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EDITORIAL
Editor: Neil Wyatt
Tel: +44 (0)1689 869 912
Email: neil.wyatt@mytimemedia.com

PRODUCTION
Designer: Andrew Tompkins
Illustrator: Grahame Chambers
Retouching: Andrew Tompkins
Ad Production: Robin Gray

ADVERTISING
Senior Account Manager: Duncan Armstrong
Email: duncan.armstrong@mytimemedia.com
Tel: 01689 869855

MARKETING & SUBSCRIPTIONS
Subscription Manager: Louisa Coleman

MANAGEMENT
Group Advertising Manager: Rhona Bolger
Email: rhona.bolger@mytimemedia.com
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On the Editor's Bench

Cameras Old and New

Recently I fixed my Yashicamat Twin Lens Reflex, an interesting workshop project!

The shutter got 'sticky' several years ago, this seems to be pretty much normal for these cameras when they get to about 50 years old! Sadly the leather/vinyl on the front goes hard and won't survive removal, but it was just removing several tiny screws, then unscrew the front lens element to expose the shutter.

The problem was that the grease on the shutter button and oil on parts of the mechanism was a thick goo. I was able to get it going again with carb cleaner, but after it had dried out, it was sticky again. I then removed an impossibly thin washer to reveal the mechanism by releasing another cover plate and very careful oiling with tiny drops of sewing machine oil and it works again!

After cleaning the lenses and reassembly, I covered the front with a bit of old leather wallet, not quite the old textured leather, but better than nothing. I may now invest in a roll of Velvia and processing - I fancy trying some long widefield exposures of the night sky.

Eye in the Sky

In contrast to the land-bound Yashicamat, www.hawkin.com sent me one of their 'Recon Drones'. It's an entry level drone with an on-board camera that has had it's price slashed from £100 to £39.99, which includes a 4GB micro SD card. I found it fun and easy to fly as it has an onboard gyro, although it gets a bit hard to be sure where it is pointed when it gets really high. The still photo quality isn't brilliant, but the video is of higher quality so it's better just to leave the video recorder running and grab any frames of interest. I was even able to check a loose slate on our roof with it! It's a great introduction to drones and could be handy if you want to make a aerial video of a club track or boating lake.

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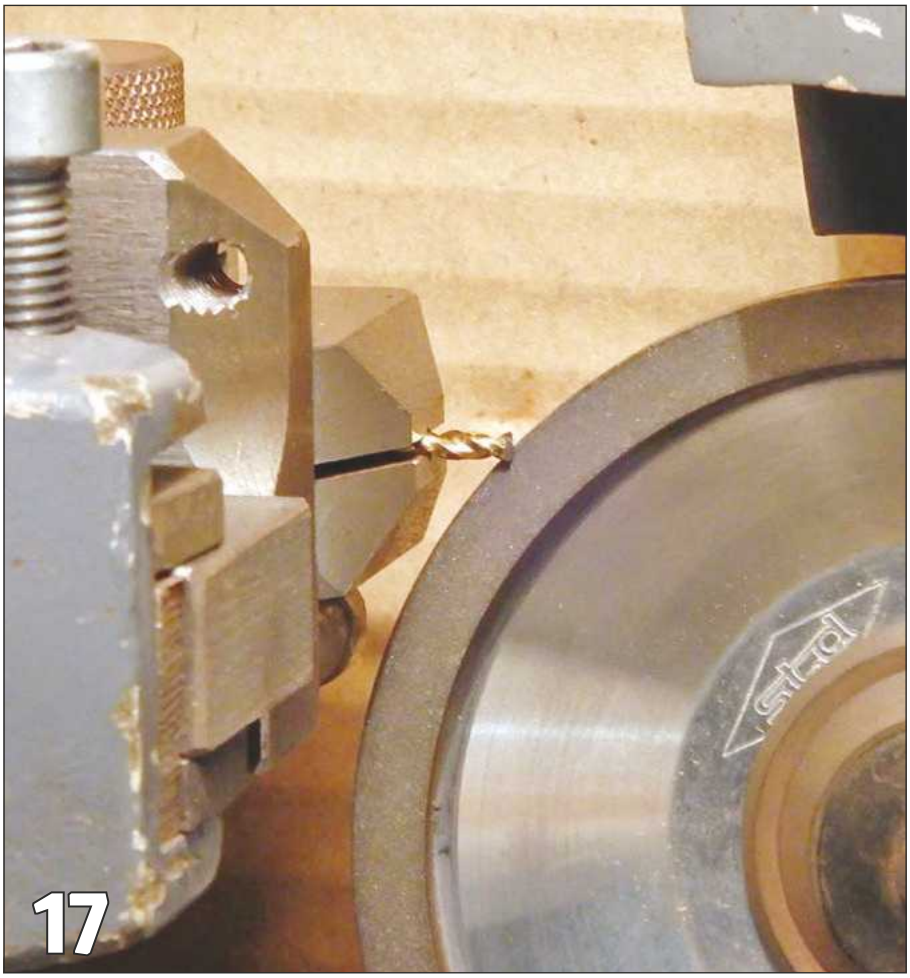
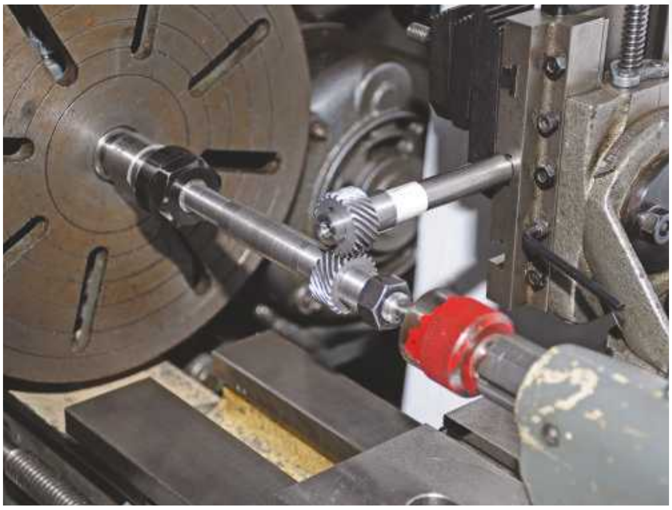


Coming up...

in our next issue

Coming up in our next issue, MEW 258 will be another rewarding read.



Regulars

ON THE COVER

This month's cover features Jim Kent and his versatile Myford 254 lathe, more details on page 27.

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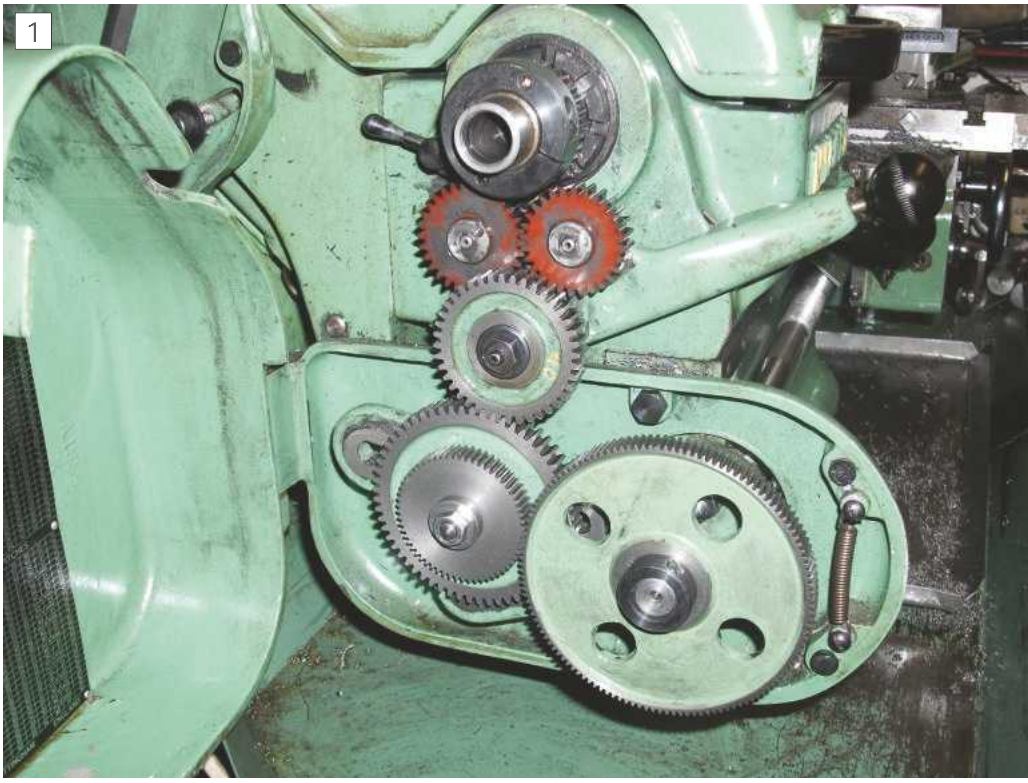
Warco Lathe Imperial Conversion

John Pace cuts imperial gears on a metric lathe.

When I bought my Warco lathe the only real thing I disliked was the machine was metric, as all of my other machines are imperial it was something that I had to live with. It has never been much of a problem as all the machines that I have are fitted with digital readouts so converting from one system to another is only a push of a button. When it comes to making something like a leadscrew the machine has similar problems to most other machines in that the conversion is near but not perfect. I have to say this Warco machine is able to make a 10 tpi leadscrew about 10 inches long with slightly less than 0.002 inch error.

This Warco machine has a system of changewheels and feed gearbox to be able to make a fair range of metric and imperial threads and dp and module worms. Some time ago the machine was converted to part cnc operation and was seen in an article in MEW 207 to 212.The addition of the cnc system has increased capability of the machine for most machining operations and has increased the ability of the machine to be able to machine threads and worms by milling. The electronic connection between two axis means that compromises and errors can be eliminated that exist between the spindle and leadscrew by a purely mechanical connection.



1

A 0.8 module 127/60 tooth gear set made by Richard Bartlett fitted to the Myford.

2

The changewheels on the rear of the Warco headstock.

A time arrived where I needed to be able to make a 1/10 inch pitch leadscrew with as little error as possible. The usual route for this has a 127 gear in the train between the spindle and the leadscrew. I have such a set for my Myford shown in **photo 1**. This 0.8 module set was made for me by Richard Bartlett.

The 0.8 module gears can be fitted within the standard gear change cover, the 127/60 pair used in conjunction with the standard changewheels allow a full range of error free metric threads.

More of a problem than I thought.

Initially I considered that this modification would have been easy. This Warco machine uses a set of changewheels between the spindle and feed gearbox, the feed comes out from the rear of the headstock via some internal gearing at 1/4 spindle speed, **photo 2** shows the rear of the headstock, the top red arrow shows the last gear in the output of this set. This 45 tooth gear has a spline

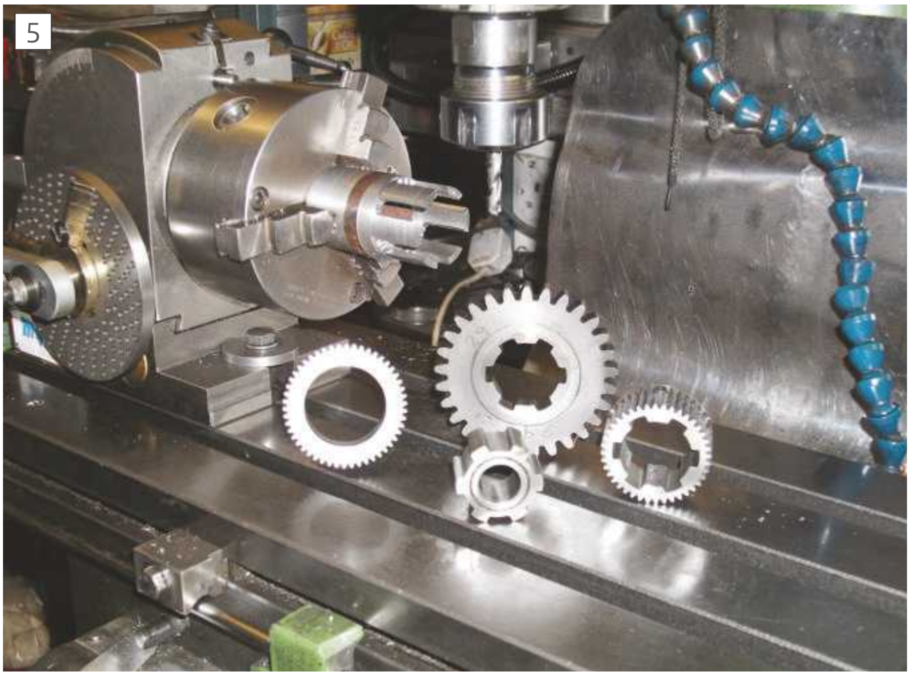
The 1 module conversion set of gears in place.

The 50 tooth gear with the splines loctited in.

on which the first of the interchangeable wheels fits. The changewheels are 2.5 module and comprise of 12 gears of a tooth count from 27 through to 36 and 38 ,41, 43 and 45. The leadscrew is 4 mm pitch, the gearbox has 9 settings ranging from 4 in to 1 out and up to 1 in to 3.5 output. At the end of the gearbox the drive out is either to the feed rod or the leadscrew, when feeding the leadscrew a pair of internal gears engage to make the connection, a 45 tooth driver and 21 driven transmits to the leadscrew.

This is very inconvenient as a direct connection to the leadscrew is not possible as these gears cannot be bypassed. It just shows how useful it is referring to the handbook that was supplied with the machine. As with many of these Chinese machines the drawings look as if they are drawn by hand but still have this important information contained within. A set of correction gears are fitted on the first stud to drive the 127 gear. This pair are 84 tooth fitted on the 45 tooth gear spline and a 90 tooth fitted on the same hub as the 127 gear, this pair cancels out the 45 /21 gears but at 2 to 1 gear up.

The gear box setting resolves this, the initial 4 to 1 reduction cancels the 4mm leadscrew to 1mm driving this with a 127/50 results in a pitch of 0.100 inch. Driving using a 127/40 combination results in a 0.125-inch pitch. In Ivan Law's book gears and gear cutting some reference is made to the setting up of gear trains in particular the problems when fitting gears and clearance between the securing shafts and nuts, this has been problem for this machine as the 127 gear, even at 1 module, is over 5 inches in diameter and will not fit on the first stud for this reason. The 84 and 90 tooth initial train solves this and was used to space the gears to clear. **Photograph 3** shows the new gear train in position, the 50-tooth gear is used here for a 0.100 inch pitch. The conversion was only intended to be able to make these two pitches, 32 tpi remains elusive and is not available within the available pitches on the machine. 8mm is close enough for most screw cut fixings, 32 tpi would be possible by making a new gear change quadrant and



Machining the inner spline hub.

some extra gears but this would see the gears exposed beyond the line of the gear change cover and the safety considerations that result from this.

As a Myford owner overdriving the leadscrew is not recommended practice. On this Warco lathe the maximum pitch is listed as 9 mm so the leadscrew is overdriven at 2.25, this perhaps gives a clue why that the changewheels are 2.5 module to cope with the low speeds and high loading. The hubs on which the changewheels fit have six large splines that would be more at home on the axle of a light truck, the gears sit on the outside diameter of the spline hubs which provides the central location. The location and the size of the splines provides a very easy solution to the problem of making this type of internal spline.

Fig. 1 shows the basic layout of these hubs and as can be seen they are quite large. This sketch only shows an 84 tooth gear, the same six screw fixing is used on all of the gears.

A central piece is turned to fit in the bore of the gear, the bore of this is a clearance fit over the base circle of the splined hub, fitting this in the mill and cutting the six slots to clear the splines. Using the loose idle hub as a gauge to test the fit. These two smaller gears fit on to the input shaft of the gearbox and as such can be made the width of two gears, as usually these fit with a gear and spacer this extra width is very useful for this application as it provides a location for some fixing screws. The spline pieces are fixed into the bore of the gear with Loctite and spare piece of round material pressed in the centre to hold until it sets. Six holes are drilled through and tapped M3 for some cap head screws ,the screws are fitted before removing the retaining piece is removed, **photo 4**.

Photograph 5 shows one of these central parts with the slots having just been cut, alongside, in the centre, one of the original Warco changewheels and the idle splined hub. To the right is the completed

40 tooth gear, on the left the 50 tooth gear ready for fitting the cut spline in the chuck. The 40-tooth gear was hobbed on a slightly larger blank outside diameter as the normal size brings the tooth roots close to the splined hub size. The 84 tooth gear uses a slightly different arrangement in that a complete hub is made and Loctited into the gear after assembly. Seen here on the mill table the three made gears with splined hubs, **photo 6**.

Photograph 7 shows the 127 gear being hobbed and some of the other gears and blanks for this conversion, this electronic system was made for me by Richard Bartlett and was featured in an article in MEW 193 "Gear hobbing on the mill". I believe that this system is the only commercially available hobby unit that is available for hobbing, Ref 1. A similar electronic system was also featured in MEW 108 by Brian Thompson for those of you who wish to build your own.

Most lathes, English or metric, usually have available conversions from one to another and in most instances these are more than adequate for thread cutting, using the 127 gear combinations will obviously give the best accuracy although you have to bear in mind that other factors when machining can also affect the finished result.

Machining leadscrews obviously one should try to obtain the best accuracy that is possible, making a 0.100 inch pitch leadscrew from a similar leadscrew on the machine will copy any errors that are present, it may well be better to make imperial screws from a metric leadscrew and vice versa as any periodic and or cyclic errors in the original will be radially positioned on the copy. In any event the overall accuracy will be no better than the original on the machine.

6

Only three new spline parts were required.

7

The 127 tooth gear being hobbed and the other gears and blanks.

I mill this type of thread, **photo 8**, as the cutting in this way places much less load on the work, on the smaller sizes this can be significant with conventional screwcutting as the small diameter of the work will tend to wind further away from the chuck. In both of these modifications on these machines using a smaller pitch of gear keeps the gear trains within the existing casing which is good from a safety point of view. ■

Ref. 1: Richard Bartlett, Compucut, 17 Lime Tree Avenue ,Tile Hill ,Coventry CV4 9EY. Syncron gear Hobbing system, Compucut Cnc system and Cnc machines. www.compucutters.com

8

Milling a 10 tpi leadscrew

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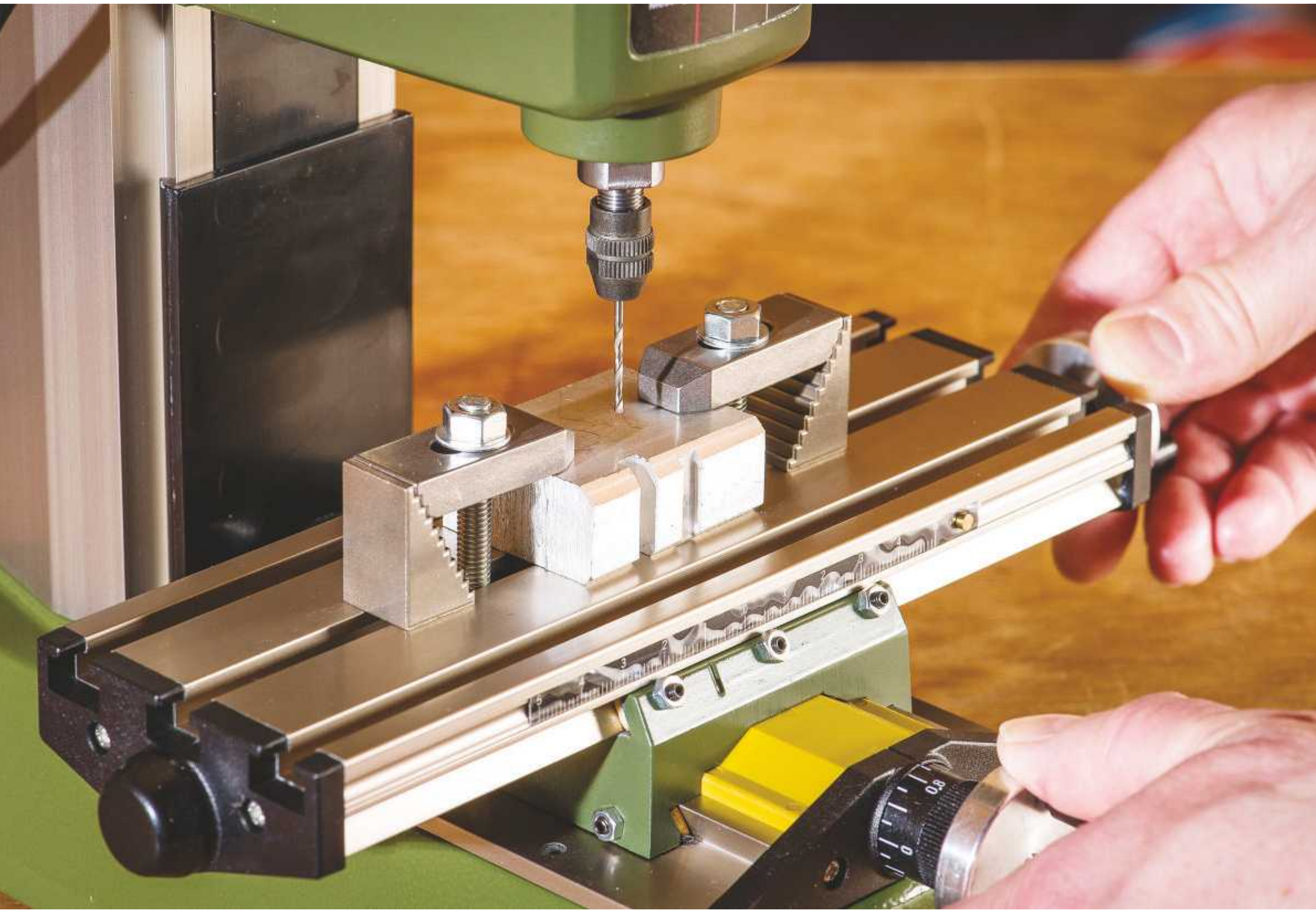

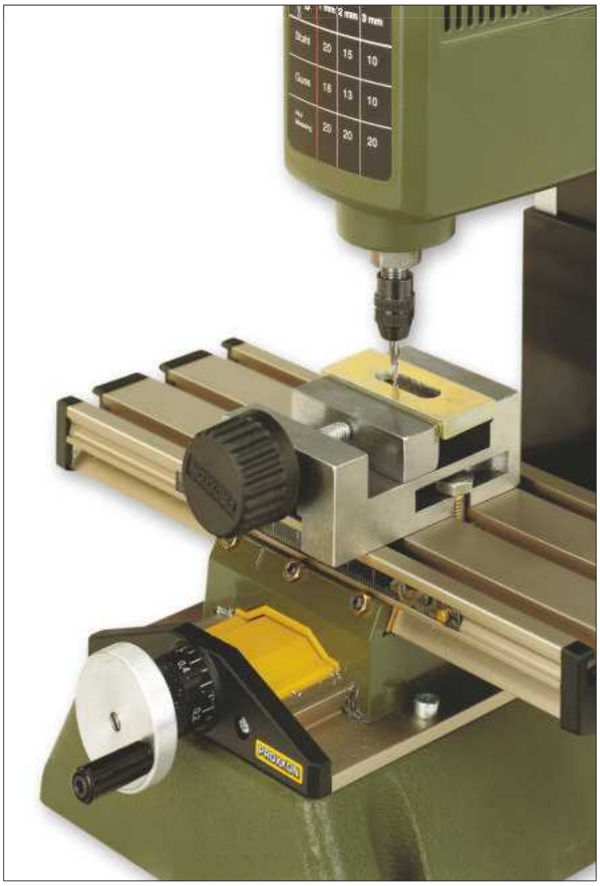

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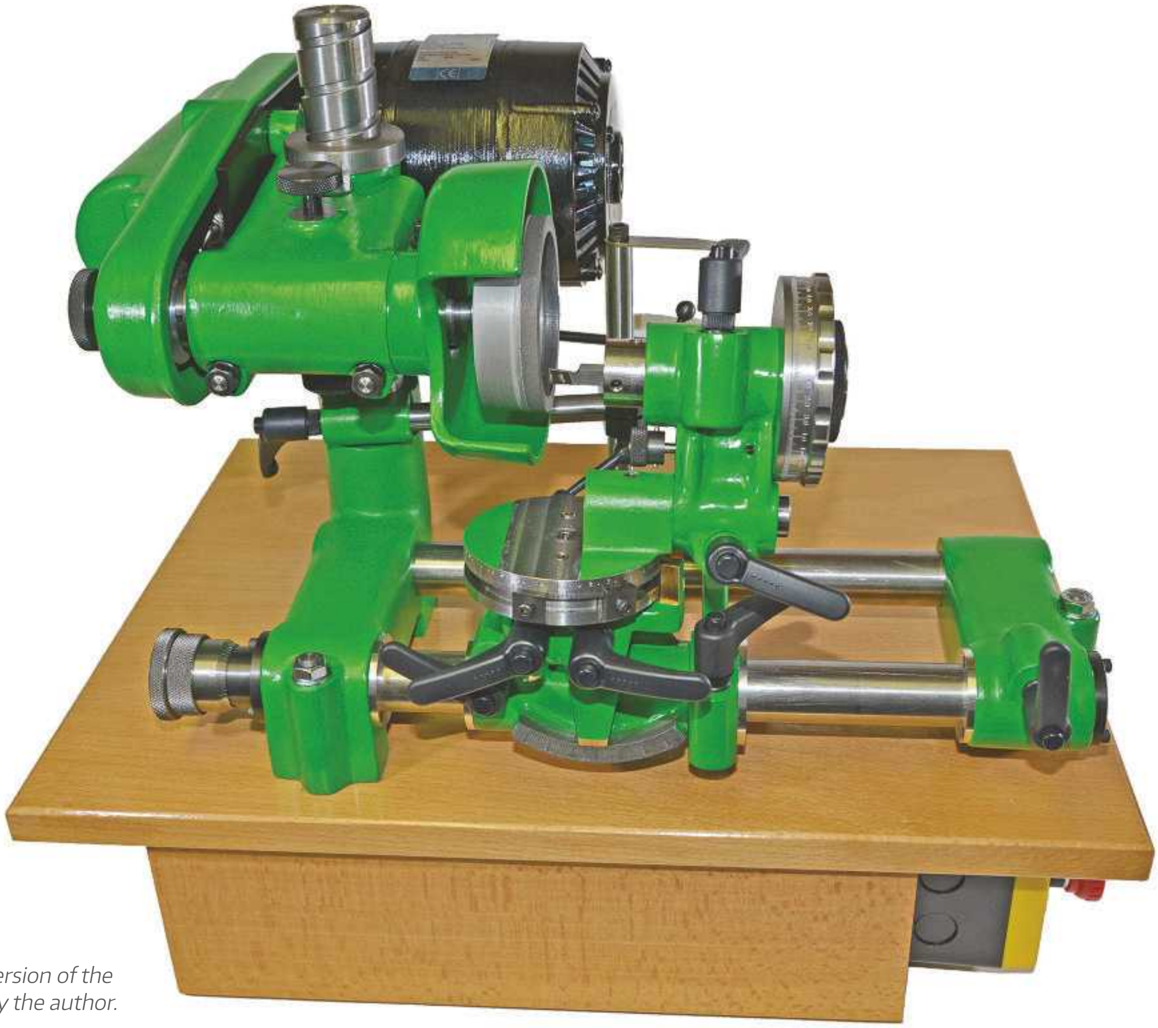
Safer
Quorn Electrics

Adrian Garner makes some sensible improvements to a much-loved machine

1



The Mark II version of the Quorn built by the author.

