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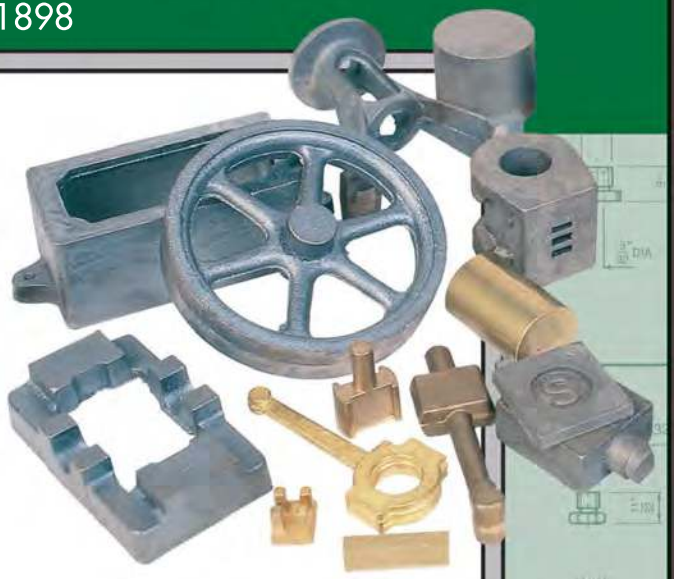

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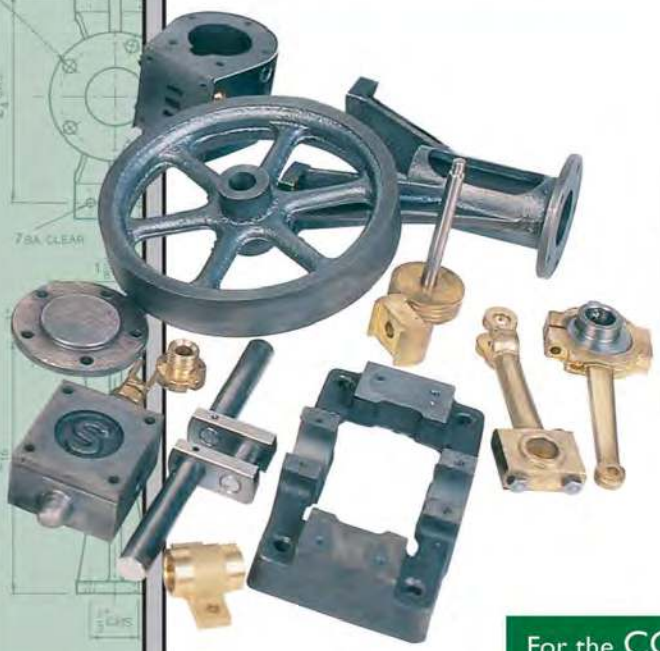

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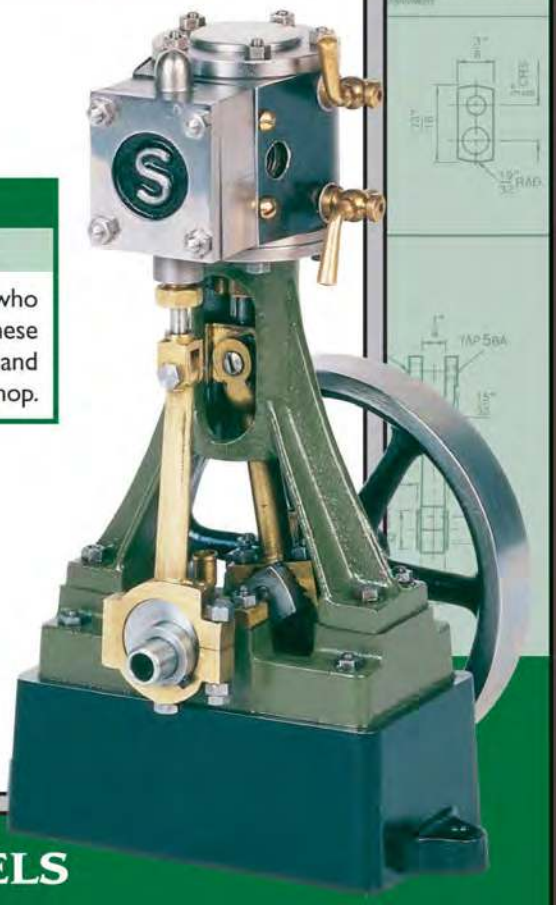

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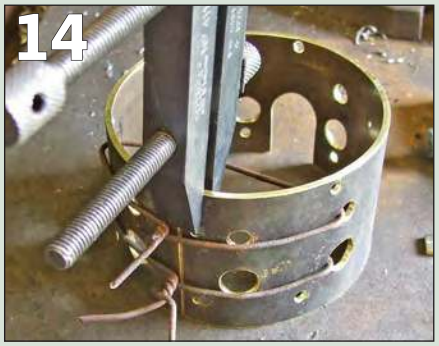

FRONT COVER

Regular correspondent Jan-Eric Nyström has the answer this month to those wanting a loco they can simply switch on and run – the build series begins on page 08. We also showcase a battle to achieve reliable gear cutting... *Photo: Jan-Eric Nyström*

EDITORIAL

A rich variety but ever more needed...

Welcome to EIM. and the conclusion of another volume, the 40th, of this long-established magazine and my first full one as Editor. Longer-term readers will immediately be relieved to hear that I have not repeated the rookie error that gained me a few brickbats this time last year – I have remembered to include the index in the final issue of this volume and not the first issue of the next, so those who bind their copies into individual volumes will not have their careful plans disrupted this time!

Compiling the index to 12 months' worth of EIM is certainly an interesting experience, as it brings home the rich variety that is available across our hobby and the wide-ranging subject matter of our articles over the past year – and we are only really scratching the surface of what is a very old and intensive vocation.

Take last month's May issue for example – we looked at everything from building a 'Star Wars' like CNC laser cutter to removing rust with electricity, designing a boiler for a large Fowler road engine and highlighting a track gauge many will be unaware of.

In the past year we've built two designs of stationary engine, made lots of useful workshop tools, got an insight to the operating technology of one of the UK's best-known landmarks, built unusual new items such as an electronic water gauge, gone inside the building of some lovely models including a glorious 5-inch gauge Midland loco, described the building of a very unusual vertical water-tube boiler and much more, while continuing to bring you the latest from the shows and as much advice for newcomers as we can squeeze into each issue.

All this is great and fulfils the basic mantra your editor sets for each edition, 'helping readers to build things'. But we couldn't do it without you, and principally those of you who have built things writing them up and sending them in for other readers to enjoy reading about and learning from. As ever, the cupboard is perennially emptied as we try to use as much as possible as soon as possible. So if you have ever considered writing up your project for EIM, now is the time! We pay for features, and we are interested in anything, no matter how unusual – so long as it fulfils that mantra... Enjoy your EIM, and hear from you soon?

Andrew Charman – Editor

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A diesel-outline battery loco

Steam enthusiast Jan-Eric sees the benefit of building an easy-to-run battery locomotive, especially as his previous example became very popular with fellow enthusiasts...

BY **JAN-ERIC NYSTRÖM** Part One of a short series

Even though I am an avid steam fan, I don't disparage electric, gasoline or other ways of powering a miniature locomotive – the important thing is that we all have lots and lots of fun, both building and operating our engines!

Readers may know that some time ago I built 'Quickie' – a battery-powered, small 0-4-0 switcher (*described in the September to November 2016 issues of* **EIM**), mainly for the enjoyment of relatives' and neighbours' children – even though adults like to run it too! It was very simply constructed, using a windshield-wiper motor from a bus, and it took only 48 workshop hours to build (not counting the later modifications).

Nevertheless, Quickie is the one loco that has run the most hours (and miles) on my home track – sometimes children run it for hours on end. However, it doesn't really look like much; my own definition of it is 'a plywood box on wheels'. Thus, I decided to build a somewhat better-looking, more powerful battery-powered engine.

Browsing through my library of locomotive books, I finally chose an example of perhaps the most typical and ubiquitous of all the diesel engines running on our Finnish railroads, the Dv12 B-B type. It is a medium-weight diesel-hydraulic locomotive, and as all the main lines of the Finnish railway network have been electrified, the class is nowadays designated mostly to working on un-electrified, less frequently used side lines. Occasionally these locos still pull cargo trains on main lines and they have also been put in service as shunters, replacing older classes as they were retired.

ABOVE: The full-size Dv12 prototype. Photo by *Mikko J. Putkonen*

PHOTO 1: Jan-Eric's model in 7¼-inch gauge, with its driving trolley behind.

All photos and drawings in this series by the author, except where noted.

A total of 192 of these locos were built by Lokomo and Valmet between 1963 and 1984. Even Wikipedia has an article about them, at http://en.wikipedia.org/wiki/Dv12 – so it must be a very popular type, indeed!

By international standards, this is a small engine, 'only' 14 meters long, weighing 62 tons – but that would suit me eminently, considering my small workshop, my small trailer, the small curve radius on my home track, and so on... The one-eighth scale, 7¼-inch gauge model would nevertheless be 1.75 meters over buffers, so this would be the largest chunk of loco that I'd ever built!

Starting the job

What's the best way of starting to build a loco? Personally, I always begin with the wheels. In this case, I didn't need any castings, since the prototype has solid wheels.

My friendly metal supplier sawed nine almost 25mm thick slices from 140mm round steel bar (**Photo 2**) – nine, since I wanted to have one extra, in case I goofed... Usually, if I have a spare, everything proceeds nicely, but if not – well, you know Murphy's law!

I'll explain some of my machining procedures for those who want to start off building a locomotive without any castings at all. The first job is of course to mark the centre on each of the slices; easy to do with a 'centre ruler' if you happen to have one, or even with just a pair of compasses or measuring calipers.

PHOTO 2: Nine slices (eight and one spare) will become wheels in a couple of evenings.

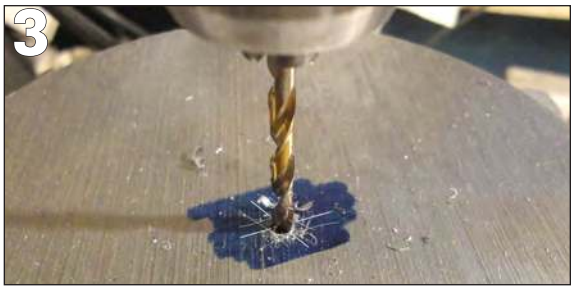


PHOTO 3: Starting with small drill, slices drilled through centre, as marked. Final drill size was 10mm.

PHOTO 4: Centreing wheel blank with aid of a dial indicator with magnetic base.

PHOTO 5: Turning back side and diameter of the flange to size.

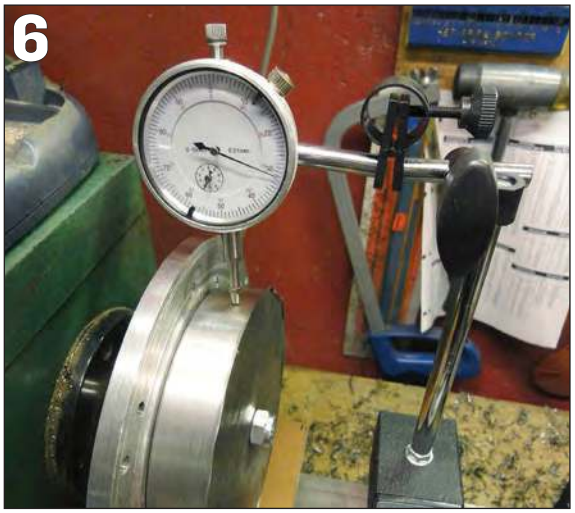


PHOTO 6: Re-centreing wheel after flipping it around - this must be done carefully, with high precision.

Measure the diameter, then halve that, set compasses or calipers accordingly, and scratch a line over the centre area from each of four positions, approximately 90 degrees apart on the circumference. The lines may not coincide at the centre – if they do, fine, but if they don't, they will have marked a little square, the centre of which is exactly at the centre of the wheel blank. Scribe a cross and make a punch mark there, and you're ready to drill!

I started with a small, 3mm drill, and stepped up a couple of times until the hole was 10mm in diameter (**Photo 3**). This ensured that the drill didn't wander, and enlarging the hole in small steps also didn't overload my little tabletop pillar drill.

Then, I was ready for the lathe work. Mounting my home-made aluminium face plate on the mandrel, and the blank on it with the aid of a foot-long piece of M10 threaded bar, a big washer on the left end of the mandrel, and a couple of locknuts, I could centre the almost 3-kilogram chunk of steel with the aid of a dial indicator with a magnetic base – an absolutely necessary item of equipment for any precision lathe work!

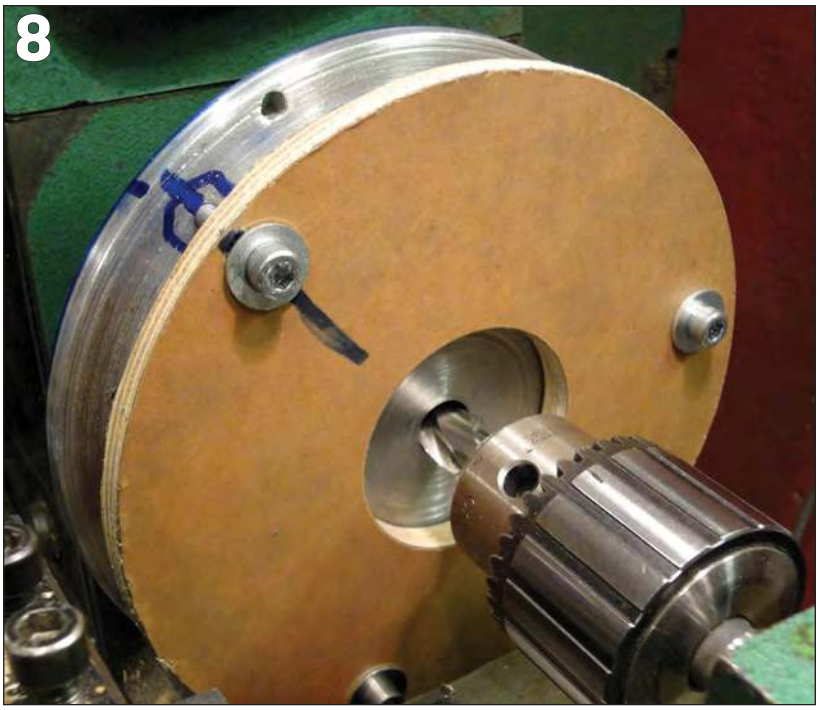
Note the piece of plywood under the wheel blank in **Photo 4** – a safety measure, in case I dropped the blank onto the lathe ways... Centring the blank took only a minute or two – revolving the mandrel by hand, I could check the indicator reading, and try to halve the back-and-forth deflection by nudging the blank with a rubber hammer (the locknuts were only slightly tightened at this stage).

After a few iterations, I got the piece centred as well as I could, noticing that it was a little bit out of round – about 1.5mm. This was of no importance, since I would turn down the diameter by about 5mm. Most important at this point was to get the blank well enough centred and balanced, so that it would not cause shaking when the lathe was running.

That done, I started turning the outer diameter of the blank to the size of the flange, but not the wheel tread. You can see what will become the back of the wheel in **Photo 5**. I also 'cleaned up' the sawn back surface by turning off a mm or so, as close to the centre as the nut would allow.

Note that you can dispense with the nut altogether, if you make a threaded hole in the wheel blank. Then you can turn the surface all the way in one go. I completed the turning of the back side by turning the outer edge of the blank to the back-side's rounded profile of the flange, then I removed and turned around the blank, and re-centred it (**Photo 6**).

This time I did it very carefully, again using my indicator – in fact, to a tolerance of about one hundredth of a ▶



mm. Light blows with the rubber mallet allowed me to move the blank in very tiny increments. Finally, the needle of the indicator hardly wiggled at all, and I could tighten the nut – and then do a double-check that nothing had moved, the needle still just barely oscillating between two 1/100mm marks.

Now, I could start turning the font of the wheel, beginning with the tread diameter, **Photo 7**. At first, I used the longitudinal feed, moving the carriage with the hand-wheel, but to finish the tread, I had set the top slide of the lathe to an angle of 2.5 degrees, so I could get the standard conical shape. This I did very carefully, so as not to cut into the flange, which I had shaped to the right profile, using a file for the very final cuts.

Finally, I turned the front side, with a depression between rim and hub, just as in the full-size originals. At this stage, the wheels were finished to their final thickness; 19mm, i.e. ¾-inch as per the IBLS 'standards'.

Now, I had a slight problem: Since the nut had obstructed the very centre of the wheel while holding it to the face plate, I needed a way of turning off the 'spigot' and finishing the centre hole – without moving the blank! (if you have threaded the hole in the blank, you of course have no spigots to remove...).

For this, I used a round piece of plywood that I had prepared ahead of time, as seen in **Photo 8** – attaching it to the face plate with three sturdy M6 bolts, I could tighten it so that it held the wheel securely, then remove the threaded bar and continue machining through the hole in the plywood; first turning off the spigot, then enlarging the hole in the wheel to the correct size. This must be done with an end mill, not a drill!

Since the centre hole is drilled only approximately in the centre, it may not run true. A drill will follow the original hole, while an end mill will cut in truly the centre. The hole was turned to its exact, final size with a lathe tool, **Photo 9**. You can also use a reamer, if you happen to have one of the correct size.

Note here that the lathe motor shouldn't be used for reaming; revolve the mandrel by hand, and do it in one go – no back-and-forth revolving, that may damage the reamer!

Having turned all eight wheels

PHOTO 7: Turning wheel tread and outside edge of flange. Tread cut to conical shape, top slide set to 2.5 degrees.

PHOTO 8: Tightening wheel to face plate with circle of plywood enables the axle hole to be enlarged and centred.

PHOTO 9: Lathe tool used for final cut, turning axle hole to exact size.

PHOTO 10: Four wheels turned to size. Depressions in front are turned quite roughly, to facilitate adhesion of paint to the metal surface.

PHOTO 11: Marks made with felt pen scribed to indicate how far to turn down diameter along axle.

(four of them shown in **Photo 10**) certainly gave me a feeling of accomplishment already at this stage. There would be a lot more to do before the loco was completed, however!

The axles

Next, I turned the four axles. Using 20mm round steel stock, I cut four pieces to dimension, calculating the necessary length thus: wheel gauge (7.25 inch) plus two times the wheel thickness (2 x 0.75-inch), plus spaces between wheels and bearings (2 x 0.25-inch) plus the thickness of the bearings (2 x 0.35-inch), plus a little extra (2 x 0.5-inch) for the bearing retaining nuts. Thus, the total length of a finished axle is 10.95 inches or just over 278mm.

