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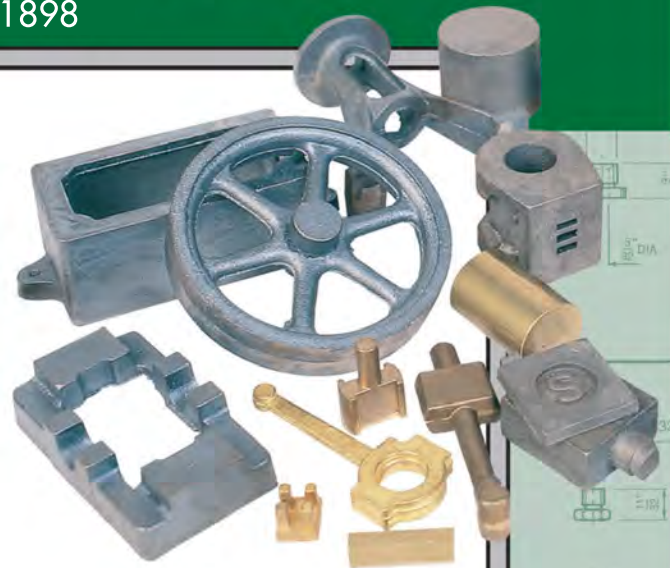


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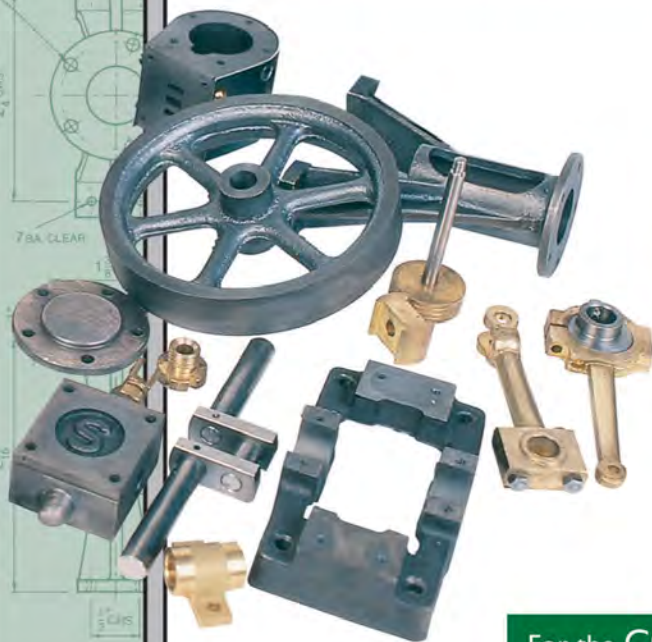
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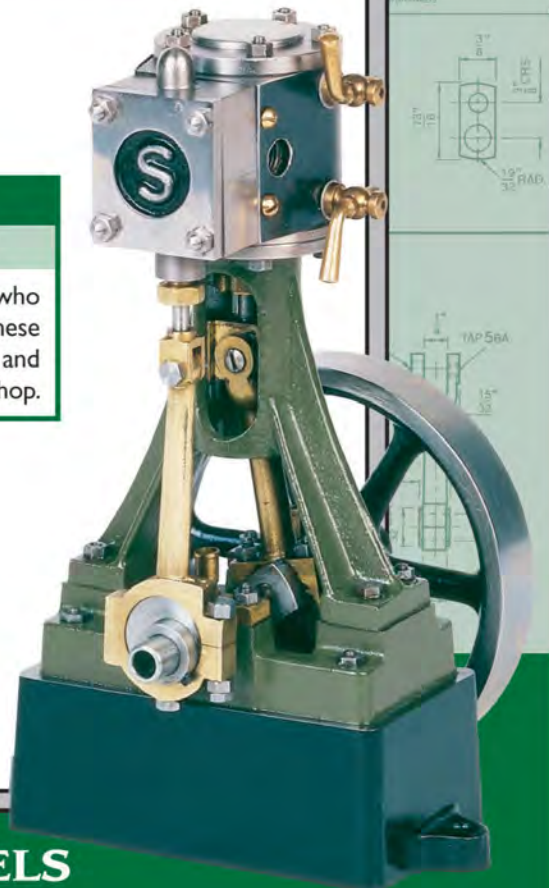
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### FRONT COVER

This 6-inch Marshall tractor was conceived as a father-and-son project, to rekindle the fun of rallying a full-size Marshall for many years. Alan Barnes tells the story starting on page 8, while a fascinating insight into the engineering of Tower Bridge starts on page 26.



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### EDITORIAL

## From tips to Towers and lots inbetween...

Here we are with another issue of **EIM**, containing hopefully something to interest a wide range of the many different varieties of model engineer out there.

I must immediately apologise to those working in the smaller scales as for a second month you won't find the feature on simple loco building in these pages – there were some technical issues with the piece and we won't publish it until we are happy with it, so it's being held over for now.

New entrants to the hobby, of which I know there are more than some outside observers may think, will be pleased to hear that from the next issue we will be starting a new series aimed at novices, alongside the already highly popular 'Tips for Model Engineers' that John Smith produces each month. We'll be offering more general advice on the setting up of a workshop, starting with choosing your first lathe.

It's not all about beginners though, far from it! One feature I'm particularly pleased to include this month also comes from the pen of Mr Smith, and provides an insight into the steam-powered hydraulic machinery that originally served Tower Bridge. Yes this is about as far from engineering in miniature as one could get, but we are sure many readers will find the two-part feature fascinating, delving not only into the machinery but the calculations made to ensure there was enough grunt to routinely lift two bascules each weighing well over 1000 tonnes... John is writing a book about the bridge, to be published next year by Haynes.

Hopefully you will agree that there is plenty of variety in this issue, from Martin Gearing getting into the build of the **EIM** steam plant boiler, through the building of clever forming rolls to create miniature representations of corrugated iron, to even more clever automata, to an impressive 6-inch traction engine almost entirely fabricated, and a welcome return of the young engineers pages, John Arrowsmith demonstrating just how widespread the younger branch of the hobby is.

This variety is made possible by the many writers who send in articles for publication, for which many thanks. But if we are to maintain that variety we need more! So please, keep them coming – not only will you get a fee for your efforts, but you will also be providing interest for your fellow model engineers, which is always well worthwhile!

**Andrew Charman – Editor**

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Editor: Andrew Charman Technical Editor: Harry Billmore

Email: [andrew.charman@warnersgroup.co.uk](mailto:andrew.charman@warnersgroup.co.uk) Tel: 01938 810592.

Editorial address: 12 Maes Gwyn, Llanfair Caereinion, Powys, SY21 0BD

Web: [www.engineeringinminiature.co.uk](http://www.engineeringinminiature.co.uk)

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**Publisher:** Steve Cole  
Email: [stevec@warnersgroup.co.uk](mailto:stevec@warnersgroup.co.uk)  
**Design & Production:** Andrew Charman  
**Advertising manager:** Bev Machin  
Tel: 01778 392055  
Email: [bevm@warnersgroup.co.uk](mailto:bevm@warnersgroup.co.uk)  
**Sales executive:** Allison Mould  
Tel: 01778 395002  
Email: [allison.mould@warnersgroup.co.uk](mailto:allison.mould@warnersgroup.co.uk)  
**Advertising design:** Amie Carter  
Email: [amiec@warnersgroup.co.uk](mailto:amiec@warnersgroup.co.uk)  
**Ad production:** Pat Price  
Tel: 01778 391115  
Email: [patp@warnersgroup.co.uk](mailto:patp@warnersgroup.co.uk)  
**Marketing manager:** Carly Dudge  
Tel: 01778 391440  
Email: [carlyd@warnersgroup.co.uk](mailto:carlyd@warnersgroup.co.uk)

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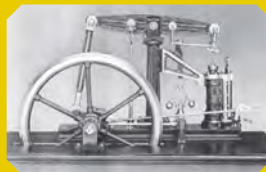
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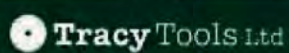
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# A 6-inch Marshall

Steve Casey's Marshall traction engine, built using just two castings, is a tribute to the engineering skills of his late father Tom.

BY ALAN BARNES



**ABOVE:**

Resplendent in the sunshine, the finished 6-inch Marshall that was built using just two castings.

**LEFT:** The inspiration – Steve and Tom with the full-size Marshall that they rallied for many years on behalf of its owner.

*All photos of finished model by Alan Barnes, other photos by Steve Casey*

“My father, Tom, was a real old school engineer and it was very sad that he passed away before the Marshall, which we had worked on together, had been completed,” recalls Steve Casey.

In memory the 6-inch scale Marshall proudly carries its ‘Tom’ nameplate on the front of the chimney. “Dad was a skilled boilermaker and had worked for Southern Region Marine so it was hardly surprising that when we had decided to build a scale Marshall of our own that the work would also include building the boiler ourselves.

“He had his own method of working, never wasted anything and while he was using the lathe or the mill they would be covered with newspaper to catch the swarf when he was machining any brass or bronze. This was collected after each ‘session’ and placed in a bin as he maintained that it would come in handy one day – it was this swarf that we later melted down to make the ‘Tom’ nameplate for the Marshall.”

The story of the 6-inch scale Marshall traction engine begins with Tom and Steve’s involvement with a



full-sized engine which they not only repaired for the owner but also used during the rally season. This was a 1912 7NHP, works number 59435.

"We had carried out various repairs to the engine at the request of the owner and these included some major work to fit a new firebox. Following the completion of the work the owner kindly allowed us to rally the engine. These arrangements lasted many years and we both thoroughly enjoyed our seasons with the Marshall attending as many rallies as our work commitments would allow."

However, as they say, all good things come to an end. "Although we felt that we had a good 'innings' we were rather disappointed when the owner finally decided that his interests lay elsewhere and decided to sell the engine."

### A new direction

Now 'playing' with an engine for part of the year is fine but actually owning one is entirely another 'kettle of fish' entirely, as Steve and Tom considered. "Certainly we considered ourselves to be experienced enginemen and could handle a steam engine and our engineering skills meant that maintaining and any repair work would not present any undue problems. However buying an engine would be a considerable financial investment and one which we could not commit to at that time."

The two considered the options – Tom had by this time officially retired so time was not a problem and he was looking for a retirement project. "It did not take too long to start to consider building our own engine," Steve recalls "Not full-sized obviously but a 6-inch scale engine would be ideal – big enough to rally and take out on the road but not too large for

*"Our engineering skills meant that maintaining and any repair work would not present any undue problems..."*

#### TOP LEFT:

Tom Casey catching swarf for future use while machining – the swarf later formed the basis of the loco's naemplate.

#### TOP:

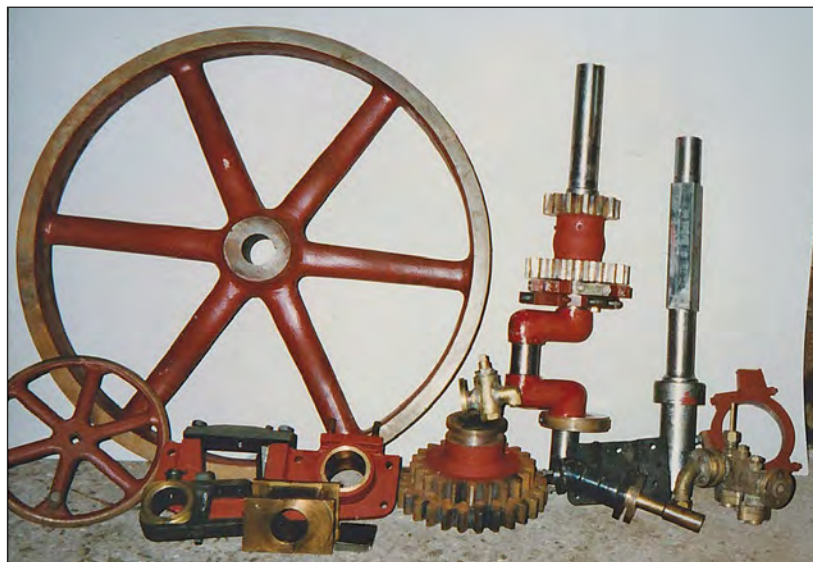
The finished boiler undergoing its hydraulic test.

#### ABOVE RIGHT:

The flywheel, crank and other components made for the engine.

#### RIGHT:

The engine's first test run on compressed air in the workshop.



the workshop as the build progressed. And after our years with the full-sized Marshall it also did not take very long to decide that our new engine would be a Marshall."

Tom and Steve commenced work on the 'retirement project' in 1995 beginning with a search for as many

Marshall drawings as possible. They also spent time at events and rallies photographing the details of practically every component on various full-sized Marshall traction engines. At the end of the research exercise the two had amassed a considerable collection of photos along





with many drawings which ranged from full-size to 3-inch scale. Then came the task of scaling down the original drawings and scaling up the 3-inch drawings to the 6-inch scale

that was required for the new engine.

"With my father's considerable boiler making experience this is where the work began and there would certainly be no short-cuts in the

#### THIS PAGE:

Component views of the finished Marshall engine. A fine half-size replica of the engine Steve and Tom rallied with.



making of a traditional flanged and riveted boiler."

Initially a set of formers were made to produce the backhead and throatplate, then the hornplates were profiled out and the crown and the barrel were rolled. Then all the parts were fitted up and tack bolted and the hornplates were set up with dummy shafts. All the seams were riveted and caulked including the longitudinal barrel seam.

"We found that building in 6-inch scale led to a compromise when it came to the number of tubes as we found that when trying to fit the correct number they came too close to the flange and could not be expanded. We decided to reduce the total number of tubes by two and made the necessary adjustment to the tubeplate. A welded firebox was made as per the original drawings and this was riveted in and the stays screwed in, knocked up and then caulked."

### Cylinder challenge

One difficulty which presented itself was the cylinder block. "After a lengthy search, we were unable to locate a suitable casting so the only solution was to fabricate one ourselves. A series of sketches of the block were made along with several hardboard templates and after some thought we came up with the idea of making the cylinder block from the inside out."

A rather elaborate jig was set up in the workshop and this was designed to hold all the parts, starting with the cylinder sleeve and the steam ports, then the valve face, the regulator valve, the end plates and the wrapper.

"This was basically a three-dimensional jigsaw puzzle but instead of starting with all the edge pieces we started with the middle bits and left the edges to the end. We were very pleased with the end result and we must have done something right as the cylinder block is still going strong today."

While the cylinder block was not the only problem it did highlight for Steve the fact that when building a scale model from scratch a good deal of 'thinking on your feet' is required when issues arise. "Even slavishly following a drawing, even an original one can sometimes cause problems. We found that if the drawing was followed the water pump eccentric rod fouled the spectacle plate so that had to be amended. In fact we had produced quite a number of parts from the drawings which could not be used and had to be remade in order to get them to fit correctly. Our 'sin bin' of rejected parts was getting quite full as the build progressed."

The crankshaft was made up in

five separate sections and again a jig fabricated to hold the parts. The webs and pins pressed together and the jig was used to hold the shaft ends while everything was welded into place and then the crankshaft was set up between centres and finished to size.

"We had a problem with the second shaft end pinion which was one third of a tooth out on the drawing. There were a number of other parts which we had scaled up or down from the various drawings but when made just did not look right. These parts were more 'fodder' for the sin bin as they were remade to what we considered a more correct size and shape."

A friend was kind enough to map out the gears on a CAD system and then Steve and Tom arranged to have them cut by a local engineering firm. "For the final finishing and 'fettling' we bought our own die milling machine and this is where Dad's skill and patience really paid off."

## Wheel designs

The wheels and hubs were fabricated in the workshop, Steve and Tom designing and making sectional hubs which were welded together as were all the brackets and the bearing keepers. "We also fabricated the trunk guide which had cast sleepers riveted in and then bored to the correct size. The cylinder itself had a liner taken from a Fordson tractor which was pressed in, while the valve face was made up from boiler plate built up with cast electrodes, then machined and fitted with a bronze valve."

"The whole engine only has two castings, the flywheel and the weigh shaft bracket and both of these were obtained from Phil Ives."

Steve admits that progress was not exactly rapid and it was not until 2004 that the two considered the engine to be basically complete. "We had only run it on compressed air to check for any tight spots. Very sadly 2004 was also the year that my father passed away so he never got to see the Marshall finished and in steam. I continued to work on the engine but it seemed very strange to be spending time on my own in the shed finishing Dad's retirement project."

Over the next few months the final details were attended to, the lagging and boiler plates fitted and then the Marshall was stripped down and prepared for painting. "With the engine re-assembled it was steamed for the first time and we had a few trial runs before arranging the steam test, which it passed with flying colours. The trial runs had revealed a couple of minor issues and a couple of tight spots but in truth the engine ran pretty well for a brand new machine."



**BELOW:** Steve at the controls of the finished engine – note the ladder that apparently makes cleaning – particularly of the motion – an easier task!

The Marshall made its rally debut in 2005 proudly carrying its 'Tom' nameplate and I think that Dad would have been well pleased with the way his retirement project had turned out."

Since then the Marshall has been rallied every year and apart from regular winter maintenance has needed nothing in the way of major repair work. "This is surely a testimony to my Dad's undoubted engineering skills and attention to detail," Steve concludes.

Some further work is planned in the future including the making and fitting of a set of governors together with a winch drum to make the engine closer to the original specification. The paintwork has stood up pretty well over the years but it has worn in a few places so Steve intends to carry out a full repaint when time allows. **EIM**

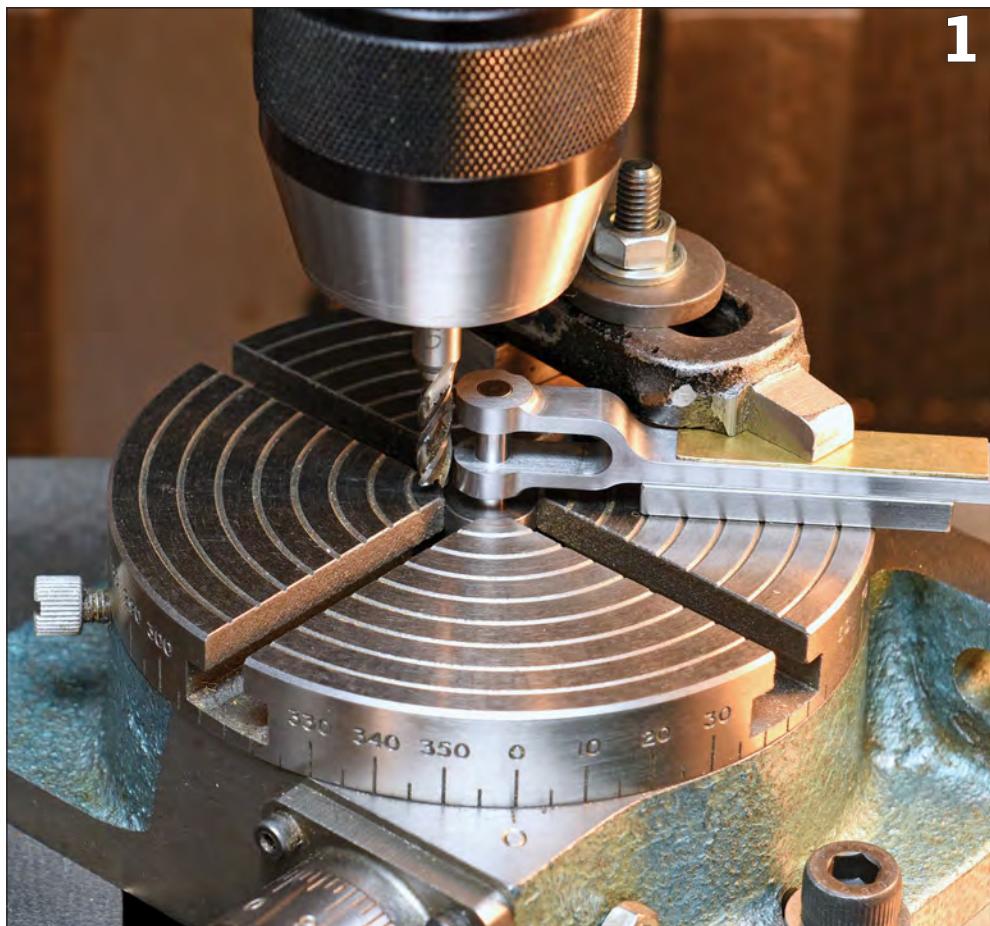
■ My thanks to Steve for providing the details and information on the building of Marshall Tom.



# A Rotary Table on the Mill

For the latest in his series of best practice techniques John goes full circle on the milling machine – how accurate is a rotary table, and how do you clamp parts to it?

BY JOHN SMITH



The rotary table is a most useful accessory for the vertical milling machine. Larger tables (six or eight inches in diameter) generally feature a No. 2 or No. 3 Morse Taper centre. Smaller tables (3in or 4in) often just have a cylindrical central bore.