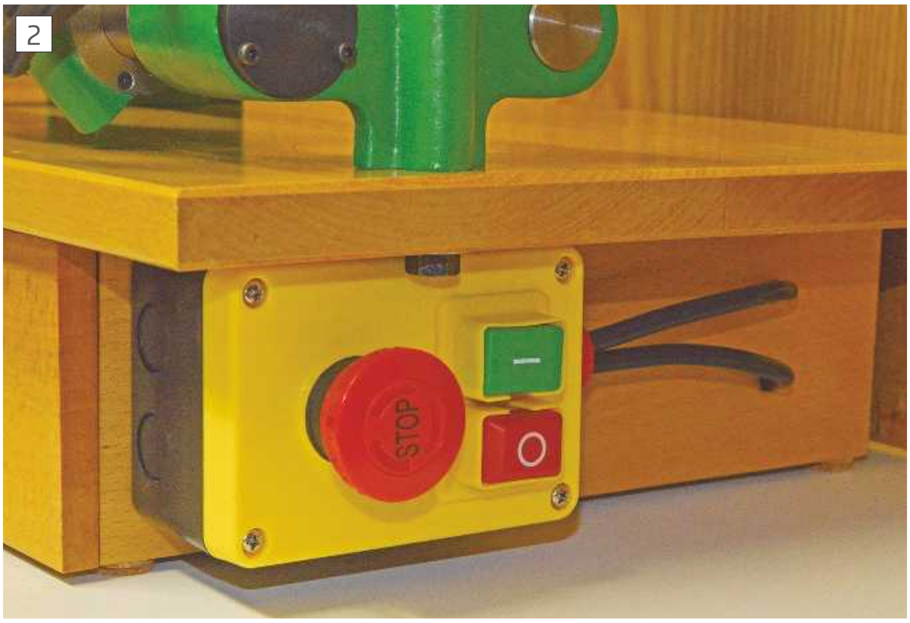
Professor D. H. Chaddock designed two versions of the Quorn tool and cutter grinder in the 1970's. The Mark I version had no cover for the belt drive from the motor to the spindle and had a three-way forward/off/reverse switch mounted on a separate plate at the rear of the machine. This machine would not have met the safety standards required in industry even in the 1970's as it had both an exposed driving belt and allowed the possibility of replacing the spindle and motor pulleys to provide higher rates of rotation of the grinding wheel. The latter is extremely dangerous unless the user knows when higher rates are permissible (Professor Chaddock intended to re-sharpen dies with very small diameter grinding wheels) and the user does not make a mistake by accidentally forgetting to lower the speed for "normal" wheels.

To meet commercial needs, and it is understood that the possibility of the commercial use of the Quorn was considered, a Mark II version was designed which included a driving belt cover which also had the effect of preventing changing the pulley sizes to any significant extent. The Mark II machine looks a little more elegant but that has nothing to do with its operation.

The much-adored steel ball handles were not made for my Quorn Mk II, **photo 1**. Instead the movements are locked with split brass clamping pads (much preferred by the late George H. Thomas and used on many of his tool designs) as they do not require the castings to be split with the inevitable change in bore size. The clamping pads are drawn together with ELESA adjustable handles. The handles can be positioned as desired for any operation and have the major advantage that they do not rust. (Any form of oiling on a grinding machine to prevent rust forms a superb grinding paste, adding to wear.)

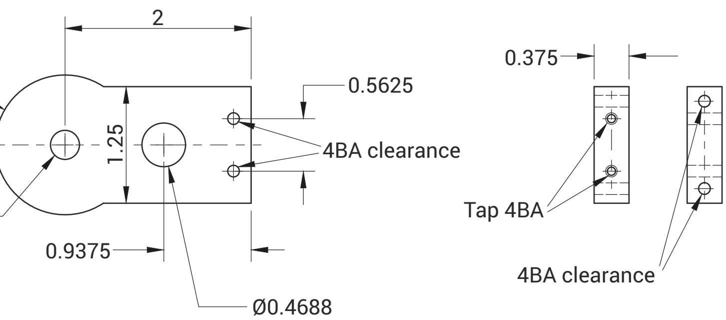
The layout of the electrics on both versions, however, was not particularly safe. Firstly, neither included a No Volt release, an essential in the author's view as it would be an unfortunate surprise to plug the

2



A No Volt release mounted on the right hand side of the base makes for easy on/off operation as well as additional safety. Mount on the left if you are left handed.

Fig.1



Quorn into the mains and turn on the mains switch to suddenly find it leaps into action. It would also start automatically after a power cut. Not great with a grinder. Even more importantly, if a problem occurs and it is necessary to quickly stop the spindle, it would be so easy in haste to flick the switch from "forward", past "off" and into "reverse" with possibly disastrous consequences.

The above problems apply to both the Mark I and Mark II versions. The Mark II version, however, has an additional hazard. As a deterrent to running the machine without the driving belt cover in place the three-way switch and motor capacitor are mounted on the removable belt cover. The connecting motor leads for this assembly have to pass (out of sight for inspection) between the pulleys and driving belt and be long enough to allow the cover to be opened. The original instructions suggested that they are taped to stop them coming into contact with the driving belt. Difficult to do effectively when the belt guard is being secured.

The electrical safety can easily be improved. When I completed my Quorn, I mounted it on its own base with a draw for accessories. A commercial No Volt release was fixed to the right-hand side which, as I am right handed, is safely and easily accessible and acts as the on/off switch for machine, **photo 2**. The wiring is little different from adding a switch to the circuit.

A "forward/reverse" switch is still required as the direction of rotation of the grinding wheel the grinding wheel must always be in a direction to hold the work against the tooth rest. The required two-way double pole type is mounted within the driving belt guard on an angle plate along with the motor capacitor. In this configuration, the machine cannot be accidentally reversed in a hasty reaction to a problem and, importantly, the bracket allows all the wiring to be strapped down so that it does not get caught up in the rotating belt. The need to open the driving belt guard to reverse the direction of rotation is not a great handicap as it only tends to be required occasionally.

A lock and sensor switch could be added to ensure the machine will not operate without the driving belt guard, I leave others to fit if appropriate to their environment.

All the above changes can be fitted retrospectively but the hole for the switch in the driving belt guard will need filling.

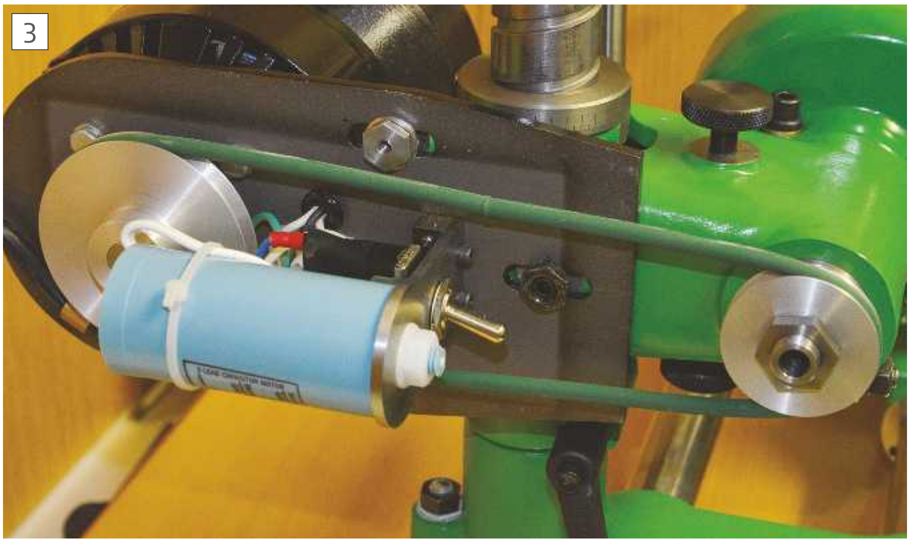
Figure 1 shows the angle bracket to hold the motor capacitor and switch. The angle bracket shown in the drawing was cut from 1/3" (3mm) mild steel plate and is held in place with screws through a short length of 3/8" square mild steel.

The bracket should be mounted on the centre line of the motor plate. The outer face of my bracket is mounted 1 7/8" from the front edge of the motor plate but if retrofitting you should make your own judgement allowing for the already drilled cable holes.

A terminal block for the wires may also be fitted under the capacitor and secured to the motor plate.

Photograph 3 shows the tidy electrics, the apparent additional rectangular plate on the motor plate is an optical illusion - the motor mounting plate was spray painted on its outside whilst standing on a rectangular card board box. Inside the belt cover the print of this shape on the motor plate from spray overspill does not matter! ■

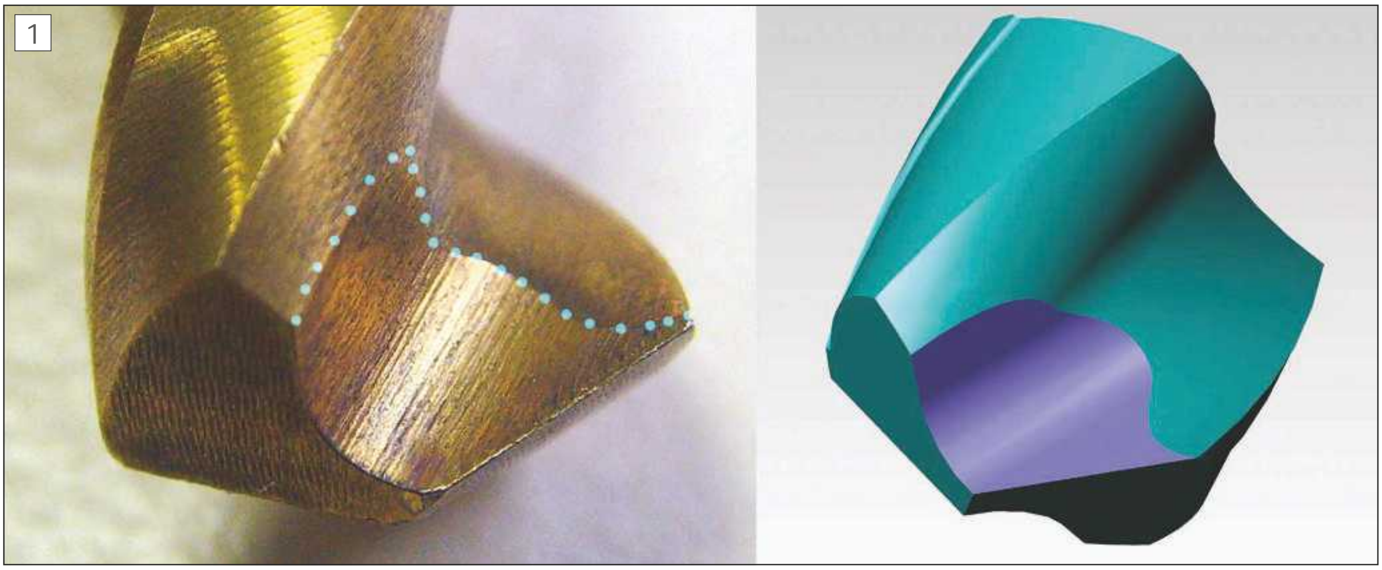
3



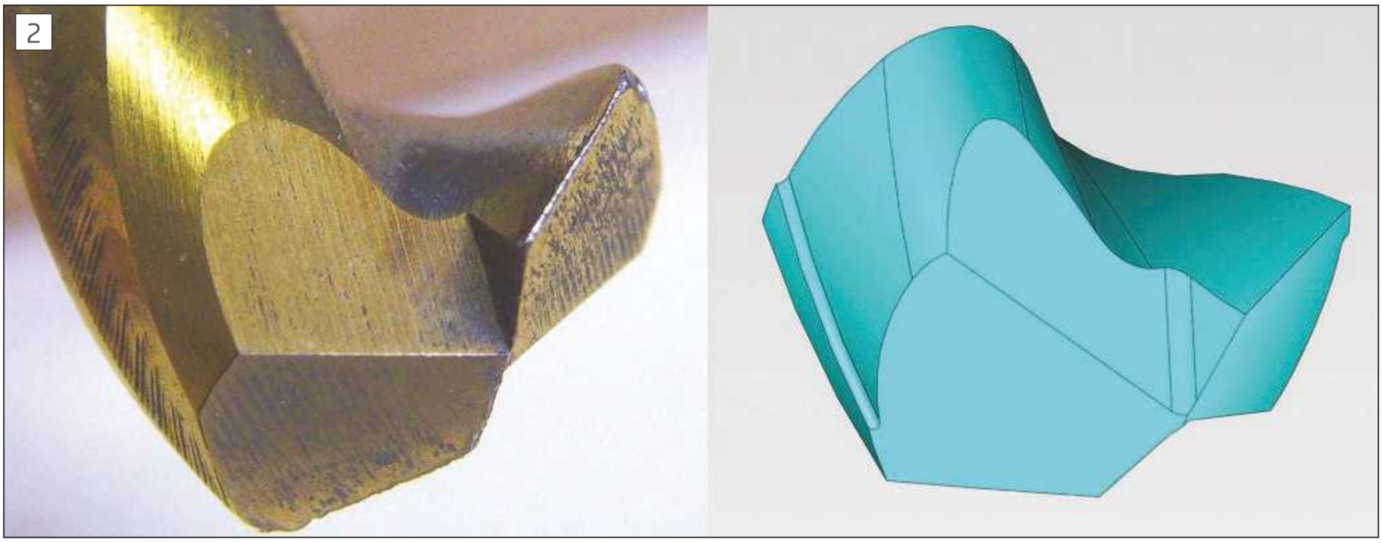
The tidy electrics using an internal mounting bracket for the motor capacitor and reversing switch.

Drill Web Thinning

Jacques Maurel explains fine-tuning your drills using a further development of his sharpening system described in MEW issues 245 – 247.



Grinding inside the flute



Point splitting

Thinning is necessary for thick web drills (the web thickness can reach 40% of the diameter) and worth making on usual drills as it lowers the penetration force (see later for an experience). In any case you must allow a few tenth of a mm for the chisel edge length or the point will crumble (unless being made of very good steel). This is usually achieved in one of two ways:

1 Grinding inside the flute (photo 1)

This is possible using a T&C (tool and cutter) grinder, but difficult, as a special time consuming set up must be made for each drill, so it's not a convenient process for a model engineer having many different drills to sharpen.

On the photo, a dotted line shows the boundary between the flute and the reground part. Moreover, this machining diminishes the rake angle and increases the risk of heel rubbing (for a same relief angle) as the web thickness is smaller (see the article "3D CAD help for drill sharpening").

2 Point Splitting (photo 2)

Two notches are ground along the chisel edge to create cutting lips (with 0°or a few degrees rake angle). In fact, it is no more than making a small drill (using the web) inside the big one. This is relatively easy to do on drills even if they don't have the same diameter.

Figure 1 shows a split pointed two-facet (thick web and short heel) drill with self-centering capability, and the result (on a thick web but standard heel) 6mm drill, "split" made with a conical grinding wheel as described later.

This begs the question, why should I make a (almost) no web drill as I said previously that this was not advisable (see the note about web thickness in my previous article A Look at Drill Sharpening informed by 3D CAD, MEW 245)

The answer is easy: this new small drill made (with the web) along the chisel edge will have a 180°point angle (or about 160°if the self-centering capability is maintained as described later) in which case only a small clearance angle will suffice to prevent heel rubbing. Moreover, the clearance angle is near β (see drill point definition in the previous article) so 30° for 120° point angle.

Example:

Sharpening and splitting a thick web drill, web thickness: e = 0.3d (d = drill diameter).

Fig.1

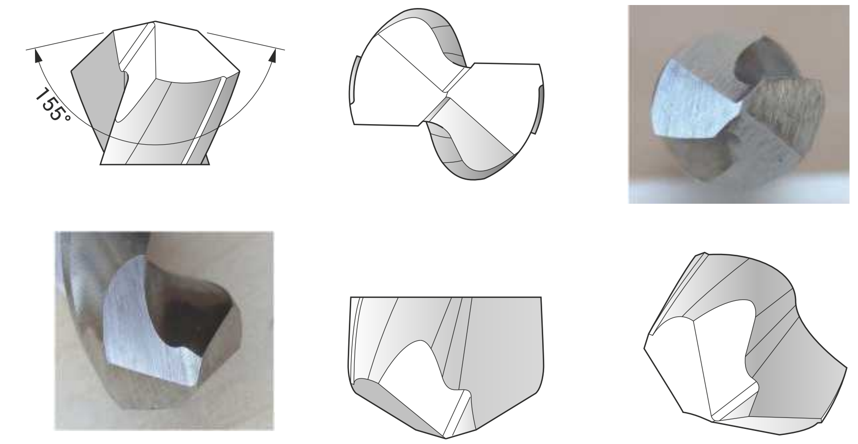


Fig.2

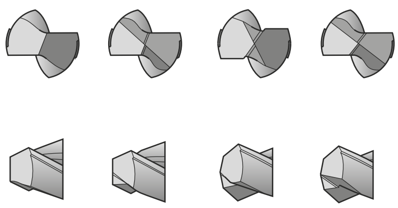
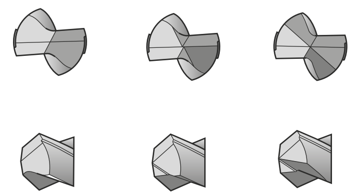


Fig.3



Using two facets:

First grind the 12° clearance, it's sufficient to prevent rubbing here (short heel); chisel edge length: 0.35d. See **fig. 2A** (the side views under the face ones are oriented for the chisel edge to be in the Figure plane).

At this stage it's impossible to use the drill due to the chisel edge length. If you split the point along the chisel edge using a cylindrical grinding wheel (90° edge),see **fig. 2B**, the point will be a 0.35d flat drill that will wander when used, so drilling is still impossible.

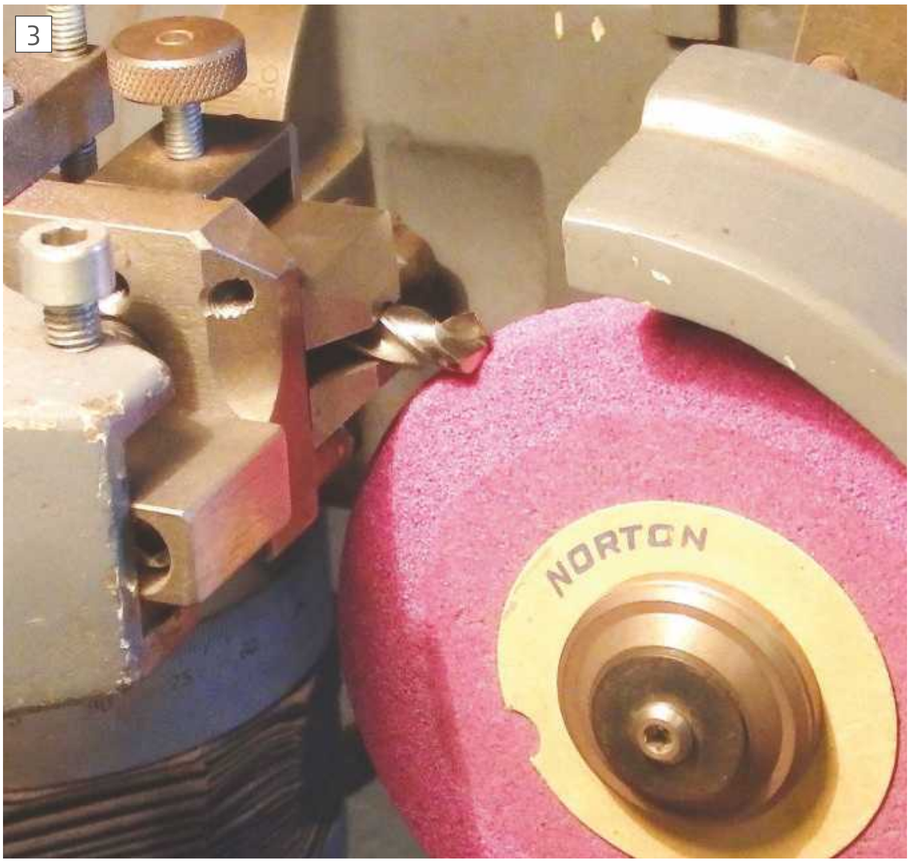
To get a center point, turn the drill in its Vee (see fig. 4) before splitting. Result: see **Fig. 4**.

Notes:
1 – The bottom line of the notches must make a 35° angle with the drill axis (recommended by drill makers).
2 – The smaller the grinding wheel edge radius the shorter the remaining chisel edge so the sharper the point; use a diamond or better a CBN wheel (for HSS) if possible, but a standard wheel works well (see later).
3- It's worth working with a conical wheel (110°edge) see **fig. 2D** and **photo 2**.

This gives three advantages:
- A stronger edge for the wheel due to obtuse angle (so a longer life for the small radius).
- More room for the chips when drilling.
- The drill heel is automatically removed (while this is not necessary for short heel drills, but is essential on standard ones, thus avoiding the secondary clearance).

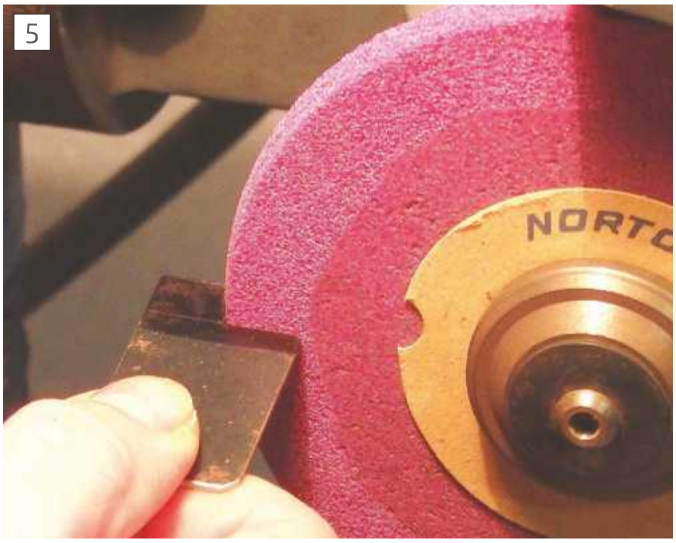
And some inconveniences:
- You'll have to chamfer the grinding wheel (see later).
- It's difficult to find such CBN wheels (but spare wheels for Vertex drill grinding and thinning attachment will do).

3



Point splitting in progress

Dressing the wheel with a 'Diabolo'.



Checking with a template

Using 4 facets:

After grinding the primary 12°clearance, grind the secondary 25°clearance to get a center point; chisel edge length: 0.4d. see fig. 3A.

You can now split the point along the chisel edge using a cylindrical grinding wheel (90° edge), see **fig. 3B**.

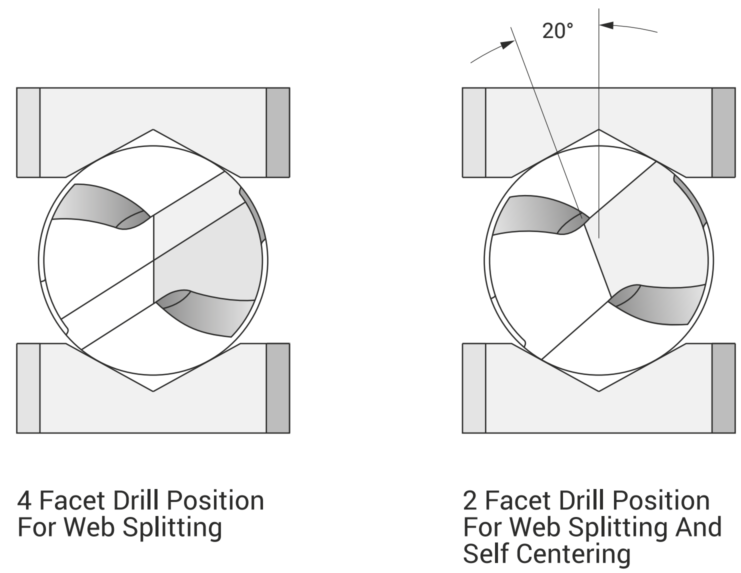
Notes:
1 – Here also the smaller the grinding wheel edge radius, the shorter the chisel edge, but the center point allows the drill to be "self centered" whatever this radius.
2 – It's also worth using a conical grinding wheel here. See **fig. 3C**.

Practical point splitting process (**photo 3**)

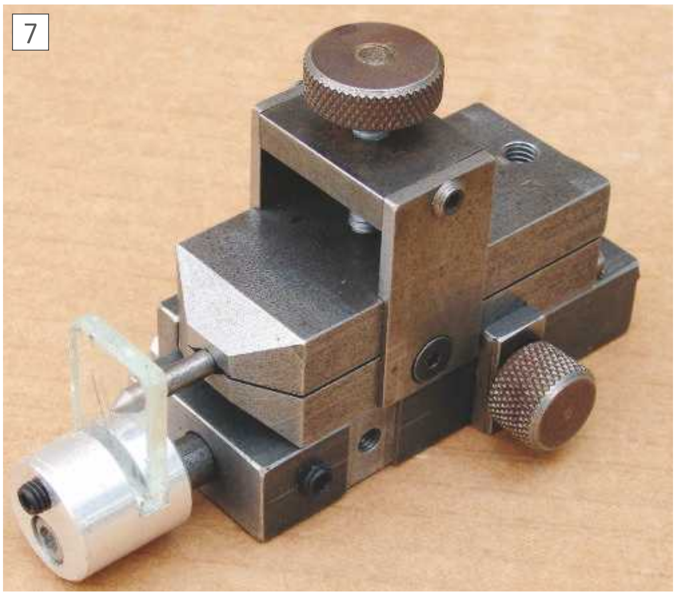
This description uses dividing blocks and other items described in my previous article in MEW 245 with an additional web thinning jig, its construction is described at the end of this article.

The notches are ground by the outer edge of the grinding wheel (the bottom of the notches is an arc of cylinder or cone in

Fig.4



Refreshing the wheel with a boron carbide stick



The web thinning jig

place of a plane), an adjusting pin is used with an adjuster (see **Fig. 5** and **photo 10**) so that every drill point will have the same position on the grinding machine. This is suited to a 3 axis T&C grinder (like the Stent for example) but it can also be adapted to simpler grinding rests (see later).

The grinding wheel must be well dressed to have and keep a sharp edge. For this, the wheel must run true (so all the circumference will be used) and should be of the largest diameter.

The process is easier to do than to describe!

