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THE MAGAZINE FOR MODEL ENGINEERS

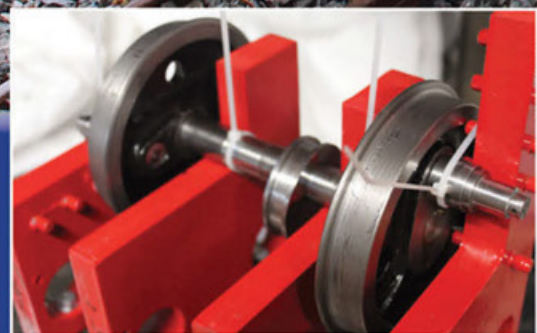
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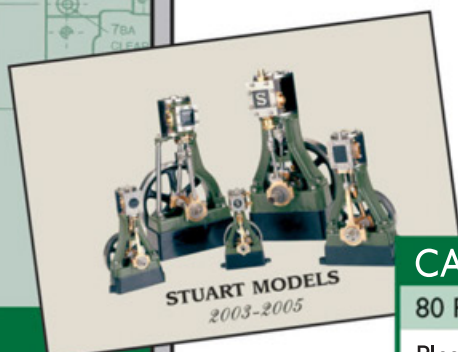


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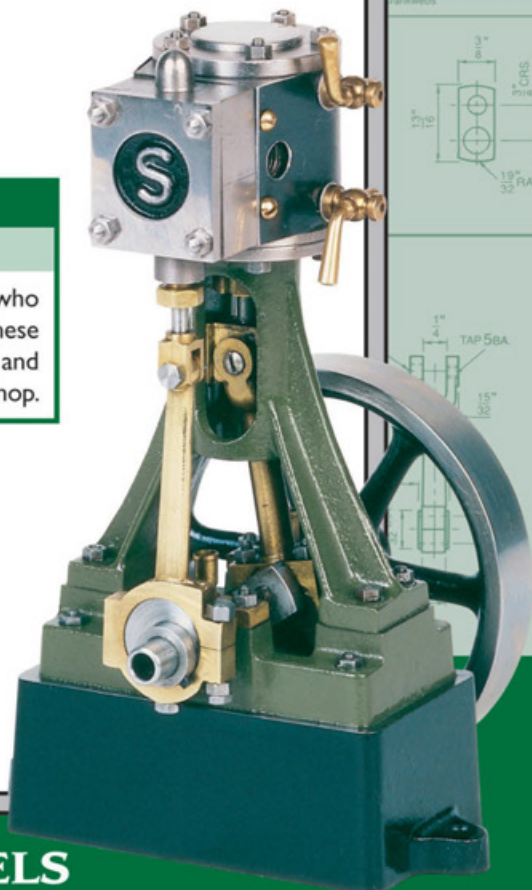
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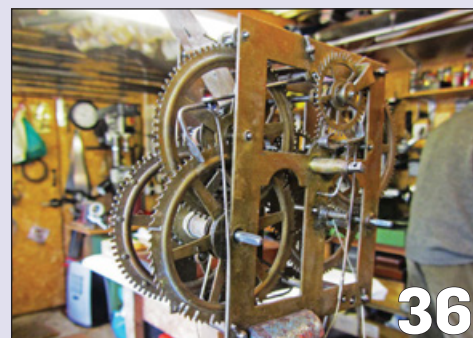
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FRONT COVER

We haven't seen scenes like this for a goodly while, taken on the 9½-inch gauge Downs Light Railway in 2018, but hopes are rising that we will be in for a steamy summer in 2021.

Photo: Andrew Charman

EDITORIAL

Rising hopes and good old workshop therapy...

Welcome to the April **EIM** and as I write these words in early March there is a real sense of optimism, that we may see something akin to normality returning by the summer.

The Government's 'road map' out of Covid restrictions certainly offers a great deal of hope that by the time we get to the middle of the year going to the club for a steaming session, hosting public rides at the weekend, or maybe planning a visit to a show or a rally, will again be part of the model engineer's normal existence, as we try to put firmly behind us a truly depressing 15 months or so.

Of course, all this is crouched in caveats – we cannot be sure that things will happen like that, and as I write we are still in a stay-at-home lockdown. So we are crossing our fingers but the 'mood music' suggests we have brighter times to look forward to. Perhaps the Midlands Show in October will be a big celebration as we all meet up again? We can but hope...

Turning therapy

With my garage still choked with mainly the detritus resulting from two of my offspring moving house more than once, and my workshop in the back of it remaining inaccessible, some readers will know I've been getting my model engineering fix with several sessions assisting tech ed Harry in the workshop of the Fairbourne Railway.

On my most recent visit Harry wanted me to turn up some pins, around 10 inches long and ¾-inch in diameter, as part of the suspension on the loco 'Sherpa'. Trouble was, the smallest bar in stock was around twice the diameter of that needed and the pins were too urgent to await new stock. So I had an enjoyable afternoon on the Colchester lathe making a lot of swarf! This journo's normal life before Covid varied from crewing steam engines to flying around Europe to drive new cars and report on motor races, but I have spent most of the last year staring at a computer screen at home. So there was nothing more therapeutic than setting the auto feed and adding a quick spray of coolant as the tool calmly removed another 10 thou or so along the length of the pin... Enjoy your **EIM**... **Andrew Charman – Editor**

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A first model engine for first-time model engineers

Matthew's build series for complete novices, constructing an oscillating engine he made when aged just 12, focuses this month on the crank and its pin, and the upright support.

BY MATTHEW KENINGTON Part Three of a short series

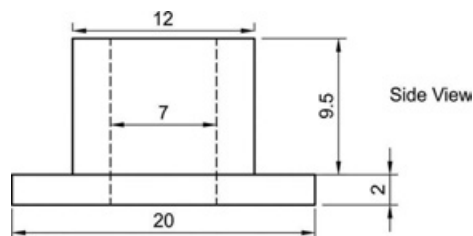


FIGURE 6
Reproduced
approx twice
full size
(all drawing
dimensions
in mm)

The next component to be made is the flywheel shaft bush and I used brass for it; this is a reasonable material for a bush in a light-use application such as this oscillating engine, although bronze or bearing steel would be even better.

The first step is to hacksaw, to an appropriate length, a suitable piece of brass, phosphor bronze or bearing steel. **Note:** make sure the material you are using as the bearing is softer than the shaft material you have chosen otherwise the shaft itself will wear, which defeats the object of having a bush in the first place. The length chosen, at this stage, should include provision to hold the material in the lathe chuck, but with only a small section sticking out.

Next, set up your material in a three-jaw chuck. Turn the basic shape (Figure 6), aiming for the bearing to be a press fit in the upright. **Note:** If you make the bearing too much of a press fit, the shaft itself will not fit, once the bearing has been installed!

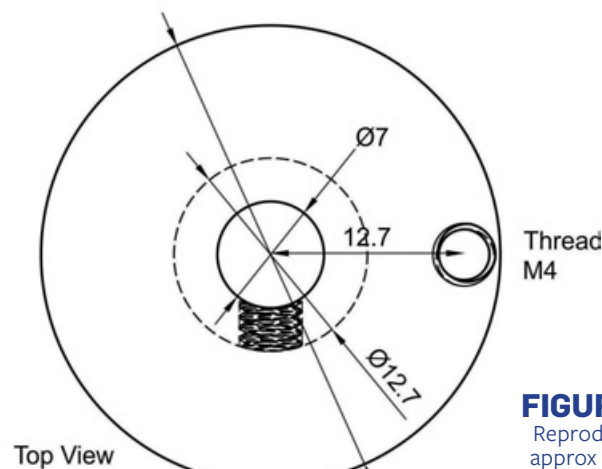
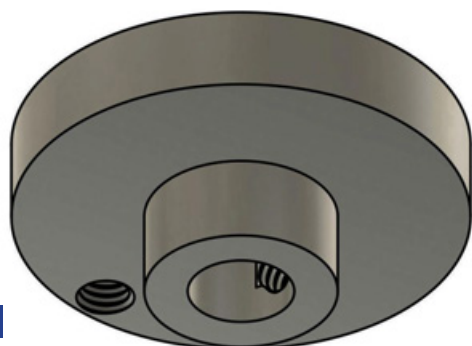
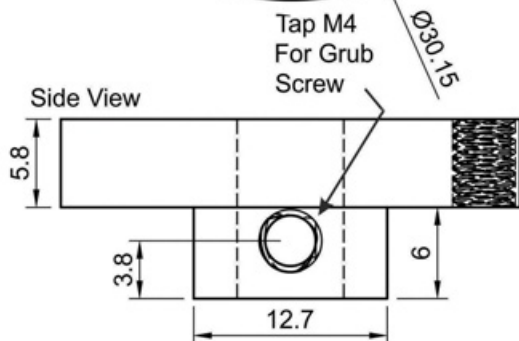


FIGURE 7
Reproduced
approx twice
full size



This is a tricky compromise, particularly given that it can be difficult to open-up the bush, once fitted and it will also prove almost impossible to remove (without scrapping it afterwards).

One way of 'cheating' is to use Loctite glue (such as 603) to retain the bush, thereby allowing it to be an easy press fit, yet still not rotate or fall out. I didn't do this on the prototype, preferring to use it as a learning exercise for press-fit components. Charts are available online to help with dimensioning parts for a press-fit – enter 'press fit dimensions

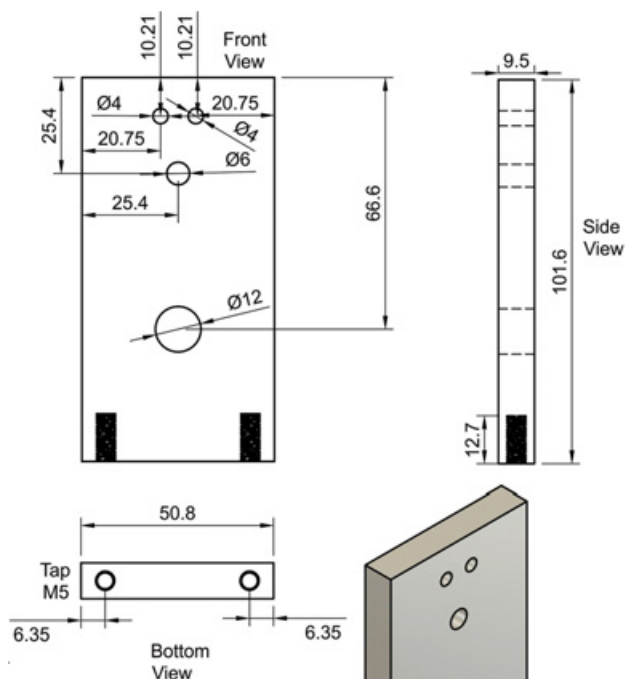


FIGURE 8
Reproduced approx
half full-size





chart' into Google for some options.

Once the basic (outer) shape is complete, centre drill the bearing. The shaft-hole can then be drilled – start with a drill half a millimetre below the size of your shaft and slowly work your way up with reamers (or an adjustable reamer) until your shaft is a snug fit. Note that reamers must be run slowly or they will not work properly; aim for a hundred rpm or less.

Another thing to keep in mind is that there may be a lip on the inside of the hole so be careful when trying your shaft (chamfer the corner slightly to ensure that there is certain to be no lip). Likewise, the end of the flywheel shaft should be slightly chamfered to ensure that it does not have a microscopic 'lip'.

Crank and crank pin

The dimensions of the crank pin are given in Figure 4 (published last month along with dimensions for the flywheel shaft) and those of the crank itself, in Figure 7. The material used in both cases was mild steel rod (of two, rather different, diameters). Note that the crank pin could be made out of a softer material (such as brass), so that the hole in the piston does not wear as quickly. Again, this would be a serious consideration if the engine was to see a lot of use.

Starting with the simpler part, the crank pin, and assuming that material of suitable diameter is to hand, then it is simply a matter of cutting the rod to length and facing-off both ends, before threading one end as shown in Figure 4. Better still, you could thread one end after facing off that end, then cut to length and face off the end just cut, as this is quite a short part. 'Facing off' could simply be filing in the latter case.

The crank itself is more involved but still fairly straightforward. It is possible to use a four-jaw chuck for this part, as a learning exercise, but it is not really necessary. I put off this particular bit of learning until building a Stuart S50 engine (from castings) and so I will assume that you wish to avoid this, too.

"Note that reamers must be run slowly or they will not work properly..."

FIGURE 6: Flywheel-shaft bush, drawn twice-full size.

FIGURE 7: The crank, twice full-size.

FIGURE 8: Upright support, half full-size.

PHOTO 14: Finished crank and crank pin.

PHOTO 15: A set of parallels.

PHOTO 16: Pair of parallels mounted in a vice, ready to add the workpiece.

All photos and diagrams in this feature by Matthew and Peter Kenington

The basic shape can be turned on the lathe in a similar manner to the flywheel-shaft bush discussed earlier – hacksawing a length of rod, turning down the flange and boss to the required diameters and then drilling the centre-hole (not forgetting to start with a centre-drill), before parting off to the exact length needed. It does not matter if the shaft is a slightly loose fit in this hole as there will be a grub screw keeping it in place.

This is the point where a four-jaw chuck could be used, as it would allow the part to be offset by the required amount (12.7mm) to enable a tailstock drill bit to drill the required hole for the crank pin.

A quicker and easier way however, (for the novice, at least) is to move the part to a mill or drill (having marked and centre-punched the required hole position, if using a drill) and then centre-drilling and drilling the required hole (3.3mm diameter). This hole can then be tapped to M4 – don't forget to use oil or cutting compound to aid in the cutting process (it's worth its weight in broken taps...).

Next rotate the part and mark out the hole for the flywheel-shaft grub screw, then centre punch and drill to M4 tapping size (3.3mm). Tap the hole, again remembering to use some oil/cutting compound, and this component is done.

All being well, you can install the crank pin and grub screw and end up

with something which looks like **Photo 14** – not the nicest finish on this one; I wouldn't accept these standards now! The crank pin could just be threaded into the crank, but I opted to use a nut to make the arrangement shake-proof whilst still being able to be disassembled. Loctite could be used instead of the nut (with a shorter thread on the crank pin), if you are brave.

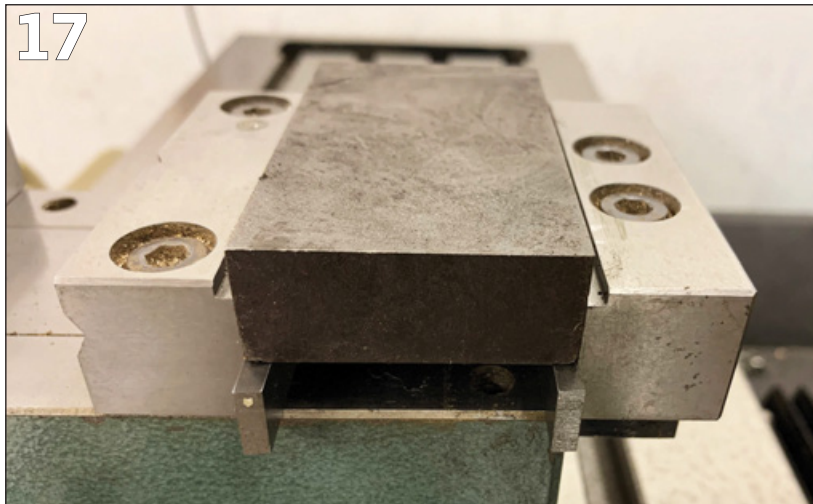
Upright support

For this part, I used a piece of aluminium plate, approximately 10mm thick. This was machined (milled) to 9.5mm to give a good, scratch-free, finish. It was a satisfactory material for the part, but, being much wealthier than I am, you could use a material that does not scratch so easily, such as brass or even stainless steel (if you are brave and have some carbide tooling). I am but a poor schoolboy...

Machining the surfaces involves clamping the workpiece in a machine vice so that the surface to be machined is protruding above the jaws of the vice – so we machine the workpiece and not our lovely, expensive, vice. It also needs to be level and a good way of ensuring this is to use a set of parallels – these are precision machined pieces of flat steel, manufactured to highly accurate dimensions (**Photo 15**). They are placed on edge adjacent to the faces of ►



17



the vice jaws (**Photo 16**) and can then be used to support the base of the workpiece, such that it protrudes above the upper faces of the jaws by the required amount (**Photo 17**). Ideally, this protrusion should only be slightly more than the amount of material it is intended to remove. For example, if 0.25mm is to be removed (as in this case), then having the material 1-2mm above the jaws should be fine. This leaves plenty of material for the vice jaws to grip.

As I am also a very lucky schoolboy, I was able to draw the part in 2D CAD (based on **Figure 8**) so my dad's CNC milling machine could drill all the holes. If you do not have such luxuries (and you probably don't), you will either need to mark out manually or use a milling machine with a DRO (digital read-out) and employ an edge-finder to locate and drill the holes.

The first step is to mill the aluminium plate to the correct dimensions. I would suggest a 1 or 2-flute end-mill (since we're dealing with a soft material) around 10mm in diameter and a spindle speed of 1200 rpm or less. Technically it is only necessary to machine the sides (**Photo 18**) but you could machine the large, flat, faces using a face cutter (**Photo**

19), as I did, to make a good seal between the cylinder and upright and remove any deep scratches.

I found that the most difficult holes were those on the underneath (used to attach the upright to the base) as the drill needs to be accurately perpendicular to the face to prevent the hole from exiting the material to one side (if it is a long way out) or attaching the upright at an angle which is not (upright, that is).

Having drilled these holes to the required depth – 12.7mm plus a generous allowance for the tap to reach its full thread-depth, assuming you don't have a set of plug-taps (again I can plead 'poor schoolboy' here...) – it is time to tap them. Since there is a lot of material and no danger of the holes causing problems, if too deep, I would be generous with the depth, say 20mm or more.

Tap these holes (**Photo 20**) to M5, with lots of lubricating oil or cutting compound; 3-in-1 oil is good as a starting point, or you could use a professional thread-cutting compound which is much better and easier to use. I would then recommend finishing all of the faces with emery and, ultimately, diamond grit stones, to make the surface very smooth. My dad has some 300, 600 and 1200 grit

18



PHOTO 17:

Parallels in use supporting a workpiece (not one from this project!).

PHOTO 18:

Machining the upright to correct dimensions using two-flute milling cutter.

PHOTO 19:

Typical example of a face-cutter.

PHOTO 20:

Tapping holes that attach upright to base (M5 thread).

PHOTO 21:

Connector for air line to power the engine.

PHOTO 22:

Upright support with the flywheel-shaft bush inserted.

stones which produce a lovely job (when I can summon the patience to use them properly...).

Feeding the engine

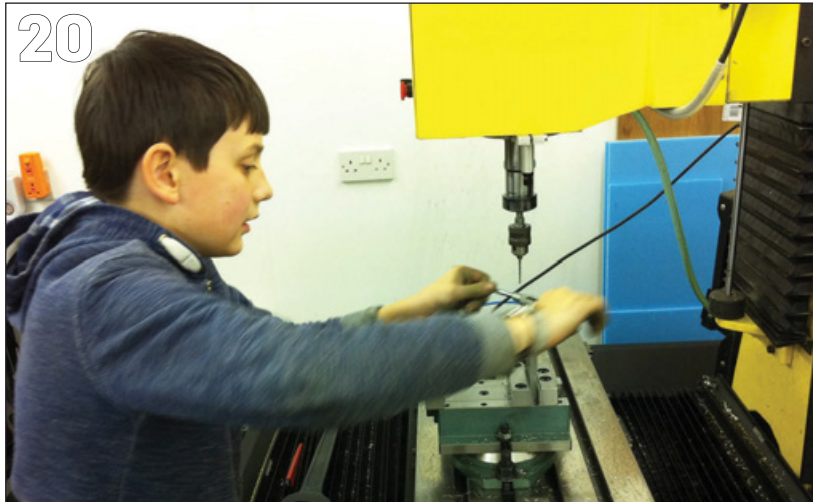
At this point, you might want to consider widening and tapping one of the two port-holes, located at the top of the part. Once you have finished your engine, you will undoubtedly want to run it and hence will need to get either steam or compressed air into one of these two ports – so a suitable fitting will therefore need to be attached.

I used a miniature air-line connector of the type that takes a 4mm diameter plastic pipe and grips it using a collar mechanism (**Photo 21**). This particular variant features a tap/regulator, allowing the speed of the engine to be controlled locally to it. These connectors cost only a few pounds and are widely available (such as from ebay).

If you opt for the same connector, you will need to widen one of the holes from 4 to 4.2mm and then tap the hole to M5. It would also be possible to use a standard steam fitting (such as a globe-valve), in which case a suitable ME (model engineer) thread would be needed.

Once complete, and with the flywheel-shaft bush inserted, the part should look like **Photo 22** – in this case, the right-hand port hole has been tapped to M5 for the air-line connector. We didn't have a fly-press available, so our woodworking vice

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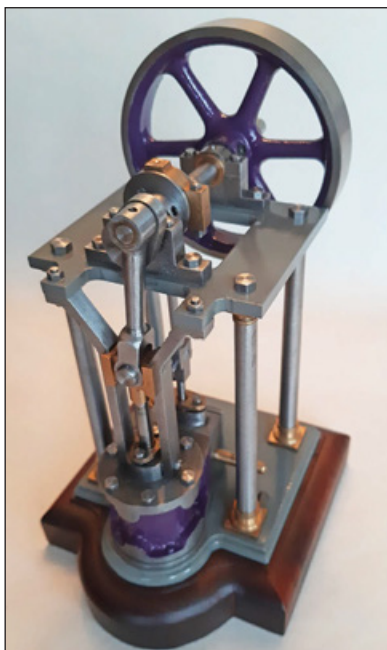
22



was pressed into service (if you'll excuse the pun). **EIM**

■ Next month Matthew makes the cylinder. The first two parts of this series were published in the February and March 2021 issues of **EIM** – you can download a digital back issue or order printed copies from www.world-of-railways.co.uk/store/back-issues/engineering-in-miniature or by calling 01778 392484.

Also next month and for those looking for something a little more complex, perhaps as a follow-on project, Geoff Walker will begin describing his latest Muncaster engine build, the attractive Entablature engine pictured here.



Snapped it...

A boiler breakage gives Harry the runaround...

BY HARRY BILLMORE

During the 10-year inspection of the boiler of 'Sherpa' on the 12¼-inch gauge Fairbourne Railway (see page 23), it was noted that a number of studs were waisted. I took the decision to replace all of them since those that didn't need doing, didn't look fantastic either!

While I was removing them I managed to snap one of the main steam pipe flange studs on the front tubeplate – you can see in the photo that there is a slight darker patch across the stud where it had been slowly cracking for some time, which is another reason to replace these at sensible intervals.

This broken stud fought me all the way – I first tried drilling a hole down the centre and then using an easy-out extraction tool. Normally these they do not sufficiently bite into the material and just end up slipping round, but that was not the case this time. The easy-out bit into the stud, but the stud was far firmly stuck to be removed that easily and the easy-out snapped. It was then a pain to remove from the stud!

Once I had removed the easy-out, I set the magnetic-drill up dead centre on the stud and drilled through it, slightly under tapping size for the stud thread. This was then followed by chasing the remaining pieces of stud out of the tubeplate using a small chisel and a punch.

I peeled sections out from the tubeplate threads as I went. This method usually preserves the thread profile in the parent metal, though it does take a lot of patience! **EIM**

PHOTO 1: One of the boiler studs on 'Sherpa' with the waisting clearly evident.