Big is not necessarily better; smaller tables are better suited to the clamping of small components such as eccentric rods or lifting links (**Photo 1**). Larger tables are ideal for milling coupling rod ends; they can also tackle the milling of an expansion link clamped to a plate bolted to the rotary table.

## True to form?

It's a good idea to check the accuracy of your table, by which I mean does the table rotate truly about the centre, or is there some eccentricity? I used a 6-inch rotary table, badged for Myford, for several years before I thought to check this; I found that there was some 0.015in of eccentricity – far too much to enable good work to be done. (I'm sure that it is most unusual for a Myford rotary table to exhibit this problem.)

You'll need a Morse Taper adaptor so that lathe chucks can be mounted. This will enable you to mill a square or hexagon onto a cylindrical workpiece held in the chuck. I have never felt the need for dividing plates, finding that the basic rotary table provides sufficient angular precision for my needs, as long as I remember to always eliminate backlash by rotating the table in one direction only.

Much rotary table work involves clamping a workpiece down onto the surface of the table and the question is always, 'How do I position the workpiece accurately?'

The first step is to make an accessory for the table which fits the ground Morse Taper and features a half-inch diameter bored hole into which a variety of turned inserts can be fitted. A blank MT arbor provides the basis for the accessory. A tapped hole in the bottom of the ½in bore provides the means to extract the accessory without the need to take the table off the mill.

**Photo 2** shows MT2 and MT3 accessories and a variety of inserts. Any workpiece which features a



reamed hole at the centre of the radius to be milled can now be positioned accurately on the table.

### No hole, no problem

How do we position a workpiece when there is no hole in the centre of the radius? One solution is to drill a hole, use it to position the workpiece on the rotary table, mill the radius and then fill the hole with a rivet. A better approach is:

1) Position the rotary table on the table of the mill so that the centre of the rotary table is aligned with the machine spindle in the Y-axis; a  $\frac{1}{2}$ in diameter dowel held in a drill chuck will facilitate this task. Clamp the Y-axis.

2) Turn an insert of diameter twice the radius you need to mill on the workpiece, with a  $\frac{1}{2}$ in diameter spigot to fit the hole in the centre of the accessory. Place it on the rotary table. If the radius to be milled is smaller than  $\frac{1}{4}$ in, then you need to make a bush with an outer diameter of  $\frac{1}{2}$ in and with a reamed hole of the required diameter in the centre into which a dowel can be fitted.

3) Set the table to a convenient angle ( $0^\circ$ ,  $90^\circ$ ,  $180^\circ$ ,  $270^\circ$ ).

4) Clamp a precision steel square (without base) to the table so that it is held tight against the disc and aligned with the X and Y axes of the mill (**Photo 3**).

5) Remove the insert/dowel and replace it with the workpiece plus a sacrificial spacer to protect the surface of the table (**Photo 4**).

6) Clamp the workpiece down and remove the square. You are now ready to mill an accurate radius.

7) Mill the workpiece, moving the table of the mill only along the X-axis until the desired radius is reached (**Photo 5**).

A small V-block can be used in place of the plain square. **EIM**

■ Next month – Turning small convex and concave radii

**PHOTO 1:**

When smaller components need work a smaller table suits best

**PHOTO 2:**

Accessories and inserts for use with the rotary table.

**PHOTO 3:**

A steel square offers an answer to clamping without holes.

**PHOTO 4:**

Workpiece in place with spacer to protect table.

**PHOTO 5:**

The milling operation underway, table moving along X-axis.

Photos:  
John Smith



#### Previous episodes in the Top Tips Series...

|                                      |                |
|--------------------------------------|----------------|
| Holding material for machining       | March 2018     |
| Planning, and making spares          | April 2018     |
| Achieving quality surface finishes   | May 2018       |
| The art of marking out               | June 2018      |
| Tool setting and marking on the mill | June 2018      |
| Using toolmaker's buttons for boring | July 2018      |
| Measuring internal diameters         | August 2018    |
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# Gas-fired vertical boiler for The EIM Steam Plant

Martin's new series describing the building of a suitable boiler to complete the EIM Steam Plant beginners project focuses on bushes and boiler tubes.

BY MARTIN GEARING – Part Two of a series

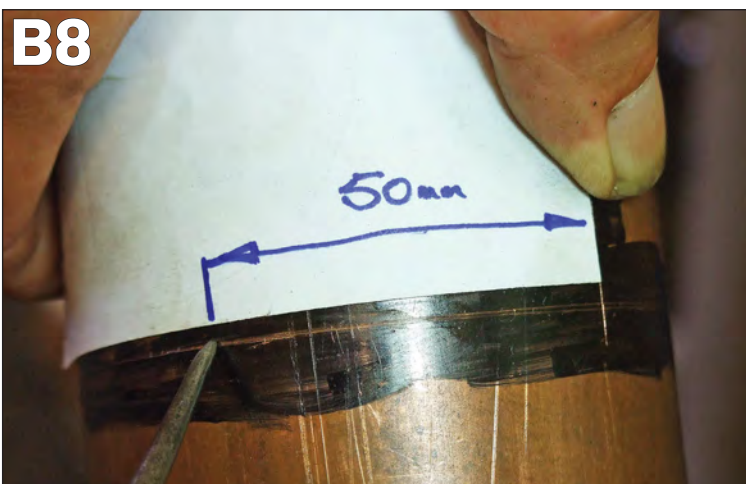
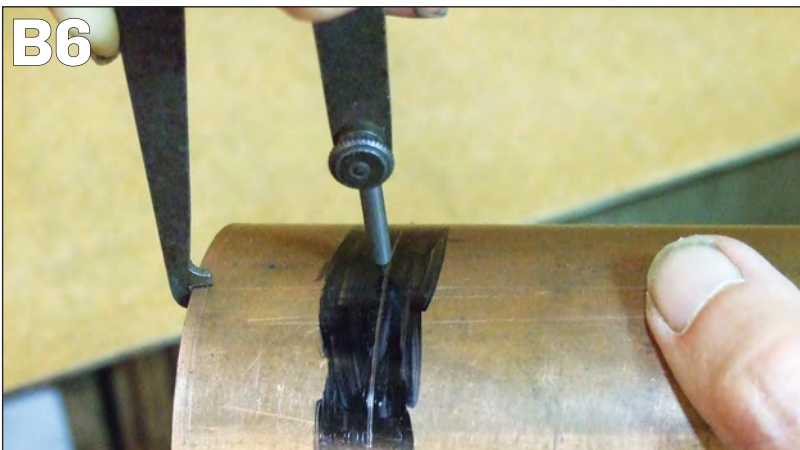


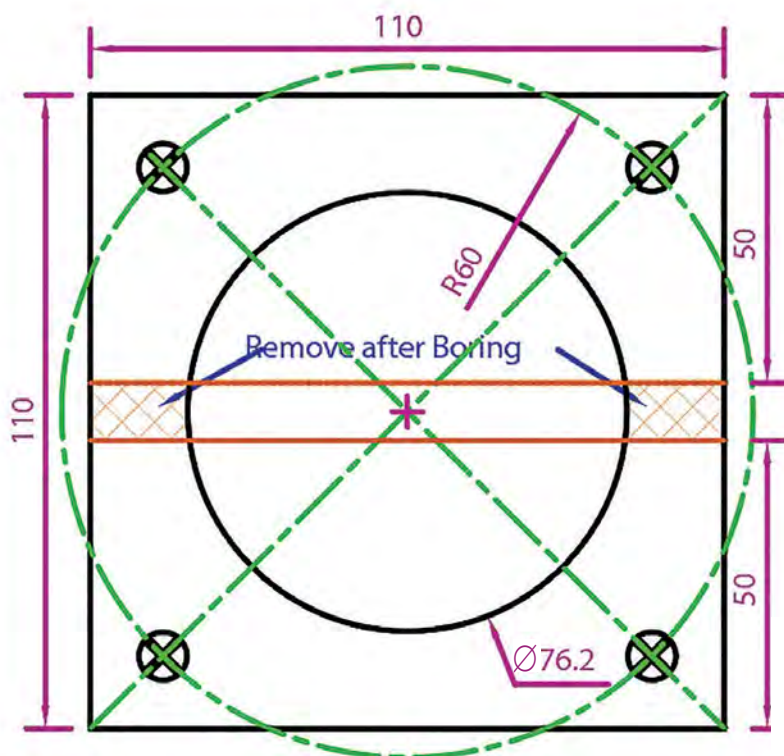
This month we begin by drilling the boiler barrel for its bushes (refer to **Drawing B1** in last month's issue).

Mark a line around the tube 30mm parallel up from one end – if necessary coat the area with permanent marker to make the line clearer (**Photo B6**).

Using a try square with the stock resting on the machined end and the blade running along the length of the barrel, scribe a line along the length of the barrel (**Photo B7**).

On a piece of card, mark a line 50mm from one edge. Locate this edge against the line just scribed and holding the card firmly around the barrel, scribe across the 30mm line up from the edge (**Photo B8**). Scribe a further line along the length of the barrel from this point as before. This should result in two parallel lines 50mm apart running along the length





**DRAWING B1A** Boiler shell nest (reproduced approx three-quarters full size) 2 off 18mm thick

**ALL DRAWINGS  
REPRODUCED APPROX  
FULL SIZE  
UNLESS STATED**

**PHOTO B6**

Marking the position of the bush from the base.

**PHOTO B7**

Marking out the vertical line on the boiler barrel.

**PHOTO B8**

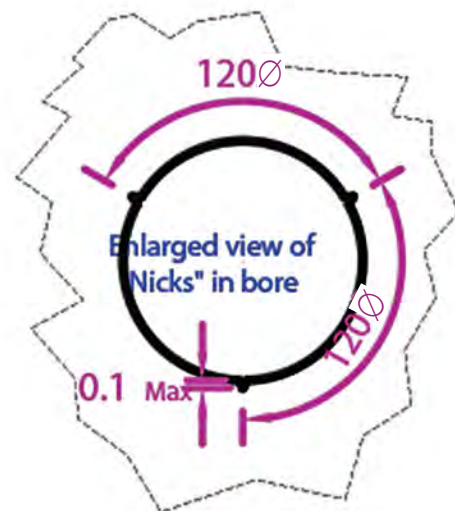
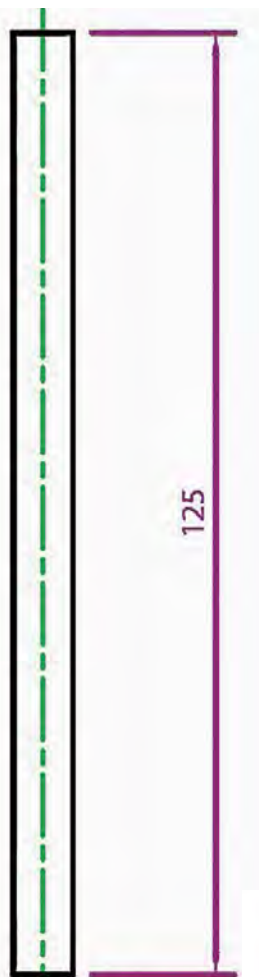
Transferring the distance to the tube.

**PHOTO B9**

Vertical centre lines for bush marked out.

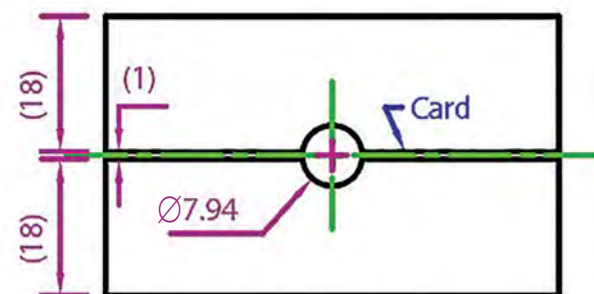
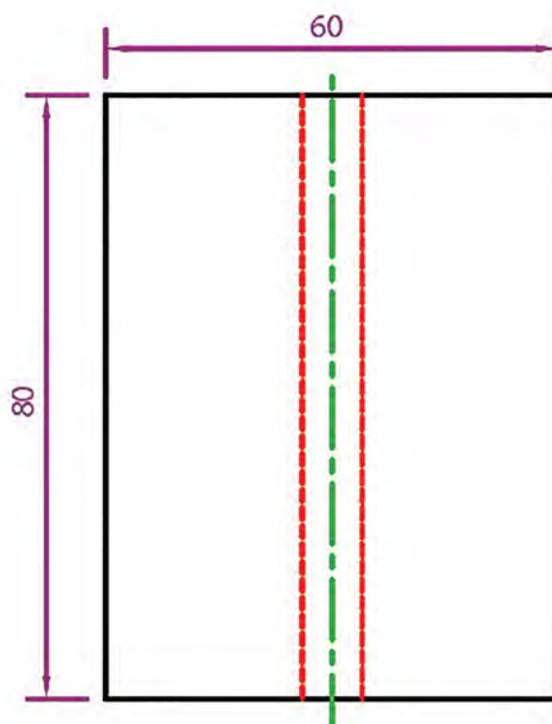
All photos and drawings by Martin Gearing

**DRAWING B2**  
Firetube - 19 off



**DRAWING B1B**

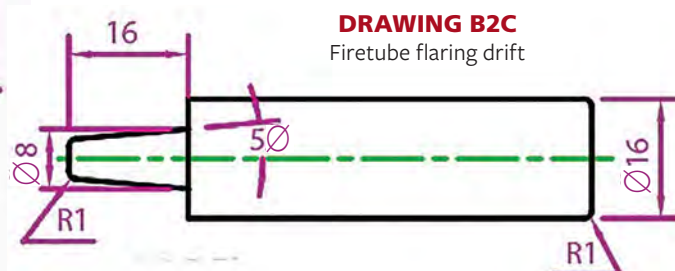
Tubeplate hole detail (not to scale)



**DRAWING B2A**

5/16-inch firetube flaring clamp

**DRAWING B2B**  
5/16-inch Firetube forming ring



**DRAWING B2C**

Firetube flaring drift



of the barrel (Photo B9).

A mark needs to be scribed on these two lines 77mm further on from the first two marks (107mm up from the base). Refer to drawing B1 in last month's issue.

Holding thin-walled tube firmly, but without risk of damage, so as to be able to drill and tap the four holes as required, is best done if the time is taken to make a simple 'nest', made to the dimensions shown in drawing B1A. Cut two 110mm squares from the same sheet material used when truing the barrel ends. Secure together using wood screws located as shown on drawing B1A, truing up the four edges if necessary.

Scribe two parallel lines 50mm in from opposite edges, creating a central 10mm wide parallel strip that will be sawn out later. Scribe two lines across between the two opposite corners. Lightly centre punch at the point the lines intersect.

Using this punch mark, set the assembled nest blocks to run true in a four-jaw chuck, spacing them away from the chuck body using the two spacers such as M12 nuts. Mark them using a permanent marker so that the orientation can be maintained with a matching top and bottom for each square. (Photo B10). After final tightening of the chuck remove the two spacers and bore out to a diameter of 76.2mm. Remove from the chuck and saw out the central

**PHOTO B10**

Machining the holding nest.

**PHOTO B11**

Locating the centre line on the barrel...

**PHOTO B12**

...and then locating the centre point of the bush.

**PHOTO B13**

Tapping the boiler shell for the bush.

10mm strip before separating by removal of the clamping screws.

Locate the boiler barrel in two 'nest' bottom halves positioned at the ends of the barrel's length, and pushed back against parallels dropped in the table's T slots. Hold a stub of silver steel of which one end has been turned to a 60-degree point in the spindle chuck (or a small tap with a ground point).

Move the table to position the point approximately at the highest point of the tube by eye. Carefully bring the point to rest roughly midway along the length on the surface of a steel rule rested across the tube's diameter. By moving the table on the Y-axis, whilst keeping very light pressure on the point resting on the steel rule, you will find you can bring the rule to a horizontal attitude.

When this is achieved, and it is very sensitive, you have positioned the centre of the tube in line with the machine spindle. (Photo B11). Making sure the nest bottoms remain pushed back against the parallels remove the steel rule and rotate the tube to bring one of the longitudinal scribed lines exactly under the point.

Fit the corresponding top halves of the nest, and clamp the two halves together, before bringing the spindle to the first intersection of scribed lines. (Photo B12). Centre drill, drill 3mm and then 8.7mm diameter and tap  $\frac{3}{8}$ -inch x 32 ME supporting the

end of the tap with a pointed stub of silver steel. (Photo B13).

Moving the table on the X axis bring the spindle above the second intersection of scribed lines 77mm along, checking with the pointed stub. Repeat drilling and tapping  $\frac{3}{8}$ -inch x 32 ME at this second location. Slacken the clamps and rotate the tube to bring the second longitudinal line in alignment with the pointed stub held in the spindle chuck. Repeat the process for drilling and tapping the two remaining  $\frac{3}{8}$ -in x 32 ME holes.

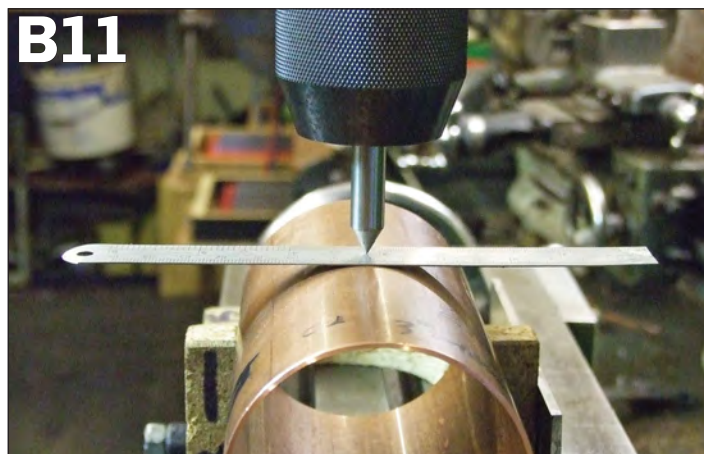
To guarantee the silver solder is able to form a fillet on both sides of the bush, it is recommended that you file three nicks with a second cut triangular needle file about 0.1 deep at 120-degree intervals around the thread on all four holes as shown in Drawing B1B, before putting to one side (Photo B14).

## The Firetubes

Item B2 –  $\frac{5}{16}$ -inch diameter x 20swg copper tube. Refer to Drawing B2.

Using a fine (32 TPI) toothed hacksaw, cut 19 lengths of tube at least 127mm long. Hold in a self-centring chuck with 5mm protruding and skim the end – taking light cuts with a sharp right-hand knife tool until all traces of the saw marks are just removed. Carefully deburr the end face bearing in mind all said previously.

Turn around and face off the



second end in the same manner taking off only enough to just remove all trace of saw marks. Repeat for the remaining 18 tubes.

I would like to describe a technique that does not seem to be in common usage that is applicable to making multiple items all to the same dimension. The affordable digital caliper has to be considered as one of the greatest conveniences to arrive in the home workshop in recent years. Quite apart from the fact that you can use the same tool for measuring in metric, imperial, inside, outside and depth very quickly with reasonable accuracy, it has the ability, because of being able to be zeroed at any point, of telling you directly how much material needs to be removed from a blank to become correct to size.

Take your digital caliper and zero with the jaws shut. The head is then carefully moved along the beam until the required **finished** dimension of 125mm is displayed. The caliper is then zeroed again.

If one of the oversize firetube blanks previously skimmed is now measured the caliper will show how much **more** than the set (**finished**) dimension it actually measures. This is the actual amount that has to be **removed** to bring the blank to the required size.

A word of warning must be mentioned – If you either cut the blank too short before facing off both ends **or** were overly heavy with the amount skimmed to ‘**just** remove any trace of saw marks’ instruction, you will still see a reading – but one preceded with a minus sign(-).

That is telling you how much you are **undersize** of the required dimension. If you are very lucky, it could still be in tolerance given that most dimensions have a plus as well as a minus figure, if not, cut another blank, and take more care!

Now armed with the knowledge of how much over length the firetube is, grip it in the chuck with 5mm protruding and after touching the tool on the rotating surface remove that



**PHOTO B14**

Three nicks filed out on bush hole help provide a fillet for the silver solder.

**PHOTO B15**

Tube clamp made from same material as nests.

**PHOTO B16**

Forming ring made to maintain tube outside diameter while flaring.

**PHOTO B17**

Tube flaring drift made up with machined tapered end.

