A VINTAGE INSPIRED BIG END DESIGN

MODEL ENGINEER & WORKSHOP

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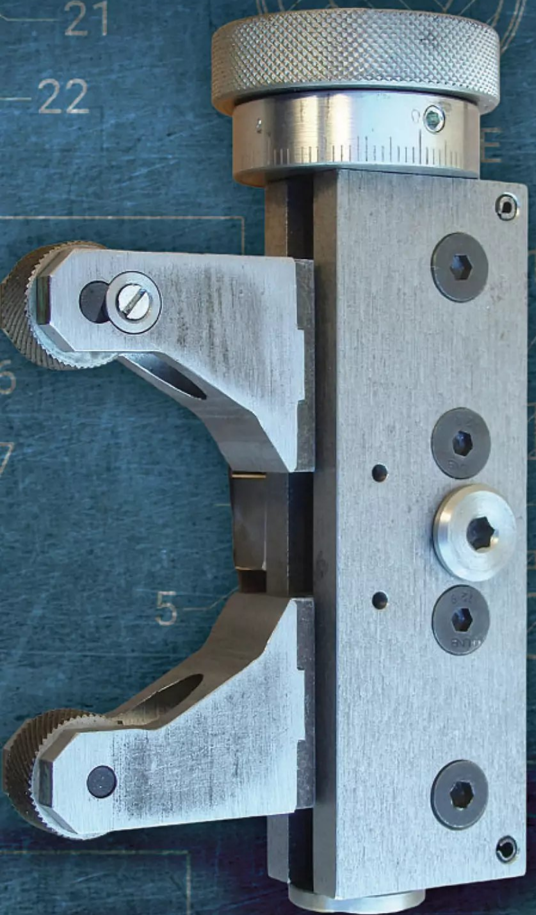
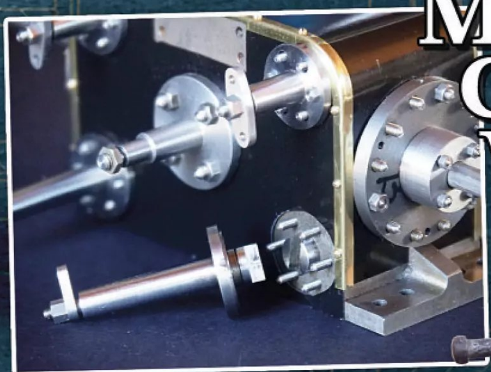


Make an Advanced Knurling Tool

JACQUES MAUREL'S DESIGN FOR EXTERNAL AND INTERNAL KNURLS



Machining Corliss Valves

HOW TO TACKLE THESE CRUCIAL PARTS

Portable Tool Stand

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The Yield Point Method for Boiler Design • How to use a Boring Head • Make a Sub-Base for a Hydraulic Press
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The BR Standard 2-6-0 Mogul • Make a Tube Expander • Top Tap Tips • A Gear-cutting Clutch for the EMCO Compact 5 • Spark Arrestors • Special Nuts • Giants of the Industrial Revolution
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JUNE 2025

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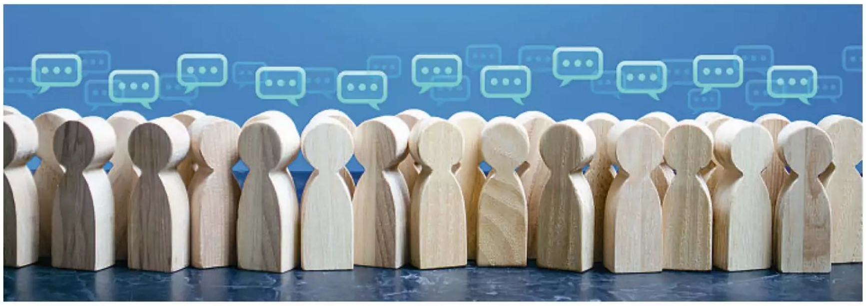
SMOKE RINGS

The Reader Survey



I would like to thank the many readers who took part in the online reader survey – all 335 of you! The downside of such a response is that it's taking rather longer to sift through and understand all the results, especially the written comments, than we had expected. There will be a brief summary of the responses in the next issue, with some extra details for the website as I am sure readers will find the results enlightening.

However, the purpose of the survey was not to entertain, but to inform and shape the future of this magazine. It has left me a number of circles to square, always an interesting workshop task! For example, several of the most frequently criticised articles appeared were also rated amongst the best! But some messages are clear, for example on the length of articles or instalments of longer articles. This will be very helpful in the future. It was also evident that there is appreciation for our efforts in trying to capture the best of both Model Engineer and Model Engineers' Workshop are appreciated. The mix of relatively brief articles and series with a few, well written, longer series that has been facilitated by our extra pages seems to be about right.

Competitions

Readers may recall two competitions decided by a reader vote. MEW had the Stevenson Trophy, for workshop tooling, while ME had the Bradford Cup, for the best article or series. These will continue, but we will run them in parallel, with the aim of awarding the trophies at the Midlands Model Engineering Exhibition in October. The next issue will include a call for nominations. ME&W will also continue to sponsor the IMLEC and LittleLEC competitions.

On My Bench

I have found some time in my workshop, and with delicate use of a 1/16" end mill and much filing I have completed a connecting rod. That may not sound like a lot of work, but it has sixteen parts, largely due to three wedge and cotter bearings like those in this month's 'Big End' article. I also found a cylinder casting and machined it… why can't I finish one project before starting the next one?
Neil

Neil Wyatt
Editor

Diane Carney
Deputy Editor

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Regulars

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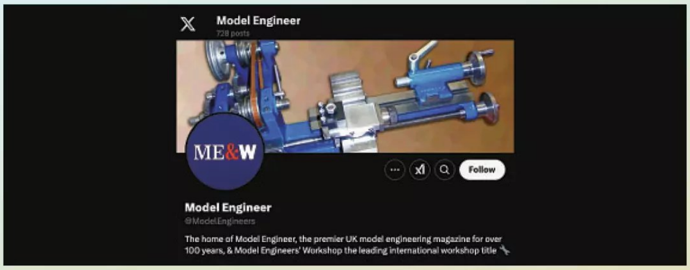


Extra Content!
Your magazine is growing and changing into Model Engineer & Workshop. Find out more and let us know what you would like to see in the new, larger magazine at:
www.model-engineer.co.uk/forums

Download patterns for the Mill Engine dashpot here, you can also download a video of the trip gear in action: www.model-engineer.co.uk/795667/dashpot-patterns-for-arnold-throps-mill-engine/

Hot topics on the forum include:

24cc DIESEL ENGINE FROM SOLID started by Dean Clarke 2
A new blog about making a compression ignition engine for a model aircraft.

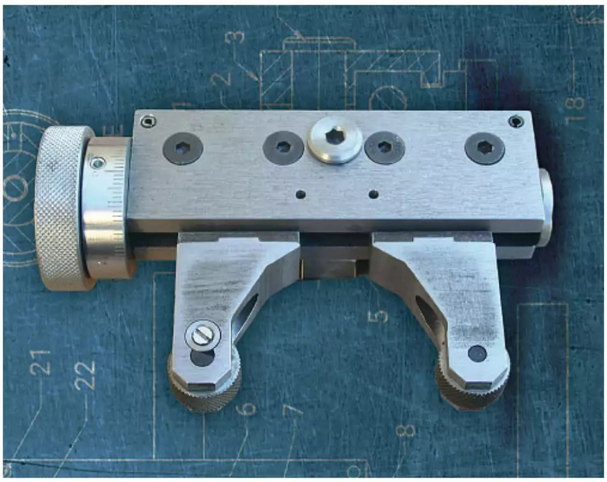
Armortek series 1 landrover kit started by Plasma
Building a challenging and detailed prefabricated model.

Some help with a Cowells speed controller needed Started by Hollowpoint
Ageing electronics with failed capacitors.

Building Bernard Tekippe's Precision Regulator started by Chris Raynerd 2
Discussion of a clock capable of keeping accuracy to within 0.008 seconds a day!

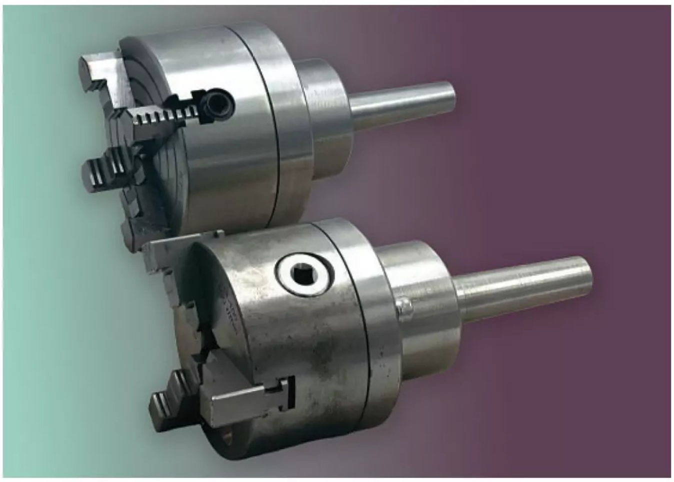
Come and have a chat!
As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support.
Come and join us – it's free to all readers!

On the Cover



Our cover features Jacques Maurel's advanced knurling tool. Read more from page 9.

Next Issue



In our next issue, Gavin Blakeman explains an accessory for attaching lathe chucks to the machine's tailstock.

Jacques Maurel describes how to make a versatile knurling tool with various modes of operation.

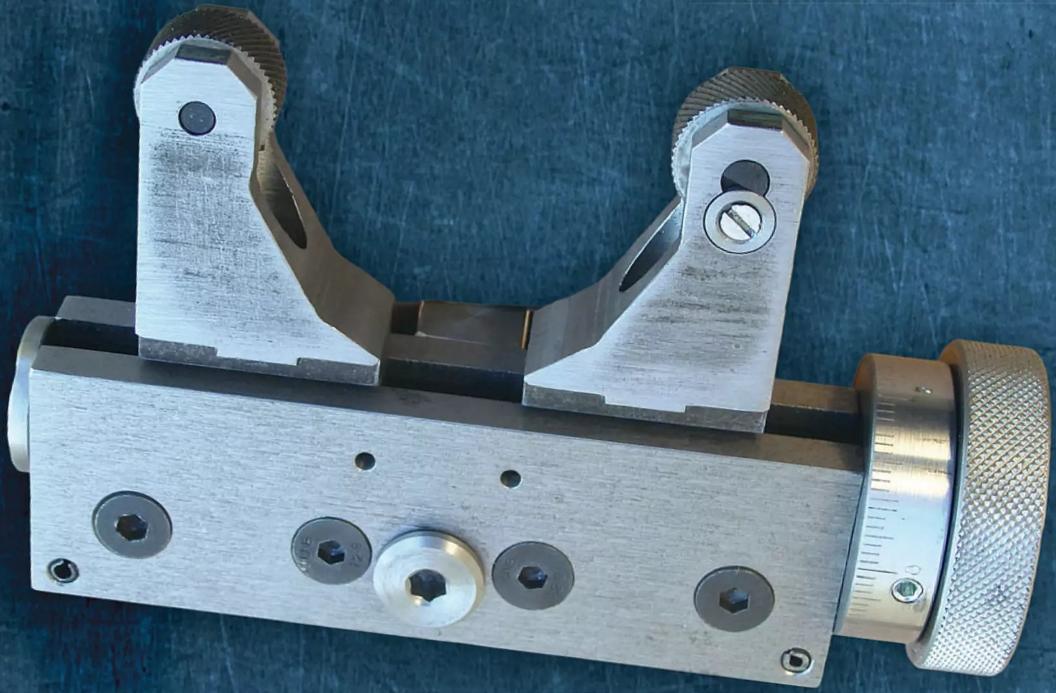


Photo 2: M. Maurel's knurling tool described in this article.

A Multipurpose Knurling Tool

PART 1

This tool is inspired by the *Moltor* knurling tool, **photo 1**, which was a scissor type tool squeezing the work between two opposed knurling wheels. This approach minimises sideways forces on the lathe spindle.

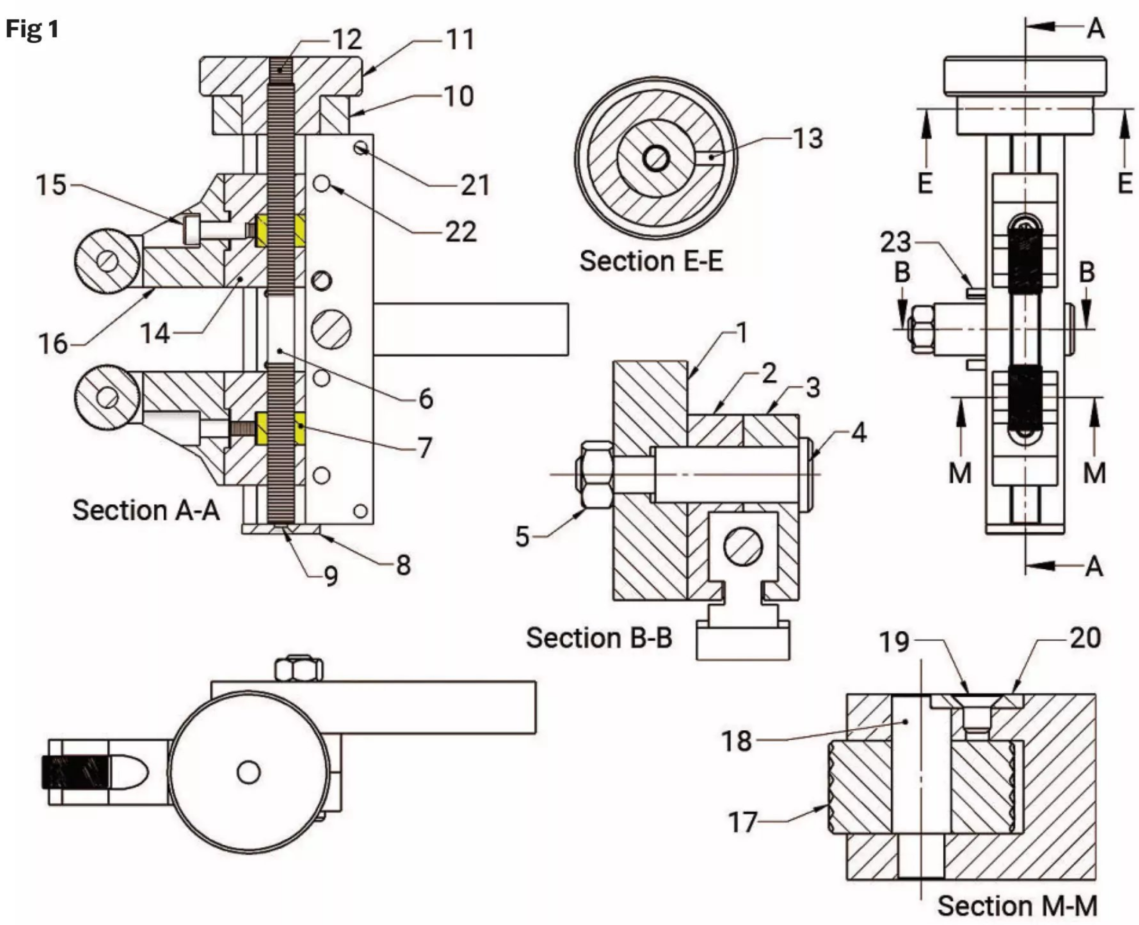
Editor's notes: Due to space constraints and to avoid introducing errors by renumbering part references, the drawings will appear across the two parts of this article in numerical order, not the order they are referred to in the text. The article makes a distinction between 'crush knurling' where the knurling wheels rotate on an axis parallel to the work making a linear contact, and 'cut knurling' where the knurls are angled so they only contact the work around one point, requiring less force but requiring a more complex geometry.

FIRST FUNCTION: A CRUSH KNURLING TOOL

This tool, **photo 2** and **fig. 1**, is of the scissor type. The knurling wheels **17** are carried by two sliders **14** having a translatory motion, these sliders are driven by a single screw **6** having a right-hand thread on one side and a left-hand thread on the other side. This screw is itself driven by the knurled knob **11**, so when this knob is turned, the two sliders are moved symmetrically inwards or outwards.
Notes:

- There is no axial force between screw and guide (other than friction), the crushing force being applied only by tensioning the screw between the two nuts **7**.
- The knurl holders **16** are reversible, so the slider throw needs only be half the maximum knurling diameter of 80mm.

Photo 1: Moltor knurling tool.



• A graduated collar **10** allows an accurate control of the knurls movement that will be very useful to control the knurl's depth (for repeatable batch work) and also for the other purposes of this tool
• The guide **2** and **3** is free to rotate around its axle **4** for a free alignment on the workpiece, the shank **1** being locked in the tool post. The two pins **23** are for limiting this rotation at rest
• This type of tool is useful for making parallel knurls as it's difficult to adjust the cut knurling tools for straight knurls; see my article Machining Shiny Knurls in *Model Engineer* 4543.

USING THE ATTACHMENT

The tool shank **1** being clamped in a toolholder, adjust the pivot axis (part **4**) to centre height.

Adjust the cross slide for the knurls axis to be in the vertical plane along the lathe's axis.

Tighten the knurls until just contacting the job for about 2mm length, 'zero' the graduated collar.

Give a squirt of cutting oil before starting the spindle.

Tighten the knurls (quite quickly to avoid double knurls) on the rotating

Parts List for Crush Knurling:

Ref	No.	Name	Material	Remarks
1	1	Holding shank	FCMS	
2	1	Rear guide	FCMS	
3	1	Front guide	FCMS	
4	1	Main axle	FCMS	
5	1	Nut M8	8	
6	1	Driving screw	FCMS	
7	2	Driving nut M8	Bronze	One LH & one RH
8	1	Stopping washer	FCMS	
9	1	Screw FHc M4-12	4-6	
10	1	Graduated collar	FCMS	
11	1	Driving knob	FCMS	
12	1	Locking screw Hc M8-8	8-8	
13	1	Collar lock screw Hc M5-7	8-8	
14	2	Slider	FCMS	
15	2	Screw CHc M5-15	8-8	
16	2	Knurl holder	FCMS	
17	2	Knurl	Tool steel	See text
18	2	Knurl axle	Silver steel	Hardened
19	2	Screw FHc M3-4	4-6	
20	2	Knurl axle stopping washer	FCMS	
21	2	Elastic pin		Dia. 4, 15mm long
22	4	Screws FHc M6-20	8-8	
23	2	Elastic pin		Dia. 3, 10mm long

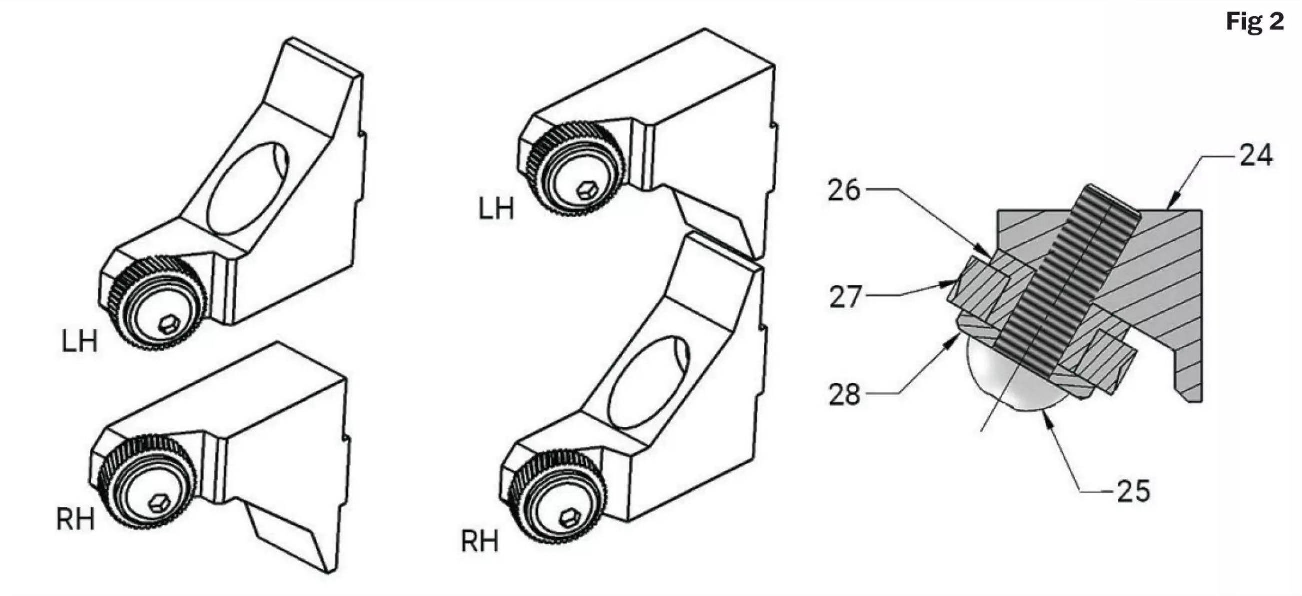


Fig 2

work, take 'half the knurl pitch' from the graduated collar (0.5mm for example for a 1mm knurl pitch); stop the spindle to control the depth obtained.

Start the lathe, correcting the depth if necessary, engaging the self-act (feed ~0.2mm/turn) to machine the knurled part.

Stop the lathe after completion and remove the attachment

Note: FCMS- free cutting mild steel. CHc – cap head. FHc – flat head cap screw. CRS – Cold Rolled Steel.

The following notes cover some of the more unusual machining operations:

Rear guide 2 and front guide 3: I've used two parts for guiding the sliders **14**, to avoid the use of a special T slot milling cutter. This means it is possible to adjust by shim packing between **2** and **3** to get a small amount of play, to allow slight lateral rocking of the knurl holders **16**. To achieve good geometry, it's necessary to clamp the blank directly on the machine table, **photo 3**. Assemble the two parts on the sliders, or with a 120mm (minimum) length of 15mm square CRS, align lengthwise and drill and set the pins **21**. The block **2** and **3** is then drilled, tapped and reamed. Set now the screws **22** to lock the guide parts **2** and **3**.

Slider 14: For good geometry, the side grooves must be made with a side cutter at the same setting of the machine vice for each operation, see **photo 4**.

Driving screw 6: To ensure coaxiality, the threads are rough cut between chuck and centre, and finished with a die.

Driving knob 11: Be careful as the tapped part must be left hand thread to fit **6** (2/3 of the length) and

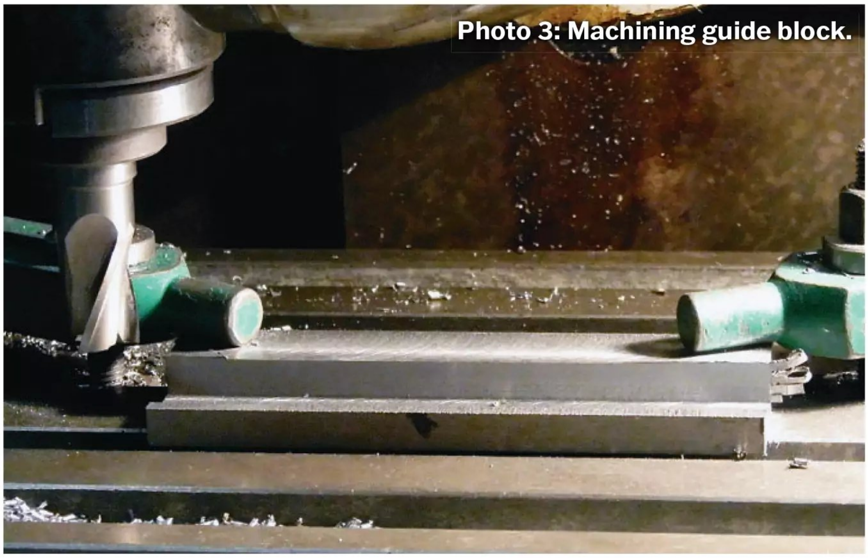


Photo 3: Machining guide block.

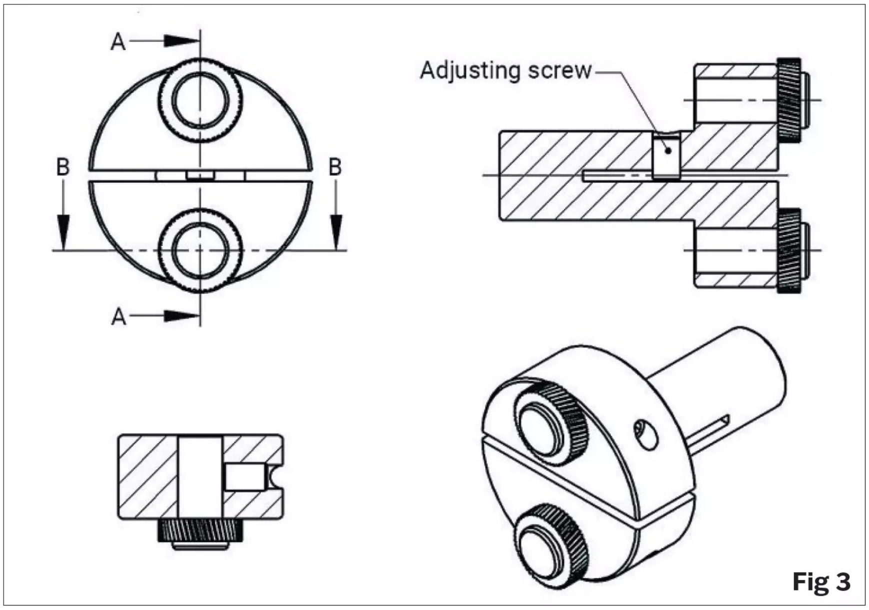
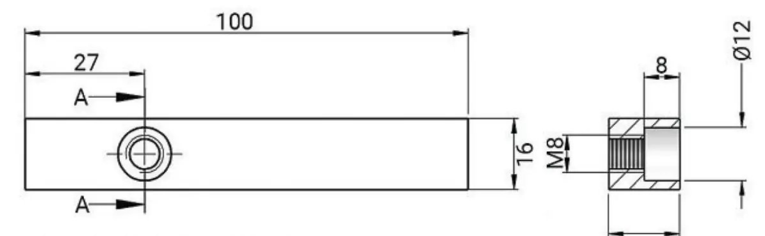


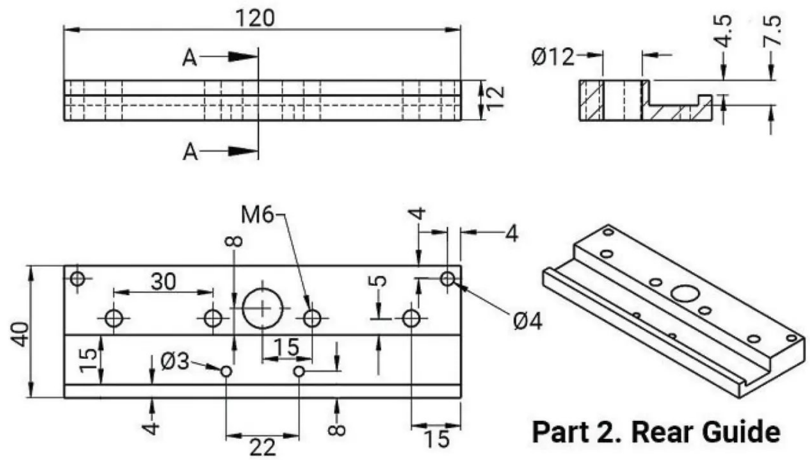
Fig 3

Photo 4: Machining guide block with a T-cutter.

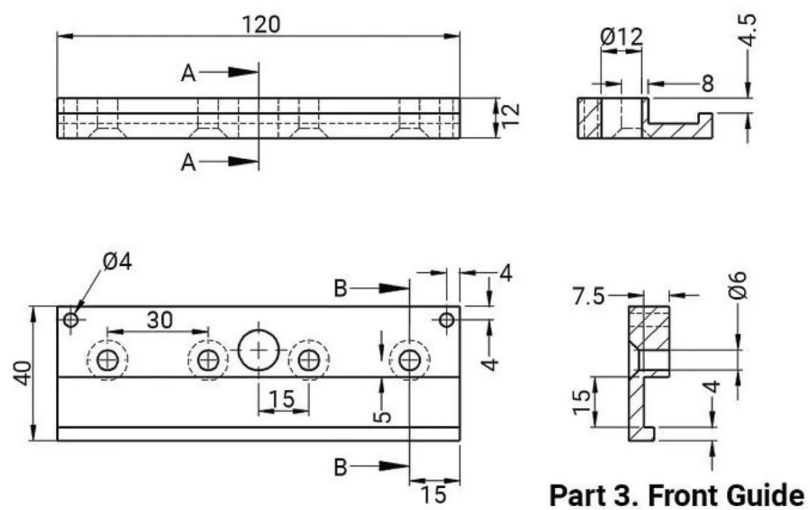
Photo 5: Alternative way to secure the axle.



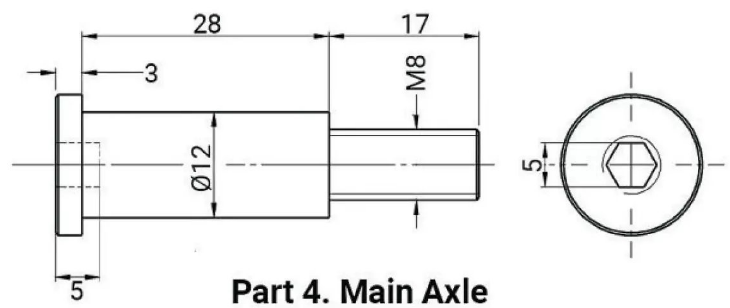
Part 1. Holding Shank



Part 2. Rear Guide



Part 3. Front Guide



Part 4. Main Axle

right hand to fit **12** (1/3 of the length). There is no problem if there is some interference at the join between the two threads.

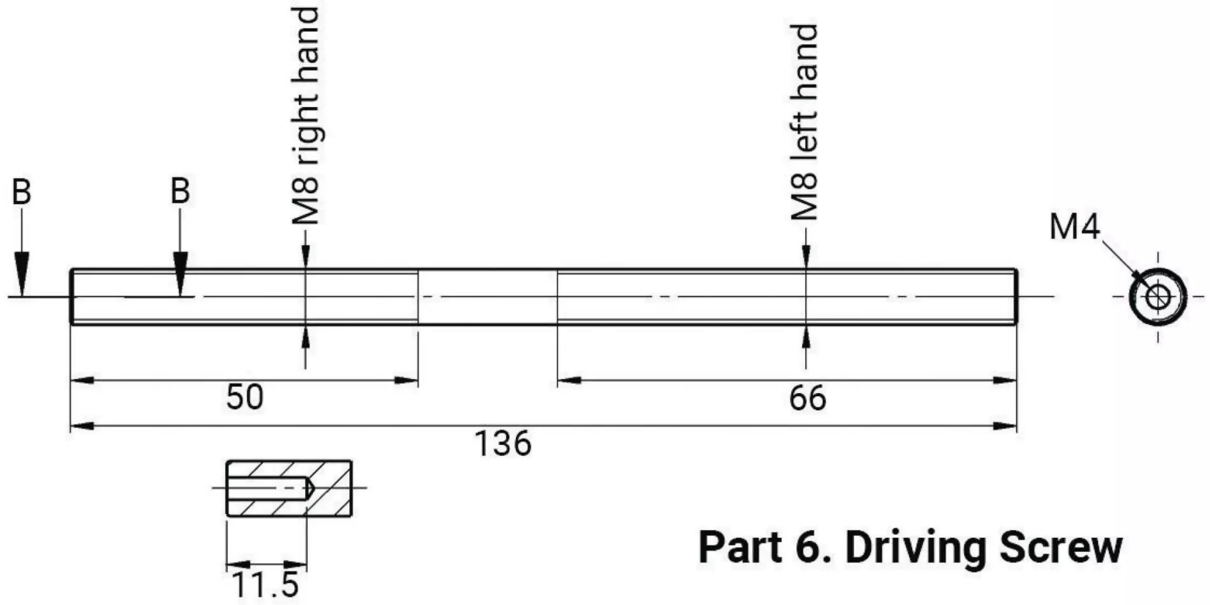
Graduated collar 10: I've made 100 graduations, the movement being 0.025mm for each, as the equivalent pitch is 2.5mm (relative movement of the two sliders **14**) for one turn of the driving knob **11**.

Knurl holder 16: First machine the 'cube' and the 'tongue' that fits **14**, then drill the holes, then the 'polygon' (to clear the 80mm diameter). Finish with the knurl groove and chamfers.

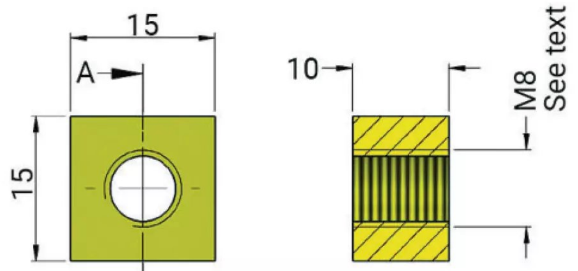
Knurls 17: The ones I use are: bore 6.4mm, external diameter 20mm, width 10mm. You need two identical for straight knurls. One left hand and one right hand for diamond knurls with a helix angle 30 degrees.

Knurl axle 18: Made of silver steel, must be hardened and tempered in the usual way.

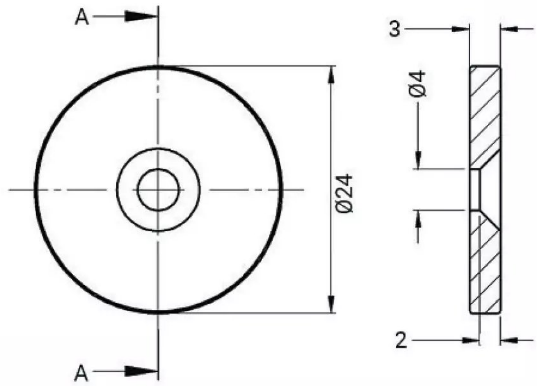
Main axle 4: Turn all the cylindrical surfaces at the same setting (to ensure coaxiality), part off and finish with the driving hex bore. The screw **19** is very short, it's possible to use an alternative solution, **photo 5**, but in



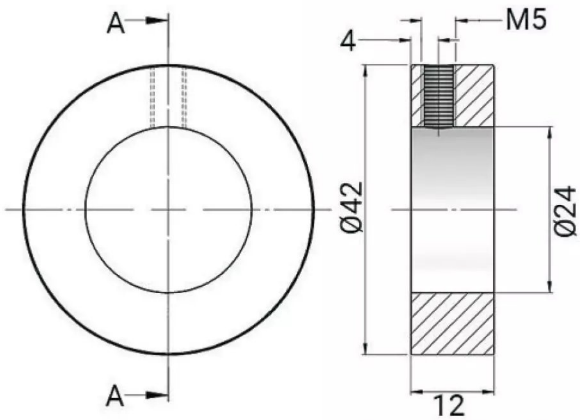
Part 6. Driving Screw



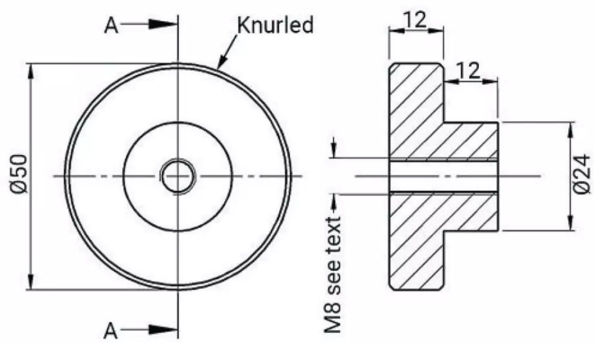
Part 7. Driving Nut



Part 8. Stopping Washer



Part 10. Graduated Collar



Part 11. Driving Knob

this case if you reverse the jaw it will be necessary to reverse the locking mechanism for it not to protrude outside the jaw.

ASSEMBLY

Place the nuts **7** in the sliders **14** and fit them on the screw **6** in symmetrical positions relative to the centre part of the screw. Set the whole inside the guiding blocks **2** and **3**. Don't forget to put some grease between the threads and on the sliding surfaces.

Fit the washer **8** with its screw **9** on **6**. Fit the collar 10 on **11**, don't forget to place a small brass pad under the screw **13**; screw the whole on **6** (it could be worth locking axially the sliders **14** with a clamp to ease this job). Adjust **11** for slight axial play, set and tighten **12**.

Assemble the whole on the holding shank **1**, screw on the axle **4**, adjust for slight axial play and tighten the counter nut **5**. All the moving contact points should receive some grease.

Assembling the knurls **17** and knurl holders **16** is straightforward.

SECOND FUNCTION: CUT KNURLING TOOL

It's only necessary to change the knurls and the knurl holders, see **photo 6** and **fig. 2**. This tool works like the more usual type, **photo 7**, the upper knurl is cutting while the lower is crushing for a forward rotation of the lathe spindle (there is a kinematics explanation in *Model Engineer* 4543), but the result is very good after one pass only and the depth of cut adjustment is easy with the graduated collar.

USING THE ATTACHMENT FOR CUT KNURLING:

Always be careful to set the right knurl at the right place, and the knurl holders **24** in the right position! They must be as shown on fig. 2 or you'll obtain bad looking knurls crossing at 30 degrees instead of 90 degrees. For example, if you want to go from the small diameter position (left of fig. 2) to the large diameter position (centre of fig. 2) the lower knurl holder will be exchanged with the higher one but the knurls also need to be exchanged between the holders. Remember that the screws **25** must always look toward the lathe chuck.

