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Vol. 220 No. 4578 • 19 January - 1 February 2018

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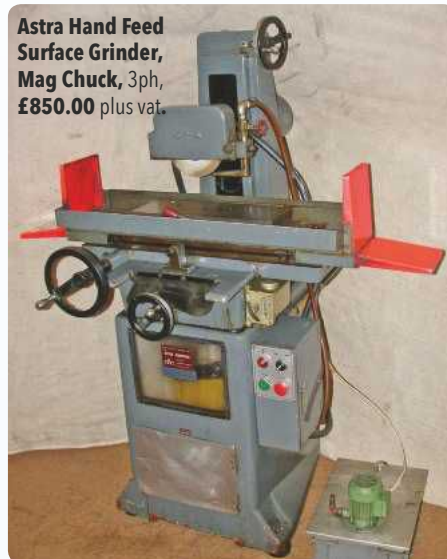
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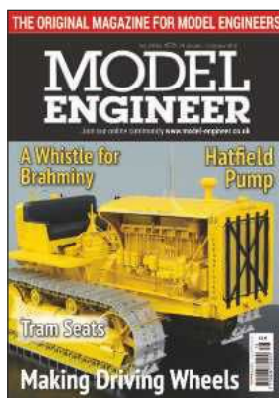
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ON THE COVER...

Caterpillar D8, to a scale of one inch to the foot, built by Bruce Geage of the Otago Model Engineering Society (photo: Bruce Geage).



This new design from Wilescot in brass and red is mounted on a black base and demonstrates how energy is produced today. With its specially designed boiler, the turbine is able to run at speeds in excess of 10,000 rpm and gives a realistic turbine sound. It is equipped with a powerful generator and also a transmission drive for models. The turbine is manufactured using CNC which guarantees vibration free operation.

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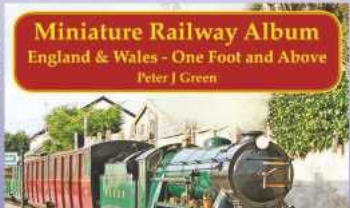
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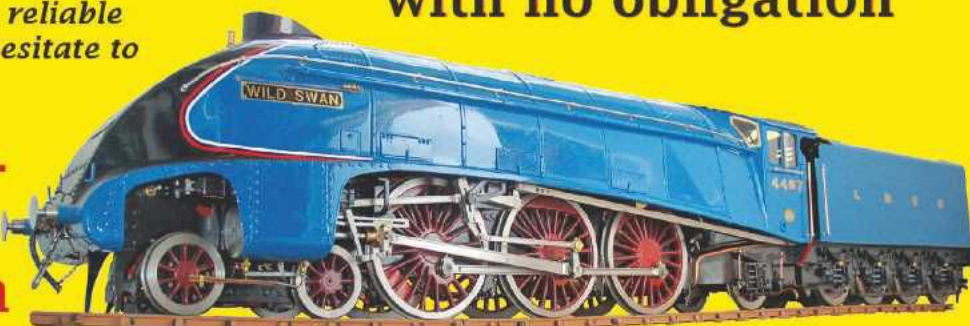
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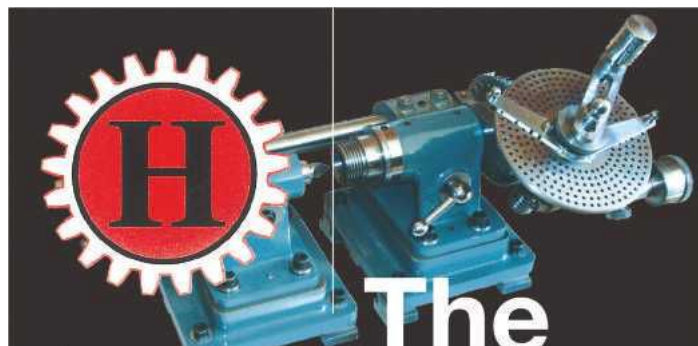
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Encouraging Scotland's Future Engineers

A Royal Academy of

Engineering project from Abertay University has built connections with more than 1,500 school pupils and families from across Tayside and Fife. Staff from Abertay organised a series of engagement activities designed to teach youngsters about civil engineering while improving the communication skills of engineers themselves. Using the new Dundee Railway Station project as a focal point, organisers created teaching sessions and information banners, before designing a range of simple construction tasks to be carried out in schools and during Dundee and Fife science festivals.

Children learned about the complexities of operating the project over live railway lines, removing the old railway station and building the foundations for the new station. They also learned about installing new (and protecting old) services such as electricity, telephone cables, water and green infrastructure networks and the railway station superstructure. The sessions included family drop-in workshops where parents and children were encouraged to construct and compete against each other. Volunteer engineers were challenged to explain complex engineering and scientific ideas and processes confidently, avoiding any jargon, to communicate the message that the wealth

and wellbeing of society is dependent upon engineering.

Fife schools including Crossgates, Hill of Beath, Lochgelly West, Coaltown of Balgonie, Carleton, Rumbleton and Warout all took part. In Dundee, Craigowl, St Peter and Paul's and Grove Academy were involved, while in Angus the engineers engaged with Carlogie Primary and Websters High.

Project partners included Dundee City Council, Perth and Kinross Council, Aberdeen and Dundee universities and industry experts such as BEAR Scotland, Fairhurst, Balfour Beatty, SWECO, WSP and Carruthers Renewables.

The work was funded by the Royal Academy of Engineering's *Ingenious* scheme for projects that engage the public and school children with engineers and related disciplines such as construction, structures, transport, geotechnics, materials and urban engineering. *Ingenious* has funded nearly 200 projects to date, providing opportunities for over 5,000 engineers to take part in public engagement activities and gain communication skills to bring engineering to society.

Research Project Officer Alison Duffy, who coordinates the scheme for Abertay with Dr Dan Gilmour and Neil Berwick, said "It's never too early to get children interested in education and this project has been a tremendous way to engage pupils in engineering. For our volunteer engineers, the experience of communicating working methods to such a young and enthusiastic

audience has been invaluable and both children and parents have been completely engrossed during the sessions".

The project was launched in 2016 and is due to come to an end next year.

For more information on studying civil engineering at Abertay visit <https://www.abertay.ac.uk/discover/academic-schools/science-engineering-and-technology/>

A New Club in Wales

Here is some good news for model engineers in mid-Wales. Robin King writes:

'A small number of us model and home shop engineers located around the central area of Wales have been meeting up regularly over the last year and, as member numbers have steadily grown, we've now established ourselves more formally under the title of the 'Cambrian Model Engineers'. Our members' interests are widely varied including live steam, toolmaking, clock making, large to very small-scale railways, mechanical antiques restoration and anything else engineering related. The intention is to expand those interests to attract a wide range of members, particularly those areas which are of interest to younger age groups.

'Our members are a sociable bunch and currently we meet on a fortnightly basis at various members' homes for general chat, 'bits and pieces' meetings and a look at each other's workshops, always accompanied by tea/coffee and cakes. We also have use of a 5 inch gauge ground level track for 'steam up' meetings, through the generosity of our chairman Martin Rant, weather permitting of course (and that's saying something in Wales!).

'We're always keen to hear from anyone interested in joining us, so for further details they're welcome to contact me on 01686 414939.'

Martin R Evans
Acting Editor



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AN EXHIBITION FOR THE BIGGER GAUGES

LARGE SCALE MODEL RAIL

0 GAUGE, G SCALE, GAUGE 1, 16MM & MORE...

2018 marks the 17th year of The Midlands Garden Rail Show – 'Large Scale Model Rail' - which continues to go from strength to strength and is regarded as one of the leading garden rail exhibitions in the UK. The exhibition, which will take place at the Warwickshire Event Centre near Leamington Spa, attracts over 2,000 enthusiasts from all over the UK and Europe. Organisers are looking forward to presenting another inspiring exhibition showcasing exciting railway layouts covering the larger gauges and scales. This exhibition is well supported and organisers are expecting 35 leading suppliers and 15 layouts and displays covering many gauges. Visitors will see live steam model locomotives hauling coaches and wagons - the real thing in miniature.

The show takes place on Saturday and Sunday, the 17th and 18th of March but it is not too early to reserve the dates in your diary! Further details may be found at www.largescalemodelrail.co.uk

New Gears for Wally

Bob Reeve puts the 'ting' into Wally's bells to complete his restoration



Continued from p.43
M.E. 4576, 22 December 2018

With the thread completed, there was still a lot of machining to be done. **Photo 45** shows the milling and drilling completed on one side. Note the off-centre through hole which was used to locate and bore the bearing location on the surface formed when the component was parted off.

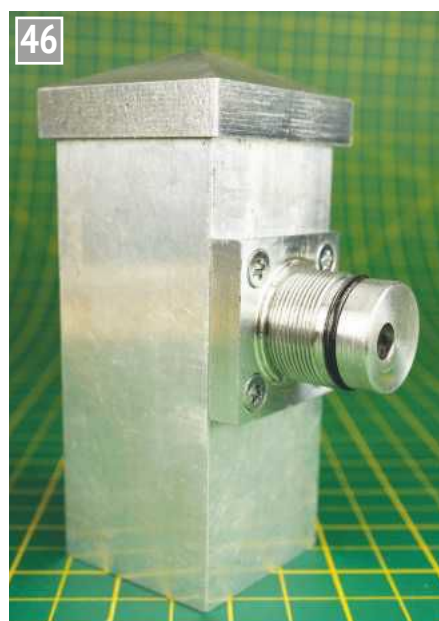
The completed component, with its 'O'-ring and bearing in place, can be seen fitted to the striker box in **photo 46**.

Fig 9 shows the intended arrangement for attaching the winding house to the striker box and providing the drive which will animate Wally himself. The captive nut near the winding house end of the tail shaft tube allows the assembly to be easily removed. As mentioned earlier, I had no intention of fiddling with the design of the winding house itself.

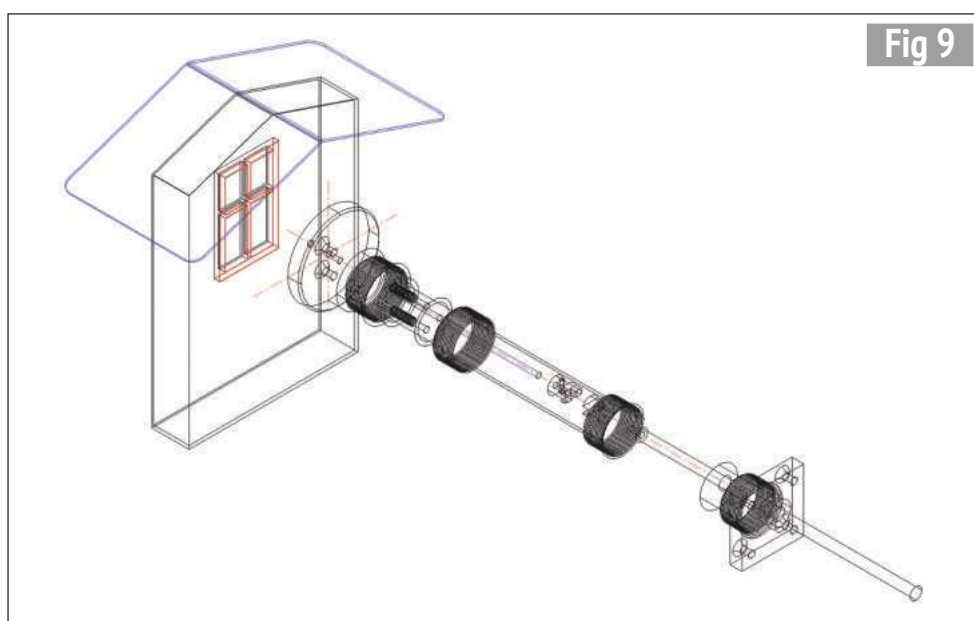
The three machined components and 'O'-ring comprising the winding house mounting can be seen in **photo 47**. To disconnect the drive train there is also a simple



Milling and drilling the flange.



Flange fitted to the striker box.



Attaching Wally's winding house.



Coupling components.

coupling, half of which is shown alongside to illustrate its comparative size.

Photo 48 shows the coupling in more detail.

The flange was a simple aluminium disc and posed no problems. The captive nut, however, was more difficult; it is made in stainless steel with a fine thread which needs to be a good fit on the threaded aluminium tube. I screw cut the aluminium tube first then made the nut to fit. The central spigot was initially intended to be stainless like the nut. However, after breaking a reamer and a tap, I concluded that brass was the better option, as in the photograph. The origins of the stainless steel were uncertain - probably escaped from an aeroplane engine somewhere.

These components can be seen assembled on the winding house with the tail shaft tube attached in **photo 49**. At this stage the tube had not been cut to the correct length.

The next feature to be tackled was the pivot assembly. The design (**fig 10**) incorporates a thrust bearing to minimise any frictional resistance. The design is little changed from the original



Tail shaft coupling.

except that it now clamps a round tube instead of a square one.

I was aware that for weather vanes some frictional resistance is required in order to damp out undue oscillations in blustery conditions or where there is vortex shedding from nearby structures. Should that be a problem I can tighten the centre bolt a little.

The parts comprising the swivel assembly are shown in **photo 50**.

At this stage a near-complete assembly of the entire windmill was available to establish where the axis should be positioned to allow the windmill to swing into the wind (**photo 51**).

This axis should pass through the centre of gravity for optimum results. This is because, from experience, I have found that as the wind blows and the rain falls the mounting pole tends (without guys) not to stay perfectly vertical for very long. If the axis is not on the centre of gravity the windmill will swing



Winding house attached to the tube.

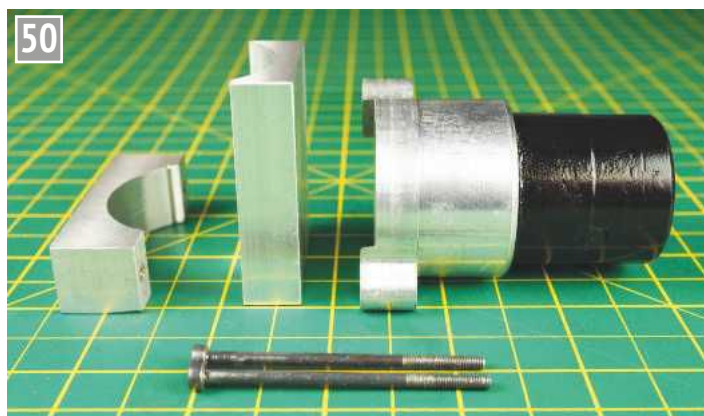
so the heavy end is downhill. It was surprisingly sensitive to small angles of tilt.

Strictly speaking, the windmill should have been balanced about three axes at right angles if the centre of gravity was to be accurately located. However, in this case, it was sufficiently accurate to find the location of the centre

of gravity along the long axis of the windmill.

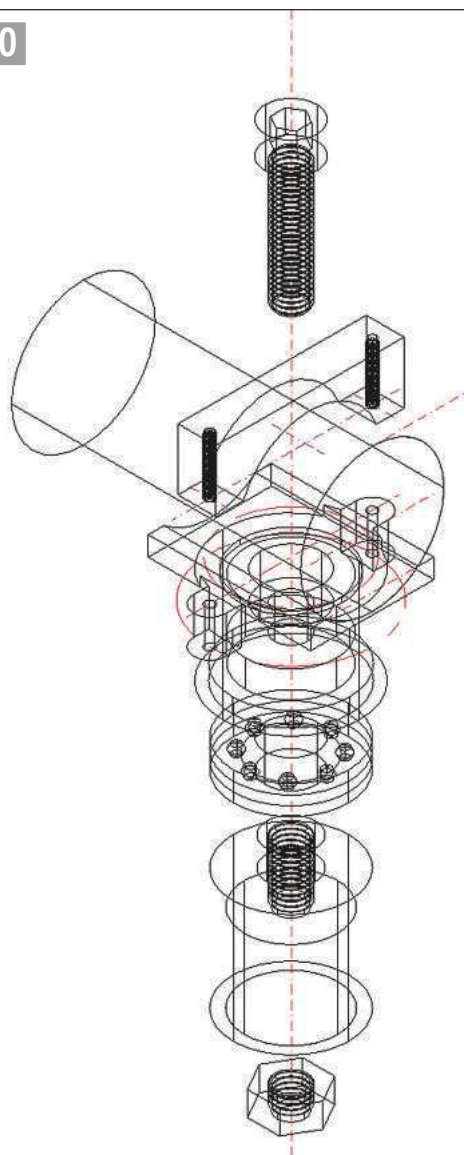
Photo 52 is not the one I took after returning from the pub! It is not upside down but is taken looking downward with the pivot axis of the windmill horizontal. The pivot axis is clamped to the edge of a table by a small vice mounted on the underside. The windmill was balanced about this axis by sliding the clamp along the gearbox body until it remained horizontal as shown.

There were more adjustments to be made, as might be expected. Initially there was a problem with too much friction stopping the turbine rotating when the wind was light. There were several causes including too tight an interference fit on one bearing and a slight misalignment due to the length of two gearbox



Swivel components.

Fig 10



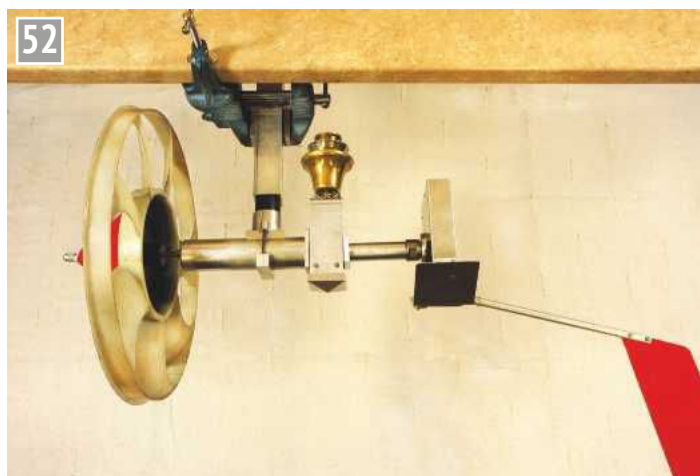
Swivel design.

51



Ready for balancing.

52



In the balance.

spacers differing by a fraction of a millimetre.

After that the adjustments were mostly to do with the bell striking mechanism. The screw adjustments (previously shown in photos 39 and 40) on the lever arms were needed to get the arms to trip at the correct point. As can be seen in **photo 53** lock nuts have been added and the arms have all been adjusted to the correct length. The striking sequence was adjusted by rotating the cam discs slightly. In the photograph the lower arm has struck and the top arm is about to do so.

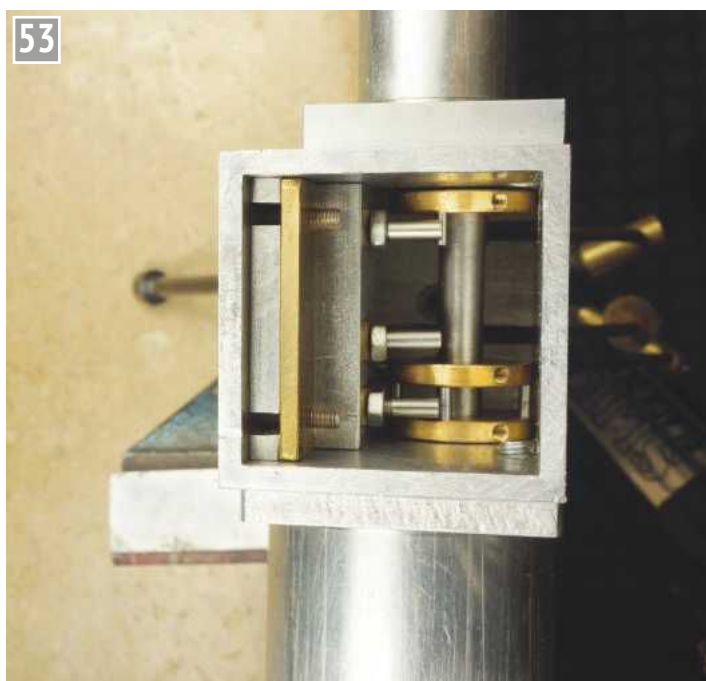
I did consider that Wally might play a tune but with three notes the options were limited. There was also the issue of intermittent and variable winds here in our Midlands location. The brisk continuous winds found in coastal regions are much less frequent here so Wally would be unlikely to get to the end of the tune in one go. If by

chance he did get to the end it was unlikely to be at the same speed that he started!

The chiming sequence was therefore set so the small bell is struck once for every sixteen revolutions of the turbine, the middle bell after 32 revolutions and the large bell 64. The strikes for the separate bells are set close together (as in the photograph) to give the chiming effect. The result is a sort of chiming tachometer!

The brass clamping strip on the left was loosened to allow the pivot block for the striker arms to move, so adjusting the lift of the actuating arm. However, since all the bell cranks pivot around a common axis, they all have the same angular movement. The hammer arms, though, are of different lengths so the hammer on the longer arm would rise and fall further than those on the shorter arms. For a given hammer weight, the hammer on the

53



Adjusting the cams.



Adjusting the hammers.



Dismantled solar light.

longer arm would have more kinetic energy available to strike the bell. Unfortunately, the shorter arm strikes the larger bell and bigger bells generally need hitting harder. The Big Ben story (ref 8) provides some interesting background on a much larger scale.

I experimented a little with the bells and the hammer weights, ending up with the arrangement in photo 54. The two larger hammers have both been increased in weight. Comparison with photo 43, where the middle bell was electroplated, shows that it has been replaced with a cast bell. The original was pressed or spun from flat brass sheet. The top bell is also cast but the bottom one is machined from solid brass.

Generally, the larger the bell the lower the note and, if necessary, a bell can be tuned by machining material from the inner surface. However, bells do not produce a single frequency but a mixture of 'partials' which are responsible for the tone. The tuning process is therefore a mixture of art and science which I could avoid since the bells were not producing a tune.

The duration of the note was important and is affected both by the material from which it is made and by the



Electronic work in progress.

metallurgical state of the metal. There is a particular alloy that looks like brass but is actually a bronze, specially developed for bells. I thought

it unlikely that any of my car boot bargains had that kind of pedigree! However, the performance of the cast bells was noticeably better

but I did have to reject a few contenders at the first audition, particularly the die cast ones, usually zinc alloy, electroplated with brass. These were more 'tunk' than 'ting'.