PHOTO 2: Rats... Attempting to extricate a stud, it has snapped close to the plate.

PHOTO 3: Looking at the broken piece, a crack is evident propagating through the stud.

PHOTO 4: Double rats – now we have a broken easy-out to deal with as well...

PHOTO 5: Bring in the big guns – the mag drill set up to drill through the remains of the stud.

1



2



3



4



5



Turning accurate tapers

Roger tackles a workshop technique that some find challenging...

BY ROGER VANE

I recently needed to turn an accurate taper on the end of a spindle to mount a drill chuck, and thought that the method of setting the taper angle might be of interest to those readers who may have a similar job to do, and have not come across this method, relying instead on 'trial and error'. I claim no originality for this method, only a good memory, as it dates back to my apprenticeship days and that was more years ago than I wish to admit to.

So, how to go about setting the taper angle? How do you measure it? Taper turning can be achieved by swivelling the lathe top slide or setting a taper turning attachment if you have one, but whatever method you use you will still have to set it accurately to achieve the desired result.

In my case this had to be a tight-fitting taper, with no wobble and which once assembled into the drill chuck would stay in position, whilst enabling the chuck to operate with minimal run-out.

This method can be used to set up to turn any relatively shallow angle including Morse tapers, taper plugs and reamers (such as drain cocks), as well as the taper for mounting a drill chuck as covered here. I say 'relatively shallow angle' as the method uses a 'plunger-style' dial gauge as the means of measurement, and so the maximum travel of the gauge spindle becomes a factor in the degree of angle that can be set.

Although I would probably use a taper turning attachment for turning even the short taper required for the small chuck (as it's easier to set precisely), I appreciate that this is not an option open to everyone, so I have given a description using the top slide.

The dial gauge

The first requirement is for a dial gauge fitted with an 'elephant's foot' – mine is shown in [Photo 1](#). The elephant's foot is simply a disc with a threaded stem to suit the dial gauge, and it means that setting to exact centre height is not necessary as the flat takes care of any height deviation. The thread for the elephant's foot is

"Whatever method you use you will still have to set it accurately to achieve the desired result..."



normally either M2.5 for a metric gauge or 4-48 UNF for an imperial gauge (although 6BA is so close that it should fit).

Setting the taper

Firstly, we need to identify the taper required and more importantly, the 'half angle' taper per inch (or mm if working to metric dimensions).

The spindle for the drill chuck that I had to machine had a JT0 taper, the dimensions for which are shown in the table.

With this method we are adjusting the top slide deviation over a distance of 1-inch along the lathe axis (0.0493-inch for the included angle and therefore the top slide

should be set to achieve a deviation of 0.02465-inch for the half angle when machining the taper).

A setting bar is also needed – this is simply a length of bar marked with two lines scribed at 1-inch apart – it is used when setting the top slide angle. It means that it is easy to see the travel along the bar as the top slide is advanced, rather than having to count turns of the top slide handle. Simply set the top slide lead screw dial to zero when the DTI (dial test indicator) is at the first position, and then go to the second position. An error in top slide travel of one turn is easy to spot.

[Photos 2](#) and [3](#) show the general idea.

To set the taper, start off by swinging the top slide round by just

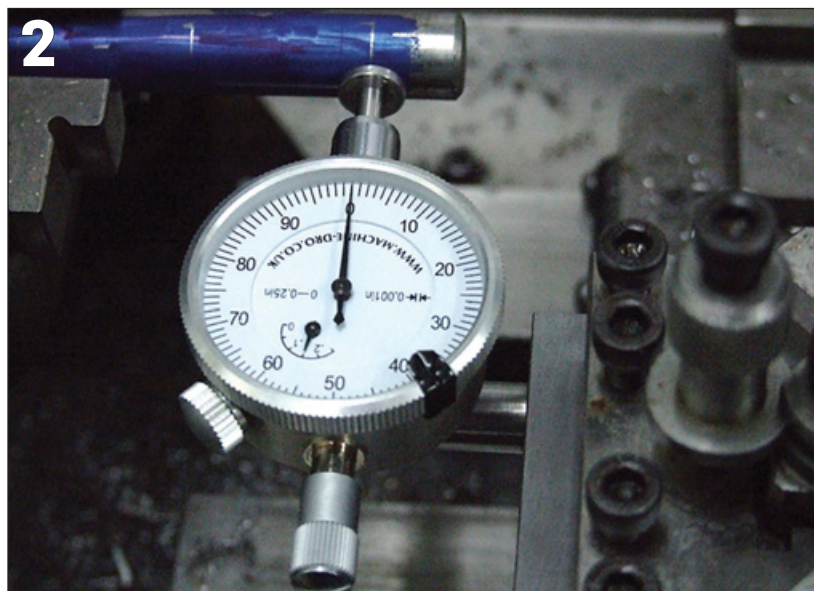


TABLE 1

Taper	Large End	Small End	Length	Taper/ Inch	'Half' Taper/ Inch	Angle from Centre
JT0	0.2500	0.2284	0.44	.0493	.02465	1.4117

under $1\frac{1}{2}$ degrees, and chucking the setting bar. Then set the dial gauge so that the elephant's foot rests squarely on the test bar. There will be no errors due to chuck run-out as the chuck will not be rotating when you are setting the taper angle.

It is also necessary to calculate the top slide travel, which will be greater than 1-inch due to the angular effect. We are looking for a deviation of 0.02465-inch over 1.000-inch travel along the lathe axis.

To move the top slide by 1.000-inch is not absolutely correct as the top slide is travelling along the hypotenuse (good old Pythagoras). At very shallow angles like this, the length is almost equivalent to the 1-inch travel along the lathe axis. I did set the CAD to 5 decimal places and measured a deviation of just 0.00031-inch – and it's fairly academic as I doubt that any of us can achieve the fourth and fifth decimal places on the top slide movement. In this case I used a top slide travel of 1.000-inch to achieve a travel of 1.000-inch along the lathe axis.

So, move the top slide by exactly 1-inch to match the scribed lines and note the deviation shown on the dial gauge. The deviation should be 0.02465-inch – 25 thou being a realistic target (small adjustments can be made by just nipping the top slide to prevent rotation and then gently tapping with a lightweight plastic mallet, but not forgetting to lock the angle before taking a trial cut).

Machining the taper

The final setting may well require some trial and error against the chuck, and I found it worth practicing the taper turning on a length of $\frac{1}{4}$ -inch diameter bar as a test piece – aiming for the chuck to fit securely. In fact, my chuck fitted so securely that it took a wedge against the three-jaw chuck to remove it – just by setting with the dial gauge.

Now to machining the spindle itself – at this stage concentricity should be considered and an accurate chuck or collet used to hold the workpiece as appropriate.

Photo 4 shows the taper being turned – the marking blue on the spindle is definitely an aid to seeing exactly how far the taper is progressing. When turning the taper care will be required not to take too big a cut and go undersize. At these shallow angles, even the smallest cut can result in the taper going well undersize, so small depths of cut really are the order of the day here.

I'm pleased to say that the new chuck locked on straight away with no problem (**Photo 5**). Getting it off again could be a problem though. **EIM**

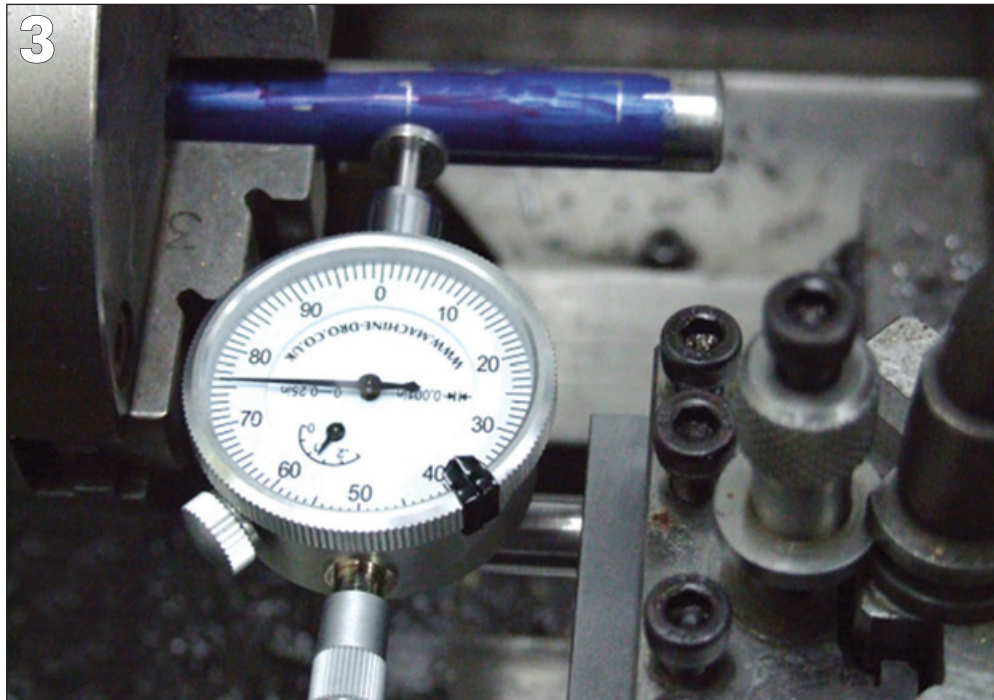


PHOTO 1:

The DTI holder for the quick-change toolpost.

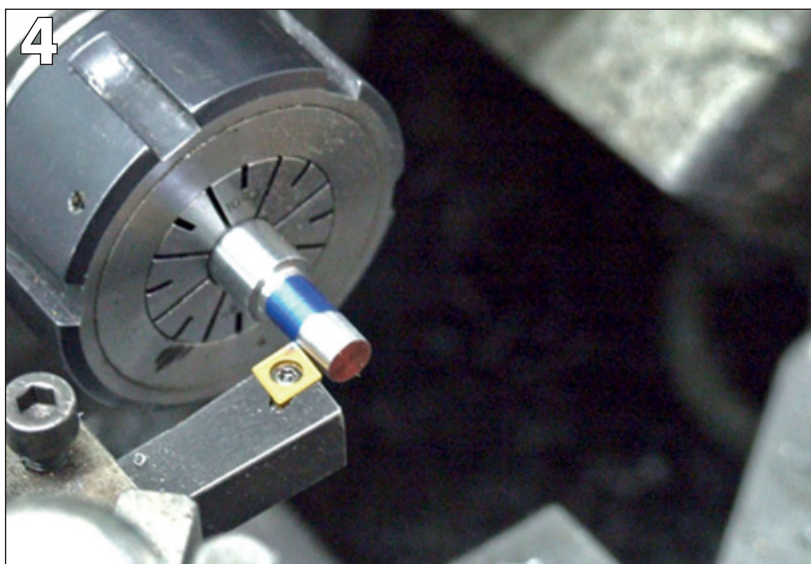


PHOTO 2:

Setting the top slide for taper turning the spindle – DTI zeroed at the 'small' end.

PHOTO 3:

The top slide and DTI have now been moved by 1.000-inch – note the difference in readings.

PHOTO 4:

Turning the spindle taper.

PHOTO 5:

Drill chuck fitted to tailstock drilling attachment.

All photos by the author



Building a Ten-Wheeler

Jan-Eric tackles the final construction details as his 7¼-inch gauge locomotive build project approaches its conclusion.

BY JAN-ERIC NYSTRÖM Part Fifteen of a series



The ten-wheeler was finally taking shape, after six years in the workshop! However, I must admit that there was an almost two-year hiatus during the period; I had some animation and movie work to do, an apartment to refurbish, and sometimes, inspiration was simply just lacking.

In the spring of 2012, I finally pulled myself together, and decided to make a spurt; the Finnish Railways would be celebrating its 150-year anniversary at our Railroad Museum with a two-day festival in August that year. My 4-4-0 and 0-6-0 had been staple attractions there for eight years already, and people were asking "When? When do we see your new loco?"... There weren't really that many things left to do, actually – a few valves, some cosmetic details and the final piping.

Before I could do that, however, I needed to add thermal insulation to the boiler and make a cosmetic wrapper – on its own, the TIG-welded boiler is a pretty rough-looking piece



of metal... **Photo 177** shows my method: the insulation is simply two layers of corrugated cardboard; cheap and easily renewable. It works, thanks to the stagnant air trapped in the corrugations. I have used the same material on my 0-6-0, and even though it does become brittle after a few years of use touching the 165 degrees C hot boiler, it does hold together. If it gets damp, it will quickly dry, before it can deteriorate.

This time, I spent out on some 0.3 mm brass for the boiler wrapper, instead of what I used on the previous

PHOTO 177:

The thermal insulation of corrugated cardboard fitted around boiler.

PHOTO 178:

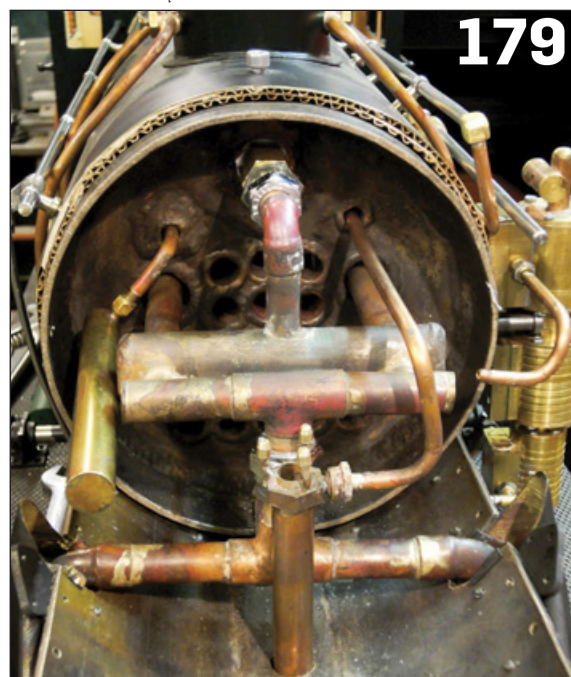
Boiler wrapper made of 0.3mm brass, carefully perforated.

All photos by the author

engines; too-easily dented, discarded aluminum printing plates, which I still had several large sheets of.

Screwing in small grub screws into all the welded-on, threaded holders for the handrail studs on the boiler, I could use a rubber hammer and mark their position onto the brass. After careful cutting and drilling, I could test fit the piece around the boiler, **Photo 178**.

Note the wide, folded edge – that was only for temporary attachment with small bolts; I later cut it away when tightening the wrapper around



the boiler. The final fastening was by soft-soldered, narrow brass strips. In that way, there are no protrusions of the wrapper, nor any bolts, visible under the boiler.

Inside the smokebox

Since this loco has a 'proper' firetube boiler with an ordinary firebox, as opposed to my previous engines with 'Cornish' flue-type boilers, I knew I needed a good draft for complete combustion, enabling the hot gases to move through the 24 firetubes and the two superheater flues in the boiler. Therefore, I needed a typical exhaust nozzle, and a blower in the smokebox. **Photo 179** shows these, as well as all the other stuff that hides inside. I know it's roughly soldered and not very pretty, but hey, it will all be hidden when the cover is on!

Note that the steam pipes to the whistle as well as the blower pass through hollow tube stays inside the boiler – in this way, the pipes will stay hot, and no water will condense in them. The whistle won't gurgle! The large, horizontal tubes in the middle of the photo belong to the 'concentric' superheater, described in the June 2020 issue of *EIM*.

Photo 180 shows a close-up of the blower nozzles. The three brass nipples can be exchanged, since they are threaded onto 4mm copper tubes that are bendable for accurate alignment. I first tried 1mm holes in the nipples, but soon found out that they were way too big – too strong a blast, and too much steam used. The next ones were 0.6mm, but they were still too large and I settled on holes just 0.4mm in diameter in the nipples.

The steam consumption is so small that I can leave the blower on all the time – which is in fact necessary when gas firing. If the blower is closed, the gas flames will exit the firebox, either through the firebox door, if it is open, or below, through the small space between the baffle and the firebox! The flame may also go out completely, if there is no draft at all.

There is one drawback with such small blower orifices; any little dirt particle carried from the boiler into the live steam may lodge in, and clog a nozzle. If this happens, it is quickly apparent – the fire shows a tendency to exit through the fire door.

Since the nipples are threaded, I carry spares that can quickly be interchanged just by opening the smokebox door. It's also a simple task to fix a clogged nozzle using a thin sewing needle, always in my toolbox.

Cosmetic details

As said, the boiler itself is an unsightly chunk of welded metal, so in addition to the wrapper, the boiler's backhead



PHOTO 179:

Piping in the smokebox.

PHOTO 180:

Close-up of blower nozzles.

PHOTO 181:

Boiler after receiving cladding.

PHOTO 182:

Backhead, with manifold, water gauges, regulator and fire door.

PHOTO 183:

The pair of safety valves.



also needed a cosmetic cover. In **Photo 181** you can see the entire wrapped boiler with some of its accessories already attached, including all the handrail studs.

Photo 182 is a close-up of the backhead. The cover – with holes for the water gauges and regulator – is made of the same 0.3mm brass as the boiler wrapper. A 10mm-wide cosmetic strip along the edge is soft-soldered to the last section of the wrapper around the backhead end of the boiler. This cover, which includes the mechanism for the fire door, hides the stay bolts and gives a more pleasing appearance to the backhead.

The regulator in the picture was still temporary, planned to be replaced by one that has a proper latch mechanism – this one is just spring-loaded. It does work well, nevertheless. The four valves on the backhead manifold are for the whistle, the generator, the feed-water pump, and the blower.

There are two 'pop' safety valves



on top of the boiler's steam dome, **Photo 183**. I used the same design I developed for my first two steam locos; a construction drawing appears in the March 2016 issue of *EIM*. The left valve has a manually operated lever, and is adjusted to open at 7.2 bars, while the other opens already at 7 bars. They have a very distinct pop action, and close automatically when the pressure has dropped by 0.2 to 0.3 bars. I have yet to see both of the valves blow simultaneously, so their capacity is evidently sufficient for this boiler.

The steam-operated water pump (described in detail in the July 2020 issue) finally had all its pipes





installed, **Photo 184**. Some pipe bends are not exactly prototypical; I've used the cosmetic sand dome's pipes for boiler water supply, and my water pump was actually an air compressor in the original loco. There is no connection to the middle cylinder (even though there is a union screwed on), since I have no use for compressed air in this engine.

Note the addition to the right of the pump: it is a displacement lubricator, made from a piece of brass tubing, with a screw-on lid on top, and a condensed-water drain cap at the bottom – both are car tyre valve parts!

Feeding from the tender

In order to get the water and propane from the tender to the loco, I installed quick-release couplings – the type used for compressed air – in both the loco and tender. **Photo 185** shows the front end of the tender; here, I've

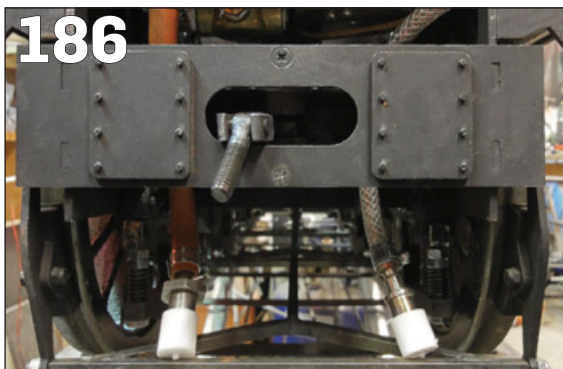
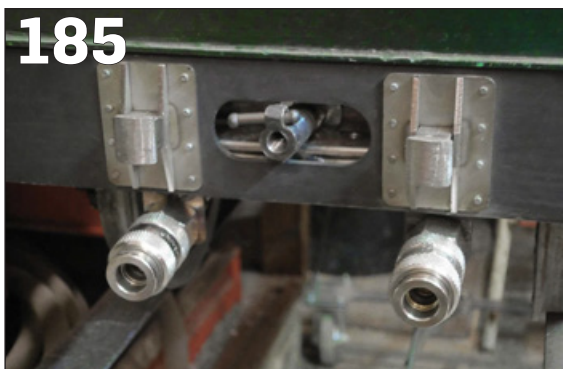


PHOTO 184: Pipes to water pump and sand dome mimic prototype, but for different use.

PHOTO 185: Quick-release couplers on tender front end.

PHOTO 186: Corresponding hoses below cab.

PHOTO 187: Ten-wheeler at Helsinki Model Expo in 2015.

PHOTO 188: Simply made display track.

installed the self-closing part of the couplings, thus avoiding water and gas leaks when the loco is not attached to the tender.

Photo 186 shows the rear end of the locomotive. The mating parts for the quick-release couplings have simple covers turned from Teflon. They protect the hoses from sand and dirt when the engine is moved onto the track. Note also that there is a knuckle joint on the screw-coupler to the tender – this is absent on the prototype, but since a miniature train is often driven on a very uneven track (at least mine is!), there must always be free vertical movement between loco and tender.

Photo 187 shows the finished loco on exhibition at the 2015 Helsinki Model Expo. I hope you will excuse me for tooting my own steam whistle, but I might perhaps mention that the loco was awarded the 'Best of Show'

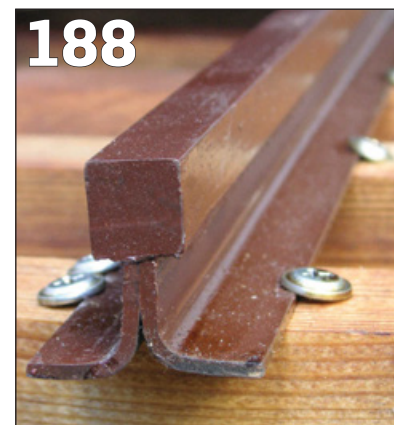
trophy and diploma that year...

Finally **Photo 188** shows a close-up of the display track I built for the exhibition – the rails consist of two pieces of angle iron spot-welded to a 10x10 mm hot-rolled piece. Woodscrews secure the rails to the sleepers, which are treated with real wood-tar creosote, reminding the expo visitors of 'ye olden days' when railroads had that evocative fragrance – now lost because of the use of modern concrete sleepers.

Next time – a first steaming! **EIM**

■ Jan-Eric concludes this series in next month's issue. Previous episodes have appeared as follows; **Feb 2020:** Introducing the Ten-Wheeler and design considerations; **Mar 2020:** Metal-cutting options; **Apr 2020:** Tab & hole – assembling components; **May 2020:** Frame construction; **Jun 2020:** Building the boiler; **Jul 2020:** The water pump; **Aug 2020:** Propane burners; **Sep 2020:** Casting the wheels; **Oct 2020:** Machining the wheels; **Nov 2020:** Making the tender; **Dec 2020:** Pumps, valves and generators; **Jan 2021:** The water feed; **Feb 2021:** The braking system; **Mar 2020:** Cab plates and carry cradles.

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Rebuilding a Winson

16-year-old Sussex Miniature Locomotive Society member Sam continues his first model engineering project, the rebuild of an unfinished kit from a defunct manufacturer.

BY SAM RIDLEY Part 2 of a short series

The approach of September meant that for me a new academic year would be starting. The year was 2019, I was going into year 10 and that meant work for my GCSE exams would begin. Unfortunately, I didn't have a workshop at home or even a place to do the work needed on my engine, so the club was my only real access point to a workbench.

It was around this time of year that winter maintenance of our Beech Hurst Gardens track in Haywards Heath and preparations for the Christmas event took place so work on my Winson Engineering GWR 14xx tank loco was postponed until the New Year rolled around as the 'winter work' started to take place.