There is 0.4mm play specified

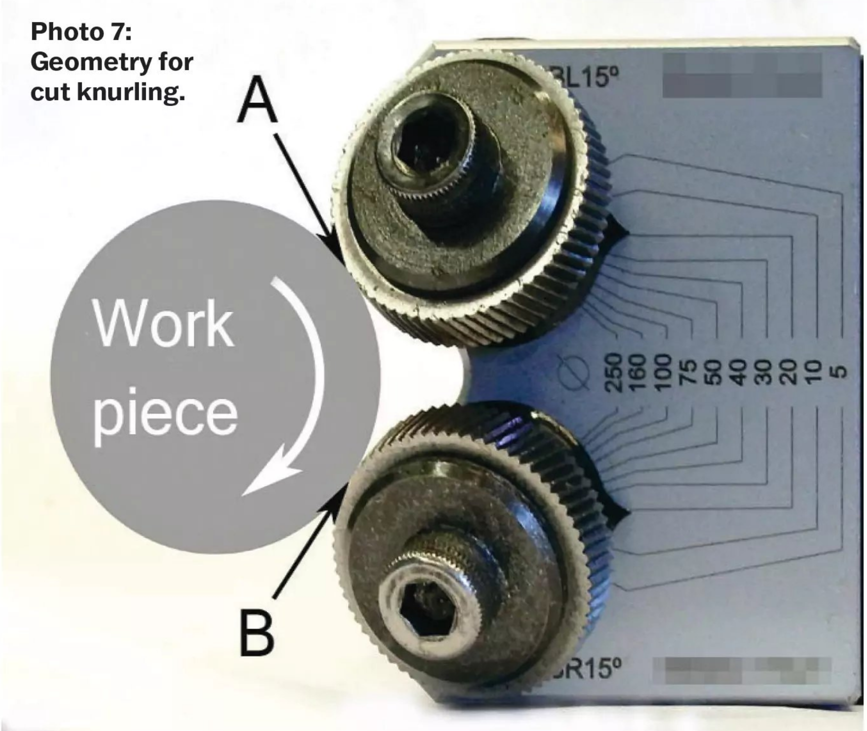


Photo 7: Geometry for cut knurling.

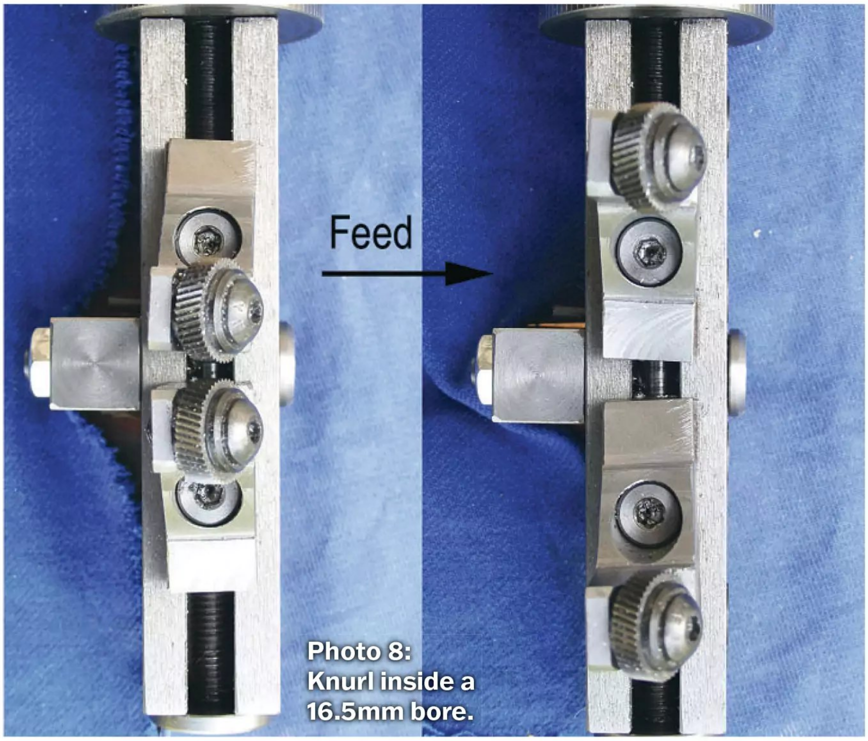


Photo 8: Knurl inside a 16.5mm bore.

Additional Parts List For Cut Knurling:

Ref.	No.	Name	Material	Remarks
24	2	Cutting knurl holder	FCMS	
25	2	Screw M5-15	8-8	Cheese head
26	2	Cutting knurl bearing	Silver steel	Hardened
27	2	Cutting knurl	Tool steel	See text
28	2	Cutting knurl bearing washer	Silver steel	Hardened

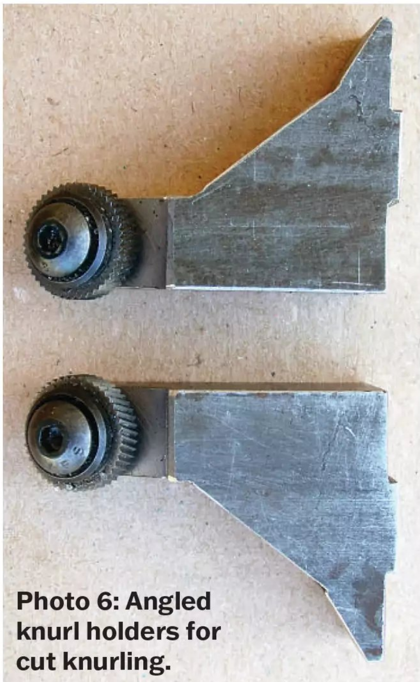
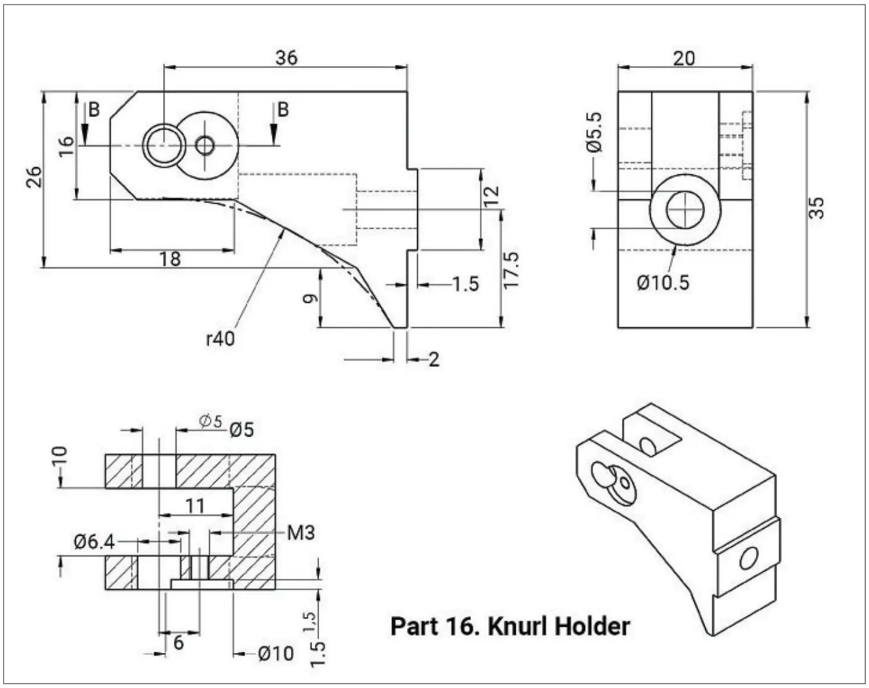


Photo 6: Angled knurl holders for cut knurling.



Part 16. Knurl Holder

between parts **24** and 14, so part **24** can rotate around part **15** to give about 1.5 degree clearance. Be careful to check the inclination relative to the feeding direction, **photo 8**. If there is no clearance, some swarf is crushed on the machined knurls and they won't form cleanly.

The holding shank **1** is clamped in a toolholder; adjust the pivot axis (part **4**) to centre height.

Adjust the cross slide for the knurl's axis to be in a vertical plane along the lathe's axis - a strip of 1mm thick gauge plate can help, see **photo 9**.

Tighten the knurls until just contacting the job for about 1.5mm length, 'zero' the graduated collar.

Give a squirt of cutting oil before starting the spindle.

Tighten the knurls (quite quickly to avoid double knurls) on the running part, take the knurl pitch from the graduated collar, feed for a few millimetres and stop the spindle to review the depth obtained.

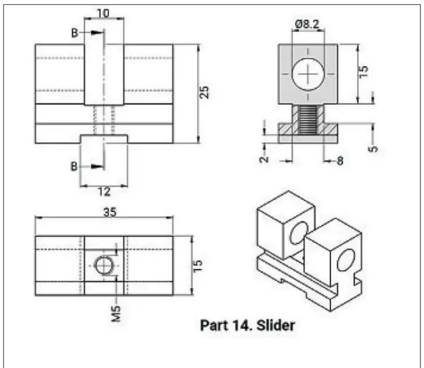
Start the lathe, go to the starting position to correct the depth if necessary, engage the self-act to machine the knurled part.

Sometimes the right-hand helix is deeper than the left-hand one; it's necessary to increase the depth of cut from 1.2 to 1.4 knurl pitches to cure this problem.

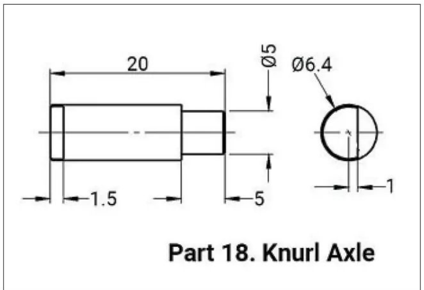
Stop the lathe after completion and remove the attachment, **photo 10** shows the result with mild steel.

In the next instalment I will give notes on making these parts and illustrate further additions for internal knurling a wide range of diameters.

To Be Continued.



Part 14. Slider



Part 18. Knurl Axle

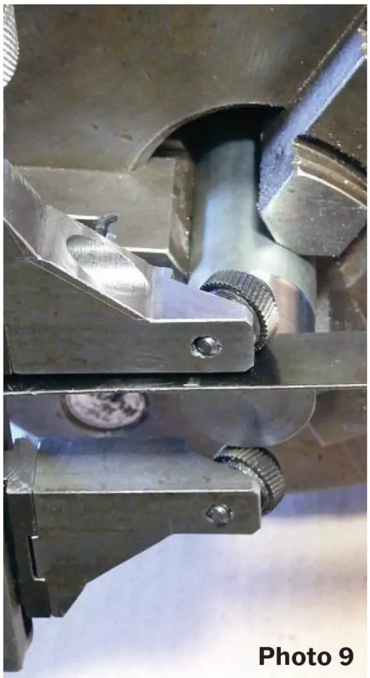


Photo 9

Photo 10

Photo 127: Drilling what will be the flanges.

Doug Hewson continues with the valve gear of his BR Standard Class 2. 155 of these locomotives, known as Moguls, were built for British Railways.

The BR Standard 2-6-0 Class 4 Tender Engine

Continued from Model Engineer & Workshop issue 4764

PART 16

There are two things missing from the valve gear as it was left in Part 14 (ME&W 4763) and they are the weighshaft and the return spring, which is largely there for decoration.

Plus, if you want to finish your chassis off you will also need the vacuum cylinder as it is quite visible - and even if you are not intending to fit the vacuum brakes on your engine it would be very nice to see it in there. I was speaking to a gentleman at a Harrogate Exhibition one day who was from Northern Ireland and he was building a 7¼" gauge 4MT but his name escapes me. (I think it was perhaps Geoff.) He saw my 4MT on our stand and exclaimed "Oh, so that's how you get your weighshaft in, is it?". The flange was missing off his drawing making it impossible to assemble! Anyway, he went away happy.

Photo 128: Parting off to form two flanges.

We will begin with the actual shaft and I began with the offending flange. I used a rotary table on my drilling machine and drilled six No. 43 holes, but you need, first of all, to turn a piece of bar down to 7/8" diameter and bore it 7/16", **photo 127.** If you part off at just over 5/16" long, you can then silver solder it in the centre of the shaft once you get that made. The shaft is shown on my drawing, **fig 58**, and you can then part that off halfway through the flange. This is shown in **photo 128**. This will just give a nice little amount to clean up to leave two flanges at 1/16" wide. **Photograph 129** shows the finished job.

There is a pair of lifting arms at 1 9/16" centres which will need fabricating. 3/8" inboard of the right hand frame plate there is another small arm set

Fig: 58

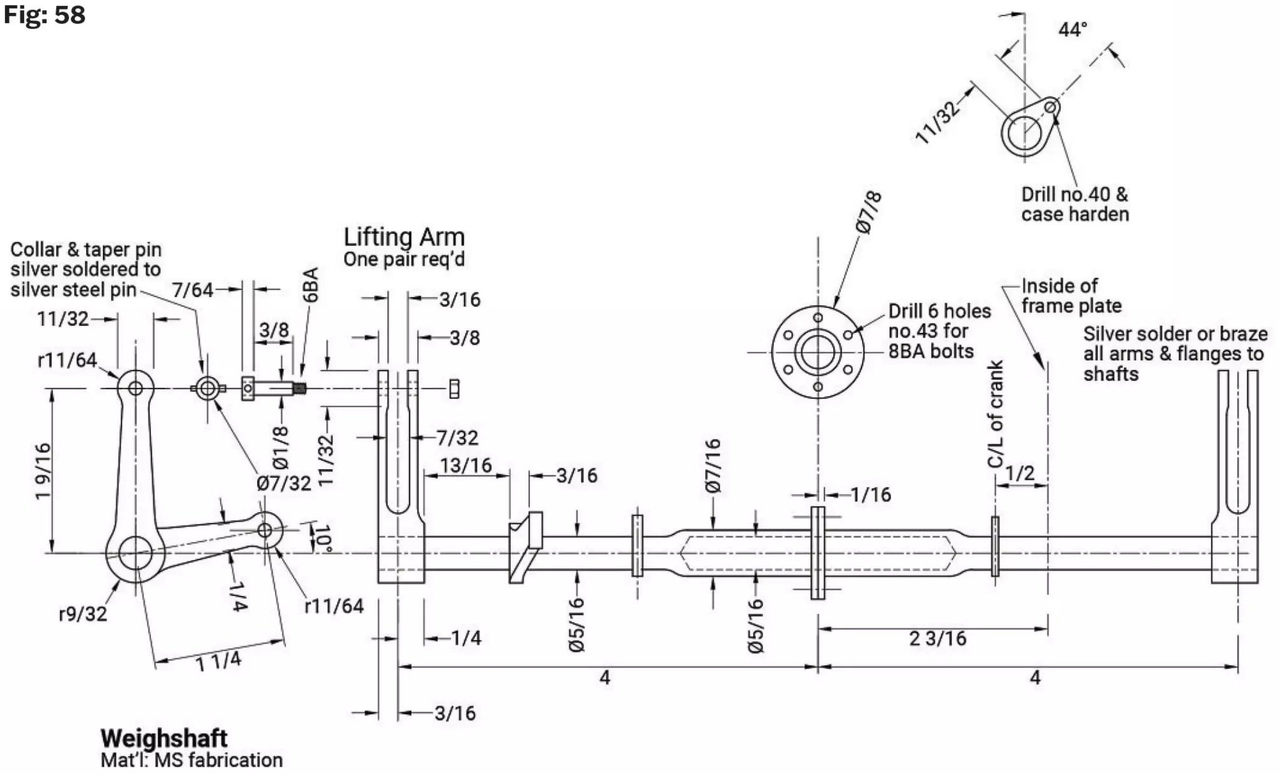


Photo 129: The completed weighshaft flange.

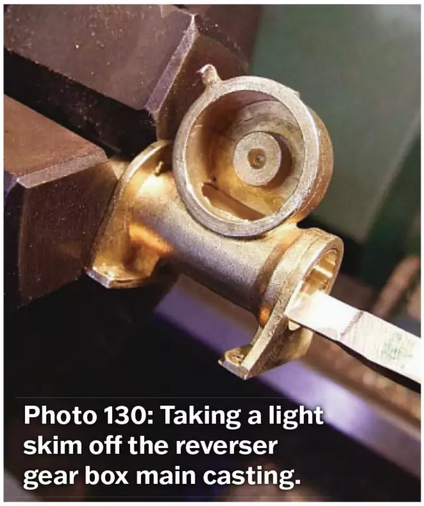


Photo 130: Taking a light skim off the reverser gear box main casting.

at 44 degrees which is connected to the weighshaft return spring, which we will come to later. If you like, you could finish the job off properly by drilling a 5/16" hole, 1 5/16" deep from the centre flange outwards. No, I know no one will ever see it but you will know that it is there!

We will now come on to the weighshaft return spring, **fig 59**. First of all, there is a bit of fabrication to do but I am sure that it won't hurt! This was one thing I missed off my own 4MT as it would not have been visible because of the tanks so - really sorry chaps, I haven't taken any photos.

There is a long shaft onto which the spring is fitted and that is 3 3/8" long. There is a plate which has a piece of 3/32" welding rod across the centre but perhaps I should have said half a bar as it needs half filing away! This is just to give a little bit of pivot to the spring when the gear reverses. The spring needs a bit of trial and error, but I would guess it should be no more than 20 swg wire x 3/8" diameter.

I think the next thing has to be the reverser gear box. I made twelve patterns for this piece of equipment and it is now on sale at The Steam Workshop. It was very gratifying that we did sell a few hundred of these when I was in business, but I made all of these parts while one of my friends was making a pattern for the manifold for the BR Standard engines. There are actually thirteen castings in the kit of parts as there are two universal joints. I have made several gear boxes for various people and I started on the main casting which has the indicator drum on the side. **Photograph 130** shows Geoff machining this piece. (I had to use the photos that Geoff Whittaker took for me while he was building 75069.) He only had to take a bit of a skim out of it. The next job was to drill

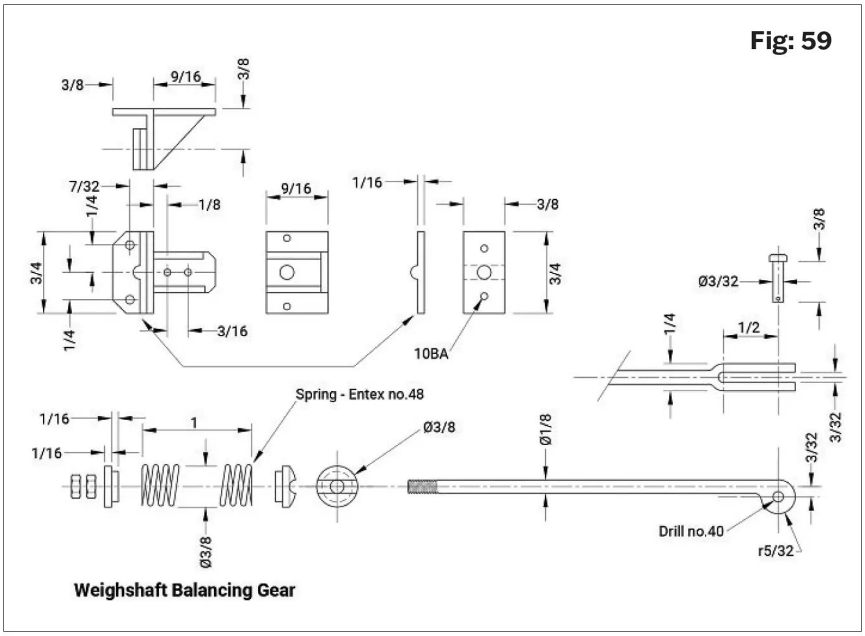



Photo 131: Drilling the branch.

and tap the branch and this is shown in **photo 131**. It will also be advantageous to machine down the flange of the branch as thin as possible to give better clearance to the operating handle, bearing in mind that you also need to machine the branch so that the lock is upright once assembled.

As shown in **photo 132**, I provided a chucking spigot so that the flange could be machined. I have just shown, in **photo 133**, where the hole needs drilling to give access to the grub screw on the shaft. One thing I must say about the indicator drum is that you need to counterbore the back of it so that it will fit over the protruding boss where the shaft is fixed in. The cap is just fixed on with a tiny drop of soft solder. I have chosen the gears so that the indicator drum reads the cut-offs correctly. Once the gear box is all machined and assembled it is now time to fix the stand in place; **photo 134** shows this bolted into the cab and **photo 135** shows the gear box in its rightful position. **Photograph 136** also shows the reverser gear box in


Photo 132: The casting has a chucking spigot.


Photo 133: Drilling the hole for a grub screw.

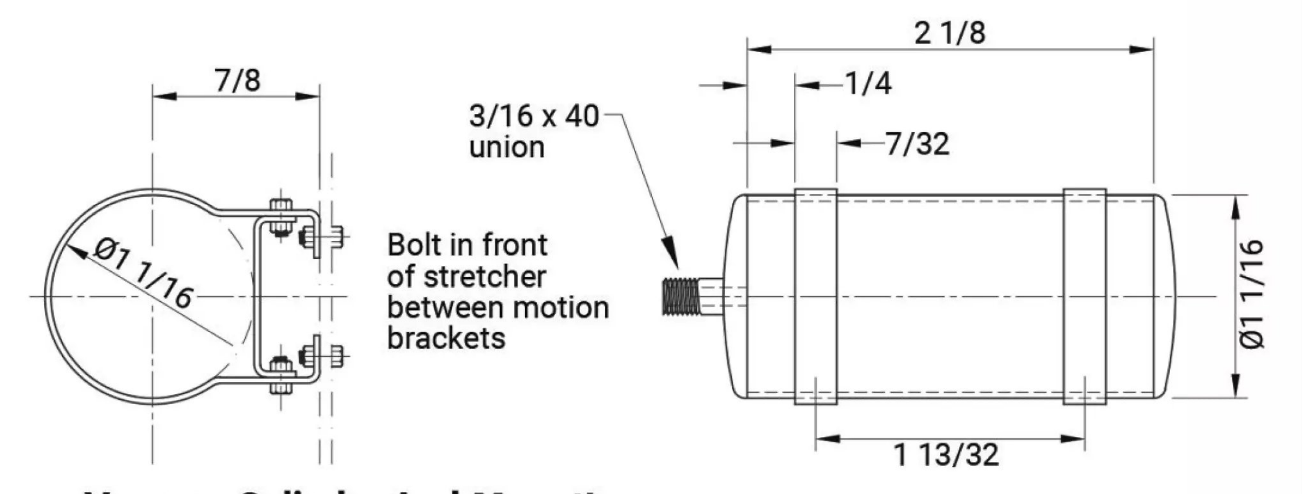


Fig: 60

position with one of the universal joints attached to the shaft ready to receive the torque tube down to the motion bracket. **Photograph 137** shows the gear box from a different angle so that you can see that it fits snugly in place. Geoff also fitted another universal joint into his cab to make it much easier to reverse the engine with an additional handle between engine and tender. This, of course, meant extending the shaft out the back of the gear box so that the UJ could be attached to it. This photo, **photo 138**, is the best view I could get of the arrangement. The alternative is to use a small file handle with a piece of 1/8" rod in it, about 4" long, with a loop on the end which you can slip over that handle, and you can wind

Photo 134: The stand bolted to the cab wall.

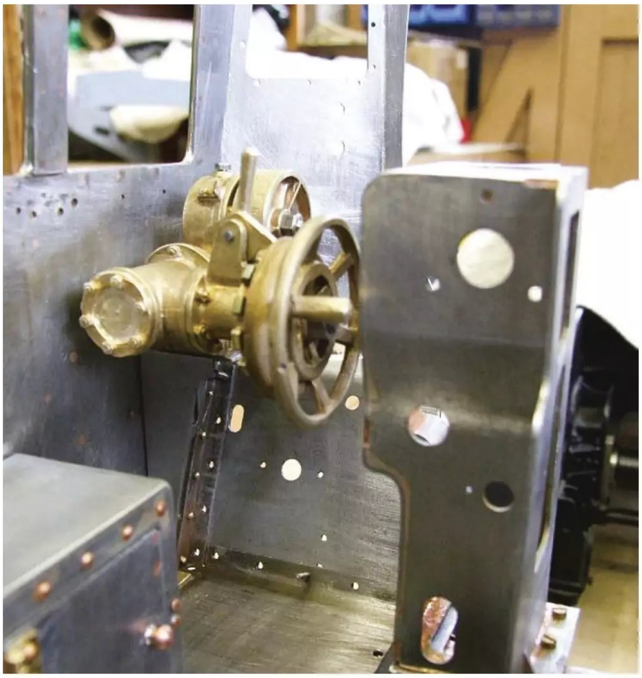


Photo 135: The gear box in its final location.

Photo 136: Another view showing the first universal joint.

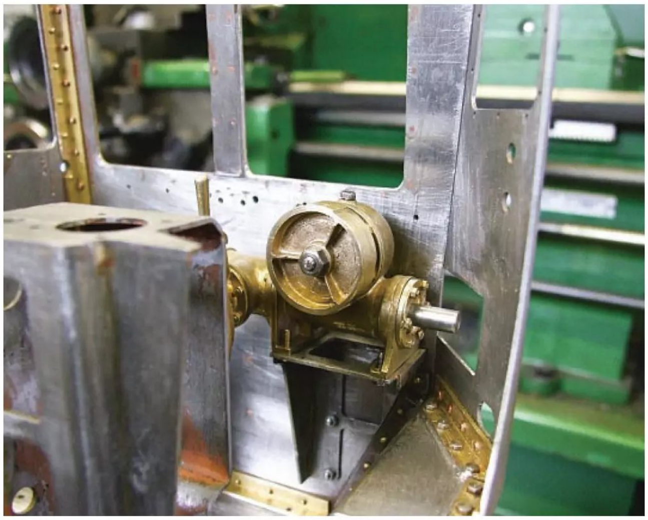


Photo 137: A third view to show how it fits snugly.

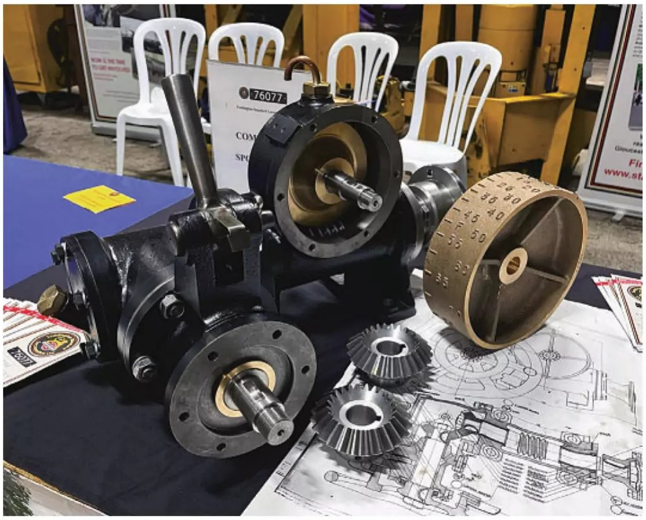


Photo 139: A new reverser gear box for 76077.

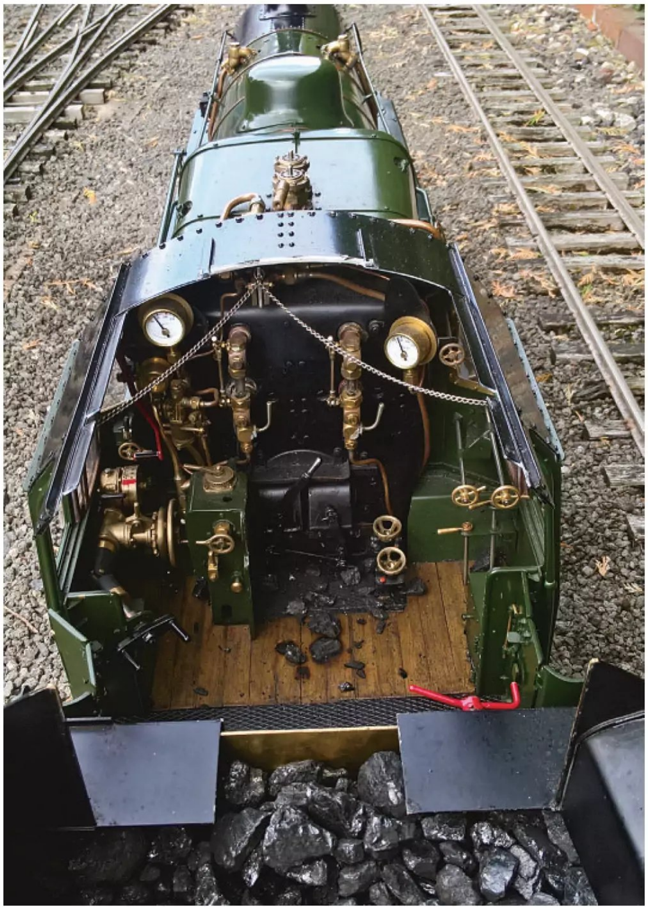


Photo 138: Additional universal joints bring operation closer to the driver.

Photo 140: The vacuum reservoir *in situ*.

this backwards and forwards to your heart's content!

I have also shown in **photo 139** the new full size reverser gear box for 76077 being finished off on Andrew Meredith's work bench.

One more little job that you can do in this session is make the vacuum reservoir. This is quite a visible item on your engine so even if it is a dummy it needs to be there for completeness. I have provided the drawing for it in **fig 60**. It is just a tin can, really, and it is bolted to the engine with a couple of straps to hold it in place. It needs bolting centrally to the back of the cross stay between the motion brackets. I am hoping that I have just given it a bit of clearance to keep it from resting on the stay below. **Photograph 140** shows it sitting there nicely out of the way. Please note, however, I may have shown it on the drawing the wrong way round. The inlet should be on the left hand side of the engine.

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

NUTS and SPANNERS

THOUGH there may be sound reasons-design or commercial-for the extraordinary locations of some nuts, bolts, setscrews and small detachable components, one may in moments of impatience attribute a certain lack of foresight to manufacturers. They have seen to it, of course, that assembly was a logical sequence, slick and straightforward and in reverse dismantling would probably be equally simple, though it may be quite different when a component has to be detached on its own.

Apart from a natural tendency to inaccessibility in complicated assemblies, the main cause of most difficulties seems to be the reduction to minimum dimensions of such features as flanges, bosses, lugs and pitch circles of bolts and studs. Of course, it makes for compactness and adds to strength. But often one could wish for just that little extra space-for example, round bolts on spot-faced seatings close to the adjoining mass of components.

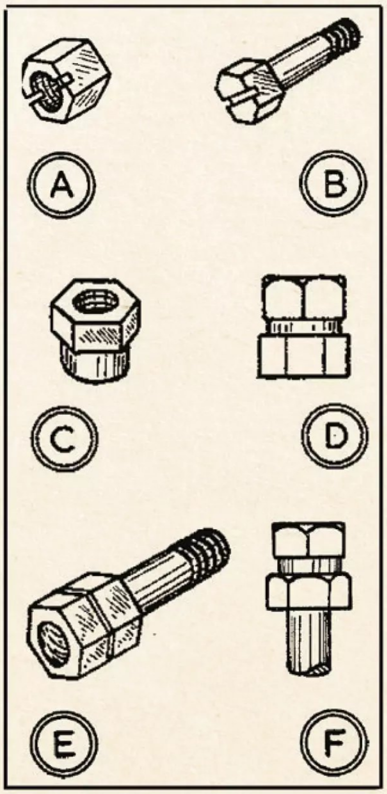
There are situations in which it is sufficiently easy to perform the initial loosening or final tightening of a nut or bolt with an open spanner, the removing or fitting proving tedious. Then a screwdriver slot cut with hacksaw or slotting saw across the end of nut or bolt, A and B, may prove helpful-for a screwdriver can often be used, particularly at an angle where a tubular box spanner cannot.

In other awkward situations, tubular box spanners may permit nuts to be fitted easily. If the corners of such a spanner foul the component they should be reduced just to clear by careful grinding or filing.

Given a lathe, hexagon bar, drills and taps, the type of nut at C can be substituted for ordinary ones too deeply sunken on spot-faced seatings and much subsequent trouble will be avoided.

The nut at *D* is a " double-hexagon off-set " type intended to permit assembly with open spanners where because of space restriction, angular movement is very limited and in situations in which ring spanners cannot be used-and where even the jaws of open spanners will not pass properly from one flat to another.

Round bar of over-the-corners diameter is used, drilled, tapped, reduced centrally with a parting tool. The corners of the hexagons are marked out of line (a flat to a corner) then the hexagons are carefully filed and, finally, the nut is parted off. In tightening or loosening, the spanner is shifted from one hexagon to the other, required angular movement thus being reduced by half.



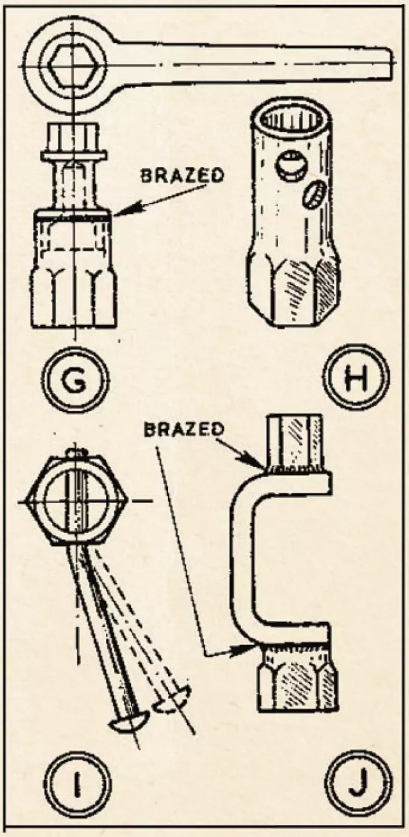
A deep bolt head, like a deep nut is often all that is required to facilitate assembly and dismantling. Special bolts can be turned from hexagon bar, a somewhat lengthy and deterring process, and another method, quicker and generally equally effective, is to braze an ordinary nut on top, *E.* If the double-hexagon principle is required a nut as C can be used on the bolt somewhat shortened, *F.*

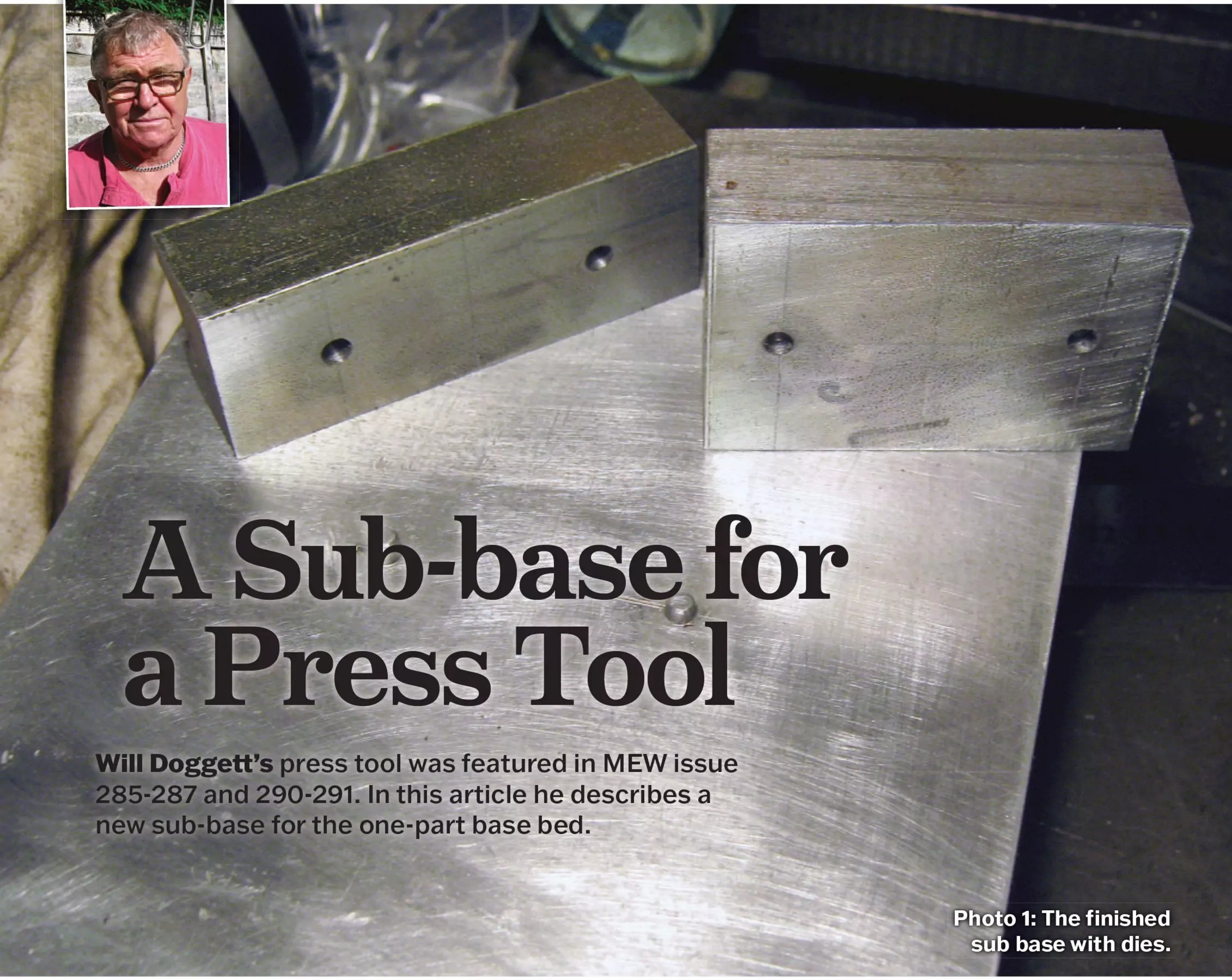
For sparking plugs of car engines which demand a tubular box spanner the modification at G to the standard spanner is very useful. This permits an open or ring spanner or the ratchet jack handle to be used-with the advantages of small angular movement and working at the most convenient position.

