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MODEL ENGINEER

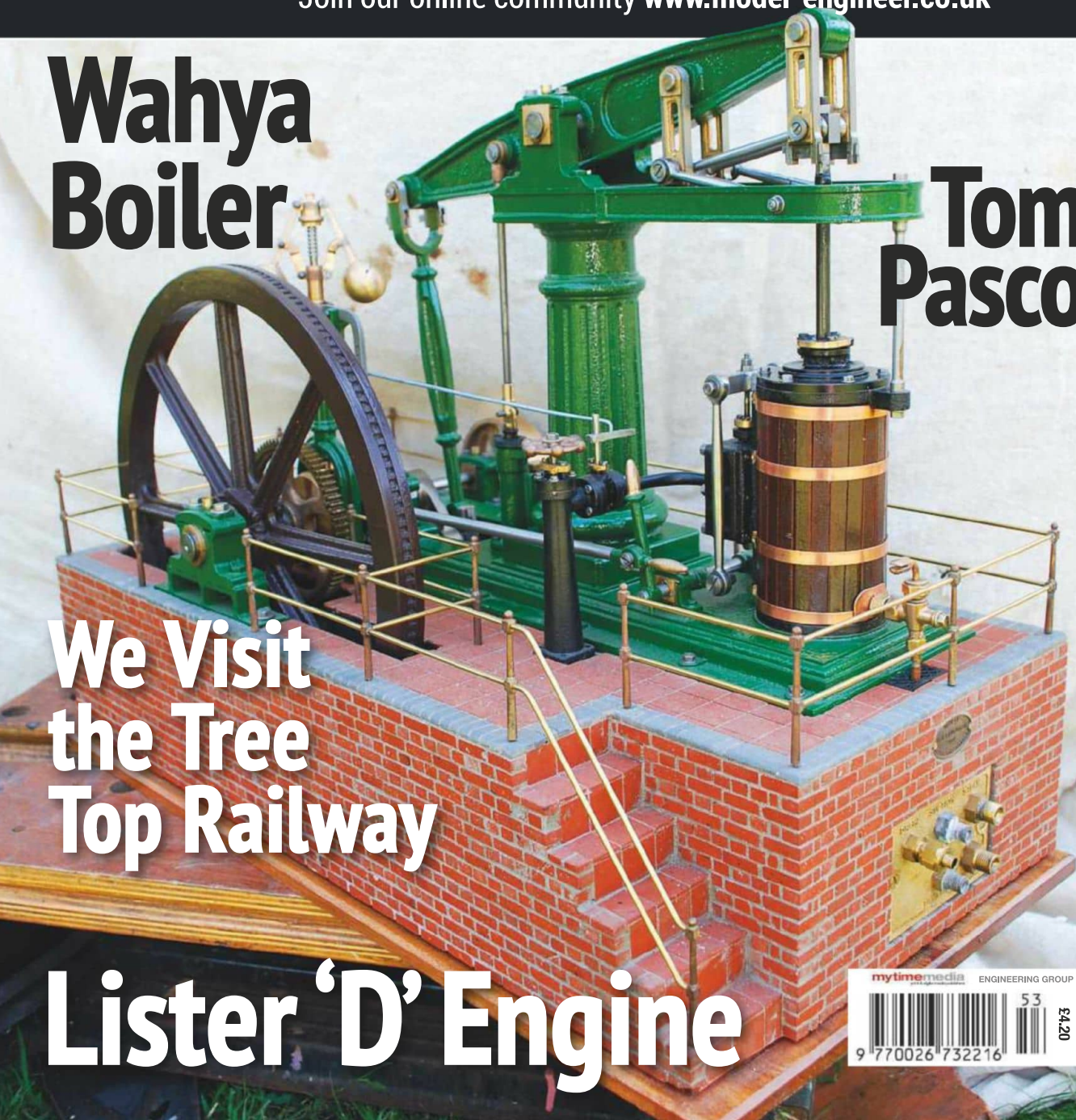
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749

758

ISSUE IN THIS ISSUE IN THIS ISSUE IN THIS ISSUE

Vol. 225 No. 4653 4 - 17 December 2020

728 SMOKE RINGS

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

729 WE VISIT THE TREE TOPS RAILWAY

John Arrowsmith checks on progress in Buckinghamshire.

733 GRASSHOPPER HAULAGE ENGINE

Stewart Hart makes a model of a haulage engine displayed in the Manchester Museum of Science and Industry.

736 WENFORD

Hotspur takes up the ongoing story of Wenford, his 7¼ inch gauge Beattie well tank.

740 POSTBAG

Readers' letters.

743 OBITUARY

Mike Sayers celebrates the life and work of Tom Pasco, designer of original and innovative internal combustion engines.

744 A HALF SIZE LISTER 'D' STATIONARY ENGINE

Daco describes the construction of his own version of this well-known engine.

746 THE STATIONARY STEAM ENGINE

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

749 WAHYA

Luker builds a freelance 5 inch gauge model of a typical American 4-4-0 locomotive.

754 150 YEARS OF THE QUARRY HUNSLY DYNASTY

Mark Smithers celebrates 150 years of one of the best known small locomotive manufacturers.

758 'BRITANNIA' CLASS 7 LOCOMOTIVE IN 5 INCH GAUGE

Norm Norton rebuilds a Modelworks 5 inch gauge 'Britannia' locomotive.

763 PETROL ENGINE AND ALTERNATOR SETS

Jon Freeman investigates the design of efficient petrol-electric locomotive traction systems.

766 THE MAKING OF HILARY JANE

Peter Smith fulfils a long-held ambition to build and steam his own locomotive, with Polly's help.

770 CLUB NEWS

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

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<http://twitter.com/modelengineers>

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ON THE COVER...

Ian Couchman's Model Engineer beam engine. The plinth is constructed of individual bricks and terracotta tiles (photograph: Ian Couchman).

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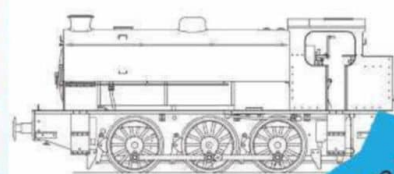
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These tools use the industry standard 16mm 'laydown' 3-edge inserts. With tough, tungsten carbide inserts, coated with TiAlN for wear resistance and smooth cutting, threads can be cut at very slow speeds if required. Tools are right hand as shown. 55° or 60° insert not included - order separately at £5.65. See our website for more info.

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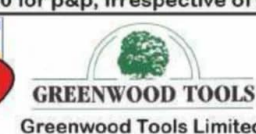
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Other books by Alex Weiss are:



Building Small Boilers for Gas Firing • Weiss • £10.20

In this popular book Alex Weiss describes how to make small gas fired copper boilers which can be soldered in one go. 'Small' in this instance means a capacity of under three bar/litres. Huge amount of useful information for the beginner, but the more experienced will find the background information useful as well. **This MUST be ordered on our website**

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In this best-selling book Alex looked at the various methods of getting that 'right' finish on metal, be it for fit, or aesthetic reasons. Included are 10 chapters covering: Grinding, Sanding, Buffing and Polishing, Honing and Lapping, Reaming, Bore grinding, Burnishing and Scraping, Bare Metal Finishes (these include plainishing and peening, chasing and repoussé, engraving, knurling, oil or grease coating, other rust barriers and etching), Metal Colouring and Painting. Whilst you will not learn every last-thing on these subjects from this book, there is a huge amount of relevant information here, useful for any model engineer. Paperback, full of B&W photos and diagrams, plus a listing of useful contact and suppliers.

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and - by another author and a skilled filmmaker:

Step by Step Metalwork 3 Weiss • £25.30

First published in 1972, when the author was in Charge of Metalwork at Manor Court School in Portsmouth. This volume was aimed at more experienced pupils, and contains drawings and full building instructions for a low-pressure stationary steam unit, and a simple traction engine model. In building either you are instructed in working sheet metal, soldering, simple lathework, filling, folding, tapping and threading, annealing, flanging, silver soldering, pattern making, molding and much, much more. 94 landscape A4 format pages, with considerable number of drawings, and B&W photographs. Spiral bound with acetate outer covers.

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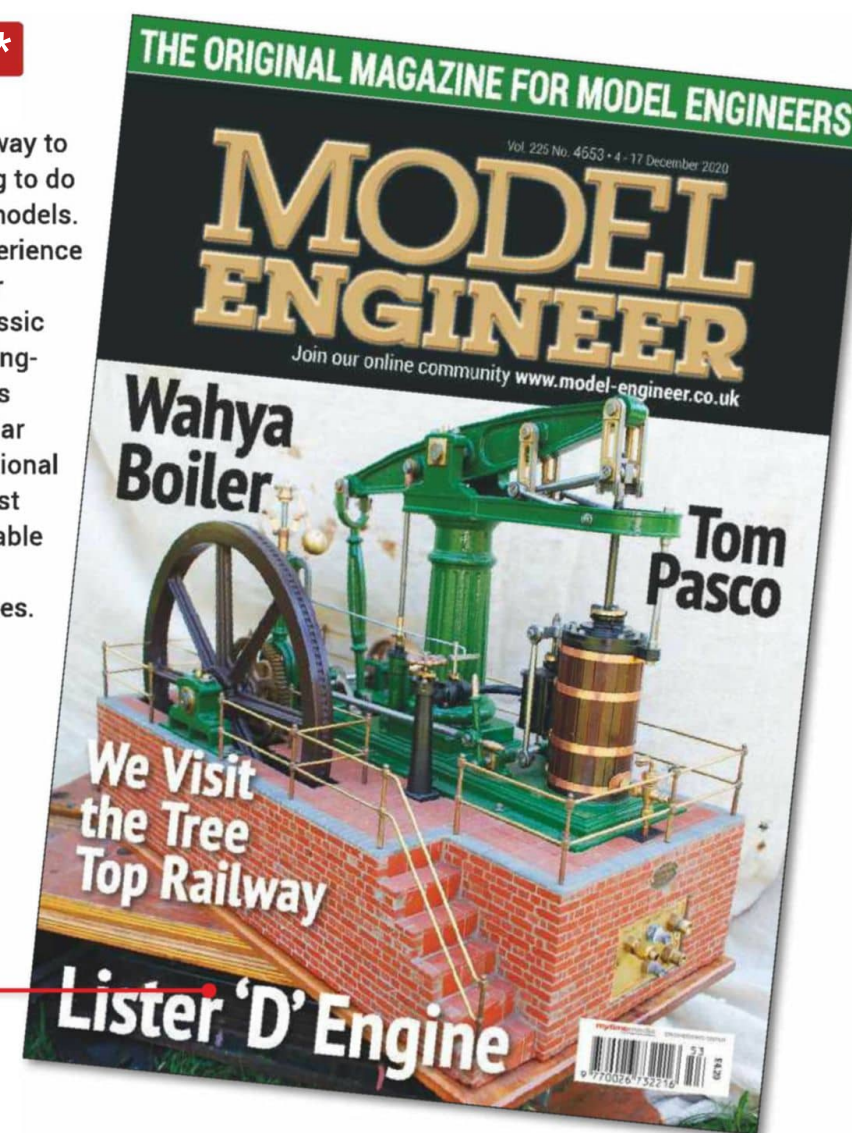
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Lockdown II

As you read this our (mercifully) fairly brief second lockdown should be over.

I imagine that you, like me, probably handled this second spell of confinement rather better than the first, having already had plenty of practice at it. As before, I made good use of the extra time in the workshop and my GWR pannier tank is now almost complete. All major parts are now made and even painting has been started with the cab looking a lot more cab-like, in grey primer. The chassis is already painted (long ago) and the tanks and smokebox await the application of paint. The smokebox needs a trip to my friend's sand blasting cabinet before paint goes anywhere near it though, which will have to wait until after lockdown. Once a set of gaskets comes back from the laser cutters final assembly will begin in earnest!

Another good use of this lockdown period would have been to contemplate the approach of Christmas. As you read this we are already into Advent and Christmas is only three weeks away. So perhaps you have been making your lists of Christmas presents. Those of you who are ultra-efficient will already have a complete list and packages will be arriving daily from Amazon. If you are one of those people you can stop reading now. The rest of us though are still scratching our heads, wondering perhaps what to get for the model engineer in the family.

Well, during lockdown I have had more time for idle pursuits and I have found the ideal thing. We model engineers live in a miniature world so how about a book about miniature things? Here it is – *In Miniature* by Simon Garfield, subtitled *How Small Things Illuminate the World*.

This is a hugely entertaining, informative and philosophical book. In the words printed on the front flap, this book

'teaches us that there is greatness in the diminutive', something which, as model engineers, we of course already know. Mr Garfield takes us on a tour, a sort of 'mini-break' perhaps, to a varied series of destinations in the miniature world. These include an Eiffel Tower made of matchsticks (don't worry, it gets better...), the greatest model railway in the world, Lutyen's royal doll's house, warfare in miniature and, smallest and strangest of all perhaps, the flea circus. Sadly, it doesn't explore the subject of nanotechnology – something for volume II perhaps.

Rather appropriately for Christmas, this book strikes me as rather like a box of very fine chocolates, both light and dark, and with both hard and soft centres. These delights range from Father Ted's explanation of scale and perspective ('Dougal, these cows are small; those cows are far away') through Wilberforce's use of a wooden boat model to persuade Parliament to legislate against the slave trade, to Mrs Frances Glessner Lee's rather gruesome dioramas of 'unexplained deaths'.



I don't know if the book is available in large print (surely not...) but it is available in both printed and digital editions or as downloadable audio.

In Miniature by Simon Garfield
ISBN 978-1-78689-077-1
£14.99, 289 pages
www.canongate.co.uk

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.
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Back Issues

If you are interested in back issues of *Model Engineer* then the usual source of these is mags-uk (www.mags-uk.com). However, they are likely only to be able to supply fairly recent issues – in fact I note that stocks of *Model Engineer* there only go back about a year. Online auction sites like eBay are good places to look but I'd like to highlight two retailers that have considerable stocks of older and even historic issues of our magazine. They are TEE Publishing (www.teepublishing.co.uk) and The Engineer's Emporium (www.theengineersemporium.com).

While we're on the subject of back issues, we are still looking for copies of issues 4635, 4636, 4637 and 4641. As before any offers should be addressed to Beth Ashby on 07739440641.

We Visit Tree Tops Railway

John Arrowsmith ventures into leafy Buckinghamshire on a summer's day.



The beautiful lake around and across which the railway will run.

I visited this fledgling railway in August on one of those very hot '30 degree plus' days, following an invitation from the organiser, Peter Dickson to come and see them. This small group of model engineering and railway enthusiasts

are building a superb 7¼ inch gauge railway in the grounds of a private house in rural Buckinghamshire which, hopefully, will provide a working base for the introduction of young people into the world of both model engineering and railways. The organisers have a passion not only to build a railway for themselves, but to construct a railway that will deliver education and enlightenment for young people. The location will provide an environment that is safe and, importantly, encouraging in order to foster the interest of youngsters as they venture into our wonderful hobby. In addition, of course, they hope to provide a railway that will incorporate all that is best in design, build and operating procedures for their own benefit, as well as to demonstrate to younger members that embracing

these ideals can increase their opportunities in the world of full size as well as miniature railways.

The infrastructure being built into this railway is of the highest standard and will result in a very special place to enjoy this form of model engineering. The whole layout has been planned to make maximum use of the space available which will result in a railway about a mile long around the main circuit (photo 1). Additional sidings and a branch line will add interest to the overall operation. One of the main features of this new railway will be the steel bridge over the lake (photo 2). When I tell you that the foundations for this bridge are impressive - 3 metres long with a 45cm section, weighing in at one and a half tons each and were placed into position by specialist divers - you can



Scaffolding and supports for the new bridge await the installation of the steelwork.



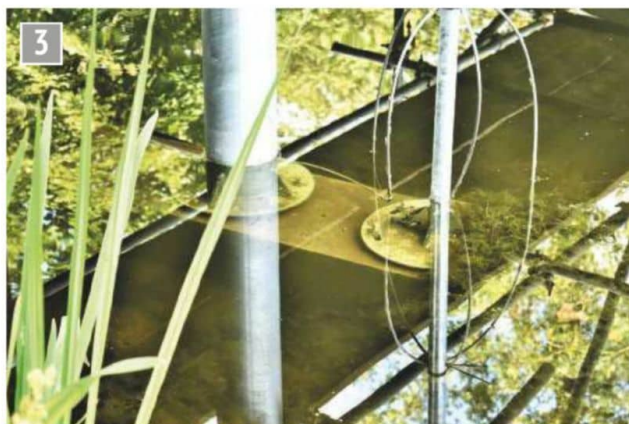
MARTIN EVANS
Editor



DIANE CARNEY
Assistant Editor



YVETTE GREEN
Designer



Large sunken concrete bridge supports already installed.



New steel sections for the bridge deck.



The control signal box and approach to the main station.



Two platforms in the main station.



Site of the branch station terminus and access to the lake.

see this is a serious railway structure (photo 3). Deck steel comes in at 305 x 127mm and with ten of those beams in place it will, when completed, be quite a sight to see (photo 4). The foundations are in place and all the steelwork is on site ready for installation. The bridge, which will be about 90 feet long with a 70 foot radius, will be on the main track circuit which runs around the perimeter of the site, crossing the main entrance into the land before passing through a large station, complete with its own signal box (photos 5 and 6). A spur line will take passengers to another terminus station in the middle of the site adjacent to the lake (photo 7) where they can alight from the train and then, perhaps, enjoy a short

boating experience on the lake.

Much of this trackwork is already in place having been built on site by the group over the last 12 years. Some excellent point work was also on show. Substantial buildings for both the storage and maintenance of stock is well established (photos 8 and 9) along with a large and comprehensive workshop (photo 10). All have rail connections which is going to be a real advantage when trains in regular use need maintenance etc. All the usual railway features are yet to be constructed but the sites for the engine shed and turntable, together with additional signal boxes, are already pegged out (photo 11). It is proposed that the four road engine shed will be similar in build to that from



A neat level crossing feature alongside one of the main railway sheds.



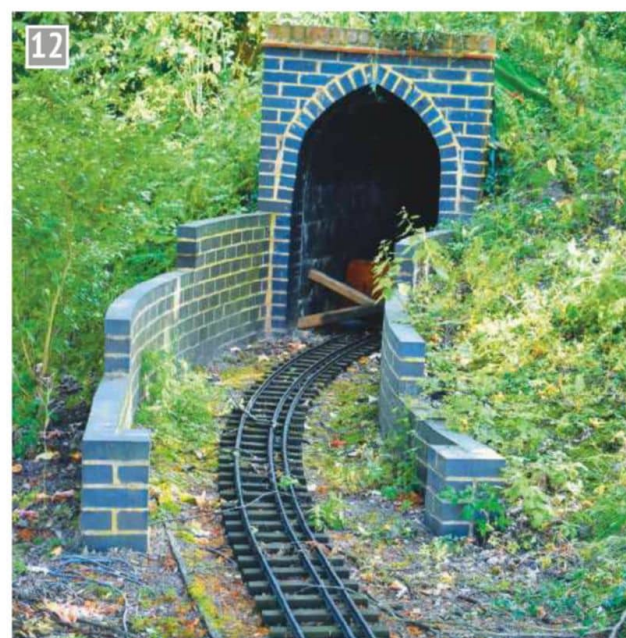
Another view of the excellent storage facilities at the track.