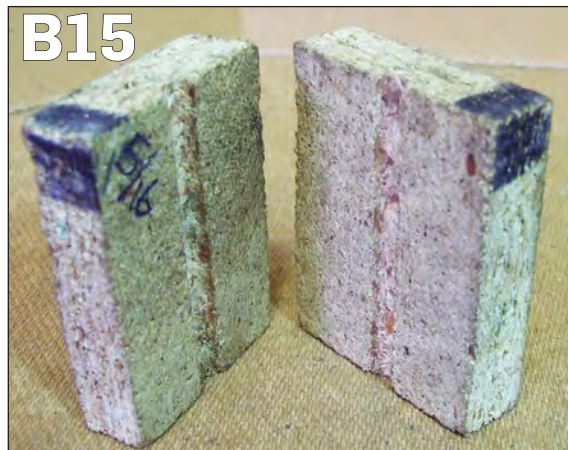
amount carefully, taking light cuts. Remove from the chuck, measure and deburr. Repeat this process for the remaining 18 tubes. Put the 19 tubes to one side.

### Flaring the firetubes

I came across this method for locating the tubes in the tube plates when reading the excellent book *Building Small Boilers for Gas Firing* by Alex Weiss assisted by Kevin Walton and published by Camden. I was struck by the simplicity of the process which absolutely guaranteed the tubes remained exactly in the position required, with **no chance** of failure through unseen movement whilst silver soldering. To ensure that process was consistently successful I developed the following method using three simple aids.

**A - Flaring Tube Clamp.** Refer to **Drawing B2A**.

The ‘Tube Clamp’ is quickly made from four 60 x 80mm rectangular pieces of the same sheet material as used previously for the supporting discs and nests. Cut a piece of cereal packet or similar thickness card to the same dimension, putting one thickness of card between two rectangles of wood, before clamping together, and stand long-ways vertically 10mm clear of the base in a drilling or machine vice, fit an additional clamp in the centre near to



the top to prevent the rectangles separating during drilling. Mark the two rectangles to retain correct orientation. Set the spindle to the middle of the 60mm width and on the centre of the cards thickness before drilling  $\frac{5}{16}$ -inch diameter through the length of the ‘sandwich’. Take apart and dispose of the two pieces of card and put to one side. (**Photo B15**).

**B - Forming Ring.** Refer **Drawing B2B**. Hold a length of  $\frac{3}{8}$ in diameter mild steel or free-cutting stainless in a self-centring chuck with 20mm protruding, face off. Centre drill, drill 6mm diameter x 16mm deep.

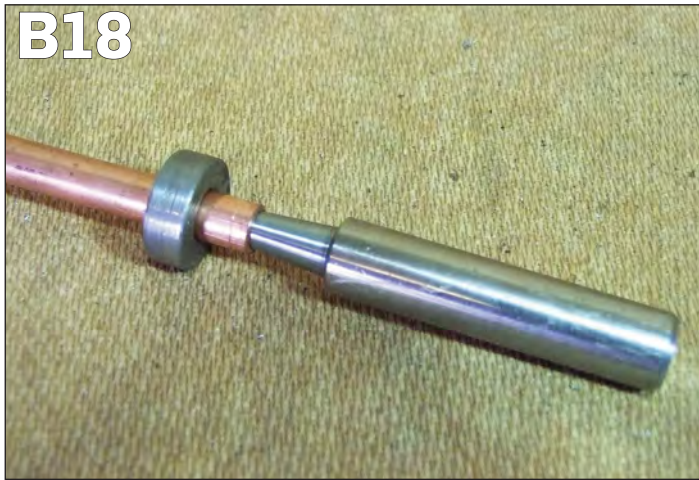
Because the purpose of this ring is to prevent an increase in the outside diameter whilst flaring the tube, I strongly recommend boring the  $\frac{5}{16}$ in diameter ( $7.94\text{mm} \pm 0.02$ ) x 8mm deep hole required, as drilling generally produces an oversize hole with a debatable surface finish.

Having achieved the bore dimensions, machine the 1mm radius detail as shown in drawing B2B. Part off the ring 6mm wide. Carefully remove any burr formed on the ring by the parting off. Put to one side. (**Photo B16**).

**C) Tube Flaring Drift.** Refer **Drawing B2C**. Hold a 70mm length of  $\frac{5}{8}$ -in diameter mild steel or free-cutting stainless in a self-centring chuck with 25mm protruding. Face off and machine the



B18



diameter 8 x 16mm long. Swing the top slide anticlockwise five degrees. Take light cuts, adjusting the depth of cut with the cross slide, feeding along slowly by hand using the top slide, stopping at the shoulder 16mm from the end, formed by the increase in diameter.

Continue until the full length of 16mm has been machined to a 5-degree taper. Take care not to reduce below the 8mm diameter. Machine the 1mm radius on the end face as drawn (Photo B17).

The result of your efforts will be a forming ring that just slides over the outside and a tapered drift that should just enter the bore of a prepared firetube (Photo B18).

### Tube Flaring

To assist the flaring process because the tube is supplied in the 'half hard' state, one end of each of the 19 fire tubes needs to be **annealed**. This is a simple process where the stresses created by working that make for hardness and brittleness are removed, returning the material to its soft state, and is essential in this application.

This is done by placing them in a cavity ideally made from refractory bricks/blocks which will speed the process by reflecting the heat. If you don't have these, heat-resistant aerated concrete blocks, such as Thermolite or

Celcon, which can be sawn easily to a convenient size will serve. **Do not** be tempted to use blocks from a night store heater as their sole purpose is to store heat in the first instance. Your gas will be running low before they decide to give anything back!

Build a flat-bottomed 'Trough' with the blocks and load all the tubes side by side with one end facing out towards the front. Direct the flame over the projecting end of the tubes, starting at one end of the line, bringing the end evenly to an even dull cherry red. Because the mass of copper being heated is relatively small take care not to linger too long heating the end above dull cherry red as you run the risk of melting the tube due to the short time taken to raise the temperature.

Maintain the cherry-red state for about 15 seconds before removing the tube with tongs or large pliers and dropping it in cold clean water, leave the tube in the water. (Photo B19).

Return to the stack and repeat the process 18 times. When all the tubes have had one end annealed remove them from the water, shake off as much water as you can and dry the outside.

Slip the  $\frac{3}{16}$ in diameter forming ring over the end of a firetube with the radiused bore/face facing outwards, before locating a firetube between the pair of  $\frac{5}{16}$ in diameter flaring clamps.

#### PHOTO B18

Checking the ring and the drift for fit.

#### PHOTO B19

Annealing the tubes to cheery red.

#### PHOTO B20

Setting the assembly for tube flaring.

#### PHOTO B21

Finished job - neatly flared boiler tubes.

B19



Adjust the assembly so that when the forming ring is butted firmly against the ends of both flaring clamps, the copper tube protrudes 3mm beyond the forming ring.

Position the assembly with the tube horizontal midway between the top and bottom edges of the vice jaws, and flush to the right hand side of the jaws. Tighten the vice (Photo B20).

Take the tapered end of the flaring drift and with a soft-faced hammer gently tap the drift into the open end of the copper firetube, stopping when you find the forming ring no longer rotates freely, bearing in mind little force is required. Remove the flaring drift by a gently rotating action of the protruding end which will cause it to part from the taper it has formed.

Dismantle the flaring clamps, slide the forming ring down the length of the tube until it is free, and then repeat on the remaining 18 tubes.

The ends of the tubes will now have a definite 'Flare' consistently positioned precisely 3mm in from one end of all the fire tubes, the purpose of which will become clear a little later when the boiler assembly is undertaken. (Photo B21).

■ Part 1 of this series appeared in the October 2018 issue of **EIM**. See page 33 for details of how to order digital copies or printed back issues. **EIM**

B20



B21



# Miniature Forming Rolls

Hereford MES member Roger and his father-in-law Bill combined to produce a useful little tool for creating corrugated iron and other curved metal surfaces....

BY ROGER BROWN and BILL WILKINSON

Some years ago my father-in-law, Bill Wilkinson, offered to help me with my Gauge 1 railway. I was, at the time, constructing an electric locomotive with a view to building a small layout to take to exhibitions. Bill decided, quite rightly, that the most difficult thing to make was corrugated iron and what do you see a lot of around a railway? Rusty corrugated iron!

Bill, therefore, proposed making a set of rolls to produce corrugated iron and actually decided to make them capable of rolling an arc – having just been reminded of wartime Nissen huts... At this point, I was having fun producing a smooth curve in a sheet of brass for the cab roof of my electric engine and suggested that he include a plain section wide enough to roll a G1 locomotive cab roof.

From this, you may deduce that these rolls were not intended for any material much thicker than 0.5mm. They will just about cope with 0.75mm brass, but anything larger than this is pushing the mesh of the gears too far apart. For rolling the corrugated profile, however, one should use a maximum thickness of 0.2mm brass – do not attempt to roll shim steel corrugated iron.

Before we go any further, these were not intended to be slip rolls to be able to roll tubes! However, it can be seen that a small modification to the top roll bearing housing, the fitting of a clamp and a duplication of the adjustable pinch (lower) roll bearings will do the job. You will also have to



**ABOVE & RIGHT:** Two views of the completed bending rolls.

**BELOW:** The constituent parts of what is a useful little tool.

*All photos and drawings in this feature by Roger Brown and John Arrowsmith*

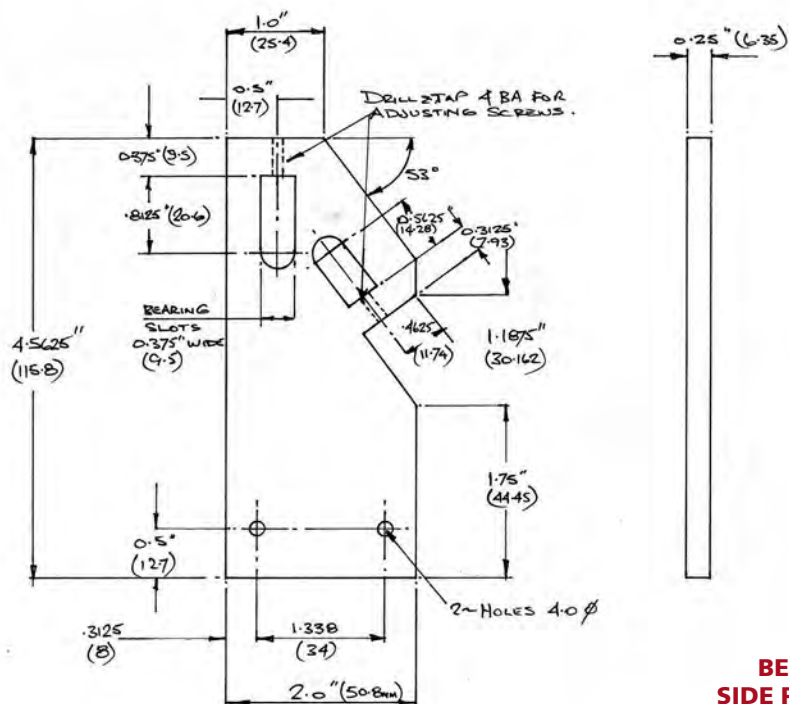
re-site the top spacer bar to a position below the bending roller otherwise the minimum diameter will be limited and you will carefully roll your tube round the spacer!

The drawings accompanying these words are largely self-explanatory, but may need adjusting to suit the gears that you have available.

The gears that we used were actually scrap gears from a job that Bill was working on at the time for his employer and were partially instrumental in the inspiration for this little project.

First thing was to determine the minimum roll centre distance and the



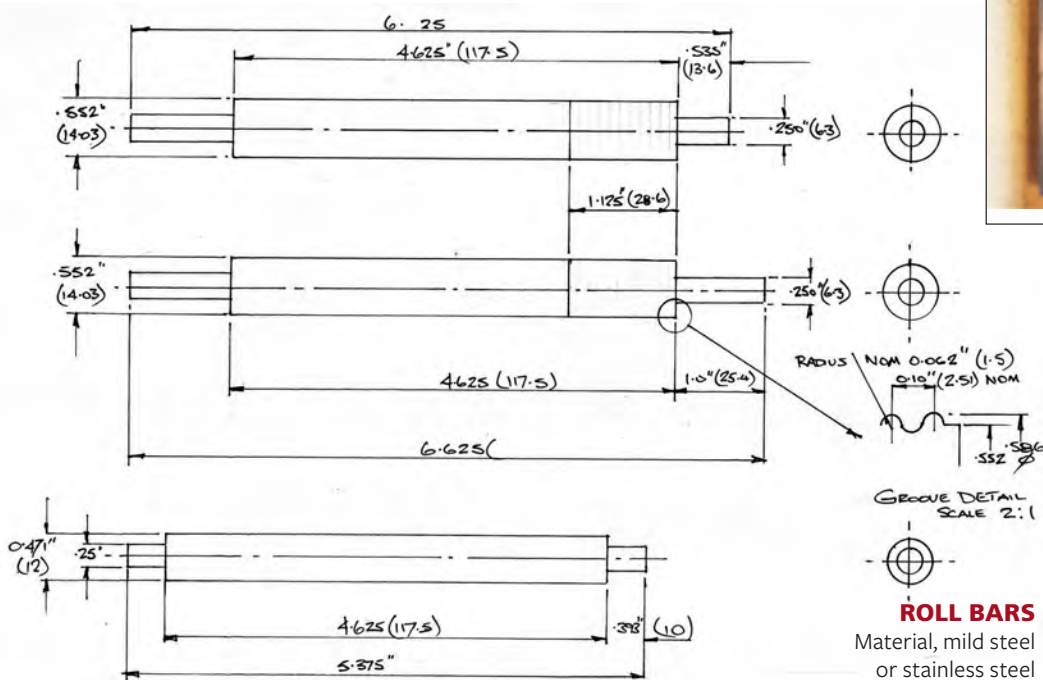


## BEARING SIDE PLATES

2 off – Material, mild steel

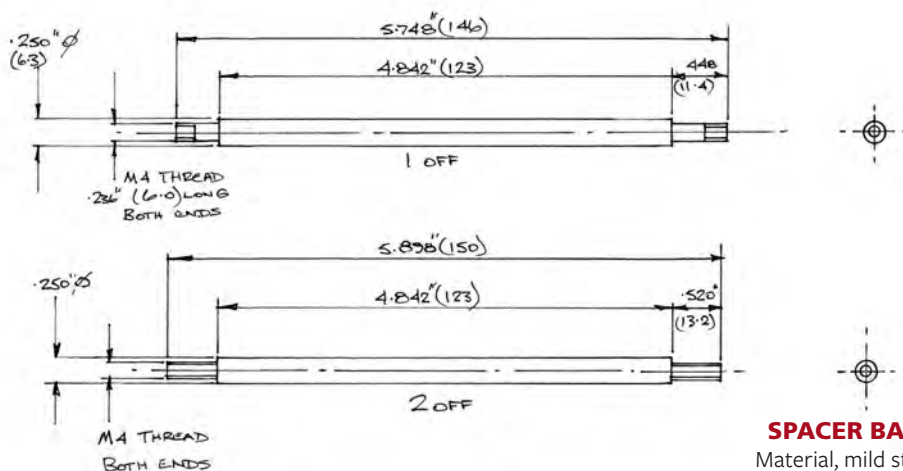


**ALL DRAWINGS  
REPRODUCED  
APPROX HALF  
FULL-SIZE**



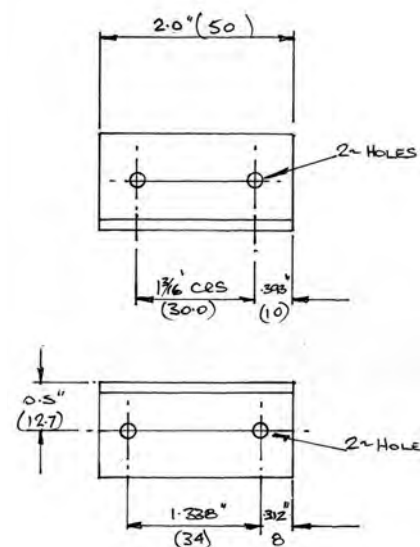
## ROLL BARS

Material, mild steel  
or stainless steel



## SPACER BARS

Material, mild steel





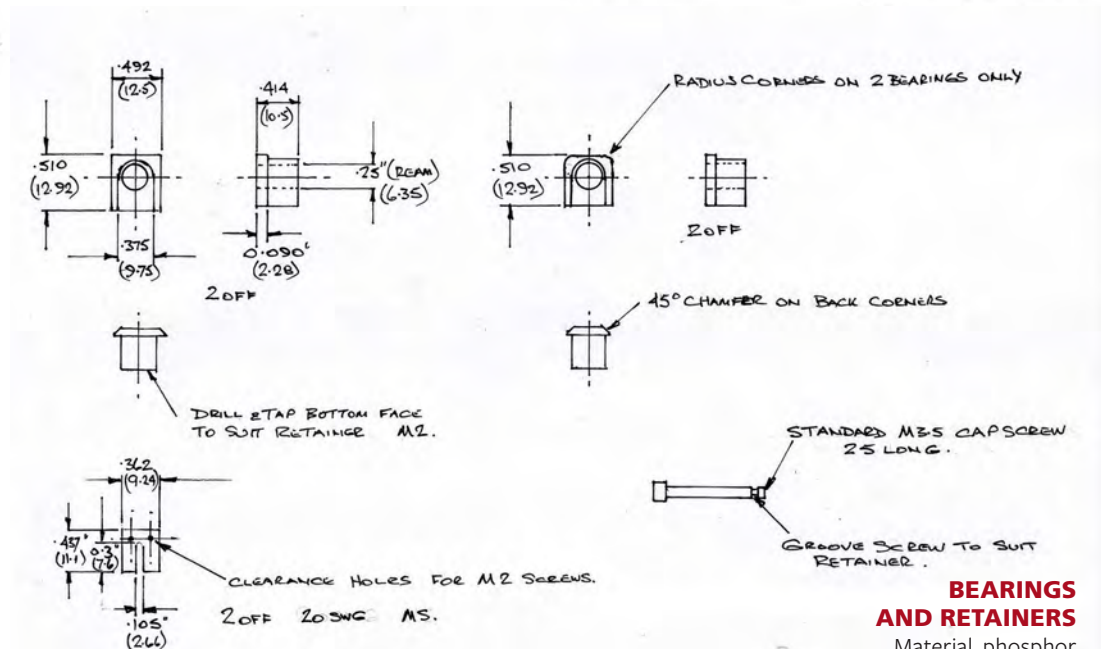
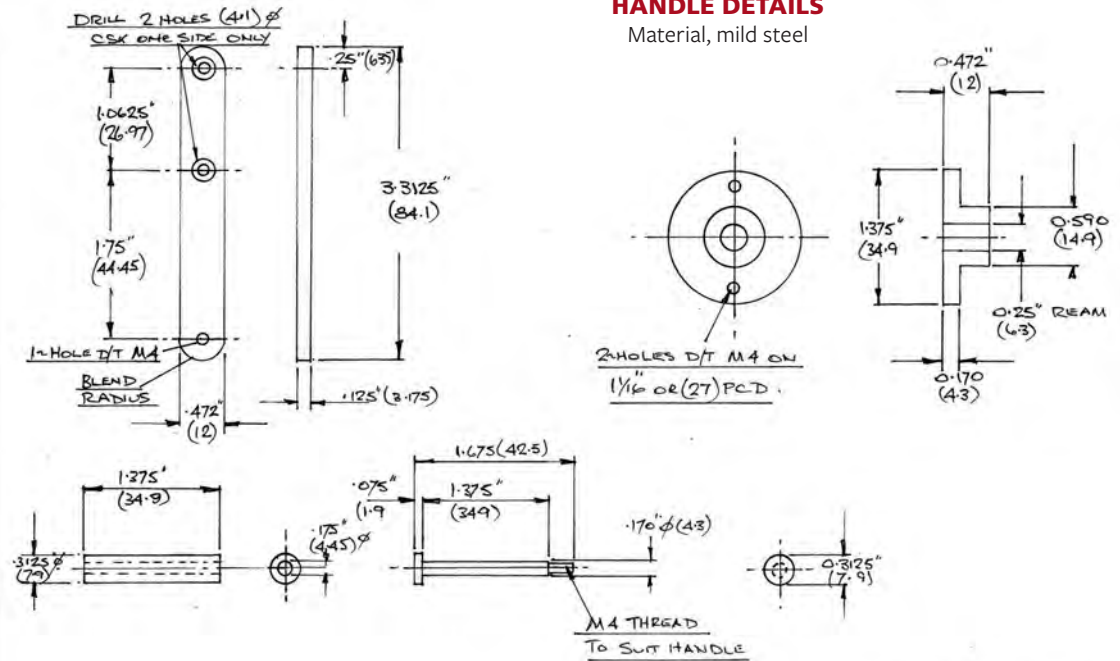
**ABOVE LEFT:** Completed bearing side plate.