I had expected that this might be the end of the development story. However, the solar lighting unit refused to light anything. My first thought was that the rechargeable cell was defunct but that was not so and, once recharged, it was functioning as it should, which was more than could be said for the rest of the solar lighting unit. I had three of these garden solar lights and found that in all of them the solar cell had deteriorated to the point where they were unusable. Two of the lights had suffered corrosion damage and two of the electronic modules were no longer operational. So much for my intention to not fiddle with the winding house - it was time for some replacement lights.

Small commercially available solar lighting units provide most of the necessary components at a much lower cost than buying individual components. My search for a replacement started at the local garden centre. I was looking at a huge display of solar powered garden lights when my eagle-eyed wife

found one that was broken. After minimal haggling with the shop assistant it was mine for £1 and all the components I needed were fine. **Photo 55** shows the unit dismantled.

The next stage was to evaluate its performance, which was surprisingly good. The three LEDs gave a lot of light and used only 7.5mA. All I needed to add was a battery carrier and an enclosure to keep the weather off.

Photo 56 shows the development work in progress at the breadboard stage. One LED was lit and was enclosed in one of the small plastic pots for painters that can

to measure the short-circuit output of the solar cell at 15mA. This was better than the previous cells and it would just fit on the winding house roof as in **photo 57**.

Wally now needed a longer-term evaluation, up in the wind outside my own back door, before being erected again at No1 Nephew's house. This would need to include some night time trials to see how long the new solar cell and battery kept Wally illuminated.

The worst-case scenario was starting with a flat battery on a dull day then limiting the hours of daylight by keeping Wally indoors until mid-

morning. I did the test in mid-August, giving Wally about 10 hours of daylight to charge the batteries.

Wally duly lit up at dusk and remained illuminated until 2am - more than enough time to see the children off to sleep. I then let the test run into a second day, which was bright and sunny, with Wally up in the sunshine all day. No one in the house stayed awake long enough to see if the light went out but it was still alight at 4am.

Photo 58 shows Wally at night, with the acrylic cover removed to avoid

unwanted reflections.

So, with the tests successfully completed, Wally was restored to his rightful position and is aloft once more winding the wind (**photo 59**). For how long remains to be seen.

Some statistics:

All up weight	4052g
Turbine rotor diameter	400mm
Nose cone to tail length	860mm

References

Ref 8 <http://www.horologica.co.uk/horology/BigBen.html>



The night shift.

be found in craft shops. The meter is indicating just over 0.5mA so the 250mAh battery (AAA size) fully charged should maintain the lighting for the hours of darkness. The battery and electronics fitted conveniently in another small plastic box available from the craft shop. Shown alongside is the smallest electronics enclosure I could get from the local electronics shop. It was big enough to get an AA size battery and the electronics module inside but would not fit in the winding house.

While I was doing this I also took the opportunity



New solar cell in place.



ME Back up in the wind.

A Whistle for Brahminy

Robert Walker

Readers who remember my series of articles about the design and manufacture of a steam engine for my brother-in-law's fifteen foot launch will remember that I live in England and he lives in Australia. Following the successful initial outings, two additions were requested from 'down under'. The most important was a hand boiler feed pump in case the engine driven pump failed, which is a normal safety requirement, and the other was a steam whistle.

Pump

The design of the pump was based on plans from 'The Steam Engines of Ray Hasbrouck' (2013). If anyone wants details of the pump design, send me a message on the *Model Engineer* website - I am 'Robert Walker 6'. Readers may also be interested to see how complex the plumbing becomes in a steam launch where the steam is condensed and the water reused (see **photo 1**).

Whistle Design

It was agreed that a commercial, spring return valve would be used to operate the whistle. I then began to search for a design and, as with the boat engine, found very little around until I looked in my 'Model Steam Locomotive' book by Henry Greenly. There I found a drawing of a steam whistle and the following design (**photo 2**) is based on Greenly's.

The material used is almost entirely brass, the

only exception being the stainless steel studding that forms the core of the whistle. The critical part that gives the tone of the whistle is the bell that the steam blows over and causes to resonate. Tuning the whistle cannot be done with compressed air, it must be done with steam, as compressed air and steam have different densities. Compressed air is, however, a good initial test to ensure that it does at least whistle.

The path of the steam through the whistle is as follows: it enters through the taped hole in the whistle body, through an annulus that directs the steam at the base of the bell, the vibration of which produces the sound.

The radius at the top of the bell and the top nut are



Plumbing in Brahminy.

purely decorative and, as you can see from photo 2, I chamfered the corners as I did not have an easy way of forming the radii. The internal form of the top of the bell is not critical and I have no idea what the exact internal form is, probably 120° from the drill point. The features that generate the sound are the height and thickness of the bell and the chamfer at the lower edge.

Manufacture

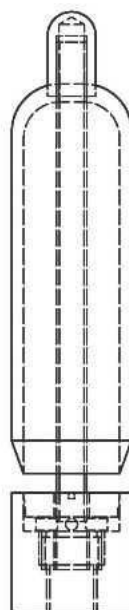
The whistle (**fig 1**) was almost entirely made on the lathe and in my opinion was a very interesting and enjoyable job. The key quality requirement is the alignment of the threads as they maintain the alignment of the bell which, if out of line, would look very unsightly. My lathe is a Myford 254S.

The whistle body (**fig 2**) is

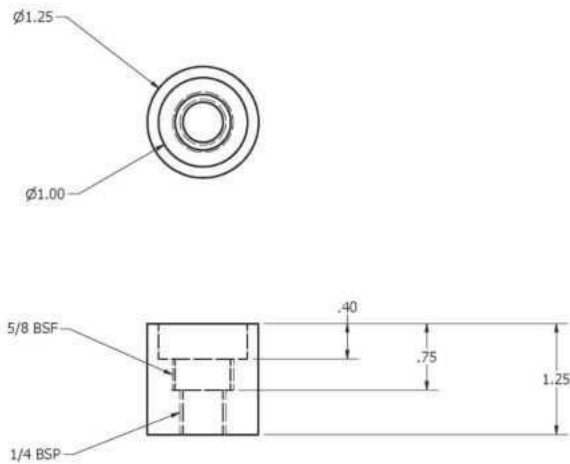


Completed steam whistle after testing on compressed air.

Fig 1



Whistle assembly.

Fig 2**Whistle body – material: brass.**

turned from 1 ¼ inch diameter brass bar. First, I faced off the bar, then I drilled the tapping size for ¼ inch BSP to a depth of 1 ¾ inches then, with a flat bottomed drill (I used a slot drill), I drilled ⅝ inch BSF tapping size to a depth of ¾ inch. I followed the drilling by boring with a boring tool the 1 inch by 0.4 inch deep pocket, ensuring that I had generated a flat bottom to the pocket. A centre in the tailstock must be used to guide both taps to ensure that they are square to the front face. I then polished the outside diameter prior to parting off the body from the bar and lastly faced off the bottom surface.

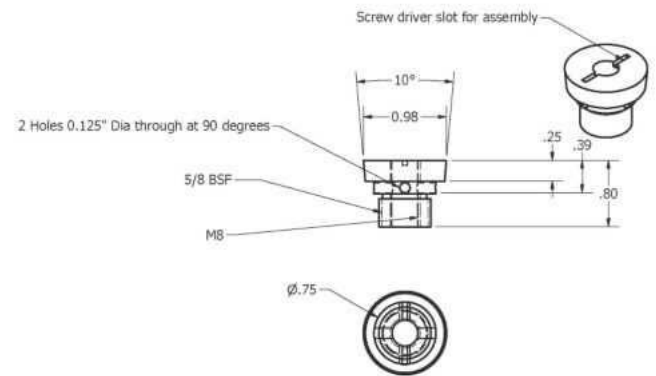
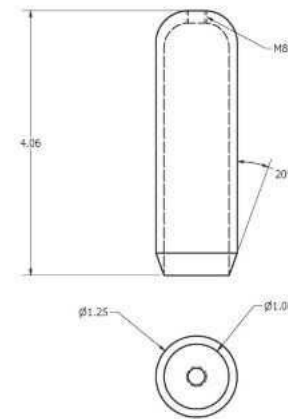
My method for producing the core (fig 3) was to turn the outside shape, including the 10° taper and the undercut for the thread run out. I then drilled and tapped the M8 thread, again using the tailstock centre to guide the tap to ensure that the thread was square to the face. As ⅝ inch BSF is too large to cut with a tailstock die holder, as the round bar will slip in the chuck, I roughed out the thread by screw cutting and finished it off with a die in the tailstock die holder. I used my milling machine with a dividing head to drill the two 0.0625 inch diameter holes. These holes are to pass the steam from the inlet port.

The core was then returned to the lathe to part off and

then back to the mill to cut a screwdriver slot. It is vital that the slot does not reach the outside diameter otherwise the steam path will be distorted and the whistle may not work. To mill the slot I screwed the core into a ⅝ inch BSF nut and held the nut in the dividing head chuck. This of course is not a precise piece of machining as it is just a screwdriver slot. The critical feature of the core is the 0.02 inch clearance between the core and the body for the steam to pass through before being directed at the bell.

To make the bell I cut the 1 ¼ inch diameter brass to length, faced off both ends and drilled and tapped the one end, again using the tailstock centre to guide the tap (fig 4). I then put the form on what would become the top of the whistle; here you can use your creativity to produce a pleasing form. I then reversed the body in the lathe chuck and cut the taper followed by drilling out the bell to about 0.8 inch diameter. I then bored the bell to size. From experience of making Stirling engines with first year engineering students I know that drilling a thin wall component will burst if the drilling force becomes too high, so to avoid this problem I used a boring tool.

The top nut (fig 5) is a simple turning job and again the form on the top is up to

Fig 3**Whistle core – material: brass.****Fig 4****Whistle bell – material: brass.**

you and I suggest it should be similar to the bell.

The last part is to cut a length of stainless steel studding to form the centre spindle of the whistle.

Assembly

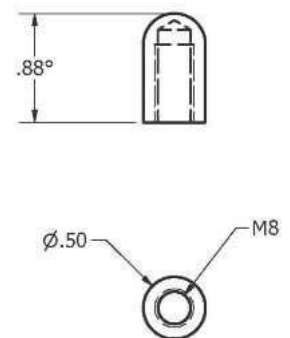
The most important consideration on assembly is to ensure that the steam passes through the orifice between the core and the body and hits the bell. To achieve this the ⅝ inch BSF thread should be sealed with a thread seal compound. As can be seen, the top core is not level with the top of the body but protrudes by about 0.03 inch. Similarly, the M8 studding should also be sealed and locked in the body but not screwed in too deep such that the 1/16 inch steam

holes are blocked. The bell is screwed onto the studding and locked with the top nut. Tuning the whistle is done by adjusting the gap between the body and the bell. As a starting point the gap should be about a quarter of an inch. As I stated in the introduction there will be a difference between the tuning using compressed air on initial testing and when the whistle is finally tested with steam.

References

'The Steam Engines of Ray Hasbrouck', published by Village Press Inc 2013
'Model Steam Locomotives' by Henry Greenly, revised by E. A. Steel, Cassel 1962

ME

Fig 5**Top nut – material: brass.**

Making a Special Purpose Laboratory Measuring Device PART 2

Dennis Stones discusses the manufacture of transducers for his device.

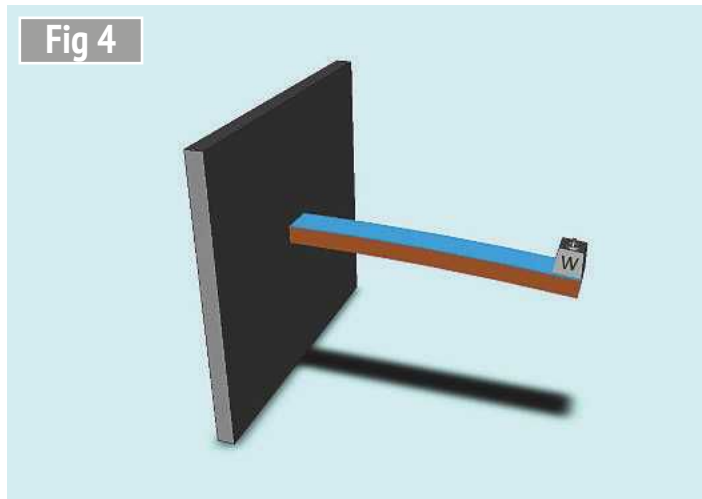


Continued from p.644
M.E. 4572, 27 October 2017

Part 1 of this article described the design and building of a small assortment of specimen manipulators. Running concurrently was a more significant and challenging aspect to be resolved - design and construct a device (a transducer) that could measure forces less than 100mN (1mN $\approx$ 0.102 grams of force). While there might have been other means, I chose a cantilever beam as the simplest reference device (see **fig 4**).

In this case, the cantilever is

Fig 4



The simple cantilever.

Fig 5

Material: Stainless Steel
6.4mm (1/4") diameter



The reference beam.

bending downwards due to the end load 'W' whereas, in reality, it was necessary to tilt the cantilever vertically.

Having chosen a cantilever, there were several possible ways of determining the load (force). Within the experimental constraints however, two showed some potential:

- measure the actual deflection at the tip of the beam, or
 - measure the strain on the two surfaces of the cantilever.
- I chose b) as the simpler of the two.

Referring to **fig 4** again - as the load 'W' bends the beam down it induces a tensile (positive) stress along the upper surface of the

beam. This stress increases (strains) the length of the upper surface. Similarly, the compressive (negative) stress in the lower surface causes a reduction in the length of the lower surface, inducing a negative strain. Given that the stiffness (modulus of elasticity, also known as Young's Modulus 'E') of a solid material relates to *stress* divided by *strain*, it can be seen that for a known material (in this case steel) strain can be derived by dividing stress by the modulus of elasticity 'E'. In the case of the beam in the transducer the modulus is

of the order of 200GPa (200 gigaPascals or, in old units, 30x106lb/in²).

In a cantilever, the fundamental stresses and strains are greatest at the fixed end of the beam gradually decreasing to zero (non-linearly) at the free end.

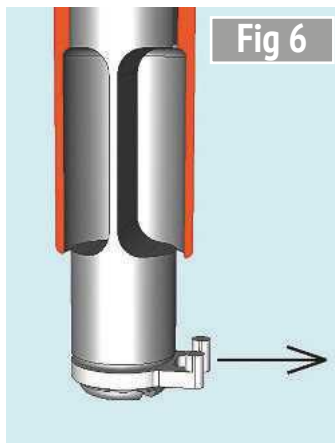
For this particular design, the stress-strain gradient was not a significant issue since calibration of the transducer was to take place against reference forces in the research laboratory. However, it will be seen shortly that both types of strain (positive and negative) can be added together by means of a very neat electrical solution.

A couple of rules governing the use of beam theory are that:

- the degree of bending must remain small, and
- in the case of the transducer, the amount of strain must always remain within the elastic limit of the material.

The image in **fig 5** represents the preferred shape of the beam within the confines of suitability. In reality, 6.4mm (1/4 inch) diameter stainless steel

Fig 6



Beam operating vertically.

rod was the starting point. The thinned down section formed the actual beam on which to glue (bond) the strain gauges.

Hanging vertically, as in **fig 6** with the tip able to dip into the fluid bath, positioning the transducer vertically also allowed slightly more access to the specimen. The arrow indicates the direction of the force. This creates a tensile strain in the left-hand surface of the beam.

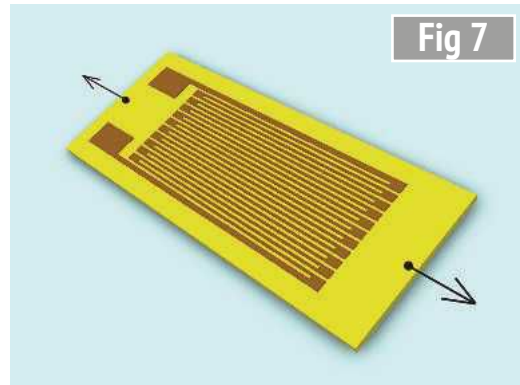
Also visible in **fig 6** is a tubular steel sleeve. I have shown it half sectioned for illustration purposes. It limits the degree of movement should excessive force be applied which could damage the beam. It also offers some physical protection for the strain gauges although **photo 6** shows that (for some reason) I cut windows in the side of the sleeve.

It is important now to look more closely at the construction of a typical strain gauge (see **fig 7**).

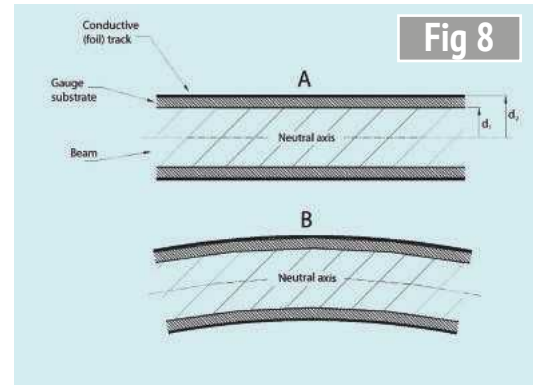
Bonded to the surface of a thin substrate of insulating material is an electrically conductive track usually made of copper, alloyed with nickel (constantan). The track is fashioned into a zigzag as shown. In the case of the ones I used, the substrate was about 6mm long by about 3mm wide, and a recent search reveals the thickness to be in the order of about 45 microns (0.045mm).

Straining the conductive track longitudinally (either by stretching or compressing) alters its physical length and therefore its electrical resistance. Stretching the track *increases* its electrical resistance, while applying compressive strain *decreases* its resistance. Having a multiplicity of parallel tracks connected in series (the zigzag pattern) significantly increases the working length of the track thereby providing a much greater change of resistance within a small area.

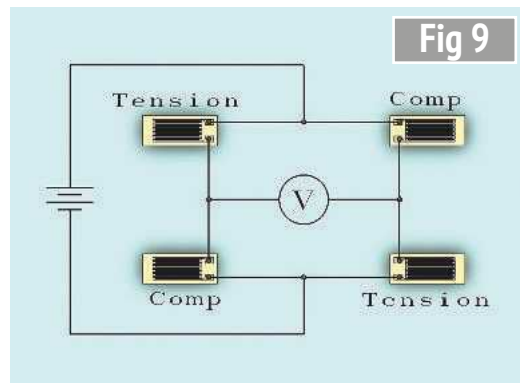
Secure bonding of the strain gauge to the reference surface is imperative. I chose epoxy resin although, thirty years on,



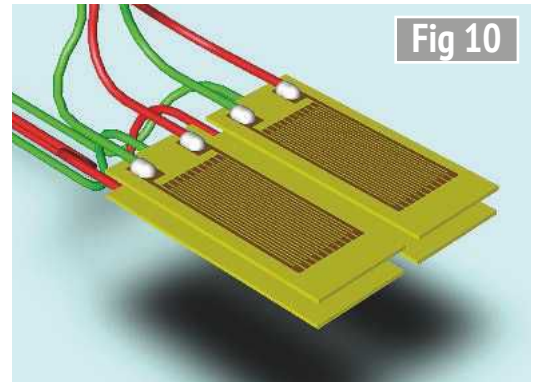
Typical strain gauge.



Substrate thickness.



Bridge circuit.



Four strain gauges.

a search of the Internet reveals suppliers offering special cements.

In **fig 8** (section A), the reference beam thickness (as I recall) was 0.25mm. The distance d_1 from the neutral axis to the extreme fibre of the beam was thus 0.125mm. Assuming the thickness of the substrate was 0.045mm, the two values of d_1 and d_2 are therefore 0.125mm and 0.17mm respectively. It should thus be borne in mind that, when in pure (linear) tension, the strain on the strain gauges would be the same on both surfaces. Although in bending on the other hand (see **fig 8** - section B) the actual strain on the gauge would be greater due to the thickness of the substrate; about 36% greater in this case. Now here comes the clever bit.

A single strain gauge might be sufficient to determine the force exerted by the specimen. Attached to either the top or the bottom surface of the beam, it could measure either tensile or compressive strain. However, the change in resistance would be low and other complications of

temperature could influence the reading.

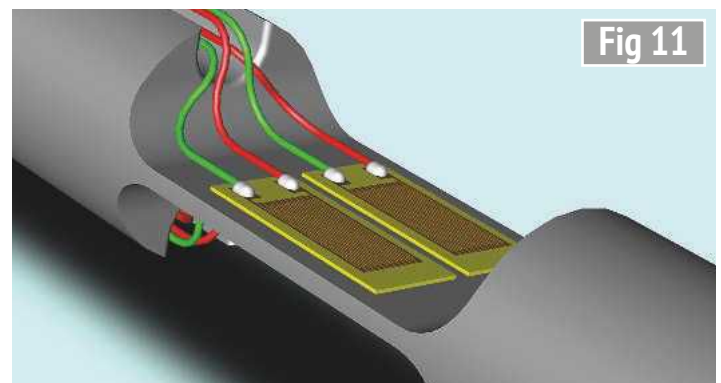
A better solution would be two gauges, one attached to the top surface and one on the bottom surface but, again, the same sorts of artefacts have to be considered.

The preferred arrangement, however, is a bridge circuit using four gauges; two gauges on the top surface and two on the bottom surface. Electrically, a bridge circuit is shown in **fig 9**. In this layout, the two top gauges measure tension and the two bottom gauges measure compression. An important factor here is that the changes in resistance should be equal in all four

gauges. Accurate positioning of the gauges (top and bottom and side by side) is therefore important. It is worth noting here that pairs of gauges arranged side by side are available for this very purpose.

Another exacting requirement was machining the stainless steel rod to form a thin 0.010 inch (0.25mm) web. An alternative approach would have been to trap a strip of stainless steel shim at both ends, not unlike the method of suspending the pendulum of a clock. Although slightly more difficult, machining the beam from solid seemed more

Continued on page 160



Strain gauges in position.

ME Vertical Boiler PART 2

A project aimed at beginners wishing to develop their skills or those requiring a robust vertical boiler for the running or testing of small steam engines.

Martin Gearing explains the conventions he will be using.

Continued from p.45
M.E. 4576, 22 December 2017

In this part we'll spend a little time looking at the conventions we'll use in these project notes. Please understand though that the notes are not the only way of completing the project. However, the methods described are ones that have worked for a person with no prior experience and are shown in the supporting pictures. They have also worked for everyone I have been involved with so far who has completed a successful certificated hand pump, boiler and fittings.

