

THE ORIGINAL MAGAZINE FOR MODEL ENGINEERS

Vol. 224 No. 4629 • 3 - 16 January 2020

MODEL ENGINEER

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Wheel
Profiles

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Notes from
a Novice

COVER FEATURE

Midlands
Club Stands



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81



86



123

ISSUE IN THIS ISSUE IN THIS ISSUE IN THIS ISSUE

Vol. 224 No. 4629 3 - 16 January 2020

80 SMOKE RINGS

News, views and comment on the world of model engineering.

81 MIDLANDS MODEL ENGINEERING EXHIBITION

John Arrowsmith completes his report with a survey of the club stands.

86 BUILDING THE MODEL ENGINEER BEAM ENGINE

David Haythornthwaite offers a modern perspective on building the ME Beam Engine to 1 inch scale.

89 WENFORD

Hotspur takes up the ongoing story of Wenford, his 7 1/4 inch gauge Beattie well tank.

92 MAGDALEN ROAD REVISITED

Jeremy Buck welcomes us back to Magdalen Road for a tour of the locomotive works.

98 MODEL LOCOMOTIVE WHEEL AND BRAKE BLOCK PROFILES

Hiroyuki Watanabe presents a method for forming accurate wheel profiles.

103 BOOK REVIEW

D. A. G. Brown reviews *The Remarkable Jim Crebbin* by Roger Backhouse.

104 MORE SLOTCARS

Henk-Jan de Ruiter takes a look at a few classic chassis from the 1960s and 1970s.

107 THE STATIONARY STEAM ENGINE

Ron Fitzgerald tells the story of the development of the stationary steam engine.

111 MY FIRST PROJECT

Dan Watson remembers his first steps up the model engineering learning curve.

114 BRILL 22E TRAM TRUCK

Ashley Best describes an American design of tram truck that was widely used on British trams.

118 BACKYARD FOUNDRY TECHNIQUES

Luker explains how you can set up your own foundry at home.

123 ALI BUBBA

James Wells disappears into his shed and turns a few scraps of wood into an entertaining toy.

124 CLUB NEWS

Geoff Theasby compiles the latest from model engineering clubs around the world.

127 DIARY

Forthcoming events.



ON THE COVER...

Noel Shelley checks the melt during his casting demonstration at the Midlands exhibition (photograph John Arrowsmith)..

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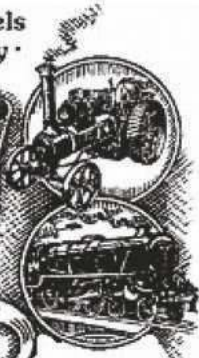
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Designer

Evening Classes

Phil Beckett, of MET Northbrook College in Worthing, has contacted me to let me know about the evening class his college runs (see flyer). This is not a formal course but instead is very flexible in what is taught, according to what people want to learn. I'm told the workshops are very well equipped and have an extensive range of equipment.

I attend a very similar evening class in Cambridge and have been for the last 33 years. Like the class at Worthing, it is not a taught class but has a very 'clued-up' tutor who can answer most questions related to model engineering. What he can't answer, someone else in the class usually can. It's really part 'communal workshop' and part extended tea break and it's a great way of meeting people with similar interests. There's also always the possibility of getting some useful work done!

Another benefit of the class I attend is that, however well equipped our own workshops at home are, they are unlikely to contain the range of equipment available in a college workshop. At Cambridge this includes a forge, oxy-acetylene, vacuum forming and casting facilities.

I think these classes are of immense value to model engineers so, if you know of a similar class that would welcome new members, please tell me and I will let your fellow readers know about it!

SMEE Courses

SMEE launches its training courses for 2020 on 8th February with the successful course *Introducing Model Engineering*. Run over three Saturdays it includes basics of



setting up a workshop, what's essential to buy and where to buy cheapest, key model engineering operations and basic workshop safety. It is followed in May by the Part 2 or 'Polly' course where students make a working model steam engine and boiler.

SMEE training course can help anyone interested in developing metalworking and simple model engineer skills. Participants have gone on to build a variety of models in different scales.

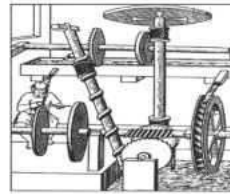
Over 150 students have taken courses and nearly all have gone on to develop further model making skills. One of the 2019 students, Ian Grant, discovered the course while visiting the London Model Engineering Exhibition at Alexandra Palace. He says "Going on the courses was a great help in setting up a workshop so I knew what to buy. I reckon the tips on where to buy tools saved me a large part of the course cost! Although I did metalwork at school I had no engineering experience so it was a great help. Even better, SMEE training gave me an impetus to make things. I made the Polly model

and am now making another. I plan to make a Stuart engine afterwards."

Ian is a civil engineer currently working on the Silvertown Tunnel project. He says the tuition was excellent and he liked the way everything was demonstrated with members around to give one to one advice. He adds "the course is excellent value for money". Although he now has his own workshop Ian also used the SMEE facilities to make parts including rolling boilers.

Other SMEE training courses this year include an introduction to milling and a 'hands on' course for members only on tool grinding. SMEE has members from a wide variety of backgrounds and with diverse interests. Interests include a Gauge One group, an Engine Builders group and the Digital Group which meet online or at the society's headquarters and workshop, Marshall House, in South London.

For more information about SMEE courses see their website www.sm-ee.co.uk or write to SMEE Courses, Marshall House, 28 Wanless Road, London, SE24 0HW.



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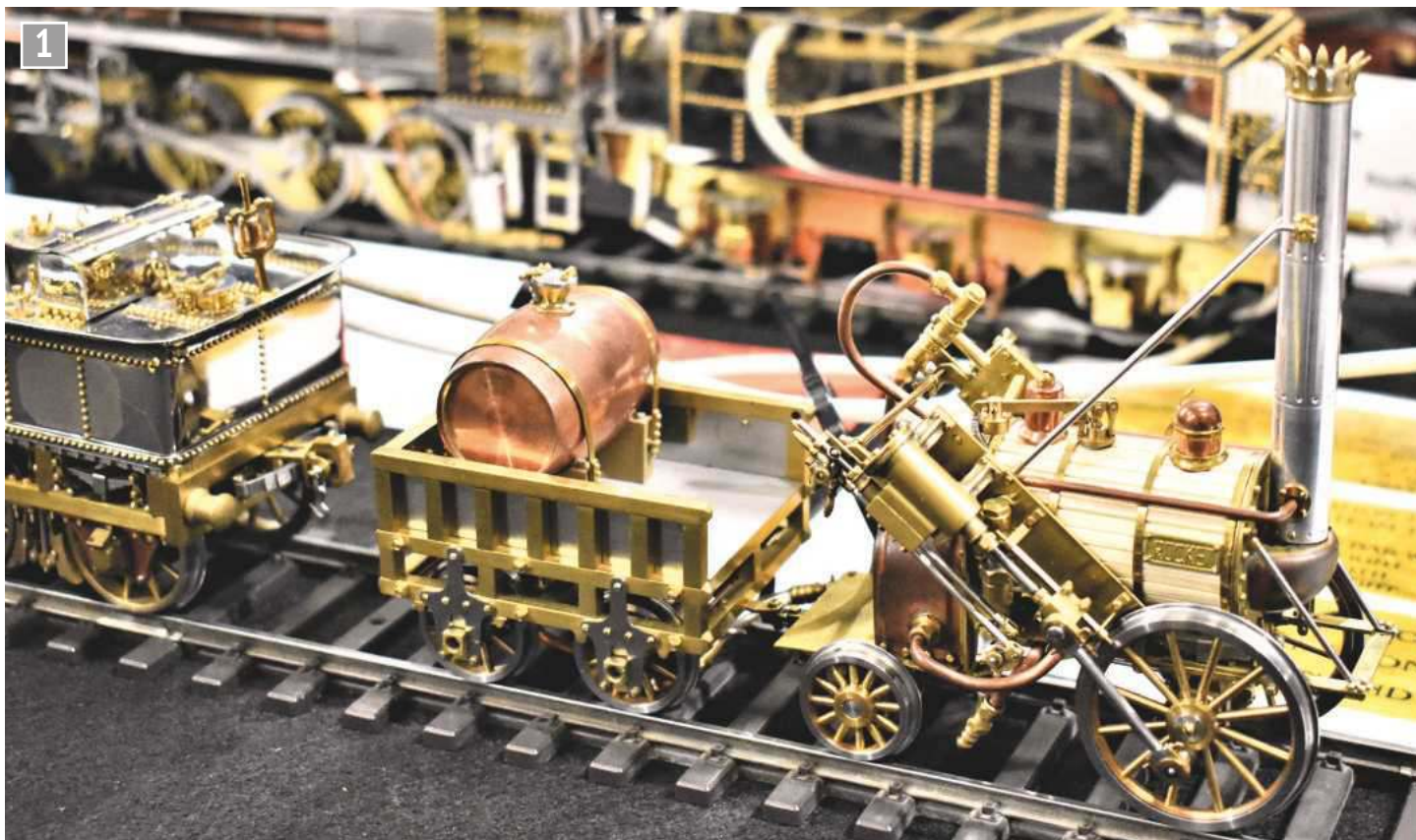
You will be instructed in practical and safety matters as required by individual needs.

People who attend have and are making, Model engineering, mechanical restoration, refurbishment, sculptures, mechatronics, boat parts, bike & car parts and all sorts of personal projects. Just look up ECL022 or contact admissions for fee details. 01273 667704

Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
07710-192953
mrevans@cantab.net

Double Beam Engine

If you are building Bob Middleton's double beam engine and are about to start drilling holes in the baseplate – stop! There are some small errors in the placement of three of the holes which were, unfortunately, only discovered after the last issue went to press. We shall be printing a corrected version of the relevant drawing next time.



Another of Giancarlo Mastrini's masterpieces in Display Class 1.

Midlands Model Engineering Exhibition

John Arrowsmith surveys the club stands at this year's Midlands show.



Bob Shephard's 9F is progressing very well.

In this final part of my report from the Midland Exhibition I will be looking at the Display Classes together with the Club Stand displays and all the other demonstrations and activities presented during the show. Display class numbers were a little disappointing this year but the quality was still there and the lack of entries was more than made up for by the club stand displays. Giancarlo Mastrini added some of his past winning locomotives to the display (**photo 1**) which added to the class and with some excellent 5 inch gauge models and a 7¼ inch gauge American locomotive there



Stuart Brown owns this 7¼ inch gauge American 'Galloping Goose'.

was lots to see on the stand. Bob Shephard's 5 inch gauge BR Class 9F 2-10-0 now fitted with its boiler and cladding and the tender chassis is looking superb; it will be an excellent example of the prototype when completed (**photo 2**). Another 5 inch gauge locomotive owned by Jeremy Buck also stood out as an excellent example of the prototype. The LNER A4, *Golden Plover* finished in garter blue with lots of fine detail really caught the eye. Stuart Brown's American Rio Grande Southern 'Galloping Goose' is a rare model of an unusual rail

bus but was well made and really looked the part (**photo 3**). In Display Class 5 a small range of stationary engines provided some variation and Malcolm Green's Horizontal Mill Engine was a fine piece of work (**photo 4**). The little twin cylinder oscillating engine built by Laurence Drybrough was also well made (**photo 5**). A much larger entry in Class 6 was the 4 inch scale Garrett Traction Engine being built by Richard Betts which looks to be making good progress (**photo 6**). Nicholas Farr provided a new revision to an

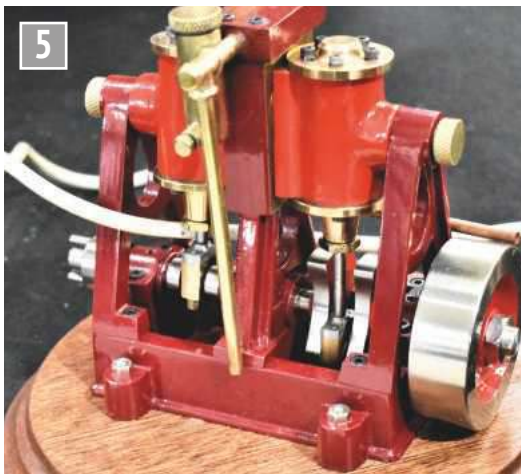


Malcolm Green built this fine Horizontal Mill Engine.

old standard manual drilling machine with his spindle and stand improvements (**photo 7**). A very well made Stirling Engine by John Wing added another quality exhibit for visitors to enjoy. An unusual model was the Jan-Eric Nyström Engine built by David Rhodes which was nicely made and had interesting motion work (**photo 8**). In Class 10 a couple of fine boats provided a contrast in types. Clive Dent's

1:48 scale lobster fishing boat (**photo 9**) was in complete contrast to Trevor Orton's fully rigged French Naval Schooner, *La Toulonnaise*.

Moving on to the club displays, there were some really excellent presentations by all the clubs and societies which made for a time consuming visit if you looked at every one. Take the Club Shield winners - the Hereford SME - they had a wide range



The Twin Cylinder Oscillating Engine in 1/8th scale built by Laurence Drybrough.



Richard Betts, a member of the Black Country Live Steamers, is building this 4 inch scale Garrett traction engine.



Modifications to an old favourite by Nicholas Farr.

A Jan-Eric Nyström Engine built by David Rhodes.



of models and equipment on show from simple centre punches made by their young engineers to sophisticated locomotives and boats. The Stirling engine being built by 15 year old Daniel Bell is showing some fine workmanship and design (photo 10). On the Second placed stand the Melton Mowbray MES provided another excellent range of models and fittings with Norman Smedley's Speed Six Foden steam lorry receiving a great deal of attention; now finished in a striking blue livery it looked superb. Alongside was the boiler which is still under construction. Stewart Jackson's 5 inch gauge Shay locomotive is an impressive model and Martyn Shenton's example of a Woodroffe 'Verto' engine circa 1880-9 again showed some excellent workmanship (photo 11). One of the joint Third placed clubs was the Rugby SME who were also celebrating their 70th Anniversary and they provided a very large display of members' work ranging from a large *Cricceith Castle* locomotive still under construction, to a small stationary engine, with a wide range of quality models in all scales and gauges in between. The other Third placed club was the Knightcote Model Boat club who had a very wide range of marine craft on show ranging from modern lifeboats and submarines to fine, fully rigged sailing ships.

One of the other noteworthy anniversary's being recognised

at the exhibition was the 130th year of the opening of the Eiffel Tower in Paris. The Midlands Meccano Guild had built a range of models to commemorate this anniversary. Polly Model Engineering also had an important anniversary as well and celebrated with a range of models covering the 20 year production of their range.

A special display of a rake of nine superb Pullman carriages built by Brent Hudson and Ben Lyons in 5 inch gauge did attract a lot of attention. Part of a batch of 18 such carriages, they had every detail as per the originals including working table lamps. Both the informative organisations were present with the Northern Association of Model Engineers having a display of tools and paperwork while the Southern Federation of Model Engineering Societies provided their usual informative literature and a video of their activities during annual rallies etc.

Outside, the Fosseway Steamers were active for the whole show with demonstrations of how traction engines were put to work before the advent of electricity and modern methods of production. Sawing bulk timber was a regular job for full size engines but their smaller brothers are also able to handle these tasks as well. Phil Scarborough with his 4 inch Garrett *Lady Lucy* was coupled up to Richards Kew's saw bench and was



A delightful little lobster boat built by Clive M. Dent.

Work in progress by 15 year old Daniel Bell with his self-designed Stirling engine.

busy cutting long lengths of timber as well as making plenty of sawdust! Another 4 inch engine, this time a Foster owned by Steve Lee, was busy grinding wheat to make flour, which made some very

good bread. The Model Steam Road Vehicle Society MSRVS displayed a range of vehicles and engines both inside and outside. The inside display included the exemplary 2 inch scale Fowler Showman's



Martyn Shenton built this example of Woodroffe's Verto Engine.



Noel Shelley has his furnace almost up to heat during his outside demonstration.



First time ever on a traction engine, 12 year old Jev looks like he is enjoying himself.

engine and crane built by Davinda Matharu which really attracted people to the stand.

The traction engine world is very good at encouraging young people to get involved and the Haynes family from near Wolverhampton were a case in point. Dad, Mum and their three sons were all enjoying themselves at the show and twelve year old Arthur proudly showed me his working Mamod collection as well as demonstrating his competence at driving larger engines. He handled a 4 inch Burrell and a 3 inch Aveling & Porter engine with all the skill of a real professional, with dad's supervision of course. There were other outdoor activities to entertain the crowds with the popular Noel Shelley and his working furnace busy melting brass and making

castings always drawing large crowds of onlookers (**photo 12**). James Hill from the Gas Turbine Builders Association was another busy man demonstrating the power of these high tech engines to large crowds of visitors. The Coventry MES were again operating their portable track with a steam locomotive supplied by Polly Engineering and younger visitors were invited to ride with accomplished traction engine drivers to enable them to feel the experience as well as see it. One young man, Jev, attending with his Gran and Grandad had never been to an exhibition like this before so the pleasure of riding with Les Riley on his 4 inch scale McLaren was really something special (**photo 13**).

Inside the main hall visitors could enjoy a small range of

interesting demonstrations. Derek Brown is a regular Demonstrator and Lecturer at the show and he was again showing the techniques involved in sharpening small drills down to a No. 80 diameter and, for the larger sizes, his method of creating a four facet drill point was also very informative. Alongside Derek, Brian Sankey was welcoming visitors to his 3D printing process and showing how the system can be operated. If gear cutting was your interest then Chris Robinson was busy using his own built Jacobs gear cutting machine cutting helical gears and worm wheels. Sheet metal working was carried out by Peter Stevenson as part of the Coventry MES workshop which itself was busy building a simple 'Wig Wag' stationary engine. To add to the

contribution made by Coventry MES, their display stand was full of excellent models and fittings which again provided lots of interest.

The display by the London & North Western Railway Company had three very nice period locomotives supported by a large collection of photographs and paperwork relating to this pre-grouping railway on show. As if to compliment this, the 10¼ Inch Gauge Society displayed a fine example of a Royal Scot locomotive along with lots of information about the organisation and its railway (**photo 14**). A comprehensive display of exhibits on the SMEE stand varied from a modern wire eroding machine to a collection of some of their archive models.

The display also included a one-third scale model of a Myford ML7 built in 1956 by Leonard Roe and which was acquired by Chris Moore, late owner of Myford, some years later. With Chris passing away in 2019 the family donated this machine to SMEE for their collection (**photo 15**).

Regular exhibitors at the exhibition are the City of Oxford SME who presented an interesting selection of members' work and equipment. The little Southern Railway Q1 class 0-6-0 locomotive in 3½ inch gauge owned by Stephen Jakeman was a fine model of a rare prototype (**photo 16**) whilst the rotary table and dividing head to the David Piddington



A model ML7 lathe, now part of the SMEE collection.

One of the largest models in the show was this 10¼ inch gauge Royal Scot, part of the 10¼ Inch Gauge Society display.

design built by Ian Varty was a well made and useful piece of workshop equipment.

A nice, compact display by the Gauge 3 Society showed some well detailed models in 2½ inch gauge to provide a good insight into the scenic aspects of this popular system. The latest model from Harry Williams on the I/C Builders display was a valveless Pulse Jet which attracted a lot of comment and attraction. Harry kindly demonstrated how it worked and explained some of the build problems which he had to resolve. A varied display by members of the Erewash Valley MES included a lovely model of the refurbished station on the Welshpool & Llanfair Railway along with a couple of handsome traction engines and a model of a Burrell-Boyden traction engine, circa 1858, which is under construction by Brian Hutchings.

The display by the Nottingham SMEE was a colourful presentation with a multi-coloured Class 08

engine and crimson and cream carriage, complemented by Nigel Ball's blue 'Scamp' and the club's large green shunter. A good model of the paddle steamer, *Waverley* (photo 17) was a feature of the Kingsbury Water Park MBC stand along with a wide variety of other marine craft.

A large display by the National 2½ inch Gauge Association covered a wide range of larger models including an American 'Big Boy' along with the LBSC designed 4-12-2 Caterpillar locomotive. This really was an interesting display with some 'under construction' models showing some fine workmanship; it is almost down to watch-making levels for some of the components! In contrast to these smaller gauge engines the 7¼ inch Gauge Society had two excellent locomotive examples on show along with some rolling stock which demonstrated the scale very well. Another large display was by the Bromsgrove SME



This Southern Railway Q1, 0-6-0 was displayed on the City of Oxford stand.

who had built a locomotive repair shop, full of detail, combined with an excellent selection of captivating engines (photo 18). Full size steam boat enthusiasts would have been pleased to see the launch, *Zara Finn* on display along with a good range of typical engines and fittings (photo 19). There was a good diversity of models from the Wolverhampton & District MES. Some unfinished locomotive models combined well with the larger examples of, for example, a vacuum fitted carriage bogie. Stationary engines and a small train of Gauge 1 stock added to the overall effect.

There was a good selection of models on the Birmingham SME stand with the George Thomas modified Myford top slide built by Cyril Millward, the graduated vernier scale giving an adjustment down to 0.0001 inch. An attractive display by the Northampton SME featured a number of locomotives and a superbly made front end of a steam roller by Richard Folwell which will be an amazing model when completed. Some good photos of club activities

and a couple of nice boats added to the overall effect.

For what I think was the first time at any model engineering exhibition we had a specialist artist at work during the show. Eric Petrie was working quietly away through the whole show completing one of his excellent canvases. I hope his efforts were appreciated by the many visitors; he had a good range of finished works on show covering many topics.

This brings my notes on the Midlands Exhibition to an end. I hope they give you a flavour of the event and my apologies if I haven't given you a mention. I can say, however, that if you exhibited there, your contribution in whatever way was greatly appreciated by both the organisers and the visitors. It was a good, well attended exhibition and I look forward to doing it all again next year. Let's hope that every competition class will have some competitive entries and the club stands again meet the very high standards they have set. Thanks again to everyone I met and spent time with. It was all most enjoyable.

ME



A well made example of the popular Paddle Steamer, *Waverley*.



A rail locomotive repair shop was part of the Bromsgrove SME display.



Full size steam launch, *Zara Finn* was a well maintained example of a steam driven launch.

PART 14



I am not including all the plan details in this series, as builders will purchase their own copy of the plans. However, I am showing in **fig 3** the drawings of the crossbar and crosshead, as it is impossible to describe the machining of these components without reference to the drawing.

Fig 3

Crossbar

Crosshead and crossbar.

I made the piece 1.6875 inch long, centred it and drilled the ends with a 2.1mm drill – tapping size for 7BA. I left a small centre on the ends for the tailstock support. While supporting the end with the tailstock, turn the end down to 0.186 inch diameter for a length of 0.469 inch. Reverse in the collet chuck, now using a $\frac{3}{16}$ inch collet, and repeat that procedure for the other end. This should leave you with a bar, onto which your parallel links can slide, with a $\frac{5}{16}$ inch



A normal collet chuck interferes.

central boss. This is then mounted in the collet chuck in the lathe, using the tailstock support, and the central boss barrelled to $\frac{1}{4}$ inch diameter at the edges, using a mixture of taper turning, using the top slide, and filing in the lathe whilst the lathe is turning to give a uniform curved surface.