**TOP:** Toothed gear.

**ABOVE:** Detail of handle.

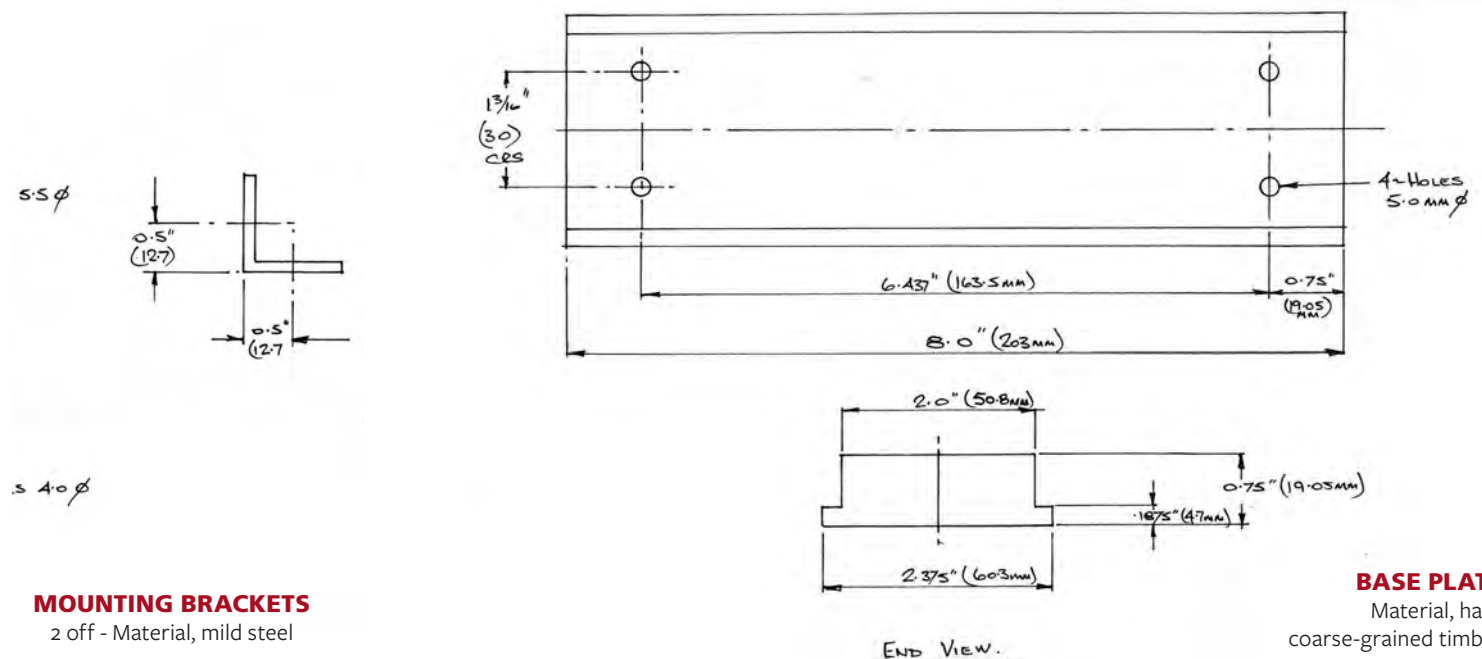
## HANDLE DETAILS

Material, mild steel



## BEARINGS AND RETAINERS

Material, phosphor bronze and mild steel



## BASE PLATE

Material, hard  
coarse-grained timber



*"At this point we realised that you have to wind it backwards..."*

roll diameter, by the following means:

- 1) Fit two of the gears with dummy shafts and squash them together with short dummy shafts of diameter 'd'
- 2) Measure over the dummy shafts, dimension 'x', and compute the centres of the gears; ie gear and minimum roll centre distance =  $x - d$
- 3) The diameter of the rolls is therefore  $(x - d)/2$

The design of the unit was then based round these two dimensions so that when the rolls are fully closed the gears are as close together as they can get. Introducing the material for rolling will then give you the gear mesh clearance. If you intend to roll/

**THIS PAGE:**

Detail photos of completed bending rolls.

**BOTTOM:**

The reason for it all – neatly formed corrugated iron effect in brass sheet.



form very thin material it may be advisable to increase the roll size by 0.02 mm or so to make sure that you can pinch the material to drive it through the rollers.

The side frames were rough cut out of 6mm steel strip 50mm wide and tidied up on a milling machine. The three spacer bars are 6mm silver steel with 4mm threads cut on each end.

A fixed top-roll bearing was chosen because we had to hand some sintered bronze bearings of about the right size – bronze or brass turnings would be perfect here or made as lift-out bearings to convert the unit to slip rolls. The side frames would also need modifying to accommodate lift-out bearings.

The adjustable bearings were made from a stick of phosphor bronze machined to a top hat shape and cut into four pieces. After drilling and reaming for the roll journals the radius on the one end of each bearing block was formed by filing to fit the cut outs in the side frames, always remembering to keep the blind edge of the file towards the flanges.

Adjusting screws are 3.5mm Allen cap screws with a groove carefully machined in the threaded area to take the bearing retention plates. Small threaded collets were made to hold the screws in the chuck concentrically.

4BA or No.6 UNC screws would also serve as adjusters.

The form of the corrugated iron section of each roll was determined next by guesstimating a profile and trying it to see what we would get. We measured a section of full-size corrugated iron and made a set of rolls, remembering at the second attempt to offset one form by half a pitch, and gave it a whirl. At this point we realised that you have to wind it backwards, but we did not want to put the handle on the adjustable roll as this may rock it up and down during operation and therefore give a variable form.

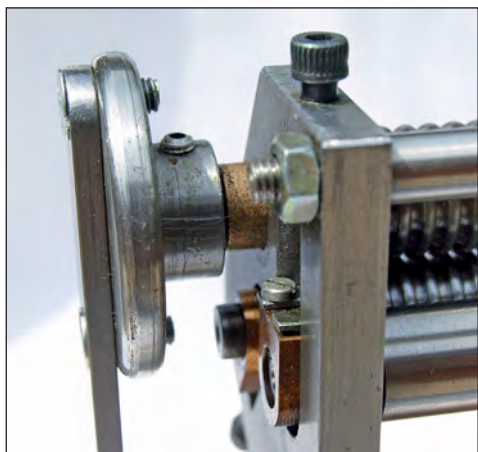
**Minimal reduction**

The roll form that we eventually came up with gives a slight pinch on the flanks to squeeze the material so that the crest is stretched and gives minimal reduction in width as the material is fed through. We have also allowed about 0.5mm end-float in both of the rolls to permit an element of self-alignment of the corrugated forms.

For a base I talked a wood-working friend, Andy Hawley, into making a wide inverted top hat section of oak to which the unit is bolted via short lengths of mild steel angle. The flanges sit on the top of the vice jaws making it easy to set the unit up one-handed without it falling through the jaws while you wind up the vice with the other!

In retrospect oak is maybe not the best material to use as I understand that it may be slightly acidic in nature which may lead to corrosion in the interfaces in the long term.

In conclusion the unit has performed well, within its limitations, producing 10mm scale corrugated iron, G1 locomotive roofs and various roofs for the rolling stock on my 7mm scale O-16.5 narrow gauge layout. I took it, partially finished but functional, to an HSME meeting and was persuaded to exhibit it on the HSME stand at the 2009 Midlands Model Engineering Exhibition where it created, to my surprise, considerable interest. I must thank Bill Wilkinson for the original inspiration and considerable help, the encouragement of members of Hereford SME to finish it for the exhibition and John Arrowsmith for 'persuading' me to write this article and assisting with drawings and photos. **EIM**



# Fun at Marlborough

Another Christmas present build, this automaton recalls a favourite outing venue for Dave's family, through five separate movements.

BY DAVE ROWE

It was the autumn of 2007 and I had no inspiration for a Christmas present automaton for the grandchildren. I asked my wife for ideas and in 20 minutes I had her response. "If you were to ask the children where they would like to go what would they say?"

"Marlborough" I replied. "There you are then, a Marlborough automaton," she said.

At that font of delights, the procedure was always the same;

- 1) Buy the cheapest loaf at the supermarket.
- 2) Feed the ducks in the stream by the playground
- 3) Enter playground. Enjoy equipment for an hour while mother sits on the seat and reads
- 4) Move on to the library
- 5) Move on to a converted church, now a cafe and craft shop for a drink and a cake
- 6) Three happy, contented children return home after a perfect day out.

## Keep it simple

It didn't take long to measure up the playground and photograph the equipment. There is a good maxim for automata – keep things as simple as possible. On this one there is a musical movement and five things in motion, but although someone viewing it might imagine great complications in the works underneath, taken one at a time each is childishy simple.

The crank on the front is connected directly to the musical movement and has a pinion which engages with a gear on the drive axle which runs front to back. Hand-cranked musical mechanisms need to be turning at about 110rpm to play the tune sensibly.

Although this was being made for children, I didn't want to see the swings oscillating at unrealistic rates, so gears giving 3.3:1 were used.

The first piece of equipment is the roundabout, driven as in **Figure 1**, grandson Oliver aboard in the photo.

The swings with safe seats for the very young are entertaining the favourite doll, Ellie by name and the simple cam motion in **Figure 2** kept her swinging.

The rocker arm A was pivoted at B and was depressed by cam C. The arm was kept pressing against the cam by spring D which was supported from a

5 x 75mm machine screw, E.

Two nuts at F locked the spring at the required height, its lower end being held by an eye G. Bracket H carried a 3mm threaded rod which had two nuts on it and a 1mm hole at its upper end for the 0.4 mm brass wire that linked the mechanism to the swing. This wire needed to be unobtrusive but anything thinner would have been too frail.

Hannah on the ordinary swing had an identical mechanism, but to move her on the other side of the playground this one was installed the other way round. The cams for the swings were plywood discs on eccentric holes and, to avoid any jerky swing movements, they needed very smooth rims.

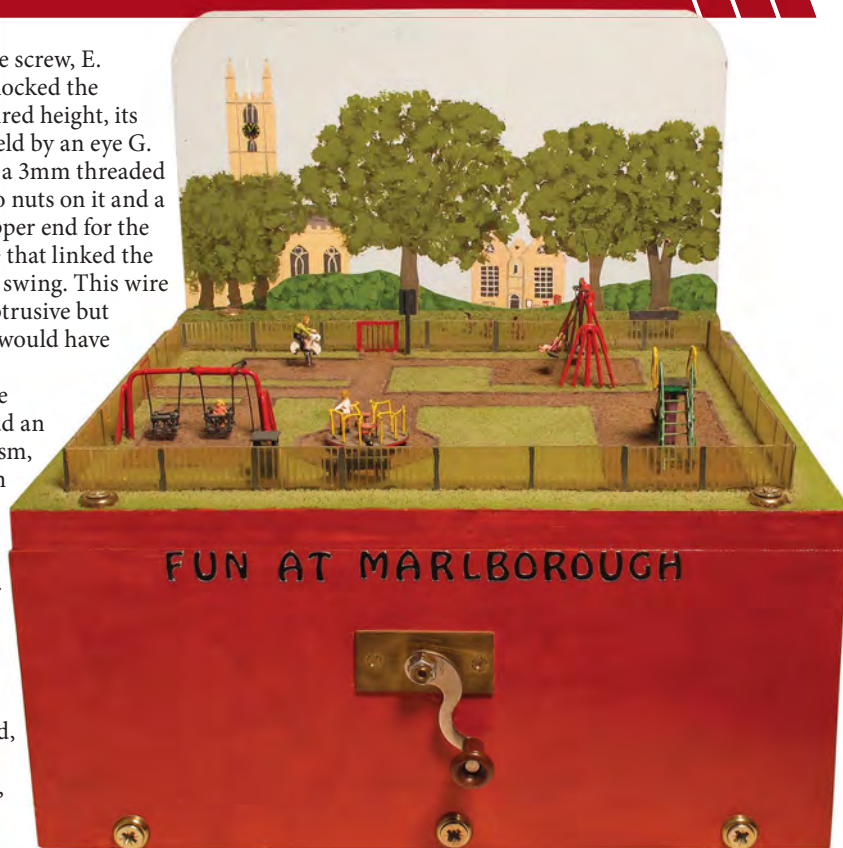
Making the provision for the speedy adjustment of the swings and the bucking horse took a little more time but saved so much annoyance later on.

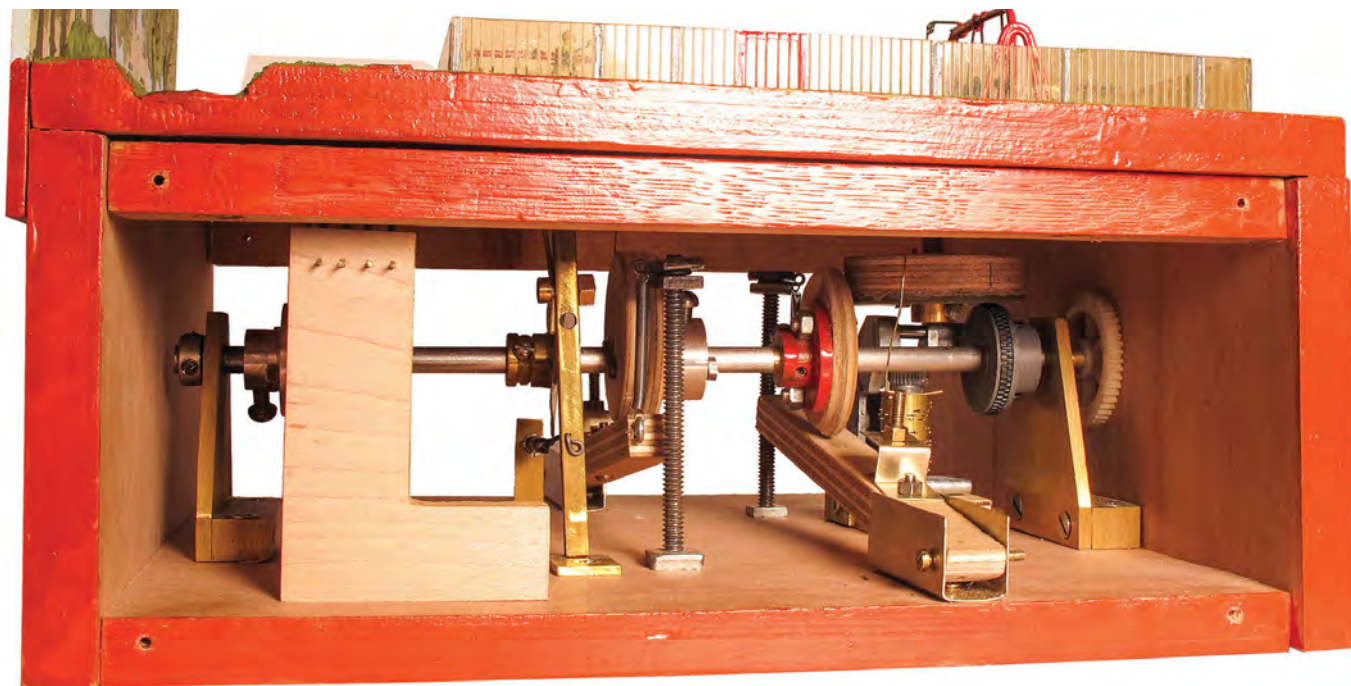
The frames supporting the swings were of 1.6mm brazing rods, the static swings being suspended by drilling 0.8mm holes through the frames and the 0.5mm rods (representing the chains to the seats) were soldered into the holes.

## Careful with the brush

The moving swings had a 13mm long, 2.4mm outside diameter brass tube slid onto the frame before it was bent to shape. Seats, 'chains' and the crank arm were soldered to this tube, great care being taken when the swing was painted, that no paint ran into the tube.

Playgrounds often have an animal figure with a saddle, the whole thing being mounted on a mighty spring which allows its rider to move as though they are on a bucking bronco.





Andrew was mounted thereon and **Figure 3** shows how he was made to be so energetic.

A was a 5mm square brass tube with three sides being cut away at its base, leaving the fourth side to be bent to give a flange at 90 degrees, B. This flange had a 2mm hole drilled and the tube was loosely screwed into position. This tube needed to be capable of moving a few millimetres in any direction but not to twist, so a 'keeper' plate from 2mm brass, C, was fitted around its base (Figure 4). Loose pulley D on

*"Although this was being made for children, I didn't want to see the swings oscillating at unrealistic rates..."*

its bracket was soldered onto the tube and ran against cam E which had an irregular perimeter. Spring F had its tension adjustable at G and served to keep the D and E in contact. Screw H had a 1.2mm hole drilled through its shank adjacent to its head to take a 1mm brass rod J, which had its upper end formed into a ring and another 1mm rod K linked through it to form a crude universal joint, this second rod going up into the horse's body. I drilled a 20mm hole into the underside of the top plywood leaving only 3mm wood into which a 3mm length of 3mm diameter brass tube was set. The visible rod K had a 2.5mm spring around it to replicate the actual suspension L – **Figure 5**.

Back now to the cam which was 0.5mm nickel silver soldered to a brass hub. Using small pliers I crudely wrenched it until its rim was wavy and pulley D had to follow a side-to-side movement as well as its forward and back motion. This

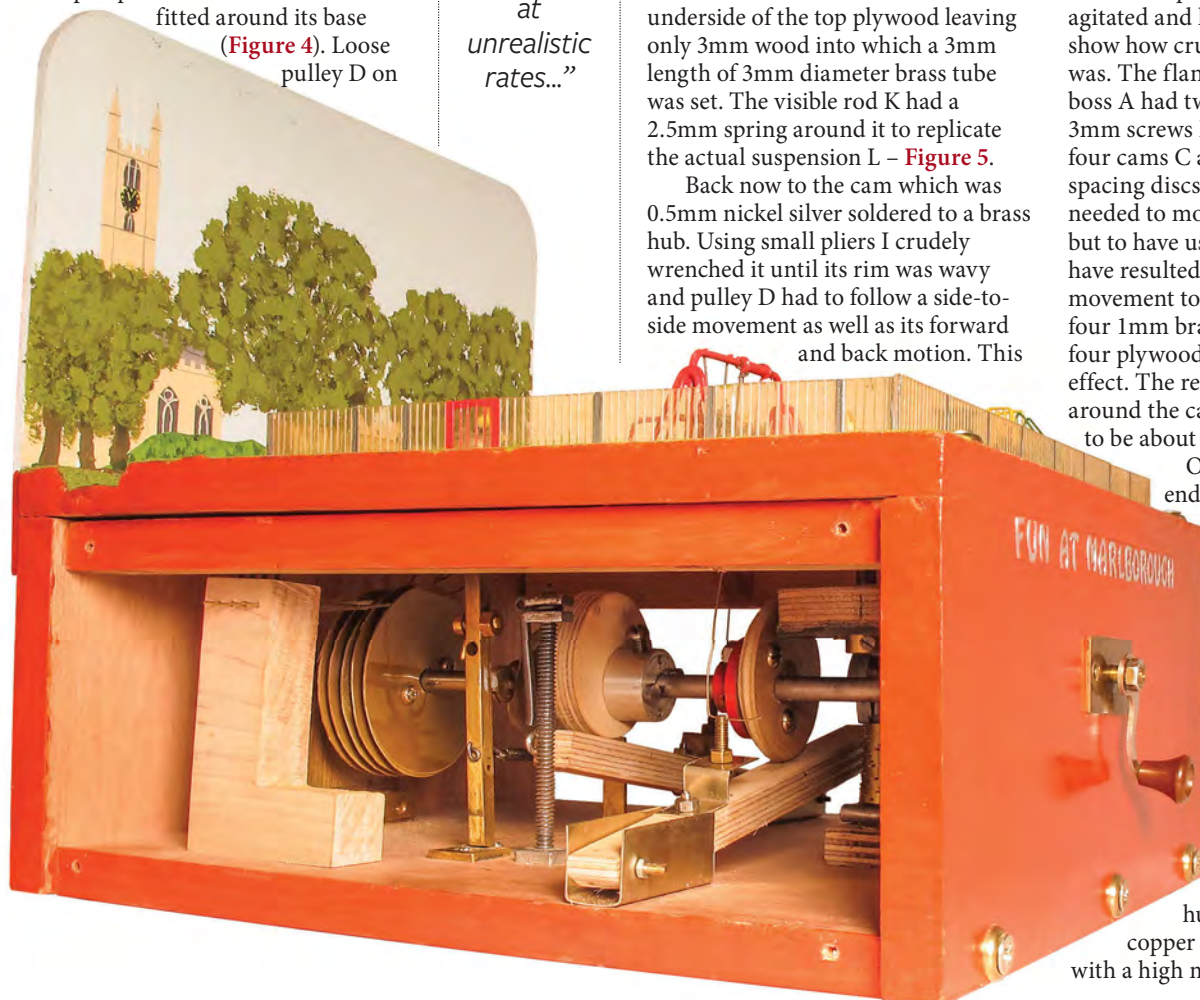
part of 'Marlborough' took some time to sort out, through my first trying to take rod J straight into the horse, but failing to achieve the movements that I had seen at the playground. The little universal joint proved to be essential for those.