A trusty Colchester Bantam lathe in the workshop.



The site of the new four road engine shed.



Fine brickwork on the tunnel entrance.

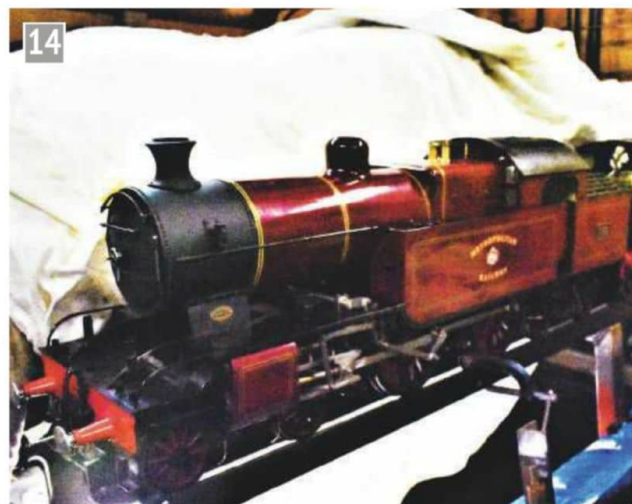


Substantial steelwork for the turntable and storage sidings in one of the sheds.

the old Garden and Woodland Railway of the late Ted Martin in Thame. That has a sunken floor level so that drivers and fitters can get to the underside of their engines easily without having to lie on the ground or have precarious elevated sections of track in order to

attend to problems etc. This will be another secure and substantial building which may also have additional storage capacity for the line.

An unusual feature of this railway will be the tunnel (photo 12) incorporating a point so that a change of



A rare model of a 4-4-4 Metropolitan tank locomotive.

direction will be able to take place inside the tunnel. Not many clubs have one of these on their sites!

This small group of eight members hope to have the main circuit finished in the next twelve months. When you look at the amount of work still to be completed that is quite a target but, with the enthusiasm I encountered at my visit, I fully expect that to happen.

Moving on to the various storage and workshop facilities on site I was impressed by the standard of buildings being used for these purposes. One of the main sheds has a very substantial approach track which incorporates a turntable (photo 13) enabling these large 7¼ inch gauge engines to be easily positioned inside without any need for lifting or other weight taking equipment. In one shed alone there was a 7¼ inch gauge GWR 47XX 2-8-0 alongside a 5 inch gauge 4-4-4 Metropolitan Tank engine (photo 14), a 5 inch gauge 0-4-2 Ajax (photo 15) and 5 inch gauge Sweet Pea all in working order. In the main workshop area, a 5 inch gauge 2-6-4 locomotive was in the final stages of assembly and was accompanied by a mock-up of the valve gear (photo 16) which had been built to a computer generated model by Don Ashton. New cylinder castings have been produced (photo 17) with

greatly improved passageways so that, when complete, this locomotive should have plenty of power to tackle the various gradients on the main track.

In concluding my notes on my visit to the Tree Tops railway I would like to thank Peter Dickson and Dave Alexander for their time and patience on a very hot day and to say I enjoyed my visit very much. This is certainly a railway to look out for in the future. Their aim to construct something that will encourage the younger generation is to be very much applauded and, indeed, it is attracting the attention of both Network Rail



The 5 inch gauge 0-4-2 Ajax locomotive in the shed.

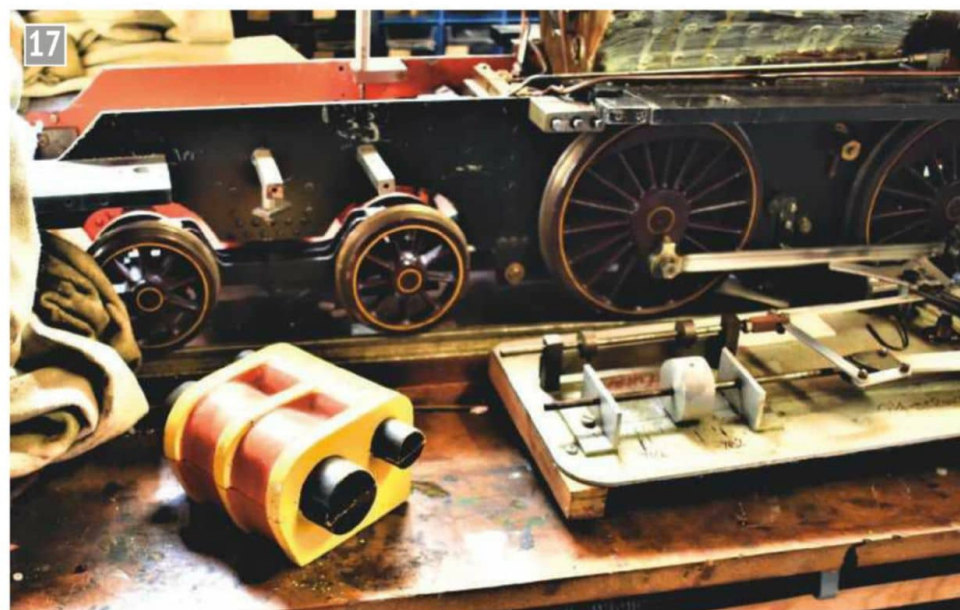


The 2-6-4 locomotive and trial gear system.

and the heritage sector along with the STEM education program available in some schools. I for one look forward to visiting them again in the not too distant future when hopefully the development

will have progressed and many young people will have begun their introductions into the rewarding world of model engineering.

ME



One of the new cylinder patterns for the 2-6-4 locomotive.



A trilogy of engines.

Stewart Hart completes his trilogy of stationary engines with a grasshopper haulage engine.



Continued from p.682
M.E. 4652, 20 November 2020

PART 8 - VALVE LINKAGE

Grasshopper Haulage Engine

Valve linkage assembly

We start with the valve lever bracket (fig 12). This is made from a piece of 1 inch square mild steel box section, that will require silver soldering or, as

the part is not stressed, you could use soft solder. Cut off a 50mm length of box section and cut it down the middle length wise, then file or mill the bottom face flat (photos

77 and 78). Drill 6mm right through both sides to take the steel bush and drill the four 2.2mm bolting down holes (photos 79 and 80). Turn up a bush 34mm long, 6mm outside



1 inch box section cut to size.



File or mill base flat.

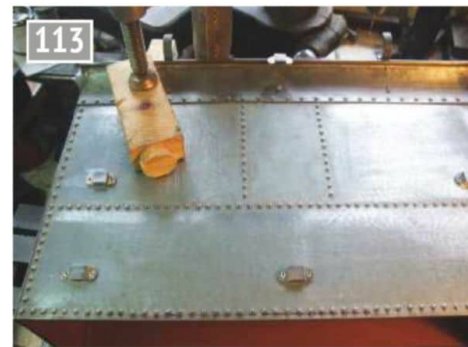
a small clamp and pieces of steel, see **photo 112**. The joint surfaces were cleaned and the bunker was given a small dab of super glue so the bracket could be placed in position (the right way round). Allowing a few minutes for the glue to set, the second hole was spotted through but do be aware that super glue can come adrift with a slight impact.

The rivets were shortened to $\frac{5}{32}$ inch long and added from the inside with tweezers to be swaged into the shallow countersinks. Each rivet was held on a wide steel support bar to carry out the closing down process and a small punch was also found useful. A small file was used to tidy up the result where required. This process was repeated for the three lower brackets but for the top two positions the distance down from the top of the bunker is much greater so, to avoid any damage, some wooden packing was used to hold the single rivet in place; see **photo 113**. Adding the rivets for these two brackets was a struggle as the confines of the coal space makes sighting the holes difficult. **Photograph 114** shows the final result.

The last of the bunker brackets in this style is the central one at the top of the curved sheet and it is fitted in a similar way to the fire iron brackets. Again, it consists of a plate which has rounded ends with a channel section soldered to it to produce the slot and a parallel stem that is curved



112 This picture shows the first off-set rivet hole drilled and the rivet held up from underneath with a small clamp and pieces of steel packing for one of the lower brackets.



113 The two upper brackets were more awkward and a larger clamp and wooden packing was used to hold the rivet in place. Here the brackets are ready to be riveted to the bunker on a stout steel backing bar.



114 All the rivets have been carefully peened down here and in some cases a small punch was needed to get them flush.



115 The central lamp bracket has been cut out with the channel silver soldered and the slot for the blade opened out to ensure it is functional.

to fit against the inside of the bunker top plate. Conveniently, on my original drawing for the water filler casing, I had put a small slot at the back to allow this lamp iron to be offered through and a 10BA bolt holds it in position. This bracket started out as a flat plate from 18SWG stainless steel and the corners were formed with the profiling gauge used for the first five parts but the upper

edge is blended into the $\frac{7}{32}$ inch wide stem.

Adding the inverted channel section and cleaning out the slot followed the practice described earlier; see **photo 115**. Now the stem of the bracket needs to be formed over a piece of $\frac{3}{16}$ inch steel plate which has a full radius on its edge and **photo 116** shows the bracket plate held against the steel plate with

two toolmakers clamps ready for the bending operation. The steel plate was then held sideways in the vice to form the curved stem of the bracket with a pair of small plain jawed pliers as shown in **photo 117**.

Drilling the hole for the 10BA bolt was straightforward enough but only one fixing seemed feasible initially and **photo 118** shows the central bracket in place with

a conversion blade fitted. However, on the final assembly, it was realised that a single bolt would not be sufficient so a further 10BA hole was spotted through from the outside of the curved bunker plate and the bracket was drilled for a second bolt to ensure the part did not work loose. **Photograph 119** shows the bunker primed and undercoated showing all the brackets in place.

Those who are building the later version of the Beattie tank will need the design for the more modern lamp bracket for the bunker and I have included

this outline on my drawing; the shape is similar but with an upward tail that is given an off-set of $\frac{1}{16}$ inch for the lamp. Here I have suggested the fixings should be $\frac{1}{16}$ inch diameter snap head rivets and, from what I can deduce from the information available, the holes should be at the same pitch as the original slotted mountings. A picture of the bunker of one of the preserved Beattie tank prototypes is given here as an illustration of these later lamp brackets - **photo 120**.

●To be continued.



118 The top bracket in position but only one bolt added.



119 The outside of the rear bunker primed and undercoated with all the early design of lamp brackets fitted.



120 The bunker plate on a preserved well tank showing the later lamp brackets. (Image courtesy of David Aitken.)



116 Here the central lamp bracket is being formed over a steel plate which has been given a $\frac{3}{16}$ inch radius.



117 Now the steel forming plate is held horizontally and the tail of the bracket formed with small plain nosed pliers.

No.299

Look out for the December issue:

MODEL ENGINEERS' WORKSHOP



John Garnish offers advice on accurately drilling holes across a diameter.



Laurie Leonard fits new bearings to a Tom Senior Milling Machine.



Stewart Hart improves a pan folder.

Pick up your copy today!

Prostate Cancer

Dear Martin,
The article by Roger Backhouse in *Model Engineer* (M.E.4648, 25th September) gave me the needed fillip to write this letter.

Colonoscopies are often something to be derided or avoided. They are just as necessary as one ages as PSA tests. In any case, when I came into my fifties my doctor recommended that I start having them. Since I find it unwise to argue with people who have the authority to stick needles into me, I agreed. Some fifteen years later, after a routine colonoscopy and the removal of some polyps, I was asked to go to see the doctor. My heart was sinking but he greeted me with, "It's good news!". It turned out that the cancer had started in the mucous membrane of a polyp but had not yet managed to get into the rest of the body. I missed a case of colon cancer by about 1 mm according to the pathologist.

Model engineers of both sexes and their mates please note.

Best regards, John Bauer

Dear Martin,
I would like to echo the letter published from Stewart Hart on the subject of prostate cancer. I am 71 years old. My own diagnosis and treatment, starting four years ago, was almost exactly the same as his. I had hormone injections and radiotherapy, and have now had three years of good blood test results. My next test is coming up next week. I am very aware of how lucky I was that this cancer was detected and treated early enough to make a difference, and how the detection was entirely a matter of chance.

I expect that you are receiving quite a few letters on the subject. I just want to reinforce Stewart's final point that for the typical age profile of readers of this magazine, it is vitally important to get a PSA test, never mind about 'no



Trevor Shortland

Dear Martin,
I too was saddened to learn of the passing of Trevor Shortland and I much appreciated Dennis Herbert's comments in *Model Engineer* (M.E.4650, 23rd October).

I built my 7¼ inch 'King' – 6010 *King Charles 1* – from Trevor's drawings between 2006 and 2012. The detail that Trevor put into the drawings was absolute. Every dimension from the original drawings was scaled exactly even to areas that most of us would be guilty of rounding up or down to suit the materials we had in stock. There were a lot of 1/64ths in Trevor's drawings – a great perfectionist.

My own King's first outing was on a very wet Sunday in 2102 even before it was painted and even though it was still very stiff the potential could be appreciated as the regulator was opened. When the King was stripped and painted and put into service it was, and still is, a joy to drive.

Trevor's attention to detail in the areas of valve gear give the engine a very satisfying bark even when notched back and a turn of speed that is a truly amazing. It still holds our track speed record for exceeding well over its scale maximum speed. Everybody who has driven it has always been very complementary about its performance at our track and other sites that we have visited.

It is sitting on my bench now after the completion of some minor repairs to the superheater and even though it has covered over 2000 miles there is no wear on any of the parts outside acceptable tolerance.

When the virus has passed and we can get back on track it will resume its career here in Leyland. A true memorial to Trevor.

Incidentally without knowing about Dennis's loco when I built mine his loco number is just one different from mine – Dennis's is 6011 and mine 6010.

Vic Whittaker

symptoms'. By the time you have symptoms, it is too late.
Best regards, Paul Horth

STEN Guns

Dear Martin,
Peter King's letter (M.E.4647, 11th September) prompts me to offer some further information.

In 1941 Captain David Stirling, when setting up the Long Range Desert Group, required a short-range submachine gun. This was designed on the back of an

envelope and Captain Stirling was sent to Enfield Small Arms factory.

Major Reginald Shepherd designed the gun and Harry Turpin made the prototype. Harry Turpin was a well-known model engineer who, being a professional, was not allowed to compete at the *Model Engineer* exhibition. His loan model of a GWR 4-4-0 locomotive in 1935 or 1937 still sets the standard for model riveting.

The prototype was made and tested by firing a minimum of

rounds and completed in two weeks. When it was returned to the Ministry of Defence, the only criticism was the fitting of a hard wood front hand rest, Harry Turpin being a true craftsman.

The prototype was sent to Bassett-Lowke in Northampton for production.

A price of £25 each was charged and the first batch of weapons was delivered to the Scottish training camp within four weeks. The name is Shepherd, Turpin, ENfield – hence STEN.

The Long Range Desert Group became the SAS.

Regards, Paul Collyer

Dear Martin,
Having just got my latest issue of *Model Engineer*, I found the letter in the post bag section from Peter King regarding STEN guns very interesting.

Having served in the Corps of the Royal and Electrical Mechanical Engineers (R.E.M.E.) for 6 years from Oct 1974 to Oct 1980, it reminded me of what one of our platoon instructors told us during our basic training. We trained on three weapons. First was the L1A1, the 7.62mm self-loading rifle. The second weapon we trained on was the light machine gun, probably better known by our older readers as the Bren gun. The final weapon we trained on was the Sterling 9mm sub machine gun, which was a derivative of the old STEN gun. This fired the standard 9mm pistol cartridge. It had a three position safety catch – Safe, Rounds and Automatic.

Our instructor did however caution us to handle the weapon with care; if you had a full magazine on it (30 rounds) and, even if the weapon was on 'Safe', if dropped the shock of hitting the deck could chamber a round with inevitable consequences. It was always drilled into us that before we laid a weapon down that we should remove the magazine, cock the weapon at least three times to eject any unfired round that may be in the breech and then for inspection

port arms. What people tend to forget is that an unloaded weapon on its own does not kill; it is when it is fitted with a loaded magazine that it becomes a lethal weapon.

Regarding the STEN gun it was indeed a cheaply made weapon that was made by the thousands during and possibly after the second world war. It was made to serve a purpose and armed many thousands of both regular army personnel as well as many hundreds of partisans in France and other occupied countries during the war. The good thing about it was that it could also fire captured German 9mm parabellum ammunition which the Germans also used in both personal sidearms i.e. the Luger and Walther pistols and some of their sub machine guns or what they called a machine pistol. I don't know if any armies still use the STEN gun but the Sterling is probably still in use to this very day.

Yours sincerely, J. E. Kirby
(London)

Colonel Stephens

Dear Martin,
Peter King's story about his father, the powers-that-be and the railway gun (M.E.4645, 14th August) reminded me of a similar incident later in the war. (Then) LCDr Beattie commanded *HMS Campbelltown* in the St Nazaire raid. He was captured and his interrogator noted that the British must have really underestimated the strength of the caisson at the end of the Normandie dock to be satisfied with ramming it with a flimsy destroyer. At that moment there was a loud boom and the window came into the room. Bettie remarked that that should demonstrate that there had no underestimate.

There is also a connection with railways here. The King George V dock in Southampton is of the same design as the St Nazaire dock so Combined Operations HQ asked the owners, the GWR, to provide a set of drawings. The drawings were delivered in person by the chief civil engineer of the GWR. He said that he inferred that a descent upon St Nazaire was likely being considered and that the fewer people knew of the request, the better.

I have taken the liberty of attaching two pictures, one of restorations for the war museum and the other of work for the course. The 25 pdr trunnion nuts had been welded up and so I had to cut them off and provide new upper threads and nuts. (1 in BSF castle nuts were only available by the 1000.) The gash in the lower threads on the right is because the painter did not cover the holes and the paint had to be gotten out of the threads. The other photograph shows the metal parts of a nose gear assembly for a 200 lb UAV. (Having aluminium slide in aluminium was NOT my idea!)

Best regards, John Bauer

Railway Brakes

Dear Martin,
Just a short letter to say how much I have enjoyed Rhys Owen's series of articles on railway brakes (M.E. 4647, 11th September *et seq.*). The final part on air brakes and the Westinghouse triple valve was especially enlightening. As my Simmons-Boardman book on US Railroad operation and technology states, in a chapter on freight cars, 'the only one (item) that has some components which could possibly be called delicate'.
Mike Gray

Belt Sanders

Dear Martin,
I had the same problem as *Hotspur* (M.E.4649, 9th November) with hard spots in a dome casting. I was about to get the propane torch out from the garden shed to anneal the base flange when another idea occurred to me. Could my recently-acquired belt sander tackle the hard spots? A trial

run quickly showed that the sander could not only deal with the hard spots but, with careful handling, could do most of the shaping needed to finish the casting. This included the rounded base to fit the boiler barrel. Eye protection mandatory of course, and gloves advised.