From round mild steel, a stem or neck piece is machined to push into the tubular spanner. It is then drilled for lightness and given a filed hexagon on top to take whatever spanner is used. The piece is brazed in.

Half the normal angular movement on tubular box spanners can be obtained by drilling another cross hole, as H, in line with the corners of the hexagon when the original is across flats. Another method, to the same effect, is to bend the tommy bar slightly, I-and the two can, of course, be combined.

An " avoiding " spanner for projections can be made as **J** from a tubular box spanner. A piece of stout rectangular bar is turned U-shape deep enough for clearance, then the cut-off spanner is brazed on one end and a piece of hexagon bar on the other. Thus any suitable spanner can be used.





A Sub-base for a Press Tool

Will Doggett's press tool was featured in MEW issue 285-287 and 290-291. In this article he describes a new sub-base for the one-part base bed.

Photo 1: The finished sub base with dies.

After using the press tooling to form some square sections I found it was difficult to hold the base die in the correct position under the former all the time, as it would sometimes move around when using larger pieces of material. This required a solution.

The answer was to make a sub base with locating pins on the top to locate the dies, **photo 1**, and a locating ring that fits the base bed hole. **Photograph 2** shows the press without a bed fitted, and **photo 3** is the one-part bed with the locating hole fitted. The materials for the sub base and locating ring to hold it in position are shown in **photo 4**.

The material for the sub base is a piece of aluminium 120 x 130 x 20mm thick and the round is a piece of mild steel 50mm long with 35mm and 40mm diameter sections before machining to size.

The first part to be made was the stepped locating ring. The material was put in the lathe chuck, holding it on the 35mm section, and the 40mm part was turned with just a light cut to true it up on the diameter. It was then faced and an M8 clearance hole was drilled to about 25mm deep, then this hole was de burred. A 5mm deep step was then turned to fit the hole in the in the base bed. The ring was then parted off at 10mm overall, **photo 5**, and deburred .

The base was next to be marked out

Photo 2: The press, as described in MEW 285 -287.

Photo 3: Original one part bed fitted.


Photo 4: Materials for the sub-base.

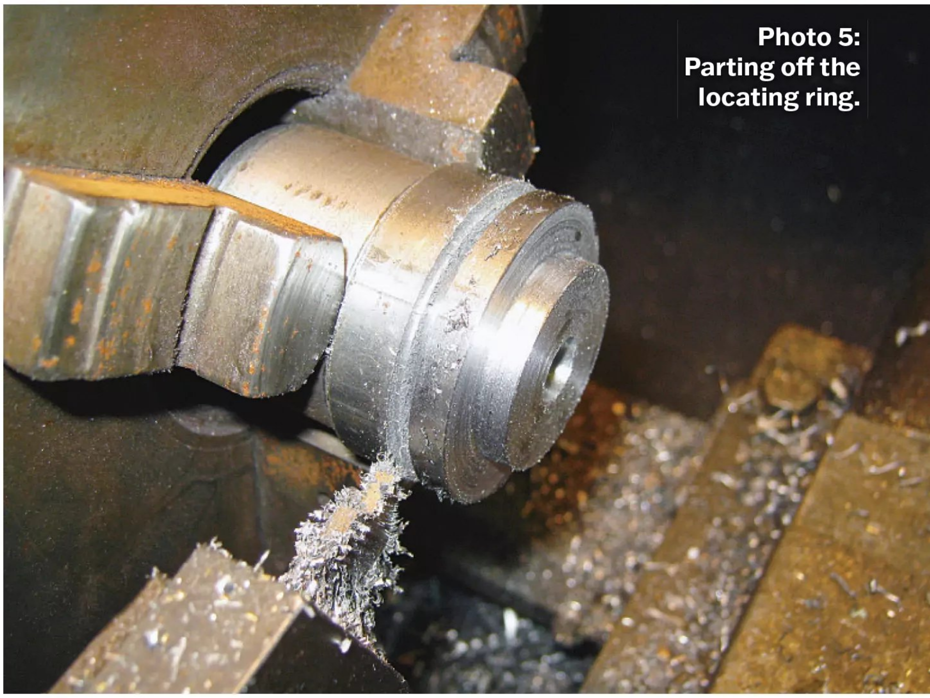


Photo 5: Parting off the locating ring.

for the fixing stud. This I did by placing a rule from corner to corner and marking a line on the centre line. This intersection point was centre punched and drilled for an M8 thread part way through. I then put an M8 thread in the hole. I cut a piece of M8 threaded rod roughly to size and fitted the sub base to the press base bed. **Photograph 6** shows the underside with an over length stud holding the parts together. The stud was shortened later.

Setting the position off the sub base to the press base was done next. The sub base was positioned on the press base and then I measured from the corners of the sub base to the front of the press base edge to get the two parts parallel with each other, **photo 7**. Next, I marked a line across in front of the sub base on the press base bed; this will help when refitting the sub base at a later date.

To set the centre line for the die locating pin's position I fitted the press screw chuck to the press ram and then fitted the square former, **photo 8**, to the screw chuck. I then placed the one-part base with the sub base fitted on the support bars of the press and lowered the ram, so the square former was making contact, then marked the position where the former's V was touching the sub base. This will be the horizontal centre line for the die locating pins.

Moving on to the dies, these were marked out on the underside on their centre lines in both directions. From the width line I marked a line 20mm each way giving a 40mm pitch for


Photo 6: Test fitting.

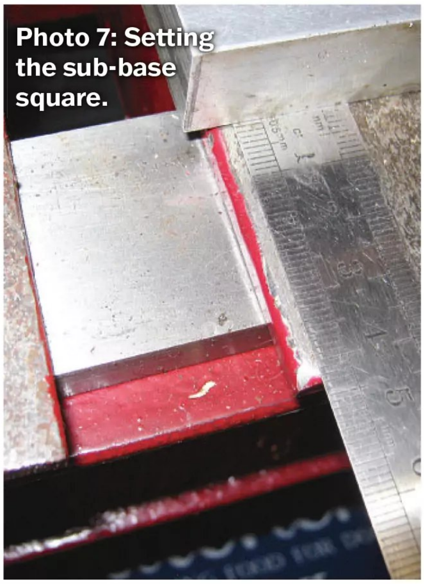


Photo 7: Setting the sub-base square.

Photo 8: Square former.

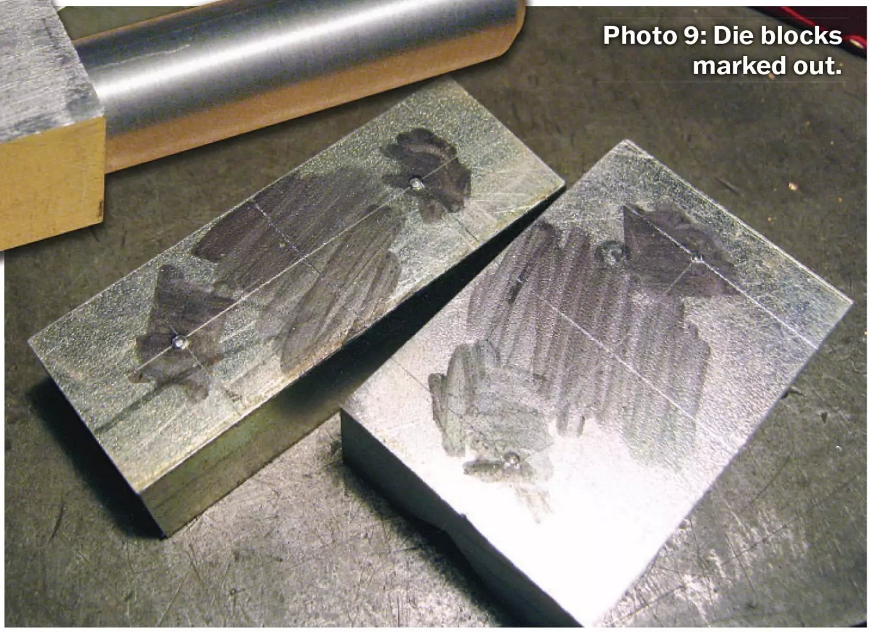


Photo 9: Die blocks marked out.

Photo 10: Drilling locating holes.

the holes on the long face, **photo 9**. These were going to be drilled as they were, but I then thought about using the milling machine with the indexing facility on it. I put the first of the dies in the milling machine vice and centred the drill on the centre lines, then indexed 20mm to the left and drilled a 4mm hole about 10mm deep. I then zeroed the digital readout, moved the table 40mm and drilled the other hole in the same way. **Photograph 10** shows the second hole being drilled and **photo 11** shows the indexing on the digital readout. The other die was drilled in the same way as the first, **photo 12**.

The sub base was initially marked out but was fixed to the machine vice and indexed the same way as the dies. The locating pins were made from some 4mm round steel, the part of the pin that fits the dies was reduced in diameter slightly to make an easy fit for the dies but without any movement of the die when fitted. **Photograph 13** shows the pins test fitted before the sub base was cleaned up and finished. ●

Photo 11: Indexing locating holes on the mill.

Photo 12: Finished die block.

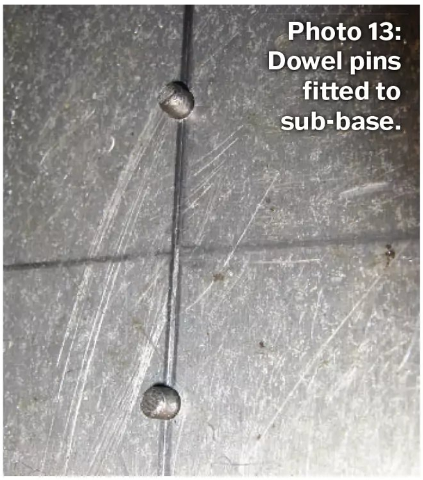
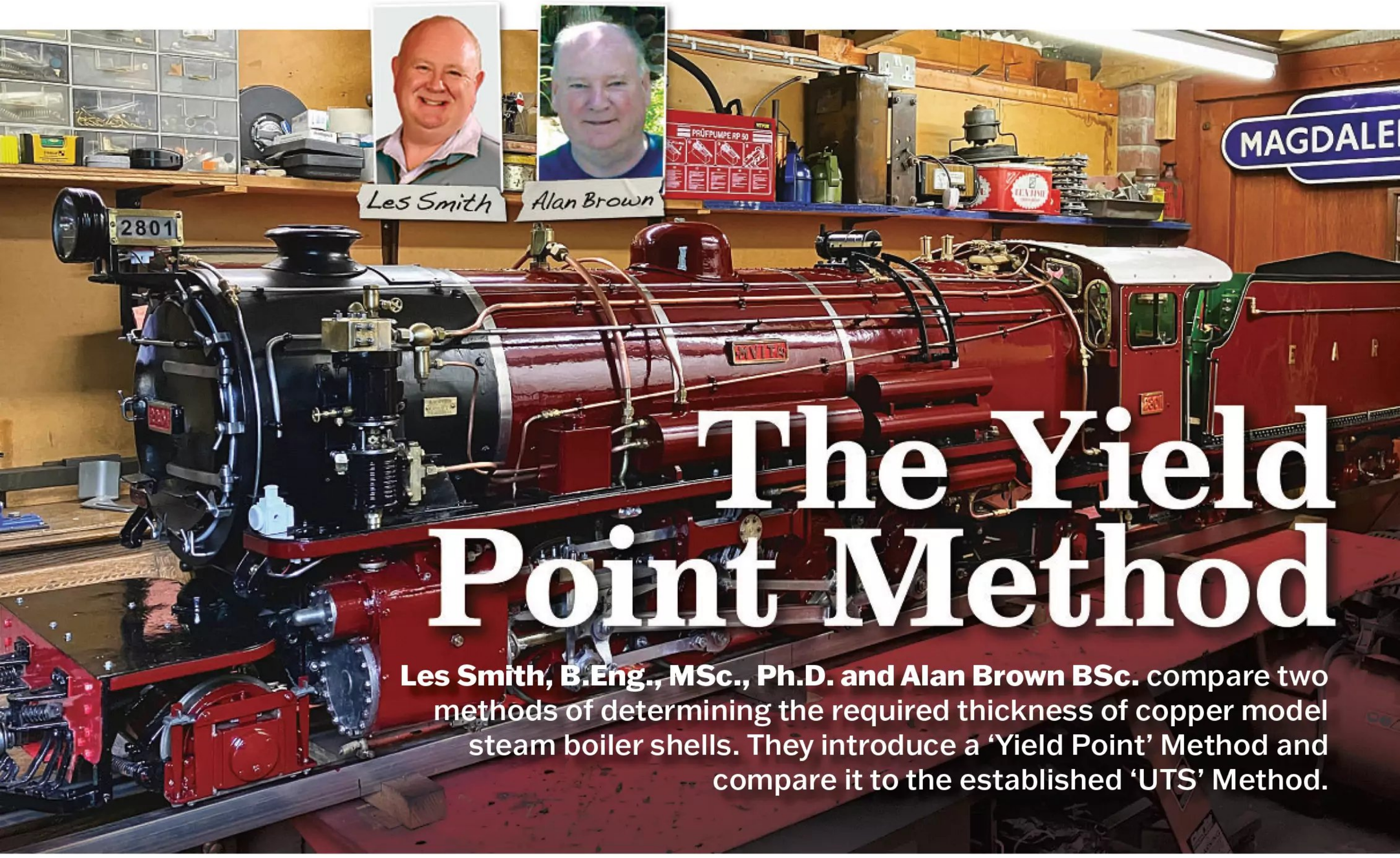


Photo 13: Dowel pins fitted to sub-base.



The Yield Point Method

Les Smith, B.Eng., MSc., Ph.D. and Alan Brown BSc. compare two methods of determining the required thickness of copper model steam boiler shells. They introduce a 'Yield Point' Method and compare it to the established 'UTS' Method.

THE UTS METHOD

Over the years the thickness of a boiler shell has been determined by multiplying the Ultimate Tensile Strength (UTS) of cold worked (or cold drawn) copper by the Working Pressure (WP) then by an arbitrarily large safety factor (SF), typically 8. A Temperature Factor is also sometimes applied. This will be called 'The UTS Method'.

The fact is that when copper is heated during the brazing (silver soldering) process, the strength of the material is dramatically reduced in the heated zone because of the annealing effect, see **fig 1**.

The original UTS figure used to determine the boiler thickness, therefore, becomes invalid. The yield strength of annealed copper can be as much as one sixth of the original cold rolled copper material.

The calculations below illustrate that boilers having wall thicknesses sized using the UTS Method are susceptible to permanent deformation during pressure testing.

However, many model steam boilers have been constructed of copper and brazed (silver soldered) where the UTS Method has been used to determine the shell thickness but there are few reported cases of boiler failure or permanent deformation. The reason for this may be because, firstly, in many cases the entire boiler shell is not heated to annealing temperature and the remaining material strength thereby remains largely unaffected and, secondly, any amount of deformation is not noticed or is considered 'acceptable' by the tester.

If this is the reason, then it is a rather haphazard and unpredictable design method. In the case, for example, of a boiler barrel rolled from flat plate and having a lap joint, the annealed zone could be extensive.

If proper engineering procedures and practices are to be followed it is unacceptable to say that because there have been no failures, then the formulae and assumptions used during the design process must be correct.

THE YIELD POINT (YP) METHOD

The yield value of copper has been mentioned in a few forums but no one has proposed an update to the traditional UTS Method formula.

This article presents a new formula removing the arbitrary safety factors from the UTS equation. Instead it uses the Yield Point (YP) value of copper to give a minimum wall thickness for a boiler and also allows the designer to add an appropriate safety factor based on the environmental situation the boiler will be subject to during its operation.

It allows for the reduction in yield strength of the copper due to annealing during the brazing (silver soldering) process.

This new method uses sound engineering principles and does not rely upon the large safety factors of the UTS Method that have neither scientific nor logical basis.

OBJECTIVE

The premise of the new method is that when subject to the maximum expected pressure during hydraulic testing, the boiler will not deform permanently. This cannot be guaranteed with the UTS Method.

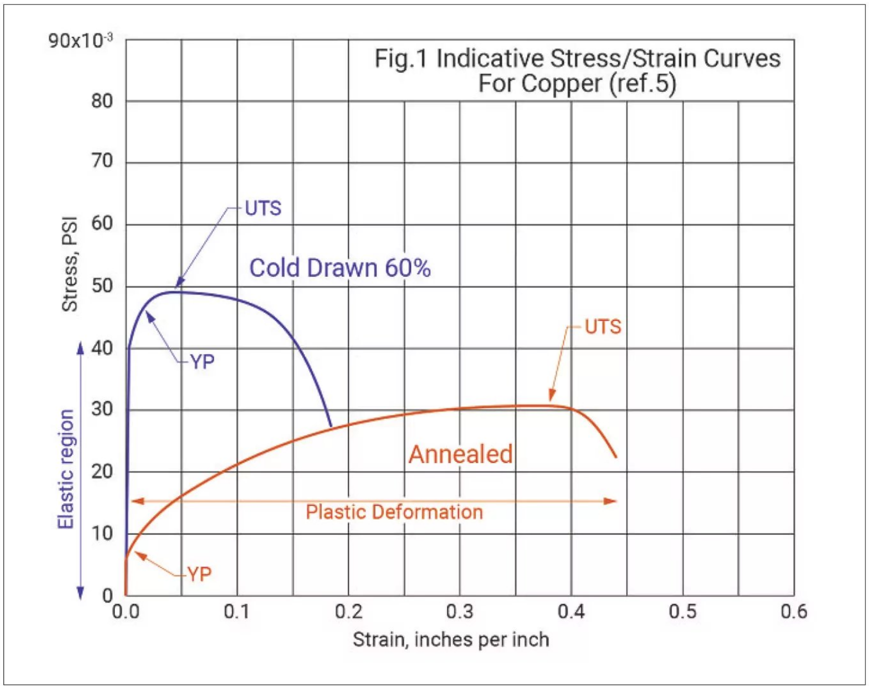
For the YP Method the maximum stress in the boiler shell must not exceed the yield point of annealed copper.

REFERENCES - SUMMARY

The following published books form a key component of this article:

- *Model Engineering* by Henry Greenly, 1915
- *Model Boilers and Boiler Making* by K.N. Harris, 1967
- *The Model Steam Locomotive* by Martin Evans, 1983

These books may well have been superseded, or even withdrawn, and they all carry a warning that the content may not be to current safety standards.



Further details are given in the References section at the end of this article together with other references.

ASSUMPTIONS AND LIMITATIONS

The Yield Point (YP) Method is intended to apply to model steam boilers made from copper and brazed (silver soldered) in the range up to around 6" in diameter; much above that size a more detailed analysis may be appropriate. The YP Method may also be used to determine the minimum thickness of water-tube (monotube) boilers.

The method is intended to determine the safe minimum thickness of the shell of a cylindrical boiler. The joint efficiency of longitudinal lap joints has not been allowed for and is assumed to be the same for both methods. No consideration has been given to the strength and hence thickness of other sections of the boiler, such as flat plates, tube plates, fireboxes, etc., and such items are excluded from this discussion.

The YP Method is not applicable to fire tubes because fire tubes are placed under compression by the boiler pressure and the YP Method is only applicable to tubes under tensile stress.

It is recognised that the shell of some copper boilers, i.e. those using a straight piece of cold drawn copper for the boiler barrel, may not be heated to annealing temperature but that cannot be guaranteed, and some heat will be applied to all of the shell either by silver soldering of bushes for fittings or by conduction when silver soldering the boiler tube plates.

It is noted that there is not a single point where copper is annealed, annealing happens between 200 and 400 degrees C, silver solder melts at 630 degrees C so the area that is silver soldered is 100% annealed and the surrounding area will be annealed to some extent.

The maximum static pressure a boiler is normally expected to withstand during its lifetime will be the hydraulic test pressure. This is taken by Harris to be twice the working pressure (Page 126), as does Evans (Page 152).

STRENGTH OF COPPER

The key to understanding the strength properties of copper is to understand how copper deforms when placed under stress as illustrated by the stress/strain curve.

We apologise if the explanation of the stress/strain curve below is familiar to the reader but understanding it is essential to understanding of the UTS and YP Methods.

THE STRESS/STRAIN CURVE

When a metal is placed under stress i.e. it is pulled by a force, the material stetches in a manner like stretching an elastic band. If the stress is reduced again the material returns to its original length. This is called elastic deformation. The distance by which the material stretches is proportional to the force applied. If the 'amount of stretch', called the strain, is plotted on a graph horizontally and the applied stress plotted vertically the result is a straight line. The slope of the line is stress/strain and is called the Elastic Modulus (also known as Young's Modulus) with the symbol E.

If the load (stress) on the material is increased further the material deforms permanently, called plastic deformation, and eventually fractures.

Figure 1 showing how copper behaves throughout this cycle is called the stress-strain curve and it provides valuable insights into a material's behaviour under tension.

Here are its key features:

1. Elastic Region:
- Initially, the material behaves elastically, meaning it returns to its original shape when the load is removed.
- The stress increases linearly with strain during this phase.

2. Yield Point (YP):
- Beyond the elastic limit, the material undergoes plastic deformation.
- The Yield Point (YP) represents the stress at which elastic deformation ends and plastic deformation begins.
- Yield Strength (YS) is the stress at this point.

3. Plastic Deformation:
- In the plastic region, the material deforms permanently.
- Strain continues to increase even if the load remains constant.
- Ductility is the ability to withstand plastic deformation.

4. Ultimate Tensile Strength (UTS):
- The highest stress the material can withstand before breaking.
- UTS occurs at the peak of the stress-strain curve.

5. Fracture Point:
- Beyond UTS, the material necks down and eventually fractures.
- Fracture strength is the stress at this point.

ULTIMATE TENSILE STRENGTH (UTS) OF COPPER

The quoted Ultimate Tensile Strength (UTS) of hard (unannealed) copper varies according to the material and source of information. In particular the UTS depends upon the 'hardness' of the copper which is determined by how 'hard' the copper has been worked in its cold state during production. Here are some published figures of the degrees of copper hardness and corresponding UTS at room temperature:

Cold Drawn	Cold Drawn 60%	Cold Drawn 26%	Unstated	Unstated	Unstated	Units
Ref 4	Ref 5	Ref 5	H Greenly	M Evans	KN Harris	
49,900	48,400	51,800	29,000	25,000	25,000 *	psi

* At (unstated) boiler working temperature.

For the purposes of the examples following below, the figure of 25,000 psi is chosen to be consistent with the referenced books.

Yield Point (YP) of Annealed Copper

Again, the quoted yield point (YP) of annealed copper varies according to the source of information

Ref. 1	Ref. 2	Ref. 5	Units
4,786	4,830	6,700	psi

For the purposes of the examples following below, the figure of 4,830 psi (ref 2) is chosen as this seems to be the most reliable source of information.

THE YIELD POINT METHOD CALCULATION

Allowable Pressure (AP) Testing Procedure

In the absence of any more authoritative figure, the YP Method uses the well-known 'two times the working pressure' as the test pressure and the Allowable Pressure (AP). However the authors recognise this value is somewhat arbitrary.

There may be operational factors acting on the boiler that will increase the shell stress but that cannot be readily determined. A boiler for a model traction engine, for example, will have additional stresses derived from its own weight when travelling over rough terrain.

Due to the wide range of uses and environments a steam boiler can be employed in, the authors have not added any allowance for such environmental conditions and leaves it to the boiler designer to account for such factors in the design.

CALCULATION FORMULA

The Barlows Formula

The Barlows formula is the industrial standard formula used to calculate the stress in the walls of pipes and shells of boilers.

As explained by **fig 2**, in a boiler of diameter D, and internal pressure P, the force on the shell per unit length will be PxD. This will be resisted by twice the boiler shell thickness T, per unit length.

In other words, imposed stress S, per unit length = (P x D)/2T;

(psi x inches/inches = psi)

Rearranging this we get:-

T = (P x D)/(S x 2), where:

P = Pressure, psig

T = nominal wall Thickness, in inches

D = outside Diameter in inches

S = allowable Stress in psi

The YP Method

Since P = AP = 2 x WP, and S = YP,

T = (WP x 2 x D) / (YP x 2) inches.

Substituting value for S = YP = 4,830 gives

T = (WP x D)/4,830 inches.

YP Method Versus UTS Method - Comparative Examples

Example 1

Taking a known published design for a G.W.R. boiler for a 5" gauge locomotive from Page 150 of *The Model Steam Locomotive* as an example, where:

Diameter	D	=	4.75	inches
Working Pressure	WP	=	110	psi
Shell Thickness	T	=	13	swg
Shell Thickness	T	=	0.092	inches (just under 3/32")

YP Method

T = (WP x 2 x D) / (YP x 2) inches

= 110 x 2 x 4.75 / (4,830 x 2)

= 0.108 inches. (12swg)

UTS Method

Following the UTS Method:

A = (D x WP x F)/(S x T x 2)

Where:

A is the shell thickness in inches

D is the boiler diameter in inches

WP is the Working Pressure in psi

F is a safety Factor

S is the ultimate tensile strength of the material in psi/square inch

T is a Temperature allowance

Using the factors recommended by Martin Evans we have:

A = (4.75 x 110 x 8)/(25,000 x 0.8 x 2)

A = 4,180/40,000

A = 0.1045 inches – (12swg, thicker than the 13swg selected) being <u>85% of the YP Method thickness.</u>

At what pressure would this boiler exhibit permanent deformation, i.e. exceed the yield point of annealed copper?

Taking the Yield Point equation, (AP x D) / 2T = YP) and rearranging for AP,

AP = YP x 2T/D

= 4,830 x 2T / D

= 170 psi

In other words, the boiler would start to deform permanently just before the recommended test pressure of twice the working pressure = 220psi.

Example 2

From page 31 of *Model Boilers and Boiler Making* by KN Harris, example 2:

Diameter	D	=	6	inches
Working Pressure	WP	=	90	psi
Shell Thickness	T	=	3	mm
Shell Thickness*	T	=	0.0865	inches

YP Method

T = (WP x 3 x D) / (YP x 2) inches

= 90 x 3 x 6 / (4,830 x 2)

= 0.168 inches. (About 11/64" – just less than 3/16", approximately 7 ~ 8swg, 4.267mm.)

UTS Method

Following the UTS Method:

A = (D x WP x F)/(S x T x 2)

Where:

A is the shell thickness in inches

D is the boiler diameter in inches

WP is the Working Pressure in psi

F is a safety Factor

S is the ultimate tensile strength of the material in psi/square inch

T is a Temperature allowance

Using the factors recommended by Martin Evans we have:-

A = (6 x 90 x 8)/(25,000 x 1** x 2)

A = 4,320/50,000

A = 0.0864 inches – (12 thou under 3/32", 13~14swg, 2.2 mm) <u>51% of the YP Method thickness.</u>

* The example in the book includes a 95% allowance for a lapped joint, showing a thickness of 0.0864/0.95 = 0.091 inches.

** Harris does not make a Temperature Allowance as Evans does.

At what pressure would this boiler exhibit permanent deformation, i.e. exceed the yield point of annealed copper?

Taking the yield Point equation, (AP x D) / 2T = YP) and rearranging for AP,

AP = YP x 2T/D

= 4,830 x 2T / D

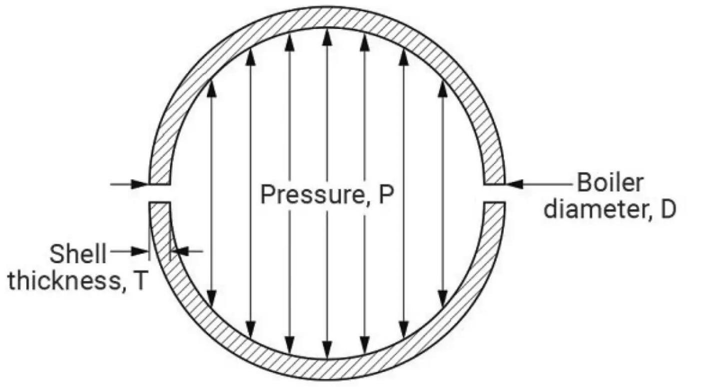
= 139 psi

In other words, the boiler would start to deform permanently well before the recommended test pressure of twice the working pressure = 180psi.

FURTHER OBSERVATIONS ABOUT THE YIELD POINT METHOD

Due to the inherent characteristics of the YP formula the resulting boiler shell thickness will always be slightly above that calculated by the UTS Method, therefore, arguably, a safer boiler would result.

So, if the benefits of using the YP Method include avoiding permanent



Per unit length of boiler,
stress on boiler shell, S = P x D
Resisted by twice the boiler shell thickness, T x 2

$$\text{Stress, } S = \frac{P \times D}{T \times 2}$$

Fig.2 Barlows Formula Derivation

deformation during testing, no matter how much of the boiler has been annealed during brazing, and a safer boiler, for only a very slight increase in boiler shell thickness, why not adopt it for future boiler designs?

REFERENCES

The following references form a key component of this article:

Published Books

Model Engineering by Henry Greenly, 2004
First Published in 1915
ISBN 1 55918 312 8

Model Boilers and Boiler Making by K.N. Harris, 2000
First Published in 1967
ISBN 1 85761 114 4

The Model Steam Locomotive by Martin Evans, 1991
First Published in 1983
ISBN 0 85242 817 0

The following references are relevant to this subject but not directly quoted in this article for copyright or unavailability reasons:

Shell boilers. Part 3: Design and calculation for pressure parts BS EN 12953-3:2016, Copyright.

Australian Miniature Boiler Safety Committee (AMBSC) Code Part 3, Download Unavailable.

WEBSITES

Universal Barlow's Formula https://www.worldwidepipe.com/barlows-formula.html

Pressure Systems Safety Regulations 2000 (PSSR)

https://www.hse.gov.uk/pressure-systems/pssr.htm

Properties of Copper

Ref 1 https://material-properties.org/Copper-mechanical-properties-strength-hardness-crystal-structure/

Ref 2 https://www.matweb.com/search/DataSheet.aspx?MatGUID=9aebe83845c04c1db5126fada6f76f7e

Ref 3 https://www.matweb.com/search/DataSheet.aspx?MatGUID=1980eb23287a4408adc404dd39293942&ckck=1

Ref 4 https://www.matweb.com/search/DataSheet.aspx?MatGUID=ca486cc7cefa44d98ee67d2f5eb7d21f

Ref 5 https://www.copper.org/resources/properties/144_8/

Mechanical Properties of Copper and Copper Alloys at Low Temperatures https://www.copper.org/resources/properties/144_8/

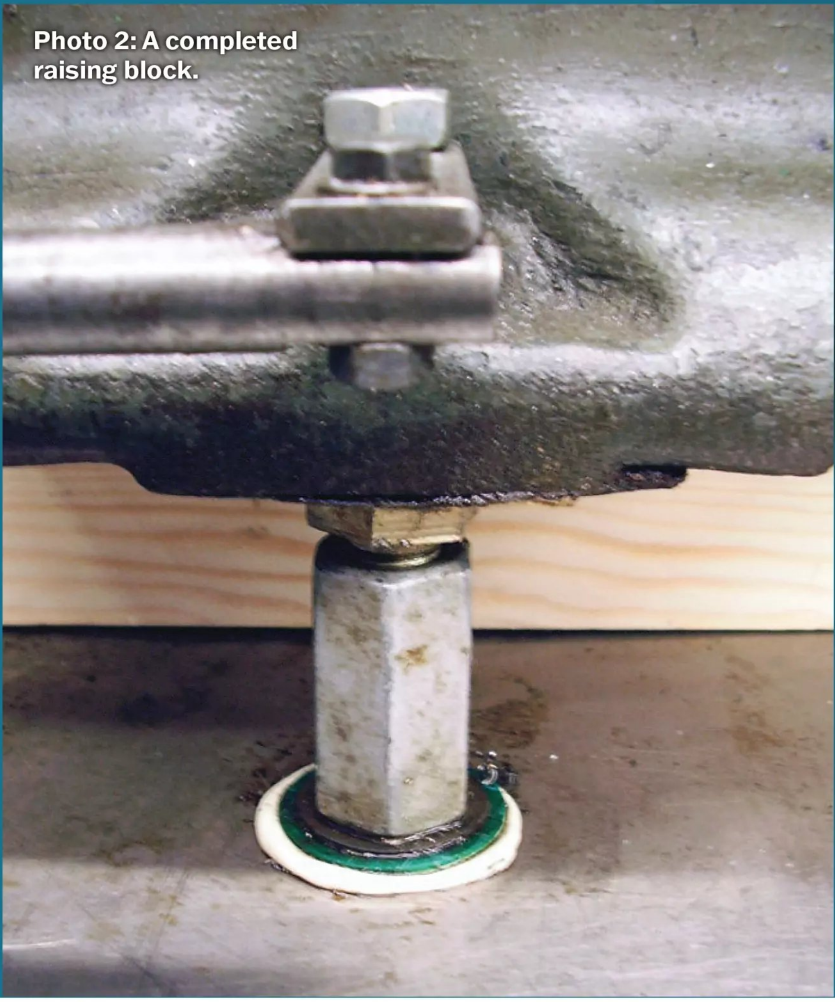


Photo 2: A completed raising block.

Photo 1: A single M12 studding connector.

Lathe Raising Blocks

Mike Joseph

I needed and wanted to be able to clean my Myford lathe and in the restricted space of my workshop I am not able to get around the back easily. In fact, it is more of a commando exercise warm up to struggle through the obstacle course of lathe, shelving, detritus and the bits that have 'gone over the edge'. Also, I have added an auto-stop (I must get around to adjusting it properly some time) and this makes scrabbling under the lathe challenging.

I decided on some raising blocks and searched online, where I found that raising blocks seemed quite costly for what they are.

Looking at some posts on the Model Engineer website, various people had made their own. The basic idea is to have four blocks, threaded so that they can lift or lower the lathe feet ('levelling') and then be tightened by a bolt through them to the underside of the stand so I drilled and tapped some M12 bolts to M8 for studding and then set about making the 'blocks'.

With some steel about 1.5 inches diameter (or 40mm in new money) I drilled some holes to tap to M12 and then found that I could not hold the steel tight enough against the torque of the tap and ensure that it was vertical. What to do now? I left the task unfinished.

A few days later I was flicking through the Orbital Fasteners catalogue, **ref 1**, and my eye was caught - nay, verily dragged back unto the page upon which I discerned 'Studding Connectors' in various sizes. So easy! I picked the M12 x 36 size because I had already prepared the adjusting screws, **photo 1**. Sizes up to M24 are available and would give a more solid base. (Imagine tapping the bolts for those monsters a mere M8 or so). What a bit of luck!

Lifting the tailstock end of the lathe was easy, but the headstock is weighty and at first I called upon two of my neighbours to seek assistance but neither (wisely) was available. Think again. (Not normally the department that I go to first.) Who was it who said, 'give me a lever long enough and I can move the World'? And lo, I recalled that I have a collection of crowbars sitting idly by (seven at the last count). With a little packing I lifted the lathe bit by bit and slid the connectors under. Shades of the Severn Bridge but without the manpower, steam, crowds or the celebration afterwards. Okay … that last bit is a lie, I did have a couple.

And then I found that the suds were leaking through the holes, a few days later. What you see at the base of the stud is some silicone sealant that was squirted under the connector, **photo 2**. A piece of cork would probably have been better, but it works well enough. On top of the foot of the lathe is part of my auto-stop system. I might write that up some time, but I will have to reverse engineer it!

Now I just need to clean the lathe.

P.S. It is not the only time that a bright idea has occurred by looking through a catalogue – see *Model Engineer* 4730 for an angle plate built up from a quality fire door hinge.

Reference

Ref 1: Orbital Fasteners, Olds Approach, Tolpits Lane, Watford, Herts WD18 9XT (www.orbitalfasteners.co.uk) – one can buy a single bolt or nut if you wish and they have a vast range of 'stuff' – usual disclaimer.

Three Giants of the Industrial Revolution

In the heart of Birmingham, standing in Centenary Square, is a statue that pays homage to three pioneering figures of the Industrial Revolution: Matthew Boulton, James Watt, and William Murdoch. The sculpture celebrates the contributions of the three to industry and engineering, symbolising Birmingham's historical significance as a centre of innovation.

MATTHEW BOULTON

Matthew Boulton was a key figure in the industrial revolution, known for his pioneering work in manufacturing and engineering. Born in 1728 in Birmingham, Boulton was instrumental in the development and success of the Soho Manufactory, which became a hub of innovation and production. His partnership with James Watt was particularly significant, as it led to the commercialisation of the steam engine, which revolutionised industry and transportation.

Boulton's contributions extended beyond engineering; he was also involved in coinage and metallurgy, playing a crucial role in the introduction of new minting techniques and machinery. His dedication to improving industrial processes and his entrepreneurial spirit left a lasting impact on the industrial landscape of his time.

JAMES WATT

James Watt is celebrated for his contributions to the field of engineering and innovation. Born in Greenock in 1736, Watt's early life was marked by curiosity and an eagerness to understand the workings of the world around him. He pursued studies in instrument making which laid the foundation for his future endeavours.

Watt's most significant contribution came in the form of advancements to the steam engine. His improvements to the design and efficiency of steam engines played a crucial role in the industrial revolution, transforming industries and paving the way for mechanised production. His work was instrumental in moving away from reliance on manual labour to more automated processes, bringing about a seismic shift in manufacturing, transportation and economy.

WILLIAM MURDOCH

William Murdoch, another luminary in the field of engineering and invention, left his mark through his contributions to many innovations. Born in 1754 in Ayrshire, Murdoch's early fascination with mechanics and experimentation led him to pursue a career that would help shape the technological landscape of his time.

One of Murdoch's most notable achievements was his pioneering work in gas lighting. He discovered that coal gas could be used to produce light, leading to the development of gas lamps that were first used to illuminate factories, streets, and homes. This innovation revolutionised urban living and industrial efficiency, extending working hours and improving safety in public spaces.