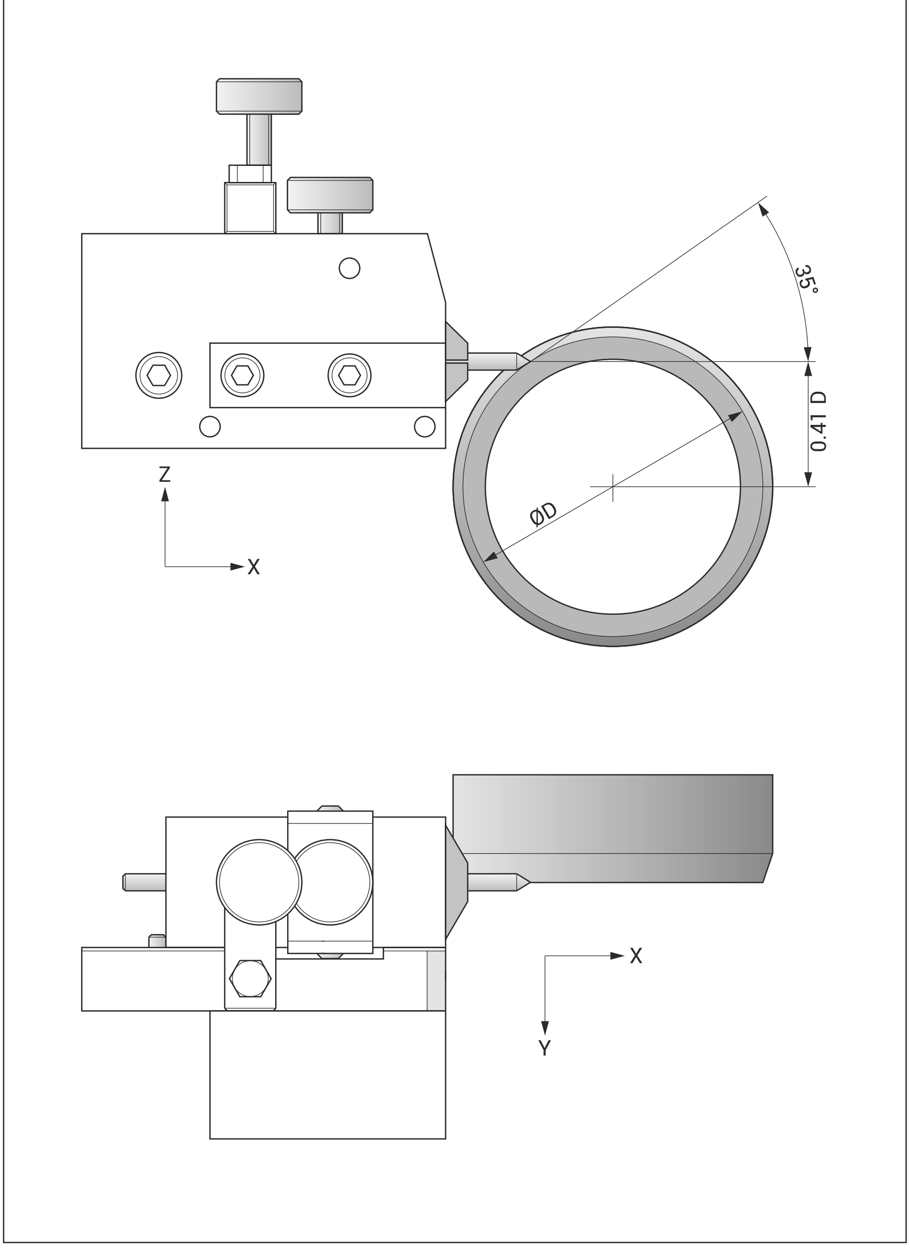
Grinding wheel:

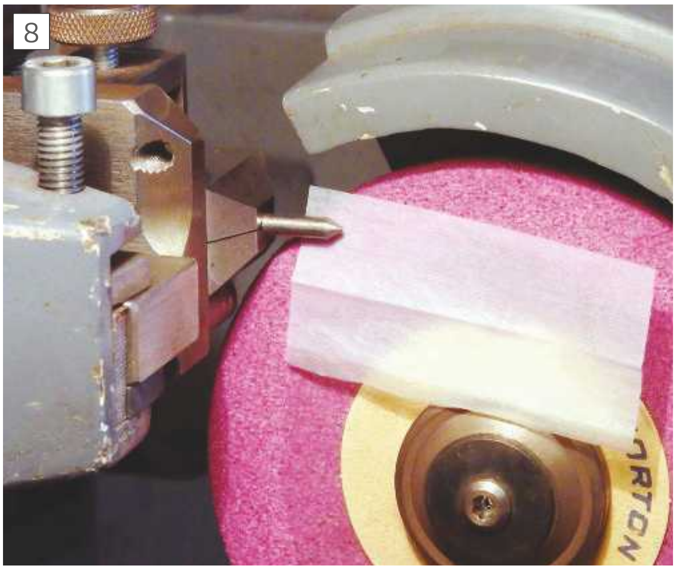
I used a Norton grinding wheel ref: 25A60LVG (Ø125, Ø20, thickness 6mm) the usual type for web thinning. The first dressing (cone and front side) was made with a "diabolo" and the angle controlled with à template (see photos 4 and 5). From time to time the wheel is then "refreshed" with a boron carbide stick (see photo 6).

Adjustment of the jig: (**photos 7, 8** & **9**)

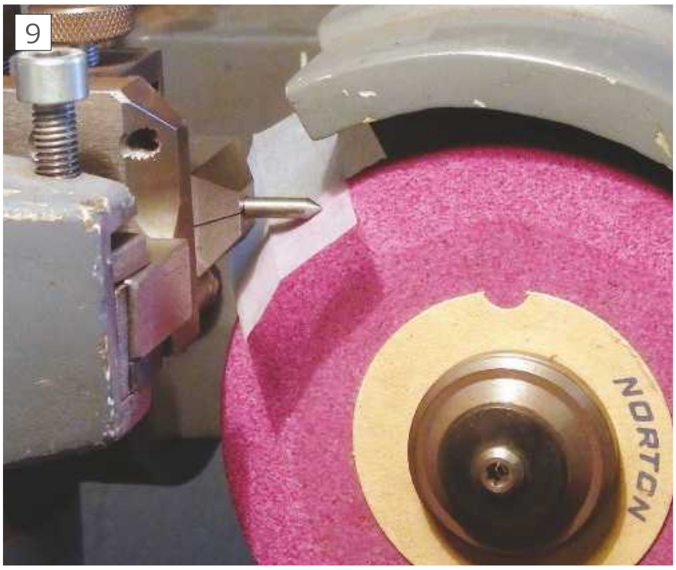
- Set the adjusting pin (Ø4mm) in the medium dividing block protruding for about 15 mm.
- Set the assembly on the adjuster and lock with the adjuster's knurled knob (S20).
- Set the glass plate (S13) to stop against the point of the adjusting pin and lock the glass holding stem (M6 grub screw S18).
- Remove the dividing block and pin from the adjuster and set it (and lock) on its bracket set on the grinder, the cylindrical part of the pin is used (with a piece of cigarette paper) to set the plane of symmetry of the vee in the active plane of the grinding wheel (take a "0" on the y-axis collar).
- Adjust the offset (Fig. 5) with a scribing block (take a "0" on the z-axis collar) this position is for the bottom of the notch to make a 35° angle with the drill axis, it's not a critical value.

Fig.5



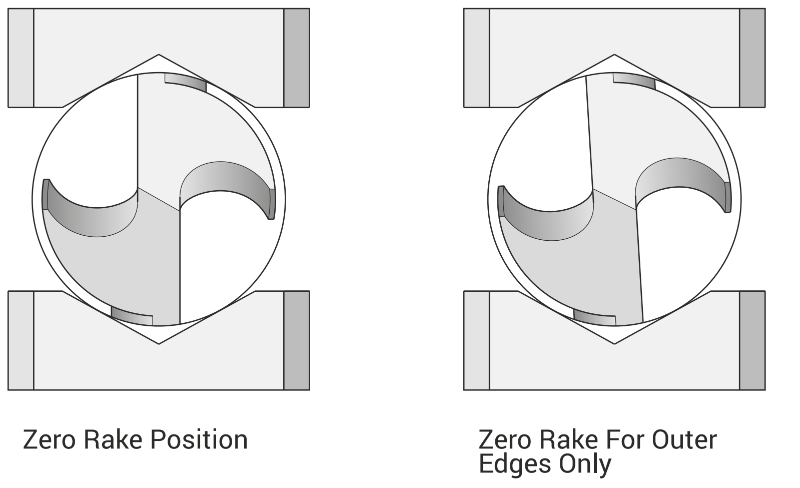


Using a cigarette paper to judge a fine clearance



And again.

Fig.6

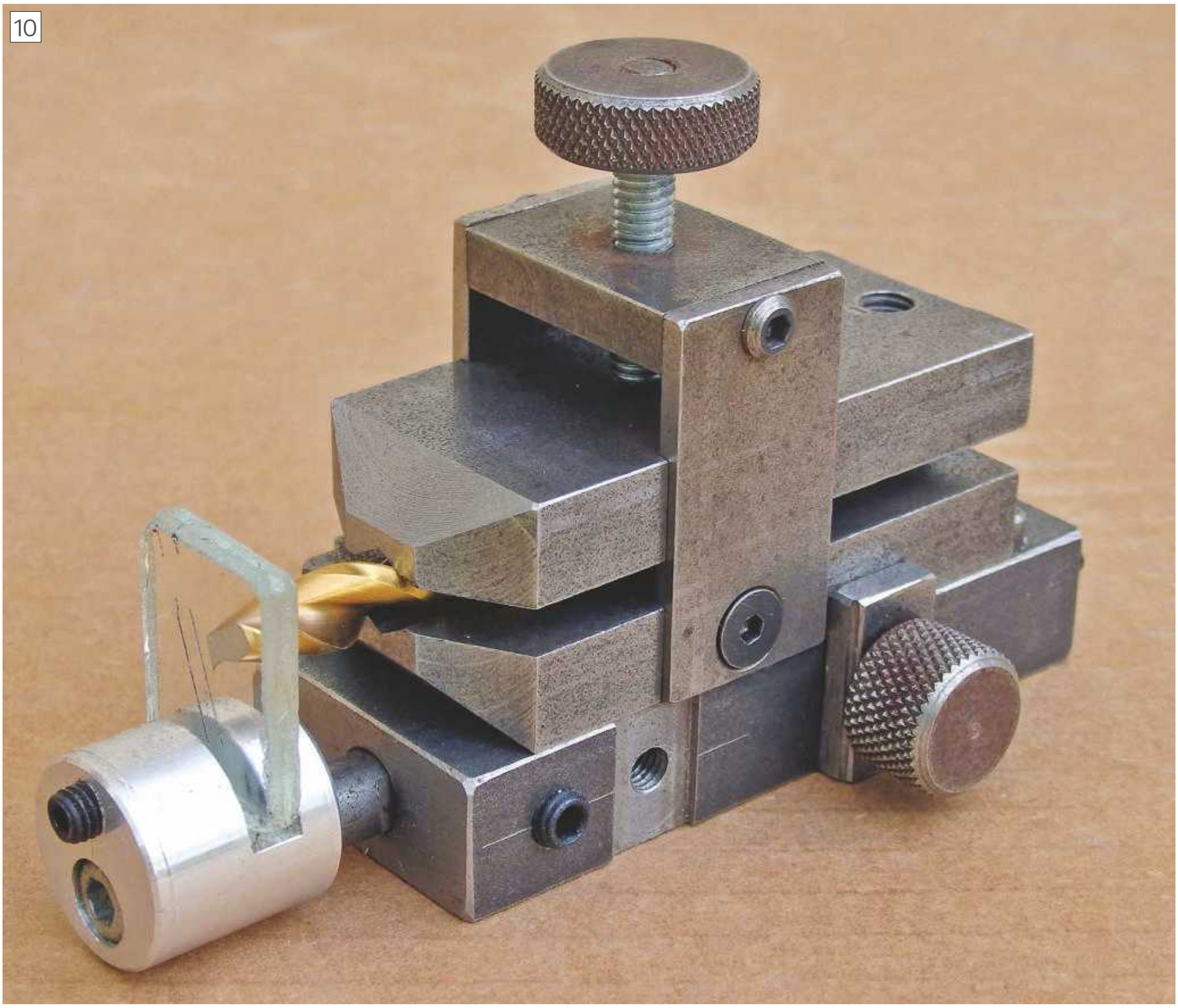


- Adjust the x-axis for the point of the pin to be just on the edge of the wheel and set a stop at that position (or take a "zero" if a hand wheel is available, according to the type of grinding machine used).
- Move the x-axis to the left (to clear the wheel for loading, unloading and dividing); move the y-axis backwards to clear the point for about 3mm.

Point splitting a Ø4mm drill (this being the diameter of the adjusting pin) (**photos 3, 10 and11**)

- The drill is set (but not locked) in the medium dividing block, itself set and locked on the adjuster, stop the point of the drill on the glass, turn the drill for its chisel edge to be vertical (4 facets drill) or turn 20°anticlockwise from the vertical position (2 facets drill) and lock. 2 lines are drawn on the glass (using a carbide scriber) to be used as a template for the 20° angle.
- Put the assembled dividing block and drill on the grinder bracket and lock.
- Move the x-axis on its stop, and slowly

10



Setting a drill in the jig

11

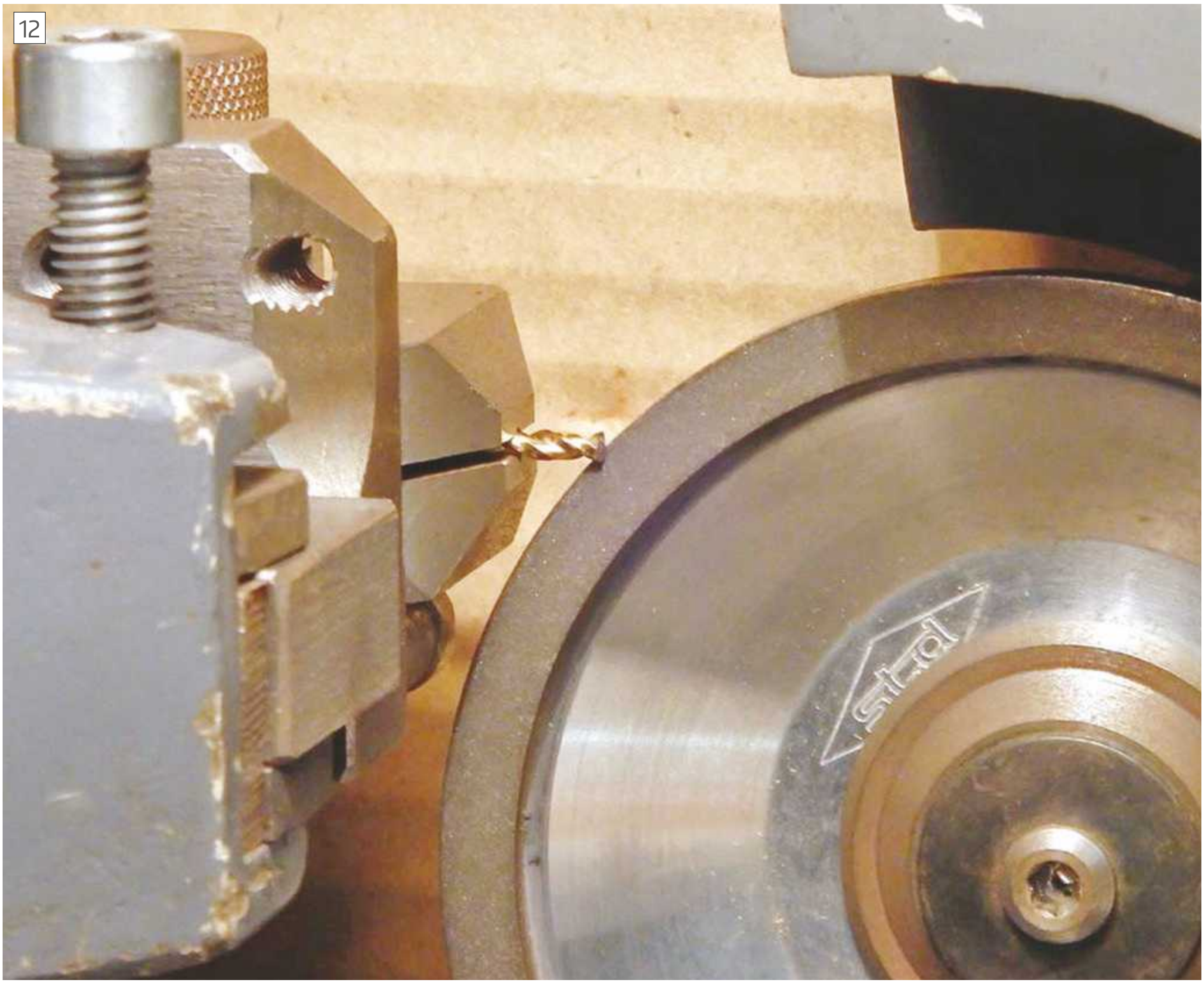
Angling the drill for a 2-facet tip

Table 1: Parts list:

Number	Quantity	Name	Material*	Remarks
S10	1	Adjuster bracket	CRS	
S11	2	Side stops	CRS	
S12	2	Screws H M5-15	8-8	
S13	1	Glass 4mm thick	glass	20x25mm
S14	1	Glass holder	2017	
S15	1	Screw Hc M4-8	8-8	
S16	1	Screw CHc M5-15	8-8	
S17	1	Glass holding stem	CRS	
S18	1	Screw Hc M6-12	8-8	
S19	1	Clamp	CRS	
S20	1	Clamping knob	CRS	See text
S21	1	Screw H M4-8	8-8	
S22	1	Rear stop	CRS	Length 20mm

“ 8-8 – stainless steel, CRS- cold rolled (mild) steel, 2017 – aluminium alloy.

12



Splitting a 2.5mm drill

move the y-axis (for grinding the point) until it reaches the "0". Move the y-axis backwards to clear the point for about 3mm, move the x-axis on the left for dividing, grind the second notch, take out the dividing block to verify if the remaining chisel edge is about a few tenth of a mm long. Adjust the (micrometer) x-axis stop and regrind if not satisfied.

Notes:
1 – At the beginning adjust the X stop so that the drill doesn't touch the wheel and turn the stop micrometer thimble until you hear the grinding noise, grind the other notch at the same setting, and check the result, Adjust the x-axis and regrind if not satisfied.
2 – Moving the y-axis slowly when grinding is essential to keep the wheel edge sharp.
3 – When thinning many drills, it's worth beginning by the smallest one as the wheel edge radius increases as it wears.

Web thinning another drill having a different diameter:

If you use the same medium dividing block (used from Ø4 to Ø13) you must alter the Z setting by this value: Hz = (D - d) x 0.577 to keep the same offset, as the drill axis is moved upwards in its vee when the diameter is increased.

The Z adjustment being originally made for the 4mm (smallest drill for this dividing block), a "0" is taken on the z-axis so that the Z movement will be increasing with the drill diameter(as on my machine, the z-axis moves the wheel spindle).

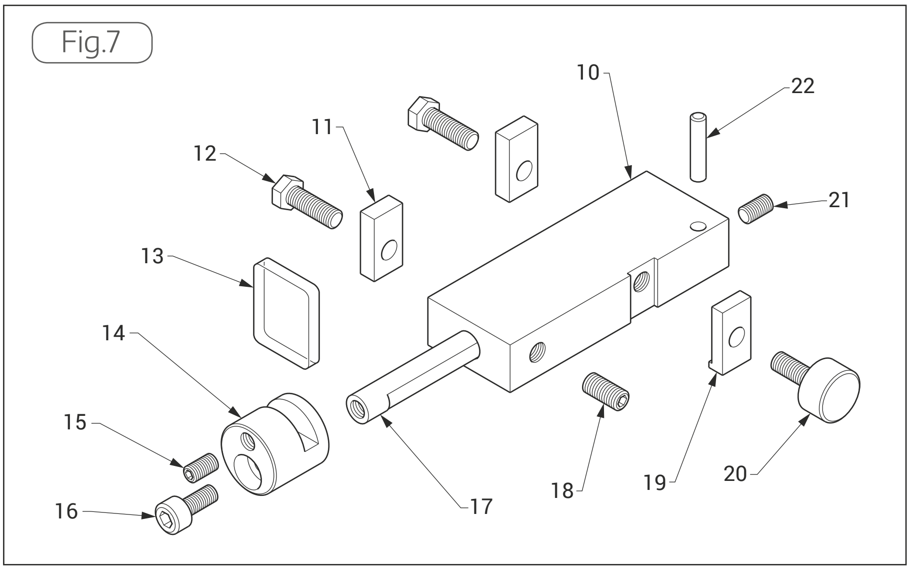
- For a Ø6mm drill, the Z setting would be increased by 1.15mm.
- For a Ø10mm drill, the Z setting would be increased by 3.46mm.

It took me less than 1 hour to split all the drills from 4 to 10mm (**photo 15**).For drills bigger than 7 mm, it's necessary to cool the drill. I use an air jet in the following way: slowly take 0.2mm on the y-axis, withdraw, let cool, and so on until the Y is "0". Most of the time was used for cooling.

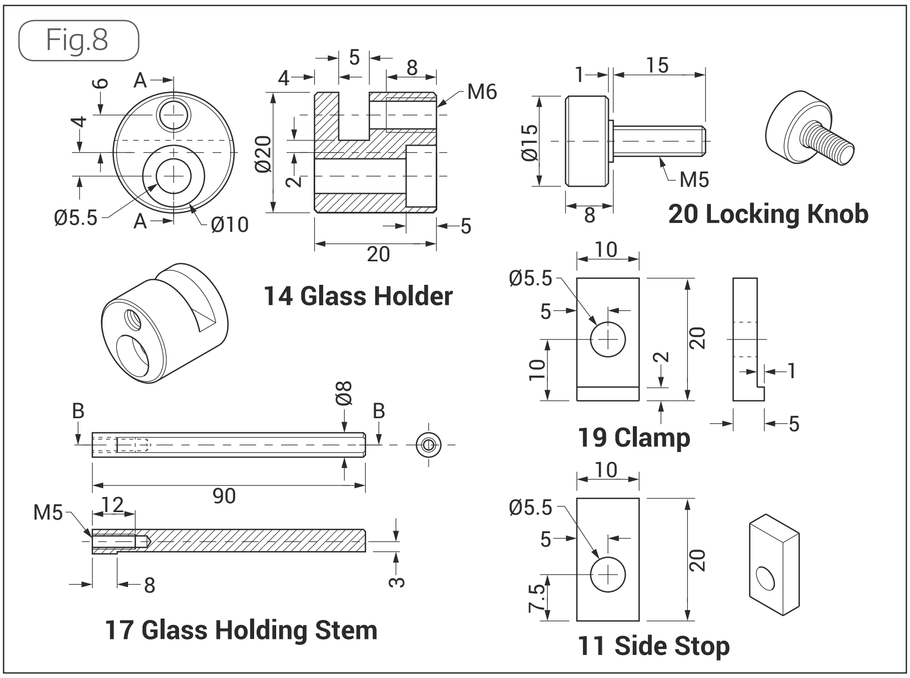
This process is also ideal for grinding a small flat giving a 0° rake angle along the lip edge (for brass and plastic drilling, see **Fig.6**). It's worth turning the drill slightly so that the "small flat" is made only on the outer edge of the drill (where the rake is maximum, **photo 16**) as the rake at the inner edge is already very small.

If you use another dividing block, this will be rarely the case, drills smaller than 4mm are difficult to split, I tried using a diamond wheel to split a 2.5mm drill (photo12) and succeeded at the third attempt, but I think that this doesn't worth the time spent in fine adjustments. Drills more than 13mm are usually used after a pilot hole having been drilled, so the splitting is of limited use.

Small Dividing Block (from Ø1.5 to Ø4) use a Ø3mm adjusting pin with 8mm protruding, keep the same Z offset and set



Using a bench grinder with a simple rest



Setup for a drilling test at a constant feeding force

a new X stop.

Big Dividing Block (from Ø10 to Ø26) use a Ø10mm adjusting pin with 25mm protruding, keep the same Z offset and set a new X stop.

Making the Accessory (Table 1)

Only the "adjuster" will be described here as the dividing blocks and bracket have been described in the previous article. All the glass (S13) edges must be ground, a plastic pad must be set between the grub screw (S15) and the glass (S13) to avoid breaking it when tightening.

The clamping knob (S20) is made from a piece of standard threaded rod stuck in the knurled knob with epoxy glue. The adjusting pin is a piece of silver steel Ø4mm, 70mm long, with a 60°cone machined at the end (let a small flat at the cone end). The other parts are easy to make.

Using a bench grinder with a grinding rest for web splitting (photo13)

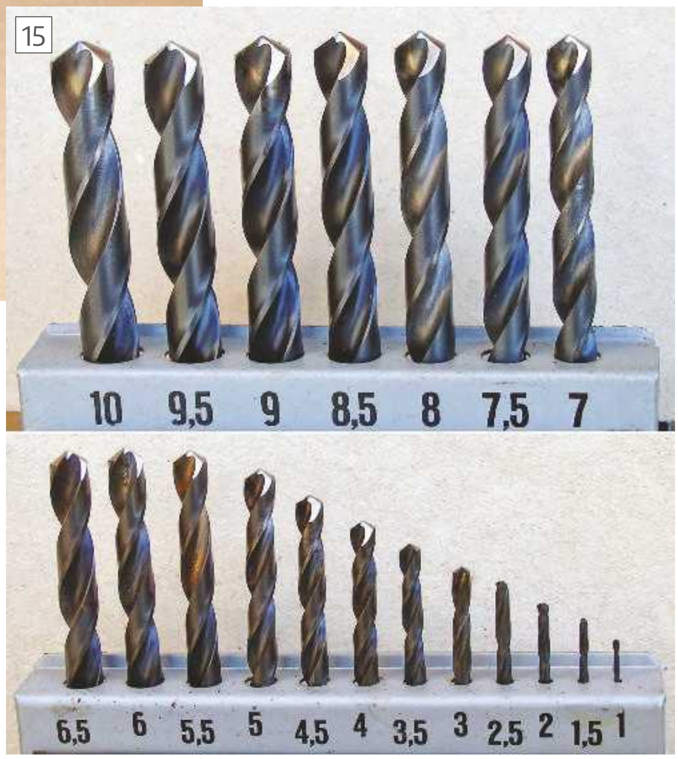
Splitting can be made with the pictured grinding rest as the fine adjustments along x and y-axis are possible using the knurled knobs.

The z-axis can't be easily adjusted (to take into account the drill diameter) but in place you can control the Y infeed (with a DTI or the depth gauge part of a sliding caliper for example). The amount Hy = 0.824 (D-d) compared to a "zero" taken for the 4mm drill.

Drilling test (photo14)

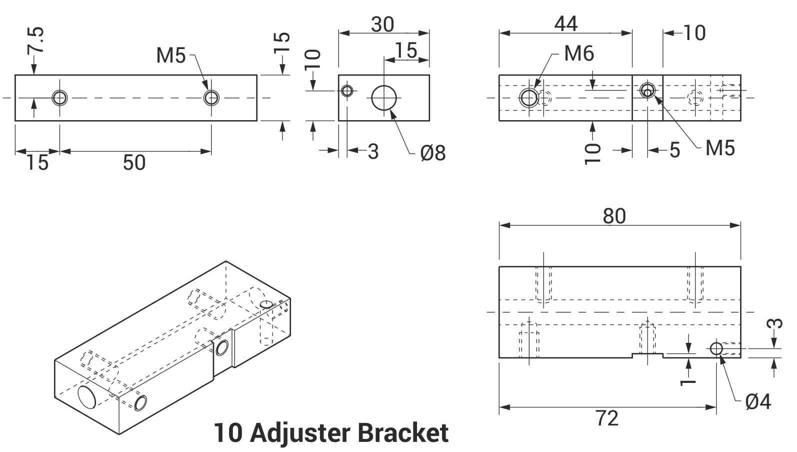
I wanted to compare the drilling performance of the different sharpenings, 2 drills (Ø9mm) were compared: a standard one and a 2 facet split. The drills having the same helix angle, and pushed with the same feeding force (82 daN), into a free cutting mild steel bar, 10mm thick, N = 580 rpm, the drilling time was measured with a stop watch. The results were as follows:

- Standard drill: 24 seconds.
- Split drill: 14 seconds. ■



A full set of drills, 4 to 10mm ground with split points

Fig.9



10 Adjuster Bracket

A close up of one of the points.