This central boss has now to be brought to $\frac{1}{8}$ inch thick to make a central flat panel and this would be fairly straightforward except for the fact that the ends of the panel have to curve outwards to $\frac{1}{4}$ inch diameter to make the shoulders for the $\frac{3}{16}$ inch bearing surface. I mounted the crossbar on the milling table between a collet on my rotary table and a tailstock as shown in **photo 120**. I decided to thin the central boss down to $\frac{1}{8}$ inch wide, using the side of a $\frac{1}{4}$ inch end mill, despite the fact that I do not like using the sides of end mills. I found, however, that my Clarkson end mill holder would interfere with the collet holder on the rotary table for this small part. **Photograph 120** illustrates the problem and **photo 121** shows that by using a simpler end mill holder the problem was overcome.

Mill across the front and back of the barrelled section using side milling and take the same amount off each side. Ensure that your direction of travel does not cause 'climb milling'. Thin down until the centre section is $\frac{1}{8}$ inch thick but be careful not to mill away the left and right edge of the barrelled section, thus

leaving a full circular edge to the bearing surface. When I had finished this, I measured for the two holes that need to be drilled at $\frac{7}{16}$ inch centres for the ends of the parallel rods. I was amazed to find out how little room is available for these holes and I needed to use a $\frac{5}{32}$ inch slot drill to side mill closer to the bearing edge. Even when this was done, I needed to spot mill both faces to allow a flat surface for the ends/nuts of the parallel rods. After measuring a 7BA nut, I decided to make the ends of the parallel rods 8BA, so that the nuts would be smaller.

To finish the crossbar it is only necessary to make the $\frac{1}{4}$ inch collars (spacers), which sit between the bearings, and to make the $\frac{1}{4}$ inch end sections. These end sections are really 7BA bolts with large round heads. When fitted to the shaft these look to be part of the crossbar itself. I tapped the ends of the crossbar in the lathe using a tailstock tap holder. I turned the end 'bolts', turning the 7BA end down to 0.098 inch diameter and then threaded it with a tailstock mounted 7BA die. Remember that, as dies will not cut a complete thread right up to a shoulder, you will need to either open up the threaded (female) ends of the shaft for one or two threads, or narrow the thread on the screwed-in end caps (male) - up against the shoulder. I chose the latter and, when fitted, it was impossible to tell that the whole assembly was not one



Milling the central panel.

piece. Part off, with a sharp parting blade, leaving the head of the bolt to be $\frac{1}{16}$ inch long. The crossbeam is shown assembled with its two parallel straps in **photo 122**.

Crosshead

This part is fairly straightforward in terms of machining with a lathe and mill. As a picture saves a thousand words, the finished part is shown in **photo 123**. The item

needs to be made from $\frac{3}{8}$ inch square steel bar. I had 10mm square in stock which is just a few thou larger so ideal to allow cleaning up to the drawing size.

As I have a collet set I chose my machining sequence appropriately. I started by cutting a length of square bar, set it true in the four jaw chuck, and faced both ends bringing the length to exactly 1.1875 inch ($1\frac{3}{16}$ inch). One end



Crossbar and parallel straps.

123



Crosshead.

When fitted it was impossible to tell that the whole assembly was not one piece.

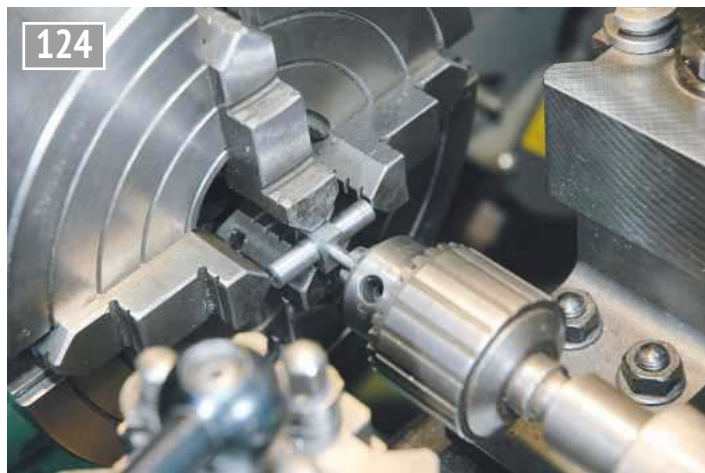
was turned down to $\frac{1}{4}$ inch diameter for a length of 0.4688 inch and then the item was reversed and held in a collet chuck to carry out the same procedure on the other end. This left a central section of the square bar $\frac{1}{4}$ inch long and this was cleaned up to $\frac{3}{8}$ inch square on the mill.

I chose to drill and ream the $\frac{5}{32}$ inch diameter hole through the square section at this point. This will carry the piston rod. To do this at this stage makes setting up for making the boss round the piston rod much easier. Returning to the lathe, I chucked a short length of $\frac{5}{32}$ inch silver steel in the tailstock chuck, slid the part machined crosshead onto it as a dummy piston rod and used this to present the item to the four jaw chuck for further machining. This makes setting the piece straight and central in the four jaw much easier and can be tested by withdrawing and re-inserting the rod into the part. The procedure is illustrated in **photo 124**. The small boss round the piston rod hole can then be created by normal turning. In **photo 125** I am using a home-made tangential tool holder for this, and it is difficult to see as everything is the colour of steel. I do prefer to use sharp HSS tools for

these small parts rather than replaceable tips which require a heavier cut in order to work.

Lastly, the part was returned to the mill in order to mill the small slot for the piston rod key and the part was placed on a thin parallel in the machine vice. As this slot is only $\frac{1}{16}$ inch wide, care needs to be taken using a $\frac{1}{16}$ inch slot drill. I went to a depth of 10 thou on each pass. I do not like marking out but I have a DRO on the mill, so I located the centre using edge finders on opposing sides and halved the readings to find the centre. Once the slot on one side was finished, I reversed the part in the machine vice and carried out the same procedure on the opposite side. It does not state this on the drawing but I milled the slot to be 5 thou shorter on one side than on the other side

124



Setting the crossbeam in the four jaw chuck.

125



Turning the crosshead boss.

to allow for a tapered key.

The part was once more returned to the lathe and the $\frac{3}{8}$ inch bearing surfaces for the parallel link bearings were cut to 1 thou shy of $\frac{3}{8}$ inch diameter to give a running fit. Again, I use a DRO to control things and hardly ever have the need to use marking out. If you haven't yet made the pins that go through the beam, and onto which hang the parallel

links, now is a good time to make these. I used $\frac{1}{4}$ inch silver steel which was a snug fit into the reamed holes in the main beam.

●To be continued.

NEXT TIME

We complete the parallel motion.

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

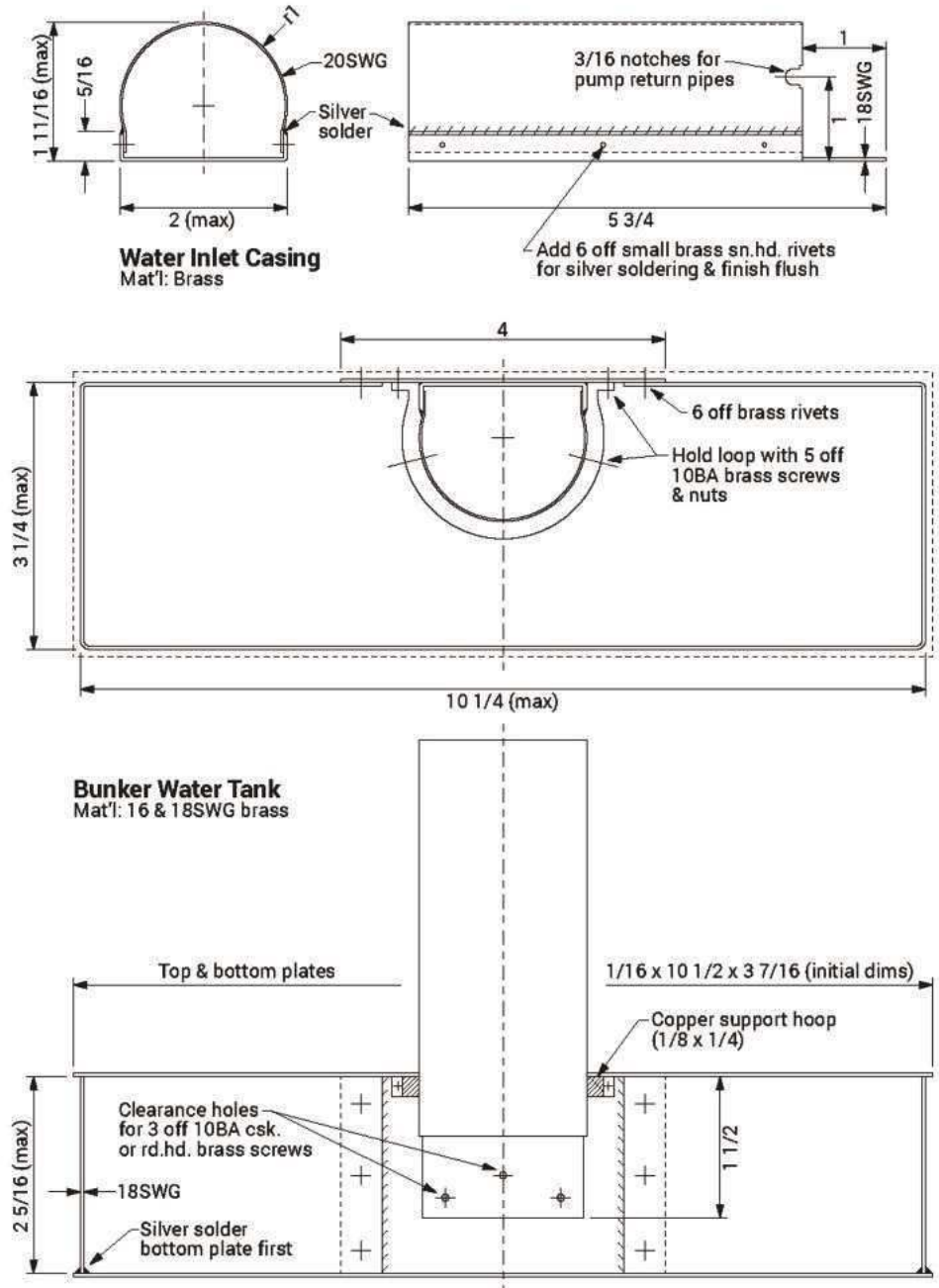
PART 2

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



Continued from p.855
M.E. 4627, 6 December 2019

Fig 2



Construction of the bunker water tank assembly

This tank construction has not been detailed previously and the assembly sits up

underneath the bunker coal supply space. It also has a vertical water filler entry casing that has to pass up through the protective steelwork

already in place and must be coupled to the rear well tank that is down between the frames. My pictures and the new drawing should make



This shows the completed water filler casing - note the $\frac{3}{16}$ inch slots added at the base to act as a location for the two return water pipes from the crosshead pumps.

this clear. As the steel bunker is already drawn, the sizing for the internal tank has to be judged to be easily assembled into the space available and with water capacity in short supply it is tempting to make the fit as close as possible. My drawing sizes allow for some sensible clearance and this is important as the water connection between the upper and lower tanks is by means of a sliding sleeve with an 'O' ring joint and the rear cab/bunker assembly has to be fitted over the top of these two tanks.

To begin the work I have included the drawing for the bunker tank (**fig 2**) and this gives the sizes of the component parts I used. It is important that the final overall dimensions allow the two parts of the assembly to fit easily into the rear bunker casing, so my drawing shows the initial sizes for the top and bottom plates which will be trimmed back after silver soldering to fit into the bunker structure. Although I feel this is the logical place to begin the description, I will have to stop part way through and offer information for the rear well tank as well, because the hole for the sliding connection needs the holes in both tanks to be marked out from underneath the well tank with the bunker in position.

Water entry filler pipe

Start by cutting a piece of 18SWG brass plate $5\frac{3}{4}$ inches

long by $2\frac{1}{2}$ inches wide and flanging the sides to be just $4\frac{3}{4}$ inches long and to an overall width of 2 inches. Before going any further, check that this plate passes up into the water entry casing in the bunker; if it does not, either the obstruction needs to be dealt with or the width over the flanged edges needs to be amended. The length of the curved closing section of pipe is also $4\frac{3}{4}$ inches and uses a piece of 20 SWG brass plate which requires bending around some steel bar to fit inside the flanges. To get the size right I used a piece of brass strip to simulate the curvature, again to allow sensible clearance and the developed length turned out to be $4\frac{5}{16}$ inches.

Cut out the piece of plate and anneal if necessary to form the curved shape, then hold the parts together with six small brass rivets and silver solder the assembly. Both edges of the plate are given a slight reverse bend to sit inside the flanges of the backing plate and it leaves an extension at the bottom of the flanged plate which is used to attach it to the rear side of the tank in due course (**photo 4**). Again, try the fabrication in the bunker water filler passage to make sure it fits. Note, that I also made two $\frac{3}{16}$ inch wide notches in the base of the curved water entry pipe to allow the location of the water return pipes from the cross-head pumps when these are fitted.



Two views showing the way the side strip for the bunker tank body was clamped against a steel block in the vice to form the right angled bends. A folder would have made life easier but I do not have room for one!

Rear bunker tank

The construction of the tank is also all in brass and I began by cutting out the two top and bottom plates from $\frac{1}{16}$ inch material. If stuck for material the upper plate can be 18SWG instead as it is the bottom plate that provides the initial rigidity of the tank. The overall sizes are given on my drawing and I have left them a good

$\frac{1}{16}$ inch oversize all round as this helps the heat flow for the silver soldering and the overlapping edges can be filed back afterwards to fit into the riveted internal frame of the bunker casing. It is surprising how much space the rivet heads take up.

Next, I made the rectangular sides in one piece from a 24 inch length of 18 SWG

plate material cut into a strip $2\frac{5}{16}$ inches wide, maximum. Working out from the centre, the front panel was made $10\frac{1}{4}$ inches long and the two return bends were added to leave a gap of around 3 inches at the back. **Photographs 5 and 6** show the method I used to form the corners using a steel block held in my vice with the strip material set squarely and clamped against a marked edge then formed using a mallet.

To complete the initial assembly I made the rear support plate for the back of the tank to attach the water filler pipe itself. The extra plate is also 18 SWG, fits outside the tank wrapper and is held by six small rivets to keep everything square. I then made sure this part would fit easily into the bunker tank space.

It is now time to offer the water entry filler pipe and the assembled rectangular side strip for the bunker tank into the bunker casing and mark

out where the attachment for the two parts should be; **photo 7** shows the result and with the body of the tank placed centrally, scribe a line around the lower end of the water entry filler. I have shown the parts being joined using three $\frac{1}{4}$ inch long 10BA brass round head screws and nuts, and not rivets, as these two assemblies need to be removable for other parts to be added before the final soldering operation. So clamp the two parts together, perhaps just adding the central screw to begin with, and then offer the pair into the bunker casing again to be sure it fits.

The next task is to silver solder the side section of the tank to the lower plate but it is best if the task is done in two halves. Hold the parts down flat on a firebrick with the edge to be soldered overhanging the brick slightly so heat can be applied underneath as well as from the side. Only solder the front edge and the two ends to begin with and then clean the



The tank sides and the water filler pipe have been fitted into the bunker space to check the clearances and mark out where the attachment should be made. There is some sideways movement for the tank - just centralise it but the filler pipe needs to be at right angles.

parts and re-flux the back edge to complete the lower joint.

Now file away the excess material overhanging the wrapper plate all the way round and use a block inside the tank to properly support the casing. **Photographs 8**

and **9** show the trimmed tank base after soldering and the assembly being gripped for the filing operation with the filler assembly in place. If all is well the partly made tank base can be fitted into the bunker casing. If there is a hindrance check that there are no rivet ends protruding from the earlier construction and, if so, deal with them carefully with a small chisel.

The last task for the construction of the bunker tank for now is the addition of the copper strip formed into a hoop to support the curved edge of the top plate when it is ready for silver soldering. I annealed the $\frac{1}{8}$ by $\frac{1}{4}$ inch strip to form the bend around the same steel bar used for the filler platework and then thinned the ends of the strip to bend them at right angles to form small brackets, as well as to give clearance for the edges of the channel. Another five 10BA screws were used for this assembly, as shown in **photo 10**.

Now it is perfectly feasible to go on and cut out the top plate for the tank and make it a close fit around the water filler casing (**photo 11**). This will not be attached permanently until the internal tank pipework and connections have been added.



Two views of the tank so far with the lower joint trimmed back to allow the assembly to fit the bunker. The fabrication is held in the vice with a steel block to remove the outer edges of the bottom plate.



This view shows the supporting copper strip formed into a hoop and attached to the filler pipe casing and the rear side. It will provide a secure soldered joint for the tank top plate when it is fitted.



The top plate with an opening made to fit around the filler pipe and ready to be silver soldered in place in due course; note the overhang for the soldering operation.

●To be continued.

Magdalen Road Revisited

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



Continued from p.40
M.E. 4628, 20 December 2019

Stirling Single No. 1003

The second locomotive to be completed was the Stirling Single (photo 14), also mentioned in my earlier article. A few features may be of interest. Sadly, I have no photographs of the locomotive when first acquired and have been able to find out nothing about its origins. The wheels had been machined from good quality castings, so these were retained, albeit after re-machining to an acceptable tyre profile.

Unfortunately, the rest left much to be desired and needed to be replaced or, at least, major surgery. The ports had been formed in the casting of the cylinders but the latter had been bored oversize so the walls were locally wafer thin. Insertion of liners cured that. There was insufficient clearance for the bogie wheels on curved track so I inserted ¼ inch thick spacers between the mounting lugs and the frames to achieve adequate clearance and silver soldered onto the blocks correspondingly thick slabs of gunmetal to bring the port faces back to their correct positions between the frames. New steam chests and slide



Was there ever a more elegant prototype?

valves were made and fitted, along with cylinder and steam chest covers.

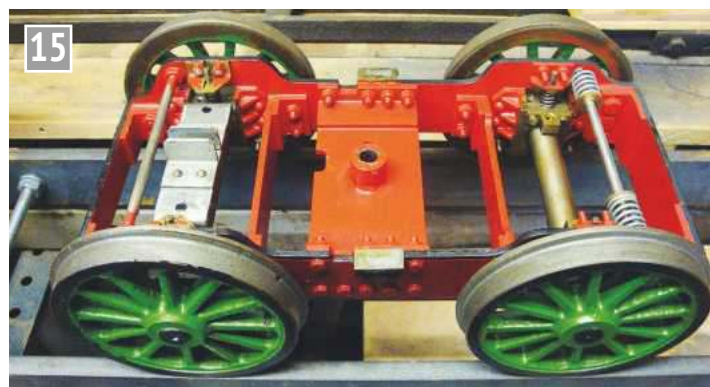
New frames, including for the bogie, were laboriously hacksawed, chain drilled (with a hand drill) and filed from ½ inch thick steel plate in order to get the correct wheel spacing for the final 1895 series which I had selected as the prototype for my locomotive. Incidentally, the original bogie was an iron casting; it had to be replaced because the wheelbase was shorter than the correct scale dimension which exacerbated the curving problem referred to above. As in the prototype, I originally arranged for the bogie to be pivoted on a non-translating pin that is slightly to the rear of midway between the axles (photo 15). Accordingly, the rear of the bogie frame translated in the opposite direction to the front, rather than both in the same direction as should be the case when the locomotive was on curved track. As a partial mitigation I provided extra side clearance between the flanges of the trailing axle boxes in the bogie so that this wheelset did not get pushed out of line when the front wheelset entered a curve. In practice, I found it necessary, also, to introduce a lateral restraint to

keep the rear wheelset in line. I introduced a rudimentary side control at the front of the bogie via coil springs, visible in the photograph, between the bogie frames and brackets on the main frames.

Weight transfer from the main frame to the bogie was through rubbing blocks in the plane of the frames; the central pivot bearing taking no vertical load.

I also introduced side control to the trailing wheel axle boxes in an attempt to discourage the wheel rims from rubbing against the brake pull rods.

Unfortunately, and perhaps not surprisingly, these measures were insufficient to provide the necessary flexibility of the chassis on my minimum 20 feet radius curves and a propensity for derailment caused the locomotive to be sidelined for many years. However, when writing the first draft of this article, I decided that acceptance of failure was a poor return for the effort that had gone into building the locomotive so I set to work and modified the front end framing to create more sideways clearance for the leading wheelset of the bogie (photo 16) and introduced a sliding block to allow the bogie pivot to translate sideways. The hole in the sliding block is bored



Bogie. First iteration. On the right are the side control springs at the front end. The axle boxes for the rear wheelset have ½ inch side play in the horns and were originally unconnected. This detail proved to be unsatisfactory because the locomotive 'yawed' about the driving wheels on straight track. To counter this, the cross tie between the axle boxes with upward projecting fin was added. The rivetted restraints on the cross tie engage with a downward projecting fin on the frame stretcher above, thereby constraining lateral displacement of this wheelset. The holes in the cross tie are to accommodate lubrication pipework.

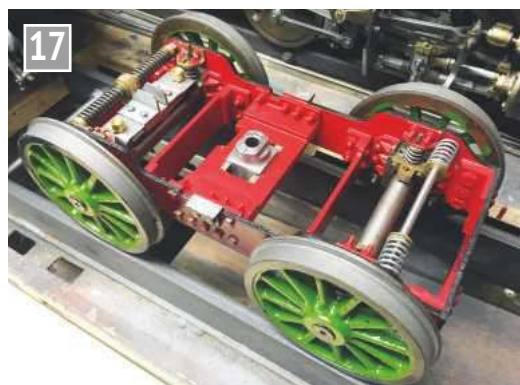
with a slight taper to give the bogie more flexibility. The weight was transferred to the central pivot by relieving the rubbing blocks to give about $\frac{1}{16}$ inch clearance, thereby limiting side-to-side rolling. I retained the original front end side control springing, supplemented by additional side control springs at the rear of the frame, so the sliding block is not, itself, spring controlled (**photo 17**). A certain amount of trial and error was required to optimise the side control spring stiffnesses, but the modified and slightly unconventional arrangements have been entirely satisfactory.

Several iterations were required to achieve satisfactory springing of the axle boxes in the vertical plane and my experience on this topic with this and other locomotives might be worth an article in its own right. Suffice to say that my dislike of very soft springing was put to the test in arriving at a solution that put adequate adhesive weight on the driving axle while maintaining suitable loading on the other axles. It has been interesting to observe how the bogie axle box and side control springing interact on a curve.

