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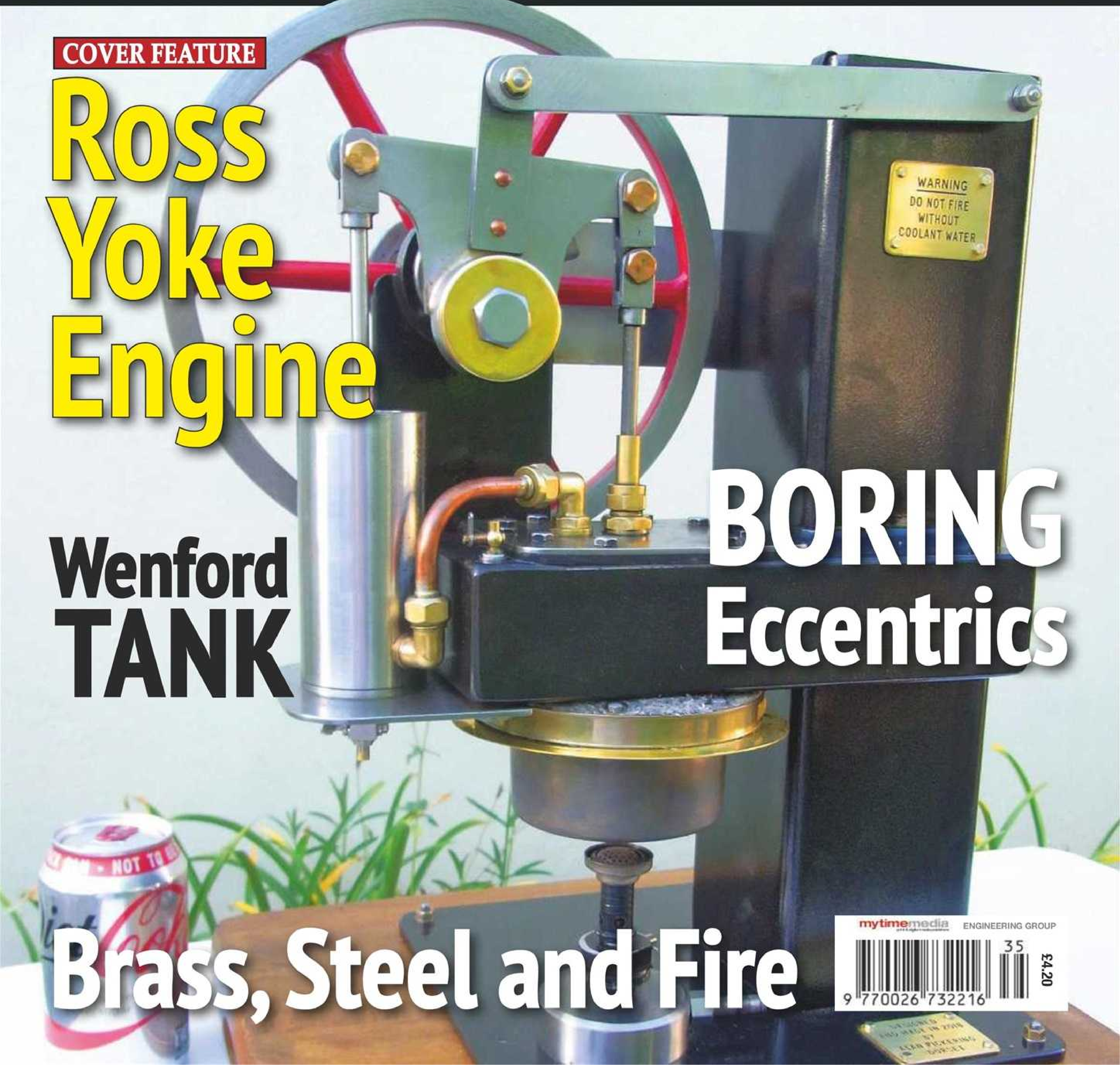

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Brass, Steel and Fire

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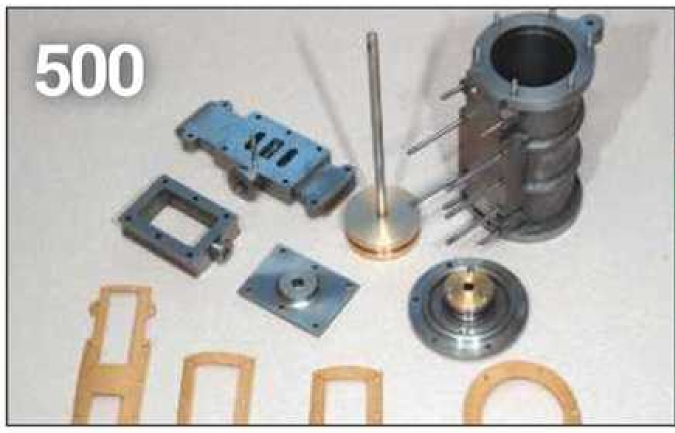

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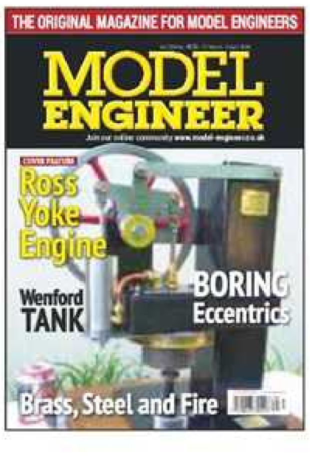

ON THE COVER...

The Ross Yoke Stirling engine, built (as usual) from his scrap box by Alan Pickering (photo Alan Pickering).


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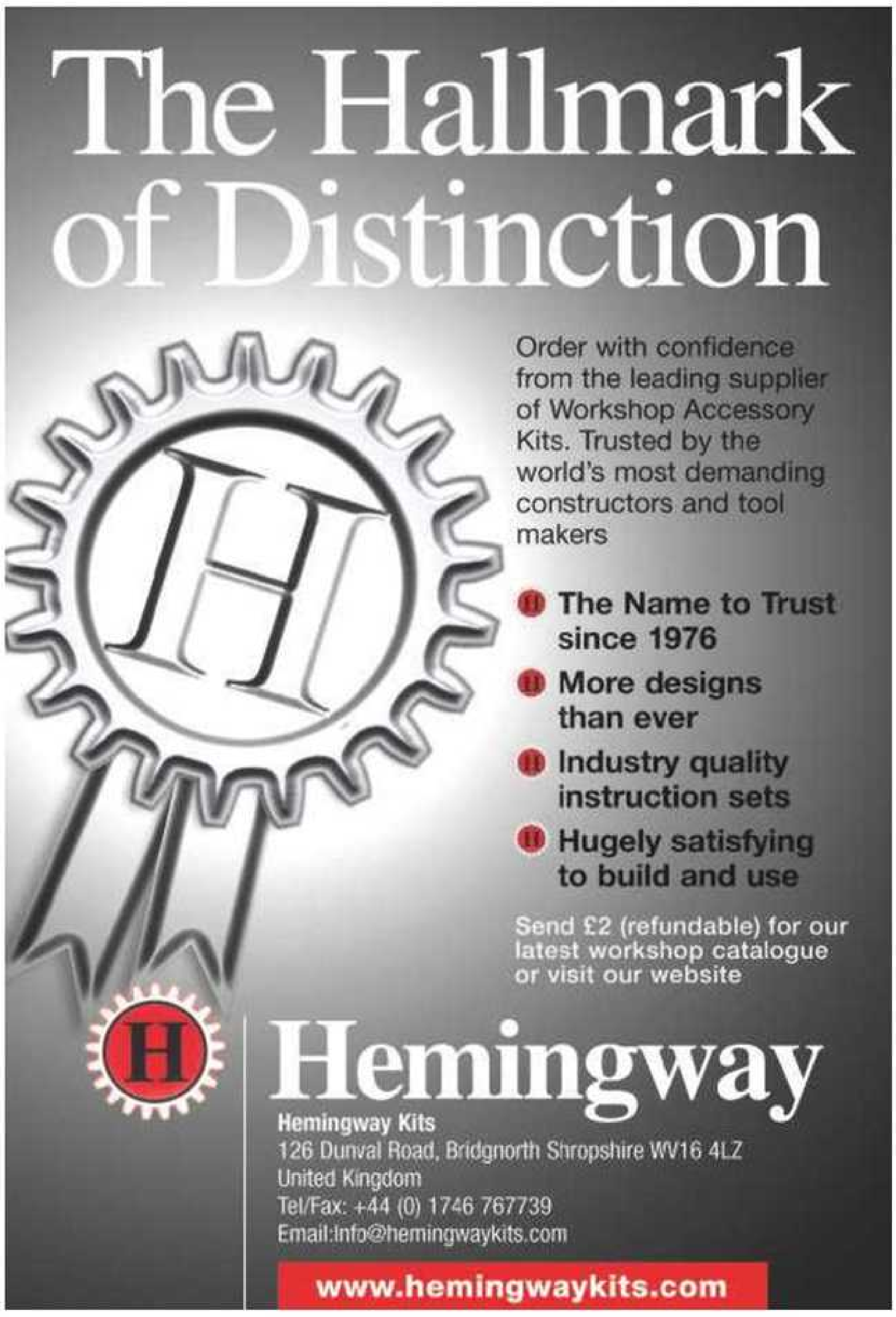
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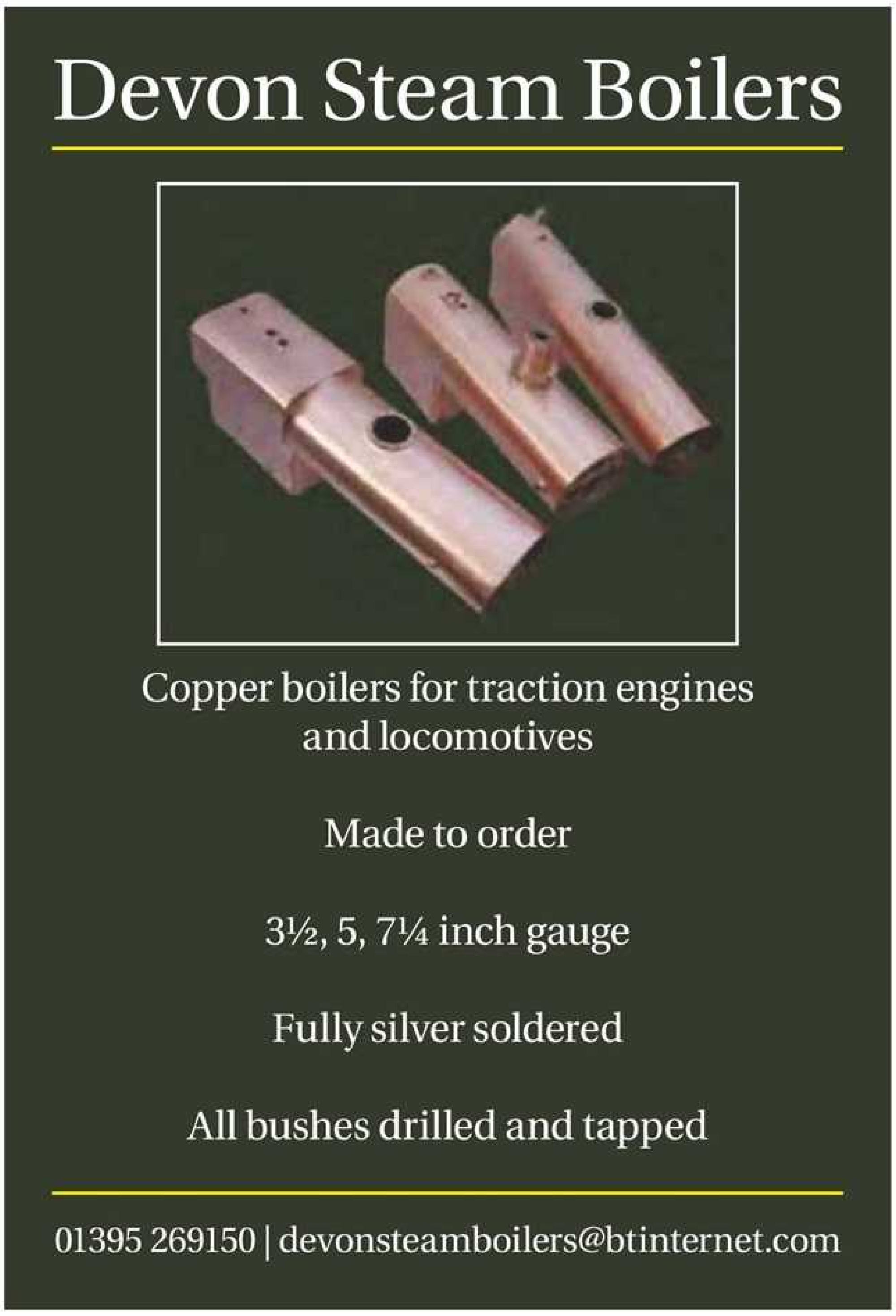
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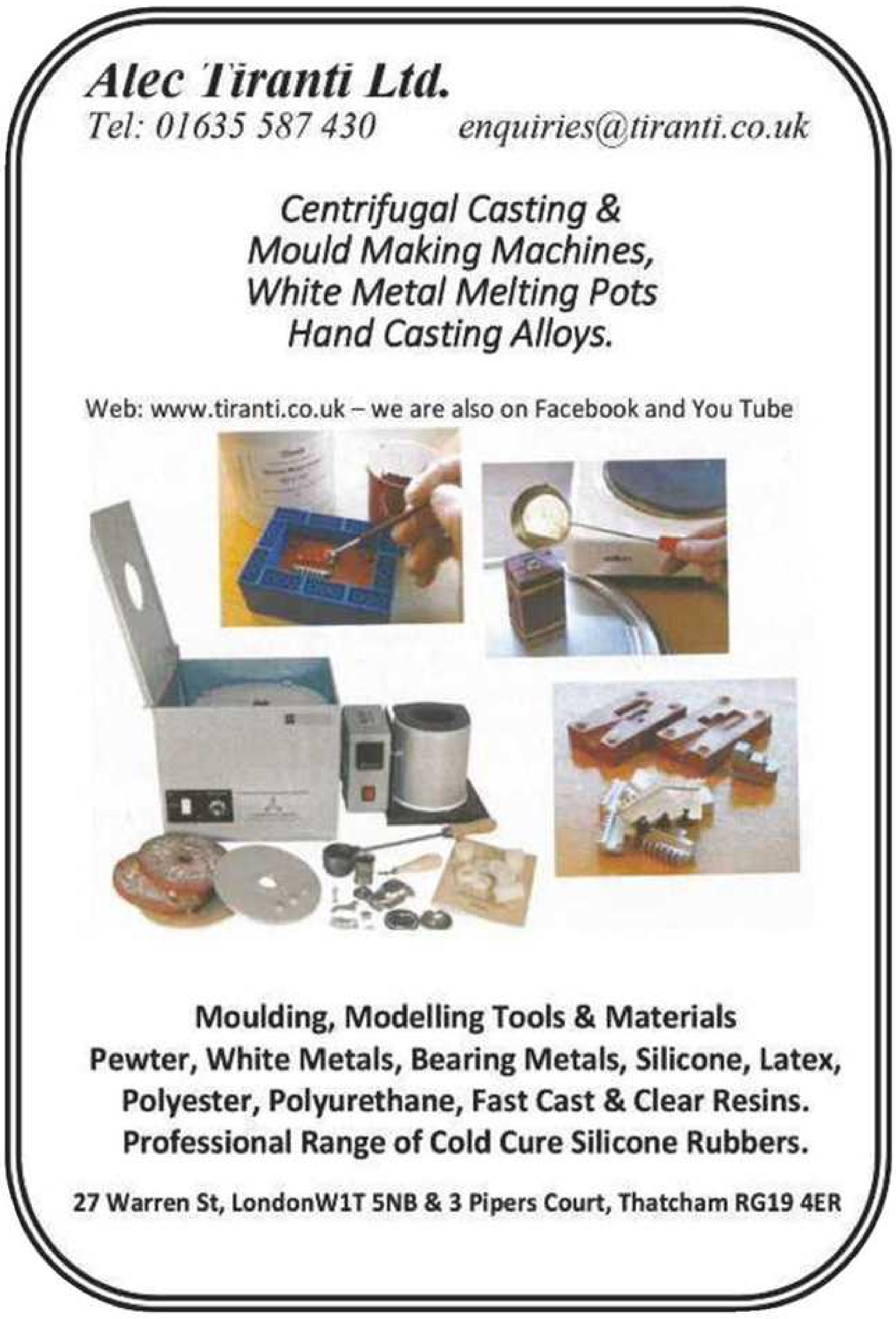
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SMOKE RINGS

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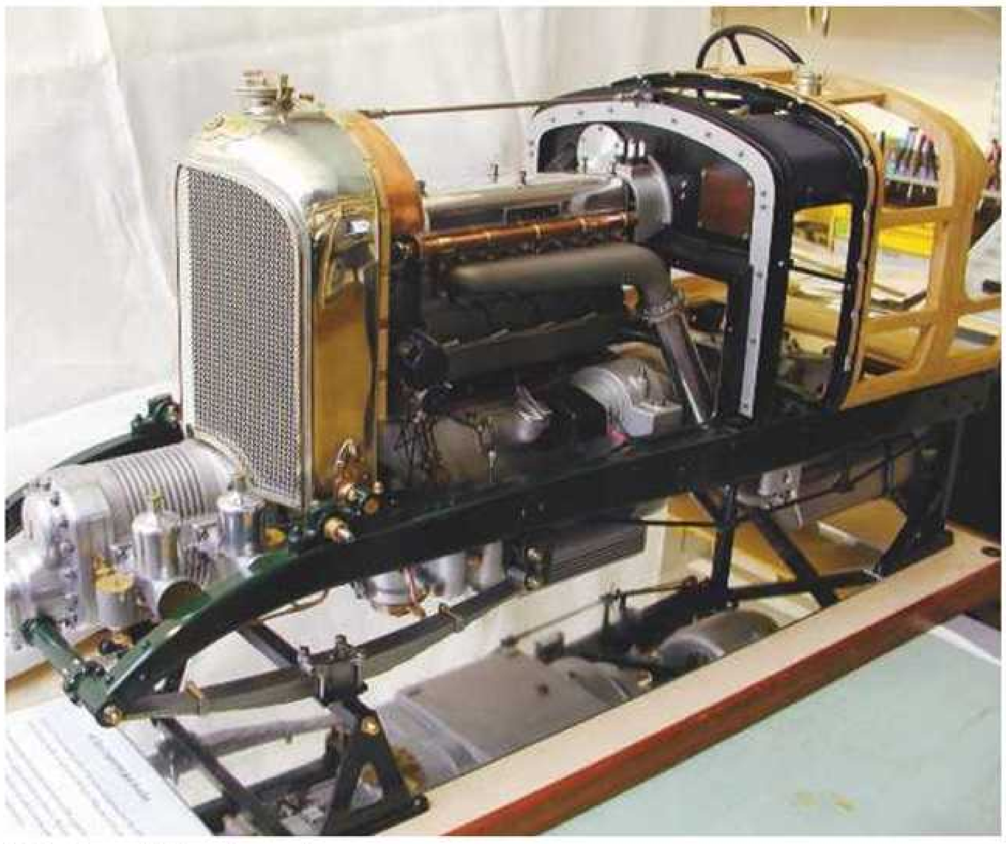
Model Engineer Competition

The Doncaster Exhibition is not far away now, and with it the Model Engineer Competition. The closing date for entries is the 10th April so this is your 'last call'. The entry form and rules are available either in issue 4630 (17th January) of this magazine or by request from Mike Law at post@michaellaw.co.uk. We have received a good number of entries already and the latest, for the Duke of Edinburgh trophy, is Mike Sayers's ⅓ scale 1929 4½ litre supercharged 'Birkin' Bentley engine. Mike won a Gold Medal with this engine at last year's Doncaster Exhibition. If you don't want to enter a competition class, how about entering your model into the loan section? The more models there are, the better the show!



Mike Sayers's Bentley engine.

Doncaster Exhibition

The show runs from the 8th to the 10th May and more details are available at www.thedoncastershow.com. There will be a good selection of the usual trade stands – Blackgates, Chester, CuP Alloys, Myford, Polly, Stuart Models and many others. These can provide you with all the tools and materials you need to build the model of your dreams – from a Stuart stationary engine, through a Polly kit locomotive, all the way up to one of Michael Breeze's authentic, very detailed, high quality designs. One of these is perhaps not for the faint hearted but a gaggle of *Duchesses* seen recently at Nottingham proves it can be done! Michael will be manning a stand at the show if you want to find out what is involved.

For the less intrepid builder (or possibly those with less time) there is a good range of kit locomotives available at Polly Models, from a simple 0-4-0 engine, through a choice of two narrow gauge saddle tanks, up to one of two Orenstein & Koppel locomotives. Traction engine enthusiasts could take a look at the range of kits offered by Live Steam Models. If you have no time at all, then a 'ready to run' locomotive from Station Road Steam may be the answer. If it is simply inspiration you need then browsing through the competition entries and loan models will almost certainly supply it. A full list of traders attending the show is available on the show website.

Easter Gift Card

If you're stuck for gift ideas this Easter why not let your resident model engineer choose for him(her)self with a Machine Mart gift card? Perfect for those with a craving for even more tools and machinery!

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Brass, Steel and Fire

This exhibition, showcasing the work of early builders of steam models, opened last September at the National Railway Museum in York. Both Diane Carney and Roger Backhouse represented *Model Engineer* at the opening event and Diane reported on the opening in issue 4624 (25th October 2019). The exhibition remains at York until April 13th and then moves down to the Science Museum in London, where you can see it from the 21st May to the 2nd November. So, if you are up north, you have just a couple of weeks left to pay a visit and if you are down south, it'll be coming to your area soon.

Roger made an Engineer's Day Out of it and presents a comprehensive view of the exhibition on page 503.

Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
07710-192953
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An Inverted 'Ross Yoke' Watercooled Stirling Engine

Alan Pickering has a quick rummage in the scrap box and makes yet another hot air engine.

The scene of my latest triumph.

This engine was built during the horrendous snows of the 2018 winter months in my garden workshop (**photo 1**). As with all my hot air engines they are cheap to build, mostly from scrap. This is my 5th attempt and can be seen running on YouTube along with my other large Stirling engines, running in the workshop or at shows. The only bought in casting is the 9 inch flywheel casting from eBay. It was theoretically cheap, except for the heating costs of keeping a large workshop and me alive - but only just!

I wanted a slow, low compression, educational engine that was different with lots to see. I stumbled across a working animated 'Ross Yoke' crank design on YouTube and this fascinated me. I couldn't leave it alone. That meant it would also fascinate others - it ticked all the boxes – so I zoomed it to the scale I wanted and printed out several copies. This led to some research into the finer points - as always, these things are far more complex than they first appear. The mathematics are horrendous, frightening and eventually were to come back and bite me for getting it wrong.

Eventually, after many sketches, I came up with this layout. It has many good points – it's inherently strong and stable, has built in water cooling tanks (always a major problem, a serious must have), no water jacket casting needed, compact, interesting and quite lightweight, by my standards, very visible and hypnotic - the seeds were sown for yet another unusual engine that I promised not to make.

The Ross Yoke crank is attributed to the hot air super star Andy Ross, who has published books on the subject along with his many advanced Stirling engines - good reading. The beauty of this design is that the connecting rod remains near vertical thereby putting no side load on the piston, causing no friction or wear. The downside is that there are lots of linkages to rattle around (all needing ball races) and poor balance. The rattle is eliminated with accurate workmanship.

The Ross Yoke is usually in a vertical configuration with the flywheel below the power and displacer cylinders. This makes for difficult firing with the burner 2ft in the air pointing downwards. This layout was developed as a more practical solution. In researching this there are inevitably many options and the mathematics are frightening so I turn, yet again, to doing it the hard way - trial and error. Unfortunately the error bit predominates and is indeed a trial. The animated copies were made with cardboard and pins,

>>

Displacer cylinder and pistons.

Milling out the displacer cylinder.

Tricky 2BA drilling and tapping.

Drilling the displacer cylinder top for 4BA bolts.

which was okay in theory but disastrous for me - too much free play with no accuracy, totally useless. However, this was no obstacle to my bloody mindedness and Yorkshire grit so I just ploughed on, later painfully to regret it .

A start was eventually made. I decided to do the difficult bits first, so that if disaster strikes all that time is not wasted if it's back to the drawing board.

The main chassis is the 16 x 4 x 4 inch and the 4 x 2 inch steel box sections, cut out and offset 2 inches then arc welded together to make room for the 9 inch flywheel (**photo 2**), after remembering to drill the water circulating holes first. Before the welding could begin two 3½ inch holes had to be milled out for the displacer cylinder (**photo 3**). There was no room for error here so the 12 inch rotary table was essential equipment, as only the box wall thickness remained. This made the many cylinder cover 2BA screws a precision tapping/drilling job along with the cylinder sealing (**photo 4**).

The displacer piston is a stainless steel sugar basin.

The next step that could be put off no longer was the arc welding together of the two box sections. This looks straight forward but it isn't due to the fact that they both had to be square in all planes - this is the basic framework that everything else depends on, which that means the 'L' shaped cut out had to be square. A jig was improvised, the job tack welded then hammered square - these box sections are meant to hold up skyscrapers not precision hot

Baseplate fixings.


So far, so good.


Turning the flywheel.


Drilling the flywheel for the grub screw.


Main crank bearing and big end.

As I said in the beginning, lack of thoroughly understanding the Ross Yoke principles in the design stage now came back to bite me big time and scrapping the lot was seriously considered.

air engines and as such are not exactly surface ground.

With the help of clamps, surface plate, big squares and height gauge all was well. The displacer cylinder top was next (**photo 5**), drilled for 2BA bolts. As usual, the displacer cylinder was a stainless coffee container, which I find ideal, along with a stainless sugar bowl for the piston (**photo 6**). The main box section was fixed to the steel baseplate with two M8 bolts tapped into the sealing plate welded underneath the 4 x 4 inch box (**photo 7**).

A nasty bit was sealing the displacer cylinder to the 4 x 2 inch box section both top and bottom, which both had different coefficients of expansion - a stainless can to a thick mild steel box section (**photo 8**). This, after 100 attempts, proved impossible. After each successful attempt, on cooling a crack was heard and the silver soldered joint had split in several places. The only cure was a smear of epoxy and a softer gasket - this proved 100%. On completion, a brass plaque was affixed saying 'Do not fire without water coolant' - for this reason.

The 9 inch flywheel was duly machined (**photos 9** and **10**) - £30 from eBay, the only expense. The power piston was off a scrap Seagull outboard, which also supplied a half of the crankshaft web (it was soft and hack-saw-able - **photo 11**). A stainless

Boring the power cylinder.

Tapping the power cylinder for the transfer pipe.

Milling the extra balance weight.

cylinder was machined to fit the piston's 1½ inch bore (**photos 12** and **13**). An additional web was made to help the balance (**photo 14**). An outrigger ballrace completes the crankshaft set up (**photo 15**).

Alignment was a major headache as 9 ballraces were used and had to be spot on with alignment, as no friction can be tolerated. This took lots of time, refitting, making spacers etc. (**photo 16**).

As I said in the beginning, lack of thoroughly understanding the Ross Yoke principles in the design stage now came back to bite me big time and scrapping the lot was seriously considered (**photo 17**). The stroke was calculated to a thou yet was half an inch too long, connecting rods crashed into things, angles were miles out - a total mess. A new yoke was made and the geometry altered completely, fixings reference point moved

Outrigger bearing and support.

Getting everything properly aligned.

The complete engine.

by inches - no joke - this took me as long to fix as to build the engine, a month or so. Sheer bloody mindedness plus trial and error proved superior yet again - the story of my life - you can't kill a weed! Had I known this in the beginning no way would I have started. There has to be a message in there somewhere... Old age and cunning will always win over youth and skill. I later fitted two extra brass balance weights (**photo 18**) for smooth slow running.

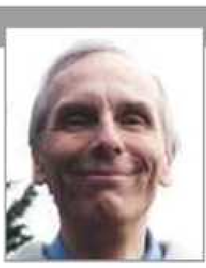
The final result was perfection - 1 rev per second continuous for 5 hours on a low flame using virtually no gas. All the pictures speak for themselves. This engine is quite hypnotic and it hypnotized the wife enough to say "this is the last one". I prefer something more straightforward for the future like completing the Atlantic tunnel.

ME

Balance weights.

PART 2

A Draught Proposal



Peter Kenington re-examines the electrical side of the humble steam-raising blower and proposes a couple of simple (and cheap) alternatives to traditional solutions for powering this essential piece of kit.

Continued from p. 391, M.E. 4633 28 February 2020

A step up (or down)

Having been caught out by the availability of both 12V and 24V supplies on the same steaming bay and the same connectors, depending upon who was last (or is currently) using the club blower supply, I was determined to use my electronics background to come up with a 'universal' solution to this problem. The system was to have the following specification:

1. An ability to cope with a 12V or 24V DC supply without having to know, in advance, which was available or in use.
2. A pre-settable output voltage, which did not change whichever input voltage was being used (eliminating the need to carry around a multimeter to measure either or both of the supply and output voltages).
3. A 'nice to have' would be the ability to vary the speed of the blower, to allow it to be adjusted as the fire progressed from the initial lighting of charcoal or wood, through to a fully ignited coal-bed.

Fortunately, modern switched-mode regulators have the ability to meet all three requirements and, even more usefully, are available as ready-built circuit modules for only a few pounds. These are typically in the form of DC-DC converter modules, which provide exactly the functionality we require.

The converter board I chose was based around the XL6009 buck-boost converter chip from XLSEMI (**photos 9** and **10**). This chip is widely used in DC-DC converters for a range of applications and it is important to choose a board

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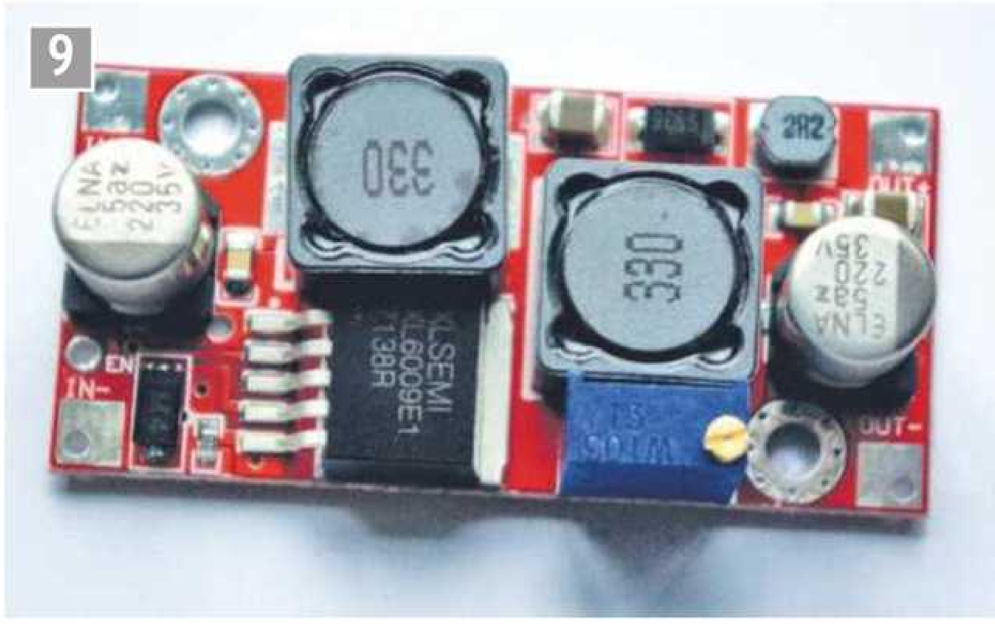

Boost-Buck DC-DC converter used in the blower system.

which has both 'buck' and 'boost' capabilities, since this device can be used for either, individually, or both together and different commercial circuit cards covering all three options are widely available. So - what do these bizarre terms mean?

Firstly, it is worth spending a minute or two discussing DC-DC converters in general, since many model engineers probably won't have encountered them, other than in the form of pre-packaged phone chargers for use in the car, and the like.

DC-DC converters are seemingly magical devices which can turn a wide range of DC input voltages into an equally wide range of DC output voltages with very high levels of efficiency (typically 90%+). As a result, they don't tend to get hot (or even warm) in use, at least at the current levels we are concerned with in a steam-raising blower application. This, in turn, means that we can safely house them in a plastic box, without a heatsink – more on this later. Unlike traditional mains transformers – those heavy things full of copper and iron which used to form the basis of power supplies for electronic equipment

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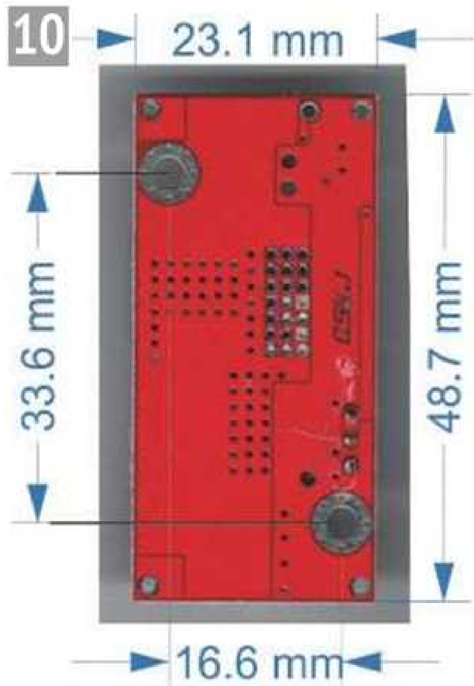


Dimensions of the DC-DC converter board.

prior to about the mid-1980s – they are small and very cheap to manufacture. They achieve this by replacing the traditional mains transformer, which operated with a low AC (alternating current) frequency (50Hz in the UK and 60Hz in the US), with a very high AC frequency (400kHz in the case of the XL6009). This, in turn, allows very much smaller transformers (and also capacitors) to be used and these can be made more efficient by using exotic ferrite materials in place of the iron laminations of a traditional transformer.