Finally, 2020 arrived and work recommenced on Project 14xx. In the last article I described the work done to get the chassis largely complete so it could be tested using compressed air (Photo 8). Andrew Brock, my mentor and I succeeded, and with the knowledge that the chassis ran successfully on air the decision was made to strip the chassis back down to be re-painted – the paint on the frames, buffer beams and frame stretchers at the time was looking old, tired and was just not up to standard.

Stripdown and painting

The first step to get the chassis down to bare frames was to remove the front axle, followed by the rear (crank) axle, plus the motion work and cylinder block all in one go! This was possible because the engine has

inside cylinders and this saved us some time, but it still proved an oily couple of hours!

With all of this removed from the frames, we were able to unbolt the buffer beams and frame stretchers to make all of them single items. To remove the old paint from the buffer beams and frame stretchers, we took the parts to the shot blaster (often referred to as a sand blaster), a device based on a high-pressure air gun firing sand or grit onto the piece of material to remove the old paint.

Matters were different for the main frames because I decided not to strip them back completely but to rub them down with Scotchbrite and then over-paint the existing red and black. This was, overall, still in a pretty good condition compared to the buffer beams and frame stretchers.

Painting Process

Just before we got to this part of the project the London Model Engineering Exhibition had taken place where I bought myself some paint brushes, as I had intended to brush paint the chassis of the locomotive. So with the buffer beams and frame stretchers off, it was time to clean and prime them. These pieces were rather unorthodox as they were made of aluminium so I was going to need to use a special etch primer. A standard metal primer will not key properly into the aluminium pieces to give a good and strong base layer for the paint.

Before they were primed the pieces were given a thorough



"The paint on the frames, buffer beams and frame stretchers was looking old, tired and not up to standard..."

PHOTO 8:

Adding major encouragement to the project – the loco chassis is run for the first time on compressed air.

All photos in this feature by the author

rub-down with Scotchbrite and cleaned with white spirit to eliminate any unwanted grease or grit left on the surfaces. The primer I used was Bilt Hamber Etch Weld; this was available in a spray can, which I tried because other members of the club had brushed this primer before and had not had a very good experience with it. We were also in a well-ventilated area with masks as this stuff can be very potent.

This was not my first time using a spray can but it was my first big job with one. To achieve full coverage on the material with minimal excess paint on the surfaces I held the spray can at an optimal height above the work (about seven or eight inches) to give a good consistent layer of primer, not too thick, not too thin!

To ensure the edges were as well covered as the main body of the work I started spraying just before the edge of the part and brought the can right across and past the trailing edge before stopping spraying. I did this at a relatively fast, consistent speed for full coverage of the material (Photo 9).

I also needed to learn not to move my arm in a swinging motion but to stay at the correct height across the work. I repeated these steps on all of the pieces and then covered them up and left them to dry overnight.

With the etch priming complete, it was time to get the brushes out and my hands dirty! I used an old paint made by Cherry's, Buffer Beam Red. We mixed this with a paint conditioner called Owatrol to a ratio of four parts paint and one part Owatrol. The paint conditioner was recommended to me because it increases the 'wet edge time' – the paint does not dry so quickly, which means that I get more time to blend the paint and produce a better finish as a novice painter.



9



I brush painted the buffer beams, frame stretchers and the insides of the main frames using this mixture. To apply the paint, I used quick and continuous brush strokes with a small amount of paint for consistent coverage – using only small amounts ensured that no excess paint bumps would occur and later on more coats would be applied so no bare metal would show.

Valve gear pins

As the paint would take 24 hours to dry between coats, I needed something to do in the time. Turning new valve gear pins was a perfect task for this time and with four eccentric rod pins, two lifting arm pins, two expansion link pivot pins and two crosshead pins required, I had lots to do.

Each existing pin was removed and measured using a micrometer and a dial caliper. This was my first time using a micrometer but I learnt to adjust to this way of measuring the pins. I rotated the barrel down a fine screw thread until it ratcheted onto the surface of the work, I was then

able to measure the length using the 25-thou' increments on the side of the barrel.

Outside micrometers are limited because as the name suggests they can generally only measure the outside of a surface, which is also why I employed a dial caliper. This can measure in four different ways, the inside and outside measurements, depth and thickness. However, it can prove the calliper can be less accurate than a micrometer. Once all the pins were measured and checked, a detailed list was made of each required pin before beginning the turning.

These pins would be turned from a bar of silver steel, which is an ideal metal for the purpose. Each would be a 'fitted' pin – this means that it would have a head, plain body, shoulder and a thread on the end. The eccentric rod and lifting arm pins were to have a 1/16-inch thick head, while the plain body would be 1/8-inch diameter and 5 thou' longer than the thickness of the fork the pin would go through on the valve gear. Finally, an

PHOTO 9:

Priming parts for painting – steady strokes across the work, starting before and ending after the component.

PHOTO 10:

Machining pins for the motion in silver steel, a very different material to brass...

10



8BA thread would be cut onto the final 3/32-inch of the pin.

Tool making

With my list complete, I needed a tool to turn with (I made the boiler bungs in the last article with a club-owned turning tool). I was lucky enough to have two pieces of 3/8-inch square high-speed tool steel given to me to practice with.

Tool grinding was another new process for me to learn, and an off-hand grinder did look intimidating at first. However, I got the hang of it and worked out that the grinder was only as intimidating as I made it. So, I just had to produce lots of sparks!

I made a turning tool with one piece of the tool steel and a parting tool with the other. The turning tool I found the hardest to make – I had to focus on how I positioned the steel to ensure the top left corner was higher than all the others allowing it to cut the material in the lathe. With help however I got there and soon I had my very own turning tool mounted in the lathe ready to turn some pins.

The parting tool was more simple as all I had to do was to grind away some of the tool steel to leave an approximate 40 thou' thick blade, followed by holding it perpendicular to the grinding wheel and angling down the sides and top of the blade.

Now it was time for the turning to begin. I had used the Myford Super 7 lathe before, but this was going to require more precision-based turning with each pin being unique by a few thousands of an inch. I learnt how to set the height of the tool to the centre of the work, and I also learnt how to use an engineer's clamp on the back of the lathe bed as a stop when cutting the main body length of the pin.

Machining silver steel proved different to brass – the latter is quite a soft metal and silver steel is much tougher. This meant that I had to take much smaller cuts to avoid too much spring on the work; doing this became quite challenging when the work got to smaller diameters as sometimes there could be a difference of two or three thousands of an inch in diameter along the whole length of the pin (Photo 10). The turning tool also required occasional sharpening because the cutting point on the tool was becoming slightly worn from all of the repetitive cuts.

The end of the pin required an 8BA thread cut into it. This operation was carried out in the same way as for the boiler bungs in Article 1 with the die stock being pushed onto the work by the tailstock of the lathe. This time however, the much shorter die stock could be rotated with the

chuck locked in position (Photo 11). In addition I used an RTD cutting compound to lubricate the metal surfaces before the threading started.

Unfortunately, not every thread would start properly causing the thread on the pin to have an unsatisfyingly large taper on the end. To overcome this issue, I cut the thread off the pin with a junior hacksaw and then re-faced the pin to make it smooth.

Because I had cut the thread off the pin, I needed to re-thread the end of the pin and to also extend the plain body of the pin back. To extend the pin, I turned the pin head to the same diameter as the plain body and also turned some more of the bar into the main pin body. Once this was done, I used a needle file to remove the small ridge between the different sections.

Once I had all the pins turned and threaded, I finished them with some maroon Scotchbrite to remove any machine marks left on the surface; I also used a needle file to remove any burr left on the end of the pin, plain body and pin head. I repeated this process for all the remaining pins in varying sizes of head or body for each component of the motion work.

Lockdown delays

Disaster struck at the beginning of March 2020 when the Covid-19 pandemic caused the country to go into lockdown. This meant that the club was not open and work on the 14xx could not continue. However, in mid-May the lockdown measures were relaxed and I was able to restart work on the project, but in a different setting. Andrew offered me the opportunity to work in his home workshop while the club's facilities remained out of action.

Day 1 at the new location provided another different task, as we decided that it would be a good time to list what items/parts we now had. This was a largely successful exercise showing us that 95 per cent of what was needed was present – but unfortunately, a big issue surfaced within the 5 per cent that was absent. The inner dome was nowhere to be seen and consequently, making a new one became a primary point on the to-do list. Numerous magnetic balls and nitrile O-rings were supplied with the kit and were subsequently replaced as these would be no use!

From here work began to run more smoothly as I returned to finishing off the jobs I had been doing before lockdown. The frames, buffer beams and frame stretchers were fully painted and the four remaining pins were turned – two silver steel valve gear pins and two pivot pins in stainless steel.

"Micrometers are limited because they can generally only measure the outside of a surface..."



PHOTO 11: Using the lathe tailstock to accurately cut 8BA threads in the end of the pins.

PHOTO 12: Final step on pins, machining flats on heads to accept a spanner.

All the ¼-inch diameter heads on the silver steel pins were then machined to final measurements of 0.193-inch across two flats. This was so they would take a 5mm or 6BA spanner and was done using a vertical slide mounted on the cross-slide of the Myford lathe. I clamped the pins into a block in the vice on the vertical slide and ran an end mill cutter across the heads of the pins until the desired width was achieved (Photo 12).

With more than 50 hours under

our belt by late May and extra effort over the school holidays the chassis was back up and running on air which concluded for the most part what was needed on the motion. **EIM**

■ Sam continues his project next month. Part 1 of this series was published in last month's issue of **EIM**, you can download a digital back issue or order printed copies from www.world-of-railways.co.uk/store/back-issues/engineering-in-miniature or by calling 01778 392484.



Threads laid bare

In the second part of his feature Peter continues his quest to identify any thread type, whether external or internal, using a free and simple-to-use software package designed for the scientific analysis community.

BY PETER KENINGTON Part Two of two

Last month I looked at the problems of measuring threads we might encounter in model engineering and establishing which of the many and varied types they might be. I also introduced you to ImageJ, a free, open-source, scientific image analysis software package originally written to perform tasks such as counting or measuring cells on a microscope slide, but which is useful for many aspects of model engineering – measuring threads being one of the simplest. This time I will show you how this is done.

When downloaded, ImageJ should place a 'shortcut' on your PC desktop – double-click on this to start the program. You should then see the window shown in **Figure 1**; note that this is all you will see – just a taskbar, in effect – until you open an image file to work on.

In the 'File' menu, choose 'Open' and navigate to the image file you wish to analyse. This will open in a separate window (**Figure 2**).

We are now ready to analyse the picture. To make this easier, we can zoom-in to a particular area, in our case, a portion of the screw-thread for the left-hand machine screw (to begin with). To do this, hold down either the <shift> or <ctrl> ('control') key and move the scroll-wheel on your mouse – this will zoom in and out, centred on where the '+' cursor is located.

To scroll the picture up and down, simply use the scroll wheel on its own (with no key pressed) and to scroll left and right, hold down the <spacebar> and use the scroll wheel. In this way, it should be possible to home in on a suitable area to measure (a clear, well-focused, portion of thread, in this case). The result should look something like **Figure 3**.

Note that the solid blue square within the blue rectangle, in the top left-hand corner of **Figure 3**, shows you where the portion of the image you are looking at is located within the overall image.

We are starting with the scanned image – the two image types (scanned and digital photo) need to be treated slightly differently. In this case, we can simply draw a line between the 'peaks' (or troughs, if these are clearer) of two adjacent threads and

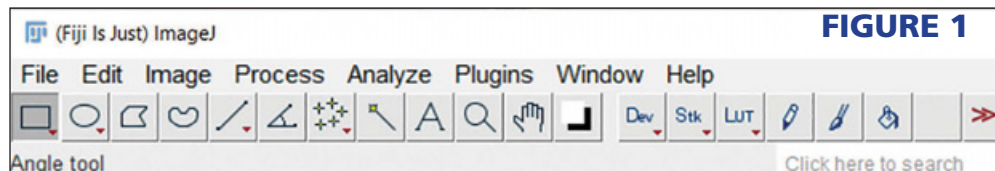


FIGURE 1

get ImageJ to measure the distance.

A slightly more accurate method would be to draw a line across a number of threads, measure the length and then divide by the number of threads. Either is good enough with the images we have here, although the latter would be better if the image quality was poorer. This is due to the fact that the uncertainty inherent in the placement of the line's end points (where exactly is the thread peak in a blurry picture?) will be reduced by a factor equal to the number of threads traversed – if the uncertainty is 0.1mm across 10 threads, the thread-to-thread error we are interested in will be 0.01mm.

Before we draw our line, however, we need to calibrate our image. To do this, we need to know the resolution

to which the image was scanned; in our case, this was 1200DPI. We then need to convert this to a pixel size in millimetres, using:

$$\begin{aligned}\text{Pixel size (mm)} &= 25.4 / \text{<resolution>} \\ &= 25.4 / 1200 \\ &= 0.02116666667\end{aligned}$$

This needs to be entered into ImageJ as follows: select <Image>, <Properties> from the menu bar and dropdown, and enter the values as shown in **Figure 4**. Ticking the 'Global' box ensures that any images subsequently analysed, in this session, use these values (the alternative is to go through this process for each image opened). Then click 'OK'.

Next, we need to draw a line between two 'peaks' of the thread. Click on the straight-line icon (fifth from the left) to enter the line-drawing mode. Move the cursor to the image and click and drag to draw a line from one peak to a neighbouring peak. Do this with the <shift> key held down if your thread is reasonably vertical (as it is in **Figure 2**); this will constrain the line to be vertical (or 45 degrees or horizontal, if relevant). Other angles can be accommodated by drawing the line parallel to the length of the thread (without <shift> pressed). Once you have done this,

All photos and diagrams in this feature by the author – for descriptions refer to text



FIGURE 2



FIGURE 3

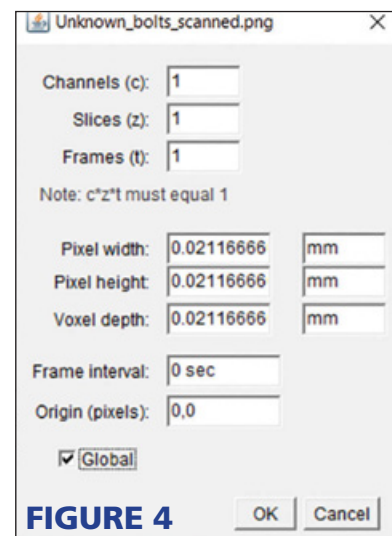


FIGURE 4

you should have something looking like **Figure 5**.

To measure the length of this line, select: <Analyze>, <Measure> from the menu bar. This will bring up a window like that shown in **Figure 6**. The only result of relevance here is the one in the 'length' column: 0.392. Since we calibrated the system in millimetres, this can be read directly as: 0.392mm. So, our thread pitch is 0.392mm which, it is worth noting, is suspiciously close to 0.4mm...

As a final test, we can attempt to measure the thread angle. Remember that threads are typically either of 55 or 60 degrees and this can further help in distinguishing thread types. To do this, we need to select the 'angle' icon on the taskbar (sixth from the left).

To select the starting point for our angle measurement, move the cursor to a clear 'peak' of the thread and double-click. This should place a point and, when the cursor is moved, a line is drawn. Move the cursor to a 'trough' in the thread and click once. The middle point has now been fixed and a further line started.

Finally, move the cursor to another (adjacent) peak and click once. The result should look something like **Figure 7**. Again, select: <Analyze>, <Measure>, and this should bring up a window looking like **Figure 8** (or it will insert the result into the previous measurement window, if you didn't close that window). From this measurement, it is clear that the thread angle is approximately 60 degrees.

Note that performing this latter (angle) measurement accurately is difficult, given that we are trying to distinguish between 55 and 60 degrees. Unless your picture is very high resolution and pin-sharp (a camera with a macro facility is useful here), then it is very difficult to achieve a convincing result. The (scanned) image shown in **Figure 7** is marginal for this purpose and it would be fairly easy to reach the wrong conclusion with a poor measurement of this angle. How convinced you are by the result obtained from this particular measurement is down to your judgement, but it is likely to be much more uncertain than is the measurement of the thread pitch (or, indeed, the thread diameter).

One tip for the angle measurement is to draw the first line where the angle is clearest. In **Figure 7**, both angles are fairly clear, however when we get to **Figure 13**, I would argue that the lower part of the thread angle is a little clearer than the upper part.

Once this first part of the line has been drawn, the upper-part should be a mirror-image of it. Note that you do not need to get this right first time,

the line start, mid and end points can be moved individually by 'clicking and dragging' them (this is also true when using a single line to measure distance, as we did earlier).

Finally, we can measure the inner diameter of the thread. For this we again use the straight-line tool, but this time being careful to hold down the <Shift> key whilst tracing the line across. The reason for pressing the <Shift> key is that it ensures that the line is constrained to be horizontal, allowing us to move the cursor upwards (say) to meet the lower point of the opposite thread. If we didn't do this, we would end up with a shallow-diagonal line, which would be longer than the true inner diameter of the thread. Assuming we do this correctly, we should end up with something looking like **Figure 9**, yielding the result shown in **Figure 10**.

For completeness, it is worth pointing out that it is also sometimes possible to directly measure the depth of the thread (or, to be more precise, the inner thread diameter, from which the thread depth can be calculated). This can be done with a set of calipers, using their chiselled ends to fit between the thread peaks. Clearly this is only possible, with any degree of conviction, on coarser threads and larger bolts and will yield a result which is 'too large', since it will effectively be taken on a diagonal. It is therefore probably of limited (but some) value.

So, we now have the following results for our first 'mystery' thread:

- 1) Outer thread diameter: 1.935mm or 0.07615-inch (approx. $\frac{5}{64}$ -inch)
- 2) Inner thread diameter: 1.471mm
- 3) Thread pitch: 0.392mm
- 4) Thread angle: 59.962 degrees

Reading the Runes

What do the above results tell us? Result no. 4 indicates that the thread is likely to be metric (ISO), NPT or UTS (including UNF and UTC) although we mustn't forget the uncertainty of this measurement, so it needs confirming by other means. Result no. 1 is suspiciously close to 2mm. The closest UNF/UNC thread diameters to this are: 1.85mm and 2.18mm. Considering that a 'real' bolt/screw thread is much more likely to be smaller than its nominal value than larger (customers would soon complain if a commercial bolt would not fit through a precisely-correct hole!), ruling out the 1.85mm option, and that 1.935mm is a lot smaller than 2.18mm (the only remaining option, given the previous statement), the evidence is beginning to point quite strongly toward M2.

Looking at the parameters for an M2 thread, its pitch should be either

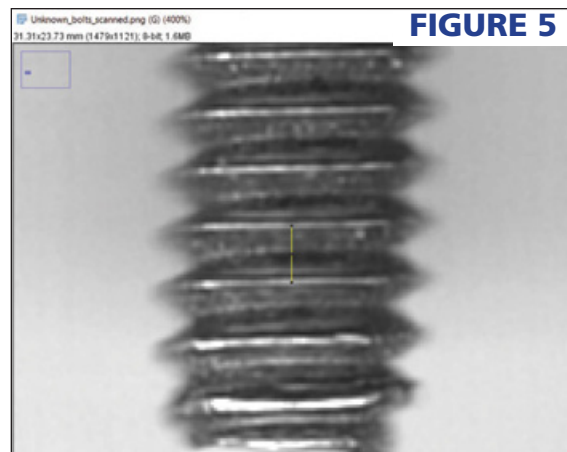


FIGURE 5

0.4mm ('coarse') or 0.25mm ('fine') and its inner diameter should be around 1.5mm; our results indicate therefore that it is very likely that our bolt is an M2, coarse-thread, type.

As a final sanity check, it is worth checking the parameters of other potential candidates, such as BA. This

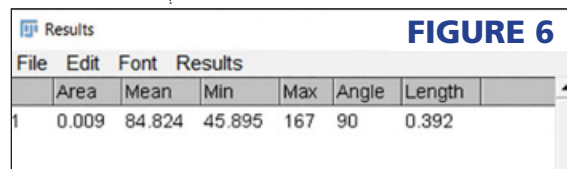


FIGURE 6

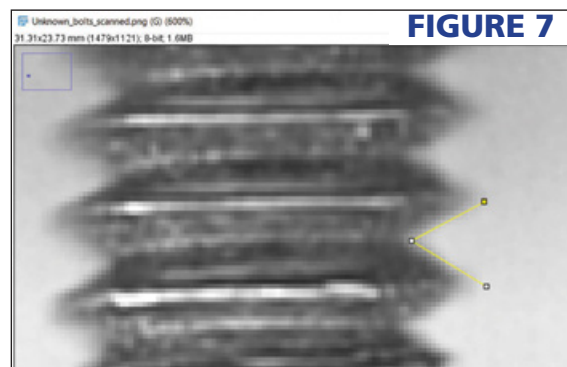


FIGURE 7

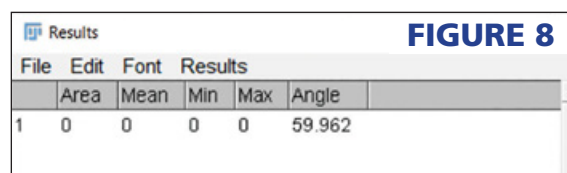


FIGURE 8

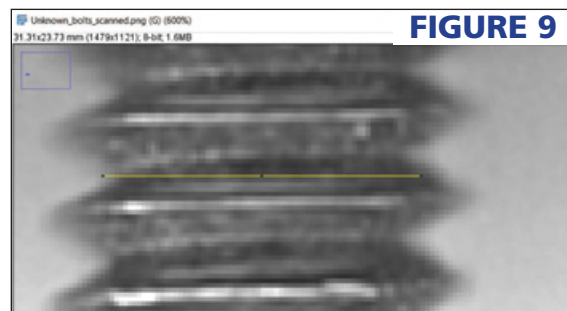


FIGURE 9

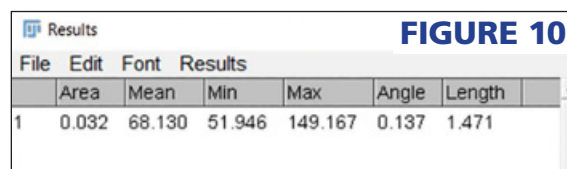


FIGURE 10

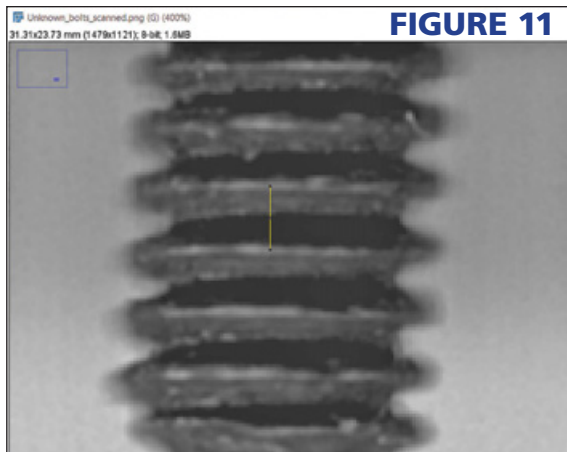


FIGURE 11

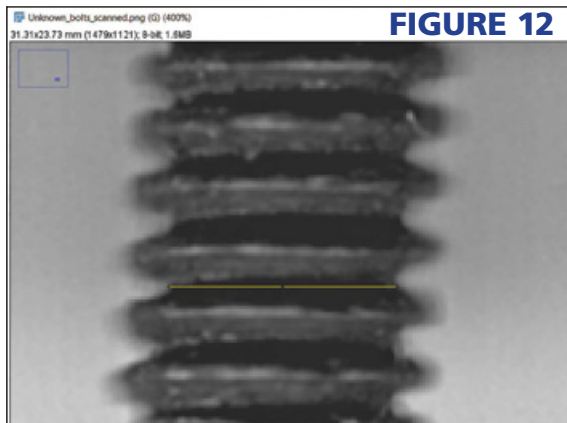


FIGURE 12

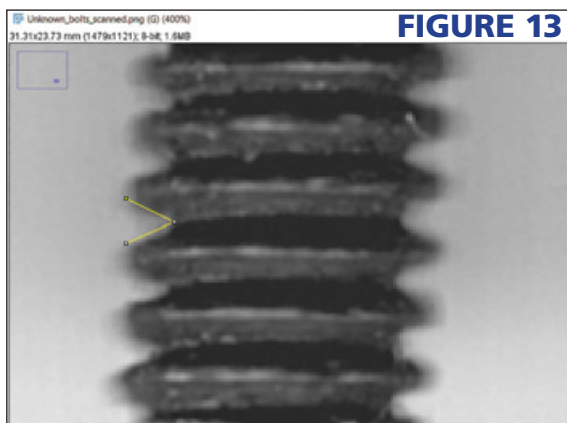


FIGURE 13

FIGURE 14

Results						
File	Edit	Font	Results			
	Area	Mean	Min	Max	Angle	Length
1	0.000	0.000	0	0.000	49.353	0.000
2	0.010	46.794	28	79.500	-90.000	0.434
3	0.034	30.429	28	70.000	0.000	1.561



16

is actually quite a strong candidate, since a 9BA thread has the following nominal parameters:

Thread pitch: 0.39mm – a very close match to our 0.392mm)

Thread diameter: 1.90mm – a close match to 1.935mm, but our thread is very slightly larger. So long as we are convinced that our micrometer measurement is correct and adhere to the ‘real threads tend to be smaller than specified’ maxim, then this may be a partial convincer.