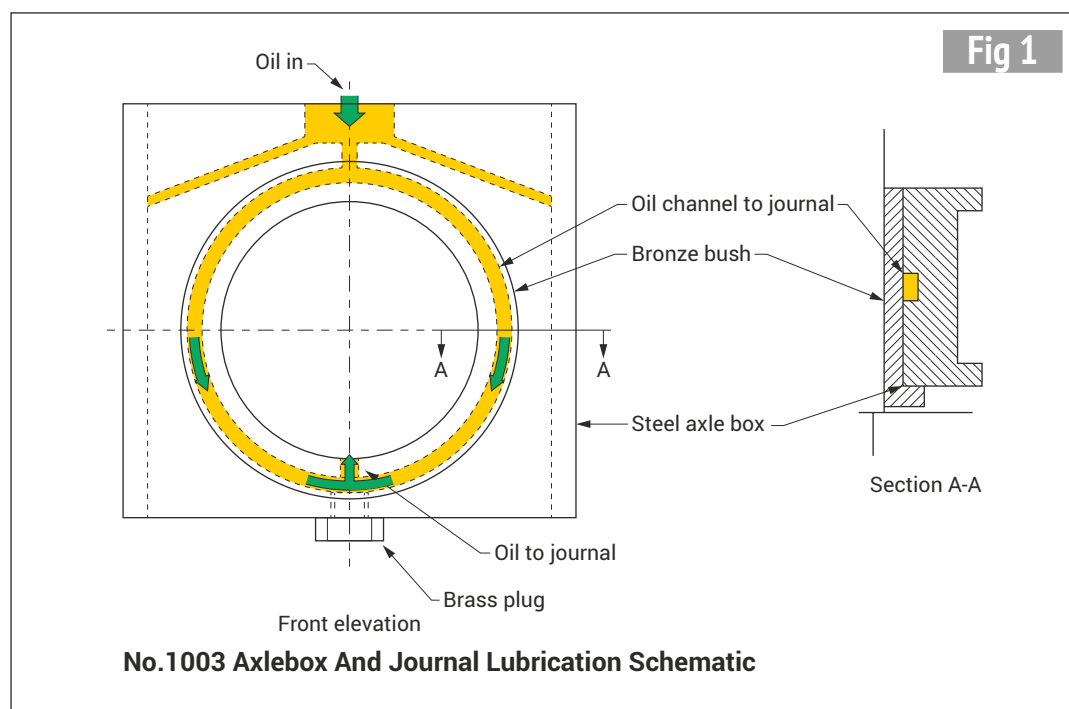
The axle boxes were fabricated from steel with bronze bushes. Gravity feed of oil to the journals was arranged to be from the underside, via a peripheral groove between the bronze bush and body of the axle box (**fig 1**). The original intention was to provide a felt pad at the bottom of each box but although the appropriate recess was formed, it became apparent that changing the pad would be impracticable because of the horn stay. The recess is therefore provided with a brass plug only (**photo 18**) thereby creating a small reservoir for oil. For the driving axle boxes, oil feed is piped to the hornblock and thence to the journal and horn faces from an oil box (which also has separate feeds to the valve gear eccentrics) mounted above the running board (**photo 19**). Similar feeds from suitably positioned oil boxes are



16 Modifications in progress to the front end framing in order to accommodate more side play for the bogie wheels. The bracket against which the side control spring bears is prominent.



17 Bogie. Final configuration. Sliding block and spring control at rear introduced. It was difficult to persuade the lubrication pipework to pass through the holes in the cross tie, so they were shortened and terminate in small 'funnels' above the axle boxes.



18 Bogie wheel set from below. The bronze bearing surface in the steel axle box is evident. The original plan was to have a spring loaded felt pad to direct oil to the underside of the journal. Lack of space and inaccessibility proved to be intractable so a simple plug was substituted. The horn stay had to be recessed to accommodate the plug.

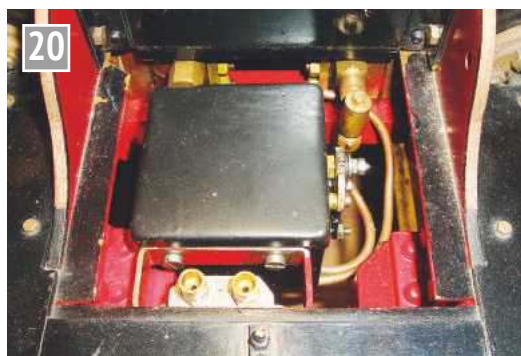


19 Oil boxes mounted on the forward sandbox for driving axle journal and horn guides, and two eccentrics. Two further oil boxes can also be seen, one for the upper slide bar, and one for the bogie rear wheel journal and horn guides. Between the frames can be seen some of the more accessible parts of the Stephenson's valve gear. Some of these are very difficult of access for the oil feeder.

provided for bogie (**photo 20**) and trailing axle boxes. Suitable gunmetal castings were sourced for the hornblocks.

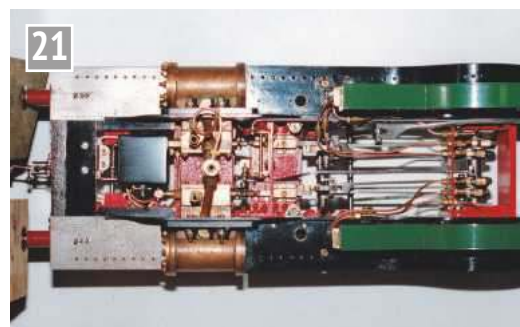
The valve gear is about as simple as Stephenson's gets, with a direct drive horizontally from driving axle to slide valve (**photo 21**). The only slight complication is a horizontal offset from each die block to the corresponding valve spindle. Each die block drives an offset rectangular spindle which reciprocates in a box section bearing bolted down to a horizontal stretcher. The expansion link is thereby prevented from twisting due to the offset drive. The longitudinal position of the valve spindle on the offset link can be adjusted in order to set the valve. Each expansion link is supported on its centreline by a pair of lifting links, thereby eliminating any possibility of twisting; I have never liked the single offset links so often seen in published designs. Launch links were adopted in order to get the required valve travel from the smallest possible eccentrics. Each pair of eccentrics was assembled to achieve the required angle of advance before mounting on the driving axle and setting relative to the appropriate crankpin. After securing with grub screws (if I was doing it today I would have a go at forming key ways and using a key to prevent rotation) the eccentrics cannot, and should not, be adjusted on the axle.

Many years earlier, my father had commissioned Mr. Evans

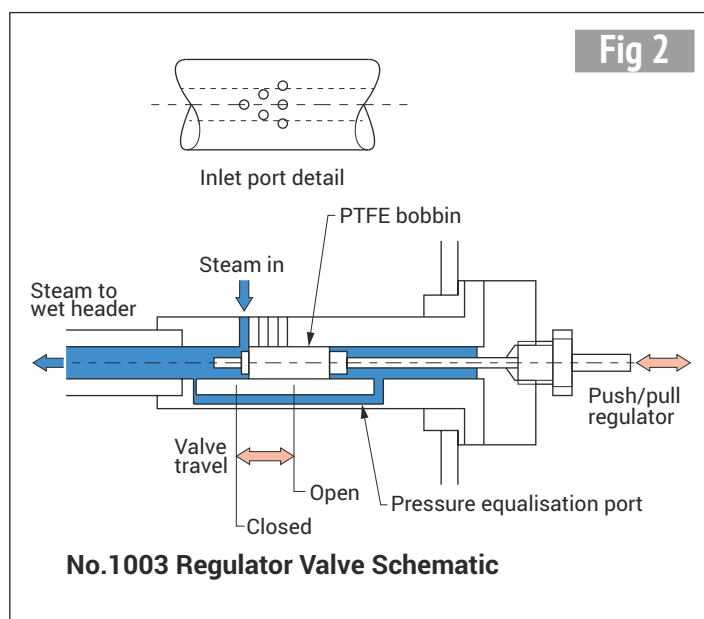


20 Twin ram mechanical lubricator with independent feed to each steam chest. Oil boxes for bogie wheel set in front. To each side are the brackets that engage with the bogie side control springs.

to design a new boiler for the locomotive and, for some reason, his design incorporated a dome. This seemed to me to be an unnecessary feature that was both unattractive and detracted from the fidelity to the prototype (I am aware of the Ivatt rebuilds, but my locomotive is No. 1003, which was never so rebuilt). Accordingly I redesigned the boiler to eliminate the dome and had it commercially built. Unfortunately, I gave rather too little thought to the regulator design before procuring the boiler and the bore of the backhead bush proved to be a significant constraint when I later schemed out the push-pull regulator. In the end I came up with a PTFE piston in a perforated cylinder (**fig 2**) which works well. Accommodating the superheater and other steam and exhaust pipework in the smokebox was a challenge (**photo 22**). Most, but not all, of the boiler fittings were from



21 General overhead view of chassis. Lubrication via the oil boxes to the eccentric straps has to be done with the nearside crank on back dead centre. Outside cylinders and valve gear are much more satisfactory from an accessibility and lubrication viewpoint.



Don Young. I made new bodies for the injectors in order to replicate the overflow from the side rather than bottom (**photo 23**). Although in the correct position between driving and trailing wheels and apparently easily accessible,

it is necessary to first remove the trailing wheel brake blocks and hangers in order to remove them when they need cleaning.

The ashpan is a permanent fixture to the foundation ring and cannot be dumped as a unit. The floor of the pan comprises two hinged panels that can be released by pulling out two dump pins (**photo 24**). The contents of the ashpan are thereby discharged between the rails, and the grate and its contents can then be released from below. This feature is shared by the Y4 and I find it much preferable to dropping the complete ashpan/ grate assembly which is usually too hot to do in a controlled manner.

By the time that the locomotive was approaching completion, Reeves were marketing the Scarth Stirling Single design so I used their



22 Inside the smokebox. Access for sweeping the flues from the front is very limited. The multi-jet blower is integral with the blast pipe and fed from the pipe on the left. Steam is delivered to this through the handrail on the offside of the boiler. The pipe on the right is to the snifting valve. This is tucked away behind the frames just in front of the tubeplate which is set back from the rear of the smokebox wrapper.



23 Nearside injector with delivery pipe bracketed off the ashpan. Above the injector is the bottom end of the whistle which extends up into the dummy sandbox. The dump pin for the drop down doors of the ashpan can be seen below the injector support bracket. As in all of my engines, except No. 8783, the whole ashpan cannot be dumped.



24 View of the ashpan from below showing drop down doors. This view also shows, partly hidden by the brake rigging, the blowdown valve bracketed off the side of the ashpan and fed by an external pipe from the lowest point of the foundation ring.

castings for chimney and safety valve bonnet; both were cut down to suit the 1 inch to 1 foot scale of my locomotive.

The addition of a steam brake cylinder below the cab floor, and associated valve and pipework in the cab (**photo 25**) was a late decision and rather spoilt what had originally been a rather bare aspect not unlike that of the prototype. The push-pull regulator is a reasonably close representation of the Stirling design and the screw reverse is correct for the 1895 batch, but I could have made a better fist of the door to the firehole which bears little resemblance to the GNR design. I do not like the traditional hollow stay solution for getting steam from the blower valve to the smokebox; in this instance I used the boiler handrail on the driver's side – the valve can be seen partly hidden by the right hand end of the regulator handle.

A feature from the original locomotive that I was determined to retain was the tender frames. These are brass castings, apparently unmachined and of astonishing uniformity of thickness. They are hard stamped 'GNR W.M.&CO' (**photo 26**). I stripped them down, plugged and silver soldered all the original holes, and mounted them on a new steel subframe. New hornblocks were machined to suit the exact frame thickness at each location.

New axle boxes, of similar construction to those for the locomotive, but with external oilboxes delivering to the underside of the journals were fabricated. The original dummy leaf springs were retained but the buckles bored to accommodate coil springs. I cheated with the wheels which even after being re-machined to an acceptable tyre profile would have required splashes to be formed within the soleplate. I got round that by purchasing castings of slightly smaller diameter, machined them and Loctited them onto new ground mild steel axles. The tank superstructure was all new, fabricated from $\frac{1}{16}$ inch thick brass sheet. I opted for riveted, screwed and glued construction as I did not want to take the risk of distortion due to uneven heating during soldering. This was generally successful but I made a mistake in being too sparing in the screwed fixing of the corner angle at the base of the side sheets to the sole plate. Before screwing the side sheet down, the mating surface of the angle was coated with Araldite which I anticipated would ensure a strong and watertight joint. Unfortunately, when I subsequently bolted the soleplate down on the frames the inevitable, not quite perfect fit caused the soleplate to spring and locally break the Araldite bond, with consequent local weeping at that location. I cured the problem by lining the joint on the inside with foil



25 Backhead and cab controls are rather let down by the steam brake valve.

backed bitumen tape. It was a crude but effective repair.

The locomotive was brush painted with a mixture of Humbrol and Cherry (now Phoenix) enamel paints. I did this as I assembled the locomotive as I could not face the thought of taking it apart after completion. All lining was done using a draughtsman's bowspring pen using undiluted enamel paint. This I found particularly challenging,

especially the longer lines on the tender and the boiler bands, and some lines were re-done several times before I was satisfied. On completion of painting and lining, components were finished with gloss enamel varnish sprayed on using aerosol cans.

Initial commissioning of the locomotive identified a serious problem as opening the regulator caused the steam to exhaust from the



26 Cast tender frame. Original holes have been plugged and silver soldered. Open holes are for the spring hangers and the brake rigging. New hornblocks are fitted with bolts in close tolerance holes. The angle on the near side is bolted through the casting to a steel sub-frame.

chimney with no apparent contact with the pistons. The problem was traced to the fact that the slide valves were not pressed into contact with the vertical port faces under steam pressure (even though the appropriate freedom was allowed in the valve/buckle interface. I could not face the prospect of stripping the newly completed locomotive down at that point so I opted for the easier (??) option of removing the bogie and bogie stretcher and accessing the steam chests from below. Removal of the covers allowed me to install phosphor bronze springs which rub against the back of the valves and keep them in contact with the port faces. All this was done from a posture lying on my back under the mobile bench, so it was a great relief to me that, when tested on air after re-assembly, the locomotive ticked over smoothly and almost silently except for four crisp beats from the blast pipe per revolution, on 10 to 15psi in both forward and reverse gear even at short cut-offs.

With the recently completed modifications to the bogie, described earlier, it is now a reliable addition to the railway's available motive power although, given the gradients, its capacity is limited by the adhesion achievable on its single pair of driving wheels.

Having started the build as an eighteen year old, I was in my mid fifties before it was finished. I am sure that there is nothing unique about taking more than thirty years to build a locomotive but the experience certainly influenced my subsequent approach to locomotive building. I decided that unless I could speed up the process, I would never complete another one. The solution appeared to be to find a suitable part built locomotive in need of completion.

Aspirations

I had an extensive list of aspirations and for two of them I even went as far as acquiring general arrangement

(GA) and some detail drawings. Back in the 1960s I had obtained, from the Public Relations Officer of British Railways Eastern Region, a GA of Nigel Gresley's superb P1 2-8-2. It never went any further and the bar has now been raised far too high for me by Geoff Moore's superb example. In 1976/77 I was working in Kenya and was captivated by the magnificent Beyer Peacock Garratts of Classes 55, 59 and 60 as well as the conventional classes 13, 24, 29, 30 and 31 then still active on East African Railways (EAR). The Class 59 locomotives (**photo 27**) were definitely the stars but I was particularly taken by the Class 55 (**photo 28**), a slightly older and smaller 4-8-2+2-8-4, all of which, according to the literature that I had armed myself with before going to Kenya, had been withdrawn from service. But two were still operational, Nos. 5505 in Nairobi and 5510 in Mombasa. This, I thought, would make a truly impressive miniature locomotive. But what gauge? At 1 inch to 1 foot, 3½ inch gauge was about right for EAR's metre gauge prototype, but I was already committed to 5 inch gauge. Nevertheless, I obtained GA and detail drawings from Manchester Museum of Science and Industry and started to prepare



Mombasa, Kenya. 59 Class Garratt, No. 5922, Mount Blackett draws to a halt with a long freight from Nairobi. When I took this photograph in 1976, these magnificent locomotives were still responsible for haulage of nearly all the heavy freight traffic between these cities. The black number plate indicated that it was allocated to Mombasa MPD.

my own GA drawings for 3½ inch gauge. Sadly, they never got very far and that aspiration remains unfulfilled. However, a recent turn of events (of which more later) has, in part, compensated for that failure.

Regarding fulfilled, rather than unfulfilled aspirations I had, since my schooldays, been an admirer of the LNER D16/3 4-4-0s, some of which were still operational around King's Lynn where I then lived. The publication by M.E. of Martin Evans' Super Claud (D16/2) design in 5 inch gauge made the building of such a locomotive a realisable

objective and long before the Stirling Single was completed I had acquired drawings and castings from Norman Spink. With the Stirling Single complete it was time to get on with it, but the opportunity to acquire a part built Maid of Kent proved too much of a temptation and thoughts turned to how this might be converted to a Claud. With hindsight, the notion was absurd, but it did yield a tender which I converted to a driving truck for the Stirling Single.

●To be continued.



Nairobi, Kenya. 55 Class Garratt No. 5510, also in 1976. Allocated to Nairobi MPD as indicated by the red number plate. For reasons that I cannot explain, I was captivated by this locomotive and its classmate, No. 5510 which was allocated to Mombasa MPD.

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Model Locomotive Wheel and Brake Block Profiles

Hiroyuki Watanabe explains a method for achieving correctly profiled wheels and brake blocks.



A full size locomotive's wheel profile is optimized so as to ensure safety and stability, and to minimize friction and wear. Japan National Railway's driving wheel profile is shown in **fig 1** as an example. In the case of a model locomotive, it's not so critical but we like to employ the same profile as the prototype if we can.

For my newest model locomotive JNR C53, the wheel profile is similar to the prototype but a little modified (**fig 2**). Its dimensions are based on 1:8.4 scale. I increased the flange height and the angle difference from the tread in order to prevent derailment. Also, I decreased the flange thickness so as to fit two different track design standards. In Japan, five inch gauge model railway track design has two main streams. One is a design coming from the UK with 119 mm back-to-back. The other is a design originating in Japan with 117 mm back-to-back. My wheel profile is based on 119 mm back-to-back but can also ride on 117 mm back-to-back track. I chose ductile cast iron as the wheel material, as that has high impact and fatigue resistance.

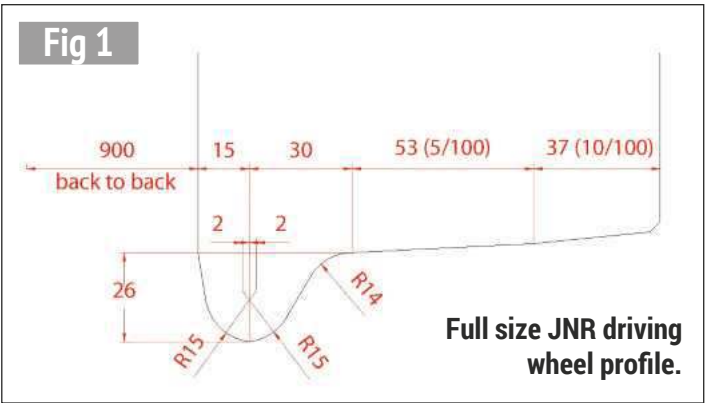
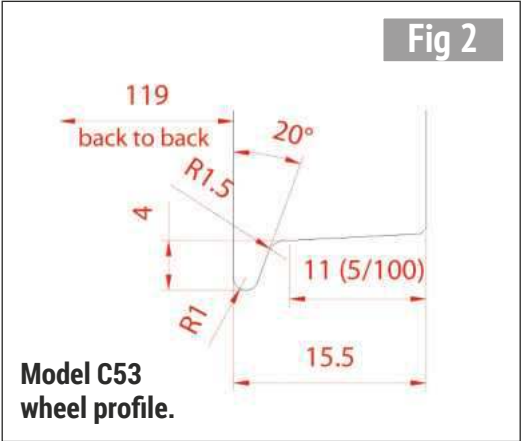
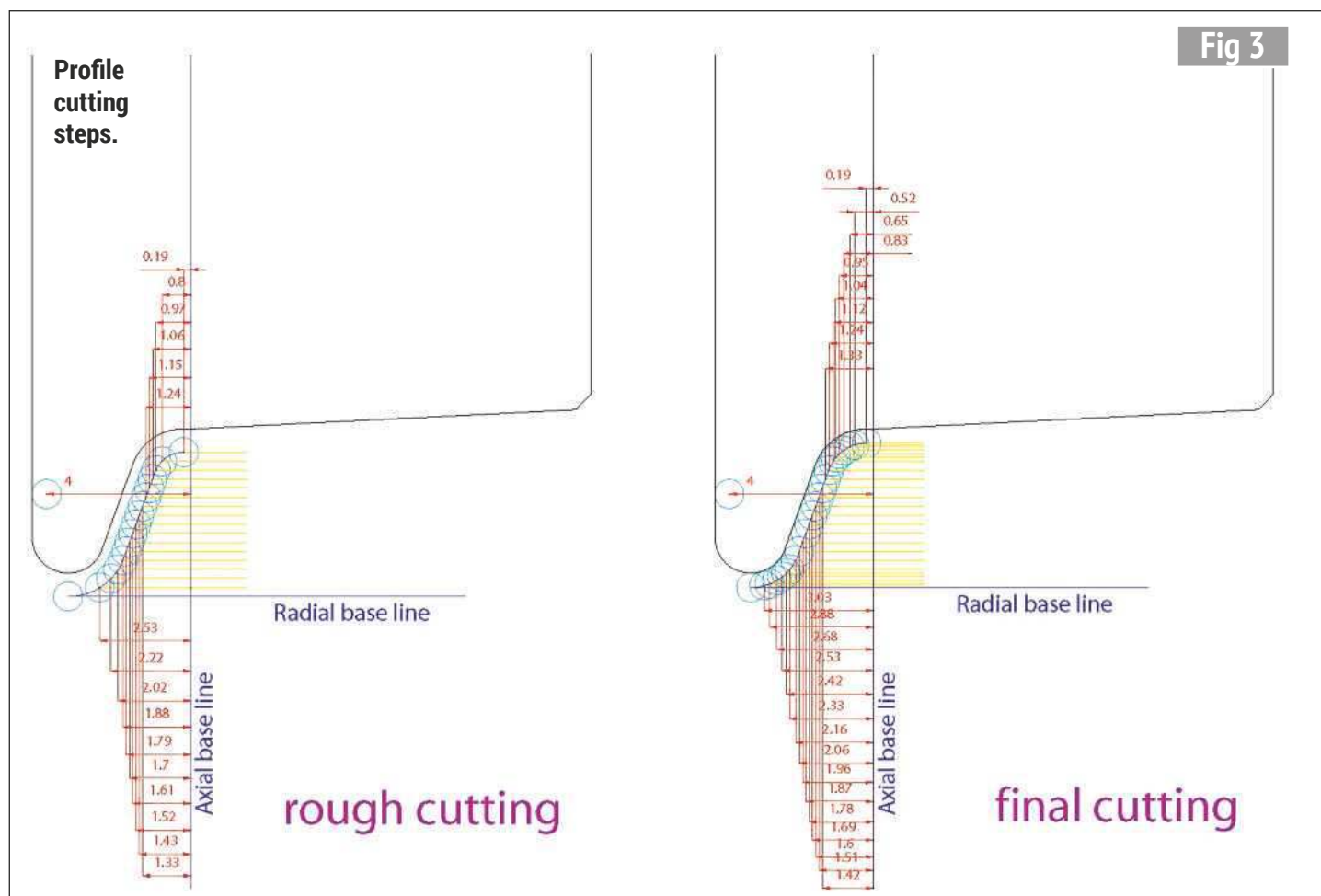


Table 1. Check Sheet.			
Radial	Cross Slide	Axial	Top Slide
0	0	-	-
4	0	0.19	3.8
3.95	39	0.52	10.4
3.9	38	0.65	13
3.8	36	0.83	16.6
3.7	34	0.95	19
3.6	32	1.04	20.8
3.5	30	1.12	22.4
3.25	25	1.24	24.8
3	20	1.33	26.6
2.75	15	1.42	28.4
2.5	10	1.51	30.2
2.25	5	1.6	32
2	0	1.69	33.8
1.75	35	1.78	35.6
1.5	30	1.87	37.4
1.25	25	1.96	39.2
1	20	2.06	1.2
0.75	15	2.16	3.2
0.5	10	2.33	6.6
0.4	8	2.42	8.4
0.3	6	2.53	10.6
0.2	4	2.68	13.6
0.1	2	2.88	17.6
0.05	1	3.03	20.6

The flange profile is formed by cutting a lot of small steps. **Figure 3** shows the steps for the rough and final cuts. Note the flange profile is traced with small circles of 0.4 mm radius which is the tip radius of the cutting tool that I used, then the figures indicate the X and Y distances from the base lines. For the rough cuts, the circles follow a line offset 0.25 mm from the surface. The radial direction base line is the outer radius of the wheel flange, while the axial direction





base line is 4 mm away (to the right) from the back face of the wheel, which is the same as the faceplate surface. Note the distances in fig 3 indicate each centre position of the tip circle, so the position is 0.4 mm shifted in each direction.