Ah, but I hear you say, we are starting here with a low DC voltage and not 240V AC mains. This is indeed the case, but the device 'chops' the incoming DC current (by effectively turning it on and off very quickly, 400,000 times per second) to create a high-frequency squarewave which is, by definition, now AC. This can then be supplied to the small transformer, discussed above, thereby isolating the output from the input (one of the main functions of a transformer) and allowing the voltages present on each to be different. The above is a somewhat simplistic explanation of what is, internally, quite a complex device, but hopefully it helps to lift a veil on the black-magic contained within these devices.

Returning now to our strange terms: 'buck' and 'boost' and accepting, as we now hopefully do, that the input and output voltages are isolated from one another, then it follows that these voltages can have any relationship to one another. In other words, the output voltage can be higher than the input voltage, or lower, or exactly the same. There are clearly limits on the absolute voltages involved, but these are impressively wide, as we shall see.

The terms 'buck' and 'boost' simply refer to which way around these voltage are permitted to be; in a 'buck' converter the output voltage must be lower than the input voltage (typically by around 1.5V or so). In a 'boost' converter (and I'm sure you're way ahead of me by now...), the output voltage must be higher than the input voltage. Finally (and I'm in great danger of being pedantic here), a 'buck-boost' converter combines both options, allowing the output voltage to range continuously from rather lower than the input voltage to rather higher, with the only limits typically being the absolute range of each. The version I used covers an input voltage range of 3.8V - 32V and an output voltage range of 1.25V - 35V.

These are truly flexible devices, so a 6V battery, say, can be used to generate a voltage of 24V, or a 24V lorry battery can be used to power a 12V LED inspection lamp, or any other combination of input and output voltage, so long as they fall within the above ranges. You're impressed, I can tell.

I obtained my converter from a UK-based eBay supplier for the princely sum of £5 (including P&P). Try searching for 'Adjustable DC-DC step up step down converter 3.8V - 32V to 1.25V - 35V'. (You could also use the terms 'buck' and boost', now that you're an expert, but being careful that any converter circuit found must be capable of both – there are many more examples of circuits which will only do one or the other, although this may be all you need in your application – see below.)

Calculators at the ready...

We now need to decide upon what we need our converter to do for us and choose a couple of external components accordingly. The details are provided below, although it is not necessary to understand the calculations in order to build the controller – they are provided in case you wish to use alternative batteries/ supplies and motors, and feel confident with a calculator and some GCSE maths!

Option 1: 12 or 24V input, 1.25 – 24V output

This is the option I needed for my application, namely the ability to cope with either a 12V or a 24V supply at a steaming bay, without needing to know (or care) which was provided and the ability to control a blower with a motor capable of operation at 12V or 24V (or anywhere in between). Specifically, what we must ensure is that the output voltage cannot exceed 24V (approximately) to ensure that we don't overload the motor, irrespective of the setting we use for the motor-speed control.

The output voltage of the XL6009 is given by the equation:

$$V_{out} = 1.25 * (1 + R_2/R_1)$$

Equation 1

In the circuit of photo 9, R_1 = 330 ohms; whilst this can be changed, it is very fiddly to do and we don't need to do so, to meet our objectives here. The variable we have to play with, therefore, is R_2. Re-arranging Equation 1 gives:

$$R_2 = R_1 * (V_{out}/1.25 - 1)$$

Equation 2

Our design goal is for V_{out} not to exceed 24V and if we plug this into Equation 1, together with the value of R_1 = 330 ohms, this gives us a value for R_2 of 6k ohms. Unfortunately, this is not a standard, widely-available, value for a potentiometer and so we must modify its maximum resistance value using an additional resistor. The resistance we need from this (fixed) resistor is 15k ohms (calculated using the standard 'resistors in parallel' formula – search for this on the internet if you're interested). This, fortunately, is a standard fixed-resistor value and can be installed in parallel with the potentiometer, as will be discussed below in relation to **photo 17**. This maximum resistance value, corresponding to the designed maximum output voltage for our system and hence the maximum speed for the blower, is obtained with the potentiometer rotated to its clockwise end-stop.

To achieve the minimum voltage (1.25V), R_2 needs to be small relative to R_1 which is achieved naturally when the potentiometer is turned to its opposite extreme (anti-clockwise end-stop), where its resistance is, effectively, zero.

With the proposed potentiometer and its parallel-connected fixed resistor the resulting circuit will, no matter what setting we choose on our speed controller, never exceed the maximum voltage rating of the motor (24V).

I actually chose a slight variant on this scheme: I still used a 10k ohm potentiometer but picked one with a logarithmic resistance variation vs rotation angle. This may sound like an exotic (and hence, hard to source) option, but it is actually quite common – such potentiometers are used for the volume controls in analogue audio equipment and hence are widely available. The component I used was sourced from CPC (catalogue number: RE06778) although similar items are available from RS and elsewhere.

What is gained by the use of a logarithmic resistance characteristic can be revealed by considering what happens at the 50% rotation point of the potentiometer (and, for the present, we will assume a linear potentiometer resistance characteristic). For a linear-characteristic 10k ohm part, with 15k ohms in parallel, the output voltage at 50% rotation is approximately 15.5V (so the blower will be generating quite a strong draught), whereas for an equivalent 10k ohm logarithmic-characteristic part, again with a 15k ohm resistor in parallel, the equivalent output voltage is approximately 6.5V – providing much more precise control of the strength of the draught in the first 50% of the useful control range. Both linear and logarithmic potentiometer options are available and it is a case of personal preference as to which you choose.

The 15k ohm resistor was also sourced from CPC (catalogue number: RE05046). Unfortunately, the minimum order quantity is 50 but, since these only cost a total of around 88p (for all 50), this is not a huge issue. You can pass any spares on to your friends, who will all want to copy your system once they see what a whizzy new blower controller you have.

Option 2: 12 or 24V input, 1.25 – 12V output

This option is targeted at those with a 12V blower. Our design goal now is for V_{out}

>>

not to exceed 12V and if we plug this into Equation 2, this gives us a value for R_1 of 2.84k ohms. Again, this is not a standard, widely-available, potentiometer value and a parallel resistance will again need to be added. In this case, a 5k ohm potentiometer is a good starting point (e.g. CPC part number RE06776), in which case a parallel resistance of 6.57k ohms is needed. This is also not a standard value (for fixed resistors, in this case) and the nearest options are 6.2k ohms (e.g. CPC part number: RE05321) and 6.8k ohms (e.g. CPC part number: RE03766), both of which are standard values. Using the former will result in an output voltage of 11.7V and the latter 12.2V. The latter is probably the best option.

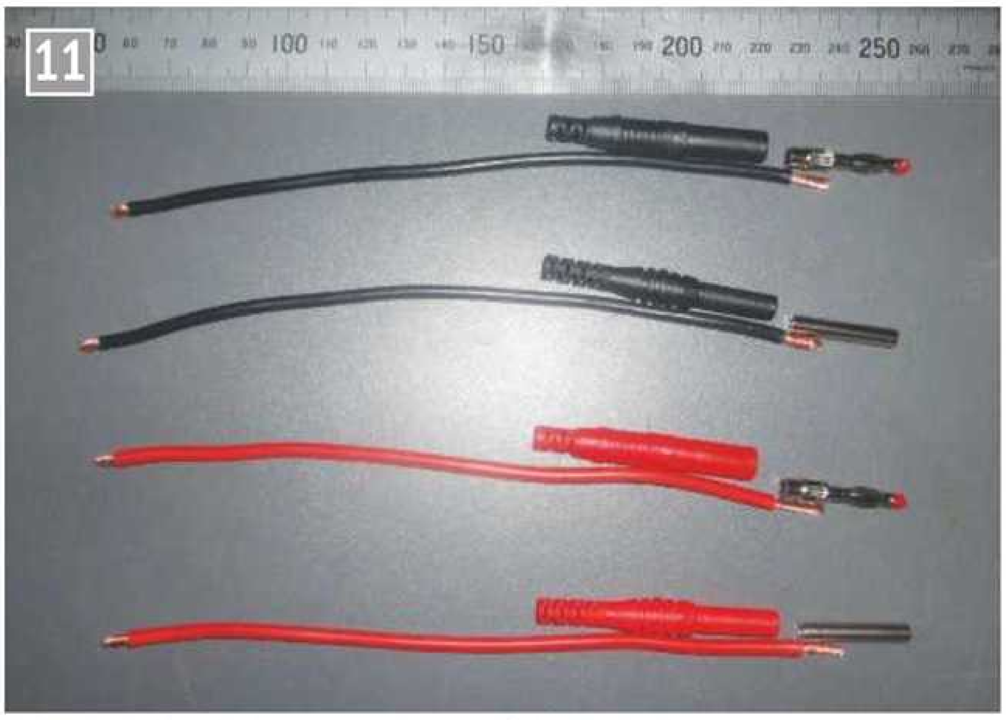
Option 3: 24V input, 1.25 – 12V output
The aim of this option is to allow a standard 12V motor to be operated from a 24V supply. In this case, only a 'buck' converter is required and these are available for little more than £1 if you shop around! They typically use the same active device (XL6009), however, and so Equation 1 is still valid. Again, 6.2k ohm or 6.8k ohm resistors may be chosen, as discussed above.

Option 4: 12V input, 24V output
In this final option, only a 'boost' converter is required (again, these are very cheap), together with a (fixed) 6k ohm resistor (and no potentiometer). Since 6k ohms is not a standard fixed resistor value, either 6.2k ohms (giving an output voltage of 24.7V) or 5.6k ohms (giving an output voltage of 22.7V) may be used, as desired (the CPC part number for a suitable 5.6k ohm resistor is RE03763). The aim of this option is to allow a 24V motor, say from a lorry windscreen washer, to operate from a 12V battery (or battery pack). The reason why we can't generate a variable output voltage as low as previously (~1.25V) is that the output voltage of a 'boost' converter must always be a few volts above its input voltage so the lowest variable output voltage would be around 14 or 15V (assuming we made use of a potentiometer in place of the fixed resistor).

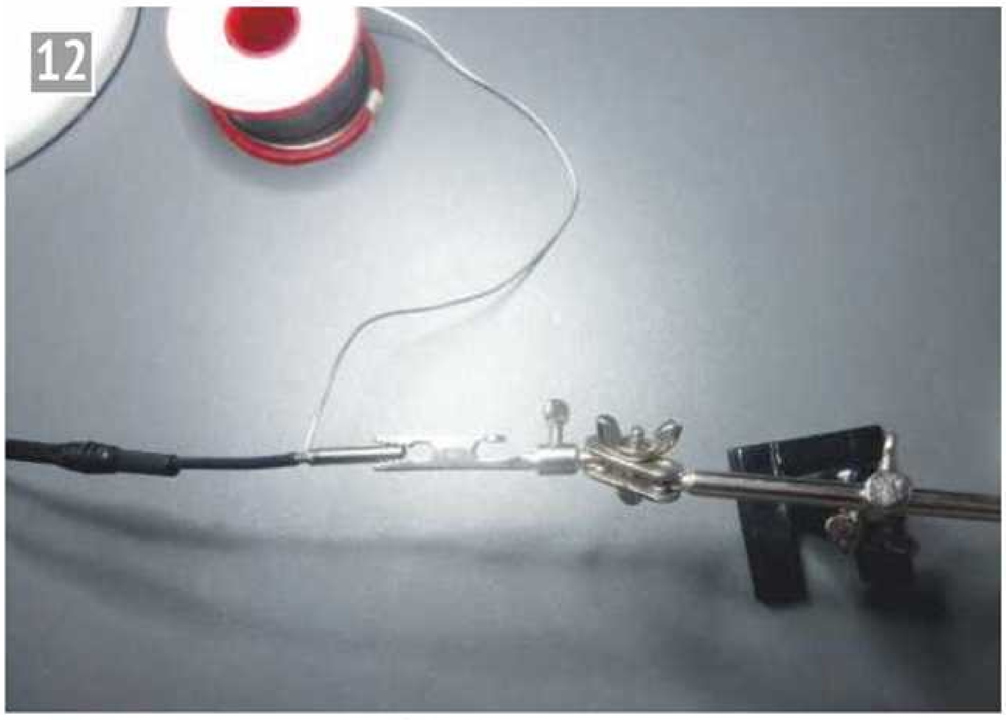
All the right connections

The wiring of the converter board is straightforward. **Photograph 11** shows the four power connection leads, stripped and ready for soldering to their respective plugs and sockets (also shown). Note the differing amounts of insulation removal on each end of the wires: the shorter ends should be less than 5mm (for connection to the circuit board) and the longer ends around 7 – 10mm (with the shorter length being for the sockets and the longer for the plugs).

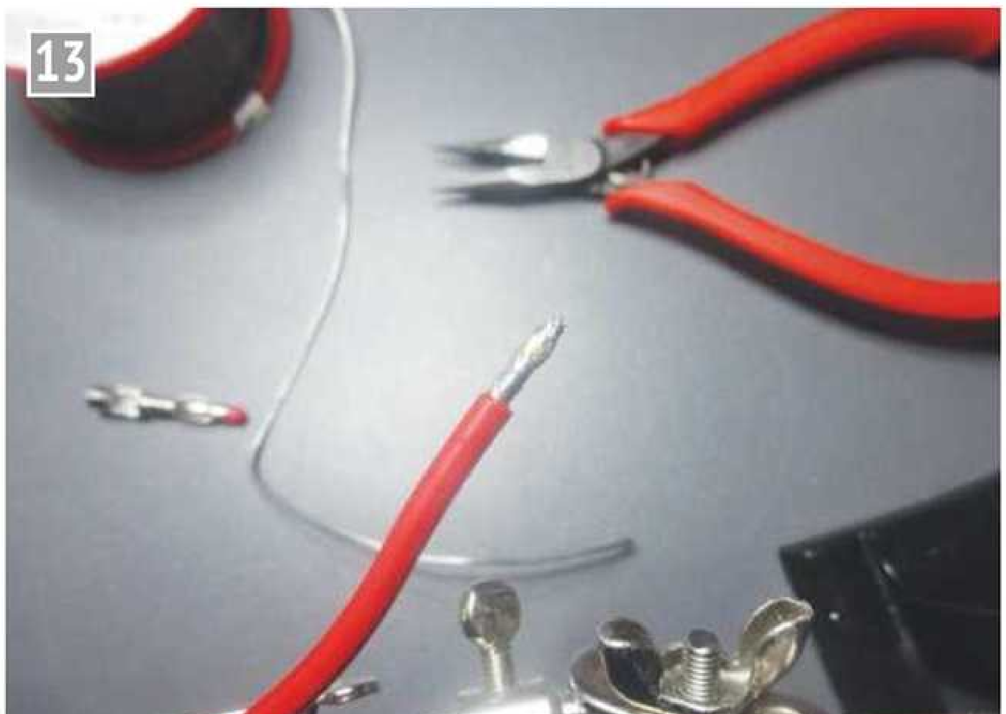
The leads can then be soldered onto the plugs and sockets, as shown in **photos 12, 13** and **14**. Note that for the sockets (and using the cable diameter specified previously), it is usually easiest to insert the bare (twisted) wire into the socket-cup and then to both tin the wire and solder it to the cup at the same time (photo 12) – use plenty of heat and


11

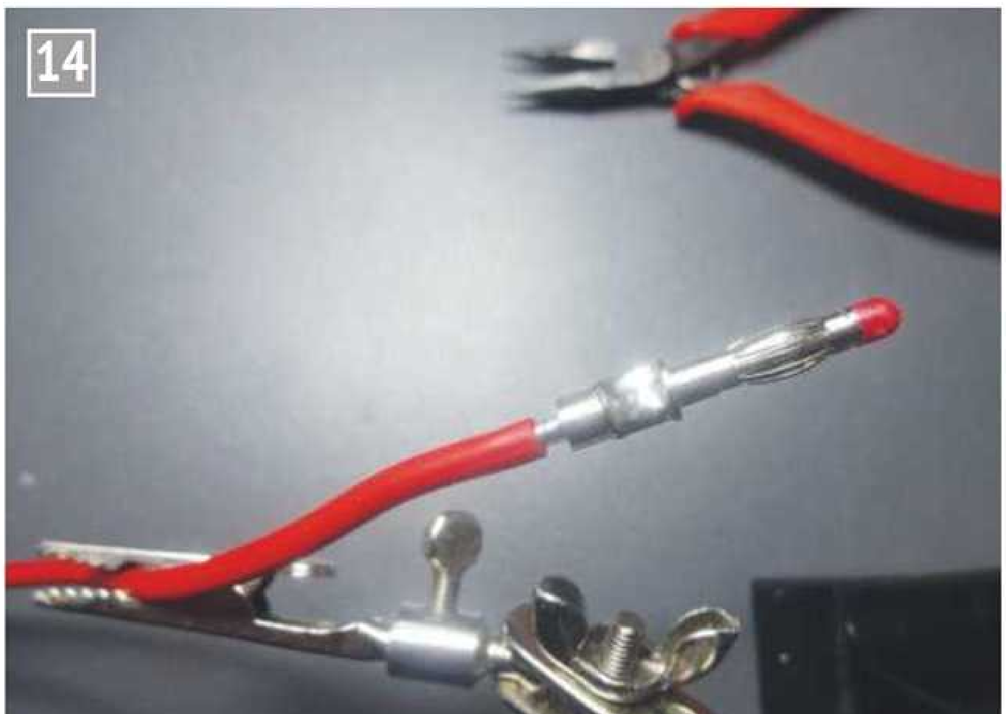
Stripped-leads with the correct allocation of plug and socket components.


12

Soldering a socket cup onto one of the wires.


13

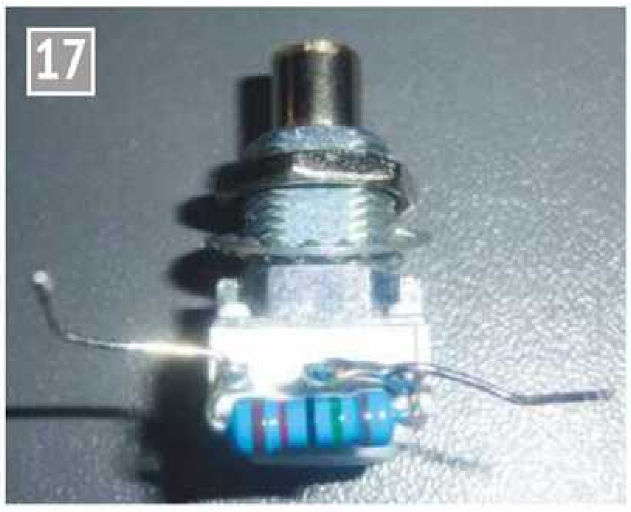
Tinning a lead.


14

A completed plug (without sheath).

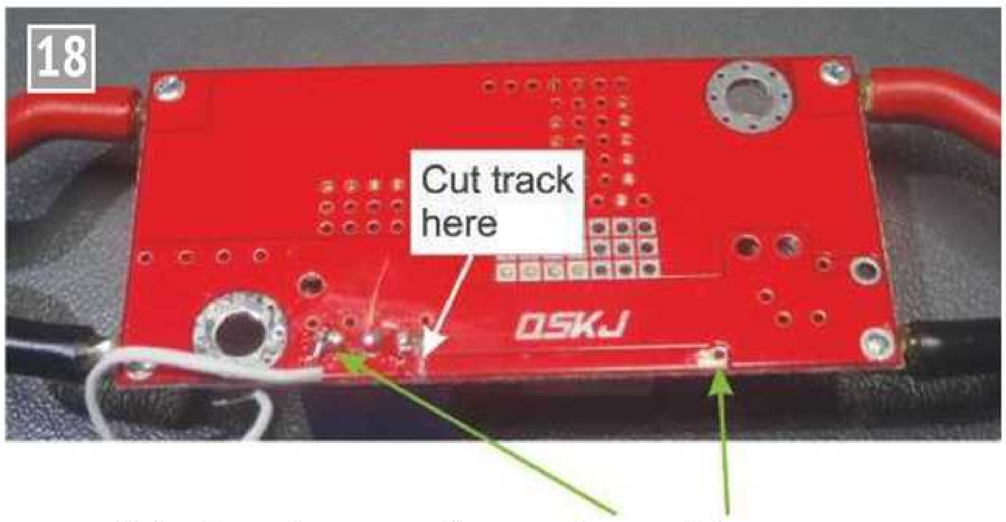
Completed flying leads.

Circuit card, complete with flying leads. Note the polarity (see text).



Wiring of the potentiometer and resistor (prior to trimming the excess off the resistor leads).

Wiring the potentiometer/ resistor into the circuit board. Note the cut track at the bottom, to the left of centre (carefully cut using a scalpel).



Potentiometer connections go here and here

taking your time, to allow the solder to flow. The socket is held in a set of 'helping hands' – a useful addition to the workbench if you don't have a set.

In the case of the plugs, these seem to have a slightly wider bore in which to insert the wire and so the wire can be pre-tinned (photo 13), which is a much more satisfactory step in the making of a good joint. Note that the wire is held a long way from the end where the soldering will take place, to prevent the crocodile clips on the 'helping hands' from squeezing through the softened PVC insulation, as it would if the wire was held close to where the heat is applied.

Finally (photo 14), the plug can be soldered on. Don't forget to add the plug and socket sheaths, prior to soldering the wires to the circuit board (**photo 15**).

The flying leads can now be soldered to the circuit card, as follows (**photo 16**):

- OUT+ (plus): red socket
- OUT- (minus): black plug
- IN+ (plus): red plug (Note: take care that this connection does not stray too far into the circuit board, such that it could touch the head of the adjacent mounting screw, particularly if you opt to use a metal housing for the circuit board.)
- IN- (minus): black socket

The potentiometer and fixed resistor can now be added (**photo 17**). Note that it is important that the potentiometer is wired as shown in the photograph – if the connection order is reversed, i.e. the wrong two pins are shorted, then almost all of the motor speed control will occur in a very small degree of rotation of the knob, if you use a logarithmic-track potentiometer (as I did). If you find this problem, then you will need to reverse the connections. Note that there is no need to remove the existing multi-turn potentiometer; it is disconnected by means of the track-cut shown in **photo 18**.

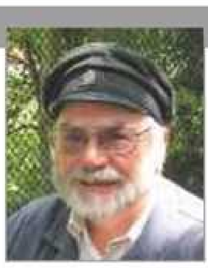
Solder sucker – depress the latching plunger, hold close to the joint whilst melting the solder with a soldering iron and then press the release button. Hey presto, no more solder! Note that the plastic tip is heat-proof.

At this point it is probably worth discussing, in generic terms, what we are doing here; if a different buck-boost converter circuit card is chosen from the one described herein then, armed with this knowledge, it can be made to work successfully (assuming that it still uses the XL6009 or a similar part). Essentially, we are replacing the on-board multi-turn potentiometer (the blue cuboidal component with the screw-adjuster on top) with an external equivalent. To do this we need to either remove (which is fiddly) or disconnect this component. If you wish to (or need to) remove the component, then the use of a solder-sucker is recommended (**photo 19**); whilst not perfect, these handy little devices certainly make the job of removing solder from a joint much easier.

Alternatively, since the potentiometer is wired as a variable resistance (by wiring together the 'wiper' – central connection – to one of the resistance track end terminals), we only need to disconnect one end of the potentiometer from the remainder of the circuit and this can be accomplished by cutting a single track (as shown in photo 17 for the board featured here – similar tracks will exist on other boards). The new (external) potentiometer can then be connected to the opposite end of the cut track from where the potentiometer (was originally) connected and the remaining (untouched) original-potentiometer connection on the circuit card. As an example of this, the former connection is shown by the right-hand green arrow in photo 18 and the latter by the left-hand green arrow. If you do choose to remove the original multi-turn potentiometer, then you can use the vacated holes to wire in the replacement, external, potentiometer.

●To be continued.

Union Nuts, and How to Make Them PART 2



Brian Baker makes some olives to go with his nuts.

Continued from p.360 M.E.4633 28 February 2020

So, to make the olives. These are quite different from those commercially available and are made from copper. First, chuck a suitable piece of copper rod in the three jaw chuck with enough material protruding to make three or four olives. I should mention that thick wall copper pipe is also suitable for use. Using one of the union nuts that you have previously made, turn the outside of the rod or pipe to be about 5 thousandths of an inch (0.1 mm) smaller than the diameter of the threaded portion of the nut (**photo 18**). This allows clearance for the olive to swell slightly when tightened.

Next centre drill and then drill about ¼ inch (6 mm) deep a hole, with a drill size about 4 thousandths of an inch (0.1 mm) larger than the pipe size you are using (**photo 19**). The 'little extra' allows a small gap for the silver solder to penetrate easily when we attach it to the pipe. Next part off about 1⁄16 inch (1.5 mm) long (**photo 20**). As the olive is parted off, it tends to distort and slightly close the hole previously drilled but this is just what we want since this reduction in diameter stops the olive sliding down the pipe when silver soldering takes place.

Another annoying habit these olives have is of disappearing into the pile of swarf on the lathe, so I use a simple 'catcher', in this case a blunt scriber, to collect them (**photo 21**). So, we finish up with a batch of nuts which are ready for use and olives awaiting soldering (**photo 22**).

Now we are ready for silver soldering the olive to the pipe. This type of olive is not suitable for soft soldered fixing, which will simply not give a strong enough joint, nor soften the copper to allow it to deform when tightening to form a good tight seal.

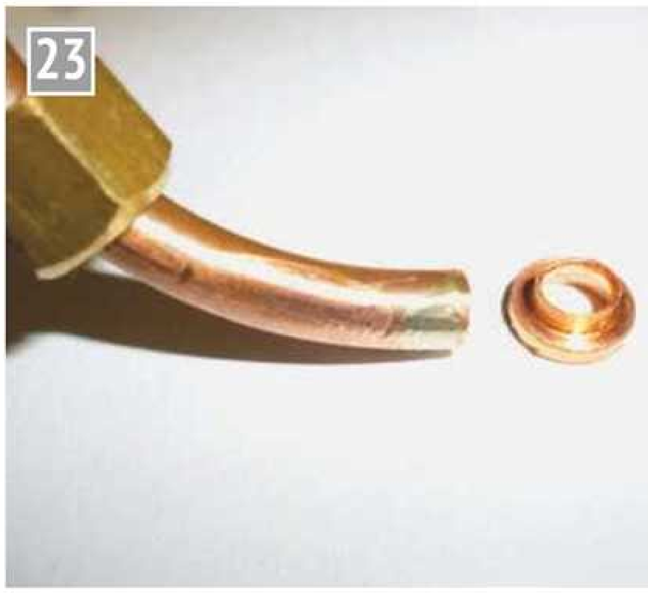
The bevelling tool used to turn the outside diameter of the olive so that it is an easy fit onto the nut.

The copper is centre drilled and then drilled for the pipe.

Slices are then parted off.

The olives are caught on this makeshift catcher.

The part finished olives are stored alongside the nuts.



The pipe is carefully cleaned prior to silver soldering.

After pickling, ready for final cleaning up.

The remnants of the parting off burr, which we used to position the olive, is sawn off.

After a final touch with the file, the union is ready for use.

I find this modified union nut helpful in lining up the tender hand pump joint.

Clean the pipe carefully, slide on the correct size of union nut - yes, now and again we all forget this step - apply a small amount of appropriate silver solder flux and push on the olive (**photo 23**). Carefully heat the pipe, 2 or 3 inches from the olive, and protecting, as much as possible, the union nut from direct heat, until the flux melts and turns 'watery', then apply a small amount of silver solder to the olive. Alternatively, a ring of wire can be wound around the back of the olive when it can be heated until the silver solder melts and runs right round the joint. Try to avoid putting on too much solder, as you will only have to file it off again if a blob stops the union nut seating.

When the joint has cooled down somewhat, put it into your favourite pickle, I prefer citric acid. Then polish up with a bit of wire wool if needed when it is removed from the pickle bath (**photo 24**).

Finally, we need to trim off the 'fleggs' that remain after parting off. I usually use a fine bladed saw (**photo 25**), afterward touching up with a file, and a touch of a round needle file ensures the pipe is fully open (**photo 26**).

In use, the softened, annealed olive can seat onto the conventional 'V' shaped recess that most fittings have, or fit the flat joints usually found on injectors. The nuts just need ordinary tightening for them to seat cleanly and leak free.

A special union nut is shown in **photo 27**, which has a knurled ring, silver soldered to the back of the nut, and used to start and tighten the outlet from the tender hand pump joint from the tender to the locomotive, which always seems to be inaccessible, as well as needing a special shaped spanner. It can be turned with finger tips.

In the time you have taken to read this description, you could have made a quite a few of these mundane fittings - all the techniques described are simple. Then, you will be pleased when someone asks about your current creation "Did you build it?" and you could get the satisfaction of saying truthfully, "Some of it". ME

Building the Model Engineer Beam Engine

PART 17

David Haythornthwaite writes a series on how he built the *M.E.* Beam Engine. This is an old favourite and construction of this engine to 1½ inch scale was serialised in *Model Engineer* back in 1960. Times, methods and equipment have now moved on and the series describes how to build this magnificent engine in 1 inch scale from available castings.

Continued from p. 381
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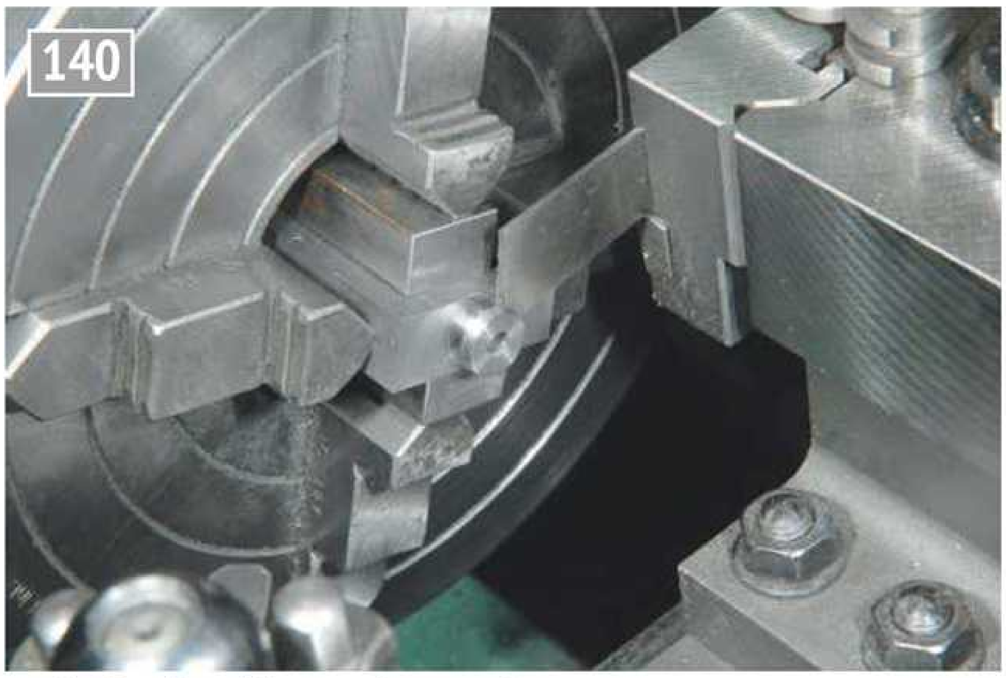
The steam chest

The steam chest was first milled to the correct thickness of 15⁄32 inch by mounting it on parallels in the machine vice. Three sides were then milled in the machine vice in similar manner, bringing the width to the correct dimension and using parallels and engineer's square to ensure correct geometric form. The inner rectangular void, where the valve is to slide, was milled out using a ¼ inch end mill and the corners filed true. This left the top edge to machine, which carries the flange where the valve rod exits. The best way to machine this is to mount it in the four jaw, being incredibly careful to clock all sides, to ensure that it is running central. It is then possible at this setting to machine the final side and turn the flange - and I used a 3⁄32 inch parting tool to turn the collar behind the flange. **Photograph 140** shows the set-up and you can see that I had to pack the sides of the chest, with strips of bar, in order to make the jaws hold it. The hole for the valve rod should be reamed 3⁄32 inch and counterbored for the stuffing gland.



Turning the valve rod flange on the steam chest.

Drilling holes for the studs.