Murdoch was also an innovator in steam power, inventing the oscillating engine and D-slide valve. His inventive spirit and relentless pursuit of improvement were exemplified through his various projects and partnerships, including with Watt and Boulton. Their combined efforts brought about significant advancements that were crucial in driving forward the technological progress of the 19th century.

William Bloye's statue of Boulton, Watt and Murdoch.

THE STATUE

The statue, unveiled in 1956, is a masterpiece of sculptural art created by William Bloye, a sculptor and teacher at the Birmingham School of Art. The gilded bronze statue, set upon a Portland Stone plinth, captures the three men in a moment of discussion, symbolising their collaboration and ingenuity. Boulton, Watt and Murdoch are depicted engaging in what seems to be an intense conversation, possibly about their groundbreaking work in steam engine technology and industrial advancements.

Matthew Boulton is shown holding plans for a Steam engine with James Watt at the other end, listening intently – leading to one of the statue's nicknames, 'The Carpet Sellers'. William Murdoch stands with a hand raised, as if making a point or presenting an idea. The dynamic composition not only highlights their personalities but also their collective contribution to the fields of engineering and manufacturing.

Over the years, Centenary Square has undergone numerous changes, but the statue, also known as 'The Golden Boys', remains a striking tribute to these three remarkable individuals. It stands not only as a memorial to their achievements but also as a symbol of Birmingham's role in the industrial revolution.

On the Wire

News from the world of engineering

South West Miniature Engineering Show announced for 2026

In the South West, there has been a dearth of model engineering shows since the Bristol show ceased in 2018. So, next year, we are excited that there will be a South West Miniature Engineering Show to showcase our hobby for those who miss the buzz of a good exhibition.

This is a two day show for Friday 15th - Sat 16th May 2026, featuring 16mm scale models and upwards.The venue for the show is Newton Abbot racecourse, Devon, TQ12 3AF, and will bring together displays from the majority of Societies in the area, plus other specialist groups, local interest groups and traders.

There is also an external area where there will be a ride-on miniature railway and space for traction engines etc. and other demonstrations. The site has level access, refreshments and free parking.

There will be a strong emphasis to ensure the displays also appeal to a younger generation, particularly on the Saturday, with items to find and technical questions, with the answers among the displays.

This is a not-for-profit show, supporting local cancer charities.

The website : swemes.uk will be updated closer to the event, along with a Facebook page for the South West England Miniature Engineering Show.

Chester Machine Tools Open Day

Chester Machine Tools are pleased to announce their forthcoming Open Week at their Hawarden showroom this July 7th-11th. Come along to view the latest machines and discover some great deals all week!

The showrooms are open from 9am-4:30pm, Monday-Friday. Visit them at Hawarden Industrial Park, Clwyd Close, CH5 3PZ. What Three Words: ///ever.launch.page

You can contact Chester to register your interest sales@chesterhobby-store.com or 01244 531631.

Midlands Model Engineering Show 2025

The Midlands Model Engineering Exhibition, organised by Meridienne Exhibitions, will return from Thursday 16th October to Sunday 19th October 19 2025 at the Warwickshire Event Centre in Leamington Spa. Highlights of the exhibition will include:
The exhibition will feature a diverse array of models, including a 10 1/4″ Gauge Class 60 Diesel Electric Locomotive—a unique, high-tech model that has taken 30 years to build, weighs 1.5 tonnes, and measures 13.5 feet in length.
The UK Micromouse and Robotics Society will be demonstrating small autonomous robotic vehicles, adding a modern technological edge to the event.
Model Engineer & Workshop magazine will host a series of presentations covering various aspects of model engineering.
Over 30 clubs and societies will display hundreds of exhibits, offering visitors a chance to engage with the modelling community and learn about different modelling skills.
Nearly 40 specialist trade suppliers will be present, providing a wide range of products and services for modelling enthusiasts.
The Society of Model & Experimental Engineers will present live demonstrations, showcasing various skills and techniques related to model engineering.
Opening Hours are Thursday to Saturday: 10:00 AM – 4:30 PM; Sunday: 10:00 AM – 4:00 PM. Tickets: Adults: £13.50; Seniors (65+): £12.50; Children (5-14 years): £5.00; Under 5s: Free. Tickets are valid for any one day and can be purchased in advance from 6th April 2025 via the exhibition's official website www.midlandsmodelengineering.co.uk.
The venue offers free parking, restaurant and coffee shop facilities, and a shuttle bus service from Leamington Spa Railway Station on Thursday, October 16, 2025 (charges apply).

Gloucestershire Vintage & Country Extravaganza

The Gloucestershire Vintage & Country Extravaganza is set to return in grand style to celebrate a major milestone—its 50th anniversary. Taking place from 1st to 3rd August 2025 at South Cerney Airfield, near Cirencester, the landmark event promises its most spectacular edition yet, featuring thousands of exhibits, three live arenas, and a rich variety of countryside attractions.
Hosted by the Stroud Vintage Transport & Engine Club, the Extravaganza has become a much-loved fixture on the national events calendar, drawing in enthusiasts, families, and collectors from across the UK. Over three fun-filled days, visitors can enjoy a nostalgic celebration of transport history, countryside traditions, and all things vintage.

The event showcases an extraordinary variety of vintage transport—including steam engines, classic cars, military transport, vintage commercials, trucks, historic buses, tractors, motorcycles, vintage caravans and more!
Visitors can enjoy a vibrant lineup of live music, retro fashion shows, free dance lessons, and interactive vintage entertainment. The popular Animal & Countryside Arena also returns, featuring a charity dog show, falconry demonstrations, rare breeds, and rural skills displays—offering something for everyone to enjoy.
For advance discounted tickets and full event details, visit www.glosvintageextravaganza.co.uk.

Photo: *shironosov/Getty*

End of the Big End?

The late **David Fulton** took an unusual approach to making a big-end bearing. This article is published with his son's permission.

Photo 1: Strap and cotter bearings on a beam engine model.

Photo 2: Drilling the strap with the bearing compressed in a vice.

Having recently constructed a four-cylinder oscillating engine it was found fiddly and time consuming to repeatedly assemble and dismantle the big ends. They followed the conventional pattern of a split bearing clamped together by a bolt on each side.

Since the next project was a high-speed twin-cylinder engine, I wanted the big ends to be as lightweight as possible and, in particular, easy to take apart and put together. The drawing, fig. 1, shows the result.

In the course of production I felt I'd seen something similar. So it proved: I'd been beaten to it by about 150 years. On vintage beam engines the link motion employs a similar strap, held in tension by opposed wedges, see **photo 1** of a model beam engine. In the present design a single tie-bolt replaces the wedges, passing horizontally through the assembly. Would an un-tapered bolt do the job, not only keeping the split bearing closed but also preventing slack developing later due to rapid reciprocating forces?

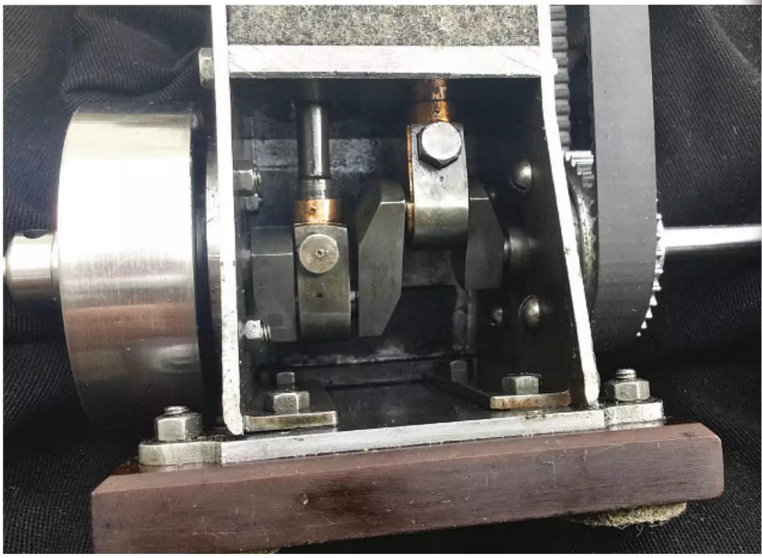


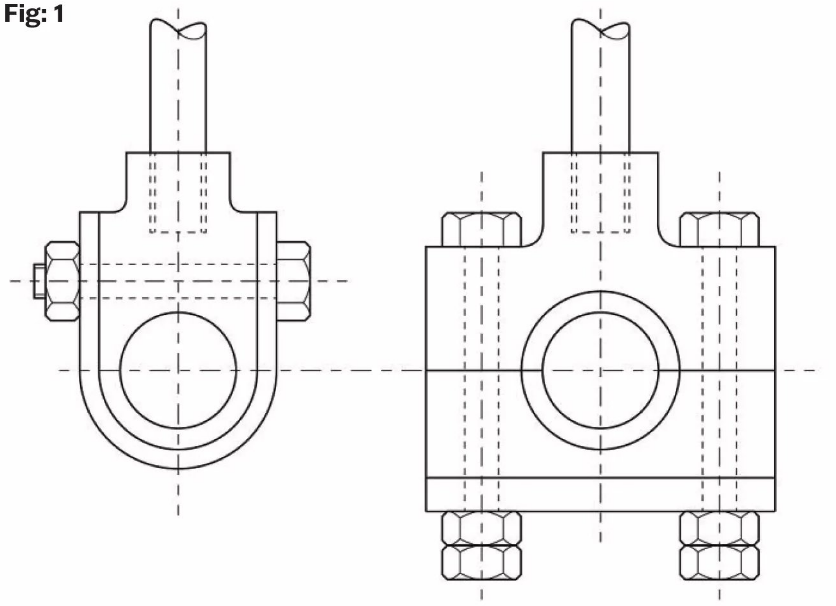
Photo 3: The finished bearing.

Photo 4: Two bearings in place in the high-speed steam engine.

In fact, neither problem arose. Provided the assembly is tightly clamped together while drilling through block and strap, all will be well, **photo 2**. Of course, a custom-made fitting bolt is required. If there is concern that the bottom half-bearing might move sideways in the strap, a rebate can be made into which the strap can sit. This too is common in beam engine practice.

The design described, **photo 3**, has performed without trouble, even at speeds of around 4,000 r.p.m. **photo 4**. It is extremely easy to take out and to put back these not-so-big ends — just pull out the bolt! As a lighter and more convenient alternative, they are no more difficult to make than the time-honoured two-bolt type.

Fig: 1



Quick Notes from the Workshop

The article by Stewart Hart on making small threads in ME&W 4763 brought to mind some more classic tips for minimising the breakage of very small taps. The first is quite simple – drill a larger pilot hole, the usual advice is to choose a size that gives 60% thread engagement, as this still delivers nearly all the strength of a 'standard size' pilot hole. In soft metals like many aluminium alloys, you can even go a little larger as the thread will 'extrude' a little.

Always use a lubricant, if you don't have any specialist tapping fluid, you can use cutting oil, or at a push, ordinary oils. For very small taps you can even rub them against a wax candle. For aluminium use paraffin or a very light oil like WD40 that will stop the metal sticking to the tap.

The biggest problem for hand tapping very small threads is getting the tap started accurately in the hole. The simple 'top hat' guide in **photo 1** is easy to make and easy to hold firmly in position on a flat surface.

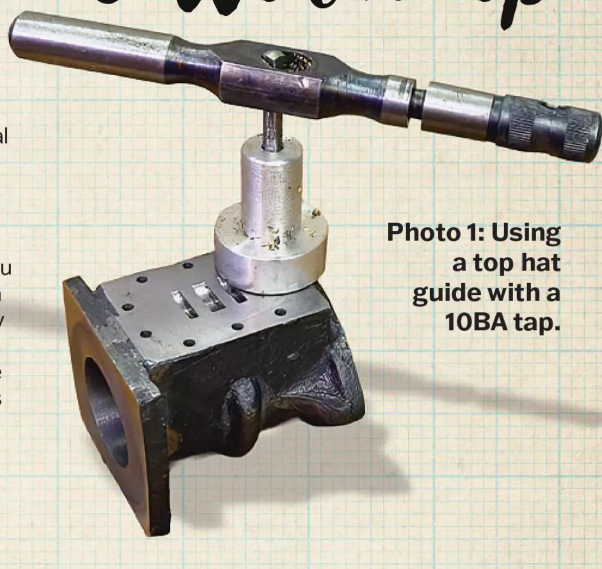


Photo 1: Using a top hat guide with a 10BA tap.

A Folding Workstand

Stephen Steliou shares a novel workstand he designed and made to save workshop space.

Photo 1: Belt grinder mounted on the stand.

Photo 2: Pillar drill mounted on the stand.

I am seventy-eight years of age and a regular reader of *Model Engineers' Workshop* magazine. In the years of my employment I was an electrical engineer.

Now-a-days, the time is not measured in nanoseconds but hours; the frequency not in gigahertz but a few kilocycles when the machinery is misused. The budget which I shared is not hundreds of thousands of pounds but only what one can selfishly remove from one's pension. When the job required a lot of muscle, it was always for somebody else to do, whereas now one has to do everything for one's self and, to my great surprise, I like it.

Now, to the subject. I have a small workshop and, when one puts a lathe and a milling machine into it, the available space for a bench is not very much and, if one puts a vice on the bench to hold a long piece of material, there is no space for anything else so everything else has to be cleared in order to work. If then, one wants to cut some material with the angle grinder, the abrasive dust goes everywhere and especially onto the lathe, after which the cleaning operation takes longer than the actual cutting job.

I needed something whereby I could mount my vice and wheel it outside my workshop to where the job can take place, **photos 1** and **2**. It must be able to be folded and locked away in a corner without requiring much space, **photo 3**. I did not want it to be assembled on the side and I wanted none of those screws and nuts that remind me of the Supermarket flat packs (for which one needed an IQ of 140 to guess what joins with what, especially if the instructions are written in broken English!).

I wanted the height of the vice to be adjustable from the normal bench height to a height where a basketball player is assured not to develop a hump. I wanted not only the vice to be held but any other tool I had that produces unwanted dust or swarf, **photo 4**. So, every tool I wanted to secure would be fitted to its individual tool holder and kept under the bench. I have chosen the foldable stand, as I named it, to have three legs in order to avoid adjusting them for height. It will be of considerable weight because my No. 6 Record vice is 29 kg so this is certainly not a living room job but one which requires an outside,

Photo 3: The folded stand ready for storage.

Photo 4: Bench grinder mounted.

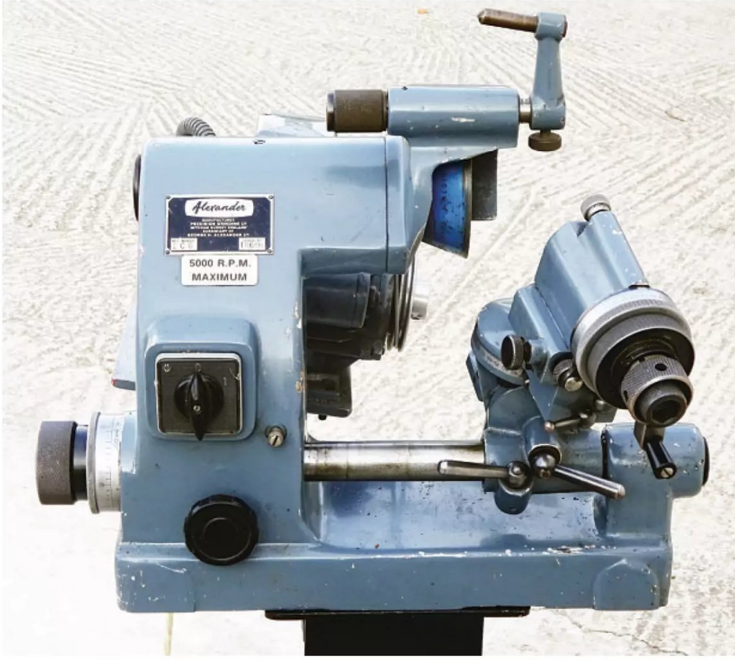


Photo 5: High precision – Alexander tool grinder.

sheltered space. As it happened, the foldable stand weighs 34.5 kg. without the tool holder which will be different for every tool to be used, **photo 5** and **6**.

The foldable stand is comprised of six parts:

1 THE DELTA UNIT

The delta unit, visible in **photo 7**, is made of square tubing 40 x 40 x 3mm; the angle of the apex of the delta is approximately 35 degrees so, with about 86cm leg length, this gives the base side of 60cm. If one adds the wheels, one on each side will give 71 cm width which is within the required width to go through the doorway. On the base side there are two sets of hinges to take both the standing platform and the tool platform. Two barrel-bolts are used to hold these platforms secured in the folded position on the delta frame, **photo 8**. I used heavy duty hinges of two sizes (the type used to hold heavy metal doors).

I have further cut the one half of the hinge, as shown with a line in **photo 9**. This is in order to have a balanced hinge and loses the lift-off advantage for which they are designed. So, on the apex of the delta frame, the quarter half of the large hinge is welded. (I used welding throughout the project because I also wanted to improve my welding. In my previous project making a foldable bench, I was not that impressed.) Once one uses welding, forget micrometric measurements; a tape measure will do and I must admit that, in one particular case, I used hammer persuasion.

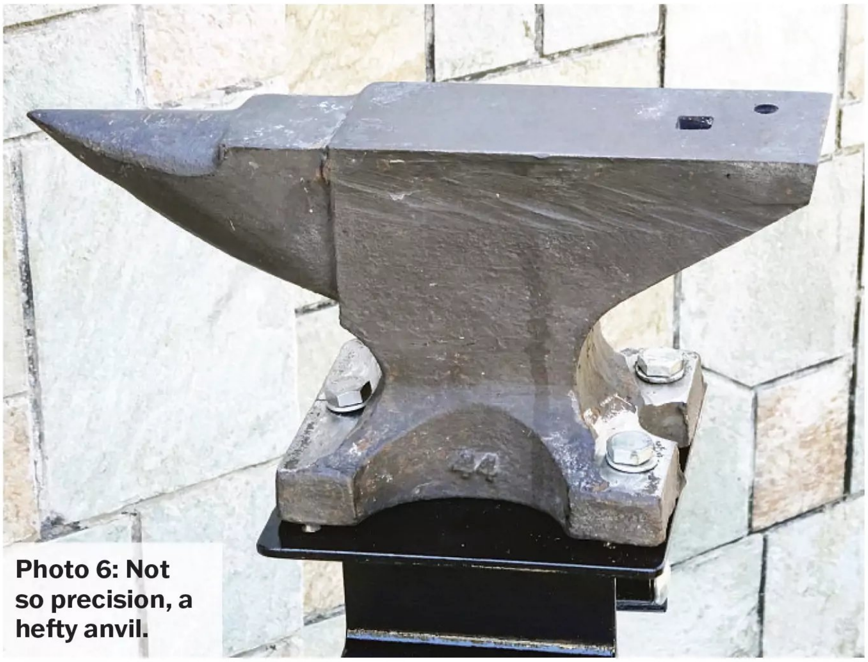


Photo 6: Not so precision, a hefty anvil.

2 THE I UNIT

This is the third leg of the stand, **photo 10**, and is secured on the tool unit with a pin on which I welded a washer in order to tie it somewhere so that I don't lose it. On the top end again, the quarter halves of the large hinge are welded. The I frame is used as a handle to carry the folded stand in the folded position if you are strong enough.

3 THE TOOL PLATFORM

The platform, **photo 11**, provides space for some tools one needs on site and also gives some rigidity to the stand. It is made from angle iron 40 x 40 x 4mm and the platform is made from composite wood. The two complementary small hinges are welded on the long side that mates with the delta unit. On the bottom side is a pair of 'ears' on each side so that it can mate with the I unit in both the folded and unfolded positions through a pin.

Photo 7: The delta unit lies mostly between the two platforms when folded.

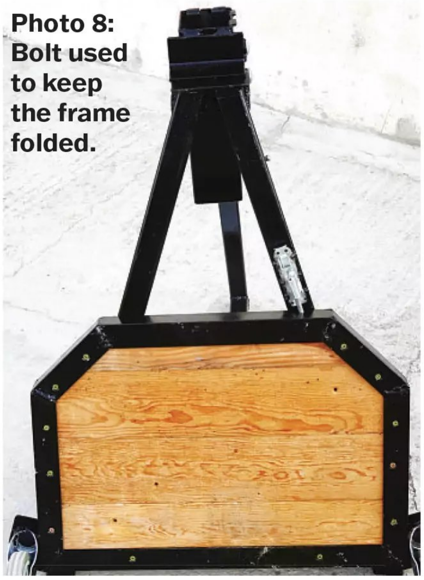


Photo 8: Bolt used to keep the frame folded.

Photo 9: Hinges before cutting.

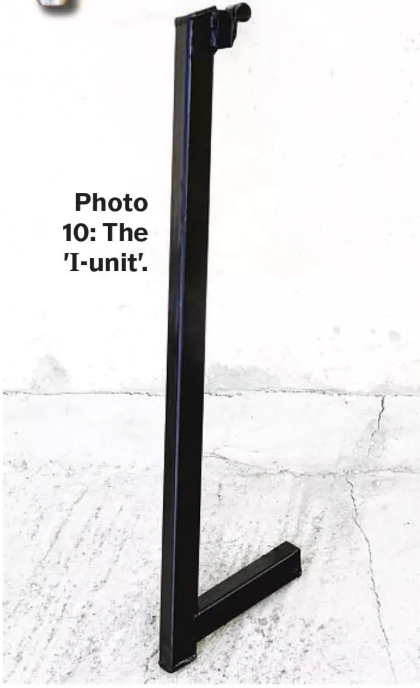


Photo 10: The 'I-unit'.

Photo 11: The tool platform.

4 THE STANDING PLATFORM

Photograph 12 shows the standing platform, a six-sided frame made out of angle iron. A wooden floor made of floorboards is inserted so that one can stand on it. The wooden floor is not for one's feet to keep warm away from the cold floor, but to give more stability on the stand from the lateral forces exerted. It is therefore an essential part of the stand. It also carries the complementary hinges that connect it to the delta unit.

5 THE TOOL HOLDER RECEPTACLE

The tool holder receptacle is made from a short piece of square tubing 80 x 80 x 3mm, **photo 13**. Inside it slides the tool holder that carries the required tool. Because the next standard square tubing is 70 x 70 x 3mm, steps have been taken to reduce the inside dimensions so that the tool holder can snugly slide inside. Four strips of 20 x 2mm, two on each adjacent side, are bent at the ends at right angles and welded outside the 80mm tubing, **photo 14**. On the top, it carries the mating half of the large hinges on which the delta and I units are hinged.

The two short pieces of larger angle iron 50 x 50 x 4mm are used to prevent the stand from doing the splits during assembly and folding time - and to keep one's fingers intact. It also carries holes on adjacent sides in the middle that go through the other side. There are four holes, one on each side, of 60mm because that is the diameter of the large

Photo 12: The standing platform, used to add stability.

pin with the washer welded onto it that can secure the tool holder at different heights. The holes on all sides enable the tool holder to rotate fully at every 90 degrees.

6 THE TOOL HOLDER

The tool holder is made out of square tubing 70 x 70 x 3mm and the length is as long as is required to raise the actual tool. If necessary, it can be made different for every tool, **photo 15**, so that one can interchange tools without having to screw the tools again and again. The vice tool holder has two platforms, the normal horizontal and the vertical one, **photo 16**. The reason is that the vice can be used in the vertical position when thick plates of material are cut with the angle grinder, thus holding the material in a more convenient position.

To an experienced reader, it is obvious that one can weld the tool holder to the delta unit and, therefore, simplify the construction and save one hinge without affecting all functions. I specifically wanted the tool holder removable and replaceable with something else for another project I had in mind.

Finally, I must confess that this is not as precise as many wonderful engineering projects offered by fellow readers, but I think it will be a very useful accessory for readers who, like me, have limited space.●

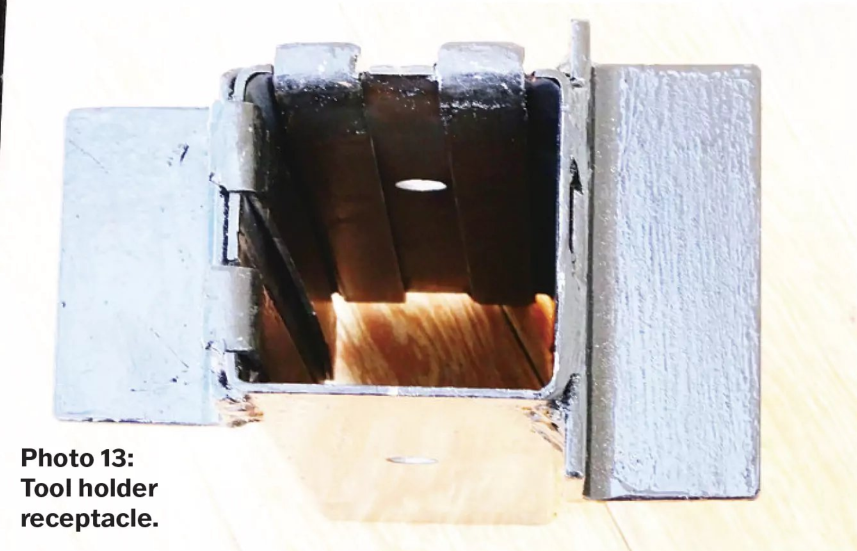


Photo 13: Tool holder receptacle.

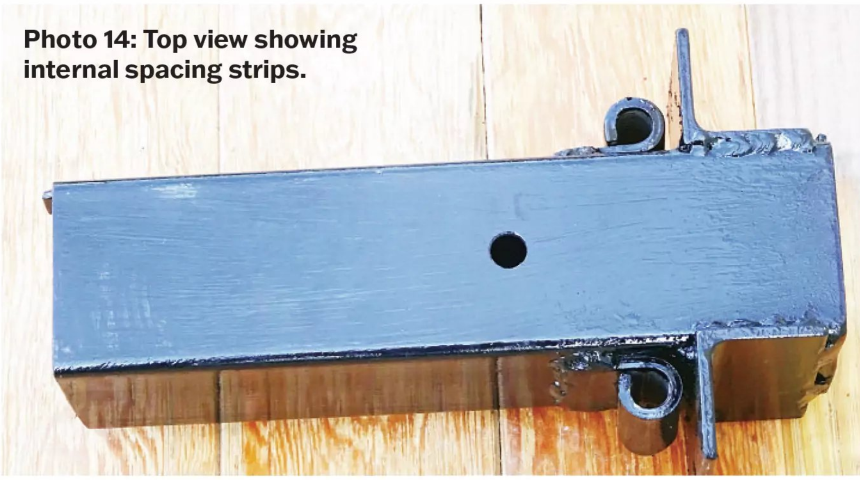


Photo 14: Top view showing internal spacing strips.

Photo 15: A selection of tool holders, one variable height.

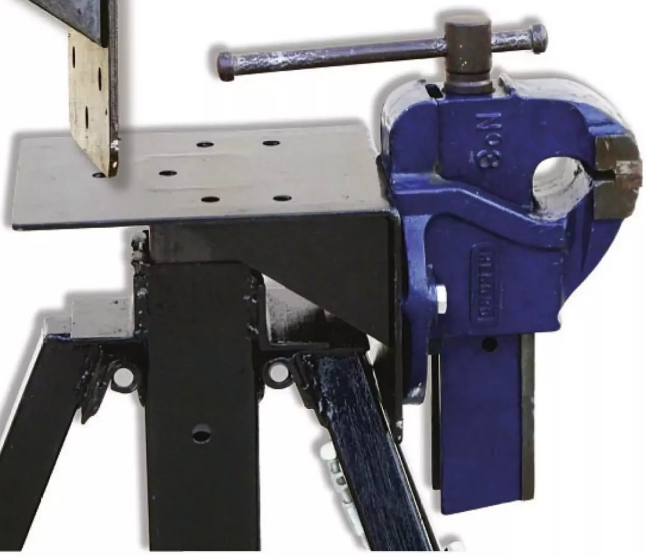


Photo 16: Record No. 8 vice fitted vertically.

Club Diary

Please send your events for Club Diary to meweditor@mortons.co.uk

2025

Every Sunday
Warrington MES
Running day. Contact : contact@wdmes.org.uk

MAY

20 Nottingham SMEE
Geoff Turner – building Clan Pacific 72010. nsmee.org.uk/events

21 Leeds SMEE
Geoff Rogers – Traction Engine. Contact: Judith Bellamy, jabellamy29@gmail.com

24-25 Bradford MES & Bradford Industrial Museum
Event with members' models & demonstrations. Adrian Shuttleworth, 07767 375648

29 Guildford MES
Public open day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

JUNE

1 Guildford MES
Small Model Steam Engine Group meeting, 14:00-17:00, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

6 Rochdale SMEE
Models running night. Springfield Park, 17:00 onwards. See www.facebook.com/RochdaleModelEngineers

6-8 Cardiff MES
Welsh Locomotive Rally, Heath Park. Contact: Ross Hopkins, rally@cardiffmes.com or see www.cardiffmes.co.uk

8 Guildford MES
Public open day from 1:30, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

15 Bradford MES
Public running day from 1:30, Northcliff. Contact: Russ Coppin, 07815 048999

17 Nottingham SMEE
Evening Run and BBQ. nsmee.org.uk/events/

20 Rochdale SMEE
Bob Hayter – 'Evil Spirit'. Castleton Community Centre, 19:00. See www.facebook.com/RochdaleModelEngineers

JULY

4 Rochdale SMEE
Models running night. Springfield Park, 17:00 onwards. See www.facebook.com/RochdaleModelEngineers

5/6 Guildford MES
Railway Gala, 10:00-17:00, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

5 Bromsgrove SME
Modern Traction Open Day. All gauges welcomed 5″, 3.5″, 2.5″, G1 and 16mm. Contact Doug Collins 07585 524836

6 Bradford MES
Rae Day Gala, Northcliff. Contact: Russ Coppin, 07815 048999

18 Rochdale SMEE
General meeting. Springfield Park, 17:00 onwards. See www.facebook.com/RochdaleModelEngineers

19 Gauge 1 North
Gauge 1 live steam at Bakewell Agriculture and Business Centre. Gauge1north.org.uk

20 Guildford MES
Public open day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

AUGUST

1 Rochdale SMEE
Models running night. Springfield Park, 17:00 onwards. See www.facebook.com/RochdaleModelEngineers

3 Guildford MES
Small Model Steam Engine Group meeting, 14:00-17:00, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

7 Guildford MES
Public open day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

15 Rochdale SMEE
Auction Night. Castleton Community Centre, 19:00. See www.facebook.com/RochdaleModelEngineers

17 Guildford MES
Public open day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

17 Bradford MES
Running Day, public from 1:30 pm to 16:00, Northcliff. Contact: Russ Coppin, 07815 048999.

19 Nottingham SMEE
Evening Run and BBQ. nsmee.org.uk/events/

28 Guildford MES
Public open day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

SEPTEMBER

6 Bromsgrove SME
Open Day. All gauges welcomed 5″, 3.5″, 2.5″, G1 and 16mm. www.bromsgrovesme.co.uk. Contact Doug Collins 07585 524836

19 Rochdale SMEE
Bits and pieces/personal project ideas. Castleton Community Centre, 19:00. See www.facebook.com/RochdaleModelEngineers

20 Bromsgrove SME
Hosting the Rob Roy Rally And 3.5″gauge friends. www.bromsgrovesme.co.uk. Contact Doug Collins 07585 524836

21 Guildford MES
Charity and Heritage Day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

27 Bradford MES
Visitors Day – BMES welcomes members and their locomotives from other societies to Northcliff for breakfast & lunchtime butties. Let Russ Coppin, 07815 048999 know in advance, please.

OCTOBER

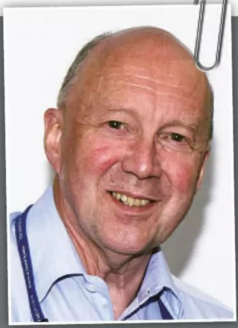
5 Guildford MES
Small Model Steam Engine Group meeting, 14:00-17:00, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

5 Bradford MES
Running Day, public from 1:30 pm to 16:00, Northcliff. Contact: Russ Coppin, 07815 048999.

17 Rochdale SMEE
Annual General Meeting. Castleton Community Centre, 19:00. See www.facebook.com/RochdaleModelEngineers

19 Guildford MES
Public open day, Stoke Park. Contact: Mike Sleigh, pr@gmes.org.uk or see www.gmes.org.uk

21 Nottingham SMEE
Bits and Pieces Evening. nsmee.org.uk/events/



PART 16

A Tandem Compound Mill Engine

David Thomas builds Arnold Throp's model of a Corliss mill engine. Continued from Model Engineer & Workshop issue 4764.

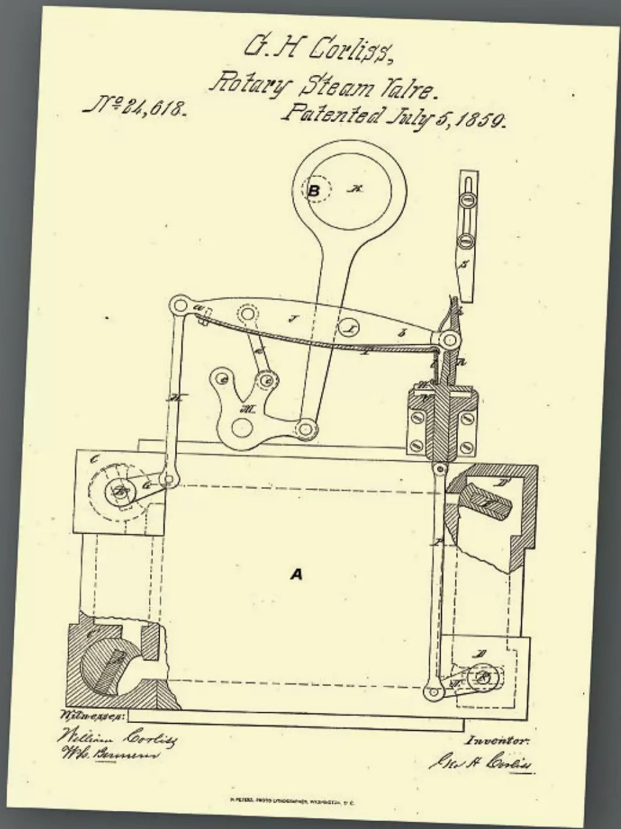


Fig 38: A figure from US-24618-A: Corliss's patent of 1859 for a rotary steam valve.

Before describing the Corliss valves and Musgrave trip gear on the model it is worth going back and looking at just what it was that George Corliss contributed to steam engine design. In Part 1 of this series I described the list of patents obtained by Corliss. As far as steam engine harmonic valve gears are concerned he made three key developments: separating the steam inlet and exhaust valves to allow them to be operated independently; the idea of using a trip gear linked to a governor to control steam admission and finally the semi-rotary valve. In those mid-nineteenth century patents the valves and trip gear were applied to beam engines so in **fig 38** you need to imagine a piston moving vertically in the central space marked A and driving to a crankshaft centred at B. The steam inlet valves and trip gear are on the right hand side of the diagram and the exhaust valves are on the left. There were linkages between the pairs of valves that aren't shown, and which Corliss tells us were omitted for clarity. If I'm interpreting the diagram correctly the piston is at, or close to, the bottom of its stroke with the lower steam valve about to open and the upper exhaust valve likewise. When lever h contacts adjustable slide S it will pivot and release the valve. The potentially violent movement of the valve is damped by an air dashpot. The cut-off point setting is static, there is no input from a governor in this diagram. **Figures 39** (a section on the cylinder vertical mid-plane) and **40** show the HP cylinder of the model with the valves and linkages in equivalent positions to those shown by Corliss in his patent. In the model the gear is at the latest possible point of cut-off. The piston is moving away from the crankshaft (a direction I'll refer to as towards the 'rear' of the engine but that

Photo 243: The lost PLA castings for the dashpot parts.

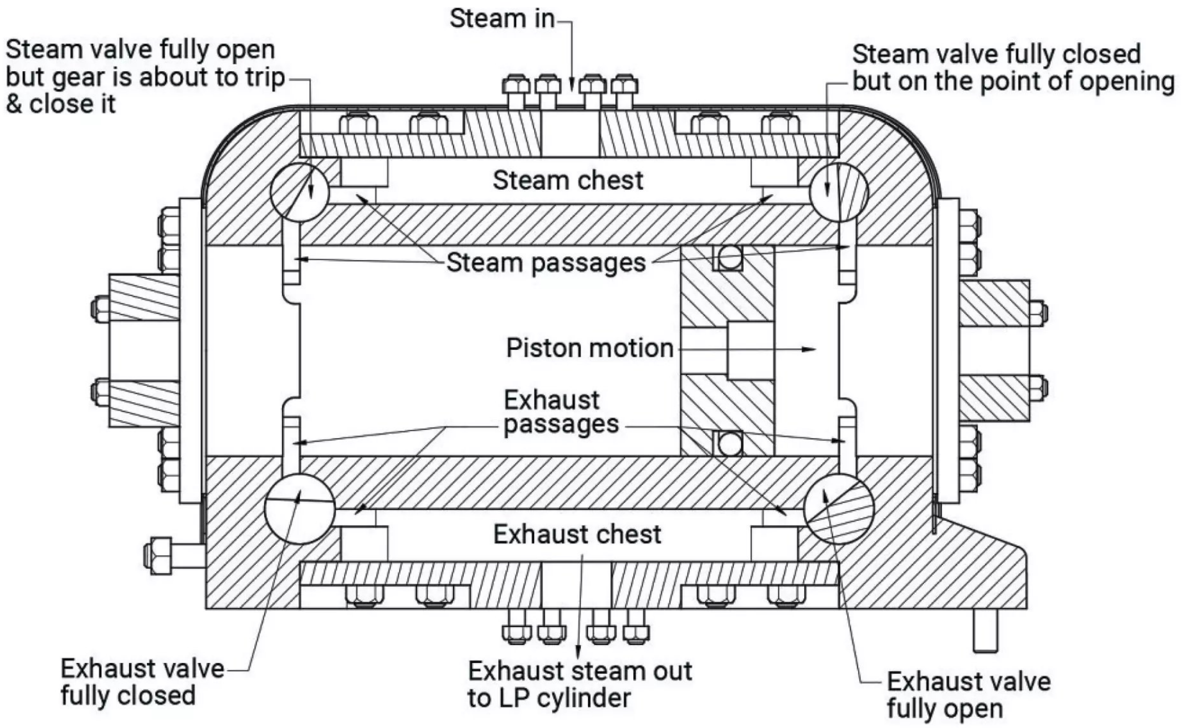


Fig 39: A cross-section of the HP cylinder on the vertical centre plane. As far as possible the valves are in the same positions as in fig 38.

is a bit arbitrary) and is close to the end of its stroke. The forward steam valve is still fully open, but the valve gear is on the point of tripping and closing it. The rear exhaust valve is open but starting to close, the rear steam valve is about to open to admit steam to cushion the piston at the end of the stroke. In **fig 40** the steam lever is almost at the forward limit of its swing and has pushed the forward valve fully open via the trip blade, thus fully compressing the spring inside the dashpot; a slight amount of further movement will cause the trip cam to lift the blade and release the valve. Adjustable needle valves control the admission of air into the dashpot to cushion the valve motion. I've made a short video of the trip gear working which I hope can be uploaded to the forum.