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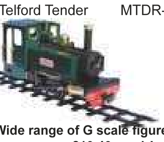

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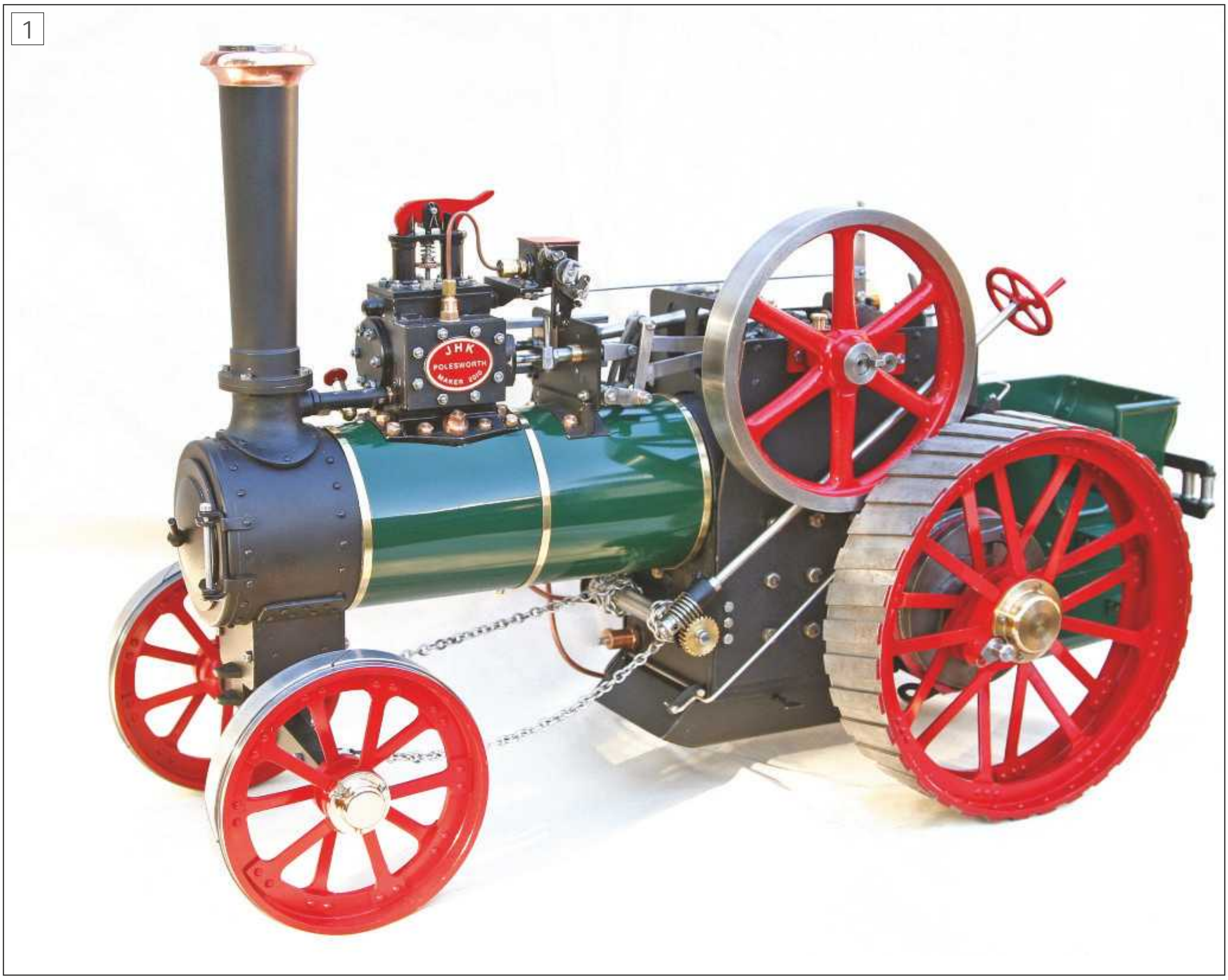


1

Minnie Traction Engine

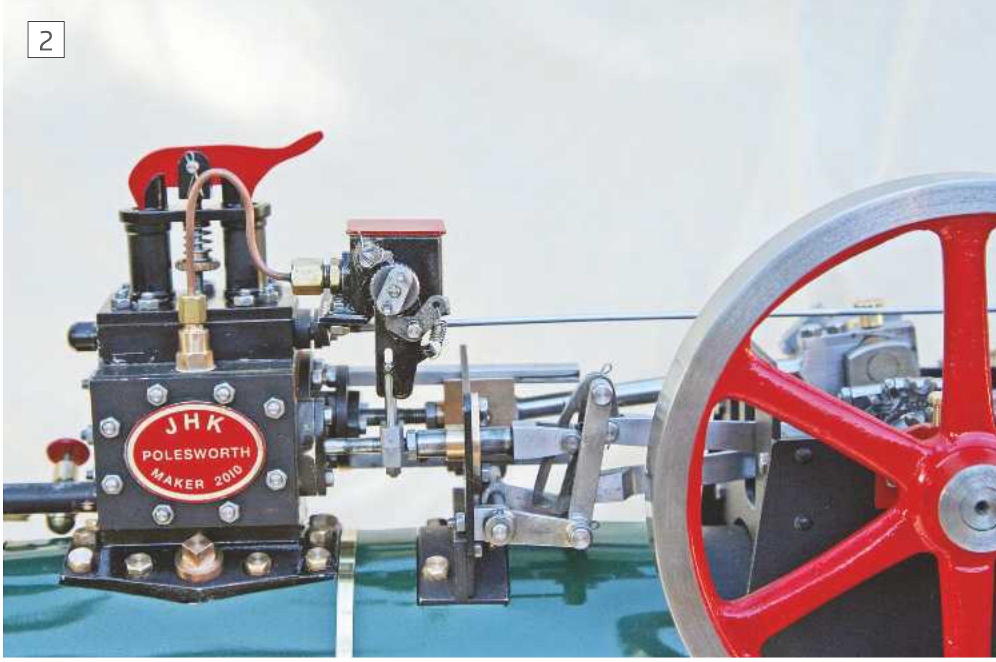
As with many people of my era I served an apprenticeship, did my National Service then started work! I served my time as a machinist at Alfred Herbert's in Coventry so have always had a keen interest in machine tools. A working lifetime of running my own production machine shops left little time for hobbies, but Model Engineering has always figured and during this time I built most of a "Minnie" traction engine, **photos 1** & **2**, on a Myford Super 7 along with a Myford vertical mill. I changed the Super 7 to a Myford 254 and it was this machine that I used to complete the traction engine along with other projects on the larger more robust machine. In this article, I will describe using the 254 in a home workshop with some of my projects and associated setups to give an idea of how the lathe performs and maybe offer the odd tip for fellow model engineers / home machinists.

I purchased the Myford 254, **photo 3**, in 1994 after using the Super 7 since 1973. The machine was supplied new by Percy Martin of Leicester in 1989, based on its condition it had only had light use from new. The first job was to acquire a single phase motor to replace the original 3 phase unit. The motor was purchased up the road from Myford Nottingham (the good old days!)

The machine is a professional tool with hardened bed ways and with the headstock enclosing the back gearing and tumbler reverse gears in an oil bath, with splash oil feed to the spindle bearings. Being slightly larger than the S7 it is noticeably more rigid, with a good speed range.

For the first years of ownership I completed numerous model internal combustion engines and Stuart Turner steam models. One of my projects was a Stuart Turner Sirius Twin high speed steam engine. The reason I mention this one is because the block of the engine was mounted on a faceplate, **photos 4** & **5**. The machine coped with the operations for this engine with ease. The chuck or faceplate is mounted on three studs and gives a positive and accurate location to the lathe spindle. This mounting method has the benefit of being quicker than a spindle nose thread that requires fastidious cleaning of both male and female threads between setup changes.

By far the most useful addition to the machine was the addition of an inverter variable speed drive. I purchased a dual voltage 3 phase 3/4 hp motor and installed this in place of the original single-phase motor. This modification transformed the machine adding speed control and reverse. Drilling, tapping and reaming are a dream with the fine control available. I would highly recommend this modification to any home machine owner.



Some of Minnie's motion work

The business end of the Myford 254, note the wall mounted inverter

Line boring the Sirius crankcase

Additional Tooling

Over the next few years of ownership I purchased additional items of tooling that were not supplied with the machine; notably a 4 jaw independent chuck, faceplate and a rear tool post. These were obtained before the sell off of original "Myford" in Nottingham. The last item I purchased was a gear set to enable metric threads to be cut as the machine is an imperial in its standard guise. The first chuck I purchased was a 4 jaw self centring unit to compliment the 3 jaw as supplied with the machine. This chuck is used a great deal for general machining as it has a much better grip with the extra jaw and less pressure required to hold fragile items. A very useful item purchased from eBay was a British made Keats angle plate, when mounted on the face plate this provides a great fixture for holding jobs for offset machining - with suitable counter weights where necessary to maintain balance.

The machine uses a "Dickson" style tool post with removable holders locked with a rotating cam assembly. This gives a reliable means of holding a variety of tools with the repeatability of centre height that is so important.

I felt the need for some collets, which can be very useful for some operations as they can give greater accuracy and repeatability. As nothing commercial was available at the time i decided to make up my own using ER 40 collets giving a maximum holding diameter of 1 inch - this matched the through bore of the 254 spindle. This involved buying a commercially available collet unit with a parallel shank including the nut, peg

Facing the cylinder head

spanner and a backplate from Myford. I shrunk this into a steel body mounted on the backplate, **photo 6**. This has been a very successful item of tooling that has been useful on a number of occasions.

Current Projects

Having recently completed a Stuart Turner Double 10 I turned my attention to a larger model from the ST inventory; a Stuart Turner No. 1.

The ST No. 1 is a single cylinder vertical engine and with a 2" bore and stroke and an overall height of 13 1/2". This is a sizeable project for a home workshop although I appreciate the large size as my eyes will not have to deal with any 12ba screws on this one!

The engine has one cast vertical support with a machined second support from base to cylinder block. The machined support was turned in the 254 from a flat blank. The intermittent cutting caused some initial issues which I got round by using a positive rake cutting tool. This tool coped well with the intermittent cut and speeded up the initial roughing out of this part to give the round form for the centre section of the support with the integral square foot to mount to the base, **photo 7**.

The cylinder was setup in the four jaw chuck for machining and boring operations, **photo 8**.

The machine coped with ease completing the No 1 cylinder which is quite large at 2 inch bore, the irregular shape made it necessary to use the 4 jaw independent chuck. While the 4 jaw was mounted it was used to machine the mild steel column turned from a length of 1 1/2 in X 1/2 in BDMS flat supported by a running center. The intermittent cutting was made easy with the aid of an Eccentric Engineering tangential (positive rake) turning tool.

6

ER40 collet chuck

The next part of the engine needing the 4 jaw independent chuck was the conrod. This is supplied by Stuart as a mild steel forging. Holding the part on the opposite "small" end and using a small centre for support; the seating for the gunmetal bearings were machined.

By far the largest job on the machine to date is the flywheel for the Stuart Turner No 1. At 7 1/4 in diameter it was too big to fit in any of the chucks and therefore it had to be mounted on the machines faceplate, **photo 9**.

Two clamps were used at 180 degrees and the casting set running true, no balancing had to be employed with this set up. To get the spindle torque to machine such a large diameter the back gear was used to keep the inverter frequency up to 40/50 hz this gave around 80/100 rpm with carbide tooling. This setup provided plenty of power to machine the outside diameter and face, normal direct drive was used for the facing, drilling, boring and reaming of the bore.

I hope I have demonstrated some of the capabilities and versatility of this lathe and through the words and pictures given an indication of its strengths.

In summary, the 254 has shown itself to be an impressive machine for the home workshop. It is a larger machine than a Super 7 or other lathe that could possibly be bench mounted - its robustness is evident from the stand through to the headstock and bed. If you have the space and wish to pursue projects of a larger size the 254 will be an excellent workshop companion. Highly recommended! ■

7

Machining cylinder support for Stuart Number 1

8

Boring cylinder in four-jaw

9

Flywheel mounted on faceplate

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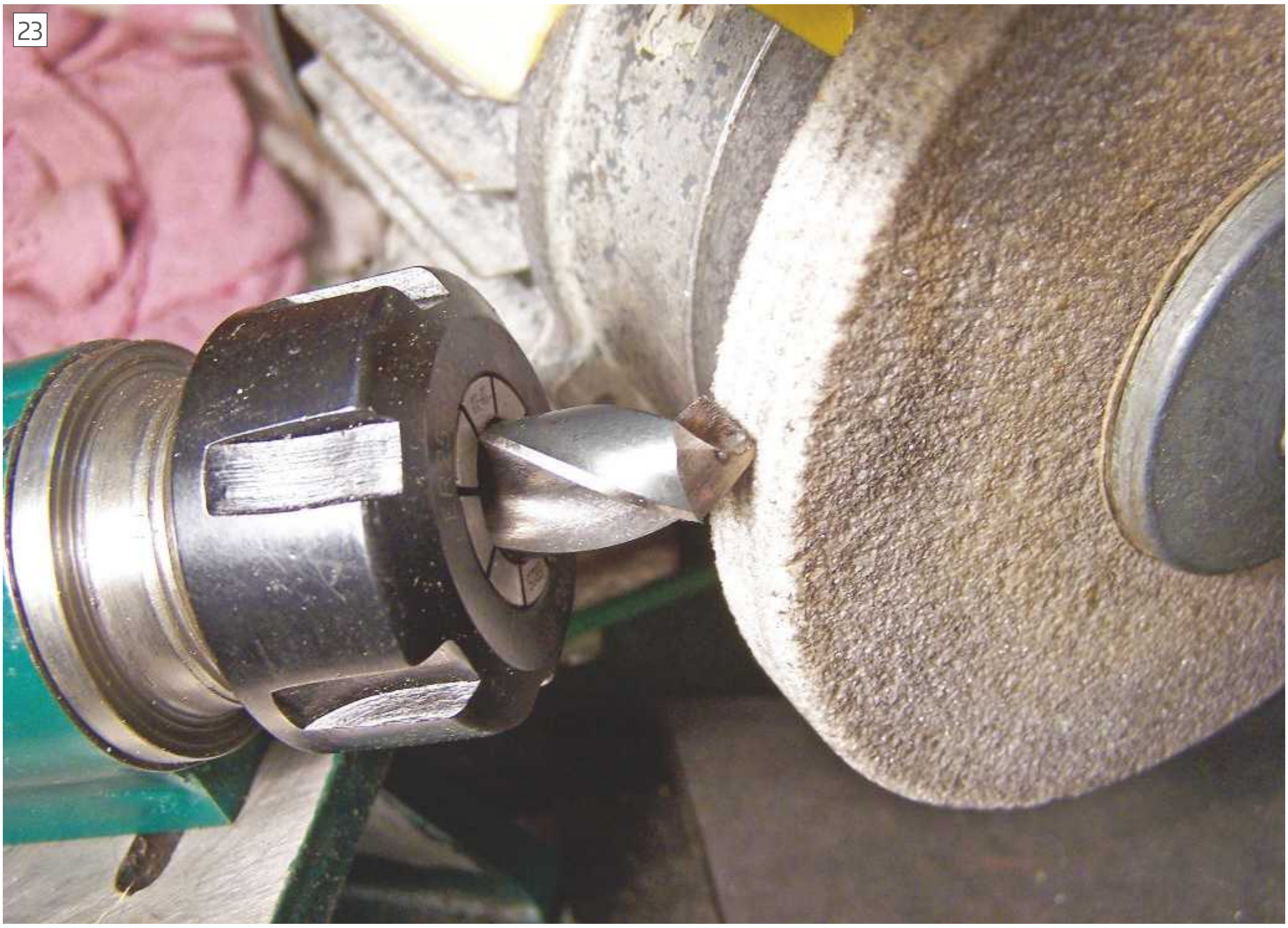
Drill sharpening With A Cutter Grinder

Will Dogget makes a useful pair of accessories to aid drill sharpening using his cutter grinder. Part 2



23

Drill on grinding wheel

The carriage is pulled away from the wheel and the grinder is switched on. The carriage is then brought to the wheel and onto the stop, this should give a light grind. After the initial grind check the face of the drill - we are looking for a clean face all the way across the cutting face. If not advance the holders by moving the carriage stop screw two turns to bring the drill closer to the wheel and try again. Then slacken the clamp and turn the holder-indexing ring to the next position and lock the clamp and grind the other face of the drill. **Photo 23** shows a 13mm drill ready to sharpen in the ER collet.

Most of the setting up is done by following the original drill contours. If you come across a badly shaped or damaged one, use one of a similar size and good condition to set up and then change to the damaged one to grind it.

Do not be tempted to take large cut as this will overheat the drill and damage it and render it useless.

A Large drill grinding jig

After making the ER drill grinding jig, I later found that I wanted to grind some lager drills in particular a 1-inch drill. As the ER grinder was only designed to hold drills up to 16mm this drill was too big so I needed to find a solution to this?

The first thought was to use a standard vee block as this seemed the most obvious thing to use. The main problem with this was the land on the drill was not supported all the time when the drill was turned to a new position it tipped into the helix, **photo 24**, so a solution had to be found.

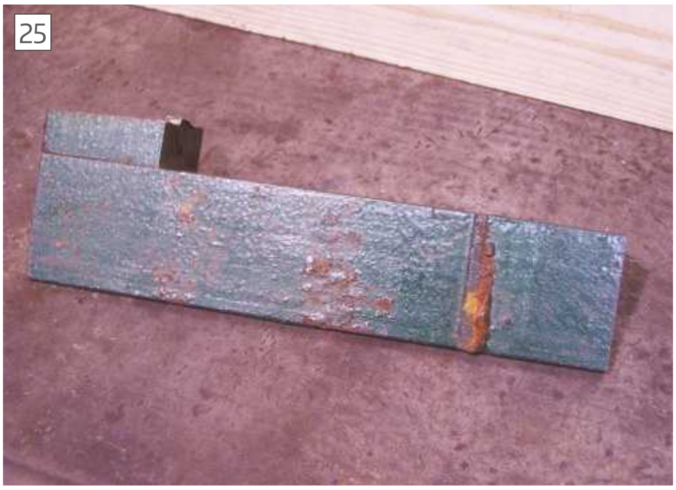
As the vee is the right form for this a long vee block was required but as I did not have one the right size an alternative was sort.

Looking at a piece of two-inch angle **photo 25** I had a flash of inspiration it looks to me that with some imagination a vee block of some sort could be made from this.

A piece of the angle that was about 5- inch long was held in the vice and a

24

The vee block and the helix



25

Scrap angle

26

Testing the drill and angle

1-inch diameter drill was placed in the vee of the angle, **photo 26**. I then rotated the drill and there was now no rocking on the land as I turned it. (The land on a drill is the narrow part of the body that runs full length of the drills helix - this is the bit that is the full size of the drill). So, the angle was going to be the basis of the large drill jig.

The first thing to do was make a sketch of the basic idea, this also had to incorporate a flat bottom for the vee to sit on so that it could be mounted on the tool grinder.

The other requirements were a backstop with a way of moving the drill forward as the grinding progressed also a clamp of some sort to stop the dills from moving when being ground.

The general arrangement and sizes for the Vee block and support are shown in **figs 7** and **8**.

The Vee block

To make the vee block the piece of scrap angle that I had found in the workshop, 50mmx50mm and about 5mm thick, and used as a test was put in the bandsaw. The ends were cut to remove the welding and another bit that was welded on one side this can be seen in photo 27. The finished length was 115mm. The base for the vee block was the cut this was a piece of 20x60 cut to125 long this was then welded on to the angle shown, **photo 28**. The plate to hold the over lock clamp is a piece of 40 x 50 x 6 welded on the top of the angle, 30mm from the front, **photo 30**.

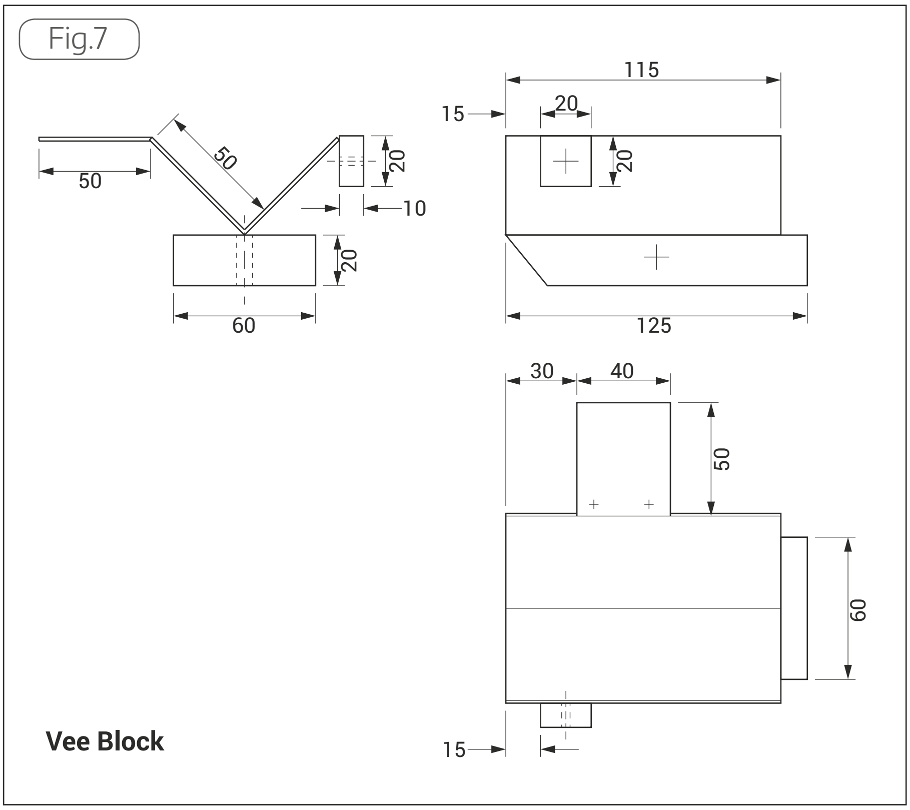
After the welding was finished a 5/16" hole was marked out and drilled in the back of base for the depth stop/adjuster arm then the holes for the overlock clamp were drilled. The stop/adjusting rod was made of 5/16" steel and is 200mm long and held in place with a 2 BA socket head grub screw. To hold the stop/adjusting screw in place a piece of 10 x 20 x 55 steel was drilled with a 5/16" hole, 5mm from the bottom and a hole drilled and tapped M6 at 32mm centres. The stop/adjusting screw is an M6 large head screw, 60mm long and with a knurled finger ring at the end of the thread so that it makes it easy to turn. There is a knurled locking nut to the back of the screw that is 15mm dia and 15mm overall this has an 8mm section of knurling on it the rest of it is smaller diameter. The finished stop/adjuster can be seen in **photo 32**. The next thing was to drill an 8mm hole in the side of the base this is to support the vee block in the base.

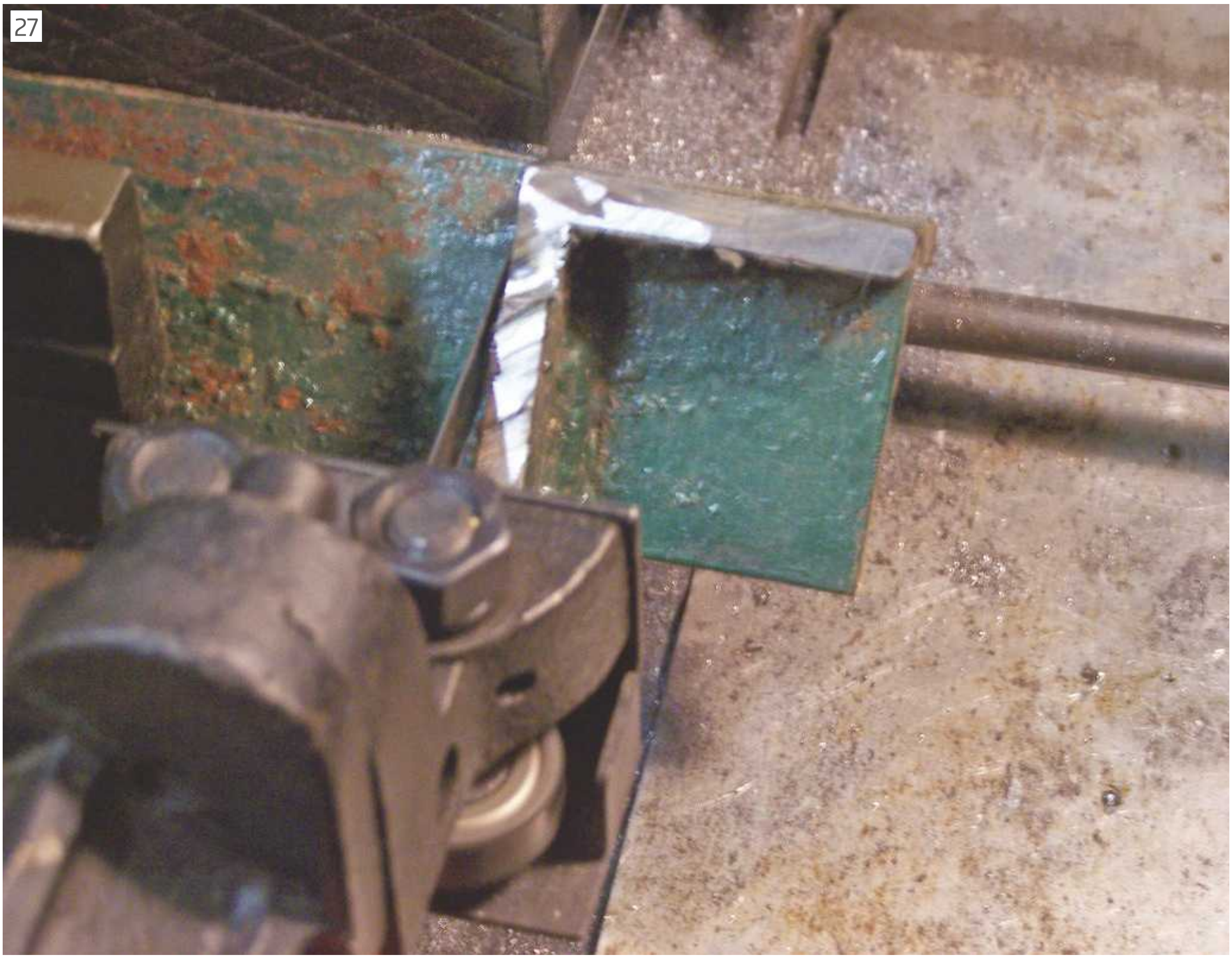
To check to see if it was all going to plan so far, the parts were put together to see if they fitted - all was OK as shown in **photo 33**.

The overlock clamp required a large foot to hold the different sizes of drill, this was made from15mm steel 18mm long which has an M6 thread fitted and this is fixed to the over locking clamp with a piece of 6mm threaded rod 90mm long shown in **photo 31**.

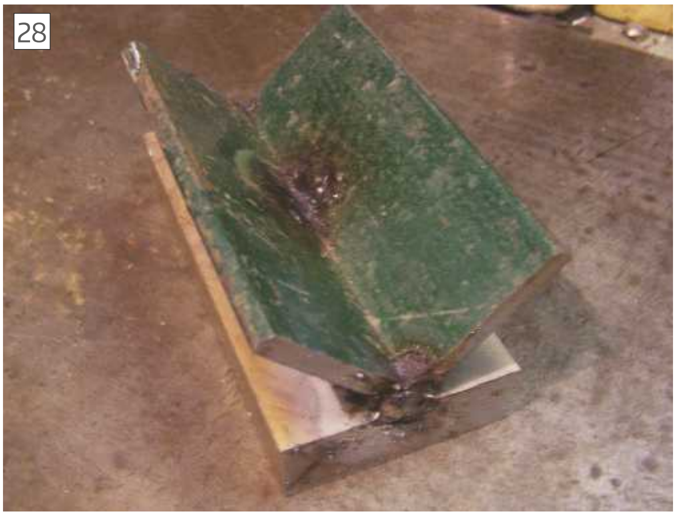
The support

Photograph 35 shows the construction of the support.The support was made of a block 60 x 20 x 75 long and two pieces of 50 x 5 x 65 all steel and held together by M6 socket head counter sunk screws. One of the uprights is tapped M8 and the other is drilled 8mm this for the clamp, as **photo**





Cutting the angle


Front view of welding


Rear view

36 shows.

The support clamping bolt is a piece of 8mm rod with a large head screwed on to it, made of 20mm dia steel 50mm long and tapered at the end to fit the locking handle. The other side of the support is tapped so that the clamp will tighten, **photo 34**. The locking handle is made of 5/16" rod turned down on both ends to 6mm this is then threaded one end to fit the large head screw and the other a 25mm diameter plastic ball is fitted.

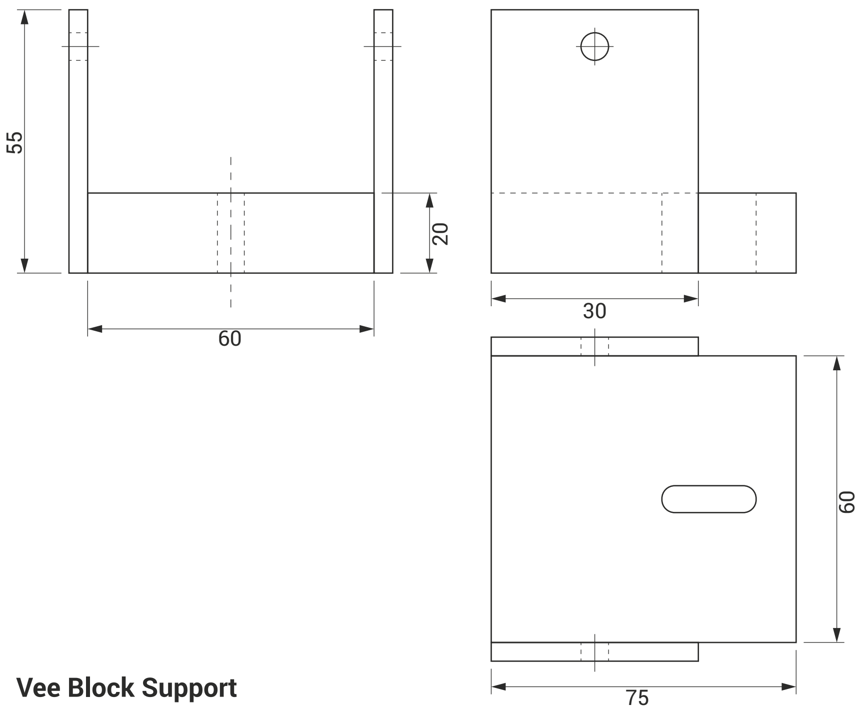
The reason for the clamping bolt to be made with an angled handle is so that it will clear the overlock fixing plate. As all the fixings and clamp need to be on this side to give clear access to the drill when grinding as this is done on the left side of the jig.