More experienced builders will note that the threads used for the boiler fittings are not from the conventional ME 40TPI range but from the ME 32TPI range. Experience has proven to me that the finer thread is more problematic when used by beginners and that the 32TPI range gives a very much higher rate of success as well as being more robust. However, it does mean that the fittings will have to be made because commercial fittings are not generally available in this range – but the whole purpose of the article is to gain experience in the construction of items,



Fig 1

WORKING DRAWINGS

Drawing Conventions Used

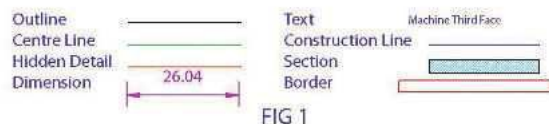
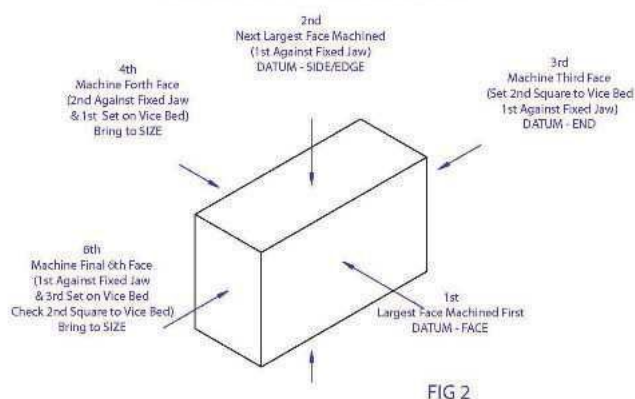


Fig 2

Preparing Blanks

DATUM Locations



so I feel the choice is sound. Nipping out and buying the fittings would be cheating!

In the following 'Build Guidance Notes' the component headings are followed with the parts drawing reference and the suggested blank material size (thickness – width – length), all shown in bold type and underlined e.g. **MAIN BODY - Item HP1 - Brass – ½ x 1 x 2 inch**

Refer to - Drawing – HP1 - refers to the drawing that accompanies the text.

Virtually everything you will be constructing from these notes will make reference to a drawing. The drawings I have provided take some liberties

with the currently accepted 2D drawing standards in an effort to simplify things. The editor has agreed to reproduce the drawings using colour in an effort to make things easier to understand as the majority of beginners may never have received tuition in formal 2D mechanical drawing - or it was so long ago they've forgotten!

Those who may have been lucky enough to have been shown drawing used with 3D modelling will be more used to putting detail onto a screen and applying the material around it. This is the way it happens in 'additive' manufacturing such as 3D printing and will tend to be the opposite of conventional 2D

drawing. 2D drawing assumes that we start with a 'lump' of material and remove areas in the form of drilled holes, grooves, slots, reductions in diameter/specified sections – in simple terms – 'Subtractive' manufacture, the way it used to be done - until recently!

The different conventions I have chosen to use within the drawings in this article are shown in **fig 1**. This shows what the different colours and types of lines define.

Before an item can be made from a drawing an understanding of the principles behind dimensioning must be understood. A simple example would be if you were asked your size you would give a figure, let's say 1800mm tall. The number would be meaningless without the word 'tall'. By adding 'tall' after a number, it is universally understood that the measurement is taken from the ground on which you stand to the top of your head. The ground in engineering terms is referred to as the **DATUM** from which the measurement is taken and in this case only applies to one direction – vertical - your height. When you become involved in making three-dimensional articles you have to have three DATUMS, one for thickness, one for width and one for height/length.

The first task when beginning to make an object using conventional methods is to prepare the material blank by accurately forming three **DATUMS**, from which the three dimensions of **THICKNESS**, **WIDTH** and **LENGTH** may be created (**fig 2**). This will hopefully make it easier to understand **DATUMS** and a suggested sequence of preparing a blank, after which any further details may be machined, turning the blank into a part - with luck identical to that shown in the drawing the dimensions have been taken from!

Another convention that needs to be understood is the reference of machine tool slide movement related to the tool position,

equally relevant to manual or CNC machinery (**fig 3**).

In simple terms it may be thought of as three separate planes each at 90° to one another. A simple description is that both the horizontal movements are referenced to the machine column. **LEFT** and **RIGHT** movements are given the letter **X** and **IN/TOWARDS** and **OUT/AWAY** are **Y**. To make sense of the direction in each plane **RIGHT** = **X+**, **LEFT** = **X-**, **IN/TOWARDS** = **Y+**, **OUT/AWAY** is **Y-**.

The vertical movements **UP** and **DOWN** are given the letter **Z** and are slightly more difficult to comprehend as it appears opposite to the way one would expect but it relates to the progression of the cutting tool *into* and *out* of the work or, to put it another way, whether the distance between the tool and the work gets larger (+) or smaller (-).

The **Z-** value indicates the distance is decreasing and because of that the tool goes deeper **INTO** the work. Conversely, the **Z+** value indicates that the tool moves **AWAY** from the work.

Depending on the machine design and construction, **Z-** can be used for either when the quill moves the cutting tool *down*, OR the knee on the machine column moving the work up onto the cutting tool, **INCREASING** the depth of cut. Whichever it is, **Z+** denotes the opposite. This is shown graphically in **Fig 3**.

Please note that because



Checking the milling spindle is truly vertical to the table.

Fig 3

AXIS Conventions & Locations

It is always assumed the cutter moves around a fixed workpiece. This is regardless of if the workpiece or the cutting tool move.

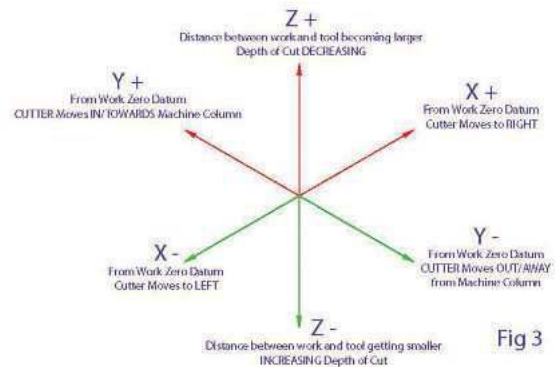


Fig 3

most beginners/constructors will be using conventional manual machines, and not all will have the benefit of Digital Read Out (DRO) on the Z axis, I've departed from the 'true' convention and the build notes that follow will refer to taking a cut on the Z axis as positive (+).

This is because the Z axis table feed dial graduations do increase as a cut is taken, because the work is moved towards the cutter, in the case of raising the table and likewise the quill or head graduations increase if moving the tool into the work. Should you be using a CNC machine you will be working from the drawing to write the code so the deviation from convention in the text won't cause a problem and if you did use the text you'd be cutting in fresh air!

The series is broken into four parts, each with a reference letter:

1. HP - Hand Pump
2. B - Boiler.
3. BF - Boiler fittings.
4. GB - Gas Burner.

These are followed by the final section with details for completion, testing and operation of the boiler.

Each part is able to function as a separate stand-alone unit for those who may find interest in the individual sections as they are covered.

Checking machine head and vice alignment

The fastest method of producing flat surfaces square to adjacent faces, and parallel to opposite faces, is by using a milling machine and in the home workshop this is almost always of the vertical type. You must ensure that the head is truly vertical to the table, which is quickly checked by swinging a dial test indicator (DTI) mounted on a 'L'-shaped bar across the table to see if there is any deviation and adjusting the head until zero movement is achieved when at extremes on the X (left and right) axis and extremes on the Y (away and towards you), assuming you are standing at the front of the machine (**photo 1**).

Depending on the machine's construction, the Z (up and down) axis is a function of a moving quill in

the head and/or machined slides in the mainframe, onto which the knee and head is mounted, and will be at 90° to the X and Y slide ways. In the following descriptions I will be referring to a machine (generally referred to as a VMC type) with a quill in a head rotatable in two planes and has a depth stop but with no fine graduations, and the X axis table and Y axis subframe, mounted on a knee moving the Z axis on dovetail slide ways in the front of the machine frame. The X, Y and Z slides all have graduated dials. All references to 'setting feed dials' to zero is of course equivalent to 'push to zero' for those lucky enough to have a DRO!

If you have a machine with the X axis table and Y axis subframe located on a fixed base and column with the Z axis movement provided by the head moving on the main column you will have to amend some of the instructions.

Before any metal can be cut the means of holding it has to be set true to the milling machine table. In almost all cases this will take the form of a milling machine vice having a fixed jaw on the body that is secured to the table bed by means of 'T' bolts that locate in the slots in the machine table. Machined into the body of the vice are slides that accurately guide the moving jaw at 90° to the fixed jaw by means of a feed screw.

It is customary to align the fixed jaw parallel to the X axis (left and right movement) and this is done by using a DTI with its base mounted firmly to a convenient part of the machine head or frame and the vice mounted onto the table with the fixing bolts lightly secured. The table is then moved so that the fixed jaw passes the stylus of the DTI. Any deviation from parallel will show up as movement on the dial. This must be reduced to zero by moving the vice body as



Setting the vice fixed jaw so it runs parallel to the X axis.

necessary by tapping the body – always remembering to lift the stylus. This is so that the shock of the tapping doesn't damage the mechanism of the DTI. Tedious though it may seem at first, the time spent in achieving zero will be repaid in the accuracy achieved in all of the work held in the vice from now on.

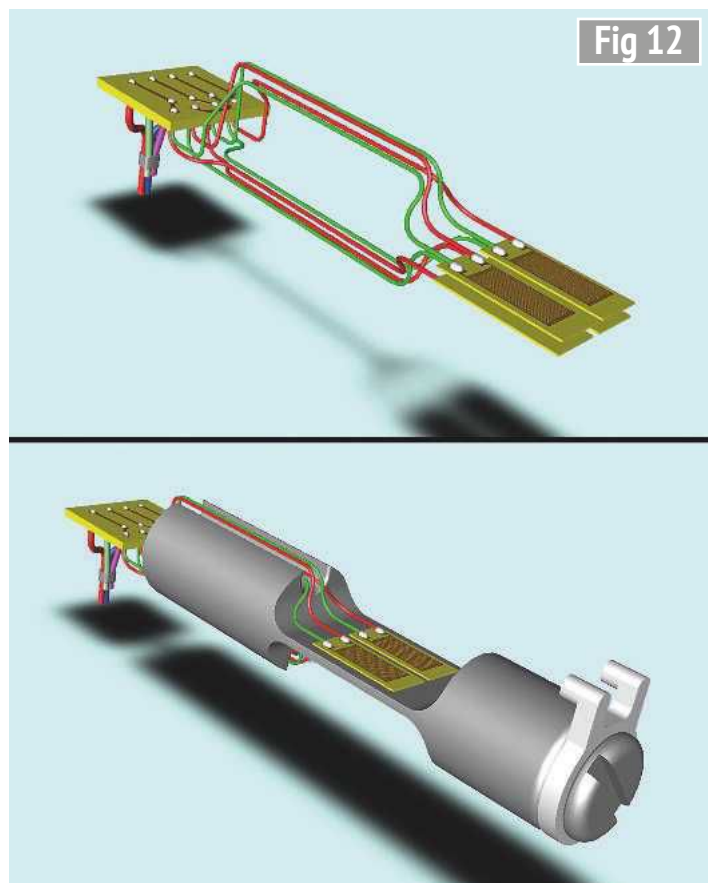
When no movement on the dial gauge results after

passing the stylus the full width of the vice jaw with the securing bolts fully tightened, you are ready to make a start. The fixed jaw becomes your vertical reference at 90° to the bed of the vice within the inherent accuracy of the vice (**photo 2**).

Next time we will look at the bill of materials you will require.

●To be continued.

'Special Purpose Laboratory Measuring Device' continued from page 157



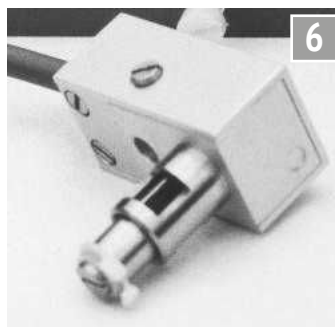
Transducer wiring.

Fig 12

appropriate at the time.

Setting up for machining the beam was critical. In particular, supporting the web (reference section) from the underside during the second step was quite fiddly. Very small cuts were necessary to avoid distortion and lack of beam symmetry. As can be seen, grooves provided conduits for the eight wires.

The next rather tricky bit was bonding the four strain gauges into position, and dealing with the extremely fine lead out wires. **Fig 10** shows their relationship prior to bonding.



The completed transducer.

Figure 11 shows the strain gauges in position.

Had I positioned the gauges close to the fixed end of the beam with their lead out wires doubled back, the electrical response would have been greater. I didn't think of that until I was writing this article. At the time, I preferred to position the delicate wires furthest from the wet end of the device.

The first version of transducer was rather cumbersome in that the main lead-out cable exited vertically and got in the way. A tiny PCB (printed circuit board) and a right-angled terminal box fixed this problem (see **fig 12** and **photo 6**).

REFERENCES

1. Here is a useful article about strain gauges (and other things): <https://www.allaboutcircuits.com/textbook/direct-current/chpt-9/strain-gauges>

Ramon Wilson finishes off the remaining woodwork



Wide-A-Wake

Continued from p.50
M.E. 4576, 22 December 2017



Wide-A-Wake is a 2 inch scale model of a clinker built steam launch that plied the waters of Lough Erne in Ireland at the turn of the 19th Century. The model, designed by H. Croker and built in similar fashion to the full size, is powered by a Stuart Turner Double Ten engine and was first featured in the February 1972 issue of *Model Boats* magazine.

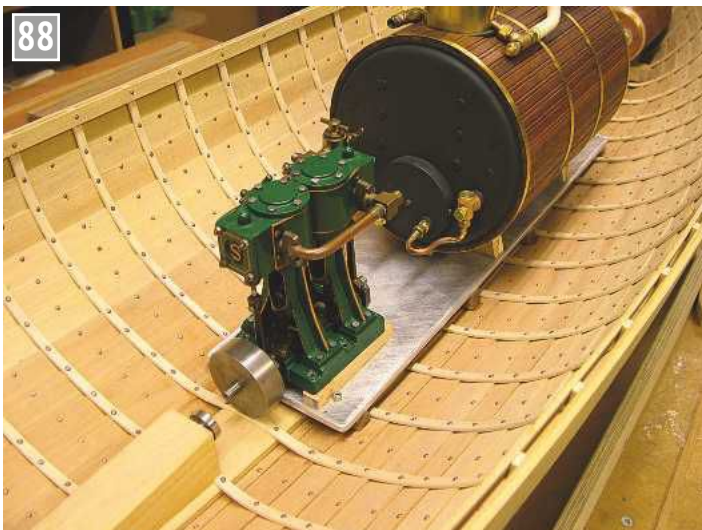
The next phase of this project proved, without doubt, to be the most enjoyable. It did take some time but as it grew on a daily basis the reward was extremely satisfying.

First off however was to see how the engine and boiler would sit. So that it could be easily removed

after a steaming the whole plant would be mounted on an aluminium plate and the means to mount that required to be established. Four beech-wood bearers were cut to support the mounting plate and shaped to fit the contours of the hull and hog. Once established for level these were epoxied into place – one

of the rare uses of epoxy glue in this build. The plate was held in place by four stainless cap head screws locating in holes tapped into the end bearers (**photo 88**).

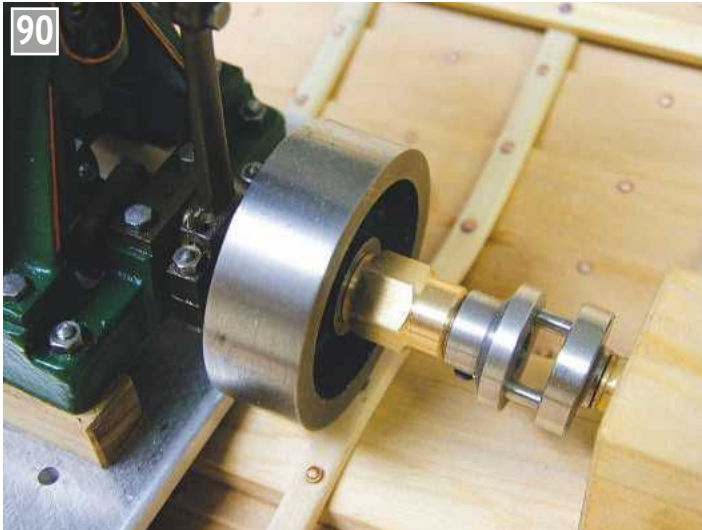
An expanding collet type flywheel mount and coupling drive was made to replace the single grub screw fastener of the original engine (**photo**



Initial alignment of the power plant.



The parts for the collet type flywheel drive and coupling.



Final alignment of engine and shaft.



Fitting the stringers and the final riveting.

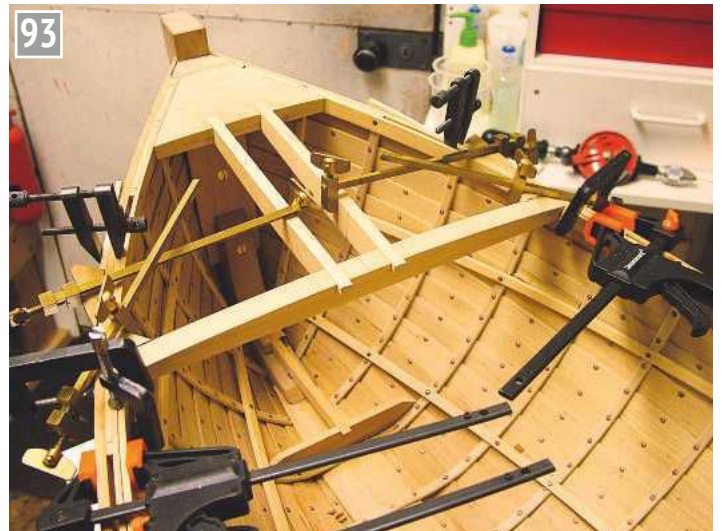


Home-made 'thicknesser' at work.

89). Mounted on shaped hard wood bearers and taking into account that reversing gear would be fitted at a later date the engine could now be positioned and aligned

correctly (photo 90).

With the position of the plant now established work could begin on the remaining woodwork. First up was to introduce the stringers, which



The internal breastwork gets under way.

meant more riveting of course, but that procedure was coming to a rapid end (photo 91).

Most of the internal woodwork was done using the ever-dwindling supply

of Parana pine and, with the bought in sections used for the planking, it would be the recycling of old window sills that provided the rest. Access to a universal wood working



Fairing the spacer blocks with a spline.



Fitting the inner coaming boards.



Ready for the decks.



The true lines are seen for the first time.



The aft bulkhead from the engine side.



Aft bulkhead from the aft cockpit side showing the fixing ribs clear of the planking.



Attaching the 1.5mm ply sub fore-deck.



Showing the Bass wood planking and thick card 'caulking'.

machine helped in cutting up the larger sections but most was cut using a very old circular saw, bought originally from 'Gamages' and given to me by a fellow model

engineer many years ago. Fitted with a fierce looking and coarse toothed planer blade this produces a finish from sawn that just requires sanding. The mill was pressed

into use as a thickener at times too using nothing more than some sections of ply to create a means of containing the section. A new ¼ inch FC3 Cutter run at top speed

produced excellent results (photo 92).

The breast work went in at the bows (photo 93) followed by the spacing blocks to hold the inner coaming boards



102 *Finished planking after much sanding, scraping and more sanding!*



103 *Fitting the mahogany rubbing strake, 10 BA countersunk brass screws were used for scale head effect.*



104 *Laminating the forward coaming from three layers of mahogany sheet. As elsewhere there are never enough clamps at times.*



105 *Laminating the side coaming from two layers – more clamps!*

(photo 94). Once these were faired to the sheer line the inner boards could be glued and screwed in place (photo 95) and faired ready to accept the deck (photo 96). By this stage the true lines of the boat were really having a very encouraging effect on further progress (photo 97).

A trip to the Boat Building College was made at this stage for further advice. So far so good - so armed with new information the aft bulkhead was fitted to provide a water channel and no touching areas where rot could possibly start (photos 98 and 99). The wood used for the boarding was from off-cuts of the planking timber using the darker grain for a bit of contrast.

With the bulkhead finished, the decks could be laid. Firstly,



106 *Ready for the final two parts.*



107 Cutting and shaping the external breastwork.

a sub-deck of 1/16 ply was glued in place and trimmed all round once set. Made in four pieces, this was easily curved to the contours of sheer and camber (**photo 100**).

The decks proper were laid using 2mm sheet Bass wood cut into the required width. The caulking was cut from 1mm thick black card about 2.5 to 3mm wide and fixed in place using Zap thin cyanoacrylate 'super glue' (CA). Once the centre 'king' plank was fixed the next was brought up to it with a strip of card nipped tightly between. The CA was applied to the outer edge and capillary action allowed this to wick through and capture the card too (**photo 101**). This method had been used very successfully before on other models but not on such narrow planks. No glue is applied on the outer surfaces in this method and, despite the initial doubt that it may not wick through sufficiently, these fears proved unfounded and the planking was quickly established. Finishing, however, was not quite so simple as it took a considerable amount of effort to sand down the excess thick CA soaked card and then the planks themselves to give a nice smooth and even surface (**photo 102**).

The rubbing strip (**photo 103**) was cut from mahogany and glued, clamped and screwed in place, and the deck



108 The simple cutters made to create small plugs – the plug cutter was left unhardened.



109 The last major pieces in place just requiring some trim work.

coaming laminated from thin sheets of Mahogany. Three 1mm layers around the fore curved area going to two layers of 1.5mm along the sides were glued and screwed to the inner boards (**photos 104 and 105**). Once faired off and sanded, it was felt that the contrast at least helped overcome the out of scale grain in the mahogany parts (**photo 106**).

This left more or less the final parts of construction - the external breastwork. These were probably the most

difficult parts to shape of the whole project, partly due to the compound curvatures of the deck beneath, and not least because the Parana supply was now virtually terminal, but careful sanding and shaping paid off (**photo 107**). Gluing and nailing these into position using long copper rivets left open holes which would require plugging. Simple cutters were made to create plugs from a scrap of Parana, which finished this part off just as in full size (**photos 108 and 109**).

With this complete a final sanding all over was carried out followed by a thorough vacuuming to remove all traces of dust. It was time to apply the varnish.

● To be continued.

Next time – Varnishing and making the various cosmetic parts.