Regards, Tim Coles (Elsworth, Cambridge)

'Glass' Cases

Dear Martin,
I note your article (M.E.4646, 28th August) on building dust cases for models.

I have done this in the past, but I have dispensed with the fuss of making a framework for mine. I have used the fact that chloroform is a great solvent for Perspex.

My method is to make the box sides and top as accurately and square as possible, and out of material 3-5mm thick. Perspex, if scored heavily both sides will snap reasonably cleanly,



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Responses to published letters are forwarded as appropriate.

leaving an edge that needs to be squared off by sanding or draw filing. These edges need to be finished off with fine sandpaper, which will help final polishing of the edges, using buffing compound and Brasso. It is most important that these edges are square and flat.

The next step is to mock up the box by holding it together with sticky tape. This will identify all the mating surfaces. Those surfaces that are going to butt up against each other then need to be sanded lightly so that they are translucent. This gives the chloroform a fine space to wick into.

The box is then reassembled using sticky tape on the outside in as many places to ensure that it is rigidly held. Once this is done, using an eyedropper, one with a cranked end is best, I then introduce the chloroform on the insides of all mating parts. The chloroform then is seen to wick into the joins and then melts the roughened surfaces so joining them together. Leave for an hour or two, remove the tape and polish.

The advantage of these boxes is that there is no annoying woodwork in the way but, if the joins are not perfect, the corners may still be painted. I have built a turntable cover and other items in this way.

Chloroform can be obtained from the chemist. Not a lot is needed. Once I explained the purpose for which I needed it, I was sold a small bottle. As it is highly volatile, I store the remainder in the fridge.
Regards, Chris Pattison (New Zealand)

Lubrication

Dear Martin,
Lubrication! SMOKE RINGS (M.E.4650, 23rd October), IS IT A TYPO ? Some unfortunate assumptions may be being made between the SAE and ISO oil specifications! Vic Whittaker clearly states SAE 220. Older engineers may use SAE numbers whilst others

might use ISO numbers and, due to some of the standard numbers being used for BOTH systems being the same, BUT for very different oils, problems occur. SAE10 is ISO32,(a light engine or hydraulic oil, ideal for lathes). We use SAE140 in some of the wash monster gear boxes, It's thicker than treacle at 15°C but runny(ish) at 90°C, sticks to almost anything, and trying to wipe it off your hands is nigh on impossible. So SAE220 could well be used on hot motion work. It is a standard heavy gear oil with the ISO460 designation, whilst ISO220 is SAE90, a much lighter gear oil. I'm not a lubes expert and these numbers are from memory!

On the subject of oils, a cautionary note, the old adage of 'any oil is better than none' is no longer really true in the context of modern engines, which MUST have the right oil. In one case I dealt with the Diesel particulate filter was clogged due to the DPF/ cat being poisoned by the additives in 'ordinary' oil. It cost over £2200 to replace this part of the exhaust system. Always check that any oil put in the engine IS correct. Most engines now use fully synthetic oils.
Noel Shelley (Norfolk)

Etching PCBs

Dear Martin,
I would like to add to my friend Less Kerr's article with a simpler way of etching the boards.

I have been making PCB's since 1956 having obtained the PCB material from the Admiral TV Factory, Sydney who were the first in Australia to use PCB's in TV's.

Firstly, I prefer to use fibreglass board (see step 3) and when you cut it to approximate size use a hacksaw - if you use a guillotine it will crush the edge of the resist and tear it off. The final size may be trimmed with a guillotine though. When drilling holes I use carbide drills, available also from

Tauco Drill

Dear Martin,
I have no idea if you can help, but am needing to source a part for a Tauco DP220 Drill which is a family heirloom, handed down to me some 30 odd years ago and already 30 or 40 years old then!
I do not normally inhabit the world of model engineering but, in googling for info on this drill, I came across your forum. A member had rebuilt this drill model and was amazed that he got stuff from Wilkinsons in Edinburgh to rebuild it. Today I find they went into liquidation earlier this year!
The part I need is the DP-264 spindle sleeve. This is the drive between pulley and spindle, which has shattered, and looks like a weak link in an otherwise robust machine.
Again Martin, any signpost you can find I would be most grateful for.
Regards, John Grainger

Kalex, provided you are careful (no movement while drilling). The drills last for ages (thousands of holes). I always break them long before they are blunt.

The method I have settled on is as follows:

ETCHANT ferric chloride obtainable from the same sources as Les's article. It comes as a liquid in a plastic bottle and can be used at room temperature.

Step1
Pour a quantity into a dish, on a level surface, large enough to accommodate the PCB, to about 25 mm deep or greater.

Step 2
Make sure the surface of the etchant is free of bubbles or any floating matter, if there is, draw a piece of cardboard or plastic (not metal)across the surface to sweep the surface clean.

Step 3
Make sure the exposed PCB is clean and DRY and place it carefully upside down on the surface of the etchant - the surface tension will hold it there and it will not sink.
When the etching has finished, as evidenced by appearance of the track pattern (if using fibreglass PCB) visible through the board.
Take out, wash and dry. If there is still some areas not etched, clean, dry and repeat.

CAUTION
Ferric Chloride is messy and stains everything, including your fingers! So keep everything clean and tidy. Above all DO NOT carry out these operations on the stainless steel sink as the sink will be etched as well. Don't ask me how I know this!

Step 4
Stripping the resist off the PCB is easy - just wipe with a rag soaked in methylated spirits or acetone.
John Chappell

Dear Martin
I have been following Luker's article with interest. I note his method of etching the loco nameplates and I wonder why he does not use ferric chloride for etching as this would seem to be a simpler method. I have made quite a large number of etched nameplates using it and found it quite successful. For the ones that I have made the image has been screen printed onto the brass and then etched in ferric chloride face down. The solution is kept warm in the container surrounded by a water bath. I have not tried transferring the image from a laser printed transparency but this method would eliminate screen printing and would be much simpler.
Yours sincerely, Peter Brown (Orange, NSW, Australia)

Obituary Tom Pasco

Tom's internal combustion engines will be familiar to anyone who visited any of the model exhibitions at Harrogate, Doncaster and the Midlands over the last two decades. All were superbly built and regular winners of medals and trophies.

Tom was born in Wilton near Redcar and spent his early years on the family farm at Thorpe Thewles near Stockton on Tees. It was here that his love of machines began and he acquired his first lathe. He joined the Thornaby Pathfinders model flying club and, with his friends Keith Dale and Wesley 'Bill' Haley, formed a control line team racing team. Tom, of course, was the 'engine' man. His home modified ETA 29 and McCoy glow plug engines won them nationwide success, their team photograph featuring in the E.T.A. Company's regular advertising in *Aeromodeller* magazine. At this time he was an apprentice toolmaker at Metro Vickers, Stockton on Tees.

Transport to and from their team racing contests was always by motorbike; eventually leading to modifying one for local club racing,

initially using a BSA Goldstar engined Norton, ridden by his friend 'Bill' Haley. Success led to a series of engines modified and tuned by Tom. These were initially four stroke but later two stroke engines, one of which, ridden by Alan Stuart, won the British Championship in 1981. Tom had become nationally known as an engine tuner and received several offers from Works racing teams to join their squads which, as he now had a wife and family, he chose to decline.

An opportunity of a partnership in a toolmaking business was accepted and Steelnorth Tooling became a very successful business, making injection mould tools for the pharmaceutical and cosmetic industries until his retirement. On retirement Tom divided his time between building his famed internal combustion engines and long distance walking.

His output of engines was enviable. One per year was his aim, beginning with a model of the four cylinder 'Gale' two stroke engine. This was a much publicised effort, around 1960, to build a four cylinder 50cc racing unit that used a form of cycloidal crank mechanism to provide straight line motion to opposing cylinders in order to reduce piston wall friction. Tom knew the inventor, Norman Gale, well and it is possible (though cannot now be confirmed) that Tom actually made the original test engine. His model, made in 2001/2, was exhibited at the Midlands Exhibition in 2002.

Of the 16 engines Tom built only one was a true scale model, his beautiful ¼ scale Gypsy. Tom followed existing commercial drawings for this but machined everything from solid. All his other engines were his own original designs and utilised every possible

configuration. To say that his engines were often unusual is, perhaps, understating the case. Many could be hardly understood by the casual observer but they all ran beautifully.

Of all his unusual engines, perhaps the most thought provoking is his two cylinder Demont engine. This was built to demonstrate the configuration of the original Demont six cylinder rotary of 1916. Whether this was ever built and fitted to an aircraft is unknown but the engine fired above and below the piston, double acting as in a steam engine. That this two cylinder engine runs so well is a testament to the ingenuity and design capability of the man.

To list the number of Gold and Silver Medals and trophies that Tom acquired is unnecessary but there was never a more worthy winner of The Edgar Westbury trophy. His understanding of all forms of the internal combustion engine and his ability to transform this understanding into working prototypes was incredible.

His penultimate engine, a four cylinder, supercharged, two stroke engine with poppet valve exhaust has never been exhibited. This will be entered in the next Doncaster and Midland Exhibitions whenever that may be.

His final legacy will be the single cylinder horizontal engine with rotary valve induction and exhaust designed for the Minimag Company. This will be marketed as a set of drawings with suitable ignition equipment in due course.

Tom leaves his partner, Carol, son Brian and daughter Lisa, to whom all friends offer their sympathy.

Mike Sayers

The twin cylinder Demont double acting engine.



A Half Size Lister 'D' Stationary Engine

Daco constructs his own half-size version of the well-known Lister 'D' type engine.

First designed and built in 1926, over 250,000 'D' type Lister stationary engines were built up until 1964.

Very few would not recognise this little engine, often seen driving machines on farms such as chaff cutters, turnip slicers and such-like equipment. Lister 'D's also powered sludge pumps seen at road repair sites as well as small generators and the like.

All over the world the trusty 'D' type could and can still be seen at work.

I have always been drawn to its simple lines and its almost indestructible build. The engine could be had as 1½ hp at 750 rpm up to 2 hp at 1500 rpm. I think late models such as the 'DK' could make somewhat more. It was (is) hopper cooled with magneto



The crankcase.

ignition and variants could be had that would run on petrol, paraffin TVO or gas. Often seen covered in dirt and grime and also having little or no maintenance, these engines would run forever.

The half size model is fully fabricated, apart from two small castings used in the construction of the carburettor, from mild steel plate and machined details. The crankcase, or body, and the complex cylinder head each comprise over forty parts, assembled in stages by silver soldering. Another method thought of at the time of building was to have these assemblies vacuum brazed. Now I do have a semi-professional TIG welder but even this would not have been as adaptable as my method.

The half size model is of no particular full-size engine but is a close general representation of the type. It stands over 13 inches tall and is of 60cc capacity, some one-

sixth of the full size. Governor controlled, the speed range is from 400 to 2200 rpm. I fitted a non-original device to override the governor so that a slow idle speed was possible with no-load conditions.

Inside the model it is made very close to the full-size design. There is an overhung type crankshaft running in two large ball bearings mounted in a removable housing.

The cylinder liner, piston and piston rings are machined from continuously cast iron bar.

A follow crankshaft drives the valve gear and, via a cross shaft, the magneto and governor. The connecting rod is mild steel with bronze bushes each end. The main shaft is in EN24T steel pressed into the crank disc, this being balanced to a 66% factor. The crank pin is made from hardened alloy steel.

The valve gear, cam shaft etc. are as in the full-size engine. Lubrication is by the splash method, a dipper on



Kit of parts.

Often seen covered in dirt and grime and also having little or no maintenance, these engines would run forever.

the connecting rod picking up oil via a trough which has a sort of slot to control the amount the dipper picks up. An addition was made to the engine in the form of a small port or window fixed to the cover plate. This allows one to view if oil is being sprayed about inside the crankcase.

The carburettor is my own version of E. T. Westbury's 'Dolphin' design, being more advanced than the Lister design, and works very well.

The magneto is also my design, based again on Westbury's work. It uses a ready-made HT coil and a powerful rare earth magnet, and produces a good strong spark even at a slow speed. On the full size engine the magneto is driven by a roller chain (some later engines, 'DK' etc., used an all gear drive). I did have some 0.25 inch pitch roller chain but that is being saved for another project, so I used a 2.5mm pitch HTD belt. As this drive is hidden by a guard it is not noticed – besides, it is a much better way to drive the magneto.

The lettering on the crankcase cover plate and on the cylinder head was a simple job, the letters being formed

by bending to shape from flattened soft steel wire. After positioning, the letters were soft soldered in place. Making the Lister logo seen on the end face of the silencer took time, being cut from steel sheet with a jeweller's piercing saw. It is silver soldered to the silencer. The silencer and many other parts are nickel plated. Studs, nuts, screws etc., which I make myself, are black oxide finished. Paint is a synthetic enamel made for stationary engines and is Lister's No. 3 Brunswick Green.

The engine both starts and runs very well and is surprisingly very powerful. At one time it was set up to drive a three-phase alternator which I made up from a motor cycle 180 watt output generator. The engine drove this well enough and would light up three or four car headlamp bulbs.

However, after about twenty minutes the water would boil up. This is not a problem, as such, as it is meant to but a piped-up system would have been better. This was not the only problem – the generator being housed in a machined aluminium alloy casing (well ventilated, with a fan) would also get hot. It took a while for



More parts.



Complete engine.

me to understand that stray eddy currents were being formed in the housing. Perhaps the housing should have been in steel – who knows? A much better job would have been for me to have built or purchased an old-style DC dynamo.

Building the half size 'D' type was an interesting and rewarding experience. Would it drive a ride-on Ruston style 0-4-0 locomotive? I'm sure it could.



Magneto.

The Stationary Steam Engine

PART 15 - CORNISH AFFAIRS

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

Continued from p.641
M.E. 4651, 6 November 2020

A handful of engines had been built by the time that Colville started the Torryburn machine and although none of them had been trouble-free they were sufficiently effective to attract interest. Smeaton, shown the engine that pumped water from a well at the Stratford-le-Bow distillery of Cooke, Adams Wilbie and Sagar, was guarded in his response. He expressed the view that it was a pretty engine but that it appeared to him to be too complex. At the same time, he conceded that the impression that he had formed might be in some degree due to his not understanding fully how it worked.

A more complex engine raised questions of greater expense in first cost and reliability. In both of these respects the Watt engine might compare unfavourably to the Newcomen engine. Its indisputable advantage was the substantial reduction in fuel consumption that it was capable of offering but this was only an attraction where coal was expensive. To the coal owner with substantial quantities of unsaleable slack coal to dispose of, fuel efficiency in his pumping engines was not an argument. In coal mining the cheap and well understood Newcomen or common engine, as it was increasingly known, would often continue to serve perfectly well until the second decade of the nineteenth century.

The situation in the Cornish copper mines was different. The South-West had to import

virtually all its coal from across the Bristol Channel and thence haul it overland to the mine. Against this background of high fuel costs the Cornish copper mining industry was also facing an existential threat from Anglesey where the Parys Mountain was about to yield its vast reserves of copper ore without the need for deep mining. This was the insistent Cornish case for the Watt engine.

In mid-1776, a deputation led by Thomas Ennis visited Soho, by which time the Broseley and the Broomfield engines were at work. Boulton and Watt were absent but the party was shown over the works and saw the 18 inch engine which was pumping water back from the waterwheel tailrace into the dam. They were evidently also shown drawings and Richard Trevithick senior took the opportunity to abstract one. Discovering this petty act of theft on his return, the irate Boulton wrote to Ennis:

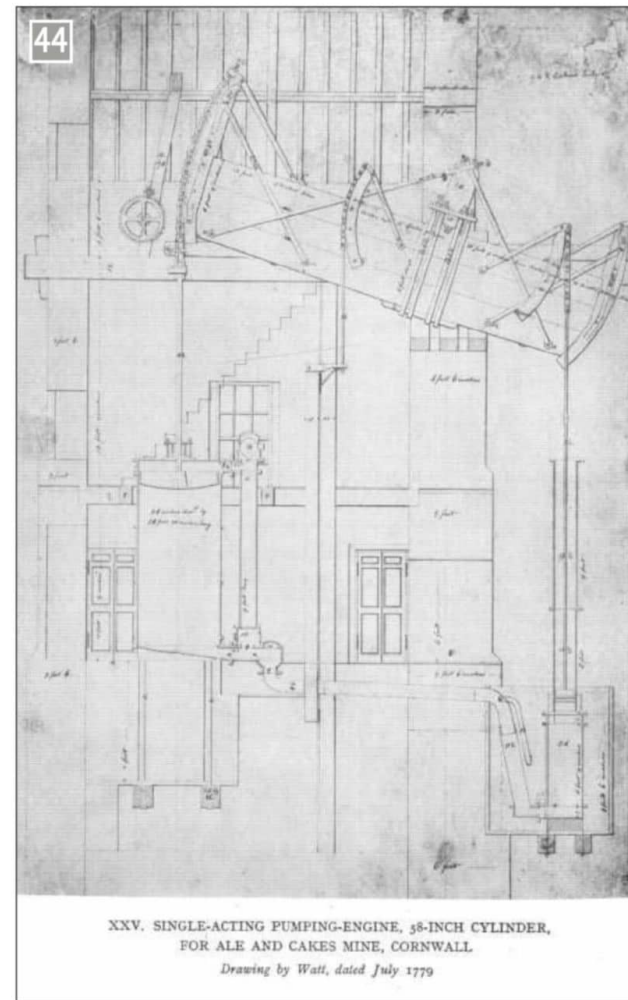
.....We do not keep a school to teach fire engine making, but profess the making of them ourselves....

This incident became a keynote in Watt's ensuing relationship with the Cornishmen, a mutual dependency hedged round with equally mutual hostility. Boulton and Watt clearly understood the critical importance of the Cornish market to the commercial success of the engine and for their part the Cornish copper masters appreciated the significant cost savings that

the engine offered but as long as the patent protected the central working concept they would have to meet the Soho firm's terms.

The first Cornish engine was ordered on 23 November 23 1776 for Ting Tang Mine by Jonathan Hornblower the elder, engineer to the mine. Within a few weeks of the Ting Tang order Wheal Busy mine ordered a further machine. Bersham had the parts for both engines ready for shipping to Cornwall in May 1777 but the cylinder for the Ting Tang engine would not fit into the ship's hold and Wheal Busy's cylinder was despatched first. This advantage was maintained and in September 1777 it became the first Watt engine to work in Cornwall. Wheal Busy's engine started working before Colville's which ran in January 1778 but Ting Tang was delayed until July of that year. Both of the Cornish engines were mechanically identical to Colville's machine but Ting Tang's cylinder was eight inches larger in diameter at 52 inches whilst Wheal Busy's cylinder was 30 inches in diameter.