In this part I'll describe the valves themselves and the fixed parts that hold them and the other moving valve gear bits in place. In a subsequent part I'll describe the moving parts of the linkages and give some measurements from the working model that should provide an initial set-up to get the engine turning over.

The dashpot, two pistons and the dashpot spring provide and control the force that closes the valves. Two brackets attached to the dashpot carry the shaft, pivots and levers that make up the trip gear and link it to the governor. The dashpot and its two brackets, **fig 41**, may originally have been provided as gunmetal castings but were not available when I bought the casting set

Photo 244: Machining the dashpot body to size. There was a bit of JB Weld used as filler but none of it in a vital place.

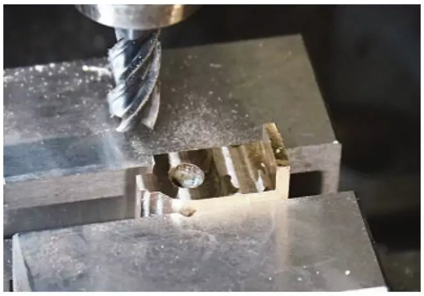


Photo 245: Where the bronze had poured well the dashpot body machined very nicely. The metal had flowed well around the cylinder core.

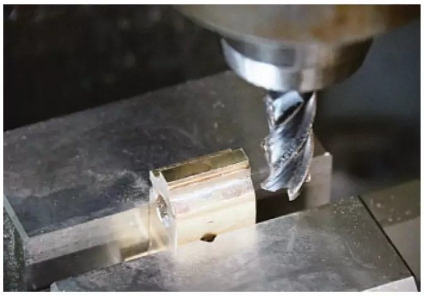
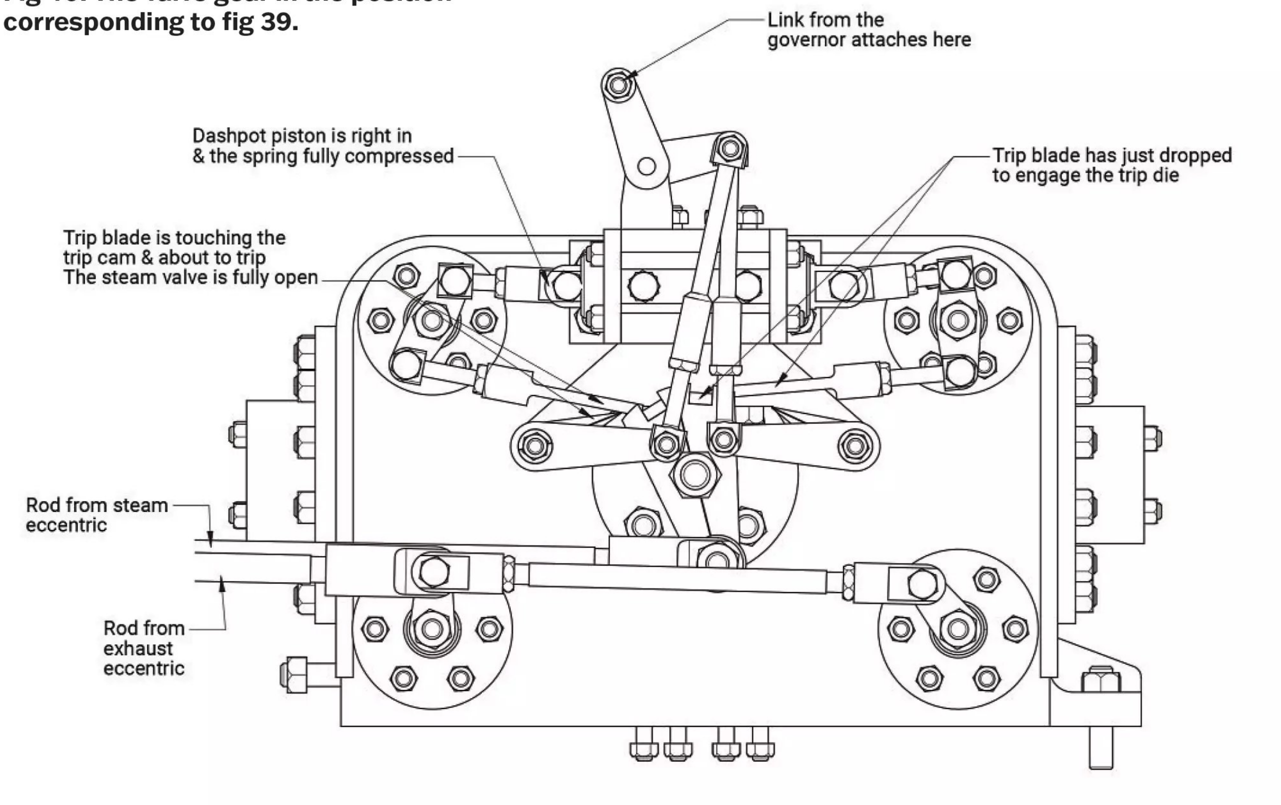


Photo 246: The profile of the front of the dashpot is complex and would be difficult to fabricate.

Fig 40: The valve gear in the position corresponding to fig 39.



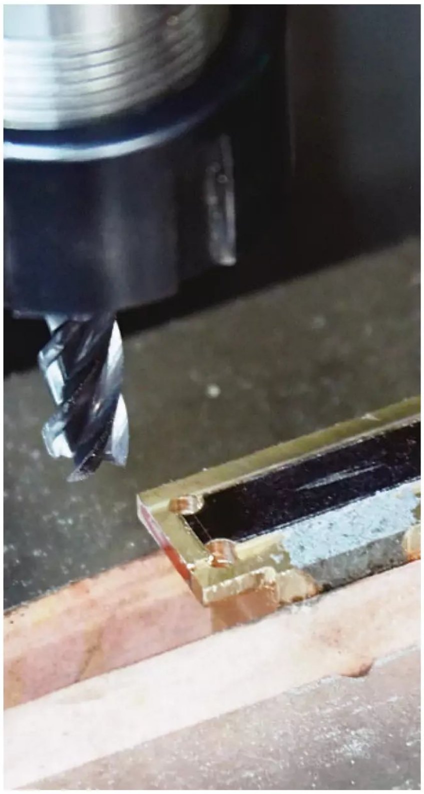


Photo 247: Machining the recess to cover the edge of the cladding, it didn't need to be quite so wide or deep!

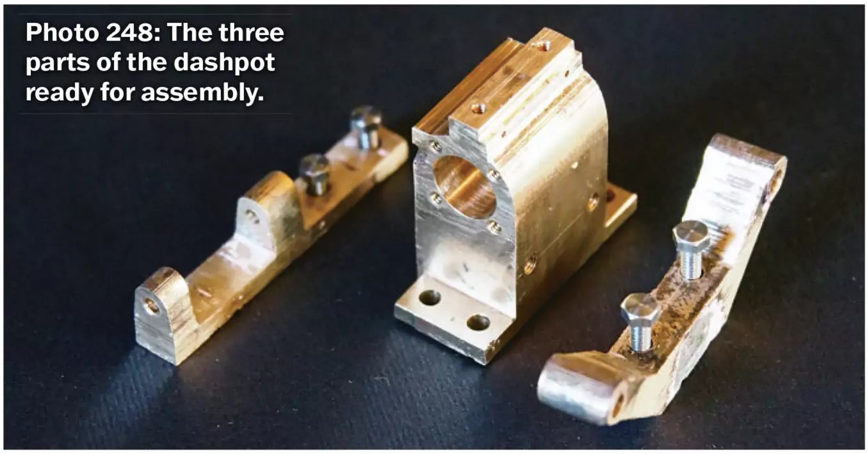


Photo 248: The three parts of the dashpot ready for assembly.

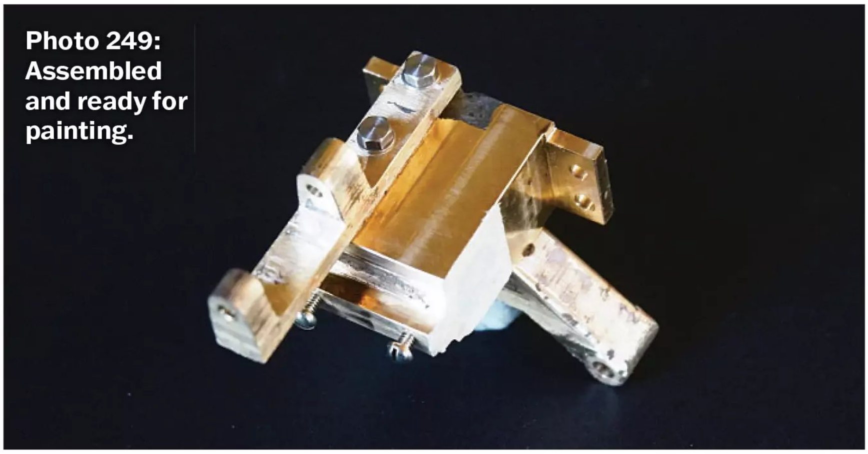


Photo 249: Assembled and ready for painting.

and look likely to stay that way. All three parts could be machined from the solid, fabricated or cast by the builder and the last of these gave me an excuse to try out lost PLA casting. Unless you really want to learn a new set of techniques I suggest fabrication followed by a bit of machining! The castings ended up doing the job and I hope to use the method more in the future, but it was a lot of work and expense to get set up and produce useable castings. For the record I used Polymaker Polycast filament and Omega Gold Star investment. The initial attempts using less specialised materials just didn't work very well. I'll pass the .stl files to the editor with a request that they be made available on the forum. **Photograph 243** shows three castings just after cleaning up. There were defects but none of them were in critical places and some JBWeld fixed those well enough, **photo 244**. **Photograph 245** has the dashpot body casting showing its best side, the investment having flowed nicely around the cylinder 'core' and the metal having followed suit. In **photo 246** the details on the front of the dashpot body are being cleaned up but very little metal needed to be removed. As described in the previous part I chose to tuck the cut edges of the cladding into recesses in the edges of the external parts and

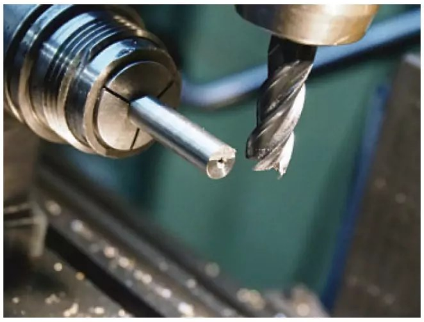


Photo 250: A small flat is machined across the end of a valve to show the orientation of the D shape...

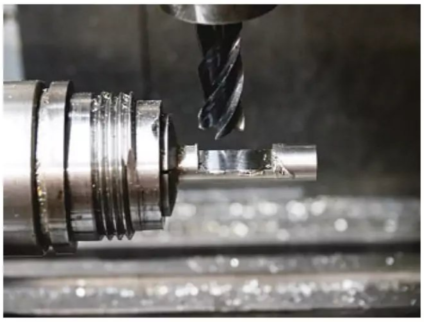


Photo 251: ...and then the flat is milled at the same setting.

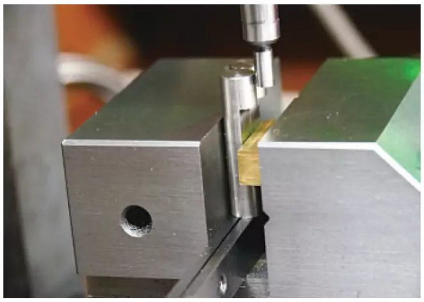


Photo 252: A pair of valves set up on end and located with an edge finder to line them up for cutting the driving slot.

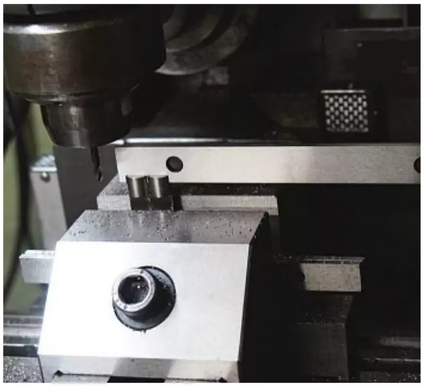


Photo 253: A good result with a 1/8" parallel sitting firmly in the slot.

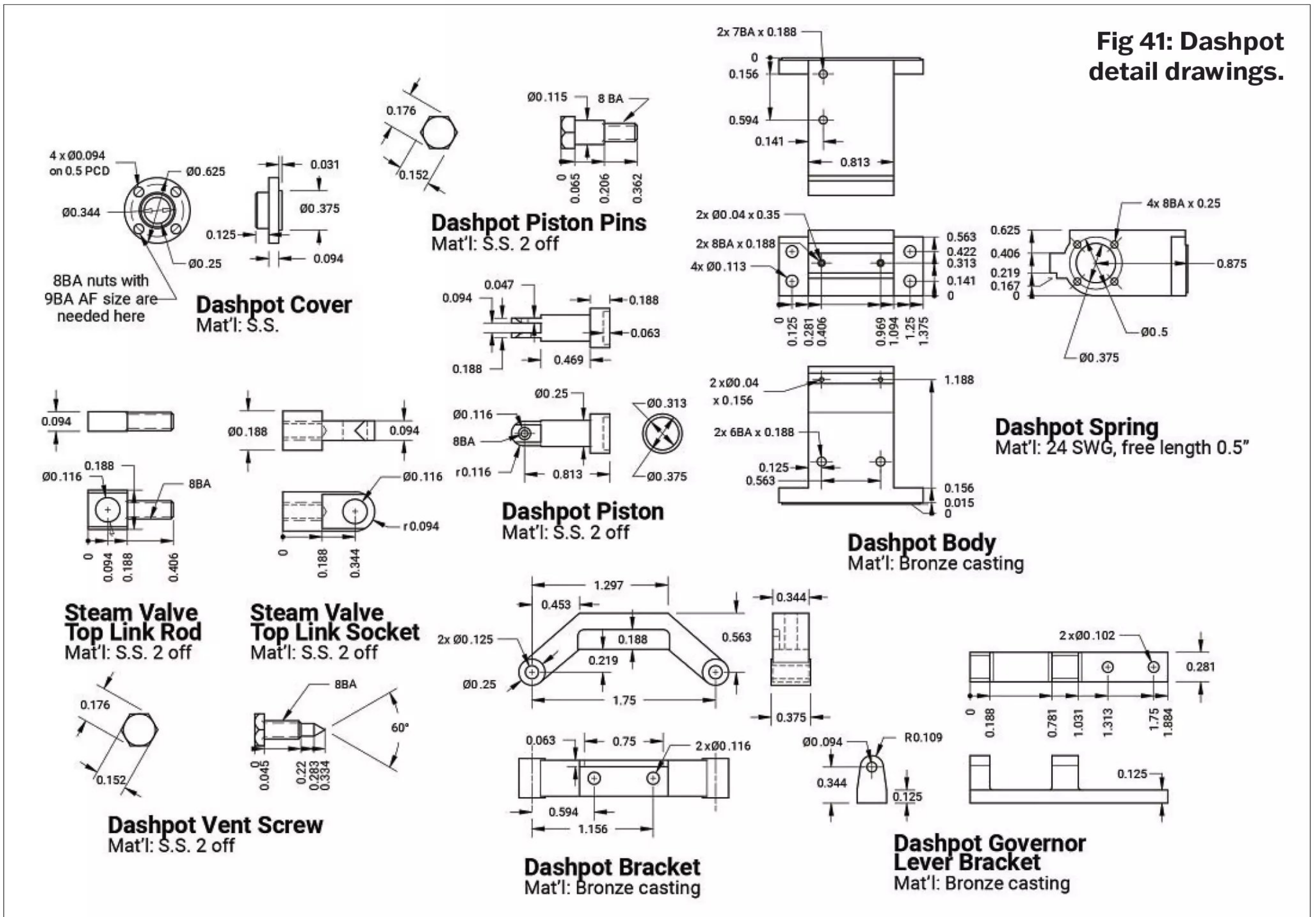


Fig 41: Dashpot detail drawings.

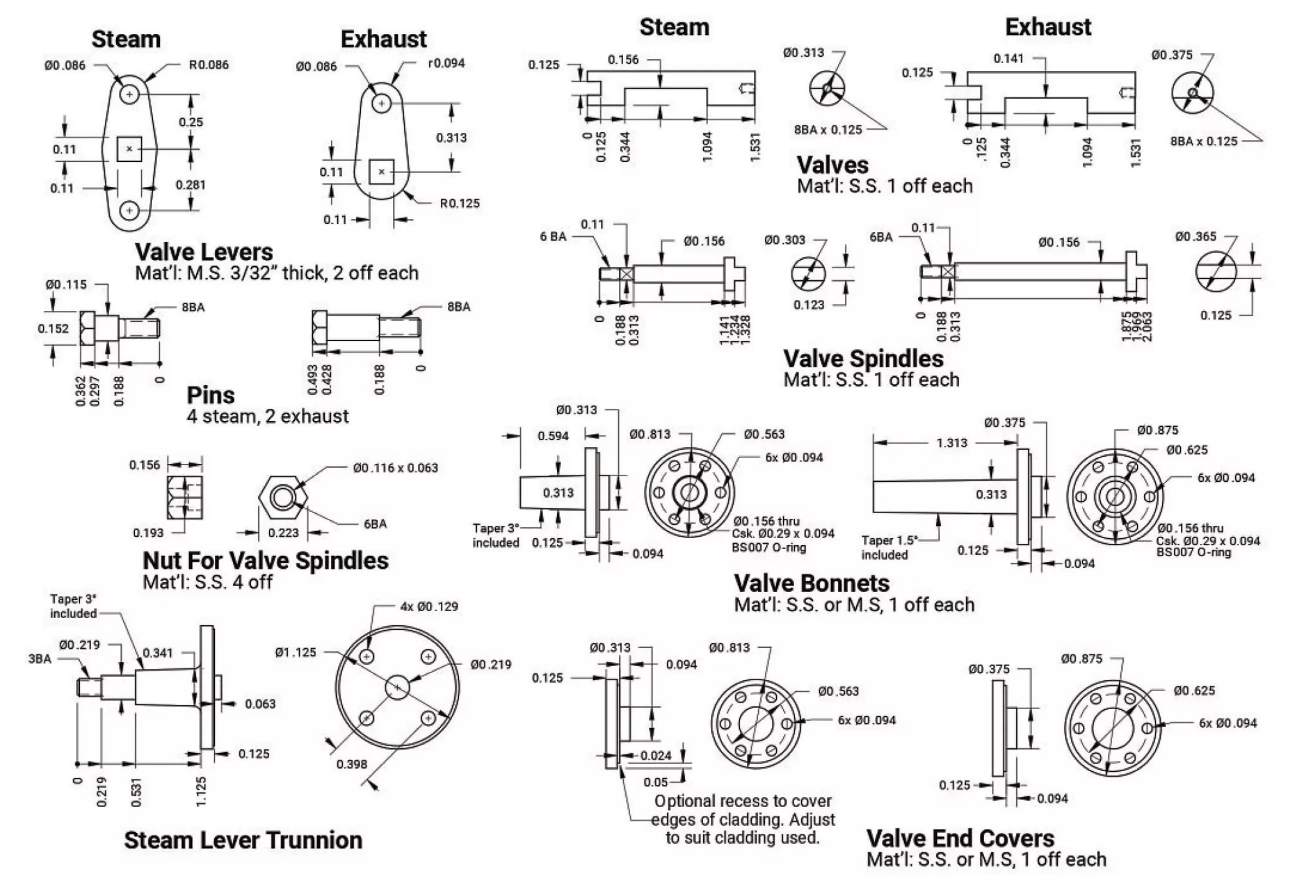


Fig 42: Valves, spindles and lever details.

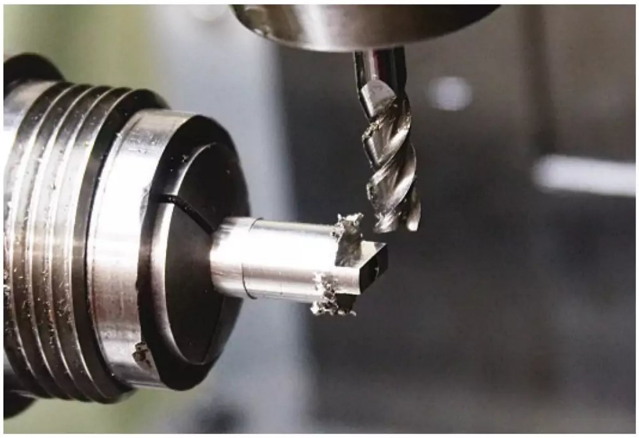


Photo 254: The valve spindles were made in two parts; this is the valve end.

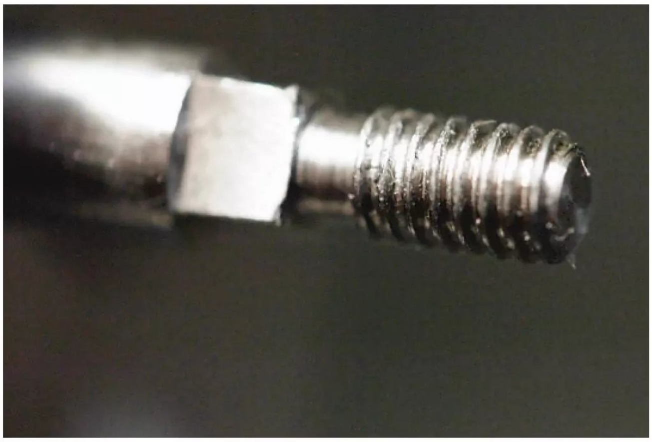


Photo 255: The outer part of the spindle is turned down and threaded.

photo 247 shows these being machined on the back of the dashpot body; they don't need to be so wide and the depth can be chosen to suit the cladding used. A reamer gave a nice finish to the bore and the finished parts are shown in **photo 248** - and assembled and ready for painting in **photo 249**. 'One size smaller' BA hex heads have been used in most places on the model.

The valves themselves, **fig 42**, are turned from stock round FC stainless steel, starting by drilling and tapping what will become the outer ends 8BA for screws to extract the valves from the block. If these are omitted then getting the valves out will involve dismantling the trip gear. With the valve set up to mill the flat a shallow witness can be machined on the same end so you can see where the flat is when setting the valves, **photo 250**. In **photo 251** the flat has been machined. Even with so much of the cross section removed, the valves haven't show any tendency to distort. The final feature needed on the valves is a slot to engage with the valve spindle and this needs to be central and align as well as possible with the flat, which is where the set-up in **photo 252** comes in. Using the edge finder and the DRO gets the valve axis lined up for cutting the slot with a 3 mm slot drill. A 1/8" parallel was used as a check, **photo 253**.

The valve spindles I made in two parts to simplify cutting the flats/squares at

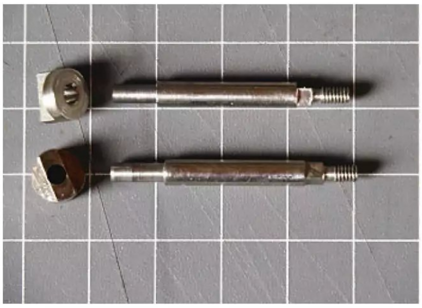


Photo 256: Two valve spindles ready for assembly.

the ends and to save material. **Photograph 254** shows the valve end in the dividing head. I'd skimmed the OD of the stock to allow for slight misalignment between the valve bores and the bonnets; this could be left until you know that it is needed. Enough of the outer end was machined square for both the lever seating and the thread on the end, then the very end turned down and threaded 6BA, **photo 255**. Before assembly the two parts are shown in **photo 256** and they were laid across a pair of parallels whilst the Loctite 638 set.

The valve end covers were made in pairs, first turning the locating boss then setting up, **photo 257** and drilling the stud holes deep enough for both parts, **photo 258**. After that the first cover was parted off and the next one turned. The outsides of these were cleaned up with the parts glued to a fixture in the chuck. The outsides of the valve bonnets were turned parallel to start with, then turned around and the internal details completed whilst held in a collet. An O-ring was used to gauge the internal size of its housing. With the outsides still parallel the parts were held in vee-block for the DRO to step out the stud holes, **photo 259**. With all the details complete

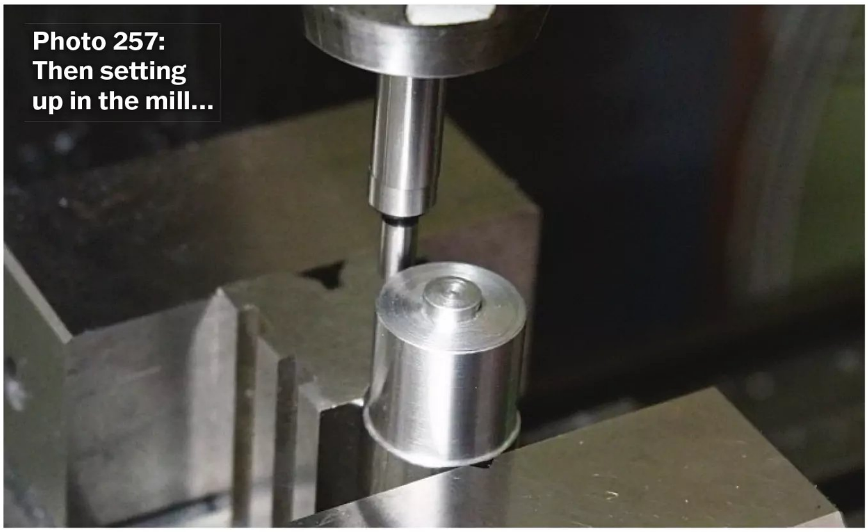


Photo 257: Then setting up in the mill...

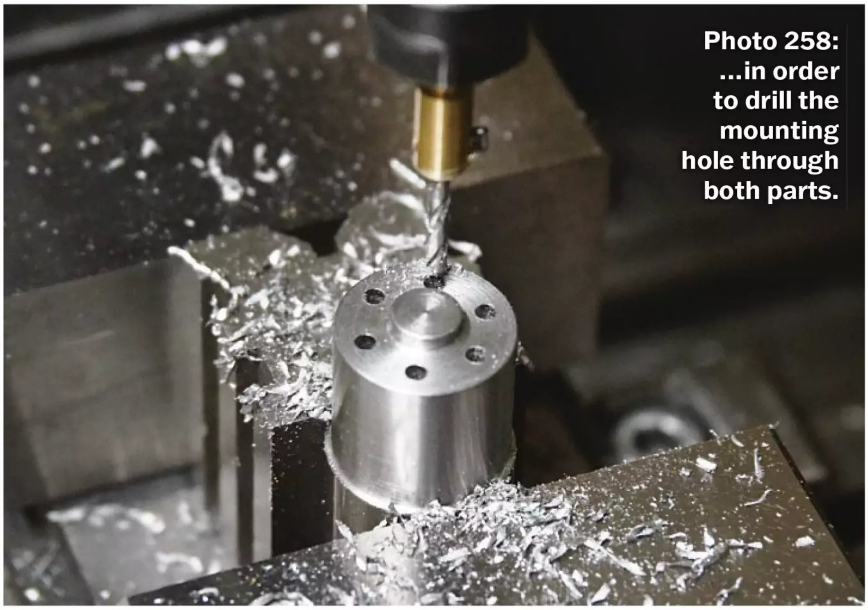


Photo 258: ...in order to drill the mounting hole through both parts.

Photo 259: With the body still parallel it's back to the mill to drill the mounting holes.

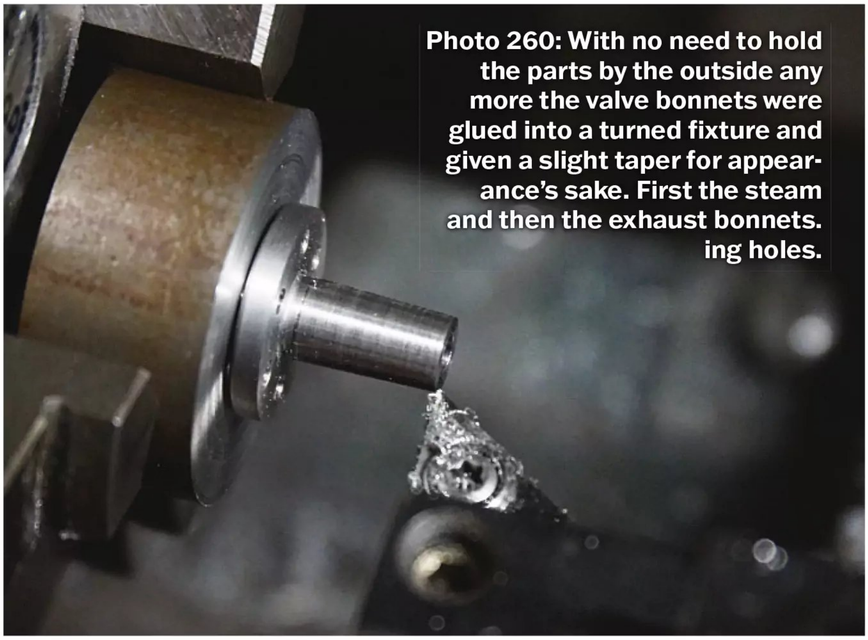


Photo 260: With no need to hold the parts by the outside any more the valve bonnets were glued into a turned fixture and given a slight taper for appearance's sake. First the steam and then the exhaust bonnets. ing holes.

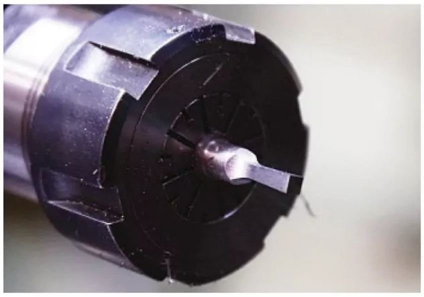


Photo 261: The valve levers need a close fitting square hole to go over the end of the spindles. The first job is to make a broach to go in the Hemingway rotary broach.

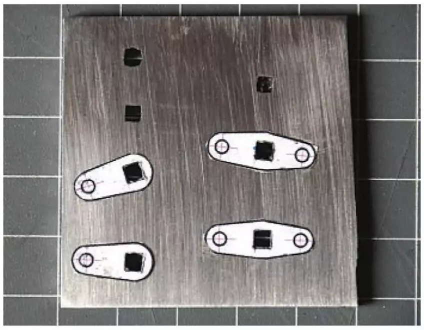


Photo 262: It wasn't easy to get the broach to start in a controlled orientation so the 'marking out' was applied after the fact.

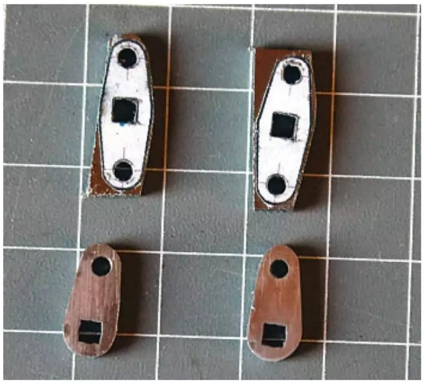


Photo 263: Hand filing of the levers under way.

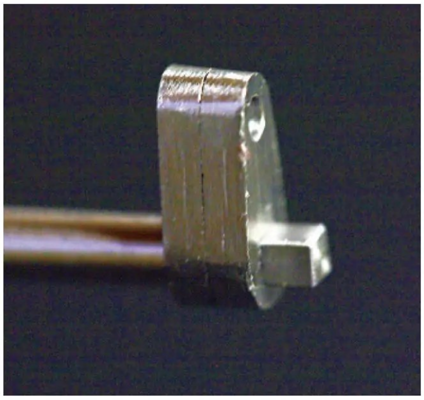


Photo 264: The levers were given their final shape in pairs.

the parts were glued into a turned fixture and the slight taper turned on, **photo 260**. The exhaust bonnets were dealt with in the same manner. The steam lever trunnion was a very similar shape and the same approach dealt with that.

The levers for the valve spindles require square holes that need to fit the squares on the end of the spindles closely to minimise lost motion in the valve gear. I built a wobble broach from a Hemingway kit a while ago, just to find out if it was useful and now it came into its own. The broaches are made on stubs of 8 mm silver steel, **photo 261** and hardened. I found two difficulties using this tool; first, that even with a large enough pilot hole, it needs quite a lot of force to penetrate steel and secondly that persuading the broach to start at a defined position was very hard. My solution was to drill a group of pilot holes in the steel stock then 'mark out' the levers around the square holes, **photo 262**. The outline shapes are arbitrary; the only critical dimensions are the holes centre distances, so this approach works well here. The lever outlines on the original drawings are quite complex and I avoided those by copying the shapes from the Anson Engine Museum engine shown in Part 10. **Photos 263** and **264** show stages in forming the lever outlines and at this stage the cylinder assembly looked like **photo 265**.

To be continued.

Extra files and video

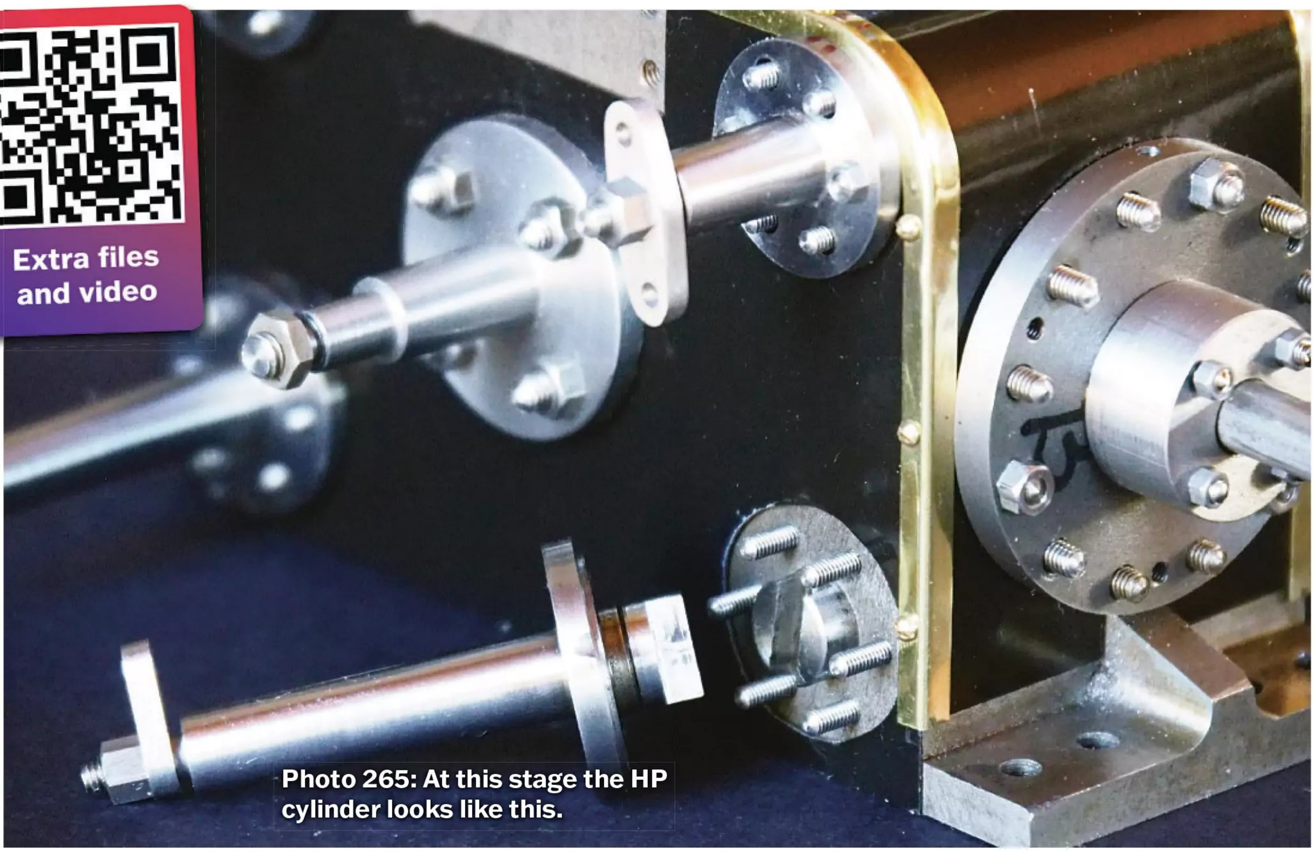
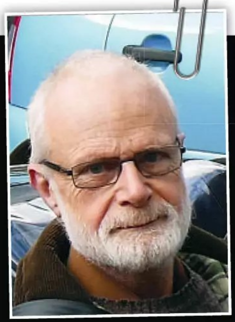


Photo 265: At this stage the HP cylinder looks like this.