Steam chest cover

The steam chest cover is a casting and comes with a chucking piece cast on to the outer side. The chucking piece is almost superfluous to requirements, but I started by mounting the casting in the four jaw chuck with a lathe backstop behind it, so that the plate was held by the ends of the jaws and the chucking piece was towards the tailstock. This enabled me to face the outer side of the cover, and to form the boss in the centre, which the steam supply flange would eventually bolt to. I also trued up the chucking piece at this setting. The part was then reversed and held in the four jaw by means of the chucking piece. The inner face was then turned flat and the thickness of the cover plate brought to 3⁄32 inch. Unfortunately my casting had chilled cast iron on all four corners, which would only machine using tungsten carbide tools. It was the first time that I had come across this phenomenon and, with a part so thin, I was very concerned lest I shattered the part as the tool clattered on the chilled portions.

The corners were absolutely as hard as … … well, I was going to say iron – but they would be, wouldn't they?! It was like turning hardened steel and with a thin part with square corners, extreme care had to be taken not to break it. The flat, inner side finished up ever so slightly concave with the stresses of machining and I ended up lapping it, by hand, onto wet and dry paper on a flat surface plate. Whilst in the chuck I drilled the steam inlet hole 3⁄16 inch diameter. I did not fit the studs for the inlet flange as I preferred to spot these through from the flange itself, at a later stage.

For parts that have to bolt together on many studs, I like to drill one part and then make a sandwich of the other parts to spot the holes through to the mating parts. In **photo 141**, the steam chest and steam cover are mounted together in the machine vice and both parts are drilled through together at 8BA tapping size. After drilling, the steam chest and the port face were clamped together

Steam chest parts.

Tapping the cylinder block.

and the port face was similarly drilled 8BA tapping size. The steam chest parts are shown in **photo 142** ready for the port face to be clamped onto the cylinder and the cylinder drilled and tapped for the 8BA studs. Note that the fixing bolt holes for the port face have also been drilled. IMPORTANT – the parts in the photo are incorrect. Having started with the cover plate, transferred the hole positions to the steam chest, then drilled the port face, I realised that the central stud was going through the exhaust outlet. When I looked at the drawing for the port face modification, I saw that there are eight studs to attach the steam chest, not six as on the main drawing and as made by me. It does say on the port face drawing that the hole positions should be transferred to the steam chest and cover, but that is no help when I had already drilled those parts according to the drawing. I stood on the naughty step for a while, kicking myself for not paying more attention. It isn't the end of the world to have the stud going through the exhaust pipe, but it is annoying for it to be wrong. I actually tapped the port face for that stud and put a shorter stud into it; i.e. the port face was not bolted to the cylinder at the position of the exhaust port. If this proves to be a problem, I can bolt it through the exhaust port at a later date. The spot over the valve rod, on the photo, is not a hole but is a felt tip spot to show which side goes next to the cover plate. Of course the steam ports have yet to be milled in the port face and the steam ports are still to be milled in the ends of the cylinder.

I stood on the naughty step for a while, kicking myself for not paying more attention...

Tapping the cylinder for the studs

The port face was clamped to the cylinder, using engineer's clamps at both ends and protecting the bore of the cylinder with wood packing. I used the saddle that I had made for boring the cylinder as a cradle to support it and ensured that the top was horizontal with a spirit level. The port face could then be used as a drilling template to drill through at tapping size for 8BA (1.8mm). I first drilled the two diagonal holes, tapped them and fitted short studs so that the port face could be mounted more securely before drilling the other holes.

The rest of the stud positions were drilled tapping size, the port face removed, the holes in the port face were drilled out to 2.3mm, and the port face replaced. The cylinder was then tapped using a home-made tapping/pillar tool, using the port face holes to guide the tap true. The set-up is shown in **photo 143**.

The cylinder cover was mounted in the three jaw chuck, holding it by the register disc, and a drill was mounted on the cross slide. A 60 tooth gearwheel was mounted on the end of the mandrel, complete with detent, and the six mounting holes were divided/drilled tapping size for 8BA. The set-up is shown in photo **144**. The holes are on a $1^{21}/_{32}$ inch PCD and having a DRO on the lathe, I was able to centre the drill to the lathe centre, zero the DRO and then move the cross slide out so that the DRO read 1.656 inch. Like most lathe operators, I have my X direction set to read diameter. The cover was then clamped in place on the cylinder and the stud positions spotted through to the cylinder. When doing this, do give due thought to stud positioning, so that you do not have a stud going through the top cylinder steam port (yet to be created in my case).

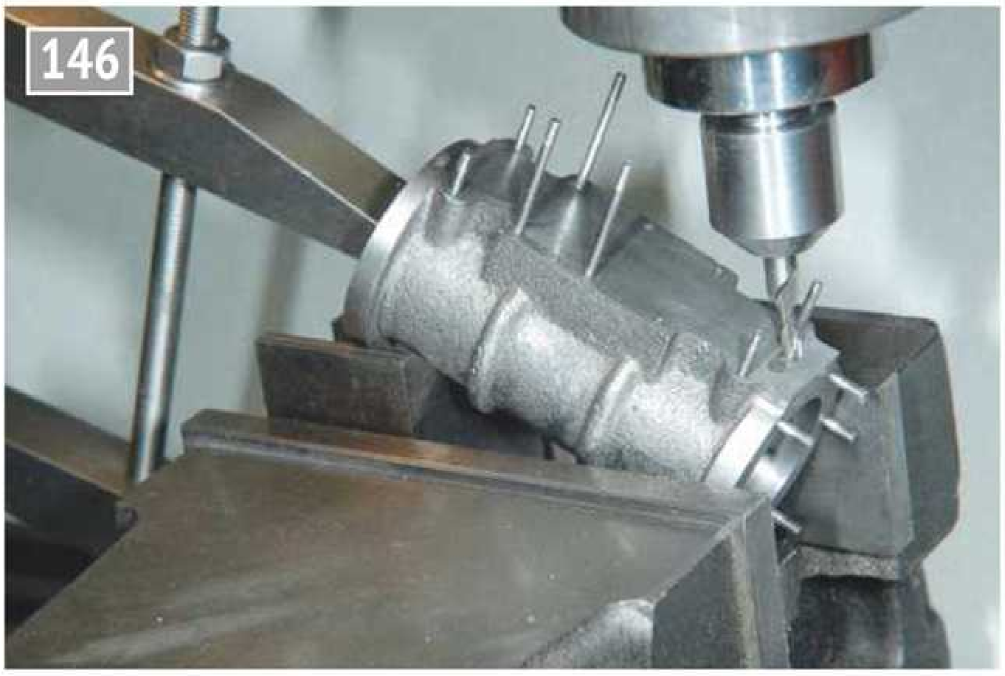
Whilst drilling the stud positions, I drilled and tapped the cover 4BA to take a lubricator/ vent device. This hole should be ½ inch from the centre, i.e. on a 1 inch PCD. Again note its position carefully relative to studs and stuffing box bolts.

Drilling the cylinder cover.

Creating the steam ports

The steam ports on the port face are shown on the drawing as being square cornered $^5/_{32}$ x ½ inch, but for ease of manufacture I milled mine and left them with curved ends. This would give me a slower steam cut-off, but I am not sure if this will be important. I am not looking to obtain maximum power from this

Milling the steam ports.



Milling the cylinder ports.

model, but I am sure that some steam expert will be shouting at me that they should be square. I didn't have a suitable file to hand to square them off, but may return to this task later if necessary.

It may just be visible in **photo 145**, that underneath the slot drill I have drilled a small hole through the centre of the slot. When lowering the slot drill for the next cut I always did this in the centre of the slot where the hole made it much smoother and eased the slot drill on its way. I know that slot drills will drill a blind hole, but sometimes they make a bit of a meal about it.

When it came to milling the top port in the steam cylinder, I agonised about how to proceed for quite a while. The $\frac{5}{32}$ inch port has to exit in the cylinder bore in the $\frac{5}{32}$ inch relief counterbore, i.e. it must be absolutely adjacent to the cylinder cover. As this port is milled at an angle and is difficult to mill from inside the bore, it had to be milled from the port face of the cylinder, with the cylinder held at an angle (**photo 146**). I set the cylinder in the machine vice at an angle of 27 degrees with the higher end clamped onto a Vee block and the lower end resting on the vice. A bit of trigonometry went on but eventually I dropped a vertical bar touching the end of the port face and used feeler gauges to measure the gap between the bar and the edge of the cylinder bore. I then lined up the right hand edge of the cutter with the edge of the port face, zeroed the DRO and moved the table right by this measured distance. Adrenaline was running high as I started to mill the port and I was suitably pleased when the port broke through in exactly the correct place. The port is deeper than you would think and my slot drill was only just long enough.

The lower port is much easier, being at right angles, but the drawing of the cylinder modification shows the lower edge of the port to be $\frac{1}{4}$ inch from the bottom of the cylinder. There is to be a cast iron plug to be made for inside the lower end of the cylinder and this is to be 5/16 inch thick at the port side (not the left for you sailors!). The plug would cover most of the port if the port was located as in the drawing, so I raised this so that the bottom of the port was $\frac{5}{16}$ inch from the cylinder bottom. It exited nicely in the counterbored section which is $\frac{1}{2}$ inch deep at the lower end of the cylinder.

Cylinder parts and gaskets.

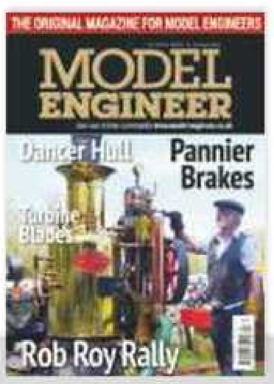
I was unsure whether to use Loctite 574 to make liquid gaskets but I knocked out paper gaskets as shown in **photo 147**. Time will tell whether this is the right decision.

The piston is a straight turning job and has a $\frac{1}{8}$ inch or a 3mm groove for a ring of a suitably sized square graphite string packing. I turned it from a bar of phosphor bronze, cut the piston ring groove with a rear mounted parting tool and drilled and tapped it 4BA for the piston rod, all at one setting in the chuck.

●To be continued.

NEXT TIME

We'll mount the cylinder on the engine.



An Engineer's Day Out

PART 1

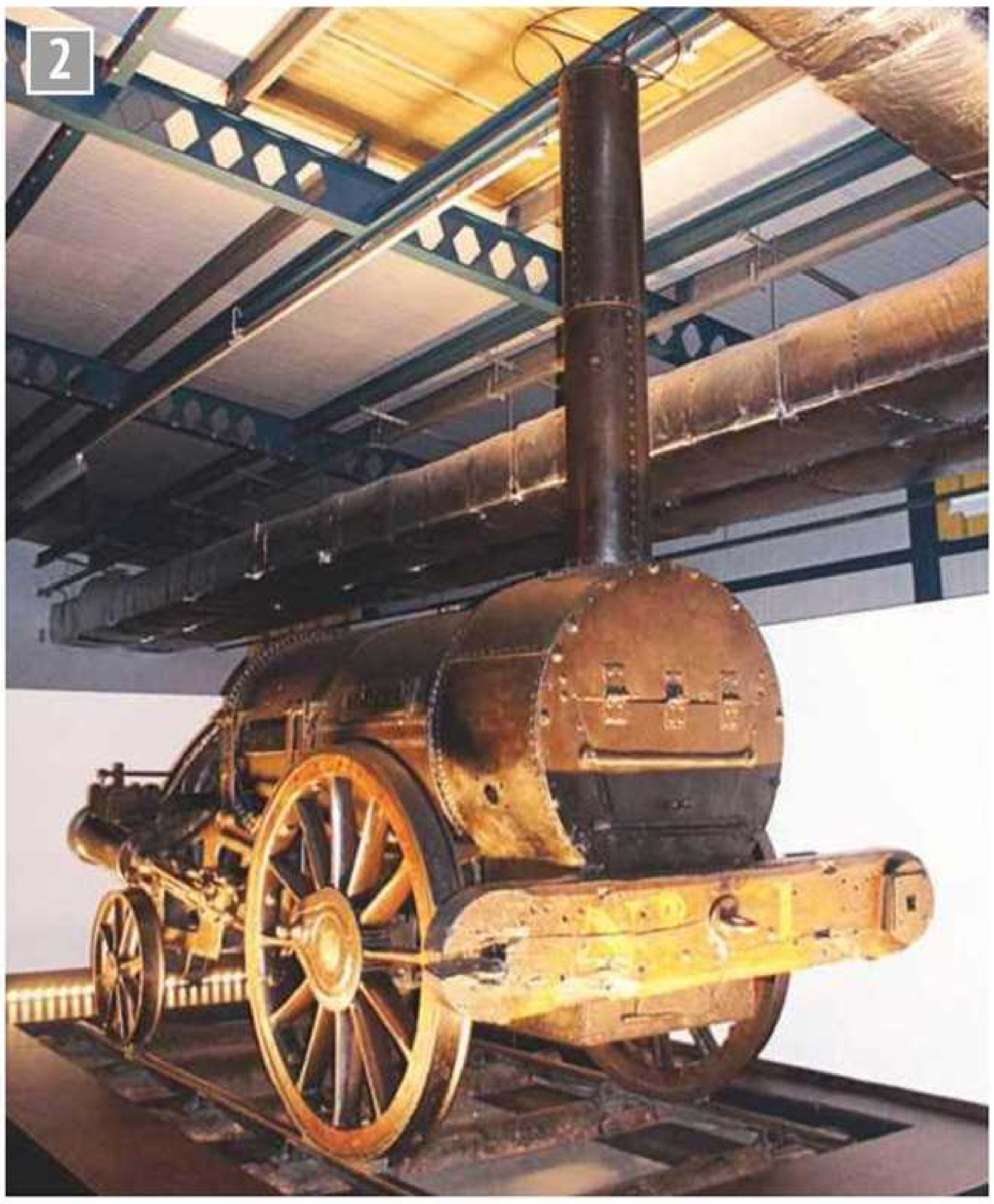
Models at the National Railway Museum, York, including the Brass, Steel and Fire Exhibition

Roger Backhouse visited the 'Brass, Steel and Fire' exhibition at York before it moves to the Science Museum in London.

Exhibition signage; this was an expensive exhibition to curate and display.

As reported by Diane Carney (*Model Engineer* issue 4624), York's National Railway Museum currently hosts an exhibition of significant models, mostly locomotives from the 'heroic age' of model engineering. This was before twist drills, when treadle lathes and hand tools were all model makers had and before writers like LBSC helped makers with detailed advice about locomotive construction.

Opening the exhibition the Director, Judith McNicol, described Brass, Steel and Fire as a 'monument to models' pointing out that 'modelling and crafting is simply engineering on a small, personal scale'. It is at York until 13 April and moves to the London Science Museum from 21 May to 2 November 2020 (**photo 1**). Linked to the exhibition the original *Rocket* has been moved from the Science Museum to York (**photo 2**).



The original Rocket, *now moved from the Science Museum.*

Besides this display the museum has many models of locomotives, equipment, rolling stock and ships. Some have come from model engineers and model railway constructors and are also well worth seeing.

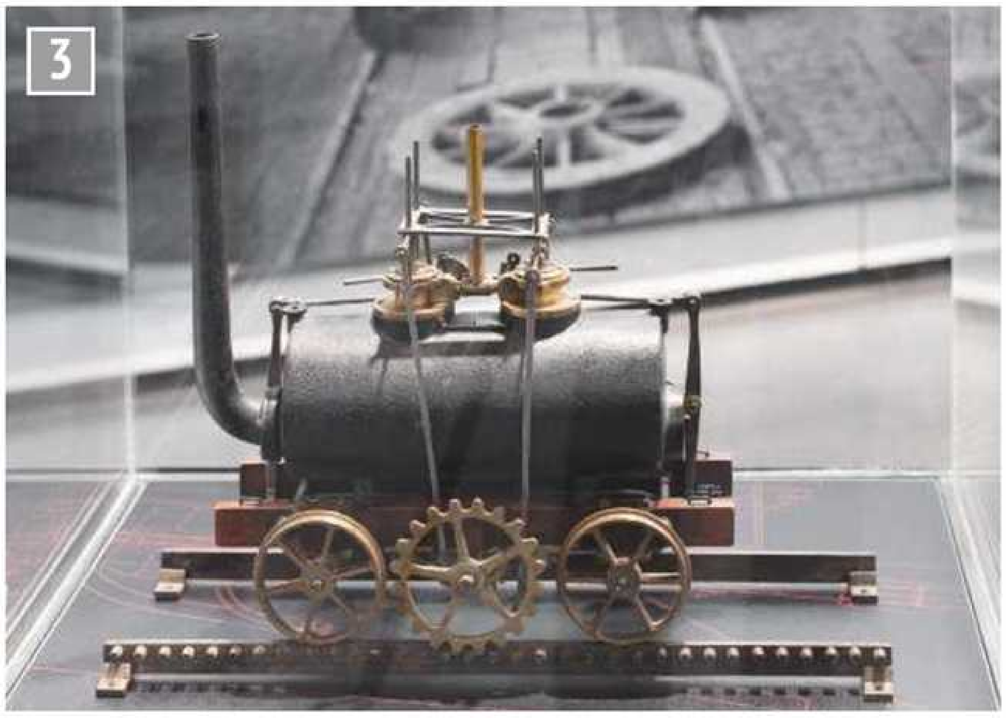
Putting a major exhibition together takes time. Ideas originated around December 2016 in curatorial staff discussion, encouraged by Andrew MacLean, Chief Curator, and supported by the Head of the Science Museum Group, Sir Ian Blatchford. Senior Curator, Anthony Coulls says he originally envisaged a display of around 30-40 engines, eventually selecting 20 from over 200 models seen in different countries.

Some owners did not wish to loan models and logistical problems prevented other inclusions. All models chosen have interesting features or stories reflecting the varied skills and resources of their builders.

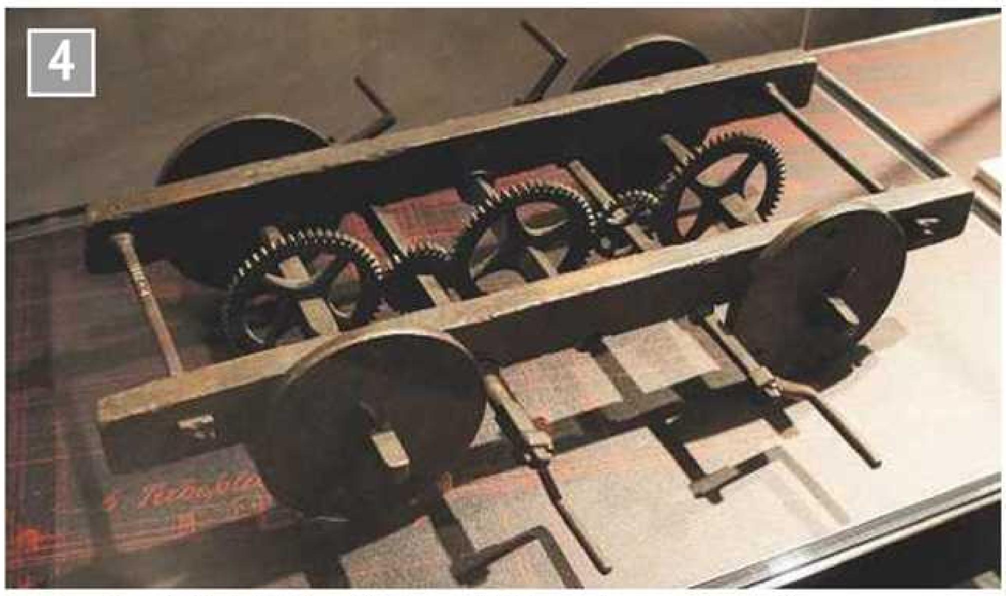
In the beginning

Early steam engineers used models to trial concepts of a working engine. Trevithick's model steam locomotive tested his ideas for a road locomotive leading to a full size steam carriage run in Cornwall. He followed with the Penydarren engine, the first true steam locomotive to run on rails.

Believed to be the oldest railway model here is the Middleton Railway's *Salamanca*, with a cogwheel engaging a rack. This was the first successful steam railway and the model is a remarkable survivor from 1812 (**photo 3**).



Salamanca - ***possibly the oldest model of a railway locomotive showing the Middleton Railway's unique cogwheel system. (Photo courtesy Jason Hynes, National Railway Museum.)***



Test carriage built by William Hedley and Wylam colleagues to see if a smooth iron wheel could grip a cast iron rail. The most significant experiment in early railway history led to Puffing Billy and the steam railway.

An unprepossessing exhibit is the most significant experiment in railway history. At Wylam Colliery horses hauled coals on a wagonway to staithes at Lemington for shipment. Owner, Christopher Blackett was concerned by the rising cost of horse feed due to the Napoleonic Wars. Could steam engines be the answer? Fuel was readily to hand. He was ready to invest in new technology and knew of Trevithick's work, encouraging investigation.

The viewer (or manager), William Hedley, foreman blacksmith Timothy Hackworth and the wright, Jonathan Foster devised a solution. But could a smooth cast iron wheel grip a cast iron rail? A locomotive wheel was not a rotating support like a cart wheel but a means to propel a vehicle. So the team built the hand powered model shown here using gears from a Newcastle clockmaker to test their theory (**photo 4**).

It worked, so they tried a full size version operated by man power hauling wagons (**ref 1**). That also worked, confirming that an iron wheel would grip a cast iron plateway.

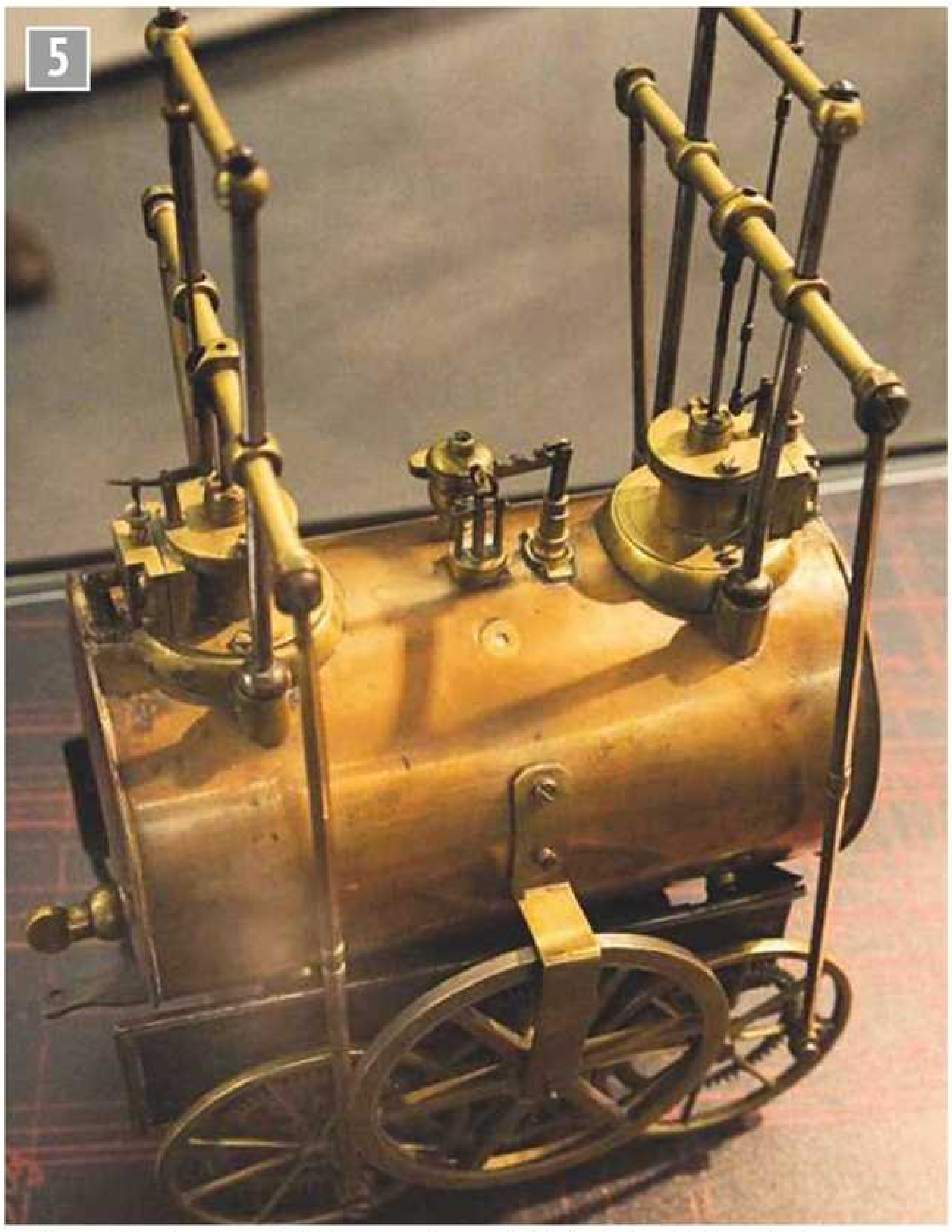
Hedley had a model built, probably around 1812 by the local clockmaker, Isaac Jackson, to see if a twin cylinder engine worked (**photo 5**). This model has also been attributed to Richard Trevithick but the two cylinders and slide valve suggests it was not his design (**ref 2**). Though named *Sans Pareil* it is unlike Hackworth's later engine for the Rainhill Trials. The caption says William Hedley 'discovered a new way of connecting locomotive wheels to give them more grip' which completely misses this model's importance. (It has to be said that there are other questionable captions in the exhibition.)

Wylam's model experiments led to *Puffing Billy* which operated successfully on the wagonway, encouraging others like George Stephenson to develop steam locomotives.

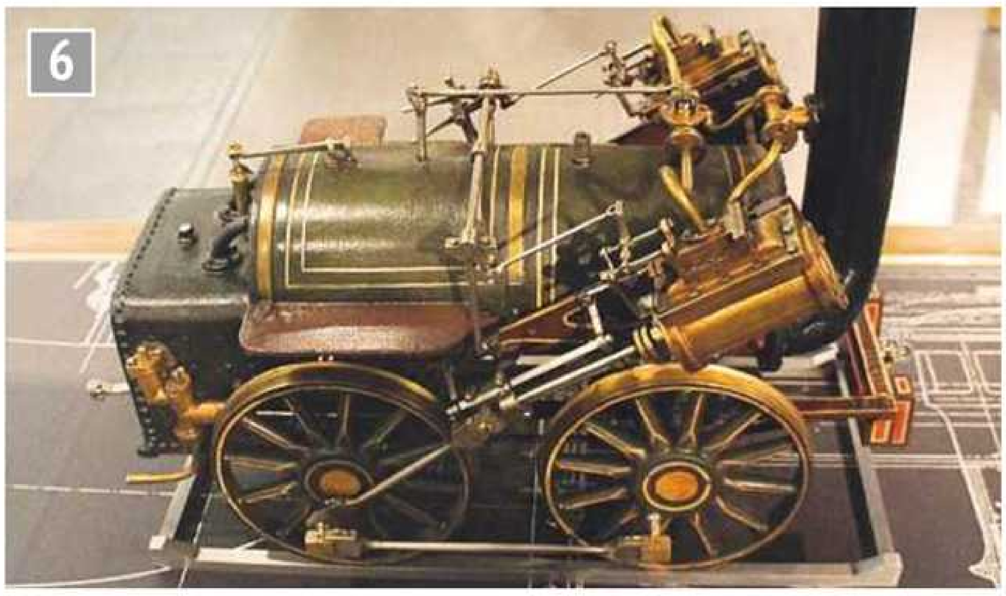
Moving on

Apprentices often made models of full size objects they worked on. Smaller versions were to prove skills and help familiarise apprentices with the 'real thing'. One was Edward Fletcher, an apprentice at Robert Stephenson's locomotive works when that company was developing fast. He worked on the full size *Invicta* for the Canterbury and Whitstable Railway and was its first Driver.

In his spare time he modelled the locomotive. It's a fine work showing his potential as an engineer (**photo 6**).



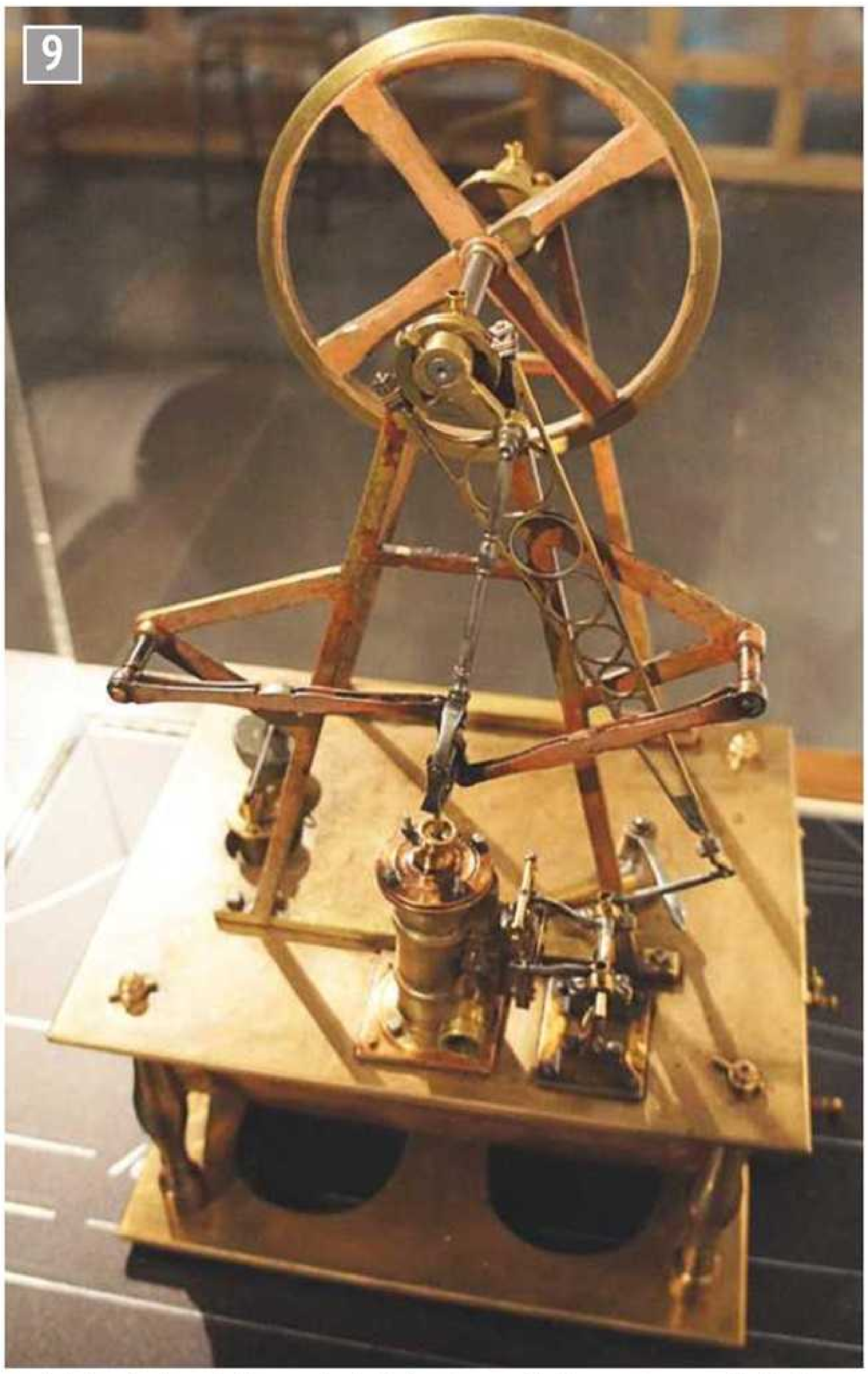
William Hedley's twin cylinder locomotive, probably built by a Wylam clockmaker. This tried out ideas for steam power on the Wylam wagonway.



Model of a Canterbury and Whitstable locomotive built by Edward Fletcher who drove Invicta *on its first run.*

Another locomotive experiment; Arthur Parsey's idea of a compressed air locomotive. Though the Great Western Railway did not take up the idea, such locomotives found favour in underground workings.

Cosmo Bonsor *built by Bank of England clerk, Jim Crebbin in 1903 to test ideas about superheating and compounding. It hauled the first train at the first Model Engineer exhibition in 1903 and ran there until 1950.*



Model of an incline winding engine built by 16 year old Thomas Greener of Etherley, County Durham. It is the oldest working model steam engine.

A 19th Century toy locomotive; known as 'dribblers' they left a trail of water drips and a smell of meths but were popular toys.

He later became locomotive superintendent of the North Eastern Railway developing a range of simple but reliable locomotives.

Trying new ideas

Models were often used to test new ideas. One was the compressed air locomotive devised by Arthur Parsey around 1845 and offered to the Great Western Railway. With two copper tanks it is distinctive, though not enough to persuade the Company to try it. Ahead of its time, compressed air locomotives were later used underground (**photo 7**).

Jim Crebbin's *Cosmo Bonsor* was built as a 4-4-2 oil burner to try compounding and superheating. He was an amateur engineer working full time in the Bank of England. Completed in 1903 it hauled the first train at the first Model Engineer Exhibition in 1907 (**photo 8** and **ref 3**). Like most of Jim Crebbin's engines it was much altered later, in this case to a simple expansion coal burning 4-6-0 wheel arrangement.