The Ting Tang engine left a record of the distribution of work involved in supplying this early Watt engine, a pattern that was to subsist for the next twenty years. Wilkinson provided the inner and outer cylinders, the cylinder bottom, the lid, stuffing box and piston along with the complete condenser and air pump. He was also responsible for the cast-iron nozzle boxes but Soho made the valves and the valve seatings with associated



The Ale and Cakes Engine, 1780. A separate steam jacket was used but is not shown. Drawing in the Boulton and Watt Collection, City of Birmingham Library.

brass and ironwork. Soho also made the valve gear components, the buckets and clacks for the condenser and air pump. The piston rods for both steam cylinder and air pump were forged by anchor smiths in Rotherhithe and sent to Soho for despatch to Cornwall. The Cornish engineers built the boiler and provided all of the mine-shaft gear. It will be seen that Boulton's Soho Manufactory made the parts to which it was best adapted whilst Wilkinson concentrated upon the heavier castings and the machining of those castings.

It is a measure of the superiority of the Watt engine that in an area well populated with often very recently built Newcomen engines, progress was rapid. After Ting Tang

and Wheal Busy had proved themselves a steady influx of orders began to flow into the Soho works. A 63 inch for the Wheal Union mine at Tregurtha and an engine for the Chacewater mine of the Fenton's Yorkshire Copper Company were ordered within a few months of each other, in the second half of 1777. The Chacewater engine was particularly notable in that it was a partial rebuilding of Smeaton's great 72 inch engine completed only two years previously and embodying the most developed of Smeaton's ideas. The Watt engine incorporated the cylinder of the Smeaton engine which formed a steam jacket for the new 63 inch Boulton and Watt cylinder. Smeaton's massive timber

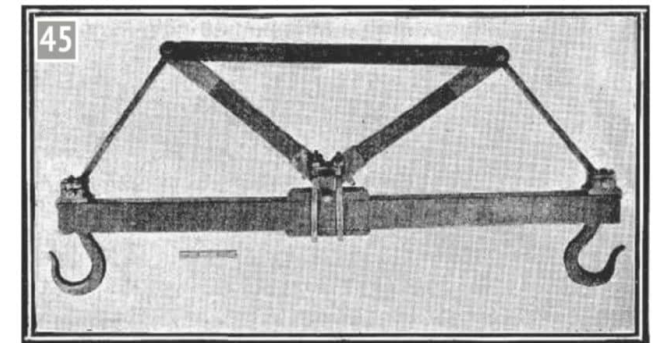
beam, built up from twenty fir baulks of 12 inches by 6 inches section, was retained along with the framing and house for the earlier engine. The stroke of the Watt cylinder was 9 feet and the pump 17 inches in diameter lifting water through 318 feet. The suspended pumping gear weighed 9 tons even before the water load came on. This loading would have been too great for a 72 inch Newcomen engine with an assumed net 7 p.s.i. atmospheric pressure acting on the piston. Smeaton's engine despite its fame was a failure.

At first the Boulton and Watt engine was magnificently successful, dewatering a mine of unprecedented depth and water accumulation but within a few weeks its performance fell away. Watt attended on site and some dismantling followed, the trouble eventually being traced to a nozzle seating that had come adrift. Once this was rectified the engine recommenced its illustrious career. Engines for Hallamannin, Poldice and Wheal Chance followed. Poldice was eventually to have four engines. Again there were problems but by the time that the United Company's Ale and Cakes engine (photo 44) was built in 1780, matters were progressing more smoothly as the engineers gained experience.

The Ale and Cakes engine shows how the Watt engine had been refined under the influence of Cornish demand. The cylinder has been simplified and given top and bottom nozzle boxes

connected by a vertical transfer pipe so that the steam jacket no longer served to convey the steam from either end of the cylinder. Steam inlet is now through the top nozzle box into both ends of the cylinder, the lower end by a second valve at the foot of the external transfer pipe. In the equilibrium situation with steam on both sides of the piston the pump load raises the piston through its stroke. When the bottom steam admission valve closes, the steam from underneath the piston passes to the condenser by way of a second valve but the boiler steam supply continues to be admitted to fill the upper cylinder through the top valve box. As in the Torryburn engine condensation takes place in the eduction pipe, a water tube penetrating the wall of the pipe by which cold water was sprayed through a nozzle against the steam flow. The water jacket attached to the eduction pipe, which was used in the Torryville engine, has been dispensed with as has the furnace under the cylinder bottom.

Smeaton's beam at Chacewater was complicated in construction and subject to working loose at the joints. At Ale and Cakes, Watt's beam (photo 45) was suspended from the gudgeon bearing and used three substantial baulks placed one above the other bound together by long bolts passing through the depth of the beams with nogs to prevent shear movement. It was also trussed with wrought iron rods tying the outer



James Watt's test model beam. Science Museum.

ends of the lowest timber to a timber saddle above the gudgeon. Watt had carried out experiments to assess the effect of truss rods and derived an empirical formula which was used wherever a trussed beam was called for. The formula was based upon symmetrical trussing and it is not clear how it was modified to meet the case used at Ale and Cakes where the gudgeon was asymmetrical.

By this time half of the total production of engines was concentrated in Cornwall and Boulton and Watt were about to enter into the largest single order up to that date; five engines for the Consolidated Mines Company. So important was the Cornish market that after spending much time travelling between the Cornish sites, Watt decided to buy a house in the Gwennap valley where, for a number of years, he became permanently resident.

Generally, Watt did not relate easily to his fellow man. Diffident and shy, he recoiled from awkward situations and the often truculent Cornish mine owners and engineers caused him considerable anguish. His salvation was a succession of able assistants, the first of whom was Thomas Wilson, the mine manager at Chacewater, who had ordered both the Smeaton engine and the Watt engine. Wilson effectively became agent for Boulton and Watt in Cornwall. Of even greater significance was Jonathan Hornblower, whose father, Joseph had been associated with Newcomen personally in some of the first atmospheric engines and who went on to become one of the foremost builders of steam engines. His son followed the tradition and it was Jonathan who had ordered the Ting Tang engine. He became a close friend of Watt and until his death in December 1780, a key factor in Boulton and Watt's success in the South-West.

Fortunately, Hornblower's loss was compensated for by William Murdock who joined Watt in Cornwall. The story of Murdock's home-made

wooden hat, elliptical in form and turned on a lathe which he had made himself, is well known but bears repeating. When Murdock dropped it on the floor in the course of his first interview with Boulton, the clatter caught Boulton's attention and Murdock's account of its origins immediately convinced Boulton of the man's worth. Boulton employed him without hesitation and he rapidly became the firm's most accomplished practical engineer and engine erector. Murdock was to spend much of his career with Boulton and Watt in Cornwall where he also bought a house. As far as the Cornishmen were concerned, he proved to be a far more formidable proposition than Watt.

Boulton and Watt clearly understood
the critical importance of the Cornish market
to the commercial success of the engine...

Much of the friction between the Cornish mine owners and Boulton and Watt arose from the payments system that the firm operated. With fifteen years emotional and intellectual energy invested in the separate condenser steam engine, Watt was understandably jealous of his creation and the patent was vigorously defended throughout its life. This was not straightforward and it may have been unduly complicated by the way in which the partners chose to secure an adequate financial reward.

Remuneration from a protected innovation might be secured in a number of ways. The object of the patent might be exclusively manufactured by the patentee for the duration of the patent or the patentee might issue licences to selected manufacturers. The second option was firmly

rejected by Boulton and Watt throughout the patent's life but exclusive manufacturing brought its own problems. Matthew Boulton had initially envisaged building the engines at his Soho works and this had been specifically mentioned in his earliest correspondence with Watt. It was also an argument in the patent extension act of 1775. Whatever his intention it quickly became apparent that the nature of the Soho Manufactory's current products was incompatible with the production of steam engines. Once Wilkinson had demonstrated his unique facility in making the critical heavy components for the engine, the folly of attempting to compete was obvious. Thus, Boulton retreated to

the manufacture of the more specialised, smaller parts at Soho, in keeping with the factory's experience. In consequence, the value added in manufacturing the engines was limited, particularly as Wilkinson dealt with, and was paid directly by, the customer rather than being a commissioned sub-contractor subject to contractual payments.

Instead of relying upon manufacturing profits the partners decided upon a system of premium payments based upon the saving of fuel that might be expected had a comparable common engine been installed. The premium sum, calculated as a one-third drawback on the estimated fuel saved, was to be payable annually throughout the lifetime of the patent. This hypothetical arrangement met with immediate difficulties.

Coal prices varied enormously across the country and as has been seen, the colliery owner might cost his coal at zero. There was also the question of the great variability in common engine coal consumption which Watt had experienced directly. A notional improvement of between 1:2 and 1:4 was estimated over the common engine but this was arguable and provided a ready opportunity for contention. Additionally, the Watt engine was constantly improving in performance whilst the common engine underwent only marginal change. The circumstances in which an engine operated might change during its lifetime - the pumping shaft might be deepened and the water load increased - so a figure fixed at the start of the engine's life might not reflect its later performance. A mine might cease production and the engine be left standing for several years at time. In such circumstances was the premium still payable?

These and other issues led the Cornish engine owners to increasingly resist the hold that Boulton and Watt had taken upon the engine market. In turn the Birmingham firm felt that it was never adequately recompensed for the coal savings that it had achieved. Surviving records show that the firm's averaged income never attained the one third of fuel savings that had been postulated in the beginning. Nevertheless, for the first ten years of the life of the Watt engine the Cornish copper trade played the dominant part in sustaining the firm of Boulton and Watt.

● To be continued.

NEXT TIME

Expansive working makes an entrance.



Old girl all dressed up posing for the camera.

PART 8 - BOILER

WAHYA A 5 Inch American Type Locomotive

Luker
builds an
American
4-4-0.



Continued from p.632
M.E. 4651, 6 November 2020

Boiler design and material considerations

We now come to the part of the build that I'm sure is going to spark much debate (which is of course welcome, provided it is backed by rigorous calculations or published literature and not 'one of my friends' experience').

The boiler for the Wahya is a stainless steel boiler. I chose stainless as the construction material for a number of reasons but, in short, copper, and especially the silver solder, is way too expensive. However, one of my smaller copper boilers is copper - TIG welded and it works very well and was relatively inexpensive. With the availability of steel boiler tubes in South Africa an issue, and the need for additional plate thickness for corrosion

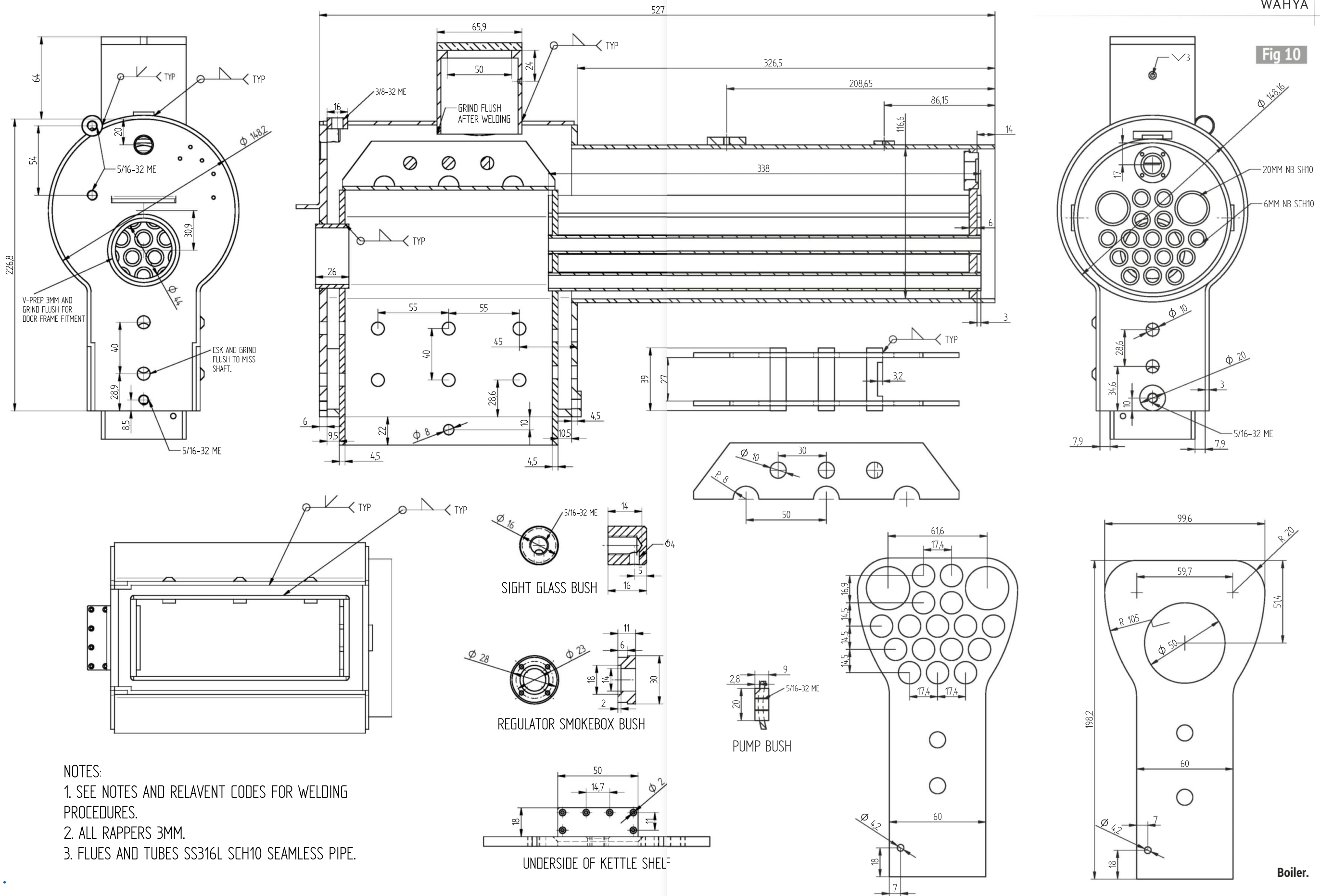
allowance, the cost of stainless becomes comparable to a steel boiler. A stainless steel boiler is also much lighter than a normal steel boiler, which is a consideration in a small workshop where moving the boiler is a one man job. There are of course certain problems related to the use of stainless and I had someone tell me once 'it will work, but it will eventually fail'. Well, that's true for anything really.

I'll start by describing the major issues with stainless and this will give the builder some idea of what to look out for when constructing stainless steel boilers. The biggest issue, especially with the austenitic grades, is stress corrosion cracking (SCC) due to chlorides in the water. This typically occurs where the

metal has been sensitized, normally at the welds. If the proper filler rods are used and the weld area is clean and of course you don't overheat the weld area you'll probably be okay. I personally use DC pulse TIG welding at a relatively high frequency to decrease the heat affected zone.

I'm also meticulous about cleaning the weld area, setting the shielding gas correctly and ensuring all welding is done in a draft-free zone. You can also only back grind and repair once; any more than that and you're inviting issues by sensitizing the weld. With this in mind, the designer is well advised to limit the amount of welding on a stainless boiler and not be tempted to have stays all over the place.

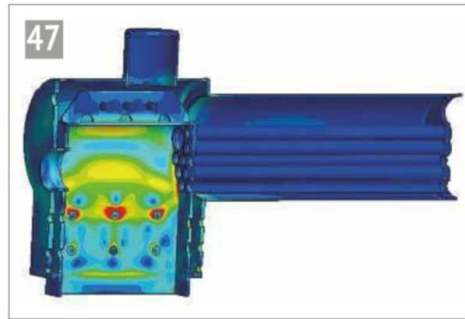
Fig 10



The different stainless steels expand differently and under no circumstances can you mix materials in a stainless steel boiler. The expansion difference is very small but you only need small deflections to push the materials past the ultimate tensile point, especially with a material like stainless that is considerably stiffer than copper.

The Wayha boiler is specifically designed, using finite element analysis (FEA), for SS316L. The stay design and spacing are not suitable for other materials like copper and it is unlikely a copper boiler built to these drawings will be satisfactory. The boiler is also designed to have very few areas yielding at the 2x working pressure hydraulic test, which means that after the test all flat areas will still be flat and the boiler shape, if measured, will be the same as it was prior to the test. From the FEA plot (photo 47) the areas around the stays are just beginning to yield at 2x working pressure. Those of you that have tested copper boilers will know they're not exactly the same shape after the pressure test but you would need a straight edge to pick it up. This just means the metal has yielded and distributed the loads to a more balanced state.

It's not good practice to have stays that are not square to the adjacent plates. As stainless is so stiff you're inviting large stress concentrations on one



SS316 stress plot.



Tubes welded to the firebox tubeplate.

side of the weld. You'll notice the stays don't extend past the flat sections of the boiler - to avoid this condition the crown is stayed using plate stays, which is perfect for welded boilers. I've read of these crown stays failing in copper boilers due to the silver solder letting go during subsequent heating operations, but this is not an issue with a welded boiler. There is also the argument that the foundation ring will take most of the load without stays connecting the crown to the outer shell, but

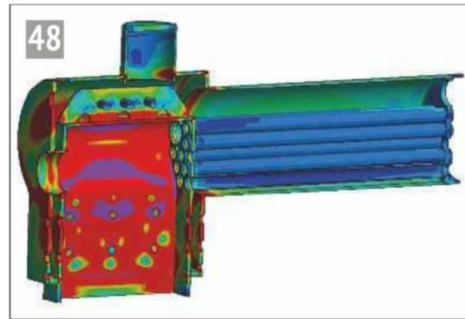
from the FEA this is definitely not the case and this area sees very low stresses (photo 47). While I'm on the crown, the holes between the plate stay and crown are to take up any differential expansion, with the added benefit of improving water circulation over the top of the firebox.

Just for fun, the copper stress plot (photo 48) shows what copper would look like if made to this design, with the red areas above yield and the purple areas having failed (i.e. exceeding ultimate tensile

strength). And no, Mr Wiki Engineer, there is no bilinear isotropic hardening applied to the material properties of copper. Again, this is by no means an indictment on copper boilers; I'm just trying to illustrate that the design is material dependent.

Building the boiler

Building the boiler (fig 10) is a straightforward fabrication job and I finished mine in a weekend in between accompanying my lovely wife for some retail therapy. Very



Copper stress plot.



Firebox and tubes welded.

few builders will be able to roll the outer shell and this was done, in my case, by the same shop that does my laser cutting. I think you do get stainless steel pipe very close to the shell size but it's unlikely you'll find a supplier willing to cut such a short piece and, if they are, the cost will be exorbitant.

Generally, all holes can be cut to size with the exception of the threaded holes in the backhead, throat plate, and the regulator hole. These need to be machined prior to welding. The three holes for the tri-cocks on the right of the backhead are optional and only for show; they're not functional. When drilling and tapping stainless I drill to within 0.5mm through, leaving a dimple on the other side. In the unfortunate case of the tap breaking, the dimple can then be used as a reference to punch from the back and drill to the tap. You then have two sides to wiggle the tap free. Of course, sealing that hole is then left for good old Stag or some other steam jointing compound (good luck with that!).

The inner firebox and tubes need to be tacked and welded together first with the smokebox tube plate used as a brace for the tubes (photo 49). The tubes are probably the trickiest item to weld. You need a solid 2-3mm fillet weld but no V-prep on the tube plates (this will cause burn through or over penetration on the tubes).