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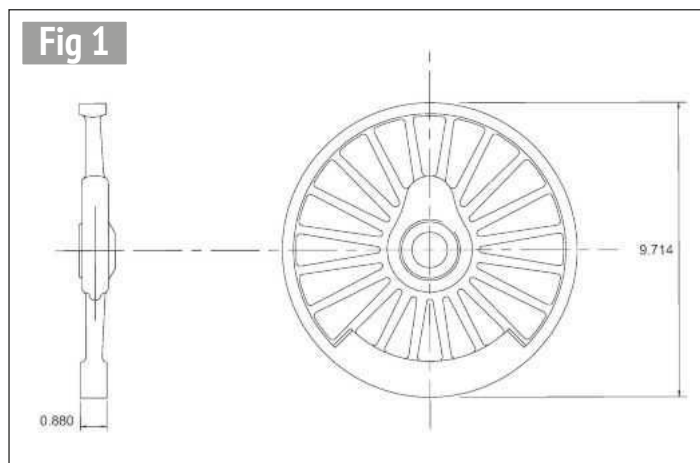
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Making the driving wheels for 4457 PART 1

Bob Bramson explains how he designed and made the driving wheels for a 7¼ inch Great Northern C1 class locomotive.



Trailing driving wheel pattern.

Designing and making working models is one of the most satisfying and rewarding of pastimes. For one thing, it keeps the mind active and healthy and, although being locked in one's workshop can lead to a rather hermetic existence, once you meet other likeminded people, dialogue ensues and those little problems and unimagined techniques can be solved and shared to mutual advantage. In this article, I am pleased to share with you the little I have learned on one particular aspect of miniature locomotive construction –

driving wheels.

The model that I am building is a Great Northern C1 Class (large boilered) Atlantic in 7¼ inch gauge. Big sister was designed by Mr H.A. Ivatt at the very beginning of the 20th Century and the model is based on locomotive No.4457 which was outshopped in 1910. I chose this particular locomotive simply because it was retired on or about my birth date and I plan to finish it as it was in LNER days (I dislike the Ramsbottom safety valves fitted to the original GNR builds). I estimate that there is about 4,000 hours' work to complete it and so far I have racked up nearly 1,600. I hope to have it running by the summer of 2020.

I thought an article about the design and construction of the driving wheels might be of interest to those who are new to the hobby or to 7¼ inch gauge. It includes the fitting of steel tyres, quartering the cranks and a discourse on the subject of wheel balancing. In 7¼ inch gauge, being ⅛th full size, the engineering loads become significantly greater

than those encountered in the smaller gauges and greater attention needs to be paid to the design and construction to cater for these.

For my project, there were no castings available either from the 7¼ Inch Gauge Society or from the usual model engineering suppliers. Fortunately, I had the privilege of making contact with that renowned model engineer, Mr Bill Carter, shortly before he died. Bill's 5 inch gauge model of Atlantic No.3295 is a delight to behold and in 1964, when it was completed, it won many accolades for his craftsmanship. By courtesy of his daughter, I was fortunate to obtain copies of the Doncaster works drawings and the loan of Bill's complete notes and photographic records of the construction of his superb model.

Now an Atlantic, having a 4-4-2 wheel arrangement, only has limited adhesive weight and I decided from the outset that I would fit shrunk-on tyres as did Bill on 3295. For those with a technical bent, the dry coefficient of friction of steel on steel is between 0.25 and 0.28. For cast iron on steel it is only about 0.15 to 0.18 thus it is a 'no brainer' to opt for steel tyres.

With no readymade castings to hand, patterns had to be made. Originally, I intended to make a wooden pattern and, since the leading and trailing driving wheels have different size balance weights, this would have entailed casting the leading wheels first and then building up the pattern to adapt it for the trailing wheels. Fortunately, at one of the Model Engineering



Locomotive wheel patterns.

exhibitions, I had a chat with Peter Thomas of Polly Model Engineering about this and as a result of Pete's extensive experience became convinced that another approach was practicable.

A wooden pattern would have taken considerable time to produce, even supposing that my skills could support the making of them. On the other hand, drawing them out in CAD and machining the patterns in stable plastic for both varieties using CNC would be a lot quicker and considerably easier. When I was at work, I often managed to get one of our draughtsmen to do the occasional CAD drawing for me but when I retired this was no longer possible so I sat down to teach myself CAD. At first it was like wading through treacle, so I went back to pencil and paper but soon gave up the traditional approach as it was slow, inaccurate and, as the drawing board was located in the store shed, cold and damp. I persevered with the impenetrable *geek speak* of the TurboCad user guide and after a while discovered that my skills were beginning to develop. I suppose it took about six months to become reasonably proficient in two dimensional format and, having got to grips with the 'electronic pencil', I burned my bridges and sold the drawing board.

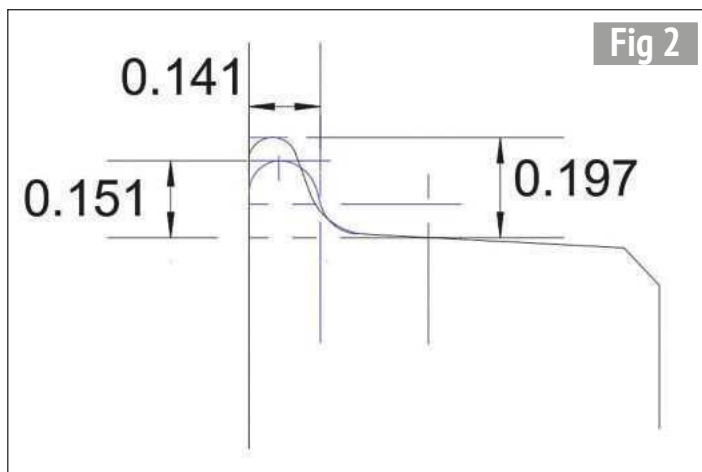
Figure 1 shows the completed wheel pattern drawing which included both shrinkage and machining allowances.

A 'Sections Thro' drawing was also prepared to enable the CNC machinist to cut the exact spoke and blend profiles. The patterns are shown in **photo 1** and when the finished castings arrived from Polly Model Engineering (**photo 2**) they were found to be of excellent quality and faithful to the drawing.

The running diameter of the wheel tread is 10.264 inch which equates to 6 feet 8 inches. Now here comes a conundrum. On the Doncaster

drawing, the wheel diameter is shown as 6 feet 8 inches but the wheel centres are 6 feet 10 inch inches. That means that the standard flange height of $1\frac{1}{8}$ inch would overlap by $\frac{1}{4}$ inch! The original 990 Class (small boilered) Atlantics had 6 foot $7\frac{1}{2}$ inch diameter wheels, as did the LBSCR H Class Atlantics.

It took ages for the truth to be discovered and it was Brian Penney, my former mentor, who provided the answer. When Brian examined No.251, before it was moved on BR lines in the York area, the



Comparison between BR P1 (blue to scale) and $7\frac{1}{4}$ inch gauge flange profiles.



Locomotive driving and carrying wheel castings.

flange heights were found to be only 29/32 inch. With new tyres, that gives a bare 3/16 inch flange tip clearance! That apparently was how the GNR designed them. Why, you ask? I'm afraid I don't have the answer to that one. I can only imagine that the turntable diameters on the GNR at the time these locomotives entered service were not large enough or perhaps the American doctrine was that the wheel centres must be as close together as possible - I doubt we shall ever know.

This then presented a problem with the model as standard $7\frac{1}{4}$ inch gauge flanges would extend the coupled wheelbase way beyond scale. Clearly, some form of compromise was necessary. If you look at fig 2 you will see the disparity between the standard BR P1 flange profile to scale and the $7\frac{1}{4}$ inch gauge standard.

The people who specified the $7\frac{1}{4}$ inch gauge standard may not have had railway engineering experience and the flange thickness is rather thin giving rise to a weakened

flange with little provision for wear. Additionally, the radii are so imprecisely specified that machining of that profile becomes a bit of a lottery. Worse still, the flange heights are well over scale, for what reason I know not. I decided to adopt the P1 profile to minimize the additional axle spacing, the flange height being 0.150 inch and the tip clearance between flanges I chose as just 0.070 inch. The distance between the axles is 10.633 inches. The flangeway clearance is not adversely affected with a back to back dimension of 6 13/16 inches.

Now here comes another one. The standard $7\frac{1}{4}$ inch gauge tyre width is 13/16 inch. The scale dimension is $\frac{3}{4}$ inch. The extra $1/16$ inch I suppose provides some sort of safety margin when running on model tracks because those have to cater for oversize narrow gauge monsters which share the track and tend to spread the gauge, especially on curves, switches and crossings. I therefore decided to retain the additional width but this then

compromised the cylinder centres. Again, some changes became necessary. As it happened, the 'as cast' wheel boss width worked for me as there was ample machining allowance in the castings. In the end, it turned out that the boss sat just a little more than scale. A bit of layout using the CAD proved that all that was necessary was to extend the cylinder to locomotive centre line by 0.038 inch.

Now some of you will think why am I giving these dimensions to three decimal places? Well, 0.001 inch represents 0.008 inch in full size, and 0.010 inch is getting on for 3/32 inch. There is of course, room for minor constructional errors (there has to be) but I try to work as close to drawing as I can (where it matters) with the skills and equipment that I have.

Next time I shall make a start on machining the wheel castings.

● To be continued.

Tales of the SMEE Collection: the *Hatfield* Water Pump

Peter Haycock and Roger Backhouse take a look at the *Hatfield* Water Pump.



Hatfield pump on Merryweather fire engine of 1907-08 in the Museum of Technology and Transport, Auckland New Zealand. It could pump up to 250 gallons per minute. © Lisa Truttman 2012 and reproduced by permission.

In its 118 year history the Society of Model and Experimental Engineers (SMEE) has acquired a collection of engineering models including locomotives, ships, stationary engines, tools and experimental equipment. All have stories, whether of their makers, donors, construction or restoration. Some will feature in these articles.

SMEE's Stationary Engines Committee members have restored many to working order and conserved others for display. Though models are kept off site SMEE arranges displays at exhibitions when possible.

The Hatfield water pump is a splendid example of model engineering from a craftsman working for Merryweather's who'd also made full size versions. A highly successful pump design in its own right, the pump also has local connections as the original was made in Greenwich, near SMEE's South London base.

The model was built by Harry Roughton and presented to the Society by his widow in 1984. Mr Roughton was a member of the Society remembered as a pleasant, modest man who always worked to the highest standards. There is a description of the techniques he used to construct the model as well as a history of Merryweather and fire fighting published in the Society's *Journal* of May 1966.

This article is interesting as it gives us an insight into the life and times of a model engineer living almost 100 years ago when conditions were so very different to those of today. I can think of no better introduction than by quoting him from the *Journal*:

'What were the reasons for my building the model? Let's call it nostalgia; in 1926, when jobs were very hard to find, I was fortunate to get a job as a fitter at Merryweather's of Greenwich. I spent a number of very happy years there, mostly in what they called the pump shop although we also did other types of jobs.'

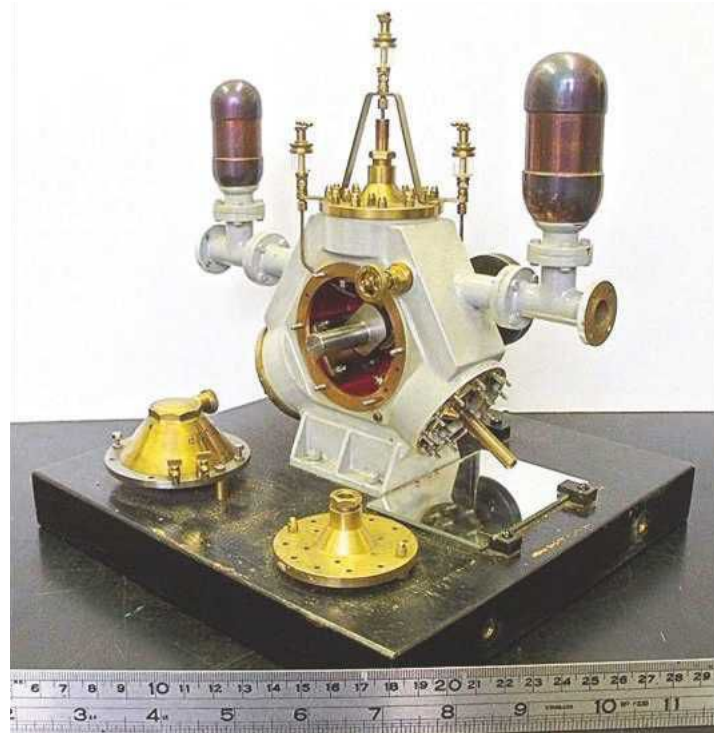
'A lot more work was done by hand than would be tolerated in these days and Merryweather's were justly proud of the quality and finish of their products.'

'Spit and polish' we called it but it did look good and many of the jobs screamed to be modelled, especially the steam engine pumping sets. 'Greenwich Gems' they were called and ranged in size from 350gpm (gallons per minute), used on the old steam fire engines, to 2000gpm, mostly used for fire protection on ships.'

He then continued discussing the development of fire-fighting and fire-fighting equipment following the Great Fire of London and how the firm of Merryweather can be traced back to the second half of the 17th century when a Samuel Hadley commenced making leather buckets and pipes. The business, later trading under the name Merryweather, became pre-eminent in the fire-fighting industry. By 1842 Merryweather, responding to market demands, had developed a manual pump that needed 40 men to operate but could throw a jet of water 100 feet or more.

The demand for more power led to the development of steam powered pumps. The first of these supplied to London went to a Lambeth distillery owned by Frederick Hodges. By 1903 the first petrol engine engines began to appear and in 1908 Merryweather supplied the first petrol driven pump to the London Fire Brigade, having a 50hp engine and a Hatfield pump with a capacity of 500 gallons per minute. The first ever Hatfield pump had been built and installed at Hatfield House in 1896.

There are particular



Model Hatfield pump made by Harry Roughton. © Peter Haycock 2017.

features of the design of the Hatfield pump that made it so successful. The pumping action was produced by three pumping cylinders, driven by a central crankshaft, timed to act in concert to give a continuous water flow. Each cylinder was coupled to a valve design that utilised the direction of water flow to operate the valves; similar to the way a 'clack' valve operates. The whole was housed in a body having internal passages directing the water to flow continuously into the discharge pipe.

The pumps were made in various sizes depending on the duty required. Tests of the model conducted by Mr Roughton showed it to be capable of producing a jet of 1.5 gallons of water a minute driven at 425rpm.

Construction of the model was by fabrication, as in Mr Roughton's own words 'complicated patterns and core boxes are not my strong point and, even had I succeeded, the machining operations required would have been extremely difficult'. He noted that on the full-size pump many of the

manufacturing operations were done by hand, some taking a week to complete.

The workmanship of the model is first class. It is presented for display with a valve exposed and the internal working of the drive shaft visible. The two components that have been removed but required to make the pump operable are displayed with the pump.

While not the most spectacular model it is beautifully made, clearly created by a craftsman who loved his work.

The Science Museum in London has an example of the full-size pump dating from 1904 and the Museum of Transport and Technology in Auckland, New Zealand has a similar example. Their 1907-08 Merryweather petrol-engined fire engine served with the Sydney (Australia) Metropolitan Fire Brigade before being brought to New Zealand in 1969 by a private individual. It is one of the oldest motorised fire engines in the world.

Further articles will look at other models in the SMEE Collection.

Bolton Corporation No. 46

Ashley Best's illustrated description of an award winning, scratch built model in 1:16 scale.



Continued from p.20
M.E. 4576, 22 December 2017

When Number 46 was withdrawn for scrapping in 1937, it was just another typical British four-wheel, double deck balcony tram. There was nothing to indicate that it was, in fact, a significant tramcar. This article explains the significance and describes the making of the model.



Forming the seat slats.



A steel profile for the seat frame.



Using the profile to form a seat frame.

Seats

Before embarking on a description of seat making I feel it is important to make a few general points about what might be considered to be a complication too far. Flip-over seats in the top saloon of a model tram are, after all, practically impossible to access or to function except via open windows with a small stick. They could, therefore be made simply with fixed backs and with impressions of wooden slatted seats – any method in fact, secure in the knowledge that only very close inspection would expose the short cut. In my view that goes against the spirit of model engineering, in which accuracy and attention to detail is essential, hence the following description.

The balconies on No.46 had the usual curved seats for three passengers. I made these with a wooden profile former for the laminated frame edge. Thin plywood strips cut cross grain were glued down to form the seat slats. These were set on edge as on a real tram to drain rainwater (**photo 110**). In the saloon are typical flip-over tramway seats and, as these had to be made in quantity, I made a number of jigs and tools to help. I have in the past made white metal cast seats and painted them to resemble wood but, apart from the inaccurate use of materials, their weight is rather high. The new seats were made more correctly with metal frames and wooden seats and backs. The main



seat frames are actually made from copper wire salvaged from scrap electric cables. This round section wire was stripped of its insulation and annealed - more than once - and drawn down to rectangular section with the aid of a draw plate - a huge cost saving. The metal was annealed again and cut into suitable lengths for the frames. I made a steel profile (**photo 111**) marked for two lengths as the frames have to have different heights because of the floor camber. The jig is held in the vice and the wire hammered round to fit the profile (**photo 112**). A second more complicated tool was made with a sliding adjustable height gauge. **Photograph 113** makes clear how this works and again it is held firmly in the vice while the legs on the side frame are hammered down for the feet. The adjustable cross piece can be slid and locked at any desired height for the seat frame sides (**photo 114**). The back rest pivot points are soldered into the frame sides in appropriate positions. These pivot points were made by pre-drilling a marked out brass strip then cut into sections and soldered with silver solder into the frame sides (**photo 115**).

To assemble the seat frames I made a wooden jig (**photo 116**). A spindle wire, 1/32 inch diameter, was soft soldered through both frames (**fig 18**) to form the seat back frame pivots. An assembled seat



A second tool for forming the seat frame feet.

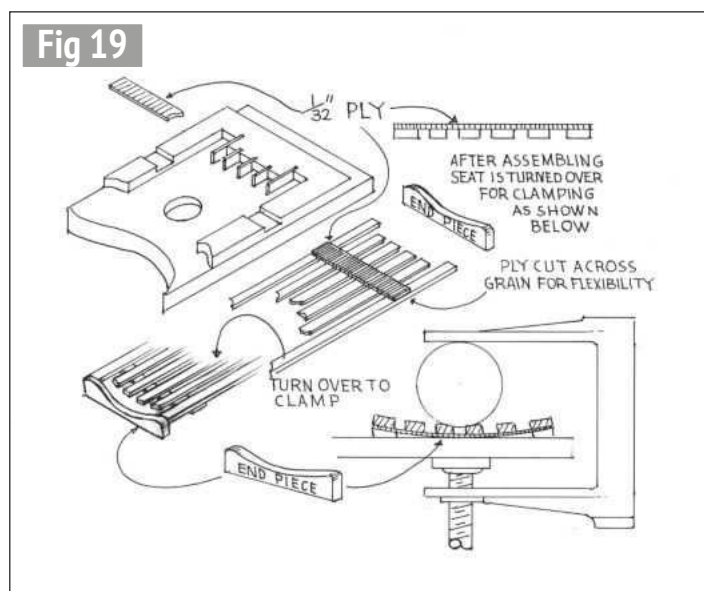
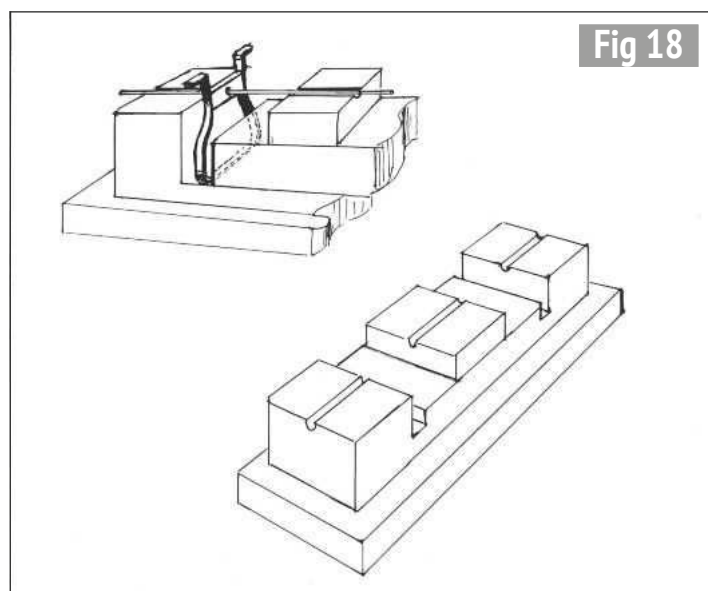


How beautiful are the feet.

frame is seen in **photograph 117**. The complete set of frames was carefully checked for levels then painted black. The wooden seats also required a jig and this was made from timber and is seen in use in **photograph 118**. Each seat needed 2 long and 4 short ply strips 1/32 inch thick and an additional pair of cross pieces cut across the grain from the same plywood. These are flexible and fit one on each end of the seat to hold everything together. 1/32 inch is a nominal size as the currently available equivalent ply is sold as 0.9mm. Cutting accuracy was maintained by use of the modified cutting tool already referred to. A sketch of the jig and how it works is shown in **figure 19**. A slight curve was imparted to

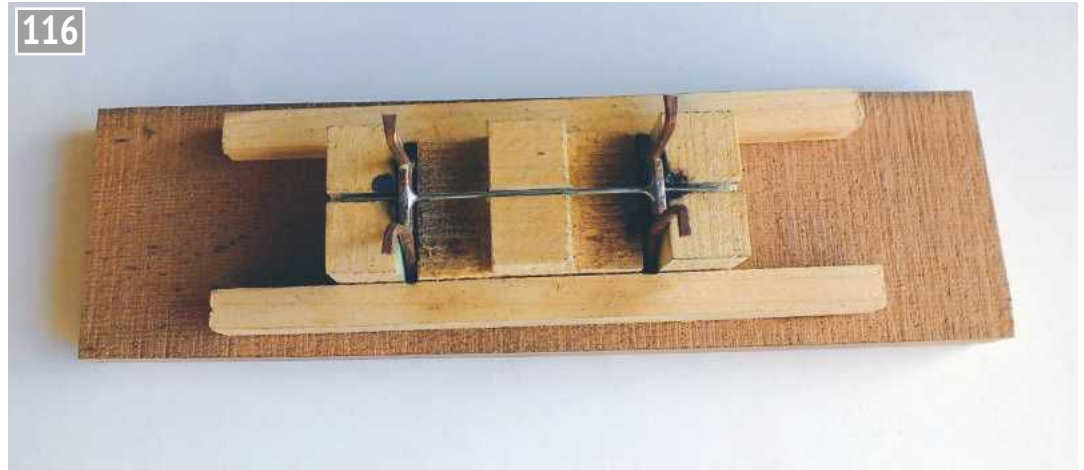


Mass production of back rest pivot points.