Other models

Every engine has a history, some highly complex. A brass model depicts an incline winding engine and is claimed by the caption to be world's oldest working model steam engine though this is disputed - another questionable caption! (**ref 4**). It was built around 1836 by Thomas Greener who lived at Etherley Incline cottages on the Stockton and Darlington Railway. (The museum has the full size Weatherhill Engine from the Stanhope and Tyne Railway.) It's a delightful model (**photo 9**) and a remarkable achievement for a 16 year old. This model's history was researched by Thomas Walker who traced the model's subsequent owners (**ref 5**).

Toys for children - and grown-ups

Many models are built for enjoyment. There's an example of a 'dribbler' model, spirit fuelled and probably run round a room indoors (**photo 10**). A young boy (or perhaps

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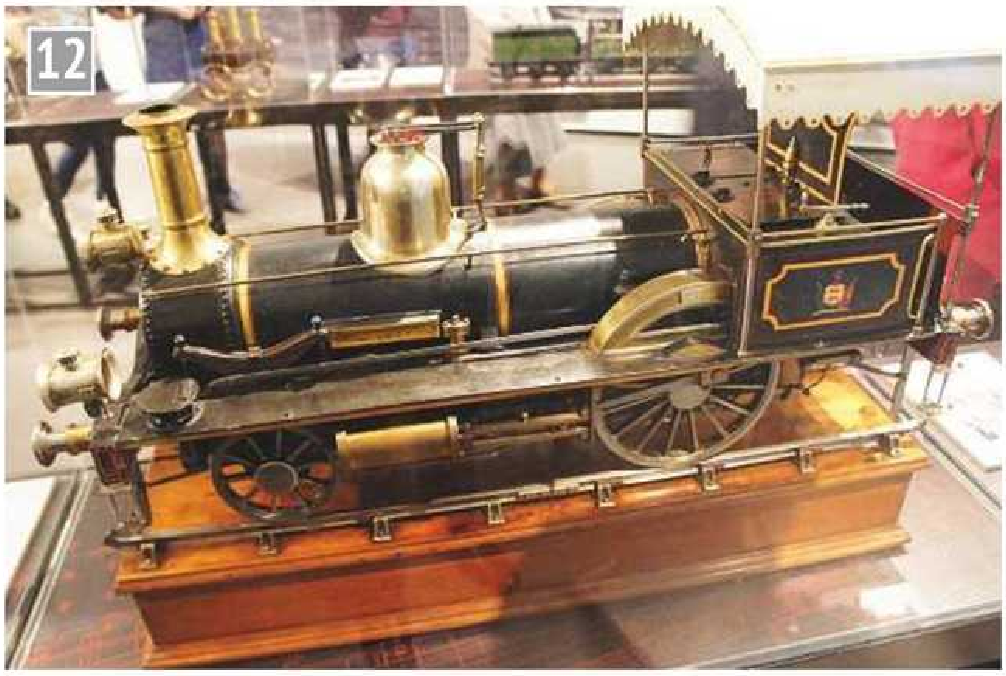
Garden railway locomotive built by Edward Leatham for fun riding on a garden railway. (Photo courtesy Jason Hynes, National Railway Museum.)



Locomotive builders often used models to promote their engines. This was a design for an Egyptian locomotive, with the English name on one side and Arabic on the other.

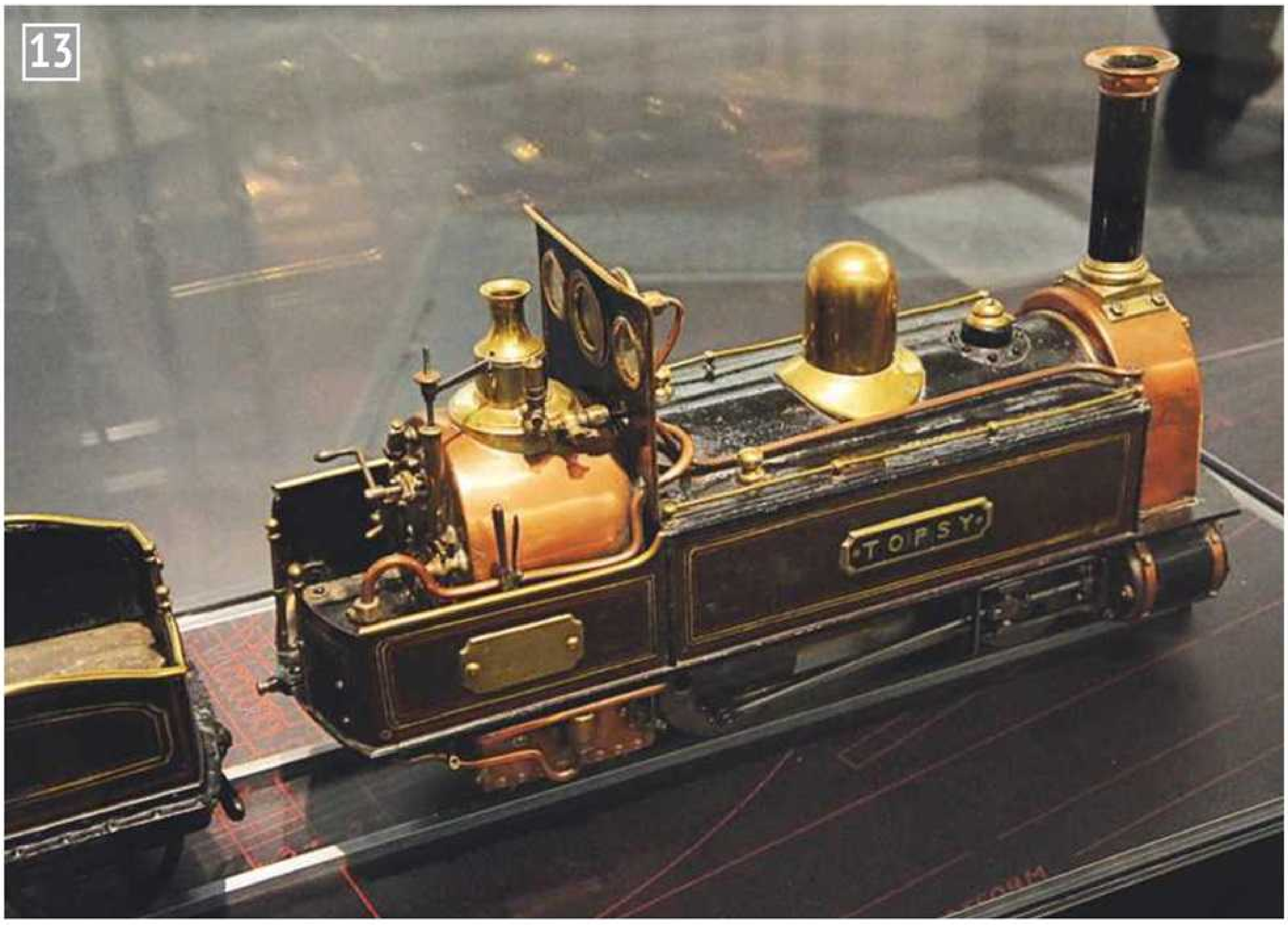
his father and sister) must have enjoyed this toy. Later, richer families built garden railways with ride on trains; the model of a single driver locomotive was built by the M.P. for Huddersfield, Edward Leatham, for his garden railway (**photo 11**).

Selling engines

Models can encourage interest in new equipment or reach fresh markets. The exhibition has a delightful 0-4-0 engine built in 1862 to demonstrate a locomotive to a foreign buyer, in this case an Egyptian railway. It has the name in English on one side and in Arabic on the other. This engine eventually ran between Alexandria and Suez. Unfortunately the caption does not indicate the builders (**photo 12**). Railway manufacturers often sent models of equipment out to India and the Indian National Rail Museum has some examples (**ref 6**).

Charles Spooner of the Ffestiniog Railway used his engine, *Topsy*, built in 1869 by his son George and the engine driver, William Williams, to try out new ideas. It ran on his 3⅛ inch gauge garden railway but it also tested an idea for rope haulage up steep inclines, although no trace of this equipment remains on the locomotive. Visitors to his Porthmadog home would often see *Topsy* operating (**photo 13** and **ref 7**).

●To be continued.



Topsy *ran in the Porthmadog garden of Charles Spooner. It was also used to test ideas for cable haulage.*

REFERENCES

1. *Timothy Hackworth and the Locomotive* by Robert Young. Shildon Stockton and Darlington Jubilee Committee. 1923 reprinted 1973.
2. For a detailed discussion of this model see Jim Rees' *The Model: Its Purpose and Possible Origins in Early Railways 4.*
Papers from the Fourth International Early Railways Conference. Six Martlets. 2010.
3. *The Remarkable Jim Crebbin and his Experimental Locomotives* by Roger Backhouse. £14 from the N.R.M. shop or from booksales@sm-ee.co.uk . See also Ann Hatherill's booklet: *James Charles Crebbin; an Extraordinary Model Engineer*. Also published by SMEE. Both available from the N.R.M. Shop.
4. Nicholas Oddy - *Train Collector* Issue 53, December 2019 pp40-41.
5. Thomas Walker - *Three Greeners of Etherley and a Model Steam Engine*. 2nd revised edition. 2019. Obtainable from the N.R.M. shop or direct from Thomas Walker, 38 Redlands Road, Reading, Berkshire, RG1 5HD
6. Thanks to Dr. Ron Fitzgerald for this information.
7. Thanks to Paul Davies for this information. For a full history of Ffestiniog engines see also Chris Jones' and Peter Dennis' *Little Giants: A History of the Ffestiniog Railway's Pre-revival Locomotives*. Lightmoor Press. 2018.

WORKSHOP TIP

Boring Eccentrics

Ray Griffin makes the eccentrics for his 1 inch scale traction engine.

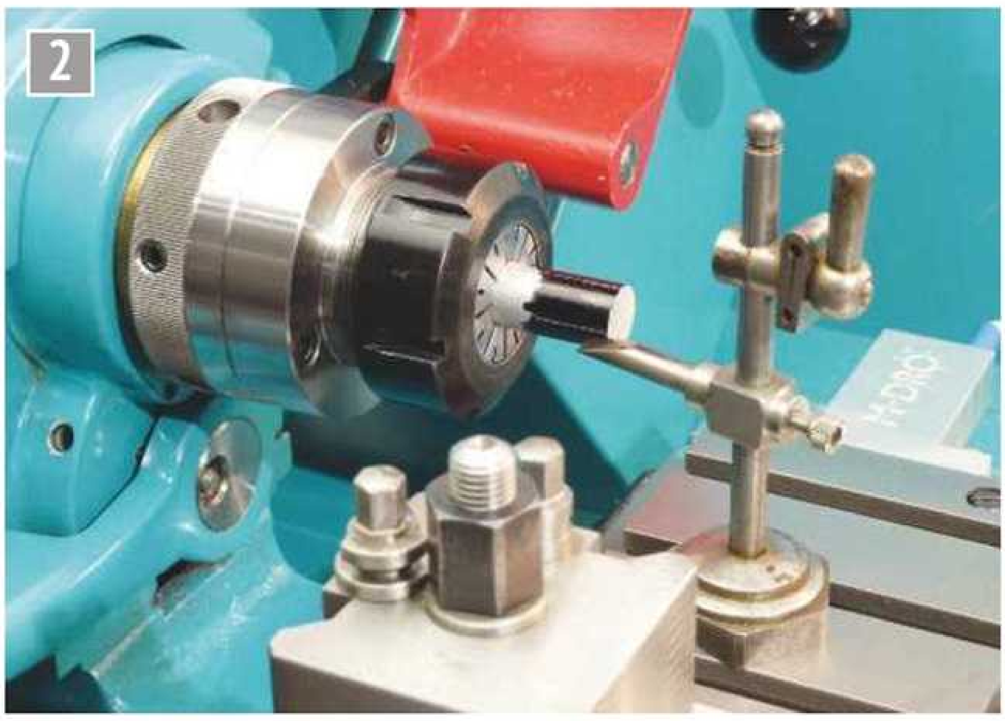
I am making a 1 inch *Minnie* traction engine and have arrived at the machining of the eccentric straps. The castings provided have a rough hole in the centre. In the past, I have made eccentrics for steam engines using solid castings. I machined them to approximate size, drilled holes for the bolts to hold the halves together and then cut the body in halves across the centre using a thin slitting saw. The halves were bolted together and the centre of the work established along the sawcut. The centre was clearly identified and initial drilling and work with the boring bar soon established the hole for the eccentric - a comparatively easy set of operations.

Not so with the current casting. How is it possible to locate a centre (**photo 1**)? I came up with a solution that I have not seen in print before so thought it worth recording. The bolt holes were drilled, and the strap cut across the centre using a fine slitting saw. The location for the cut was found from the middle of the two flats on each side.

Rough hole in centre of the casting.

The longitudinal centre was scribed with a height gauge with the casting stood on one of the flat surfaces on the side. I prepared an indicator gauge to act as a centering aid. This was simply a piece of rod the same diameter as the hole to be bored, in this case 0.625 inch.

The rod was secured in a collet chuck on the lathe and the outer end of the rod coloured with ink from a marker pen. I then used a scriber/centre height finder to make four lines at 90 degrees (**photo 2**). I use this little tool to ensure that lathe tools are correctly set at centre height. My Myford Super 7 Connoisseur lathe has a useful dividing gadget operating on the teeth of the bull wheel, so it was easy to make the four divisions.

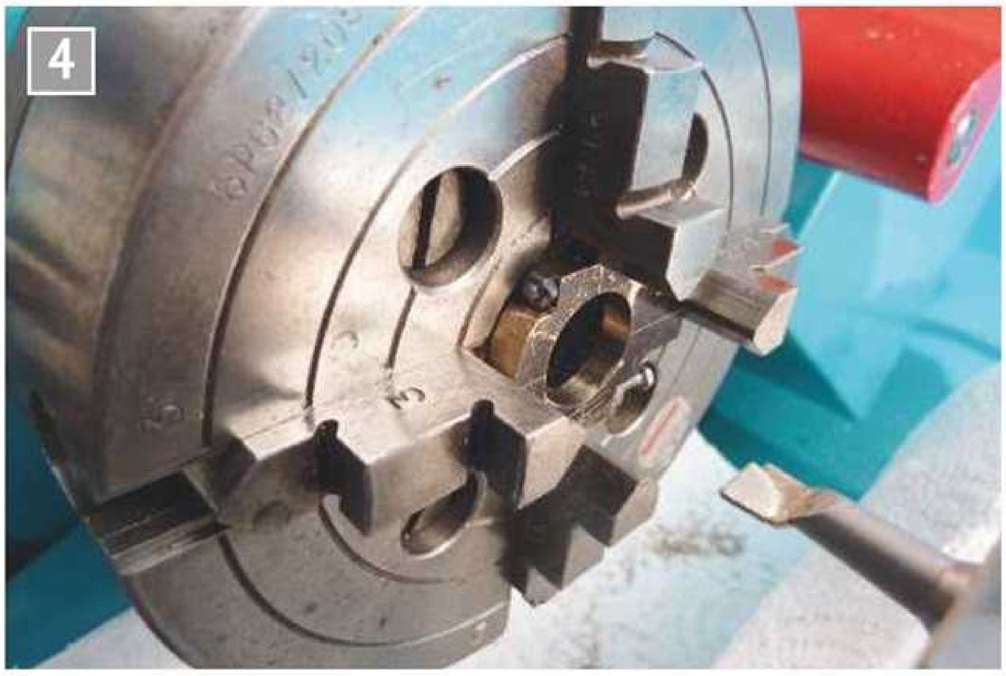


Scribing four lines.

The gauge was removed from the chuck and held in an ER32 collet chuck on a Morse two taper in the tailstock. The small four jaw independent chuck was screwed in place and the casting roughly centered with its rear face in contact with the surface of the chuck. The tailstock was advanced until the end of the gauge contacted the face of the castings. Using the four adjusting screws on the chuck it was easy to make the lines on the casting and the lines on the gauge match up (**photo 3**). The chuck jaws were tightened, making sure that the casting did not move in the process.

The tailstock was drawn back and the alignment tool taken out of its collet. I used a small boring tool to enlarge »

Matching the lines on the casting with those on the strap.



Boring the hole.

the hole (**photo 4**). I had a small length of round steel bar 0.010 inch smaller than the size required and bored the hole until the bar was a close fit. Removing the final 0.010 inch from the diameter was made easy using the DRO fitted to my lathe. Some time ago I fitted the M DRO kit to my lathe with the magnetic strip fitted into a slot that I made in the underside of the cross slide. Every time that I work with my lathe, I am so pleased that I fitted it. With the cross slide adjusted properly and a sharp tool, it is easy to take off portions of a thousandth of an inch with great control.

The clean end of the 0.625 inch bar was used as a test piece and boring stopped when a close fit was obtained. I had already made the eccentric sheaves, so it was a delight to find that when the casting was removed from the chuck the pieces fitted together perfectly (**photo 5**). With difficult castings, a lot of forethought and a little ingenuity can make short work of the job.

ME

Finished strap.

The Stationary Steam Engine PART 6

Ron Fitzgerald takes a look at the history and development of the stationary steam engine.

Continued from p. 378
M.E. 4633, 28 February 2020

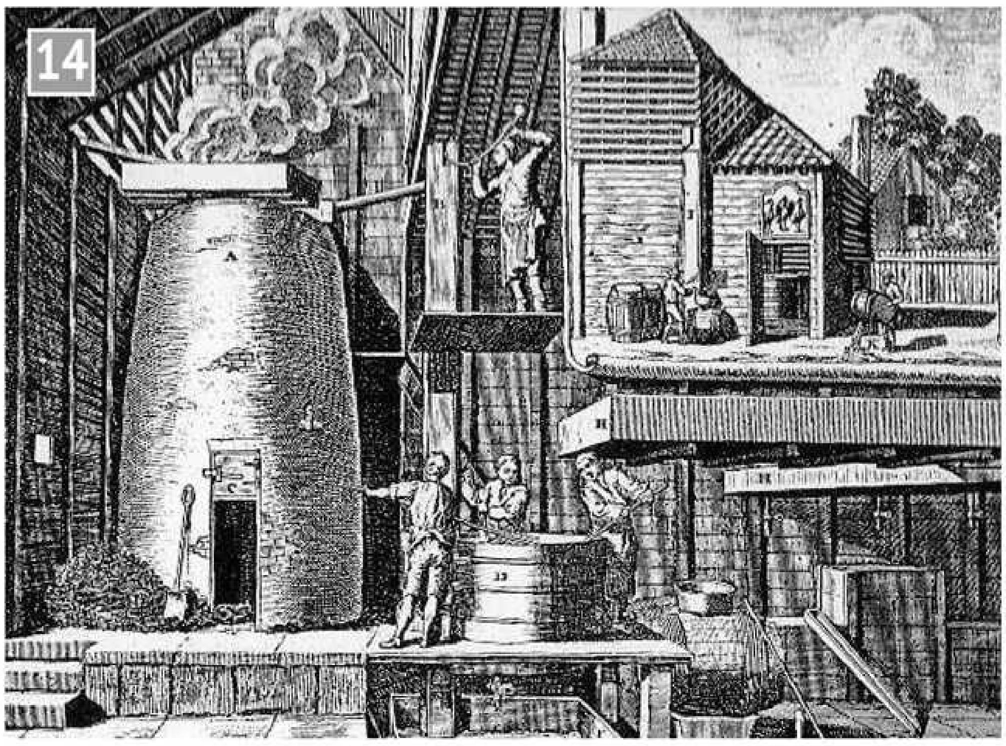
The technical development of the Newcomen engine

The first Newcomen engines displayed a degree of mechanical maturity that has often caused incredulity that Newcomen and Calley should have arrived at this level of sophistication in the very earliest phase of the engine's lifespan. Notwithstanding the fact that substantial elements of the engine embodied established elements of the water-powered colliery pump, the machine was radical in introducing an entirely new theme - engineering in metal on a large scale. It is difficult to think of any comparable mechanism at this early period.

Parts of the engine were common to both the Savery and the Newcomen engine, particularly the boiler. The boiler shown in Barney's engraving is virtually identical to that in Savery's *Miner's Friend* of 1702. A cylindrical brick casing encloses the tank boiler which Barney describes as

...The Boyler 5 Feet 6 Inches Diameter, 6 Feet 1 Inch high the Cylindrical part 4 Feet 4 Inches, Content near 13 Hogsheads...

The cylindrical steam vessel has a shallow domed lid and faint dotted lines shown in the engraving seem to suggest that it had parallel sides but the quotation above gives the impression that the vessel had two diameters, possibly a cylindrical lower drum with a dome of larger diameter. The drawing carries a scale but the measured distance between the dotted lines does not conform to either of the two dimensions.



The brewer's copper.

This form of boiler construction almost certainly reflects its origins, the common brewhouse copper which Savery and Newcomen adopted in both form and material of construction. In the Seventeenth Century the brewery boiler or copper had evolved as the industry became increasingly industrialised, particularly in London. The domed roof of the Newcomen engine boiler was an innovation as the brewhouse copper was open-topped. Soldered lead sheets formed the dome with a flanged joint where it met the copper drum.

Triewald's view of these earliest boilers was not favourable:

...the false principles concerning the steam which the inventors harboured in their minds according to which the steam... is generated by the boiling water in proportion to the quantity of water in the boiler. In consequence their boilers were made very high as demonstrated by the Stafford engine, the boiler of which is higher than its width. It is thus evident that the inventors do not know that the boiler must be given a suitable shape. Neither did they know that the flames should be allowed to play all around the side of the boiler as well as on the bottom...

Triewald seems to overlook the fact that a brewhouse copper (**photo 14**) was intended to provide hot water in large quantities, not to raise steam, hence the greater ratio of volume to heating surface.

Newcomen's boiler seems to have rapidly become more functionally adapted to raising steam. The shape changed from straight-sided cylinder to a taper with a narrower base at fire level expanding to a larger diameter at the waist where it merged with the domed top. The tapered sides provided an increased combustion space between the parallel walls of the fire brick casing, greatly improving the hot gas circulation. The shallow segmental profile of the lid evolved into a hemisphere, providing greater volume for steam disengagement.

The most important improvement in boiler construction was the introduction of wrought iron plates. Such plates had been used as early as 1717 but Desaguliers credited Stonier Parrott with the first use of iron plates riveted together. In Parrott's boiler, iron replaced copper for the lower part but lead was retained for the domed top. The Stevenston Colliery boiler in Ayrshire built in 1725 was of this type of construction although it is not clear whether Parrott was involved. The break-down of cost at Stevenston was:

To the plumber's bill for lead and lead top for the boyler, with sheet lead and lead pipe
£78. 10. 6.
To plates and revet iron for making the boyler
£75. 10. 0.
To six Swedish plates
£6. 3. 0.

The iron boiler cost about 20% of the price of a copper boiler but the spread of iron was retarded by the difficulty in obtaining satisfactory iron plates. Rolling mills were capable of producing only bar and rod iron, and plate rolling did not develop until later in the century. Prior to the plate rolling mill, flat sections were produced under the tilt hammer; the resulting plates were small in size and variable in thickness with thin edges and thicker centre sections. By mid-century Coalbrookdale was forging engine plates at a plating forge specifically for boiler making but it was not until 1790 that boiler plates about 4 feet by 8 inches by ½ inch were rolled by the company at their Horsehay works. Although it was maintained that nowhere else in Shropshire were such plates rolled, plates of 18 inches width were being produced in Sheffield and at Kirkstall Forge in Leeds (**ref 38**) by 1780. Narrow plates were not necessarily a disadvantage as long as boilers were largely spherical in shape.

Like the boiler, the steam cylinder of the Newcomen engine had a precedent for it was effectively a reciprocating pump working to a reversed cycle. As previously discussed, pump technology advanced throughout the seventeenth century to the extent that brass cylinders and pistons were commonplace by Newcomen and Calley's time. The term brass was invariably used in describing both pumps and engine cylinders but to Barney and his contemporaries brass was a material that is closer to today's bronze, an alloy of copper and tin in the ratio of 9:1 with less than 1% lead and zinc. This was the bronze used in cannon founding. Bell founding bronze had a higher tin content whilst the alloy of copper and zinc which is the modern brass was formerly called latten.

Recent discussion (**ref 39**) concerning the manufacture of Newcomen engine cylinders has focused upon the bell foundry of Richard Sanders of Bromsgrove as the source of castings for the Tipton engine but the argument is circumstantial rather than supported by direct evidence. Whilst the techniques of bell founding lent themselves to cylinder production, the central technique, loam moulding, was widely used in other kinds of ferrous and non-ferrous foundries, particularly the pump makers of Birmingham and London.

The cylinder of the engine shown in Barney's engraving had a diameter of 21 inches and was 7 feet 10 inches high. The Austhorpe engine was said to have a cylinder 23 inches in diameter with a six foot working stroke and the Griff colliery engine cylinder as described by Desaguliers was 22 inches in diameter (**ref 40**). Thereafter the usual diameter ranged up to 33 inches but Newcomen was reluctant to advance beyond this as he felt

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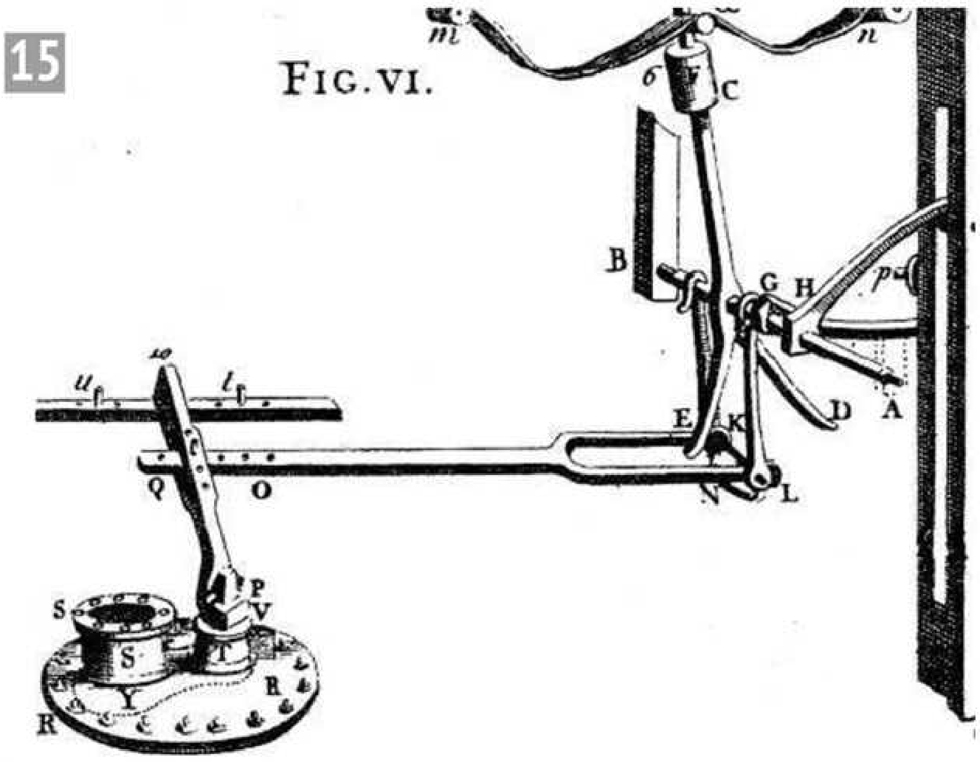

The steam admission valve.

that the boiler would be unable to supply sufficient steam if the limit was exceeded. It was also the case that that the cost of bronze cylinders increased disproportionately with size - a 29 inch cylinder in 1727 cost £250 and this became the most persuasive argument for iron cylinders although it did not convince Desaguliers, who remained opposed to iron cylinders as late as 1744 (**ref 41**). He felt that the thicker walls needed in casting an iron cylinder slowed the condensing part of the steam cycle and thus reduced the number of strokes per minute.

Cast iron cylinders are recorded 1718 and 1719 (**ref 42**) but the most important development in stimulating the introduction of iron came around 1722 when the Coalbrookdale Company began to cast cylinders in iron (**ref 43**) along with pump barrels and riser pipes. Until the seventeen-sixties, Coalbrookdale established an effective monopoly in the supply of cast iron cylinders and their surviving account books are a barometer of the spread of the Newcomen engine.

The part of the Newcomen engine that called forth the greatest inventive energy was the valve gear. Effectively there were two valve operations: the control of the steam admission to the cylinder and the control of the water injection to condense the steam. Both of these had to be synchronised with the appropriate position of the piston within the cylinder. It has been suggested that the Savery engine had some kind of mechanism for the semi-automatic actuation of its steam admission valve and Newcomen certainly seems to have arrived at a satisfactory steam valve operating mechanism by the end of the experimental phase of his engine (**photo 15**). Newcomen's steam admission valve was similar to the valve used by Savery - an oscillating sector plate (Y – lower left, under the plate) which covered and uncovered the mouth of the pipe communicating between the boiler and the cylinder (S). The spindle which rotated the valve plate passed through a packed gland and was squared at the upper end to socket into a wrench bar (P, V).

In the Newcomen engine a link motion actuated the wrench bar. The wrench bar was moved between the open and closed position by a connecting rod (Q, O) with a pitchfork end. The tips of pitchfork legs were connected by a link bar (K) and each leg was suspended by a freely swinging pendulum lever hooked over a cross bar (A, B) at their upper ends. The same cross bar carried a vertical inverted ***Y*** bar (C, E, D), the legs of which (E, D) were located between the legs of the pitchfork bar and on either side of the linkbar (K). This inverted ***Y*** bar had as its fixed axis the cross bar and as the cross bar oscillated through an arc on either side of the vertical centreline so the inverted ***Y*** bar swung through the same arc. With each oscillation the tips of inverted ***Y*** bar (E, D) drove the crossbar connecting the pitchfork legs alternately to the left and right and the resulting horizontal reciprocation of the pitchfork bar swung the wrench through its arc, opening and closing the steam valve. A weight attached to the top of the inverted ***Y*** assisted the swinging motion but leather straps limited the length of the arc.

The ultimate source of the valve gear's motion was a vertical timber pole known as the plug rod which was suspended from an arch head on the main beam. As the beam rocked the plug rod was raised and lowered. Trips or tappets fixed to the bar adjacent to the valve gear caught the tips of two splayed arms rotating them around a common axis, the crossbar (A, B), to which they were rigidly fixed. This gave to the cross bar the semi-rotation that was passed as reciprocating motion through the rest of the link system to the valve spindle. Barney's engraving differs little from the admission valves shown in illustrations twenty years later but his description is sufficiently picturesque to warrant quoting:

12. The Sliding Beam mov'd by the little Arch of the great Beam

13. Scoggan and his Mate who work Double to the Boy, Y is the Axis of him.

The steam admission valve gear was a workmanlike solution to the problem of mechanically activating the most important control valve. It called for some degree of precision on the part of the blacksmith in the making of its parts but it also included provision for regulation to secure optimum working. As a piece of design, it seems to have functioned well from the beginning and changed only marginally throughout the lifetime of the Newcomen engine. In contrast, the water injection control mechanism underwent a fundamental change in the principle of its operation between 1712 and 1730.

In 1929 Clarence Becker and Arthur Titley gave a paper to the Newcomen Society in which they tried to historically systematise the evolution of the water injection side of the valve mechanism using well-known engravings ranging from Beighton and Barney through Sutton Nichols, Switzer, Desaguliers and Belidor. From these engravings they prepared five schematic drawings to show the changes in injection valve gear design over a period of thirty years. Unfortunately, the article is confusingly written, the annotation is inconsistent between the drawings and obvious flaws make impractical the operation of some of the mechanisms shown. The following is an attempt to give an acceptable interpretation of the Becker and Titley analysis using the drawings from the article with common annotation.

The part of the Newcomen engine that called forth the greatest inventive energy was the valve gear.

Becker and Titley take the earliest version of the injection gear to be that shown by Barney. The key to the operation of the link gear is the open-ended tube inserted into the boiler through the domed top. This is marked B in the following drawings. The tube contained a floating buoy and the buoy had a vertical spindle which emerged from the external open end and was continued upwards. In the Barney engraving the tube is thus described:

...The Pipe which contains a Buoy, 4 inches Diameter...

Barney's engraving (**photo 16**) shows the pipe within the boiler continuing down not only through steam space but also for almost the full depth of the water in the boiler suggesting that that the buoy moved under the influence of hydraulic pressure rather than directly by steam pressure. Closing the steam inlet valve to the cylinder would allow the pressure to rise in the boiler and this steam pressure acting on the surface of the water would cause it to rise in the pipe, floating the buoy upwards. As the buoy rose within the tube, the vertical rod attached to it was also raised and, through a pin, made contact with the end of a small lever. Pushed upwards by the pin, the lever rotated about a fulcrum at the opposite end.

From the rising end of the lever a cord was suspended and this cord raised the end of a latch lever. The latch lever restrained another larger weighted lever, the ***F*** lever, in its upper position. As the cord raised the latch lever the catch on its underside released the ***F*** lever which fell under the influence of its weight and the short arm of the ***F*** turned the injection water valve (C) spindle opening the injection water flow into the cylinder, initiating condensation and the formation of the vacuum.