Thread angle: 47.5 degrees – this is some way off our measured 59.96 degrees and, even if it is difficult to distinguish between 55 and 60 degrees, distinguishing between 60 and 47 degrees is more straightforward.

We can (more convincingly) conclude, therefore, that what we have is an M2 coarse-threaded machine screw. And, indeed, this is correct (at least, according to the drawer it was sourced from!).

Note that the relevant thread parameters, for the different standards listed in Table 1 last month, are widely available by searching online, so there is no need to reproduce them here.

Thread #2

Quickly running through the same exercise on the second bolt yields the following parameters (Figure 11-14 and Photo 14-15 published last month):

- 1) Outer thread diameter: 2.179mm or 0.0858-inch
- 2) Inner thread diameter: 1.561mm
- 3) Thread pitch: 0.434mm
- 4) Thread angle: 49.353 degrees

So, could this be an M2.2 machine-screw (based upon No. 1) or a UNC/UNF #2 (2.1844mm)?

First let's check the thread pitches: $M2.2 = 0.45$, $UNC = 0.4536$, $UNF = 0.3969$. UNF is easily ruled out at this stage, with both M2.2 and UNC looking unlikely with around a four to five per cent error.

The thread angle is the main issue with all of these types, however – they all specify 60 degrees, which is quite a long way from the approximate 49 degrees measured. Again, this is dependent upon the accuracy of your angular measurement, but it should be relatively easy to do this within, say, 5 degrees.

So, what other options are there? The main one is BA, since we're assuming that this came from a model engine or loco and ME threads are not usually used (or ever used?) on threaded machine screws or bolts. The relevant parameters for the nearest size of BA thread (8BA) are:

- 1) Outer thread diameter: 2.1996mm
- 2) Inner thread diameter: 1.679mm
- 3) Thread pitch: 0.4293mm
- 4) Thread angle: 47.5 degrees

Based on the above, the outer

thread diameter, thread pitch and thread angle are all a very good match, with only the inner thread diameter (minor diameter) being significantly different. Overall, since the three most important parameters agree well, this is the most likely candidate and is, indeed, the correct choice. So, the bolts is a round (or dome) slotted-head, 8BA, machine screw.

Photo Opportunity

If instead of a scanned image we use the photo taken with a smartphone camera (Photo 9 last month), the procedure is very similar to that outlined above, but with one key difference. We need to use a different mechanism in order to ‘calibrate’ the image. The pixel-based calibration, described in conjunction with Figure 4, will no longer work, since the distance from which the photo was taken is (assumed to be) unknown, at least to any degree of accuracy. Fortunately, ImageJ has a simple way around this problem.

Firstly, we must manually (and accurately) measure something which is on the photograph – this can be anything which is both clearly visible on the photo AND easy to measure. In general, the larger and better-defined the object chosen, the more accurate will be the final results derived from it.

One technique is to place a ruler within the frame of the photo (this technique is used in Photo 21 which we'll get to later on). Another is to pick a precisely-machined part (such as a connecting rod on the motion) which can be measured easily and precisely or which is known to be accurate to the drawings (for example because you made it yourself and know this to be true) or any other object of known length which can be placed within the frame before the photo is taken.

For this illustration, the length of the left-hand machine screw shown in Photo 9 was measured using callipers (Photo 16). This measurement can then be used to set the scale of the photo by drawing a line as accurately as possible along the length of the bolt, once Photo 9 has been opened within ImageJ as described previously (Figure 15). Note that this needs to follow the angle at which the item appears in the photo, hence the <Shift> key should not be used (unless the item happens to be precisely vertical or horizontal in the image).

We then select: <Analyze>, <Set Scale>, from the menu bar and enter the length of the item in the ‘known distance’ field (Figure 16), and click ‘OK’. The remaining fields can be left at their default values (the distance, in pixels, is automatically read from the line drawn on the image and so will

differ, when you do this process, from that shown in Figure 16). The 'unit of length' should be set to mm, if this is not the default shown when the window opens. The drawing scale is now set and the remainder of the process proceeds as before, starting with the tasks described in relation to Figure 5.

With this image, it is easier to use the thread 'peaks', shown against the white background, to judge the pitch (bottom-centre of Figure 17), with the result being shown in Figure 18. Note that this is a genuine measurement and not 'staged' for the purposes of this article! It shows the accuracy/repeatability of this technique, with the result agreeing almost perfectly with that obtained when using the scanner (Figure 6).

Bear in mind that this is a 2mm diameter bolt with a 0.4mm thread pitch and the repeatability between two very different image-capture techniques shows agreement to be almost perfect down to the third decimal place! And I'll remind you that, assuming you already have a digital camera of some (decent) sort, all of this comes for free. Isn't technology wonderful?

With some older thread types (such as Whitworth) the figure quoted in relation to their threads is: threads-per-inch (often abbreviated to TPI). To convert this to a thread pitch in mm, we need to use:

$$\text{Thread pitch (mm)} = 25.4/\text{TPI}$$

So, for a 26 TPI thread, this equates to a thread pitch of 0.977mm. We can then use this thread pitch to check if it is a good fit for our measured pitch, as outlined above.

Divining Rod

So far, we have discussed how to work out the thread present on a part which is reasonably accessible, at least sufficiently so that it can be photographed. What happens if the thread in question is located in a hole and is sufficiently small that adequate photography is impossible? – one obvious example would be a bush in a boiler backhead, but most other threaded holes on a model locomotive would prove just as tricky. Indeed, most nuts would prove equally tricky, due to their small size.

Again, let's assume that you don't have a huge selection of bolts or a diverse range of dies, in order to make test threads or, indeed, exactly the right diameters of rod in order to cut them. All of these things were true in my case when I was first starting out in the hobby, and I suspect the same is true for most people – even in the best-equipped 'normal' workshops, a set of ME taps and dies is likely to be notable by its absence and I defy

anyone to find a vendor of ME-threaded bolts! I may be wrong, of course, in which case the letters page will fill up accordingly...

One method of solving this problem is to get the troublesome nut/threaded hole to itself cut a thread which you can then measure. This requires a little caution and a rudimentary appreciation of materials science (notably, hardness), but is relatively straightforward.

Firstly, you need to know, or have a pretty good idea of, the material the thread is cut into. In the case of a boiler backhead, this is likely to be bronze of some sort (probably phosphor bronze), whereas for the motion it will probably be mild or perhaps stainless steel.

You then need to find or make a piece of rod of the correct diameter in a material which is appreciably softer than the material in which the hole is tapped. Ideally, this rod should be metal, however if the hole is tapped into a soft metal (such as copper), then a plastic rod or even a wooden dowel may be needed.

Note that the 'rod' could be an existing bolt (for example a brass bolt for testing a steel threaded hole), with the existing thread on the bolt removed in a lathe, or some soft copper tubing (such as the kind used to 'plumb' a loco – you may well already have a stock of this, in a range of sizes). If a bolt is used, its diameter must, of course, be large enough that it will turn down to the correct diameter to take the new thread, without any of the existing thread still being apparent.

It is helpful, also, to turn (or file) a taper onto the end of the rod, of a similar length/angle to that found on a first-tap for a similarly-sized thread (as in Photo 17 for M6). This does not need to be accurate and could even be achieved (crudely) using a pencil-sharpener, if a plastic or wooden rod is to be employed. It is also a good idea to file some flats on the opposite end of the rod, such that it may be gripped by a normal tap-wrench. An example part is shown in Photo 18.

Our new 'blank' tap can then carefully be turned into the 'unknown' threaded-hole (Photo 19-20). With care, it should 'take' and gradually carve a thread onto the

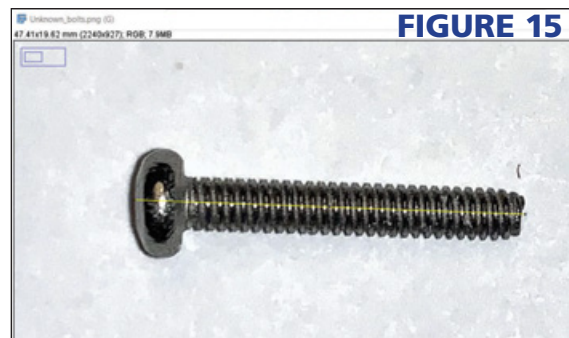


FIGURE 15

"What if the thread in question is located in a hole and is sufficiently small to make adequate photography impossible?"

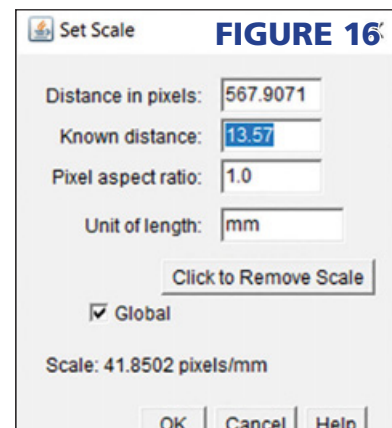


FIGURE 16

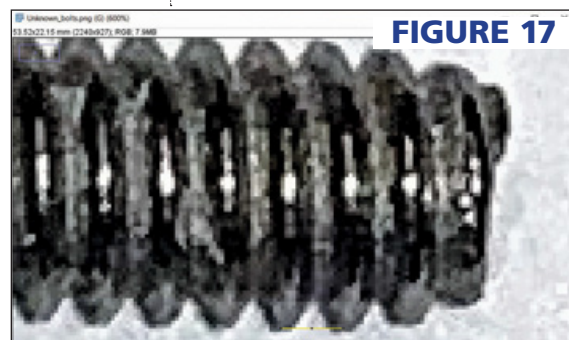


FIGURE 17

File	Edit	Font	Results	Area	Mean	Min	Max	Angle	Length
1				0.010	176.633	71.912	247.691	0	0.394

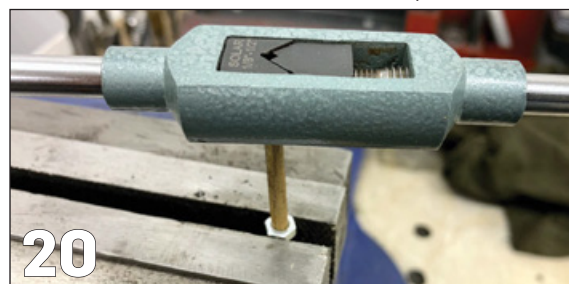
FIGURE 18



17



18



20



19



blank shaft of our test-piece (Photo 21). Doing this will inevitably create a small amount of swarf and care should be taken if this is likely to be significant and fall within a boiler, for example. The loco could be oriented so that most should fall out and the bulk of the remainder could be vacuumed out using a small, flexible, pipe attached to a vacuum cleaner.

Once the thread has been cut on the blank, it can be measured in the manner described earlier and the thread-type deduced – note the addition of a ruler to Photo 21, to allow the scale of the photo to be calculated within ImageJ. Note also the poor quality of the threads appearing on the wooden blank; despite this, they are still measurable, as we will see.

Again, a little context may help to narrow or speed up the search; the aforementioned boiler bush is likely to have an ME thread, for example, however this should not be totally relied upon, as the builder may not have invested in a set of ME taps and dies, particularly if he only ever intended to build one loco. A change

“The builder may not have invested in a set of ME taps and dies, particularly if he only ever intended to build one loco...”

from ME threads would, however, have forced him to make his own steam fittings which, if it is a loco built in the last 30 years or so, would seem unlikely.

The results of the measurement process, in this case, are provided in Figure 21, with the measurement pictures provided in Figure 19-20. The first entry in the table shown in Figure 21 indicates the diameter measurement (final column) and the second indicates the thread pitch (again in the final column). Measuring thread angle from such a crudely-threaded piece would probably be impossible with any degree of conviction. Wood is a poor choice of material for this purpose and almost anything else is preferable, however it was chosen here to show that even in this extreme case, useful results can be obtained.

From the results shown in Figure 21, it appears likely that the thread is an M4 x 0.7mm (the ‘fine’ thread pitch for M4 is 0.5mm, which is clearly much smaller than the measured result and hence can be disregarded as an option). The context of this nut looking modern and being bright/shiny, indicating it is probably not too many years old, would tend to support this view, as most modern, small, shiny (passivated zinc or stainless steel), nuts, in a UK/EU context, will probably be metric. This is, indeed, the correct answer.

Note that the use of wooden dowel, in this illustration, makes the task of thread identification quite difficult, since the wood ‘squashes’ when it is being threaded and hence the thread cut onto the dowel is not as deep as it should be and is, as a result, less distinct. The ‘unknown’ threaded item (nut) we are using to cut a thread onto the dowel was never intended for thread-cutting and so does a relatively poor job of it – it was never designed to do the job of a die. However it is

just about good enough for us to make a decent guess at the thread type and pitch and certainly good enough to narrow down the options. In other words, the use of wood should be a last-resort and the results not relied upon. Most plastics and more or less all soft metals are a better choice.

In Conclusion

As a beginner, I found screw/bolt threads a bit daunting. I had a lovely loco, which was well made and had only a few minor issues to sort out (mostly involving threaded components, as it happened). I understood the consequences of getting it wrong and, at the time, didn’t have the facilities or expertise to recover from any mistakes made. This made anything involving screws and bolts somewhat scary. Gradually, as with all things, my knowledge and skills grew and the fear subsided, but I am close enough to the ‘absolute beginner’ I was at the time to still remember such feelings.

Hopefully the above discussion of techniques, hints and tips will allow you to feel a little more comfortable in replacing missing nuts, sheered bolts and the like, on your new pride and joy. As with all things model-engineering related, there is a friendly club somewhere near you, full of people far more expert than you (or I, for that matter) and most will be only too willing to help. This is a little more of a challenge in these Covid-restricted times, but Zoom, Google Meets, Skype and the like can help.

Once my thread-related problems had been sorted, I had a lovely loco, which steams beautifully, and a very happy young engine driver (Photo 22).

And as to the solution to the quiz in part 1, which asked which bolt/machine screw shown in Photo 8 has a BA thread, the answer is (drum-roll please): the fifth from the left. Sorry there are no prizes, other than that

feeling of smug satisfaction if you got it right. **EIM**



■ Part 1 of this feature was published in last month’s issue of **EIM** – for details of how to obtain a copy of this issue see page 35.



FIGURE 19



FIGURE 20

Results						
File	Edit	Font	Results			
	Area	Mean	Min	Max	Angle	Length
1	0.105	88.076	45.073	179.000	90.756	3.970
2	0.019	172.282	68.926	224.137	3.708	0.709

FIGURE 21

Machining cylinders

The accurate machining of cylinders is a practiced technique whether on a 1-inch scale model or, in the case of our Tech Ed, refurbishing a 6-inch scale workhorse...

BY HARRY BILLMORE

Regular followers of this column will be aware that my first winter as the engineer at the 12¼-inch gauge Fairbourne Railway, on the mid-Wales coast, has been dominated by the major 10-year overhaul of 'Sherpa', our 6-inch scale representation of a Darjeeling-Himalayan 0-4-0. I've even had Editor Charman in our workshops piling up the swarf making various components for the rebuild.

In the past few weeks my attention turned to Sherpa's cylinders and on close inspection, I could see that the bores of both were very worn. They were both oval, barrel shaped along their length and nearly ¼-inch oversize, as you can see in the photos. This was not particularly surprising as talking to various longer-serving and former members of staff revealed that this was likely the first time the cylinders have been off the engine since it was built in 1978.

In the pocket

So along with the worn bores, I also had to deal with a badly worn port face (Photo 1), exacerbated by the inclined nature of the valve chest, the lower side always wearing more than the upper. Along with these rectification jobs, I also needed to machine a pocket into which the new exhaust stubs would be brazed – putting them into a pocket will ensure the bore of the stub and the bore of

PHOTO 1:

A view of the wear, showing deeper wear at the top of the photo, which is the lower edge of the valve.

PHOTO 2:

Shimming the corners to ensure the valve face is perfectly flat to the cutter.

PHOTO 3:

View showing the clamping arrangement, this later was moved so that the flat edge on the left of the photo sat in a T slot on the milling table.

All photos by the author



the casting line up precisely, thus reducing any turbulence caused by poor alignment to a minimum.

The first operation I decided to tackle was the valve face. Having trammed in (finely adjusted to perfectly square) the milling machine

to ensure the head was running true to the table, I then set about shimming the cylinder (Photo 2) so that the edge of the valve face that had been under the gasket, and therefore original, was flat to the bed.

This proved a somewhat arduous





PHOTO 4: Clocking up on the un-worn section of the valve face.

PHOTO 5: After a couple of passes the wear became more evident.

PHOTO 6: Nearly there, just some scoring and slight wear to deal with.

PHOTO 7: Last of the wear about to be machined out, note the position of the edge of the cut, the cutter machining across the full width of the rubbing surface.

PHOTO 8: The valve face completed.

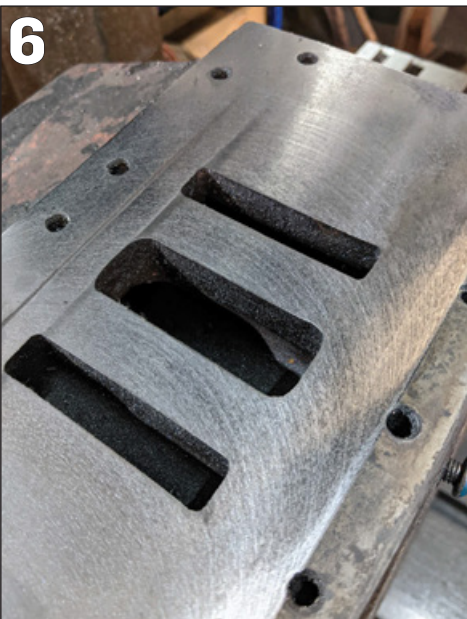
PHOTO 9: Boring out the pocket for the exhaust stub.

task, as the inclined face meant that I was clamping on a partially round and partially flat-edged section of the casting, requiring some careful positioning – the flat edge that would normally be against the frames was wedged partially in one of the T-slots on the milling table (**Photo 3**). This worked quite well, although I had to be careful in positioning the holding-

down clamps to ensure that they did not rotate the cylinder and pull the flat edge further into the T-slot.

After a great deal of checking, tightening, re-checking, adjusting and checking again (**Photo 4**) I was ready to start machining. Rather than take several passes across the face with a narrow cutter I made up a face-cutting tool to fit into the boring head – this

“Viewing the indicator at the bottom required a torch and a mirror, plus a lot of patience...”



would cut the full width of the face that the valve travels on. I did this as even a slightly rough finish using this method reduces any chance of a slight error in tramming the quill to the table and as a result causing scores along the workpiece by the sides of where the cutter passes. I then proceeded to take very fine cuts to remove as little material as possible so that I would alter the height of the valve rod by as little as possible (**Photos 5-8**).

Once the valve face was flat, I then proceeded to machine the pocket for the exhaust stub – this was a much easier setup as the casting rested handily flat with easy hold-down positions. After using a dial indicator to centre the quill on the bore of the exhaust in the casting it was then a simple matter of opening the hole out a quarter of an inch or so with the boring head (**Photo 9**), the final size not mattering too much as I was going to be making the exhaust stubs to fit the hole anyway.

A boring task

My attention then focused on machining the bore back true and round. I set the cylinder up so that the rear bolting flange of the casting was held on good parallels just off the table

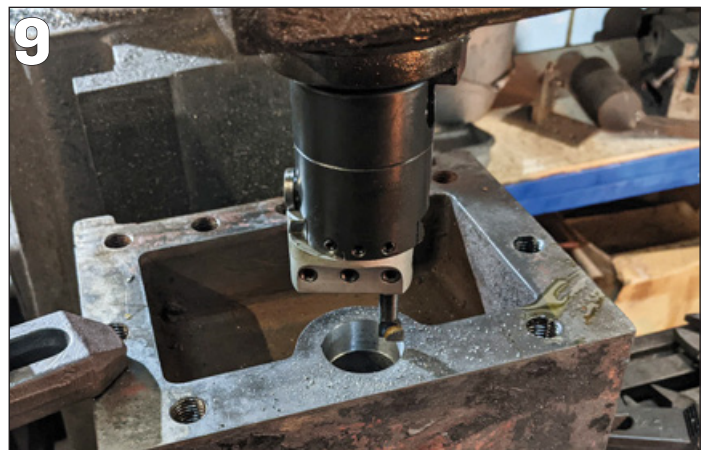


PHOTO 10: Machining down the bore of the cylinder, note the parallels on the rear bolting flange.

PHOTO 11: Some of the interestingly shaped wear becoming noticeable.

PHOTO 12: Using the lathe chuck as a pipe clamp to thread the exhaust stub.

PHOTO 13: The completed stub and pocket ready for brazing.

PHOTO 14: The exhaust stub after it was brazed on.

PHOTO 15: Close-up of the TIG-brazed joint, note the lack of heat discolouration across the cast iron.

of the mill – this meant that the bore of the cylinder would be absolutely true to the table's movement. This was checked by using a dial indicator on the small amounts of the bore left at each end that were not worn due to the piston rings not travelling over them. To view the indicator at the bottom required me to employ a torch and a mirror, plus a lot of patience due to the quill nearly filling the bore of the cylinder.

Once it was set up, it then became an exercise of my arm, to wind the knee of the mill up and down, with the quill set to its furthest extension to allow the cutting tool to pass over the entire length of the cylinder (**Photo**



“The pipe vice had been left outside for some years and had rusted quite spectacularly in the salt sea air into a beautiful bit of rust art...”