As you can see, sometimes I use imperial measurements, even though all my tools and measuring equipment are metric! In this article series, I will use a mish-mash of both in order to please (or maybe fluster) everyone...

Cleaning up the ends of the rough, somewhat rusty steel, and centre-drilling them, I then marked and scribed the exact length of each 'step' on the axle, **Photo 11**.

Using a micrometer to check the progress, I turned the diameter of the axle to 0.1mm smaller than the hole in the wheel – this is the correct clearance for the retaining compound I used (Loctite 603), which will hold the wheels in place. In addition, there will be nuts on the outermost ends on the axles, securing the bearings. Two tentatively assembled axles are shown in **Photo 12**, still without their retaining nuts.

Before the wheels could be secured to the axles, there were a few more things to do. If you look closely at **Photo 13**, you can see that there are chain sprockets on all of the axles, two large gears attached to the wheels of two axles, and a brake disc on one axle. The sprockets are ordinary bicycle spare parts, as are the chains, which will provide drive to all axles.

PHOTO 12: A pair of tentatively assembled axles – parts will later be separated for addition of sprockets and gears.

PHOTO 13: Chains connect two axles in each bogie, one motor per bogie will power all wheels. Note large gears on inside of two of the wheels.

Thus, only two motors are used, one in each bogie.

The motors – a little over one-half horsepower each – have a small spur gear that meshes with the large gear attached to the back of the driving wheel with three M6 bolts. This gives a reduction ratio of 1:4.75. Nominal speed of the motors is 2,300rpm, so at full speed, the wheels will turn at 480rpm. The wheel circumference is 408mm, so the maximum speed of the loco will be about 12km/h.

The chain sprockets are welded to the axle, as is the brake disc. Since I could not find any locally, I ordered the motors from the UK, where there are several companies specializing in electric scooter parts. The delivery cost to Finland was reasonable – no Finnish VAT or duty was levied. We have yet to see what a possible Brexit will mean here...

The Superstructure

When you model a certain prototype, it is important to get your model to look right. I don't intend to copy every single detail, every bolt head or rivet – for me, it's enough if the loco looks 'right' from, say, 6ft away. So I decided to build the cab and the hood mainly from waterproof marine plywood, with only a few parts in metal.

Photo 14 shows the basic construction of the cab - front and back ends of ⅜-inch plywood, sides of somewhat thinner ¼-inch plywood. The corners are reinforced with ⅝-inch strips of square wood. This enabled me to round the corners of the cab, just like on the full size loco.

In **Photo 15**, both engine hoods are tentatively in place – take no notice of the extra wheels under the base, I just happened to have the frame of Quickie on the stand while taking the photo.

I rounded the corners of both the cab and the hoods with an electric planer; making just three passes (at approximately 20, 45 and 70-degree angles) leaving an easy job to sand the corners round and smooth with an electric sander.

In **Photo 16** you can see how I ▶

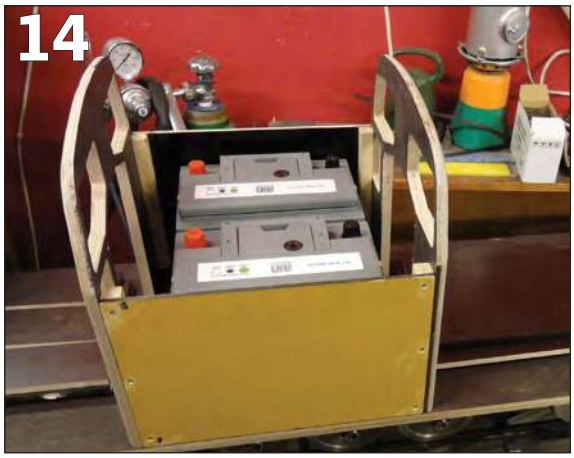


PHOTO 14: Thicker plywood forms front and rear walls of cab, thus corners can be rounded using an electric planer.

PHOTO 15: After a few cuts with the planer, all corners can be sanded smooth and round with electric sander – 'extra' wheels belong to my 0-4-0 'Quickie' loco.

PHOTO 16: Cab windows cut from steel plate and sunk into plywood. Note five strips of wood that will carry roof.

PHOTO 17: Tin roof made of galvanized steel plate, secured to wooden strips.

PHOTO 18: Polyester filler covers all screw heads and gaps between steel and plywood. Electric sander helped to produce smooth surface.

PHOTO 19: Cab after painting with epoxy primer. Acrylic windows still to be installed.

mounted the steel window 'mask plate', by first routing out a cut as deep as the plate, then attaching the 3mm steel plate with a few countersunk screws, and smoothing everything out with an epoxy filler (this one is green and contains glass fibres, so it won't crack easily).

The five wooden strips on top of the cab enabled me to attach a tin roof, cut from galvanized tin roof steel – what else? In Photo 17 this has been done. A bit more filler was used over the screw heads, which were countersunk by simply punching the plate with a sturdy centre punch. Again, the electric sander made a quick job of smoothing everything out, Photo 18.

Do wear a face mask when sanding any plastic materials – the dust can be toxic, and is certainly irritating! Note by the way that there are two glued-on aluminium hatch covers on the cab side, following the prototype. A coat of two-component epoxy primer paint, Photo 19, provides a good base for the final paint work. EIM

NEXT MONTH: "My loco would look like a very expensive, famous British car..." Jan-Eric adds the detail to his body shell.

A nut and washer holder

John continues his series of tips for workshop novices with this useful little tool.

BY **JOHN SMITH**

Why is it so much quicker to disassemble a model than it is to assemble it? Because, when we assemble a model we spend a lot of time on our hands and knees, looking for nuts and washers which we have dropped.

I find it particularly difficult to assemble pieces of running board to hanging bars and bracketry. A nut and washer has to be held in one hand precisely under the bolt hole, while the other hand reaches up to hold and twist a hex bolt or rivet-bolt to engage with the nut.

For a long time, I struggled along using masking tape – wrapped sticky side out around a suitable piece of steel or wood – to hold the nuts and washers. Eventually, I made this simple tool to solve the problem once and for all.

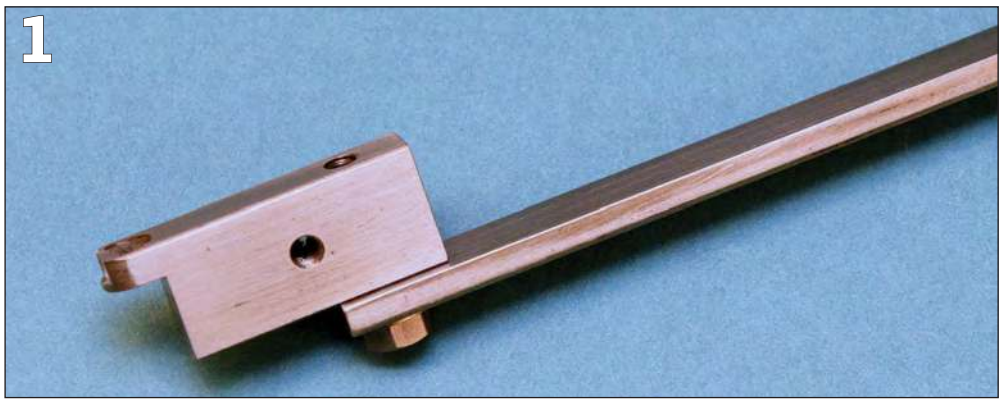
Firstly, a word about BA fasteners. If, like me, you still use BA screws, nuts and washers, you will know that it has been increasingly difficult to find these items, one-size-smaller nuts smaller than 7BA being a particular challenge. EKP Supplies carries a wonderful range of really nicely-machined one-size-smaller BA steel screws and nuts – now including 8BA nuts! ModelFixings carries a similarly extensive range of fixings, my favourite being metric 304/A2 stainless steel washers, which work very well with BA screws as follows:

BA Thread	Metric Washer Size
10BA	M1.6
8BA	M2
7BA	M2.5
6BA	M2.5 (tight) or M3
5BA	M3
4BA	M3.5
3BA	M4
2BA	M5

The 8BA nut and washer holder is shown in **Photo 1**. The bright mild steel handle can be mounted on the base or side of the holder to suit the job in hand.

The 'business end' of the holder is shown in **Photos 2** and **3**. It's a simple milling job using slot drills. The tool can also be used to offer up a hex bolt and washer to the underside of a piece of running board.

Much time can be saved! EIM



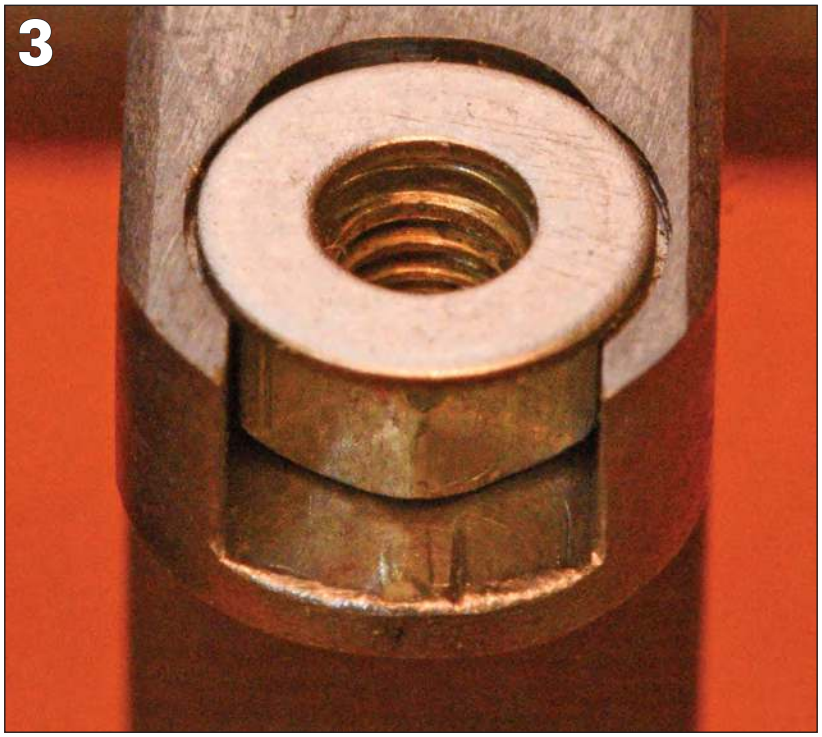


PHOTO 1: The completed nut and washer holder – a very useful tool.

PHOTOS 2 & 3: The business end of the holder.

All photos by John Smith

NEXT TIME: Effective ways to anneal brass.

Gas-fired vertical boiler for the EIM Steam Plant

Martin assembles the firebox shell of the EIM Steam Plant project.

BY **MARTIN GEARING** – Part nine of a series

Take the wired firebox shell and rest it on a flat surface. Slip the butt strap behind the joint and after checking that it is resting on the flat surface, position it so that the filed central mark lines up with the joint. Clamp the butt strap to the shell at its top end checking that the clamp jaw doesn't go past the two 1.6mm diameter drilled holes (**Photo B73**).

Take the assembly off the flat surface and hold the open ends in a vice (soft jaws fitted). Fit a second clamp to the free end checking that the filed central mark lines up with the joint and that the clamp jaw doesn't go past the two 1.6mm diameter drilled holes (**Photo B74**).

Drill through the four 1.6mm diameter blank holes into the butt strap. Scratch an identifying mark on the butt strap before removing the binding wire and dismantling. Deburr both sides of the butt strap and pickle that and the firebox for 10-15 minutes. Rinse in clean water and dry off.

Lightly centre punch the butt strap in eight places, 3mm either side of the drilled holes in two lines along the length. The deformation in the surface created will prevent the two surfaces from making full contact, creating a capillary gap for the silver solder.

Joining the firebox

Coat the inside face of the joint and the centred punch side of the butt strap thinly with flux before inserting four copper rivets through the drilled holes. Clip any excess length off so that about 2mm protrudes and, resting on a suitable length of tube, lightly peen over the rivets, checking to keep the ends tightly together so there is no gap (**Photo B75**).

Apply flux along the length of the butt strap before laying two 30mm lengths of 1.5mm diameter silver solder MT (38 per cent) on each side of the butt strap. Position the firebox between two fire-resistant blocks set about 40mm apart (**Photo B76**).

Apply the heat from below until the solder flows – easing the molten metal along the length of the joint with your scratch stick if necessary. Allow to cool, pickle for 10-15 minutes, rinse in clean water and dry.

Place the firebox with the flush end of the butt strap down on a flat surface, and position one of the boiler support rectangles so that the end rests on the flat surface and the scribed line is visible through the two 1.6mm holes. Hold with a clamp located with the jaw clear of the

PHOTO B73
First clamp fitted to the firebox butt strap.

PHOTO B74
Both ends of the butt strap now clamped.

PHOTO B75
Butt strap riveted to firebox shell.

All photos by Martin Gearing

"I just kept making hacksaw cuts as close to one another as possible between the marks and crumbled the remaining wood away..."

PHOTO B76 Setup ready for silver soldering the firebox together.

PHOTO B77 Cleaning up the outer surface of the firebox shell.

PHOTO B78 Setting up to drill the hole for lighting the burner – a ground point, in this case of a tap, is being used as a centre finder.

PHOTO B79 Drilling the lighting hole.

1.6mm hole. Remove from the flat surface and fit the second clamp.

Hold in the vice and drill two 1.6mm holes through the firebox blank into the support. Scratch an identifying mark so that you can return in the same position. Dismantle and deburr the holes on both sides, centre punch in a line 3mm either side of the drilled hole in four places. Pickle for 10-15 mins, rinse in clean water and dry.

Coat the inside face of the joint and the centre-punched surface of the rectangle with flux before lightly riveting the support rectangle onto the firebox with two copper rivets. Silver solder, but this time using two 15mm lengths of 1.5mm diameter silver solder (38 per cent) on each side. Pickle, rinse and dry. Repeat the process for the second support bracket.

Modifying the Former

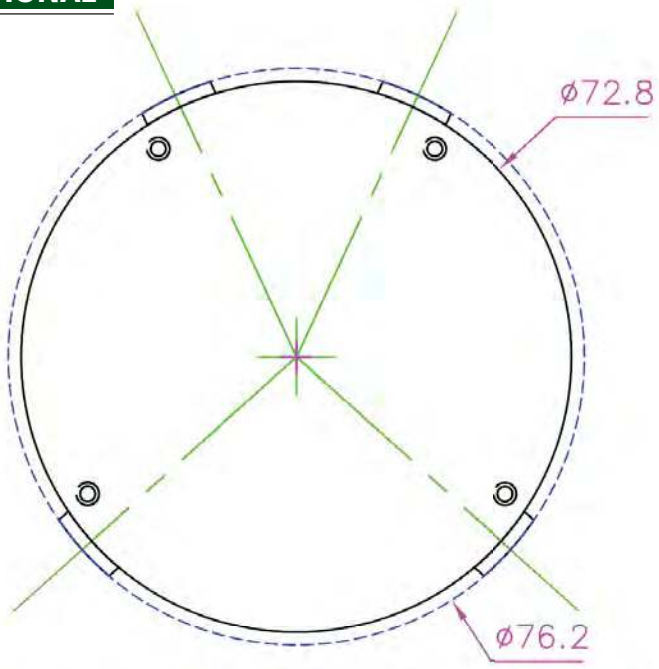
Refer Drawing B15A – 2nd stage (published EIM May 2019).

The protruding rivets should now be filed flush and the firebox formed truly round. This is easily done if the former made earlier is modified by turning a 30-degree x 2mm chamfer on one end, and cutting three 5mm deep slots. The position of these slots can be marked out by placing the firebox on top of the former and marking with a pencil 3mm either side of the three rectangles.

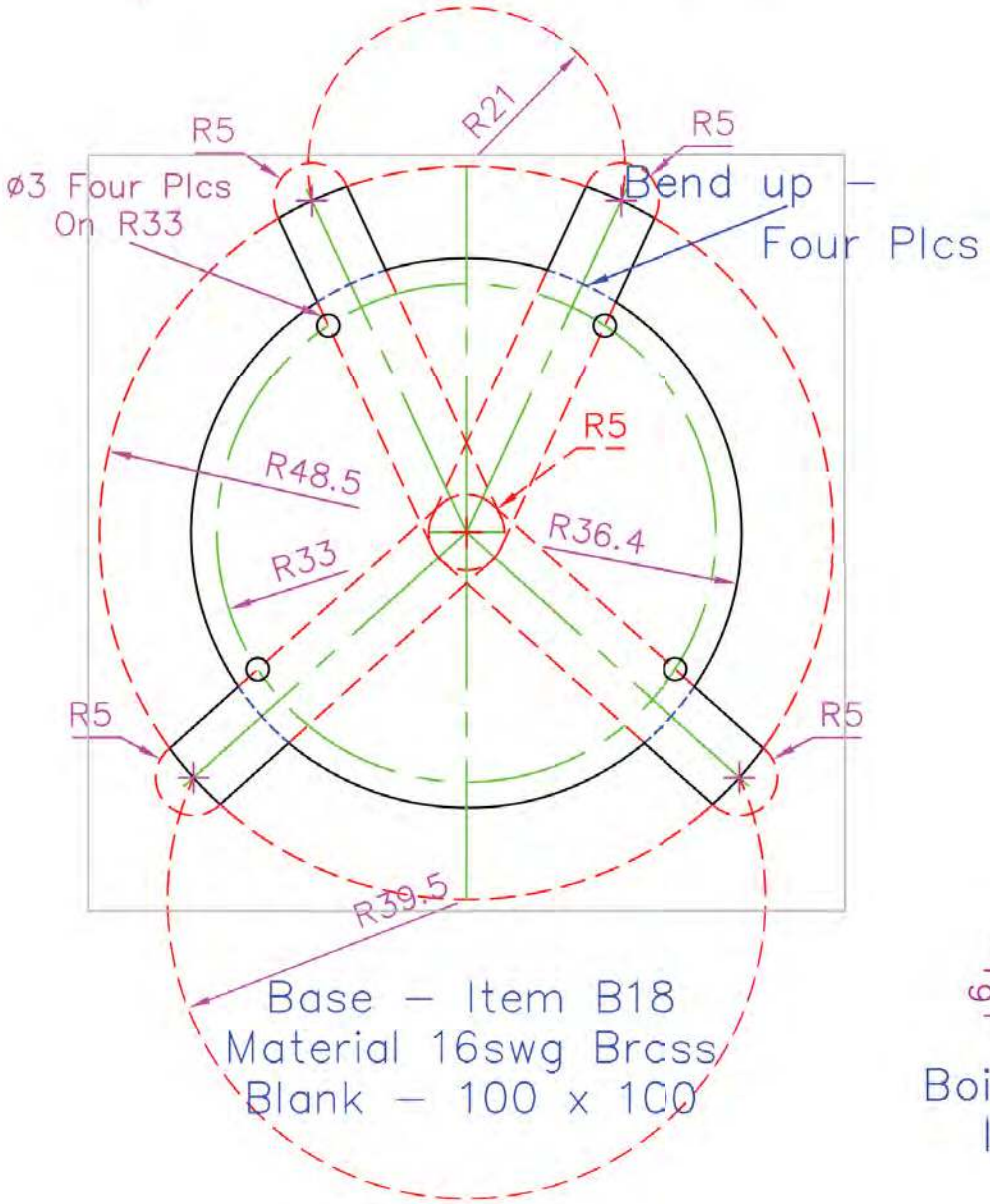
Six guidelines from these marks can be pencilled in along the length of the former using a square. On each of these lines make a cut about 5mm deep with a hacksaw and remove the waste. I just kept making hacksaw cuts as close to one another as possible between the marks and crumbled the remaining wood away.