All of the calculated distances are input to a PC spreadsheet i.e. Excel and then the actual dial settings of the top slider and the cross slider are calculated. My lathe is a Myford Super 7 metric version and its dial reading is twice the actual millimeter distance. **Table 1** shows a check sheet made by Excel, to be printed out and used during the lathe operations.

Before cutting the profile, the wheel's back face, rim and centre bore have to be finished. Then the rough and final cuts of the flange profile are done using the check sheet. During the rough cut, in order to remove the bulk of the excess metal from the casting, the tool is set to each radius and moved from the wheel



1 Cutting the flange.

surface to the desired depth. For the final cut, the tool is moved carefully and smoothly to each of the final positions (**photo 1**).

The back side of the flange profile is cut similarly but with the casting reversed in the fixture (**photo 2**). After that, micro grooves left by the step turning are removed using files. The work should be turned at a comparatively high speed and a fine file used to carefully remove the marks. Finally, the tapered tread surface is finished with the lathe top slide tilted at the



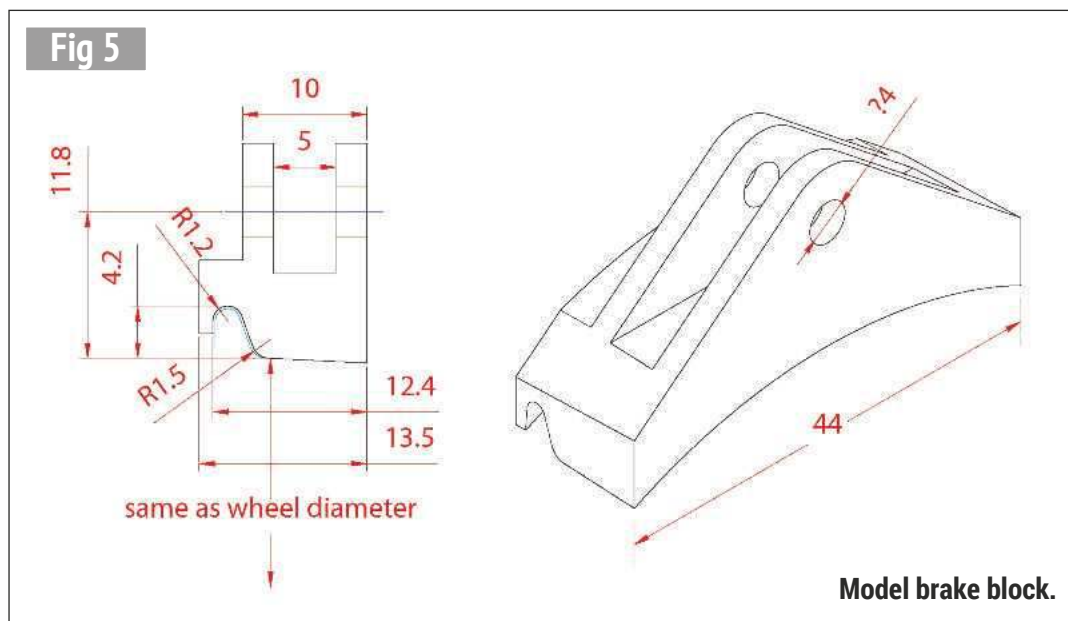
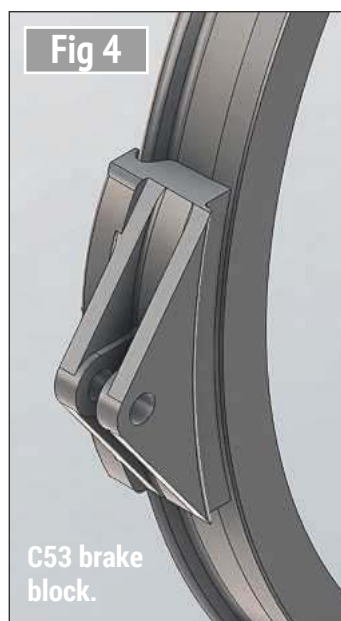
2 Facing off the back.



3 Bogie wheels.

desired angle. A locomotive should have the same profile for all its wheels - driving, bogie or pony truck - although

they have varied diameter and thickness. **Photograph 3** shows finished bogie wheels ready for painting.



Brake block castings for the bogie wheels.



Brake block castings for the driving wheels.



Turning tool.



Cutting tool.



Rotary table.

in order to ensure close contact between the tread and the wheel (**fig 5**).

If you don't want to wear iron wheels out, aluminum is a suitable material for the brake block; it is comparatively effective for a cast iron wheel and easy to make in large numbers. Usually, I prepare wooden patterns of them and ask a local foundry to cast them. **Photograph 4** shows brake block castings for a tender bogie. The casting is arranged to have the same diameter as the wheel. **Photograph 5** shows the casting for driving wheels. They aren't arranged around the wheel's diameter because the size of the driving wheel is too large to make that practical. They will be separated before turning.

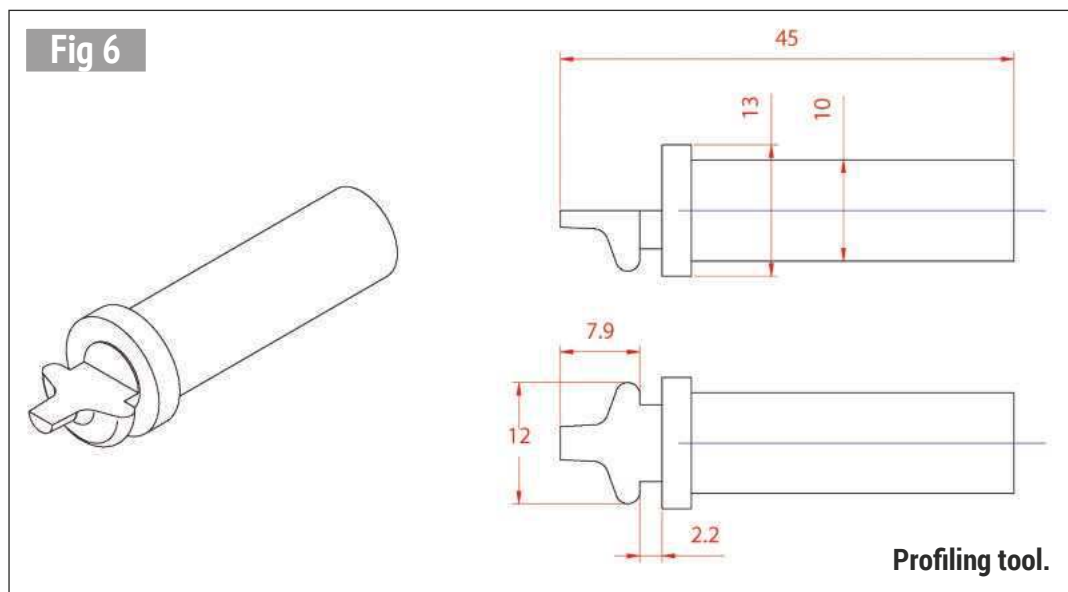
Before making the brake blocks, I prepared a tool for cutting the flange profile. A silver steel rod was turned to the desired profile using the same manual numeric control process described above (**photo 6**). It was then cut half round using an end mill, hardened, tempered and ground (**photo 7, fig 6**). I used Japanese Industrial Standards carbon steel SK95 that contains 0.9 to 1.0 % carbon. After machining, it was heated to bright red (750° centigrade) with a propane gas torch and quickly quenched in cold water to harden it. The tool is now

Normally, full sized brake blocks also have the same profile as the wheels. **Figure 4** shows a CGI image of a full size C53 locomotive's driving wheel and its brake block. On the other hand, typical model locomotive brake blocks adopt simple plane surfaces. However, it is obvious that the full profile is more effective for braking. So, I have adopted the full profile for my locomotive. The profile is almost the same as the wheel flange profile, but a little larger than the wheel's,

Normally, full sized brake blocks also have the same profile as the wheels.

sufficiently hard but brittle. It was then heated again to 200° centigrade gently in a small electric furnace for tempering to increase toughness. Finally, the tool's top flat face was ground with a fine oil stone.

Let's start with the bogie wheel brake blocks. Chuck the casting in the three jaw chuck with its top face towards the tool and clean the top face. Reverse and chuck parallel, then finish the back face to the desired thickness. Next, the casting is bolted down to a handmade faceplate. To do that, bolt holes in the castings and the faceplate are drilled in advance on the rotary table (**photo 8**). Then the faceplate is centered in the lathe and bolted onto the lathe faceplate. First the tapered tread face is finished with a boring tool in the lathe top slide, set to the desired angle. **Photograph 9** shows how to set the top slide angle exactly the same as the wheel tread angle. After that the flange profile is finished with the handmade tool (**photo 10**). The cutting speed should be very slow because the



Set top slide.



Cutting the bogie brake block profile.

cutting resistance of such a profiling tool is relatively big. Finally, separate the blocks using a hacksaw and cut a slot for the hanger.

Next are the driving wheel brake blocks. After finishing the top and bottom faces in the three jaw chuck, the blocks are separated using a hacksaw and bolted down on the same faceplate but at a larger

diameter - the same as the driving wheel's diameter. The block's top face has a step and the faceplate also has a step bearing against the block's step to prevent the block turning around the bolt. Then the wheel profile is finished similarly to the bogie brake blocks (**photo 11**).

Usually I make twice the required number of brake

blocks in preparation for maintenance (**photo 12**). It is easy to make a large number with these special tools and faceplate. Incidentally, if you use profiled brake blocks like these, you need to provide suitable side play in the brake block hanger because the blocks must follow the wheel's side play.

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Cutting the driver brake block profile.



Finished brake blocks.

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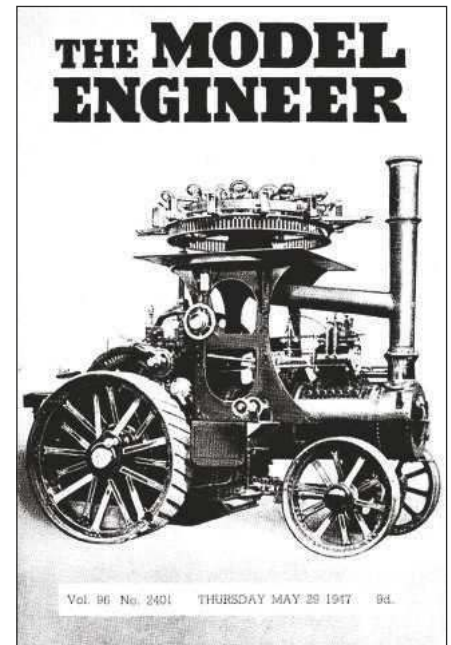
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Book Review

The Remarkable Jim Crebbin and his Experimental Locomotives

By Roger Backhouse

This book, published by the Society of Model and Experimental Engineers (SMEE), is a fascinating account of one of the pioneers of the model engineering hobby. Roger traces Crebbin's early life in East London, where he was influenced by the maritime environment, followed by a successful career in the Bank of England, in which he got to know a significant number of chief mechanical engineers of railways both in this country and overseas. He developed a fascination for compounding and determined to experiment with it in a small scale. At a time when there were no established standards as we know them today, he could not even aim for a recognised gauge; he had to devise boiler designs from scratch and Roger points out how this led to some interesting features which we might not now recognise.

So the picture emerges of a brilliant mind working literally in a garret with a home-made lathe producing locomotives. He genuinely sought to explore the complexities of compounding, drawing not only upon the work done in France and Austria but also naval sources. None of his locomotives was a model of any existing prototype, although they all look

impressive and realistic.

Starting from scratch he had to make his own patterns for wheels and cylinders and to get them cast in areas such as Clerkenwell Road, which today has been completely changed into commercial power houses. He did not shy away from locomotives with complex wheel arrangements, into which he fitted copper boilers, albeit sometimes with such irregular features as brass backheads, which were riveted and soft soldered to maintain pressures not unknown in our modern designs. Originally his primary interest was not in passenger hauling on a raised track as we know it today but, nevertheless, this inevitably followed and his engines were trailblazers in this art.

Roger lists in some detail a total of eight locomotives that Crebbin built in his lifetime, including mention of what is known of their present ownership where that is certain. Even this is not altogether straightforward, as many were drastically rebuilt during the builder's lifetime.

In a hobby that is still male-dominated, Crebbin actively encouraged female drivers for his machines; he was also an advocate of the rolling road for investigative work as used in some of the full sized railways' works; there is a fine picture from the 1948 *Model Engineer* exhibition of his locomotive *Old Bill* running in this mode in

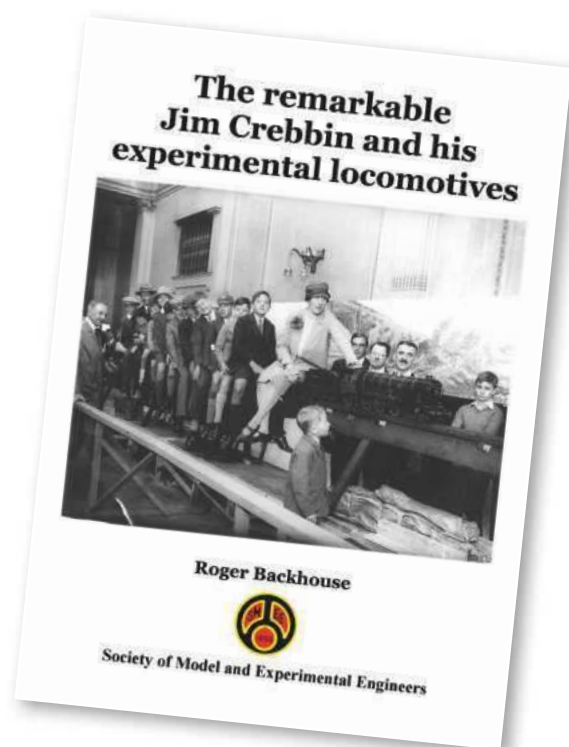
a demonstration to the (then new) Duke of Edinburgh and Professor Chaddock.

During the early years of the twentieth century it was normal to fire locomotives on meths or paraffin, so Crebbin's predominant use of coal firing was adventurous and novel. Again, he could not make use of what had been done before, so his work included some forward thinking ideas and experimentation, some leading to the modified models which are illustrated in the book.

The research done into Crebbin's life's work yields an interesting insight not only into his extensive contacts, with some wonderful old photographs of smartly dressed people partaking in the excitement of miniature locomotives, but also a picture of his enquiring mind into the subjects of exhaust blasting and compounding. Right up to his death in 1950 he pushed out the boundaries of knowledge in the hobby and had at one time been the elected president of SMEE, a society which honourably maintains his memory, especially in the custody of *Cosmo Bonsor*.

The book contains copious references to the published literature, giving a clear insight into the life's work of a remarkable man.

D A G Brown



Published by Society of Model and Experimental Engineers. Obtainable from SMEE at Marshall House, 28 Wanless Road, London, SE24 0HW or order from booksales@sm-ee.co.uk. Cheques should be made payable to *Society of Model and Experimental Engineers*.

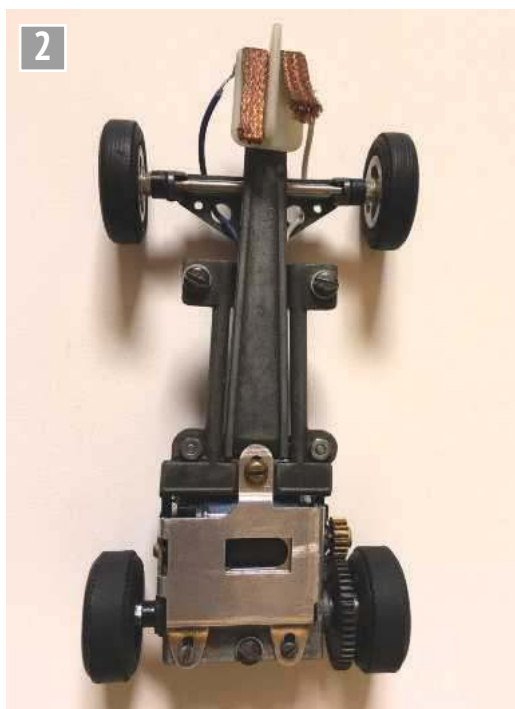
The retail price is £14 plus £2 post and packing for UK. Europe £19 inclusive, USA, New Zealand, Canada, Australia £21.50 inclusive of postage.

82 pages. ISBN 978-15272-4532-7

Henk-Jan de Ruiter revisits the slot car scene and takes a look at some classic chassis from the '60s and '70s.



Cox 1/24 vintage magnesium slotcar chassis.



Cox 1/24 vintage magnesium chassis underside.

More Slotcars

In *Model Engineer* issue 4595 (14th September 2018)

I presented *A History of Slotcars*. This time we will have a closer look at some vintage slotcar chassis from the 1960's-1970's era and their set-up.

A slotcar, whether old or new, consists of many parts, such as a motor, a pinion, a drive gear (like a spur gear,

crown gear or a bevel gear), front/rear axles, wheels, a slot guide, suspension, shock absorbers and sometimes (mechanical) brakes. Tyres are important too as they are the only contact of the slotcar with the track and, for the right amount of traction, the best compound must be chosen.

During this period, competition slotcar races

were held all over the world and especially in the United States. Therefore the need for speed was paramount and slotcar drivers were looking for a strong, rigid chassis to withstand rough treatment during races. They also needed a light chassis and this soon led to the use of materials like aluminium, brass or some more exotic metals like magnesium.

There are about three types of chassis to distinguish - the 'inliner' type, the 'sidewinder' type and the 'anglewinder' type. Which it is depends how the axis of the motor is lined up along the rear wheel axle.

One of the first companies to enter the market was the American company Cox, who already made miniature gas engines for model airplanes. So it was only a small step to get involved in the slotcar business as well. Their Cox aluminium/magnesium sidewinder chassis is one of the most famous and regarded as a standard for high quality in the slotcar world (photos 1 and 2).



Russkit 'black widow' 1/24 metal slotcar pan-chassis with two motors.



Russkit 1/24 'black widow' slotcar chassis underside.

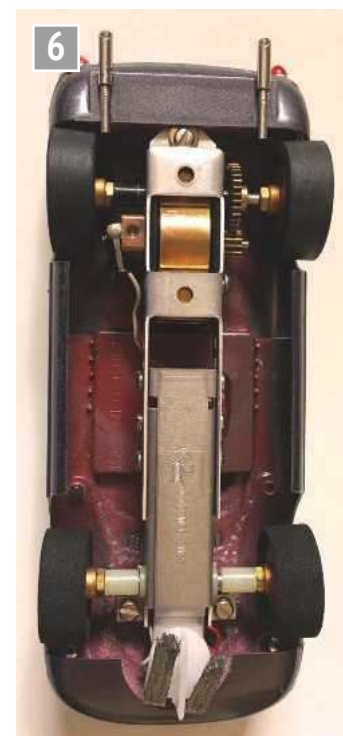


K & B 1/24 slotcar with metal chassis customised with copper rivets.

Another American company, Russkit, producing accessories for slotcars in the early stages, came up with the 'Black Widow', inliner chassis (photos 3 and 4). It is a unique four wheel drive

chassis, using two motors and coupled gears and no rubber belt system. The story goes that the company needed to get rid of a superfluous stock of motors and came up with this novelty.

As a third chassis I would like to mention the K&B super lightweight sidewinder aluminium chassis. It uses a regular Challenger motor or a Super Challenger motor for high performance, mounted in



K & B 1/24 slotcar metal chassis underside.

a 'U'-type of frame (photos 5 and 6). From the same brand the 'Kangaroo' sidewinder chassis also appeared, made of a combination of aluminium with magnesium. The motor is embedded in a sort of case, where it still gets enough airflow around it for proper cooling and to prevent overheating of the motor and the risk of melting plastic parts, which is of course important during endurance events. An original K&B chassis is shown here with the iconic Batman slotcar body, albeit a modern remake (photos 7 and 8).

In other parts of the world, the slotcar boom didn't go unnoticed and Japan came up with brands like Tamiya, revered for their high quality model kits. The Tamiya inliner chassis has many possibilities for different set-ups, by adjusting the wheelbase and using different motors (photos 9 and 10).

No article about slotcars would be complete without the mentioning of Scalextric. Therefore, I would like to conclude this variety of slotcar chassis with the Scalextric Ferrari F1, a highly collectable slotcar using a specially designed (for this model



Batman replica 1/24 slotcar body customized on an original vintage metal K & B Batman chassis.



Vintage K & B Batman slotcar chassis.

type) aluminium/magnesium 1:24 scale chassis (photos 11 and 12). The chassis is of the inliner type and the motor is using a tapered pinion on the motor-axle. It is, even by modern standards, an impressive piece of slotcar engineering and still has the 'good looks'. This particular slotcar was only made during a short period of time between 1967-1970.

Like in real racecars, all slotcar components should interact with each other in a harmonic way to produce the best results. Some slotcar companies of today are doing research on high-tech features, such as the use of carbon-fibre or a combination of both metal and carbon-fibre parts in their chassis to stay on top. It is worthwhile mentioning that most 'Pro' competition slotcar drivers of today, like in Germany or Italy, prefer a metal chassis.

Many people think of slotcars merely as 'toys for the kids'. I hope this article has given more insight into the techniques involved and that there is much more to discover in the world of slotracing and that slotcars can still be part of your leisure time, either to race, to restore or simply to collect them.

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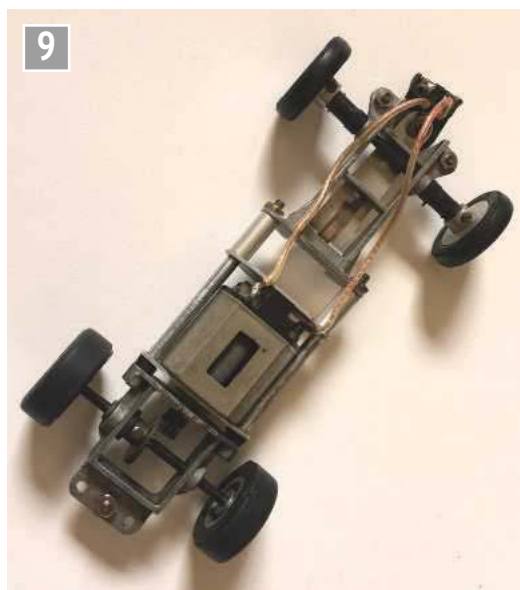
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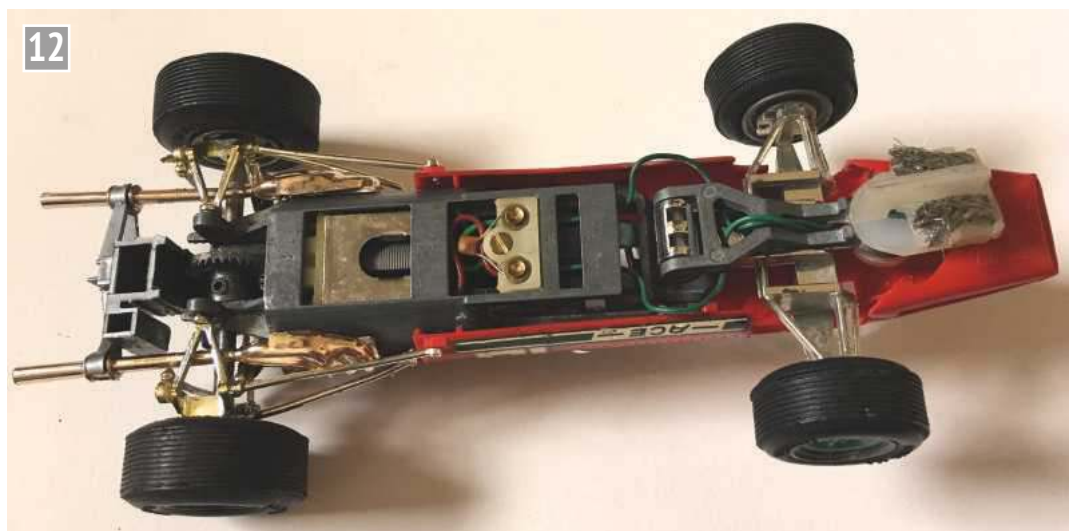
Tamiya metal vintage slotcar 1/24 chassis.