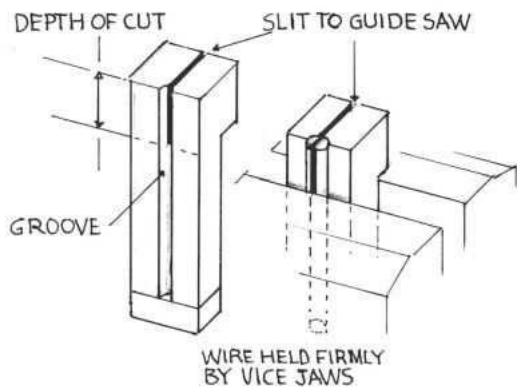
each seat in a set-up to hold it in position while the end pieces were glued in place. This is seen in **photo 119** where a seat is cramped under pressure with a cylindrical former while end pieces are glued in position. When the glue has set the slight curve on the seat is maintained and it can then be glued to the frame (**photo 120**).

The next part of the seat, the flip-over back, requires a wooden back rest and metal side struts. The back rest was cut to length and stained and



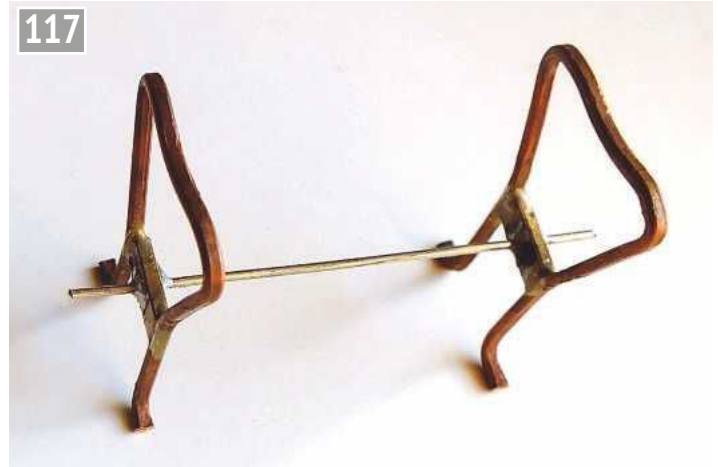
A seat assembly jig.

Fig 20



varnished. The side struts were formed using a piercing saw with the thinnest fine tooth blade. The two struts for each seat were made from 1/16 inch brass wire placed in a metal holder to be split by the saw. The guide and wire strut held in the vice and being sawn is shown in **photograph 121**. **Figure 20**

is a diagrammatic sketch of the guide. The three stages, a cut, opening out and finally shaping the top end to fit the back rest are seen in **photograph 122**. This was a difficult exercise and I did only a few at a time before my concentration lapsed. Finally, each strut had its base hammered flat and drilled

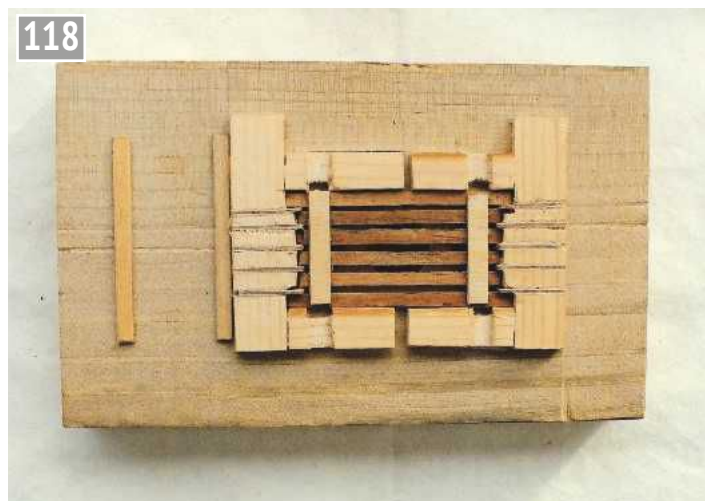


A completed seat frame.

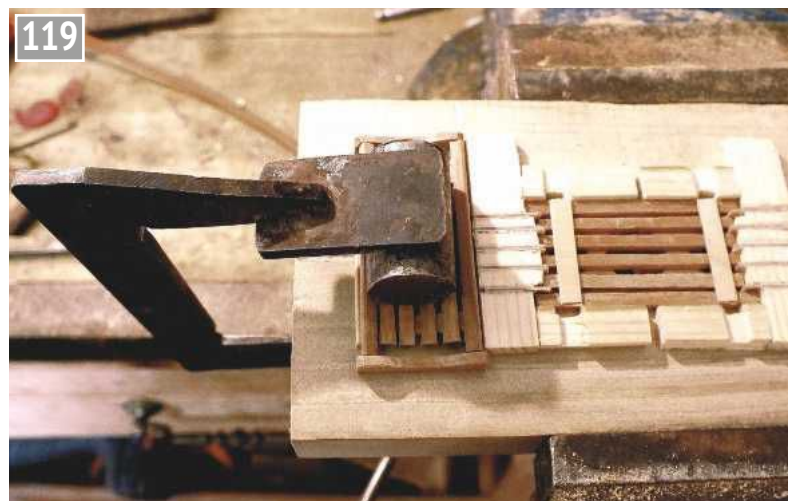
0.9mm to provide an easy running fit on the spindles of the seat frame. The side struts needed to be slightly cranked before being glued to the seat back and placed in a wooden jig (**photo 123**). While the glue set the jig held everything in exact alignment thus ensuring that all the seats were identical. **Photograph**

124 illustrates this in a set of upper deck seats.

Making seats as described above does take considerable time but results in working examples that look realistic. In No.46, because the model has working drop windows, the seats are accessible and can be shown to work.



A jig for assembling the wooden seats.



Giving a wooden seat the correct degree of curve.

Handrails

So far the description of construction has more or less worked upwards from the truck via the lower saloon to the upper saloon and its interior. The final main construction is the roof with its trolley gear. This exercise is made particularly awkward by the rails on the balcony and the stairs which have largely to be assembled and put in position before the roof is



A perfectly curved seat, united with its frame.



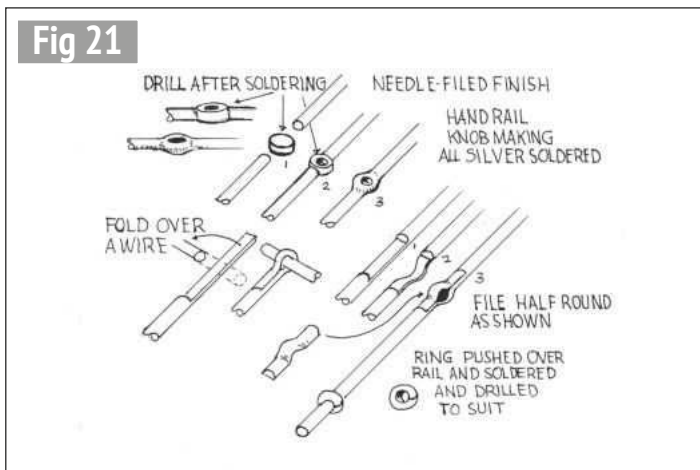
Splitting brass wire to make side struts.



Forming the ends of the struts.



A fully assembled seat.



A set of upper deck seats.

fitted (photo 125). There are two full height stanchions on each side, on each balcony and the destination boxes have short stanchions and a top rail. Already mentioned are the brackets on the canopy screen to hold all these upright stanchions in place. Small sockets on the bulkheads are fixed at the correct height



Balcony and stair handrails.

for the horizontal rails and sockets are also provided for the foot of each stanchion. Of vital importance are the knobs where the uprights and horizontals cross. The same problem is encountered on the hand rails on the stairs. There is no easy way to form these knobs and the task is time-consuming. The simplest method of crossing the rails after filing a notch in one or both and then soft soldering

should be avoided – it looks crude and is inaccurate. **Figure 21** shows some ways of making knobs and all give acceptable results but it is never quick. **Photograph 126** shows the complicated array of stanchions and rails to be fitted on each balcony. It is quite a difficult operation as it has to be done exactly at the final joining of the upper and lower decks.

● To be continued.



A closer view of the balcony handrails.

Lathes and more for Beginners

PART 5

Graham Sadler discusses cutting lubricants and takes the first cut



Continued from p.100
M.E. 4577, 5 January 2018

Cutting lubricants (coolant)

There's just one thing we now lack, and that's some form of cutting fluid. One of the reasons that industry turns metal so fast is that the tools are totally flooded and I mean flooded with neat cutting oils. We are talking gallons per minute here coming from multiple nozzles. Most model engineers tend to apply cutting fluid with a brush from a tin can and dab it on the tool, some rig up a slow drip feed from a gallon container on a shelf while the lucky ones use a coolant pump. Some won't use any at all - they say it's too messy!

Coolant is definitely needed as even modest cuts generate a lot of heat which can distort a work piece. Without any coolant the tool will wear super fast or you will get a tiny bit of the work piece pressure welding itself onto the tool tip causing a loss of accuracy and poor finish. This is especially true when turning aluminium. In this case, it is the rough chip which does the cutting, not the well finished tool. I must say here that, in the testing of the tool ground in the last instalment, it got a chip welded on when cutting dry after a cut of only 2mm long, which had to be removed with a small oil slip stone; this is always handy on the lathe shelf.

When I got my new Myford, after the excitement of using it on the first day, I was horrified next morning to find dirty (rusty?) spots on the bed and carriage. I was

using *soluble oil*, which is an *emulsion* (mixture) of water and a special oil - the former cools, the latter lubricates. The water, in evaporating, had left the marks. It won't really damage the machine but it was new and shiny and I wanted it to stay like that. So, from then onwards, I have used neat cutting oil. I buy 25 litre barrels, which last about 10 years, as it is cheaper buying in bulk. The advantage of this route is that the coolant does provide some form of lubrication for the machine slides but, due to the cost, one has to be careful with recovery from the swarf.

As an alternative to coolant I suggest using a mixture of engine oil and paraffin (the latter is used neat on aluminium). A mixture of 1:4 or 5 will work and you can even use paraffin to make the neat cutting oil go further. My lathe at 33 years old is still shiny and accurate. Cast iron and brass are not turned with any lubricants due to their mechanical properties. Both produce tiny chips - brass produces razor sharp slivers and cast iron is almost black dirty dust.

The first cut!

Note here that, in all this series, I will only use the tools, accessories and equipment which we have covered within the series. This is a bit frustrating for me as without some of my better tooling things take a lot longer! Often in beginner type publications the writer often uses highly expensive kit to

do some of the tasks; I hope to avoid that but at times I will show you how I would do it now.

Anyway, at last, we are ready to start turning! The lathe is mounted on the bench; the HSS knife tool is fitted at centre height and the electrical connections are complete (and safe!). You have lubricated the machine and a piece of mild steel about 20mm diameter is in the chuck with about 30mm sticking out. From the start get into the habit, when tightening the chuck and when it's almost gripping the bar, of rotating the bar back and forward a little at the same time (and when fitting a drill as well). This will displace any *swarf* (machine cutting waste) which may be on the chuck jaws, resulting in a better, more secure grip which won't damage the work so easily.

Angle the lathe tool towards the chuck by rotating the tool post so that we can cut across the end. This is called *facing*. Set the speed at about 300-330rpm. Then take a thin skim working from right to left. The lathe hand wheels have a handle sticking out of them and are of circular or ball handle type. These are intended to allow rapid movements of the slide, not for taking cuts. What you do is lightly grip the complete hand wheel and feed by rotating your wrist - at times you will alternate between hands for large facing cuts. This ensures you get an even, non-jerking cut, which



is far more sensitive and controllable.

The bar will almost certainly not face clean with the first cut, so repeat until it's flat. Examine the result, especially at the centre. Look for signs of a pip in the middle and, if there is one, it will indicate the tool is not at centre height. If it's like the classic idea of a volcano cone or an insect bite pimple then your tool is too high, while if it has sharp edges and a distinct corner where it joins the faced end then the tool is too low.

The tool must be on centre height but being too high is much worse than being too low, as the tool will have reduced clearance at the front and it will rub, getting blunt quickly and giving poor results. We examined how to set this when we discussed grinding the tool bit. By the way, once you have got the tool packing to the correct height, sort out your tool storage so that, if it is removed, then all the packing should stay with the tool, then it's easier when you replace it. A block of wood drilled with holes drilled (say) 12mm diameter is the easiest way, with a separate hole for each tool and its associated packing. Then you won't have to go hunting for the correct sized packing again until the tool needs a regrind. By the way, a right-hand knife tool is best reground by cutting off only on the front clearance. This will usually remove any bluntness without altering the height by very much.

So how do you tell if it is blunt? The first, obvious sign is that the cut is yielding a poor finish. Otherwise, examine the very tip of the tool. You should not be able to see the actual cutting edge as a sharp tool 'splits the light' and won't reflect back. If you can see the edge it means that light is being reflected back to you and you will see a shiny line. This principle is also applicable to all cutting tools from milling cutters to kitchen knives.

Now change the angle of the tool so that it is angled just towards the chuck and take a tiny skim over the outside diameter. Repeat with small cuts until it cuts all along to the edge of the chuck.

The dials

We will now examine the use of the dials fitted to the machine slides. Most lathes have dials which are not locked but held from rotation by friction from a special fitted washer, to keep them in place. Older lathes, especially the Myford ML7, do not have friction dials and a bit more mental arithmetic is required (another area where you can easily get things wrong). With one hand, carefully hold the cross-slide hand wheel so it can't move, while with the other hand rotate and zero the dial. It is now set to the diameter of what you just turned. Now measure the diameter with the callipers. Clean the jaws, fully close them then zero the scale. Measure the diameter; let's say it's 17.2mm so we will now try to turn the bar down to 16mm. This means that we have to reduce the diameter by 1.2mm. However, moving the cross-slide inwards is a radial move, so we need a cut of 0.6mm (total). So, with the tool to the right of the work, add a cut of 0.5mm and run this, checking the resulting diameter, followed by a cut of 0.1mm.

Now re-measure, and the result should be exactly 16 mm. If it isn't, take another cut at the same setting. This checks the machine and you shouldn't have any material removed. One thing you will have to learn is how to allow for the vagaries of your machine. If material is removed and the machine is new then it probably needs some adjustment, so refer to the handbook to find out what to do - but a general guide is given below.

Now, without moving the friction dial (the lathe is set to cut at 16mm diameter), repeat this exercise to bring

the diameter to 14mm then again to 12mm. Each requires a 1mm cut. To show you why a piece of work cannot be removed and replaced in the chuck until all machining at that setting is completed, do the following. Without moving the cross slide from the last cut, slacken the chuck and rotate the bar half a turn, re-grip and again traverse for a cut.

Unless you have a fantastic and very rare, perfect 3-jaw or unless there's a pig flying overhead, you will find that there is a cut again but it will be on one side of the bar only, proving that it is no longer on centre and is *eccentric*. For this reason, you need to plan the order of manufacture of a component (especially if you want, for example, to try the fit of a hole on a shaft) so this can be achieved without removing the component from the chuck. I have even removed the chuck from the lathe complete with work in place to avoid this problem but it's not recommended! Take tiny cuts to see how much needs to be removed in order to get the cut all round the bar again and measure it.

That's the basic turning and sizing function and it is one you will do hundreds of times. Do remember, though, that the setting will be lost if the tool is removed from the tool post.

The next task is to turn a simple taper. We will produce a *taper* of 30° *included* angle and this means we need to move the tool at an angle of 15° to the lathe axis. The tool post is mounted on what is called the *top slide* or *compound slide*. It is normally set parallel to the lathe axis but it can be rotated after loosening the fixing. This is usually by a spanner or hexagon key, depending on the lathe. The top slide, or perhaps the cross-slide, will have some form of scale on it so set it to 150° and lock it in place.

Adjust the tool angle and bring the tip of the tool to the corner of the work with cross

feed and saddle hand wheel. Add cut with the cross slide and smoothly and slowly cut the taper. At the end of each cut, rewind the topside back to the start, add another cut and repeat. If you find the tool also cuts on the return then I advise switching off first then repeating the cut if you are ever getting close to the finished size. Note now that we have lost our diameter setting if we return the top slide angle to zero.

Some top slides have a problem when turning steep tapers as the handle fouls the cross slide, or their mounting method precludes this as well. On my S7 I have removed the top slide hand wheel, fitted a screw and locknut then used a screwdriver to work the slide.

A note here about how to actually turn the feed-screws. Their handles are in two main forms, a disc and a cross bar both with a sticking out handle. The handle is used only for rapid movement and is difficult to accurately control. For sensitive movement, this can only be done properly by grasping the crossbar or disc itself, probably with both hands, then rotating the screw by a twisting action of the wrist.

●To be continued.

Garrett 4CD Tractor

in 6 inch scale

PART 39

Chris Gunn
makes the
parts for
the flywheel
brake.



Continued from p.15
M.E. 4576, 22 December 2017



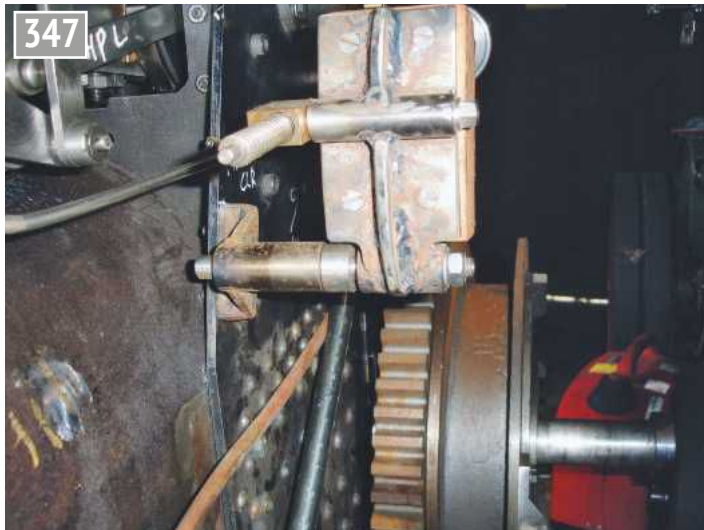
This article has been written to guide the builder through the construction of the 6 inch scale Garrett 4CD tractor designed by Chris d'Alquen. The writer has previously built a 4 inch scale Garrett and a 6 inch scale Foden wagon so has the benefit of considerable experience in larger scale modelling. Most machining can be done in the average home workshop but the supplier from whom the castings and drawings are currently available is able to provide a machining service for the largest items if required.

Once the flywheel was finished I continued with the parts for the flywheel brake.

The assembly consists of a bracket to support the brake shoe, the brake shoe and its pivot pin, a square thread screw and nut to actuate the brake, a swivelling support to support the screw and a small handwheel. In my odds and ends bin I had a short leadscrew, together with the bronze nut to match, that came from some scrapped machine or project and, at the point of using these items, I had no idea what they came from. Suffice it to say that they did come in handy just as I knew they would. I hope someone is keeping count of how many

items that were saved from the scrap man have come in handy on this project. The screw and nut were of course not exactly the same as specified on the drawing but were close enough for me to consider using them.

The screw was the right diameter, although nowhere near long enough, but I felt that the plain end could be extended to suit. The nut could also be adapted without departing too far from the drawing. In the absence of a suitable screw and nut under the bench, the screw and nut of course could have been manufactured or commercial items could have been used and adapted. HPC, for example, list small rolled thread lead screws with matching nuts and are geared



347 Flywheel brake bracket.

up to deal with small quantities; other suppliers can offer the same type of equipment.

I personally would rather adapt or buy such items rather than spend hours making special tooling that would only be used once.

To make a start, the first item to be dealt with is the support bracket. The drawing shows a cast bracket but in fact a casting was not available when I built my engine - although a casting may be available in the future. I started with a piece of $2 \times \frac{1}{4}$ inch angle, which formed the base, and a triangular plate to from the main web. This was made bigger than needed to start with and a hole drilled to accept a round boss, then the waste partly cut away until the bracket had been welded. The bracket was made to the dimensions shown on the



348 Flywheel brake shoe.

drawing. Scraps of $\frac{1}{4}$ inch plate were used to make the rest of the webs and the boss was turned up on the lathe. The assembly was welded in stages and, when fully welded, the waste was cut away and, after some fettling, this began



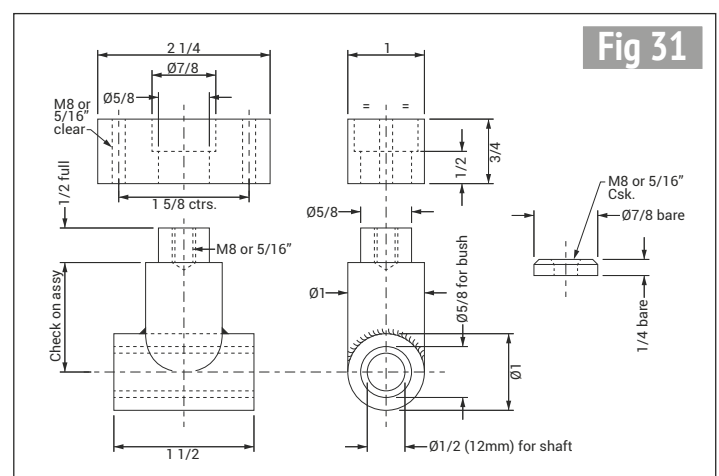
349 Brake shaft bracket.

to look like a casting. Before painting the bracket will be filled to simulate smooth fillets around the joints. **Photograph 347** shows the bracket fitted to the engine.

The next item was the brake shoe and, once again, this was fabricated in the absence of a casting and made to the dimensions shown on the drawing using turned bosses and $\frac{1}{4}$ inch plate. The boss in the centre of the shoe was bored to accept the boss on the end of the bronze leadscrew nut; the rectangular part of this nut can be seen in **photo 348**.