10). You can see some interesting wear patterns in the photos I took (**Photo 11**) as the cutting tool took interrupted cuts on the way down.

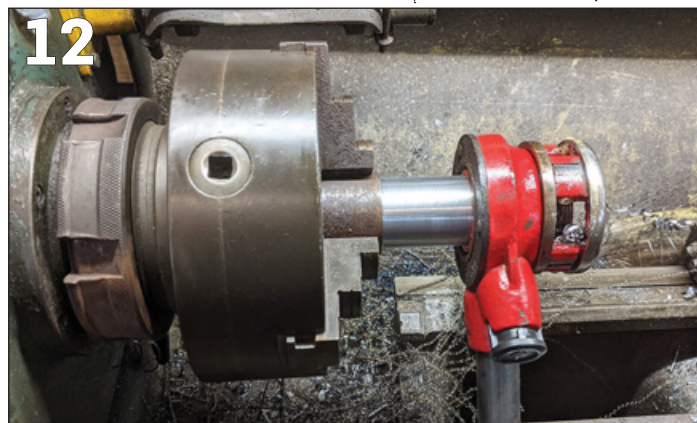
It was then a simple matter of turning up the exhaust stub and then threading the end 1½-inch BSP. Helpfully at the railway we have a set of dies for cutting the thread, but less helpfully the pipe vice had been left outside for some years and had rusted quite spectacularly in the salt sea air into a beautiful bit of rust art...

So it was back to the lathe chuck and some more workout for my arm putting the thread on the end (**Photo 12-13**). I then TIG-brazed the stub

onto the cylinder, I used TIG due to its useful ability to not require heating of the whole casting, so is much faster to do (**Photo 14-15**).

With all that done one more job of the many required on Sherpa's overhaul could be ticked off, as we work towards the loco's return to the steam later this season. **EIM**

■ The Fairbourne Railway is awaiting Welsh Government guidance before deciding when it can start its 2021 operating season. Readers wishing to visit will find the latest news on potential services on the railway's website www.fairbournerrailway.com



A magnetic swarf collecting tool

Mike comes up with a solution for a problem that plagues all of us with a workshop...

BY MIKE COOK

I am sure any of you with access to a workshop will be aware that swarf seems to get everywhere, and will frequently find its way into living areas. In my fight against the metal shavings I have used vacuum cleaners, brushes and pans, all to good effect, but I thought I could do better and started to look for other options.

Magnetic swarf collectors are available from a number of suppliers and the prices are not too damaging. However a look around my workshop revealed most of the parts I needed to make such a collector available for nothing, apart from the magnets.

For most readers of this magazine a full description of this build will be over the top. However when I started model engineering I was frequently on the hunt for small projects that helped me develop my skills and produced a useful workshop tool at the end. For this reason I have several homemade workshop tools that I use frequently. Examples include Harold Hall's grinding rest from his book *Milling – a Complete Course* and I also have a rear tool post holder for my Myford made from a description in Geo. H Thomas's *The Model Engineer's Workshop Manual*. So this short article may be of interest to someone.

The dimensions for this build are not critical and the tool can be made from a variety of sized parts. The tool can be made using hand tools only, but access to a lathe is useful. Whether you are a beginner or more experienced I would always start by asking that you adhere to the usual safe workshop practices – Matthew Kenington provided a useful overview in his first engine build article in the February 2021 edition of *EIM*.

Thoughts on magnets

Magnets are very versatile items with many uses around the workshop. One example – my pillar drill and milling machine both adjust their speed by means of a belt mechanism. So that I don't have to keep opening the belt cover to check the speed of the quill, I have printed labels with each of the drill speeds identified. I then have a small magnet that I simply move to indicate which speed the belts are adjusted to, as pictured at right.

Please be aware that the magnets used in this project can have some dangers – commercial supplier www.first4magnets.com offers some great advice, parts of which I have used with permission (I have no connection with the company).

Key warnings: Firstly anyone with a pacemaker should not put strong magnets close to their chest. Heart pacemakers will be adversely affected by the close proximity of a magnet and can cause the pacemaker to operate in a mode that does not respond to the user's own heart rhythm.

Also, keep small neodymium magnets away from children and pets. They are very dangerous if a child or pet swallows more than one as they can attract in the intestines requiring immediate surgery.

Keep any electronic devices and wristwatches away from strong magnetic fields. New wristwatches may be fine, but older ones may become magnetised and cease to operate correctly.

Don't attempt to cut or drill a magnet as most (excluding flexible magnets) are very hard and brittle. They can be drilled with diamond tooling and plenty of coolant as the dust is flammable. However the grindings are magnetic and within a few seconds of drilling the whole magnet will look like a hedgehog due to the grindings being attracted to it. It is much better to purchase the magnet with a hole already drilled in it.

Note also that subjecting a magnet to temperatures above its maximum operating temperature will cause it to lose performance that won't be recovered on cooling. Repeatedly heating beyond the maximum



operating temperature will result in a significant decrease in performance. So be careful if using heat to seal the ends of the tubes.

Stacking for strength?

It is often asked whether stacking magnets together makes them stronger. Using two magnets together would be the same as having one magnet of their combined size – for example, if you stack two 10mm diameter x 2mm thick magnets on top



of each other you have effectively created a 10mm diameter x 4mm thick magnet, essentially doubling its strength and pull.

Note, however, that once the length of the magnet exceeds its diameter, it will be working at an optimum level and further additions to magnetic length will provide only small increases in performance.

It's also worth considering air gaps – simply if the contact steel is rusty, painted or uneven, then the resulting gap between the magnet and the contact steel will lead to a reduced 'pull' from the magnet.

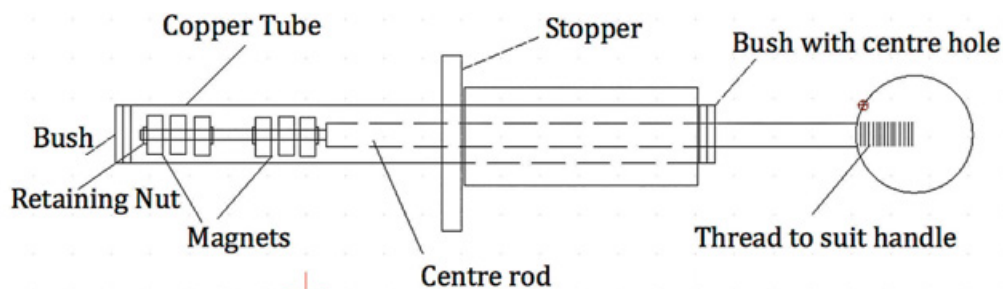
Building the tool

So to the build – the simple drawing here provides brief details of the main parts, which are as follows:

- 1) Copper or other thin-walled pipe – I used copper, 15mm outer diameter for the smaller one and $\frac{7}{8}$ ths-inch thin-walled mild steel pipe for the larger one that I made later (see below).
- 2) Round BMS rod, threaded at both ends, one for the retaining nut and one for the handle (4mm at the magnet end and 6mm at the handle end).
- 3) Two plugs to suit pipe dimensions.
- 4) Magnets – neodymium-type to suit your design.
- 5) A retaining nut to suit round BMS (best made from plastic if possible).

The copper pipe and magnets were selected first. The pipe was 300mm long with an internal diameter of about 12mm. I sourced magnets to suit this diameter with a central hole already drilled in them. I used neodymium magnets (rare earth 'strong' magnets) with a diameter of 12mm, 4mm thick with a 4mm hole, basically because they were on special offer from First for Magnets (other suppliers are available...).

I then carried out a few trials, trying different combinations of magnet in the pipe and testing how effective it was at swarf collection. From this I opted for three magnets, followed by a space and then another three magnets – I found this provided the best strength with the effective stacked length of the magnets remaining under the diameter, the point where performance increases becomes marginal as stated earlier.



The other aspect to consider was the gap between the pipe and the magnet. Magnets lose their strength quite quickly and so a sliding fit between the internal pipe and the magnet is required. Make it too loose and you lose too much of the magnet's power, but if it is too tight it all becomes a nuisance when using the swarf collector.

The next step was to find a suitable piece of metal for the rod that the magnets would be mounted on. I found it best to have the rod larger than the diameter of the magnets' central holes. Having determined the length of the rod I threaded the end of the rod to suit the magnets. I then placed a suitable nut at the top of the thread, threaded on the magnets and placed a nut at the bottom.

The nuts were Loctited in place – as the tool becomes in effect a sealed unit I wanted the magnets to stay in place. On reflection I would have been better turning and threading PTFE or plastic to use as magnet stops, as this would have created less loss of magnetism. Indeed I did this on the larger version I made later.

I then made a suitably sized end stop for the copper pipe and soft soldered it in place. The heating required to do this was done without the magnets in the pipe so as not to destroy their forces.

I then slid the rod with the magnets into the pipe, before making the top-retaining stopper with a suitable hole drilled in the centre for the rod to move through.

I pushed the rod to the bottom of the pipe and soft soldered this in place, again using as little heat as possible to melt the solder. This worked fine, but with hindsight I

could have used a two-part epoxy glue such as Araldite to fix this part in to avoid any problems with heat.

The next job was to find a suitable place to epoxy a piece of nylon in place, wood would have been just as suitable. This acts as a 'stopper' for the swarf to drop from the main pipe as the magnet slides up past the stopper.

The results

I have found the small version of the tool great for using around my Myford lathe and my pillar drill. However it was not really strong enough for my milling machine. So I made a larger version using mild steel pipe with an internal diameter of 19.3mm.

For this version I used larger magnets of 19.1mm diameter ($\frac{3}{4}$ -inch), 6.4mm thick ($\frac{1}{4}$ -inch) and a 9.5mm ($\frac{3}{8}$ -inch) hole in their centre. I stacked the magnets as a set of three and this time used nylon as the locking nuts. The rod was 9.5mm in diameter ($\frac{3}{8}$ -inch). As all of these were imperial sizes a $\frac{3}{8}$ ths-inch 32 x 20tpi thread was used on the rod and the locking nuts. I found that the one set of magnets did a good job.

In the end I made three swarf collectors, one for a very experienced model-engineering friend that has been a massive help to me. I am pleased to report that he found the tool a useful addition to his workshop.

Most of the material for these tools was already in my workshop and so they cost very little. The most expensive parts were the magnets coming in at about £15. For £15 you could probably buy a good commercial version of the tool, however I made three of them and added some new learning to my repertoire as I went.

EIM

LEFT: The clearly effective magnetic swarf collector in use.

BELOW LEFT: Typical of the versatile uses for magnets is as a simple belt-drive speed indicator.

ABOVE: This diagram shows the general arrangement of the collector – size is not critical, builders can size to suit their application.

BELOW: The completed small version of the swarf collector.

All photos and diagrams by the author



A budget but effective wheel-quartering jig

Useful jigs for employing in locomotive building are all the more attractive when they cost little or nothing to make, as Julian demonstrates...

BY JULIAN HARRISON

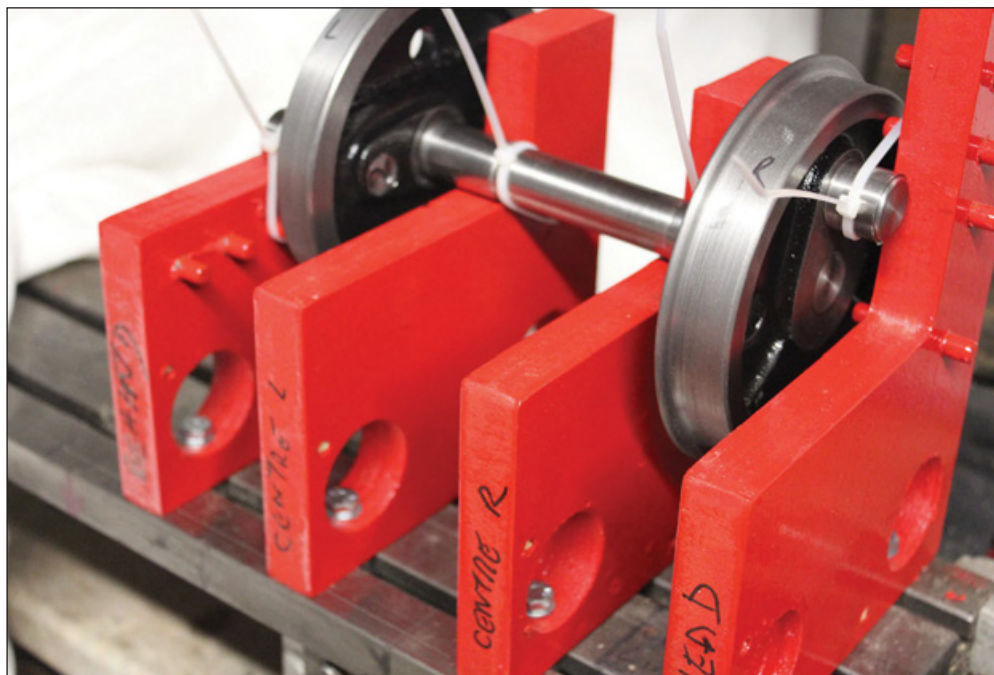
Progressing through my latest loco build, a 5-inch Sweet Pea designed by Jack Buckler, I have come to the point that I need to accurately quarter the wheels, as they are glued and pinned to the axles.

For those who are unaware of the reason for this procedure, I think a quick explanation is appropriate. All locomotives that use external cranks or crank pins to drive the wheels always have to have the cranks on each axle set at 90 degrees to each other. This allows self-starting of the loco and equal force being applied because at any point of rotation of the wheels one piston will always be exerting force on the drive system.

The connecting rod only drives one wheel on each side. All the other drive wheels are driven by these wheels via coupling rods. These rods provide their drive via crank pins set into the wheels all at the same distance from the centre of the axles.

All these pins on all the driven wheels must be correct and identical in two measurements. These are their distance from the axle and their relationship to the opposite wheel on the same axle. One crank has to be 90 degrees ahead of the other **and** all the drive axles **must** be identical.

It does not matter if they are not quite 90 degrees. They could be, say, 88 or 91 degrees but **all** the driven



ABOVE: The completed quartering jig in use.

FIGURE 1: Relationship of cranks on each axle.

All photos and diagrams by the author

axles **must** then be this same measurement. If any are different the wheels cannot turn.

The number of drive axles is totally irrelevant – however many there are they have to be identical. **Figure 1** shows the relationship of the crank pins on an axle.

Why build a jig?

This is the reason that a jig of some kind needs to be used so that the setting up is accurately repeatable. Many people own or borrow such a jig when they need one. They rarely come up for sale and are very expensive when they do so.

In the Sweet Pea build book (*and the original build series, way back in the January 1982 edition of EIM - Ed*) the author describes a way of quartering the wheels using a four-jaw chuck on the lathe, but every time it is required the lathe has to be set up and is then out of action while the quartering is being carried out on all the axles. The procedure also requires a vertical slide which I do not possess.

I have several locos to set up in the future so wanted a quick and easy way forward. I wanted a jig to be adjustable for use on any gauge and any size of wheel – I required it to cover 3½-inch,

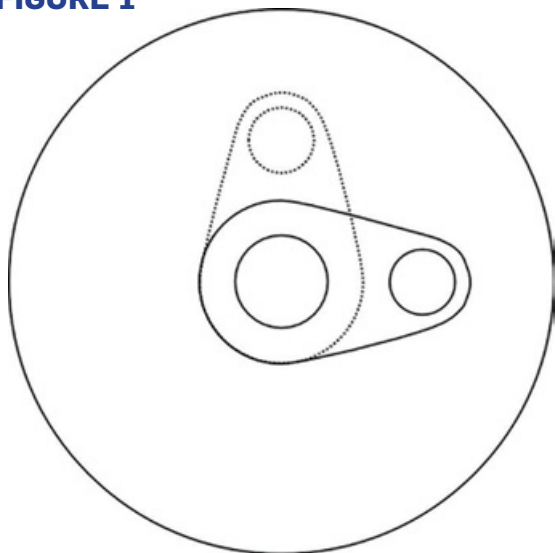
5-inch and 7¼-inch gauges and wheels up to at least 7-inch diameter.

To be adjustable between gauges the jig would need to be able to expand in and out, while merely having to be built to a suitable size to accommodate larger wheels – smaller wheels will then naturally fit. It would also require a solid base with parallel slots or holes in it to allow for the gauge adjustment.

Looking around my workshop I realised I did not need to make this base as I already had one – so do many of you! Look at your vertical mill. They all have a cast table onto which you fix the work to machine it and this table invariably has two, three or even four slots for fixing the work down using Tee nuts and studs. These slots are parallel to the table and ideal for fitting an adjustable jig. And the table will allow accurate adjustment but still have the capability to hold everything solid and square.

I am lucky in that I have two mills with identical tables so can choose which I use but if you don't have a mill you could make a suitable base from metal or MDF to match so the jig is adjustable and freestanding. As I don't need to make a base I will leave that to your ingenuity.

FIGURE 1





Thinking the problem through I could see that the axle needed support at each end and there needed to be two parts with faces 90 degrees apart for the cranks – so four plates that can be moved to adjust the width but that remain square wherever they are.

Materials choice

I originally planned to build the four major parts of this jig in metal. To hold them accurately down to the table they would need to be thick enough to allow 6mm bolts to pass through the bottom section or to have angle plates fitted to do the same. The plates would also need to be very accurate to hold them perfectly upright.

I had some 12mm steel plate to hand but it would take a lot of work to cut to shape and machine accurately. The same applied to some aluminium plate I had available. Wanting something cheap and quick to build I settled on some 18mm MDF offcuts I had lying around. I am sure we all have them – the bits chopped off for some job are kept as they may eventually come in handy!

MDF is stable, flat, machines well and is strong, though strength is not a great necessity here. There should be very little strain on it as it is only supporting the axle and wheels and holding them in position while they are glued with Loctite or similar. Pinning the wheels to the axles for added security is done once the glue has dried and the axle assembly removed from the jig.

While I use a lot of MDF for numerous jobs and have plenty of offcuts, it is very cheap material and can be bought easily. With its edge machined square 18mm MDF will stand on its end very well, so if you only have 8mm or 12mm board I suggest gluing two bits together to make them thicker. Use a quality glue that is suitable for MDF and glue and clamp them together before machining them square.

I used an offcut big enough to make all four parts (Photo 1). I cut out the four pieces to shape and size as in Figure 2 – I used a band saw but they will cut equally well with a jig saw or a

hand saw. Cut them on the larger side to allow a little machining to square the edges.

The table on my Seig mill is 145mm front to back so I cut to this size along the base edge. If your mill table is a different size I suggest you cut the parts to the size of your table or to cover at least three tee slots.

One piece needs to be flat on the top. I marked it at 100mm from the base. This measurement allows for wheels of up to about 8-inch diameter. This 100mm edge is common to all four parts – I will call this edge the ‘axle face’ to save confusion. Mark this piece with an ‘R’ for right.

The next two pieces are identical in their shape. They match ‘R’ but have a piece above the axle face, giving a face at 90 degrees to the axle face 100mm in from the front. This face will have the axle held against it so needs to be high enough above the centre line of any axle necessary – I chose 45mm which seems more than enough to support any axle I am using. Mark these two pieces ‘C’ for centre.

The last piece is the same as the centre pieces but instead of 45mm the height needs to be 100mm, matching the distance of this face from the front to accept the crank pins of larger wheels. Mark this plate as ‘L’.

These four pieces need to be produced reasonably accurately but they will all be corrected shortly. If you plan to use this jig for larger wheels then expand all the measurements to allow for them.

Clamp all four plates together in your vice with the base and rear faces aligned as best you can. Drill through them all and bolt them together with a couple of nuts and some threaded rod. I used M5 because it was in my stock of metal offcuts – any similar rod or bolts would do just as well.

Site one near the 90 degrees of the axle face and the faces adjacent to it. I placed them about 15mm away as they will be used later to secure the axles when in use. The others are a personal choice but you need to avoid intruding within the areas to be machined later. With hindsight I would suggest the other holes coincide with some of the

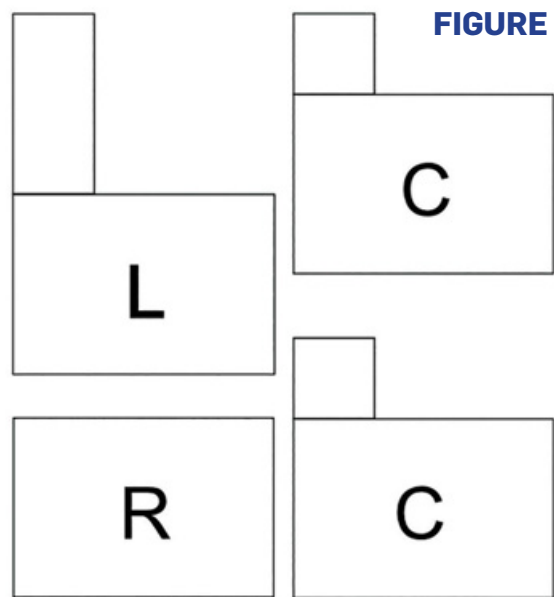


FIGURE 2

PHOTO 1: MDF marked ready for cutting.

PHOTO 2: Four plates cut out.

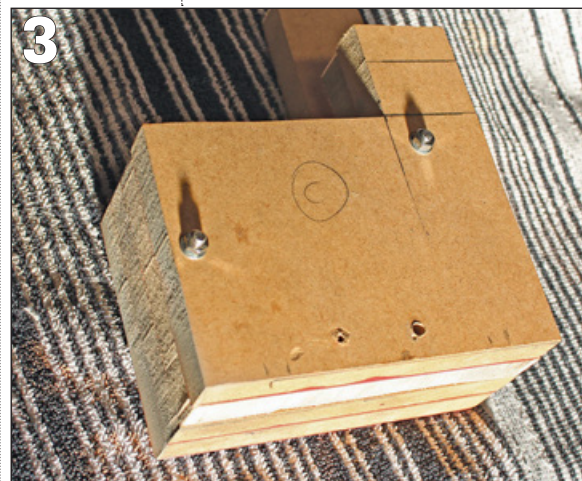
FIGURE 2: Shape of four plates required.

PHOTO 3: Plates fastened together ready for machining.

holes that will be drilled later in the build for securing the axles and cranks. They should now look like Photo 3.

Do not now undo these fixings until **all** machining is completed. There are three edges that need to be accurate – the base must be flat so the four parts sit level on the table of the mill. The axle face and the faces at 90 degrees have to be level, square and perfectly aligned on all four plates.