Tamiya 1/24 slotcar chassis underside.



Scalextric 1/24 slotcar with metal chassis.



Scalextric 1/24 magnesium chassis.

The Stationary Steam Engine

PART 2

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

Continued from p.46
M.E. 4628, 20 December 2019

The atmospheric steam engine

The main limitation of the water wheel was the inflexibility of the natural supply of water. Waterwheel pumping was only viable where a source of water with a sufficient hydraulic head and quantity coincided with the location of the pit shaft. The market for Thomas Newcomen's steam pumping engine (**photo 5**) was to be found where these advantages did not occur.

Newcomen's engine inherited much of the established technology of the waterwheel pumping engine. The rocking beam or bob, supported by the bob wall, the chains and arch heads connecting the pump rods, or spears, to the beam and the pump barrels with their rising mains were all familiar to mining engineers before Newcomen incorporated them into his machine. The novelty lay in replacing the waterwheel by a steam cylinder-with-piston and working the piston by atmospheric pressure rather than the propulsive force of the steam.

The ancestry of this part of Newcomen's engine has been the subject of lengthy discussion (**ref 11**) but the fact that Newcomen's piston and cylinder arrangement was clearly an adaptation of familiar pump technology has tended to be overlooked. The almost perfectly matured character of the first known Newcomen engines is partly owed to the ease with which Newcomen was able to translate the water pump

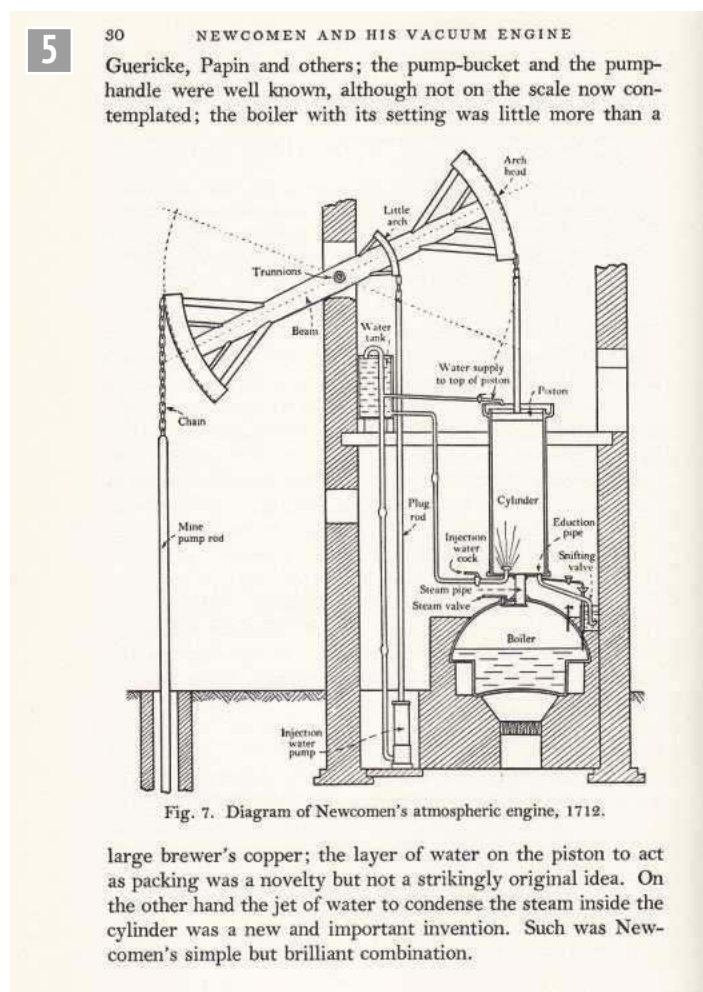


Diagram of Newcomen's atmospheric engine 1712 (H.W. Dickinson, *A Short History of the Steam Engine*).

into a steam cylinder. The originality lay not as much in the employment of the cylinder and piston but rather in the utilisation of a vacuum generated below the piston by condensing steam which allowed atmospheric pressure to be the working agent.

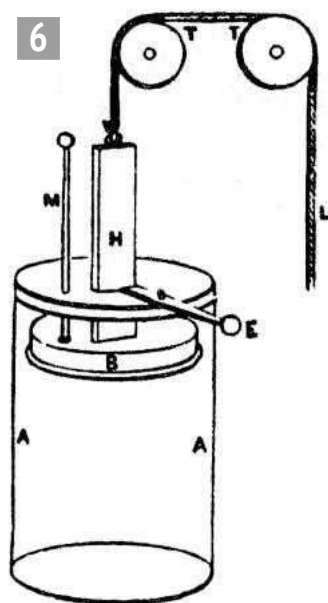
The concept of employing atmospheric pressure to drive the piston was firmly rooted in the European tradition of scientific thought. Beginning

with Galileo and his disciple Torricelli, progressing through Pascal and von Guericke to Robert Boyle, the weight of the atmosphere had been determined and nature of the vacuum explained without recourse to metaphysics. Von Guericke's development of the air pump had demonstrated the force exerted by atmospheric pressure and he went on to demonstrate that air has

mass, giving a numerical estimate of its density. Boyle also measured the density of air and with Hooke and von Guericke collaborated in the improvement of the air pump. It was Boyle who first proved that the limiting height to which a column of water will rise under the pressure of the atmosphere was 33 feet 6 inches. By 1670 the basic physics relating to atmospheric air had been established and quantified.

Von Guericke had made use of a piston in a pump cylinder to exhaust his vacuum vessel and one demonstration involved men hauling on a rope to raise a piston in a cylinder whilst the air was pumped out of the cylinder until the vacuum resisted efforts by the men raise it further. Papin, pursuing a related theme, condensed steam under the piston to create the vacuum. An engraving of his apparatus, published in 1690, shows a cylinder with a sliding piston fitted with a rod that passes through the lid of the cylinder. Steam under pressure is admitted underneath the piston driving it upwards within the cylinder (**photo 6**). At the upper limit of travel a catch locks the piston rod retaining the piston at the top of its stroke. The steam is condensed by pouring cold water over the exterior of the cylinder and a vacuum forms beneath the piston. On releasing the catch, the piston descends violently and a rope connected to the piston rod lifts a weight.

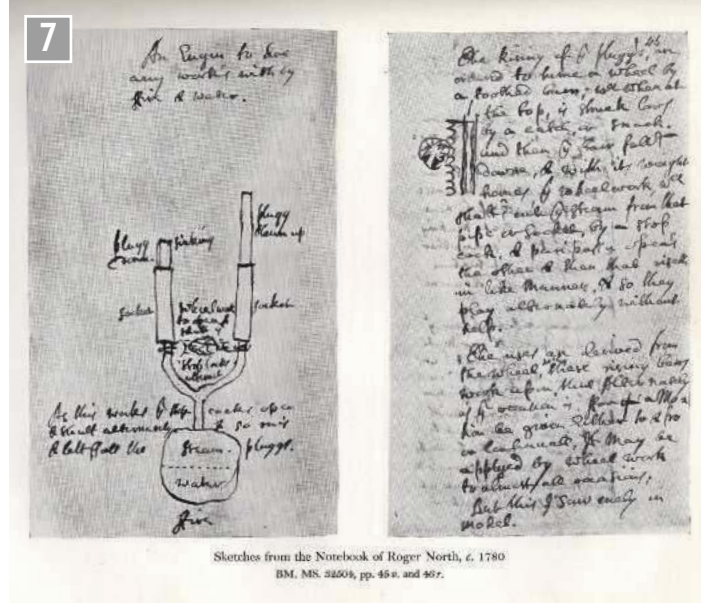
Papin was deeply involved with the newly founded Royal Society in London. He was successively a friend and enemy of Robert Hooke, the Society's curator of experiments, and he would have contact with the leading English natural philosophers (scientist was a nineteenth-century term) of the day - Newton, Wren, Boyle - whilst at the same time continuing to correspond with the continental circle that surrounded Descartes, Pascal and Huygens.



Papin's demonstration of the power of atmospheric pressure.

In parallel with these investigations of atmospheric pressure, the use of steam purely as a pressure agent was also being pursued. Of the several lines of enquiry that were followed, Samuel Morland seems to have made the closest approach to a practical device. Rhys Jenkins in his paper on *The Notebook of Roger North* (**ref 12**) believed that he had located a sketch of Morland's proposal (**photo 7**). The sketch shows a steam boiler with a branch pipe conveying steam to two cylinders which contained ram pump type pistons of the type that Morland had recently developed. Steam was admitted under each ram alternately and, by a rack, the movement was translated into the semi-rotation of an axle. A ratchet produced the full rotary motion. Necessarily, the steam generated by the boiler had to be of appreciable pressure.

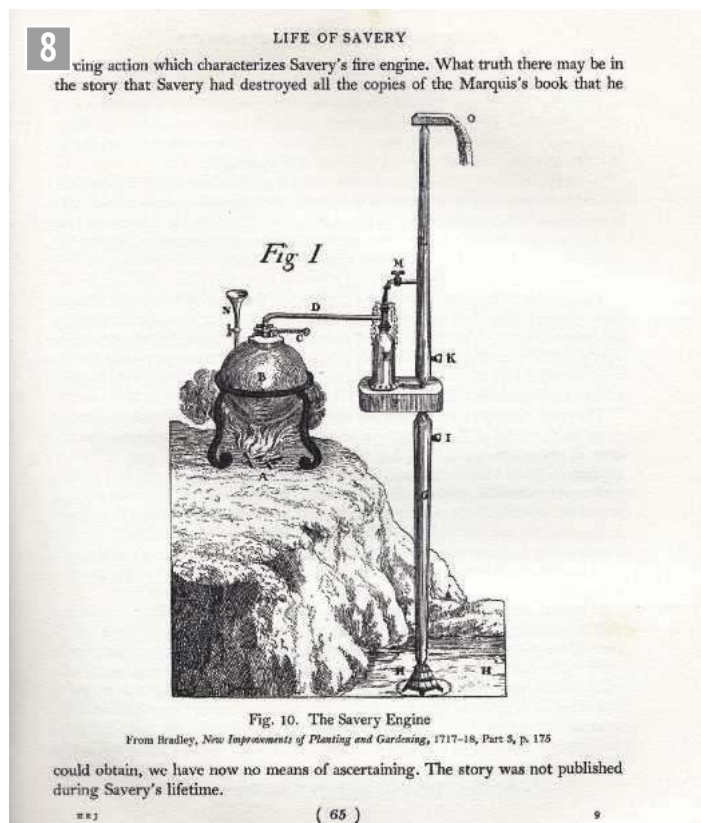
The vacuum and pressure steam avenues of experimental investigation merged in Thomas Savery's steam pump (**ref 13**). A native of Devon, Savery had strong links with the City of London and was sufficiently well accepted as a natural philosopher to be elected to the Royal Society in 1705. He was an active and diverse patentee but only his steam pump gained



Pages from Roger North's Notebook reproduced in Rhys Jenkins Collected Papers.

lasting fame. The device may have owed some debt to the Marquis of Worcester who seems to have first conceived the idea of driving water by steam pressure acting directly on the water surface but the documentary sources for Worcester's work are so opaque as to make his intentions virtually impossible to determine.

In its simplest and probably earliest form, Savery's pump consisted of a boiler which raised steam which was then admitted into a cylindrical receiver (**photo 8**). The base of the receiver was mounted on a hollow transfer box which carried vertical pipes above and below. The lower pipe descended into the sump containing the water to be



A single chamber Savery pump.

pumped and the upper one ascended to the discharge offtake. Valves in each pipe enabled communication with the boiler and allowed its linking transfer box to be closed off.

The operating cycle commenced with steam being admitted to the receiver and the transfer box. The steam valve was closed and a stream of cold water doused the receiver, condensing the steam and forming a vacuum. With the lower valve open and the upper one closed, atmospheric pressure drove the water up the pipe until the receiver, the transfer box and the pipe were filled. The valve in the lower pipe was then closed preventing the water from falling back into the sump and the valve in the upper pipe was opened. Fresh steam at pressure was admitted to the receiver which propelled the water out and via the upper pipe to the discharge offtake.

According to Switzer the first practical demonstration of the Savery pump was not without incident:

I have heard (Savery) say...that the very first time he play'd it was in a potter's house at Lambeth (Lambeth Pottery?) where though it was a small engine, yet it forc'd its way thro' the roof and struck up the tiles in a manner that surpris'd all spectators...

The patent for the steam pump was added to Savery's existing list of patents on 25th July 1698. Its prologue states that it was:

...A New Invention for Raiseing of Water and occasioning motion to all sorts of mill work by the Impellent Force of Fire which will be of Great Use and Advantage for Drayning Mines, Serveing Towns with water and for the working of all sorts of Mills where they have not the benefit of water nor constant winds...

Whether the Lambeth pottery demonstration preceded or followed the

patent is not clear but Savery was in a position to exhibit a model of his engine before the King at Hampton Court in the 1699. Probably the same model was demonstrated to the Royal Society on the 14th June (photo 9). The journal of the Society, the *Philosophical Transactions* reported:

...Mr Savery entertained the Royal Society with shewing a small model of his engine for raising water by the help of fire, which he set to work before them, the experiment succeeded according to his expectation and to their satisfaction...

Presumably the entertainment did not involve lifting the roof tiles of the Royal Society's meeting premises nor indeed, of Hampton Court.

As illustrated in the *Transactions*, Savery's pump has two condensing chambers which could be operated alternately to secure more continuity in pumping. It is likely that this is a development of the single chamber pump although both types were produced subsequently.

Savery's social connections doubtless assisted him in the application for extended patent protection that followed his promotional exertions. By Act of Parliament in 1799 the normal fourteen years of protection was prolonged to 35 years bringing the expiry date to 1733.

Three years later he advertised in the *Post Man* for the 19-21st July 1702:

Captain Savery's Engines which raise Water by force of fire in any reasonable quantities and to any height, now being brought to perfection and ready for the Public use. ...to all proprietors of Mines and Collieries which are incumbered with water, that they may be furnished with Engines to drain the same at his Workhouse in Salisbury Court, London, against the Old Playhouse, where it may be seen working on Wednesdays and Saturdays ...where they may be satisfied

of the performance thereof with less expense than any other force of horse or hands and less subject to repair...

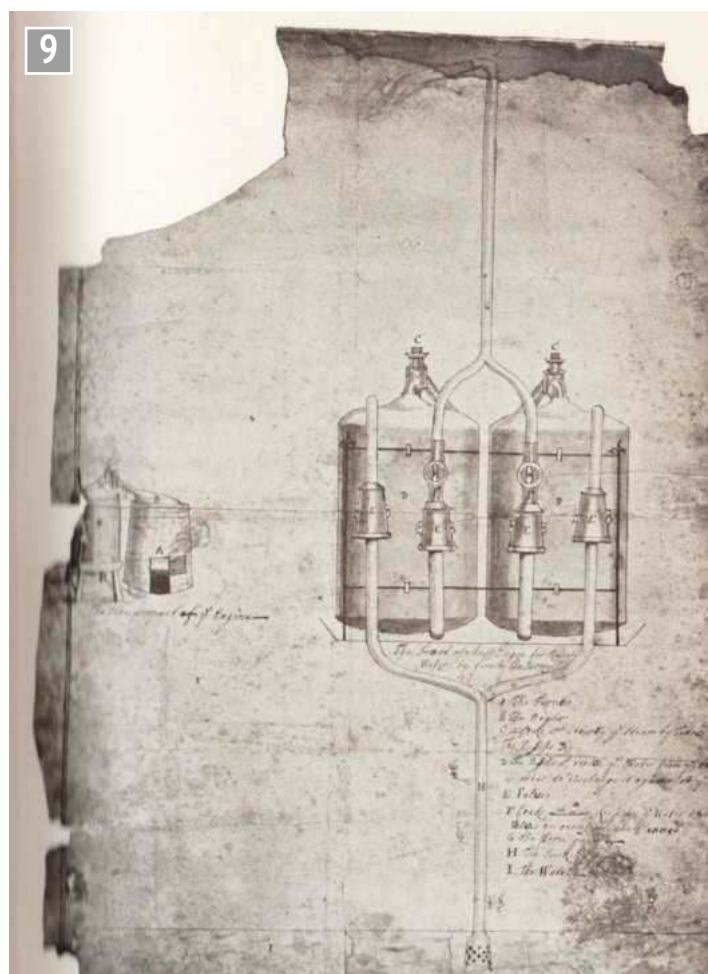
In the same year Savery published a more ambitious advertising puff in the form of a booklet (photo 10) entitled **The Miner's Friend:**

...or an engine to raise water by fire, described and of the manner of fixing it in mines with an account of the several other uses it is applicable unto; and an answer to the objections made against it.

His preface carried a dedication to the King, The Royal Society and The Gentlemen Adventurers in the Mines of England of whom he says:

And though my thoughts have long been employed about water works I should never have pretended to any invention of that kind had I not... found this new but yet much stronger and cheaper force or cause of motion... But finding this rarefaction by fire, the consideration of the difficulties the miners and colliers labour under by the frequent disorders, cumbersomeness and in general of water engines incouraged me to invent engines to work by this new force that tho' I was obliged to incounter the oddest and almost insuperable difficulties I spared neither time, pains nor money till I had absolutely conquered them.

How convincingly he had conquered these ...oddest and almost insuperable difficulties... emerged over the succeeding years. A *hiatus* seems to have followed the initial burst of publicity. Possibly some small domestic pumping engines were made but it is not until ten years later that evidence exists for the erection of seemingly viable machines. Country houses, whose ornamental waterworks were a perennial source of hydraulic enterprise figured amongst Savery's earliest known customers. Campden House, Kensington and, more illustriously, Sion Hill, the mansion of Handel's great patron, the Duke of Chandos,



The Savery pump as it appeared in the *Philosophical Transactions* MS drawing in the Royal Society Collection reproduced in Dickinson.

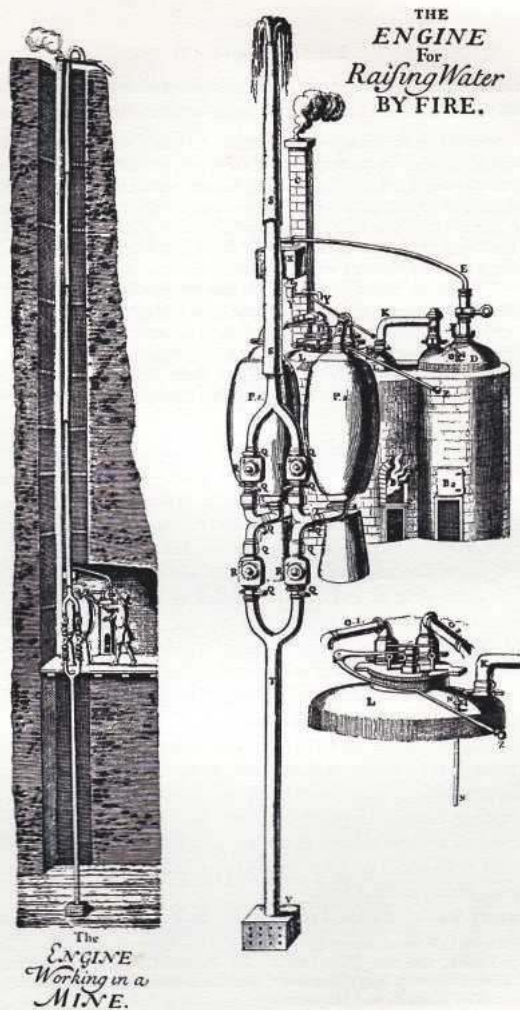


Fig. 9. The Savery Engine, 1702

From Harris, *Lexicon Technicum*, 1704—reproducing the plate in Savery's *Miner's Friend*, 1702

Illustration reproduced by Harris in his *Lexicon Technicum*, 1704, a copy of that in Savery's *Miner's Friend*, 1702.

both had Savery pumps. The former was the single chamber engine illustrated.

These were relatively undemanding roles for the pump but as more ambitious tasks were attempted the shortcomings became apparent. A two-receiver engine was supplied to the York Buildings Water Works in 1712. Otherwise favourably disposed, the commentator (ref 14) was forced to admit that in attempting to gain more power Savery had created problems:

(Savery) tho' he had before set up his engines with good success at Camden House ... was not content with the plainness of them when he undertook so great a work as furnishing the public with water but doubled every part of the

York-buildings engine and by that made it impracticable for one man to work it and it was liable to so many disorders if a single mistake happen'd in the working of it that at length it was looked upon as a useless piece of work and rejected.

Savery also seems to have pressed his boiler(s) to a higher pressure as a later account by Dr. Richard Wilkes, repeated by Desaguliers, says:

I have known Captain Savery at York buildings make steam eight or ten times stronger than common air and then its heat was so great that it would melt common soft solder and its strength so great as to blow several joints of his machine so that he was forc'd to be at the pains and charge to have all his joints solder'd with spelter or hard solder... These

discouragements stopp'd the progress and improvements of this engine...

As far as it being the *Miner's Friend*, a vague reference in Hamilton's *Excelsior: Helps to Progress in Religion, Science and Literature* states that Savery's first mining engine was erected at a Cornish tin mine called Creegbraws and there may have other attempts to demonstrate the pump to Cornish mine owners. In view of their desperate need to de-water their mines, that the Cornishmen were unconvinced suggests that they recognised fundamental problems with Savery's pump. Local doubts in Cornwall did not prevent Savery from finding a potential customer in the Midlands coalfield. Dr. Wilkes, who had known Savery personally, gave an account of this venture:

Mr Savery set down one of these engines in the Liberty of Wednesbury not far from Willingswoth, in order to drain what was then called the Broad Water as well as to lay the mine dry which was so much wanted. The place lying low had been covered by a sudden eruption of water from old hollows and springs some years ago which came so hastily that the old ginn and many stacks of coal on the bank were covered too deep to be removed ... the engine here erected could not be brought to answer the end proposed: for the body of water being too great such a quantity of steam to be raised and so large a fire required as rent the whole machine to pieces so that after the loss of much time and money Mr. Savery was

forced to give up the work and so the engine was laid aside as useless and the scheme for raising water was dropt as impracticable.

It may not have been the only attempt to use a Savery pump in the area. Wilkes briefly alludes to another near West Bromwich but the failure at Broad Waters marked the effective end of the Savery engine as a mine pump.