The brake block and a spare

nut to match the drawing. I started with the nut, which had a boss underneath the rectangular section, and which was fortunately tapped, so all I needed to do was to make a shoulder screw to match the thread and of a length to allow the nut to pivot in the boss of the brake shoe. The next item was the screw itself. As previously stated this was too short over all but the thread length was sufficient so I turned the end down and then made a shaft extension to match the outside diameter of the leadscrew end. Once this is finally assembled I intend to put



Support bracket sketch.

were made from two pieces of mahogany salvaged from my first house when I rebuilt the porch in 1968 or thereabouts. The two pieces of mahogany which originally supported the porch roof have been very useful over the years and there is still a bit left in case anything else crops up.

I fitted the flywheel to the crankshaft, positioning it in the right place so it cleared everything, and then I was able to clamp the bracket to the hornplate, offer up the brake shoe to the flywheel, check the dimensions of the pivot pin and then make it to suit. It was made basically as the drawing but with a longer boss in the middle, as the flywheel was slightly further away from the hornplate than the drawings showed.

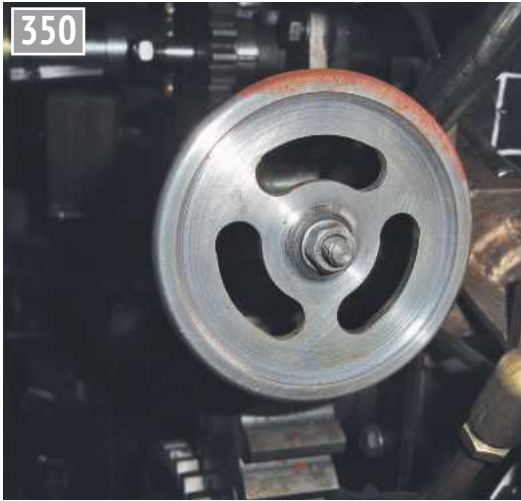
Once the brake shoe was in position, the next step was to adapt the leadscrew and

a roll pin through to hold the two together. I also made a pair of collars to retain the shaft in the support bracket. If you are making the screw from scratch then the drawings can be followed or alternatively, if using a commercial screw and nut, then the design can be adapted to suit along the lines described.

The next item in the group was the brake shaft support, and this had to pivot slightly to allow the shaft to move as the brake was operated. This was made in three parts, first the base of the bracket, made from rectangular stock, and the centre hole was drilled and counterbored to give room for a washer with a countersunk screw. The washer retained the body of the bracket, made up from a solid shaft and a collar.

Figure 31 shows my sketch of the support bracket, which is not fully clear from **photo 347**.

The base of the bracket was



Flywheel brake wheel.

made from $\frac{3}{4} \times 1$ inch stock. This needs to be thick enough to accommodate the washer. I have a collection of various counterbores so I picked the nearest one, marked out the holes, drilled them and then turned my attention to the collar. That was reamed $\frac{5}{8}$ inch to accept a $\frac{5}{8} \times \frac{1}{2}$ inch bore bush. I took another piece of 1 inch diameter bar for the shaft section, held it in the vice on the Bridgeport and plunged a 1 inch diameter cutter through the end, to accept the collar when welded. Then I turned the other end, to pass through the base, and tapped the hole for the washer. I had a trial assembly to make sure the brake shaft finished up the right distance from the horn plate. I trimmed the end

down a little to get this right and then I could weld the collar in position. Once the bracket was finished, I could position the bracket on the horn plate and spot through the holes. The mounting holes were drilled and tapped freehand. **Photograph 349** shows the completed bracket in position, held in place by temporary cap head screws.

Lastly, I made the brake hand wheel. No casting was available but I did have a short piece of 4 inch diameter steel so that was popped in the lathe, held in the soft jaws in a shallow recess and faced off. I cut the recess in the wheel and formed the boss using my small round tipped tool. Then the opposite side was dealt with and the centre hole



Crankshaft cap.

drilled. Once the blank was cleaned up I marked up the rough positions for the holes at the ends of the slots. It was then taken to the Bridgeport, held in the chuck on the spin indexer, which was centred to the spindle, and the blank moved into position so the spindle was on the centre of the slots. The blank was rotated and the first hole drilled. The five remaining holes were then drilled, using the rotary table graduations to space the holes out equally.

Once the three pairs of holes had been drilled the drill chuck was changed for a smaller cutter and the waste cut out from the slots in two passes per slot, one on the inside and one on the outside of the slots. The blank was then removed from the miller and returned to the lathe. This time I held the blank with the standard jaws, holding the blank through the three slots. Then I was able to profile the outside diameter using a form tool as described before. **Photograph 350** shows the completed wheel.

The eagle eyed will have spotted that this wheel is going rusty. I did not use stainless for this, so maybe I will remake it. I cut the square in the bore of the handwheel by hand, using a square file, and then cut the square on the shaft also by hand,

fitted the two together and assembled them. I will use a dome nut to secure the wheel on final assembly.

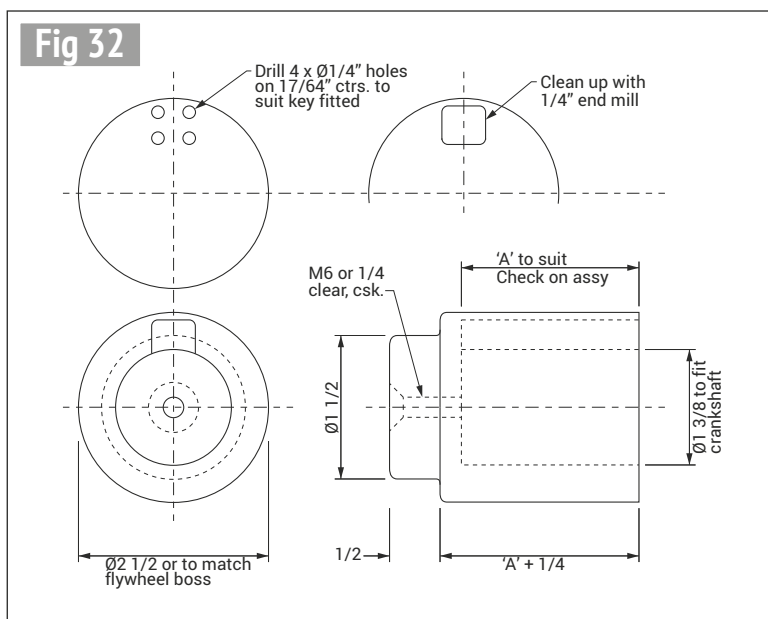
While I was working on this side of the engine, I made a brass cap to fit on the end of the crankshaft to cover the end of the gib head key and made this to look like the undimensioned cap shown on the drawings. I could not find a lump of brass big enough in my own bins but managed to get an offcut from my local non-ferrous stockist then proceeded to turn it into swarf.

The boss of the flywheel is quite small and the head of the gib head key is almost as high as the outside diameter of the boss. I did not want to make the cap bigger than the diameter of the boss so I faced off both ends of the piece of brass and marked out on one end the shaft diameter and the head of the key. I held the brass blank in the Bridgeport and drilled a couple of holes so that they would create a pocket for the head of the key. I squared off the sides of the pocket with a long series end mill. I returned the blank to the lathe and turned the outer end and drilled and countersunk the holes for the fixing screw. I then turned the blank around and drilled down the centre with a drill big enough to allow my small boring bar in, which was small enough not to break through into the pocket. The hole was made deep enough to clear the end of the shaft. This dimension needs to be checked from the engine. I bored the blank out to $1\frac{3}{8}$ inches to my plug gauge. The interrupted cut was no problem. The cap was then offered up to the crankshaft and was spot on.

Figure 32 is a sketch of the cap for my engine and **photo 351** shows the finished cap in situ.

That concludes this instalment and next time I will continue with the governor and other details.

●To be continued.



Crankshaft cap sketch.

Ferrabee Pillar Engine, 1862 PART 10

Anthony Mount continues his construction series; an unusual stationary steam engine.



Continued from p.23
M.E. 4576, 22 December 2017



I was looking through some old technical books and came across an engine exhibited at the International Exhibition of 1862 (not to be confused with the Great Exhibition of 1851); I rather liked the look of it, thinking it would make an attractive model.

Governor spindle (Part 39)

For the governor spindle a length of 3mm mild steel was used, threaded one end M3 to screw into the fork. The fork was a length of 5mm square mild steel with the end faced off and then cross drilled for the pivot pin. A slitting saw was used to put in the slot and then it was transferred back to the lathe, parted off, reversed in the chuck and centred, drilled and tapped M3.

Once assembled the bottom of the slot was further

filed to give an internal taper so that the governor arms could fully close, rather than foul the bottom edge of the slot.

A couple of loose collars are used to hold the spindle in position in the governor bracket.

Governor arms (Part 40)

The governor arms are supplied in the laser cut set. Only one is in the set but it is of thick material and can be sawn down longitudinally to make the two. They are then

filed to thickness and for this I pinned the arms to a piece of wood with panel pins passing through the two holes in each arm; this made it quite easy to then file to thickness.

The arms are a little unusual in that they are overlap each other at the top and have a single pivot. This means they need to be reduced for half their thickness and at an angle so they fit together when in the closed position. This is more easily accomplished by filing than to try and machine them on the milling machine. Note that they are the same hand when viewed separately.

The ends of the arms are rounded to fit in the holes in the balls and I just filed them and stuck them in with *Loctite*; do check that you get them the same length as they will look odd even if only a little different.

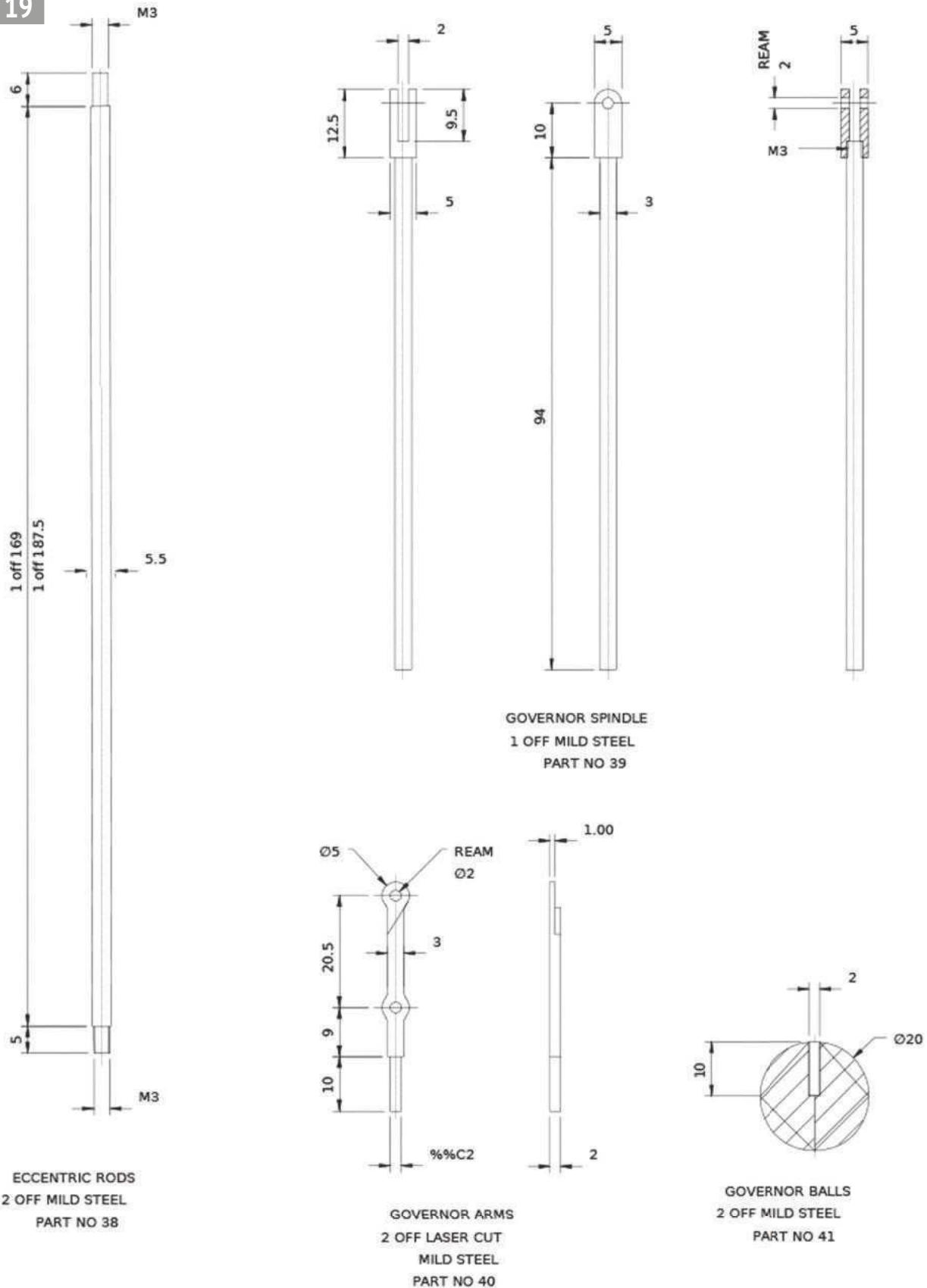
Governor balls (Part 41)

Two balls are needed for the governor. One's first thought to procure them is a ball bearing - they could well be found in a scrap ball race - but even if you find two they will be virtually impossible to drill for the governor arms. You can try and soften them but the clean finish will be oxidised.

Brass balls could be used but these are the wrong colour as nearly all governors had steel balls or cast iron for the early examples. I did come across a drawing of an engine with brass balls in the shape of rugby balls; they were in fact brass shells filled with lead.

All this brings us to thinking about making them. Ball turning accessories are available for the lathe, usually a horizontal type with a cranked tool swinging around a pin or fixed to a worm and wheel for rotating in the horizontal plane.

The other type is an up and over type usually held in the

Fig 19

FERRABEE'S COLUMN ENGINE 1862



FIRST ANGLE PROJECTION

ECCENTRIC ROD

DRG NO 19

REV'

SCALE 1:1

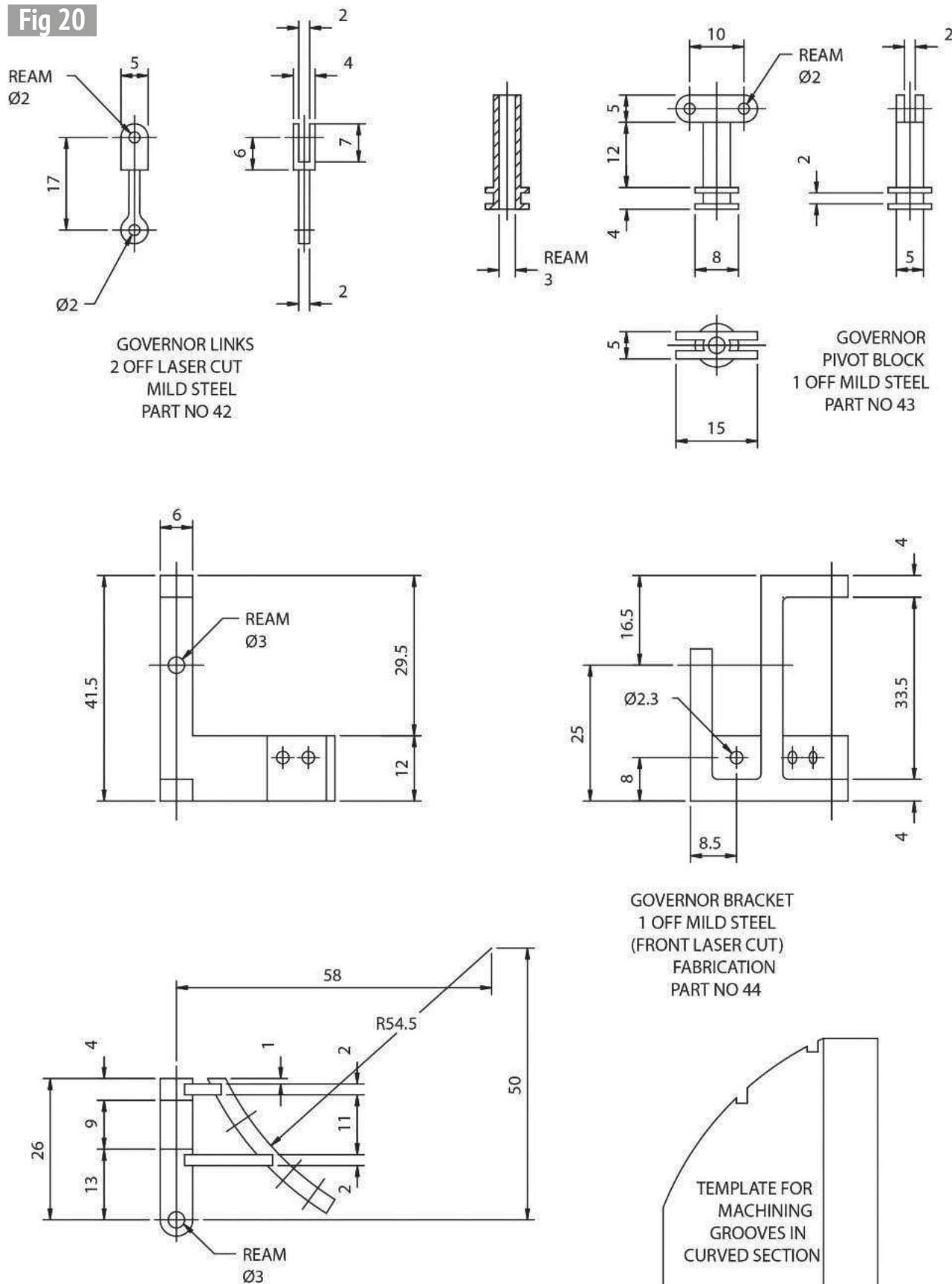
DATE 06-07-13

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Historic
Engines
South
West

Fig 20



FERRABEE'S COLUMN ENGINE 1862	 FIRST ANGLE PROJECTION		Historic Engines South West
GOVERNOR PARTS	DRG NO 20	REV'	
	SCALE 1:1	DATE 08-07-13	
Reproduction for any purpose whatsoever without writtem permission is strictly prohibited	z COPYRIGHT A.MOUNT 2013		

tool post, most being to a derivative of the Radford/Thomas design. The problem with both of them is the large amount of overhang of the raw material required from the chuck.

For balls up to about 20mm diameter I like to use a form tool; overhang is minimal and the size repeatable. If you use say a piece of 3mm or thicker gauge plate, you can cut off a strip, mount it in the four-jaw chuck and bore out to the diameter required with the top slide set over at 5 degrees, which automatically forms the front rake to the cutter.

The strip is sawn through offset; this gives one form tool for the ball and another for a part ball that would occur between two straights. The tool is hardened and tempered and is ready for use.

You cannot of course make a ball in one go. It needs a neck to hold it to the parent material while cutting and the neck cannot be too small a diameter or the part formed ball will be torn away. You will notice quite a few governors still have a short neck attached after they have been parted off. Unfortunately, our example does not and is a complete sphere.

So, turn the ball, as much as possible, polish it up with abrasive paper (watch the fingers do not stray near the chuck) pull it out of the chuck while polishing, and then push it back further in for rigidity while parting off. Make up a brass bush to hold the embryo ball while working on the parted off end.

I have built up a collection of these brass bushes over the years. Being top hat in shape the inside of the rim is pushed against the chuck jaws and the inside diameter is a close fit to the ball, the depth being enough for the ball to be a little more than halfway in. The bottom face inside of the hat has a hole in it to seat the ball but still stop it passing through. The holder is split in its length and in fact it has a slot through which the stem of a ball handle can pass if you

are making one of these.

To set the ball end running true, I use the partly open end of the drill chuck in the tailstock to push against the parted off face which pushes it into the collet squaring it up at the same time. The short section of neck can be turned away and the other form tool you made, if set at an angle in the toolpost, can be used for this. Then the polishing can be continued at this end, followed by centring and drilling for the governor arm.

Governor links (Part 42)

The governor links are available laser cut to profile but they do need slotting one end and reducing in thickness at the other. I have a machine vice with a small rebate in each jaw which allows the link to be clamped while a slitting saw is used to put in the slot. The rebates in the vice jaws were deep enough so that the slitting saw just clears the top of the machine vice jaws.

Likewise, the rebates are used to hold the link while an end mill reduces the link in thickness one side. The other side has to be done by filing alone. The two links are then cleaned up all over with Swiss files.

Governor pivot block (Part 43)

A pivot block is needed for the governor links to be able to pull up the control lever. This can be machined from a length of mild steel bar 15 x 8mm in section; my nearest section was $\frac{5}{8} \times \frac{3}{8}$ inch. This was milled down to size for a length of 35mm and then held in the independent four-jaw chuck for facing off.

The bar was transferred to the milling machine for drilling the two pin holes, followed by milling in two slots with a three flute 2mm FC3 cutter to receive the links. Back to the lathe again for turning down the body to 5mm diameter behind the ears, then the 8mm section can be turned, followed by putting in the 2mm wide groove. This setup is shown



Machining the pivot block.

in photo 37. I used a brazed carbide parting tool ground to cut on the sides as well as the front for these operations behind the ears.

The end was then centred and drilled down, followed by reaming to 3mm diameter, after which the block was parted off and the ends of the ears were rounded by filing.

Governor bracket (Part 44)

To support the governor there is a bracket that bolts onto the top flange of the column; it's a complicated shape and undoubtedly was a casting full size. Our method of manufacture is a brass fabrication. Alternatively, you could use mild steel and put little brass bushes in the pivot holes.

The vertical part can be made from a piece of 6mm thick material; machine first to overall dimensions and then drill and ream the pivot holes. Mark out the shape of the cut outs and, holding horizontally in the machine vice with packing on what will be the open side, so that the cutter does not touch the vice jaws, machine out the central cut out but leave a small rib at the top which can be sawn away later. Then machine the open cut out. This is all done with a 4mm three flute end mill.

Change to a 2mm slot drill and machine the grooves at the bottom for the spacers. The top part of the enclosed

cut out can be sawn away and the ends rounded at the pivot locations. To save this work I have included this part with the other laser cut pieces.

The spacers are just little rectangles of 2mm thick material made up from suitable offcuts. The curved plate was made from a segment cut from a slice of tube that was in the scrap box but it can also be machined from a suitable ring cut from a length of tube.

The drawing has a template adjacent that can be used to orientate the segment in the machine vice for machining in the slots for the spacers.

The parts can be wired together with soft iron wire for silver soldering together. Once cold the bracket can be cleaned up and a reamer passed through the holes to check they are clear and aligned.