I clamped the parts down onto the mill table on their side with the base square to the front edge. To avoid any clashes with the table and because



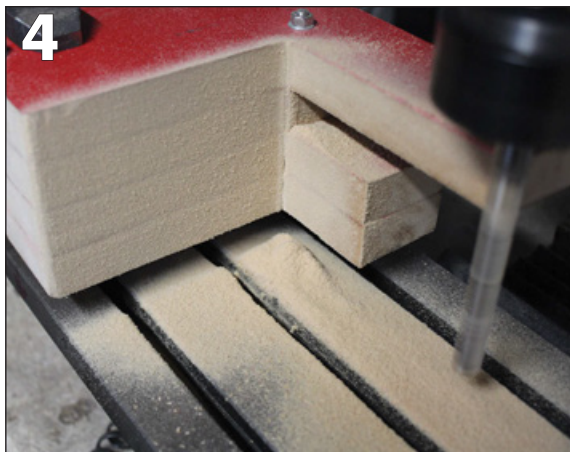
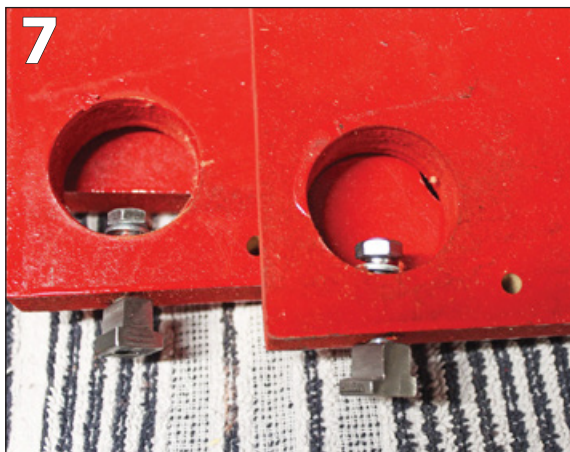
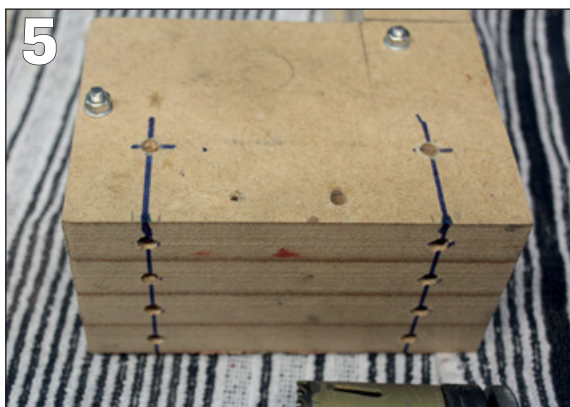


PHOTO 4: Block of plates being machined to 90 degrees.

PHOTO 5: Plates drilled and marked.

PHOTO 6: Four plates with clamping holes drilled.

PHOTO 7: Fixing bolts and tee nuts fitted.



there were bolts holding the parts together I used some MDF to pack the block above the table. Four pieces of 18mm MDF is 72mm thick which is beyond most milling tools.

Because MDF machines easily I used a 10mm drill bit as a milling tool. The side of most drill bits is sharp enough to mill MDF and 10mm is strong enough not to bend under side stress. It may not be the correct use of a drill bit but it easily machines MDF without any strain. I machined along the base to square them all and to make them all square to the sides.

Next the block was repositioned as in **Photo 4** and clamped so the axle faces and the 90-degree faces were within the machining area of the mill. The axle face needs to be square to the front edge of the mill table. Using the X and Y axis of the mill you will get 90 degrees. I machined the axle face and the adjacent face alternately with small cuts of the drill bit until both faces had been squared up. Once you are happy these two faces are at 90 degrees to each other you are finished with the critical machining tasks. The axle face is less critical and does not need to be absolutely parallel to the base. If you feel you need to check them mark the two faces with a pencil. Machine again and ensure that on both faces the pencil marks have been fully machined away.

Next I placed the base of the block on the mill table with the rear face level with the rear face of the table. I marked onto the block the centre of the front and rear T-slots. I used a tee square to extend these marks for about 45mm up the side of the blocks. These two lines are used to drill large holes to accommodate bolts to hold the parts down to the mill table.

I drilled a 6mm hole up from the base into the plates for about 20mm. I chose a hole saw of about 25mm diameter and marked a spot on the line that places the bottom of this hole at 10-15mm above the base edge. I drilled at this point through with a 6mm pilot hole ready for the hole saw. This put the same holes through all four parts at the same places – **Photo 5** shows this stage well. To keep the holes square in the plates you can use either the mill or in my case a pillar drill.

All the critical machining is now done so the four parts can be separated. I drilled each part at the previously drilled 6mm holes with the hole saw to produce two 25mm diameter holes in each plate. The size of these holes can be varied to suit any hole saws you have available but don't go too big otherwise you may weaken the plates if you drill too close to the edges. If you don't have any hole saws use your mill to machine square holes in their place or chain drill and file.

Photo 6 shows these holes completed.

These holes take the bolts that hold the plates down onto the mill table. Each bolt will screw into a Tee nut to suit the table. I milled my Tee nuts from a short offcut of mild steel but you can buy them ready-made. The M6 bolt goes through the previously drilled hole from this circle through the base and into the Tee nut. If your slots take bigger Tee nuts either adjust the bolts to suit or machine some nuts to suit your table but tap them to M6 – if your mill uses M12 or M10 studs for the Tee nuts you will only have at the most 3 or 4mm each side of the hole which could significantly weaken the base. **Photo 7** shows this process completed.

You may also notice that the plates have had a coat of paint. They will need painting at some point to seal the MDF – I took the opportunity at this point to give them a first coat but the timing comes down to convenience.

Fixing points

We now need to provide fixings for holding the axle and crank pins in position when securing with glue. For flexibility and convenience I decided to use electrical zip ties for this. I bought a thousand 200mm long for a fiver so they are cheap enough.

The fixing pins are some spare 6mm mild steel rod I had but any other similar rod would be suitable. I cut 12 pieces about 30mm long. This allows them to protrude equally from both sides by 6mm. This dimension is not critical but if they are too big they will be in the way when quartering the wheels. My zip ties are 2.5mm wide so 6mm on the fixing will be adequate.

Placement of the holes for these fixing pins is your choice. The hole mentioned earlier near the 90-degree corner of the axle face and the uprights must be used on all the centre plates, while both these plates need no other fixings.

The left plate needs four holes on the upright and the right plate needs four on the axle face. I spaced them equally at 20mm from each other and 15mm from the relevant edges. This allows the use of either one or two to hold any length of crank.

I drilled the holes out to 6mm and partially pushed the fixing rods in. I then placed the plates down on some M8 nuts which happened to be the same size as the 6mm protrusion of the fixings, put a bit of Super-Glue on each rod and gently tapped it in until it hit the surface of my bench. This fixed them in place and left them sticking out equally on both sides. **Photo 8** shows this task completed on all four plates.

The last job is to add some small alignment lugs on the back face of all

four plates. In keeping with this project I found an offcut of some 10mm wide 1.5mm thick mild steel bar and cut four pieces each 60mm long. All four were drilled and countersunk to take some small posi-drive board screws. They were then screwed onto the rear face with 8mm protruding below the base edge.

Be sure to drill pilot holes for all these screws to avoid splitting the corner of the MDF. This will be the locating lug for each plate that will align the plates against the rear edge of the mill table. **Photo 9** shows them in place.

When the plates are fitted to the mill table these lugs need to be held against the rear edge while the bolts are tightened. I used a set square on the front edge of the mill table just to ensure the plates were square to the table and each other.

Different diameters

Photo 10 shows one of the axles complete with its wheels and cranks fitted on the jig for testing. The axle is supported by the centre two plates and held there by zip ties. The crank pins are held one on the axle face and the other on the adjacent 90-degree face, again held in position by zip ties.

Here with most locos we hit a problem – the crank pins are a different diameter to the axles, altering the angle they can be set at which will not be 90 degrees.

One solution is to find a plate the same thickness as the difference between the axle and crank pin. This plate would need to sit on the axle face between this face and the crank pin. The thickness of the plate must be very close to the difference and used for all the axles.

The other method which I have decided upon as follows. Ensure that the bar used for the axles on the loco is long enough to leave a piece an extra couple of inches long. After you have machined the axles and the crank pins place this piece in the lathe. Drill it and bore it out to be a sliding fit on the crank pins.

Cut the tube in half and clean the ends. These can be slipped over the two crank pins to make them an identical diameter to the axle. Now when the axles and crank pins are held to their relevant faces the cranks will be at 90 degrees. **Photo 11** shows the spacers for my Sweet Pea.

If the pins are different diameters on each axle you will need to make different-sized spacers for each axle. But so long as you use the same bar as the axles or spacer plates they will still work properly.

At this point I need to talk about which crank leads – which is ahead of the opposite crank on the same axle

when rotating forwards. Sometimes this is the choice of the builder and sometimes it is in the design. On Sweet Pea the designer specified the right crank leading.

This jig lends itself to selecting the lead crank by the positioning of the plates. I have written on the front of the four plates to identify them. The centre plates are marked 'Centre Left' and 'Centre Right' to keep them in their correct positions. The flat plate originally designated 'Right' is now renamed 'Behind' and the plate designated 'Left' labelled 'Ahead'.

The Behind and Ahead plates are interchangeable and can fit at either end. Use them so they match your frames with the left and right wheels in their correct positions on the jig. If, like me, you need the right crank to lead put the Ahead plate on the right and the Behind plate on the left. If you need the left to lead swap them over. The Ahead plate is always the one with the large upright face.

Because this project is meant to work with most gauges and configurations I will stay with the tube style of spacers. The plates can be positioned to suit the axles required. If the wheels are to be inside the frames with outside cranks they can still be accommodated. The wheels will be fixed onto the axles first and then will sit inside the centre plates. The axles will still sit on the centre plates either inside or outside them. The tubular spacers will still be the same diameter as the axles but will be drilled or bored to fit the pins on the outer ends of the cranks again with a sliding fit. The cranks will usually be glued or pinned onto the ends of the axles but if they are only clamped on they will need to be permanently marked so they are always refitted in the correct position.

Whether you are setting two axles or more this jig will give repeated and accurate quartering on them all. Bolt the jig onto the mill table and set all axles before moving any of the plates.

Testing and use

Rather than simply trusting my design I decided to have a trial construction. I roughly turned a couple of MDF disks and using wood dowels for the crank pins and axles I set them up in the jig. I left the axle sticking through the disks so I could later check the cranks. **Photo 12** shows the result of this test piece.

I was happy with the accuracy and repeatability of this jig so I went ahead and used it for real. I glued the right wheel onto the axle on the bench and left it to cure. With this wheel solidly fixed it was an easy task to drop the whole assembly into the jig. The axle was strapped lightly to the centre plates and the right crank was

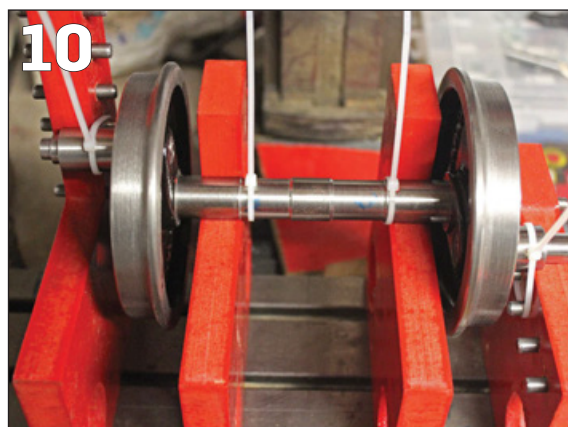


PHOTO 8: Axle and crank holding points fitted.

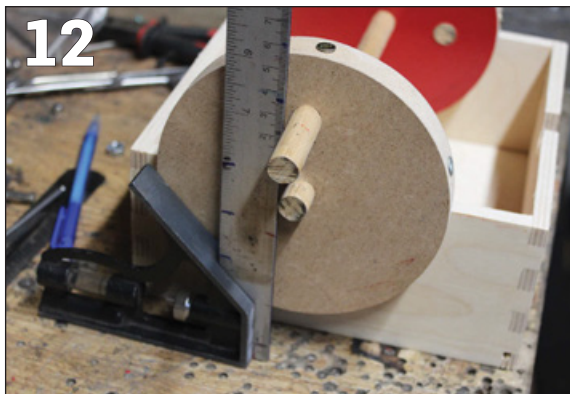
PHOTO 9: Rear locating lugs added.

PHOTO 10: Axle fitted for trial.

PHOTO 11: Tubular spacers turned to suit crank pins.



12



strapped to the right plate (Ahead). I kept the axle and right wheel as far across to the right plate as possible and set the left plate (Behind) so it just caught the spacer on the crank of the left wheel. This allowed the left wheel to have some lateral movement.

A couple of trial movements and I was ready. Pulling the left wheel towards the left plate allowed me to put some Loctite glue onto the axle on the inner face and in the hole in the outer face of the wheel. I pushed the wheel fully onto the axle and partially rotated it a half turn each way several times to distribute the glue evenly in the joint, ending with the crank and its spacer sitting on the axle face of the left plate.

I lightly placed a zip tie around the crank and a fixing rod to hold in

"If you view offcuts as free then all this project cost me was some time..."

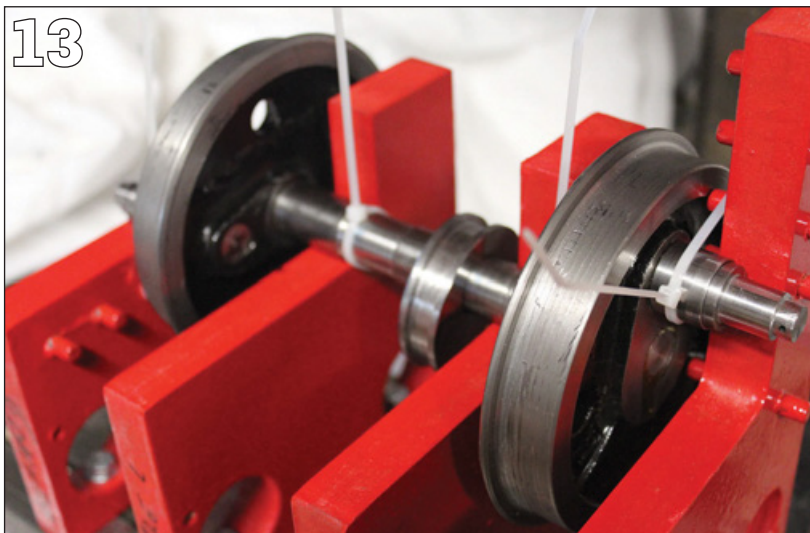
PHOTO 12:

Dummy axle and wheels for testing.

PHOTO 13:

First axle assembly being fixed for real!

13



position. Do not overtighten any of the ties otherwise the assembly could be twisted. **Photo 13** shows the first axle glued in place with the right crank leading. The glue dries quickly but needs to cure properly for 24 hours. If you are careful after an hour you can cut the straps and remove the assembly to get on with the next axle.

I used Loctite this time but there are several grades and other makes of glues available so the choice is yours. You will need to check the drying and curing time for the product you choose. After curing I fitted extra pins into the end of the axles.

Conclusion

Once this locomotive had its wheels quartered the plates were stored and will be used for all my future loco builds, so saving me time and money. The jig has since had its second coat of paint and should be good for many years of use.

This jig took me a couple of afternoons to build from offcuts I had kept from other jobs – I bought nothing except a few zip ties but I buy them anyway, so if you view offcuts as free then all this project cost me was some time. We surely all must like free tools that do a good job! **EIM**

PHOTO EXTRA



■ A spare half page provides another chance to reminisce about steam events we are all missing terribly right now, but which thankfully should be starting up again before too long.

This time it's the Statfold Barn Railway Miniature Steam Weekend, held at the absolute mecca for fans of narrow-gauge steam locomotives near Tamworth in Staffordshire. Editor *Andrew Charman* took these pictures back at the 2016 event – this year's weekend was due to be in May and the good news is that it hasn't been cancelled, merely postponed to a new date set to be announced shortly – have a look at the Trust's Facebook page, @statfoldbarnrailway, for the latest news.

A water and coal wagon

Stewart created a bespoke vehicle to feed his recently restored Simplex locomotive with its essential elements...

BY STEWART HART

When I first completed the reworking of my 5-inch gauge Martin Evans Simplex tank locomotive better known as 'Gremlin' (the rebuild of the used purchase serialised in the December 2020 to February 2021 editions of *EIM*) I relied on the water supply from the side tanks, while for a coal bunker I used a 1lb Bread tin nailed to a bit of wood that I sat on with the tin between my legs holding the coal supply.

This system worked quite well but it did have its drawbacks mainly because of the limited water supply. Also if I forgot about the coal tin when I stood up, it tipped all over the track, while the water from the side tanks being warm did result in the occasional injector problem.

Commercial option

Some club members had made themselves water/coal wagons, most having adapted commercially available five-plank wagons that can be bought complete or as a kit. (Photo 1). I had a good look at these wagons but I wasn't too impressed with the robustness of their build – they undoubtedly do the job, but I went to the school of robust Victorian Engineering, and I've seen how easily such wagons can be damaged.

From time to time my club enjoys visits from other clubs – one of these clubs brought along a rake of wagons they had made, so they got the old once over and these were more like what I was looking for (Photo 2-3).

About this time the opportunity arose to purchase a part-made Fowler locomotive tender that I duly bought. I wanted this tender to use with the



ABOVE: The completed wagon coupled behind Stewart's Simplex o-6-oT 'Gremlin'.

PHOTO 1: A water/coal wagon made from a commercially available wagon.

PHOTO 2-3: This bespoke wagon looked suitably robust, as did its chassis.

All photos by the author

5-inch Gauge Horwich Crab 2-6-0 that I'm currently building, but with a fall-back of perhaps using it as a wagon for the Simplex, and once I got it home I realised that it would be unsuitable for the Crab.





This part-built tender comprised a near-complete chassis and wheels and all the brass for the tank. My plan was to just retain two of the three axles and to use the brass to make a cut-down tank for the wagon. This would provide me with practice at soldering up a tank – a skill that I would need for when I come to make the tender for the Crab.

Construction

The first task in building my wagon was to convert the tender chassis from three to two axles – this was easily achieved by simply removing the central wheel hanger and then adding

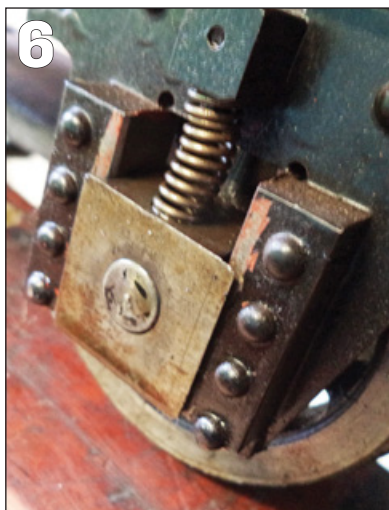


PHOTO 4:

Centre wheel hanger removed and stiffening stretchers added.

PHOTO 5:

Brass leaf spring recycled from Crab Stanier tender.

PHOTO 6:

Completed tender for use with Crab loco.

PHOTO 7:

Front draw bar on tender.

PHOTO 8:

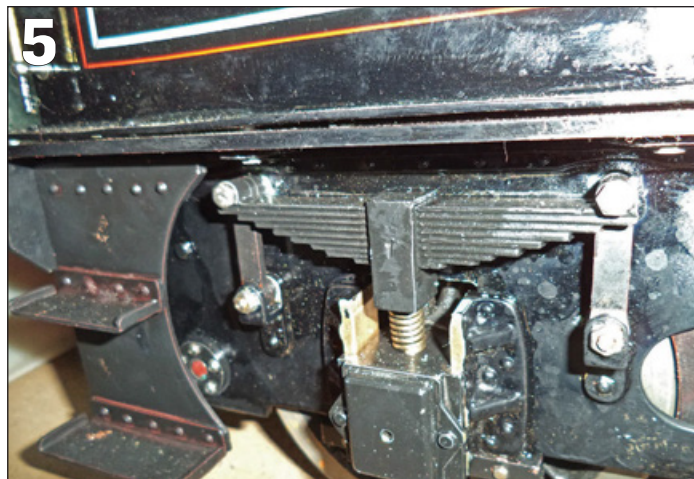
Coupling fitted to rear beam.

PHOTO 9:

Pan folder used to bend up body for tender.

PHOTO 10:

Hinged filling lid on top of tank.



a couple of stretchers to stiffen everything up (**Photo 4**).

Each axle was fitted with brass cast dummy leaf springs that are used with a compression spring, I removed these and set them aside for use with the Crab tender – waste not want not (**Photo 5**). The axle boxes were drilled to take a compression spring and an upper support made from some square mild steel with a spigot to support the spring screwed onto the frame from the back. This simple arrangement works very well (**Photo 6**).

For the front draw bar I used the slot already present in the front buffer beam of the tender and simply screwed a piece of box section to the back of the buffer beam, passing a draw pin through the draw bar (**Photo 7**). The rear coupling is again made from a piece of box section cut away to form a channel and with a couple of thickening bushes welded in place. This is screwed to the rear buffer beam and is used with a sprung shackle (**Photo 8**).

The brass sheet from the tender was cut to size and the bottom and top sheet edges given a 90-degree bend using my pan folder (**Photo 9**). A filling funnel was added to the top sheet – this was made from a short piece of brass tube with the edges flanged, and a hinged lid fitted (**Photo 10**).

I made a tactical mistake as I silver soldered this funnel to the sheet, and the heat required for the silver soldering caused the sheet to warp. No bashing with a hammer could completely remove the warping and I ended up just having to work round this. I should have used soft solder – you live and learn.

Big iron

The rest of the tank was soft soldered together, again I learnt a valuable lesson in that I needed a decent-sized soldering iron, I bought this from one of the internet sites (**Photo 11**). It took me two or three goes to finally get a leak-proof tank – my soldering wasn't that neat but at least it would be out of sight.

A tee-section was soldered into the base with a couple of outlet couplings (**Photo 12**), one outlet going to the bottom of the locomotive's bunker tank that would feed the axle pump, the other going to the injector that would feed cold water directly from the wagon's tank. This set-up links the side tanks, and the bunker tank with the wagon's tank giving the engine a considerable water supply.

The wagon sides, base and coal plate were made from MDF. I simply measured things up and went along to my local DIY store, in the middle of the week when they weren't too busy,





and asked the man in charge of the saw to cut the parts out to the required size – job done. To make the sides look as though they were made from planks I simply milled a series of grooves using a small ball-nosed cutter.

The box was glued and screwed together and the heads of the screws hidden under the corner angle irons, these and the side bracings were fixed in place with panel pins. One final addition was a couple of steel strips, added to the top inside edge of the wagon's sides. These were fitted to secure the firing irons that have magnets glued into their handles with epoxy adhesive. This keeps them secure, preventing them from dropping onto the track and saving me the embarrassment of having to stop to retrieve them (Photo 13).

Finally the inside was painted

PHOTO 11: 200W soldering iron had to be bought in to provide enough heat for build.

PHOTO 12: T- section water outlet and couplings

PHOTO 13: Magnets secure firing irons.

PHOTO 14: Completed wagon with personalised markings added.

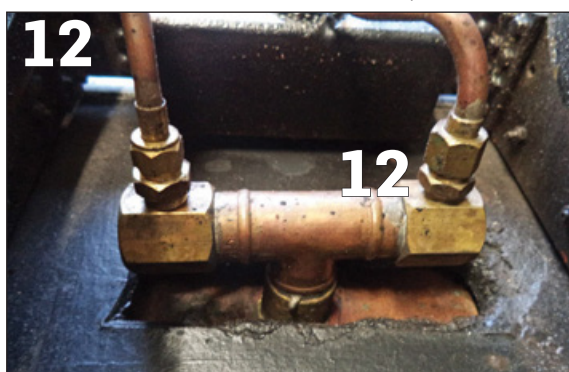
matt black and the outside matt brown, with the coal plate simply resting on top of the tank.

Bespoke identity

Lots of these vehicles, particularly coal wagons, had the name of the owner or colliery on their side so I decided to personalise my wagon. I served my apprenticeship with the Ministry of Defence at one of the ordnance factories where I spent all my working life. This factory's wartime designation was ROF 13, otherwise known as Radway Green on the border between Staffordshire and Cheshire. Hence the wagon carries the

WD lettering and government arrow and the designation ROF13, plus for an added bit of fun 'TANK' – this description was used in WW1 as a way of a disguising the early tanks, and the name stuck (Photo 14).