The Savery pump was endemically inefficient which was tolerable where coal rubbish could be used as fuel but ultimate limitation of the Savery pump was the maximum lift that the vacuum induction could support - about twenty-five feet. This left the remaining work of raising the water to the pressure steam pulse and the greater this lift, the greater the necessary pressure, a path closed by the limitations of boiler building. Proposals were made to house a succession of pumps at different heights in shaft insets so that the total lift was spread over several units but this was simply replicating an intrinsically flawed device. For low heads the pump retained some potential but it was never even remotely practical as a mine pump.

●To be continued.

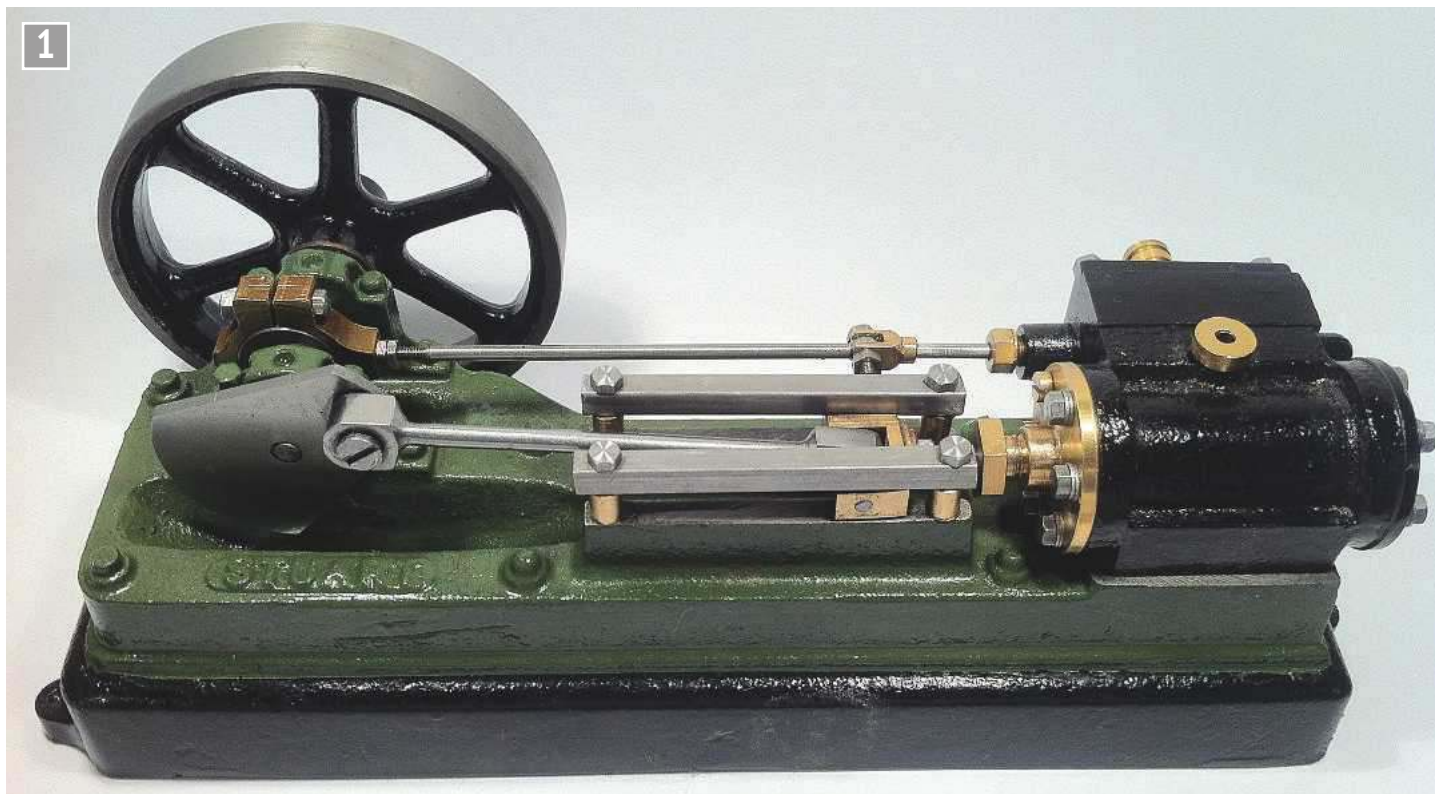
NEXT TIME

We continue the story of the Newcomen engine.

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13. The best summary of the history of Savery's engine remains the *Life of Savery. The Collected Papers of Rhys Jenkins* ibid. p. 38 et seq. to which additional facts have been added by Rolt and Allen: *The Steam engines of Thomas Newcomen*.
14. *Ten Discourses concerning the Four Elements etc...* R. Bradley, 1733, p. 33.

1



I am the proud owner of this completed steam engine.

My First Project

Dan Watson makes a good start in model engineering with a Stuart S50 mill engine.



I have recently completed my first project as a hobby engineer, a Stuart S50 horizontal engine. Whilst I expect most proficient engineers could knock one together in a relatively short amount of time, I'm very proud of my achievement, which spanned about two years from start to finish. In this article I intend to look at the mistakes I made whilst trying, learning, and mostly scrapping parts but ultimately still persisting until I had a working engine I was proud of.

I spent a very happy childhood 'playing trains' with my old man but, as my teenage years unfolded, so did my interest in other areas develop, such as music, friends, evening and weekend jobs, and perhaps most intrusively, the pursuit of love and romance. This was followed by university, embarking on a

career and so on. But in recent years I have re-embarked on a meaningful hobby and decided to relive my childhood years through learning how to make engines and building my own workshop.

Early on I was always intimidated by the quality many engineers I know are able to produce. Most locomotives I saw looked thoroughly pristine and I couldn't even imagine how one acquires the skills to produce such beauty and elegance. I almost felt that if you can't do it to this standard then you should leave it to the big boys. I've always tried to take the view, though, that it doesn't matter if I make a mistake. I've accepted that I will make them and that's all part of learning.

You don't have to look very far to find mistakes in my S50. I mean - where do I begin? I've chosen a small number of

corners to share, so let's start with perhaps the most critical area, the cylinder assembly.

My chosen method for making sure the stud holes holding the valve chest and cover on to the cylinder valve face lined up was to glue them together and drill four holes in each corner before breaking the adhesive bond and cleaning off all the remaining residue. Sounds simple and effective, right? Wrong. In reality I gave myself more work than the time I would have saved by doing it properly. As you can see from the pictures, the valve chest has a part-hole in the corner (**photo 2**) and the cover has a faint but noticeable brass plug which I had to make and fit perfectly before drilling again (**photo 3**). Had I simply squared off all the side edges and taken the time to set up both parts in the mill first then drilling



everything would have been easier, better, more fulfilling and less frustrating and time consuming.

The cylinder is a cast iron casting and I was terrified (sweaty palms and increased heart rate apply) at the prospect of threading with small taps - 5BA and 7BA. I just couldn't get the knack and when doing the cylinder cap securing holes in the cylinder ends, I was petrified that a nice threaded hole would just crumble before me, as actually happened.

Sometimes luck is on your side though. The two holes I destroyed just happened to be the two on the inside end which were closest to the valve face (**photo 4**), which meant I could re-drill and tap a slightly larger thread and in the end longer screws were used, which gave me more material to thread. I just had to avoid the internal airways to avoid creating leaks and significant problems later.

You'll notice the inner (piston side) cylinder cap is brass, not cast iron as designed. After creating both caps from the same supplied cast iron stock, the parting operation (or rather, the hacksaw method) left an unsightly rough patch which needed cleaning up, most importantly, for the piston to have enough room inside the cylinder. I decided to mill it down to a clean finish but when I clamped it too tightly, during one fateful pass on the mill, it cracked. So I made a new one from brass.

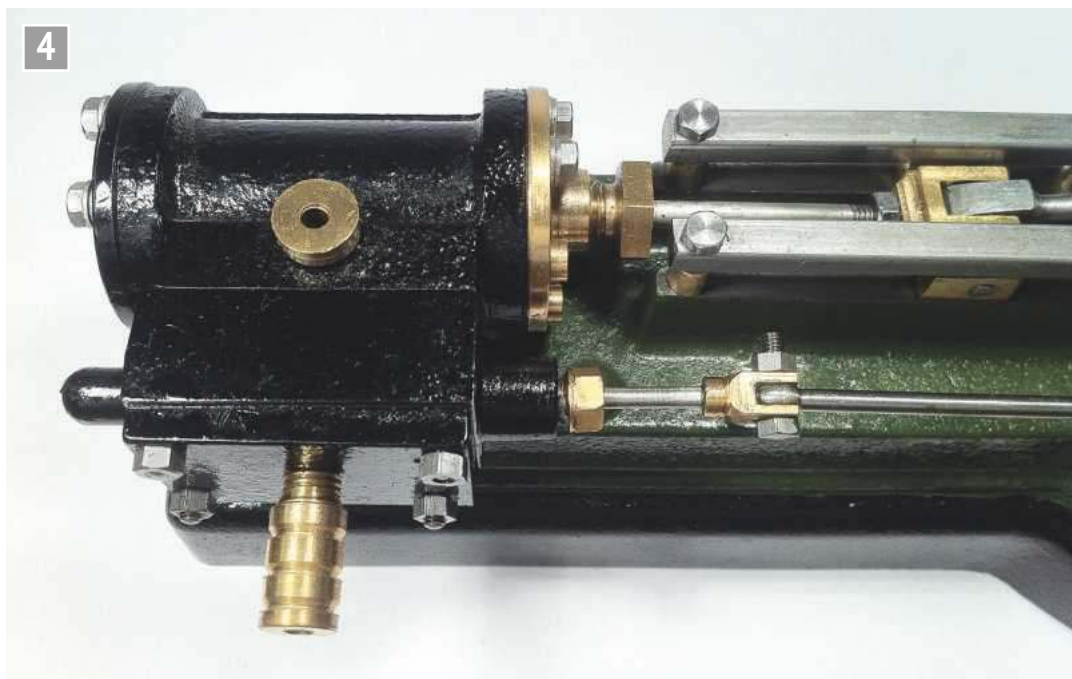
One lesson I've learnt is to read the drawing carefully. The six holes in the cylinder end caps are designed to hold the caps securely in place whilst at the same time avoiding the port holes. I didn't take any notice of this and merrily drilled the holes in the cylinder end in such a way that the one closest to the valve face was directly where one of the outer port holes should be. I noticed in time to get it right on the opposite side, but the cylinder cap on the outer side (**photo 5**) simply has to make do with five holding studs, instead of six.



The valve chest, complete with poorly drilled holes.



The valve chest cover. Notice the brass plug, bottom right.



Cylinder, with brass inside cap after scrapping the cast iron one, and two brass screws on the valve side.

Another area in which I didn't read the drawing correctly was in drilling and tapping the grub screw hole which holds the flywheel on to the crankshaft. I drilled the hole on the wrong part of the casting where there is less material (**photo 6**). It worked though and now the grub screw sticks out in a very unsightly fashion but it is still functional.

My lathe was built by Denham Engineering Co, Halifax, and I think the serial number (3160) dates its manufacture to the early 1930s. It also has an Air Ministry serial number (W 17141) and I can only imagine what sort of contribution it may have made to the war effort. I bought it from Echills Wood Railway, where I am a member, as they were offloading some surplus equipment. It was in my

price range and I desperately wanted a lathe to learn on and make things with.

Having bought a lathe, I could now complete a good proportion of the engine but later I felt I needed a milling machine for other tasks. I've read about individuals who could do this sort of project on a lathe only. My inexperienced mind can imagine it but in reality it feels like nothing short of wizardry. Imagine drilling and tapping all the holes in the base casting using a four-jaw or a faceplate.

So, after enough pestering, my wife allowed me to buy myself a mill for my birthday.

We bought a ZX30 Mill from Axminster, new. It's very young in comparison with my lathe but brilliant. I have to say that Axminster customer service has been second to none. I bought a drill press

from them which I didn't feel was good at all and, after complaining and asking for a replacement, which they provided (and the replacement wasn't very good) they gave me a full refund on the basis that it wasn't accurate enough. One problem was that when tightening the table its angle changed dramatically and I couldn't rely on it tightening sufficiently rigidly and square at the same time. The fact that they were so compliant and helpful encouraged me to buy from them again as I knew that if there was a problem with the machine it could be resolved. The ZX30 Mill is in their 'engineer' series, and I'm very pleased with it and what I've achieved with it so far.

There are a few oddities though and I've had to learn to work around them. For example, the machine

has metric handwheels, as expected, but the handwheel readings go up to a reading of 12.5, with no unit given. One full rotation of either the X or Y handwheels moves the table by 2.5 mm. So even when working in metric I need to make a conversion. As it happens, my drawings and projects are generally in Imperial, so I have to convert from Imperial to metric and then make a handwheel conversion. There is quite a bit of room for error here but I like it because it makes me think carefully.

The mill was a huge help though. I didn't fancy marking out the holes in the base casting that secure the cylinder assembly and slide bars. Firstly, I milled the underside of the casting to make it flat, and then turned it the right way up to accurately drill and tap all those holes with the right spacing between them according to the drawing dimensions. I then needed to simply use the very same calculations on the mating parts to make sure they would marry accurately.

Another bit of kit I couldn't do without is an accurate tapping stand. It simply needs to be consistently square, and relies on my parallel machining of opposite sides of castings and parts. It easily beats non-perpendicular tapping by hand.

When it came to assembly, I was so excited to see if the engine would work. It didn't. Embarrassingly, I hadn't appreciated the importance of oil. Using my air compressor, I pumped in a lot of air until the engine would move a bit but everything was jerky and unpleasant. Simply adding steam oil really was the key here. I learnt that the thick and viscous properties of steam oil act as a seal between the valve and the valve face of the cylinder but, if the valve doesn't move freely at the end of the valve rod, it won't be able to stick against the valve face of the cylinder. The air pressure needs to be able to push the valve against the

cylinder face so that it seals as it moves.

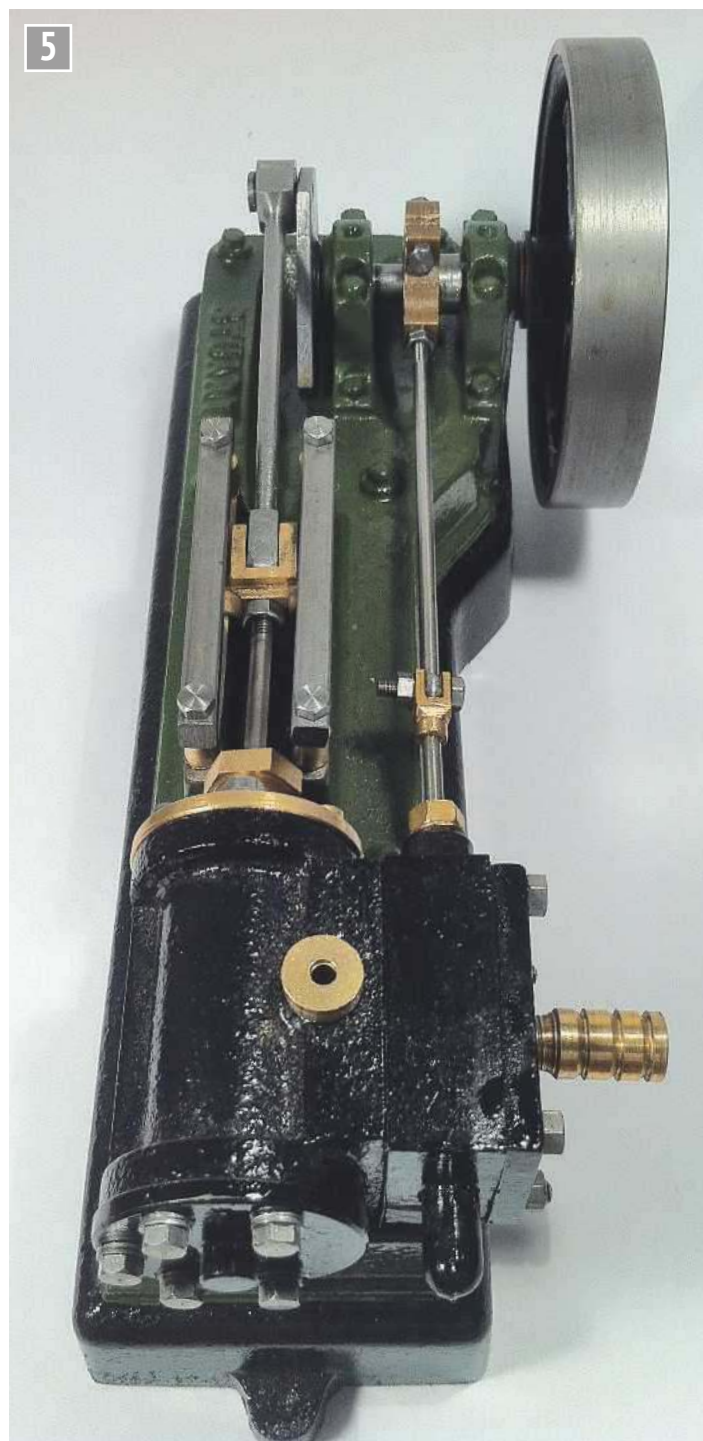
I must have dismantled and re-assembled the engine three or four times whilst ironing out these little niggles.

Finally, when it came to painting I ordered green and black paints supplied by Stuart Models. They arrived in a surprisingly small parcel and I could not believe there was enough paint in these small pots to paint my engine. I phoned them up and they reassured me, with a friendly chuckle, that there was enough. After degreasing and painting a couple of coats, I was very pleasantly surprised that I even had enough paint left to do the same with another two models of a similar size.

If nothing else, I hope this article has given some of you a good chuckle too. I also hope that the less confident or experienced will be encouraged and perhaps learn from my mistakes. I ought to re-machine some parts to make it more presentable or to run more smoothly and efficiently. For every error I could have bought a new casting but I'm proud of my slightly lack-lustre engine, warts and all.

You only get better at your craft if you're willing to make mistakes and learn from the experience. We also have to learn to be patient. I would often come in late in the evening from my workshop covered from head to toe in oil, sweat and swarf, and my wife Sally would ask, "what have you done this evening then?", to which I proudly declared that "I have drilled a hole", but then I would think to myself that at least it's an accurate hole.

Despite being subject to some unintended mild ragging from the experienced engineers I know, as described earlier, one encouraging and supportive member of Echills Wood Railway said to me, "if you can make one of those, you can make a *Romulus*".



Notice five screws instead of six holding the outside cylinder cap.



ME Flywheel and grub screw.

Brill 22E Tram Truck

Ashley Best describes an American design of tram truck that was widely used on British trams.



Continued from p.845
M.E. 4627, 6 December 2019

The typical British electric tramcar had become established early in the 20th century. Mostly they were double deckers on either four wheel single trucks or, for larger cars, a pair of four wheel bogie trucks. It is interesting to note that most of these trucks were American designs. Britain was only later to develop its own successful truck types. Of the makers that supplied these early trucks, the most successful was the Brill Company of Philadelphia. Their two most prolific products for the British market were the 21E four-wheel truck and the 22E maximum traction truck for eight-wheel cars. This latter design forms the subject of this article.



Typical trams.

Source for motors, gears, castings and plans:
Model Engineering Secretary,
Tramway & Light Railway
Society,
9, Manor Close,
Bognor Regis,
West Sussex
PO22 7PN
Or e-mail: tlrs.mesecretary@tramwayinfo.com

Alternative methods

The axlebox could be milled and drilled from the solid. It could be fabricated as a solid and drilled as required or it could be cast in white metal from a carefully made pattern. I have tried all these and **photo 26** is of white metal examples. Should this last material be considered, rest assured that white metal is absolutely fine and is perfectly robust. It is, of

course, an ideal bearing metal. Later in this article I shall feature white metal casting as it might be applied for a variety of parts.

The axle boxes were fitted to the wheel sets and carefully adjusted and eased accurately to fit the axle pedestals. Once this had been achieved, coil springs and keeper bars were fitted temporarily before turning to the truck's internal

equipment. There are two cross beams that establish the frame's width. At the front is a Tee-section beam that carries the radius thrust guide, the pilot board and brake hangers. This beam was made simply by setting up on the hearth and silver soldering together the two pieces needed to form the beam (**fig 16**). It has to be just long enough to facilitate fitting the four 12BA bolts used at each end to join to the side frames. Truck side frame centres are a scale six feet apart. Small head 12BA bolts were used for this, being about scale size.

Load bearing

The truck has no king pin at its pivotal centre. Instead there is a king bolt fixed to the car underframe and passed down through a radial slot in a bracket attached to the front Tee bar. **Photograph 27** is of

**T SECTION FRONT CROSS BAR
SILVER SOLDER. SCALE 6' 6" LONG
SIX INCHES X SIX INCHES SECTION**

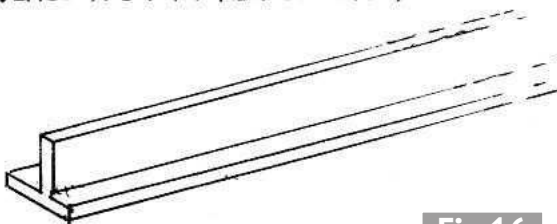


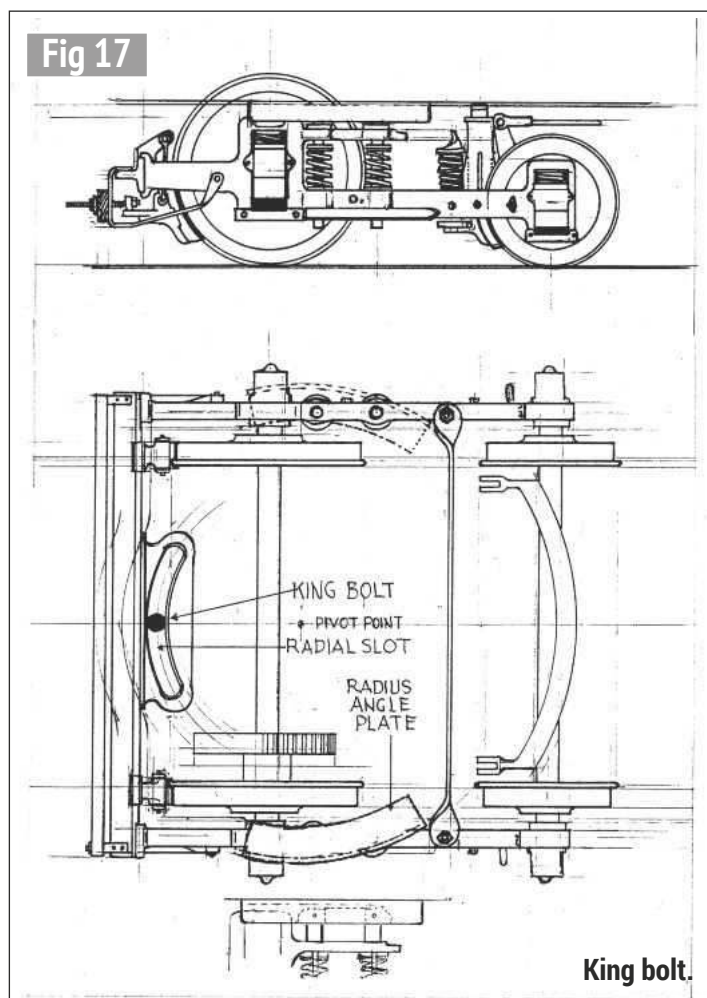
Fig 16



Cast boxes.