After all the parts were made it was time to fit them all together before finishing, **photo 37** shows the assembled parts before moving to the grinder.

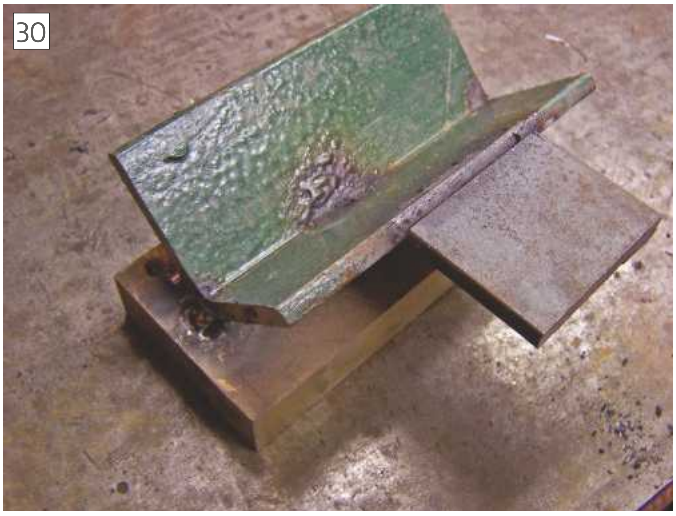
Photographs 38 and **39** show testing the jig on the grinder, as you can see the grinding is also done on the face of the wheel.

After the test was done, I decided that the front face was in the way when grinding so this was machined as **photo 40** shows. The results of the machining are a much cleaner front face with no interference with

Fig.8



Vee Block Support


The overlock plate mount


The overlock with large foot


32

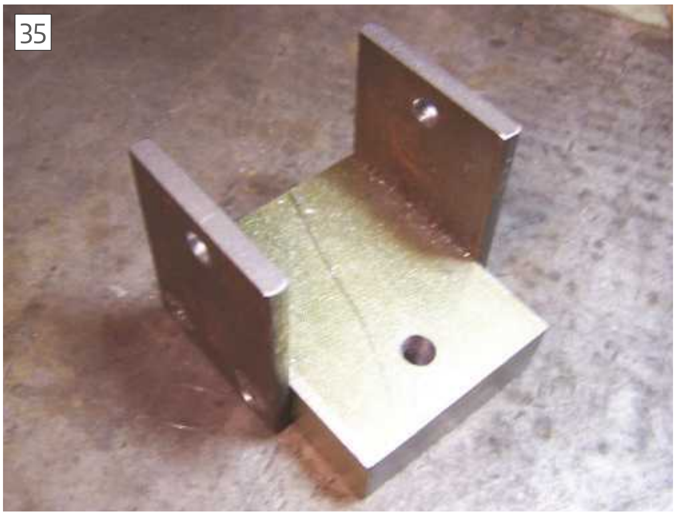
Stop arm


33

Stop arm adjuster


34

The clamping bolt


35

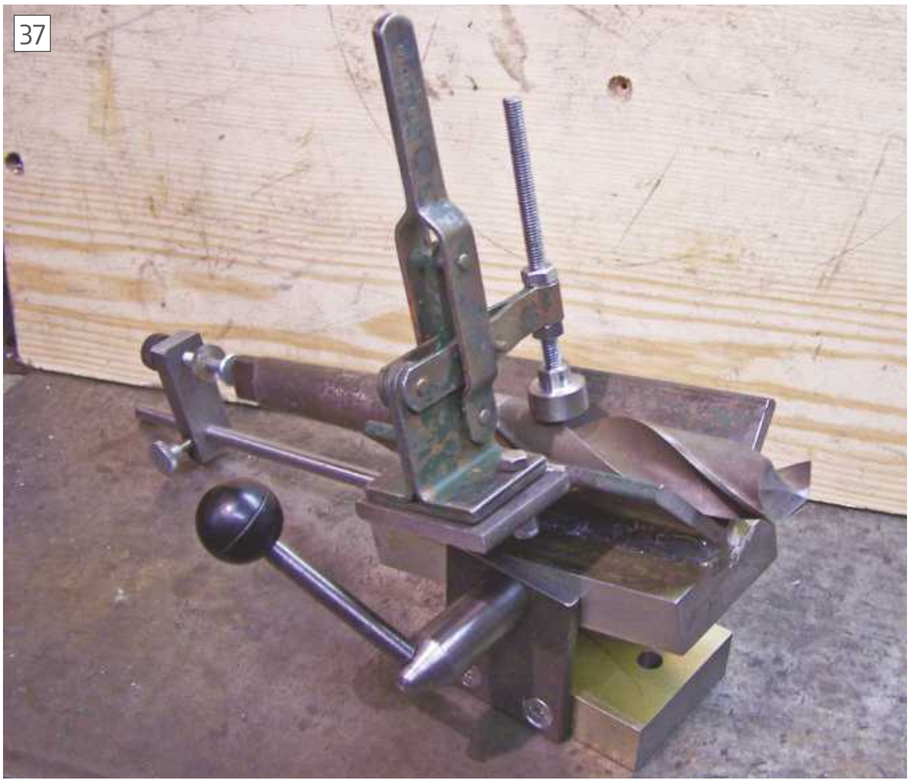
The support base before the slot was cut


36

Fixing screws in base

the grinder itself, **photo 41** shows it back in the jig. At the same time the 8mm hole in the base was made into a 25mm long slot, after the photo was taken, this is to aid positioning when setting up.

After the test run positioning the second edge of the drill accurately for grinding it was difficult to get it level. The solution was a setting arm to get the edge straight. After some experimenting with all sorts of options the one shown in the photographs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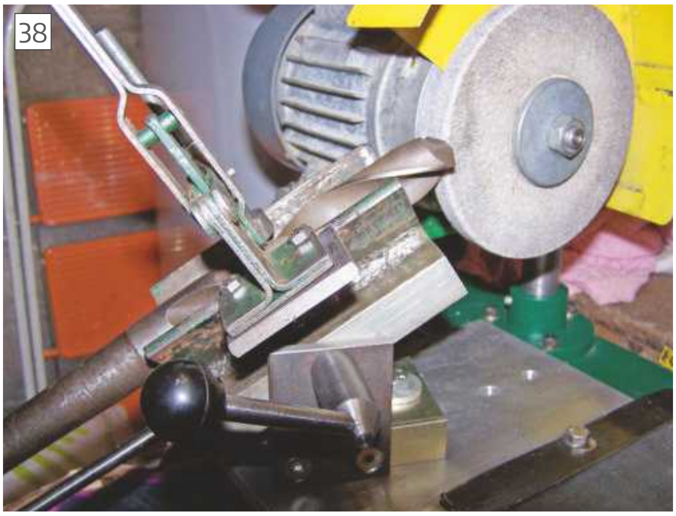
The assembled parts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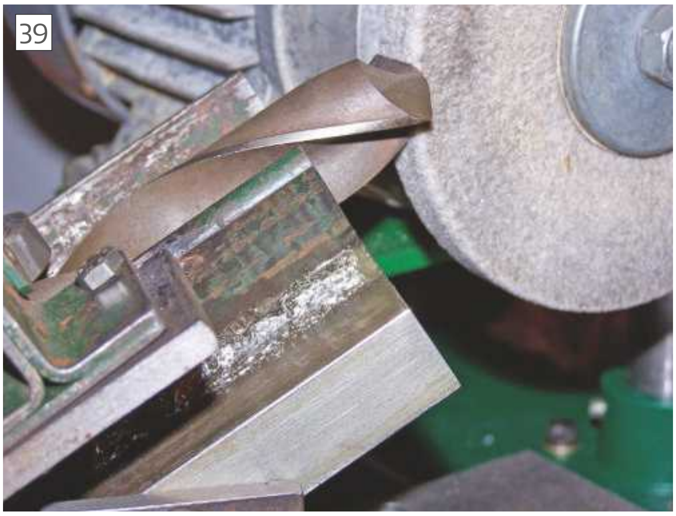
Shows testing the set-up for grinding


39

Close up of drill and wheel


40

Machining the front face of the jig


41

The rest back in position on the jig


42

The setting arm hinge post


43

The setting arm under consecution

was the one I used. The hinge post is 20 x 20 x 10mm and has a M6 tapped hole in the face, it's welded to the side of the angle at the top of the vee about 10mm from the front edge, **photo 42**.

The arm is made from some 15mm x 3mm stock and has a 6mm-slot cut in it this is to allow for some adjustment. The arm is held in position by a M6 socket head screw and a washer the front of the arm is bent around to 105degs and must be level with the base of the jig, **photo 43**.

The nearly finished arm is also shown in **photo 44** and the next **photo 45** shows the arm setting the drill lip level.

The next job is to paint the bare steel and chemically black the other parts that are not plated, this was done and is shown in **photo 46**.

The material used was all from workshop stock and as such is a little on the large side. The idea of cutting it down to a smaller size, I did not consider as the more mass there is then there is not so much vibration. Also, what was I going to do with the waste?

To use the large drill grinder jig

With the grinder switched OFF mount the large drill jig onto the grinders table and bolt it at about 59 to 60 degrees to

›

Nearly finished setting arm

The setting arm and drill

The painted and blackened jig showing new 8mm slot

Drill set up and clamped in the jig

the grinding wheel face. This will give approximately the standard Point angle of 118 degrees to the drill.

In the unlikely event that you are going to drill thin sheet material with very large drills reduce this angle to 70 deg this is 140 deg in total.

The place the drill to be sharpened onto the vee and bring the setting arm over and holding the drill and arm together then operate the over lock clamp to hold the drill in position as shown in photo 37.

Having locked the drill in the vee check that the drill is straight with the setting arm photo 45.

Now bring the stop/adjuster to the end of the drill and lock the stop in place as was shown in photo 33.

Next set the drills lip clearance, to achieve this set the wheel height and the angle of the drill holder to angle of 10 to12 deg this is done by eye following the original angle the if this is possible. It is now time to check that the drill is close to the wheel face by moving the carriage in front of the grinding wheel so that the drill is jut touching the wheel. This is done with the add of the 8mm slot in the base. The position of the drill and grinding wheel when ready for grinding is shown in photos 38 and 39.

Now move the carriage away from the grinding wheel by moving to the right and then switch on the grinder. It is now time to see if the setting up is correct by making a pass across the face of the wheel, there should be just a light grind at this point. If the grind is to big then stop and readjust the drill as a big grind will overheat the drill.

With the carriage pulled back again away from the grinding wheel turn the grinder OFF and release the clamp and turn the drill over and line it up with the setting arm again keeping the drill against the stop. Then lock the clamp then restart the grinder and repeat the grind as before. After the two passes check the progress of the grinding if more is required to be removed. Advance the adjusting screw by one turn and then put the drill back in the holder against the stop and clamp the drill in position and repeat the grinding. Repeat this until the drill ground all the way across the lip angle.

After a lot of grinding with a 150 mm or under diameter grinding wheel the drill lip angle on larger drills could become concave. The concavity on the drill means that the lip angle will become weaker. To overcome this concavity on make the drill a four-facet drill this means that instead of two lip angles on the drill there are four.

To do this grind another angle behind the first of between 12 and 15 deg both of equal width to the first, **photo 48** shows a drill ground with four facets.

For more information on drill grinding I can recommend Harold Halls book Tool and cutter Sharpening number 38 in the workshop practice series. ■

A four facet drill

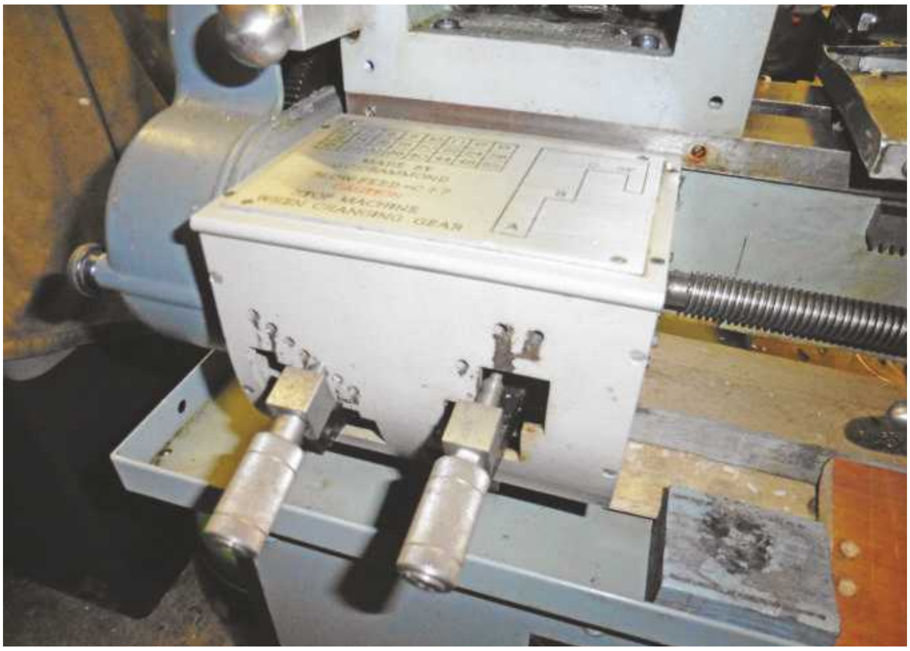
A pair of quick change gearboxes

John Crammond recounts making and fitting a pair of home-made gearboxes

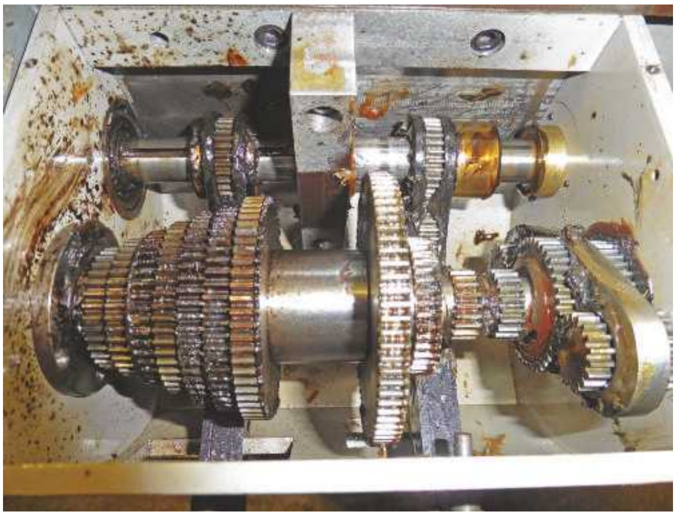
Many years ago, I was struggling through a rather uncertain period and worried that I might have to part with my faithful old Myford Super 7 that I'd bought secondhand in 1970. Presented with the possibility of being lathe-less I decided to make a machine of my own, and over the next few months patterns were made for all the major components and cast in iron at Birchenlee Foundry in Colne Lancs. At that time, this was run by a wonderful gentleman called Mr Slinger who I was horrified to learn some years later had lost his life in a road accident. I'm not sure whether the Foundry is still operating, but I always feel a tinge of saddness that of the thousands that once were the cornerstone of our Industrial Revolution, only a tiny handful still remain.

To cut a long story short the lathe was finished and as the mandrel ran in the time-honoured configuration of large twin opposed Timken rollers at the front and equally robust ball races at the rear, rigidity and hence performance was excellent. Ironically my circumstances improved and the threat of losing my Myford evaporated. My home made lathe continued to perform impressively as a backup machine when I came across an article on Quick change gearboxes, written by Mr Alan Buttolph appearing in the winter 1990/91 MEW. In it he describes the construction of a box predoinantly based on the Sparey plans that may possibly still be available from MAP (I believe plans and castings for a development of the Sparey design, the 'Machin' gearbox, are available from Hemingway). Like Mr Buttolph I too had considered the Sparey box but had discounted it because of its bulky size. However Alan had persevered and redesigned the whole using 28dp gearing in place of the 20dp ones. This effectively shrunk the dimensions to 6" long by 4.5" wide and high, resulting in a very compact box of similar size to Myford's own.

The attraction of such an addition was very persuasive, but being unsure that the box would be a success and also being reluctant to make what seemed like irreversible changes to a perfectly good S7, I decided to make a box for my home-made lathe where holes drilled etc. were of less consequence if the project failed. However, the box was completed without too

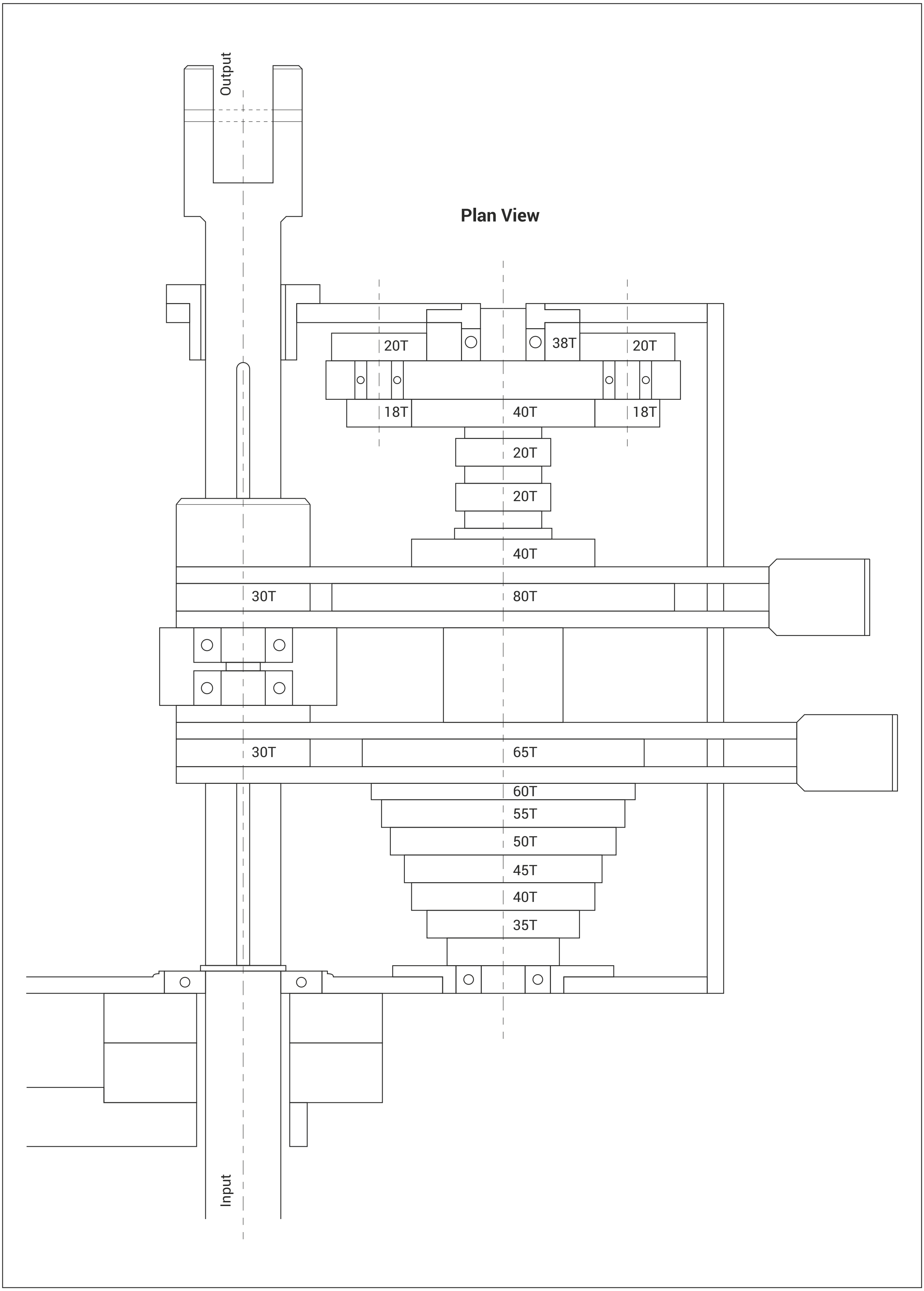


Gearbox fitted to the 'Crammond' lathe



View inside the gearbox

Input end of gearbox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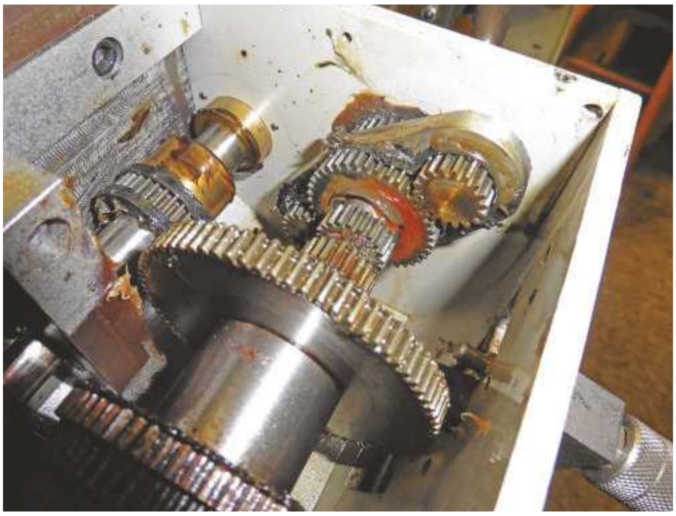


Output end of the gearbox

'Butchered' leadscrew leaving the S7 box

many problems and is shown in one of the accompanying photos. Those eagle-eyed of you may have noticed a familiar cover to the change wheels which is indeed of S7 origin. It fitted perfectly and saved me hours of sheet metal work which is a skill I readily admit that I do not possess. It was included in a list of Myford spares by one of MEW's regular advertisers costing, from memory, £25 complete and finishes off the back of the lathe nicely. The box has been running now for some years and doubts I may have had concerning the durability of 28dp gears have long since faded.

My story moves on to one of those infrequent times when all projects have been finished and the workshop and machines are all clean and tidy. Looking around for something to occupy my time, my eyes fell on the unthreaded portion of the Myford leadscrew, and a decision was made, with the experience of the first QC box behind me, to make a second one. With every good intention of keeping the workshop clean, little did I suspect how quickly the best laid plans would be abandoned in the heat of battle.

Gearbox fitted to Super 7

Mr Buttolph's article was resurrected and a start was made on the fabricated casing, again made out of 5mm steel plate. I had forgotten over the years the monotony of cutting 23 gears with a total of 844 teeth, nor had I fully appreciated the difficulty of shaping and fitting the box's central pillar (which provides the housing for the inner bearings for input and output shafts). This has to be contoured exactly to the lathe bed in the right location and line up with the leadscrew axis. In addition it provides a major anchorage point for the whole box; success was achieved only after hours of fitting plus a cheap adjustable profile gauge and a tin of engineers blue. The procedure is well known, apply blue, test, file, repeat again and again until; satisfactory contact areas are seen.

I'm not going to describe the construction of the boxes as it followed closely the eloquent and comprehensive narrative in Mr Buttolph's article which is accessible from the archives if you subscribe to the On Line issue. With the knowledge gained in constructing the first box stored away I did make a couple of minor changes firstly to the small ballraces used, that I was able to increase in size. I also provided a dedicated output shaft instead of using the lathes leadscrew for this purpose. This was later joined to the leadscrew using a sheer pin to provide protection for the gears. This enables the gearbox to be installed or removed without the need to dismantle the output train of gears. Where Alan had pressed two gears onto a common axle, I made one of the gears integral with the axle leaving only one gear to be attached. I also provided a positive means of lubricating the clever epicyclic 7/1 reduction via an axial hole through the right hand end of the second motion shaft where oil or grease is needed. As you can see a grease nipple closes off the hole to the ingress of dirt. Lastly I made the right hand bearing for the output shaft in steel with a bronze lining which can be cheaply replaced in the future should any wear occur.

I had not remembered that there were a couple of errors in the original drawings and groaned with frustration as I had to remake the side members of the fabricated gearchange levers. Apart from the difficulties already mentioned, other aspects requiring extra care are the two trains of three gears in each of the two gear change levers which must mesh with minimum backlash yet revolve freely. Similarly the planting of gears in the epicyclic gear reduction arrangement needs care and precision. Of course success or failure of the transfer of power through the gearbox relies to a large extent in the accurate placing of the selection lever locating holes in the front plate. Each hole has to be dealt with individually and is best drilled with the aid of a guide bush screwed into the lever. In fact I used two bushes, one sized for a reaming sized drill, the second being sized for the reamer itself.

Alan had forewarned of "mutinous" feelings when it came to butchering the

Information plate engraved on home-made pantograph

leadscrew and I have to confess to such emotions as I removed the end nine inches. The difficulties he experienced with machining the shortened end did not materialise as it disappeared down the cavernous mandrel of my Colchester. With a cleanup of both inside and outside of the casing, followed up with a few coats of grey paint plus of course a meticulous cleaning of all gears and moving parts, a final assembly with oil and grease was uneventful and the box ran smoothly and quietly.

No alteration was needed to the change wheel cover, however as it was now 5mm further back, it was possible that swarf travelling through the lathe mandrel could fall inside the cover with disastrous results. A short piece of aluminium tubing machined to a wringing fit on the end of the mandrel ensured the any turnings would now exit safely outside the cover again.

Information plates were engraved on my home-made pantograph engraver and finish off both boxes nicely. To any one with a boxless lathe and with mangled fingers through reaching behind banjos to change wheels, and who does not possess the several hundred pounds needed if you can locate a Myford box, think of the benefits and convenience of instant threads and feeds. One of my original doubts about adding a box to a Myford was a belief that a changewheel lathe was more versatile than one with a box. WRONG. John Peters in his article in MEW issue 65 explains that the reverse is in fact the case.

If you have the time to spare and the facilities to cut gears I would urge you to read Alan Buttolph's original article and have a go. The financial outlay is small, and as the old saying goes, nothing ventured nothing gained. ■

Readers' Tips

CHESTER MACHINE TOOLS

Easy Setting

TIP OF THE MONTH WINNER!

George Barczi wins this month's Chester Vouchers with advice for four-jaw chuck setting

A lot of Hobbyists; along with some professionals of old, have during their 4 jaw set ups over the ages, resorted to using white paper or similar to eyeball a 4-jaw setting prior to truing up with a DTI. It is surprising how accurate the eyeball method can be, it is said that the normal eye sight can be accurate to within five thou' - 0.005'' so before the common use of DTIs turners and machinists, including myself, placed a white background under the 4 jaw chuck, and using a surface gauge quite regularly achieved near accurate set up without resorting to DTIs, especially if the article didn't need to be absolutely within tolerance.

I still use my small surface gauge on occasion to set up in a 4 jaw, mainly when machining cast cylinders on kit parts which are not completely round, as we all know, and has proven to be effective method prior to machining the bore to size. I know a lot of people use a faceplate to set up but sometimes a faceplate can be over kill (as in my faceplate size) for a small cylinder so I use the 4 jaw.

What I have done is to fix up a permanent white 'backsplash' behind my chuck & also attached similar to the saddle so I can eyeball from the top & front as needed. All I have used is a piece of white plastic table top cover remnant from a previous use, bought cheaply from a local homeware store, it also helps to reflect light from the lathe lamp & fluorescent ceiling light which, for many of we elderly is an extra bonus, plus added protection when machining cast iron which we all know is a pain in the proverbial, another advantage, being plastic coated, can be used to scribble with dry wipe marker any odd note or figures for handy reference.

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 400 words and a picture or drawing. **Don't forget to include your address!** Every month I'll chose a selection for publication and the one chosen as 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. Other prizes are at the discretion of the Editor.