The former should now be pushed into the firebox, chamfered-end first and eased all the way through which will bring it truly circular. Push it back in midway and hold the firebox between soft jaws in the vice. You will find that the job of cleaning up the protruding rivets is made very much easier because of the support the former provides (**Photo B77**).

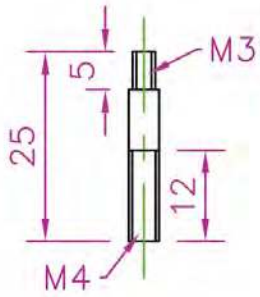
Next comes drilling the hole for lighting the burner. Hold the firebox in the milling machine vice and position the joint uppermost by eye. Locate the spindle at the joint on the X axis and 31mm in from the base on the Y axis. Clamp both slides – holding a tap that has a ground point in the drilled chuck makes for a small convenient centre finder (**Photo B78**). Centre drill then drill 6 diameter, then drill 13 diameter (**Photo B79**). Remove from the vice and deburr both sides of the hole. ▶



Base – After Folding "Ears"



Base – Item B18
Material 16swg Brcss
Blank – 100 x 100



Mounting Studs
B20 x 4

The Base

Item B20 - 16SWG Brass
Refer Drawing B18.

Cut out from 16swg brass a 100mm square. Anneal the square of material at this stage, as there will be a need to bend parts of the base at a later stage.

1) Scribe diagonal lines from the opposite corners and lightly centre punch at the point of intersection.

2) Using a pair of dividers scribe circles of 5, 33, 36.4 and 48.5mm radius.

3) Use a square with the stock set against one edge to scribe a line from one edge to the other, passing through the centre.

4) Where this centreline intersects the 48.5mm radius circle centre punch at the two intersections.

5) On one intersection scribe a 21mm radius circle.

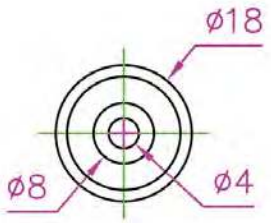
6) Where this circle intersects the 48.5mm radius circle **lightly** centre punch at the two intersections.

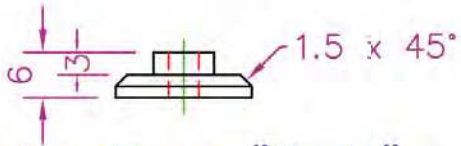
7) At the opposite intersection scribe a 39.5mm radius circle.

8) Where this circle intersects the 48.5mm radius circle **lightly** centre punch at the two intersections.

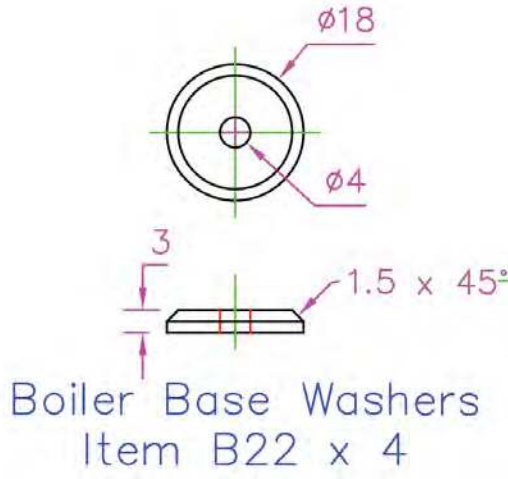
9) Scribe four 5mm radius circles at each of these four centres.

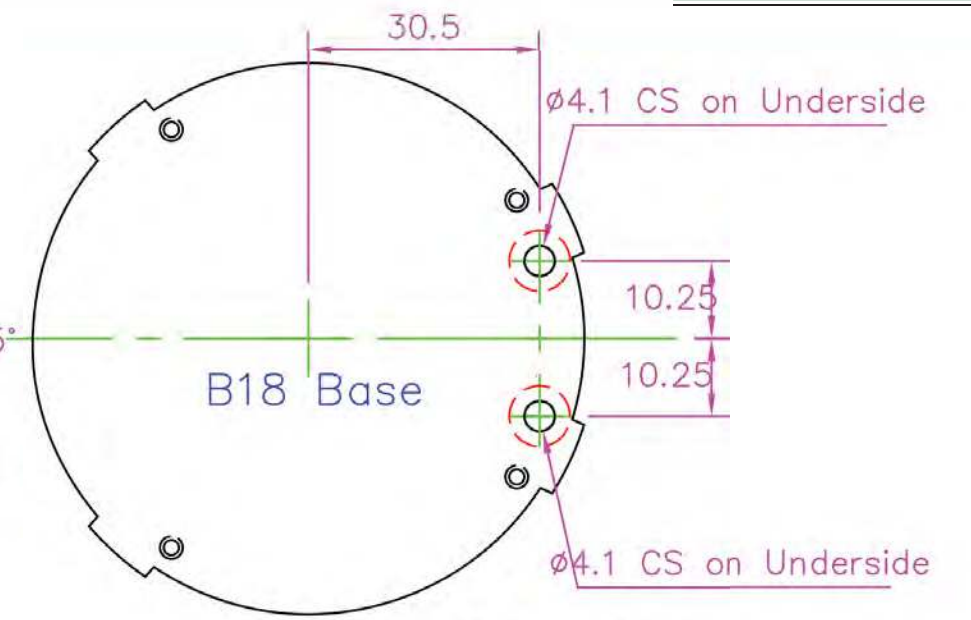
10) Using a steel rule and sharp





Boiler Base "Pads"
Item B21 x 4





Location of two ø4 holes
(Countersunk on Underside)
Required when using ø2"Ceramic Burner

scriber, scribe tangential lines between each side of the four outer 5mm radius circles and the central one.

11) Refer to drawing B18 and centre punch in the four places indicated where lines intersect the 33mm radius circle.

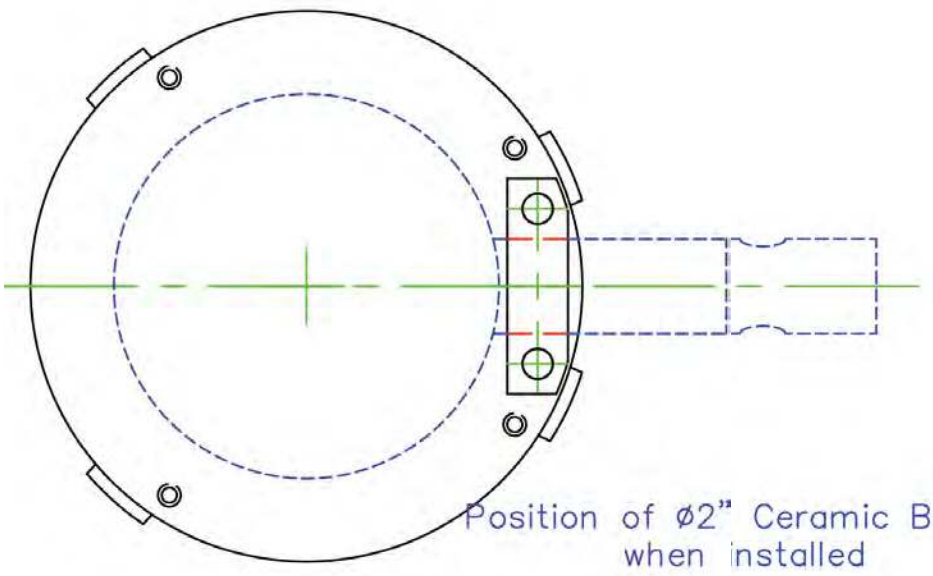
Cutting outside of the lines with a 32 TPI hacksaw, remove the waste sections of brass before filing to the line. With a fine flat file deburr all edges by filing a small chamfer. Drill 3mm diameter at the four places indicated on the 33mm radius circle (**Photo B80**).

Holding the base with each ear protruding above the jaw in turn, bend at 90 degrees to the base at the point the parallel sides of the ear meet the 36.4mm radius circle (**Photo B81**).

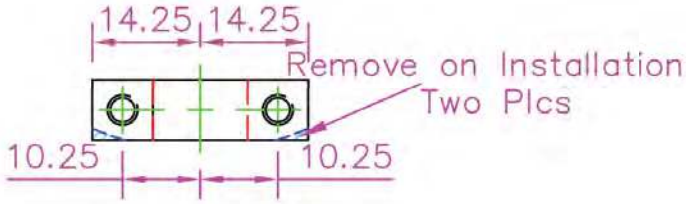
Fitting base to firebox

Fit the base into the firebox positioning it radially so that the four 3.2mm diameter holes drilled in the firebox fall equally within the width of the ears. It will be necessary to relieve the base edge in three places where the butt strap and two support rectangles contact the base. Place the firebox onto a flat surface and check the inserted base is flush (**Photo B82**).

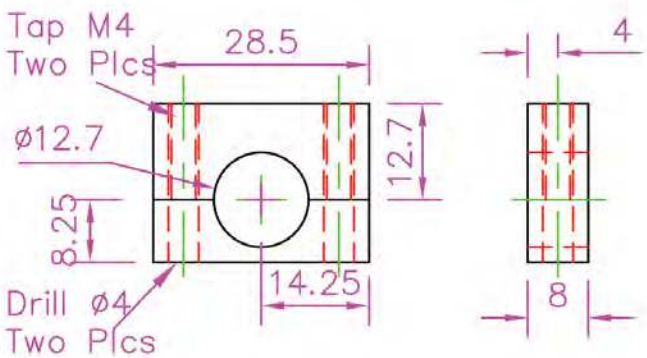
Clamp the ears to the firebox making sure the 3.2mm holes are ▶

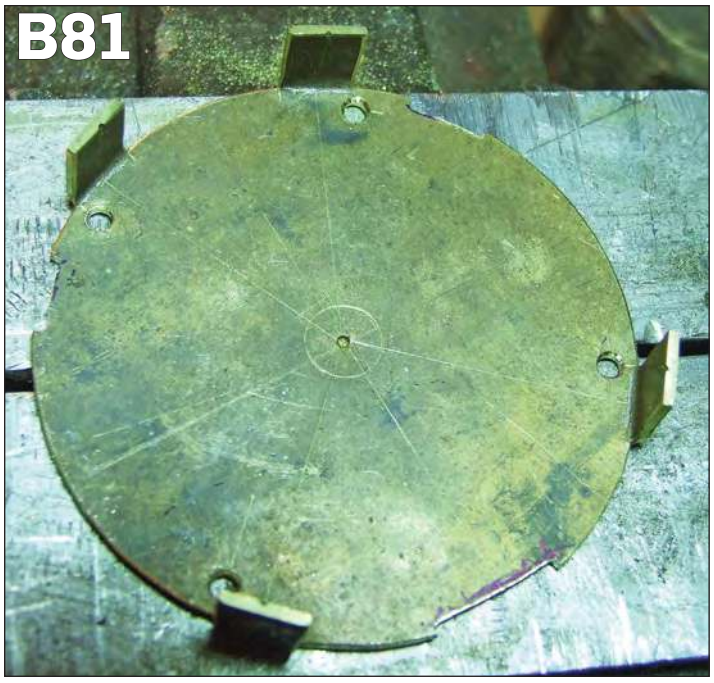


Position of ø2" Ceramic Burner
when installed



ø2" Ceramic
Burner Mount
Item B19





clear of the clamp jaws. Using a 3.2mm drill spot the ears of the base through the four holes in the firebox. Remove the base and centre punch at the four spotted positions (against a support) before drilling through 2.5mm and tapping M3.

Fit the assembled firebox to the base of the boiler barrel so that the 13mm lighting hole is positioned midway between the two pairs of vertically adjacent bushes in the side of the boiler barrel. Check to ensure that the boiler barrel is firmly seated against all three top ends of the butt strap and two location strips – there may be a silver solder fillet that will have to be removed.

Spot through the three holes drilled in the top edge of the firebox with a 3.2mm diameter drill. Remove the firebox and drill through the bottom of the boiler barrel at the three 'spotted' locations 2.5mm followed by tapping M3 for the securing bolts.

Ceramic Burner Mount

Item B19 – ⅜ x ½-inch Brass
Refer Drawing B19

For the 2-inch diameter ceramic burner we need to manufacture a holder. This is in the form of a clamp holding the gas tube of the ceramic burner to the previously made base, item B18.

From the brass supplied cut off a length 65mm long and machine the ⅜-inch dimension to 8mm thickness. Machine both ends square, just removing the saw marks. Cut in half, then clamp both together after setting the machined ends on a suitable parallel and bring both pieces to 28.5mm length.

1) Release from the vice and separate. Set one piece on a suitable parallel with at least 5mm protruding and reduce the 12.7mm width to 8.25mm.
2) If you have an end-stop set it against the end of the blank. Centre the spindle between the two vice jaws on the Y axis and clamp the slide. Centre the spindle to the centre of the blank on the X axis, zero the X axis feed dial.
3) Move the blank 10.25mm to the right on the X axis and clamp the slide. Centre drill and drill 4mm.
4) Move the blank back to zero and then continue 10.25mm to the left on the X axis (remember to account for backlash) and clamp the slide. Centre drill and drill 4mm diameter. Remove and deburr.
5) Clamp the second (wider) piece on a suitable parallel and against the end-stop if fitted, otherwise zero the spindle to the centre of the blank on the X axis.
6) Move the blank 10.25mm to the right on the X axis and clamp the slide. Centre drill and drill 3.3mm, then tapping M4.
7) Move the blank back to zero and then continue 10.25mm to the left on the X axis (remember to account for backlash) and clamp the slide. Centre drill and drill 3.3mm, then tap M4.
8) Cut a piece of card to fit between the two blocks and bolt together using 15mm long bolts.
9) Clamp the assembled block raised on suitable parallels, with the 12.7mm width against the fixed jaw and against the end-stop if fitted, otherwise zero the spindle to the centre of the blank on the X axis.
10) Zero the spindle to the fixed jaw

PHOTO B80
The base marked and cut out.

PHOTO B81
Four ears bent up from plate.

PHOTO B82
Trial fitting of the base.

"The holder is in the form of a clamp holding the gas tube of the ceramic burner to the previously made base..."

on the Y axis and zero the feed dial. Move the work towards the column 12.7mm. Centre drill and drill 4mm, then drill 12.7mm (**Photo B83**). Remove, but **DO NOT** disassemble.

Gas Burner assembly

Take the Base B18 and on the underside mark out the positions of the two holes as indicated on drawing B19. Centre punch, drill 4.1mm diameter and countersink (the flat surface) in the two positions shown. Check the depth of countersink to ensure the screws do not protrude beyond the surface of the base.

Trial fit the assembled Mount B19 – filing the back of the mount to clear the internal radius of the ears by about 0.5mm. Dismantle, remove the card spacer and deburr.

Confirm that the mount will fit by the installation of two M4 bolts, passing through the countersunk holes in the base and lower section of the (thin) mount, screwing into the M4 threads in the upper (wide and threaded) mount section, without interference with the inside of the ears bent up from the base. If necessary file a chamfer where the radiused surface contacts the flat face on the lower Mount section (thinner) to clear any radius where the ears are bent, to allow the mount to sit flat on the base.

Assemble with the 8.25mm section against the inside of the base, laying the gas tube of the burner into the 12.7mm diameter semi-circle before fitting the wider top section above it. Install finger tight, two 20mm long M4 countersink-headed set screws through the base into the mount top section. Adjust the burner so that it is central on the base and fully tighten the two screws (**Photo B84**).

Assemble the Base (B20) into the Firebox (B17) (**Photo B85**).

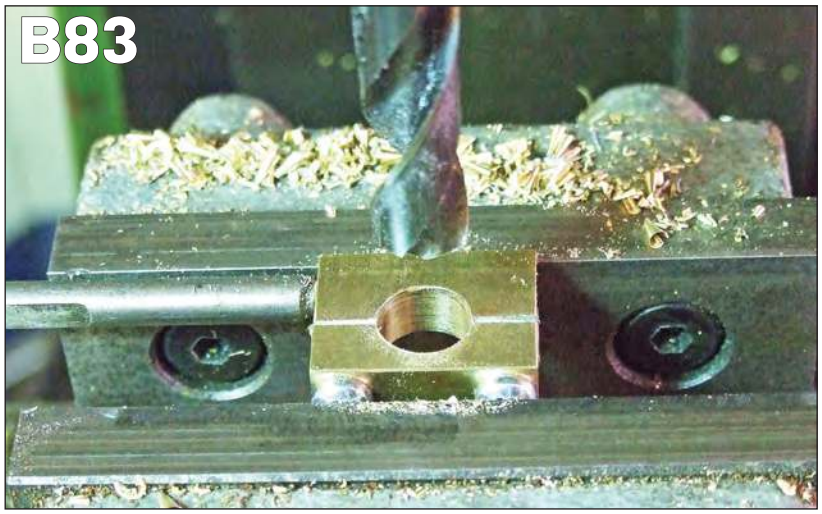


PHOTO B83
Drilling the burner clamp.

PHOTO B84
The burner installed on the base.

PHOTO B85
The burner and base assembled in the firebox.

Mounting Studs

Item 20 x 4
4mm diameter 303 Stainless
Refer Drawing B20.

Hold in a self-centring or collet chuck with 20mm protruding. Face off. Thread M4 x 12mm long. Rechuck with 30mm protruding and part off 25mm long. This is correct if mounting on the recommended 6mm thick heat resistant base. Repeat process three times.

Hold on the 4mm diameter with 8mm of the plain section protruding. Face off, and turn down to 3mm diameter x 5mm long.

Thread M3 to the shoulder. Repeat three times and put to one side.

Mounting Pads

Item 21 x 4 – 19mm diameter Brass
Refer Drawing B21.