### Agitated ducks

The fifth movement is that of four ducks by the stream. They missed out on the feeding and, seeing humans still in the playground, are rather agitated and hopeful. **Figures 6 and 7** show how crude their mechanism was. The flange on the aluminium boss A had two holes through which 3mm screws B held a sandwich of four cams C and five polystyrene spacing discs D. The ducks only needed to move about 2mm vertically, but to have used only one cam would have resulted in synchronised movement to them, but mounted on four 1mm brass wires F running on four plywood cams gave the required effect. The regular undulations around the cams' perimeter only need to be about 1.5mm.

On the left side the far ends of the ducks' wires were held in 1mm holes in an oak block E and secured there by screwing 10BA hex-headed bolts G directly through the wood.

The playground was a very small one but, even so, soldering up the equipment for it was a slow job (the roundabout was about 10mm high). The human figures had a copper wire armature joined up with a high melting point solder. This



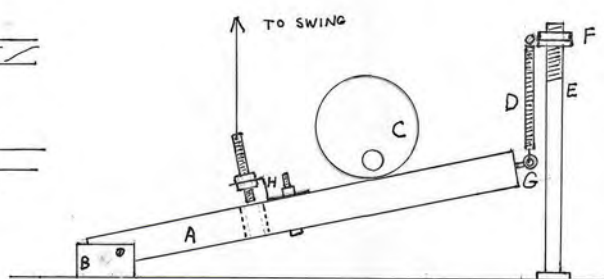
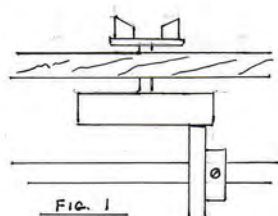


FIG. 2

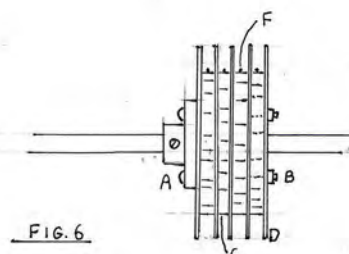


FIG. 6

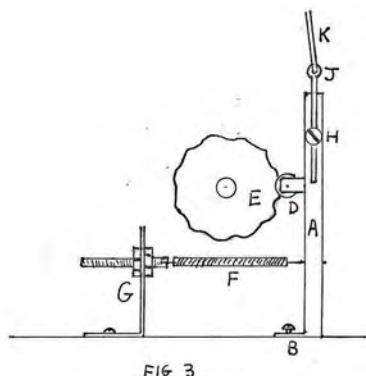


FIG. 3

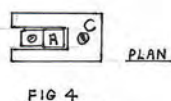


FIG. 4

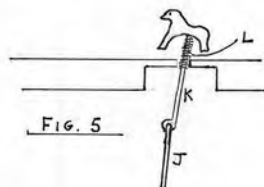


FIG. 5

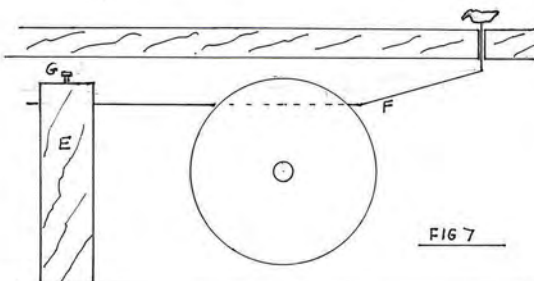


FIG. 7

was then bulked up to a more human shape by adding low-melting-point solder. Any excess was easily filed away.

Although in real life they are not visible from the playground, the library and converted church were

*Drawings by  
Dave Rowe,  
photos by  
Andy York*

painted on the little backscene.

Some 11 years after this particular automaton was made, the twin boys who enjoyed Marlborough so much are choosing their universities, but in the family home there is still this souvenir of umpteen happy outings.

Total cost of building Marlborough – £8. Total pleasure in building it – Immense... **EIM**

■ Previous episodes in this series appeared in the February, April and June 2018 issues of **EIM**

## START HERE

# Understanding Lap and Lead

Latest in our beginners series unlocking the mysteries of steam locomotives.

**T**his series was inspired by a reader commenting on the mystery language of steam locomotive engineering and a typical example is lap and lead. In the September issue we looked at valves admit steam to the cylinders and lap and lead are important elements of this process.

Lap is the amount by which the valve overlaps the steam port at the middle of the stroke and is important to the efficiency of the process. There are two types and they can be varied depending on what type of work the steam engine is expected to do.

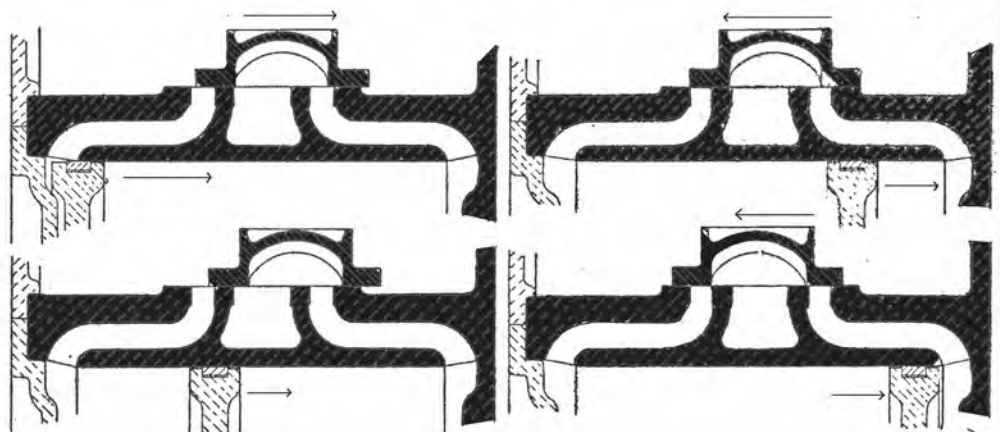
Steam lap describes the amount the valve covers the live steam admission port, and exhaust lap does the same on the steam exhaust port. Exhaust lap is more common on slow-running locos built for heavy hauling, as it ensures the steam stays in the cylinder for as long as possible before being exhausted, which makes the loco a more efficient hauler.

Lead is the amount by which the live steam port is permitted to be open at the end of the piston stroke,

when the piston comes to a halt at either the front or back of the cylinder. By admitting steam to fill the space between the piston and cylinder end, pressure is increased to aid the beginning of the next stroke. This is a very useful feature on locomotives planned for fast running such as on express passenger trains, where the pistons and valves will routinely be moving very rapidly. **EIM**

**BELOW:** This diagram, showing the four stages of a slide valve's stroke, demonstrates the principles of lap and lead. At **1** the piston is at the end of its stroke and the live steam port open to 'lead'. At **2** the piston has travelled halfway to the point of cut-off and the valve is open to allow maximum steam in – the amount the valve covers the admission and exhaust ports is the 'lap'.

At position **3** the piston has reached cut-off and the valve closes. The piston continues to travel to the end of its stroke, **4**, where the port opens to exhaust and the port at the other end closes allowing compression.



# The original operating technology of Tower Bridge

Ahead of his new book, John describes the fascinating engineering solutions inside one of the UK's most familiar landmarks.

BY JOHN SMITH



If you have never visited the Tower Bridge Exhibition in London, it is well worth a trip, if only because it will remind you how important hydraulics had become in the late 19th

century. Hydraulic engines were used to power bridges, gun turrets, dock gates, cranes, riveting machines and all kinds of workshop and manufacturing machinery. Despite

this I have yet to see a working model of a hydraulic engine. It would make a unique project and I hope this article inspires someone!

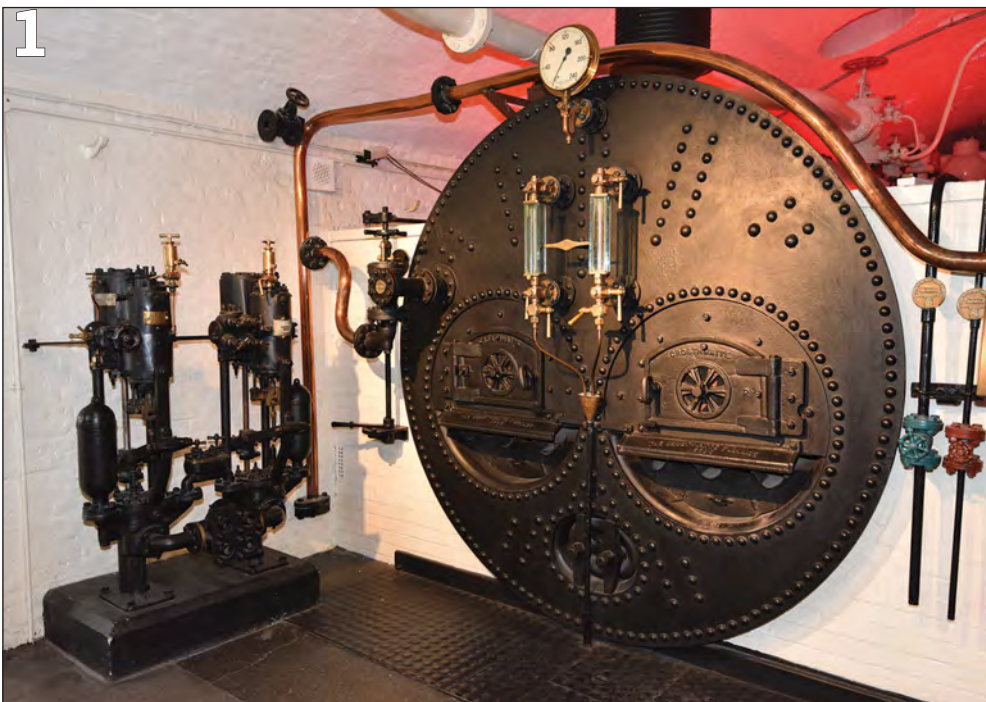
Built between 1886 and 1894, Tower Bridge has since 1974 been operated by an electro-hydraulic system, and the original steam engines and hydraulic system formed the basis for the exhibition that was opened in 1982.

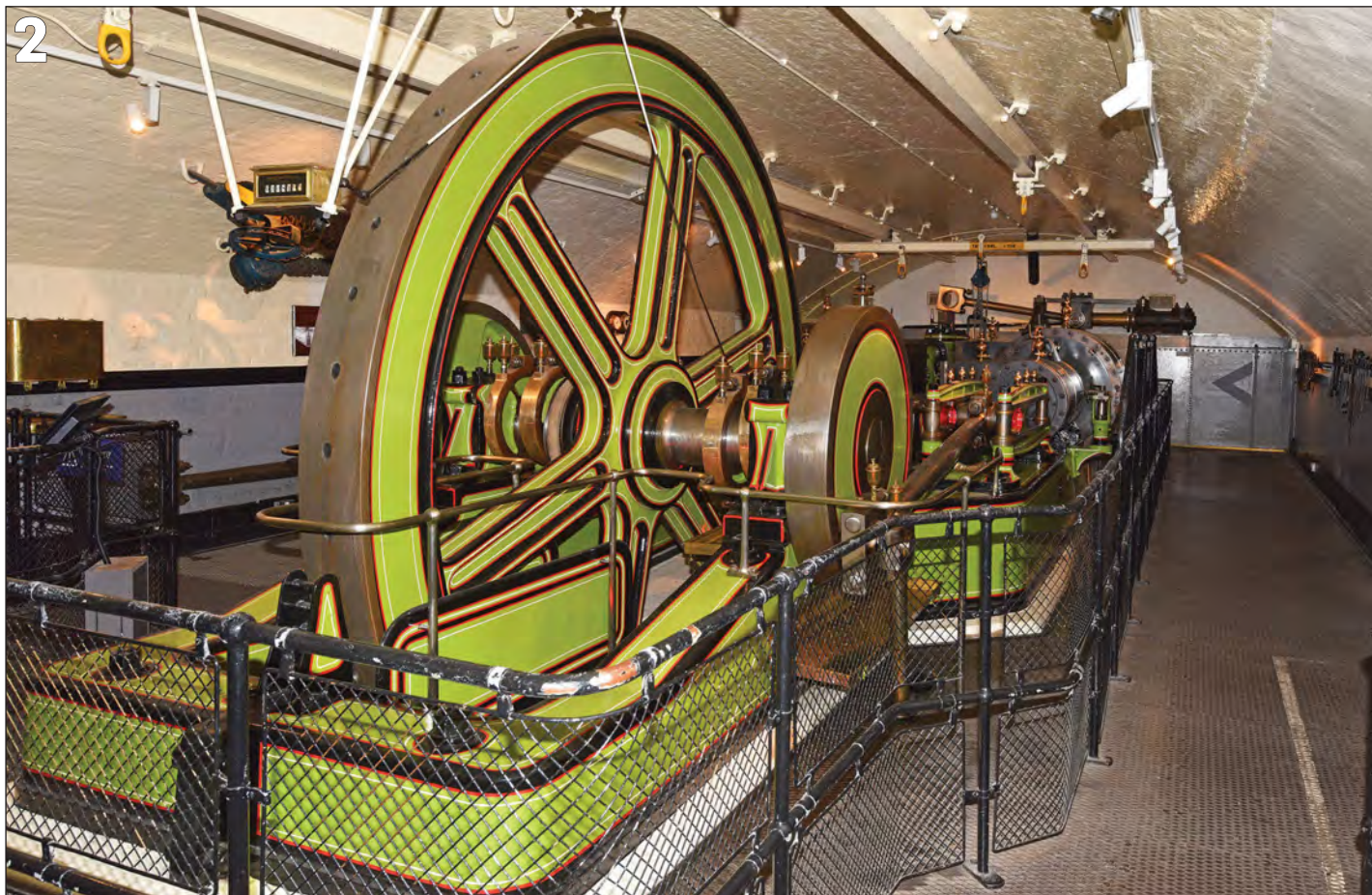
The original plant of Tower Bridge was designed, built and installed by Sir W G Armstrong, Mitchell & Co. Limited under the watchful eye of Sir William himself – the father of hydraulics and a veritable titan of 19th century engineering.

## Design principle

Tower Bridge was designed to deliver an extremely high level of availability – defined as the percentage of 24x7 time that the bridge was able to operate on demand. Everything necessary to operate it was duplicated. It did not have quite the level of availability of an Air Traffic Control (ATC) system, but it came close.

There were two steam-operated hydraulic pump sets and two pairs of





boilers, just as an ATC system has two independent electrical supplies and standby diesel generators.

Six high-pressure water accumulators were provided, the equivalent of battery back-up and uninterrupted power supplies in the ATC environment.

There was also a duplicated system of high-pressure water distribution, just as an ATC centre has multiple data and voice networks.

Four engines were installed in each pier, even though one was sufficient to operate a bascule bridge (*also known as a drawbridge - ed*) in almost all circumstances, just as an ATC centre has multiple servers, running mirrored databases, ready to take over from each other in an instant.

There were two quadrants on each bascule, two racks on each quadrant, two pinions working on each rack, two pinion shafts in each pier. Even

the stairways, lifts and walkways were duplicated. Tower Bridge was designed to be highly available and extremely reliable.

### The steam plant

The working pressure of the Tower Bridge hydraulic machinery was 700 pounds per square inch (psi). This is an enormous pressure, equivalent to the pressure 1600 feet below sea level and sufficient to crush a Second

#### HEADING:

Tower Bridge in all its glory – known the world over as a symbol of the UK.

#### PHOTO 1:

One of the four double-flued Lancashire boilers installed on the bridge.

#### PHOTO 2:

Flywheel end of one of the steam-driven pump sets.

#### PHOTO 3:

The same pumping engine from the pump end.

All photos by John Smith unless stated





World War U-boat. Even a modern nuclear attack submarine operating at such pressure would be close to its maximum depth.

The hydraulic pressure generation plant occupied five of the arches under the southern approach road of the bridge. Two of the arches housed the four double-flued, manually-stoked Lancashire boilers used for steam generation, two boilers per arch. These boilers are 7 feet 6 inches in diameter and 30 feet long, producing saturated steam at a pressure of 85psi. At any time, two boilers were in use, with the other two kept in reserve. **Photo 1** shows the front of one of the Lancashire boilers, together with a pair of steam-operated feed pumps. One can imagine the temperature under these arches on a hot summer's day.

Two arches are occupied by the horizontal tandem steam engines and

#### PHOTO 4:

A coal wagon, used to supply the boilers, on the hoist.

#### PHOTO 5:

A view looking up into the engine room accumulator tower. The engineering of the bridge cannot fail to impress...

pumps used to generate the hydraulic pressure for the bridge. Each engine is rated at 360 indicated horsepower and has a high pressure cylinder 19 $\frac{3}{4}$  inches in diameter and a low pressure cylinder 37 inches in diameter on each side of the engine, each low/high pressure cylinder pair being coaxial and driven by a single piston rod.

Each side of each engine drives a force pump with a diameter of 7 $\frac{3}{4}$  inches and a stroke of 38 inches. Each tandem engine has sufficient power and pumping capacity to power the hydraulics of the bridge, the other tandem engine and pump set being kept in reserve. **Photos 2 and 3** show the flywheel and pump ends respectively of one of the steam-driven pump sets. The engines were governed at 45rpm and one engine was normally ticking over at 4rpm to top up the supply of high-pressure water.

In between the boilers and the

engines is an arch occupied by a coal store. The coal was lifted from barges moored against the southern abutment of the bridge by means of a hydraulic crane and transported to the coal store on small tipping wagons running on rails and pushed by hand. An elevated track running down the centre of the coal store was used to distribute the coal in the store, the wagons being lifted onto the track by a hydraulic hoist. **Photo 4** shows a wagon on the hoist.

### Hydraulic accumulators

The raised weight hydraulic accumulator is believed to have been invented by Sir William Armstrong; he certainly perfected it. Its purpose was to store high-pressure water for use in hydraulic machinery, just as an electrical accumulator stores electrical energy.

Prior to the invention of the accumulator, it was common practice to build very tall towers containing water tanks as a means of generating hydraulic pressure. The tower at the Royal Dock, Grimsby is a good example. Designed to provide hydraulic power for lock gates and cranes, the water tank was 200 feet above ground and contained 30,000 gallons (134 tons) of water. However, the pressure of a 200ft column of water is relatively modest, just 87psi.

A raised weight accumulator does not need to be very tall yet it can provide pressures of 700 – 850psi very easily. The principle is very simple. A vertical pipe containing the hydraulic fluid (water in the case of Tower Bridge) is closed at the top by a piston which is weighted. The large volume of pig iron which is normally used to weight an accumulator is held in a large cylinder which is free to move between vertical guide rails.

Water is pumped into the accumulator. When the pressure in the fluid multiplied by the area of the piston equals the weight acting on the piston, the piston begins to rise. Thus it is simple to design an accumulator to achieve any desired working pressure. When the accumulator is at the top of its stroke, the pumps can then be switched off and high-pressure water remains available on demand, the pumps being used spasmodically to top up the supply of high-pressure water.

At Tower Bridge, there are two accumulators in an accumulator house just to the east of the plant rooms (**Photo 5**). These have a pipe/piston diameter of 20 inches and a stroke of 35 feet, storing between them up to 153 cubic feet (951 gallons) of high-pressure water.

Each pier had two further accumulators, in deep chambers at



each end of the pier, each with a pipe/piston diameter of 22 inches and a stroke of 18 feet. This enabled each pier to store up to 95 cubic feet (592 gallons) of additional high-pressure water.

This begs the question as to whether a bascule could be raised or lowered using purely the stored high-pressure water in the two accumulators in the pier. Given that water is incompressible, it is easy to calculate the maximum volume of water that will be required to lift and lower a bascule using one small hydraulic engine.

The circumference of an 82-degree arc of a circle of radius 42 feet is 60.11 feet, or 721.3 inches. The pitch of the rack is 5.9 inches, so there are 122 teeth on the rack. There are 13 teeth on the pinions which engage with the racks, so 9.4 revolutions of the driving pinions are needed to lift the bascule and another 9.4 revolutions are needed to lower the bascule again, 18.8 revolutions in all. As there is reduction gearing of 6.097:1 between the hydraulic engine crankshaft and the final pinion drive shaft, the engine crankshaft will need 114.6 rotations to lift and lower the bascule.

Assuming that the engine is operating in full gear with 0% cut-off, the water required will be  $3 \times 114.6 \times (\pi/4) \times 7.5^2 \times 24$  cubic inches, which equals 364,526 cubic inches, or 211 cubic feet. So, with the engine in full gear and the regulating valve fully open, it would not be possible to fully lift and lower the bascule safely using

purely the stored high-pressure water in the two accumulators in the pier.