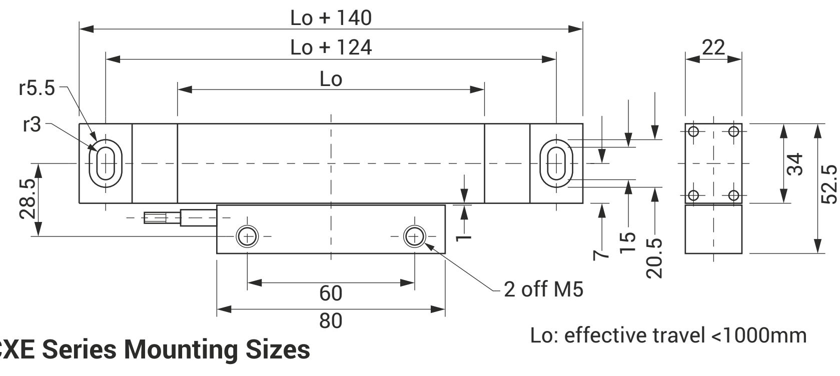
Fitting a Digital Readout to a Warco WM-16 Mill

The Warco WM-16 has been around for a good while now, and remains a popular choice of benchtop mill. David Addison found that adding a DRO brings many benefits.

I have made R/C model aircraft for many years and have always had a desire to learn model engineering. So, about 16 years ago I bought a second hand Myford ML7, but I never had the money to get all the tooling required (getting a lathe is only the start and it is easy to spend the same again and more buying all the tooling bits required). It also turned out that the lathe bed was quite worn and really needed a regrind, so it only got used occasionally. After retiring I decided that I would like to have a 'proper go' at model engineering, and, rather than going down the route of having the bed reground on the ML7, I bought a Warco 250VF lathe and a WM-16 mill at the Alexandra Palace show in 2013, then sold the Myford.

I then spent the next few months learning the skills required to use the lathe and mill, by reading Harold Halls books (Lathe work and Milling complete courses, which I highly recommend), making small items from the books (I have not made them all yet!). However, I found it more difficult to use the mill than the lathe, using the hand wheel markings, and having to allow for leadscrew backlash, so I decided to look into fitting the mill with some form of DRO.

Fig.1



JCXE Series Mounting Sizes

Initially, it seemed that the cheaper scales with remote readout connected via a usb connector, as sold by the usual well-known retailers, would suit my needs. However, after a little more research, it seemed that I would be paying about £200 or so for a system that could easily be damaged by oil and swarf. Also, forums views indicated that these systems are not as reliable or as accurate as one would hope. So that left the likes of the 'proper' DRO systems, which use glass or magnetic scales. The cost of these systems is considerably more, but then I thought that I might as well pay twice the price and get something that should last and be accurate. My choice in the end was a system called SINPO (not Sino), and was available from a Singapore supplier, who uses an agent in the UK. It came with a 1 year warranty, with return to Nottingham (this seemed better, should I encounter any problems, than having to pay postage to Singapore).

Having chosen a supplier, I then had to decide what length of scales I would need. To do this I measured the maximum travel of each of the Mill's axes and these were as follows:

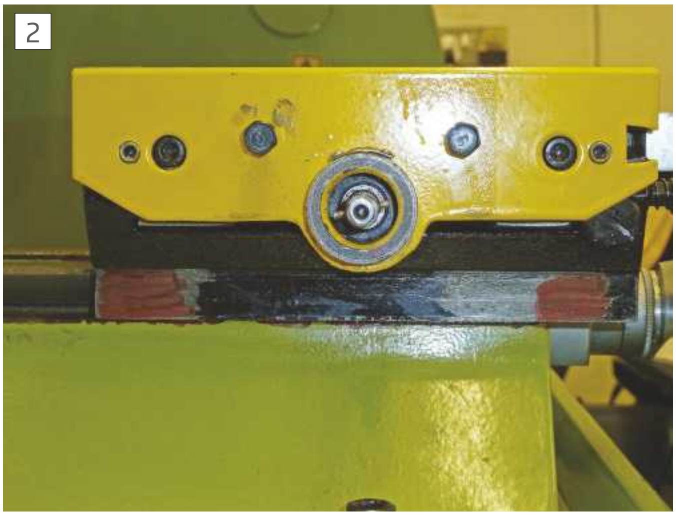
X-axis - 493mm
Y-axis - 155mm
Z-axis (head, not quill) - 280mm

Other considerations were:

Mounting length available for mounting, without the scales overhanging and getting in the way (the total length of glass scales

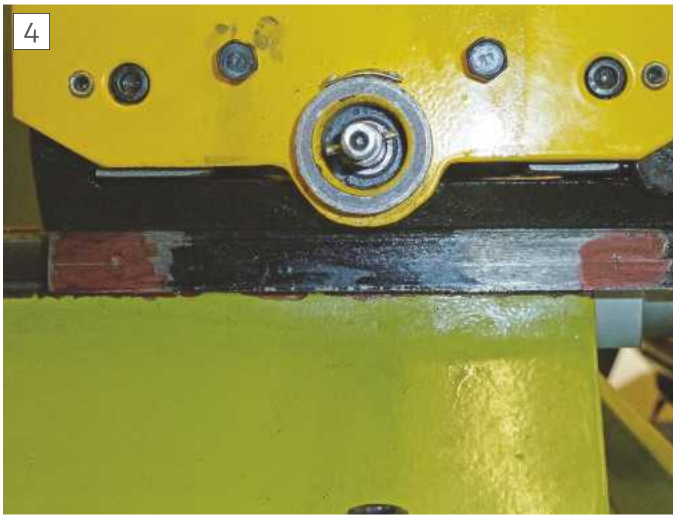
1

Choosing a mounting point for the y-axis

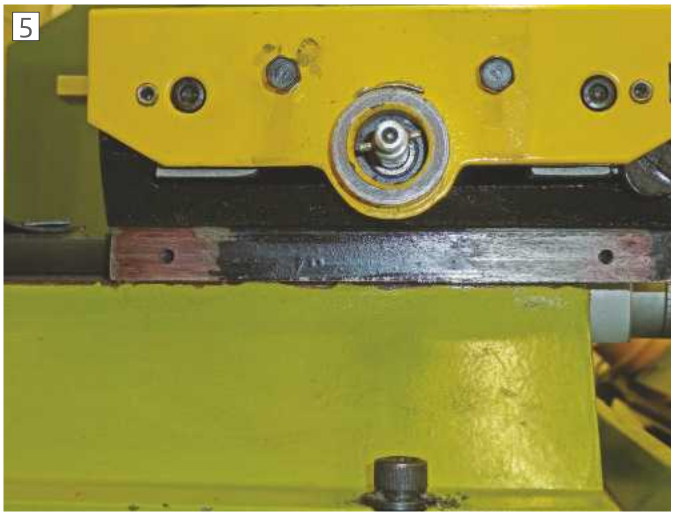


The end of the table

Drilling mounting plate



Hole positions transferred to cross slide (just visible on the dark surface)



Holes drilled and tapped

is more than the reading length) – see **fig. 1** for dimensions of scales used on this installation.

Whether to mount the x-axis scale at the front or rear of the table. If mounted at the front it would be easier to fit but would mean I would have to lose the mechanical travel stops and I have found these to be very useful. Additionally, I had already fitted a homemade power feed to this axis and had modified the mechanical stops to function as both mechanical and electrical stops for this. My preferred option, therefore, was to fit the x-axis scale to the rear of the table. However, this would result in some loss of y-axis movement due to the thickness of the scale chosen. Some scales available are slimmer but more expensive than the product I intended using, these being 22mm wide without the mounting plate or the protective cover. I figured that I didn't need the mounting plate for the y-axis as the scale was being mounted to a machined surface. I also figured that I could dispense with the cover as the scale would be mounted with the seals downwards and I could stick a plastic cover over the scale to provide some more protection. This would still mean a reduction in y-axis movement of 22mm. Looking at the movement of the cross slide it was apparent that the movement was limited when it contacted the cap head screws that secured the concertina protective cover for the head dovetailed column. By replacing these with button head screws I could save about 4mm (more if I replaced them with countersink head screws). With button head screws the total loss of y-axis movement would be 18mm, which I decided would be acceptable, considering that I would be retaining the mechanical and power feed stops.

My final scale size choices were:
X-axis - 150mm scale
Y-axis - 500mm scale
Z-axis - 300mm scale

Fitting the scales

Y-axis

It is important to mount the scales with the seals downwards (x and y axes) or pointing away from the machine, in the case of the z-axis). Towards the end of this article, photo 22 shows that this has been achieved and it should mean long term reliability due to minimum likelihood of dirt or fluid ingress.

Firstly, after removing the power feed unit (in my case) or the left-hand wheel if no power feed is fitted, I moved the table over to the extreme right-hand side, to access the best way to mount the y-axis scale. The scale is best mounted on the left-hand side, as the table locks are located on the right hand side, which would make it impracticable to fit the scale to. The WM-16 has a base with sloping sides so I determined that it would be best to fit the scale to the side of the cross slide and mount the reading head to the flat section of the base. This made for a neat and straightforward installation. With the scale mounted to its mounting plate and with the use of spacers, **photo 1**, it protrudes far enough out to clear the angled part of the base and allows for the reader head to be mounted to an angle bracket located on the flat section of the base. There is also just enough depth on the cross slide for this to be done and allow the protective cover to be fitted (the side of the cover had to be angle outwards a few degrees to clear the reader head mounting bracket, as can be seen later in photo 21).

The first operation was to fix the scale mounting plate (these were provided by the supplier for each of the scales and are 9mm thick aluminium with pre drilled and tapped

6

Mounting plate in position

7

Scale in position

8

Table centralised for stability on removal

holes for mounting the scale to), to the side of the cross slide. The ends of the cross slide were cleaned of black paint, photo 1, and marked with a permanent marker **photo 2**, to aid laying out the best positions for the tapped holes. Having decided the best position for the holes, the mounting plate was drilled for these positions, **photo 3**. The hole size chosen allowed for some small adjustments in the position of the plate so that it could be set using a DTI, to ensure it ran at a constant height throughout the travel. The holes were then counterbored to ensure the screw heads would be below the surface of the plate. The mounting plate was then positioned against the cross slide and transfer punches used to mark the positions of the holes on the cross slide, **photo 4**. The drilled and tapped holes can be seen in **photo 5**. A selection of M5 cap head screws are supplied with the kit for this purpose.

Following this the mounting plate was screwed to the cross slide, **photo 6**, and a DTI was used to ensure the plate was at a constant height over its full travel.

Next the scale was screwed to the plate and the DTI used again to verify all was good. As can be seen in **photo 7**, there is plenty of adjustment available to ensure the scale runs true over its full range of movement.

The next job was to figure the best way to mount the reader head to the base of the mill. A selection of aluminium brackets were provided by the supplier for this purpose and a suitable size one was selected for this. It was necessary to modify the bracket to provide a neat installation. This had to be done using a bandsaw and hand tools, rather than using the mill and creating bits of swarf and having to clean up before continuing with the installation.

Photograph 7 shows the modified bracket attached to the reader head in preparation for marking the fixing points in the base. Note that the reader head has red plastic inserts which keep the head at the correct distance from the scale and these should be left in place while fitting, to ensure the correct gap is maintained.

9

Table after removal

10

Positioning mounting blocks

The screws securing these plastic inserts to the scale can be removed to allow the head to be moved along the scale for checking that it runs true to the scale throughout its movement, just leave the screws securing the plastic insets to the head itself until after everything is fixed satisfactorily.

I then adjusted the protective cover to clear the reader head bracket and checked that it fitted ok, before removing the scale and mounting plate, in preparation for fitting the y-axis scale.

X-axis

Having previously decided to fit the x-axis scale to the rear of the table it was necessary to start by removing the table from the mill. After a little thought, I determined that the easiest route was to remove the table and cross slide as a unit, as I needed to mount the reader to the rear of the cross slide. This was reasonably straightforward to do. Before I started I centralised the table to make a balanced unit for lifting, **photo 8**. Firstly, I removed the cross slide locking screws completely, as these can easily be bent when removing the cross slide and table. Next, I wound the table out and removed the screws that secure the plate that fixes the rubber protective cover to the back of the cross slide. This allowed me to gain access to the Allen headed grub screws that secure the leadscrew cross nut to the cross slide (these are accessible from the rear of the cross slide). I then removed the rear gib securing screw, followed by the front gib adjusting screw which will free the gib strip.

11

Reader positioned slightly off centre

12

Checking for free operation

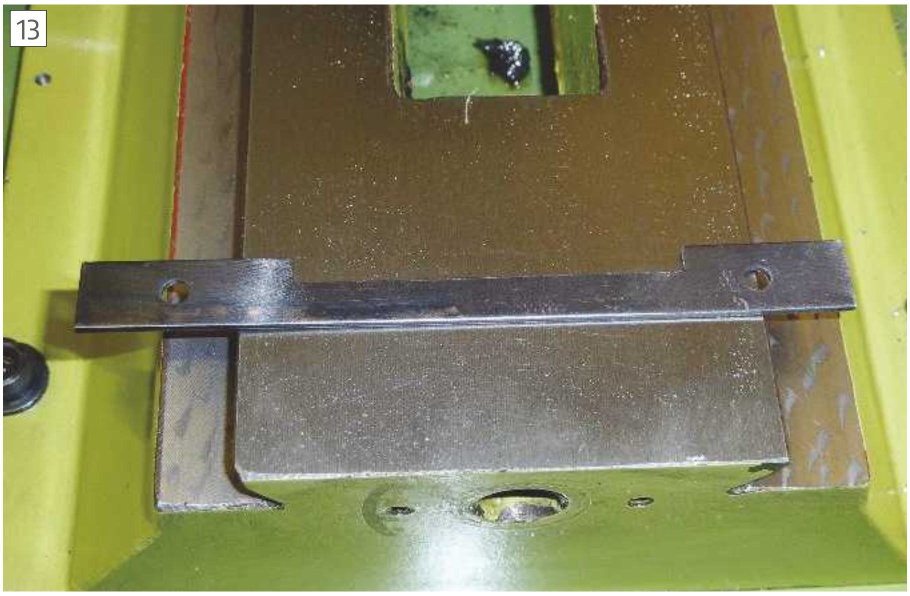
Next, I removed the hand wheel and the screws securing the front bearing housing. This allowed the leadscrew and cross nut to drop down sufficiently to allow the table and cross slide assembly to be slid forward and off the base (be aware that this assembly is very heavy). The removed assembly is shown in **photo 9** (rear view), and it can be seen that I have put marking out red on in preparation for marking the fixing holes for the scale.

The 500mm scale allowed me to fit it without removing the coolant drain plug (not that I use coolant, but I might want to in the future).

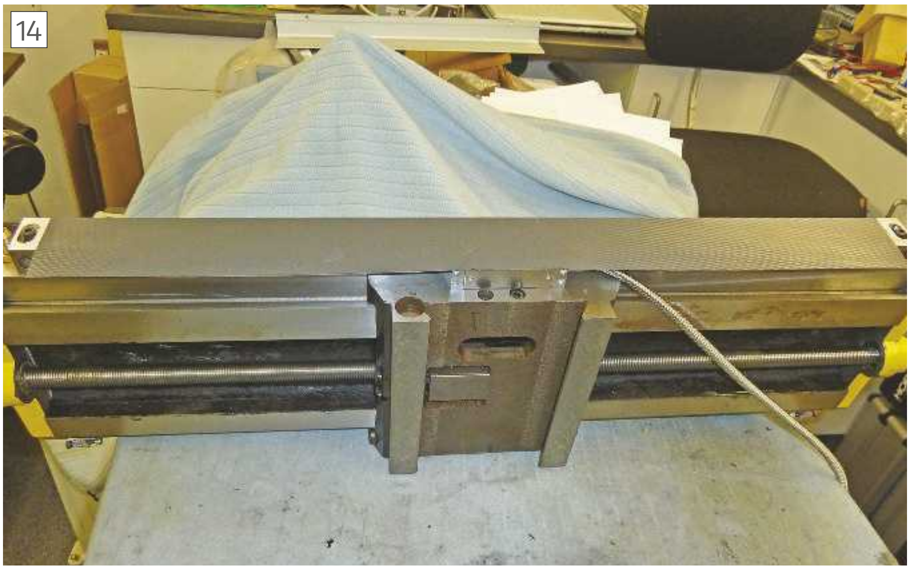
The rear of the table is a machined surface, so it is safe to mount the scale directly to it without needing to use a mounting plate. I positioned the scale so that the mounting blocks at each end were level with the top surface of the table, by using parallels, **photo 10**. These blocks are slightly higher that the main part of the scale, so the scale sits slightly below the table over most of the table length. As mentioned before, there is plenty of adjustment with the fixing slots, so the vertical position of the fixing holes is not that critical, but ensure the horizontal positioning is accurate.

The next operation was to fix the reader head to the rear of the cross slide. Because the scale is positioned slightly to one side to clear the drain plug, the reader needs to be mounted slightly off centre to ensure the full reading width of 500mm is available, **photo 11**. Note also, that the reader head only just clears the holes for the grub screws that secure the leadscrew cross nut, so, whatever scales are chosen, ensure the total depth including the reading head will allow access to these holes.

Having completed the scale and reader head fitting, I inverted the table and checked its operation over the full length


13

Modifying the clamp for the rubber shield


14

DC flap added to help keep coolant out


15

Choosing a location for the z-axis


16

Location allows rotation of the head


17

Reading head on angle bracket

18

Button head screws maximise travel

19

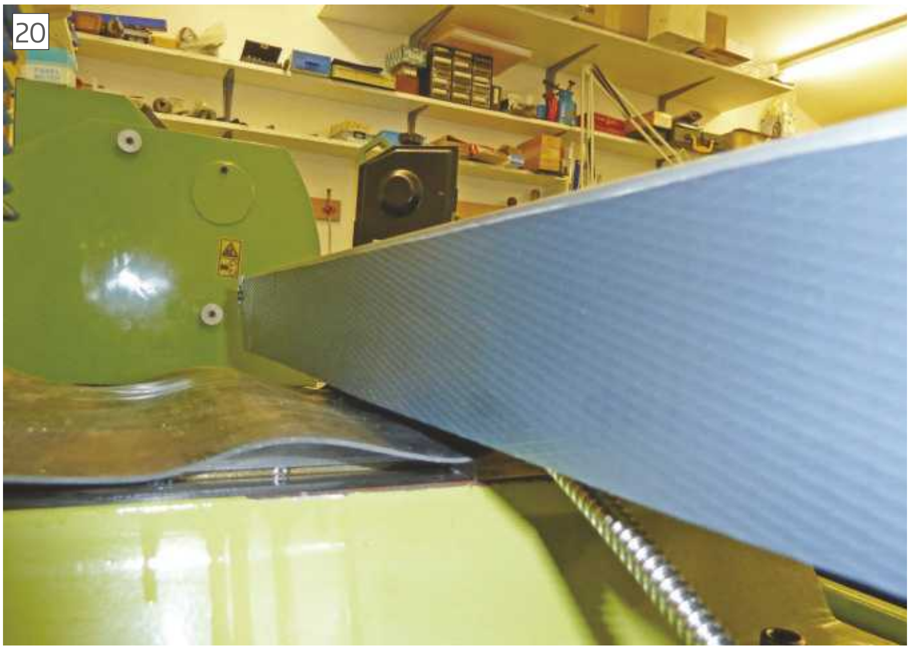
X-axis beneath cover...

of the travel, before removing the red plastic inserts, **photo 12**.

The next thing to do was to modify the plate that secures the rubber protection sheet that covers the cross slide bed. As can been seen in **photo 13**, this needs cutting out to clear the reader head. There remains sufficient material after cutting out to adequately clamp the rubber to the rear of the cross slide.

I then cut a piece of plastic damp proof course and attached it to the rear of the scale using thin double-sided tape, to reduce the chances of swarf and oil coming into contact with the scale, **photo 14**. However, I subsequently had to temporarily remove this to gain access to the grub screws to secure the leadscrew cross nut, so I would advise waiting until reassembly is completed before doing this part.

The table and cross slide assembly was then reinstalled on the mill and the gib adjusted correctly to provide smooth, but firm, movement of the y-axis.



20

...and with cover in place

21

All scales fitted

Z-axis

The WM-16 has a basic DRO fitted to the quill as standard, but as most milling should be done with the quill fully retracted and locked, for rigidity, it is well worth fitting a scale to the head (true z-axis).

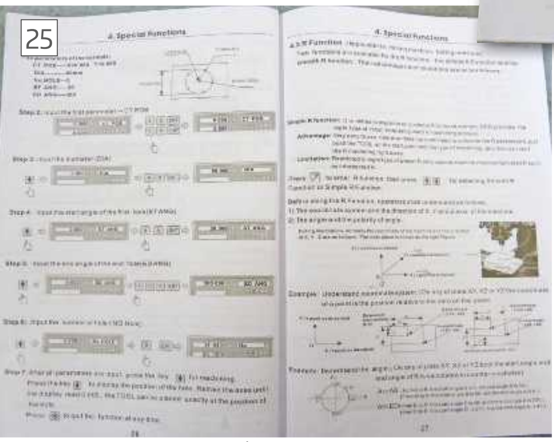
I wanted to have the scale seals facing away from the table to minimise the chances of contamination and the simplest and neatest way of achieving this was to mount the scale on the head and the reader on the fixed column, **photo 15**. Note that the control box was rotated as shown, and measurements showed that I would just be able to get my power hand drill in to drill the required holes in the head. Mounting the scale in this way (as shown in photo 16) also allowed me to keep the facility to rotate the head should I wish to do so, unlikely as it is, as I prefer to use my tilting vice. As **photo 16** also shows, I used the mounting plate for this scale and set the end level with the bottom of the head. The fixing procedure was the same as for the y axis, checking

With the control panel in position

Close up of the control panel

correct alignment with a DTI. As before, this arrangement made for easy installation of the reading head, using a simple angle bracket as shown in **photo 17**.

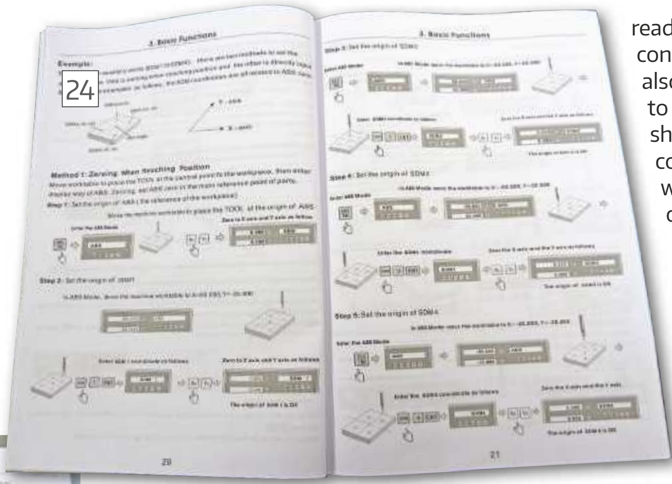
As can be seen in **photo 18**, I replaced the cap head screws securing the concertina protection, with button heads, to reduce the loss of y-axis movement. **Photographs 19** and **20** show the finished x-axis installation with the cover stuck in place. **Photograph 21** shows the completed y-axis installation



More example pages

with the cover fitted. **Photograph 22** shows the finished installation with the control panel fitted and all cables dressed neatly.

Photograph 23 shows the control console in close up. This appears to be a well-made unit. The case is cast aluminium and the led displays are clear and bright. The unit appears to have all the functions that are available with more expensive types such as being able to machine radiuses, PCD holes, etc. The comprehensive manual supplied is reasonably readable although it is written in 'chinglish' in places. **Photographs 24** and **25** show examples of pages in the manual for some basic and advanced



Example pages from the manual

functions.

One thing that I found confusing in the manual was the setting of the direction of reading of the scales (the direction of reading can be changed during the control panels initialisation phase, this also means the scales can be mounted to read either way). When setting as shown in the manual, I found that the coordinates for milling a radius were wrong, so I had to set the direction of reading opposite to the manual. Other than this I have found the manual quite good. There is lots of information on the internet regarding these control units which all seem to have the same or very similar functions.

General Notes

Care needs to be taken when drilling the holes with a hand drill in the machine for fixing the mounting plates to ensure they are square.

The reader heads can be fixed to the brackets using M5 screws into the side holes or M3 screws into the base holes, so

Crankcase and cylinder head for a Nemett Lynx there is flexibility with the mounting of these. It is important to ensure that the reader head is square to the scale, it therefore might be necessary to use shims under one edge to ensure this.

Medium strength thread lock was used on all fixing screws to ensure that machine vibrations do not cause inaccuracies in the future through slight movement of the mountings.


27

Further progress


28

The crankcase was milled out on the WM16

Conclusions

So, was it worth fitting a DRO system, that cost me £370 total, to a mill that I paid £998 for?

Without a doubt, yes. As I mentioned at the beginning, my aim was to build a model IC engine and shortly after completing the fitting of the DRO, I made start on building the Nemett Lynx 15cc petrol engine. I can honestly say that I do not think that I would have been able to do what I have done so far, to the accuracy I have achieved, without the DRO. **Photographs 26,27** and **28** show progress, and **photo 29** is the finished engine. I would also like to say how useful I have found MEW and the archives, as well as the MEW forums, for information and advice on how to do things. It is proving to be a very enjoyable and rewarding experience. I have learnt a great deal since I started this hobby and I still have a great deal more to learn. ■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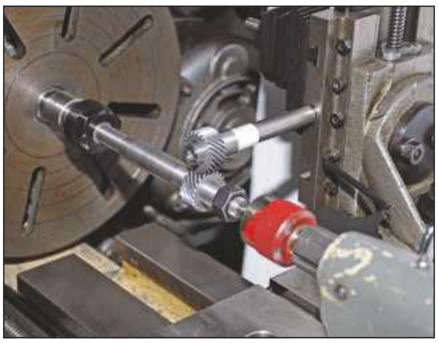
The completed engine

In our Next Issue

Coming up in issue 258
On Sale 11th August 2017

Look out for the September issue, 258, of Model Engineers' Workshop, for some more fascinating workshop stories:



Jeff Thyer adapts his Myford lathe for hobbing helical gears.

Alan Wood joins an 'open house' CNC visit in the USA.

Glenn Bunt replaces the bearings on his Tom Senior milling machine.

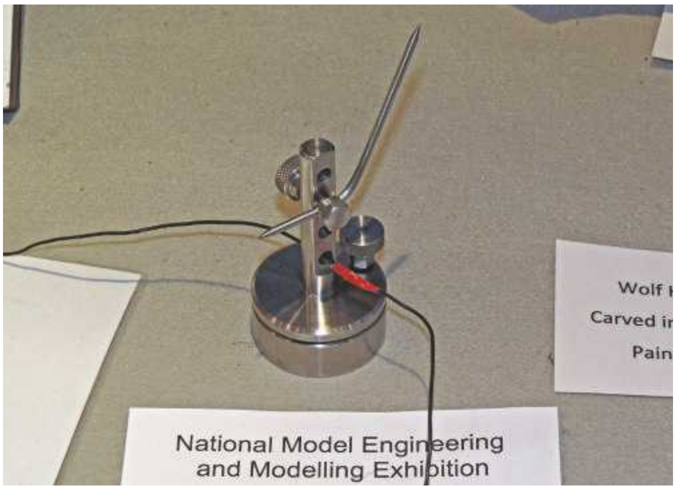
DON'T MISS THIS GREAT ISSUE - SEE PAGE 32 FOR OUR LATEST SUBSCRIPTION OFFER

On the Wire
NEWS from the World of Hobby Engineering

The Doncaster Show

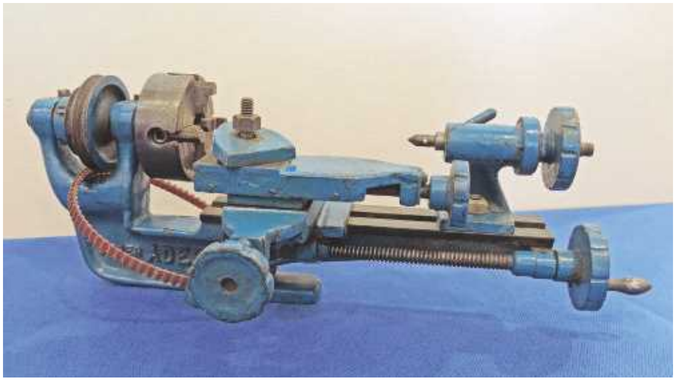
Last month we ran out of space and had to leave our Doncaster photo-report short, here are some more pictures from this year's National Model Engineering and Modelling Exhibition.