It's unlikely the laser cutters will roll the firebox hole and regulator dome but this is an easy job with a vice, hammer and a piece of round bar. The firebox wrapper should be kept as one piece and it can be bent over the firebox side plates with a vice and clamps, tacking as you go. This requires a little brute strength but little by little the wrapper can be formed (by bending not hammering) around the firebox plates (photo 50).

I don't want to turn this article into a lecture on welding (for that I could scribe my lecture notes and do a proper job, besides, the internet is filled with welding

experts). However, because the welding is the most likely part to give the builder a serious headache, I will highlight some of the critical areas. When welding stainless you need to constantly balance the heat input by moving from the one side of the job to the other to limit distortion. Welding with a high frequency DC pulse set-up avoids some of this distortion by limiting the overall heat input. All butt welds need to be properly prepped with 60 degree chamfers; this is typically the barrel and outer boiler shell. The fillet weld root shouldn't be larger than the thinnest plate but it is critical to have an offset between the thicker plates and outer shells to get a good fillet in (photos 51 and 52).

The steam dome needs to be completed before it is welded to the outer shell and it needs to be welded with the cover firmly bolted in place.



Clamping the barrel for welding.



Regulator boiler dome.

The outer flange for the bolt holes should be pre-drilled and tapped, welded to the dome and then the sides and top skimmed on the lathe to get a good seal. I suggest allowing modest clearance for the ornamental dome cover. Again, a decent V-prep is required prior to welding (photos 53 to 55). If you're going to use gunmetal instead of stainless for the cover plate then a dummy cover needs to be bolted to the dome for welding. Either way, don't drill the holes for the steam whistle or the safety valves before the pressure test.

Fitting the boiler

The boiler centreline on the parallel section should be pitched roughly 102mm from the top of the frame. Like the real locomotive the expansion angles are bolted under the spring equalising beams through the frame. You need a minimum of 2mm expansion

allowance for the stainless steel boiler, and make sure the hold down clamp on the angle has a little play between the expansion angles to allow movement. There should be around 2mm gap between the backplate of the boiler and the back coupled axle, then you're good.

Testing the boiler

Finally, without exception the boiler should be pressure tested to twice working pressure for at least one hour (photo 56). If made properly you'll find that the dimensions taken before the pressure test are virtually identical to dimensions taken after, with very little yield. The top of the firebox should be checked to make sure the plate stay has done its job but if welded properly that configuration is much stronger than the normal stay method.

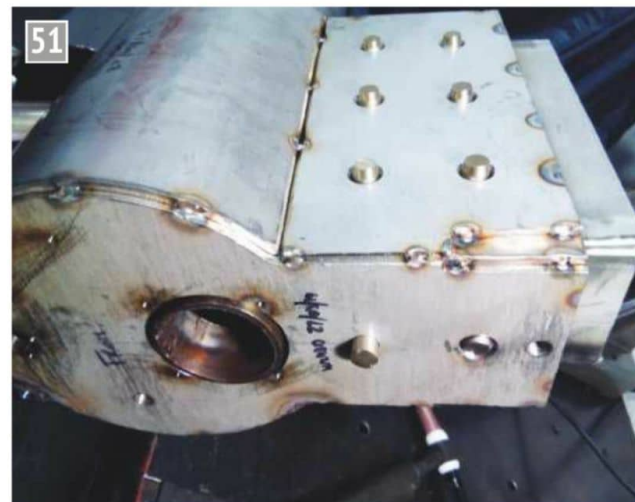
●To be continued.



Butt weld V-prep.



Boiler pressure test.



Outer boiler tacked ready for seam welding.



Firebox fillet weld.

150 Years of the 'Quarry Hunslet' Dynasty

PART 5 - THE 'LARGE QUARRY' CLASS

Mark Smithers celebrates 150 years of the famous Leeds locomotive builder.



Continued from p.709
M.E. 4652, 20 November 2020

Controversially sectioned during its period in Canada, the intact left hand side of Large Quarry class locomotive Gertrude is seen here at Statfold Barn on 6 May 2017. The later pattern Hunslet chimney found on this class makes an interesting comparison with the Manning Wardle-inspired pattern found on the Penrhyn 'Port' class.



In 1904, the first of the Penrhyn 'Large Quarry' class appeared. It appears that, by this stage, the Penrhyn owners were prepared to be a little more generous in terms of maximum wheelbase allowance for locomotives in use in the quarry galleries themselves, although the new class was equally at

home at the Port. The new locomotive was Makers' No. 855 *Hugh Napier*, named after the fourth holder of the Penrhyn Baronetcy. The wheel, wheelbase and cylinder dimensions of the locomotive were the same as for *Gwynedd* and its sisters, but the running boards were not dropped at the rear, the Salter safety valves gave way to Ramsbottom and the boiler pitch was raised by some 3½ inches to give room for a deeper firebox and allow better oiling access to the inside valve motion. *Hugh Napier* apparently remained in use for approximately half a century but by 1964 was reduced to a pile of components in the carriage shed at Bethesda, having been withdrawn with a condemned firebox. Fortunately Quarry employee, lowerth Jones, who was later to work for the National Trust, facilitated the transfer

of the locomotive's remains to the Trust's Penrhyn Castle Museum on 11 November 1966 and a protracted overhaul commenced. In 2011 the project was relocated to the Festiniog Railway's Boston Lodge Works where a new boiler was constructed. The official 'launch' of the restored locomotive took place at Harbour Station, Porthmadog on 11 May 2012. The locomotive has since become a 'roving ambassador' for the National Trust, being based on the F. & W.H.R. under an agreement currently extended until at least 2029, but available for occasional visits elsewhere, including to Kings Cross in February 2018 with *Velinheli*. On the F. & W.H.R., *Hugh Napier* is mainly used for light duties, such as giving footplate rides and special occasions, as it retains its reliance upon displacement lubrication.

In the Penrhyn Quarries, *Hugh Napier* was to be followed by five classmates: in order of construction *Pamela* (W/N 920 of 1906); *Sybil Mary* (W/N 921 of 1906); *George Sholto* (W/N 994 of 1909); *Gertrude* (995 of 1906) and *Edward Sholto* (W/N 996 of 1909). All of these locomotives were named after members of the Pennant family in line with general Penrhyn naming policy. Of these locomotives, it was perhaps *Pamela* that was to have the most interesting pre-preservation career. As we have seen with *Elin*, Coed-y-Parc Workshops were not averse to swapping components around in order to keep locomotives running and in 1946 *Pamela* was withdrawn from service, with its boiler being condemned, and scrapped five years later. A replacement was to hand, of a totally different design from Hudswell Clarke Ganges class 0-6-0WT *Bronllydd* (W/N 1643 of 1930). This was fitted, but entailed some radical changes to the locomotive's design including a new smokebox, adapted to cope with a higher boiler pitch, and a radically different front tubeplate design. The shorter barrel ensured that the firebox sat partly over, rather than behind, the trailing wheelset. This, of course, was the cause of the raising of the boiler pitch and would have entailed removal of the original firebox stretcher to clear the new ashpan. A new,

semi-circular section tank and *Bronllydd*'s canopy completed the ensemble, which re-entered service on 11 January 1952. With the general run-down of railway operations on the Penrhyn system, the re-built *Pamela*'s revenue-earning career was destined to be a short one and the engine was ultimately withdrawn, with firebox problems, from Red Lion Level in March 1958. Initially purchased by the Cornish Traction Preservation Club, *Pamela* was soon sold *in situ* to John Vernon of Church Farm, Newbold Verdon, Leicestershire on 9 October 1966. After the fitting of a new, somewhat ersatz inner firebox, the locomotive saw some use on a railway at this site until onward sale to Gerald Cannon of the Old Kiln Light Railway, Tilford, Surrey in the autumn of 1984. Currently, although the chassis of the locomotive is in good condition, the boiler has been declared beyond economic repair and a Crowdfunding campaign has been instigated to raise the necessary funds for a new one, of Hudswell Clarke design to replicate the locomotive's post-W.W.2 working condition. *Sybil Mary* remained in use until February 1955, being condemned the following month following problems with the boiler and firebox. After a period of storage in the workshops and train shed at Coed-y-Parc, the locomotive was sold to the



Another Penrhyn Large Quarry class locomotive, but this time *Sybil Mary* at work on the Statfold Barn system on 9 April 2016. The token is being exchanged at Statfold. As referred to earlier *Sybil Mary* received Lady Madcap's studded dome during the preservation era during the exchange of parts between many of the Quarry Hunslets when undergoing restoration.

late Colin Pealing in 1966 and initially stored at Newbold Vernon. Transferred to Lynton & Barnstaple Railway Association at Landkey, Devon in March 1988, *Sybil Mary* was shortly afterwards sold to Mike Hart and transferred to the Festiniog Railway on 26 February 1991 until sold to Paul Martin, a Leicestershire-based enthusiast and removed on 13 March that year. During all of this time, various components had been collected, several from other Hunslet locomotives, but no restoration to working order had been undertaken, not even the obligatory re-gauging from 1 foot 10¾ inches to 1 foot 11½ inches. The locomotive eventually passed into the ownership of the Statfold Barn

Railway, who restored *Sybil Mary* to full working order, with the work being completed in 2013.

George Sholto (named after the third Baronet) was the earliest member of the Large Quarry class to see service in preservation, having been purchased by the late Alan Bloom for Bressingham Gardens, Norfolk in February 1966. After the necessary overhaul and re-gauging, *George Sholto* re-entered service on Bressingham's Nursery Railway later during the same year and has been a useful and reliable member of its operational fleet ever since. In addition to the usual refurbishments, the main modification carried out during the preservation era has been the fitting of a new boiler, supplied by the Washington Boiler Co. in 1975 to the same basic design later fitted to *Gwynedd*. The locomotive was temporarily re-named *Bill Harvey* after the former Shed Master at Norwich in 1998 but has now reverted to its former guise, although it now sports a cab. It has recently been the star of a Channel Five documentary on the subject of Bressingham Steam Museum.

After its period of revenue-earning service in Wales, *Gertrude* suffered the greatest indignity of the Large Quarry class members. Following withdrawal from service



A more recent view of *Sybil Mary* taken outside the locomotive shed at Statfold on 8 August 2020.

This view shows the sectioned side on the same day. On this class, the handbrake was mounted on the firebox wrapper with the reverser mounted in the outboard position.



in February 1955, *Gertrude* was sold to Messrs Lamb of Bromsgrove on 13 September 1960 and thence to Charles Matthews, Ontario, Canada, who sold the locomotive to the Centennial Centre of Technology, Don Mills, Ontario in the spring of 1965. In 1967-8, *Gertrude* was unforgivably sectioned for display purposes and it remained in Canada until repatriated to appear in Statfold Barn's Grain Store in time for the Enthusiasts' Day of 25 March 2017.

As with *Gertrude*, *Edward Sholto* was to be a trans-Atlantic export following its withdrawal from service in 1956. After four years' dereliction, this locomotive was sold to Charles Matthews and departed for Thornhill, Ontario, Canada in October 1961. By October 1979 it was advertised for sale by Andrew Merrilees Ltd. of Toronto and by 1991 it was with J. Johnson, Illinois, U.S.A. During all of this time no work was ever carried out on the locomotive and it was eventually repatriated by Andrew Neale from Chicago in June 2006, being restored to working order in a private workshop by March 2010. After visits to several preserved railways, *Edward Sholto* migrated to Beamish Museum in October 2012 where it remained operational until 2017. When compared

with other Quarry Hunslet survivors, it was found that *Edward Sholto* retained much more of its original material including the boiler barrel and inner firebox, but it proved impossible to retain these items for future operation. For the foreseeable future, therefore, it has been decided to display the locomotive as at static exhibit in Beamish's Colliery Engine Works.

Hunslet supplied a substantially similar locomotive, *Betty*, to Trefor Granite Quarries in 1912 (W/N 1101 of 1912). Its main cosmetic difference from *Hugh Napier's* class was the fitting of a cab, of a design which was not typical of Hunslet practice, and two pairs of cylindrical sandboxes as opposed to one. Unlike the *Dinorwic* and *Penrhyn* locomotives, its wheelsets and axleboxes were made to suit 1 foot 11½ inches from the start. *Betty* was sold on 15 June 1940 to Thomas Ward Ltd., having been procured for the Brymbo Steel Co.'s ironstone workings at Hook Norton, Oxfordshire. It was scrapped in 1949.

Lilla and the Dinorwic Mills Class

One member of the greater Quarry Hunslet dynasty that has proved popular with model engineers over the years is *Lilla*. Completed in November 1891 as W/N 554, *Lilla* was initially supplied to the Cilgwyn



Another 'on shed' view, but this time showing classmate, George Sholto at Bressingham in July 1999. The *Penrhyn*-pattern buffer beam, without buffers (in contrast to *Dinorwic* Quarry and *Port* practice) is very much in evidence although the cab had yet to be fitted at this stage.

slate quarry, whose railway system was a 'feeder' to the Bryngwyn branch of the North Wales Narrow Gauge Railway. Being fitted with 8½ by 14 inch cylinders, 2 foot 2 inch wheels and having a wheelbase of 4 foot 6 inches, *Lilla* was significantly larger than *Junior* of the Groby Granite Co., although in common with the latter, it was

built with a domed boiler and a crosshead-driven feed pump but this time driven from the right hand side. Unlike *Junior*, however, there was no dropped rear footplate and a stylish cab was fitted. Although *Lilla* remained unique, there were to be at least two important design spin-offs, one of which will be discussed later. The other was *Marjorie* (W/N 858



Lilla's basic proportions were used for two new locomotives constructed in 1895-8 for the *Dinorwic* Mills tramway, although the design was heavily modified with two injectors (no pump); dropped rear footplate; round cab spectacles and altered cut-outs; dome mounted safety valves; *Dinorwic* 'Port' pattern drawgear and rectangular (as opposed to radiused) bufferbeams. The hole for the linkage to operate the uncoupling mechanism for the leading set of drawgear can still be seen in this May 2018 view of *Hollycombe*-based 1895 vintage *Jerry M* (formerly *Vaenol*) on the W.H.R. road at Harbour Station, Porthmadog.

of 1904) - a 2 foot 6 inch gauge variant for South Wales Cement and Lime Co., Penarth - larger in most dimensions (e.g. 9 by 14 inch cylinders and 2 foot 4 inch wheels) but with the wheelbase reduced by an inch and fitted with counterbalanced flycranks. By the inter-war years, the *Penrhyn* Quarry owners had resorted to acquiring second-hand locomotives and *Lilla* was purchased in May 1928. Following acquisition, much remedial work was needed to put the locomotive into suitable operating condition, particularly to the boiler, and, as with *Penrhyn's* other ex-Cilgwyn purchase, Manning Wardle *Jubilee* 1897, the feed pump gave way to a second injector. For some reason, the inevitable tyre renewal to reduce the gauge from 1 foot 11½ inches to 1 foot 10¾ inches was not carried out until September 1934. Despite its relatively long wheelbase, *Lilla* remained largely a quarry-based locomotive until officially taken out of use in March 1957, thereafter joining the line of 'derelicts' outside Coed-y-Parc workshops. *Lilla* was eventually sold to J. B. Latham of Woking, Surrey on 12 December 1963 and, after the obligatory restoration to working order (completed in 1972) and 'tyre pressing' to restore its original gauge, an initial public run was made in Battersea. The locomotive



The *Dinorwic* 'line-up' at Minfordd during the Hunslet 125 Gala. From left to right can be seen *Velinheli*; *Alice*; *George B*; *Cloister*; *Jerry M*, and *Holy War*. Note the fixing holes where the buffers have been removed from *Velinheli* and *Cloister* during the preservation era.

was then based at Knebworth House (1972-87); Kew Bridge (1987-91) and the Bala Lake Railway (1991-3) before taking part in the F.R.'s Hunslet Hundred Gala of 1993. Since this latter period, *Lilla* has been based on the Festiniog Railway. A new all-welded boiler replaced the original during an overhaul carried out in 2004-8, whilst another overhaul in 2014-15 saw the fitting of a new stainless steel smokebox and a chimney of original design. *Lilla* has recently emerged from its 'ten yearly' overhaul in 2019 with two new injectors of authentic Hunslet design.

The second spin-off from *Lilla's* design was the Mills class for the *Dinorwic* system. Designed as replacements for *Dinorwic* and *Charlie* on the Mills tramroad, this pair of locomotives followed the same basic dimension as *Lilla*



A lovely 5 inch gauge model of *Jerry M's* 1898-built sister, *Cackler* on display at Minfordd in May 2018. This view shows the neat outlines of the design to advantage, including a cab cut-out profile similar to several *Thomas Green* and *Hudswell Clarke* products of the engine's period of construction. The access holes for the cylinders in the leading bufferbeam are also evident.

but reduced loading gauge requirements dictated the need for a dropped footplate beneath the classic Hunslet cab. As with settled *Dinorwic* policy by the 1890s, the locomotives were not, unlike *Lilla*, fitted with feed pumps when new and the safety valves were moved from the firebox wrapper to the top of the dome. Sprung kidney-shaped buffers were fitted at each end, along with linkages to allow uncoupling from the footplate. The first of the locomotives, *Vaenol* appeared in September 1895 as W/N 638, later being renamed *Jerry M*, whilst the sister engine, W/N 671 *Port Dinorwic* (later *Cackler*) followed in May 1898. It apparently differed from its precursor only in being initially fitted with rail-washing gear. *Jerry M* apparently remained in use until the cessation of operations on the Padarn Railway in October 1961,

being sold on 20 April 1967 to J. M. Baldock for use on the *Hollycombe* 2 foot gauge railway, Liphook. Following the fitting of a new boiler and the necessary gauge adjustment, *Jerry M* has remained based at *Hollycombe* ever since, although its blue livery applied on restoration has given way to an attractive re-creation of its original red colour scheme. *Cackler*, by way of contrast, was taken out of service in August 1959, thereafter being stored in Gilfach Dhu Workshops and sold on 30 March 1966 to D.C. Potter of Yaxham, Norfolk. The locomotive has enjoyed a somewhat chequered career in preservation, having been associated with no fewer than three failed railway schemes and it is currently in store as part of the Thursford Museum Collection in Norfolk.

●To be continued.



One-off locomotive *Lilla*, built for Cilgwyn Quarries and later transferred to the *Penrhyn* system, is beautifully maintained in an attractive green livery on the Festiniog Railway and is seen here at Minfordd during the Hunslet 125 Gala. Sadly the one thing of significance that this view does not show is the right hand motion bracket, which once carried the feed pump and where (unlike *Velinheli*) the holes for the ram and fixing bolts are still visible.



Classic second generation *Alice* class locomotive, *Holy War* is seen here at Minfordd during the Hunslet 125 Gala. The chunkier mainframes (as pioneered on *George B*) when compared with *Velinheli* and the current *Maid Marian* will be immediately apparent, as will the authentic block buffers. A cab has been fitted but sadly the need to fit a cabside number plate has resulted in the distortion (i.e. a straight portion) being incorporated into the otherwise curvaceous cab cut-out.