However, the drivers could decide how high to lift the bascules. They could also decide how fully to open the valve, which would determine how fast the engine would run and how much water would be used. Also, when the bascule was opened or closed, the link blocks in the expansion links were moved automatically towards the centre of the links to cut off the valves before the end of the stroke of the rams, thus economising on water usage, so it is likely that the bascule could have been raised and lowered again using just the water stored in the accumulators in the pier.

The maximum volume of high-pressure water which could be stored in all six accumulators was about 350 cubic feet. What this tells us is that the bridge could certainly be opened and closed using just the high-pressure water stored in all six accumulators, but one of the steam-driven pumping engines would definitely be operating during a bridge lift to top up the supply of high-pressure water. Some sources state that the bridge could be opened and closed twice using just the high-pressure water stored in fully-charged accumulators.

One revolution of one pumping engine pumps 2.075 cubic feet of water, so in one minute two engines operating at 45rpm could pump 186.7 cubic feet of water. This means that it would take only 1 minute 50 seconds



to refill the exhausted accumulators. If only mobile phone chargers were as efficient!

**ABOVE:** The complexity of the Victorian engineering within the two towers surprises many a visitor.

**BELOW:** The two bascules are raised to admit a Thames barge – each bascule weighs more than 1,000 tonnes. Photo: Dreamstime

## Water distribution

The system for distributing high-pressure water to the piers and the engine rooms within them was duplicated, with both manual and hydraulically-operated valves installed at many points to allow the system to be configured to operate even when technicians were engaged on the repair or maintenance of part of the system – for example dealing with a leaking flanged joint in a high-pressure pipe, or re~~EM~~ing a seal in an accumulator.

■ Part 2 of this feature will appear next month. John is working on a detailed history and engineering appreciation of Tower Bridge, due to be published in the spring of 2019 by Haynes Publishing.



# Dougal – a 5-inch Barclay

Young Sussex engineer Andrew's entry-level locomotive construction project reaches an eccentric stage of the build...

BY ANDREW STRONGITHARM – Part Seven of a series

The eccentric strap castings were initially set up in the outside jaws of a three-jaw chuck where I faced off both sides of the three separate castings. I would need two to drive the valves and a third to drive the axle pump. As the eccentrics were already made and fitted to the rear axle, I was able to measure the groove and face the straps to the correct width to fit them.

Once they were to thickness I clamped them in the vice on the vertical slide on the lathe and used a  $\frac{3}{8}$ -inch end mill to square up the rough cast finish on all the flat faces. Four of these faces would be used to bolt both halves of the eccentric strap castings together once they had been split to fit over the eccentrics. The remaining face would contain an oil hole to lubricate the bore of the straps when they are rotating around the eccentrics. An important note at this point is to ensure that all the flat faces have been machined square and to the same dimensions on each casting. These flat faces will form datum points from which the following machining will be set up.

With all the flat faces machined square, I could now drill the bolt holes on either side of each strap with a 3.2mm drill. To do this I placed the first casting flat in the vice on the vertical slide.

Next, I measured the distance from the back of each bolting lug to the back of the vice. Knowing both dimensions are the same, the holes will therefore be square through the lugs. All that was left to do was to centralise the casting vertically and I was good to start drilling. These holes

The prototype 'Dougal' loco is a 2ft 6in gauge Barclay 0-4-0 built in 1946 for the Provan Gasworks in Glasgow and today resident on the Welshpool & Llanfair Light Railway in mid Wales.



would be used to help set the castings up square again once they had been cut in half.

I had now done everything I could with the eccentric straps in one piece, so it was time to split them. I used a pair of dial calipers and a six-inch steel rule to scribe across the centre line in order to give me a guide to follow when cutting them with a hacksaw. Prior to cutting, I letter stamped the front and rear half of each strap so that I could easily match them back together when separated.

With them cut, I held each half in the vice on the vertical slide and repeating the aforementioned process set each half up square with the back of the vice. Once parallel I machined the mating face of each lug to clean up the hacksaw marks and to make them all a uniform thickness. For this particular job I was lucky in that the vice I have on the vertical slide was almost a perfect width to hold half a strap in. It is important that as much land as possible is left on the casting

and therefore due care should be taken to ensure cutting and machining removes the minimum of material.

Whilst set for cleaning up the mating face, I took the opportunity to open out the previously drilled 3.2mm holes to 4mm on the front half of each eccentric strap. The rear halves were threaded 4mm to accept a stainless steel socket bolt. I could now bolt both halves of the three individual castings together and check to see if the alignment of the bolts was correct.

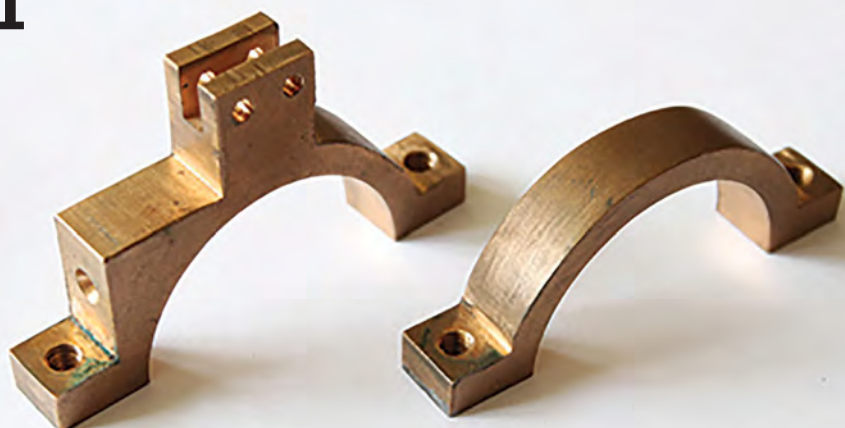
I chose to use 4mm socket cap bolts as there was insufficient land to turn a hexagon head bolt clear of the side of the casting. There was also hardly any room to use a spanner to tighten a hexagon head bolt when all the eccentric straps were mounted on the axle, so a socket cap bolt provided a very strong and suitable alternative.

In order not to be reliant on the bolts alone whilst I was turning the main bores, I decided to soft solder both halves of the eccentric strap castings together as an added

**PHOTO 1 & 2:**

Two halves of the eccentric straps, and once bolted together.

1



2



precaution. This was the first use of soft solder on the project and it was an interesting comparison to the silver solder which I had used whilst building the boiler.

Taking each half in turn I prepared the mating face with Fry's soft solder flux paste and carefully tinned each surface with a small amount of solder. I then placed each pair back together, bolted them up tightly and then reheated so that the tinned surfaces bonded together.

Checking to make sure the bolts were still done up tightly, I proceeded to mount each eccentric strap one at a time flat against the front face of a three-jaw chuck on the Myford lathe. I was lucky as the jaws did not foul on any of the flat faces on the castings and held firmly on the curved surfaces. I could now clean up the inside bores by using a boring bar and I took 5 thou' cuts to gradually open them out to a finished size of  $1\frac{1}{4}$ in to fit over the eccentrics.

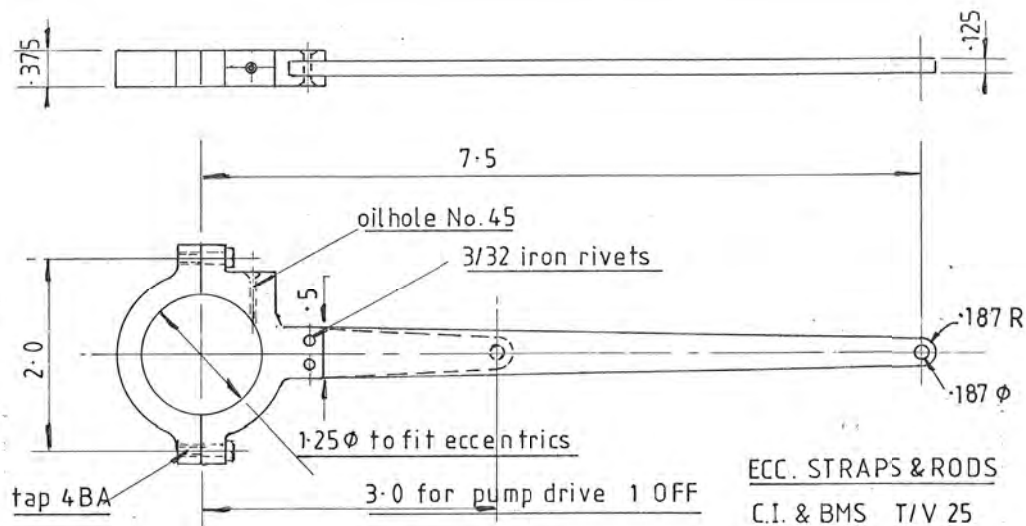
### Splitting the straps

I double checked the diameter of the bores with dial calipers before removing the bolts and heating the castings to melt the soft solder. Once up to temperature, both halves of the eccentric straps easily came apart and using a needle file and emery paper I cleaned these faces up to remove any remaining solder.

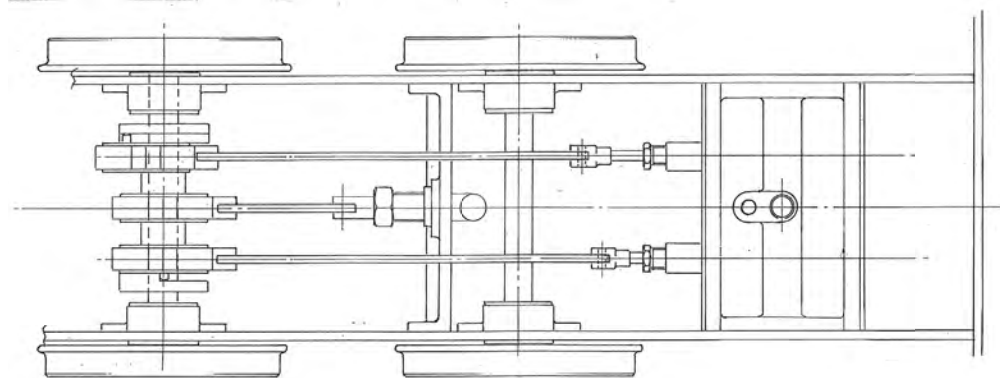
Next, I placed the front half of each strap on its side, flat against the back of the vice on the vertical slide to drill the oil holes in them. One oil hole was drilled in each eccentric strap on the flat face next to the top bolt. These were drilled out using a 2mm drill and a small countersink was added to the top of each hole to help direct the oil towards it. I then de-burred the hole on the inside of the eccentric straps where it broke through into the main bore.

The final job on the eccentric straps was to machine a slot on the front edge for the eccentric rods to locate in and to drill two rivet holes to hold them in place. I used the lugs to set up the front half of each casting level with the back of the vice on the vertical slide to machine the slot. With an  $\frac{1}{8}$ in end mill, and carefully taking 5 thou' cuts, I machined these slots to a depth of  $\frac{5}{16}$ in before taking them out of the vice and holding them vertically to drill the rivet holes.

I had already scribed the position of these holes on the castings and after spot drilling with a centre drill, I confirmed the location was correct with the dial calipers before drilling them all the way through with a  $\frac{3}{32}$ in drill. Instead of using rivets, I turned six  $\frac{3}{32}$ in mild steel pins on the lathe to press into the holes that I had just



**DRAWING 1**



**DRAWING 2**

**DRAWING 1:** Eccentric straps – drawn approx half full-size.

**DRAWING 2:** Layout of the eccentrics (not to scale).

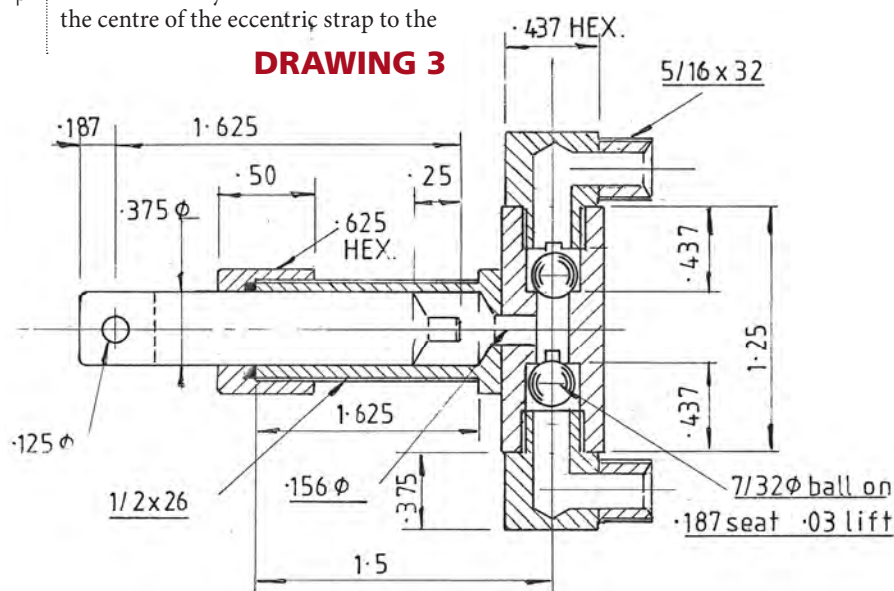
**DRAWING 3:** Axle feed pump – drawn approx half full size. Andrew bought his pump ready-made.

drilled, once I was ready to fit the eccentric rods which were the next pieces to make. (Photos 1 & 2)

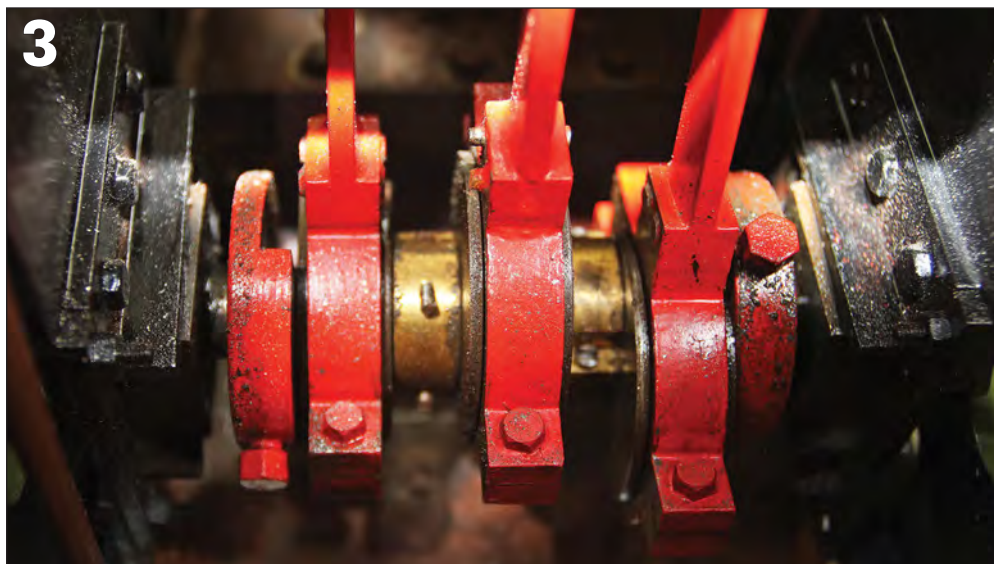
The eccentric rods transfer the forward and backward motion of the eccentrics to the valve rods and valves. The rods started life as two pieces of  $\frac{1}{2}$ in x  $\frac{1}{8}$ in bright mild steel flat cut into two lengths.

The drawings state that the length between the centre of the eccentric straps and the centre of the 'little end' valve gear pin should be  $7\frac{1}{2}$  inches. To determine the actual length of each eccentric rod, the length of  $7\frac{1}{2}$ in had to be reduced by the dimension from the centre of the eccentric strap to the

back of the slot in the front of the eccentric strap casting, which the rod is bolted into. This was relatively easy to measure as I could place the front half of each eccentric strap down onto a surface plate and using a pair of dial calipers measure the distance from the surface plate to the top of the casting. Then, I measured the depth of the slot separately and took this number away from the previously measured front half of each eccentric strap. Once this dimension had been calculated, I subtracted this from  $7\frac{1}{2}$ in and then added the radius



**DRAWING 3**



required at the 'little end' plus about 15 thou' extra to obtain a full length.

I began by drilling the hole for the 'little end' into each rod. These were drilled out oversize and reamed to  $\frac{9}{32}$ in to take a PB102 bronze bush which I made to be a push fit. This bush was then reamed out using the same 5.2mm reamer that I used to make the valve rod fork ends with.

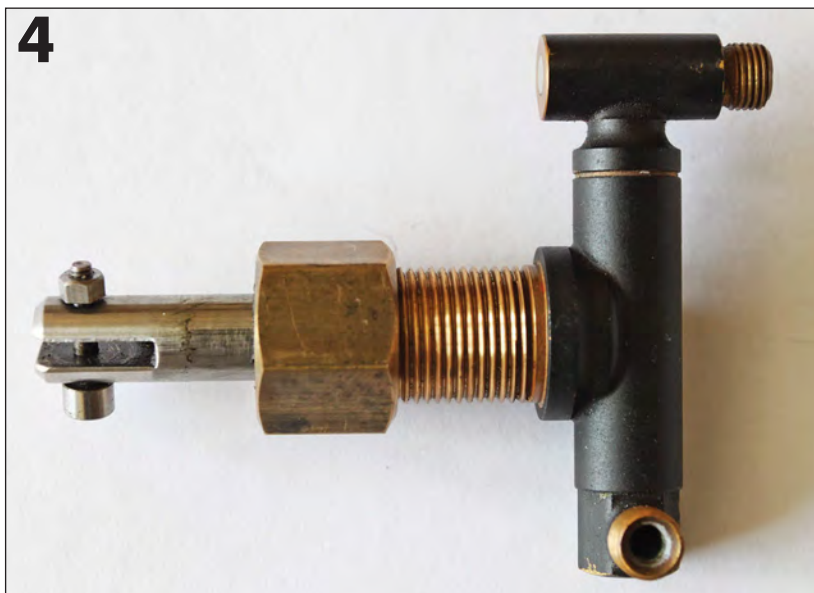
I was now ready to machine the taper along each rod. The drawings show the width of the rods starting off as  $\frac{1}{2}$ in at the eccentric strap end and taper down towards the 'little end', although no dimension for the width of the rod at the 'little end' is given. As they will be fitted into the valve rod fork ends I decided they should be the same width as them which was  $\frac{3}{8}$ in. This also simplified the measurements for me as I had to ensure the taper on both sides of each rod was  $\frac{1}{16}$ in.

I held each rod lengthways in the mill vice with one end roughly  $\frac{1}{16}$ in further out of the jaws. Using a depth micrometer, I measured the exact distance each end was sticking out of the jaws and continued to adjust the

rod until the difference was exactly  $\frac{1}{16}$ in. For reference, the mill vice on our club Bridgeport has stepped jaws, which are roughly 100 thou' deep.

For this particular job these steps were very useful because they allowed the depth micrometer to lay flat across the top of the jaws whilst being able to measure down into the step. A  $\frac{1}{4}$ in end mill was used to machine the taper and I was careful to ensure that when I took each rod out of the vice, I simply turned it over and not around, so the tapers were machined in the correct direction.

I then double checked the overall length of both rods with them inserted into the slots which I had machined into the front half of each eccentric strap. Since these were a good fit in the slots, I could mark the location of the holes for the two pins which would hold them in place by spot drilling through the casting. I marked one hole at a time, drilled it out  $\frac{3}{32}$ in and reinserted the rod into the eccentric strap before putting a temporary bolt through and repeating the same process for the second hole.



**PHOTO 3:**

Assembled eccentrics on the rear axle..

**PHOTO 4:**

Andrew obtained a ready-made axle pump for his loco.

**PHOTO 5:**

Modifications were made to ensure the gland nut locked in the correct position.

**PHOTO 6:** View

from overhead of the completed setup. Axle pump left disconnected until valve timing has been set.

All photos by the author

I used bolts initially as once the mild steel pins were fitted, they wouldn't be coming out very easily again! Because the pins were made to be a tight fit, they each had to be gently tapped into their final position with a hammer. As a final security measure, I silver soldered the eccentric rods into the eccentric straps and after cleaning off any excess solder, I turned a  $\frac{3}{8}$ in filing button to radius the 'little ends' of the eccentric rods.

This concluded the manufacture of the eccentric rods and so it was now possible to connect all of the inside motion together for the first time and fit the valve gear pins between the eccentric rods and valve rods fork ends. (Photo 3)

### The axle pump

One of the few items that I decided to purchase for the locomotive was an axle pump with a  $\frac{5}{16}$ in diameter ram, Photo 4 (the drawings include a suitable pump - Ed). It was therefore necessary to have the pump to hand in order to make the eccentric rod to drive it. This was manufactured in a similar way to the main eccentric rods apart from being considerably shorter!