A well-finished Stent grinder by J. D. Chilver.

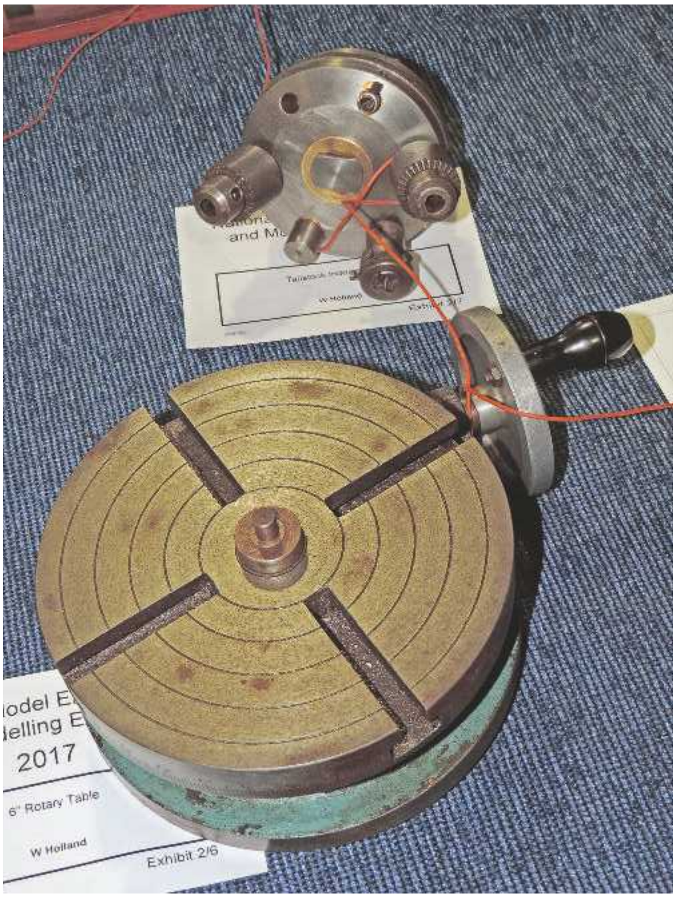


J. Chambers exhibited this beautifully finished height gauge.

A natty little milling machine by M. Dixon.



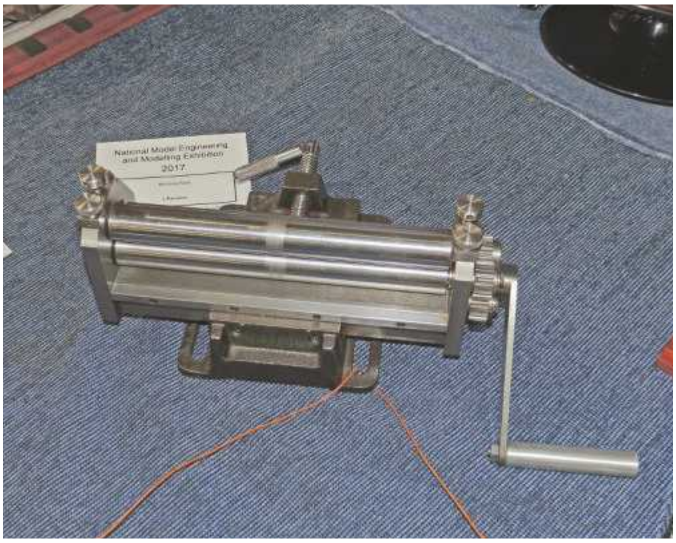
A reader copped a bargain with this Super Adept, in good condition, brought along to the MTM stand.



A sizeable rotary table by W. Holland.

A nice finger plate, unfortunately I didn't get the maker's name.

A Eureka backing off device by Tony Phillips of the SMEE



Bench Rolls by L. Batchelor

Representatives from the trade included Chester (left) and Axminster (right).

Several 3D printers were being demonstrated, these are 'Threedy' machines.

As I was leaving I spotted the owner of this cutter flute grinding machine , which I hadn't spotted inside the building.

Midlands Model Engineering Exhibition

MMEX returns to the Warwickshire Exhibition Centre Thursday 19th to Sunday 22nd October 2017.

This year, the ever-popular Midlands Model Engineering Exhibition will be celebrating its 40th anniversary! It is established as one of the leading model engineering exhibitions and the second longest running show of its kind in the UK.

Over 50 of the leading suppliers to the Model Engineering world will be present - check out the confirmed list of trade attending on the website, as well as around 40 clubs and over a 1000 models will be on display from both societies and individuals.

There are also a wide range of outside attractions to see, like the well regarded 5" gauge outdoor track, operated by the Coventry Society of Model Engineers and the Polly Owners Group, who will return with the magnificent Fosse Way Steamers.

2017 will also see the Midlands Meccano Group celebrate their 50th anniversary with a special display. Don't forget there is also a full lecture programme which is presented by leading specialists, together with various workshop demonstrations.

Why not be part of the show and enter your work? Entry is free and there are 32 classes of which 16 are competition and 16 are display. These classes include: Locomotives, Rolling Stock, Stationary and Internal Combustion Engines. Models still under construction can also be entered in the display classes. A commemorative plaque and exhibitor's certificate will be presented to every entrant, with trophies and cash prizes awarded to winners - please call the organisers for an entry form on 01926 614101 or download it from the website.

Tickets at discounted prices and all the latest exhibition information is available online at **www.midlandsmodelengineering.co.uk.**

A New Guide for the Safe Operation of Passenger Carrying Miniature Railways

The Health & Safety Executive has withdrawn support for HSG216 which was published in 2002. As a result, a new group, Passenger Carrying Miniature Railway Safety Group (PCMRSG), has been established with the objective of drafting a new guide for the safe operation of passenger carrying miniature railways.

This group presently includes 10¼" Gauge Railway Society, 7¼" Gauge Society, Midland Federation of Model Engineers, Southern Federation of Model Engineering Societies, Northern Association of Model Engineers, Britain's Great Little Railways and manufacturers/suppliers of passenger carrying miniature railway equipment. For further information please contact one of the above organisations.

We would love to hear your comments, questions and feedback about MEW

Write to The Editor, Neil Wyatt, Model Engineers' Workshop, MyTimeMedia Ltd., Suite 25, Eden House, Enterprise Way, Edenbridge, Kent TN8 6HF. Alternatively, email: neil.wyatt@mytimemedia.com

Scribe a line

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Drop us a line and share your advice, questions and opinions with other readers.

More on BA Threads

Dear Neil, I read the historic article on Lehman Archer and BA taps in issue No. 256 with interest. The BA system of threads has an interesting background. It was adopted from a Swiss standard known as Thury threads which were established in 1877. It is sometimes described as the first "scientific" thread system because all thread dimensions can be determined mathematically from the thread number and is centred around a number 0 thread of 6mm OD and 1mm pitch. If the thread number is N, then:

Pitch p = 0.9N
OD = 6p1.2 = 6 x 0.91.2N
Nut A/F = 1.75D

The Thury system had numbers from 25, the smallest at 0.254 mm OD and 0.17mm pitch, to -20, the largest at 75.2mm OD and 8.23mm pitch. The flank angle of the thread was close to 47½ degrees but not exactly so. It also had many advanced features, see the website https://sizes.com/tools/thread_thury.htm for more details.

Our British Association proposed the standard in 1884 for thread sizes of 6mm and smaller, ie numbers 0 to 25 with some simplifications such as defining the thread flank angle as exactly 47½ degrees and it was formally adopted as a British Standard in 1904. As we all know it has the useful feature of the clearance drill for any BA thread being the same size as the tapping drill for 2 sizes larger.

Chris Robinson, by email

PS. The above formulae could be set in Excel format as follows if it is easier :
Pitch p = 0.9^N
OD = 6p^1.2 = 6 x 0.9^(1.2N)
Nut A/F = 1.75D

Heath Robinson is Alive and Well

My brother is mastering the art of woodturning on an ex-school Union Graduate lathe whilst I am similarly employed on an ex-school Harrison L5 lathe and a Harrison horizontal milling machine. He asked me to tidy up his long tool rest as it had a distinct curl on the ends (possibly the result of the iron de-stressing?) and had several severe "dings" on its edge (probably the results of youthful misuse). Well, fools rush in...

The photos show the lash-up I concocted from my limited resources. The shape of the rest made holding it very awkward as there was nothing square about it. I first planted a V-block on the deck clamped the 1" diameter toolrest post to it. The top edge was almost level but had a dip in the middle. I then used two angle blocks to prevent any horizontal rotation and added support bars to them to hold the tips up against the downward pressure of the cutter. I couldn't see a way to stop the wings from lifting without obstructing the cutter's path so went very gently with the cutter - 0.25mm per cut. The raised edges of each "ding" caused a moment's excitement but, once I was below them, things settled down and the edge was machined until it was both level and straight.

Your experienced readers will either be rolling with laughter at my set-up or crying in despair. Either way, it worked. I learned a lot about restricting degrees of freedom to move in this exercise. Next, he wants a faceplate for the bowl turning side of his lathe so I'll be learning how to cut left-handed internal 6tpi threads over the coming week or so! Wish me luck.

Geoff Garrett, by email

Tooling System

Dear Neil, I attach a photo of my take of Richard Smith's article on tip tooling. The article appeared co-incidentally with my own efforts to put some tips into use rather than sit in a box on the shelf where they had been for all of ten years. The only thing I added was the centre height adjusting screw which worked a charm on the test! I showed it to a few of the city fathers this weekend, we had a club running day, and I think a couple more tools will be made in the near future.

Peter Wilton, by email

Silver Soldering

Dear Neil, with reference to the excellent series on silver soldering by David Banham, and with particular reference to the section on Temporary Clamps and Supports, may I recommend extreme caution when using anything with a spring in it to hold together items for soldering. It's all too easy to overheat the spring whereupon it looses its temper and everything falls apart. No prizes are offered for guessing how I know!!

As a subscriber since the first issue may I say what an excellent magazine MEW is.

David Hall, Warwick

Brazing Torches

Hello Neil, Just received issue 251 MEW, and thank you for publishing my email regarding 'lost arts', and the problem of aging artisans. I do hope it can get readers talking about how we can help those whose time in the workshop might be coming to an end.

And of course, while reading I noticed the letter from your namesake Neil MacNaughton, about brazing torches. He mentions the difficulty in reaching suitable temperatures with propane gas but no forced air or extra oxygen. Indeed, I had believed that to reach temperatures over 800C would need either forced air, or oxygen. That was until I started to assist my neighbour Hardy to move into residential care. He was most anxious to ensure that his gas torches and many part completed torches should be taken into the hands of folk who would understand and use them – especially to complete the embryos, and use his material stocks to fabricate new torches.

Hardy uses these torches in his gas forges, he has achieved 1400 degrees Celsius with his gas burners without the use of forced air, or oxygen. That is close to the melting point of steel, and is what he needed for forge welding. I had held back in quoting that temperature until I had confirmation because it sounded somewhat unbelievable, but now I am certain it is correct.

I managed to take a phone snapshot of some of these torches during a visit, and it can be seen first, these are quite large, and second they draw air from the surrounds. They use CIGWeld tips to inject the gas, run about 30psi gas pressure, and the largest will throw a flame two metres. These are seriously fierce burners.

So, I am not doubting Neil Macnaughton, or suggesting he has it wrong. After all, I thought just as he until I was shown different. But it does seem that burner design can vastly improve temperatures achievable, just don't ask me how!

I don't know how he does it, but as I mentioned in earlier emails, this man has quite a talent with metal working. I saw a crow bar he made by forging ball bearings into a 6 foot long roundish bar he made in his coke forge. The thing weighs about 10 kg, so used a lot of balls! Wasn't pretty, but it was the real deal for pounding the earth!

But I had to send you a few photos I took. I hope they show the workmanship which my now ex-neighbour puts into his equipment.

The gas forge, I now have stored in my shed, and I wonder when it will next be used. And if you recall from an earlier email, I commented about the burners my friend made. The photo of the burners with a house brick for size reference gives an idea of the sort of heat which these things can produce. Hardy has confirmed that the black forge will turn steel white hot and melt it, but I may not be able to get your reader's proof since he has now moved completely into residential care.

I have helped move much of the equipment out to various locations including my shed. The power hammer is another of Hardy's constructions, and it is just a little heavy. It sat opposite the coke forge in the 'smithys room', and there was also his machine shop, and a 'dirty' shed where most grinding took place. All in all, I made nine trips to help clear equipment, and there are still items uncollected, which I suspect will now become the property of the new owners. I also collected about 800kg of charcoal, and there is still about seven cubic metres of coke to be collected.

Much equipment has gone to a local 'old machinery' site, which has a blacksmith's shop, so hopefully it will continue to be used. The site is the Lake Goldsmith Steam Preservation Association, near Skipton Victoria. Website http://www.lakegoldsmithsteamrally.org.au/ Their next rally is actually this weekend, and I'm sure you would enjoy a visit there. Not sure if I can make it though, as I have a concert on Sunday in the opposite direction.

And finally, that Stephen Wessel is quite a talent too. Very impressed at the range of things he tackles.

Brian Sala, Victoria, Australia

MEW 255

Dear Neil, I would like to tell you how much I enjoyed Brett Meacle's article (Taiwanese Lathe, MEW 55). Could you persuade him to write an article about making the chucks featured on page 36. I also enjoyed the silver soldering, the Arduino article was very interesting but CAD is beyond me.

Ted Fletcher, Scarborough

I'm pleased to say that Brett has agreed to write up the chucks for MEW – Neil.

Chuck to DTI Base

Dear Neil, I was very interested in Eric Clark's article about using an old chuck as a dti base (MEW 255). If you have an old Unimat 3 lathe like mine you can use the drill chuck with the T bolt from the vertical column. Thanks for the tips in your excellent magazine,

Mick Groom, sent from my iPad

Modern Flute Making in a Small Workshop

Part 2 - Keywork - A further Exploration of the workshop techniques and philosophies of modern flute maker, Stephen Wessel.

Stainless key posts silver soldered to straps which are then soft soldered to body tube. Good alignment is vital.

So, we come to the engineering for a modern flute. I have already described the broad requirements but before describing how the parts are made let's drill down further into the characteristics of good keywork. All musical instruments have traditionally been built with an eye to aesthetics: apart from needing to sound well they also try to satisfy the eye and the touch. Unlike early keyboard instruments that might have been lavishly decorated with either fine veneer work or paint, the flute is relatively bare in this respect, but the keywork can be made to have an understated beauty of its own. Form, function and comfort are intricately linked. The old French makers were masters of this but their example has rarely been followed by 20thC mass producers for such subtleties of design are usually at odds with economic production. One route towards this refinement is to remove all material unnecessary to strength and stiffness, a rigour somewhat reminiscent of aircraft or bridge design.

Keys must move up and down many millions of times in just one year of playing. Each one must do this without any hesitation or binding and as silently as possible. Most keys normally stand open, are closed by the fingers and return by wire springs. Each closure, which might only last a few milliseconds, must result in a perfect airtight seal over the tone hole. The player will have no time to increase finger pressure to cure a slight leak. Instead, the note will simply not appear, or only at half cock, resulting in a passage of music that sounds "fluffed". In engineering terms the key must therefore be light in weight so its inertia is low, the spring should act instantly but have a low rate so that the finger does not feel it "winding up" as the key closes. Long thin springs are better than short fat ones. Friction must also be minimised by good pivot design and absolute minimum oil.

Every key will have a tail that limits its travel back towards the open position; the tails contact the body tube so must carry a tiny cushion to keep them quiet. These cushions are usually made of felt or cork.

Mounting the keywork

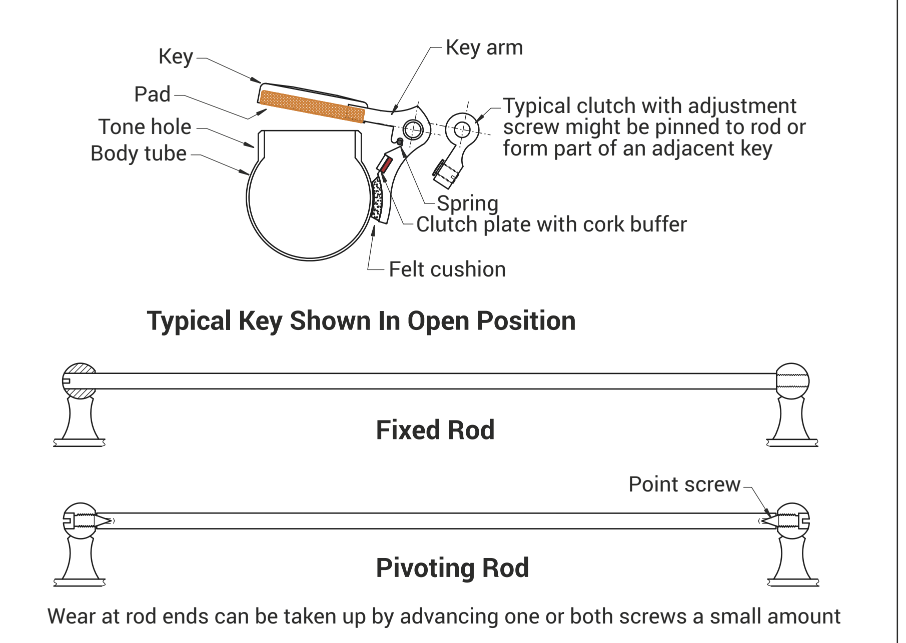
The bare body tube joints are now fitted with a support structure for all the keys. This comprises a number of posts soldered to a silver strap that is in turn soldered to the tube, usually in sections. The stainless steel posts, **photo 1**, are cross-drilled at right angles to carry the rodding which supports the keys; some are threaded, others are plain. They are also drilled for the spring anchorage, mostly about 0.025" diameter. The various rods that pass through these posts must all be parallel to the body tube and to each other so great care is needed to get the posts all exactly right. In the photo the foot joint is seen to carry all five posts in a straight line such that the rod can pass easily through four of them and screw into the fifth without any deviation from straightness. Some of the rods are fixed like this one while others can oscillate, between conical "point screws", **fig. 1**.

The cone allows subsequent adjustment to take up wear. Cheaper instruments have cylindrical screws that do not allow this, so once wear appears the resulting rattle cannot be eliminated so easily.

All the rods and screws in my flutes are stainless steel and case-hardened. This process is generally thought impossible with stainless but in practice it does work, albeit with a very slight loss of corrosion protection. Since the hinge tubes that rotate about these rods are also stainless the hardening gets around the problem of two similar materials in relative motion.

The straps are wired on to the tube for soft soldering. I use a tin/silver alloy for this which runs freely underneath leaving very little to clean off. If a blob does get in the wrong place the best way to remove it is with a tiny brass chisel that is slightly softer than silver, so won't mark it.

Fig.1



Keywork materials

The use of stainless steel seems to be unique to my instruments. All other woodwinds use more easily cast or forged metals which, if not silver or gold for high end work, will most probably be either nickel silver or silicon brass, both of which then have to be electro-plated to prevent tarnish. In all cases there are very many soldered joints, each section of keywork being built up from several components.

Stainless does have several advantages but the one big drawback is that it cannot economically be cast or forged in such small scale; instead many of the parts have to be made by hand, which is why the large manufacturers cannot consider it. In the early days, I had to hacksaw each part out by hand as no bandsaw blade will touch stainless. I improved on the situation a bit by building a vertical hacksawing machine but by then laser cutting was just arriving on the scene and seemed the obvious way to profile all the many little parts. Later on, the machines became so powerful that burning around the tight radii became a problem; for many years therefore I have had them cut out by water jet, **photo 2**.

Working principle

The tone holes of a modern flute are too

2

Water cut plates of various thicknesses, 2 – 6mm.

large to be covered by a finger alone. Each one therefore is covered by a lid, known as a "key" (to be nicely confused with either a piano key or the key in which a piece of music is written, like G major for example, or indeed a house key). Each key is fitted on its underside with a special pad that makes contact with the tone hole and seals it when the key is pressed. The seal must be 100% airtight under almost zero finger pressure. The pad is composed of a cardboard washer, a felt washer and a double layer of thin skin taken from the lining of a cow's intestine, known in the trade as fishskin (don't ask). They are nearly all made in Italy and are easily bought in a variety of sizes, thickness and hardness.

Each key is attached to an arm that is hinged by a length of tubing. Figure 1 shows a typical key in profile. There are five fingered keys that usually have a central perforation about 9mm in diameter which requires the finger to cover it while closing the key. These holes allow better "venting" when the keys are open and also encourage a better hand position in young players. The remaining solid keys are not closed directly by a finger but by a simple mechanism, lever or clutch.

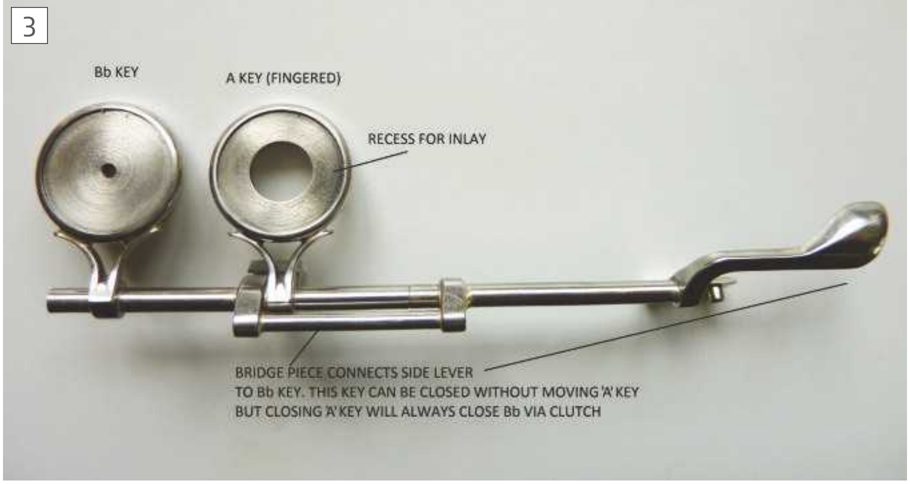
In **photo 3** the key on the left is actually closed by the other (fingered) one via a clutch plate, just visible. It can also be closed by the side lever on the right independently via the "bridge" piece, or by the second clutch worked by a key on the next section. This piece of keywork is suspended by a rod that simply slides through all the hinge tubes and is pivoted between two posts. It consists of thirteen separate components.

<please box out the next bit and place it near this point in the text>

A note on silver brazing stainless steel. For the ordinary austenitic steels like 303,304,316 etc used by model engineers there is no problem at all. I use Easyflo flux and JM Extra Easy solder. Proper cleaning is vital because it's only too easy to think that a piece of bright stainless looks clean when it isn't. Abrasion or scraping immediately before fluxing is best. The correct pickle is a 10% mixture of nitric and hydrofluoric acids (yes HF, not HCL) used warm but quickly. Nitric will remove excess solder but can leave it porous. The HF will clean off the black oxides but is a highly unpleasant and dangerous material that I ceased using years ago. Nitric on its own is good enough. Note that the normal sulphuric acid pickle found in most workshops will have no immediate effect other than to remove flux but it will severely corrode stainless steel given more time.

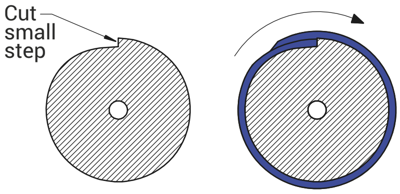
The silversmiths solders are so free flowing that a joint such as between hinge tube and key arm can be assembled tightly before fluxing to allow accurate positioning; flux is then applied all around and will find its way into the joint followed by the solder even though joint clearance may be almost nil.

Stainless is a very poor conductor of heat which means that parts can be soldered in close proximity to previous joints without danger of remelt. This is particularly useful during repair work as will be seen in Part 3 of this article. Silver by contrast is an excellent conductor making soldering work more difficult.



Typical piece of keywork operated by the left hand second finger. The side lever at right is worked by the right hand.

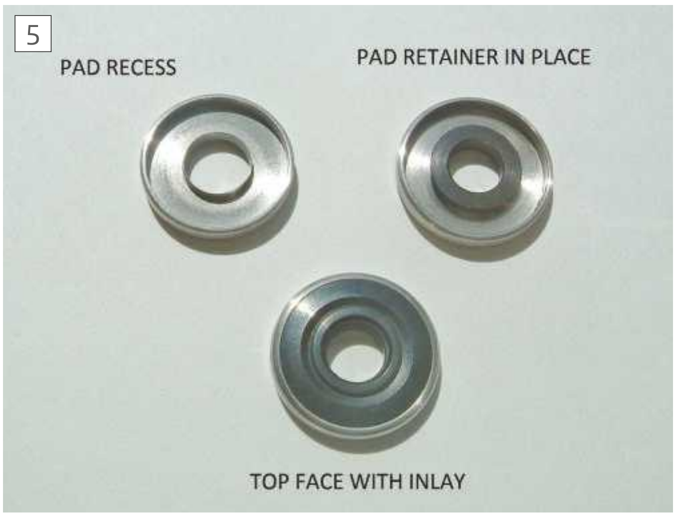
Fig.2



Use with 'J' cloth plus double sided sticky tape.
Suggested grit size between 120 & 600.
Make from plastic or metal in diameters from 1/4" to 1", lengths up to 1".
Fit Ø3/32" or Ø1/8" shaft to suit available collets.
Note direction of rotation, running at high speed in the wrong direction is extremely dangerous.

Mini Drum Sander For Use In Dremel Or Similar Handpiece

Tube straightening. The rotating tube is firmly stroked from left to right while maintaining a marked curve just within its elastic limit.



Keys are made by turning. Other manufacturers invariably press them from sheet metal.

The need for precision

I once got a friend to play through a Bach flute sonata very slowly so that I could count the number of times a particular key was moved. Multiplying the result by the number of times she might realistically practise or perform the piece in one year produced the astonishing fact that this key alone would move many millions of times in that short time. Given that the instrument will often be wet from condensation, dirty and full of fluff if used in stage or theatre environments and that service intervals are often well over three years it is clear that the demands on the mechanism are severe. During that time, the player expects flawless mechanical action and no rattles!

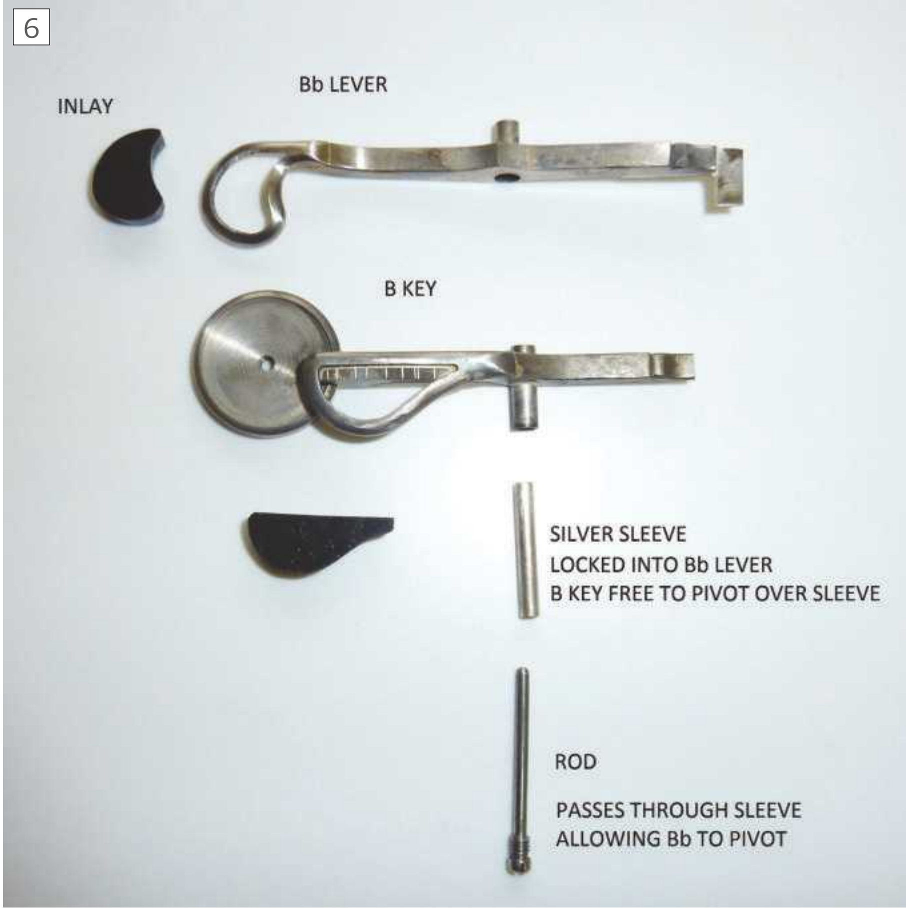
A common problem is the sticking key, i.e. it stays shut when the spring ought to open it. This is truly maddening for the player and could easily wreck a performance. Another less serious defect is the sound of a metal to metal clash often caused by too little clearance between moving parts. See photo 8 below, which shows the potential for this. Which of our famous steam locomotive designers was it who said in relation to valve gear that the art lay in the prevention of two large chunks of metal occupying the same space at the same time? He was right of course and it applies equally to woodwind keywork.