Peter Howell looks at spark control away from the field of steam locomotives.

Spark Arresters

Whilst this is not strictly a model engineering subject, most model engineers I know have a curiosity for all things mechanical and hopefully this is an area that will be of interest and new to many.

In David Rollinson's *Model Engineer* articles on American Locomotives, mention was made of the need for fitting a spark arrester (or arrestor, both spellings are used) to the exhaust to prevent sparks emanating from the engine, setting fire to the surroundings. What may not be appreciated is that spark arresters are still widely used and have a valuable role, even on modern internal combustion, petrol and diesel, engines today. The risks here are many and varied as engines are employed in, for example, forestry and agriculture, petrochemical and military etc.

In America the main requirement for spark arresters is in the forestry industry with the US Forestry Service specifying their need on many machines, from small brush cutters and chain saws through to large mobile plant and even recreational vehicles such as trail bikes are required to have them.

Here in the UK and Europe, and indeed other oil producing countries such as the Middle East and parts of Africa, the main requirements are in what are termed 'hazardous areas' i.e. where there is a significant risk of fire or explosion from a substance being handled or produced.

Whilst sparks from an external combustion engine have a fairly obvious source - the fire - it may not be as obvious in an internal combustion engine; small particles of carbon, both from the combustion process and from within the hot exhaust system can still be blown out of the exhaust pipe as sparks.

There are many different designs but two main principles of operation. One relies on some means of trapping the particles, the other in absorbing the spark's energy and so extinguishing it.

The first is obviously the simplest and hence the cheapest and is often not much more than a gauze mesh screen. As the trapped particles are retained it needs maintaining to keep it functioning; at the very least it needs periodic cleaning otherwise the resultant exhaust back pressure will have detrimental effects on the engine. **Photograph 1** shows a simple screen type spark arrester fitted to a small petrol engined generator along with a warning to keep clean.

This type is tested by evaluating its catching efficiency. Small grains, usually sand, are blown through the arrester and the output caught and checked. For instance the US Forestry Department specify that only very small particles less than 0.023" are allowed through. The energy in such a small spark being insufficient to set fire to the vegetation.

In the second type, the exhaust gas is caused to spin, usually by a louvred tube or plate or a series of vanes. The heavier carbon particles are then thrown at an outer casing where they are retained longer as they spin around and are pulverised and their energy dissipated, once inert they are then blown out with the exhaust gases, **photo 2**. The twin cyclone type shown usually has sufficient silencing properties to allow it to replace the muffler and they are often

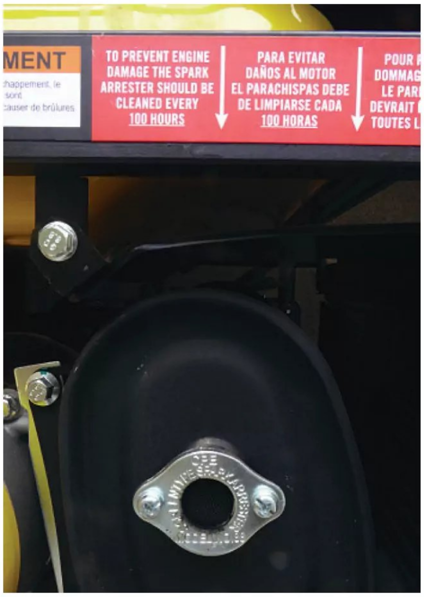


Photo 1: Mesh spark arrester with cleaning warning.

engineered with pipes and brackets to fit as a direct replacement for the standard unit.

This type is tested by feeding a specified size and quantity of powdered charcoal into the air intake of the engine, in order to produce some sparks, and observing the outlet of the arrester in a dark environment where there should be no sparks visible. A photographic record made in a successful test is a blank, black image. The author remembers witnessing an MOD acceptance test on an RAF Land Rover that was to tow a fuel bowser, the only place dark enough with adequate extraction for the exhaust fumes was the Land Rover Special Products paint spray booth.

It's been mentioned that one of the main requirements for spark arresters is on engines working in hazardous areas, such as oil and gas handling or processing facilities. The hazard can also be from certain types of dusts, seemingly innocuous cereal flour has been the cause of several catastrophic explosions. These areas come under what is known as the ATEX Directive (ATmosphères EXplosives). They are split into three zones depending on the risk, for example how much and how often inflammable gas or vapour is present. A similar arrangement exists for inflammable dusts. The directive covers not only mobile plant but everything such as electrical equipment, even hand tools, hence non-sparking bronze hammers and chisels etc. All approved products are marked with the ATEX approval symbol, **photo 3**.

In the most hazardous area, Zone 0, internal combustion engines are not permitted. In the other areas varying levels of protection are required. A whole standard, BS EN 1834 (Reciprocating internal combustion engines. Safety requirements for design and construction of engines for use in potentially explosive atmospheres), in three parts is devoted to the requirements.

Basically not only are there risks from sparks, but the temperature at which the likely vapour auto ignites has to be taken into consideration and the engine exhaust gas and general surface temperatures may need controlling. It is often necessary to fit a cooled exhaust manifold (mani-cooler).

One further problem is that if a flammable gas is present, a diesel engine, being compression ignition, can actually breath it in and run on it without the need for its own fuel source. The whole combustion process is then totally uncontrolled and the engine may well overspeed, generating flames from both the inlet and exhaust. To control this risk, flame traps need to be fitted. The inlet is not much of a problem as it is clean air, but the exhaust will carbon up in general use. Over the years various patented designs have been developed to try to improve the service life. One design had mechanically driven reciprocating plates, another a matrix of stainless steel balls that vibrated about as the exhaust gas passed through.

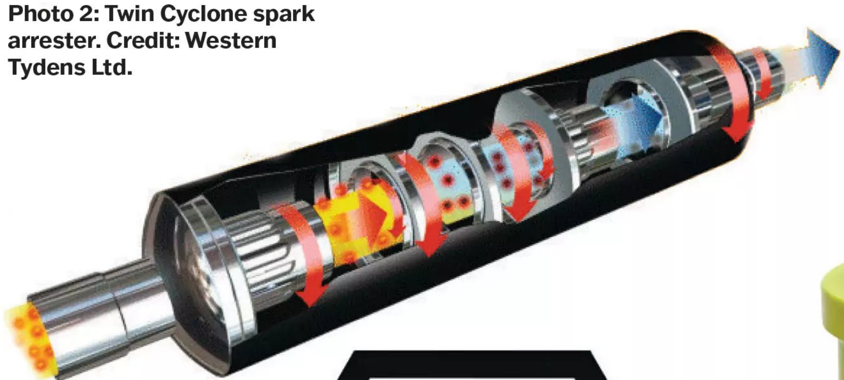


Photo 2: Twin Cyclone spark arrester. Credit: Western Tydens Ltd.

Photo 3: ATEX Approval Mark.

Photo 4: Air intake shut down valve. Credit: Chalwyn Ltd.

Special overspeed shutdown valves are also incorporated into the air intake, so if the engine tries to overspeed and the airflow increases beyond a predetermined level, a spring-loaded valve shuts off the whole air inlet so stopping the engine, **photo 4**. All other openings such as crankshaft breathers have to be protected as well. The engine's electrical system is another area for concern. Alternators must be flameproof and the starter motor is usually hydraulic powered from an accumulator, though spring powered ones have been used.

Modern developments have led to sophisticated gas detection and engine management systems that constantly monitor the environment for the presence of gases or vapour and immediately shut down the engine if any is detected.

I hope this has given some insight into a very specialised area of engineering that is not very well known, but vital for safe operations in some extremely complex and dangerous places. ●

Please mention Model Engineer when replying.

Readers' Tips

We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'. Email your workshop tips to **meweditor@mortons.co.uk** 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 we'll choose a winner for the Tip of the Month and they will win **£30 in gift vouchers from Chester Machine Tools**. Visit **www.chesterhobbystore.com** to plan how to spend yours!

A Toolblock for Parting Off

This tip to increase rigidity, comes from John Worth and echoes Tubal Cain's 'Gibraltar' tool post.

If like me, you have a mini-lathe with a quick-change tool post you will probably find that parting is painful. Even with a nice slim parting blade, the tool pressure applied at a point way off the side of the tool-post is often too much: everything tips off to the left, leading to chatter or even binding and breaking the blade. This problem can be fixed by bringing the load more in line with the supporting saddle arrangement.

I've seen a substantial reduction in parting problems since making up a specific parting-blade-holder-holder. Each time I need to part off I unscrew the top handle entirely, lift the whole QCTP assembly off and drop on the holder-holder. This consists of a bottom disc which sets the tool height, and a top block that holds the parting blade holder. I made it by facing to length, roughing out the slot with an angle grinder, then finishing up with my little Adept No.2 shaper. Alternatively you could easily make one on a mill, or even with a file if you've got more time than tools!

Note that the photos also show my compound slide replaced by another solid block of steel. This is independent of the holder-holder trick and improves rigidity for general turning. When I occasionally need to turn a taper etc I simply swap the compound back in. The block is the same height as the compound, so tool settings etc. are unaffected.

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

Photo 91: Water pump parts for assembly

PART 13

A GWR Pannier Tank in 3 ½ Inch Gauge

Gerald Martyn builds a locomotive he can lift. Continued from Model Engineer & Workshop issue 4764

A WATER PUMP

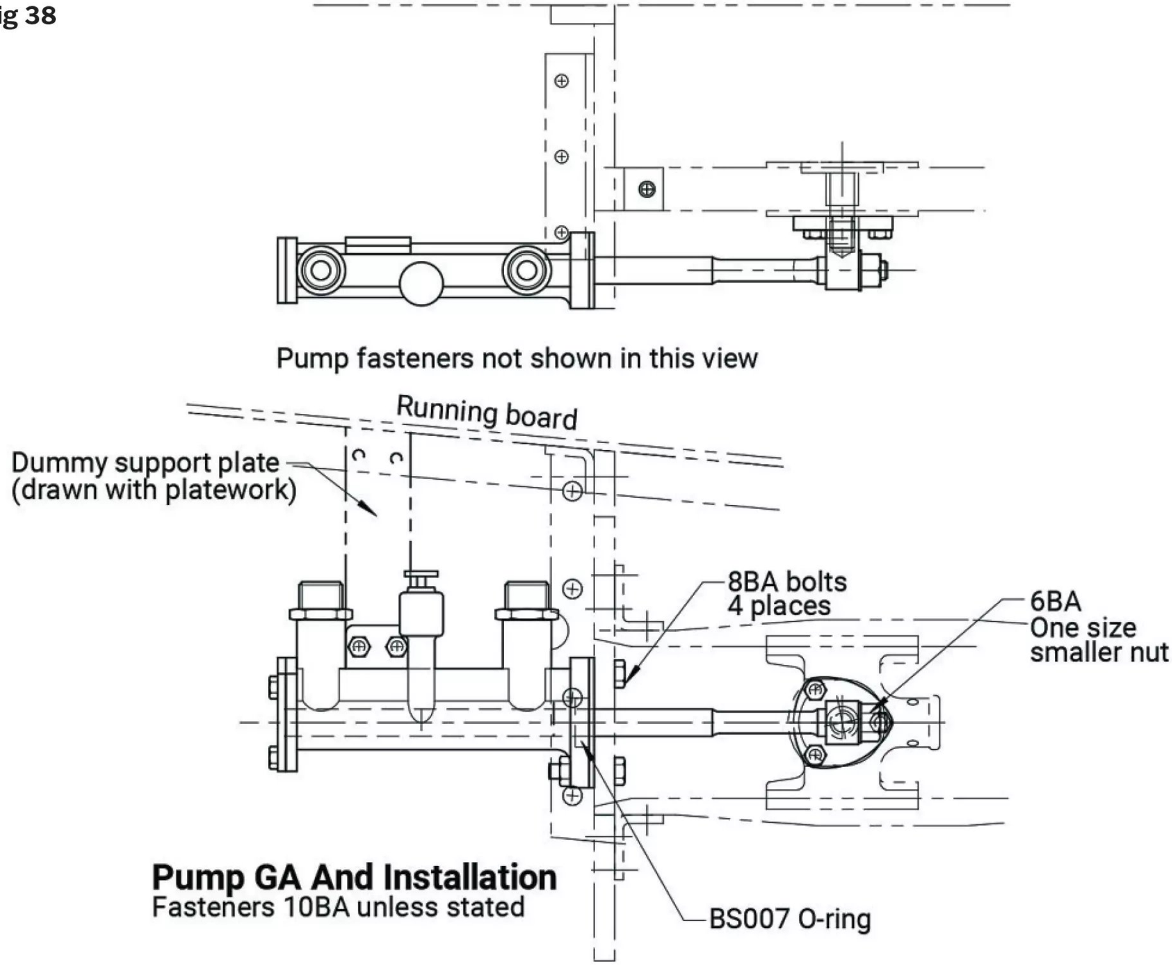
I'll describe the water pump next because it completes the motion and cylinders and from then on they can be carefully sealed-up at any time to suit your plan. The pump fits in the position occupied by the vacuum pump on the full size and is made to look as much like it as I can. It appears ideal for a little casting but my rules are that there will be no new castings. In any case, there are advantages in a fabricated assembly as the positions for all the flanges holes can be accurately marked out and drilled and alignment should then be fairly simple, given that the matching holes in the motion bracket have been accurately positioned by a laser. It is important that the cylinder itself is aligned parallel to the motion, and this means that the attachment flange bolting face must be machined accurate and square to the axis, for which I've left a machining allowance in the design. There is just one laser cut part, the drive bracket flange, so I made it part of the smokebox batch which will be the next job. Here's the list:

Title	M.E. Laser Part No.	Material	No. Required
Pump Drive Bracket Flange	29979	2mm Mild Steel	1
Smokebox Front Panel	29980	1.5mm Mild Steel	1
Smokebox Rear Panel	29981	1.5mm Mild Steel	1
Smokebox Floor Panel	29982	1.5mm Mild Steel	1
Smokebox Rear Ring	29983	1.5mm Mild Steel	1
Smokebox Wrapper	29984	1.2mm Mild Steel	1
Smokebox Footsteps	29985	1.2mm Mild Steel	2
Smokebox Crossbar Brackets	29987	1.2mm Mild Steel	2
Smokebox Crossbar	29986	5mm Mild Steel	1
Petticoat Flange	29988	1.5mm Brass	1

In many of our designs - and I have been guilty of this - there is an over-supply of water, either by pump or by injector capacity. This can lead to lots of water going to bypass, wasting energy or, in the case of injectors, a significant loss of boiler pressure. The ideal supply would just match usage but as this latter is variable, then something not much greater than the greatest possible steam usage will suffice. Therefore, I've reduced the pump ram to 5/32" diameter from the 3/16" used on Rob Roy, and as the volume ratio between water and steam at 80psi gauge is 290 this will still be more than adequate.

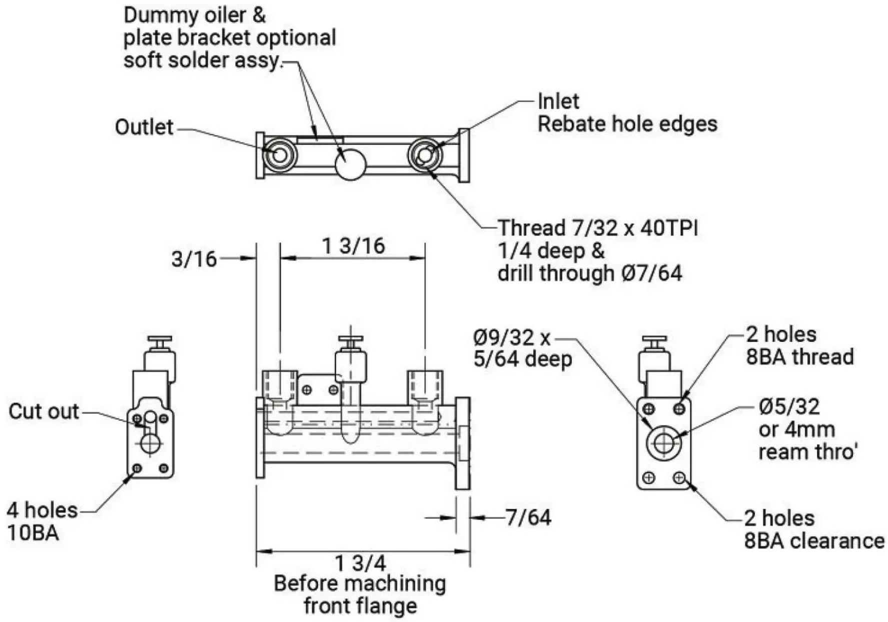
The pump G/A is shown at **fig 38** and the fabricated assembly at **fig 39**. The body component parts are shown in **fig 40**. I started with the end flanges and covers. These could have been laser cut but they're small enough to be made from bits in the scrap box and so cost nothing, and it's a nice little exercise in accurate marking out, drilling, cutting and filing that doesn't take too long. The cylinder is rather long to drill right through from one end as the drill may wander, and clearing the chips becomes a chore. The sequence I used was to turn the bar to size, with the fillet radius at the chuck end, and then pilot drill 7/64" to half-way and part-off. Reverse it in the chuck to finish the front end, pilot drill to meet up and then drill through

Fig 38



Pump GA And Installation
Fasteners 10BA unless stated

Fig 39



Pump Body Assembly
Mat'l: Brass
Silver solder & soft solder assy.

Photo 92: Water pump soldered assembly

Photo 93: Holding the pump body in the mill

at 1/8” diameter. The reason for drilling 1/8” diameter at this stage is that when it comes to the finishing operations, then a piece of silver steel can be put through and used to help centre finding. Other sizes are an option (do you have any 9/64” silver steel?) but to drill finished size now opens the possibility of irrecoverable distortion during soldering. The parts ready for assembly and soldering are in **photo 91**.

To assemble the parts for soldering start with a short piece of 3/32” brass or copper tube to align the rear flange and manifold. This will be drilled out after soldering. The flange can be retained by centre-popping the cylinder spigot end just next to its edge, then ease the flange out slightly to allow space for the solder. The ports and manifold bar are located by drilling 3/64” holes and popping brass rivets in, just as location pins. Don’t worry about holes through the manifold, they will fill with solder, but try to stop short of the cylinder bore just in case. The front flange is easily aligned with the rear and held in place with centre pops. Solder it all up and it should look like **photo 92**. Parts not aligned properly may be fluxed, re-heated and pushed into place (no need to ask how I know this).

I puzzled over how to align it to drill the holes out and skim the front flange, as the flanges rather get in the way of effective clamping. I thought first of using the lathe 4-jaw chuck and lots of packers, then I hit on the idea of using a vee-block set on parallels (so it located only on the cylinder plain diameter) in the milling vice. Either way, the measured dimension from

Fig 40

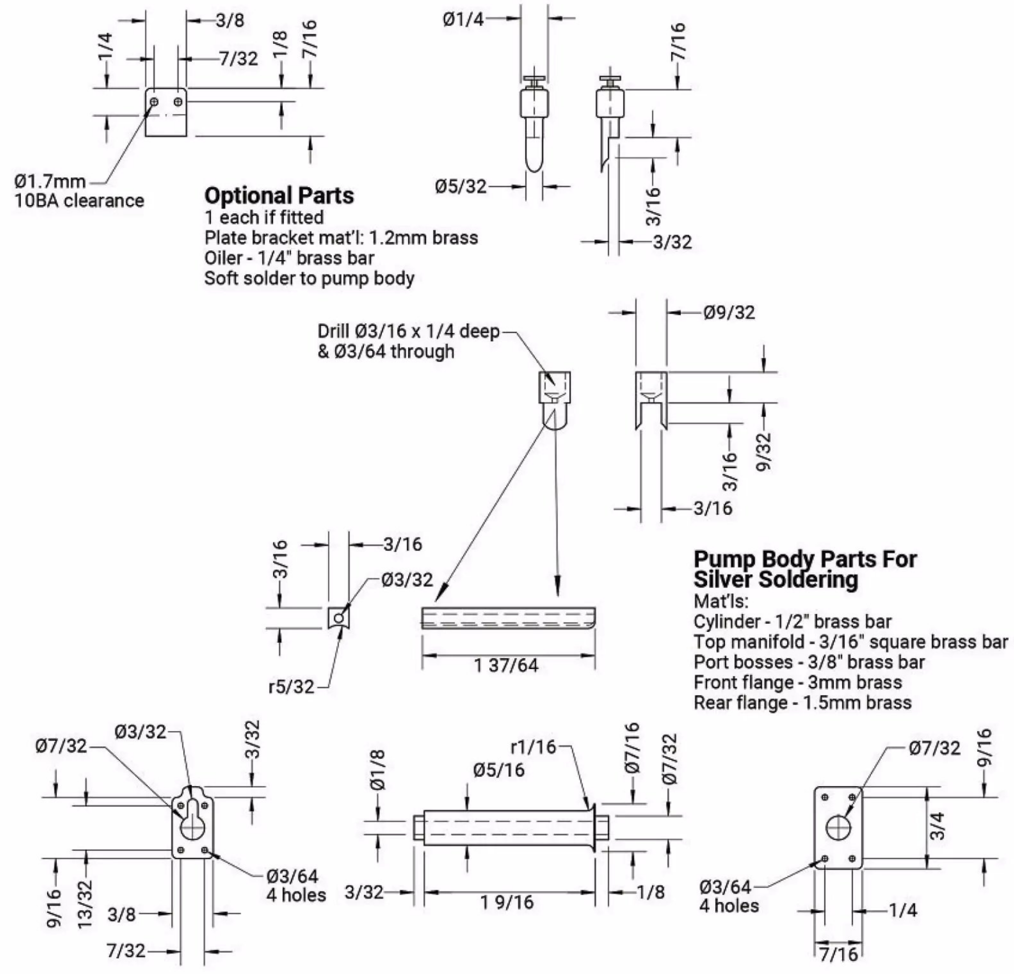
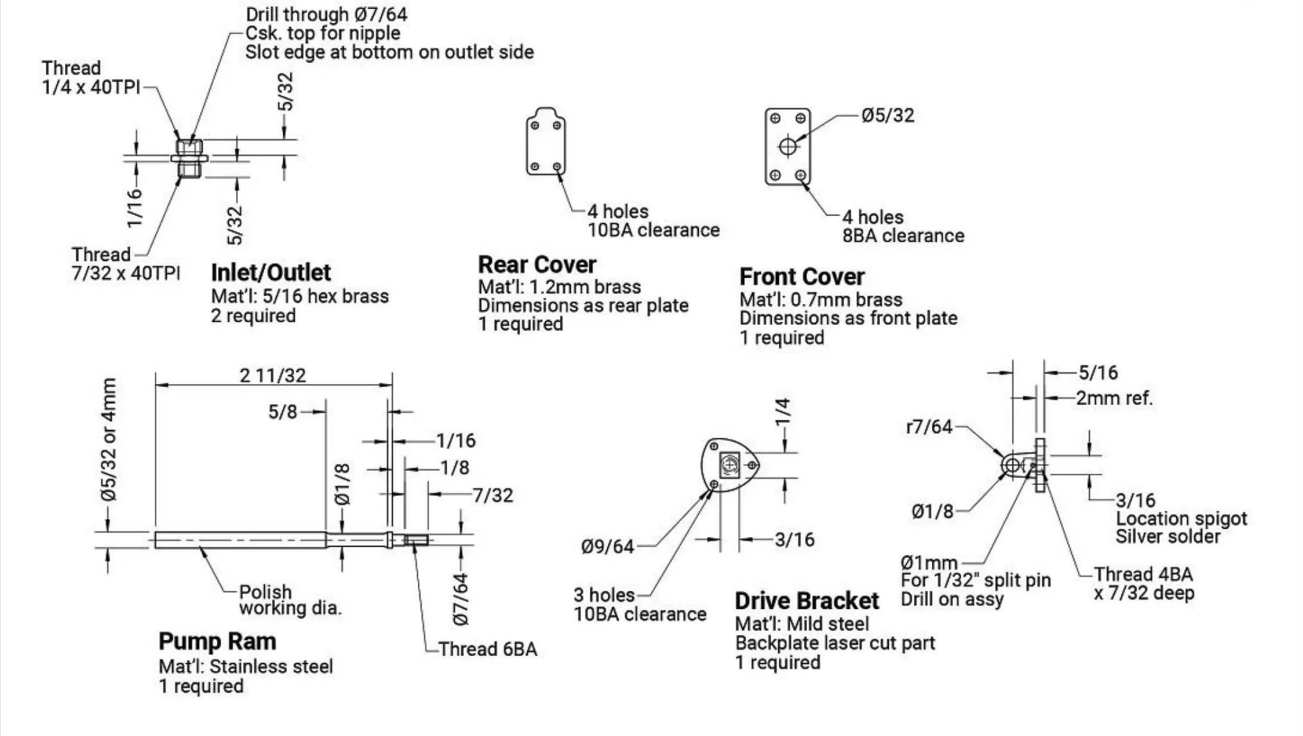


Fig 41



the cylinder diameter to the top of each port boss should be made the same by careful filing if necessary. This ensures the clamping is true in one plane and, for my method, the vee block takes care of the rest. **Photograph 93** shows my set-up in the mill, which needs a parallel at the (my) rear vice jaw to get the height for clamping on both ports. No apologies for abuse of a vee block and parallel which would make the foreman cry (if I had one). They're accurate tools and not really intended for this, but much stronger than the bit being clamped so it works a treat. Skim the front flange and then, with the bore central on the mill, drill and ream it right through. The O-ring seal at the front is the same size as for the valve spindle, but here can be a less temperature-resistant nitrile rubber for cheapness. From the rear end drill the manifold only as far as the lower port, to take out the little piece of alignment tube and any location rivets. Filing off and drilling out the port location rivets and then finishing off everything is straightforward stuff (hint; make a short guide tube for drilling the rivets and holes out).

Figure 41 shows the remaining parts. The drive bracket backplate is a laser cut part. It would be difficult to dimension and mark out if I hadn't put it on the laser cutting list. Pay careful attention to the holes layout; it's symmetric about the piston axis and must be orientated correctly. The pillar is made from a piece of 3/16" or ¼" bar, or something larger, and should be left over long before final profiling after test fitting. Get it to 3/16" x ¼" by about ¾" long then centre it up in the lathe 4-jaw chuck to turn a short spigot and to drill and tap the hole. Square it up in the flange, hold in place with a couple of centre-pops to the spigot and silver solder the two parts together. Clean-up and mark out for the drive hole, then bolt it to the crosshead and check the position using a pointy rod through the pump body. Take it off for drilling and finishing. I did a lot of cogitating about how best to lock the thread to stop the gudgeon pins coming undone. Loctite would do it but the pins can rotate in the crosshead and could be impossible to remove. In the end I opted for split-pins. For the pump fitting this is shown on the drawing. For the other crosshead I turned one end of a nut down to the flats then cut some fine slots through in line with the flats to castellate it. After doing it up tight I drilled the gudgeon pin through one slot to take the split pin. It's not prototypically correct but it looks good enough to suggest it may have been. The finished pump is shown in **photo 94** and the LH crosshead in **photo 95** (the split pin has yet to be trimmed and bent back).

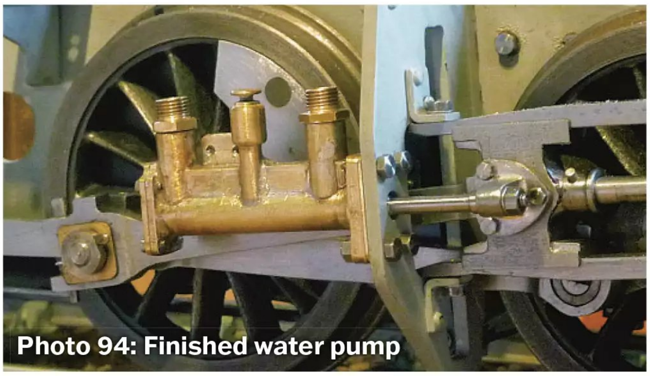


Photo 94: Finished water pump

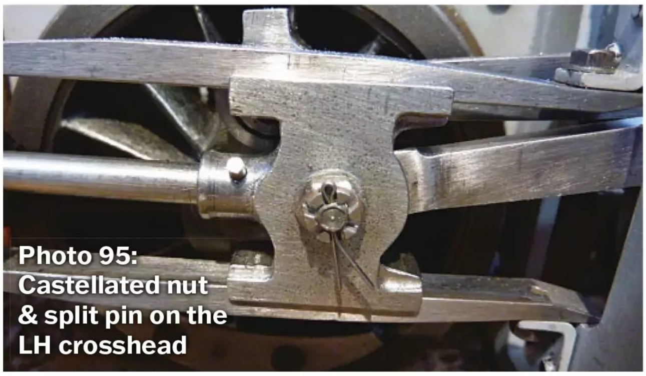


Photo 95: Castellated nut & split pin on the LH crosshead

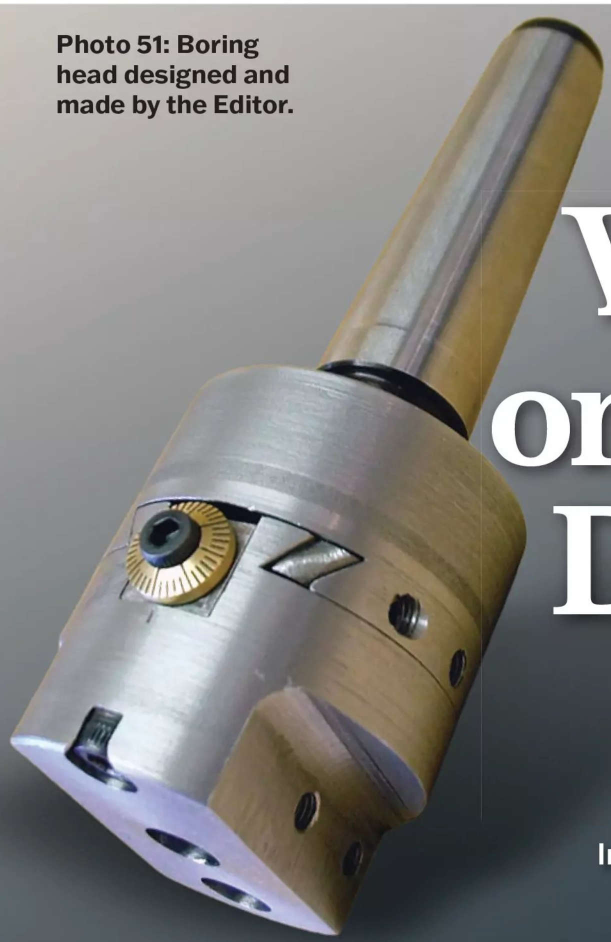


Photo 51: Boring head designed and made by the Editor.

Working on on the Lathe: Drilling and Boring

PART 7

In this instalment of our beginner's series, **Neil Raine** explains the use of an adjustable boring head.

Nowadays, there is a great range of tooling available specifically for the purpose of boring into metal. One example is the adjustable boring head, a rotating tool that fits directly onto the spindle of the machine, **photo 51**. The boring head is fixed to a machine spindle that moves linearly in one axis only (y axis milling machine and boring mill), or none (lathe). The method used to reposition the cutting tool and progressively increase the size of the bore is different between the boring head and the boring bar that is used solely on the lathe *(ME&W 4764)*.

In some respects, the boring head is a rotating tool post. In early versions of the boring head, the tool or cutter of the boring head was seated in a recessed channel and was secured in position using set screws, similar to a conventional lathe tool. To increase the diameter of the cut, the cutter was extended radially, or longitudinally, from the tool holder and this correspondingly increased tool overhang. To achieve the required precision of the bore, it was necessary to measure any adjustment of the cutter with a micrometer or caliper. In later versions, the head of the tool is split and operates on a dovetail jointed slide way, similar to the cross slide or top slide of a lathe. As the position of the cutter in the boring head is fixed, tool overhang remains constant. Adjustment of slide way is very accurate as this is achieved by turning a set screw that incorporates a graduated dial. Within a defined range the boring head is easily adjustable in small increments. The boring head increases the versatility of the lathe further still.

Nowadays, the cutting tool of the boring head will usually be pre-ground HSS or with interchangeable carbide inserts. The cutting tool of the boring head can be aligned with the axis of rotation of the spindle, or it can be orientated perpendicular to it. When a bore with a small diameter is required, the cutting tool is orientated with the axis of rotation and is plunged into the bore. In this example, the boring head itself will remain outside of the cylinder bore. This type of cut is taken using the cutting edge at the front of the tool, similar to a facing cut taken on the lathe using a right-hand turning tool. For larger bores, the boring head will enter the bore of the cylinder when cutting and the tool is orientated perpendicular to the axis of rotation. In this orientation the cutting tool is a mirror reflection of the orientation of a conventional turning tool.

Various types of fitting are available to attach a boring head to different machine tools. When the boring head is used on a milling machine, the International taper, e.g. 30, 40 or 50INT, is a common type of fitting. The boring head may also be fitted with either a Morse taper fitting or a straight shank. Boring heads supplied with a Morse taper fitting between the numbers 1 to 4, which are compatible with a variety of different lathes, are commonly available. The fitting can sometimes be changed so the same boring head can be used on different machine tools.

CUTTING SPEED WHEN BORING ON THE LATHE

Reference charts are available to select the cutting speed for conventional turning, drilling and milling, but not typically for boring. However, using the information provided for centre lathe cutting speeds the suitable speeds for boring can be calculated quite easily:
Cutting speed (sft/min) = bore circumference (feet) x spindle speed (rpm)

Photo 52: A machine reamer.

Compared to the spindle speeds used for drilling, those used for boring are much lower. Just as the diameter of the drill bit greatly influences selection of the drilling speed, diameter of the bore is a significant determinant of the spindle speed used for boring. Other relevant factors to consider when setting the spindle speed include the size, shape and weight of the component, how it is mounted onto the lathe, and whether it is the tool or the component that is rotated.

Perhaps it is because of the numerous options for boring on the lathe that a table of recommended speeds is avoided. Starting with a slow spindle speed is often prudent. This is especially so when an irregular shaped component is mounted to a faceplate and rotates with minimal clearance over the lathe bed. Suitable balancing of the component is also important to avoid it whipping when turned. Bradley provides a good introduction to boring on the lathe including mounting to a faceplate and using the boring table, **refs 2** and **3**.

Using the example of boring a two-inch diameter cast iron cylinder, the cutting speeds corresponding to the available standard (ungeared) and back geared spindle speeds for the Myford ML7 and Super 7 lathes were calculated, **fig 5**. The dotted line at the bottom represents the recommended cutting speed (125 sft/min) for machining a two inch cast iron cylinder using an HSS tool, **ref 4**. Spindle speeds for the ML7 lathe are shown to the left. The most suitable spindle speed is 200 rpm that equates to the cutting speed 104 sft/min. For the ML7, the settings on the lathe that correspond to this are, headstock belt position one with back gear disengaged. Values for the Super 7 lathe are shown to the right. The most suitable spindle speed is also 200 rpm using motor drive belt position B and headstock drive belt position four, back gear disengaged.

Using the Myford ML7 and Super 7 lathes, the slowest spindle speeds available with back gear engaged are 35 rpm and 25 rpm, respectively. These spindle speeds would be suitable to bore a cast iron cylinder of 3.57 inch diameter, ML7, and 5.0 inch diameter,S7. Obviously, cylinders of this dimension cannot be accommodated on these lathes. Nevertheless, the point is that each lathe has the ability to run at a spindle speed suitable to bore a cast iron cylinder up to the capacity the lathe can accept. Furthermore, cylinders made from materials that require a slower, or higher, cutting speed can also be accommodated.

Lathe manufacturers are faced with the dilemma of selecting pre-determined spindle speeds suitable for machining material of varying size and type. This must have been an unenviable job that has likely eased nowadays. Using the two popular Myford lathes as typical examples of model engineering lathes, it seems that when drilling using very small drill bits (1 to 5 mm) the available spindle speeds are too slow - solutions to this problem have been offered. Yet, for most turning and boring tasks the range of available spindle speeds is quite appropriate.

Many model engineers will have overcome the problem of limited spindle speed selection on a lathe by modifying it. One possibility is to fit a device called a variable frequency drive (VFD) unit that enables the rotational speed of the motor to be varied electronically. The advantage of this modification is that it offers an almost infinitely variable spindle speeds. Once the most suitable motor pulley and headstock pulley positions have been chosen, these will rarely need to be changed.

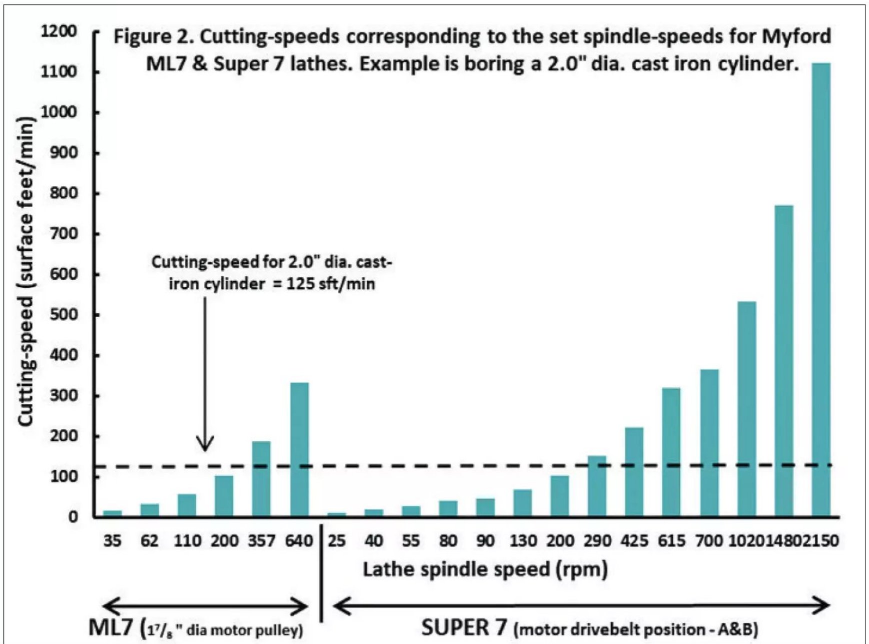


Fig 5: The calculated cutting speed corresponding to the set spindle speeds of two Myford lathes, the ML7 and the Super 7. All values represent the cutting speed for boring a two inch diameter cast iron cylinder.