Radius slot.



this item, which, initially, is cut from plate with a piercing saw (**photo 28**). The load on the truck falls on the side bearings and the pair of spring posts on each side frame. The metal bearers on the tops of these springs run in curved angle plates fixed to the car underframe and this feature confines the movement of the truck as it negotiates curves. **Figure 17** shows the position of the angle plates and the king bolt in the radius slot and **photo 29** is how it appears from outside the car.

Rear cross beam

The cross beam at the rear of the truck is a most

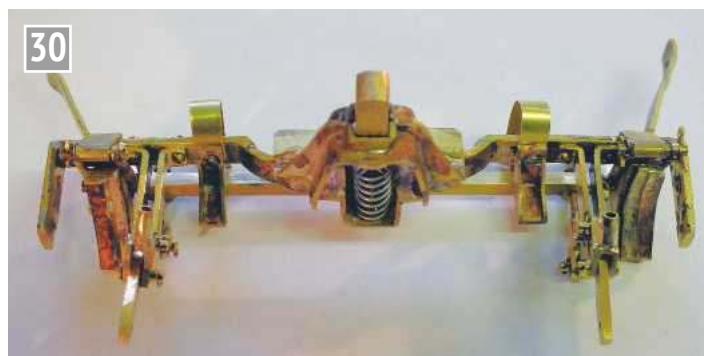
significant feature. It supports a large number of important mechanical parts including brake hangers, brackets for differential brake levers, the compression spring system and brake beam casting supports (**photo 30**). However, it is here that in this scale a satisfactory working model is possible without going to the trouble of including all the details, most of which would be invisible on a finished model tramcar. Indeed, my earliest models are without some of these features, but in this model, everything possible that I felt able to include is featured. The Brill drawings are confusing in that the rear



Cutting the slot.



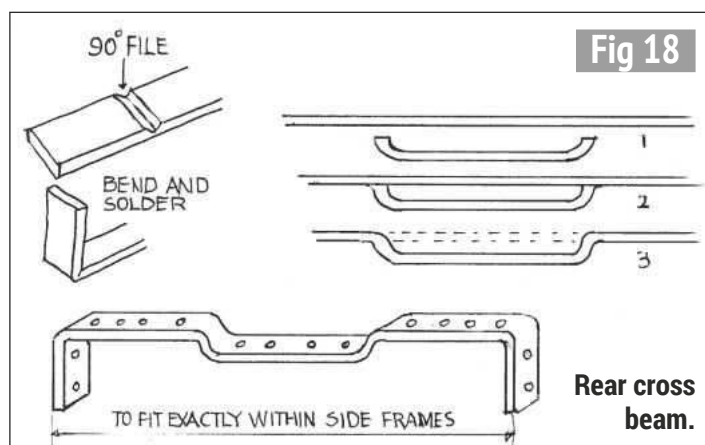
Outside view.



Rear beam.

cross beam in some is shown as a simple straight beam and as a cranked beam in others. The robust compression spring casting is the reason for the

cranked section and I have included this on the model which seems to be correct as a straight beam would put the device too close to





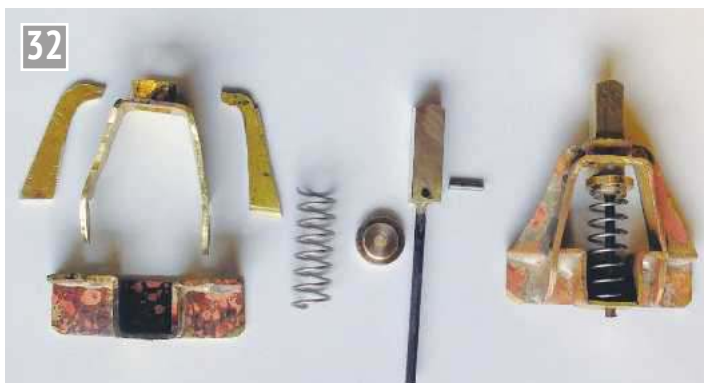
Beam making.

the motor beam. Achieving an accurate cranked beam can be manipulated in one piece, but I found the method shown in **figure 18** to be more satisfactory. First a simple, accurately formed straight beam is made (**photo 31**). The side angles are filed, bent and silver soldered. Then, a short central piece is easily formed and filed as shown, silver soldered in position before cutting away the straight centre section and filing to profile. It gives perfect alignment.

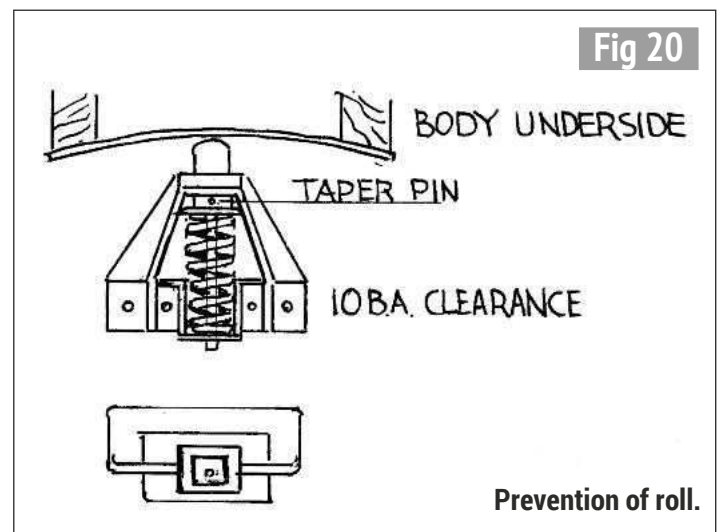
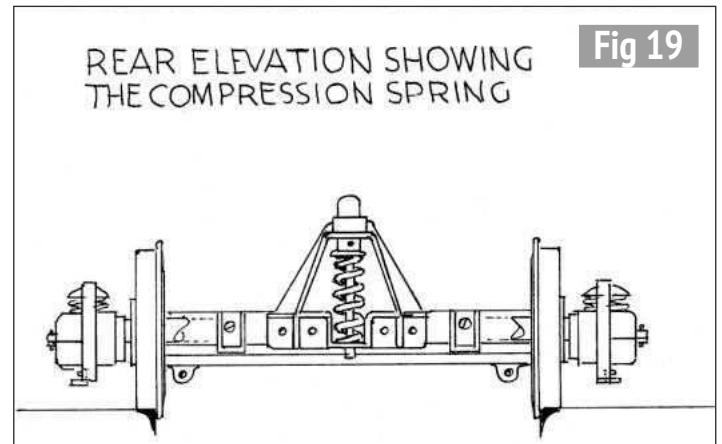
Compression spring

Fixed to the cross beam at its centre is the compression spring mechanism (**fig 19**). This device has an important function. The 22E truck has up to 75% of the car's weight on the driving axle which, being very close to the pivotal centre of the truck, has limited displacement on curved track. Not so the pony wheels. These swing out on curves, which is why they are smaller to enable them to clear underframe obstructions. However, early

examples of such trucks were prone to derailling as the weight bearing down was insufficient, particularly on poor track and junctions where the flanges could climb out of gauge. To overcome this problem the Brill truck featured a spring post with a sprung compression block at the top which sustains pressure against a curved plate fitted beneath the car body. As the truck enters a curve and swings outwards, the compression block slides against this plate which, because of its curvature, increases pressure as the outward swing increases and thus the weight bearing down on the pony wheels. **Figure 20** illustrates this function. The construction of the apparatus is shown in **photograph 32**. The feature clearly shows one reason, at least, why the cross beam has to be robust. The cross beam fits exactly between the side frames and is drilled and tapped to receive two 10BA bolts on each side. The rearmost of these bolts has to be an eye bolt to receive



Compression block.



the safety chain which was a feature of the truck and designed to act as a restraint in the event of an unfortunate derailment (**photo 33**).

Bracing

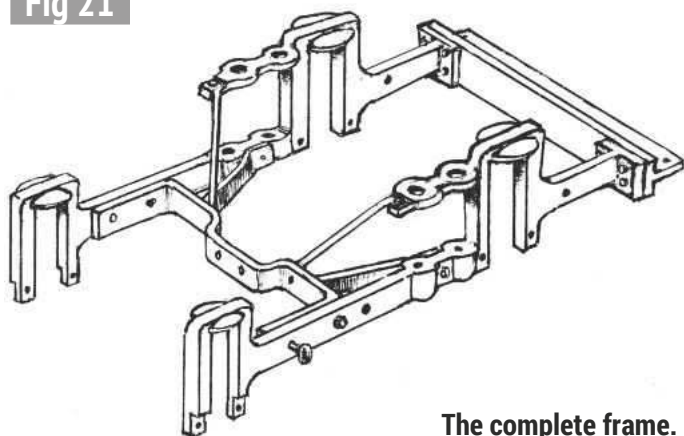
In addition to the cross beam being bolted to the side

frames, the prototype truck and the model described here had further bracing with a cross beam brace and a spring post extension rod on each side. **Figure 21** is a sketch of a complete frame with braces in position, but without internal truck equipment.



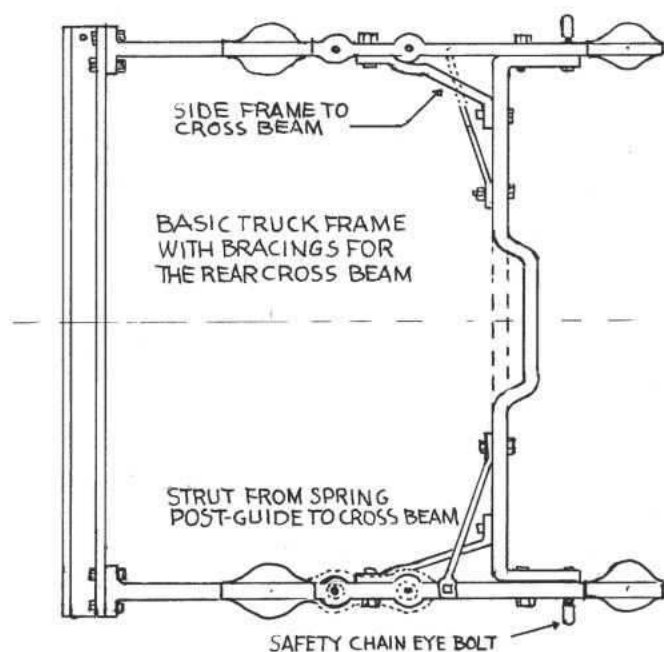
Safety chains.

Fig 21



The complete frame.

Fig 22



Frame bracing.

The cross beam brace links the cross beam to the side frame at a shallow angle. The actual connection is right next to the driving wheel in an inaccessible position, which has implications should it ever become necessary to dismantle the truck. The side frame is drilled 10BA clearance and the brace is tapped for a 10BA bolt, which can then be accessed from the outside, thus allowing the side frame to be disconnected easily from the brace.

On almost, if not all, smaller scale models and even in $\frac{1}{16}$ scale, these features are usually ignored, as

are working brakes which are often represented by dummies. A robust working model used on exhibition layouts really has no need for detail refinements, but they are included here in the interests of accuracy.

Photograph 34 shows the braces - the lower ones at a shallow angle between the cross beam and the side frame. The upper rods join the cross beam to the spring post support rods (**photo 35**). These rods were joined to the spring posts by 12BA bolts with the heads filed square. The Brill drawings offered three distinct fixing

34



Braces.

35



Support rods.

positions on the cross beam. I chose the easiest. Both sets of braces were fixed, at first, in the absence of the clutter that later occupied the interior space of the truck. The complete truck frame with

all the bracing is illustrated in **figure 22**. It is a satisfyingly rigid structure.

●To be continued.

Backyard Foundry Techniques

Part 4: Casting

Luker describes how to set up and use your own backyard foundry.



Continued from p.21
M.E. 4628, 20 December 2019

Safety and PPE

I dealt a little with safety and personal protective equipment (PPE) in the first article, and I encourage anyone who is going to do their own castings to think carefully about each action around the furnace and consider what could go wrong. I said previously that PPE doesn't make you bulletproof and it should be there as a last resort. Don't think, for example, your leather gloves will allow you to handle the components on the furnace lid; these need to be handled with tongs. And please keep kids and animals or any distraction away from you when casting.

Scavenging for materials

I don't bother with scrap yards here in South Africa as they are generally unwilling to sell any scrap to the public and when they do they sell at ridiculous prices, typically the cost of buying new material. But this is a good thing as it's forced me to rethink materials and how I go about collecting them. Cast iron is an easy one and you'll find it lying around if you keep your eyes open. I found a cast iron cistern the other day (**photo 24**) that will do a number of wheels and still had a number of brass fittings attached.

Copper and brass are two metals I keep a lookout for with electrical fittings, motors or plumbing fittings and pipe a good source. Tin is a little difficult to get, and this I source from a casting supply house as granulated tin, but



Metals treasure.

lead free solder will be a good source, albeit a little pricey. Zinc can be sourced from die cast items. A typical example is 'silver' candlestick holders.

Mixing metals for model engineering applications

Aluminium

I'm by no means an expert on aluminium alloys; there's not much call for these alloys in live steam locomotives. In total I have only cast a few dozen components. Aluminium is common and inexpensive so it makes sense to source scrap components similar to what you intend to cast i.e. melt pistons to make pistons. When making the moulds for aluminium make sure you limit any areas on the flow path that would cause unnecessary turbulence. Aluminium is particularly bad with picking up gasses in its molten stage. Larger sprues and ingrates will help with decreasing flow turbulence. Some of my cast

aluminium components are shown and this was a rare case where I wanted to move the centre of gravity back for a locomotive I'm busy with to improve weight distribution over the coupled wheels.

Copper alloys

I use the copper casting alloys handbook as a guide for mixing my copper alloys. Copper is scavenged as well as the lead and the zinc I get from scrap brass. I've included a table modified from the handbook showing my mixes and what they can be used for (**table 2**). Just a note on boiler application - stay away from zinc additions in any boiler fittings or bushes.

When melting the copper alloys I typically throw some precast metal into the crucible before adding the base metals to make a full charge; this helps when the alloys you trying to mix have different melting points

with the lower melting point metals potentially fuming if superheated. Zinc fumes badly; when it's added it should be added to the crucible first and covered with the other alloys. Don't add zinc to an already melted charge - it freezes the top of the charge and starts fuming. As a general rule I add the lower melting point alloys first. This

improves the heat transfer to the higher melting point items when they are added and you won't get the top of the charge freezing.

Cast iron

For model engineering applications you are looking for a cast iron that is relatively ductile and easy to machine with no defects. FeSi inoculant

is the key to getting good quality cast iron castings, and without adding it you likely to get excessive chill (hard as hell cast iron, that machines shiny spots). The FeSi is also good for degassing so it kills two birds with one stone. **Table 3** gives an alloy that ticks all the above boxes. I've successfully cast and bent to straighten a 3mm compensation lever for a

suspension system on one of my locomotives using this mix.

You need to add the carbon when the crucible is half full, and generally you add it with cold material, but the carbon should not be plunged. Graphite, coke or coal dust will work just fine. FeSi should be added with the entire charge melted, and plunged. You don't need anything fancy

Copper alloy calculator					Table 2
Crucible size	4 Kg				
BRASS	Cu (Kg)	Sn(kg)	Pb (Kg)	Brass (Kg) Assuming 40-60% UNS no	
High copper yellow brass	1.6	0.1	0.1	2.250	C85200
Yellow brass common	4.0	0.0	0.0	0.0	C85500
Low-cost, low-to-moderate strength, general-purpose casting alloys with good machinability, adequate corrosion resistance for many water service applications including marine hardware and automotive cooling systems.					
Bearing Bronze					
Standard bearings LG	3.2	0.3	0.3	0.2	C93200 Most commonly used bearing alloys, found in bearings operating at moderate loads and moderate-to-high speeds, as in electric motors and appliances.
Gunmetal	3.4	0.4	0.0	0.2	C90500 Hard, strong alloys with good corrosion resistance, especially against seawater. As bearings, they are wear resistant and resist pounding well. Moderately machinable. Widely used for gears, worm wheels, bearings, marine fittings, piston rings, and pump components.
Boundary condition lubrication	2.9	0.2	0.8	0.1	C94100 Lead improves machinability in these tin bronzes but does not materially affect mechanical properties. The alloys are essentially free-cutting versions of the tin bronzes, above, and have similar properties and uses. C94100 is especially good under boundary lubricated conditions.
Leaded semi red brasses					
LG2	3.1	0.2	0.2	0.5	C83600, Good corrosion resistance, excellent castability and moderate strength.
Plumbing valves	2.8	0.1	0.3	0.8	C84400 General purpose alloys for plumbing and hard-ware goods. Good machinability, pressure tightness. Alloy C84400 is the most popular plumbing alloy in U.S. markets.
Alumina bronze					
Alumina bronze	3.554	0	0	0.4	C95300
The aluminum bronzes are characterized by high strength and excellent corrosion resistance. Alloys containing more than 9.5% Al can be heat treated, some to tensile strengths exceeding 120 ksi (827 MPa). Uses include a variety of heavy duty mechanical and structural products including gears, worm drives, valve guides and seats. Excellent heavy duty bearing alloys, but do not tolerate misalignment or dirty lubricants, and generally should be used against hardened steel shafts, with both shaft and bearing machined to fine surface					

to plunge, a 30mm diameter 2-3mm thick disk welded to a 6mm rod will do. You need to pour within a few minutes to prevent what the foundries call 'fade'. Basically, the FeSi loses its effectiveness and if you wait too long to cast you are likely to have hard spots. This is typically why cast iron gets harder every time you re-melt without adding FeSi.

I suggest having a dedicated crucible for the copper alloys and one for cast iron and aluminium. When casting I generally use the same crucible for aluminium and cast iron and I cast in that order. Any aluminium left over in the crucible will have no effect on the cast iron - in fact it is used as a degasser in industry. Don't use the same crucible for any copper alloy and cast iron.

When and how to pour

To improve the life of your crucibles you should always melt a full charge and this is typically 80% of the crucible. I find in my furnace that after the last piece has melted I wait three minutes for the copper alloys and six minutes for cast iron before I inoculate and pour; this gives enough superheat to fill most moulds properly. For aluminium I need to act quickly; when I throw in the last piece I set the moulds out, and I pour immediately. To give you an idea of what to look for - when you stir the melt there should



Placing the crucible in the pouring ring.

be no freezing onto an 8mm rod, then you know you're good to pour. You need to skim the oxides and slags off the top of the charge before pouring. I generally just weld a stainless steel dessert spoon onto a 6mm rod - it is a 'cheap and easy to make' skimming spoon.

When pouring don't take shortcuts; the crucible tongs should be used to remove the

crucible from the furnace and place it in the middle of the pouring ring, which should be ready and waiting on one or two refractory bricks (**photo 25**). You should never pour using tongs; the chance of damaging or breaking the crucible is not worth the shortcut. The pouring ring should be a good fit for the crucible. I also always pour on ground level with all the moulds on the floor, standing to the side of the crucible and moulds. If anything goes wrong in the moulds the likeliest path of metal escaping would be up the sprue, so the safest place is to the side and never standing over the moulds when pouring.

Pouring should be a steady continuous stream until the mould cavity is completely filled, stopping when the funnel is filled (**photo 26**). If you pour with an inconsistent stream you are likely to push air pockets into the mould cavity that could result in short castings, cold laps or cavities.



Pouring steadily and safely to the side.

Fettling, cleaning and checking the castings

The sand can be removed from the castings using a wire brush or sand blasting if you have that facility. Fettling is the fancy word for cutting off the risers and sprues and this can be done with a simple angle grinder. I suggest marking the grinding disks and refrain from cutting ferrous and non-ferrous castings with the same disk. I generally don't cut straight through cast iron but notch it with the grinder and break the riser etc. off by knocking it with a hammer. The grain structure should be grey or dark grey with small uniform grains; then you know you have a decent casting. I also run a file over selected areas of each casting to check there is no chill and having a known piece of good cast iron handy as a reference will help. The riser should have holes in the middle or piping down the centre, and then you know it's done its job. If your sprues are long enough and haven't piped they can be used for bearings or spindles.

Cast iron mixes			Table 3
Weight of Pigiron	Weight of Recast	Table Spoon Carbon	Table Spoon Noculant
0.0	4.0	0.8	2.5
0.5	3.5	0.9	2.7
1.0	3.0	1.0	2.9
1.5	2.5	1.0	3.1
2.0	2.0	1.1	3.3
2.5	1.5	1.2	3.5
3.0	1.0	1.3	3.7
3.5	0.5	1.3	3.9
4.0	0.0	1.4	4.1

Breaking open the mould is like opening presents - you never know what you going to get (**photo 27**). If you get good castings pat yourself on the back; most foundries don't hit the mark every time and even fewer with unique moulds. Feel free to contact any friends that boast about their recycling habits and enlighten them on your casting achievement!

The smallest casting I have cast in my backyard foundry is a 2g brass steam valve handle (**photo 28**), and ten of these were cast on a tree. The largest casting was a 4kg wheel for my Stirling single (**photo 29**). The alloys and mixes I have played around with are too many to mention but the mixes I have given in this series work for my model engineering projects and you should have an alloy for any occasion.

Some casting defects and their causes

Fortunately, I take loads of pictures of any defects and I check my casting notes to determine where the problem crept in. Blow holes or draw holes are the most common defect and most foundry men misdiagnose the problem. Nearly all of these holes can be attributed to poor riser design - even if there is a spot of slag in the middle of the hole it doesn't mean the slag caused the hole, it was just the nucleate point for the draw hole to form. The American type bogie wheels show clearly that with no risers



Some aluminium and brass castings showing the detail from 3D printing.



Smallest casting - a 2g steam valve handle.

draw holes become a major issue. This was an experiment I did a couple of years back to test my riser design. I cast 16 wheels in total; ours were in a box with no risers and all four had defects. None of the other wheels had any defects. They were all poured the same day, with eight wheels from one charge, in two separate moulds (**photo 30**).

The copper alloys generally draw from the surface of the casting so holes in the casting are less likely. An example is a thick regulator dome cover (**photo 31**). There was 'burn on' with this casting as well due to the lack of carbon in the surfacing sand. It just goes to show that if you don't have something on hand for moulding it's best to wait; it saves loads of work down the line. Incidentally for the

regulator dome the extended portion at the top is to grip it in the chuck for machining, an addition I make for all my chimneys etc.

Surface porosity in green sand moulds isn't that common and I have never seen it in any of my castings. From

experience the first place to look would be volatiles in the mould coat, if applied, or in the casting sand. Too much carbon added to the facing sand could also cause this.

Short pouring occurs when your casting temperature is too low or you don't have enough



Largest casting - 4kg Stirling single wheel.



Proper risering and no risers causing draw holes.

head (sprue is too short) or the end of your casting is too far away from the sprue (**photo 32**). I generally make sure the sprue is at least as long as the distance from the ingate to the end of the pattern.

Draw on the corners is typical where the radius on the corners is too small and the part is not fed properly. The example didn't require any risers with the casting modulus smaller than 2mm but the ingate was too small, stifling feeding during solidification (**photo 33**).

Fixing casting defects

Sometimes it's worthwhile to fix a casting rather than starting from scratch and it's a no brainer if the repair will take less time than moulding and casting a new component. LSBC, one of my heros, was against silver soldering castings but I have had to do this with cylinders fed by stainless steel superheaters that go directly into the firebox. If the fix isn't in a high heat spot then soft solder with a piece of copper to fill the hole will be fine. I have used soft solder to fill cast iron but you need a good flux - normal plumbing flux won't do a good job. Fixes on cast iron using soft solder are aesthetic but won't hold up to mechanical stresses or high heat. Two part epoxy metal fillers will also work for cosmetic repairs.