The trade-off is a classic one: freedom of movement as against quietness. A free action can be a noisy one but a quiet action may well err on the tight side and have a tendency to seize. We therefore balance on a knife edge. The flute is particularly difficult in this respect. No one minds a rattling bassoon or saxophone but flute "noise" is objectionable. It mostly depends on having the right clearances between moving and fixed components while always remembering that imperceptible changes in geometry can be caused by a change of temperature. A frequent cause of the sticking key is lack of end clearance at the hinge. Bearing in mind that this would be measured in "tenths of a thou" the tiniest bit of grit or greasy grime can block it up. I shall have more to say about maintenance in Part 3 of this article.

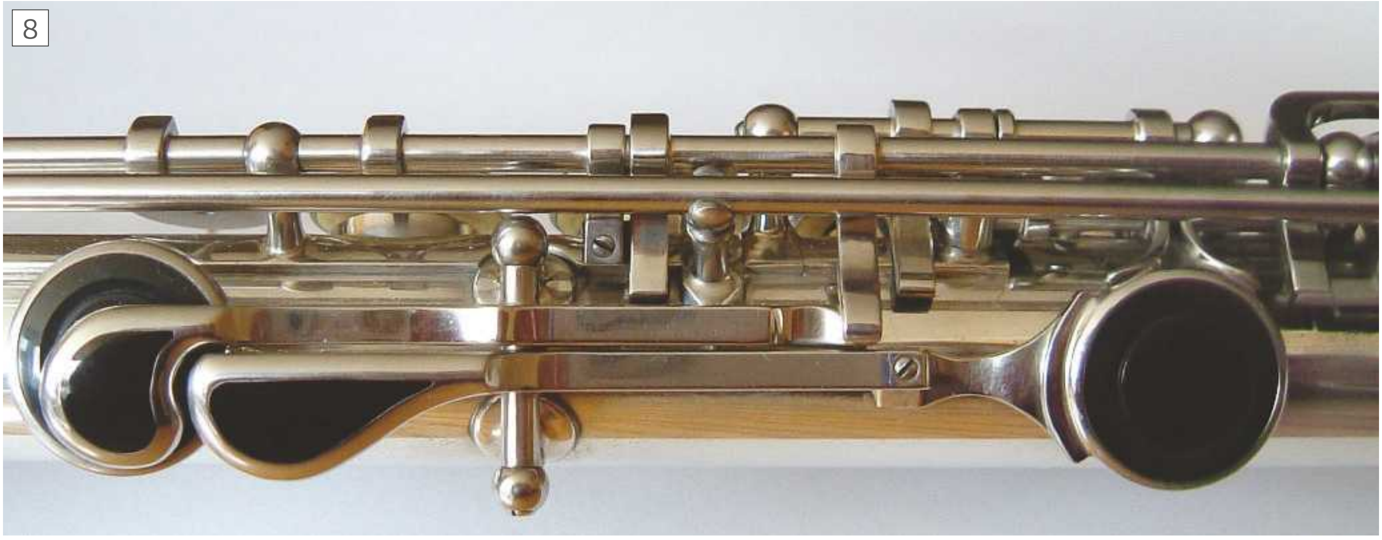
Many of the water cut parts have to be reduced in thickness since stainless plate is only available in metric whole numbers, such as 3,4,5,6mm etc. My design started life in the days when SWG sizes were available and 10G was perfect for finishing at exactly 1/8". So now I have to start with 4mm and grind the parts down further. This is done on a big sanding wheel using various holders and two grades of paper. The edges are finished with various little homemade sanding drums that can be fitted with cloths ranging in grit size from 240 to 600, i.e. much finer than anything on the market. My design for these drums is shown in **fig. 2**. They are very quick to make and I strongly recommend their use for all precision metalwork finishing.

Fortunately, imperial size hinge tubing is available and arrives semi-polished. The bore does need a small correction to bring it up to size so that it becomes a sliding fit over my ground rodding. I have a collection of drills all hovering around 3/32" to 2.4mm and choose one to give the best size. Reaming in this scale is out of the question so finishing is done by wrapping a short narrow length of 240 grit paper in a spiral around a piece of 1/16 rod. This is worked in and out of the rapidly rotating tube until the correct fit is obtained with the rod. This all sounds very crude and inefficient but I see no economic alternative and it actually works very well.

While on the subject of tube, readers may be interested in a method of straightening tubes (and rods) for it goes without saying that unless a hinge tube and its rod are perfectly straight, smooth working isn't possible. Stock material is always slightly curved. I haven't tried this in anything above 3/16" diameter and am only concerned with 1/8" or below, but I see no reason why the principle shouldn't work for larger sizes. **Photograph 4** shows what to do.



The construction and installation of the left hand thumb key cluster. The key is kept open by 2 flat springs screwed to the underside of each lever.



Right hand section

One end of the tube is gripped tightly by the lathe collet or chuck while the other is free. A piece of wood with a hole in the end is all that's needed. I use a small hammer handle and the hole is about ¼" and bell-mouthed. If the tubing is only slightly bent the procedure is as follows: pass the handle over the tube and start the lathe running at about 1000rpm. Now angle the handle so that both ends of the hole start rubbing hard against the tubing while at the same time sweeping it slowly towards the other end. This will seem to put a strong curve in the tube right at the limit of its elastic range. At the end of the sweep slowly bring the handle hole back in line with the lathe centre line, without slipping off the end. You can almost feel the original kinks being ironed out and it should now look straighter. Two or three passes may be needed. Then reverse the tubing in the chuck and do it again. If the tubing was severely bent at the outset be very careful – it is sometimes necessary to support the

Compare this picture to a normal flute shown in Part 1. It has the same basic layout of a Boehm flute but with many extra keys and levers. The black rectangle is a hand rest. Overall weight was a major consideration so keywork metal was reduced to the minimum consistent with strength and comfort.

outer end in the fingers to stop it whipping about. Straightening rod generally needs more determination and more angling of the handle, depending on the metal status, if it has been annealed it will respond better. It is possible with practice to get rid of the slightest kinks that may be almost invisible but can often be felt in the fingers. The method also works for quite short lengths down to about 1". Use a narrower handle and a collet rather than the 3 jaw chuck. With long lengths, be very careful to keep the handle on the tube while it is rotating, in order to restrain it.

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Pronomos thumb keys.

11

Pronomos foot joint keys showing several extra levers known as 'gizmos'. These are arranged to be pressed either alone or together with the main keys. A lot of work for just one little finger!

Inlay work

The reason for inlaying a black plastic into all the main keys, **photo 5**, is twofold:

1. to reduce weight and inertia
2. to provide a warmer and more secure touch than metal

Plastic, being a poor conductor of heat, feels relatively warm to the touch in cold conditions and doesn't become wet and slippery in hot climates.

I use a jet-black acrylic that takes a high polish and is fairly hard. Inlaying the round keys is straightforward; the plastic discs are turned with a form tool and set into the key recess when all soldering operations are finished. An industrial cyano adhesive fixes them.

The odd shaped pieces, **photo 6**, are cut out of thick sheet material using the hole in the key as a guide. After filing to the exact shape, the inlay is squeezed into the key until it makes contact all around. Thin adhesive is then applied at the back and finds its way into all the little hairline gaps before setting hard. Finally, the excess plastic is sanded off to produce a gentle rounded surface that blends smoothly into the metal surround.

I shall describe the finishing of the flute in Part 3 of this article. This will cover the critical subject of padding a flute such that every key can be made airtight and some of the factors affecting the life and service intervals of the instrument. Before concluding this part however, I must mention an extraordinary commission that came my way a few years ago.

The Pronomos Flute

The modern flute as we know it hasn't changed much since the middle 19thcentury except in detail design and improved tuning. The fingering system laid out and simplified by Boehm is sacrosanct and in no need of fundamental change. It will play a chromatic scale in just over 3 octaves. However, during the 20thcentury an increasing interest in "quarter tone" music has caused woodwind instrument makers to consider how all these extra notes might be sounded. To those unfamiliar with the jargon, ¼ tones are "the notes in between the semitones" such that instead of the normal 12 notes to the octave there would be 24. To most of us these notes would just sound out of tune and impossible to associate with any Western music from the last 1000 years. Music from other parts of the world however has always made much use of these sounds, so cross-cultural contemporary composers often like to blend them with more conventional Western music. In fact, a whole new contemporary music repertoire has grown to deliberately challenge our traditional attitudes as to what music really is.

Flutes able to play some of the quarter tones have been around for a long time but the Pronomos takes the ideas much further. Not only is it able to play a full 24 note octave but with non-conventional fingering it can be made to play many more. This means the player can imitate many different types of simpler flutes from around the world that will not play the Western scale. It was designed by the Hungarian player Istvan Matuz in the 1970s, then rediscovered and much developed by my client more recently. The first fully engineered version is illustrated in **photo 9**. In the hands of this remarkable Spanish musician the Pronomos is quite extraordinary. Yet it can still play ordinary Western music when required. It was very difficult to build but after 5 years of constant use around the world seems to be holding up well. It has been calculated to offer over 23 million different finger combinations, the vast majority of which, to our ears, produce very weird sounds indeed! ■

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A normal foot joint arrangement for comparison.

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Mike's Workshop

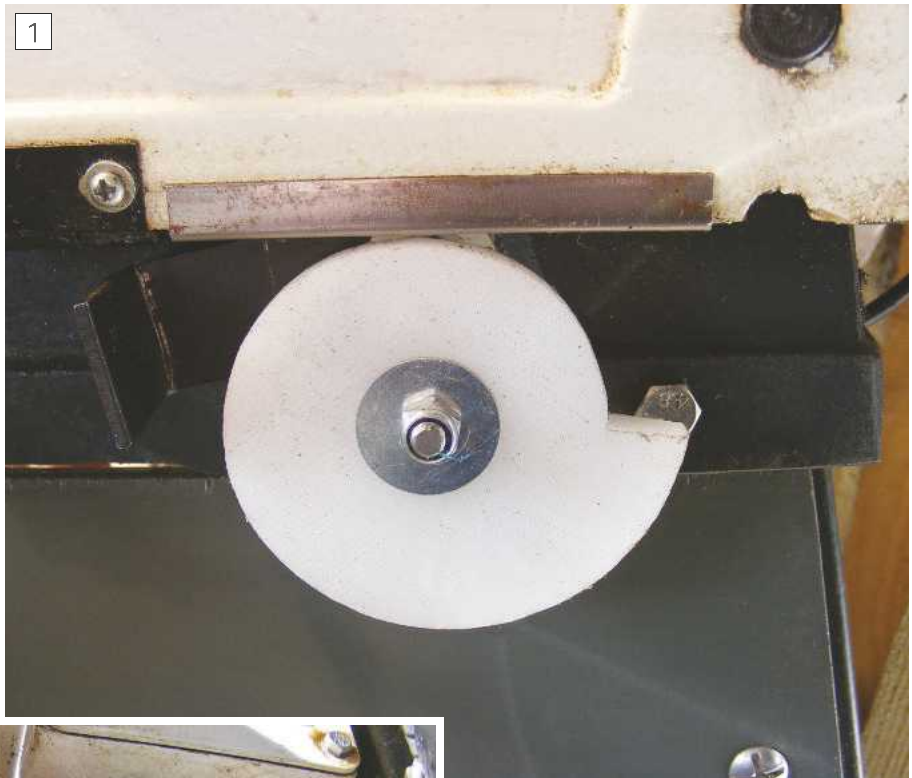
A Bandsaw Arm Stop

Another great bandsaw mod from Mike Cox

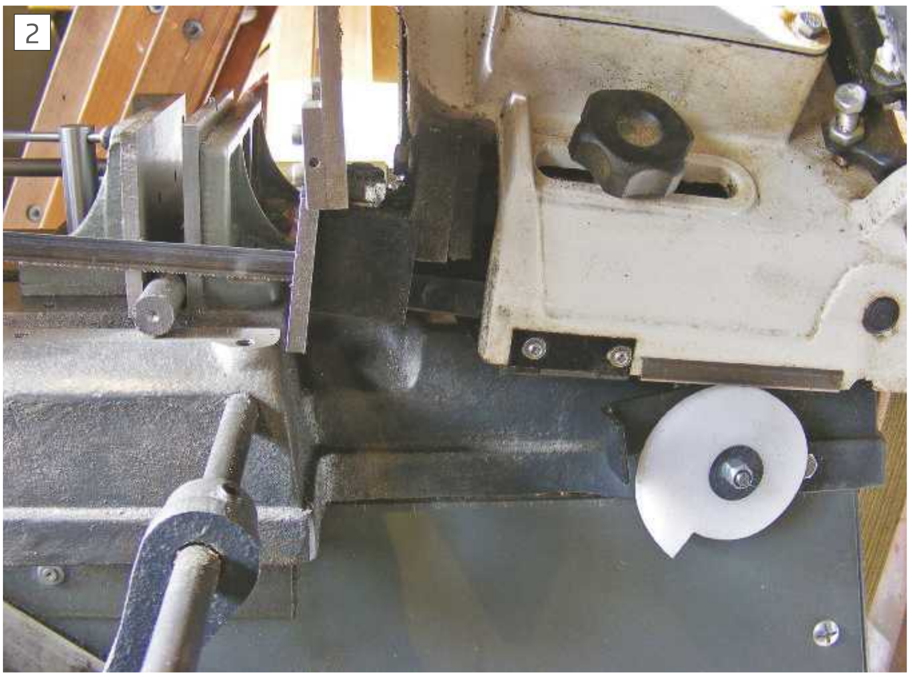
The main use of a bandsaw is to cut off a measured amount of material. One way to do this is to mark up the material before putting it in the bandsaw vice. However, I find it quite difficult to mark accurately a round bar without putting it in the lathe and scribing a line all the way round. Once you have the scribed bar in the bandsaw vice then you can bring the bandsaw arm down, holding it just clear of the bar and adjust the bar's position before tightening the vice.

Another way is to put the bar in the bandsaw vice and use a steel rule to directly measure from the end of the bar to the bandsaw blade. To do this you need to lift the bandsaw arm a little and at the same time measure and adjust the position of the bar. This sounds very easy but you need one hand to keep the arm lifted, one to position the bar and another to hold the steel rule. In practice, it is necessary to use a knee to lift the bandsaw arm and use the hands to position and measure the bar.

Things get even worse when only a thin slice of material needs to be removed from the bar. In this situation, the end of the bar is over the blade gap in the bandsaw base casting. If you do not support the arm properly and it touches the bar then the bar tries to tip into the blade gap completely spoiling the positioning of the bar.



The cam stop.



The cam supporting the arm above 16mm round in the vice.

I am sure all horizontal bandsaw users are aware of these problems. Out of sheer frustration I decided I would have to make an adjustable stop that would hold the bandsaw arm in any position so that the blade could be positioned just above the material being cut. This would leave both hands free to measure, position the material and also avoid the possibility of tipping the material into the blade gap.

The solution.

My first idea was a slotted bar at the front end of the bandsaw that was pivoted to the arm and then a bolt through the slot in the base casting. The problem with this idea is that the stay bar has to be quite long in order to raise the blade sufficient to reach the top of the vice. Also, it would be difficult to disconnect the stay when not in use without undoing bolts etc. Looking at the back of the bandsaw arm close to the pivot point there was already a stay that was designed to lock the bandsaw arm in the vertical position if the saw was used in the vertical mode. Here any sort of stay could be much shorter.

The final solution was a cam attached close to the pivot point, as shown in **photo 1**. The cam can be rotated to support the arm in any position so that the blade was just above the vice in the maximum position. The cam is out of the way and does not interfere with the normal functions of the saw but can be brought into use very easily just by rotating it. **Photograph 2** shows the arm supported by the cam above a piece of 16mm round stock in the vice. The cam is mounted on a short piece of steel bar that is attached to the bandsaw base casting by the same screw that holds the stay that locks the bandsaw arm in the vertical position. The vertical locking stay can still be used.

The parts.

The cam, **photo 3**, was drawn using a CAD program. It was designed to increase in diameter from 30mm to 45mm over an angular movement of 270 degrees. The other quadrant was a constant radius of 30mm. The cam is shown in **fig. 1**. The cam was printed out on a 1:1 scale onto paper. This was stuck, using spray contact adhesive, to a piece of 9mm thick polyethylene (PE) board (actually an old chopping board that had seen its best days in the kitchen). I used the PE board because it was available but other materials could be used. PE has the advantage that it is easily cut using regular woodworking tools. The centre of the cam was marked using a centre punch and the cam profile was cut freehand using a small woodworking bandsaw with a 6mm wide blade. The profile could also be cut using a jig saw. The cam profile was smoothed and blended using a linisher and hand tools. The centre was drilled out 10mm.

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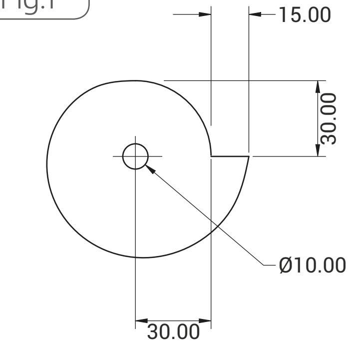
The cam

Fig.1



The Cam

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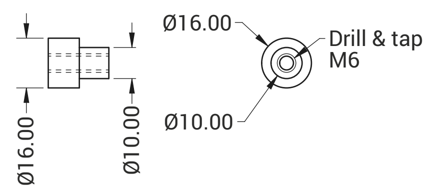
The cam pivot and mounting plate.

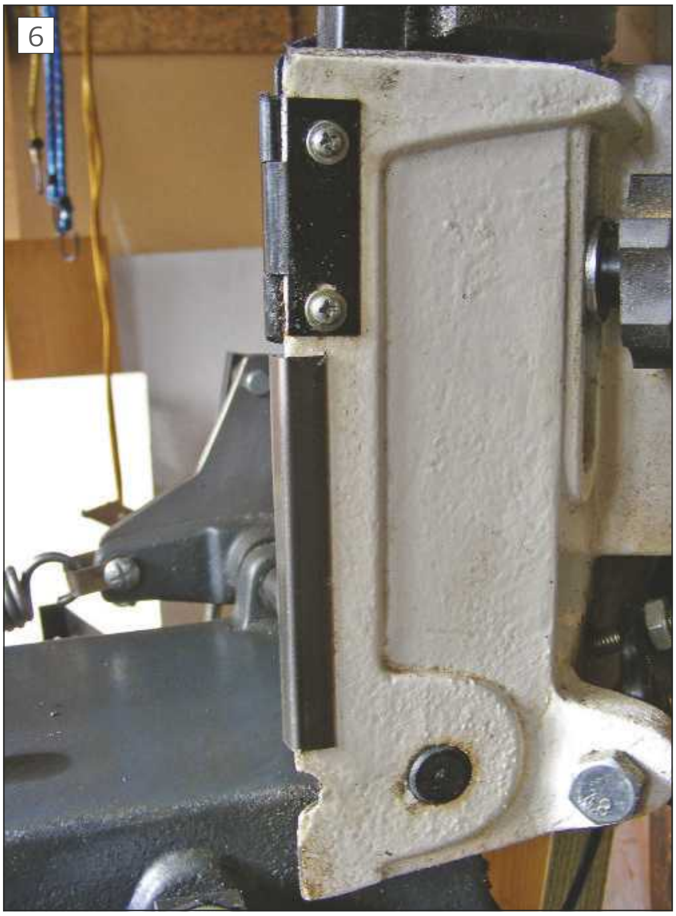
The cam pivot, **photo 4** and **fig. 2**, was made from a piece 16mm round steel bar. This was chucked in the lathe, faced and centre drilled. It was drilled out 5mm for a depth of 22mm. A 6mm tap was then fitted in the tailstock chuck and this was started in the centre hole by rotating the lathe chuck whilst pushing on the tailstock. after four rotations of the chuck the tailstock chuck was released and pulled back leaving

Fig.2



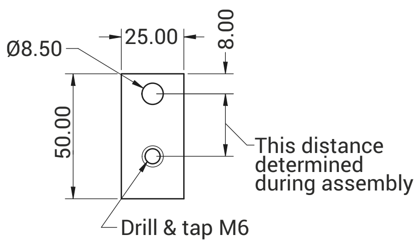
The Cam Pivot

The edge of the bandsaw arm showing the nicks.



The edge covered with steel channel

Fig.3



The Mounting Plate

Showing the cam and the arm locked vertical.

the tap protruding from the bar. The end of the bar was turned down to 10mm for a distance of 9.5mm. The fit of the cam on the pivot should be checked. This should be a tight push fit. If necessary remove a little more metal. The bar was then parted off 10mm from the shoulder. The pivot was finished by gripping the thick end in the bench vice and driving the tap through the piece to leave a threaded through hole.

The mounting plate, also shown in photo 4 and **fig. 3**, was a piece of 10mm steel plate 25mm x 50mm. A centre line was scribed along the long axis and an 8.5mm hole is drilled 8mm from the end of the plate. The other hole for the pivot was not drilled until later assembly.

The edge of the bandsaw arm where

the cam rubs is a rough casting with some nicks to enable the bandsaw arm to be supported in two other position, see **photo 5**. This is obviously unsatisfactory as a rubbing surface. Fortunately, I had a piece of 10 x 10 x 1mm steel channel and a 90mm length of this clipped neatly over the edge of the casting to provide a nice smooth surface, see **photo 6**. Note that this channel does not cover the last nick since this is used to lock the bandsaw arm in the vertical position, see **photo 7**.

Assembly.

The M8 screw holding the stay to support the arm in the vertical position was first removed. On my saw this screw goes into a threaded through hole in the casting and then on the back of the casting is a cable clamp and a nut all attached to the same screw. It is necessary therefore to remove the nut and cable clamp before the screw can be undone. With the screw removed the mounting plate can be fixed to the casting using the 8mm screw. The bandsaw arm was lowered, and with the steel channel clipped onto to the arm, the pivot with the cam was offered up to the mounting plate with the cam set to the minimum position. The position on the plate was marked using a 5mm transfer punch through the M6 threaded hole

The plate was removed and the marked position transferred to the centre line and then drilled out 5mm. The mounting plate was remounted on the base casting using the 8mm screw and a hole drilled through the 5mm hole through the base casting using a portable electric drill taking care not to damage the wiring behind. The mounting plate was removed again and the hole in the casting was then opened out to 6mm using the portable electric drill.

The hole in the mounting plate was tapped M6 and a piece of M6 studding was then cut and screwed into the threaded hole leaving 4mm protruding from the back of the mounting plate. The pivot was then screwed onto the studding. This was tightened onto the plate by gripping the pivot in the bench vice using aluminium jaw protectors and then screwing the mounting plate hard down on the pivot using a spanner.

This assembly was remounted on the bandsaw, **photo 8**. This time the stay used to lock the arm in the vertical position was slipped onto the 8mm screw before inserting the screw through the mounting plate. The screw is tightened until the stay is gripped but can still be moved albeit rather stiffly. It was necessary round the corners of the stay so that they cleared the pivot piece. The cable clip and nut were replaced on the other side of the casting.

A M10 penny washer was slipped onto the pivot, then the cam, then a M6 penny washer and finally an M6 lock nut. The nut was tightened down until the cam turns easily but is retained between the washers.

Conclusion.

This modification is quite straightforward to do and it makes setting pieces up in the vice much easier. It can also be used to stop the cut at any point. This is useful, for example, if you are cutting through the material to meet a hole. ■

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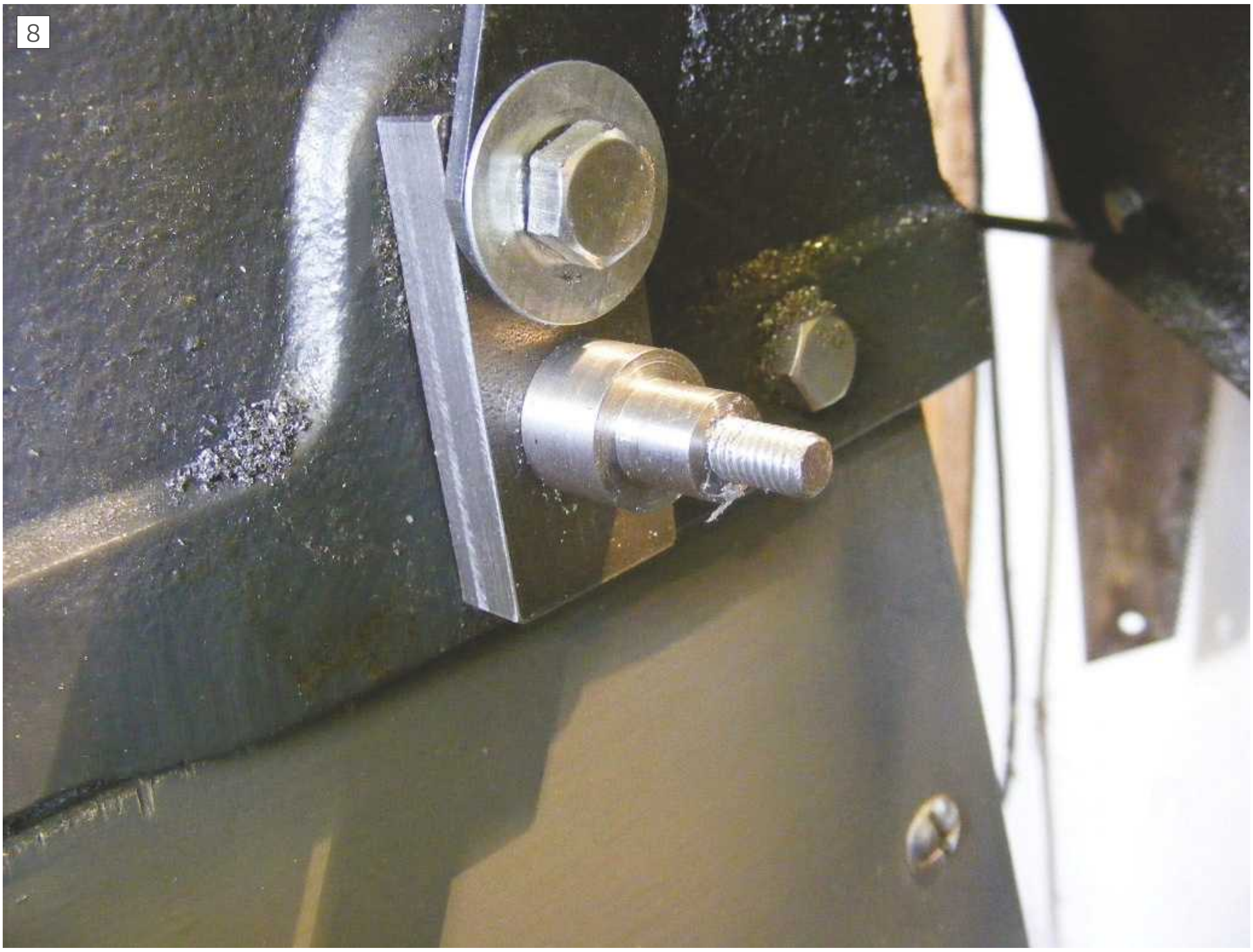

The mounting plate and pivot attached to the base casting.

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