MEASURING THE BORE

Often, the size of bore made by the drill bit will provide sufficient accuracy for its intended purpose, e.g. to accept a fixing. But, when the bore is to associate with a moving part, such as a piston or a rotating shaft, its final dimension will be specified to within a tolerance. In order to satisfy this, accurate measurement of the bore during its making is necessary. Regardless of the shape of the component, the aspects of any bore that can be measured include the inside diameter (ID), its depth and circularity. If the component is cylindrical, e.g. the barrel of a hydraulic cylinder, additional aspects include the outside diameter (OD), the wall thickness, and parallelism. Parallelism, otherwise known as concentricity, of the bore to the cylinder wall was discussed previously as this is most accurately assessed with the part in the lathe using a DTI.

The usual choice of bore measuring tools in the home workshop include the steel ruler, Vernier caliper, depth gauge, bore gauge and plug gauge. These are often perfectly suitable for the intended purpose of the model engineer. Added to these, there is a wide selection of other electronic and mechanical bore measuring tools to choose from such as 3 point bore micrometer, inside caliper micrometer and tubular inside micrometer, **ref. 19**. The Vernier caliper is a versatile tool that may be used to measure the depth and ID of the bore and the OD and wall thickness of a cylinder. Although the Vernier caliper can prove its worth to measure the component during production on the lathe, e.g. to inform of how much material is yet to remove, it is a measure of linear bore diameter and not of circularity. Another option is to make a plug gauge on the lathe to the precise dimension that is needed. A plug gauge will provide information about the precision of the bore around its entire circumference. Test fitting of matched components using a feeler gauge is also a good indication of overall bore dimension. Regardless of the measuring tool used, heat induced expansion of the component during machining is worth bearing in mind when timing any measurements.

USING THE REAMER

Similar to the drill bit the reamer is a cylindrical multi point tool that cuts inside a bore, but this is where the similarity ends, **photo 52**. A reamer is a precision tool that removes only a small amount of metal to improve the surface finish and finalise the dimension of the drilled bore. Just as a finely set and sharp smoothing hand plane is used to remove saw marks from the surface of a wood board and bring it to final dimension, the reamer is a surfacing and final sizing tool for a bore in metal. At a drill size and a bore size of less than 10.0 mm, reaming will typically increase the diameter of the bore by 0.1 to 0.2mm or 0.025 to 0.050" inch, **ref. 20**. In other words, the size of the drill and the reamer need to be very closely matched so the reamer is not over worked, and the tool is able to accurately cut the bore to final dimension.

The many different types of reamer can be distinguished by the shank, e.g. straight shank (chucking) reamer, taper shank reamer (machine), hand reamer (square end to shank), or the body, e.g. straight flute, spiral flute, tapered flute and adjustable reamer. Commonalities between different reamers include a chamfered tip to ease entry into the bore and between six to eight cutting edges. The reamer is made with either longitudinal straight flutes or flutes that gently spiral down the body; approximately one third of the overall length of the tool. The flutes are the channels in the reamer that remain after the original cylinder is machined to form the cutting edges. The cutting edges of the reamer are formed where the inner face of the flute meets the outer cylinder. As the reamer rotates and progresses through the bore, the cutting edges shear the wall of the drilled bore removing very fine ribbons of metal. Because the cutting edges of the reamer are sensitive to becoming dull or damaged, when used in the lathe it is introduced slowly into the rotating work without rotating it. To remove the reamer from the work it should never be rotated anti clockwise, as this will dull it. Reamers work optimally at a slow cutting speeds and with the use of cutting oil and / coolant, **ref. 20**.

References

19. How to ream a hole (coromant.com)
20. Mitutoyo, Category: Bore Gauges

Look out for your next issue of Model Engineer & Workshop

Number 4766 July 2025

On sale June 20 2025

Gavin Blakeman shares his designs for tailstock chuck adaptors.

Patrick Hendra looks at plastics and how we can use them in our projects.

John Arrowsmith visits Stafford and District Society of Model Engineers.

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Tube Expander

Matt Jeffery makes a tool for ensuring a steam-tight fit.

The tool works in a similar way to a roller clutch bearing, but instead of locking in tapered grooves, the rollers move around a conical core. The tool is fitted inside a tube, where it enters the tubeplate; the tool is turned and the rollers move outwards, expanding the tube into place.

THE SLEEVE

If the tube to be expanded is, say, 1/2″ internal diameter, then make a small cylinder approximately 1″ long, leaving sufficient to grip it at the end. Turn the outer diameter to 0.498″ and drill 17/64″ down the middle just a little longer than the 1″. Place the part in your indexing head and set it over about 5 degrees off centre to the axis, then mill four equally-spaced 1/8″ wide by just over ¾″ long slots in it, fig 1, then part it off. The slots are for placing four 1/8″ diameter dowels inside, to act as the rollers.

THE MANDREL

The mandrel is a 3″ long piece of tool steel (starting with a piece a little longer to provide sufficient to hold whilst machining is prudent). First face the end and put a small centre in it to support it, then turn about a 1/4″ long section to .240″ diameter. Next, turn a 2 degree taper (1 degree each side) about 2 1/2″ long, see fig 1. Next, transfer it to your indexing head and put a 1/4″ hex on the other end about 1/2″ long. Part it off and the mandrel and proceed to harden it.

HARDENING

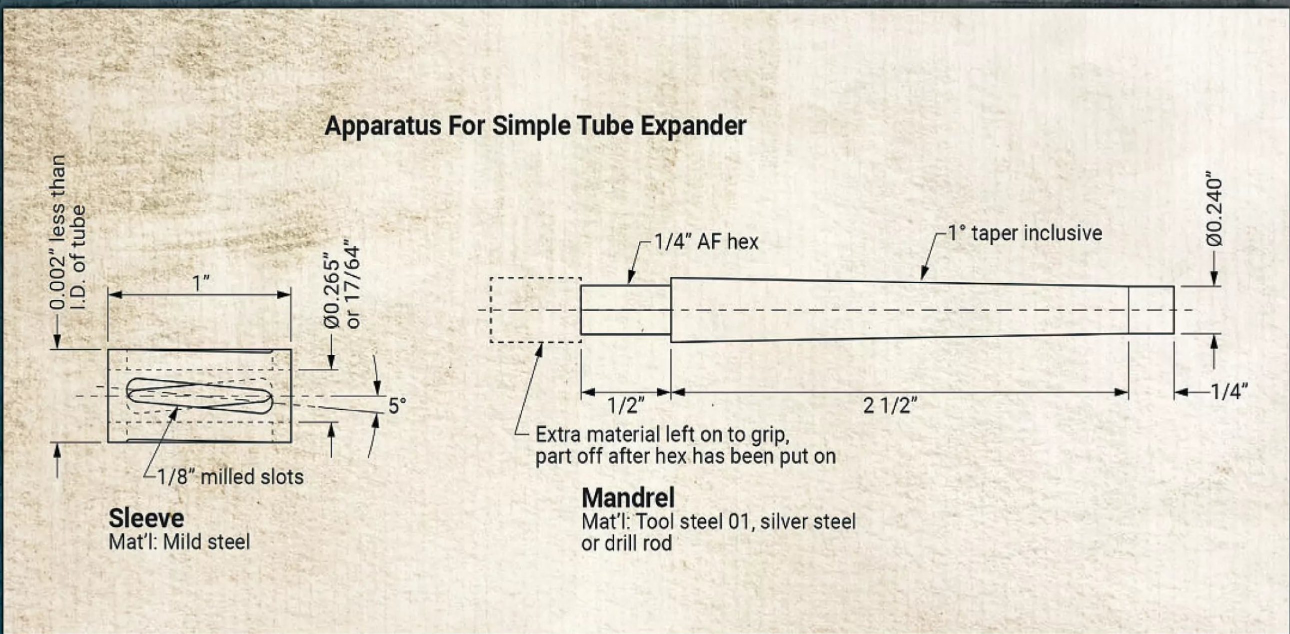
For silver steel and O1 steel it is recommended to quench in water, but I think that is too harsh. I recommend oil (almost any kind of oil with a high flashpoint will work). For other steels, such as tool steel, then follow the instructions for that particular steel. Bring the mandrel to a cherry red and quench in oil. Within 12 minutes (this is critical as martensite will set in after that time) place in the oven at 205 degrees Celsius / 400 degrees Fahrenheit, for half an hour when your partner is not looking. Leave to cool on the concrete floor.

ASSEMBLY AND USE

Now you are ready to assemble the apparatus, put just a little oil on it, then insert the barrel into the tube. Place four 1/8″ diameter dowels in the slots and start turning the hex with a socket ratchet. One way it will start to pull in, reverse it and it will slacken. Just a few turns will suffice to seal the tube to withstand a high pressure.
I have built my 7 1/4″ gauge Princess Royal boiler in mild steel (boiler plate quality) using 5/16″ thick seamless tube, with 5/16″ thick outer wrapper and 1/4″ thick inner wrapper and tube plates 3/8″ thick. The tubes were copper roller expanded in place. This was tested to 300 PSI for half an hour.

A CAUTIONARY TALE

I add this as a little post-script while on the subject of boilers. My friend Paul of Quakertown, Pennsylvania didn't habitually blow down his boilers after running and one day the tubeplate cracked. Upon examination and cutting out said tubeplate he discovered the white crud that is left by limestone bearing water was 5″ deep, all the way up to the bottom of his tubes. Upon cutting out the side sheets, the same thing was observed so the boiler was scrapped. Steel boilers need a little more maintenance than copper boilers, but the same applies when it comes to blowing down. The moral is always blow down your boiler after each run using alternate sides.



POSTBAG

The Editor welcomes letters for these columns, but they must be brief. Photographs are invited which illustrate points of interest raised by the writer

Readers! We want to hear from you! Drop us a line sharing your advice, questions or opinions. Why not send us a picture of your latest workshop creation, or that strange tool you found in a boot sale? Email your contributions to meweditor@mortons.co.uk.

RUSTON NAME PLATE

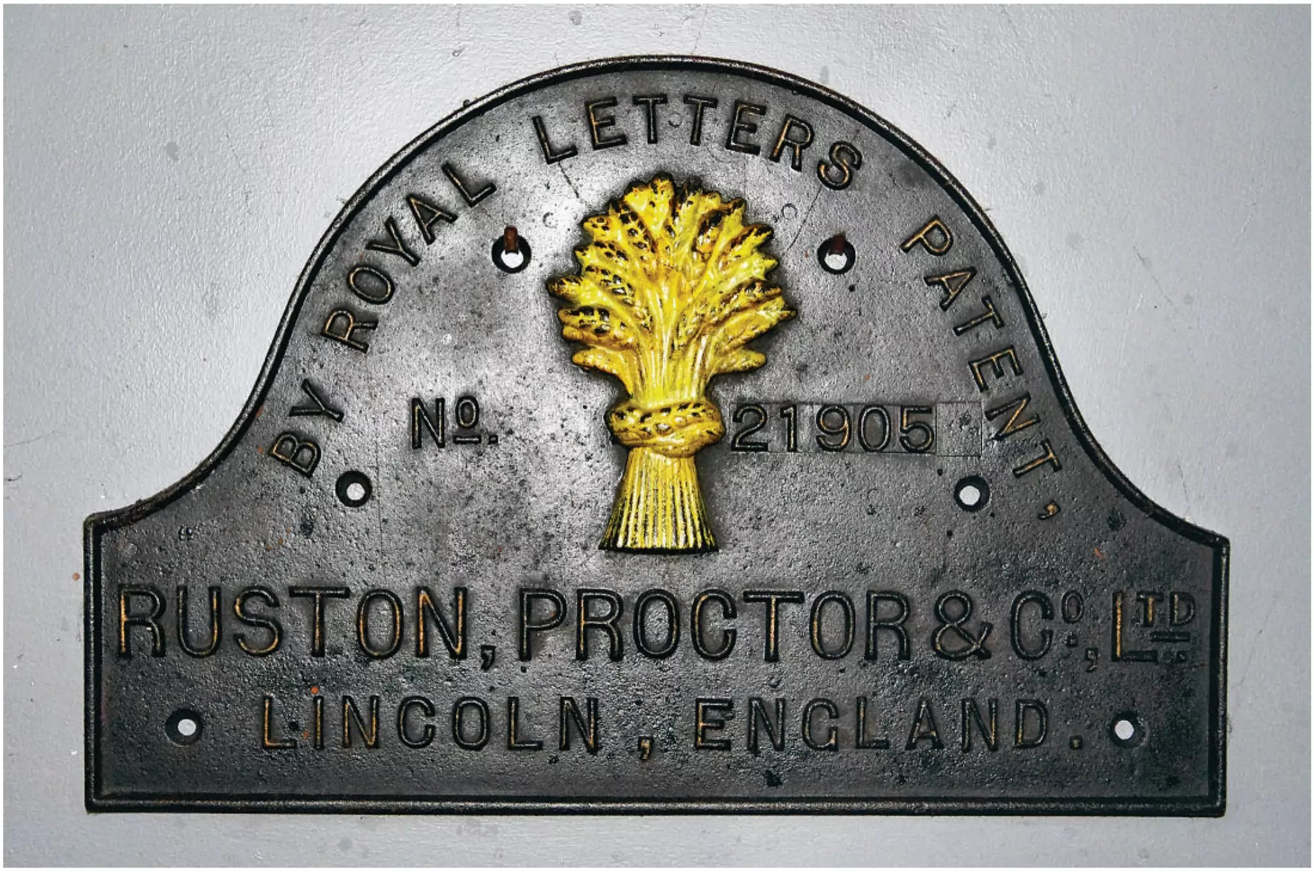
Dear Neil, I live in Yackandanda, with my son Steven. My wonderful wife, Ann, sadly lost her fight with cancer in 2013.

Back in about 2006 probably, Ann had been browsing in one of the junk shops in the high street and saw this Ruston Name plate. She just had to buy it! I screwed it on the kitchen wall, as is, a temp arrangement- and I have been intending ever since to restore the gold colour paint on the lettering and centre wheatsheaf emblem. To put it in perspective it is about 18 inches wide.

Yackandandah, of around 2500 population, is now a popular tourist venue as several buildings and much atmosphere from the Gold Rush days exists. Gold was first discovered here in quantity about 1852 and over the next 100 years more than 100 tons were found and mostly shipped to Melbourne. And yes, you can still find specks of the yellow metal in the ground and creeks of the many hectares of bush-land (mainly eucalyptus forest) which are on our doorstep. Sorry I digress, trying to paint a picture for you...

I attach a photo of the name plate. I know you have a number of readers scattered about Oz -land and if it is printed in the magazine perhaps someone might offer some clue as to the origins.

David Dunn, Yackandandah, Australia



SMALL SCREW THREADS 1

Dear Neil, after reading Stew Hart's article of small threads (ME&W 4763) I think I can add a couple of comments which may be of interest. Firstly, small metric taps and dies (or screw plates) are available down to 0.4mm diameter from clock and watch maker's suppliers. BA sizes down to 14BA (1mm) are available from our more usual suppliers. I too have made a tiny tap wrench which clamps around the plain shank of the tap, but mine was just filed from bar so is not so presentable as his. It is slightly smaller, too, and intended for 'finger and thumb' turning. When using it I clamp it on as close to the threaded portion of the tap as possible. This reduces the bending moment from any unintended side force, so helping minimise the chance of breakage. For a more sensitive feel when tapping I also prefer to hold the work with my other hand rather than hold it in a rigid vice or clamp.

Gerald Martyn, by email

SMALL SCREW THREADS 2

I am sure others may make similar observations about the interesting article on Making Small Threads (ME&W April 2025), but I thought I would add my comments.
My principal interest is repairing clocks and watches, where it is common practice to use a pin vice (sometimes called a pin chuck) to hold small taps, as well as other tools. They are relatively cheap, available in a range of sizes and easy to use. If a suitable rod is fitted into the chuck of a pillar drill, then the free end inserted into the handle of the pin vice, it makes an instant and cheap tapping guide.
Once you have a set, it is surprising how often they come in useful, for example; holding small screws to aid insertion, fitted with a drill bit or burr to clean up sharp edges around a hole, when winding a cord around a barrel use the chuck as a weight to apply tension or when twisting some wires together put one set of ends a vice and the other in the chuck, pull gently and rotate. If you need to drill a very small hole but the jaws on the pillar drill chuck don't close up enough, then insert the pin vice with drill bit into the chuck. Check that the drill is running true before starting to drill and proceed slowly, but with care it can work.
Mark Burgess, by email

AUSTRALIAN MODEL ENGINEER

Dear Neil, regarding Ron's query about missing old copies of AME, Boulton Scale Models (EJwinter.com.au) have a large collection of back issues for sale including the last few issues of the Australian Model Engineer.
Barry M Wilson, Australia.

GARDEN RAIL REPORT

Dear Neil, In John Arrowsmith's report, photo 15 is labelled as an electric shunter. I'm fairly sure it's a model of a sentinel geared steam loco, either a Y1 or a Y3. Here's a photo of my almost complete 5″g version, which is battery electric to add to the confusion.
Duncan Webster, Warrington.

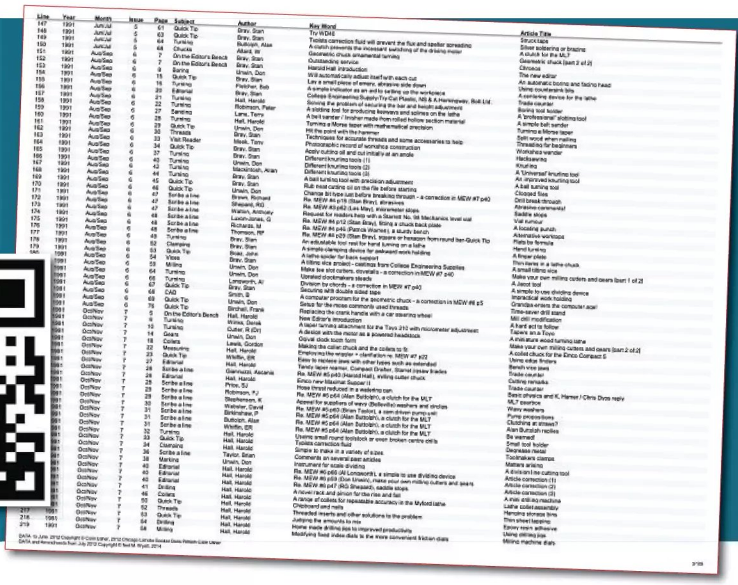
WHAT IS A BALIS?

In ME4760, the Zillertal Bahn article by Mr Roger Backhouse mentions all locomotives are fitted with a "balis" so they can be located at all times. What is a balis? I have worked with navigation systems of many types in my day job for over 20 years but have never heard of this term. Is it a brand of GPS transponder? Or a GSM transponder? Or other? Mr Google yields nothing.
Jeff Dayman, Canada

HI Jeff a 'Balise' is a train location system that uses transponders placed between the rails. Rather like some security tags used in supermarkets, these are passive radio-frequency devices. The latest iteration works up to speeds of over 300mph! They are being rolled out across the Europe and are also used on high speed rail lines in China – Neil.

ONLINE INDEXES

David Frith's has kindly agreed to prepare the indexes for Model Engineer & Workshop which can be downloaded from the Forum at **www.model-engineer.co.uk** – just select Forums and then the Model Engineers' Workshop topic. Alternatively scan the adjacent QR code. If you prefer the paper indexes, don't worry, David will be producing these in the future as well.



An EMCO Compact 5 Screwcutting Clutch PART 2

Graham Meek concludes the details of his final version of his screwcutting clutch design, for Compact 5 lathe users.

Photo 7: The operating levers are visible behind the gears.

I had initially designed the selector pivot pin to be retained by a circlip. This is shown in one of the early 3D views which John Slater did for me, render 1 (see part 1), as at that time I was having great difficulty working out where everything was from the mass of lines on the drawing. This was not helped by getting used to a new drawing package which replaced my faithful AutoCad. When it came to starting to assemble the unit onto the lathe, this circlip idea seemed to be a bit of a tall order, given the room available and the distance this item was from the end of the sheet metalwork cover on the headstock. **Photograph 7** gives a pretty good idea of the position of the bolt and the room available. In the end I decided to use an M4 hex-headed bolt and washer. This bolt and washer are cajoled into place using a thin strip of plastic. It was found that the hole in a plant pot marker label proved to be ideal. This had a good grip on the threaded portion of the bolt. A slit from this hole to the end of the label makes for easy removal once the bolt is started. Pressing this tool onto the partially exposed bolt also helps when it comes to removing the bolt, plus it's ready when it comes to reassemble. Using the label in conjunction with a 7mm A/F spanner and working the label and spanner alternately, the bolt can be inserted quite rapidly. If you should have to shorten a longer bolt to use here, I strongly recommend you put a machined chamfer on the cut-off thread. Trying to fit a bolt that has had only a hand filed chamfer in such a tight space is asking for your patience to be sorely tested. A dummy fitting external to the machine is another wise move, as the parts are then known to go together easily.

All the gears are manufactured from free cutting mild steel, (EN1APb), with the exception of the two idler gears which are made from Carp Brand Tufnol. All shafts in the gearbox are made from silver steel, as is the dog clutch and detent. The sleeve for the detent was made from EN1APb

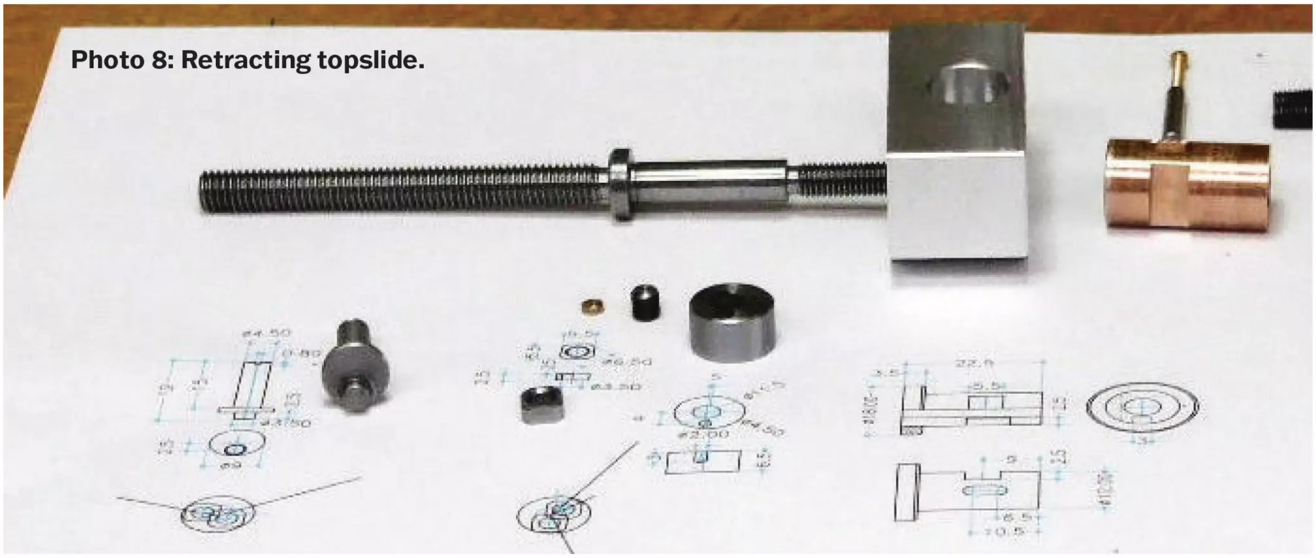
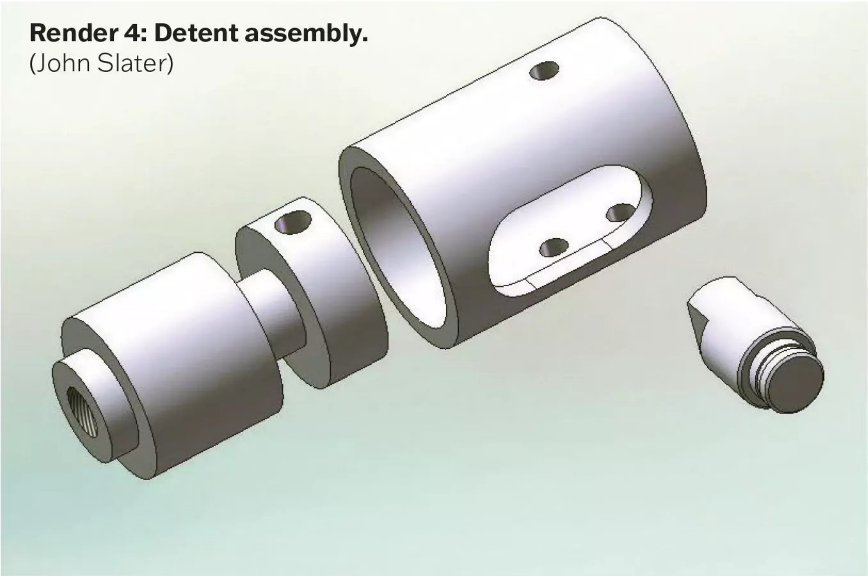


Photo 8: Retracting topslide.

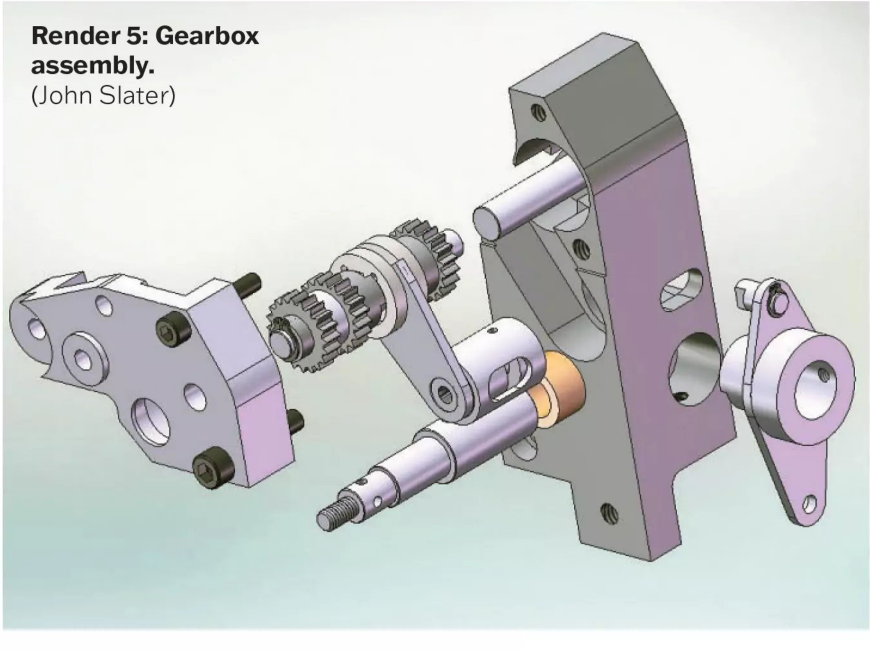
but readers in the past have been known to make this part out of phosphor bronze and even cast iron. The layout of the gears, dog clutch, detent, selector and the control linkage within the headstock are covered with John Slater's 3D views, **renders** 2 and 3 (in last instalment) **4** and **5**. All the Oilite bushes are easily found at the online bearing factors and are all standard sizes. Should the reader decide to make his or her own phosphor bronze bushes, then some attention needs to be paid to lubricating them. Given the close proximity to the Vee-belt drive, adding oiling points to the shafts was not deemed to be a good idea and was a major reason for using Oilite bushes.

I should point out that the Emco feed attachment will be required in order to scavenge the coupling, leadscrew outer gear shaft and quadrant banjo or arm, in order to complete this attachment, not forgetting the gearing that goes on the quadrant. While talking about this attachment, the original Emco die-cast main body has a heart shaped opening moulded into the end of the selector bore. This is to restrict the moment of the feed selector knob. The pin in the end of the knob that engages the leadscrew feed coupling, abuts the two sides of the heart shape. To give the 'engaged' and 'dis-engaged' positions.

A flat is machined on the phosphor bronze bearing selector sleeve in the screwcutting clutch attachment that serves the same function. Once set the selector sleeve is locked in position with an M5 Allen socket grubscrew from beneath the main body. Careful attention needs to be paid when tightening this grubscrew. Too tight and the bush will lock the engagement selector knob, plus it would be a good idea to either use a flat ended grubscrew or some kind of protection piece. This can



Render 4: Detent assembly.
(John Slater)



Render 5: Gearbox assembly.
(John Slater)

be annealed copper, or I much prefer to use Delrin. The latter tends to be deformed into the threads and stays put when there is any dismantling to be done. I also removed the badge from the Emco selector knob of this attachment. Some, I know, are held in place with a dab of silicone while others appear to have been held with what I assume to be hot glue. Knowing which version I was dealing with was not easy. I therefore chose to heat the knob gently with my small Butane torch. After allowing the assembly to cool, the badge was bathed in penetrating fluid. Prodding gently with a cocktail stick soon dislodged the item and sure enough it had indeed been held by a hot melt glue. As yet I have not attached my badge permanently to the new knob; it is a good fit in the new knob but I intend to black these external items - one day. I shall probably use a small spot of 609 Loctite, eventually, to stop it rotating.

While drawing things out I also took the time to add radial bearings to the leadscrew bearing at the tailstock end. This bearing needs to be remade in order to carry the trip rod support. This bearing modification also improves repeatability during screwcutting, as well as being smoother during manual operation. Two smaller bearings are used at the front of this housing as the M6 leadscrew bearing locking grubscrew is directly above at this point. The smaller bearings afford a thicker wall thickness to resist the pressure applied by the grubscrew, which does not need to be that great a pressure. The cutting forces experienced by the Compact 5 are relatively small.

When it comes to fitting the stop block to the carriage, things can get quite complicated due to the changes made by Emco during the production life of this machine. There are several versions of the carriage, depending on whether or not the machine has a backlash adjustment to the cross-slide feedscrew. There is also a variation on the carriage depending on whether it is a die-casting or a part that is machined from the solid, which is the current spare part available. Both of these also have two further versions depending on whether the machine is imperial or metric.

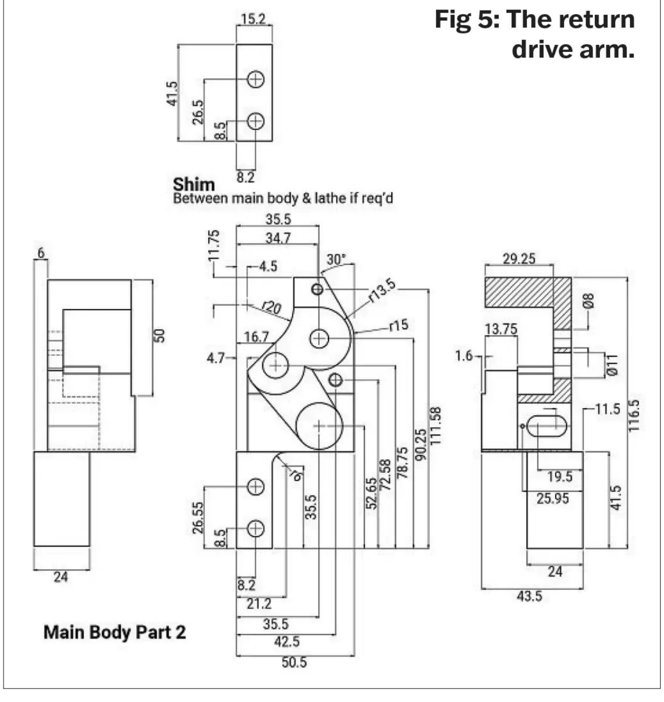
The design I have drawn for the stop block is for a metric version with backlash adjustable cross-slide feedscrew, and leadscrew, fitted to a die-cast carriage, which is my machine. The apron front is, I know, thicker on the 'machined from solid' part. Thus I must therefore ask the reader to measure up his or her own machine and not to follow my design blindly when making this part. A tip: all new leadscrew nuts are backlash adjustable.

The main anchorage for the stop block is from the backlash adjustment screw fitted to the leadscrew nut. This will mean a longer capscrew needs to be fitted and this capscrew may also need an undercut machined from the end of the existing bolt threaded portion to under the head of the capscrew. If the longer capscrew should happen to be threaded for the entire length, then this will not be needed. An M5 nut locks the stop bracket to the leadscrew nut. While two M3 Allen socket grub screws and a brass protection plate clamp it to the apron piece. This stop block will probably need several trial assemblies to get it right - as mine did.

A few words on the lubrication arrangements might not go amiss. Apart from the ball bearing on the output end of the dog clutch shaft, all other bearings are Oilite. If these are soaked overnight prior to assembly, and some additional oil applied during assembly, then these bearings will last for quite some time. Having used my machine extensively for the past 18 months I have not had any problems to date. The gear teeth were lubricated with Molykote GN paste when assembled and from time to time some additional paste is applied to the two Tufnol idler gears. This paste is also used on the steel gears which were supplied with my Emco Fine Feed attachment.

One of the first jobs was to screw cut a new topslide feedscrew for the retracting topslide attachment which I had designed, **photo 8**. I also took the opportunity to make this thread a better fit in the topslide base. This fitment then made it possible for the manufacture of a 10 TPI worm, **photo 9**, for the 40:1 drive attachment that I had designed for the Emco dividing attachment, **photo 10**. The Compact 5 handled this task easily, even at 200 RPM. One safety tip, and that is, be sure to keep your hand clear of the leadscrew handwheel when screwcutting. At even modest pitches it will give quite a whack to the unsuspecting operator.

Fig 5: The return drive arm.



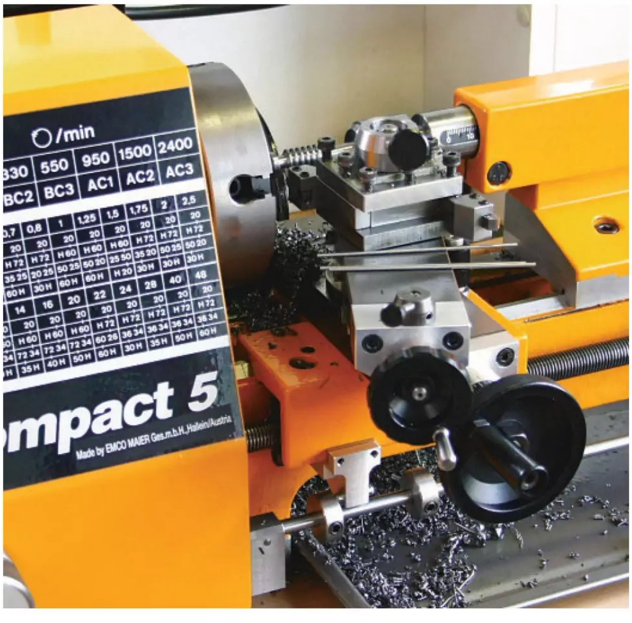


Photo 9: Cutting a 10 tpi worm.

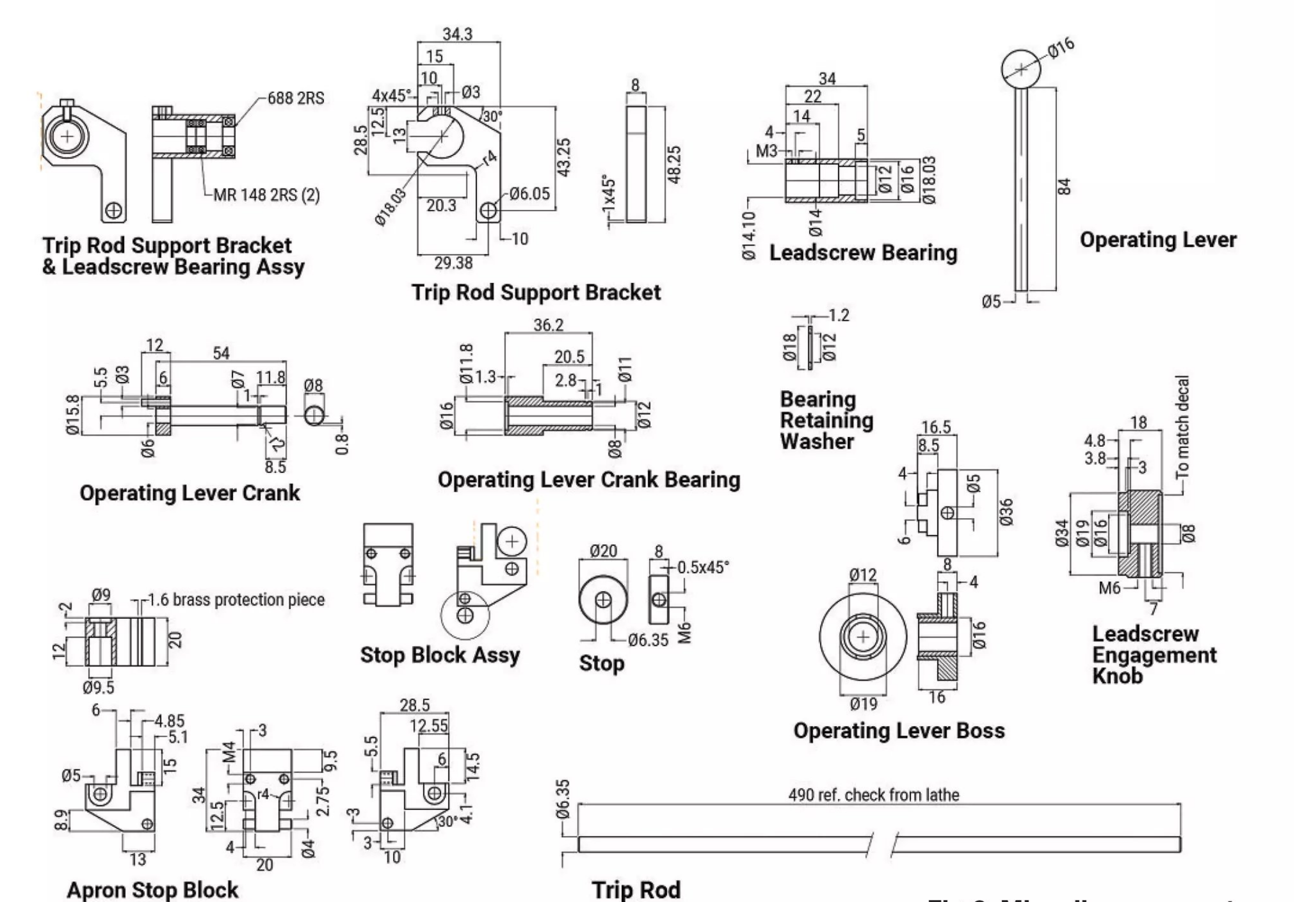


Fig 6: Miscellaneous parts.