Offer up the bracket against the column flange and spot through the fixing holes into the flange, drill the stud holes and tap 8BA. A short length of 4mm steel rod can be rested in the vee pulleys to help in aligning the bracket.

●To be continued.

Next time

Next time we move on to the pulleys and gears that drive the governor.



Write to us

Views and opinions expressed in letters published in *Postbag* should not be assumed to be in accordance with those of the Editor, other contributors, or MyTimeMedia Ltd.

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Responses to published letters are forwarded as appropriate.

Sombre Harvest

Dear Diane,

I found Terrence Holland's article on the 'Iron

Harvest' (ME 4574, 24th November) personally very interesting, as my Paternal Grandfather was a Captain (Later Major) Quartermaster of an Artillery Brigade at various front areas – but particularly in the Somme and Ypres Areas. I

have a trench map of his for the 'Hooe Sector' – showing 'Polygon Wood' / 'Menin Road' / Scots Farm / etc. somewhat stained with Flanders mud. This still has the faint pencil arcs indicating the arc of fire of the Brigade. The title 'Brigade' was changed long after WWI to 'Regiment', both in war usually had/have 24 guns – peacetime reduced to 18.

The typical Field Brigade of Artillery had eighteen 18pdr guns and six 4.5 inch Howitzers. There were however many changes in the 'make-up' then and after WWI. The number of guns in a battery varied from 4 to 8 and it is not easy to ascertain the equipage at any particular time.

My Grandfather was attached to the 90th 'City of London' Field Brigade TA (for the 'riding school') while undergoing commissioning at Woolwich Garrison in 1915. My Father was a Gun-Sergeant in the same unit, now a 'Regiment' 1937 – 41. Then post WWII with its number changed to 254th I was a member 1964-66 until posting to a 5.5 inch Medium Gun Regiment.

Losses of guns were due to several causes – counter battery fire / wearing out due to very high rate of fire / 'prematures' due to overheated barrels. My Grandfather told me that during long barrages, he had to do an inspection of the end of the chamber where the rifling starts – every gun, every night. Often a new or repaired gun that had arrived the previous night went back worn-out the next night. Crews were throwing buckets of water (not in short supply) over the barrels to try and

keep them cooler and safer. An experienced 18pdr Gun Crew could easily maintain 6 rounds a minute – in an emergency they could perhaps double that.

There is a very good chance that some of the Cartridge Cases in the Hooe Museum had passed through his hands. A Brigade like his could very easily have fired 50,000 rounds a day in a barrage – ammunition supply being the restriction. Zillebeke near Ypres was an area where he was for some time. There is however an error in the article; those are not all 'Shell Casings' as these being filled with explosive are soon reduced to fragments and are a rather different shape. Those with a 'band' round them or just some grooves are shrapnel shell casings, as the bands show the rifling marks. The conical 'things' in photo 4 with a grey top appear to be fused shells – 'dodgy'. Some of those in photo 4 stacked, piled or scattered are Cartridge Cases. Some (small stacks) are recognisable as probably 18pdr cases – i.e. the short ones about 3 inch in diameter but others (fatter) are equally probably 4.5 inch Howitzer cases. Others there are probably German cases. In photo 1, the 'things' are maybe Mustard Gas bottles or trench mortar bombs – I would hesitate to even touch them, I learned a lot on a course in disposal and demolition back in the '60s'.

It is a very 'dodgy' job handling old unexploded shells – if fired, the 'safety gates' in the fuses have been opened and the striker has retracted. Also the filling is now in a very 'touchy' state – 'weeping' explosive is bad enough, and if not 'actually' it is similar to 'Nitro-Glycerine'. However many of the shells will have passed that stage by now and the filling will have crystallised. In the crystallised state any shock that breaks a crystal will initiate the filling... I have had an 80lb shell 'premature' about 50m (?) from a 5.5 inch, not an experience one would

wish to repeat – I had fired it and I landed on my back from the unexpected blast and no-one injured apart from being shaken up.

For interest extra to those given at end of the article – these references:

Light Track from Arras, T.R. Hermitage, Plateway Press, WWI Narrow Gauge Military Narrow Gauge at War, Keith Taylorson, Plateway Press, WWI Narrow Gauge Military Narrow Gauge at War Vol 2, Keith Taylorson, Plateway Press, WWI Narrow Gauge Military, Narrow Gauge to No Man's Land, Richard Dunn, Benchmark

Regards
Peter King

Insurance

Dear Diane,

I read with interest John Roberts's letter (ME 4571, 13th October). I had a similar experience and thought you might like to publish the following and see the response, it could be interesting.

About three years ago I read in the press and saw on TV the government was concerned that many elderly men are lonely and because of the loneliness some are depressed. With that in mind, I thought I would organise a 'men's event' which would show local men what was available in our area. I contacted about 20 men's organisations who said they would be pleased to come. I then went to the Rugby club to find the hire cost and if they had a vacant Saturday afternoon in the summer. The Rugby club have a large parking area and a large venue room, ideal for what I wanted.

Next, I phoned three insurance companies who advertise in Model Engineer magazine and similar magazines asking for quotes for third party insurance. I was told come back a month before the event was to take place. I said I needed to know an approximate cost to enable me

to work out the small entrance fee and room hire. I had already contacted the county council and borough council and was told a small grant could be available. After some discussion I was told around £3000, for just one Saturday afternoon, a written quote would be available closer to the time. I also mentioned a friend would be taking along his portable track and steam loco and give free rides to children, the figure then went up to £5000. No moving vehicles, everything had to be stationary before the public arrived. Needless to say, the event didn't take place.

Ted Fletcher, Scarborough

Big Boy

Dear Diane,
I just finished reading the article (ME 4574, 24th November) about the 1.5 inch scale model of the Union Pacific (UP) Big Boy now on display at the Rahmi M. Koç museum in Istanbul.

In that article, figure 5 shows a picture of full-size Big Boy No. 4014. It may interest readers of ME to know that Big Boy No. 4014 is now being re-furbished and restored to running order at the UP Steam Shop in Cheyenne, Wyoming, USA. The latest update in the saga of this restoration can be found at https://www.up.com/aboutup/community/inside_track/steam-update-08-25-2017.htm. The restoration of No. 4014 might make an interesting article, or series of articles, for ME. I'm sure the restorers would appreciate the publicity as well.

While Big Boy No. 4014 is not exactly in exhibition condition at the moment, another UP Big Boy, No. 4012, is currently on static display at the Steamtown National Historic Site located at Scranton, Pennsylvania, USA. Steamtown is a large historic site and run by the US National Park Service. It is well worth a visit for anyone interested in the history of full size steam

railroading in the US.

Lastly, I don't, at present, recall the exact source of this bit of trivia, but I have read that from the time of the delivery of the first Big Boy to the UP in 1941 until the mid-1960's, the Big Boy held the record as the largest, land-mobile, structure ever built by humanity. The Big Boy lost that title in the mid-1960's with the advent of the moon-rocket carrier/crawler at Cape Canaveral, USA that carried the Saturn V moon rocket from the Vertical Assembly Building to the launchpad.

Sincerely, John Hannum

Old Toys

Dear Diane,
What a delightful piece (ME 4575, 8th December) on the old tin-plate models, especially the cars.

I refer to the caption to the picture of the SSK Mercedes and wonder if the exhausts were actually flexible. Might they have had flexible pipes covering the rigid pipes beneath? The Lagonda LG45 Rapide had chromium plated flexible tubing concealing the exposed area of the rigid pipes and in order to prevent heat discoloration, distance pieces maintained an air gap between the two.

Best regards,
James Buxton

*Author Henk-Jan de Ruiter replies:
Interesting remarks from Mr. Buxton. On the Märklin modelcar the hoses are indeed flexible, it would be interesting to see how these are made in real life!*

This particular 1990's Märklin modelcar is a replica from the one they made in 1930's, but that one is, as you can imagine, pretty expensive, I think in the £10,000 region.

Help – Tri-Wing Screwdrivers

Dear Diane,
I too, became frustrated trying to release deep set 'security' screws on our toaster. I met exactly the same difficulties with the depth and diameter of the recess. But I managed very successfully with an old(ish) ⅜ inch electrical screwdriver! The blade wedged very successfully into the screw head recess, with one side in a slot and the other held against the opposite blank face.

Best regards,
James Buxton

Dear Diane,
I have found a set of four tri-wing screwdrivers on the banggood.com website (https://www.banggood.com/4Pcs-3mm-4mm-5mm-6mm-Magnetic-Y-Tip-Nonslip-Grip-Tri-wing-Screwdriver-Tools-p-1128386.html?rmmds=search&cur_warehouse=CN). I have used this Chinese supplier quite often and if you don't mind waiting two to four weeks for delivery their prices are very competitive. I feel that as an awful lot of tools are produced in China anyway it is worth cutting out the middle man and shopping direct.

Regards,
Peter Browning (Liskeard)

Young Engineers

Dear Diane,
I read with interest Pat Hendra's letter (ME 4574, 24th November) about the Eastleigh Young Engineers' (EYEs) lack of competition as there are so few other societies with junior sections.

Some years ago, we at the Guildford Model Engineering Society briefly explored the idea of a junior section but very quickly abandoned it. The principal reason for this was a certain amount of paranoia (that may be overstating it a bit) that members would lay themselves open to accusations of child abuse.

Members were saying things like "It only takes one false accusation for the mud to stick" with many others were nodding in agreement. There were also many concerns about the practicality of setting up such a section with issues like CRB (now DBS) checks and who would have to undergo them, what the section would actually do, would it have some sort of programme, etc.

The only upshot was the formation of a very stringent set of rules on the use of the society's facilities by those under the age of 18 which is most unfortunate and may or may not be necessary.

I therefore wondered if it might be a good idea if Pat Hendra could be persuaded to write an article for ME on how EYEs have been set up, the issues that had to be resolved and how they were overcome etc. It would be good also to include information on what they do, how they are organised and how they encourage young people to become involved in our hobby.

I am not hopeful that such an article would totally overcome members' reluctance to become involved but it would certainly help clubs and societies to make properly informed decisions.

It is very sad that legislation that was intended to protect children has resulted in and almost total elimination of opportunities for them and especially its effect on our hobby.

Kind regards,
Roger Curtis

An Engineer's Day Out



1 Model of the Murchison platform. 254 metres tall, it stands in 156 metres of water. Drilling went down 3275 metres.

and North Sea trade. The associated boatbuilding grew into substantial shipbuilding and associated engineering industries. Aberdeen has a fascinating maritime museum featuring what is probably the largest model in any British museum (**photo 1**).

Aberdeen was particularly noted for granite. Rubislaw Quarry was reputed to be Europe's deepest quarry but closed in 1971 (see <http://mcjazz.f2s.com/RubislawQuarry.htm>). Here, John Fyfe invented the 'Blondin' system for lifting stone from the quarry and for carrying men to their work, a system also used in North Wales slate quarries.

Rubislaw provided stone for London's Waterloo bridge and many other structures. Most importantly, it contributed stone for Aberdeen's buildings, giving the city a strikingly uniform grey appearance and the nickname the 'Granite City'. More recent marketing tried 'The silver city with the golden sands'. This didn't pull tourists though. Aberdeen has much going for it with good museums and galleries illustrating the city's heritage. Parks are notably fine and Duthie Park with its Winter Gardens is one of the best.

Aberdeen Maritime Museum is part housed in the historic Provost Ross House on Shiprow where the Old Town

overlooks the harbour. Well displayed, it includes art and exhibits covering Aberdeen's maritime links from early times to the present and displays on harbour history, oil and gas production and shipbuilding, plus many models.

Shipbuilding

Several shipyards developed around the harbours but expanded in the 19th and 20th centuries, building over 3000 ships. Until the late 19th century many yards created wooden ships without plans, relying on the skills of shipwrights to construct a ship from half hull models (**photo 2**). From the models full size templates (or moulds) were made in the yard's mould loft. Shipwrights used a lead line, following the line of the model laid on the loft floor, and scaled it up to full size frame templates.

Half models were also used in constructing steel ships to plan the layout of the hull plating. Particularly with riveted ships, joints had to be staggered to ensure a stronger hull. Although computer modelling had taken over by then, some of the half hull models displayed were built by the last Aberdeen shipbuilder, Hall Russell, until their closure in 1992.

This wasn't the end for models though. Larger models were built to test hull designs. The hull model of the oil supply vessel, *Lady Rosemary* (**photo**

Roger Backhouse pays a visit to the Aberdeen Maritime Museum



Aberdeen was an early maritime centre with harbours in the estuaries of the rivers Dee and Don, used for fishing



2 Half hull models used to design wooden ships. Designs were scaled up in the mould loft. Early shipwrights rarely used drawings.



3 Model of the *Lady Rosemary* hull tested in the Denny Test Tank at Dumbarton. This was an oil supply vessel launched in 1973.

3) was tried at the celebrated Denny test tank in Dumbarton.

Some wooden ships were fitted with steam engines. One was the steam yacht *Fox*, built in 1855 by Alexander Hall of Aberdeen and later used to seek the remains of Sir John Franklin's lost expedition in search of the North West passage (**photo 4**). It was later used to carry cryolite (used in aluminium smelting) from Greenland, where it was wrecked. The museum has the propeller, returned from Greenland, showing an early



Model of the steam yacht *Fox*, used in the search for Sir John Franklin's expedition.



Lovely model of the *Thermopylae*, the fastest tea clipper. She was built in Aberdeen in 1868.



Grab dredger built for Aberdeen's harbour commissioners - it could work close to harbour walls.

design (**photo 5**).

By the mid nineteenth century shipyards used iron, and then steel. They did particularly well building composite ships with a wrought iron frame and wooden planking which was then copper sheathed. The tea clipper *Thermopylae* was built by Walter Hood and Co in 1868 and achieved the fastest ever voyage from China to the UK (**photo 6**).

A memorial to Hercules Linton, designer of the better known *Cutty Sark*, stands in his nearby birthplace of Inverbervie. Appropriately, it is a replica of

the ship's figurehead.

Like other yards, Hall, Russell and Co. built a range of steel ships, like the collier *Thrift*, made for the Cooperative Society and launched in 1931 (**photo 7**). There were fishing boats too like the trawler *Scottish Princess*, built in 1959 at the John Lewis yard.

Ships could be specialist craft, such as the *Grab Dredger No 2*, built for the Aberdeen Harbour Commissioners in 1931 (**photo 8**). It could work close to harbour walls. A suction dredger operated in deeper water to ensure the



The *Thrift*, built for the Cooperative Society by Hall Russell in 1931 and used to bring coal from Northumberland and Fife to Aberdeen.



Harbour view with oil supply vessels prominent.

harbour had a water depth of 32 feet at high spring tide.

Post war there was a decline and, although Aberdeen yards attracted some work from the developing North Sea oil and gas business, nearly all shipbuilding went elsewhere and the last shipyard, Hall Russell, closed in 1992.

Harbour and coastal equipment

The museum covers the historical development of harbour and coastal facilities with good displays. Upper floors have views across the



Propeller from the *Fox* showing an example of early design.

harbour, with offshore supply vessels and the Shetland ferry (**photo 9**).

Lighthouses built by the Commissioners of Northern Lights (Northern Lighthouse Board) played an important part in maritime safety (**photo 10**). So too did the lifesaving gun, similar to a whaler's harpoon gun (**photo 11**).

North Sea oil and gas

If much of Britain is unaware of the North Sea oil and gas industry this certainly isn't the case in north east Scotland. Nearby Dyce Airport has the busiest heliport in Europe, with helicopters flying out daily to oil rigs. Morning trains from



Light from Rattray Head.

Aberdeen are full of offshore oil workers returning home. Some oil companies have major offices here and the harbour hosts many ships associated with the industry, plus storage tanks.

After the Groningen gas fields were discovered in the Netherlands in 1959 the search for gas in the British North Sea began in the 1960's. Seismic surveys showed likely geological formations. Surveys usually involved trailing a noise generator behind a ship and picking up reflected echoes from the rocks beneath the sea bed.

Oil and gas are usually found in pores in sandstone, capped by impermeable mudstones. Mudstones and igneous rocks show up as more solid lines in seismic surveys and it was possible to detect some fault lines. At first seismic surveys weren't very accurate but, fifty years on, they have improved considerably making predictions of oil locations much better.



11 Harpoon gun used for lifesaving - it fired a line to a stricken ship.



12 Model of ship-based oil rig.



13 Jack-up type of oil drilling platform - seen from the train at Dundee. One of many signs of the offshore industry visible along the coast.



14 Semi-submersible oil drilling rig moored in the Firth of Forth.



15 Examples of drilling bits.

Drilling rigs

Drilling was a major challenge. Most of the North Sea is far deeper than previous offshore oil locations. Weather and sea conditions can be extremely hazardous.

Operators used three types of drilling rig. There were ship based rigs (photo 12), jack up rigs placed on the sea bed (photo 13) and semi-submersible rigs (photo 14).

Different types of drill bit are displayed in the Museum (photo 15). One is used for taking core samples. Nearby are samples of rocks taken from drilled holes. Drillers pump a heavy mud down the hole to prevent blow outs, lubricate the drill bit and bring rock fragments to the surface.

Holes were sometimes dry or produced little oil, which represented an expensive loss for the oil companies. A heavy oil flowed slowly and might be left until other reserves were exhausted. Under 10% of oil may be extracted from a discovery though oil recovery techniques have improved, including the ability to drill angled or horizontal holes tapping more from a find. Pumping water into parts of a field may improve recovery too.

When suitable oil was found companies would set up production platforms as a permanent base, often drilling further holes from the platform to tap nearby reservoirs. The giant model of the Murchison platform shows just how big these can be, reaching to nearly the height of the Eiffel Tower (photos 16 and 17).

Engineering these platforms and getting them into place was a major task in itself. Unfortunately, the museum has little visible information on how they were constructed. Some even bigger platforms were required for the Clair Field west of Shetland where there is deeper water.



16 The Murchison oil production platform model is almost too big to photograph. Platforms are mounted on frames known as jackets, which are some of the world's largest engineering fabrications. The Murchison platform is north east of Shetland on the edge of the Norwegian sector.



17 Detail of the Murchison platform with crew models giving an idea of the size.



18
Sub-aqua diving suit as used in the North Sea; if working at any depth divers needed to decompress to avoid the 'bends'.



19
NEWT suit invented by Phil Nuyttens and also used in the North Sea. It is made of cast aluminium and the diver controlled it by propellers. This obviated the need for decompression.



21
This mini ROV could be used for various applications including pipeline checking. Aberdeen companies lead the word in this type of technology.

Besides working in deep water platforms must withstand the gales and heavy seas of the North Atlantic and North Sea.

Piper Alpha disaster

North Sea oil exploration and extraction is dangerous but the fire on the Piper Alpha oil platform in 1988 was the worst single tragedy. It claimed 167 lives when a succession of disasters stemmed from a bodged handover between crews. Aberdeen's Hazlehead Park has the memorial and the museum has exhibits describing how the disaster unfolded. It is a tragic and moving story.

Undersea engineering

Working at such depths meant new challenges for divers. Sub-aqua gear was used at first (**photo 18**) but new equipment



20
The Scorpio Remote Operated Vehicle (ROV) was for underwater inspection with an arm to manipulate items.



22
Semi-submersible oil rig model seen in the Merseyside Maritime Museum.

valves or picking up lost objects (**photo 20**).

Smaller versions are available to go through pipelines as small as 190mm (7.5 inches), checking for leaks or blockages (**photo 21**). The Aberdeen area leads the world in developing this technology.

The future of oil

At the time of writing the North Sea's oil industry is in relative decline, although exploration is notoriously cyclical and heavily dependent on the world oil price. No wonder the museum displays the day's price for Brent crude oil. Many oil rigs and production platforms are redundant and pose disposal problems.

Britain is no longer a net exporter of oil and gas and now imports these to meet energy needs. Despite this, production will continue for many years and, with the building of wind farms in shallower parts of the North Sea, its energy contribution remains significant.

Relatively few of us will ever visit an off-shore oil or gas installation but this well laid out museum helps us appreciate the vast scale of operations and the hazards involved.

Further reading

For a readable account of the development of North Sea oil by a petroleum geologist try:

Mike Shepherd, 'Oil strike North Sea: a first-hand history of North Sea oil', Luath Press, 2015. £20

ME

The Scottish Samurai, Thomas Glover and Mitsubishi

It's easy to think of Victorians as nationalistic and inward looking. Not so - many Scots travelled abroad to work and trade. One who made a great impact on his adopted country was Thomas Blake Glover, born in Aberdeenshire in 1838, who travelled to Shanghai and then Nagasaki to work first in tea trading.

He learnt Japanese and stayed helping open up Japan to Western influences. Moving into arms and ship broking he arranged for the William Duthie and John Smith shipyards in Aberdeen to build ships for Japan including three modern warships. He also arranged for young Japanese men to visit Scotland, influencing Japanese politics with his support for the Meiji Restoration leading to major reforms and the emergence of modern Japan.

Glover helped set up a brewery and managed a coal mine but later became involved with the Mitsubishi family, assisting them become a major industrial firm. He married a Japanese woman, a relationship claimed as the origin of Puccini's *Madame Butterfly* (though it wasn't). His home in Nagasaki is preserved, testament to a remarkable man who aided Japan's development as an industrial power.

was engineered to cope with greater depths. One of these was the NEWT suit, designed by Phil Nuyttens and used in the North Sea in the 1900s. It's made of cast aluminium, which the diver could control with the propellers (**photo 19**). More submarine than diving suit, it allowed the diver to work at atmospheric pressure, removing the need to decompress on return to the surface.

Submersibles, known as Remotely Operated Vehicles (ROVs), helped deep sea operations with increased use of robotic equipment. The *Scorpio* AC-ROV is remotely operated and controlled through a cable, which also carried the power supply. It has an arm for manipulating

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.



Two hours to change a light switch! What a performance! To start at the beginning, the bathroom light pull switch broke.

Like Lord Finchley, I tried to mend it. Unlike he of the ermine, who erred, I survived. 1) Extract fuse - which one controls the bathroom light isn't clear, so trek up and downstairs 3x until found. 2) Remove switch, held in by 2nd-hand screws with burred-over slots. One doesn't turn, one turns but doesn't grip. Visit basement for more tools. Break switch apart. Screws were long enough to build a *Dreadnought* with. 3) Buy new switch. 4) Dismantle, prepare wire ends - very short, stiff ends. Extend with chocolate block terminals. In 50 years of using these I have never, until now, found anywhere the screws were seized in the terminals. Not corroded but cross threaded... Visit the basement yet again for more connectors, bin offending items. Finally, job done. Shattered!