The developing vacuum in the cylinder allowed the pressure of the atmosphere to drive the piston through its downstroke. As the end of the rocking beam above the cylinder descended so the plug rod came down and a tappet attached to the side of the rod (E) caught the upper side of the long extension of the ***F*** lever depressing it, closing the water valve and raising the opposite end until it reattained its locking position. At the same time, the reduced boiler pressure had lowered the water level in the vertical buoy pipe

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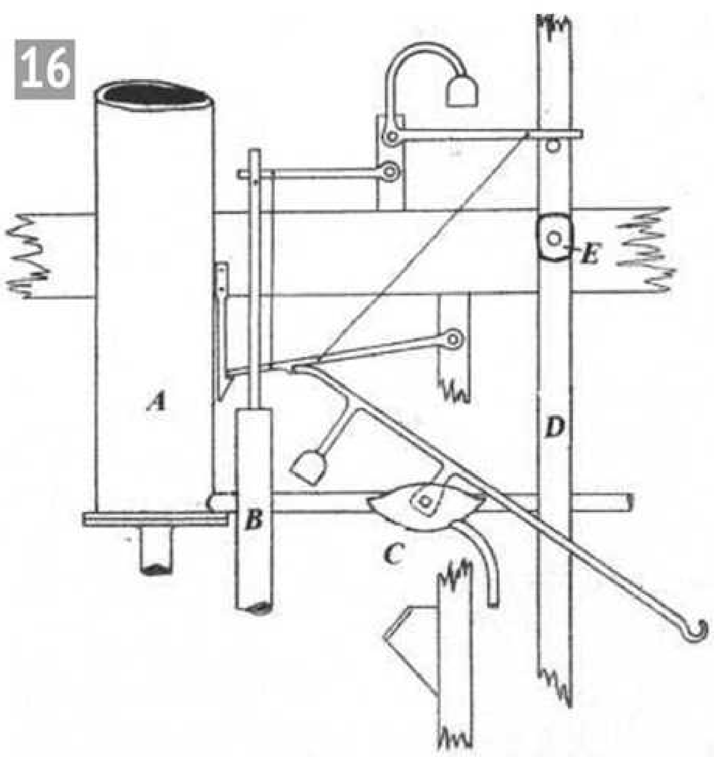

Barney's Engraving, the Dudley Castle Engine, 1712. Amended from Becker and Titley, T.N.S. Vol. X. 1929.

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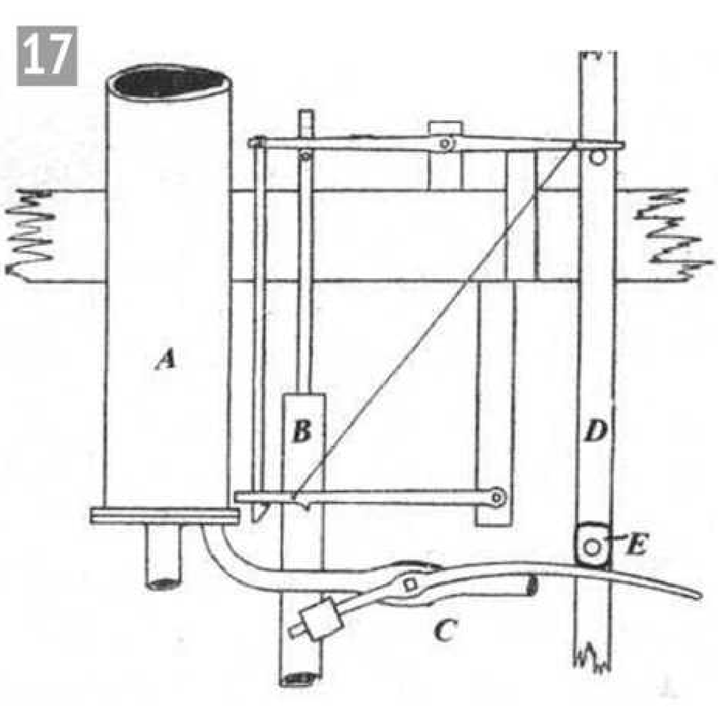


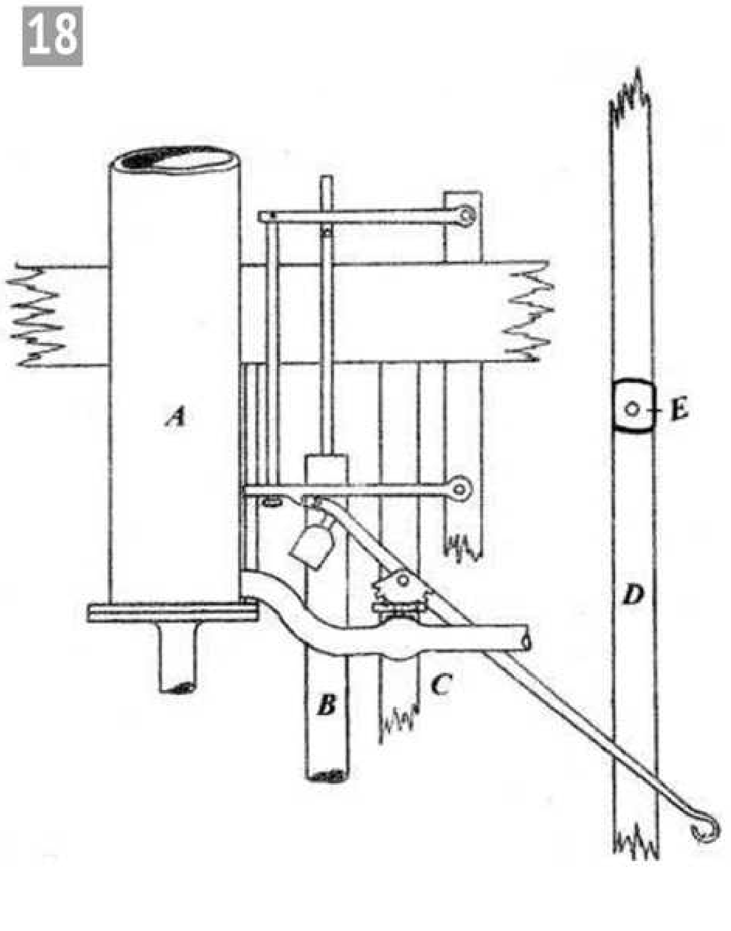
Beighton's Engraving of 1717 suggested by Becker and Titley to be the Griff engine. Source: Becker and Titley, T.N.S. Vol. X. 1929.

allowing the buoy to sink to its previous level and the catch lever to drop towards its lowered position. The locking position was re-established with the ***F*** lever raised. Barney shows a handle forged onto the outer end of the ***F*** lever which permitted the operator to manually control the engine as necessary. This handle has been misrepresented by Becker and Titley as a hook.

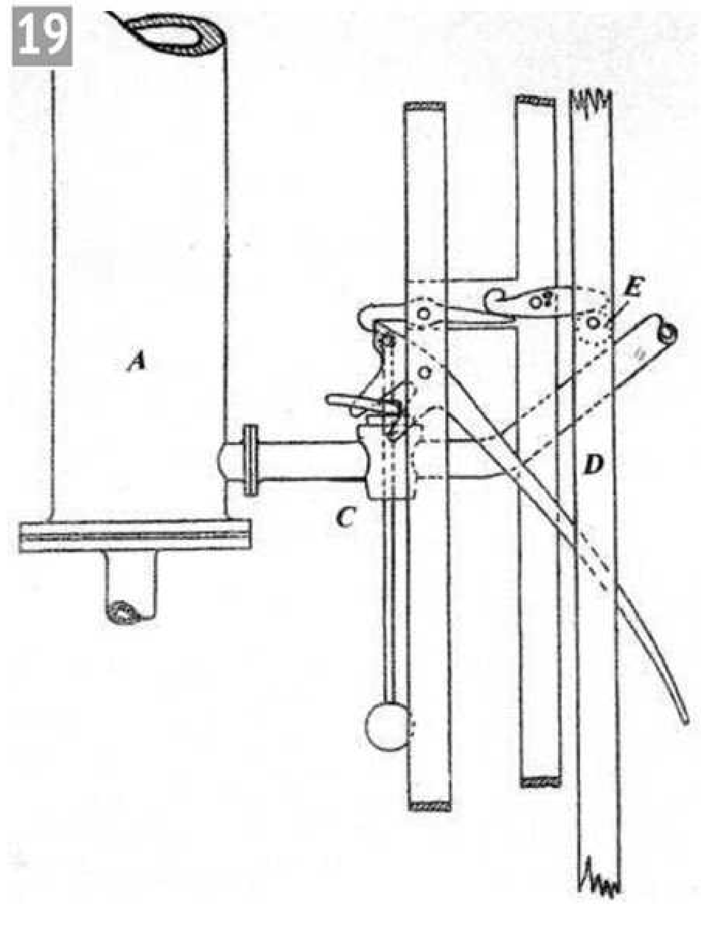
Becker and Titley's drawing contains several unexplained features, most obviously a second weighted ***L*** shaped lever is shown above the latch lever. A cord passes from this to the latch lever and the long limb of this ***L*** lever is in contact with a tappet on the plug rod. As the plug rod is shown in its raised position this tappet can be expected to fall away from the end of the ***L*** lever leaving it free to rotate in a clockwise direction with the effect of slackening the cord and leaving it without obvious purpose.

There are also problems with Becker and Titley's second drawing (**photo 17**) which is based upon Beighton's engraving, suggested by the authors to represent the Griff engine of 1714. Whilst the function of buoy is similar to that of the Barney engraving the linking cord to the latch lever has now been replaced by a solid rod that makes up the upper bar of a parallelogram. The 'redundant' lever and cord remains unexplained. The injection valve operating lever has now been simplified to a curved bar without ***F*** limbs. Somewhat unhelpfully, in understanding the sequence of operation, the lever is shown in the dropped position and the distance between the two tappets is quite different.

The later Sutton Nichols drawing (**photo 18**) is more plausible in its details. All of the cords have now been replaced by solid bars which form a parallelogram. The 'redundant' part of the mechanism has disappeared and a pair of geared quadrant plates turns the injection valve between the open and closed positions rather than the lower arm of the ***F*** lever.



Sutton Nichols Engraving, 1725. Source: Becker and Titley, T.N.S. Vol. X. 1929.



Switzer's Engraving, 1729. Source: Becker and Titley, T.N.S. Vol. X. 1929.

The final drawing, Switzer of 1729 (**photo 19**), shows that the buoy tube and its linkage system have been dispensed with entirely. Switzer resurrects the ***F*** lever in a less attenuated form but the trip system is now solely actuated by a single tappet on the plug rod. This tappet serves both to depress the tail of the ***F*** lever raising it into engagement with the latch on the down stroke and trips the release pivot bars to disengage the latch on the upstroke. Weights attached to the levers continue to assist the return action.

Allen believes that the elimination of the flotation valve was due to improved boiler performance (**ref 44**). He reasons that the origin of the flotation operated device lay in the fluctuation of boiler pressure that occurred with each working stroke, arguing that the weight of the outdoor end of the beam would draw the piston up the cylinder more rapidly than the boiler could supply steam to the cylinder. The result would be a fall in pressure. The pause between strokes to allow the boiler to recover was secured by the delaying action of buoy and riser pipe. Improved boiler performance made the pause to recoup pressure unnecessary with the added bonus of raising the number of strokes per minute.

If Beighton was responsible for the first improvement in valve gear design and that this change occurred as early as the Griff engine which was built in 1714, as suggested by Rana (**ref 45**), then the improvement in boiler performance must have begun somewhat earlier than Allen proposes although Rana recognises the ambiguity in the Beighton drawing which seems to retain the buoy tube and its mechanism unnecessarily.

●To be continued.

NEXT TIME

William Brown and John Smeaton enter the picture.

REFERENCES

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39. *Bromsgrove and the Newcomen Engine,* J. S. Allen, T.N.S. Vol. 43 1970/1. p. 183 et seq. *The First and Third Engines,* James Greener, T.N.S. Vol 88, No. 1. 2018. p. 80 et seq.
40. *A Course of Experimental Philosophy,* J. T. Desaguliers, 2nd edition, Vol. II, 1743, pp. 468, 470 and 482.
41. *A Course of Experimental Philosophy,* Ibid., p. 536.
42. A cast iron cylinder was offered for the Farnacres engine on Tyneside in 1717 but whether it was cast in London is not stated. An 18 inches diameter iron cylinder was used in the following year for the Stevenston Colliery engine in Ayrshire.
43. *Dynasty of Ironfounders: The Darbys and Coalbrookdale,* Arthur Raistrick, Pub. Longmans, Green & Co. 1953. p. 129.
44. *The Steam Engines of Thomas Newcomen,* Rolt and Allen op. cit. p. 94.
45. *Henry Beighton, The Key to Unlocking the Early History of the Newcomen Engine,* Suhail Rana, T.N.S. Vol 87, 2017 No. 2 P.259 et seq.

Obituary Rodney Oldfield

Rodney Oldfield, who has died at the age of 80, had been a member of Bradford Model Engineering Society for some years. He was born near Huddersfield, West Yorkshire, and after leaving school at 15 he began an engineering apprenticeship at Broadbent Machine Tools. During that time, he studied at Halifax Technical College where he gained a City of Guilds Certificate in Engineering. He then worked in the maintenance department of Humpray Carpets until the firm closed down. Until retirement, Rodney then worked at Cengar Universal Tools in Halifax. He considered himself very lucky that he had always had a job, in an occupation which he loved.

Although always a practical man at home, Rodney did not take up model engineering until he retired, when he converted half of an enlarged garage into a well-equipped workshop. He said, "Every man should have a Wendy House!" His first model was a large traction engine which was later sold; however, he then built a more manageable 1 inch scale model of the same engine which the family still own. While exploring the untidy workshop of a local blacksmith, Rodney discovered a very dilapidated Tangye engine which had once powered the machines. Together with another Bradford member, he renovated this to a high standard.

Rodney's passion turned to stationary engines, especially those designed by Bob Middleton. He constructed and subsequently wrote up the construction of several of these for *Model Engineer*; one of these is appearing in current editions of the magazine. He was an inspiration to many model engineers.

In September 2018, Rodney fell from a ladder while picking apples, and suffered multiple injuries including a transected spinal cord which left him paralysed downwards from the upper chest. That ended his model engineering and other interests but his inspiration to many continues. At the service to celebrate his life, in the local Methodist church in Sowerby Bridge, there were over 300 family, friends, Scouts, Morris Dancers, Rush Bearers and model engineers. Rodney leaves behind his wife Sue, son Robert, daughter Ruth and two grandsons. He will be sorely missed.

Jim Jennings
President, Bradford MES

SHOWCASE Paul's Engine

One day my son Paul came to me and asked if we could make something in my workshop, so that he could learn engineering processes. After consideration I came up with a version of a 'desk top toy'; the reason for this choice, strange for a beginner, will be revealed later.

The photograph shows the result in the form of a vertical factory steam engine in an 'A' frame, and with a drive in the base and a secret switch is made to rotate slowly and majestically.

My son learned sheet metal cutting, trimming, drilling, and filing to fit when making the frame, which was made from standard brass sections and sheet metal. The crankshaft bearings were turned and soldered in. The crankshaft built up, flywheel rim turned from two surplus plumbers nuts, the spokes cut from the solid using the rotary table on the miller. Cylinder and crosshead built up from simple parts.

The drive to the crankshaft is via a ball chain (as used on a washbasin plug) via sprockets in the bearing housing and a geared 9V motor and battery in the base. After much cutting to fit, and trial and error, the model was completed.

Perhaps a little too advanced for a first-time model making exercise for young people but just right for my son, who is 50 years old, and has renamed his model an 'executive desk top toy'. This has given me many pleasant 'father and son' hours together in the workshop.

Patrick Williams

If you would like to see your model in the 'Showcase' please send a photograph and a brief description to the editor.

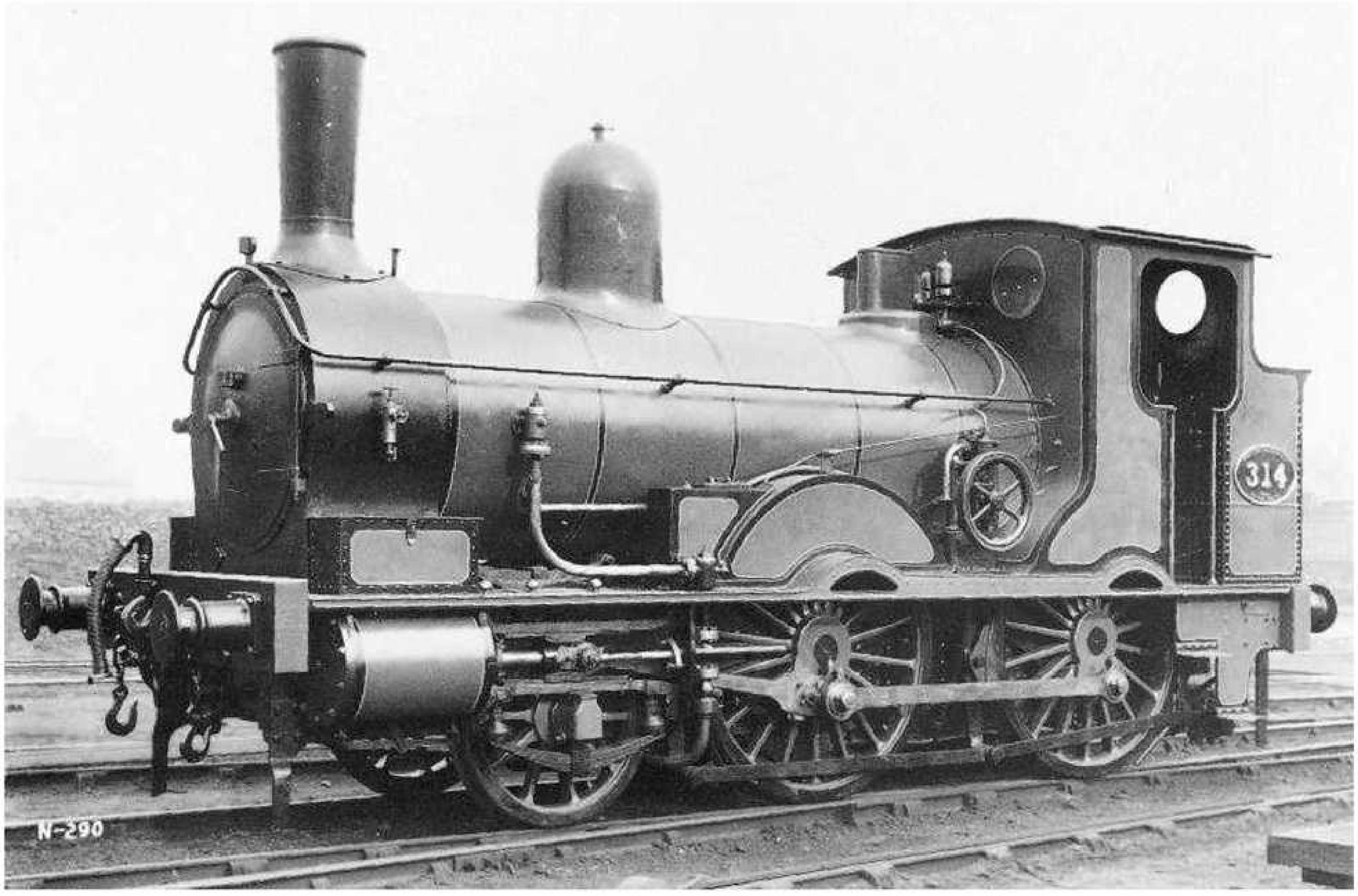
Wenford

PART 5

A 7¼ Inch Gauge 2-4-0 Beattie Well Tank

Hotspur catches up on the description of his Beattie well tank.

Continued from p. 387
M.E. 4633, 28 February 2020



Completing the well tank body

The stage has now been reached where the well tank body can be completed but beforehand there are some internal details to add. The bottom plate includes an angled section at the rear which will leave the tank partially open for a closing section to be added last - see **fig 5**.

So, cut out the bottom plate from 1/16 inch thick brass and put the bend in it to wrap around the corner. It is best if any sharp corners on the existing body sides are slightly radiused so the bend will nestle close to it rather than try to form a severe crease in the brass plate. Leave an external margin around the tank body for the silver soldering process as discussed for the bunker tank.

Before the plate is added to the body, a drain plug boss is required near the bend and three small brass or bronze blocks need to be added to the inside for the two water valve fixing bolts and the lower tank fastening position which engages with a bracket on the rear axle spring housing. These blocks are all 3/16 inch thick and are held in place with 1/16 inch copper rivets. Take care to ensure that the two blocks at the sides will allow the plate to fit onto the body. Add silver solder to all three and, should there be any distortion of the plate as the heat relieves the stress after the bending operation, it can be readily straightened at this stage.

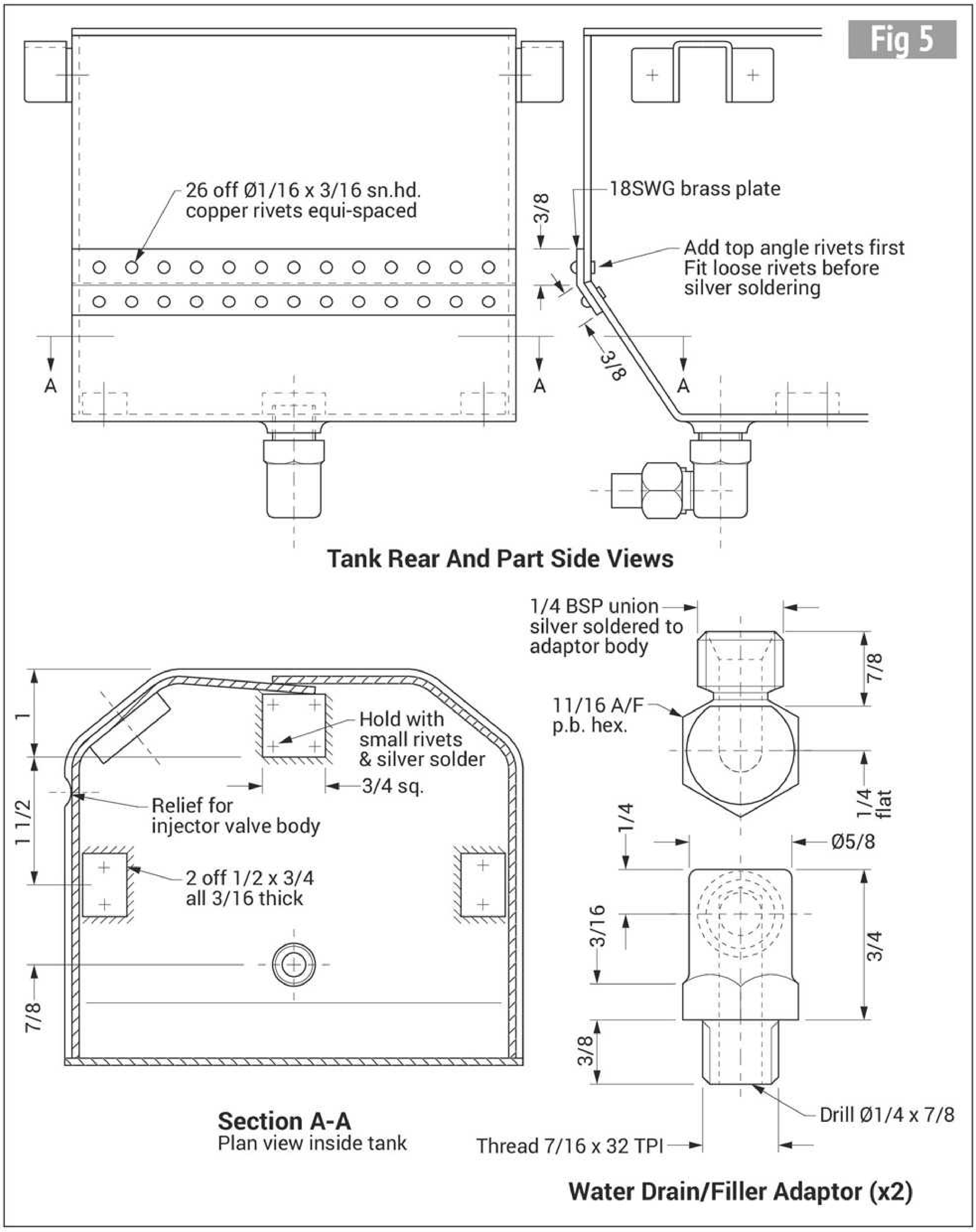
Silver soldering the plate to the tank body required a weight on top and the edge to be soldered placed to overlap the firebrick so the flame could play on the underside.

29

This is a repeat set-up showing how the bottom plate of the well tank was soldered. Note the wide ledge as an overlap for the soldering operation. The ledge was then filed back to be about 1/16 inch wide.

My photographs show the result - see **photos 29** and **30**. After a good clean up the tank edges were filed back to give a minimum ledge, especially at the front against the securing bracket.

Another view of the bottom plate from underneath showing the three sets of copper rivets that hold the internal mounting blocks for the two water valves (each side) and the front securing bolt for a bracket behind the rear suspension casing. Note also that the plate was filed away to give clearance for the injector water valve position prior to the plate being soldered to the body.



The plate is attached to the body of the tank with joints made in the same way as the other seams but to replicate the prototype the angled edge has an external flanged strip riveted to it. I formed this flange from 18SWG brass and attached it to the new plate first to check the angle and in case there was any plate distortion. Then, the second row of rivet holes was drilled and cleaned up before soldering the panel in place with loose rivets pushed into place for the second row.

Photograph 31 shows the completed tank with the last section of plate and the angled strip in place and the same cleaning and trimming along the edges was carried out to complete it. It may be seen that this last plate has slightly bowed inwards, which will not affect its function and it is hidden behind the rear beam when installed in the chassis. I should probably have soldered the long side against the top plate first; instead I secured the two sides and these constrained the plate when the long seam was undertaken.

Adding an adaptor for an external water supply

Readers who have followed my notes may remember that I was going to add a flange to the rear of the well tank to be an auxiliary water feed from a driving truck supply. However, I have decided it would be awkward to get at and so I have added a fitting to the tank drain plug. So, I have converted the drain plug into a dual function. It means that the drain plug bush is tapped 7⁄16 inch x 32 as this will allow a ¼ inch hole through the fitting for a sensible water flow rate.

Take a short length of 11⁄16 inch phosphor bronze hex bar (say 1¼ inches long) and machine down ⅜ inch long for the 7⁄16 inch diameter shoulder for the thread then add the thread with a tailstock die holder. I have used a copper washer 3⁄64 inch thick for the seal and this did not need an undercut added to the thread. »

At the same time, drill into the bar with a ¼ inch drill to a depth of ⅞ inch.

Next, fit the threaded end into the drain plug in the tank to check where it will be sensibly tight on final assembly and mark the edge which will be facing to the rear. Reverse the bar in the chuck to hold it by about ¼ inch and carefully machine the diameter down to ⅝ inch. This is simply to reduce the bulk of the fitting and, in-line with the tightening point just determined, file a flat on the newly turned diameter so the land created will be about ⅝ inch wide. Find the centre of this flat and drill a ⅜ inch diameter hole into the centre to a depth of 5/16 inch. This is to take a stub of a standard ⅜ inch gas pipe union machined down to suit and silver soldered in place. **Photograph 32** shows the adaptor mounted under the tank.

●To be continued.

The final piece of 1/16 inch thick plate with its angled jointing lap strip in place. One edge of the strip was riveted and soldered first, then the plate was lined up and the second row of holes added and cleaned up. The plate was then silver soldered in place with loose rivets through the other half of the strip to ensure the rivets did not fall out.

The final assembly of the adaptor fitting in position on the tank. The pipe union can be blanked off with a machined brass pipe union added or just a fibre washer inside the union nut.

NEXT TIME
I will describe the rest of the tank fittings.

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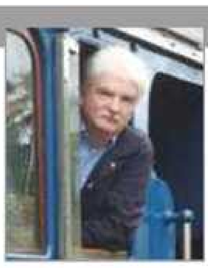
PART 8

Magdalen Road Revisited



Jeremy Buck invites us back for a further tour of the Magdalen Road garden railway.

Continued from p. 463
M.E. 4634, 13 March 2020

The tender and finishing off

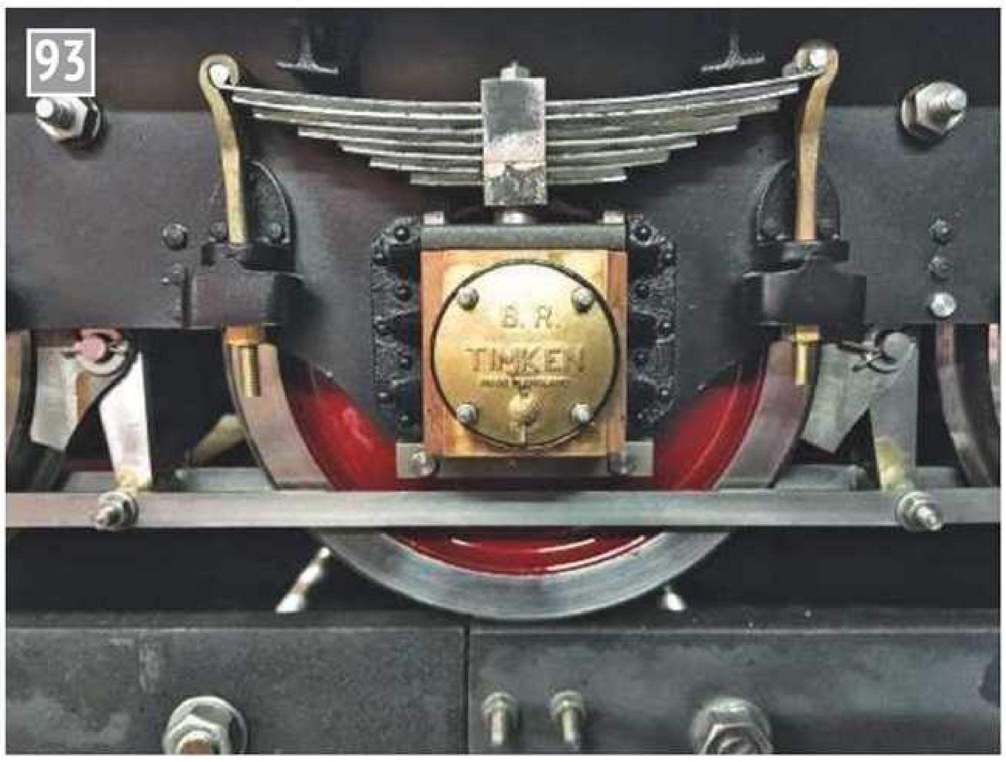
I sold the best part of the original kit. In comparison with the engine, the tender (**photo 91**) was well made and my only real criticism is that the leaf spring material - as on the locomotive - was unsuitable, the brake gear was rather flimsy and there was a lack of feed water control valves. All could have been easily rectified but it was a non-corridor tender and my chosen prototype was, throughout its life, paired with a corridor tender. Because the full size corridor tender is significantly wider than the non corridor version it would have been necessary to modify the original tank so I decided to build a corridor tender from scratch – well almost. The chassis is based on Don Young's drawings although with a number of simplifications in order to make construction easier. The corridor tender chassis is, in any case, slightly different to the non corridor tender version shown in Don's drawings. To make life as easy as possible I obtained laser cut frame and brake parts from Model Engineers Laser and the disc wheels were machined from steel by 17D Miniatures using a 3D CAD model generated by my son. I also made liberal use of lost wax castings by Doug Hewson and Cro Fittings.

In error, I riveted the hornblocks on at 1 inch spacing rather than the correct ¾ inch. Of course when the mistake was discovered it stood out like a sore thumb. What to do? 112 rivets had been closed! Fortunately the LNER fitted three corridor tenders with roller bearings, one each by Timken, Skefco and Hoffman and to accommodate these the hornblocks were more widely spaced so I could leave mine in their 'incorrect' positions with a clear conscience. My tender is modelled on the tender fitted with Timken bearings. Originally I intended to retain plain bearings but later decided to do the job properly and fit needle roller bearings. Happily, they are genuine Timken products (J-78) so the fitting of Timken marked axle box covers, from Cro Fittings, is (almost) entirely appropriate. A completed wheelset and constituent parts of an axle box are shown in **photo 92**; I should have filed the BR marking off the Timken covers but decided to live with this minor error rather than risk spoiling the covers as supplied. The needle rollers are grease lubricated and run directly on the axle journal which is unhardened; I judged this to be acceptable given the low loading.