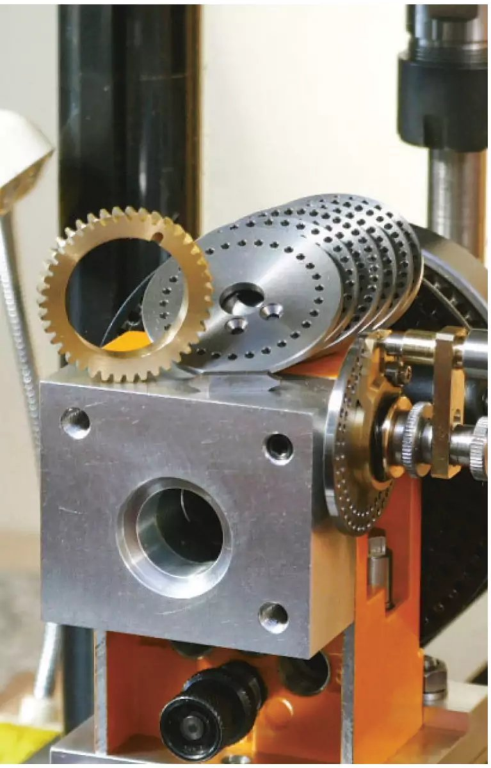
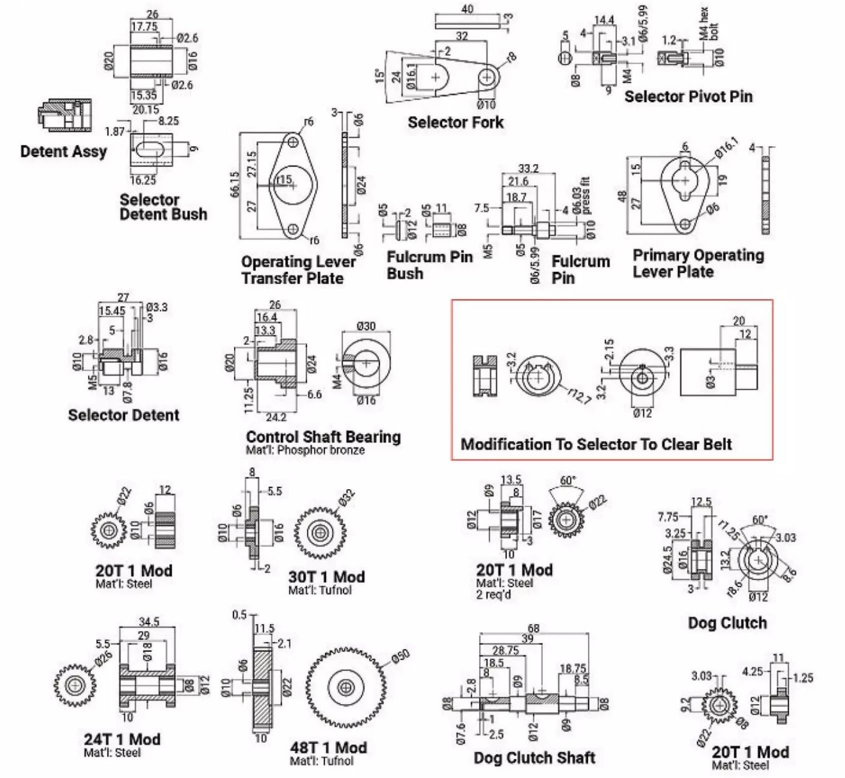


Photo 10: Dividing plates and a spare worm wheel.

Fig 7: More miscellaneous parts.



Now for Something Completely Different

Roger Vane on a story, not of model engineering, but an example of how having a workshop comes in useful, but can also have its pitfalls as you can become the local 'Mr Fix-it'.

Chatting to an old friend, she told me that she had a heron with a broken leg – "… you like a challenge don't you, so can you mend it please?" Wondering what I was letting myself in for I reluctantly agreed - not that I particularly wanted a challenge, but because honour had to be satisfied. It was time to come up with a cunning plan.

This heron stands about 16" tall above the base and is cast in brass or similar which, thankfully, was quite machinable. Fixing the broken leg was the easy bit – the real problem came with the base, which was a piece of rotten wood encased in lead sheet, and it had a couple of spikes intended to peg the whole thing into the ground, **photos 1** and **2**.

The broken leg had to be pinned to ensure correct alignment. In doing so, an area of concern was that the leg was tapered away from the break in both directions. The leg itself was oval in shape, with a maximum dimension across the oval of around 7/16". The pin was to be made of 3/32" diameter stainless steel and fitted into holes drilled along the axis of each leg. The question of how to align the legs posed the next problem, as the leg needed to be perfectly aligned when put back together. No off-centre holes at odd angles could be tolerated, as this would have resulted in a leg with a pronounced kink in it.

The solution was to make a drill jig, as seen in **photo 3**. The main body was made in acetal for ease of machining and to allow for a slight 'give' in the jig when fitting onto the leg which was oval in shape. Luckily the size of the leg increased further away from the break, and the taper could be accommodated by step-drilling the hole in the drill jig. The drill was guided by a steel bush pressed into the body of the jig.

The legs were successfully drilled, and the alignment was far better than I had anticipated. The next decision was how to fix the two parts of the leg together. Heat would have destroyed the finish and so high strength Loctite was chosen and the leg assembled, with the profile across the break aiding alignment. The joint was strong, but flexed a little as the faces of the break didn't quite touch in places – a problem quickly resolved with some JB Weld high-strength epoxy to fill the gaps in the profile and stabilise the leg. Success!

Photo 1: A heron with a broken leg. (M Brown).

The base, **photo 4**, was a different challenge altogether, as there was no practical way that the remains of the existing base could be used. The decision was made to produce a new base from 5/16" thick steel plate and to make holes for the legs to fit in.

Photo 2: ... and a damaged base. (M Brown).

As the legs are set at an angle to each other, there was no way that plain drilled holes could be used and so slots would be required. **Photograph 5** shows the extent of the angle between the legs – the reason why plain drilled holes could not be used to locate the legs onto the base.

The base material was prepared, with corners and edges rounded off. The position of the slots was marked out, bearing in mind the slope on the legs and their offset from either side of the centre line. The slots were then milled out to the marked out positions, and then the fun started; trying to settle the base onto the bottom of the legs, each of which had a rectangular 'foot'. These feet had the appearance of being poorly brazed or welded onto the legs but were in fact loose on the legs. The first task was to remove the blobs around the join, **photo 6**. I tried to angle grind these blobs away, only to find that the grinding disc quickly clogged up as the feet were made of lead and the blobs were soft solder.

The task was then to remove the blobs by another method – I initially tried to use a small cold chisel but was afraid of breaking a leg. Then I tried to melt the solder, firstly with a large soldering iron and then with a small flame from a propane torch, being ever mindful of both melting the lead foot or damaging the surface finish on the legs. I had a partial success with the propane torch and decided that I would enlarge the slot slightly to accommodate the remaining solder blobs.

During this time, thought was being given about how to fix the base into the ground, and how to attach the legs to the base on a permanent basis. The first question was easily resolved – make a couple of steel pins which were threaded so that they could be screwed into the base, whilst being removable

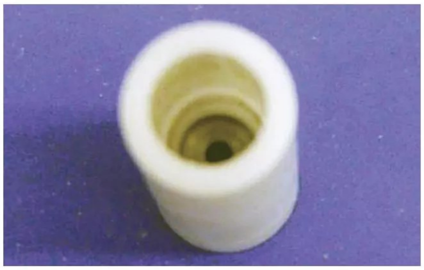


Photo 3: The drill jig used to position the hole for pinning the leg

if the heron was to be attached to a flat surface, such as a block of wood.

Fitting the legs into the base gave several options, the first being to melt down the lead from the base and pour it around the feet. This was quickly discounted on health issues, how to stop the lead running down the legs and burning the surface finish, together with premature solidification. Next up was car body filler – concerns here were how to fill the slots completely when using a spatula and the fast-hardening time. The other option considered was polyester resin as used in the construction industry for fixing fastening systems into concrete. This could be injected around the legs and feet using a sealant gun – it would be easier to fill the void than with car body filler and almost certainly result in a much stronger joint. Polyester resin was the solution to the problem, and so a cartridge was purchased.

The next task was to consider joint design, which sounds rather technical, but was just how to stop the resin plugs being pulled out of the base. A recess was machined around the top and bottom of the hole so that the resin plug couldn't be moved, **fig. 1** shows the general idea. Assembly was also aided by a 1/8" diameter hole in the bottom of each leg, which allowed me to insert a stainless-steel pin across the base plate. These pins can be seen in **photo 7**,

Photo 4: The original base in pieces - and beyond repair

which also shows my attempts to align the base to the main body (using shims), so that the heron would stand upright on completion.

Finally, the time had come to use the polyester resin to permanently position the base. Before I could inject the resin, I felt it necessary to mask-up the whole heron and the 'top' of the base in case of a spillage – never having used this resin before I didn't quite know what to expect. In the event, I shouldn't have worried. It is a two-part system which is mixed in the nozzle during application – I found that it flowed nicely into all of the crevices that I'd

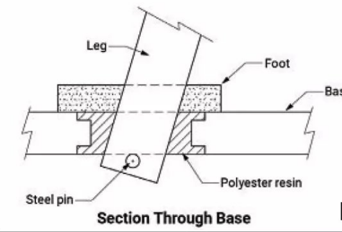


Fig. 1

Photo 5: The angle between the legs made fitting to the base difficult

created around the feet. As the resin 'goes-off' quite quickly, I had to make sure that I was happy with the joint alignment. The joint was allowed to cure for 24 hours – probably longer than necessary, but I really didn't want to have any problems.

Before painting the base, I had just a few small jobs to do – remove the shims, cut off the stainless-steel pins using the Dremel and then make good any slight surface imperfections using car body filler. **Photograph 8** shows the heron base before these jobs were completed.

Finally, it was time to paint the base with a couple of coats of satin black Smoothrite, and it was job done.

The challenge had been accepted, and honour had been satisfied, as **photos 9** and **10** show. The heron was returned to its owner, with the message that "if it breaks a leg again, please don't call me – I'll call you". In fact, doing another repair would entail removing the legs from the base, and that would be extremely difficult and probably result in further damage.


Photo 7: Aligning the base


Photo 8: The underside of the base before cleaning up


Photo 6: Close-up view of a 'foot'


Photo 9: A view of the repaired heron


Photo 10: Looking for fish?

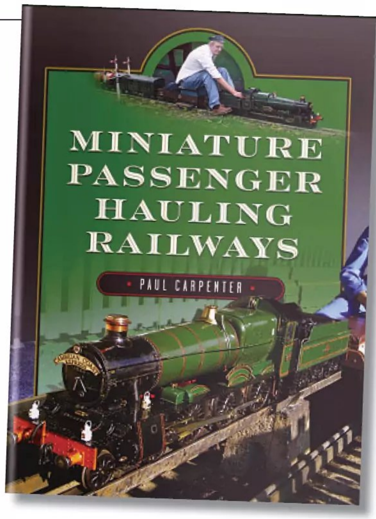
Book review

Miniature Passenger Hauling Railways
Paul Carpenter, Pen and Sword Transport. 2025. Hardback. £30. 190 pages. ISBN 978-139908-387-4

Debates about steam locomotive performance will continue to occupy pages of railway magazines, despite regular mainline steam having officially ended in 1968. An interest in steam locomotive development still flourishes among model engineers, with locomotive efficiency contests for 2½" to 7¼" gauge locomotives a significant part of their calendar.

This book is partly a general introduction to the world of model locomotive and rolling stock construction, adding to works by authors like LBSC, Martin Evans and Tim Coles. There are chapters on choosing suitable designs to model, points concerning construction - including cylinders, running gear and injectors etc. - with advice on boiler design and construction and information about building a railway together with the rolling stock to go with it.

Much of the book is then devoted to the research of miniature locomotive builders like Jim Ewins, Simon Bowditch, Richard Linkin, Bob Underwood, Don Ashton and Professor Bill Hall amongst others. Computer analyses have shown up inadequacies in many published designs of miniature valve gear and they have indicated how these may be improved through computer simulations. The book includes a helpful, detailed appendix with data on the valve events of several well-known miniature locomotive designs. As Simon Bowditch observes: when an engine underperforms, model engineers frequently resort to various expedient measures to avoid tackling the valve gear issues which lie at the root of the problem.



This book contains significant, meaningful information and deserves careful study by anyone planning to build - or who maybe is building - a miniature steam locomotive or who intends to lay out a railway track. Despite some oddities (why a wedding photograph?) it is a valuable work for anyone concerned with improving the performance of miniature locomotives. Although some information has appeared previously in Model Engineer, it is good to have it collated here for easy reference. It may even interest those whose preferences are for full size steam locomotives. Indeed, the author led the development of Night Owl, a GWR 2-8-0 project.

This book is a valuable addition to the range of specialist literature of concern to model engineers and deserves a place on any locomotive builder's bookshelf. Even more experienced builders are bound to learn something from its pages.

Roger Backhouse

Photo 1: Makeshift hearth from Skamolex vermiculite blocks.

Neil Wyatt makes a simple portable hearth using a prefabricated kit from CuP Alloys, and then carries out a few repairs to an old banjo.

A Prefabricated Hearth

I've always found silver brazing one of the most rewarding tasks among the many different things we end up doing in our workshops. I suppose that along with heat treating and casting metals, anything that involves fire appeals to my primitive instincts. Surprisingly, considering I have been at this game for over 25 years, I had never got round to making a proper hearth. Usually I would simply improvise something using pieces of Skamolex (a brand of vermiculite insulating board). **Photograph 1** shows me melting some brass (outdoors, and under a borax flux to stop zinc fume) ready to cast a lost-wax part in a plaster mould.

For any readers unfamiliar with vermiculite, its insulation properties are outstanding! It can be red heat in an area, yet cool enough to handle a few inches away. It hugely reduces the heat lost to the surroundings and

Photo 2: CuP Alloys stand at MMEX.

Photo 3: Laser-cut frame with initial bend.

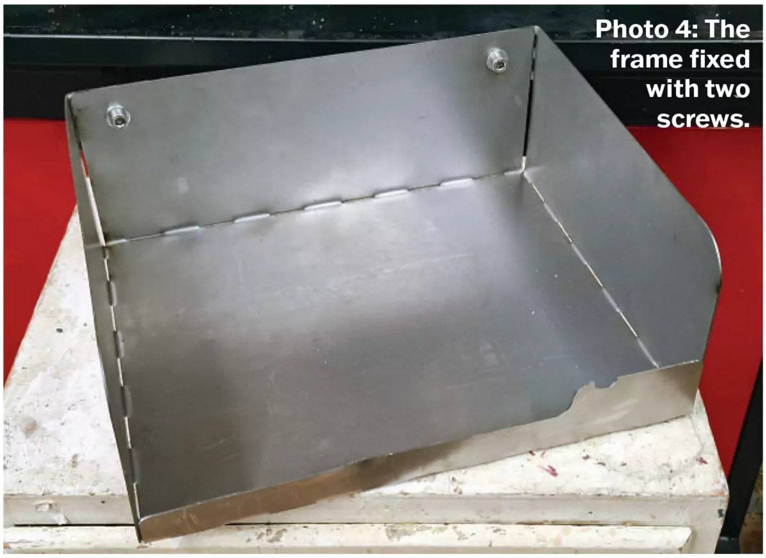


Photo 4: The frame fixed with two screws.

greatly speeds up heating. The only downside is it is quite fragile, especially if surplus flux solidifies on it.

Many years ago I silver soldered up a vertical boiler, which pushed my improvised hearth arrangements to the limit. I thought it would be a good idea to have something better so at one of the exhibitions I bought two large Skamolex boards with the intention of welding up an angle-iron frame and making a proper hearth. Like so many potential projects, the boards got put to one side as there was no urgency…

At last year's Midlands Model Engineering Exhibition I visited the CuP Alloys stand to chat with Shaun Meakin about the talk he would be giving at the show, **photo 2**. Front and centre on their stand I noticed a simple hearth kit, based around a laser-cut steel frame. Just what I needed, something I could do in a single session, without lots of fabrication. Already having the insulating boards, I just purchased the frame and a kaolin wool blanket. The blanket provides extra insulation and is incredibly heat resistant. The wool also protects the vermiculite blocks from flux damage; it is cheaper and you can pick off any blobs of solidified flux once it has cooled. All these items are available from the CuP Alloys website listed under brazing ancillaries (cupalloys.co.uk).

The frame is a single plate of 1mm steel, slotted along the fold lines, **photo 3**. I found the three large sides easy to bend up by hand, but to fold the tabs and the thinner front side, I used my trusty old Record No. 3 vice to give a bit of leverage. Probably not essential, but for peace of mind I used two screws through the pre-cut holes to ensure rigidity, **photo 4**. CuP Alloys sell pre-cut vermiculate block hearths to fit the frame and also a complete kit, but I had to cut the boards I already had to size. This was very easy with an ordinary wood saw, although you need to take care not to chip boards as you finish the cut.

I was able to complete the hearth using a single board, **photo 5**. The hearth is roughly 285 x 240 x 110mm in size and, as my boards are 25mm thick, the internal space is 235 x 200 x 85mm. I cut a piece of the Kaowool blanket to fit, this is nominally 25mm thick leaving the hearth 60mm deep, **photo 6**. This is ample for my usual needs, but for a large workpiece I would probably stand a full insulating board at the back. The hearth is light enough to carry and suitable for small jobs inside my large workshop, or

Photo 5: Frame with vermiculite blocks in place.

Photo 6: Kaolin wool blanket in base of hearth.

Photo 7: Fluxed string retainer ready for heating.

Photo 8: The string retainer at red heat.

Photo 9: String retainer after silver soldering.

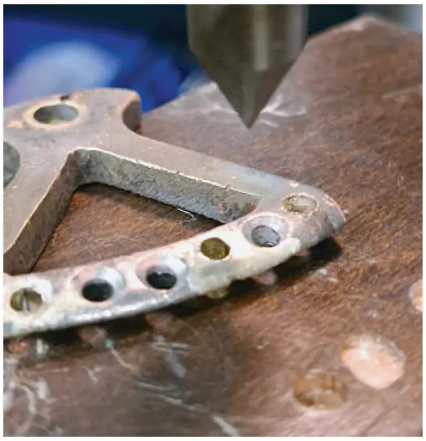


Photo 10: Countersinking a re-drilled hole.

easy to take outside for bigger tasks or those needing more ventilation. A neat feature of the hearth frame is a notch at front right giving a secure place to rest the neck of a lighted torch.

I have only used the hearth once so far, to repair a couple of parts for a 1920s John Gray 'Dulcetta' five string zither banjo. Two of the holes in the nickel plated brass string retainer had split out. I used the hearth with a couple of smaller vermiculite blocks to support it, **photo 7**. I found that surrounded by the hearth, the retainer came up to red heat very quickly, allowing me to fill the damaged holes with silver solder, **photos 8** and **9**. I had to re-drill and countersink the two holes to match the others - a simple job in the pillar drill, **photo 10**. I also repaired two cracks in the frame that stretches the banjo skin, 11" in diameter. I rested this on the back of the hearth. Again the resulting holes had to be drilled out to clean them, **photo 11**.

I then realised that two 'extra' holes in the string retainer must have been drilled by a previous owner after the two other holes cracked out. I didn't want to risk damaging my silver soldered repair, so I drilled and tapped the holes 5BA, **photo 12**, and fitted short plugs of brass 5BA screw in them, **photo 13**. To secure the studding I used ordinary multicore solder, with some additional rosin flux, and my Antex reflow gun as a source of heat, **photo 14**. I protected the bench with an off-cut of the vermiculite block, but didn't need the hearth for this small job. To finish the job, I carefully filed the plugs flat.

To return to the hearth, it is a nice, simple and robust solution and is much easier to store and move around than my original plan of a welded frame. For anyone tackling moderate sized silver soldering and other heating tasks this is a great solution. It's technically just a bit too small for a Rob Roy boiler, but you could certainly make a 3½" Tich boiler on this hearth. ●

Photo 11: Repair to cracked skin stretcher.

Photo 12: Tapping the string retainer.

Photo 13: Lengths of brass 5BA screw fitted.

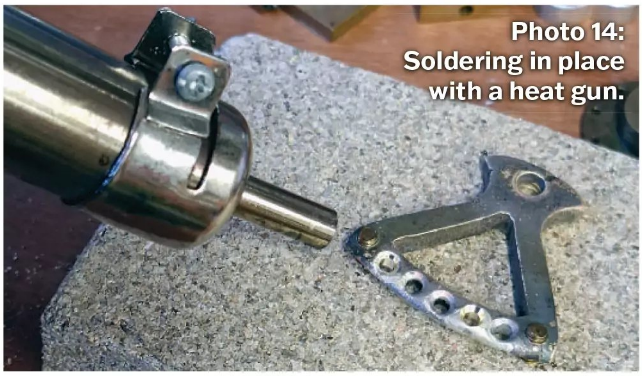


Photo 14: Soldering in place with a heat gun.

Club News

Geoff Theasby reports on the latest news from the clubs.

First, an apology. In ME 4763 I wrote an item in Club News referring to Doug Rundle receiving a part built Speedyette and completing the build. Due to the way it was written, it may have seemed to indicate that it was begun by Doug's father. This is not the case. It was built by Donald, now 100 years old, and he gave the disassembled locomotive to Doug. I apologise for the confusion.

In this issue, a first trip, a little retirement job, the Mosquito, a gravity train, Psychic? Moi? and 'Captain' Hook.

The **Gauge Three Society** Newsletter for Spring begins with a new garden railway, inspired by the Leek and Manifold Railway, by Jon Gluyas; Mike Palmer builds a Metropolitan Railway teak coach, whilst Patrick Twemlow repurposes a van for gas carrying in order to achieve a greater range for his 2-6-4 tank engine. Adrian Booth built a NER electric locomotive, **photo 1**. Ashley Wattam relates the story of the 8F locomotives of Richard Down and, meanwhile, Trevor Goodman celebrated his 90th Birthday with a party arranged by one of his daughters, featuring a tabletop Gauge 3 railway as an adjunct to the meal. W. www.gauge3.org.uk

Photo 1: NER electric 'steeple cab' locomotive (Picture courtesy of Ted Sadler.)

The Prospectus, March, from **Reading SME** advises us that Christian Wolmar will give a talk on 17 April on his latest book dealing with how the a railways were rebuilt after D-Day. Terry Wood built a 'Big Hornby' - an electrically-powered locomotive designed to wear a wooden 'overcoat', to be lifted off in case the internals need attention. He says it looks like a box on wheels (which it is, of course) so he is beautifying it by rounding off the edges with a sanding disk in a power drill, on a windy day to disperse the dust. Alec Bray asks, "Is there an ugly locomotive?" quoting the GWR Western Class 52 types as having a symmetrical and clean appearance. (I would suggest the Southern Spam Cans in this respect – Geoff.) W. www.rsme.uk

Photo 2: Warship D821 *Greyhound* at Chesterfield MES.

On 22 March Debs and I visited **Chesterfield MES** and met a number of members for whom this was a running day, including Steve Eaton and his partner, Tina, with hound - the Chairman-elect etc. This Warship, D821 *Greyhound* was warming up in the sidings, **photo 2**. Sitting on the platform, recuperating after our activities, a young man, Harry, arrived with his locomotive and a passenger carriage. Nothing ventured, nothing gained … I asked him if he was willing to take two passengers. "After I've been signed off", he said. It transpired that this was the last of three runs he needed to qualify as a driver so we were his first passengers and were pleased to be able to help in that respect. Additionally, Debs can now boast that we survived a double derailment (not Harry's fault!) - a tale to tell the grandchildren, **photo 3**. Lunch afterwards at a location suggested by a radio amateur friend, was at *Chesters* who are alleged to serve the best fish and chips in Derbyshire. I can't verify that, this being the first such meal in our experience, but they were very good. The window sills were adorned with several, possibly kit-built, sailing ships, **photo 4**. W. www.cdmes.co.uk

Worthing & District Society of Model Engineers, Spring, opens with a picture from 'Steam up Saturday', showing seven locomotives in the steaming bay but not one human being in sight. (The tea bell had just rung…) Dave Cox has a cautionary tale in which he tells of trying to explain to a to a young lad of about 8 how the steam engine works, whilst trying to take a load of passengers round the track. The young lad was clearly fascinated but was hauled off by his bored mother, not without asking one final question, requesting a piece of coal. He explained that he was going to try it in Daddy's car. Dave lived in fear for the next few weeks of meeting a fierce Daddy and being accused of ruining the car … but nothing further was heard. Did Dave tell the lad too much? Too technical? Dereck Langridge writes on Shoreham's three stations and how he drove a locomotive. As a 17-year-old apprentice with GPO Telephones, he took the opportunity of a tea break to get close to a locomotive near where his team were working. To his surprise he was invited onto the footplate and even allowed to drive the engine up a siding. He got into trouble for going AWOL but it was worth it! Nigel Buck visited the Ffestiniog Railway, the highlight of his visit being the gravity train of slate wagons, which was how the railway was operated in 1836. Horses pulled the empty wagons back up to the slate mines. The modern gravity train is well controlled by having several brakemen along the train. This was not the case when the track gang - including me, years ago - was working at the summit, laying track back downhill. We made up a train to carry rails from where they were unloaded to the railhead and had only two 'spoon' brakes operating directly on the track, which were barely adequate. I was putting all my weight on the lever and the train didn't seem to slow down until we got near to the end. Nothing was said, but the exercise was not repeated and a locomotive

Photo 4: Ship model in Chesters fish & chip shop.

Photo 3: Harry and locomotive, Badger.

was provided for future deliveries. Jim Aldeman photographed that famous railway station on Anglesey. Asked if he could pronounce it, he said "C-a-r-d-i-f-f". W. www.worthingmodelengineers.co.uk

Steam Whistle, March, from **Sheffield & District Model Engineering Society** congratulates Adam Diskin who has been appointed Contract Manager and Guardian of *Flying Scotsman*. Malcolm High retired in 2004; he then started Model Engineers Laser when, after finding himself hacking out the frames for a Holmside locomotive, his eyes were drawn to laser cutting of metal. He began by making items for friends, and friends of friends - and this was intended to be a retirement job, one day a week. He now has over 22,000 parts in the database and has sent over 400,000 parts to customers worldwide. He retired again in 2020 and sold the business. W. www.sheffieldmodelengineers.com

Holgate Windmill, York (see last month) was most interesting and well preserved. It still grinds on windy days using this machinery, **photo 5**, and Derbyshire stone for the mill grindstones. It has its own millwright, to keep it in order, **photo 6**. W. www.holgatewindmill.org

The **National 2 1/2 inch gauge association** sends *Steam Chest*, April, which has Cedric Norman making a Myford faceplate for his discontinued Clarke lathe. John Baguley writes Part Two of his series on restoring an old Maid (a Southern Maid). W. www.n25ga.org

City of Oxford Society of Model Engineers sends *The Link*, Spring, in which there is a note to promise a visit to the private Fawley Railway on 7 June. This is the late Sir William MacAlpines' private railway and is 'invitation only'. Henry Pearsall writes on building a Brandbright Talyllyn coach from a kit and is full of praise for its detail and assembly instructions. Henry is a volunteer at the Talyllyn Railway so this coach was a natural choice. Brian Holland explains what lathe chuck soft jaws are, and how to use them. Jon Potter has analysed the 2024 visitor figures and draws inferences which may influence future events at the Society. W. Www.cosme.org.uk

Duncan Webster, in *Daresbury Gazette*, from **Warrington & District Model Engineering Society** refers to the picture in Postbag (ME&W 4763) of the Sun shining through their tunnel and says that the tale of GWR's Box tunnel being so illuminated on Brunel's birthday is a myth, unfortunately. NB: this information arrived with no guide as to the club to which it referred. I'm not psychic. Handsome, suave, debonaire, talented, yes, but not psychic... W.www.wdmes.org.uk

Goodwin Park News, Spring, from **Plymouth Miniature Steam** begins

Photo 5: Inside Holgate Windmill.

with Ian Jefferson calling at Salisbury Hall, where the famous WWII Mosquito was born. A small but very interesting museum is there, which includes a replica Comet Racer of 1934, a Dragon Rapide, three Mosquito fuselages and a DeHavilland Comet Mk 1 plus a window frame therefrom, showing the cracks developing as found in the stress tests. This last aircraft was the first jet airliner to enter service. After entering through the low door, he found the internals rather claustrophobic. There are several other aircraft and accessories and a section on the 6-pounder automatic cannon developed for the *Mossie* by Molins, the cigarette-making machinery company. The same author also wrote a comprehensive article of 8 pages on fitting steel tyres to a locomotive. W. www.plymouthminiaturesteam.co.uk

Stamford Model Engineering Society contains Editor, Joe Dobson's thoughts on how to attract more members to stop the club falling apart.

Welling & District Model Engineering Society, Newsletter April-May, opens with Ukrainian arrival, Nikita Vlasiuk with his recently finished Stuart No. 10. He was nominated for W&DSMEE by his sponsor, who was aware of his engineering interests. Editor, Tony Riley listed the operational railways in 1825, of which there were several. The reason why the Stockton & Darlington, in 1830, is most widely known about is due to the North Eastern Railway having a very good publicity department. Tony also writes on spark arrestors, which for a single blastpipe are easy to make and fit. For his GWR *King John*, it was not so easy as it is fitted with a double blastpipe so when it clogs with oil and ash, it must be retired to the steaming bays to extract and clean out before returning to the fray. He is now carving out a coupling hook by cutting from a steel bar. He could have bought laser-cut blanks but didn't like the idea of trusting it with a trainload of passengers, having only six hand cut and tapped threads. Using a bar means it is firmly held for marking out and cut off when fully shaped, leaving only the hook end to finish. The alternative - pay £75 for a ready finished item. One new club member was rebuked because of his machining with the mill. *"You got a file, ain'tcha?"* But we should not shy away from adopting new technology. W. www.wdmes.co.uk

The Bristol Model Engineer from **Bristol Society of Model & Experimental Engineers** reports that the New Year 'whistle up' was attended by several people with their locomotives. Naturally, the President had the privilege of blowing the biggest whistle! The Young Engineers began work on *Ellie* mentioned some time ago on these pages. Closely supervised by club members, the youthful attendees made the frames and running gear and it was reported on by Norman Rogers and Nicola Dellard-Lyle. Parents and Grandparents watched in awe as the children gained confidence and expertise. W. www.bristolmodelengineers.co.uk

Model & Experimental Engineers, Auckland Newsletter for March begins with a piece of wood; Lignum Vitae, to be precise. Brian Baker was hoping to cut segments from it, with which to make handles for cutlery. However, whilst very stable when wet, it shrinks when dry and the handles would become loose. Richard Street is restoring a Pultra Lathe. They were high quality, being marketed concurrently with the Austin 1300 car and cost about the same. (The car, £700 new. Fully restored price now, about £15,000.) Ken Pointon has changed the top of his windpumps from a casting to a fabrication, which he says is cheaper and easier to handle. Murray Lane fell badly in 1963 and has suffered with back pain ever since. He recently bought an adjustable bed but found it lacking (for him). He designed a modification which was made up by Graham Bell and Murray can now sleep soundly for the first time in years. Editor, Graeme Quayle is to make a model Newcomen engine as designed and built by Ken Pointon (which he brought to the UK some years ago and which I saw 'in the flesh'). Ken's model is now long finished. Graeme has included a couple of drawings showing the major dimensions.

And finally, start the day with a smile; get it over with.

Photo 6: Mott the Hoople inspiration?

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TOOLS AND MACHINERY

My father's lathe, appears similar to Chester Craftsman. Was working but may have minor water damage to electrics. Sensible offers. **Email lesleygeorginabethany@gmail.com. Manchester area.**

Kennet Tool and Cutter grinder. Built from MES kit. Forward/Reverse 240v Parvalux motor. Some collets and grinding wheels. In unused condition. £275 Buyer collects. **Email: alan.1off@gmail.com Tel. 07981 850755 Sheffield.**

Axminster bench milling/drilling machine. Including drill chuck, angle vice, swivel vice, collects, various drills, side and face cutter, tee nut set, holding set and shell cutter with arbour, boring cutters. Buyer to collect £500 o.n.o. **T. 07974446321. Pontypridd.**

George Adams 2.5" lathe and accessories. Reluctant sale of a GA 2.5" lathe with good range of accessories. Crown 3" capacity chuck with outside/inside jaws, 8mm collet drawbar etc. Pickup or post at cost but it is heavy. £290. **Email: k.j.orford@btinternet.com. Durham City.**

Hydraulic scissor lift troley / table. A hydraulic scissor lift table. Hardly used. Collection only from Cambridge area. £200. **Email: robert8rpi@yahoo.co.uk. Cambridge.**

Rapidor Manchester Mechanical Hacksaw. Rapidor Manchester saw. Runs well and cuts accurately. Single phase. Auto shut-off is broken. Vice takes 6" material. 14" blade, 3 spare blades, 2 unused. Buyer collect. Heavy but can be dismantled for transport by car. £40. **Email: clivebrown@sellabank.co.uk. Carlisle.**

Boxford Model A Lathe "Project". Ex-education Boxford Model A lathe. Bought with the intention of refurbishing but project stalled. Dismantled into it's main assemblies. Lathe is in very good condition but a bit grubby. Can be reassembled in an hour or two but needs rewiring. Also includes 3 phase suds pump (untested). £325. **Email: thatsjustmad@gmail.com. Gloucestershire, Forest of Dean.**

Myford Super 7 Connoisseur. Surplus to requirements, I have a S7 Connoisseur & extensive tooling. Larger bore spindle with taper roller bearings and not the original style bronze. Accessories list runs to 37 lines. New these machines were £13,000 with only a 5" 3-jaw chuck. Offers around £10000, complete with tooling. **Email: EdParrottMyford@outlook.com Rugby Warwickshire.**

Seig SX3 Mill. Supplied by Arc Euro and on its original stand. There is a lot of tooling including chucks, vices, centring microscope, etc. The mill was owned by a skilled woodworker and model engineer. I am advertising on behalf of his widow. Can be seen running in North West London. £700. **Email: roger@woollett.org.uk. North west London.**

Engineering workshop. Due to bereavement. Well-equipped workshop within double garage, 2 lathes plus miller, (all on stands). Comprehensive tooling. Also compressor, welding table, industrial pillar drill, etc For further details **text 07403229141 Email: iris.deane@sky.com. Greater Manchester.**

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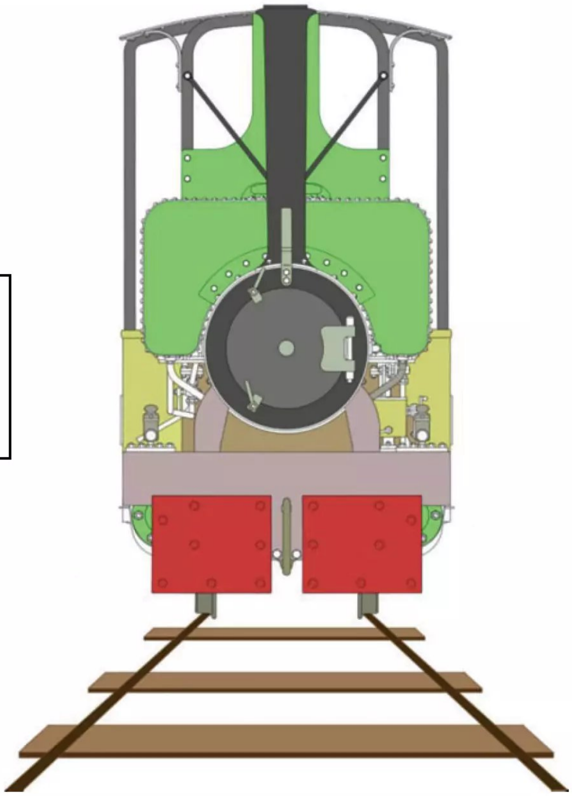

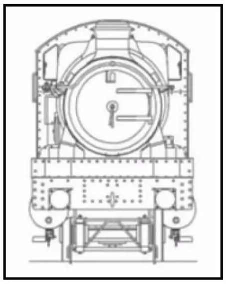

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