On surfaces requiring mechanical strength you need something more than putty or solder. Welding cast iron is relatively easy provided you



Copper alloy draw and 'burn on'.



Short pouring.



Corner draw.



Casting defect to weld.

get the correct welding rods, you preheat the casting prior to welding and allow it to cool slowly in some dry sand. The repaired example sits outside the bearing area of

the slide valve but it needed to be strong enough to seal the valve chest and tap bolt holes into (**photos 34 to 36**).

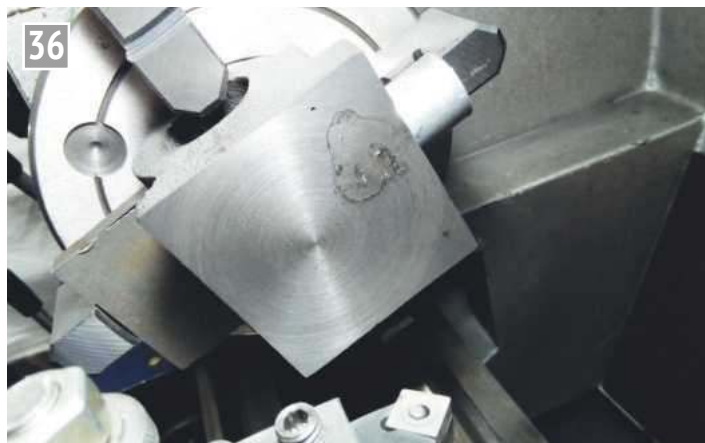
That concludes the series on casting and I sincerely hope

you enjoyed reading it as much as I did compiling it. I hope you'll give backyard casting a bash and report back on your experiences.

ME



Welded casting defect.

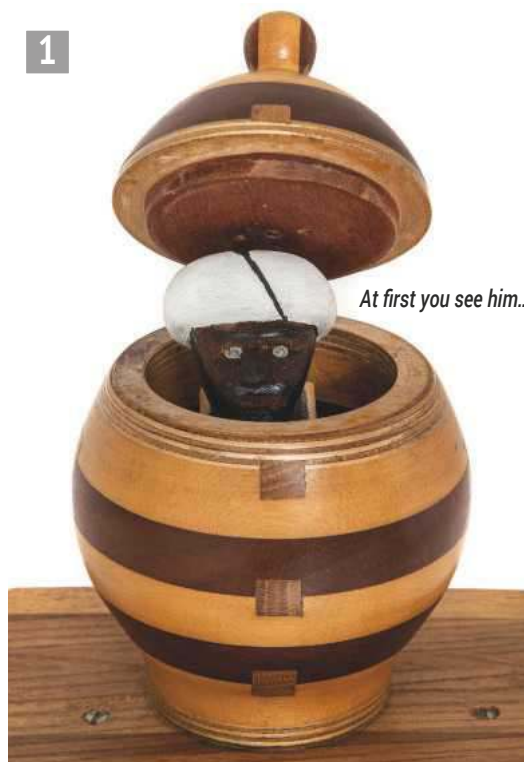


Machined welded casting defect.

Our Man in a Shed, **James Wells**, gets all seasonal and ventures into toymaking.



1



At first you see him...

2



...and now you don't.

MAN IN A SHED

Ali Bubba

While on a teacher training course it was necessary to produce a model that demonstrated some kind of movement. There were some very ingenious models produced but as most of these incorporated exposed bare brass wires of some kind I decided to try and avoid this. I also wanted to use the model afterwards as a reasonably robust training aid for future classes.

With automata, the usual practice is to divert the eye away from the mechanically moving parts and the best way to do this is to conceal these completely. With the story of Ali Baba in mind and thieves hiding in pots as a starting point, I sketched out several possible layouts. What eventually evolved was a plain bottom box and a more elaborate upper pot design.

The internal mechanism is based on simple engine practice. Turning the exposed crank handle rotates a crank shaft which in turn moves a connecting rod up and down. In effect a simple reversal of the usual engine events. This is concealed in the fairly plain bottom box with a transparent Perspex back.

Following the usual practice of trying to use woods of reasonably contrasting colours I approached the foreman of a local furniture factory about some scrap hardwood. He seemed to like the project idea and gave me free run of a massive bin of American Oak scraps. One of my neighbours, in the wood turning stage of retirement life, also had a few pieces of Elm in exchange for some redundant flower pots. In the back of my shed were also a few pieces of dark Mahogany

that would contrast nicely with the lighter Oak and Elm.

Construction didn't take long but there is a moment that I specially enjoy and that is when the varnish is applied and the colour of the wood is finally revealed. Both Oak and Elm had a distinctive grain which I thought contrasted nicely with the Mahogany.

By first demonstrating the model in action to a class, the class homework was then to figure out how it actually worked. When homework was handed in and noting that most of the class did come up with some workable ideas, I would then let the class have a look in the back.

My small granddaughter got in on this one and likes 'Ali Bubba, the little man who lives in a pot'.

ME



Geoff Theasby reports on the latest news from the Clubs.



I've been investigating Peak Programme Meters, VU (Volume Unit) meters and 'S' meters. I tried a circuit with a microphone but this was very pianissimo. I plugged it into the computer, *Donner und Blitzen*, or Haydn's Surprise symphony! Finally, I tried the output of a tape player. *Bat out of Hell*... I said to Debs, "It works".

"Eh?"

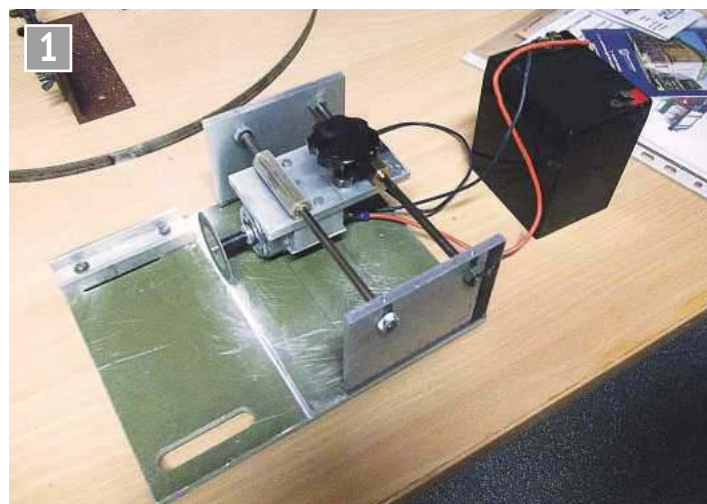
"It works!"

"I can't hear you for that blasted noise!"

Now to investigate Loudness Units ...

In this issue: Jack Russells, a noisy office, old wings for new, automata, Louis XV, a railway town, a good purchase, a Morse key and accelerating up a coal stage.

Jon Shaw sent *The Workbench*, October, from **Durban Society of Model Engineers**, which begins with Editor, Errol Koch assisting in welcoming the family of a founder member and Past President, H. V. Kellaway, to the club on the 8th September at Kellaway Hall. He took over driving *Sir Nigel Gresley*, which had been running well up to that point, after which things deteriorated rapidly! Errol also



Ted Fletcher's PCB Cutter. (Photo courtesy of Neville Foster.)

wrote up a visit to Centurion club, whose Gauge 1 track is taken up after every use in order to forestall its theft. He ran his Juliet and asked us to imagine being pulled around by a hungry Jack Russell. Well, they have four paw drive! In two months, he called at four tracks (DSME, CSME, PMES and RSME) plus locomotive, *Bliksem*. In polite company, that translates as 'Lightning'. W. www.dsme.co.za

PEEMS Newsletter, October, from **Pickering Experimental Engineering & Model Society**, visited the Anson Engine Museum in Poynton, Manchester, whose staff were very helpful and cooperative

and everyone enjoyed it. One member was pleased to see being restored the very engine he had worked on as an apprentice. The 'Bring and Brag' had several entries, including a PCB cutting machine (photo 1), a bandsaw welding jig and a new project from Mike Sayers. Having eschewed Bentleys, after 20 years immersed in the details, he is making a 25:1 scale 1500 cc, eight cylinder, supercharged Delage of 1927. This car and engine won EVERY Grand Prix of that year, sometimes finishing 1st, 2nd and 3rd hence my reference to Louis XV in the introduction, as W. O. might have said,



Rocking 'horse' for Ivy. (Photo courtesy of David Proctor.)

"Après moi, le Délage". There are 21 gears in the engine, which determined the scale of 25:1. I also liked David Proctor's rocking 'horse' in the shape of an aeroplane for his granddaughter, Ivy. That's neat! (photo 2).

W. www.bisarchtest.wordpress.com

The Aylesbury Link, autumn, from **Vale of Aylesbury Model Engineering Society**, has Chairman, Bob Jones, thinking 'aren't headshunts useful?' when locomotive failures occur. Chris Wilson has built an unusual model, a 7¼ inch gauge GWR 'Siphon' circa 1905, at a cost of about £350 and taking some weeks. The April Chairman's Cup was won by Chris for his model B1, still in build, as designed by Michael Breeze. Sheila Rapley gained the Ladies' Prize for her Gypsy caravan and a Mr. Onslow showed a skeleton anvil, horseshoe, blacksmiths' cap and a pair of clogs, all in steel. Clive Ellam describes a 1950s drawing office at AVRO (A.V.Roe & Co.), one of the largest in the country, containing about 400 draughtsmen plus support staff. So large, in fact, that on foggy days, the visibility was compromised and the noise level was 84dB! (That means ear defenders today!) A drawing office! Furthermore, it was haunted. The ghost of Roy Chadwick, legendary designer of the Lancaster, walked abroad. Sister company, Armstrong Whitworth were designing the *Argosy* freighter and it was noticed that the wing was very similar to that of the Shackleton. Some parts were originally designed for the Avro Manchester of 1938. How's that for value for money? Roy Urquhart built a Stroudley Terrier, 32661, as that was his first locomotive 'spotted'. He intended to build it for little expenditure and so far the most expensive item has been the paint.

W. www.vames.co.uk

Stamford Model Engineers Society newsletter, October, says that members were welcomed to John

Hennessey's home to see his collection of automata., some of which he made himself. They varied from being quite basic though nevertheless entertaining; to those of breathtaking complexity. There are videos on YouTube under David Roentgen, the Jaquet-Droz family and Leopold Lambert. Modern automata kits can be obtained from Maurice Feely in Leeds, or Timberkits (usual disclaimer). Sad news, the Hampshire Narrow Gauge Railway Trust is to close, due to problems with their site and the effects of Anno Domini on its membership.

The Cam, October, from **Cambridge & District Model Engineering Society**, has Helen (co-editor) building *Helen (Of Troy)*, the locomotive and ranting about those who know being condescending to those who don't. We all had to start at the beginning, none of us were born with experience or ability, so please accept that there are no silly questions if you don't know. (One note if I may – try Googling it first – Geoff) Co-editor, Tim Coles writes on the Bass railway in Burton on Trent. A total of 26 miles of track weaved around the town centre, connecting breweries, stores etc. and moving over 1,000 wagon-trips per day. Tim provides a map of Burton in 1926. Now, it has nearly all gone and is almost undetectable on Google Earth. Several photos of the civil engineering for the new carriage shed are printed, accompanied by the fact that the driver who delivered the steelwork said his employer had gone into administration that very morning.

W. www.cambridgemes.org.uk

MEEA Newsletter, October, from **Model & Experimental Engineers, Auckland**, says that their 80th meeting took place in September. Ken Pointon has built over 150 windpumps for his day job over the years and still makes the odd one. A brochure says that four sizes were available with wind wheels up to 14 feet in diameter. As an



Henley Solon plastic welding tip. (Photo courtesy of Graham Astbury.)

adjunct to Ken's humorous and informative talk on the subject recently, Murray Lane has been asked to rebuild a mill given to Howick Historical Village. After prowling around its location for some time, it was eventually located in an overgrown pile of scrap. When the bits were recovered and laid out, it was found to be uneconomic to repair, a new one would be cheaper. It was also estimated to date from the 1920s, rather too recent for its intended venue. The Stuart twin compound launch engine proceeds, with the odd hiccup, such as a cored hole being blocked. Wasn't it inspected prior to sale? Michael Cryns is working on a watchmaker's clock, very accurate (a few seconds per week) and of massive construction.

Founder member of the **Henley Solon Owners Club**, Graham Astbury, writes of his success in wrestling from the grip of his fellow BMES members at a recent club sale, a glistening nugget amongst the dross, a Henley Solon iron. It had a plastic-welding tip in stainless steel, possibly home made by its previous owner. Now he will be able to construct those many Far Eastern electronic kits which need 'welding' (according to the instructions) rather than soldering... He could scarce contain his excitement and had to put together a Meccano project as therapy. This gem cost an arm and a leg (£1) but

we Tykes can spot a bargain (photo 3).

As luck would have it (after not THAT much prestidigitation with the newsletter pile...) **Bradford Model Engineering Society's Monthly Bulletin** for November, informs us of the talk by Godfrey Wormald and the showing of a film, on the restoration of a 14 foot diameter by 12 foot wide water wheel at the Innovation café, Hebden Bridge. Godfrey managed to source an axle, which had previously been a ship's drive shaft, from the Isle of Man. Then on 2nd October, a talk on hydraulic power. There was a recent Symposium on Joseph Bramah *et al*, in Sheffield, which I wrote up separately and will publish (Editor permitting) in another issue of *M.E.* The water power for the hydraulics drew on the pressure in the public water mains and was used extensively in Newcastle industry and the docks tower at Grimsby was built as a power source for the dock hydraulics, since the flat land offered no topographical advantages. Another tower in nearby New Holland had no stable foundations to build on, so an accumulator was built in to increase the pressure, ultimately to 750 psi, the town mains providing only 80-100 lbs. Road Vehicle News concentrates on the smaller examples on our roads, finding a nice Ford Model



Morse key by Chris Robinson at York. (Photo courtesy of Roger Backhouse.)

'T' pickup, which was very popular. Basic, but reliable and tough. The unfortunate Sinclair 'C5' is mentioned and David Jackson wonders why it was singled out for criticism when recumbent bicycles (and tricycles? Ed.) are just as easily overlooked and are not so attacked.

W. www.bradfordmes.co.uk

York City & District Society of Model Engineers sent *The Newsletter*, November, in which Editor Roger Backhouse says that the AGM was 'remarkably harmonious'. *Ooh, err, I say, steady on!* In respect of track relaying, Robert Ruston was congratulated on loosening 35,000 screws. (One hopes that he also tightened them up again, or I'm not riding on your track! – Geoff.) It was noted that over 40% of the membership had helped in some practical way over the year. Model of the Month featured Len Mills and his traction engine, L. C. Mason's *Minnie*. Len's models are so well made that one may think he was a trained toolmaker, but nay! He did his national service as a tank mechanic and only narrowly escaped the Catering Corps. 'Not' the Model of the Month was a superb brass Morse key made by Chris Robinson entirely from scrap (**photo 4**). The contacts are from car thermostats, the knob is from a glider, bearings from an air brake system and the base from miniature submarine battery skids. He

worked for many years at Slingsbys (good job it wasn't Martin-Baker...) and says his key is a tribute to Duraglit.

W. www.yorkmodelengineers.co.uk

B&DSME News, October, from **Bournemouth & District Society of Model Engineers** has Chairman, Peter Burton, reporting that the survey forms distributed recently have given rise to no adverse comments, from which he infers that members are happy with the state of the Society and its progress. Chris Bracey visited Eastleigh

Lakeside Railway's Great Central Gala, at which three Great Central locomotives, all built separately, had never run together previously in public. Being 10¼ inch gauge may have something to do with it.

W. www.littledownrailway.co.uk

The Link, November, from **Ottawa Valley Live Steam & Model Engineers**, tells how President, Len Winn, made a 3½ inch scale *Virginia*, with greater success than his previous model. LBSC designed an earlier model, CPR 285 (photo in *M.E.* November 1956) so Len aimed for his to resemble the latter. Phase 3 of the new line (after the landslip) has been completed; two more to go!

W. www.ovlsme.x10host.com

Port Bay Express, November, from **Portarlinton Bayside Miniature Railway**, has Ron Griffiths describing growing up near a busy station and he often watched the footplate crew as they potted about the yard in their Victoria Railways 'D3' (small 4-6-0). One day, he was invited up and, finding he was enthusiastic, was invited back again and again. After being allowed to drive, he asked why one side

of the locomotive seemed to 'set off' earlier than the other. 'Because she has a million miles under her' laughed the driver. A highlight was being on board when pushing loaded wagons up the coal stage for coaling the engines below. Very steep and very short, a delicate touch was required or they would join them! Member, Brian Coleman wrote a book in 1978, *DARTS*, detailing all 70 railway and tram societies in NZ and Australia. He is now Vice President and newsletter Editor of the PBMR, not that the one led to the other...

Passenger numbers continue to rise; October by 164% and 65% on the year.

W. www.miniaturerailway.com.au

This is Joseph Bramah's improved fire pump: note the air chamber at the top, which evened out the flow (**photo 5**).

And finally: Narcolepsy - falling asleep randomly
Anarcholepsy - falling asleep during a left wing polemic.

Contact:
geofftheasby@gmail.com



Bramah's improved fire engine at Sheffield's Kelham Island museum.

JANUARY

- 1 Plymouth Miniature Steam.** Members' day, 10.30am onwards. Contact Rob Hitchcock: 01822 852479.
- 3 North London SME.** Members' videos, slides and photographs. Contact Ian Johnston: 0208 4490693.
- 7 Brandon DSME.** Meeting at The Ram Hotel, Brandon, 7.45pm. Contact Mick Wickens: 01842 813707.
- 7 Romney Marsh MES.** An evening with Andy Nash, 7.30pm. Contact Adrian Parker: 01303 894187.
- 8 Bradford MES.** Bits and pieces evening, 7.30-10pm, Saltaire Methodist Church. Contact: Russ Coppin, 07815 048999.
- 8 Leeds SMEE.** Members' current projects. Contact Geoff Shackleton: 01977 798138.
- 15 Bristol SMEE.** Talk: 'TSR2, the Grandfather of Tornado' – Jock Heron. Contact Dave Gray: 01275 857746.

- 14 Romney Marsh MES.** Members' social afternoon, 2pm. Contact Adrian Parker: 01303 894187.
- 17-19 London Model Engineering Exhibition,** Alexandra Palace. See www.meridienneexhibitions.co.uk/events/london-model-engineering-exhibition
- 21 Romney Marsh MES.** Talk: 'The Silver City Story' – Paul Ross, 7.30pm. Contact Adrian Parker: 01303 894187.
- 22 Leeds SMEE.** Meeting night – 'The First Train in Spain from Warrington' – Richard Gibbon. Contact Geoff Shackleton: 01977 798138.
- 28 Romney Marsh MES.** Members' social afternoon, 2pm. Contact Adrian Parker: 01303 894187.

FEBRUARY

- 4 Romney Marsh MES.** Talk: 'Judging Models at Exhibitions' – Harry Paviour, 7.30pm. Contact Adrian Parker: 01303 894187.

- 5 Brandon DSME.** Meeting at The Ram Hotel, Brandon, 7.45pm. Contact Mick Wickens: 01842 813707.
- 5 Bradford MES.** Film evening, 7.30pm, Saltaire Methodist Church. Contact: Russ Coppin, 07815 048999.
- 5 Leeds SMEE.** Meeting night – 'Drill Sharpening' – D.A.G. Brown. Contact Geoff Shackleton: 01977 798138.
- 11 Romney Marsh MES.** Members' social afternoon, 2pm. Contact Adrian Parker: 01303 894187.
- 15 Brandon DSME.** Running day. Contact Mick Wickens: 01842 813707.
- 18 Romney Marsh MES.** Talk: 'Narrow Gauge Railway Visits' – Mike Jackson, 7.30pm. Contact Adrian Parker: 01303 894187.
- 19 Bristol SMEE.** Talk: 'Robot Bodies and How to Evolve Them' – Alan Winfield. Contact Dave Gray: 01275 857746.
- 19 Leeds SMEE.** Meeting night – 'Three Short Model

Engineering Topics' – Members. Contact Geoff Shackleton: 01977 798138.

- 25 Romney Marsh MES.** Members' social afternoon, 2pm. Contact Adrian Parker: 01303 894187.
- 25 Wigan DMES.** Presentation by Mr Dean Patterson on 'What We Can Learn from the Nuclear Industry'. Contact: wigan_mes@aol.com

MARCH

- 3 Romney Marsh MES.** Talk: 'Update on Clan Line' – Colin Clark, 7.30pm. Contact Adrian Parker: 01303 894187.
- 4 Bradford MES.** AGM, 7.45pm, Saltaire Methodist Church. Contact: Russ Coppin, 07815 048999.
- 4 Brandon DSME.** Meeting at The Ram Hotel, Brandon, 7.45pm. Contact Mick Wickens: 01842 813707.
- 4 Bristol SMEE.** Themed topic evening on model turbine building with John Beddis. Contact Dave Gray: 01275 857746.

- **Pepperpot Locomotives**
Martin Ranson describes a pair of 32mm vertical boilered locomotives.
- **Boiler Feed Pump**
Ian Couchman presents a new design of steam pump for his 4 inch Ruston Proctor traction engine.

- **Wallis Advance Steam Roller**
Alan Barnes takes a look at the Wallis Advance steam roller and concludes that it would make a fine subject for a model.
- **Bradford Exhibition**
Roger Backhouse takes a trip to Saltaire to visit the Bradford society's exhibition.

Content may be subject to change.



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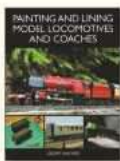
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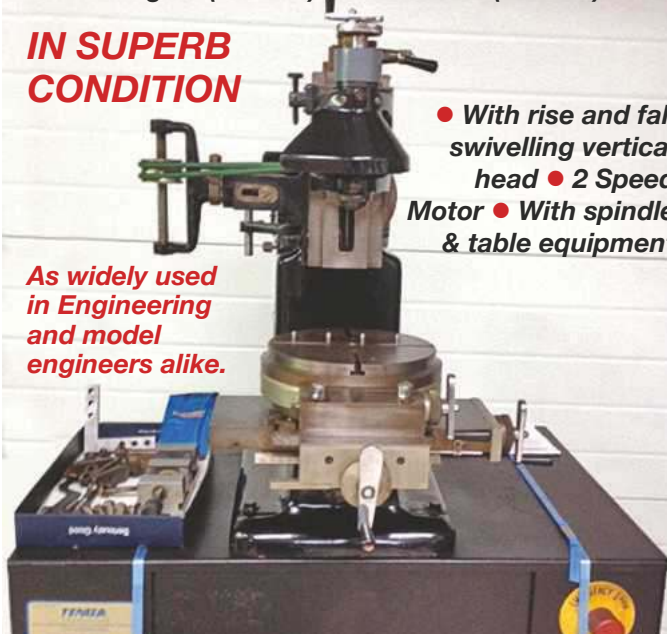
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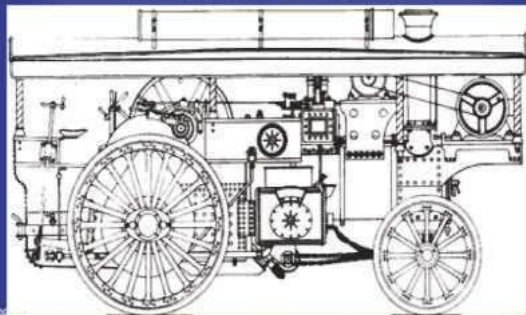
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