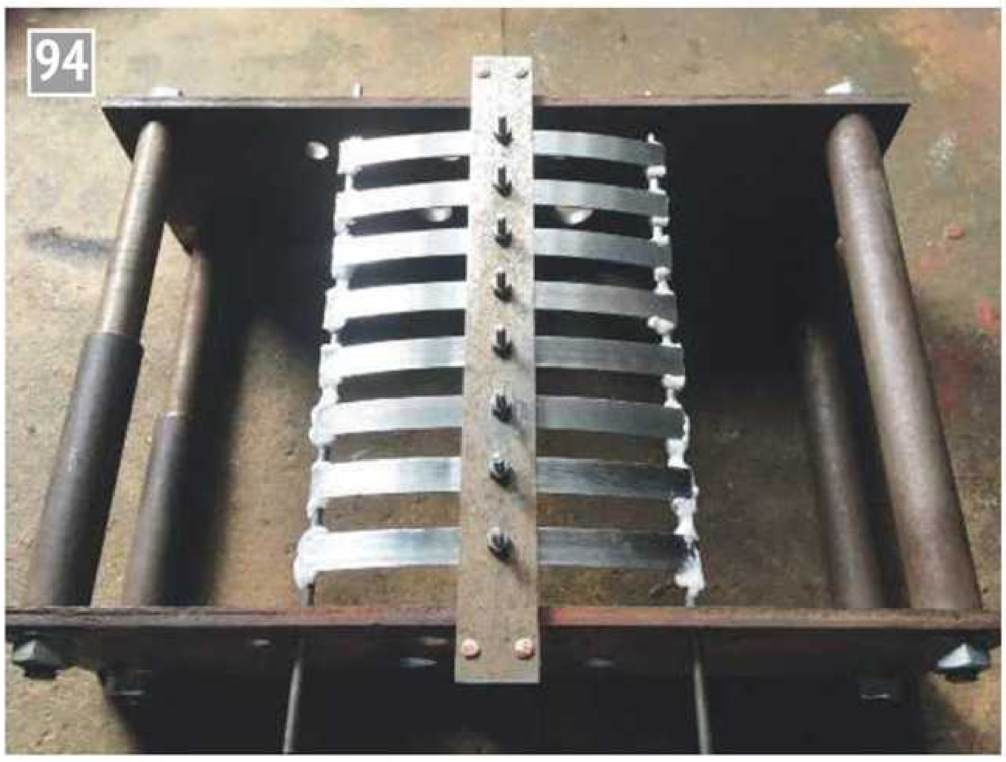
The leaf springs required a degree of trial and error. Initially I assembled them to the correct overall depth out of ⅜ inch x 22swg spring steel but unsurprisingly these proved to be far too stiff. The correct stiffness was obtained with about half the original number of steel leaves and hence half the correct

The original tender was not appropriate for my A4.

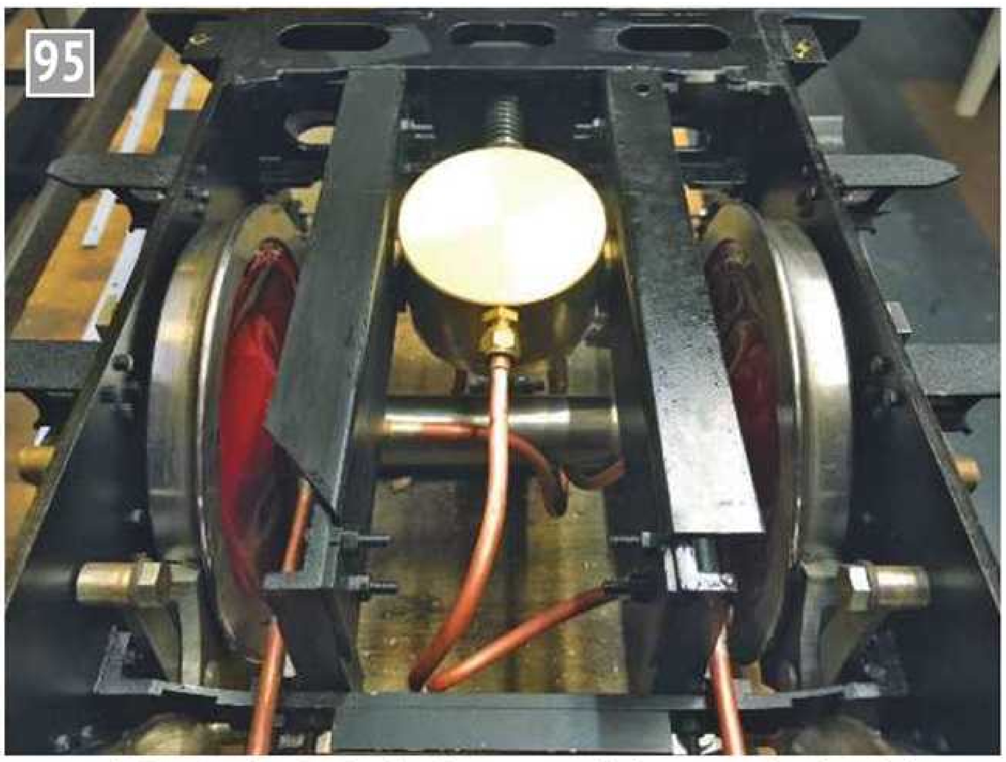
Tender wheelset showing axle box components.



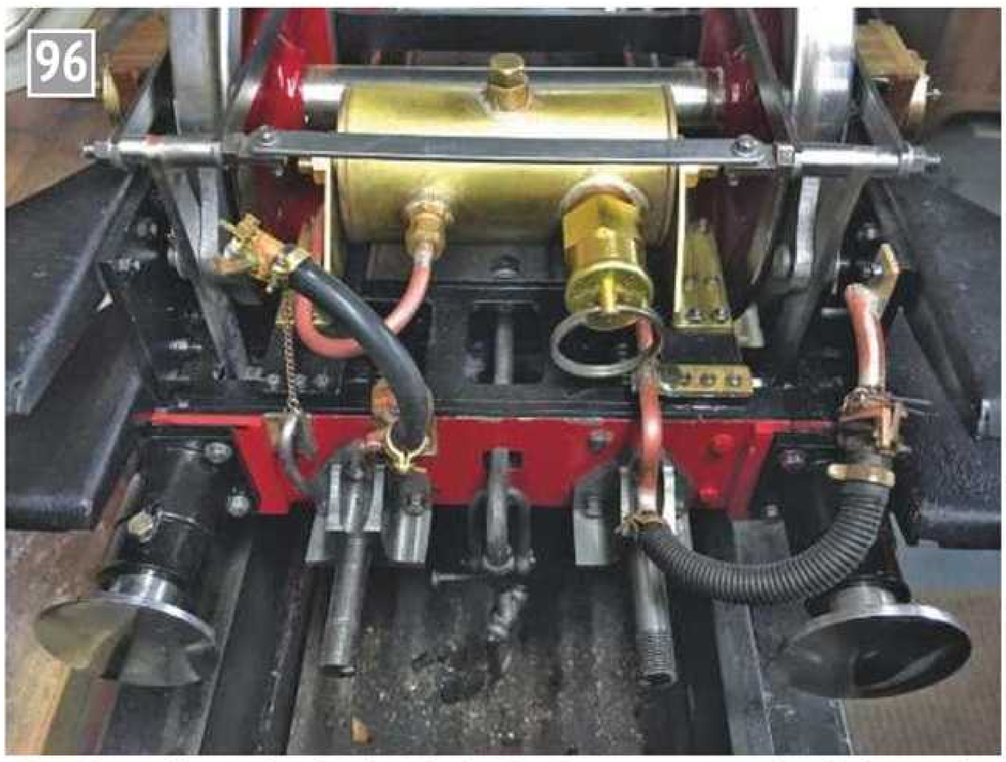
Tender axle box and leaf spring.



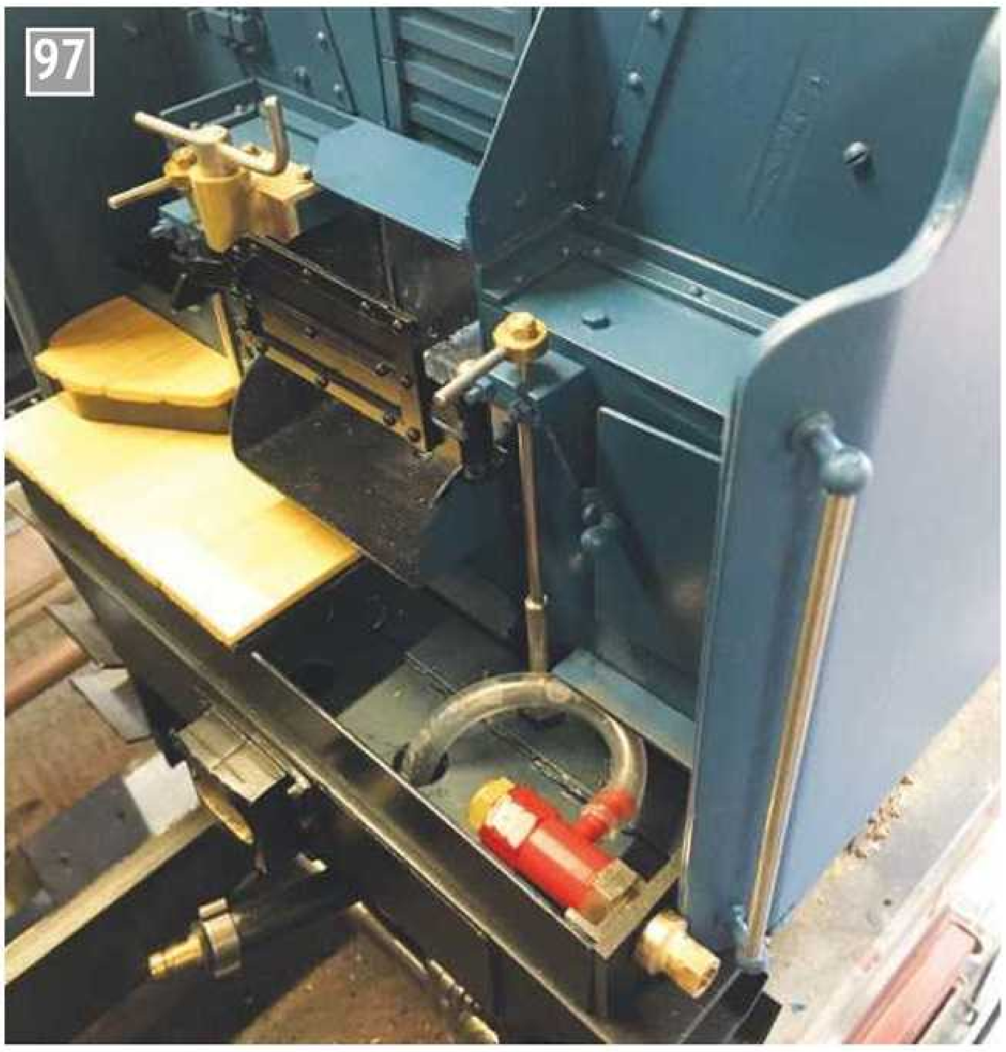
Silver soldering the upstands to the top leaves of the tender springs.



Front end of tender chassis showing the vacuum cylinder mounted on its sub-frame.



View of rear of inverted tender chassis showing the vacuum reservoir and release valve.



The vacuum limit valve is hidden but readily accessible for adjustment.

overall depth of the spring but this just did not look right. Searching around for a suitable 'gap filler' to bulk out the depth of the spring I hit upon the idea of rubber which has more than enough compressive strength to transfer the load from leaf to leaf, but zero flexural stiffness. I know that Tufnol leaves have been advocated by a number of distinguished designers over the years, but I was not persuaded that this was the right solution for me. The rubber leaves were cut from a bicycle wheel inner tube and each one is bonded to the steel leaf below using contact adhesive. The result is, to my eyes, satisfactory (**photo 93**). I claim no originality for the idea. After much head scratching I adapted my wheel quartering jig to enable the upstands to be accurately silver soldered to the ends of the top leaves (**photo 94**).

A single rolling ring vacuum brake cylinder of identical design to that on the locomotive is provided, again made by my son. Don Young's drawing copies the prototype in that it shows two vacuum brake cylinders supported off the base of the tank; I considered this to be impracticable in the model and fabricated a simple sub-frame supported off the drag box and the first intermediate stretcher (**photo 95**). A vacuum reservoir incorporating a vacuum release valve is installed at the rear end (**photo 96**). As noted earlier, the vacuum limit valve is connected to the train pipe on the tender. Finding a suitable berth for this proved to be a bit of a head scratcher, but I finally settled on a location under the footplating in front of the nearside locker (**photo 97**). In this position it is inconspicuous yet readily accessible for adjustment, if necessary, from the side of the tender. Unlike the equivalent installation on the locomotive, the trainpipe extends to the vacuum connection on the buffer beam. One day, I might install vacuum brakes on the driving truck.

I was fortunate in obtaining an LNER 8 wheel tender (**photo 98**) which, although far from acceptable for use 'as received' yielded a tank that was very close to the correct overall dimensions and a chassis for a useful wagon (**photo 99**). It was necessary to make a new soleplate in order to accommodate splashers for the wheels and this incorporates a well tank, separated from the main tank by an inaccessible but generously sized filter (**photo 100**). Should the filter ever need to be cleaned, it can be done by backflushing through one or both feed pipes. These feed from the back of the well tank (**photo 101**) in order to clear the vacuum brake cylinder framing. Although I have seen it suggested that the reliability of injectors renders a hand pump superfluous, I believe a pump is very useful for filling the boiler from empty and, accordingly, one is provided.

I reconfigured the coal space to include the corridor and self trimming sides and fitted new front and rear plates, the latter with corridor vestibule. The doors at front and rear of the corridor open and close, although the corridor is not actually continuous and I have tried to replicate full size details as accurately as possible. All new joints were made with rivets and set screws as my previous experience gave me no confidence that I could soft solder the joints without getting excessive distortion. This time I used Fernox LS-X to seal the joints and this has proved to be entirely satisfactory. To further reduce the risk of leakage of the tank, due to flexure in service, it is mounted on thin rubber pads at each of the bolted connections to the chassis. The front plate incorporates a removeable section as with the re-furbished A3, but with much closer fidelity to the prototype, amd is fitted with a coal gate and door for access to the bunker from the cab (**photo 102**).

Although I had obtained an LNER GA drawing for the corridor tender, this gave scant information on the vestibule and other details of the corridor connection, including the associated Buckeye coupler. However, on a visit to the Search Engine at the National Railway Museum, my son and I obtained most of the additional information required from Pullman Car Company drawings. My son developed 3D models of the drop-head Buckeye coupler and vestibule buffer as an aid to their manufacture. The vestibule buffer was manufactured in sintered stainless steel with a bronze filler using a 3D printing process and is connected to the buffer beam by coil sprung pistons (**photo 103**). Bolted to the vestibule buffer is the vestibule face plate which is connected to the tank back by two pistons and a single laminated spring (**photos 104** and **105**). The vestibule bellows and cover sheet are of canvas. At the time of writing, the Buckeye coupler is still in the development stage and the tender is therefore adorned

The tank on this very basic tender was used as a basis for the new corridor tender.

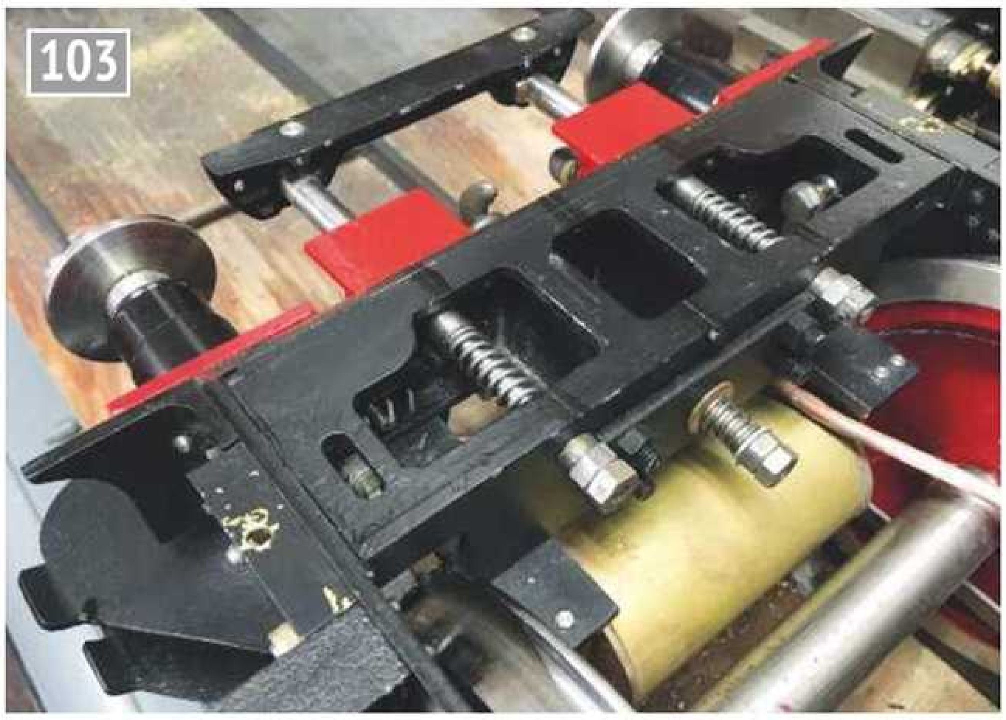
The original chassis was modified to create a very useful flat wagon.

The new tender soleplate showing splashers, filter and hand pump.

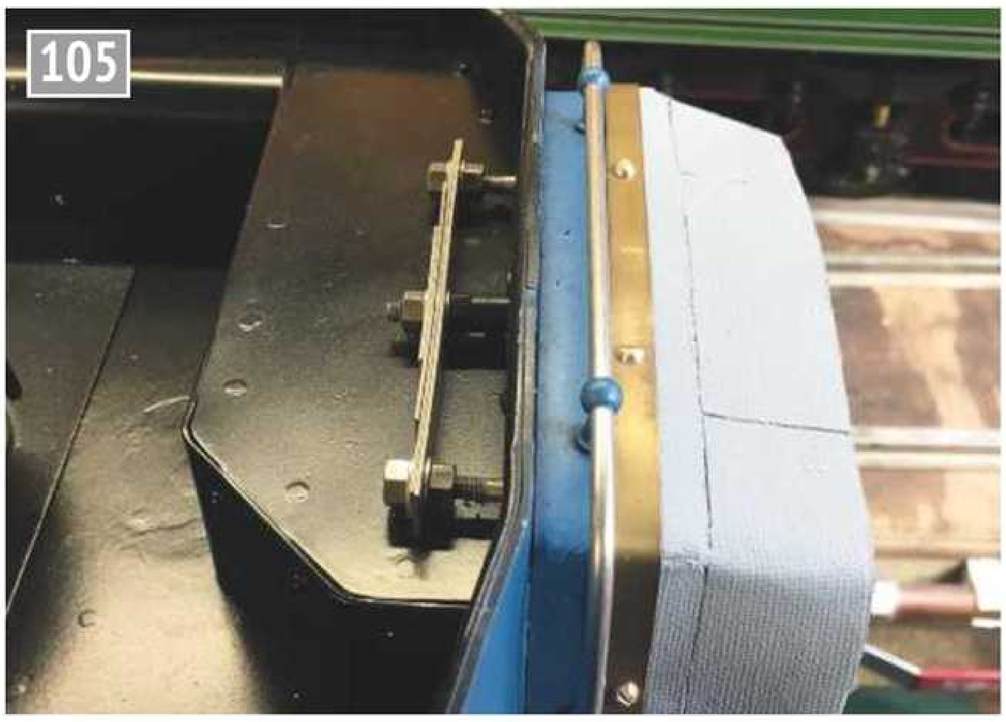
No. 4497: The tender soleplate from below showing the well tank and the gravity and hand pump feed pipes. The hand pump draws water from the main tank, not the well.

Tender front plate. Compare with photo 98.

»



Tender chassis rear view showing vestibule buffer and associated springing.



Top of tender tank showing leaf spring to top of vestibule face plate.

Tender rear view showing corridor vestibule. The Buckeye coupler has yet to be fitted.

with a conventional screw link coupling. When completed and installed, I hope that my son will pen a short article on its design and manufacture.

I had found the process of painting and lining the A3 rather trying, mainly - but not solely - because I had decided not to strip the locomotive down - any more than absolutely necessary - to its component parts. Of the 'big four' company liveries, the LNER lined apple green livery is probably the most complex and I was not enthusiastic about having to do anything like that again. Fortunately, the garter blue livery of the A4 is, with the exception of unlined black, about as simple as it gets, the only lining being red and white lines separating the blue boiler casing from the black smokebox casing. But the dust problem that I had fought when painting the A3 would remain unless I could find a quicker drying paint. I am ashamed to say that the rigour described in Chris Vine's book, *How (Not) to Paint a Locomotive* was not for me. Spraying with automotive paint or similar seemed to offer a solution that would also give a better finish. The problem was sourcing aerosol cans of garter blue paint. I eventually located a supplier of aerosol cans of Pargas blue, a colour used by VW and Audi several years ago and which is a very good match to garter blue. Aerosol cans of black by Humbrol were readily available so the A4 has been almost entirely spray painted, starting with U-Pol acid etch primer (where appropriate) followed by Halfords grey primer prior to application of the blue and the black top coats and completed with a final coat of satin finish enamel varnish. The wheels and some small fittings were brush painted. I am very pleased with the result (**photos 106** and **107**).

Admirer as I am of the great man, I think that the entirely merited naming of the 100th Gresley Pacific after its designer set an unfortunate precedent for the uninspired later renamings after LNER dignitaries and an Allied Forces Commander in Chief, of several other members of the A4 class. In any event, the length of the Sir Nigel Gresley nameplates that came with the engine required them to bridge a vertical joint in the streamlined casing which would have made dismantling difficult if the fixings were to be hidden. I therefore chose to give the locomotive the identity of No 4497 *Golden Plover*, which happens to be the only A4 that I rode behind (from Edinburgh Waverley to North Queensferry) in BR days. In more recent times I have ridden behind *Sir Nigel Gresley, Union of South Africa* and *Bittern* on a number of occasions and have driven and fired *Bittern* twice (**photo 108**) but that early memory remains vivid and I like the name. The etchings for the name, works and tender number plates were supplied by our worthy Assistant Editor.

Post script

To my eyes, the double chimney gives a more purposeful front end to the A4 than does the single chimney with which all but four were fitted in LNER days. So although No 4497 did not have the double chimney and nor did it have the valances cut away to reveal the valve gear, when painted in LNER livery, I am content that my model is so configured. Also, although it always ran with a

No. 4497 completed 1. There is not very much in common with photo 30.

No. 4497 completed 2.

corridor tender it never had one of the roller bearing fitted ones. Nevertheless, I think some licence is acceptable. My model was not built with the objective of being a slavish copy of the prototype. It was built because I admire the full size A4 locomotives and wanted to capture the essence in a working model. As far as possible, I have tried to replicate the prototype functions such as vacuum brakes, cab controls, mechanical lubricators, whistle, cod's mouth door opening, with recognisable similarity to full size but accepting simplification as necessary to suit the limitations of my manufacturing capabilities, availability of proprietary products and/ or reliable operation. I would have liked to incorporate the Kylchap exhaust arrangement, which was such a major factor in the free steaming of the full size locomotives so fitted, but reluctantly had to concede defeat when I concluded that it would be impracticable to accommodate and fix the cowls in the smokebox and that, even if I could get them in, it would make sweeping the tubes practically impossible.

It is, perhaps, worth sharing the main lesson that I have learnt from building this locomotive and, indeed, the Stirling Single before it. At every stage of the assembly I should have been thinking about the impact of later stages of the build on future access for maintenance and adjustment.

This is especially true of the valve gear which can be assembled and the valves set with relative ease when there is no boiler to impede access and the chassis can be upended for access from below if required. However, with the boiler and cladding in place, not only is access to the middle connecting rod and crosshead impossible except from underneath, but taking down the outside valve gear is also very difficult because I did not think to provide access hatches at suitable locations in the foot platforms. Also, access to the inside of the smokebox is very restricted; to do anything at all requires the chimney and top plate to be removed. This can only be done after all the streamlined casing is removed back to the front of the boiler. Had I made each smokebox cladding sheet in two pieces with a horizontal joint on the longitudinal centreline of the smokebox - which, at the time of building would have been simple - it would now be possible to remove just the upper panels to gain access to and remove the top of the smokebox.

These are just two examples and there are more, where a lack of forethought has made future maintenance more difficult than it need be.

I should emphasise that, despite having had to rework almost everything except the boiler shell, I have no regrets about taking it on. I did not anticipate, at the outset, the amount of work that would be required, partly because I raised my own requirements for fidelity to prototype as the work proceeded. On more than one occasion before significant progress had been made, on seeing an apparently better engineered part built A4 come on to the market, I was tempted to cut my losses and start again. However, had I done so, I doubt whether I would have gained the level of satisfaction that I have done by putting my own stamp and that of my son, on the completed project.

●To be continued.

View from the driving seat of a real A4; it does not get any better than that.

POSTBAG

Weapons

Dear Martin,

I wish to comment on your query regarding model weapons (Smoke Rings, M.E. 4627, 6th December 2019).

The firearms laws are a minefield made far worse by police officers in some areas interpreting the law in a different way than those in other areas, i.e. some are more reasonable, others more strict in interpreting the laws.

Under firearms law any type of gun barrel or breech mechanism must be held under licence even if the gun is not complete. Secondly, any firearm, rifled or smooth bored, must be licensed. The chances of getting a licence are very slim as forces are 'encouraged' by recent crime to discourage applications unless a 'real' need is stated - and collecting is not a reason!

As far as classes of weapon are concerned, basically anything with a barrel can be classed as a firearm if useable or recently used. An antique weapon must have not been used for many years - 50/100 years at least. Odd calibre weapons for which ammunition is no longer available may be a risky proposition as far eastern suppliers will most likely offer to make such supplies, even if just in component parts. The gun laws were being reviewed last year regarding repair or rebuild of de-activated or reproduction weapons and the manufacture of weapons by people other than registered gun shops or gunsmiths. The situation got little press coverage because of Brexit and I do not know how far changes were actually made. The direction the police and government talks were heading in seemed to be: own an illegal firearm, altered or de-activated, or a home-made gun or ammunition, a fine up to £5000 and destruction of the items, Carrying a weapon would result in arrest and a possible fine but immediate prison. Using a weapon, the above and more. *Please remember these were proposals and I'm not sure how much is now law* but remember it's up to us to obey the law and a lot of this is already law in other firearms bills.

What's this to do with models? If the model works, whether ammunition is made for it or not (you made the gun, you can make the ammo - police view) then the item is destroyed, you are charged, fined and, depending on interpretation, get a stay in prison. Any tools in workshop would be removed and sold/destroyed.

As model engineers we do not wish to break the law so the simple answer is - only bore a small depth from muzzle, do not fit firing pins or drill access holes for same, in revolver type weapons only drill cylinder holes deep enough to indicate the bullet bores from front, and for safety fit a hardened pin (roll pin etc.) near the breech end of the barrel. The only other option would be to cut the weapon away at the barrel, breech and anything covering a mechanism (for instance, in automatic pistols) so the weapon shows how it works but could never be made to fire.

Regards, Paul Norris (Boston, Lincs)

Notes from a Novice

Dear Martin,

Thanks for the recent 'My First Project' article (M.E. 4629, 3rd January). It's good to read about a fellow struggler/beginner, and confirm that not all of your readers are expert engine builders!

My first model was a Stuart S50, built from a set of machined castings, for me to assemble, paint and adjust until it ran.

Later, when sorting back copies of *Model Engineer*, I came across Harold Hall's 'Beginners Guide to Building Steam Engines' (starting August 2010). Intrigued by his idea of machining a one-piece crankshaft from mild steel flat, I set to. Many months later, I had a running model (and a broken casting and a small pile in the scrap bin!). Along the way, I had learnt the value of taper stub mandrels and soft jaws. Harold's articles had clear concise instructions and well-lit photographs, and a minimum of equipment (I only have a lathe and drill - I cannot justify spending £1K+ on a mill with DRO's). More articles like this please!

My advice to Dan would be to run your model on the lathe. I screwed the model to a timber batten on the cross slide. Using a piece of mild steel bar covered with plastic tube as a driver in the chuck, I ran the lathe at slow speed (in back gear) in short bursts, frequently checking for hot spots and loose fasteners.

I would also recommend the tapping stand (Workshop Practice Series No. 39) to get those threads accurate.

Best wishes, Charlie Bailey (Nottingham)

Foundry

Dear Martin,

May I congratulate *Luker* for writing a very informative and detailed account of making one's own castings? Long-time subscriber Ray Foulkes comments particularly on figure 7. The sketch of stage 5 should indeed show a void around the core, though most would assume this. As to the cutting of the gating system, the placing of the sprue and risers, only experience and experiment in the context of the job in hand will dictate what goes where. That photograph 22 shows no riser is possibly because one is not needed for this item! As to the wooden core box needing to stand 150°C for an hour, common sense says you remove the core from the core box BEFORE you place it in the core oven. On the other hand,

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if one is using resin sand then the core box will be steel and be running at above 150°C.

Model Engineer relies on the efforts of many contributors to maintain a steady stream of articles on a vast range of subjects, so to read criticism of the type levelled by Mr Foulkes is unfortunate. If, via the editor, he would like to contact me, I can supply him with a very long list of books on the skills involved in foundry work to read, after which he will know more about the subject than *Luker* or me.

Best wishes, Noel Shelley (King's Lynn)

Dear Martin,

I would like to thank Mr Foulkes for reading my article and taking the time to comment. He is absolutely right about the core chocking that mould in figure 7. Would you believe that is the pictorial description of casting in a hand book of one of the biggest copper development associations? I suppose they assumed that the average foundry-man would look past the obvious. I glossed over the moulding process because this is rather well captured on YouTube and the various blogs on the internet and very few people have a problem with the moulding itself. The rapping can be tricky and this I elaborated on for items like spoked wheels which are a little less common in the videos. The ingate can be in either the cope or the drag; in fact when you are using one pattern to make two parts in one mould the ingate is in both (as you can see I left one or two things out, I wasn't trying to write a book, just get aspiring foundry-men started)!

I have made some very complicated cores, and there are a number of methods to make these, but this is a little outside the scope of a beginners' casting article. Wood holds up just fine (although it does smoke a little) at 150°C. I've even printed an ABS core box and used that in the oven just under 100°C which is below the ABS glass transition temperature, and just hot enough to get the core sand hard enough to handle and then bake properly outside the box.

That cylinder photograph you mentioned has a blind bottle riser with the venting at the top of the riser (moulded above the pattern and not on the parting line to decrease the riser size), as well as a pad for feeding so it is named correctly. The riser is probably a little difficult to see in a small photograph.

I wanted to expand the series to include my home-made inoculants for some of the bearing alloy mixes I use. I've also been experimenting with my own Alumina Bronze type alloy (much stronger and cheaper alloying elements than gunmetal) for replacing gunmetal castings in model engineering. I never mentioned all the variations in my additives for the facing sand for different metals because I decided to keep it simple and hopefully fellow modelers would not be overwhelmed and would still give casting a bash.

***Luker* (South Africa)**

Steam Plant Efficiency

Dear Martin,

I'm afraid Duncan Webster has fallen into a common misconception (Postbag, M.E. 4622, 27th September 2019). The overall efficiency of a steam plant has little to do with the thermal efficiency of the boiler. Even if a boiler were close to 100% efficient in transferring heat from the hot gases into the water, it still might limit the overall efficiency of the plant to a very low figure. The boiler after all is not transforming energy from one form to another, it is merely moving heat from one place to another. By making the boiler arbitrarily large, we can approach a heat transfer efficiency of 100% as closely as we like.

The critical part of the whole process is actually that of transforming heat into useful work. The engine part has the task of doing that, but is limited in the efficiency with which it can do that by the difference in temperature which is available for it to work with. Sadi Carnot set out the limits to that efficiency many years ago, the maximum theoretical efficiency being 100 * (1- (Tcold/Thot))

Few real engines will actually achieve that efficiency at the best of times but it is worth looking at to see what we are up against. Most model boilers are only allowed to run a maximum of 100psi on the boiler. This corresponds to a saturated steam temperature of 170°C. The exhaust temperature is expected to be such that the blast pipe is exhausting steam rather than water, so the temperature here must be more than 100°C. Those figures give us a maximum Carnot efficiency of under 16%. Everything is against us actually achieving that figure in real life, since the heat loss from small cylinders is going to be much larger in proportion than for large cylinders, and the actual back pressure on the exhaust due to the blast pipe is going to be more than atmospheric, corresponding to a higher cold end temperature.

Full size engines of course can and do, or at least did, run much higher pressures, corresponding to a higher hot end temperature and so permitting a higher efficiency.

We can of course improve the efficiency of either full size or miniature engines by superheating, and actually the purpose of the superheating is to improve efficiency rather than power. It may achieve both to some degree, for instance if the boiler was not capable of producing enough steam at high speed, superheating, by reducing the weight of steam for each stroke, may enable the engine to develop more power at speed. It is still true that the smaller engine is going to suffer more from heat loss from the cylinders. Overall, I actually think that the 2% or so thermal efficiency achieved by the best miniature engines compares quite well to the 7% or so that was achieved in full size.

The thing to remember is that overall thermal efficiency is not necessarily the be all and end all. If it were we would all run electric locomotives, using power from fixed coal fired stations, which would give us a much higher efficiency even with transmission losses. (Getting the electric power safely to a miniature locomotive is left as an exercise for the student...) Back in the day, the thermal efficiency was only a minor consideration, since there were not many other ways available to achieve the desired task. Cost and effectiveness really matter more and thermal efficiency is only one factor in determining those. For those running miniature railways now, the popularity of Thomas and Friends must be a major factor, since from my own observations, everyone seems to want to ride behind the steam locomotive.