Hold the 19mm diameter brass in a self-centring chuck with 12mm protruding. Face off, centre drill and drill 4mm diameter x 8mm deep. Turn 18mm diameter x 8mm long. Turn 8mm diameter x 3mm.

Machine the 45-degree x 1.5mm chamfer detail. Break corners of two diameters with a 45-degree x 0.5mm chamfer. Part off 6mm long overall. Repeat three times, put to one side.

Mounting Washers

Item 22 x 4 – 19mm diameter Brass
Refer Drawing B22.

Hold the 19mm diameter brass in a self-centring chuck with 10mm protruding. Face off, centre drill and drill 4mm diameter x 5mm deep. Turn 18mm diameter x 5mm long. Machine the 45-degree x 1.5mm chamfer detail. Part off 3mm long overall. Repeat three times and put to one side. EIM

NEXT MONTH...

Martin constructs the display base.

■ Parts 1 to 8 of this series appeared in the October 2018 to May 2019 issues of **EIM**. Digital back issues can be downloaded or printed versions ordered from www.world-of-railways.co.uk/engineering-in-miniature/store/back-issues/ or by telephoning 01778 392484.

Eureka revisited

In the first of a two-part feature, Brian describes the trials and tribulations he experienced building and using a continuous gear cutter form-relieving device.

BY **BRIAN WOOD**

Following a great deal of hesitation and prevarication over the years, the need to make some 20 degree pressure angle gears to suit the construction of Graham Meek's combined screwcutting clutch and reverser unit finally forced me to take action.

This excellent accessory was described in a series in **EIM** some while ago (*Jan-March 2012, Ed*); for those who missed it at the time the drawings and build notes are also covered in Graham's book (Ref 1).

First some historical background to gear cutters. Making involute gear cutters is something of an art form; strictly speaking every gear is of a particular tooth shape to be geometrically true for smooth meshing with another gear of the same 'family' in the gear train.

In the last quarter of the 19th century the Brown and Sharpe Manufacturing Company (B&S) of the USA recognised the impossible supply situation this produced in working to those requirements, and simplified the whole business to sets of eight cutters covering gears in grouped tooth counts from small pinion to rack in the many diametral pitch (DP) sizes..

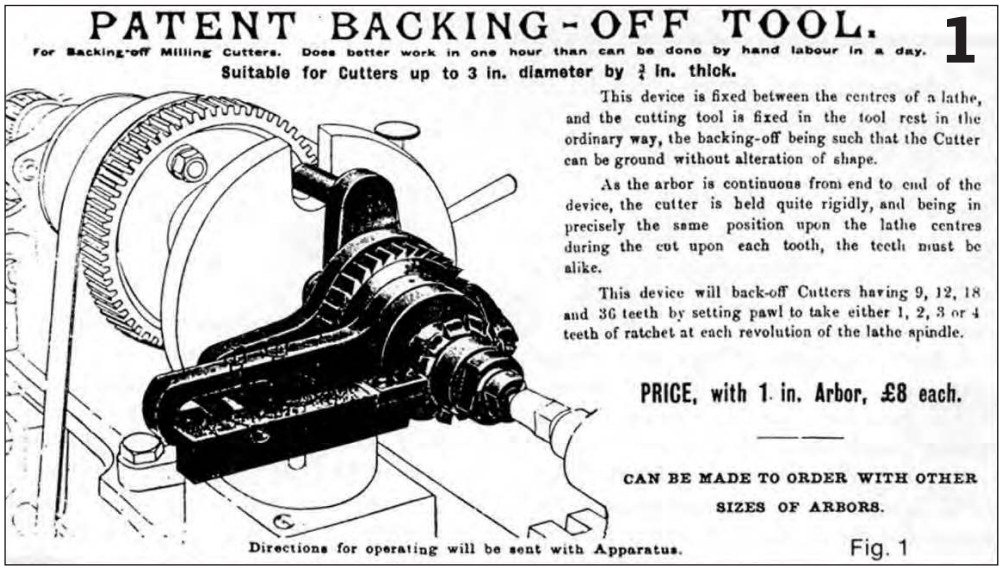
These selected cutters allow some practical tolerances within the range of tooth counts, each cutter being made to suit the gear with the lowest tooth count in that group. For more demanding work there is a half set of cutters to refine the boundaries.

The B&S classification method for gear cutters became adopted as the international reference standard and now also applies to metric gears defined by the module instead of DP.

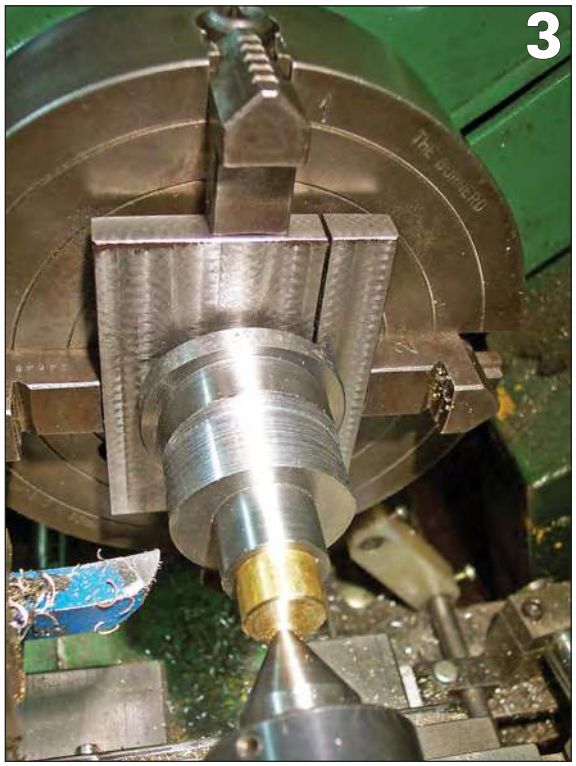
Making the involute shape of the cutters to incorporate the relief behind the cutting edge so that only that edge does the work, and takes regrinding without losing the involute form, is usually done on a form-relieving lathe.

These lathes are characterised by an ultra slow-speed spindle drive to allow for the high torque required and they incorporate a cam-operated cross-slide that resets the form tool in the cutter gaps to carve metal off each tooth in turn. Great strength and rigidity, massive section form-cutting tools that are solidly supported and the powerful drive are all necessary features for a lathe doing this work.

Most production gear-cutting work today, however, is done with generating-type cutters such as gear hobs, where the resulting gear form is automatically correct on being cut. When Brown and Sharpe was grappling with the problems of classification, specialised form-relieving lathes may only have been in embryonic form and two US patents were granted for ingenious form-relieving tooling for use on ordinary centre lathes.



All photos in this feature by the author



The first, a rather brutal looking geared device by Stephen Balzar, was patented in 1895. How successful it was is not known, as it was superseded with another US patent granted to Robert Taylor in 1906 for a ratchet-driven device.

Taylor's patent was maybe too late; the German tool company of Selig Sonnenthal had almost identical equipment for sale at £8 a time [about £900 today] in 1904.

The story behind Eureka

In 1987 two articles appeared in *Model Engineer* which described the making of 'Eureka', using as the starting point the Selig 1904 tool catalogue illustration. I noted them with great interest at the time.

A reader in New Zealand had written in to the magazine and sent a photocopy of the catalogue entry (**Photo 1**), asking what it was and how did it work?

From that very limited information, a 'Brains Trust' of respected model engineers was brought together by the interest it generated. They reverse-engineered the tool, christened it Eureka and presented a construction description and drawings in two articles in the magazine in 1987 (Ref 2 and 3).

Prior to that, a working version had been made and was demonstrated on the SMEE stand at the London Model Engineer Exhibition in 1986.

For those not able to track down copies of these magazines, drawings and build notes are included in chapter 12 of Ivan Law's book (Ref 4) which describes Eureka.

Building/using Eureka

In my case I wanted to make 2.25-inch diameter 12-tooth gear cutters, a regular commercial size, that could be used on my horizontal mill with its 1 inch diameter arbor. Eureka was really designed for 12-tooth cutters of 1.25-inch diameter having a ½-inch diameter bore so I increased the size of the device accordingly within the stock sizes I had available to me.

I elected to maintain the 12-tooth cutter format, reasoning that the eccentric throw for the indexing operation would remain the same as a standard-sized Eureka irrespective of cutter diameter.

I increased the eccentric throw for the relieving action from 0.030 inches to 0.075 inches to adequately shape the longer-tooth form of the larger cutters, having carefully studied a commercial version. I wanted to ensure the larger-diameter cutters had adequate chip clearance in use and to allow plenty of room for re-sharpening since they were not being made in HSS (high-speed steel).

"I had completely overlooked the fact that the DRO was set up to display the diameter of work, not radius..."

PHOTO 1: The entry in the Selig tool catalogue.

PHOTO 2: The mandrel jig produced for machining the eccentrics.

PHOTO 3: Another view 90 degrees apart of the machining jig.

PHOTO 4: The first mandrel, a beautiful failure.

PHOTO 5: Gashing of aluminium test blank.

I was using an oil-hardening low-carbon boron steel instead.

The fundamental working of Eureka comes from the two eccentric throws, 90 degrees apart, that are machined into the mandrel. The recommended route is to turn those features with an offset grip in a four-jaw chuck with suitably arranged support from the tailstock.

Since I had altered the scale of operation for my cutters and increased the eccentricity for the relieving action, trying to grip the job securely with that degree of offset in a four-jaw chuck was very clearly hopeless when I tried it out.

Instead, I made a rectangular jig to very firmly grip the mandrel boss that could then be much more reliably and simply offset as a result.

I also elected to drive the device with a chuck rather than a lathe dog as had been described in the literature. **Photos 2** and **3** show this jig.

In these times of full disclosure, I must record that I had very accurately offset the throws of the mandrel using the lathe DRO to set up the jig in a four-jaw chuck. However, in doing so I had completely overlooked the fact that the DRO was set up to display the diameter of work, NOT radius! Moral. Measure twice, cut once...

The resulting mandrel was a finely machined thing of beauty. It is shown here in **Photo 4** and in admiring it I did not spot that the throws were half scale, so went on to complete the assembly only to watch it twitch rather feebly when running.

It was not, however, wasted effort. Along the lines of the famous TV sketch by Eric Morecambe, it made all the right noises and all in the right places, thus proving that at least the geometry was right.

For salvage I did toy briefly with the idea of using it to make 24-tooth gear cutters but decided it had to be set aside as a monument to my stupidity. This was particularly galling as I had raided my dwindling and irreplaceable stock of top quality vacuum re-melted aero-engine grade steel to make the mandrel, so this was a double blow to my pride.

The second mandrel was then made correctly and gave much more satisfactory movements. I had also fitted Oilite bushes to the toothed cutter carrier but relied on well-lubricated steel-to-steel contact for the other running surfaces. Setting of the two pawls was helped a lot by mounting them both on individual eccentrics, this was a further departure from the published design and gave a useful degree of fine-tuning adjustment.

On a plain running test it made satisfying clickety-click noises and then went on to make a lovely job of relieving a 'cutter' made from 6mm ▶

sheet PVC as a first test piece.

Emboldened by this success, I produced an aluminium blank, all properly gashed out, shown in progress in **Photo 5**, and proceeded to relieve that with the button form tool for a more demanding test. The form tool was double ended as that suited the geometry of the two gear cutters I needed to make (**Photo 6**).

As the machining proceeded, the indexing pawl started jumping out of engagement with the teeth in the carrier; clearly these needed undercutting to hold the pawl in better contact to counter the heavier thrust effects from cutting metal instead of PVC.

Eureka was duly dismantled and the appropriate modifications to the indexing tooth form made (**Photo 7**), after which the trial continued.

It very soon became apparent that as the length of cut on the teeth grew, any slack anywhere on the compound slide allowed the cutting tool to nod slightly and try to dig in, even with feather-thin removal of material from the blank.

The tool itself was hefty and resistant to flexing. A very slight rocking action of the top slide from the clearances in the dovetails was noticeable and still present after taking the clearances up.

Clearly the rocking, or flexing (it was not obvious which applied) was really more a result of overhang and leverage effects from the cutting load on the tool. Overhang was held to the barest minimum with the quick-change toolpost but the effect could not be eliminated. These difficulties were greatly exaggerated by the intermittent cutting forces on the button tool. It is a very searching action and will promote a dig-in at the least provocation.

"Cutting then proceeded in a series of rather savage scallops of material being removed..."

Savage cuts

I tried raising the tool height a trifle to compensate for it, but that then required an increased load to get the tool to bite and only made matters worse. Cutting then proceeded in a series of rather savage scallops of material being removed. It should be remembered that I was cutting sheet aluminium alloy here, not steel.

Disaster struck when one such dig-in stalled the drive, quick action prevented lathe damage but after that Eureka behaved oddly for two revolutions before stopping dead without any cutting load at all.

After taking it to pieces (again!) I found that this time the indexing carrier had picked up on the mandrel and seized it solid. In doing so it had also overpowered the grip in the chuck jaws and scored the drive boss like a torn up drill stem. The damage is rather poorly shown in **Photo 8**.

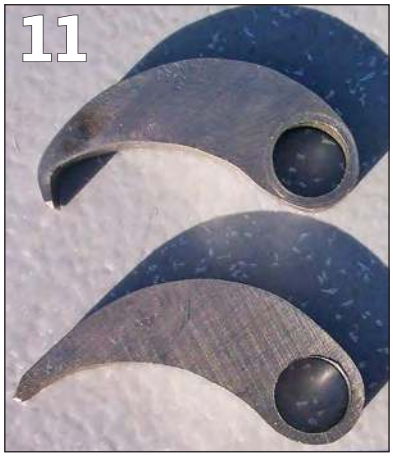
More modifications followed with brass bearing surfaces shoehorned into both the indexing carrier and the anti-rotation carrier for good measure. They are clearly visible in **Photo 9**. Also visible in this picture are early signs of bending of the indexing pawl.

Lubrication was upgraded to EP

PHOTO 6: Double-ended button tooling.

PHOTO 7: Undercutting the teeth in the indexing carrier.

PHOTO 8: Galling damage to the mandrel, indexing carrier and scoring of drive boss.



80 hypoid gear oil on all bearing and rubbing surfaces.

Finally the aluminium trial was completed with a finished 'cutter' that had the right form and was fully relieved (**Photo 10**). At least I could now go ahead with it and make gears in putty or something similar!

By now though I was beginning to seriously doubt the value of Eureka as a working tool for cutters in this size, while I had also developed a lot of appreciation for the use of relieving lathes in industrial situations.

However as I had also invested a good deal of time and materials in getting to this point, it would have been defeatist to stop; besides all that, it had now become a challenge.

The first steel blank was duly fitted and not without some trepidation. These were made in an oil-hardening low-carbon boron steel, a significantly tougher machining proposition to unhardened gauge plate.

All went well for a while as the first light cuts came off the back faces of the blank, but as the length of cut increased and with it the loading on the button tool, once more the cut hesitated and didn't complete its pass.

This time the indexing pawl had bent, despite being made in the same boron steel and being fully hardened before fitting. It is shown in **Photo 11** with a replacement pawl below it.

"It would have been defeatist to stop; besides all that, it had now become a challenge..."

PHOTO 9: Brass bearing surfaces fitted.

PHOTO 10: Aluminium trial cutter finished.

PHOTO 11: Bent indexing pawl and replacement.

PHOTO 12: Eureka and its bed support, set aside to rest.

Clearly I was asking too much of Eureka to work with this material at my cutter size so a new approach to acquire the two cutters was begun. I did want multi-tooth cutters rather that going for single-tooth fly-cutting for the better finish they produce.

A long internet search for two commercially supplied cutters in HSS finally yielded a quotation from Newman Tools in Canada which, together with DHL shipping charges, very comfortably exceeded the cost of a new mini lathe! Clearly 20 degree pressure angle cutters of 20 DP form are especially expensive to come by – unicorn hair might be easier to buy. Eureka was duly, and rather sadly, put aside to rest (**Figure 12**).

In Part 2 next month I describe a completely different approach to relieving these cutters on a lathe, and the solid support I made for the button tooling to take out the nodding action I had observed. EIM

References

Ref 1: *Projects for your workshop Volume 1*, by Graham Meek, combining his articles published in EIM. Tee Publishing Ltd, www.teepublishing.co.uk

Ref 2: *A continuous form relieving tool for gear cutters, Part 1*, by Professor D H Chaddock and Ivan Law. *Model Engineer,* 6 February 1987

Ref 3: *A continuous form relieving tool for gear cutters, Part 2*, by Professor D H Chaddock and Ivan Law. *Model Engineer,* 6 March 1987

Ref 4: *Gears and gear cutting*, by Ivan Law. Workshop Practice Series 17, ISBN 0 85242 911 8

Time and motion...

Keith's series on the beginner's workshop addresses the perennial problem of finding time for model engineering and how to save some...

BY **KEITH APPLETON**

As a Model Engineer who has set up a home workshop, you may find that often you will not have as much time to spend in it as you would like.

This can be due to a variety of reasons. For instance, if you have a job, then there is the annoying problem of;

- Pressure of work taking you away from your home workshop
- Too much time spent at work to earn the money to buy more models
- Too much time spent at work to earn the money to buy more tools
- Too much time spent at work to earn the money to pay necessary bills
- Too much time spent on partner and family commitments
- Too much time spent in the local pub... Even sleeping puts an even greater strain on your urge to make something in your new workshop.

ABOVE: Keith's tailstock die holder, which fits neatly in the back of a standard dieholder and uses a shaft to fit onto the tailstock itself.

LEFT: A commercial tailstock dieholder – this is the expensive or the time-consuming option, as it requires one for each die or time spent loading each time it is used.

All photos by Keith Appleton

All of which shows that you need to maximise your efficiency to increase the amount of time that you are actually in your workshop.

First let's dispose of some impractical solutions...

You do not need to dispose of your partner (via divorce or worse).

Don't forget that you have biological needs, one of these being to eat some quality home-cooked food regularly in order to stay healthy. Living on takeaways and junk food is not a very wise lifestyle option.

You probably don't need to have your children adopted either. All these drastic solutions are definitely NOT recommended!

Do not worry, I have a much simpler idea. Often setting up jigs and fixtures to do relatively simple jobs in the workshop can take an extraordinary long time to complete. So why not just make some special tooling accessories to speed up the setup time when making things in the workshop with your new lathe?

In the last episode (**EIM**, April 2019) I showed how to make some simple **tap guides** – making these is great for gaining experience when turning in the lathe and the finished items very useful for ensuring that

your taps enter the holes squarely in whatever material you are tapping threads in.

However, these tap guides will not speed up your workflow. So the next thing to consider buying for your workshop tools collection is a **tailstock die holder**.