The wagon has been a great success – the cold water feed has helped keep those injector blues at bay. Uninterrupted running time has been considerably extended: during a summer lockdown visit to the track when I had it to myself with just my wife in attendance, with the loco valves notched back I did 18 laps without stopping, each lap being a third of a mile. **EIM**



Turrets, posts and clocks

Michael certainly made the most of the first Covid lockdown, completing a host of projects for both his workshop and his home.

BY MICHAEL MALLESON

Editor's note: In recent editions we asked readers to send in the results of the extended workshop time that the enforced Covid-19 lockdowns had provided them with. As can be seen in this feature Michael kept himself very busy indeed!

During the early days of the first lockdown in 2020, I embarked on a series of small projects in my workshop. The first of these was a tailstock turret for my Myford lathes.

I was reading a report on making pressure pipe union nuts in *Model Engineer* magazine in which Brian Baker described how he used a turret to make these nuts quickly without constant tool changing in a tailstock chuck. So having made these items the laborious way I decided to make the turret.

A search on the internet brought up drawings by Alex du Pre with a reference to his constructional article in *Model Engineer's Workshop* of April 1917. With the relevant back number obtained from www.magazineexchange.co.uk and print-outs of Alan's drawings, I purchased the backplate and turret discs blanks from M-Machine (www.m-machine-metals.co.uk) and worked my way through the build. It all went quite smoothly, and I am now waiting for a job that will enable me to use it!

My next project was a back toolpost for my Myford 254 lathe. I



PHOTO 1: Tailstock turret and its backplate.

PHOTO 2-3: Turret partly assembled, and complete.

PHOTO 4-7: Details of back toolpost, a useful lathe addition.

PHOTO 8: Movement of 8-day clock needed TLC.

PHOTO 9-10: Wall clock looks part alongside Grandpa's barometer and medicine cabinet.

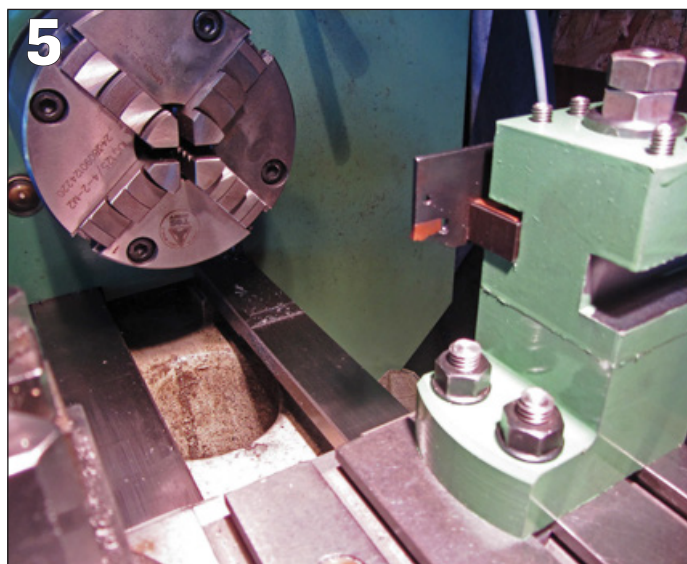
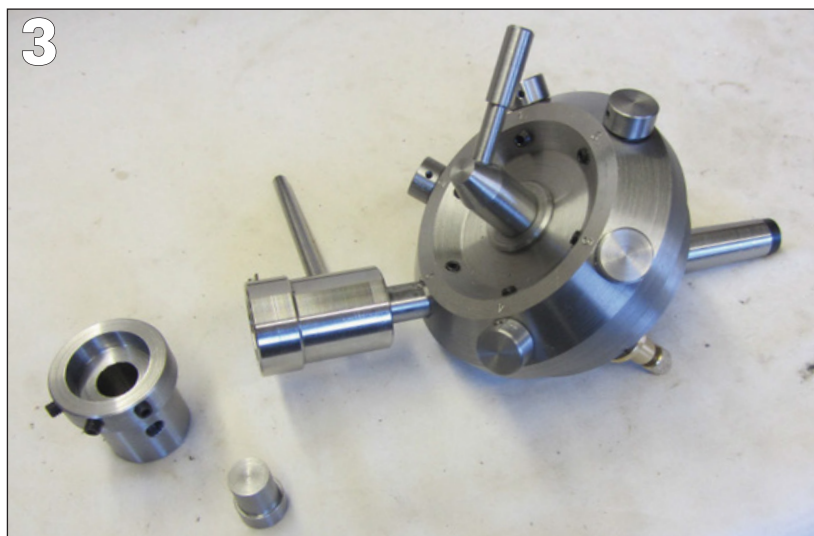
All photos by the author

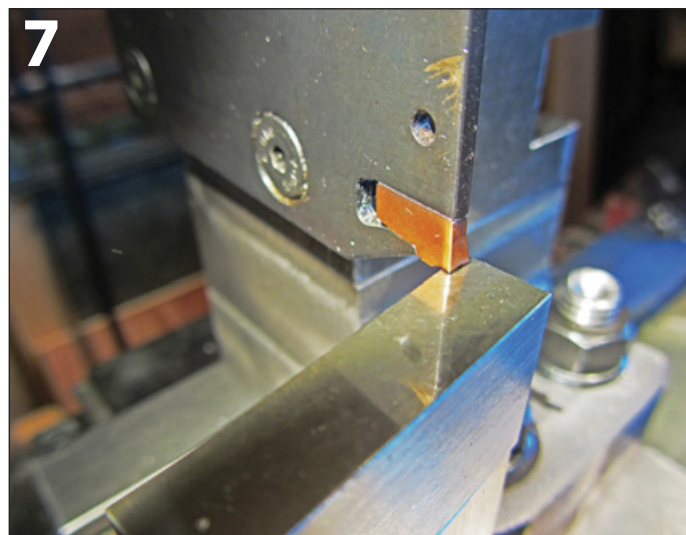
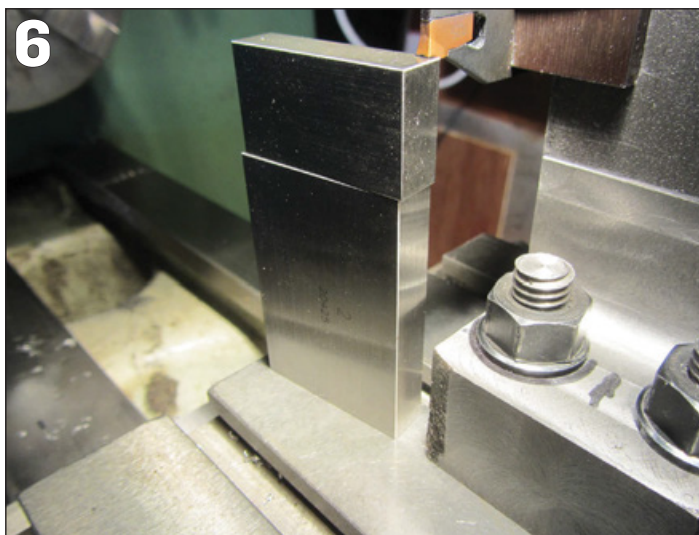
find that having to swap tools for parting off is a bit of a chore, and having found a long cross slide for my Myford ML7 I mounted an 'upside down' parting tool in an existing back toolpost, which has proved to be a great asset and time saver. I use a



Greenwood parting tool on the bigger lathe but that involves removing my quick-change toolpost for the traditional clamping type.

A quick search revealed a Hemingway kit (www.hemingwaykits.com) and so I went ahead with it. The





kit turned out to be a bit too good as it had provision for two tools with an accompanying 180-degree rotation and spring pin registration which I didn't need.

So the result is a simple arrangement for the Greenwood tool. I used slip gauges to achieve the correct upside down centre height off the cross slide thus avoiding messing about with packing strips, and the result can be seen in the photo.

Time to restore

Meanwhile I was also giving attention to the two American wall clocks that I own. One is an eight-day running type which runs very well, but the strike had become erratic. The wooden wheel carrying the weight cord had become worn and ridged through its centre due to the spindle being very thin, thus creating differential wear on the axial grain, leading to the ridges preventing smooth running.

To restore this involved removing the movement, taking off the back of the casing, (involving lots of very rusty nails), cutting through the existing spindle as it could not be pulled out, drilling out the wheel centre and fitting a phosphor bronze bush and the re-installing on a 1/8-inch outside diameter stainless steel axle.

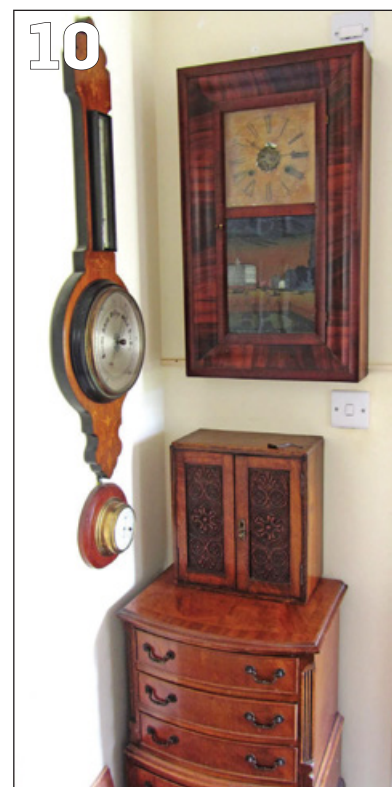
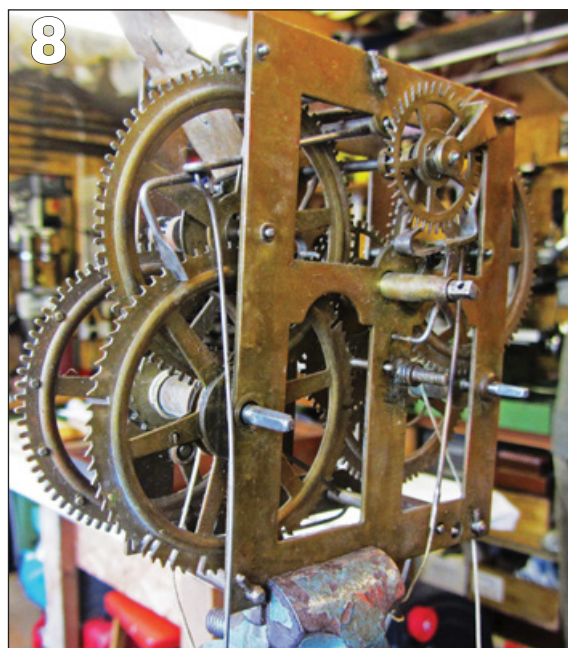
The whole casing of the clock was very dilapidated through age and, I suspect, storage in damp conditions, so a lot of work was needed to strengthen it to make it ready for re-installing the movement. It all runs well now, and it's nice to hear its mellow strike if I wake up in the small wee hours!

The other clock is a 30-hour running version that my late Grandmother gave me and which had been languishing unused in a box for more than 18 years.

This needed a good clean up but otherwise there was not much work to

do beyond hanging it on the wall and setting its timing. These clocks were manufactured by the thousand, and it's amazing how such unsophisticated engineering functions so well and for so long. **EIM**

Many thanks to Michael for sharing his projects with EIM readers. We are sure that many other readers have put in a great many hours in their workshops time during the recent trying times, so why not tell your fellow readers about *your* project and earn some funds to help the next one? Please be as detailed as you like in your description – EIM readers like to know exactly how something was done – and don't forget to include pictures! Send to the editorial address on page 3.



Coping with the backlash...

In the February issue Matthew Kenington writes about conventional and climb milling ('A first model engine', page 8). He notes that with backlash or a lack of machine rigidity the benefits of climb milling may not be realized.

I expect that Matthew's experience does not include that with machines with the amount of backlash that was common even in good machines not so long ago. For instance, my Myford Super 7 and mill have quite noticeable backlash in their feed screws but they turn out repeatable work consistently if the backlash is respected.

In conventional milling the backlash is closed up, so to say, while in climb milling it is open. That is another way of saying that in conventional milling the work is being pushed and in climb milling it is being pulled.

Thus climb milling with backlash can pull the work into the cutter with the resulting unpleasant, and possibly damaging, bang. If there is a belt drive the results will probably only scar the work but I do not care to speculate about the

result on a machine with a gear drive.

I had this happen when I first started while milling with the vertical slide mounted on my first Myford. Only the work and my ego were damaged and the vertical slide was turned about 50 degrees. I have mostly avoided climb milling since. If I have to use it I tighten my gib strips considerably and take light cuts.

John Bauer

Matthew replies: Thanks, John, for your comments. I'm glad that my article has prompted some useful feedback – as a beginner, it is always good to learn from the experience of others!

I have only ever used three milling machines so far in my 'career': an old (and massive!) Bridgeport and a large-ish hobbyist mill-drill, at Hereford SME, and my dad's manual/CNC machine (600mm in X, 300mm in Y and Z, so a decent size). All three machines have been sufficiently rigid, with their unused axes locked down (where relevant), that I haven't encountered the problem you describe.

I have no experience (yet) of milling on a lathe, as I have the luxury of a mill at my disposal and haven't needed to. I can imagine that a vertical slide is perhaps not as rigid as a mill-table and could even act as a bit of a lever, thus exacerbating any backlash issues?

Like you, I take light cuts – despite being an impatient teenager, I have learnt that making things quickly usually means making them twice. Overall it is usually quicker to take lighter, more careful, cuts and (hopefully) get it right first time.

Having said that, on my Stuart S50, I took too heavy a cut on the steam-chest and it flew round in (but not quite out of) the vice and the result wasn't pretty. Thanks again for your comments which will hopefully help others to avoid encountering the problems you did.

The Editor adds: Good to see experienced model engineers and novices in conversation, with the former imparting their experience to the latter in a friendly way. Definitely what our vocation should be about!



Petrol prototype

In the letters pages of the February 2021 edition of EIM Stuart Rothwell states he is looking for a suitable model of an early diesel/petrol shunting engine to build in 3½-inch gauge, preferably with outline drawings. Here is a starter suggestion for him – E. T. Westbury's 3½-inch model of an 1831 LMS shunting loco, using a Wallaby petrol engine and described in *Model Engineer* commencing 2nd January 2nd 1941, Volume 84 No 2069.

Patrick Cubbon

The Editor replies: Interesting prototype – do readers have any other suggestions, or even better a model they have built that they could describe in our pages?

Getting under the skin

Referring to the March 2021 issue, my letter concerning the 'skin effect' of electrical cables and Peter Kenington's follow-up feature, answering my question and others – it's good to see comprehensive articles on electricity in a model engineering magazine, and I've read Peter Kenington's latest offering with considerable interest.

Being an electrical engineer, I thought I knew something about electricity! Clearly the skin-effect of cables is not as straightforward as I thought.

Mike Hanscomb

Anyone recognise a Firefly?

I am hoping that the knowledgeable readers of EIM might be able to assist me. I purchased a 5-inch gauge Firefly locomotive (a GWR 2-6-2 *Prairie tank locomotive designed in model form* by Martin Evans – Ed) a few weeks ago in the condition visible in the photos.

The chassis runs on air and there is quite a bit that has been done. The boiler seems very well made but has no markings on it, so I think it was home made. There was also a box of bits and a set of drawings included in the sale.

I know it's a long shot but I wonder if anyone remembers this loco? I am trying to find out some of its history – who built it, where it came from and such like...

Any help would be appreciated. You can email me on steveterris@hotmail.co.uk

Steve Terris

The Editor replies: We have printed Steve's pictures at right – can anyone help him in

his quest, maybe recognise the handwriting on the drawing? It's nice to know the provenance of one's locomotives...

A matter of scale

I'm enjoying Harry Billmore's accounts. Each month of life in the workshop at the Fairbourne Railway. I must admit I never thought of this line being truly miniature, but it was really brought home to me when you started referring to its locomotives as '6-inch scale'.

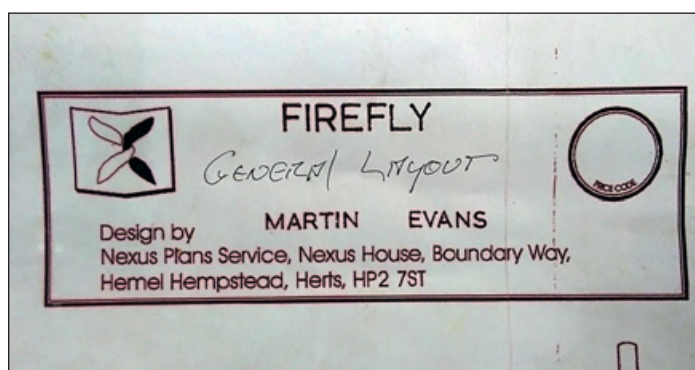
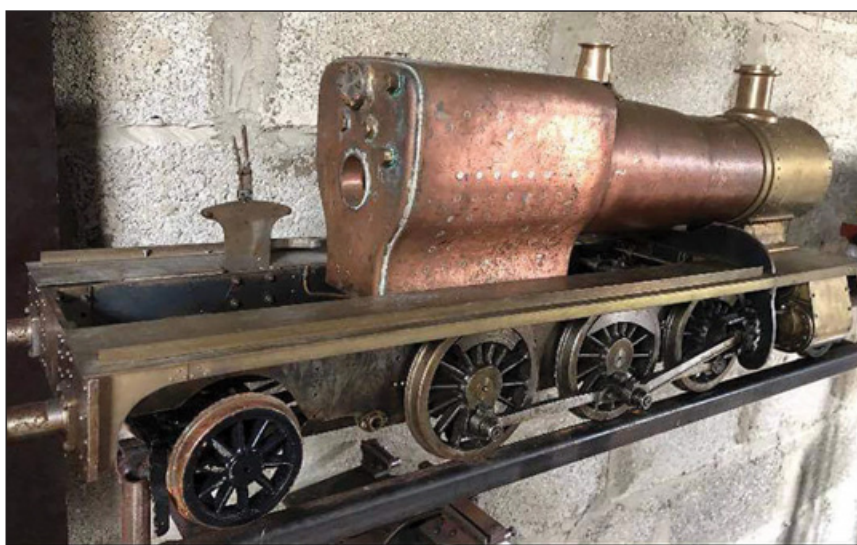
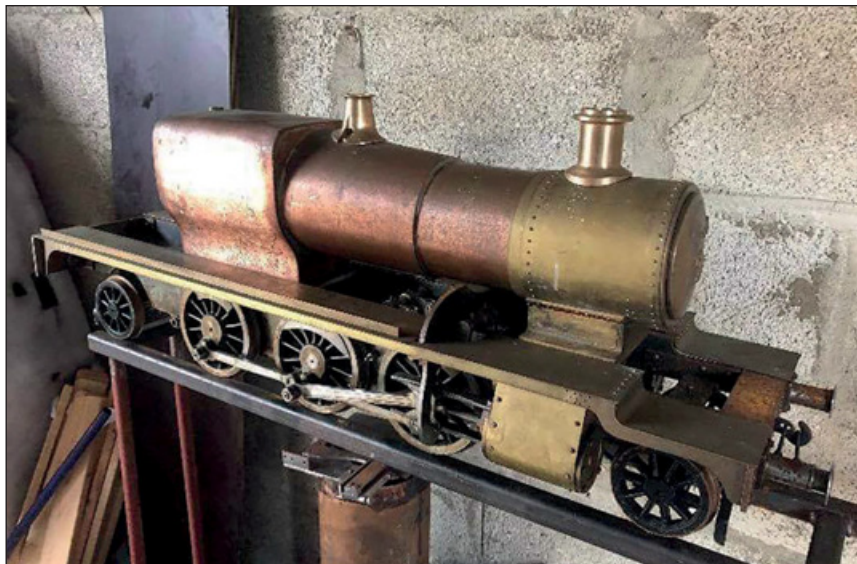
Of course they are – we don't tend to think of miniature railway engines in such terms, yet we will happily read features on 6-inch scale traction engines which of course are a major part of the miniature road loco scene. Has the Fairbourne never thought of having a miniature rally or perhaps a photo charter featuring 6-inch scale road engines?

Russell Snowden

The Editor replies: It's a great idea, next time I'm over there cluttering up their workshop I'll mention it!

Model engineering subject to raise?

Burning question requiring an answer? Pertinent point to make? Send your letters to the editor at 12 Maes Gwyn, Llanfair Caereinion, Powys, SY21 0BD or by email to andrew.charman@warnersgroup.co.uk Illustrations welcome but by no means mandatory



Peter Langridge

Peter Langridge died on Monday 25th April after a battle with illness caused by an accident some three years before. He was in his late '70s and had been a Guildford Model Engineering Society member for many years and latterly an honorary member.

The GMES was a big part of Peter's life and he was rightly proud of the work he put in, including designing bridges, mowing grass and creating the LittleLEC competition. After his accident his visits to the club meant a great deal to him although, sadly, he was no longer able to actively participate in the club. Likewise, being made an honorary member brought him some pleasure at a very difficult time.

The above words were provided by Peter's son, Roy, and in many ways sum up Peter. I first met him at the LittleLEC competition (*a fun efficiency competition for drivers of small steam locomotives, inspired by the well-established IMLEC competition – Ed*) at Swansea in 2012. During the course of the weekend his passion for small steam locomotives and their capabilities shone through, which was why of course he created the competition in the first place. The friendly and relaxed way each LittleLEC was run did him great credit.

An excellent model engineer himself, Peter's Rob Roy locomotive showed many improvements and enhancements which, with his canny driving, allowed him to win his own competition a time or two.

Peter exemplified the best traditions of the model engineer – he was always ready to help and support others, both in personal and engineering matters, and happy to share his skills and knowledge with others. I feel privileged to have known him, and he will be greatly missed.

The co-ordination of LittleLEC was picked up by Guildford Model Engineering Society after Peter had his accident a few years ago, and the Society will continue with that role. It is hoped that the Covid situation will have relaxed enough to enable LittleLEC to be held this year, hopefully at Birmingham SME on 12th and 13th June.

Bill Roebuck

The photo above, taken by Bill Edmondson, shows Peter Langridge (left) with Bill Roebuck at the 2013 LittleLEC event, held that year at the West Huntspill MES in Somerset.

Hereford club plans Sweet Pea Rally's August return

It gives us no end of pleasure to finally run a story on an event that is set to go ahead in 2021! Particularly when it is something as core to the model engineering movement as the Sweet Pea Rally.

Admittedly Hereford Society of Model Engineers, which is set to host this year's Rally for examples of the popular narrow-gauge tank loco at its extensive Broomy Hill track, has had to revise the dates.

Originally planned for the weekend of 5th-6th June, the Rally will now be held in August. The new dates were still to be set as EIM went to press but rest assured we will publish them as soon as we get them.

"We've moved the date to allow maximum time recovery from the current situation for everyone," rally organiser and regular EIM correspondent John Arrowsmith told us. "We cannot issue invitations to anyone until we are sure the current Covid restrictions will be lifted. This of course depends on Government guidelines



but as soon as we know what can and cannot be allowed, we will respond accordingly."

Once the dates are announced John will be able to provide prospective visitors with details of local accommodation and camping and caravanning facilities (no camping is allowed at the Broomy Hill site).

John can be contacted on email at pannier@hotmail.co.uk and by phone on 07484 872749 or 01432 265151.