Oliver Cromwell on the GCR, Loughborough in 2014.

Britannia Class 7 Locomotive in 5 Inch Gauge A Modelworks Rebuild

PART 4 - GRATE
AND ASHPAN

Norm Norton takes a renewed look at this popular, kit-built BR Standard Pacific.



Continued from p.696
M.E. 4652, 14 November 2020

Design considerations

The ashpan and grate appear at first not to be a major nor complicated part of a locomotive. The function of the grate is to hold the fire in the correct place and allow combustion air to be drawn through the firebed. The ashpan serves to retain the ash created and prevent it spilling all over the track until it can be properly emptied at the end of work. In full size, it also controls airflow into the grate by means of damper doors. Unfortunately, this simple description hides many problems that arise when we try to build and manage these two items in our scale models.

In the ideal world, at the end of a lovely day's steaming of our model, it is best and

quickest to drop the remains of the red embers out of the locomotive and into the ash bucket at the steaming bay, then attend to other tidying up jobs and have a nice cup of tea. If the model has a wheel configuration that places no axles, frames or parts of a truck under the firebox, then the simple act of pulling out one retaining rod can often allow the ashpan, grate and glowing embers all to fall as one into a bucket. This is the perfect version. However, if you cannot simply drop those embers then you have to shovel them out, just like full size, or wait half an hour for the fire to die. This all starts to ruin the ideal day and the tea goes cold.

Many model designs have a compromise whereby the

grate is made of longitudinal sections and these can be hooked out through the firehole with a suitably designed tool. Sometimes just the centre section needs taking out and the fire can be raked around to fall down. But the ashpan now needs openings so that the embers can continue their downward fall into the bucket. Some ashpan designs are left permanently open at the front or back for raking out but this is not popular with owners of tracks who find the sleepers being burnt when hot coals fall through. It is necessary to design a closed ashpan that retains all ash and lost fire, which can be opened back in the steaming bay. This adds complication to the design.

Some engineers will say that you must be able to drop the fire for 'emergencies'. I have always assumed that they mean that the gauge glass shows no water and they cannot hand pump any in – a panic situation that you should never get into – or that the locomotive is in some dangerous position. In both scenarios you will either have no room to remove the ashpan, or the spilling of hot coals will make the situation worse. In emergencies, the correct and only plausible response should be to block the chimney with a rag (or something) and put the steam blower on to kill the fire by displacing the air and oxygen. But do be aware that this replicates the 'producer gas' reaction to generate carbon monoxide and hydrogen until the coals cease being red, so don't attempt it in a workshop!

Locomotive constraints

The 'Britannia' is possibly the most complicated of all in respect of its ashpan design. In common with many 4-6-2 Pacific wheel configurations the trailing driven axle lies in front of the firebox, which seems good news, but the pony truck frame holding the trailing two

wheels sits directly under that firebox. In addition, there are two extension frame members that run directly under the firebox to provide the pony truck support and hold the drag box that pulls the entire train. Other Pacific configurations, like a 'Coronation Pacific' (Duchess), have rear frame members that run around the firebox. Some model owners have designed a quickly detachable pony truck and can drop the ashpan when the truck is removed by overhanging the end of the track on a steaming bay. No such luck with the 'Britannia'. Photograph 20 is a view from the underside showing the ashpan hidden behind the pony truck, and the two frame extensions can be seen running behind the axle to the drag box.

Having seen the problem we need to try and find a solution. I should raise two more considerations: 1) It is best if the ashpan seals as well as possible when the engine is running because if not, never mind setting light to the track, the ash will get everywhere and mixed with oil it is like a fine grinding paste. 2) If the grate cannot be removed from below then it needs to be capable of being taken out



Stainless steel ashpan obscured by the pony truck and frame extensions.

somewhere because at some point in time it will burn or bend or crack or block or jam and you do not want to have to lift the boiler off to repair or replace it.

If we look at what happened in full size then the 'Britannia' had a rocking firegrate for easier fire disposal and doors in the bottom of the ashpan to rake out that fire. We can see from photo 20 that a door can open between the arms of the pony truck so we have a scale solution for the ashpan. However, when the full size 'Britannia' had a problem with its rocking grate then someone could climb into the firebox (when cool!) and manually lift out parts for replacement. This solution is not available to us as we do not have any 5 inch scale workshop assistants! I once heard a story of a builder who made a near scale 'rocking grate' for a BR Standard model, which on its first steaming jammed with ash pieces. I understand the engine is still waiting for the boiler to be removed to allow the grate to be replaced.

To my mind it is essential that the grate parts can be removed somehow. Back in the workshop, next day, it will be best to get those sections out anyway, vacuum it properly, and see that any parts are still free to move. You really do not want a design that could possibly jam with lumps of ash or clinker because, sure as the wind blows, it will.

Perrier design limitations

The Perrier design does have the doors in the bottom of the ashpan. They are called shutters and I will use that description from this point on as it avoids overuse of the word door and is more precise. The Perrier design also has a drop door in the centre of the grate, held up by a crank lever in the ashpan and connected by a shaft to an external handle. However, that grate is in one piece with the centre door. If any problem arises with the operation of that drop door then the boiler has to be lifted off to effect a repair.

To address this major weakness, some builders have devised a solution whereby the grate slides out from one side of the ashpan leaving the fire to fall through. The side entry grate is one piece and this overcomes any potential problem with the door and levers. It also means that the grate is taken out every time and can be cleaned and checked; both good things. However, although it works for some, it was not something I wanted. I do have a problem with imagining a grate sliding through a fixed slot while its bars are jammed with hard fire embers.

Winston (precursor to Modelworks) presumably saw the Perrier design problem and built their grate in three longitudinal pieces. The later Modelworks variant

Sketch to show arrangement of grate drop door within the ashpan.

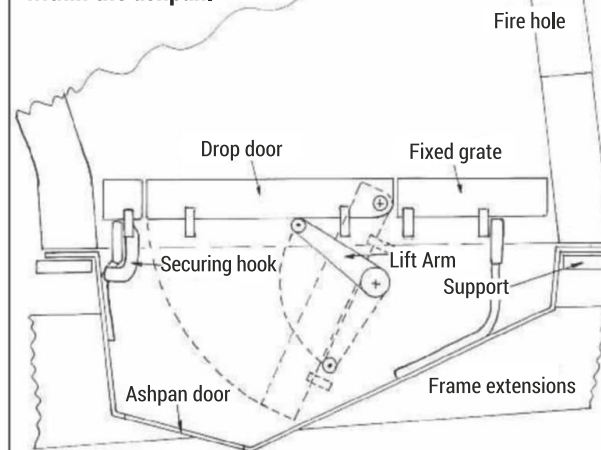


Fig 7

articulated each piece in three sections, with those sections suspended on long rods that passed through the side of the ashpan. At least, that is how I think it worked as by the time I got the engine the grate sections had been welded into stiff lengths and a previous user explained to me that the grate had been 'impossible' to manage. The three pieces could be passed through the firehole and this is where Winson/Modelworks got something right. The Perrier grate is 6 $\frac{3}{8}$ inches wide at the front and the bolt up assembly is $\frac{1}{2}$ inch deep. If you did try to cut it into three lengths you will have pieces of at least 2 $\frac{1}{8}$ inches width and the most you can get through the Perrier firehole door is a lump measuring 2 x $\frac{1}{2}$ inch. If you wanted to get it all through the firehole the grate would need to be in four lengths. Winson, however, introduced a larger firehole to the boiler design that will pass a 2 $\frac{1}{8}$ x $\frac{7}{8}$ inch grate section. The firebox is perhaps slightly narrower than the Perrier by $\frac{1}{4}$ inch at its widest so its grate is 6 $\frac{3}{8}$ inches. Cut into three, each piece is just under 2 $\frac{1}{8}$ inches.

These changes to the firehole dimensions mean that those with a Winson or Modelworks boiler do have some better options for grate design. Those with a Perrier boiler have to be a little more creative with their thoughts.

Chosen design

The 'Britannia' ashpan is divided into three portions by the two frame extension members. Because of the helpful design of the pony truck, it was clear that a centre shutter could be designed to open fully and allow the embers to pass through. Above it could sit three grate pieces, with the centre section having a drop door that discharged directly through the open shutter. A fire poker could be used to move the fire to the centre and help it fall through the door if needed. The important feature is that if there is any problem with the grate door then the centre section, and outer sections, can be lifted out through the firehole.

In the Perrier design, the drawings are not clear as to how the leverage supports the grate drop door. I thought it best to rework it from the start so made a simple sketch (fig 7) to determine the positions of all the components. The lift arm rotation point is constrained by many factors. Ideally, for leverage and stability, the lift point should be as far away from the grate hinge pins as possible and it would have been nice to have an 'over-centering' lift arm to provide a firm support but these seem unachievable. I did want the grate drop to make a clean

delivery of embers through the open shutter and this has been achieved. The centre grate piece would need to have a hook to anchor it under the support bar, otherwise the shortened lift arm would pick up the whole grate piece.

Note that the grate is located well above the firebox foundation ring. This should be a design principle for all grates because you must not heat copper firebox parts that are not protected by water on the other side. Once I was happy with this sketch design I made more specific drawings with dimensions to work to.

Firebox boiler support

The full-size 'Britannias' have two large feet, almost 12 inches square, protruding rearwards from the bottom of the firebox to ride upon the frame extensions. These feet slide on the extensions as the boiler heats up and expands. The feet are shown on the Perrier boiler drawings but they have not been copied to the Modelworks boiler. If the Modelworks boiler is left to just sit on the frames then it is far too low. This means it needs supporting on some form of bracket but mine seemed to be reliant on very flimsy pieces of iron. The Perrier design also shows firebox support brackets.

There is a problem in these models with securing the ashpan to the firebox. In

full-size there are large pegs protruding from the bottom face of the foundation ring. The ashpan is lifted up onto these, while the boiler is supported in some way, and then secured with wedges driven through slots in the pegs. This fixing method is not attempted on the Perrier or Modelworks boilers which means that the ashpan has to be propped up on those same firebox brackets with limited support at four points at best.

I thought this was all unsatisfactory and so designed a square support frame of the same shape as the foundation ring, and held this on four substantial brackets bolted to the frames (photo 21). This is not prototypical but to my mind is better than a poor design leaving everything to flop about. When finished, the square frame is not visually intrusive. I have also silver soldered a large bronze pin into the rear of the foundation ring (and yes the boiler has had a subsequent shell test) and this engages in a large bracket hole affixed to the square frame (not shown in this picture). The pin in the hole prevents upward and sideways movement of the boiler while permitting boiler expansion as the foundation ring slides on the ashpan, which is itself firmly located in the square frame.

Ashpan

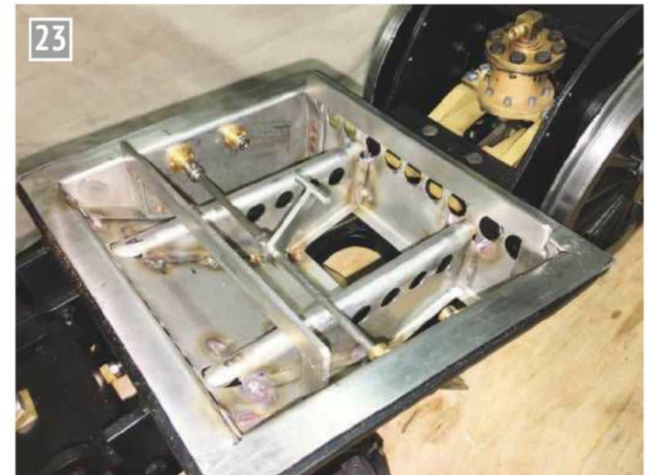
I have made an ashpan in stainless steel to a shape that largely follows the Perrier design, and indeed the prototype outline, and has three shutters at the bottom operated by lever, cross rod and arms (photo 22). The centre shutter will drop fully through the pony truck frame opening but the outside pair only drop 45° before they just catch the edge of the pony truck. This is how it has to be and I don't see it as a problem, as long as the doors don't accidentally drop while the locomotive is in motion! The centre shutter has the important task of disposing of the majority of the embers while the outer shutters need only release a smaller quantity of ash.

I drew the component outlines on card, added extra tabs and transferred the shapes to 0.9mm stainless steel sheet. When these were cut out I drilled as many holes as was reasonable in the upper vertical faces, but not in the visible sides. By choosing these positions I hope to limit the amount of ash that might escape. The engine will normally operate with the shutters closed and so there has to be adequate free air flow to all parts of the grate. Surprisingly, there are no additional ventilation holes shown in the Perrier drawings and this seems to me to be a big error.

I drilled 32 holes of 0.456 inch diameter with a step drill, this giving a cross sectional area total of around 5 sq.in. The grate is 6 x 6 $\frac{3}{8}$ inches but nearly half of this is obstructed by the grate bars giving a free area of around 20 sq.in. This means that the area of ventilation into the ashpan is only a quarter of that through empty firebars. Is this enough? Clearly, a full and burning fire offers quite an impedance to air and I am interested to find out what that might be. For now, I will be happy that I seem to have many more ashpan ventilation holes than I have seen in other designs.

I am fortunate that I have the equipment to TIG weld the stainless parts together; perhaps not beautifully but good enough to be strong! It would also be possible to fix it all together with rivets.

The grate door lift arm was made from stainless steel parts and TIG welded together (photo 23). It is fixed to the stainless shaft with a steel taper pin. I wanted to make all the parts and fixings positioned under the grate as robust as possible in view of the heat. The shaft runs in brass bushes each side that are riveted to the ashpan walls, and these bushes were eased out in diameter after fixing using long form drills to keep the bores aligned for the shaft. The shaft does have to be inserted through the bushes after the ashpan is located



Grate door lift arm and cross shaft added.

on the frame which is why, for now, I have a removable taper pin securing the lever.

The Perrier shutters sit on a shaft that runs directly under the openings and rotates in brackets fixed to the frames (photo 24). Neither of these features I wanted to replicate. I have therefore offset the shaft to lie away from the shutters and not block the openings. The shutter flaps themselves are each made from two pieces of stainless steel sheet riveted to hinge arms; a smaller inner piece that sits inside the ashpan opening and a larger cover. I made the hinge arms from a piece of stainless plate silver soldered to a round bar and then cut into slices and drilled. The arms for the centre shutter are fixed to the actuating cross shaft with small stainless grub screws.

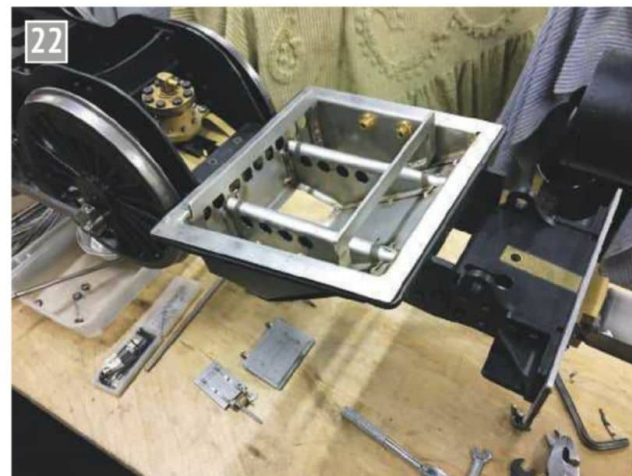
However, the outer shutters are free on the shaft and only held shut by the hinge thumbs that are grub screw locked to the shaft. By doing this the centre shutter can drop fully, while the outer shutters are free to fall until they strike the pony truck, or just happen to miss it as has occurred in photo 25.

I do not like using grub screws on a shaft to drive levers. To help make the job secure, I have drilled small pockets in the shaft to receive the grub screw ends so hopefully they will continue doing their job in the slightly cooler air outside the ashpan. If there is a failure I can always invert the engine for access and repair.

In the Perrier design, the actuating rod for the cylinder drain cocks actually runs through the ashpan with a



Square frame for ashpan and firebox support. After this picture was taken the support was lowered by $\frac{3}{8}$ inch to position better the boiler.



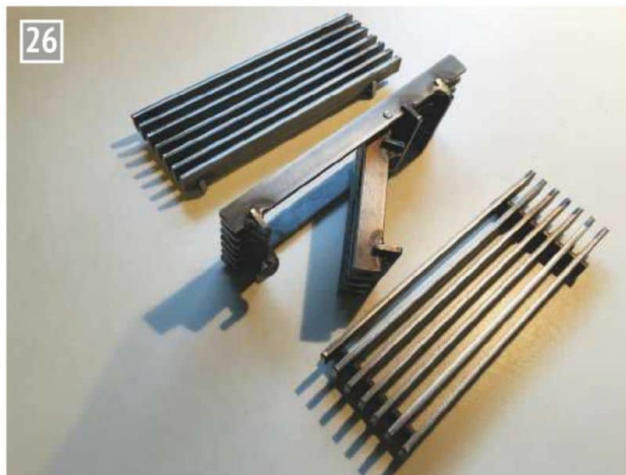
Stainless steel ashpan located in the firebox support frame.



Ashpan shutters.



Shutters open and the outer one just missing the pony truck arm.



The three grate sections.

slot in the bottom. This seems totally unnecessary. In photo 24 you can see that I have run the actuating rod in line with one frame extension to just miss the shutters and the cross shaft.

Grate

The three grate sections I have made are substantial and strong being TIG welded from 12 mm x 3 mm stainless bar (photo 26). The design was laid out in a CAD drawing which enabled a quick listing of all the lengths to cut and gave a plan for the milling of notches in cross bars. There are 21 longitudinal firebars with an average spacing of 7.7 mm, giving a free air proportion of around 60%. The milled notches made it a simpler job to align all the bars and hold them for welding. The overall shape is a little tricky to manage as it is a trapezoid (trapezium UK) so the left and right outer pieces are most definitely handed.

The centre section has solid bar sides to give it rigidity and allow the mounting of hinge pins; these are permanently affixed when it is welded together. It also has a single hook at the front to catch under the forward ash pan cross bar. This is needed because as the actuating arm swings forward and up to hold the door from below, it would otherwise lift the grate section. The centre section grate mass holds the back down. The

drop door opening is 1¾ x 2¾ inches which should hopefully be a good hole through which to push the fire.

When putting the parts through the firehole the centre section goes in last and it has angled cross bar ends that bear down on the matching angled ends on the outer sections to help hold and stabilise them. It is quite simple to locate feeding it in nose first and pointing down to engage under the ashpan cross bar. The support crossbars that rise from the ashpan are positioned to locate closely to the grate crossbars, again helping to create a firm assembly (photo 27).

I would not like to make the grate without a TIG welder. A MIG with stainless wire would perhaps hold it together and be slightly more messy. A bolted-up design would have difficulties in that the nut heads will increase the dimensions fractionally, leading to gaps between the sections and reducing



Three grate sections mounted on the ashpan cross bars.



Ashpan levers. Grate drop door lever above and shutter closing lever at the bottom.

clearance when passing them through the firehole. It might be better to have round cross bars that are riveted over into countersunk outer bars.