Cost consideration

In a perfect and ideal world, if you have a good disposable income and the spare cash it would be a good idea to buy a tailstock die holder for every die that you intend to use.

That way all you need to do is pre-load a die into each and every one of them then just select the 'ready-to-use' die holder and get åon with the job quickly, efficiently and accurately.

There is a problem with this though, when you consider how many sizes of dies that you will be using on a regular basis. For instance, popular sizes of BA (British Association) dies are: 0, 2, 4, 5, 6, 7, 8 and 10, but you may as well add 1BA and 3BA (I don't think I have ever had the need to use a 9BA die).

Then there are metric dies from M2 up to and around M10, and don't forget the ME Dies (Model Engineer) which are also frequently used in many fractional sizes.

All of this equates to the need for a large quantity of tailstock die holders readily at hand near the lathe.

This is the part that you have been waiting for: What is a good and cheap option for a multi-set of die holders that can be pre-loaded with dies of many sizes and fitted to the tailstock for accuracy?

One day whilst at Blackgates Engineering, my local model Engineering parts supplier, I noticed some 'hand-type' die holders on the display racking behind the counter, and looking at these I had an idea.

TOP RIGHT: A typical manual die holder. Our adaptor sleeve will be made to fit the smaller diameter at the back of the holder.

CENTRE RIGHT: The first step in making the adaptor is to turn down a suitable piece of steel bar stock.

BELOW: Drilling the hole that will provide a sliding fit over the shaft fitting into the morse taper of the tailstock.

BELOW RIGHT: Once the hole has been drilled it is reamed to finished size.

They were inexpensive and of good-enough quality for the type of use that they would get in a model engineer's home workshop – maybe not suitable for a heavy duty industrial application but fine for what I needed.

The Adaptor Sleeve Guide

I already have two commercial tailstock die holders with morse taper number two shanks on them that fit into the morse taper number two hole in the tailstock quill.

I thought that if I made an adaptor sleeve that fitted into the rear of one of the cheap manual die holders, and was a sliding fit on the standard part of my tailstock die holder that fits into the tailstock's internal taper, then I could use this sleeve for all of my commonly used taps and dies.

To try my idea out, I bought just ▶

ABOVE LEFT: If you don't have a suitably sized reamer than the hole can be bored out to size.

CENTRE LEFT: A spot of knurling, described in full in Keith's feature in the April issue, provides a firm grip when handling the adaptor.

BELOW LEFT: Final step is to turn down the locating lug for the die holder.

BELOW: A trial to ensure a snug but not too tight fit.

BOTTOM: A wooden stand such as this makes finding the right-sized die a matter of moments.

four of the Die Holders from Blackgates Engineering for starters and made the sleeve adaptor as shown in the photographs.

Making the Adaptor

Making the sleeve is a very simple job and was not dissimilar to the way that I made the tap guides described in my previous article.

I started with a piece of steel bar, which I drilled and reamed to fit the existing shaft from the commercial die holder. It is very important not to drill all the way through because the smaller die holders are of a lesser diameter than the shaft that supports my original tailstock die holder.

Once I had drilled the hole down the centre of the bar and opened it up to the correct size, then all I had to do was turn the bar diameter down slightly just to clean it up, followed by machining a register on the end to fit into the rear part of the manual die holder.

The adaptor needs to be a smooth sliding fit on the shaft – not a rattle-type fit, but definitely not too tight. I initially drilled the shaft using a smaller diameter hole, then I enlarged it using a drill that was one imperial size below the finished diameter. I then used a reamer for the final sizing of the hole down the centre of the adaptor.

When using the system, the resultant thread on any parts that I have made are comparable in quality and accuracy to a thread that has been cut using a commercial tailstock die holder and owing the preloaded dies, the process is so much faster than having to individually set up a die holder for every threading job.

I am now used to this system and I would find it difficult going back to the old method.

Centre hole alternative

For the purposes of the Youtube video that I filmed about making this tailstock die holder adaptor, I also demonstrated a means of using a long boring bar to machine the hole in the centre to the correct diameter. This is a useful option to have if you do not have the correct-size reamer in your new workshop's tool collection. Simply search for *Model Engineering for Beginners* on YouTube – this particular exercise is episode 18 and shows the entire operation in detail. EIM

■ Previous episodes of Keith's series appeared in the December 2018 and the February and April 2019 editions of EIM. Keith's Youtube channel includes a wide selection of workshop instructional videos – you can find it at www.youtube.com/keithappleton

Dougal – a 5-inch Barclay

Young Sussex engineer Andrew takes two tries at producing an effective regulator for his entry-level locomotive construction project.

BY **ANDREW STRONGITHARM** – Part Fourteen of a series

I've essentially tried two different types of regulator on 'Dougal' with varying degrees of success and I'll describe the merits and pitfalls of both below. D Malcolm designed the locomotive with a ⅜-inch Whitworth screw-down type regulator mounted at the front of the boiler, however for simplicity I chose to adapt this, which produced mixed results.

The first incarnation was a screw-down type mounted at the smokebox end of the boiler but with the screw actuated on the backhead. In a further change to the drawings, I fitted a 15mm copper tube which ran the full length of the boiler between the two flanged boiler plates. I bored out the flanged fitting from the backhead which I had made to seal the regulator bush during the hydraulic test and silver soldered this on to one end of the copper tube.

At the other end this tube simply pushed over the fitting in the smokebox which I described the making of last month. The tube was cross drilled in line with the dome and a fitting was soldered on to the outside of it to allow a steam take-off pipe to be screwed into the tube. I had to radius the outside of this fitting to ensure that it did not exceed the inside diameter of the backhead flange once it was soldered to the tube. This pipe stopped about ¼-inch short of the top of the inner dome to collect dry steam and to help prevent water from being carried over into the cylinders.

A ½-inch AF bronze nut was made to screw into the regulator tube flange with a ⅜-inch x 20 tpi thread on the outside and a ¼-inch x 20 tpi internally to take the regulator rod. You'll notice that both threads were 20 tpi which was because this nut would need to be screwed into the flange and up the threads on the regulator rod simultaneously.

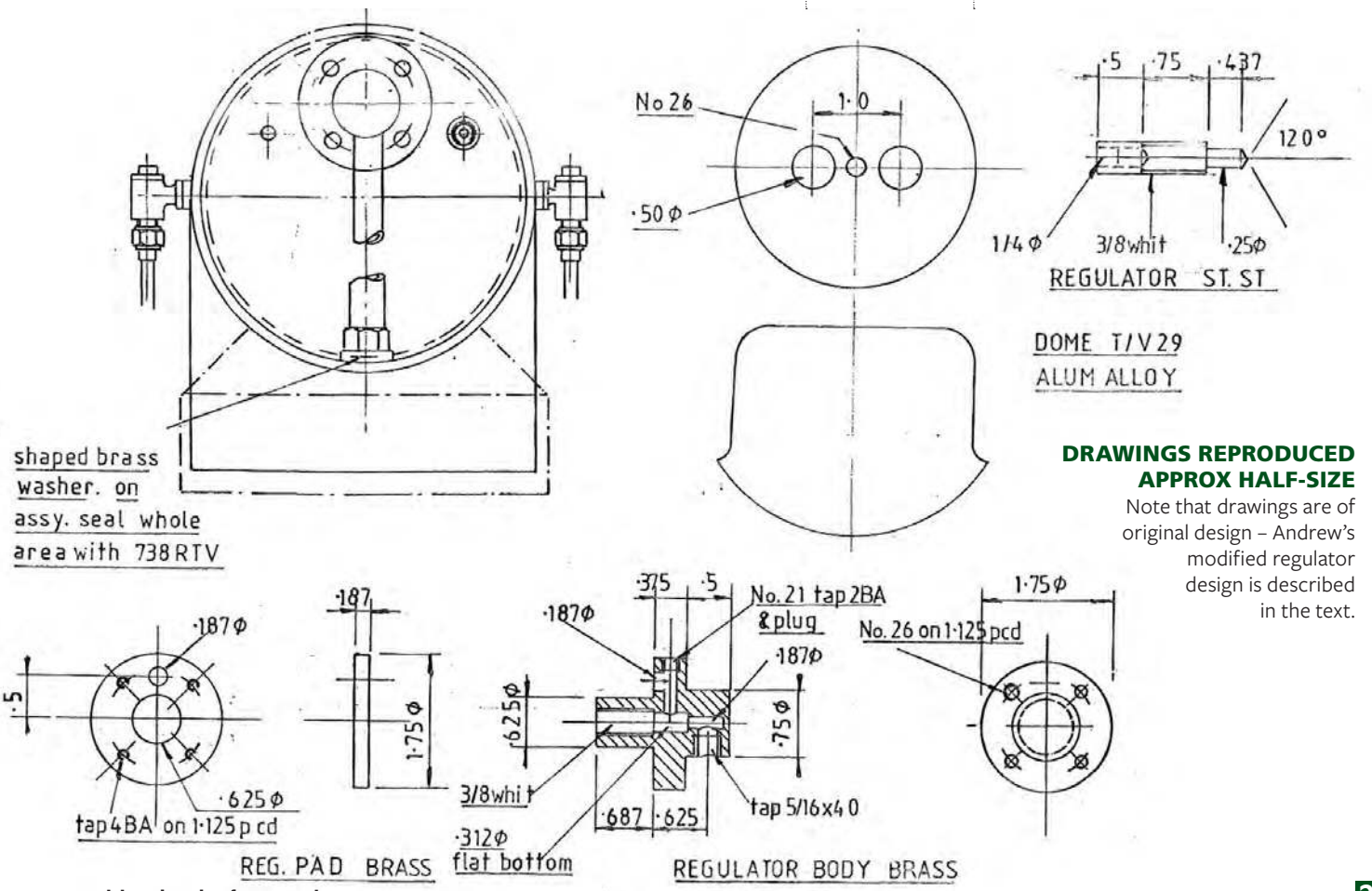
Short throw

The regulator rod was made from a length of ¼-inch diameter monel and I cut ¼-inch x 20 tpi threads on one end to form the screw. This thread was chosen because of its coarse nature so in theory the regulator handle would only need to be opened or unscrewed a short way but still produce a sufficient opening to allow enough steam into the cylinders.

The prototype 'Dougal' is a 2ft 6in gauge Barclay 0-4-0 today resident on the Welshpool & Llanfair Light Railway in mid Wales.

On the other end of the monel rod I experimented with different methods to seal the steam inlet which included a conical seal, a bronze ball and a flat-ended seal up against an O-ring. Unfortunately none of the above produced a perfect seal and the latter gave closing the regulator a 'spongy' feel. It didn't matter which method was used to seal the steam inlet as they all required the regulator handle to be unscrewed far more than was desirable.

In some cases the handle had to be unwound until it hit the gauge glass blowdown, which was about three ▶



DRAWINGS REPRODUCED APPROX HALF-SIZE

Note that drawings are of original design – Andrew's modified regulator design is described in the text.

PHOTO 1: Regulator handle on the model Dougal – not too much travel is an advantage.

PHOTO 2: Regulator pipework arrangement in the smokebox.

DIAGRAM 1: Regulator design version 2 – described in the text.

All photos and diagram by the author

quarters of a turn (that equated to roughly 36 thou) before the regulator was fully open (**Photo 1**). Because the pressure on a model locomotive the size of Dougal can fluctuate more quickly than a locomotive with a larger boiler, it is advantageous to have a regulator which does not have too much travel between the closed and fully open positions.

A couple of guides were made to hold the monel rod centrally within the regulator tube, one between the backhead and steam take-off pipe and another further forward towards the front tubeplate. I used a pair of tiny O-rings to seal the rod against the rear guide to prevent steam from going the wrong way down the tube and reaching the backhead. These however gave the regulator an undesirable springy action when opening and closing it.

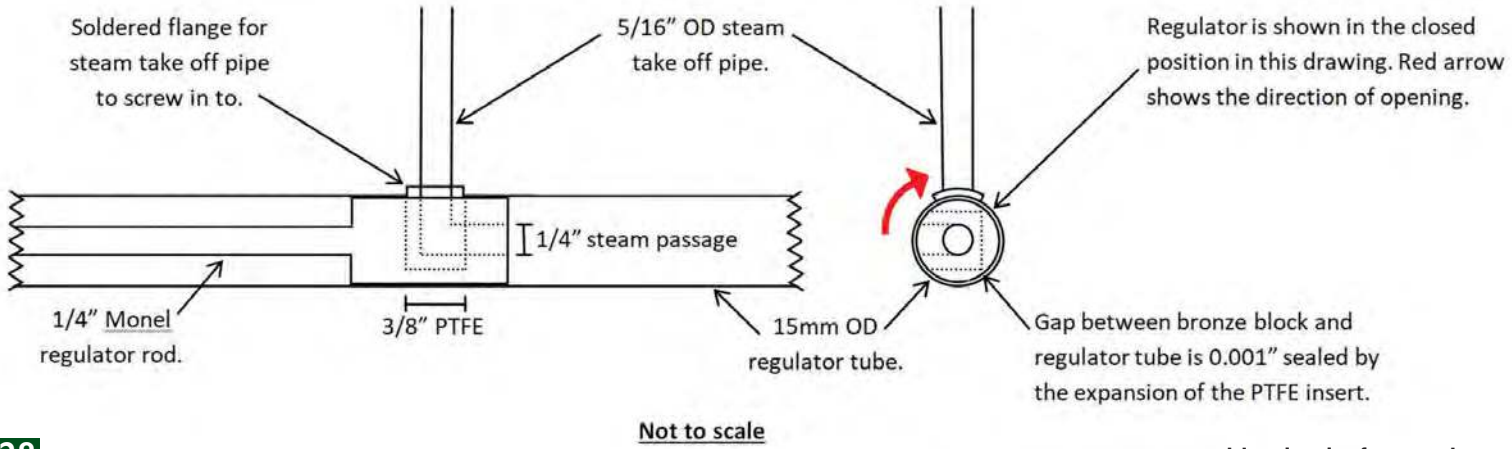
The front guide also had to include provision for steam to pass through it to reach the main steam inlet at the front of the boiler (**Photo 2**) so three grooves were cut at equal intervals around the circumference.

The regulator arm was made from a piece of ⅛-inch x ¼-inch BMS bar with a 3/16-inch round stub of stainless steel for the handle itself drilled and threaded 5BA into the top. The top of the arm was then rounded off using emery paper before the bottom of the arm was silver soldered on to a piece of 5/16-inch diameter round steel. This was threaded internally ¼-inch x 20 tpi to accept the regulator rod.

Expansion race

I also found that having a long regulator rod made out of monel was a bad idea as the copper boiler expanded quicker than the monel when the boiler was steamed. Therefore I had to keep closing the regulator whilst the boiler warmed up to ensure that the regulator remained closed. Likewise at the end of a run, the regulator had to be gradually opened to prevent it from becoming seized when the boiler was cold. Ideally, I also wanted to have the

DIAGRAM 1



regulator handle running in a quadrant as per the full size loco which limited the available travel to about 90 degrees. Therefore plan B had to be implemented! I would need to try an alternative type of regulator.

Version 2 involved moving the regulator itself to a central position within the boiler beneath the dome. I concluded that I wasn't going to get a screw-down regulator to work satisfactorily and therefore I developed a quarter-turn variant which used solid PTFE as its secret ingredient.

After cutting the monel regulator rod back to just short of the dome I silver soldered a 5/8-inch length of round bronze on to the end of it which was a slide fit inside the regulator tube. I then drilled a 1/4-inch diameter hole in the end to a depth of 1/2-inch before inserting a 3/8-inch diameter cross-hole in the middle of the bronze, which broke through into the 1/4-inch hole. I finished this hole by using a 3/8-inch diameter end mill to square off the bottom to a depth of just over 3/8-inch.

Next, I turned a short length of solid PTFE to a couple of thou' over 3/8-inch, pushed it into the hole and then turned the outside to match the radius of the bronze rod, leaving a couple of thou' proud. Finally, using a 1/4-inch drill I drilled out the two steam ways at right angles to each other within the PTFE. I was now left with a 1/16-inch ring of PTFE around the 1/4-inch steam hole and it was this that would expand and hopefully seal against the inner wall of the regulator tube when hot. (**Diagram 1**)

Uncharted territory

I found that the PTFE shaped itself to the correct radius when pushed into the regulator tube, so don't worry if you see tiny PTFE shavings during assembly. This ensured that it was a snug fit within the tube and gave a smooth movement during cold tests. I'll be honest and say that this was all a bit of an experiment and neither I nor my tutor Andrew had any idea if this would be successful.

Prior to testing this set-up on steam, I made a brass quadrant to finish off the backhead as I knew that full opening of the regulator could now be achieved in 90 degrees or less.

The quadrant was made by machining a piece of 1 1/8-inch diameter x 5/16-inch thick round brass using the dividing attachment on the Myford lathe. I machined away a 90 degree segment of the disc to leave the back of the quadrant 3/16-inch thick. Then, I bored out the centre, gradually working up to a 5/8-inch diameter drill, to make the remaining ring 1/4-inch thick. I could now cut out the segment that I was going to use, which included the two 1/8-inch thick stops at either end of the quadrant.

After a bit of cleaning up with a file and emery paper, I could silver solder my quadrant on to a piece of 1/16-inch brass plate which I used to fix the quadrant in position behind the regulator handle. I used two holes at the bottom of the backhead regulator flange to bolt this plate on and I drilled a clearance hole through the centre for the regulator rod.

The final task on the regulator was to pin the handle on to the rod to ensure that it didn't come loose whilst in use. I made and silver soldered on a new 1/4-inch diameter steel base for the handle with a 3/16-inch hole through the centre that pushed over the end of the regulator rod which had been turned down to remove the old 1/4-inch x 20 tpi threads.

A new base was necessary as the previous one was internally threaded and there was no land left to drill the threads out nor could I fit a steel plug as I had already silver soldered it on. Care was taken to check the open and closed position of the handle on the quadrant before cross-drilling it with a 1/16-inch drill using the vertical slide on the Myford lathe. I was able to use the side of the regulator arm to ensure that the cross hole was drilled at a right angle through the base of the handle by running a lever dial gauge along the edge to check that it was parallel with the vice.

With this done, I placed the handle back on the end of the rod and making sure it was resting against the right-hand closed stop of the quadrant, I turned up a special 1/16-inch silver steel punch to mark the location of the cross-hole on the regulator rod. The rod was then taken off the locomotive, drilled out to a 1/16-inch and reassembled together with the regulator handle and a fitted stainless steel pin. This was threaded 10BA x 3/32-inch at each end with lock nuts fitted on both ends and I remember that it was a 'very' good fit!