Regards, John Olsen

Bassett-Lowke

Dear Martin,

The book review on Bassett-Lowke Art (M.E. 4632, 14th February) is a subject dear to my heart, as I have a Bassett-Lowke 1½ inch scale Burrell. For those with an interest in this company one of the best books is 'The Bassett-Lowke Story' by Roland Fuller, ISBN 0-904568-34-2. Printed in 1984, it is a very readable and thorough examination of the company from start to finish. Though out of print it is readily available on the internet at a reasonable price.

Best wishes, Noel Shelley (King's Lynn)

A Boiler Feed Pump PART 6

Ian Couchman redesigns the boiler feed pump for his Ruston Proctor traction engine.

Continued from p. 423
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Cladding

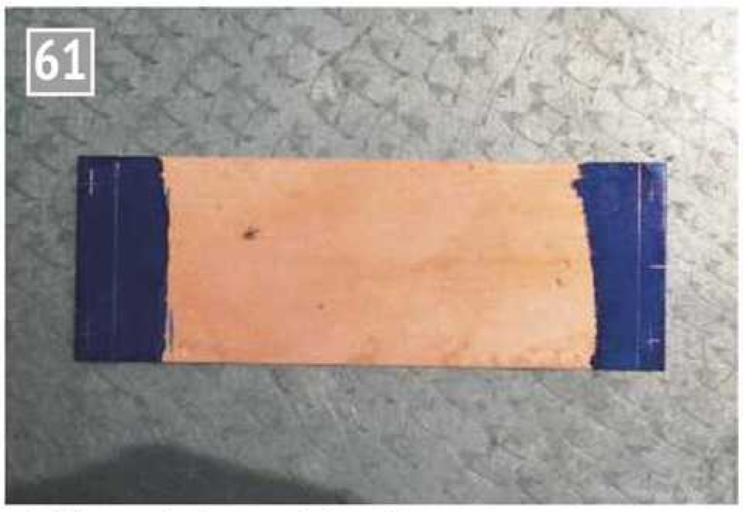
Quite a simple job. First the blank was cut as shown in fig 10 (see part 4, M.E. 4633, 28th February). The hole positions and bending lines were marked (**photo 61**) and the sheet rolled to the correct diameter (**photo 62**), resulting in **photo 63**. The bends were made by clamping between two lengths of steel in the vice (**photo 64**) producing **photo 65**, ready for fitting (or painting, if that's your thing).

Operating handle

On the same drawing (fig 10) is the last item, the operating handle. The parts are straight forward enough (**photo 66**). I drilled a hole through the boss and the two arms and held the parts together with an 8BA screw for silver soldering (**photo 67**). **Photograph 68** shows the handle in place. It is used to manually operate the pump if need be, for instance when you have no steam or to carry out an hydraulic test. It is removed before running on steam.

All done

Well, that's about it. It needs lubrication (a small displacement lubricator is fine but do ensure a good supply of oil - it doesn't like running dry) and a steam valve. I pass the exhaust and the feed water through a heat exchanger to recover a little of the hard-earned heat! Like most pumps, if the system drains between



61

Cladding marked out ready for rolling.

62

The cladding goes through the bending rolls.

63

Cladding rolled to the correct diameter.

64

Forming the bends in the ends of the cladding.

65

The cladding is ready to fit.

66

Parts for the operating handle.

Operating handle assembled.

Handle fitted to the pump.

uses, the pump may not prime against boiler pressure. I have a drain valve on the bottom of the clack (**photo 69**) which I can open to relieve pressure while the pump primes, although it's pretty rare for this to be necessary.

Verdict

So, after all this work, does it pump? Of course it does, ye of little faith! **Photographs 70** and **71** show the set-up I used to test it. I used the test rig I made for testing injectors, with a few changes to the layout. The tester consists of a piston, forced against a valve by the supply steam pressure, a water supply inlet and an outlet.

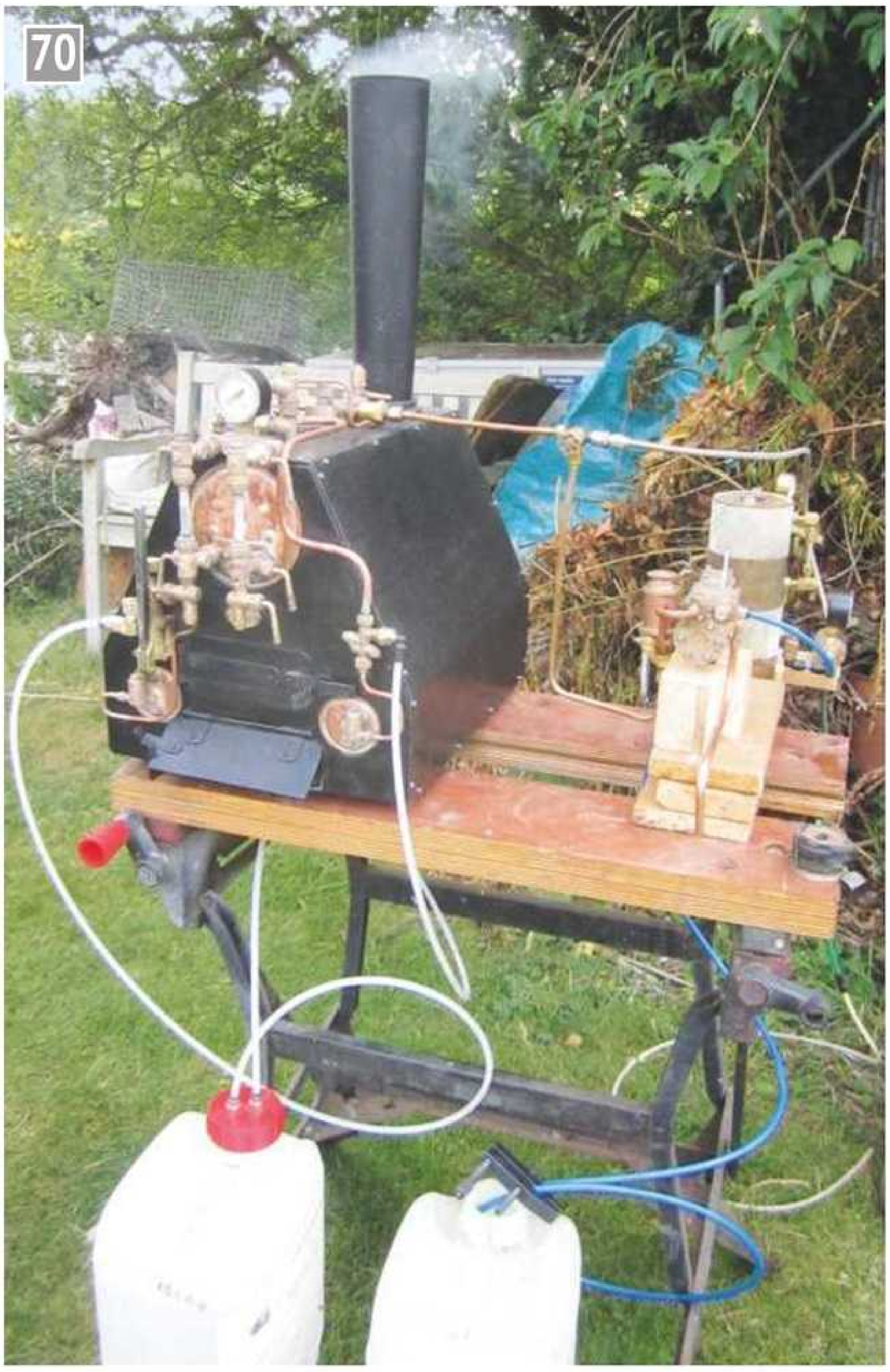
When the inlet pressure just exceeds the boiler pressure, the valve opens, allowing water to flow through to the outlet. This gives a reasonable simulation of the injector (or pump, in this case) supplying a boiler, whilst allowing the flow from the outlet to be measured. As the output from the pump is a series of pulses, rather than the smooth flow from an injector, I used an old 4 inch boiler as an air receiver to smooth out the flow so I could read the pressure gauges.

When I started the pump and it picked up load, it stopped at one end. As mentioned earlier, this often happens and just requires a tweek on the tappet to move the operating position slightly. After that - no more problems. After running the pump under load for 10 minutes or so to bed everything in, the acid test. How much does it pump?

Running flat out, at 20 psi it pumped 20oz/min, at 40 psi it was 40 oz/min, at 80 psi 26 oz/min and at 100 psi 30 oz/min. I'm happy with that!

ME

The clack and drain valve.



Test set-up – front view.

Test set-up – side view.

PART 6

Vertical Boiler Locomotives

Martin Ranson presents a pair of 32mm vertical boilered locomotives.

Continued from p. 434 M.E. 4634 13 March 2020

Dismantling

Both of these locomotives are built using a very similar method. On both of them virtually everything is removable by means of a few nuts and bolts or screws. There are lots of awkward corners on any model but this method makes sure there are no impossible corners. The method for one of the front plates is given as an example. Remove the front and rear vertical surrounds. Drain the lubricator if needed. Remove the steam and exhaust pipes. There are four bolts holding the top plate. Underneath the engine mounting is a removable mudguard (**photo 48**). An Allen key can be used to remove the first countershaft behind the crankshaft. With a few more bolts the engine mounting can then be removed. This is a very quick sequence to follow with no need to melt any solder. All the various assemblies can be removed easily and because of this any necessary work becomes a pleasure.

At the front and rear of the locomotive are the vertical plates. I know it is probably not to scale but if these are made removable then it becomes very easy to clean and maintain the locomotive. Both are made to the same pattern. Poking out of the base of each are two steel pins. These match up with tubes set into the floor plates; each tube is half an inch in length and can either be soft or silver soldered into place. Obviously, this should be done with the plates out of the locomotive. The sheet brass used was 1.2 mm thickness but it could have been 0.8 mm. I thought the thinner material might flap about a bit unless it was stiffened. **Photograph 49** shows each piece with a lamp bracket and lamps which were made from ⅜ inch square brass.

Mudguard for gears.

Lubricator

This is a straightforward displacement type, all silver-soldered together (**photo 50**). The fill is at the top and the drain is under the frames. I try to make the lubricators with no trailing pipes attached; this way the lubricator body can be fitted into the lathe chuck and, using a small centre drill, the crossbar can be GENTLY marked in the exact centre. The very small hole in the crossbar can then be drilled. I try to make this as small as possible; mine are 0.020 inch or 0.5mm in diameter.

Vertical plates.

Lubricator.

Oscillator gas valve position.

Oscillator gas valve with filter.

Gas filters

Over many years of using various gas tanks in lots of models it has become apparent that the gas jets can sometimes become slowly blocked. This is sometimes a VERY, VERY slow process and it can be awkward to work out what is happening. There is always the possibility of tiny particles of oxide or dirt from the gas tank being carried into the pipe leading to the gas jet.

The main cause of the problem does not seem to be the gas vapour itself but instead it appears to be the gas in its liquid form. Occasionally the gas tank can be overfilled or the model can be tipped to one side. If this happens the liquid gas will enter the delivery pipe and head towards the jet, any impurities being carried along with the liquid. **Photograph 51** shows the main gas valve feeding from the tank. The top and base of the valve body are split and a filter fitted in the middle, which is why the letter 'F' has been stamped into the body (**photo 52**). It is a very useful reminder that there is a filter installed. The actual filter is two layers of very fine stainless gauze. Usually these filters end up as 'fit and forget' because there is a large surface area of gauze. On some models the filter has been arranged as an in-line unit. Either way solves the problem.

Firing instructions

Both locomotives are very similar:

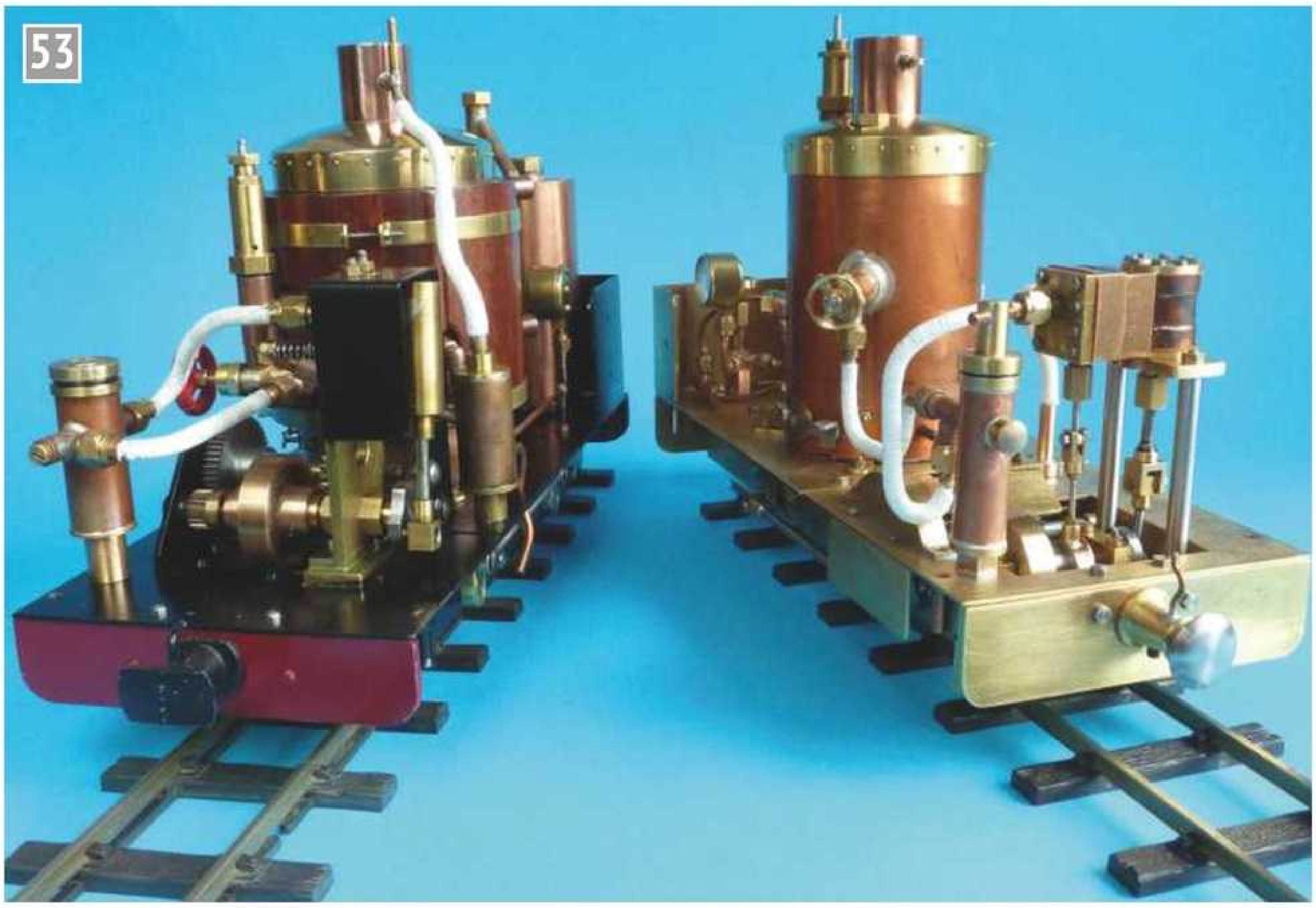
- Boiler max. capacity: 140ml
- Gas tank max. capacity: 55ml.
- Using gas restrictor, gas pressure gauge: 15 - 20 psi
- Boiler pressure preferred: 30- 40 psi
- Steam valve opening ¼ or ⅛ turn approx.
- Run time, no pump, 15 min.

Both engines are of similar size and running times. Preferably the gas tank should be filled ahead of needing to be run. The lubricator can be filled to the top of the crossbar. The boiler can be filled nearly to the top of the water gauge but no higher because all that will happen is the excess gets spat out of the exhaust. Assuming the gas tank is filled because it is wanted for use immediately it will be cold and hence the gas pressure will be very low. The tank can be warmed up by using a small duster soaked in warm water; laying it alongside the tank should produce the desired warmth.

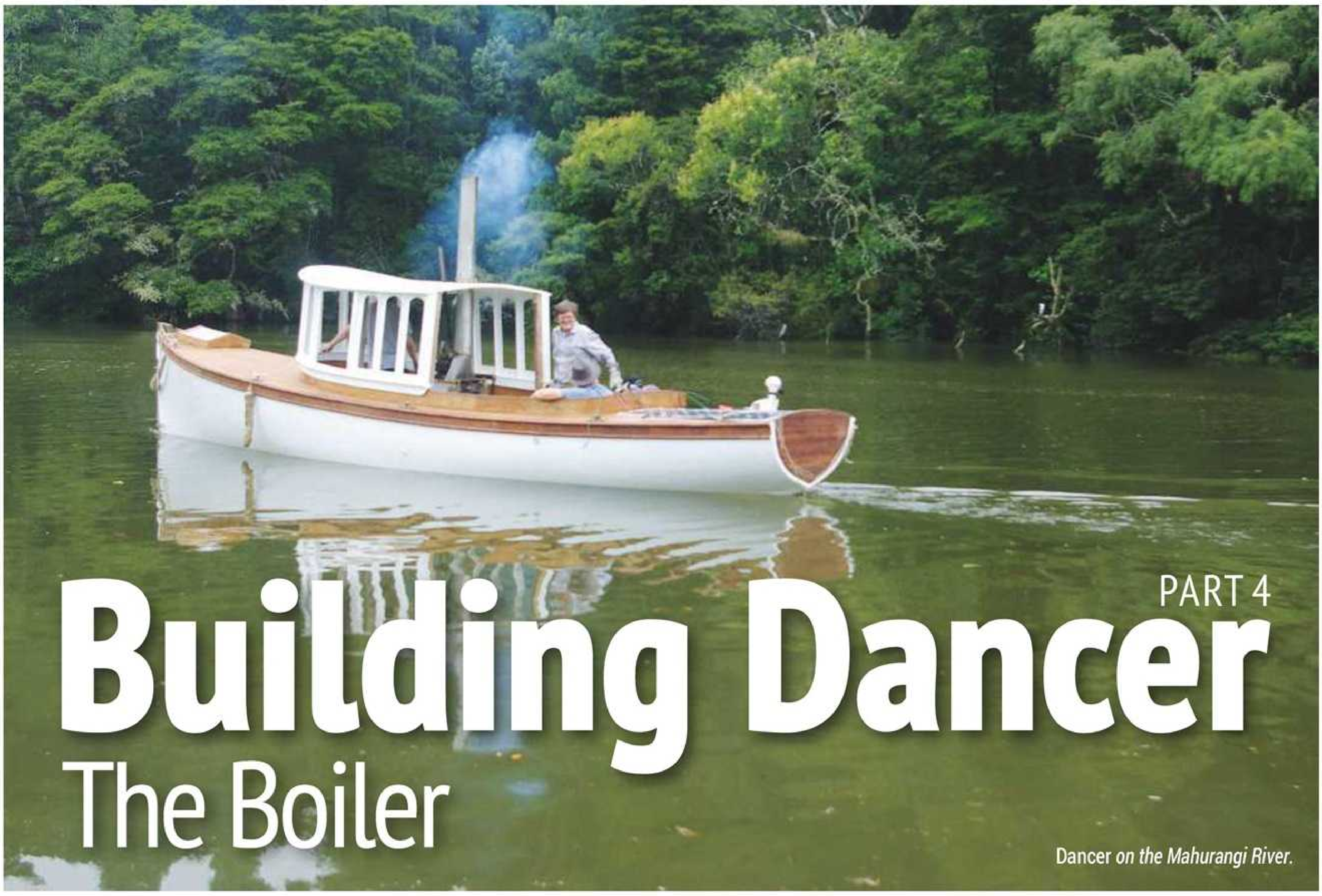
To light the gas flame is very easy and should only take one try. Open the firehole door and apply the gas match or lighter, check the flame is steady and of the required size. Shut the door and wait for the boiler pressure to rise. The steam valve and gas pressure can be set to hold the boiler pressure steady as the locomotive goes round the track. I usually set the points to keep the locomotive on a short continuous run round one part of the track. Each time the locomotive comes past I can keep an eye on the pressure readings and water level - once this is set up either of the two locomotives keeps running on its own (usually!).

Keep the boiler pressure as low as possible depending on the load the locomotive is pulling - this gives maximum running time. Both of these two 'Pepperpots' (**photo 53**) can be set up and allowed to run on their own - I just enjoy watching them run. I hope you enjoy running something similar.

ME



Two 'Pepperpot' locomotives.

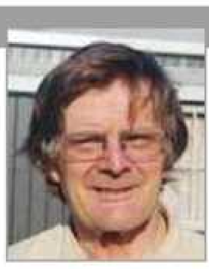


Building Dancer

The Boiler

Dancer on the Mahurangi River.

John Olsen constructs a 1:1 scale steam launch.



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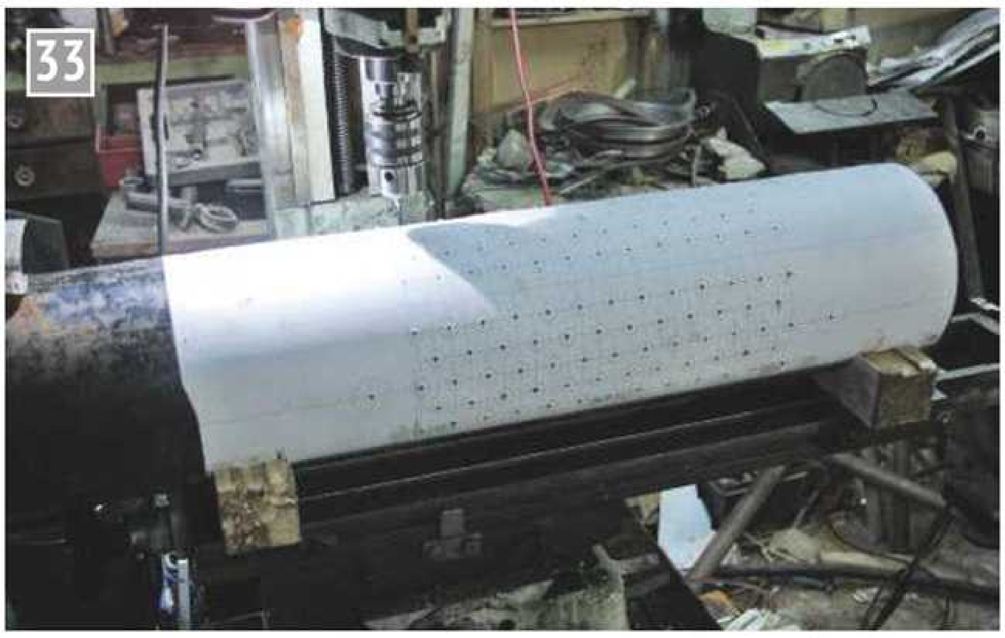
Dancer needed a boiler that would be somewhat larger than the size permitted under the Model Engineering exemptions in the New Zealand regulations. This would apply equally in the United Kingdom where, I believe, the sizes and pressures allowed are similar. This meant either finding an existing commercially made boiler of a suitable size, or building one. In the early stages of the project, this aspect was put aside on the basis that 'something will show up.' In due course, when I moved to Auckland, I found that Ken and Andrew Pointon at Colonial Ironworks (NZ) had designed and built a number of boilers in the size range required. One of their designs in particular had been built by a fellow society member in Hamilton. I was able to negotiate a copy of the drawings in return for some non-monetary consideration and the Pointons were very helpful with advice on how to proceed.

A boiler of this sort has to be built with traceable materials and all welding must be done by a suitably certified welder with several inspections along the way. The cutting, drilling and, where applicable, bending of tubes was able to be done by myself, as was the expanding of the small water tubes into place. The design is of the Yarrow type, with an 8 inch top drum and two 5 inch mud drums. The top drum has a small dome, made from the same diameter tube as the mud drums and capped off with a standard pipe flange and cover plate. The steam drum and mud drums are capped off with covers made from certified boiler plate, held in place with stays through the drums. The steam drum has three stays, while the mud drums each have one.

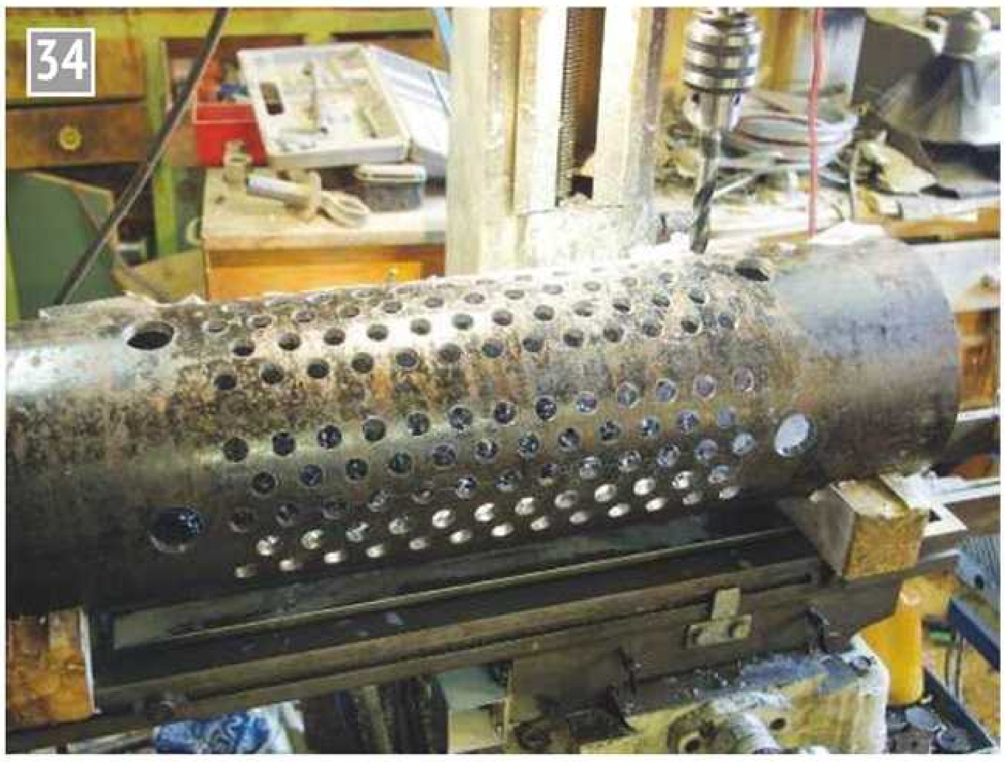
All of the tube material is ASTM standard line pipe, as used extensively in the oil industry and so quite readily available. A problem did occur with one piece, where the supplier had not arranged for it to be stamped by the certifying agency before shipping it to me. Unfortunately, the factory heat numbers on this fairly short piece of tubing were not quite complete so the local inspector would not accept it. This did reveal that the inspectors go by the painted on factory numbers and a later inspector told me that he would have accepted it since there was enough to be sure that it was, in fact, the piece of tube identified in the written documentation. By that time I had of course replaced it with another piece. **Photograph 32** shows a stamped number on one of the tubes.

The larger pieces of tube required cutting to length and then cleaning up the ends in the lathe. This was somewhat beyond the capabilities of the Myford but by this time I had plenty of contacts with bigger

The heat number is stamped on the tube and then outlined with a white marker so that it can be found easily.



Paper pattern wrapped around the drum for drilling holes.



Main drum with tube holes drilled.

machines and was easily able to do this. I also had to make the stays from the bar material provided, turning the end down and cutting a screw thread. The four large 'down-comers' for each end were bent to shape and many holes were drilled and reamed in the steam and mud drums for the small tubes. They were marked out using a paper pattern, printed and assembled from multiple sheets on the laser printer. **Photograph 33** shows one of the paper patterns in place and **photo 34** shows the tube with the holes drilled and reamed. Two holes at the bottom of the large drum had to be milled since they are tangential to the inside of the tube. One of these is shown in **photo 35**. A wooden jig was then made to hold everything in the right places (**photo 36**) and it all went off to the welders. There is not actually a lot of welding in this boiler, since the small tubes are all expanded into place. It did not take long for the welder to do the work and then the boiler came back, ready for me to fit the small tubes.

There are 126 water tubes in this boiler, in five rows each side. That is three rows of 13 and two rows of 12. In an ideal world, that would mean that the water tubes would each need to be bent to one of five shapes. The reality is that after welding, it is not very likely that the main tubes will be exactly parallel and it is even less likely that it will be possible to bend all of the water tubes consistently to the correct shape. The result is that all the tubes have to be individually bent and fitted to their locations. Getting three tubes fitted nicely into their places ready to expand turned out to be a good evening's work. Adding to the difficulty, I had two different types of tube. I had miscalculated and only bought half as much as I needed. The drawing specified three different types for the small tubes, all the same outside diameter, but differing

The lower hole for the water gauge is tangential to the inner wall.

The tubes mounted in a wooden jig ready for welding.

The inner tubes must be installed first.

>>

a little in wall thickness. The second batch turned out to be a different type from the first, one of them having slightly thicker wall which made that batch a little harder to expand. I therefore have tubes to two of the three possible specifications.

The expansion itself was a bit of a mission too. For this you need tube expander. I finished up needing four sizes; two for each type of tube. One for the initial expansion and the second for the final expansion to a good seal. The tube expanders have a tapered pin down the middle, which you drive with an electric drill. Around that is a kind of sleeve with three slightly angled slots in it, each containing a hardened steel roller. When driven by the electric drill the tapered pin rotates the rollers and the angle causes them to pull the taper pin in deeper. This forces the rollers outwards, expanding the tube into close contact with the hole it is passing through. This works a lot better than you might think and, in fact, if you have a hand on the small tube where it emerges from the large tube, you can actually feel the metal expanding as the drill runs. Before we get to that point, however, there is a difficulty to overcome. A look at the pictures will show you that there is no way that we are going to get an electric drill down inside the steam drum or the mud drums to drive the taper pin. Actually, on the mud drums it is hard enough to get the taper pin and the expander down into place and I had to modify the taper pins to permit this. **Photograph 37** shows some of the inner tubes in place.

In order to drive the tube expander I had to make a somewhat 'Heath Robinson' device to reach inside the drums. The local bicycle shop provided the necessary parts - two small sprockets and one bicycle chain - and the steel supply provided a suitable piece of steel bar. The sprockets were provided with bearings to attach them to the bar and the one nearest the middle was provided with a square to match the drive on the taper pin. The technique now was to wangle the expander and its pin into place on the tube, then wangle the square hole in the sprocket onto the square on the taper pin. This was no problem in the steam drum but was a bit of a challenge on the mud drums. Once the device was in place, with my wife supporting the far end, the battery drill would be turned on and the actual expanding would take place quite quickly. To get enough expansion to seal properly this had to be repeated with a second expander. The tube expanders I used were sourced from India. Although we often see criticism of the quality of tools from that part of the world, I have to say that these tube expanders performed extremely well. The small rollers do suffer, since they are running against the rough surface of the tube, but the life obtained was certainly acceptable in view of the sort of loads being applied. The job can be seen completed in **photo 38**. I found that getting three tubes expanded into place was about enough for an evening's work.

All tubes installed and expanded, ready to fit the end covers.

The ends of the main drum and mud drum are capped with covers made from boiler plate. These are grooved to take a copper gasket in a recess. The recess can be seen being milled in **photo 39**. The covers are retained by stays, also made from certified material. There are three stays on the main drum and one stay on each of the mud drums.

Once all the tubes were expanded it was time to fit all the covers, plug the holes and try the boiler with a bit of water. This will reveal all the tubes that have not been expanded enough so you make records of which ones are leaking, drain the water and go over them again. It is important not to overdo the expanding, since it is possible to stretch the drum material between the tubes if you do. On the other hand, boiler inspectors tend to be quite punctilious about even very minor leaks. On its first inspection the boiler inspector pointed out that one tube had leaked one drop of water after twenty minutes and that that tube should be re-expanded. Actually a better way to deal with a leak of that sort is to ignore it for a while. I just left the boiler under static water pressure for a few months, since I was by no means ready to try steaming it. After that time, when re-pressurised, the tube no longer leaked. Obviously more major leaks need proper attention, but a really minor weep like that in a new boiler will generally take up on its own.

Milling the groove in a mud drum cover for the gasket.

The next phase was to build the surround for the boiler. This is a square steel tubing frame, clad with stainless steel sheet and lined with ceramic fibre refractory. Part of the lining was done with the soft blanket type of sheet, but I later found a local supplier of the rigid sheet and redid some of the job with that. I found the rigid sheet much easier to deal with. The chimney required some tricky work to match the rectangular shape on the boiler casing to the round shape of the chimney. The transition piece was designed using 3D CAD, then made, first with cardboard then with disposable sheet metal and finally with stainless sheet once I was satisfied that the design was correct and that I could shape it successfully. The boiler is oil fired, initially with diesel fuel but I hope to obtain a supply of used cooking oil, which has a precedent as a fuel in steam launches in this country. The attraction of liquid fuel is that it is much cleaner and easier to handle, with no ash to be disposed of. The boiler can be seen in place in the hull in **photo 40**.