Like just about everything else the Sweet Pea Rally did not happen last year and of course as these words are written in early March, there is still a deal of uncertainty around, but we are growing increasingly confident that by the summer the Sweet Pea Rally will be just one of a number of events going on, as the rally and show scene comes back to life.

Photo of the 2019 rally by John Arrowsmith



16mm show set to go ahead

The Association of 16mm Narrow Gauge Modellers was planning for its annual National Garden Railway Show to go ahead as EIM closed for press.

The show is held at the Peterborough Arena and had been delayed from its usual April date to Saturday 26th June. Meeting in late February, the Association board agreed that the Government's planned relaxation of restrictions by that date would allow the event to be held.

However the show will be very different to the familiar scenes from past events as shown in our picture above. All tickets will be pre-sold, and the show will be split into two sessions to control numbers – visitors will only be able to attend either the morning

session or afternoon session, not stay for the whole day.

There will strict controls on attendance levels to maintain social distancing. Tickets will first be offered to those who pre-purchased tickets either online or by paper for the cancelled 2020 event. Only after all these have been allocated will any remaining tickets be offered for sale on the Association website, this set to happen from 29th March.

"We are limiting numbers to 750 per session and we will be making best practice provision for hygiene, refreshments, sanitation and personal safety," organisers of the show stated.

More details are on the show website at www.nationalgardenrailwayshow.org.uk

Uncertainty over restrictions hits Garden rail show

Sadly it's not all good news as the Midlands Garden Rail Show, due to be held on 22nd-23rd May, has been cancelled for a second year.

Announcing the cancellation Meridienne Exhibitions, which organises the show popular with those working in the smaller model engineering scales, stated that while the Government had released its 'Road Map' for the restarting of events from 17th May, the limitations imposed on visitor numbers would make it very difficult to run the event.

"It is also only six days from the reopening of the country on the 17th May until the event on 22nd May and the risk of slippage on the Government timescales is quite possible meaning the event could not take place at all," the Meridienne statement added, pointing out that it is not possible to accurately predict if restrictions will have eased sufficiently to enable the organisers to plan and deliver this highly popular show safely without compromise.

"We are aware that our exhibitors and visitors will be as disappointed as we are with having to take this decision," said Chris Deith, Exhibition Director of Meridienne Exhibitions.

"But given the uncertain times it is simply not possible to go ahead with the show at this time. We look forward to returning on 19th & 20th March 2022."

Work to be done as hopes grow of reopenings

Whisper it quietly but the clubs could soon be back in action...

COMPILED BY ANDREW CHARMAN

It is a case of 'what a difference a month makes' as your editor begins to compile this month's club round-up – we may still be locked down as these words are written but the Government's clear signposting of a route back towards some sort of normality is creating much more optimism across the country.

Of course as we've already stated in the pages of this issue, none of this is confirmed yet, and we shouldn't get too excited. But while we are not yet seeing lists of meeting dates coming back into the EIM editorial office, and we are not likely to be planning to restore the *Club Diary* page for a couple of months at least, you can bet club programme secretaries are beginning to have some thoughts of future calendars.

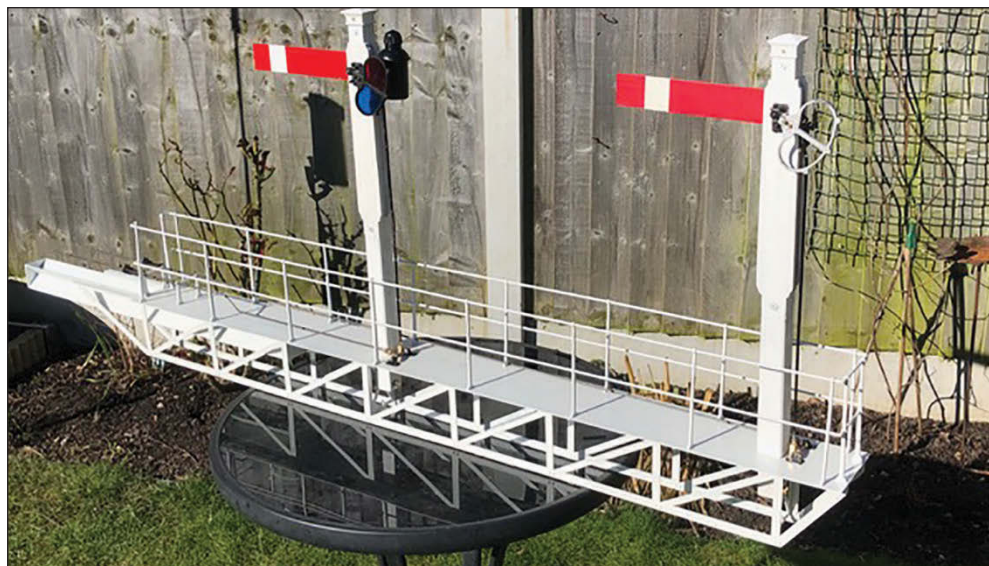
Track running days are likely to be among the first areas of the model engineering community to restart, simply because they are in the open air. Before they can restart there is much maintenance to be done.

Of course much of this work has in recent times not been possible at track sites due to lockdowns, but many are keeping busy at home on projects that will make their clubs better places to run at when we are all allowed to again.

Signalling progress

Typical of such work is the building of an impressive new signal gantry for the Ryedale SME's track at Gilling in North Yorkshire. The latest edition of the Ryedale newsletter features two pictures of the finished steelwork for the gantry, neatly crafted by member Mike Ahern, and on asking if we could run a picture in these pages the newsletter editor Walter Rinaldi-Butcher sent us an updated version complete with signals fitted! Once installed on the track it will certainly look the part.

The picture on the cover of the Ryedale newsletter shows what the editor describes as "A boring piece of track", but which he has used to highlight new expansion links fitted again by Mike Ahern – able to visit during lockdown as he lives close to the track. Walter adds that these links were made last year, "so that we were not so badly affected by the warm weather. Here's hoping we get some."



ABOVE: Mike Ahern's signal gantry built for the Ryedale club's Gilling track is an impressive addition to the facilities.

Some essential maintenance at club tracks goes on when it can of course and we admire the ingenuity of Rugby ME member Rolf Thomas, featured in the latest edition of the club's ever-packed newsletter.

Rolf is a regular member of the Rugby track gang and has not only created a neat little 7¼-inch gauge trolley on which to easily carry his tool kit around the site, but has also made a long-handled socket wrench which enables the tightness of the track-holding screws to be checked while standing up. As newsletter editor and club secretary Howard Brewer observes; "This speeds up the job and avoids a lot of backache!"

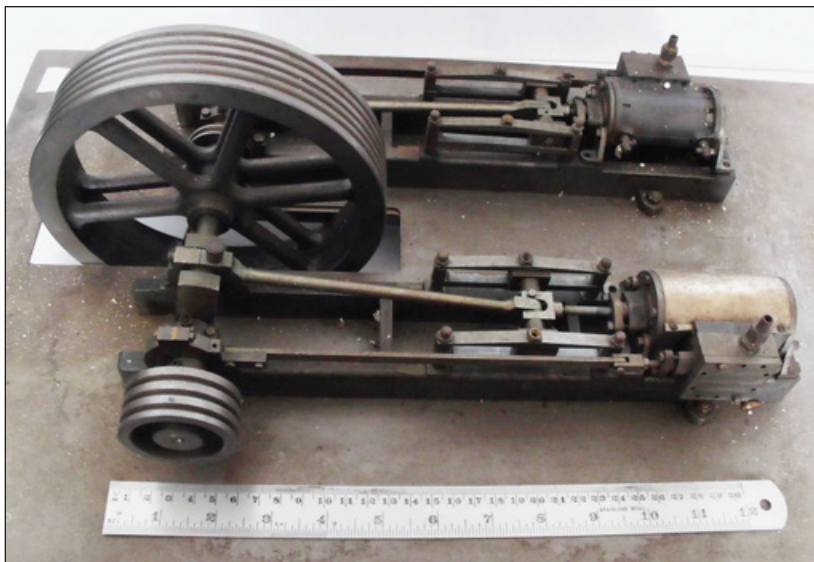
Planning the new normal

Howard also discusses the likely implications of the Government Road Map; "Your committee is busy trying to digest exactly what this will mean to our 2021 calendar of events. As we have not run for the public since October 2019 we will also need to tread cautiously to ensure our safety critical roles are all adequately covered. We would also wish to restrict numbers at the first few events to allow us to 'ease in gently' to any public event." Wise words and no doubt many other clubs are thinking along similar lines.

Writing in the latest edition of the Hereford SME's *Whistlestop* magazine editor Martin Burgess comments that the club has "once again entered the boating/paddling season," referring to

BELOW: Rugby ME track gang stalwart Rolf Thomas has come up with a couple of innovations to ease his work.





the latest flooding of the Broomy Hill track site which was so dramatically illustrated in these pages last month. On which note, John Arrowsmith has been in touch to tell us that contrary to the caption, he did not take the aerial picture. It was taken by Mike Goodman of Airo-Digital Hereford, who is a friend of the club.

New tracks

John also alerts us to a new 5-inch gauge railway, which is always good news. The **Wansford Miniature Railway** is being built as a ground-level line by the standard-gauge Nene Valley Railway at its Wansford station near Peterborough. It will carry visitors from the NVR's children's play area to the locomotive shed with its viewing gallery, and is planning to run its first season this year. Hopefully we will have some more details in a future edition of **EIM**.

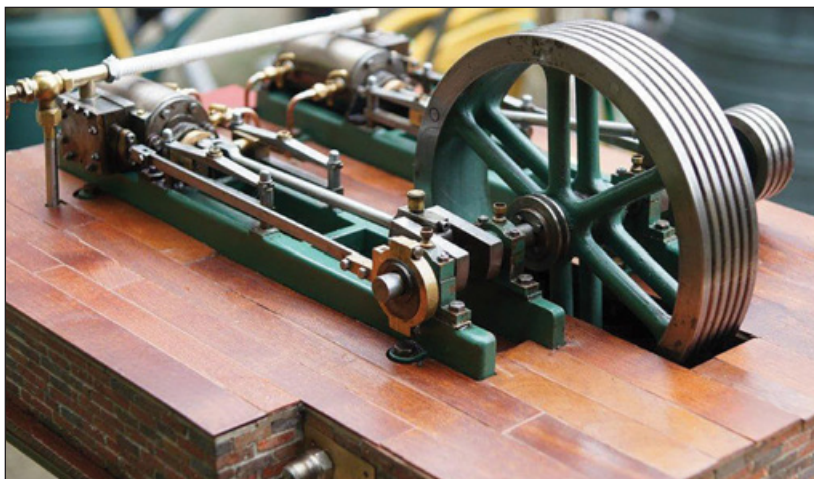
Returning to the Hereford newsletter, editor Martin also comments on the extensive technical content of the current edition. It's certainly an indication of a healthy club, varying from the building of an Alaskan main-line diesel and the smokebox for a London North Western D class, to a detailed treatise

on vacuum braking for miniature railways. Such brakes are a familiar subject to your editor, who many times has struggled to uncouple the pipes on the 2ft 6in gauge versions used on the Welshpool & Llanfair Light Railway!

The arrival of the perennially extensive *Journal* from the **SMEE** is always looked forward to and the latest edition contains much of interest. It's another to reflect the wide spread of engineering interest amongst its members, not least the front cover picture featuring the bridge of the Royal Yacht 'Britannia'!

Focusing on more traditional subjects, we were rather taken by the two images we are kindly permitted to reproduce on this page, before and after shots showing the restoration of a part-completed Stuart Turner Twin Victoria stationary engine.

The engine was donated to the SMEE as part of a collection but because it was in poor condition spent a long time resting against a wall in the Society's Marshall House HQ in London. Then member Owen Bird, an expert on Stuart engines, offered to complete and restore it, and we agree with the *Journal* editor – Owen has done an excellent job.



“Wood is not a homogenous material like a metal, it has a directional, and often inconsistent, grain which makes it more difficult to manipulate...”

Zooming on

We've mentioned before the growing use of the Zoom online conferencing tool for club meetings and SMEE chairman Alan Wragg reports that following a successful trial in December, a programme of talks for the coming year using Zoom has been approved by the committee.

“We had our first one of these on 9th January, and Adrian Garner gave us a splendid talk on The design and construction of a bracket clock with astronomical displays – this left many of us in awe at the superb workmanship that Adrian had put into his clock,” Alan writes. Interestingly he adds that even when restrictions are over and meetings resume in person at Marshall House, it is planned to also use Zoom to allow distantly-located members to be involved – an excellent move.

The newsletter of the **Worthing & District SME** always brings a smile to the editor's face, not least because always interspersed between the latest news and again an interesting selection of technical features are a host of more humorous items – features such as ‘Advice from a retired husband’ are virtually all very funny while not in the least suitable for reproduction in these pages!

The more traditional offerings in the latest Worthing issue include ‘Tales from the Lockdown (s)’ in which your editor noticed not one but two visions in brass in the form of a pair of Great Central 4-6-0 locomotives. Dave Brutnell is building both, apparently one for him and one for a friend – I wish I had the time to build one loco, but production lines? Very impressive Dave.

The latest edition of the **Bradford ME's** Monthly *Bulletin* includes a piece by member David Watts intriguingly titled ‘How to do woodwork.’ I must admit to having the odd shiver at this – I've never really been able to get on with wood, it seems a far more awkward material compared to good old metal. Why? I suspect it's for one of the two reasons David gives for many model engineers disliking wood – one is that working with it requires lots of hand tools, rather than the machine tools we use for metalwork.

The one I most identify with however? “Wood is not a homogenous material like a metal, it has a directional, and often inconsistent, grain which makes it more difficult to manipulate.” Yes, that's it in a nutshell – when I work with wood I always get the direction wrong and it splits just where I don't want it to...

Bradford is one of several clubs who have decided to offer their members subscription concessions

ABOVE AND LEFT:

The very impressive restoration job carried out by Owen Bird on a Stuart Turner Twin Victoria engine in the SMEE collection.

due to the lack of activity over the past year. Such moves are very laudable, because they help maintain membership at a time when many are struggling with finances. It can't be easy for treasurers to make such suggestions at clubs which for more than a year have not seen the considerable revenue that can come in from public running days...

The **Chingford ME** continues to impress with its newsletter, still publishing fortnightly to keep members in touch – despite such a frantic editorial schedule the latest edition runs to some 14 pages!

Classic wheels

A highlight is news of the discovery online of a Pathe news film from 1951 involving then Chingford member George Wills, who built from scratch a 3-inch scale motorcycle and sidcar with a 7.5cc engine and two-speed gearbox. The film shows him starting the model and running it, and can be viewed online at www.youtube.com/watch?v=iJA7lSx4E2M

The Chingford club also provides a lot of interest by delving back into its archives – reading about the wide range of activities in the 1950s can be quite fascinating, a different age of model engineering.

An intriguing picture adorns the cover of the latest *Leeds Lines*, journal of the **Leeds SME**. It's a rotary table, made by member Mark Batchelor basically by combining a 3½-inch diameter chuck with a 360-degree protractor – a clever design producing a useful budget device.

In his newsletter column Leeds chairman Jack Salter offers an equally intriguing view that the emergence from lockdown might prove a recruiting opportunity for model engineering societies. Jack argues that there is a feeling among many of his

"It will be equally popular and also an opportunity to recruit new members from the many people who will be looking for a new interest..."

ABOVE RIGHT:

Back in 1951 Chingford ME member George Wills made the news reels with his miniature motorcycle.

BELOW LEFT:

Interesting tool design on the cover of the latest Leeds newsletter.

BELOW: This tramcar was built from a carriage by 7¼-inch Gauge Society member Martin Redfearn.



'normal' friends (those without workshops) that there must be more to life than working and consuming and a general desire to do something more creative and worthwhile.

"I have no doubt that this is a common sentiment, a great opportunity for us to welcome new members into our ranks," Jack adds. "I understand that our Society built its first portable track in response to a request for societies and organisations to support 'Holiday at Home Weeks' during World War II. If we are allowed to once again operate our track at events later this year I have no doubt that it will be equally popular and also an opportunity to recruit new members from the many people who will be looking for a new interest." That's food for thought, let's hope he is right...

Editorial challenge

The winter edition of *7¼-inch Gauge News*, magazine of the **7¼-inch Gauge Society**, was delayed by the need to appoint a new editor and well done to Tim Morton Jones for producing an issue in very short order after assuming the editorial hot seat – this editor has great sympathies with Tim having experienced

something very similar in the past!

The magazine includes interesting features on the extension of the **City of Oxford SME's** Cutteslowe Park track and a new line in France, but we particularly liked 'Tantivy', the conversion of a four-seater carriage into an electric tramcar by member Martin Redfearn. As the picture below shows it's quite a conversion, including the addition of driving cabs on both ends of the carriage – definitely a different kind of vehicle to add interest at track days!

Finally a little more humour – the latest newsletter from the **Richmond Hill Live Steamers** in Ontario, Canada includes 'Cinders on the Footplate' offering rather different descriptions for machine tools. Space precludes us publishing them all but we liked "Belt sander: An electric sanding tool commonly used to convert minor touch-up jobs into major refinishing jobs," and especially "Drill press: A tall upright machine useful for suddenly snatching flat metal bar stock out of your hands so that it smacks you in the chest and flings your beer across the room, denting the freshly-painted project which you had carefully set in the corner where nothing could get to it..." **EIM**

Volume 23 Issue 1, February 2021
LeedsLines
Newsletter of The Leeds Society of Model and Experimental Engineers



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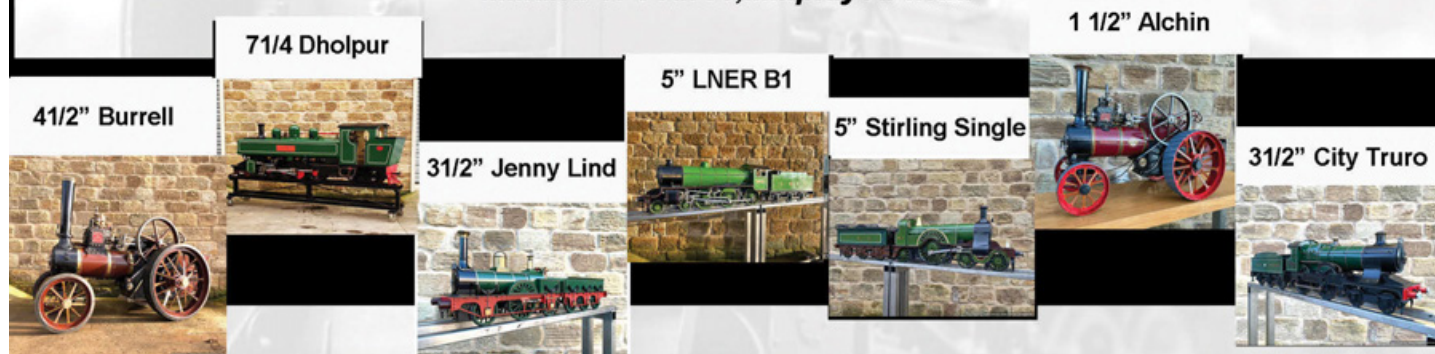
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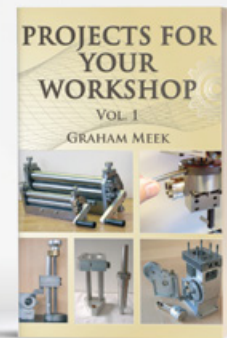
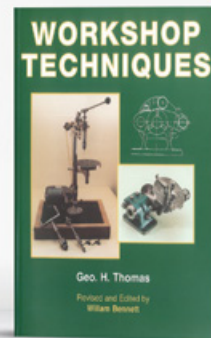
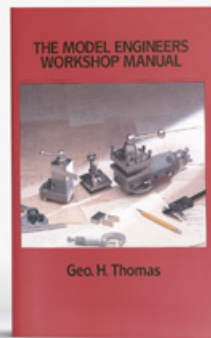
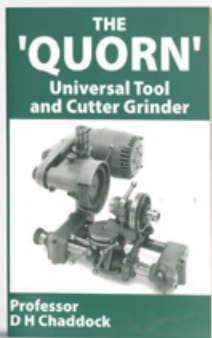
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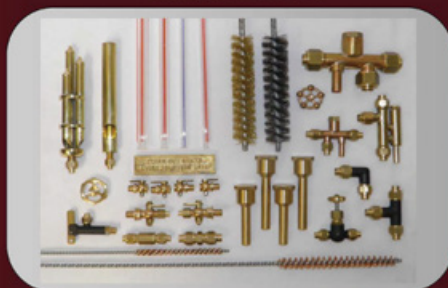
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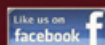


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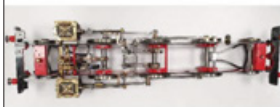
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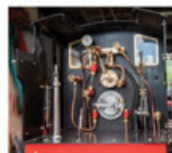


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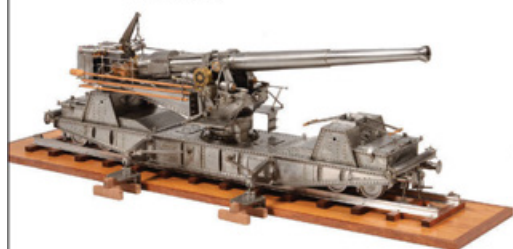
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Built to Martin Evans' "Roeder" design the engine is in "ex-works" condition, unsteamed from new. The engine has been built to a good standard throughout - fit and finish of the motionwork and valve gear is excellent. Silver soldered copper boiler is a commercially built job by Kingswood, supplied new in 2001. ref 9288 £24,500



5 INCH GAUGE LNER O1 2-8-0

An LNER O1 2-8-0, Thompson's wartime heavy freight locomotive, built to Martin Evans' 5 inch gauge "Nigel Gresley" design. An older engine, it runs well and steams freely; it's had recent hydraulic and steam tests in the workshop with certification issued for same. ref 9421 £6,500



5 INCH GAUGE STANIER 2-6-4

A particularly well built 5 inch gauge 2-6-4T, "inspired by" rather than a scale model of an LMS Stanier tank engine with robustly proportioned valve gear and generous bearing surfaces reminiscent of pre-war Greenly designs. A large, powerful and highly detailed engine, it runs very well and steams freely. ref 9361 £7,500



7 1/4 INCH GAUGE FELDBAHN 0-4-0

A 7 1/4 inch gauge Feldbahn 0-4-0, works number 1360 - delivered new in January 2014 it has had one private owner, an experienced model engineer. As usual with our own engines, we offer 12 months warranty, handbook and a starter kit including coal, oil and water treatment - exactly the same as you'd get with a new Feldbahn. ref 9406 £11,250



5 INCH GAUGE DBR V200

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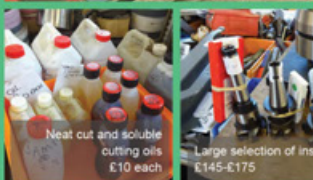
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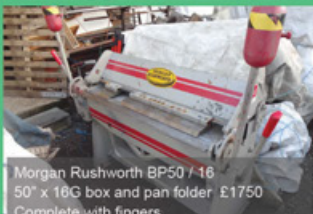
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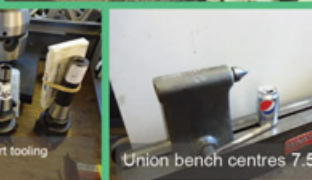
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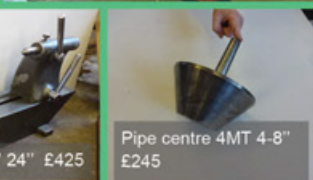
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