I'm pleased to say the subsequent steam tests showed the PTFE regulator worked extremely well and once up to working temperature seals every time. It also has a very smooth action compared to the previous attempts using O-rings (**Photo 3**). **EIM**

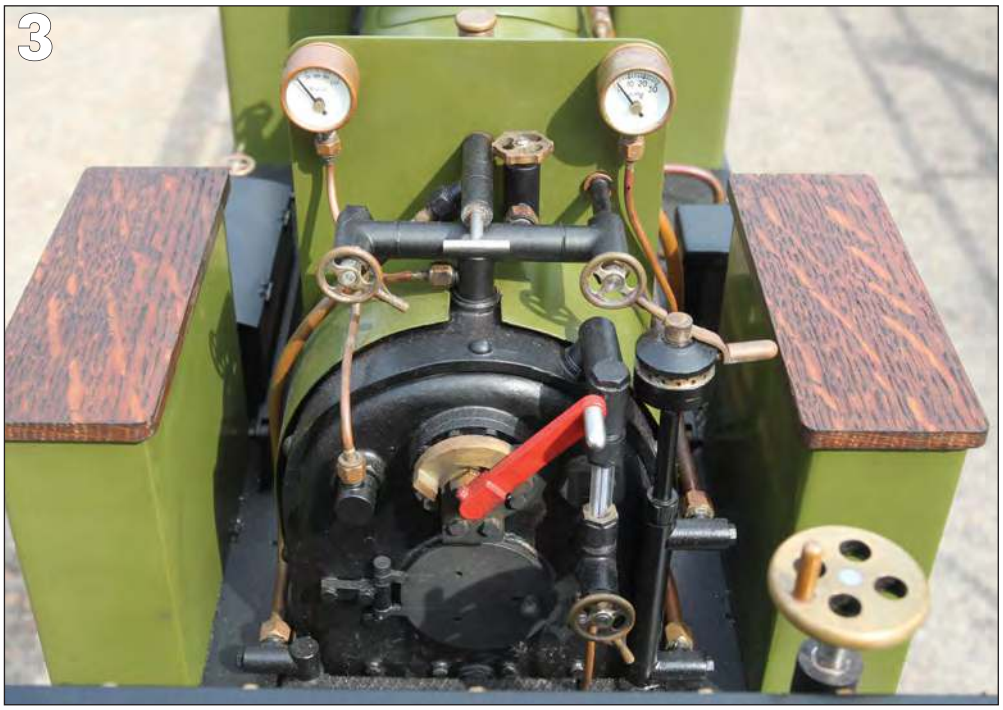


PHOTO 3: Backhead arrangement on completed model of Dougal, with successful version two of the regulator.

Drawings in this series reproduced by kind permission of A J Reeves. Drawings, castings and material for this project are available from A J Reeves.

Previous Episodes of the build...

Introducing Dougal, **April 2018**; Building the boiler, **May 2018**; Frames, axleboxes, **June 2018**; Wheels, eccentrics, **July 2018**; Rods, boiler saddle, **August 2018;** Machining the steam chest, **September 2018;** Adding the eccentrics, **November 2018;** Machining cylinders, **December 2018;** Cylinder covers & slide bars, **January 2019;** finishing the motion, **February 2019.** First run on air, **March 2019;** Building the brakes, **April 2019;** Smokebox pipework, **May 2019**

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Next Month...

"During tests on compressed air I regularly found that air (or steam) was leaking through to the blower..." Andrew continues making the essential backhead fittings.

The demands of owning a 4-inch Burrell

Alan tells the story of one model engineer who discovered that building a traction engine from a kit is no less fulfilling and the result no less involving.

BY **ALAN BARNES**

Tom Pettitt has never regretted registering his 4-inch scale Burrell traction engine for road use. "The engine could hardly turn around in the garden and while the events I attend are always fun occasions the chance to have the engine out on a bit of tarmac is always a bit special," he says.

The superbly built Burrell can be seen on its regular "excursions" around the seaside town of Bexhill-on-Sea in East Sussex, where Tom has his own garage business. The responsibilities of running the business does mean that he has little spare time to devote to his interest in miniature steam but if the opportunity does arise the Burrell will be out and about in steam. The engine, which Tom completed a few years ago, also boasts some interesting features,which would not be found on the full-sized equivalent.

ABOVE: A satisfying build – Tom Pettitt and his 4-inch Burrell that began life as a kit from Modelworks.

LEFT: Early days, Tom's two boys pictured in 2003 with the first traction engine that he owned, a 3-inch Burrell. *Photo: Tom Pettitt*

All photos in this feature by Alan Barnes unless stated

Fair inspiration

Tom's interest in steam engines began in the 1960s when his father would take the whole family to visit some of the local steam fairs. At that early age Tom was perhaps a bit too young to be let loose with live steam but he did develop an interest in building models. Like many youngsters he soon got to grips with Airfix kits, perfecting the annoying technique of gluing parts to the kitchen table. Small wooden planks were turned into boats while a venture into balsa wood aircraft was less successful with the completed model failing its test flight and thereafter remaining as a 'grounded' model.

Good at carpentry at school, Tom considered that this could be a possible career while also having thoughts of being an electrician. Eventually, however, he took a

four-year apprenticeship as a motor engineer. He gained experience working for a number of firms before he was able to open his own business in Bexhill-on-Sea.

Bought to take apart

His first venture into scale steam engineering came with the purchase of a 3-inch Burrell traction engine which he had "bought to take apart". He also bought a set of the Plastow plans with the intention of dismantling the model to decide whether he could scratchbuild an engine of his own. While the engineering aspects of the project did not present too many difficulties and he would certainly be able to make many of the parts it soon became apparent that the one thing that Tom did not have was time. So the 3-inch Burrell remained in one piece and Tom and his two boys rallied the engine from time to time.

A while later while visiting a model exhibition in London, Tom saw the 4-inch Burrell traction engine that was being produced by Modelworks and began to consider building one of the firm's kits. He had already joined his local model engineering club in Polegate, where the knowledge and experience of the other club members would be very useful if he began building his own engine.

"I bought the first nine kits for the 4-inch Burrell from Modelworks in 2008 and the work started," he recalls. However almost as soon as the project had started it stalled, with the bad news that Modelworks had ceased trading and the remaining kits would not be available.

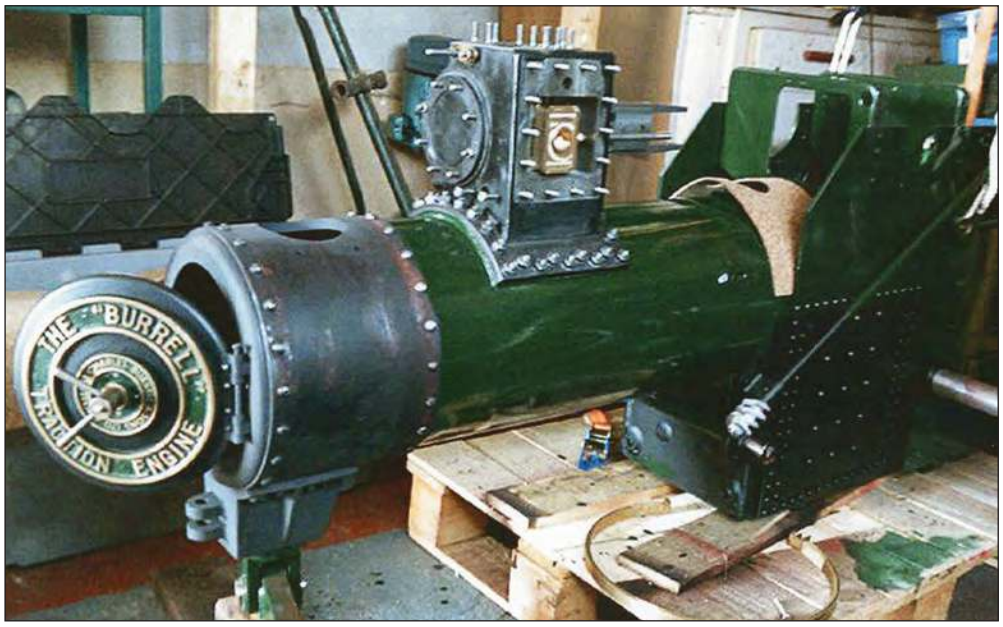
The parts which had arrived were put into store in the garage and plans to build the Burrell were abandoned. "All this was rather depressing, however there was to be light at the end of the tunnel as two of the people who had worked for Modelworks took over the business – it emerged as Steam Traction World and the kits were put back into production. Very soon my Burrell build began again."

Well equipped

Tom's well-equipped garage workshop is equipped with a 3-inch Boxford lathe, a Tom Senior horizontal/vertical mill and a heavy lifting beam, along with probably enough tools to build an aircraft carrier, so the engineering aspects presented few difficulties.

While no real deadlines to complete the Burrell had been set he was keen for the work to push ahead especially after the initial delays. "I found that the parts being provided were of good quality both in terms of machining and materials and the work progressed steadily with no major problems. The build was essentially completed in around two and a half years and I was able to steam the Burrell in the back garden for the first time in March 2010."

Tom describes the building and the painting of the Burrell as very satisfying. "I am pleased with the ▶



ABOVE: The 4-inch Burrell during its interrupted build process .

RIGHT: The build took Tom around 2.5 years, helped by his well-equipped workshop.

BELOW: Two pictures either side of the spectacle plate, showing the driver's view and the cylinder and motion.

TOP LEFT: Detail of the cylinder, with the safety valve and governor mounted on top, and a close-up of the distinctive Chas Burrell works plate .

LEFT: Clever solutions include a coffee granule filter, drilled and inverted to serve as a perfectly good spark arrestor, and a bicycle brake employed on the trailer.

BELOW: The ability to brew up for a cuppa is essential, and the Burrell has a built-in steam kettle to do so...

results although my 'exuberance' with the two-pack paint did cause a problem with the hornplates. I discovered that the bolts holding them to the boiler had become loose because the paint had melted between them, a problem which was soon put right."

Many will say that a steam engine is never finished and since the Burrell has been completed Tom has applied himself to regular maintenance to keep the engine in first class condition and to attend to any problems while also making some additions.

Stopping for tea

While the vice on the running board is a nice touch of much more use is the 'steam kettle'. Tom made this up as a 'Windermere' type built from a Second World War shell casing, part of a mahogany window sill, some copper pipe and some fittings. A coiled pipe in the bottom of the kettle is the heating element and the apparatus can boil two mugs of water in less than a minute. Later a pipe extension to the kettle was also made which can be used to heat a barrel of water for a shower at the end of the day.

Tom has also built a trailer with removable sides – this easily comes apart for loading into the Peugeot van used to transport both the trailer and the engine. The trailer is fitted with a bicycle disc brake and caliper to one front wheel and is operated by a Bowden cable.

While the engine has experienced no real major problems Tom has had 'issues' to deal with from time to time. During the most recent steam test a rather unnerving crackling sound, rather like sausages frying in a pan, started a brief panic until he realised the wax coating of a Babybel cheese was alight in the ashpan!

Heat expansion

As well as the 'cheese firelighters' there have been some mechanical problems to attend to. "I find that if the timing was set when the engine was cold, as soon as the fire was lit and everything warmed through the expansion of the boiler made it necessary to make some adjustments. As the slide valve plate could be removed while the engine was in steam it was a relatively easy job to re-set the timing."

'Tinkering' sometimes has its hazards as Tom found out to his cost when he managed to crush the end of a finger bone while trying to sort out a "heavy knock" coming from either the crank, big end or piston. The problem eventually turned out to be the piston rod which had come loose causing the piston to hit the front cover, something which Tom wished he had discovered before smashing his finger.

A problem was also encountered with the slide valve. "This has a light spring to hold it to the ports but unfortunately this spring had broken and then jammed into a port and snapped the valve.

"I stripped it down but found that brazing was not a good enough fix so I milled it flat on the edge, bolted on a strengthener and then it was re-threaded. This has worked very well and the repair is much stronger than the original ever was."

Another 'tweak' was to design,

make and fit a gear guard to protect little fingers while he has also fitted the grate in such a way that it can be quickly dropped should there ever be any emergency to prevent the fusible plug melting.

Other 'interesting' problems have included losing a tyre on the inside by the flywheel where it was touching and restricting the flywheel itself. "Re-fitting the tyre was a reasonably straightforward job, or rather it would have been if I had taken time to have another read through of the instructions first. By guessing what to do the job took almost twice as long!"

According to Tom the Burrell handles and steams well although it has its little 'foibles'. "I can make steam in just under an hour on a good day although for some reason it can take two hours if I have an 'audience' at an event. Once in steam I now find the engine very easy to manage during a six or seven-hour day especially with good coal with low ash. If needs be I can bank the engine down for a couple of hours and the Burrell will come back into steam very quickly."

Tarmac challenge

He particularly enjoys going out on the road; "It is a great experience and we have the same problems as the 'big boys' only with scale engines they seem to happen three times quicker. Of course problems such as accidental 'wheelies' or loss of steerage can be embarrassing, especially when the engine has a trailer load of school children. However I have found that pulling away with the cylinder drains open is a more 'civilised' approach although I suppose I could increase the weight on the front by adding a lead-filled toolbox or perhaps by shedding a few pounds myself!"

He adds that while time does not allow the Burrell to be rallied at the larger steam events every weekend there are some nice local fetes and gatherings where the engine can get an 'airing'. "Trundling around Bexhill-on-Sea is always fun, especially during a summer like the one we enjoyed in 2018." EIM

■ The author thanks Tom Pettit for taking the time to describe his very fine scale engine.

ABOVE: The running board is home to essential tools...

BELOW: A happy man – Tom on the regulator of his Burrell.

Uncovering the delights of the Search Engine

What becomes a very special day for Matthew also reveals the breadth of a resource that many model engineers might not realise is available to them.

BY **MATTHEW KENINGTON**

Some months ago, I wrote an article for **EIM** describing 'The Warehouse' at the National Railway Museum (January 2019 issue). Whilst bemoaning the poor display of some of the model locomotives, I enthused about it being my favourite part of the museum. On a couple of more recent visits, however, I've discovered a new and even more exciting area and I think my loyalties may have shifted.

'Search Engine' (**Photo 1**) is one of the NRM's best resources for the model engineer as it contains around a million drawings of locomotives, rolling stock, carriages and such, along with more than two million photographs (and no, I'm not exaggerating – I was told this by Andy Croxton who is a member of the Search Engine Assistant team). It is also a good place to carry out other research, as it houses a massive collection of books on various topics and subscribes to a host of railway-related magazines. There are, however, a few even more interesting items…

First, a bit of background: the Search Engine has been in existence for more than 10 years and brings together the railway-related archives of the Science Museum group, in one physical location. It contains most of the locomotive drawings still in existence that were produced by the Crewe, Doncaster and Derby locomotive works, plus many from other locations (including those of the Southern Railway).

York or Didcot?

As a brief aside, if the Search Engine does not have a particular drawing (notably for GWR locomotives built at the Swindon Works), then the Didcot Railway Centre is a good place to look and the staff at Search Engine may well point you in Swindon's direction – they have a list of the material held at Didcot.

I first came across the Search Engine on a visit to the NRM in September 2018. Previously, I had thought it was simply a library and hadn't explored it in any detail. Last September, however, I discovered that it had a mind-blowing collection of locomotive drawings and spent a few happy hours staring at microfiche copies of the general arrangement drawing for the Duchess of Hamilton and No. 1366 – an 0-6-0 Pannier tank engine for which I have a set of GLR Kennions' 7¼-inch gauge drawings – among others. I was hooked.

I returned, better prepared this time, in early January 2019 (with dad and grandad in tow). I looked at some of the drawings prepared by the Swindon works specifically to help model engineers, although these weren't quite as useful as I had hoped, but then asked to see the drawings for Gresley A4 Pacific 'Silver Link'.

There is a story behind why I wanted to view this specific set of drawings. My grandad was a young schoolboy when the loco was first run and he had been tipped-off by an uncle, who was a foreman-ganger with the LNER, that it would (unusually) be passing through Northallerton station on one of its early runs, coinciding with his school lunchtime.

He and a friend ran the length of Northallerton, from his school to the station, to watch it and then returned (a little late!) for afternoon lessons. Grandad also worked in a drawing office early in his career and so knew how to generate and read drawings.

Page of history

Asking to see these drawings turned what was already a great day into one I will never forget. The Search Engine assistant who had been helping us, Ashlynn Welburn, could not find the microfiche drawings for Silver Link

PHOTO 1: Matthew and his grandparents outside Search Engine at the NRM. *Photo: Peter Kenington*

PHOTO 2: Matthew finds out how difficult photographing from the documents viewing room is, he being reflected in the glass. The view over the NRM's Great Hall is worth it...

PHOTO 3: Matthew and his grandad with laid out in front of them the general arrangement drawing for 'Silver Link' – the step ladder in the background allows aerial photographs to be taken of drawings.

All photos courtesy of the National Railway Museum unless stated

and so he asked his colleague Andy Croxton where they might be. This led to an offer to view the original drawings rather than the microfiche copies – would I like to see them? If you had offered me a footplate ride on 'Mallard', I couldn't have been more thrilled. I said yes, with as much self-control as I could muster.

We had to go through a few formalities: all three of us (dad, grandad and myself) had to register with the Search Engine (basically, name and contact details, plus photo ID for the adults) – this made me one of the very few under-16s to register there. Since the staff only visit the archive itself three times per day, we had to wait for one of these scheduled visits, so lunch distracted us whilst we waited. We returned after lunch and were directed into a special glass-walled room (with a fantastic view over the Great Hall – **Photo 2**) where the drawings were waiting for us. These were original copies of the general arrangement drawing, and the outline drawing, for Silver Link on coated linen (not paper, as I had expected – I'm still learning, don't forget). Grandad and I (and dad) spent hours studying them (**Photo 3**).

There were some fascinating details evident on the drawings: on the outline drawing, the name 'Silver Link' had been crudely erased (**Photo 4**) and moved to a nameplate on the front (as on Mallard, currently, **Photo 5**). I researched further on the internet that evening, and found a photograph of Silver Link just after it had rolled out of the Doncaster works for the first time; lo and behold, there was its name placed in the centre of the streamlining, just as in the (altered) drawing (**Photo 6**).

My dad pointed out the pin-pricks where the compass-point had been placed to draw the arcs present on many parts of the drawing, showing that they were arcs of a circle and not freelance curves (a useful detail for the model engineer). The general arrangement drawing also showed a change to the model number of the injector (which was an outsourced component) from when it was first drawn – this is in **Photo 7** although the change is too small to be seen in this overall picture.