I toured a mass spectrometer plant recently and it was fascinating! There was so much I previously did not know. I particularly liked the electric knife. Analysing the smoke given off can identify the sample with a high degree of accuracy, its contaminants and other characteristics. So, I am 98% Homo Sapiens, 2% Neanderthal, male, had eggs



Alan Thorpe's showman's engine at Sheffield SMEE (photo courtesy of Mick Savage).

for breakfast and have an ideal BMI, vote Conservative, read the Daily Telegraph and like Merlot... (Not all the foregoing is entirely true...)

In this issue: soil, footbrakes, *Mamod* racing, a Case house, "we've met before...", er, er...

Ottawa Valley Live Steamers & Model Engineers' The Link, November, says that the Ottawa City soil engineer has forbidden any reuse of the landslip area - in fact the society were lucky not to have to abandon the entire site. After considerable cogitation (Graham Copley has over 200 emails in his *Great Reconstruction* folder) the far loop is to be removed and the track stored pending doubling of the existing loop. One positive outcome is that there will be a sizeable reduction in grass mowing and strimming, saving lots of time and petrol. Graham continues his *Royal Scot* series with the mechanical lubricator, which feeds three cylinders.

W. www.trainweb.org/ovlsme
Conrod, Summer, from **Harlow & Wembley Society of Model Engineers**, reports a successful summer, so much so that, one Sunday, the number of locomotives exceeded the capacity of the steaming bays. Janice Uphill borrowed a mobility scooter on her visit to Bucks Railway Centre but it was not tested for gauge, i.e. fit to run on

their metals. In respect of brakes, hand, air, steam, etc., in our case there is also 'feet down' as in the kids' cartoons! Further to the amateur radio activities, not only have the Edgware & District Radio Society been granted permission to operate from the site but also been allowed to make and test equipment prior to flying off to a remote atoll to activate it for radio purposes. Brian Tilbury poses a shunting puzzle, which kept me busy.

W. www.hwsme.org

The Link, November, from **Model Engineers' Society (NI)** is devoted to 'Times Past', with a selection of photographs of activities going back to the 1950s from the collection of Hazel Gillies, daughter of a former Chairman. They have now been donated to the society.

W. www.mesni.co.uk

The News Sheet, November, from **North London Society of Model Engineers**, reports the visit by Chelmsford MES & Fareham DSME to Colney Heath, during which much tea was consumed, the 'staff' worked hard and the weather was fine. Barracuda Swimming Club also held its 50th birthday party on the site; one member now living in a care home was in his element all afternoon.

W. www.nlsme.co.uk

Raising Steam/Get Technical, October, from the **Steam**



A new home for BCSME's Case (photo courtesy of Paul Ohannesian).

Apprentice Club of the NTET, confirms the fun at the Great Dorset Steam Fair, reviewed by Rebecca Hurley. One highlight was converting some *Mamod* models into 'slot cars' which were then raced - <https://www.youtube.com/watch?v=Slv7j0jzu7c>. The furry friend, 'Bear' has a name. Not 'Furry MacSurface', or many others, but 'Justin Steam', suggested by Oscar Brett, who won a year's free membership of SAC. Justin begins work by explaining how important it is to keep your engine clean. Gary Peach converted a tired *Mamod* TE1a into a crane engine, followed by more TE1s, now three, plus a low loader. The list of New Members now occupies nearly a full page and Julian Tyrrell advises how to change a water level gauge glass.

W. www.ntet.co.uk/sac

Continuing in that vein *Steam Whistle*, from **Sheffield & District Society of Model & Experimental Engineers**, describes Alan Thorpe's acquisition of a Burrell showman's engine and water cart at a local auction (photo 1). Alan writes the story of that day and will have the model converted to gas firing, as his visual impairment will cause difficulty with solid fuel.

W. www.sheffieldmodelengineers.com

Bradford Model Engineering



Gary Douglas's USS Comstock, F45, Otago MES (photo courtesy of Gary Douglas).

Society's Monthly Bulletin for November tells us that Graham gave an illustrated talk on 'Ekranoplan' machines; basically, very large, ground effect, 'aircraft', which fly at a height of only a few feet. *Road Vehicle News* covers odd but useful designs, the most numerous being the *Unimog*, but also the WWII DUKW amphibious truck, and its replacement for use at St Michael's Mount, the *Amphicraft*. Rodney Oldfield describes the need for a *Gremlin Eliminator* and speculates on their likely

origins (in Lancashire! - Geoff).

W. www.bradfordmes.co.uk

Stamford Model Engineering Society's Newsletter, October, describes a talk on Sydney Cotton, inventor of the 'Sidcot Suit' for airmen, used until the 1950s, and his development (!) of aerial photography.

British Columbia Society of Model Engineers, The Whistle, November, reports a record 72,009 tickets were sold in the year, plus completion of a specially built home for their half-scale Case traction engine (photo 2). It was designed by Editor, Paul Ohannesian, an ex-architect, who also helped to build it. An extensive series of pictures recorded its build progress and the move of the Case into it. I trust this fine edifice is comprehensively equipped with water, provision of hot and cold running oil of various types, from 'beer engines' or dispensed from optics. Not forgetting a series of greases from pump-action containers, a wheel balancer, puncture repair outfit, polish cupboard and a spare smoke and ash disposal chute. Not forgetting lots of tea and coffee!

W. www.bcsme.org

Steam Lines, November/

December, from **Northern Districts Model Engineering Society (Perth)** reports that, following a charity run, a cheque for A\$3,000 was given to the Cancer Council of WA. Reference was made in ME 4577, under the COSME Link review, to tempering springs in molten lead, or not... Now Jim Clark tells how tempering in lead is done, which doesn't seem too difficult either, so you pays your money, and you takes your choice! A meeting between UK visitor David Burman and NDMES member Bill Walker revealed that they had met before, 50 years ago. David was illegally 'bunking' the Buxton locoshed (9D) when he was thrown out by the shedmaster, who was... you guessed it! Harry Roser found two wild cats in his workshop, several years ago, and took them in. He has groomed and cared for them ever since, to the point where they are winning prizes at cat shows! He's now starting on a third, which he also found in his workshop - maybe the news is spreading in the cat world! (Word of mouse? Feline fine...) In ME 4572 I asked if photo 6 was real or a model. Bit of a dead giveaway when it appears in



Bruce Geage's Caterpillar D8, 1/12th scale, Otago MES (photo courtesy of Bruce Geage).

Model Engineer though. Yes, it's a 5 inch gauge model 15F, built in South Africa over 13 years by Jan Visagie. <https://www.youtube.com/user/andrewgiffen> Good, innit?

W. www.ndmes.net

Blast Pipe, November, from **Hutt Valley and Maidstone Model Engineering Societies**, had a talk on Lempor exhausts by Caleb, who went quite deeply into the matter, impressing the members. The design came too late for main line locomotives but has been successfully used on preserved examples.

W. www.hvmes.com

Port Bay Express, November, from **Portarlinton Bayside Miniature Railway**, has a tale from a rural railway. Elizabeth Turner said her father sent cattle by the NG railway and the Station Master would always know when an approaching train was ten minutes away. Timetables were very variable. He was never wrong so he was asked how. He replied that he sent his dog to a nearby hill and when it barked the train was ten minutes off.

W. www.miniaturerailway.com.au (Please can the final artwork be removed, as the valve gear/conrods as drawn are driving me potty! - Geoff)

Tonbridge Model Engineering Society

Newsletter, October, has a photograph on the cover of a very neglected and unhappy coach being delivered on a low loader in 1989. A 28 ton goods van, it became their new clubhouse. A new trolley store, *Maison de Poulet*, was built in April, and fitted with a *Corotile* roof for lightness. The club stand at the VMCC rally was popular and was announced over the PA several times, due to one of the announcers being a colleague of the late Chairman, Graham Caird. (Friends in high places...!) An independent THIRD mention of an AFRPS rail tour of British Steel's Scunthorpe plant appears - it must be good!

Conrod, November, from

Otago Model Engineering Society, reports that the Great Little Train show at Invercargill had some interesting models on display and in use. One was a tracked 'buggy', with full safety cage, giving rides around the lake. A fine picture of what I thought might be the Indian Navy, *Talwar* class, *INS Teg* appears on the cover. It is, however that of *USS Comstock*, which has appeared in these pages before (**photo 3**). (These 'stealth' warships all look the same! - Geoff) Editor Lachlan Clark has finished his 'dozer and begun two more. Bruce Geage of Palmerston North has built the same kit and has also completed an electric 1 inch to the foot *Caterpillar* D8, operated by levers from the drivers' position as in the original (**photo 4**). Mike Harrison from Christchurch has built a model 40mm Bofors gun, which is well detailed. (I found a YouTube video on this artillery just recently - Geoff)

W. www.omes.org.nz

Northampton Society of Model Engineers *Newsheet*, November, reports that the 'Night Run' was very popular, so much so that the kitchen began to feel the strain. The 'Guy Fawkes' event was very busy and, despite informing the authorities beforehand, the fire brigade attended after a 999 call. The fire was kept going for four hours and only a small pile of ash remained. Alan and Lesley Baker are moving away and both leave a big hole in the club, which has been fenced off so that nobody falls in. If anyone jumps in, well, that's different! The Society achieved a First for their stand at the Midlands Model Exhibition - well done all! Last year, they were Second - where next?

W. www.nsme.co.uk

Grimsby & Cleethorpes Model Engineering Society's *The Blower*, says that work on the track extension has been going apace, including levelling the track. A 7¼ inch gauge Class 08 shunter hauled 750kg of weight



T-shirt from York MES (photo courtesy of Richard Gibbon).

over the latest section, up 1 in 64, on a wet track, with very little wheel-slip. Two carriages were loaded with bags of cement, representing members (the foregoing should not be taken to imply any other resemblance... - Geoff)

W. www.gmes.com

B&DSME News, November, from **Bournemouth & District Society of Model Engineers**, tells us that there is a possibility of a Gauge 0, 1, 3 & 16mm scale track being built. Members are asked to state their interest.

W. www.littledownrailway.co.uk

My fan tells me that, currently, he isn't quite sure whether he is reading *Model Engineer* or *Practical Wireless* (I appear in both). He refers to the cheap hand-held radio I mentioned in ME asking for more details. I told him, and said that I already had a more expensive radio but the battery was dead. A new battery would cost more than the new radio! I also said that both hobbies were interested in light engineering and some cross-fertilisation could only be a good thing. Both involve men in sheds... I recall that, many years ago, my then radio society approached the Keighley & Worth Valley railway suggesting an amateur radio station at one of their events and this was met with a distinct lack of enthusiasm. Such joint events are now commonplace. It's tough being a pioneer!

York Model Engineer,

November, from **York City & District Model Engineers**, says that they have had trouble with the local wildlife. An oak tree blew down; it was healthy but the soil structure may be unable to support such a large tree so the others are being inspected and cut back. A mouse made its nest in a signalling junction box and an earwig caused a problem in a vacuum brake system. Editor Paul Howard, the resident entomologist, says they practice 'positive thigmotaxis' i.e. they like to crawl into small spaces. Roger Backhouse finds uses for the leftover biscuit tins etc., after Christmas, regretting the non-standard sizes and the lack of 35mm film cans, Oxo tins, tobacco tins and so on, in which the old hands kept small parts. (A standing joke with a radio amateur friend was that he kept resistors in an old alarm clock... - Geoff) Here is a present (**photo 5**) for the one you love, yourself...!

W. www.yorksme.org.uk

The **Gauge 1 Model Railway Association Yorkshire Group** welcome into their midst the one and only Ellis Clark (see adverts). The *Ridings* layout could use a few humorous epitaphs for Fred's splendid church and graveyard, such as 'Here lies the body of Joseph Pound, Lost at sea, Never found' or 'Here lies Lord Thing, shot dead by his butler. Well done thou good and faithful servant'. This is Peter Vincent's 54th newsletter. Keep up the good work, Peter!

W. www.gauge1north.org.uk

And, finally, from **Norwich & District SME's** e-Bulletin. The first computer can be traced back to the Garden of Eden. It was an apple with limited memory. 1 byte, then everything crashed...

Contact:
geofftheasby@gmail.com

JANUARY

- 17 Bournemouth & District SME.** Monthly meeting, Muscliff Community Centre 7.30pm. Contact George Wheatley: 01202 825307.
- 17 Bristol SMEE.** Club meeting 7.30pm, 'Dangerous Precedents' – Geoff Wallace. Contact Dave Gray: 01275 857746.
- 17 Leeds SMEE.** Meeting night – 'The Solar System' – Dave Armeson. Contact Geoff Shackleton: 01977 798138.
- 19-21 London Model Engineering Exhibition,** Alexandra Palace, London
- 19 Rochdale SMEE.** 'Victorian Engineering' – Judith Atkinson, at Castleton Community Centre, 7.30pm. Contact Rod Hartley 07801 705193.
- 21 Tiverton & District MES.** Running day at Rackenford track. Contact Bob Evenett: 01884 252691.
- 23 Romney Marsh MES.** Members' social afternoon. Contact Adrian Parker: 01303 894187.
- 25 Worthing & District SME.** Club meeting 7.30pm – 'Where all your money goes' – Neil Furze. Contact Dereck Langridge: 01903 202661.
- 27 Worthing & District SME.** Annual club social and photographic competition 7pm. Contact Dereck Langridge: 01903 202661.
- 30 Romney Marsh MES.** Members' social afternoon. Contact Adrian Parker: 01303 894187.

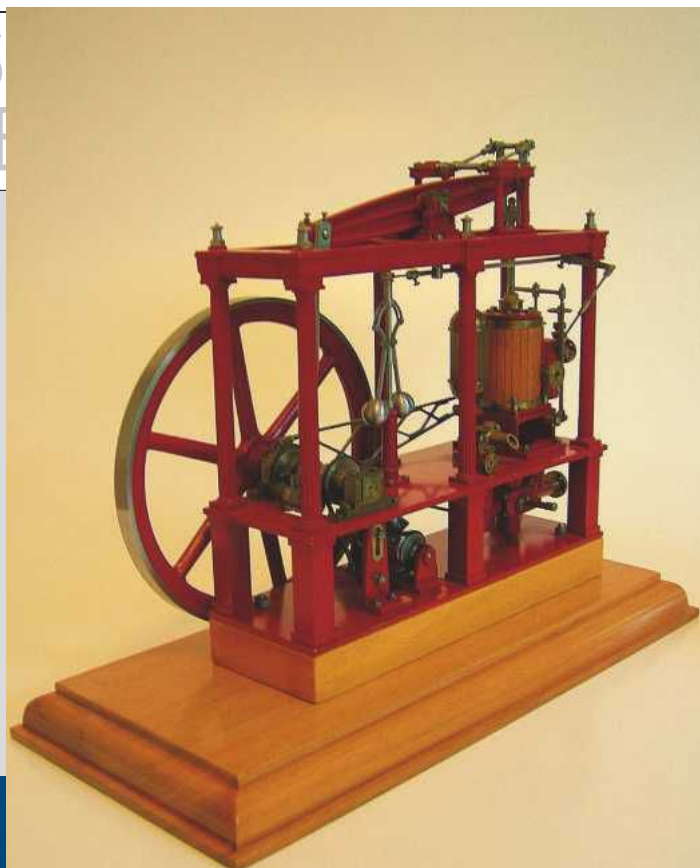
FEBRUARY

- 1 Sutton MEC.** Bits & Pieces. Contact Paul Harding: 0208 2544749.
- 2 Rochdale SMEE.** Auction Night, at Castleton Community Centre, 7.30pm. Contact Rod Hartley 07801 705193.
- 4 Tiverton & District MES.** Running day at Rackenford track. Contact Bob Evenett: 01884 252691.
- 5 Peterborough SME.** Bits & Pieces, 7.30pm. Contact Terry Midgley: 01733 348385.
- 6 Oxford (City of) SME.** 'Trevithick to Barnes Wallis'. Contact: secretary@cosme.org.uk
- 6 Romney Marsh MES.** 'Rhodesian Railways' – Colin Cox, 7.30pm. Contact Adrian Parker: 01303 894187.
- 7 Bradford MES.** The A1 Locomotive Trust: The P2 Project. 7.30pm, Saltire Methodist Church. Contact: Russ Coppin, 07815 048999.
- 7 Leeds SMEE.** Meeting night – 'Patriot – The Unknown Warrior' – John Hastings-Thomson. Contact Geoff Shackleton: 01977 798138.
- 8 Worthing & District SME.** Club meeting 7.30pm – 'My early apprentice years' – Dave Brutnell. Contact Dereck Langridge: 01903 202661.

ISSUE NEXT ISSUE NEXT ISSUE NEXT ISSUE

- **Webb Tool Chests**
Chris Rayward makes the hasp and latch plate for his LNWR tender tool chests.
- **ENV Aero Engine**
Stephen Wessell electroforms the copper water jackets for his aero engine.
- **GWR 14XX**
John Whale completes his improvements by attending to the smokebox, boiler and ashpan.
- **Out and About**
Martin Wallis recalls his visit to the Great Dorset Steam Fair.
- **Buying a Project**
Mitch Barnes continues to explore places where orphaned models may be found.
- **Steam Hammer**
Ray Griffin makes the valve chest and piston valve for the Stuart steam hammer.

Content may be subject to change.



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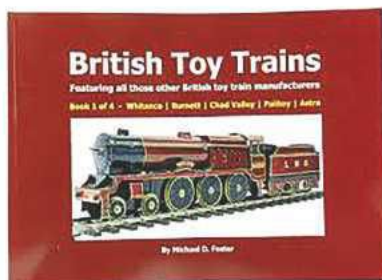
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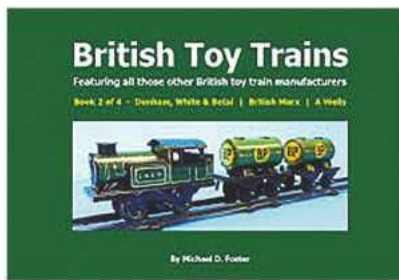
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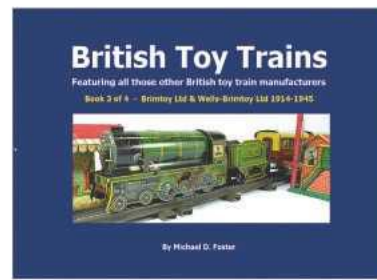
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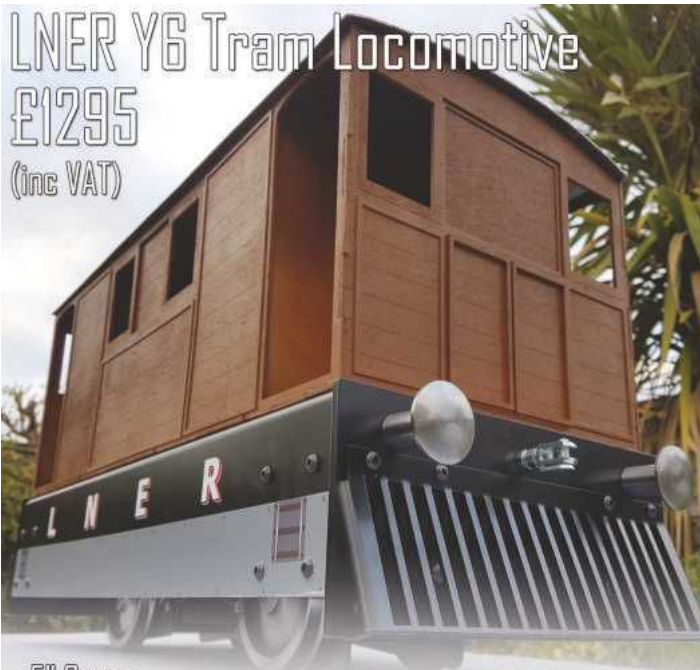
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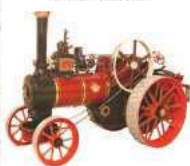
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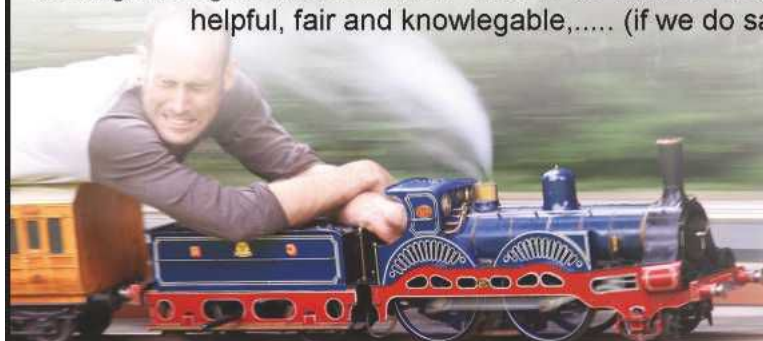
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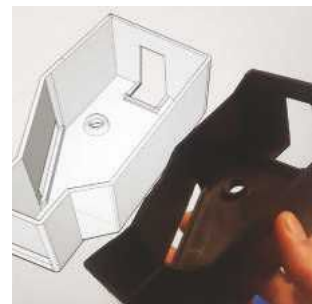
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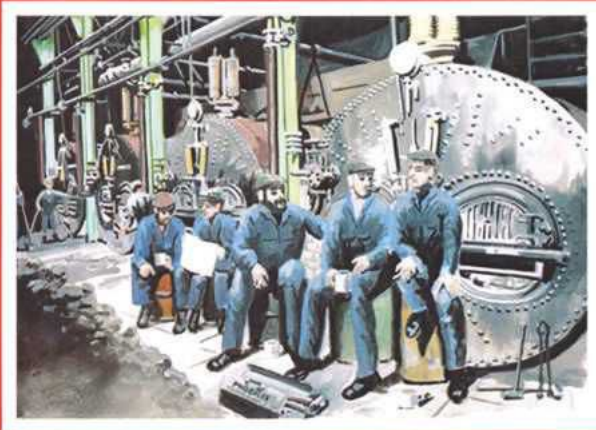
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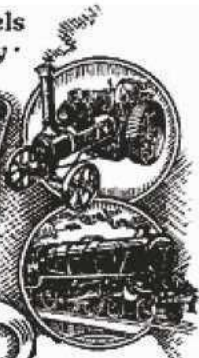
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