It is important that the travel of the ram remains within the axle pump body and that it does not get pulled out of the gland nut or get pushed too far in and bottom out. The travel of the eccentric rod is fixed by the eccentric which is offset by  $\frac{1}{4}$ in, giving a total travel of  $\frac{1}{2}$ in and therefore the exact length of the axle pump eccentric rod can only be determined once the axle pump is fitted in situ. Prior to fitting the pump to the locomotive, I gave some thought as to how and where I was going to run the pipe work to and from it.

The body of the axle pump was mounted to the chassis through the centre stretcher and this was one of the reasons why that stretcher was made out of  $\frac{1}{2}$ -inch steel plate. A 0.450in hole was drilled through it and this was threaded  $\frac{1}{2}$ in x 26tpi to accept the threaded part of the body of the pump.

The pump was supplied with a gland nut and this was used to lock everything in position on the stretcher. It was important that the gland nut locked in the right position to clamp up against the stretcher while making sure that the PTFE gland inside it did not lock up too tightly on the ram. To overcome this, I shortened the length of the threads on the body of the axle pump. (Photo 5)

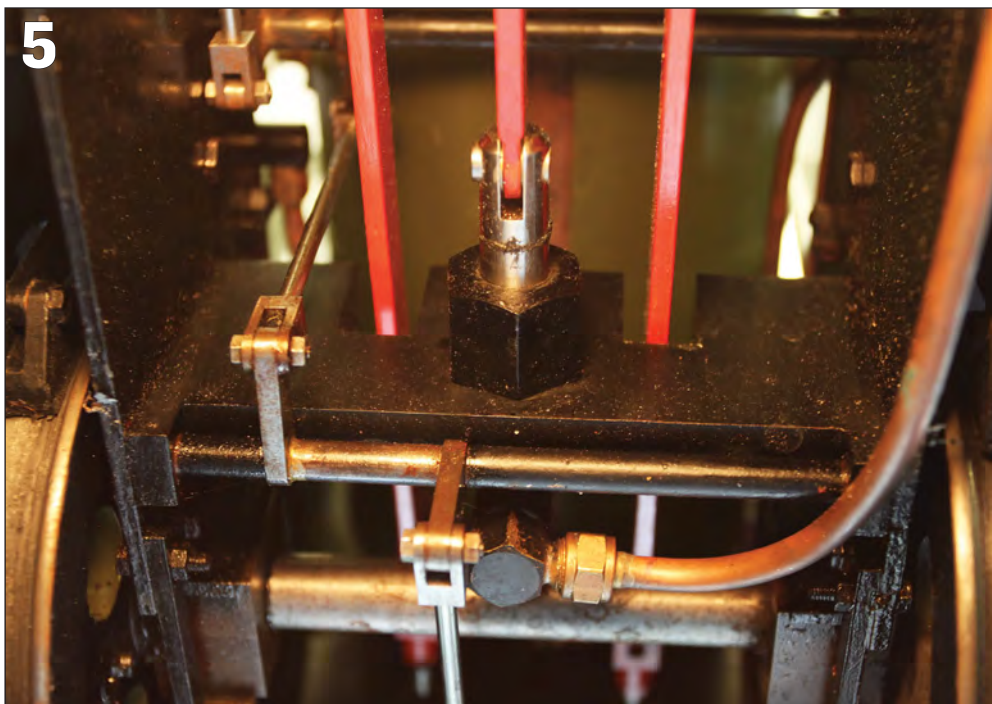
The top fitting on the pump was adjusted so that the threads faced away from the stretcher, allowing me to screw the delivery pipe into it. This was achieved by placing two or three copper washers over the threads of the

top fitting. Once I was happy with the position of the fitting, I took the washers off and measured the total thickness of them. I then turned up a single brass washer to suit.

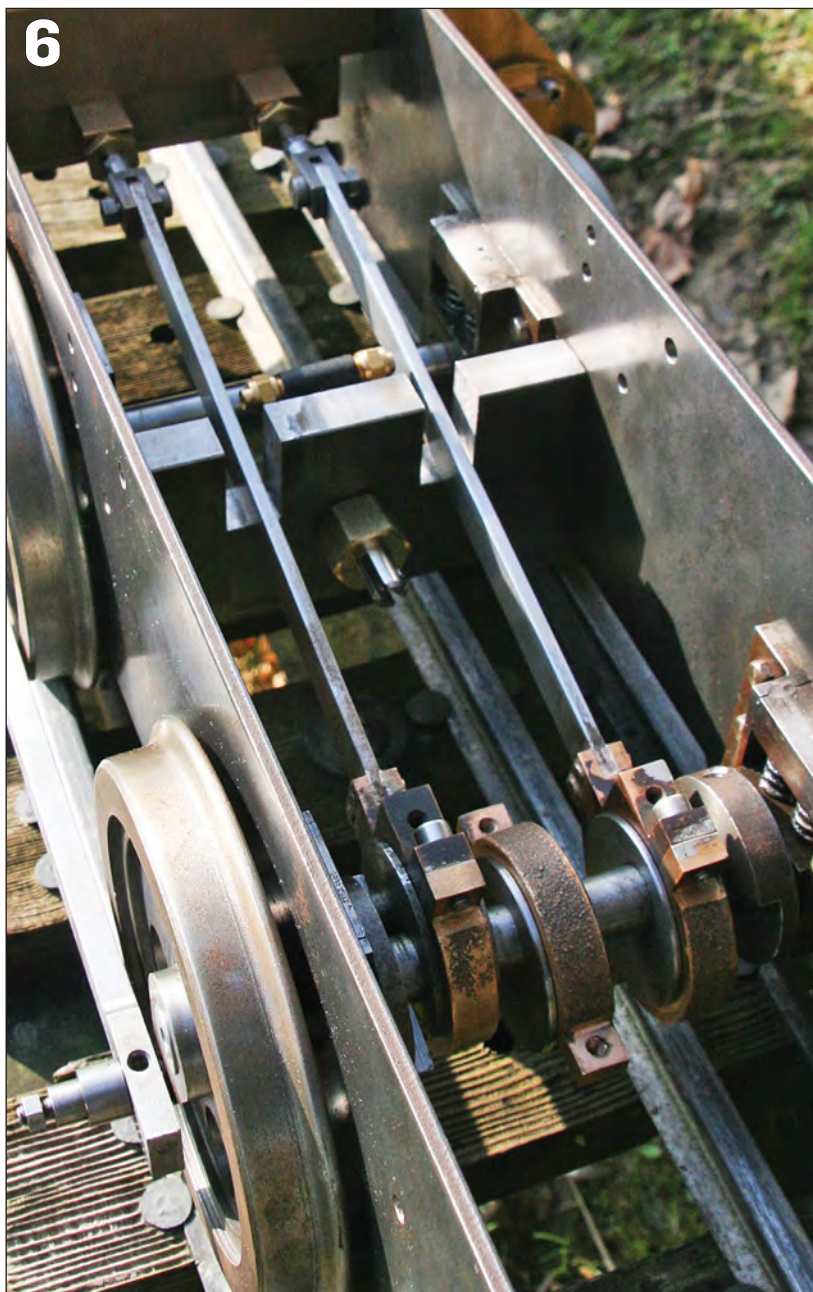
When purchased, the bottom fitting on the axle pump was 270 degrees out from my desired position. This fitting was made from hexagonal material and luckily the outlet threads fitted exactly between two of the three jaws on my lathe chuck. Therefore I managed to carefully turn down the fitting to allow it to be screwed into the pump body by a further three quarters of a turn.

With the pump fitted to the locomotive, I initially used a piece of  $\frac{1}{2}$ in x  $\frac{1}{8}$ in bright mild steel bar to act as a temporary eccentric rod to determine the correct length. Once I had confirmed this length, I used the same bar to fabricate the final eccentric rod. The bush was drilled out  $\frac{1}{8}$ in and a silver steel pin turned to connect the eccentric rod to the ram of the pump.

All three eccentric straps and eccentric rods could now be fitted to the chassis and the valve gear pins which hold them to the valve rod fork ends or axle pump secured in place with Loctite 242 nutlocker. It's good to check at this point that the wheels still rotate fairly freely now they are directly connected to the valves in the steam chest and the extra friction this produces. The axle pump will add a considerable amount of resistance to the rotation of the wheels and having checked that the length of the stroke was about right, I deliberately left this disconnected until after I had set up the locomotive timing (**Photo 6**). **EIM**



*"It was now possible to connect all of the inside motion together for the first time..."*



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



Tel: 01827 830894 E-mail: Sales@ajreeves.com  
Web: www.ajreeves.com

### 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

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/](http://www.world-of-railways.co.uk/engineering-in-miniature/store/back-issues/) or by telephoning 01778 392484.

### Next Month...

"The work would require a lot of concentration and I had to get them right first time..." Andrew machines his cylinders.

# At work and play...

Struggling to attract new, young blood to your club? John has found several clubs doing rather well for younger future engineers...

BY JOHN ARROWSMITH



The continuing saga of finding ways to get young people interested in model engineering or activities other than using their thumbs and looking at screens continues without a pause, but if you do pause and look at what is going on, a slightly different picture emerges.

I have been to a number of rallies and shows this year and it was pleasing to me to see the number of young people involved in many

aspects of both the organising and demonstrations at all of these events. At the Bloxham Traction Engine Rally in June there were a number of younger people actively involved in organising and operating the rally. The Steam Apprentice Club had a good-sized stand to show off what they can do for would-be young engineers and as I have said many times before, within the traction engine world there is a great

involvement with the families which is not so obvious in traditional model engineering clubs.

Take the young man I met at Bloxham, he was only seven but has been attending rallies with his grandad since he was three. He was really dirty from working on the engine and I suspect many modern mums would be shocked to see their offspring in such a state, but this young man is learning life skills at a much earlier age than many others and talking to him he absolutely loved it – grandad says he cannot get enough of it.

## Working and driving

Up at the Tyneside SME Linda Nichols has done a tremendous job in getting a young engineer section working well and with great support from the senior members it is now a flourishing part of the club.

I think the photos say more than I can about what they are doing, just look at the concentration evident amongst the youngsters whilst both working and driving engines. I hope this group continues to prosper and becomes a serious addition to the successful Tyneside club.

Another club that actively encourages younger people to take an active role in its rallies is the Model Steam Road Vehicle Society.(MSRVS) At the club's Tewkesbury event that was held in June the rally field was



**ABOVE:** At the Tyneside club, driving an A3 needs concentration.

**LEFT:** This lad is only seven but already an experienced traction engine mechanic, seen here at the Bloxham rally.

All photos  
by John  
Arrowsmith

alive with the younger element really enjoying themselves.

The organisers decided to offer a 'Drive a Traction Engine' feature for a donation to club funds, basically to see what the reaction would be. They were astonished at the response and I counted at least 11 engines taking part with a very long queue to join in. Many of those queueing were young visitors and the engine owners were delighted that so many people wanted to take part.

I appreciate that such initiatives are probably not going to provide lots of new members for clubs but if just one or two of those who take part establish an interest and come back for more, then I am sure the club would ensure they were catered for.

As I said above there were lots of family groups attending the rally and this emphasised my point that the family aspect is not a regular feature at model engineering clubs. It would be good to hear other ideas on this and I'm sure letters to the editor would be well received.

### Big responsibility

Last year I attended the Great Dorset Steam Fair – as you all know this is the largest event of its kind in the UK, but the theme of young people being involved had to be seen to be believed. One of the displays features a full-size standard gauge steam loco and no small tank loco either – this year a Bullied pacific was on show.

The off-loading from the low loader onto a length of track was a tricky operation involving careful use of winches at both ends which was co-ordinated by two people, one of whom was a 16-year-old young man. He had a big responsibility but which appeared to be just another day at the workplace to him.

This was very impressive as it showed the confidence placed in him by both the event organisers and the owners of the locomotive. The unloading was completed without any problem at all.

Within the Fair itself there were

Young members in action at the Tyneside club. No discrimination (**above**) as this young lady gets the Koppel 0-6-0 going well. Learning to interpret the drawings (**upper right**). Both tracks are used (**lower right**) to let their young engineers learn the driving techniques needed. A happy group of youngsters (**below**) with their new loco outside the new club house.





**ABOVE:** No minor task...This 16 year old young man was part of the unloading team for the full size loco at the Great Dorset Steam Fair.

**UPPER LEFT:** It's a big climb back up to the assembly area at the Dorset Fair.

**LOWER LEFT:** Mixing with the big boys in the playpen at the Great Dorset.

**BELOW LEFT:** These young men were part of the Grand Parade at the Much Marcle Rally.

**RIGHT & BELOW:** First time solo driver, and Charlie Warmlesley on a 7½in Black 5 at the Hereford club.

many young people taking part in all sorts of ways including driving in the main 'Playpen' with all the big boys. They all had a wonderful time every day being part of this great show. I hope my photos give you a flavour of what young people can do when given the opportunity.

## Career-building

Finally in this short round-up of young engineer activities I would mention the Hereford SME Gala weekend where again many youngsters played an active part in all aspects of the weekend.

They had the opportunity to drive different locomotives and talk to visitors about the engines they were driving. They also helped with loco preparation and shutdown at the end of the day.

One of the older lads has now been accepted as an engineering apprentice on the Severn Valley Railway so that will enhance his experience no end and will also help him with the full-size steam roller he and his family have now acquired.

So you see all is not lost in the aim of recruiting young engineers to the model engineering cause, but you do have to work at it to get the rewards everyone would like to see. Let the editor have any photographs of young people involved with your club or events – he would love to see and feature them in these pages. **EIM**



# Meeting the terms of the boiler code...

## EIM Steam Plant Boiler

**M**artin Gearing is doing a great job with the steam plant boiler. However could I suggest that he might usefully give some reminders to the prospective builders about compliance with the Boiler Test Code 2018 and to consult with their club boiler inspectors as fabrication proceeds?

The following sections of the Boiler test Code may be relevant

5.1) It seems to me to be a problem that there may be no way for an Inspector to satisfy him(or her)self whether or not the design and materials are adequate for a boiler that is brand newly published in the press and not yet 'recognised' by custom and use. Could Martin Gearing perhaps publish calculations?

6.1) The boiler should be examined twice during construction.

7.4) Might imply the desirability of having warranty certificates for the materials.

Great magazine. Thanks.

*John Boothman*

**Martin Gearing replies:** As the boiler may or may not be constructed with a view to being operated in a public place it is not essential to have a boiler certificate – that applies to all pressure systems.

However common sense dictates that by publishing an article in the UK on the construction of a pressure vessel (in this case a boiler) it would be lunacy not to comply with the most commonly used regulations likely to be used in this area, those of the MELB relating to Boilers under 3 bar Litres.

The fact that the boiler was actually designed and built in 2016 meant that it had to comply with the regulations set out in the Green Book, and it was in compliance to those regulations the article was written, however in the latest edition (depending on your interpretation) the White or Orange edition to which you refer, the regulations are in fact less demanding.

As the series introduction (EIM October) stated; "If however you do not find

favour in the methods suggested, and have sufficient experience, then by all means complete the boiler to the dimensions given, by whatever method you wish – provided that the result satisfies good working practice and achieves a recognised boiler test certificate as a minimum."

As only the introduction has been published before this issue the relevant points at which the assemblies need to be viewed by the builder's chosen boiler tester has not been printed – I admit to not having stated that the intending constructor should have discussed the build and willingness of the boiler inspector to oversee the boiler's construction, but it does assume that the constructor actually talks to the members of his chosen club and would be told the procedure. If they are a lone worker – then there's no point discussing it.

As to the code references;

5.1. As this boiler has not been completed more correctly itself refers to 5.4, relating to material specifications and design (by inference stress calculations)

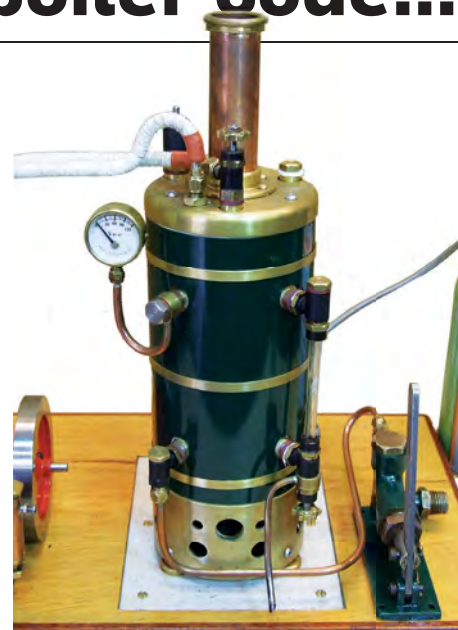
The complete calculations run to 15 sheets and a copy has been provided along with the article. It has always been my understanding that for a 'Published Design' to be published, the design calculations must be included when the article is submitted.

My design calculations were verified by a retired professional design/stress engineer who was also coincidentally the club's most experienced boiler tester with a great deal of practical boiler making experience, before I commenced the project.

To occupy that amount of space in a magazine when the accepted reference works of K N Harris, Tubal Cain, Martin Evans, Kozo Hiraoka, Alex Weiss are so freely available would be a waste of space given so few would be interested.

6.1 Under the new volume 2, this does not relate to the construction process, but in fact details the full procedure for pressure testing.

However as stated previously the boiler was built under the previous (it seems in



many ways far more practical) 'Green' book regulations and under those, regulation 6.2 states "An inspector shall require a boiler to be examined in order to be satisfied that the requirements of para 7.4 (materials, design calculations etc) and 7.5 (fitted with suitable blanking plugs prior to testing) are fulfilled, particularly where the boiler is already constructed and presented for examination.

"All prospective constructors should discuss such possible requirements with the inspector before commencing construction and the boiler should be examined at least twice during construction."

None of this appears in the latest version effective from 1st May 2018. Which is why I say the earlier regulations given in the 'Green Book' edition make more sense, and describe interim inspections as demanded in those regulations in the article being published.

7.4 All the materials specified in the two lists have been given their material codes. The suppliers suggested will give material certificates if requested by the inspector via the purchaser.

I hope this goes some way to answering the enquiry.

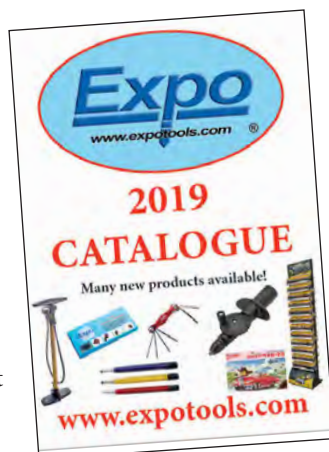
## GENERAL NEWS

### New Expo catalogue

**M**odel engineers, especially those working in the smaller scales, will be interested in an all-new catalogue for 2019 newly available from Expo Tools.

Running to 152 pages, the full colour catalogue contains a wide range of useful tools with many new items included and exclusives also listed.

The catalogue is available free with orders and at Expo stockists. It can also be ordered from the website at [www.expotools.com](http://www.expotools.com)



### Calling Warco?

**W**ell-known machine tool supplier Warco has invested in a new telephone system in a bid to make it easier for customers to reach the company more easily and to enjoy improved service.

The new system includes Fibre optic lines for improved clarity, with more lines and better access to the firm's Technical section.

The main number, 01428 682929, remains the same and callers can then select from the options offered. Warco hopes that teething problems with the new system will be kept to a minimum.

**New product for model engineers? Tell EIM readers about it on these pages. Send details and photos to the address on page 3**

# Clubs go civil engineering

Many a club has been busy in recent weeks adding to their facilities.

COMPILED BY ANDREW CHARMAN

Last month we reported on the threat to the future of the **Bristol SME's** Ashton Court miniature Railway, which the club has been running for more than 45 years. The Bristol City Council had warned the society its lease may not be renewed as it does not make enough money.

The council is said to be looking at "new income-generating opportunities" for the site on which the railway runs. However the closure threat has angered many and a petition with more than 8000 signatures protesting against the plans was handed to the council. Now the club has been granted a 12-month extension to its lease, but with a warning to the group that it 'needs to become financially viable.'

Deputy mayor Asher Craig told the BBC that an extension until the end of next summer would allow time for a long-term solution to be discussed. "I have no problem with the railway being retained at Ashton Court but it needs to wash its face," Ms Craig was quoted as saying.

"The cost of running Ashton Court is nearly £500,000 a year," the deputy Mayor added.

The club, however has argued that it provides a valuable local service, providing entertainment for the people of Bristol, offering special days for disadvantaged groups, and maintaining the site, including keeping the grass mown, at no cost to the council, in fact paying rent to the authority.

BSMEE chairman Norman



Rodgers told local media that the society should not be forced into becoming a "ruthlessly commercial" operation to satisfy the council's need for more money.