Delights down under

Seeing Silver Link's original drawings would have been quite enough to make my day, but one more surprise was in store for us. While we were enquiring about taking photos (and completing the associated paperwork) Ashlynn asked if we might be interested in a tour of the archive (which, as it turns out, sits right underneath the Search Engine rooms we were in). Having just had Christmas, another one came along so soon afterwards! We said yes, with barely-suppressed glee.

By this time, grandma and mum had turned up, so the five of us were given a comprehensive tour by the head of the archive. Andy Croxton hosted the tour, ably assisted by Ashlynn, and clearly loved his work, having such a fantastic resource at his disposal; his enthusiasm (and that of all of the Search Engine staff we met) was infectious. We saw so many wondrous things…

The first highlight of these was George Stephenson's notebook detailing the component parts for 'Rocket' and 'Locomotion No. 1'; this is the only record of his designs because the Stephensons did not produce drawings, preferring instead to make chalk sketches on the floor, which were then erased once a part had been fabricated. However this book is slightly different as it does not contain just a list of part numbers but an accurate description of each of the parts – from which, even now, a drawing could be made.

Food for thought

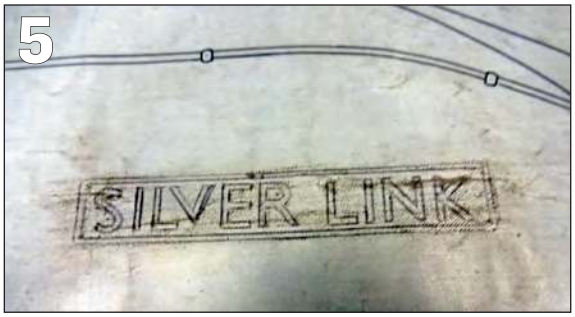
Another item associated with Stephenson is *The Stephenson Family Recipe Book*; this item is truly unlike any other as it contains their personal recipes for cakes (one of which was baked for the Search Engine's 10th Anniversary celebration), alcoholic drinks and much more. Think, Mrs Beaton meets James Watt!

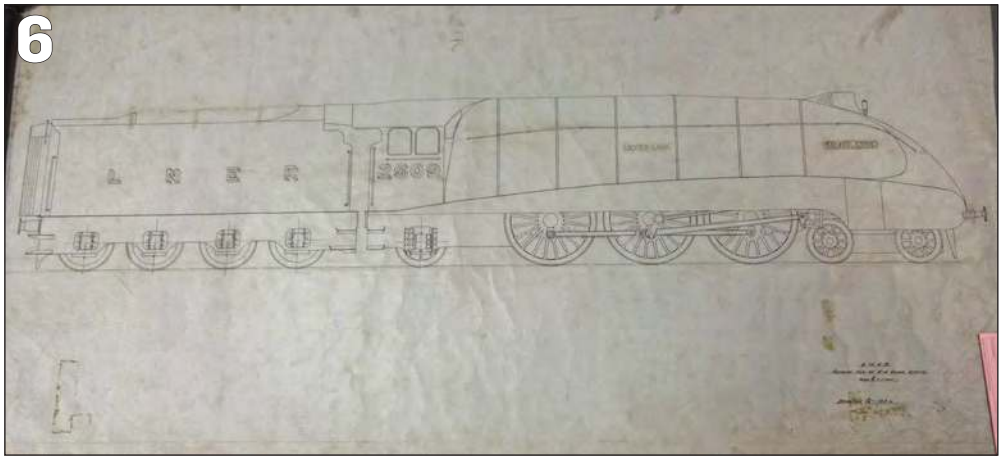
There are many more items linked to the Stephensons – the archive also houses Robert Stephenson and Co.'s files and financial documents. We also learnt of the existence of another interesting artefact linked to the Rainhill trials. John Rastrick was one of the judges for the trials and his noterbook contains sketches of all of the engines that took part and notes on their performance. Sadly, it was on loan to the Museum of Science and Industry in Manchester at the time of our visit, so we didn't get to see it.

Another interesting piece from the early days of railways is a letter believed to be from the first train spotter, containing a small sketch of Locomotion and its carriages, sent by an eye-witness to the opening of the Stockton and Darlington railway. Other gems include the Hackworth family archive, which was recently given to the NRM by a descendent of Stephenson's contemporary and rival Timothy Hackworth, and the sketch book that belonged to the first locomotive superintendent of the Great Western Railway, Daniel Gooch. ▶

PHOTO 4: The original location of the name 'Silver Link', erased on the outline drawing.

PHOTO 5: New location of the name – now in the form of a nameplate, rather than the original painted-on version.





This latter book is absolutely immaculate and contains sketches for most of Gooch's locomotives plus detailed views of their component parts. He took the book everywhere with him to note down or sketch ideas as they came to him.

The archive also contains a large collection of railway posters and their original artworks. We were shown the delightful (and very famous) 'Skegness is so bracing' poster, looking like the day it was produced.

Other oddities include carpet samples from the Flying Scotsman and other famous trains, plus a huge range of books, photos (including large glass-plate originals), railway timetables and more.

Having whet your appetite, how can the model engineer make use of this tremendous resource? There are a number of options, depending upon what you want to do:

1. You can obviously turn up in person (as we did) and access the archive. The simplest way to do this is using the microfiche collection, which is available in the main part of the Search Engine (i.e. the staff do not need to go down to the archive to retrieve these materials). The relevant portion of the NRM website (www.railwaymuseum.org.uk/research-and-archive) contains online catalogues of the drawings which are available and these can be used to work out what you would like to see.

PHOTO 6: A typical outline drawing from Search Engine's collection – for Gresley's A4 4-6-2 Pacific Silver Link. Note the resited nameplate position from centre to front.

PHOTO 7: The general arrangement drawing for the LNER A4 class locomotive – photographed using the step-ladder provided at Search Engine for the purpose.

If you do plan to request actual drawings (as opposed to microfiche copies), then it pays to ask in advance. It is recommended that you reserve items at least a week in advance and up to six items can be reserved, with a further three items being obtainable on the day.

One useful tip is that a single 'retrieval' request can mean the tube/box in which the drawings are contained – such a container may contain a number of drawings (including the one you actually want) and you can ask to see all of the drawings in the same box; the advantage being that this would only count as a single item (and you will find other useful drawings, related to the same loco, within the box).

Photography is permitted, for personal use, though it does require separate registration. Publication of photos taken or the use of the drawings for commercial purposes (including producing model engineering drawings for sale), requires separate permission.

2. You can request copies of the drawings to be sent by post or e-mail (one for the bedroom wall?). There is a charge for this, which varies depending upon whether you are looking for a copy of a microfiche drawing to be sent by e-mail, through to a scan/print of an original drawing.

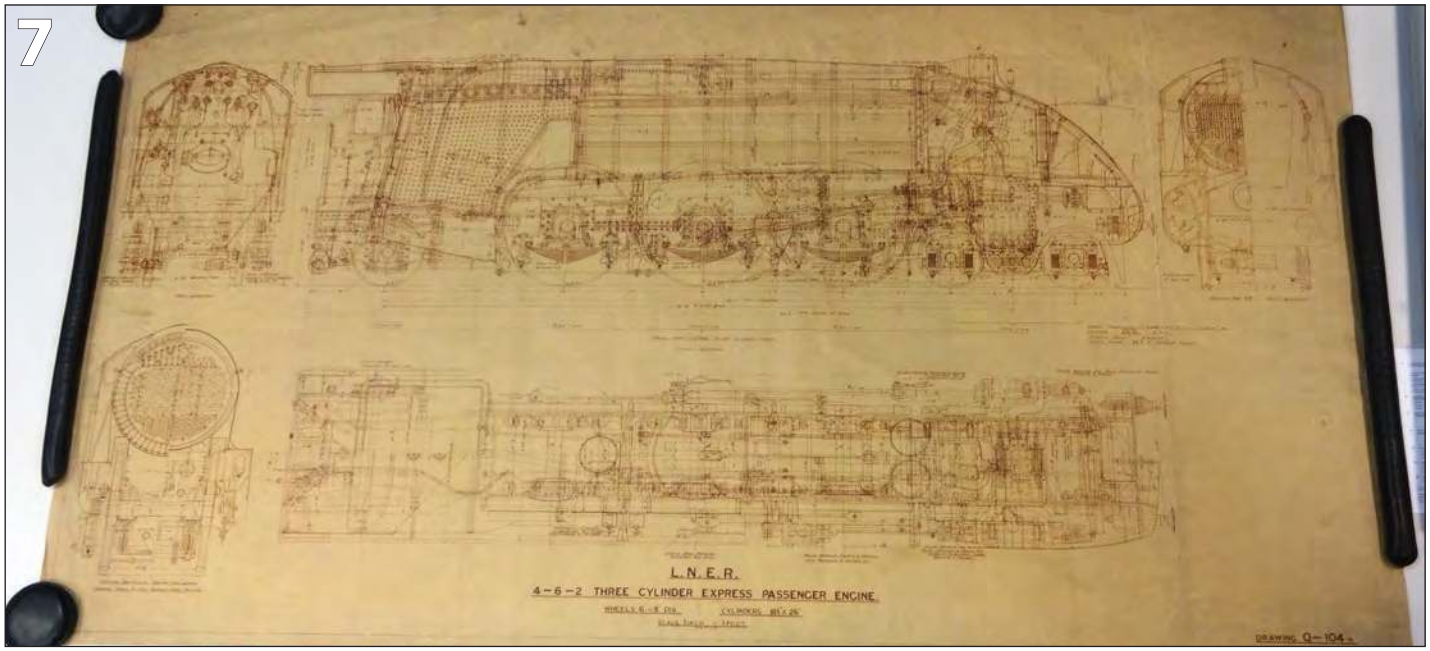
Volunteer searches

Prices vary between £7.50 for an e-mailed digital scan of a microfiche drawing to £33 + £18 postage for a full-size print, with other options in-between. Order forms are downloadable from the NRM site (see the 'copying and copyright' section).

3. You can pay a volunteer to undertake your searching for you (in person, at the NRM). This is known as the 'Inreach Service' and costs from £25 for half a day (the fee goes toward supporting the NRM archive and not to the volunteer).

The staff are also happy to arrange tours around the collection, for interested parties (model engineering societies, for example). I would thoroughly recommend you go on one if you are located anywhere near local to the museum.

As a model engineer, the Search Engine represents an invaluable resource from which to source ideas and material on that obscure locomotive you want to model, and for which no-one has yet produced drawings – I have my eye on an 0-4-0 tram engine, for example – or to obtain fuller details to enhance the accuracy of a model to be made from a published drawing. "York is lovely in the summer", you can tell your other half... EIM



Tower Bridge Operations Manual

By **John Smith**

Newly arrived in the **EIM** editorial office is this fascinating book on one of London's, perhaps the world's, best-known landmarks.

John Smith will be well-known to current **EIM** readers as the man behind the useful 'Tips for Model Engineers' articles that we run each month – he was the first new writer to the magazine secured by Andrew Charman when he tool over the editor's chair in January 2018, and John also now joins our editor in the exclusive club of Haynes Manual writers – Andrew produced *The Steam Locomotive Driver's Manual* in 2015.

You might think that Tower Bridge is all about civil engineering, and yes it is, but partly. There is also a great deal of mechanical engineering involved, principally in the originally steam-powered machinery to raise the two massive bascules and allow shipping to pass through the bridge. Any **EIM** readers who read the effective preview of the description of these with features in the November and December 2018 issues will know that the text in the book matches John's writing style in this magazine – highly readable but not lacking in any detail.

Production of the book has clearly been a passion project as the research has been extensive, unearthing and using a host of period illustrations and drawings that are as fascinating as they are informative – you really need to see some of the way-out early designs, from the most notable engineers of the time, that were considered for the bridge...

In summary this is an excellent work that offers plenty to the typical **EIM** audience – even if you don't think you are interested in Tower Bridge, you likely will be after reading this.

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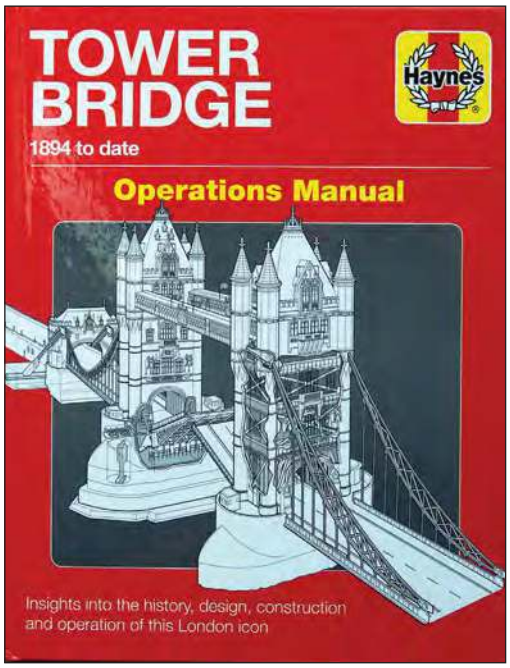

Success of SMEE Polly model engineering course

Received just too late, unfortunately for inclusion in the May issue was the news that the Society of Model and Experimental Engineers (SMEE) is again running its popular 'Polly' course this year, starting on Saturday 18th May.

According to the SMEE this is now almost the only practical model engineering training available in the UK and shows participants how to build a small stationary steam engine based on Tubal Cain's (T.D. Walshaw's) popular Polly design. At least 200 people have now enjoyed this course which demonstrates the basics of making a small working engine.

Skills demonstrated during the course include sheet metal work, boiler making with silver soldering, turning, reaming, pipe work, tapping and accurate drilling among others.

Many participants have gone on to make larger and more complex models or to work on larger engines. Those on the course come from a wide range of backgrounds – some are complete beginners, though others with more engineering experience have also found taking part in the course highly beneficial.

The course runs once a month over six Saturdays and takes place at the Society's well-equipped workshop in South London. Tutors are all experienced model engineers and SMEE members.

Details of classes and other SMEE training available including the milling course, tool grinding course and boiler management training are on the SMEE website, www.sm-ee.co.uk. Alternatively details can be had from SMEE Training Coordinator Alastair Wright at courses@sm-ee.co.uk or on 07415 133048.

PHOTOS: Paul Relf-Davies with the Polly model he made on the 2018 course and the boiler under construction.

Mixed fortunes in the clubs

One club loses its track, another extends in this month's round-up.

COMPILED BY **ANDREW CHARMAN**

We start this month's club round-up on a low note sadly, with the news, just as we closed for press (and long after our diary pages had gone to press)that the **Leeds SME** has to vacate its track site at Eggborough Power Station due to the sale of the land for redevelopment.

As a result the programme of running days has had to be deleted as during the summer club members will be engaged in dismantling the existing track.

The club's 'Speaker Evenings' later in the year have been transferred just down the road to Drax Power Station Sports and Social Club. Leeds secretary Geoff Shackleton promises us an update on the track situation soon.

Civil engineering

To better news, with a report from Rob the secretary of the **Cardiff MES** on a busy winter that has seen some serious civil engineering taking place at the Heath Park track in the Welsh capital city..

An extension to the ground-level tracks, providing an additional and extended loop around the east end of the present line, requires the 18-inch gauge electric tramway to be realigned. This realignment will eventually include a passing loop at the halfway point where the new passenger platform will be located.

The opportunity has been taken to replace many of the old wooden sleepers with longer lasting, more durable cast concrete ones on the tram line. For the time being, the tram rides on public running days will run over half the line only. This change will allow the running of both of the Society's trams, although the smaller toast-rack type needs some work to bring into full operation.

All this work required much earth removal within one section whilst also widening and building up the groundwork elsewhere. The task is ongoing and will keep the members who are involved in the job busy for months to come.

It's not all digging and wheelbarrowing, however. The Hunslet 0-4-0 7¼-inch gauge steam locomotive that was kindly donated to the Cardiff society is being rebuilt with some critical new parts to the running gear, the work in the skilled hands of members.

ABOVE: Cardiff is one of the few clubs with an active and impressive tramway.

BELOW: Progress on the Cardiff 16mm scale line includes this impressive climb to a new section on a high level. *Photos: Cardiff ME*

The 16mm/ft scale garden railway at Cardiff has also had some attention paid to it, in particular a new double track on a raised level. This will allow more locomotives to run especially for the entertainment of younger visitors and is best viewed from the new vantage point on the wheelchair/pushchair friendly bridge that gives easy access to the centre of the site. Members run a variety of live-steam and remote-controlled battery locomotives on this track.

The OO section of the club is making steady progress on their current 'Broadwell' layout, which currently is in use on public running days. A narrow gauge OO9 section has been added along the estuary whilst the scenery at the station end of the layout is all but complete.

At the same time planning has been in hand for the Society's 29th Annual Rally over the weekend of 8/9th June – this event is always enjoyed by all who attend.

June is a prime month for clubs holding open weekends with the emphasis on welcoming visitors and their locomotives, and one example is the **Melton Mowbray & District MES**. The open weekend on 1st-2nd June is known as 'Whissendine 2019', basically because it happens at the club's track at Whissendine Sports Club near Oakham in Rutland (postcode LE15 7EU).

A similar format to previous years is promised with plenty of opportunities for running and operating miniature road and railway engines as well as displaying

stationary models, aircraft, model railway layouts and more. Road runs are also planned into the village, to the local windmill or the furthest target, the White Lion Inn!

The club operates a ground-level track for 5 and 7¼-inch gauge locos and will also be serving light refreshments from its new clubhouse. A barbecue is also promised on Saturday night with attendees encouraged to steam their engines for extra atmosphere!

Also opening up to visitors in June is the **North Wilts MES**, holding its Invitation Summer Rally on 15th and 16th June at Coate Water Country Park, Swindon (postcode SN3 6AA).

The club's 7¼-inch and 5-inch ground level railway will be in operation, for members and visitors from other clubs on Saturday and for the public on Sunday. There's still time for visitors to secure an entry to this event, if they contact Ken Parker on 07710 515 507 or kenneth.parker1@ntlworld.com before 31st May.

A third club looking forward to hosting visitors this month is the **Cambridge & District MES**, which will be holding its annual Invitation Day on Saturday 29th June at its track on the outskirts of the city, just off the M11 motorway.

The club boasts a highly scenic run on its ground-level track, which includes 7¼, 5 and 3½-inch gauges and extends to more than two thirds of a mile. The clubhouse and its facilities will be open throughout the event and the club also plans a barbecue on Saturday afternoon. Camping or caravanning is available on Friday and/or Saturday night and anyone interested in attending can find out more details through the club's website, www.cambridgemes.co.uk, or by contacting organiser Sean Brooks on 07926 621670 or at events@cambridgemes.org.uk

ABOVE: Whissendene, more than lust a weekend for visiting engines...

BELOW: Super shot from Barry Green of the Grimsby & Cleethorpes club, taken from the footbridge overlooking the steaming bay n a busy boiler test day.