One item that I should mention is the safety valve. This is a commercial item and was supplied set and sealed to the pressure I requested. Although the boiler design is approved to a working pressure of 250 psi, I felt that this was more than the plain white metal bearings in the engine would be happy with. The safety valve is therefore set to 170psi. This is plenty for the power needed. Around this time the burner had to be made. I used a design by the Reliable Steam Company, an air/steam vapourising burner. This worked and on test out of the boiler appeared to be putting out plenty of heat. When steam tested in the boiler, however, it was not actually powerful enough. Some development work was needed to get the full potential from it but now it does appear to be producing enough heat, so I am now planning to book in with the inspector for an accumulation test. The burner is started using compressed air from a 12 volt compressor running from the boat's 'house' battery. Once the boiler is up to about 50 psi, it is changed over to steam vapourisation. I found that some form of pressure regulation is very desirable on the burner so I repurposed an old regulator that came from a hospital operating room. I have the pair, for oxygen and nitrous oxide. They are of good quality, but needed the seats changing to cope with steam. The second one is going to end up in another local steam launch, currently coal fired.

It will be seen from the above that building a boiler to the regulations for larger sizes can be a bit of a mission. I should perhaps also mention that the cost of inspections exceeds the actual cost of materials and welding! If you are planning a steam launch or large model, it is probably worth trying to keep the size within the range that the Model Engineering Societies can certify. Even if some of the club inspectors sometimes seem a little picky, they are a lot cheaper than dealing with the professionals. One problem is that the professional inspectors are usually only experienced with really big plant. With relatively small plant like mine, the original strength of the boiler components is not really the problem. The important thing for safety is the care that the boiler receives, particularly between uses. Corrosion is the big risk and we have recently seen a well designed and built boiler written off in this country after only about ten years of very occasional use. The boat was being left on moorings and the chimney was not being covered when left so water, salt air and probably seagull droppings went down the chimney onto the shell of the boiler. Rust followed and once the pitting reaches the maximum allowed for the thickness of the material the boiler is good only for scrap. The design of these steel boilers is not based solely on


40

The boiler fitted to the hull.

the strength of the material. The thickness required for strength is calculated and then a corrosion allowance is added. The corrosion allowance tends to make the boiler unmanageably thick in smaller sizes, which is why copper is still preferred for miniature locomotives in the smaller gauges.

Regulations will, of course, differ in different countries but most will have some sort of legal requirement for boilers over some minimum size. I believe things might be a little simpler in the United Kingdom, where it seems that the Steam Boat Association has an inspection scheme and insurance arrangements. They may also be able to help with suitable designs. It would be worthwhile looking into this if you are contemplating a boiler larger than the model engineering limits.

●To be continued.

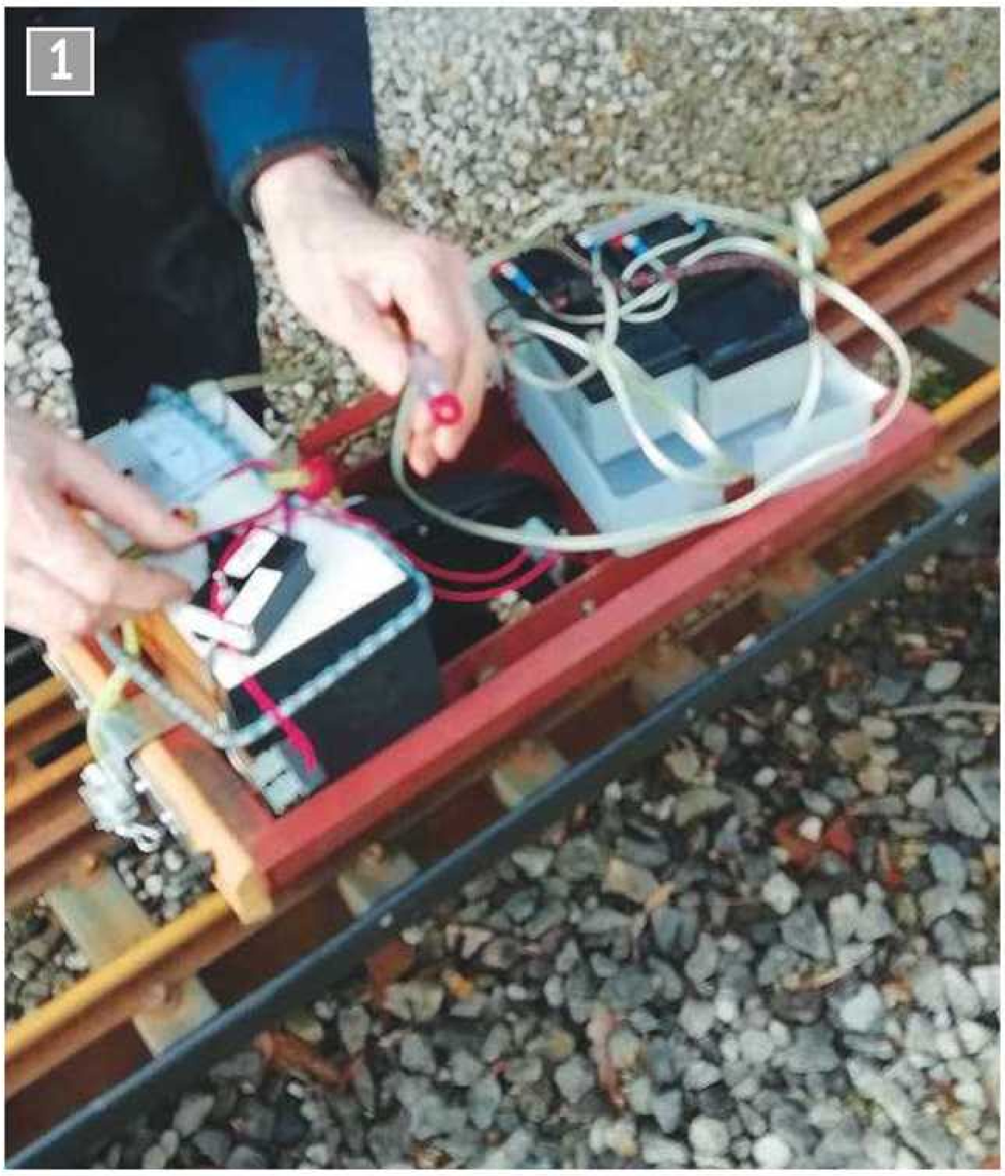
CORRECTION TO PREVIOUS REFERENCES:
In issue 4632 (14th February 2020), page 321, the references 1 and 2 are incorrect. They should be references 3 and 4 respectively and are as follows:

Ref 3. The Elliot Bay Steam Launch Company, http://www.steamlaunch.com/
Ref 4. Selway Fisher Design, http://www.selway-fisher.com/

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

My secret's out! I've joined the locomotive-owning classes! I always said that I regarded owning a locomotive was rather like having a boat or caravan - one feels compelled to use it, tying yourself to its park or mooring to the neglect of other activities. However, during the construction of my 'Bolide' I felt myself weakening and even muttering 'Get thee behind me, Satan' as I placed a classified ad. on the *Model Engineer* website. Imagine my amazement when I received a reply within days offering me an uncompleted battery-powered tram engine rolling chassis, as serialised over five issues in *Model Engineer* spring 1989. Had I not bought this item, from a gentleman in Nottingham, a week or two later a similarly priced battery locomotive was offered in the printed small ads. It was the work of a couple of weeks to make it self-propelled, as well as dealing with a deranged computer, my 'Bolide' and this column, not to mention writing for other publications. (I said not to mention them!) I used a cheap gearbox, a small motor, and two 12 volt sealed lead-acid batteries, plus a Chinese motor speed controller, to do so, then it was locomoting about the dining room, prior to being taken to the Sheffield Model Engineers' track for an initial test (**photos 1** and **2**). The gears at top right are spare mini-lathe change gears, which could not have been a better fit if they had been so designed. Watch this space!



1

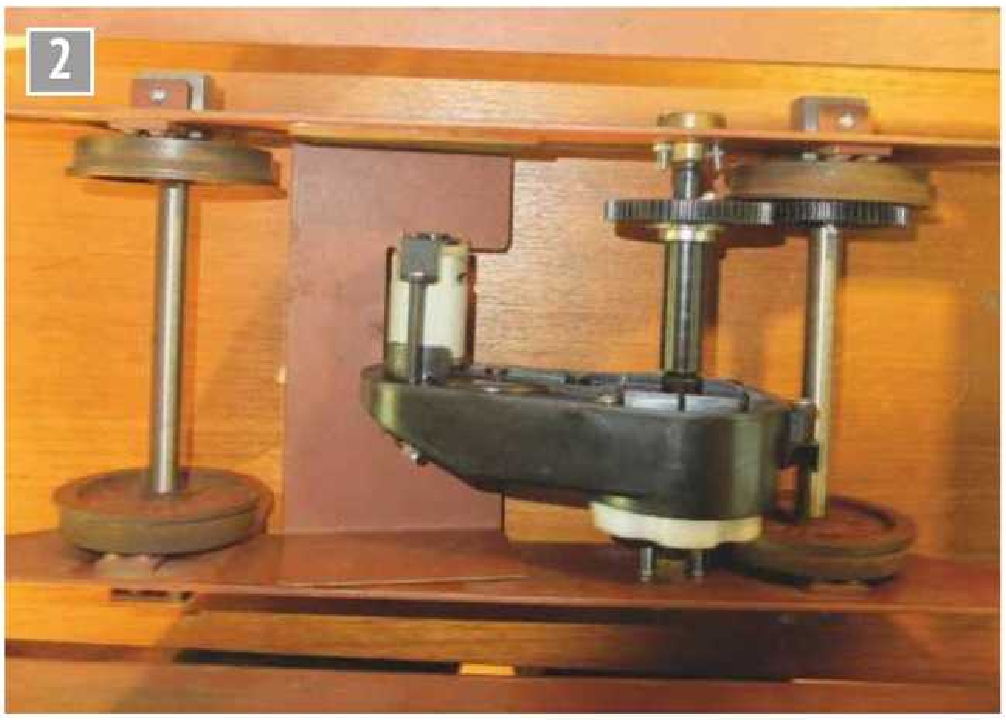
Final adjustments before first test (photo courtesy of Deborah Theasby).

On Christmas Eve, I was pleased to receive an e-mail from a very old friend of whom I had not seen or heard for 40+ years. He said he was reading this magazine, looked up my amateur radio callsign and decided to renew our friendship. So, in addition to Auld Lang Syne, we celebrated Auld Lang Callsign...

In this issue: a hurricane, floods, arboriculture, a prominence, a biblical character and a screwdriver.

Hutt Valley & Maidstone Model Engineering Societies
Blastpipe, February, was active over the festivities, in that Philip Drummond asked to try out Ian Welch's *Rio Grande* locomotive ensuring that it was shipshape and Bristol fashion for the Hamilton weekend. Whilst running on the track, there were the inevitable visitors, especially after testing the whistle! They were told it was not a running day, therefore no charge was levied, although one individual did pay, with a €5 note! Visitors noted were from Zimbabwe and Holland, one of which in the latter party was Bernhard van der Steen, editor of the Netherlands' model engineering magazine, *Ōnder Stoom.*
W. www.hvmes.com

Centurion Smokebox, from **Centurion Society of Model Engineers**, had much work to do clearing up after the flooding, including the rubbish washed downstream into their site. The electricals previously thought to be above high water mark were



2

My rolling chassis with gearbox (photo courtesy of Deborah Theasby).

again submerged, and need refurbishing. Some items could not be resuscitated, like the computer, videos, the lower shelves of magazines etc. I was also sent a 12 page .pdf about the construction of the Kaiimansrivier railway bridge, in the November *Civil Engineering*, which I did enjoy reading: mail.google.com/mail/u/0/#label/A+-+ME%2FMEW+articles/FMfcgxwGCkngQRwdtPgsCJwQzfmvkFTj?projector=1&messagePartId=0.1
W. www.centuriontrains.com

Shoulder to Shoulder, January, from the **Men's Sheds Association**, announces a new Patron, Chris Fisher RPT, (Register of Professional Turners) otherwise known as The Blind Woodturner. President, Mike Jenn, is of the opinion that more trees should be planted but, rather than grown in massive forests, they should be given away as 'whips' for people to plant in their gardens. In an unpublicised event in Camden, London, they were able to give away 240 whips - over half way to their spring target. (I have been practising this myself for 50 years, although with an ulterior motive - I plant fruit trees!) Incidentally, nowhere in this issue of *S to S* is the President named. I had to do quite a bit of digging to find out. (I'm sure this is an oversight.) Trustee Chris Lee reviews a book on D-I-Y. This activity is said to be reducing in the UK, so *The Beginner's Guide to D-I-Y and Home Repair* should help to arrest the decline. Not in decline is the number of Men's Sheds in the UK - 540 and still growing.
W. www.ukmsa.org.uk

Debs and I are thinking of asking a relative to plant some trees at the end of our garden. The trouble is, he likes carnivorous plants, Venus Flytrap, Pitcher plants, Triffids, etc. So, do we ask him to go ahead and risk receiving complaints of missing pets, small children etc? *

Victor Croasdale writes to correct me, in that the meeting of the Central Pacific and the Union Pacific railways, uniting East and West coasts of the USA in 1869, took place at Promontory, not Promontory Point, which is about 40 miles away. Rails DO now run to the latter but only since 1904. The meeting place is now the Golden Spike National Historical Park and is quite remote, being about 20 miles along an unsurfaced road after leaving the tarmac. Thank you, Victor.

Greg Burrow's locomotive, Hamilton, NZ (photo courtesy of Editor, Murray Lane).

Model & Experimental Engineers Auckland's *MEEA Newsletter* has Ray Brown showing his 'Cranko' model steam roller, one of several made by David Auld in Greymouth between 1966 and 1989. They are now quite valuable - one was recently offered on the auction website TradeMe for NZ$450. These are not to be confused with the Cranko models which were made in the UK and rather more sophisticated. Grahame Quayle has completed his ST twin engine and he was fighting it to the end. Further examples of deviation from the drawings have been found - the piston rings, he says, are too hard, and concludes: 'One would think after all this time that Stuart Turner would have managed to perfect the drawings and iron out the bugs'. Editor, Murray Lane adds, 'Not a good project for the beginner'. In the Hamilton convention, a fun competition is arranged in which a steam-driven model was to be made, using a 200g cocoa tin with a pressed-on lid as a boiler, and 50 ml of water. Heated by night light candles, it was to propel a 3½ inch gauge trolley over a set distance within a time limit. There were four entries, and MEEA's Greg Burrows came second, (**photos 3** and **4**) but the unnamed winner used a turbine driving an electric generator, driving in turn an electric motor to the wheels.

Stamford Model Engineering Society's January *Newsletter* has Editor, Joe Dobson, reflecting on the trains that pass his window, which are now owned or built abroad, even here, in the cradle of the Steam Age! Consequently, he writes on the current [re] construction of steam (and one diesel) engines, *Hengist, 10,000, Prince of Wales, 82045* - have we missed any? Then of course the civil engineering – such as the Werrington Grade Separation, which will allow more trains on the ECML.

Bradford Model Engineering Society, *Monthly Bulletin,* February, mentions the traditional social gathering on 27th December, which was dull and overcast. Only one steam locomotive turned up, says President Jim Jennings, and it was not thought worthwhile to light up, so the only steam came from the mince pies and the tea! Editor, Graham Astbury has bought a cheap (£5) electronic components tester and found no instructions but it is easy to use - insert the component and press the button. I have one of these and

The 'works' of Greg's creation, Hamilton (photo courtesy of Editor, Murray Lane).

find it most useful. (I write a more or less regular column in *Practical Wireless* describing these cheap modules, with the brief that they are normally in the £1-£10 range - Geoff) Godfrey Wormald has a collection of *Rex* motorbike bits dating from 1908, which he is slowly reassembling. The engineering is fairly basic, so it is easy to make new parts if required. The clubhouse kitchen is being comprehensibly re-built, -wired and -piped, ready for the new season. Thanks to careful planning, TEA was available throughout this process. Road Vehicle News reports friend Pete Plummer has spotted a rare 4-wheeler BSA car. See Wikipedia.
W. www.bradfordmes.uk

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Graham Copley's *Royal Scot*, OVLSME.

The Link, January-February, from **Ottawa Valley Live Steamers and Model Engineers**, reports that Editor, Graham Copley's *Royal Scot* is pretty-well finished, or pretty, well-finished, as you prefer. Nameplates are by *Model Engineer*'s 'esteamed' co-editor, Diane Carney, and Graham says they look stunning (**photo 5**).
W. www.ovlsme.x10host.com

Norwich & District Society of Model Engineers' *e-Bulletin*, December-January, carries information about a YouTube video www.youtube.com/watch?v=R-mDqKtivuI&t=378s on the history of the screwdriver. Don't laugh! Readers in Canada will know, but probably not many others, that Canada has its own type. Watch it and see! A spoof advert for 'Hornby *Northern Rail*' was found on the Norfolk Orbital Railway Facebook site. Ho ho...
W. www.ndsme.org

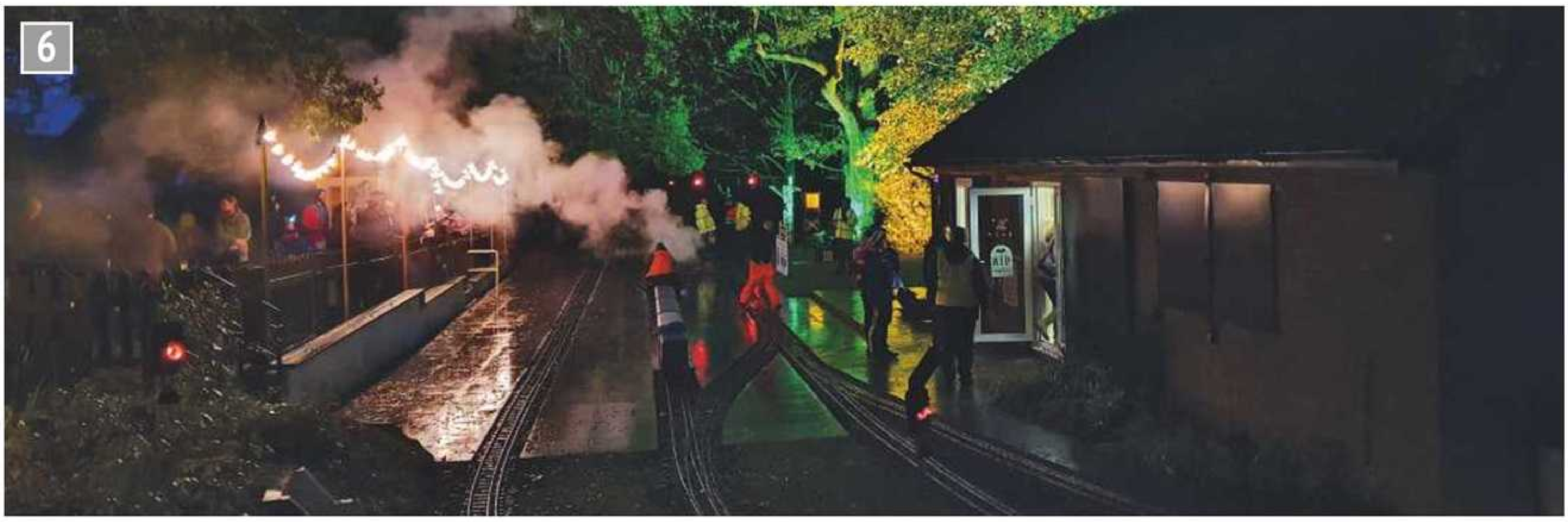
Another South African club newsletter, *Maritzburg Matters*, January, from **Pietermaritzburg Model Engineering Society,** arrives in my inbox. The front page photograph is of their Halley Park signal box, surrounded by immaculate lawns. Richard M Daniel recounts the fascinating history of the 'Jerrycan' petrol container. (He was part of it!)
W. www.pmes.co.za

Coate Express, winter, from **North Wilts Model Engineering Society,** has a fine picture of the Society's station on the front cover, on a sunny day with a scattering of snow. John Spokes continues his ghost story. Ken Parker designed and built visual aids to explain the steering geometry of model cars. Having first thought of laser alignment, rejected as a teaching aid by H&S considerations, he used red wire to simulate the laser light path, as the rear wheels must be compared with the front. John writes again of his experience on the 'Train Rides in the Dark' event at Hallowe'en. Discovered skulking near the tea and cakes in the clubhouse, he was 'volunteered' to walk the track in the aftermath of Hurricane Dorian, in case the adverse weather had caused any problems. So it was that the hordes descended on the event in such numbers that the catering team had to request further supplies in order to feed the inner revellers and the brave operating staff. There has been constructive feedback on social media, so, who knows, this was how Glastonbury started... (Whaddya mean, Joseph of Arimathea? - Geoff) (**photo 6**). Chairman, Les Stiff has had thoughts on the future of the club, in that if there is no progress, then there is regression, comparative if not actual. Brigid Harkness discusses the Baikal-Amur Railway and its history. She travelled on it in 2018, part of a tour, and an enjoyable experience. The members were the object of curiosity by the locals, many of whom had not met Westerners before. Vladivostok was closed to visitors until 1989. It is the home of the Pacific Fleet, and has rather impressive coastal artillery. The evolution of the ticket office has reached the Mk 4 version. Mk 1 was a card table. In deference to the elements, Mk 2 offered some protection. Mk 3 proved extremely heavy, when being installed. This was discovered (afterwards!) to be due to the presence of concrete blocks under the floor... Two photographs show it occupied, separately, by member, Steve, and a Dalek. Spot the difference! Mk 4 has now been installed, bearing such conveniences as lighting and a heater.
W. www.nwmes.info

Southampton Society of Model Engineers winter *Newsletter,* has John Barrett asking, 'Are we still living in the past?' He explores some different materials and techniques he uses in the production of his models, including Titanium. This 'wonder metal' as he calls it, is ⅓rd the weight of steel, rustproof, and very smooth. However, it work-hardens instantly, so you have to be right first time... Kevin Patience describes the EAR '30 Class' 2-8-4 locomotives. (They look even more cluttered than French engines - Geoff) No. 3020 *Nyaturu* is preserved.
W. www.southamptonsme.org

And finally, from Richmond Hill Live Steamers: 'How do locomotives hear?', 'Through their engineers!'
* "Feed me!"

Contact:
geofftheasby@gmail.com



Hallowe'en trains in the night from *Coate Express*.

MARCH

26 **Sutton MEC.** Club night – new and interesting items. Contact Paul Harding 0208 2544749.

28 **Romney Marsh MES.** Track meeting, noon onwards. Contact Adrian Parker. 01303 894187.

29 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker. 07710 515507.

29 **Portsmouth MES.** Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

31 **Romney Marsh MES.** Track meeting, 11am onwards. Contact Adrian Parker. 01303 894187.

31 **Wigan DMES.** 'Free and Easy' night. Contact: wigan_mes@aol.com

APRIL

1 **Bradford MES.** Spring auction (only members may bid), 7.30pm, Saltaire Methodist Church. Contact: Russ Coppin, 07815 048999.

1 **Brandon DSME.** Meeting at The Ram Hotel, Brandon, 7.45pm. Contact Mick Wickens: 01842 813707.

1 **Leeds SMEE.** Meeting night – trophy night. Contact Geoff Shackleton: 01977 798138.

2 **Sutton MEC.** Bits and pieces. Contact Paul Harding 0208 2544749.

3 **North London SME.** Talk: 'Fantastic Journeys by Traction Engine' – Prof. Timothy Watson. Contact Ian Johnston: 0208 4490693.

3 **Portsmouth MES.** Club night – 'Microscopic Examination', 7.30pm, Tesco Fratton Community Centre. Contact Roger Doyle: doyle.roger@sky.com

4 **Bristol SMEE.** Members' night – 'On the Table'. Contact Dave Gray: 01275 857746.

4 **Tiverton & District MES.** Running day at Rackenford track. Contact Chris Catley: 01884 798370.

5 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker. 07710 515507.

5 **Plymouth Miniature Steam.** Public running, Goodwin Park (PL6 6RE), 2 – 4.30pm. Contact Rob Hitchcock: 01822 852479.

5 **Portsmouth MES.** Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

5 **Stockholes Farm MR.** 'Wakey, Wakey Day' and AGM, from 10am. Contact Ivan Smith: 01427 872723.

5 **Welling DMES.** Public running at Falconwood, 2-5pm. Contact Martin Thompson: 01689 851413.

11 **Bradford MES.** BMES/Friends of Northcliffe Easter Bunny event, 12.30-3pm. Contact: Russ Coppin, 07815 048999.

11/12 & 13 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker. 07710 515507.

12/13 **Portsmouth MES.** Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

12 **Sutton MEC.** Sunday track day from noon. Contact Paul Harding 0208 2544749.

13 **Stockholes Farm MR.** Open day, 11am-5pm. Contact Ivan Smith: 01427 872723.

15 **Leeds SMEE.** Meeting night – 'Ten Years a Designer' – Jack Salter. Contact Geoff Shackleton: 01977 798138.

17 **Rochdale SMEE.** Talk: 'Arosa Line' – Roy Holt, 7.30-9pm, Castleton Community Centre. Contact Rod Hartley 07801 705193.

17/19 & 20 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker. 07710 515507.

19 **Bradford MES.** Public running 1.30-4pm at Northcliff. Contact Russ Coppin: 07815 048999.

19 **Guildford MES.** Public Open Afternoon 2-5pm. Contact Mike Sleigh: pr@gmes.org.uk

19 **Plymouth Miniature Steam.** Public running, Goodwin Park (PL6 6RE), 2 – 4.30pm. Contact Rob Hitchcock: 01822 852479.

19 **Portsmouth MES.** Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

19 **Tiverton & District MES.** Running day at Rackenford track. Contact Chris Catley: 01884 798370.

19 **Welling DMES.** Public running at Falconwood, 2-5pm. Contact Martin Thompson: 01689 851413.

19 **Westland & Yeovil DMES.** Track running day, 11am-4.30pm. Contact Bob Perkins: 07984 931993.

21 **Nottingham SMEE.** The New Build GCR 567 – Progress to Date', Andrew Horrocks Taylor, 7.30pm. Contact Tony Knowles: 01623 795242.

23 **Sutton MEC.** AGM. Contact Paul Harding 0208 2544749.

24-26 **GL5MLA.** Cinderbarrow GL5 rally. Contact John Foxton: 01205 751601.

26 **Hereford SME.** Public running day, noon-4.30pm. Contact Trevor Carter. 01989 561019.

26 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker. 07710 515507.

26 **Pimlico Light Railway.** Public running, 3-5pm. Contact John Roberts: 01280 850378.

26 **Portsmouth MES.** Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

28 **Wigan DMES.** Presentation by Mr Ralph Taylor on 'The Use of CNC in Plasma Cutting and 3D Printing'. Contact: wigan_mes@aol.com

30 **Sutton MEC.** Afternoon run from noon. Contact Paul Harding 0208 2544749.

MAY

1 **Rochdale SMEE.** Sale of items from Richard's workshop, 7.30-9pm, Castleton Community Centre. Contact Rod Hartley 07801 705193.

2 **Tiverton & District MES.** Running day at Rackenford track. Contact Chris Catley: 01884 798370.

2-4 **North Wiltshire MES.** Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker. 07710 515507.

3 **Portsmouth MES.** Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

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FEATURE OF THE MONTH: ROUNDHOUSE

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Bertie is typical of the style of Saddle Tank locos that were probably the most common type of small locomotive found on British narrow gauge railways.

Jennie
Deep Burnswick Green
32mm
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Jennie is ideally suited for those looking for something in between our smaller basic engines and larger classic engines.

Bulldog
Victoria Maroon
Chevron Buffers
£645
Bulldog is another freelance design typical of a powerful small yard shunter and, though it shares the same chassis with Little John, it has a more purposeful look and features extra detail and a working head lamp.

A range of cast white metal items are available on our website

Sammie
32mm & 45mm
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Sammie, whilst freelance in design, is typical of the small and medium sized US Saddle Tank locos like Baldwin and Porter. He is offered ready to run in a choice of either 32mm or 45mm gauge. Being internally gas fired, Sammie is efficient and powerful and is similar to Bertie in many respects.

Please note basic range takes 16 weeks from inital order and other locomotives are in batches. Batch dates will be in product description. Locomotives in stock will state instant dispatch available
*In stock as of 29/02/2020, please note these loco's may no longer be available, check stocks online or call

PECO

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Flexi Track - 4 Pack	SL600x4	£38.00
Flexi Track - Single	SL600x1	£10.00
Setrack Curve - 6 Pack	ST605x6	£55.00
Setrack Curve - Single	ST605x1	£10.00
Setrack 38 Radius Curve - Single	ST607	£10.00
Setrack 38 Radius Curve - Six Pack	ST607x6	£55.00
Right Hand Point	SLE695	£45.00
Left Hand Point	SLE696	£45.00
Y Point	SLE697	£45.00
Small Radius Right Hand Turnout	SLE691	£45.00
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Rail Joiners - 24 Pack	SL810	£3.50

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Flexi Track - Single	SL900x1	£16.00
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Setrack Curve - Single	ST905x1	£8.50
Setrack Straight - Six Pack	ST902x6	£45.00
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Sammie 32mm & 45mm	£675
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Lady Anne	Due Dec 2020
Russell	Due Nov 2020
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MSS

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Dinorwic Quarry Slab Wagon Kit	16W08	£25.50
Dinorwic Quarry "rubbish" Wagon Kit	16W09	£25.50
Slaster's Mek-Pak	0502	£5.00
Slaster's Mek-Pak Brush	0505	£3.70

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Small Brass Chimney Cowl	DSENSMCWL	£4.00
Brass Cab Hand Rails	DSENCH	£4.20
Brass Side Tank Hand Rails	DSENSTHR	£5.20
Brass Smoke Box Hand Rails	DSENSBXHR	£3.10
Cylinder Covers	DSENCYCV	£12.00
Brass Sand Boxes	DSENSBX	£12.50
Brass Tank Tops	DSENWTT	£9.40
Lubricating Oil	SWLUB30	£3.00
Meths Burner Wick	DSWWK6	£1.90
Curve Tipped Syringe	DSWCTS	£2.10
460 Steam Oil 500ml	DSW460SO500	£5.50
220 Steam oil 500ml	DSW220SO500	£5.50
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The Ubiquitous "Black 5"

With eight hundred and forty-two of the class built the Class 5's were probably the most widely used steam locomotives ever to run on Britain's railways. Designated as mixed traffic locomotives the Black 5's were equally at home pulling a rake of coaches, or at the head of a freight train.

With 6ft diameter driving wheels and a tractive effort of 25,445lbs the Black 5 proved itself a highly capable "go anywhere, do anything" locomotive. In service the locomotives were always in black livery. In LMS days a thin straw coloured lining was used. In BR service red/white/grey lining was standard. Early, or later BR crests were carried according to period.

£10,995.00 + P&P

Summary Specification

Length approx 71"

- Coal-fired live steam
- Safety valves
- Two outside cylinders
- Sprung axle boxes with needle roller bearings
- Silver soldered copper boiler
- Piston Valves
- Walschaerts motion
- Mechanical lubricator
- Reverser
- Tender brake
- Etched brass body work with rivet detail
- Boiler feed by axle pump, injector, hand pump
- Working drain cocks
- Stainless steel motion
- Multi-element superheater
- Bronze cylinders with steel pistons and valves
- Ready-to-run
- Fully painted and lined
- Choice of liveries
- Length 71"
- Height 13"
- Width 9.5"
- Weight (inc tender) 105kg

Delivery and Payment

The model is the subject of a single batch production for delivery by the end of 2020. There is unlikely to be any further production until 2024 at the earliest. The model represents excellent value at £10,995.00 + £195.00 p&p.

The order book is now open and we are happy to accept your order reservation for a deposit of just £1,995.00.

Save £195.00. Free p&p for any order received within 28 days.

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A stage payment of £3,500.00 will be requested in June 2020 as the build of your model progresses, a further £3,500.00 in September, and a final payment of £2,000.00 in advance of delivery.

The Model

The Black 5 is a coal-fired, two cylinder, engine for 5" gauge. The model offers a good level of fine scale detailing and is to a high engineering standard. This combination of appearance and performance is rarely matched by our competitors.

Certainly, our value-for-money and after sales service are second-to-none. Each model comes complete with a silver soldered copper boiler, CE marked and hydraulically tested to twice working pressure. We provide a full 12 months warranty with every model so you can buy with confidence.

Limited Production Run

We have presently reserved capacity for the production of 25 models only. With the Black 5 being such an iconic and popular locomotive we are confident the edition will sell out quickly. It may be possible for us to extend the production run a little, but this cannot be guaranteed.

"We are pursuing a course of continual product improvement. The Black 5 incorporates all of our latest improvements, delivered as a result of design and manufacturing process changes. The Black 5, like the full size prototype, is a versatile and highly capable engine that is certain to attract attention at any get-together. As an award winning professional builder I am proud to have been involved in the design and development of this fine model."

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