546. Belfast.**



■ Wanted person to finish off part built 5" Britannia class iron duke loco. Boiler and running gear are done and in place and runs on air. Tender is also finished. Have most of the parts to finish and all drawings. Live in Nottinghamshire but will travel to you. mark.t.monks@btinternet.com. **T. 07787858369. Nottinghamshire.**

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