Party time in the Lakes

Perhaps the most celebration, however, will be going on at the **South Lakeland MES**, which in 2019 celebrates 20 years since the official opening of its track in Lightburn Park, Ulverston. On Saturday 22nd June the big anniversary will be marked by an open day and celebratory event. The club intends to includes a small exhibition of work, a display by local vintage motorcycle clubs and hopefully some fun events for younger visitors – more details on the website at www.slmes.co.uk

Turning to the pleasingly varied selection of club magazines that continue to arrive at **EIM** Towers, reminds us that of course such open days and the plethora of public running now happening (see the diary pages) are only possible due to much behind-the-scenes work by the clubs concerned, and not least the early-season boiler testing days. We were much taken by a picture from the April edition of *The Blower* from the **Grimsby & Cleethorpes MES**, which shows this year's boiler test day on 16th March – despite the inclement weather a wide variety of locomotives were present for testing, in various states of completion. Particularly noticeable is the impressive 'Britannia' loco built by Graham Dumbleton – almost completed but yet to go to the paint shop. A couple of road locos also got their test on the day, and the impression that comes out of the pictures is very much of a healthy, vibrant club.

Very big road loco

The latest edition of the *Cinderbarrow Flyer* from the **Lancaster & Morecambe MES** shows that Martin Johnson's 7-inch scale Fowler, currently being serialised in our pages, is by no means the only large-scale steam wagon currently in build. Club member Adrian Nash begins to describe the build of his Foden wagon, which he is constructing in 9-inch scale.

This will be no minor proposition; Adrian says he's always wanted to build a large model – "when I say large, I mean very large..." and as a result he has simply doubled the dimensions for a 4½-inch Foden previously built with his father. The resultant engine will be six metres long, two wide and 2.3 metres high, while weighing in at a mere 2.8 tonnes! In fact it's so big that Adrian started construction by building himself a larger, centrally heated, workshop. Adrian if you'd like to write this up for a wider audience, we would love to hear from you...

Meanwhile there appears to be a lot going on at the Cinderbarrow Railway location of the club, from one member building a mini Land Rover to a group adding a brand-new Gauge 1 layout to the club's facilities.

We don't often hear from the **Frimley & Ascot Locomotive Club**, whose track, the Frimley Lodge Miniature Railway, occupies a prime site adjacent to Ascot racecourse. So we are particularly pleased to be told of forthcoming Open Running Days on Friday & Saturday, 19th-20th July, when the club will be welcoming visiting 5in and 7¼in gauge locomotives to run on its 1km track. Running will commence from 11am each day and finish around 5pm.

On Saturday there will be a lunchtime barbecue and limited ▶

public running in the afternoon using the club's vacuum-braked stock.

Visiting locomotives will require both boiler certificates and public liability insurance from their home club and the club emphasises that as the track is laid for 3½, 5 and 7¼-gauge locomotives visiting engines will need checking to ensure they meet the club standards for wheel profiles. More details are on the website at www.flmr.org and further information and running slot bookings can be obtained from Rob Myles on 07919 406488.

Of course it's not all about railway locomotives. The latest edition of the newsletter from the **Model Steam Road Vehicle Society** reminds us that this club too has its major event of the year in June, 22nd-23rd to be precise with the annual rally at the Tewkesbury Rugby Club in Gloucestershire. The great gathering of road engines will include a hog roast on the Saturday night.

One impressive tiny snippet that emerges from the latest journal of the SMEE, the **Society of Model & Experimental Engineers** is that the Society is now its 121st year, – a very impressive figure... Looking through the packed journal, with many and varied groups, talks and training, and it is clear that the SMEE is in rude health – long may this continue...

As just one example, elsewhere in the journal Bill Starling describes his impressive and unusual model of an early Burrell traction engine, with a vertical boiler. The 6-inch scale model is a recreation of the smallest engine ever made by Burrells, the firm's response to the Locomotives on Highways Act of 1896 that repealed the notorious Red Flag Act of 1865 – partly due to pressure from the embryonic motor car industry.

The Act allowed the operation of 'light locomotives of less than three tons and Burrell built something suitable. Bill built his loco from the works drawings, which survive – no photos are known to exist of this particular engine. Bill if you are reading this is another that would certainly make an interesting feature on this magazine's pages...

By the way, one aspect of the SMEE Journal we particularly like is 'Work on the Table' – simple pictures showing current projects, from stationary engines to restoring fire-damaged Christmas decorations...

How far will model engineers travel to get some steaming in? Quite a long way according to the latest edition of the **Ryedale SME** newsletter. Reports of recent steaming days include one on 31st March at which visitors included Nigel Fraser Ker, a member of the Sutton society in Sussex. Apparently he and his son George made a two-day round trip from Epsom to visit the Locomotion museum at Shildon and Castle Howard on the Saturday and then the Ryedale club on the Sunday. Nigel must have liked what he saw as he intended to make the jounrey north again for driver training at Ryedale on 2nd June...

Cambrian full of beans

They may still be a very young club and have no permanent premises but the **Cambrian ME** are enjoying an increasingly busy programme. The latest holding of the Chairman's Birthday Competition took as its theme a look back at the period at the end of the Second World War, *Martin Rant* tells us.

Members were asked to build an item of their own choice using only bean tins and household items, and constructed using only hand tools.

Judging took place on Monday 4th March, and was judged by Mr Bill Jameson from a nearby village. First place was awarded to Steve Terris for his excellent raft, and second was a delightful spider produced by Geoff Bentley. Steve also took third place with an extremely attractive bird. The morning was rounded off with tea and cakes to end a very pleasant event.

That's it for this month. Keep sending your magazines in, but we'd especially like to see some specific reports – and some photos! EIM

BELOW: Who knew that one could do so much with baked-bean tins? The spider and the bird were worthy runners up in the Cambrian ME's Chairman's competition, but the raft made by Steve Terris won the day. *Photos: Martin Rant*

Stacking measurements causes a pile-up...

Think of the engineer

I noted Harry Billmore's tribulations with successive point-to-point measurements with sympathy ('Measure for Measure', **EIM**, May 2019). However, I have little sympathy for the person who produced the drawing he was presumably working to.

It may be taken as a version of sod's law that stacked measurements will all too often result in an intolerable pileup of tolerances (pun intentional). Hence good practice demands that measurements have a common reference when they are all travelling in the same direction.

I have to point this out almost every year to innocent students who have never worked on the bench or do not understand the reason for the strictures on this point in the texts.

John Bauer

The editor replies: A good point well made – perhaps an example of the end user not really being considered when the drawing was produced. I see similar situations in the many miles I drive by car in my 'other' job, where 'road improvements' have clearly been drawn up in an office by someone who has never been to the site to analyse what effect their 'improvements' will have!

Trick to avoid a short

Reading Peter and Matthew Kenington's excellent and comprehensive article on rust removal using electrolysis (**EIM**, May 2019) they mention the possibility of a short circuit happening.

One of the things I learnt from my father in the early 1950s is if there is a possibility that a short circuit can happen then wire in series a suitability rated light bulb. In this setup a 12-volt bulb rated at 48 watts would limit the current to 4 amps in the event of a short.

To increase the current while de-rusting add further bulbs in parallel or higher wattage equivalents, two or three bulbs would probably be sufficient.

A further benefit of this technique is that one can monitor the progress by observing the glow of the bulb or bulbs used. I generally use car headlight bulbs that have blown the dip beam filament – I have a bank of six bulbs wired via five switches and this lets me select the current required easily.

The science of this technique is that when cold the resistance of the bulb is low, when hot the resistance increases. This tends to keep the current fairly constant which is good for plating and de-rusting.

This is a very useful technique when testing a new circuit, as it saves blowing things up!

Blacksmith Bob

JUNE 2019 DIARY

EVERY SATURDAY
(Weather permitting)

South Lakeland MES public running, Lightburn Pk, Ulverston, pm

Sussex MLS public running, Beech Hurst, Haywards Heath, 2-5pm

EVERY SUNDAY
(Weather permitting)

Bournemouth SME public running, Littledown Pk, BH7 7DX, 11am-3.30pm

Canterbury SME (NZ) Public running from 1pm at Halswell Domain

Fylde SME Public running at Thornton Cleveleys from 1pm.

Grimsby & Cleethorpes MES public rides, Waltham Mill, DN37 0JZ, 12-4pm

Harrow & Wembley SME public rides, Roxbourne Park, Eastcote, 2.30-5pm

Kings Lynn & District SME, Lynnsport Miniature Railway, 11am-4pm

Kinver MES public running, Marsh Playing flds, High St, Kinver DY7 6ER.

Lancaster Morecambe ME public running, Cinderbarrow Railway, Tarn Ln, nr Yealand Redmayne, from 10am

Maidstone MES public running, Mote Pk, ME15 7SU, 2.30-5pm

North Wilts MES public rides, Coate Water Railway, Coate Water Country Park, Swindon, 11am-5pm

Norwich SME public running, Eaton Pk, 1-5pm, NR4 7AU

Portsmouth MES public running, Bransbury Pk, PO4 9JY, 2-5pm

Rochdale SME public running, Springfield Park, Bolton Road (A58), Rochdale, pm

Southport MES Public running at Victoria Park 11.30am – 4.30pm

Sussex MLS public running, Beech Hurst, Haywards Heath, 2-5pm

Urmston MES Public running in Abbotsfield Pk 11am – 3.30pm

Vale of Aylesbury MES Public rides, Quainton Rly Centre, from 12 noon.

West Huntspill MES public running, Memorial playing fields, 2-4.30pm

Wigan MES public rides, Haigh Woodland Pk, School Ln, Haigh, Wigan, PM

Wirral MES Public running, Royden Pk, Frankby, 1-3.30pm.

EVERY TUESDAY
(Weather permitting)

Romney Marsh MES Track meeting, Rolfe Ln, New Romney from 11am

Bromsgrove SME public running, Avoncroft Museum of Historic Buildings, B60 4JR 11.30-3pm

EVERY WEDNESDAY
(Weather permitting)

Bournemouth SME public running, Littledown Pk, BH7 7DX, 11am-3.30pm

Harrow & Wembley SME members meeting, Roxbourne Park, Eastcote, 2.30-10pm

Kings Lynn & District SME, Lynnsport Miniature Railway, 11am-4pm

1 Ickenham SME public rides, Coach & Horses pub, Ickenham, UB10 8LJ, noon-5.30pm

1 North Wilts MES public rides, Coate Water Railway, Coate Water Country Park, Swindon, 11am-5pm

1 SMEE talk, Rail Safety Management by David Maidment, Marshall House, London SE24 0H, 2.30pm

1 Tiverton MES Running day, Rackenford, contact Chris Catley, 01884 798370

1 York ME Engineering Challenge, North Ln, Dringhouses YO24 2JE, 7pm

1 2 Melton Mowbray MES Open Weekend, Whissendine Sprts Club, nr Oakham, Rutland, LE15 7EU

2 Bristol SMEE Club Day, Ashton Court Railway, BS8 3PX 7.30pm

2 Frimley Lodge MR public running, Frimley Lodge Pk, GU16 6HT, 11-4pm

2 Northampton SME Public Running, Delapre Pk, NN4 8AJ, 2-5pm

2 Plymouth MS public running, Goodwin Pk, PL6 6RE, 2-4.30pm

2 Romney Marsh MES Small locomotive Rally, Rolfe Ln, New Romney from 11am

2 Welling MES public running, electricity station, close to Falconwood rail station, Kent 2-5pm

2 Wimborne DSME public running, Dorset, BH21 3DA, 11am-4pm

3 Lancaster Morecambe ME members evening running, Cinderbarrow Railway, Tarn Ln, nr Yealand Redmayne, from 5pm

4 Canterbury SME (NZ) meeting, Halswell Domain, 7.30pm

JUNE 2019 DIARY (continued)

5 Bradford MES Electric loco competition & running evening, Northcliffe Woods, Shipley, 7.30pm

5 Bristol SMEE CNC evening, Begbrook Soc Clb, Frenchay Park Rd, Bristol BS16 1HY, 7.30pm

6 Lancaster Morecambe ME public running, Cinderbarrow Railway, Tarn Ln, nr Yealand Redmayne, from 10am

6 South Lakeland MES meeting, Pavilion, Lightburn Pk, Ulverston, 7.30pm

6 TIME meeting, Pipers Inn, 70 Bath Road (A39), Ashcott, Somerset TA7 9QL, 7pm

7 Portsmouth MES club night, Members ME projects, Bransbury Pk, Portsmouth PO4 9JY, 6.30pm

7 Rochdale SME model competition night, Castleton Comm Cntr, Rochdale OL11 3AF, 7pm

7 Tiverton MES meeting, Old Heathcoat comm ctr, contact Chris Catley, 01884 798370. 7.30pm

8 Lancaster Morecambe ME 40th Anniversary Party & Exhibition, Cinderbarrow Railway, Tarn Ln, nr Yealand Redmayne, from 2pm

8 Cardiff MES Welsh Locomotive Rally,
9 Heath Park, 1pm-5pm

9 Bedford MES public running, Summerfields' Railways, High Rd. Haynes MK45 3BH, 10.30am-3.45pm

9 Bracknell RS public running, Jocks Ln, Binfield Rd, RG12 2BH, 2-6.30pm

9 Bristol SMEE public running, Ashton Court Railway, BS8 3PX 7.30pm

9 Cambridge MES Public Running, Fulbrooke Rd, CB3 9EE, from 1,30pm

9 Canterbury MES public running, Brett Quarry, Fordwich, 2-4pm

9 Harlington Loco Society public running, High St, UB3 5ET, 2-5pm

9 Hereford SME public running, Broomy Hill, HR4 0LJ, noon-4.30pm

9 Leeds SME public running, Eggborough Pwr Stn, DN14 0UZ, from 10am

9 Plymouth MS members day, Goodwin Pk, PL6 6RE, 12-4pm

10 Bedford MES Short Talks Evening, 'Canals, Opticians, WhizzBangs,' Summerfields Miniature Railway MK45 3BH, 7.30pm. Contact meetings@bedfordmes.co.uk

10 Otago MES (NZ) general meeting, 1 John Wilson Drive, St Kilda, Dunedin, 7.30pm

12 St Albans MES meet, canal boat President No 195 by Richard Thomas, Christchurch Ctr,High Oaks, AL3 6DJ, 7.30pm

15 Cardiff MES Steam Up & Family Day, Heath Park, 1pm-5pm

15 Northampton SME Club run, Delapre Pk, Northampton, NN4 8AJ, from noon

15 York ME Exhibition night, North Lane, Dringhouses YO24 2JE, 7pm

15 LittleLEC 2019, Bracknell RS, Jocks
16 Lane, RG12 2BH

15 North Wilts MES Invitation Summer
16 Rally, Coate Water Railway, Coate Water Country Park, Swindon

16 Bristol SMEE public running, Ashton Court Rly, BS8 3PX 7.30pm

16 Plymouth MS public running, Goodwin Pk, PL6 6RE, 2-4.30pm

16 Rugby MES public running, Onley Ln, CV22 5QD, 2-5pm

16 St Albans MES club running, Puffing Field, WD4 9DA, 10am

16 Tiverton MES Running day, Rackenford, contact Chris Catley, 01884 798370

16 Welling MES public running, electricity station, close to Falconwood rail station, Kent 2-5pm

16 Wimborne DSME public running,
17 Dorset, BH21 3DA, 11am-4pm

19 Bristol SMEE Midsummer Mayhem, Ashton Court Railway, Bristol, BS8 3PX 7.30pm

19 Grimsby & Cleethorpes MES meet, Waltham Mill, DN37 0JZ, 7.30pm

19 Leeds SME Mid-Summer steam-up, Eggborough Pwr Stn, DN14 0UZ, 12.30pm-late

21 Rochdale SME general meeting, Castleton Comm Cntr, OL11 3AF, 7pm

22 Pimlico Light Railway junior training, Pimlico, Brackley, NN13 5TN

22 South Lakeland MES Open Day & 20th Anniversary, Lightburn Pk, Ulverston, 10.30-4.30pm

22 Model Steam Road Vehicle Soc Rally,
23 Tewkesbury Rugby Club, GL20 5PG

23 Bedford MES public running, Summerfields' Railways, High Rd. Haynes MK45 3BH, 10.30am-3.45pm

23 Bristol SMEE Club Day, Ashton Court Railway, BS8 3PX 7.30pm

23 Cardiff MES public running, Heath Park, 1pm-5pm

23 Guildford MES Stoke Park Railway open day, Stoke Park, Guildford GU1 1TU, 2-5pm

23 Harlington Loco Society Teddy Bears' picnic, High St, Harlington UB3 5ET, 2-5pm

23 Hereford SME public running, Broomy Hill, HR4 0LJ, noon-4.30pm

23 Pimlico Light Railway public running, Pimlico, Brackley, NN13 5TN

23 ork ME Open Day, North Lane, Dringhouses YO24 2JE

25 Wigan MES meeting, Ince Methodist Church, Manchester Road, Ince, Wigan, WN1 3HB 7pm

26 St Albans MES club running, Puffing Field, WD4 9DA, 1pm

27 Lancaster Morecambe ME public running, Cinderbarrow Railway, Tarn Ln, nr Yealand Redmayne, from 10am

29 Cambridge MES Invitation Day, Fulbrooke Road, Cambridge, CB3 9EE

29 Romney Marsh MES Midsummer Track meeting & BBQ, Rolfe Ln, New Romney from 12 noon

29 York ME Club Maintenance Day, North Lane, Dringhouses, York YO24 2JE, 7pm

29 Southport MES Open Weekend,
30 Victoria Pk, Rotten Row, PR8 2BZ,

30 Bristol SMEE public running, Ashton Court Railway, Bristol, BS8 3PX 7.30pm

30 Otago MES (NZ) running day, 1 John Wilson Drive, St Kilda, Dunedin, 1.30pm

30 Welling MES public running, electricity station, close to Falconwood rail station, Kent 2-5pm

Details for inclusion in this diary must be received at the editorial office (see page 3)at least EIGHT weeks prior to publication. Please ensure that full information is given, including the full address of every event being held. Whilst every possible care is taken in compiling this diary, we cannot accept responsibility for any errors or omissions

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SUBJECT INDEX

AUTHOR INDEX

QUICK GUIDE

This index covers **Engineering in Miniature** volume 40 nos 1 to 12, July 2018 to June 2019. For ease of use the feature is listed with its month of publication followed by the page – so for example Aug 33 means August 2018 issue, page 33. Digital copies of previous issues can be downloaded or printed versions ordered from www.world-of-railways.co.uk/engineering-in-miniature/store/back-issues/ or by telephoning 01778 392484.

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