The one weakness of this design is that the grate lift arm has to be held in its upper position at just the right angle in order to hold the grate level. I have fixed a hook to secure the lift arm that can be seen in photo 28. The lever operation has some built in safety to

guard against accidental release. To drop the grate door the lever has to be lifted, then eased out pulling the shaft until it is clear of the hook and can be lowered. The ash door lever at the bottom will probably be fitted with a pull rod running back up to the cab, a feature that is prototypical, operating the damper doors.

●To be continued.

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Petrol Engine and Alternator Sets

PART 3

How to make them work well and why they often don't

Jon Freeman explains how to make petrol engines and electrical alternators work efficiently together.



Continued from p.705
M.E. 4652, 14 November 2020

How good should voltage regulation be?

One quoted parameter of voltage regulators is 'load regulation'. This is a measure of how little output voltage changes with load conditions. The earlier experiment with the Lucas regulator showed this quite aggressively regulated to 14.5 volts. In a car fitted with this system voltages deviating by more than about 0.25 volts either side of this would be rare, except during overloads. In powering a locomotive, regulating voltage this tightly is not required and can work against us.

For example, a club member brought his newly designed petrol-electric locomotive to the club track for testing. He'd run it at home the previous day and all was well. He ran it several laps, powered from internal lead-acid batteries. When he then tried to start the engine, this proved impossible. The problem here was that with the batteries now below full voltage, the alternator attempted delivery of high current when spun just by a pull of the starting cord! Input torque ramped up to beyond engine stall-torque, not giving the engine even a chance to spark up. In this case, more relaxed load regulation could have helped.

In a locomotive traction system, a nominal 24 volt system can be expected to work happily over a range of perhaps 22 to 30 volts, catering for batteries in all states of charge. We can design the smart-regulator

to have a softer, less rigid, attitude to load regulation, instead letting the output voltage vary a few percent either side of nominal. This suggests one possible control strategy where engine speed is set according to voltage, higher powers delivered when the voltage is pulled lower by heavy loading, and *vice versa*. This would solve any battery related starting problems.

Progressing to the detail of electronic design. The MCP1630 PWM (Pulse Width Modulation) controller chip is capable of directly driving a MOSFET switch to energise the rotor field coil. These two, with a few other small components, are nearly all that's needed to replace the old regulator with something similar, with the added benefit of a softer regulation characteristic. The MCP1630 data sheet is comprehensive and gave all the information needed to get this far. A periodic pulse train is needed to initiate PWM cycles, this to be provided by the microcontroller, a clever feature being that this is itself a PWM signal, the duty ratio of which limits the maximum duty ratio of the final PWM output. This is precisely what's needed in the attempt to match alternator and engine torque characteristics.

Use a lookup table

As the microcontroller is to read engine speed, the next thought is of how to use this in alternator control. As already noted, limiting field current

PWM in some speed related manner makes sense but what exactly is the relationship? The answer is not immediately obvious. This led to thoughts of using a lookup table in software. This would take measured engine speed as the index into a table of engine speed-related PWM duty ratio limit value percentages. The number from 0 to 100 'looked-up' and read from the table relating to 'x' RPM could then be used to limit duty ratio (hence field current and load torque) at engine speeds in the region of 'x' RPM. With some care and patience in creating the lookup table, it becomes possible to tailor your own alternator torque characteristic to resemble that of your engine, or to whatever shape you want! Filling table entries for unusable low speeds with zero percent sets the field current to zero at these speeds – there's no point wasting energy when you know no useful output is available.

That decided, how best to go about picking sensible numbers to populate the table remains far from obvious. For this reason, an external memory chip was selected, a 24LC64 EEPROM (Electrically Erasable Programmable Read Only Memory). By placing the table here it can be easily 'table-tweaked' using a laptop or PC connected through USB, enabling easy updates in the field if needed. The table is quite coarse with only twenty or so entries covering the speed range from zero RPM to a little over maximum.

This was to make it quick and easy to set up with few values to tweak. Internally, the microcontroller calculates and fills a much larger table with many more results interpolated to ensure smooth control.

Using the lookup table, and making it simple for users to set the contents, the system is useable for a wide range of engines, driving a wide range of alternators. Setting up and fine-tuning a system becomes a simple matter of tweaking table values to optimise performance.

Design of the electronics

The electronic design process for a project such as this has become easier over time. Moore's Law (more of an observation than a proper 'law') has held true enough since the mid 1970s. It states that due to continuing improvements in semiconductor manufacturing technology, the number of transistors in an area of silicon integrated circuit doubles about every two years. This means the cost of any function halves, or the capability doubles, every two years. This suggests that a pound's worth of year 2020 logic chips has one thousand times the power or capability compared to a pound's worth of Y2K logic chips purchased at the turn of the century (having doubled ten times since, $2^{10} = 1024$). If this claim seems too outrageous to believe, have a look at a smart-phone today

and try to remember those of 20 years ago.

This has radically changed approaches to electronic design. Twenty years ago the task of finding the right microcontroller for a job often involved worrying about how, or if, your application might be squeezed onto a sparsely resourced 8 bit architecture. Much time would be spent being distracted from the goal, concentrating instead on working around microcontroller minutiae. Not any longer. At time of writing there were 167 different 'mbed' (www.mbed.com) compatible 32 bit

ARM Cortex microcontroller development boards available from a number of industry leaders, all listed at <https://os.mbed.com/platforms/>. It makes for an interesting read looking through these to get a feel for the huge range of features and technologies they bring into our reach. Any one of a large number of these would have been useable for this project.

Figure 13 shows the ST Nucleo L432KC chosen, priced at under £10. At this price, spending any time at all looking at less capable Arduinos or other 8 bit

controllers simply cannot be justified. That's not to say 8 bit controllers aren't up to the job - they might very well be - but why risk wasting time finding out? Even for volume production this design route would be justifiable as it leads to a short and inexpensive journey. Time can be spent penny-pinching later, if it's ever worth it.

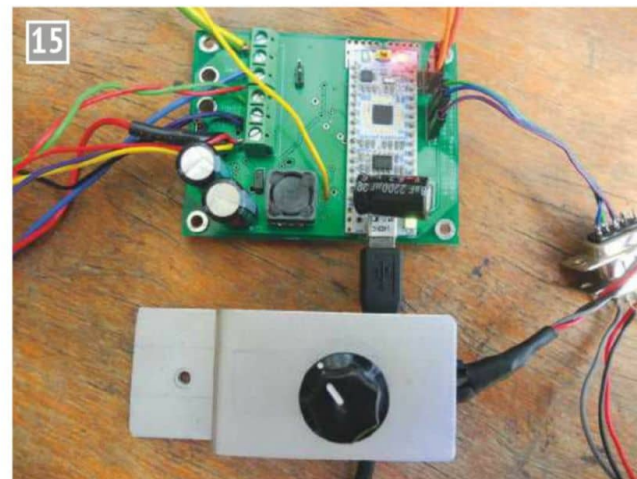
Using the free, online mbed IDE (Integrated Development Environment), all you need is any computer with internet, a web browser and a USB lead. There is nothing to download or install. Having set up a free

account and logged on to the mbed.com 'Compiler' page, you are ready to start creating code in plain, worldwide industry standard C or C++. Arduino users would have no problem working with mbed, much will be very familiar and even easier to use. Photograph 13 shows the set up used during nearly all software development. The two small boards shown connected to the Nucleo L432 are one for the eeprom and the other a temperature sensor (which costs pennies and shares the same 'I2C' connecting wires, so why not?). Library functions for these, and numerous other sensors and devices, are available to import, saving a lot of effort.

A double-sided circuit board (photo 14) was designed using 'Easy PC'. Thinking ahead to the needs of proactive control capability, other features were added including an ammeter chip capable of measuring current, or any other current, and an analogue output amplifier

for forwarding a modified driver's pot signal. The idea of including a GPS module as a speedometer was entertained - a distraction for another day. PCB output files were emailed to China and soon after the bare boards arrived. Full details, circuit diagrams, parts lists and software listings can all be found on www.jons-workshop.com

Once built, initial bench tests of the electronics were performed (photo 15). Excluding alternator field current, the electronics consumes very little, a few milliamps from a 10 to 60 volt supply. The design includes a high efficiency 5 volt switching regulator capable of delivering 1 amp. This was to cater for the most power-hungry item, the engine control servo. Tests showed the circuit cannot power a heavy duty servo, but a normal duty servo proved more than powerful enough. Experience with a similar arrangement on the 'Brushless Brutalist' suggests choosing a quality item with metal gears.



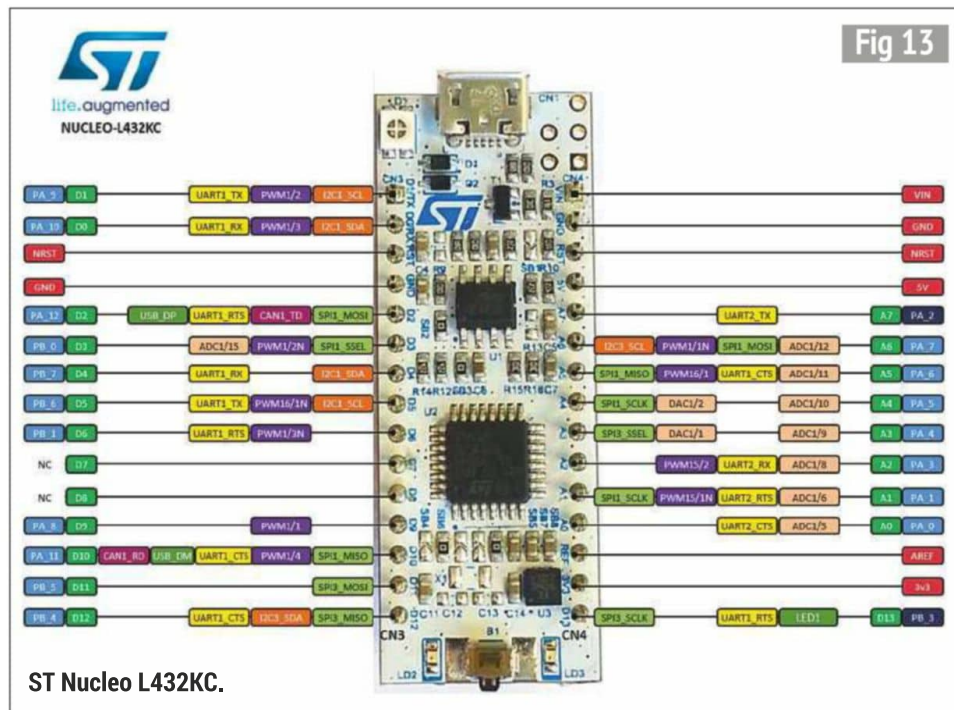
New regulator built and tested.

The only problem seen with 'The Brute' so far, was found to be mashed plastic gears in a cheap servo.

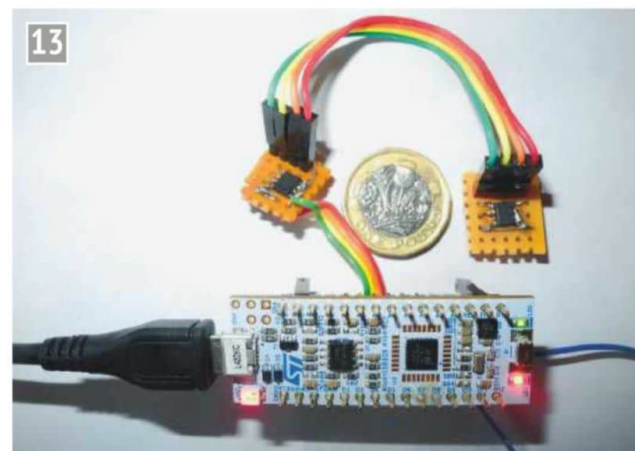
A few minor faults and problems were found with the circuit design, some errors and omissions, all dealt with by hacking and bodging a few PCB tracks, all normal project debug activities, no

big surprises. With these corrected, the PCB design was revisited on Easy PC and files for the Mk 2 board were prepared, ready to send to China with a view to building a final version at some future date.

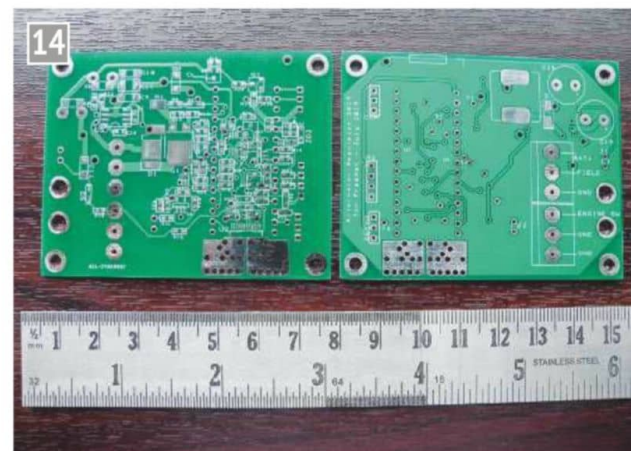
● To be continued.



ST Nucleo L432KC.



Software development kit.



Printed circuit boards.

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● Alternators

Jon Freeman conducts the first live tests of his petrol engine/alternator combination.

● Worms

John Moorhouse explores the use of worm gears in clockwork mechanisms.

● Prince of Wales Frames

Graham Langer discusses the design and manufacture of the frames for P2 locomotive *Prince of Wales*.

● LBSC's Toy Trains

Roger Backhouse looks back on LBSC's reminiscences in *Model Engineer* on the subject of toy trains.

● Christmas Tale

Rafe Shirley recalls a memorable Christmas Eve and his encounter with Santa himself.



Content may be subject to change.

ON SALE 18 DECEMBER 2020



Pete's Polly bearing his wife's name – HILARY JANE.

The Making of Hilary Jane PART 2

Pete Smith fulfils a life-long dream of building his own locomotive, with Polly's help.



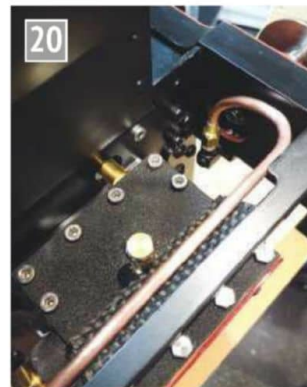
Kit 8 arrived in June 2019. Fitting the lengthy bypass pipe from the axle driven water pump to the position in the cab was proving tricky. To make this easier I decided to cut it halfway along its length and insert a connector. Under a live steam test, it resulted in cold water from the saddle tank being heated as it passed by the ash pan. Apparently, I mistakenly routed the pipe too close to the ash pan and it seemed to be picking up heat from that area. Hot water returning to the saddle tank is not a good idea, because this water is used by the injector which requires cold water to operate efficiently.

As a result of the heating problem I experienced here, I decided to re-route the bypass pipe completely. The solution I contrived was a lot more work



Experimental manifold.

but I chose to redirect the pipe from the axle pump forward and under the front buffer beam with a manifold fitting that I made up from my small material stock (photo 19). Fitting the manifold diverted the course of the pipe to the cylinder side of the frames.



Re-routing of the bypass pipe.

Then I bent the pipe up and over the steam chest covers, under and along the valance, ending up in the cab via a few more fittings at the original entry point. I made sure it was well insulated with black glass fibre insulation on top of the steam chest cover (photo 20).

Now the fun began with Kit 9 in July 2019, containing the smokebox, superheater and, importantly, the most expensive item in the twelve kits; the boiler. The boiler is subcontracted by Polly Model Engineering to Brian Nicholls (Model Engineering Services). It required little preparation as it was extremely well-made and a certified boiler (photo 21).

The smokebox was an entirely different matter. Continuing with my desire to build a well presented locomotive, I had this supplied without the cosmetic rivets in place so that I could smooth and clean up the surface prior to spray painting. In a few places I used some metal filler to achieve the finish I strived for (photo 22). I sprayed it with a paint designed for woodburning stoves, which gave an attractive satin black finish.

Kit 10 arrived and the parts here that required real attention were the smokebox door and the bottom of the chimney profile, which required extensive use of a hand file to obtain a suitable contour. Attention to detail here produced a fine-looking assembly (photo 23).

Fitting the glass fibre insulation material and steel cleading was challenging but I managed to hold the insulation together with insulation tape (photo 24) and then hit on the idea of using a ratchet clamp to squeeze the cleading tightly over the glass fibre lagging and eventually got the whole assembly to fit between the frames. The clamp also came in useful when fitting the cab over the boiler where again I had to squeeze the firebox covering to aid assembly (photo 25).

Kit 11 presented me with the backhead fittings, platework, lubricator and linkage. Again, I used the heat proof paint that I used on the smokebox to spray paint the backhead and again it gave an attractive sheen. On the fire hole door and assembly I used chemical blacking but I am not sure how

this will stand up to heat. My gut feeling is that it should be fine. Loctite 2400 was supplied with this kit which I used on the boiler valves and fittings which gave me time to adjust

the alignment before the Loctite set (photo 26).

Fitting the platework was relatively simple, just requiring the usual deburring and prepping for painting. I again

used spray paint in satin black which I much prefer to gloss (photo 27).

To paint the lubricator I had to take it apart but I am glad that I did because it helped



Boiler assembled with superheater pipe.



Preparation of the smokebox.



Completed smokebox assembly.



Glass fibre insulation in place.



Squeezing the cleading to fit the boiler into the frames.



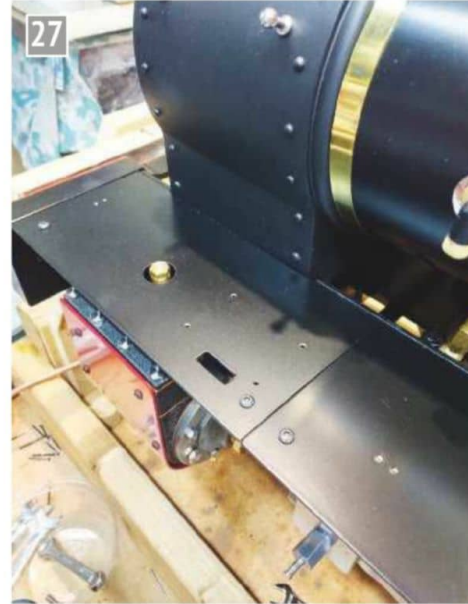
Fittings assembled on the backhead.

me understand how the piston worked regarding its position in the tube. Unfortunately, I dropped the small steel valve ball on the shop floor, resulting in a great deal of grumbling and cursing. Moral – disassemble small mechanical items in some form of retaining tray. All is well though because I (eventually) found the stainless-steel ball.

Whilst at the Midlands Exhibition, I ordered some name plates from Peter Wood Nameplates who uses a laser cutting machine for plastics. I was extremely impressed with the quality and price of his work and considered the plates very convenient until I could obtain more expensive brass made plates. I put one on the lubricator and one each side of the cab (**photo 28**). More permanent brass builder's plates have been made by Diane Carney Nameplates, which require a small amount of finishing work.