Efforts to retain the railway have also attracted support from many Bristol councillors, who have accused the local authority of bullying a voluntary organisation.

## Under cover

Much better news this month comes from the **Sale Area MES** near Manchester, which has celebrated the opening of a new canopy at its track in Walton Park.

"For several years our members discussed the dream of a canopy to cover our steaming bays which would



give us the luxury of steaming up and doing boiler tests on rainy days," club treasurer Stuart Clayton told **EIM**.

"We started with various ideas from members resulting in an artist's impression. This was followed by scale drawings.

"We are based in a public park so we had to use these together with the raft of relevant local council forms to apply for full planning permission. When we eventually received the permission we then had to employ a structural engineer who produced the detailed drawings to ensure our 'big umbrella' would not blow away!"

The search for a company to do the groundwork, concrete footings, the steel fabrication and erection, proved a much longer process than the club had imagined. "The job was well beyond our members' capabilities although we did paint the steelwork, which had been galvanised," Stuart added.

## TOP & ABOVE:

A new steaming canopy at Sales MES has taken some years to build but has been well worth the wait.

## LEFT:

Celebrations at Bradford ME as the first train takes to the rebuilt raised track after it was officially opened by Diane Carney (right).

Photos: Sale ME, Bradford ME





The roof was fitted by a member while others made the decorative gable ends and barge boards out of marine plywood. An old factory clock was provided by a member and restored by another.

"The goal was always to give the canopy a traditional railway appearance which we believe we have achieved. It was finished in time for our September Open Weekend during which we invited the Mayor to declare it open. It rained on one of the days so the canopy had a very good test allowing members and visitors to look at and talk about engines under cover."

Stuart says that the four-year project has cost the club a great deal; "but we feel it was well worth it."

The club is one of the few that runs trains all-year round, every Sunday unless Christmas day falls on a Sunday! More details are at [www.waltonparktrains.co.uk](http://www.waltonparktrains.co.uk)

## Raising the bar

Also celebrating an opening, well a reopening, is the **Bradford MES**. The club has spent the last two years completely replacing its raised track, which was opened in 1968 by the then editor of *Model Engineer* magazine Martin Evans. As chairman Jim Jennings related during the opening ceremony for the new track, the original combined steel sections on steel A-frames and wooden sleepers, providing the recipe for a lot of maintenance over the years.

The track was demolished in October 2017 and rebuilt to a design prepared by club member David Brimacombe, who sadly did not live to see his proposed design come to fruition. Running was able to recommence just in time for a very wet Easter Bunny event in the Spring, and on 15th September an official opening ceremony was held.

Appropriately the ribbon was cut by Diane Carney, assistant editor of

*"The goal was always to give the canopy a traditional railway appearance which we believe we have achieved..."*

### TOP LEFT & TOP:

An impressive Welsh dragon guarded the entrance to the equally impressive Cambrian ME display at the Welshpool & Llanfair Light Railway Gala in early September. Photo: Andrew Charman.

**RIGHT:** More civil engineering at the Grimsby & Cleethorpes track, in the form of an attractive new signal gantry built by member Tom Burton. Photo: Tom Burton/G&CME



*Model Engineer*, exactly 50 years after her predecessor had performed the same ceremony. Your editor was invited too and was annoyed that he had to decline due to a requirement to be at Silverstone race circuit in his 'other' job!

In the September issue we reported on the first outside event for the **Cambrian ME**, formed less than a year ago. Following the club's display at its local village show it was asked if it would like to exhibit at the Welshpool & Llanfair Light Railway's annual Steam Gala. The acquisition of industrial units adjacent to the W&LLR's Llanfair station has opened up new exhibition space and the line wanted to fill it with something!

At very short notice the Cambrian club provided a most interesting display, as the above picture shows varying from completed locomotives to projects underway in a number of scales. Most comment by visitors, however, was reserved for the

enormous Welsh dragon that stood guard at the entrance to the display!

The Cambrian group is continuing with its very informal programme of meetings, usually every second Monday, during the day at the home of one of the members. Local readers who would like to attend a meeting can contact Robin King on 01686 414939 for more details.

A new and prominent addition to the **Grimsby & Cleethorpes ME** track is its first signal gantry, erected in the space of five hours in September by member Tom Burton and his son Harry (though the foundations for it had been previously prepared!).

The gantry was made at home by Tom, the lattice-style frame taking a whole day to weld up on his drive. Housing for two colour-light signals were also installed and the lights will follow soon.

It is very pleasing to read the comment by Jayne Ball, the editor of the **Nottingham SME's Kingpin**





magazine, stating that the club has welcomed a lot of new members this year. We've heard this from other clubs too, suggesting that model engineering is very much on the up.

Writing in the same edition, Nottingham chairman Nick Harrison reflects on the recent very successful main line loco day, which saw 19 locos on the 5-inch track and some 40 on the site. Note to Nick and other club representatives, if you have such a successful event, why not send in some pics for these pages in **EIM**?

Good to see a copy of *Ashpan*, the magazine of the **Ickenhram & district SME**, the magazine having not appeared for a while due to, the chairman states, a number of reasons but principally difficulty in attracting enough material. It is a perennial problem for magazine editors, even this one (!) and we greatly admire the variety and interest in the various publications we receive from the clubs.

Elsewhere in *Ashpan* the club talks about anniversaries – this year marks the 70th anniversary of the club's formation but no specific celebrations have been held as it was felt it would be better to plan for the far bigger 75th anniversary in five years' time. However there is a suggestion that

another anniversary falling next year should be celebrated, 50 years since the first section of the ground-level track was opened, on Saturday 27th September 1969. Regular public running days began in the following spring, and members are being asked for their views as to how such important dates should be marked during 2019.

The Garden Railway show that the **Guildford MES** was planning for 8th-9th June 2019, and which was announced in the July **EIM**, will not now take place.

The club has not revealed why the show has been dropped, only that the decision was taken "after much deliberation." It adds that the traditional Stoke Park Railway Gala Weekend will definitely be held as usual, next year on 6th-7th July and will feature the use of the club's 16mm and Gauge 1 outdoor layouts. The club will also welcome enquiries from portable layouts and garden railway traders who would like to attend the Gala.

Writing in the Guildford club's newsletter, chairman Roger Oates reports on a very successful annual Gala, with so many visitors that the club struggled to produce enough

*"It is very sensibly laid out and spacious inside and will no doubt prove a very comfortable place to work in even in the depths of a Surrey winter..."*

train crews. The same problem is occurring at normal public running days and the club is keen to encourage more members to rain as guards and eventually drivers.

### Superb shed

Most impressive at Guildford is the newly completed additional engine shed, its building resulting from the acquisition of two Bagnall locos with tall chimneys that caused difficulties in the current accommodation.

Built to a size that will accommodate three mainline tender engines and aided by a grant from Guildford Borough Council, in the editor's opinion this shed is a case study of the proper way to do things. Even before the final touch, installing the clocks in its roof, this is an attractive building that suits its surroundings, and from the details in the club magazine it is very sensibly laid out and spacious inside and will no doubt prove a very comfortable place to work in even in the depths of a Surrey winter.

Another busy month at the **Rugby ME** has been tempered by the loss of founder member John Groom, aged 86. John had a wide range of engineering interests stemming from his days as a marine engineer and later with the English electric company. From 1963 he also volunteered for many years on the Talylyn Railway as a fireman and engineer.

Hopefully many of you are reading these words having just attended this year's Midlands Model Engineering Show. Things move on quickly, however and already organisers TEE Events are alerting us to the first big show of 2019. The **London Model Engineering Exhibition** will be held at its traditional venue of Alexandra Palace on Friday 18th to Sunday 20th January, and in its 23rd year we are told it will feature the past, present and future of modelling.

Those of us who go to both the Midlands and London shows will know that the latter event has a wider remit, featuring more general modelling alongside the traditional model engineering, and usually offering a few surprises. That's certainly the case this time, as a special exhibition at the show will celebrate Steampunk, the fashion trend inspired by the industrial revolution! Art pieces, costumes and what are described as incredible and amazing never-before-seen models will be on show.

Traditionalists should not panic – there will be plenty to interest you too, with more than 45 clubs and societies present and plenty of traders too. More details of the show are at

### ABOVE:

Even while still awaiting its roof-mounted clocks, the new shed at Guildford is imposing but wholly appropriate in its surroundings. Photo: GMES

**LEFT:** The Rugby club is mourning the loss of founder member John Groom, seen here last year being taken around the track behind his own locomotive by fellow member Edward Parrott. Photo: RMES



www.londonmodelengineering.co.uk and the editor is certainly looking forward to it – he went to the 2018 event within days of agreeing to take the helm of **EIM**, and yet to produce his first issue. Twelve months (and 12 issues...) on he's looking forward to meeting up with the many who wished him well last time!

We are out of space again. Thanks to all the clubs who forward to us their magazines and newsletters. As well as providing copy for these pages (always too much for the space available) they provide us with a very good overview of the model engineering hobby helping us plan future issues, so please keep on sending them in! **EIM**

**RIGHT:** This second shot from Rugby dates back to 2014 and shows more civil engineering, the crossing work that kicked off a ground-level extension that has now just about been completed – a good four years of effort.

Photo: RMES



# Gordon Smith Memorial Steam-up

A special event at Burton-upon-Trent MES remembered Gordon Smith, a highly respected engineer and member of the society who died earlier this year.

by **TERRY DELL**

**T**he Burton Society might be a small club in terms of total numbers of members, but it was privileged to have had a special individual and a fine model engineer in Gordon Smith as a member for more than 40 years, until he died earlier this year.

Gordon was the society's chief boiler inspector and a highly respected engineer, not only within the Burton society but amongst the model engineering hobby generally.

On Sunday 15 July the society held a very well attended 'Gordon Smith Memorial Steam Up' to remember Gordon. Committee member Barrie Wilkinson presented a moving tribute in grateful thanks for Gordon's contribution both to the society and the wider model engineering world over many years.

Barrie told Gordon's family; "You should feel immensely proud of his achievements. It must have given Gordon great pleasure that after events conspired in his younger life to restrict the opportunity for him to undertake higher technical education, his grand-daughter Morgen had become a qualified engineer."

Almost every Burton member attended, along with many other model engineering enthusiasts who knew Gordon. Guests of honour at the event were his widow, Cynthia, his daughter, Angela, his grand-daughter, Morgen and grandson Thomas.

Gordon's understanding of engineering principles and his practical ability were second to none. There are many examples of his work on developing solutions to problems

encountered in building and operating miniature steam locomotives.

Model engineers across the country can recount experiences of referring a problem to Gordon which resulted in him offering an innovative solution, most likely offering to machine the parts himself.

One of many recent testimonials came from Brian Bates of the Sutton Coldfield MES who approached Gordon last year for help resolving a problem with the steam regulator on his new build 7¼-inch 14xx loco. Brian reported "The solution he came back with was brilliant, something none of us would have thought of ourselves, really innovative, and simple to manufacture and install, and



his regulator valve has proven to be totally reliable on my locomotive."

My own experience was asking Gordon to reset the safety valves of my 'Sweet Pea' to 80psi on his test rig. A ▶

**ABOVE RIGHT:** Gordon Smith, 1934 - 2018

**RIGHT:** The models in steam on the day included two recently completed locos, Barrie Wilkinson's GWR Pannier and Keith Bloor's Jinty.





week later I was presented with my old valves and a new set of safety valves that he had made specially saying; "Here we are lad, try these, I think you will find these are better!"

Gordon was perhaps best known for his work with safety valves. His development of the valves for miniature steam locomotives was a textbook exercise in solving an engineering problem. He identified the problem, developed a theoretical solution, and then undertook testing, using rigs that he built, to develop safety valves far superior to those previously available.

He gave talks on his safety valve designs at other societies and also at the Midlands exhibition. His safety valve designs became widely used throughout the model engineering hobby and many model engineers have been proud to describe their locomotives as having 'Gordon Smith safety valves.' Gordon's safety valve designs are now marketed by Polly Model Engineering.

Gordon kept himself right up to date with modern techniques, having taught himself computer-aided design to produce the drawings for his safety valve designs, and his lectures were

supported by a computer-based PowerPoint presentation. Yet he still found time to construct a number of superb models, one of which was the Tallyllyn Railway's Fletcher-Jennings 0-4-2ST 'Tallyllyn' in 5-inch gauge. Gordon built the loco to his own design and took it to the Tallyllyn railway in 2015 to be exhibited at the line's 150th anniversary celebrations.

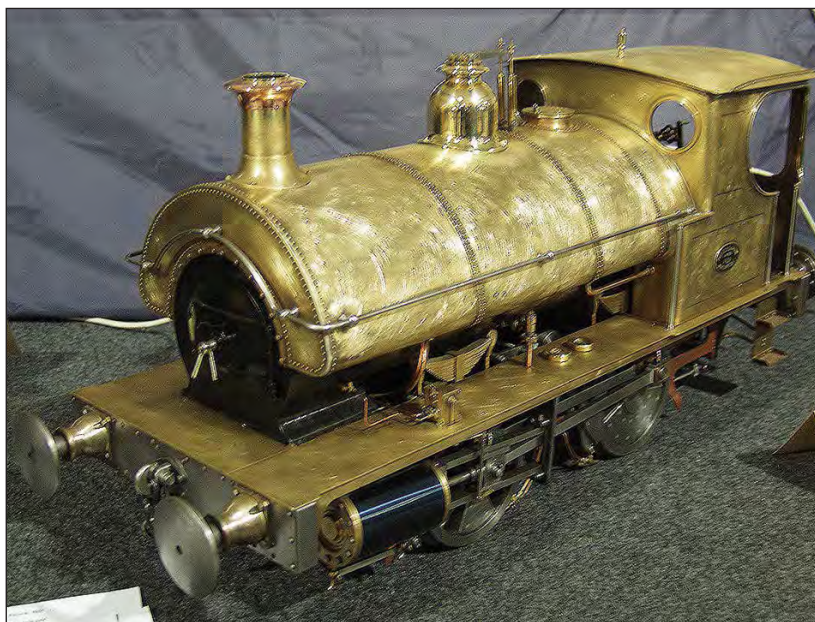
This was followed by the much admired 'Bass' saddle tank – Gordon's attention to detail was such that the rivet heads were exactly to scale.

Those of us fortunate enough to have known him will remember Gordon as a most likeable, generous and sociable person, always willing to help resolve fellow model engineers' problems, offering advice, often making components for them in his workshop, and invariably refusing any form of payment for his time.

Following his funeral and cremation Gordon's ashes were taken to Wales and placed in the firebox of Tallyllyn on a TR service train.

A special display stand with many examples of Gordon's work was planned to be on show at the Midlands Model Engineering Exhibition, opening as this issue of **EIM** publishes.

*"Many model engineers have been proud to describe their locomotives as having 'Gordon Smith safety valves...'"*



**ABOVE:** Behind Gordon's 5-inch gauge loco 'Tallyllyn' are his grand-daughter Morgen, daughter Angela and widow Cynthia.

**LEFT:** Gordon's magnificent 5-inch gauge 'Bass' saddle tank at the 2015 Midlands Model Engineering Exhibition – note the correct scale rivet detail.

# NOVEMBER

## EVERY SUNDAY

(Weather permitting)

Sale Area MES Public running in Walton Park from 12 noon.

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

**2** Portsmouth MES Railway life slide show, Tesco Fratton Centre, 7.30pm

**2** Ickenham DSME Members slides, Ickenham, Uxbridge UB10 8LJ, 8pm

**3** Grimsby & Cleethorpes MES public rides and firework display, Waltham Windmill, DN37 0JZ, noon-4pm

**3** Isle of Wight MES open afternoon, Broadfields, PO31 7NN

**3** SMEE Talk, Designing and building the SMEE wire eroder, Marshall House, London SE24, 2.30pm. Pre-book only at chairman@sm-ee.co.uk

**3** Tiverton MES Steam Up, Worthy Moor from 11am.

**4** Frimley Lodge MR Public running 11am– 4pm, Sturt Rd GU16 6HT.

**4** Fylde SME Public running at Thornton Cleveleys from 1pm.

**4** Pietermaritzburg MES (NZ), Public running, Pietermaritzburg 3201

**4** Southampton SME Annual Charity Day, supporting poppy appeal, Riverside Park, SO18 1PQ

**5** Lancaster Morecambe ME informal evening, Tarn Lane, near Yealand Redmayne, 7.30pm

**6** Southampton SME first winter meet, Bitterne Pk social Club, 7.30pm

**7** Bradford MES Autumn Auction (members only bids) Saltire Methodist Church, 7.30pm.

**7** Bristol SMEE meeting, composite structures by Ian Lane, Stapleton and Begbrook Soc Clb, BS16 1HY, 7.30pm

**7** Guildford MES meeting, talk by Mike Wheelwright, Stoke Pk, Guildford

**8** Worthing SME meeting, police collision investigation, Field Place, BN13 1NP, 7.30pm

**9** Ickenham DSME meet, subject tba, Ickenham, Uxbridge UB10 8LJ, 8pm

**10** Ryedale SME Saturday night run, Village Hall, Pottergate, north Yorks

# BER DIARY

**14** Plymouth MS meeting, 'RAF Harrowbear' by Stephen Fryer, Derriford Chh Hall, PL6 6AB, 7.30pm

**14** St Albans MES club night, subject tba, Christchurch Centre, High Oaks, AL3 6DJ, 7.30pm

**16** Ickenham DSME meeting, subject tba, Ickenham, Uxbridge UB10 8LJ, 8pm

**18** 18 Tiverton MES Steam Up, Worthy Moor from 11am.

**19** Lancaster Morecambe ME meeting, crane traction engines by Ray Blacklee, Tarn Lane, near Yealand Redmayne, 7.30pm

**19** 19 Pietermaritzburg MES (NZ), Meeting, Pietermaritzburg 3201

**20** Grimsby & Cleethorpes MES monthly meet, Waltham Windmill, 7.30pm

**20** Nottingham SME monthly meeting, '7¼in Guinness loco update' by Cliff Almond, Nottingham Transport Heritage Centre, Ruddington, 7.30pm

**21** Bristol SMEE meet, Bugatti by Hugh Conway, Stapleton and Begbrook Social Club, BS16 1HY, 7.30pm

**21** Guildford MES meeting, Bits & Pieces Evening, Stoke Pk, Guildford

**22** Worthing SME meeting, bits and pieces, Field Place, BN13 1NP

**23** Ickenham DSME meeting, light railways by Malcolm Parsons, Ickenham, Uxbridge UB10 8LJ, 8pm

**24** Bradford MES Annual Exhibition, Competition and Social, Saltaire Methodist Church, 10am-4.30pm.

**30** Ickenham DSME meeting, Tramways big and small by Mark/Simon Hamlin, Ickenham, Uxbridge UB10 8LJ, 8pm

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 that occur.

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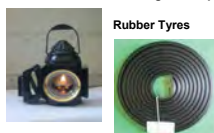
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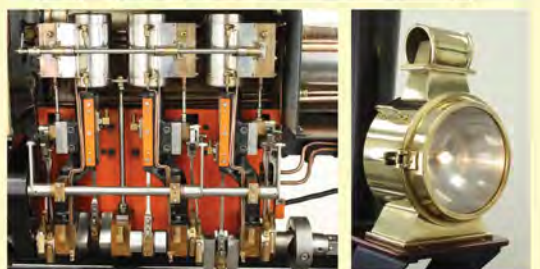
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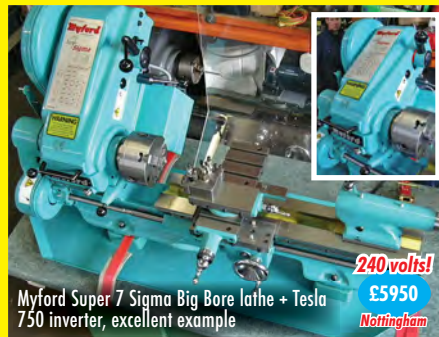
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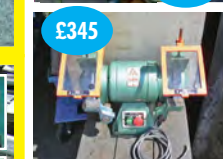
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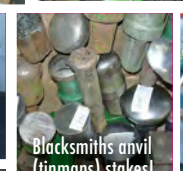
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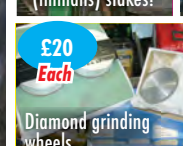
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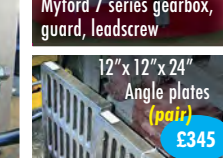
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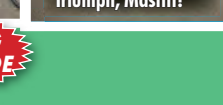
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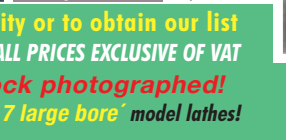
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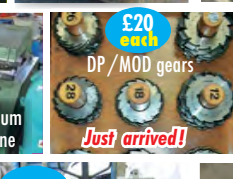
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