Kit 12 was delivered in late November 2019. This was the final kit to enable completion of my locomotive. This included the cab, saddle tank, dome, ash pan and the remaining parts for completion. All the parts required the usual deburring and preparation before painting. The saddle tank required the most work, which presented me with an opportunity to really spend some time on it (**photo 29**). The dome cover required some aggressive filing to remove the corrugated edge produced by the pressing. As these parts were going to be its crowning glory, I spent a lot of time preparing them before painting, which would prove very worthwhile.

The cab required a small amount of profiling to make it fit over the cleading but, with a careful bit of profiling, eventually it fitted nicely in place. Fitting the rear cab panels was a bit tricky and required some guess work on how to latch it to the cab. Again, with a bit of ingenuity it fits nicely into place (**photo 30**).



Platework sprayed with satin black.



Saddle tank ready for painting.

I modified the tank filler lid by replacing the small knob for a larger knob with breather holes. It now looks more substantial and looking like a safety valve. The 'Hilary Jane' name plates were made originally for my Simplex locomotive very many years ago by Diane Carney.

The window frames required a lot of fiddly deburring and polishing, but very worthwhile, and are now sitting proudly on the paintwork (**photo 31**).

Originally, I intended to do all the red paint spraying of



Builder's plate in position on cab.



Completed cab.



Window frames in position.

the tank and superstructure myself, relying on warm summer weather, away from neighbours in my reasonable sized garden. However, this was January 2020 and the weather very un-suitable for paint spraying. The solution was to get these parts spray painted by a local specialist.

The result was outstanding and the paintwork really set off the rest of my build. The choice of colour was influenced by The Ffestiniog and Welsh Highland Railway, where many of their narrow-gauge locomotives are painted red, the resultant choice being Night Fire Red. Not being a true locomotive colour, it adds a degree of fascination to a small locomotive and I am incredibly pleased with the result (**photo 32**).

When I conducted the first live steam test on a rolling road, there was no way of knowing how much water was left in the saddle tank. It was like driving a car without a fuel gauge. The obvious answer was to fit a water gauge.

I settled on making a sight glass style indicator. I chose 6mm diameter Perspex tubing, locating it in the cab on the left-hand side next to the pressure gauge. It is fed from the saddle tank via a feed pipe which goes through the running plate and supplies water to the hand pump. I introduced a tee joint before it enters the running plate, piped it through the cab and connected it with a right-angled fitting to the gauge. It clearly shows the water level in the saddle tank, looking much like a thermometer (**photo 33**).

All that was required then was to get the hydraulic test carried out and to experience what has been somewhat of a lifelong ambition, that of building my own locomotive and driving it on a track.

The build was completed just before the lockdown during the Covid-19 crisis which prevented me from testing my locomotive on a track. However, by a stroke of good luck several months



Completed locomotive in Night Fire Red.



Saddle tank water gauge in position.



Boys' toys I know, but a comprehensive and satisfying project. (Photo courtesy of Helen Hale.)

later, Dr Helen Hale and Tim Coles invited me to the Cambridge & District MES track to test my locomotive. One of the members of the club hydraulically tested

the boiler and issued the certification. After Tim provided some training on how to fire and drive a steam locomotive, to my delight, my locomotive performed

perfectly. It was then, and only then, that I realised that I had accomplished one of my lifetime ambitions (**photo 34**).

ME

I was chatting with some of the locals on the amateur radio and one of them said one of his locals, who couldn't hear me directly, had asked if I could telephone him, on a model engineering matter. When I did, it transpired that he had a model traction engine built by his uncle, now deceased, some years ago and he now wanted to sell it and what's it worth? I admitted that I was not able to do so personally "... but I know a man who can!" said I. He is to send me pictures and I will enquire.

I ordered a 2.5 metre length of plastic moulding to finish off a job in the kitchen, expecting it to be delivered in a large diameter coil. What arrived was a long, thin parcel, which reminded me of the rhubarb pie in the comics of my youth. Anyway, it had been sent in a piece of plastic pipe

for protection. This provoked a thought, 'unexpected item in the piping area'.

John Townsend writes to direct my attention towards the back page of *M.E.* issue 4649, in particular the Morgan Rushworth box and pan folder. 'How thoughtful it was to provide extra fingers', he says. Keep 'em coming!

My Bolide is reaching a critical point in its construction. Will it work? I quickly found several snagging points. The wheels are not properly spaced. The motor bracket fouled the track. The track is wide to gauge in places. These were easily dealt with and a Tractive Effort of 3kg measured, with it unladen. The wheels are not very securely fastened to the axles, being plain discs, so I have ordered a billet of aluminium and will make 'top hat' bushes to support them and provide a

means of securing them in a positive manner.

In this issue, TSGR still open, a taxi, a coffee table, a pike, petrol, a robot, value, dry storage and a pig in a poke.

At the Sheffield Auction Gallery, referred to last time, three Holtzapffel calipers were on offer. I don't know much about them beyond their Wikipedia entry but they went for about ten times the 'new' price of their more mundane workaday companions (photos 1 and 2).

Dennis Kitson writes regarding my remarks on Teesside Small Gauge Railway in *M.E.* 4648. I may have given the impression that TSGR were closing. I can confirm that this referred to another club and that TSGR is in fact thriving and membership has increased despite lockdowns. **W. www.tsgr.co.uk**

Stamford Model Engineering Society newsletter for September shows us another simple gramophone from 1920. This one is by the Pathé Brothers who, like many of their countrymen, did things differently, e.g. Citroen DS and 2CV. It is very simple; a shallow cone with a sharp tip which rests in the groove, whilst the cone is attached to the baseboard at its edge. It provides very good quality sound.

Halesworth & District Model Engineering Society's autumn newsletter saw chairman, Philip Hall, visit an antique shop and he bought a coffee table. No normal coffee table this - it had a complete, working, scenic, N-gauge railway built into it! Chris Rackham compiled a piece on his display locomotive track, with photographs, entirely on his mobile phone and sent it to editor, Julie Williams to include in the newsletter. A good use of technology! He wanted a length of proper display track but it should be (he says) suitably distressed to match the locomotive. So, in an analogy to the treatment of ordinary furniture to create 'antiques', he distressed the track accordingly. This

involved the aggressive use of a Stanley knife, a grit-blasting cabinet and some strong, black tea. Not for him, the track! This produced a very authentic-looking track with a well-used appearance. In an interesting, lateral thinking way, Through the (Workshop) Keyhole has a look round an anonymous member's workshop. *Pièce de resistance* is a stuffed pike. 'What is its name?' people ask. A double-deck display contains a couple of Mamod steam models and a train running around the top of the walls, under the eaves, is hauled by LBSC's *Virginia*. Next in this eclectic mix is a wooden fishing trawler, bought off eBay and being restored.

W. www.hdmes.co.uk

Norwich & District Society of Model Engineers sends their August-October *e-Bulletin*, which begins with a quandary. The club's A3 locomotive has seen little use, partly because its boiler is soft-soldered. It is currently okay but if it begins to leak, repair would be very difficult. This locomotive's origins are uncertain, possibly built in the inter-war years, and it may have been used commercially. Just after WWII, with petrol rationing still extant, miniature railways proved quite popular. However, some club members were reluctant to give their valued petrol allowance to the club. Chingford was one such so it therefore applied for, and got, an allowance (five gallons per month) enabling petrol locomotives to run without fuel problems. The letter requesting this allowance is reproduced in the newsletter.

W. www.ndsme.org

The Prospectus, September, from **Reading Society of Model Engineers** arrived, in which John Spokes writes on 3D printing, or Additive Manufacturing. Visiting an industrial exhibition, he was intrigued by the idea of using this process to produce a complex item such as a Nord railway bufferstock, a photograph of which which he just happened to have about his person (as you

do ...). Discussing the idea with several companies, he found one prepared to try the suggestion, in sintered stainless steel, at their expense! Alec Bray describes photographing the last steam train on BR; IT57, the Fifteen Guinea Special, at Ribbleshead, in fine weather. Mike Jones continues his series on his lifetime railway interest, mentioning *inter alia* the Darjeeling & Himalayan railway. In the course of visiting this World Heritage site he experienced a taxi ride. 'So what?' I hear you say. In a 1948 Land Rover??? This 1949 version owned by a good friend of mine is the closest I could find (photo 3). Serendipitously, the close arrival of the next edition, *The Prospectus*, October, opens with a fine picture, taken this year, of a Fowler six-furrow steam plough at work, using two Fowler Z7s repatriated from Mozambique. David Scott writes on derusting and 'fettling' several heavily corroded items of machine tooling. John Spokes details the narrow gauge railway network of North Poland. He notes that the border 'twixt Poland and Russia is a mere sign on a rusty pole and a bit of old razor wire.

W. www.prospectparkrailway.co.uk

Stockholes Farm Miniature Railway's *Newsheet* reveals that Ivan and Barbara Smith celebrated their Golden Wedding last year and toured Scotland by train. This year there were no such opportunities, so they ran their own Anniversary Special, followed by a home produced meal and a bottle. Ivan quite enjoyed it, from that which he remembers... In July, he travelled to Scunthorpe for the first time in 17 weeks. Oh, the excitement!

W. www.sfmr.co.uk

In **Bradford Model Engineering Society's** *Monthly Bulletin*, a letter has been received from a gentleman with a large (1 metre high) crane model, acquired with his new house, which he would



1949 Series One Land Rover. (Photo courtesy of J. D. Stockwell.)

like identifying. (It looks to me like the preserved cantilever crane on the Tyne - Geoff.) Dominic Scholes writes on using a rotary table. Also, the previously mentioned brief article on firebricks has taken on a life of its own ... apart from my mention in *M.E.* 4648, a full article has been submitted for publication and it has been mentioned on the Model Engineering Website. **W. www.bradfordmes.uk**

James Buxton wrote to me about the item, also in *M.E.* 4648, about tapping heads. He thought it was an Archer product, of Sheffield. I found an illustration of a box from the company, showing 'Archer' as a brand name but I can find nothing about the company that made them. Anyone know?

The Journal, from the **Society of Model & Experimental Engineers**, October, introduces Eric, a 2016 replica of the first British humanoid robot of 1928, i.e. not long after the word 'robot' had been introduced to the English language. (In 1920, Karel Capek used the term to describe a fictional humanoid in his Czech-language play, *Rossums Universal Robots* and the term has entered the language - Geoff.) Several items of correspondence discuss resisting materials for controlling molten silver solder. It seems that Tipp-Ex and Milk of Magnesia are still the best readily available compounds. Neil Read continues on tapping, in particular getting

the tap 'square on' to the work. Werner Jeggli writes on steam turbines, especially using 3D printed wax patterns. Gareth Hughes discusses price and value. Using various analogies, he shows that 'cheap' is rarely worth indulging in but many people seem unable to see this. In an item which will need much cogitation on my part, Duncan Webster describes Morton's and JMG valve gear. All valve gears have their advantages, i.e. Heywood's had no component moving closer to the rail height than the big ends, which is important in a small wheeled narrow gauge locomotive. **W. www.sm-ee.co.uk**

A slight shortage of pictures, so here is a very nice collection of very tidy small engines at Sheffield Auctions earlier this year (photo 4).

Welling & District Model Engineering Society newsletter, Oct-Nov, has editor, Tony Riley pondering on watching more TV in the lockdown and has found and thoroughly recommends, the British Transport Film, *Fully Fitted Freight*. I enjoyed this and the others in the series and recommend them for when readers need a change from the workshop. Bob Underwood explains how he burned a large hole in his locomotive firebox grate and Andy Houston spoils his own day by trying to be economical with metal. He also offered a handy tip: he keeps his raw steel in the bottom of the wardrobe - it's

Geoff Theasby reports on the latest news from the Clubs.



A Holtzapffel caliper.



Two Holtzapffel calipers.

the driest place he could find. Tony Riley found an interesting item in the 1902 *Locomotive Magazine*. This concerned the Macallan blastpipe, named after Mr. G. Blastpipe Macallan, of the GER. A model of Trevithick's steam dredger engine is to be seen online. Look for johnsmachines on YouTube.

W. www.wdmes.co.uk

Tyneside Society of Model & Experimental Engineers

has produced another copy of *Inside Motion* for October and in honour of the latest lockdown, secretary, Linda suggests it be renamed *Outside Motionless*. Mick Jordison makes a boiler feed pump for his *Wren*, Peter Dawes updates us on his garden railway, including this oscillator-powered Avonside (photo 5) and this issue concludes with a picture of Ian Spencer's prone driving style, or 'sky-diving' technique, in this case driving a locomotive.

W. www.tsmee.co.uk

On Track, from **Richmond Hill, Live Steamers**, October, has little of note to report. President, Bruno Todeschi has stepped down due to the pressure of his other interests. There are several locomotives

for sale, some due to the lockdown making it difficult to run them, especially where the seller has other engines. A posting online, illustrated by a picture of Sir Isaac Newton, says he invented calculus whilst in lockdown from the plague and asks; 'how bored do you have to be to invent calculus?'

W. www.richmond-hill-live-steamers.tripod.com

Ryedale Society of Model Engineers, September has Graham Dixon updating the details on *Madge*, his 7¼ inch gauge Jumbo. In setting the valve events, he had recourse to the internet for a 360 degree protractor, so that he could verify the valve events 'all the way round' as no one seems to mention checking a full rotation in this matter. As the gear was designed by Francis Webb of the LNWR, Graham wished to confirm that Mr. Webb's design was accurate. And it was! Colin Bainbridge bought a 5 inch gauge Simplex online, which looked okay in the pictures. 'Of course, we don't always accept such a model without reservations and some things may not meet with our approval.' *Hmmm*. He found:



A selection of small engines at Sheffield Auctions.

1) that one frame is longer than the other, so the buffer beams are not square and the stretchers are too long, making it bulge; 2) Most of the axleboxes are bespoke to their hornblocks and loose on the axle; 3) many of the cylinder stud holes have broken through into the ports and one cylinder itself is closer to the driven axle than the other. This has been 'corrected' by the cylinder casting being drilled to match and not 'as drawing'; 4) the weighshaft

bearing and coupling rods fitted very well, if the previous errors were uncorrected. So, it's a mess. He does not intend to find out if it could be made to work. *Caveat Emptor!* And then some.

W. www.rsme.co.uk

And finally, Ireland has launched a potato into orbit, named Spudnik 1.

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Avonside at TSMEE. (Photo courtesy of Peter J. D. K. Dawes.)

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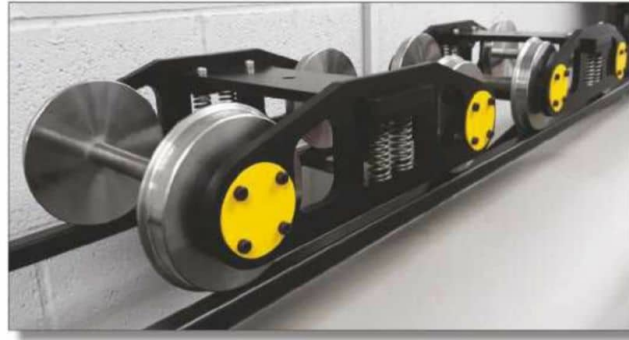
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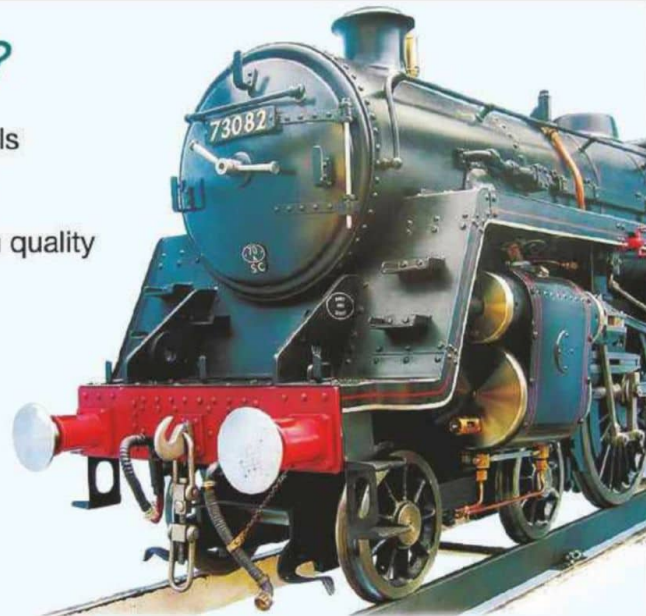
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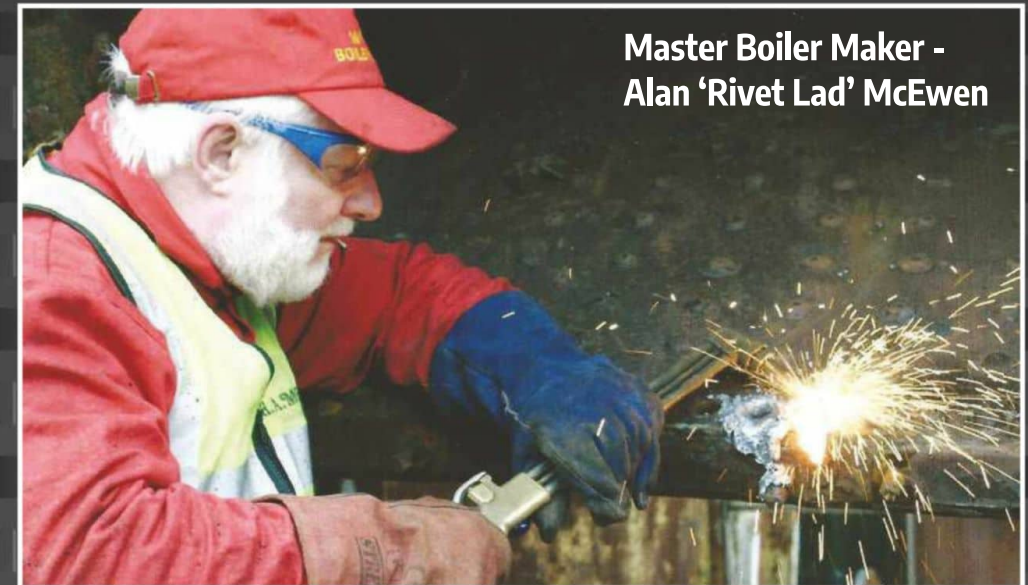
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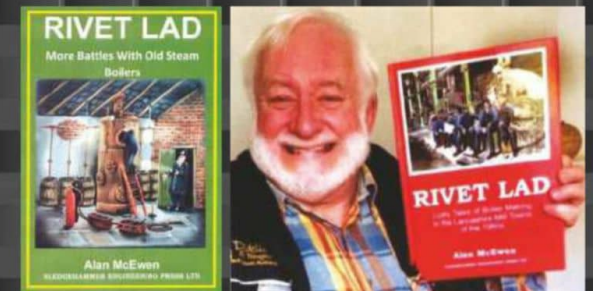
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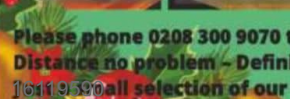
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