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MODEL ENGINEER

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Flying Scotsman
Centre con-rod

Motor Rewind
Designing a dual winding

COVER FEATURE

Dreaming Spires
A day out in Oxford

IMLEC 2022
Full list of this year's results

MORTONS

MODEL ENGINEER

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IN THIS ISSUE

Vol. 229 No. 4698 26 August - 8 September 2022

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See page 306 for details.

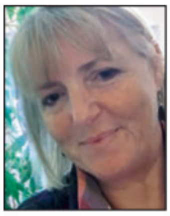
ON THE COVER...

James Duncan supervises an apprentice driver behind his five-inch gauge BR small Prairie (photo: John Arrowsmith).

This issue was published on August 26, 2022.
The next will be on sale on September 9,

SMOKE RINGS

MARTIN EVANS
Editor



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Autumn Shows

The summer is drawing to a close and thoughts turn to autumn. Cheerful thoughts though for, as well as being the 'season of mists and mellow fruitfulness' (etc.), it is the season for a couple of exhibitions.

In the middle of October is the Midlands Model Engineering Exhibition, the only major show we shall have had this year. It takes place at the Warwickshire Event Centre from Thursday to Saturday, October 13-16. Meridienne Exhibitions write to say:

'This is **THE Show for Model Engineers** and expected to be the only major model engineering show taking place in 2022. Come along and meet nearly 30 clubs and societies. Talk model engineering with other enthusiasts, pick up tips and share experiences. Learn from the experts in the workshop. Noel Shelley will also be offering a drill bit sharpening service for up to 3 items per person – time permitting.

'Buy from up to 50 of the specialist model engineering stockists and the vast range of products on offer.

'See the wide variety of steam traction and road vehicles presented by the 'Fosse Way Steamers'. Signal Fuels will be at the exhibition on Thursday only this year if you want to purchase coal supplies.

'See nearly 1,000 superb models on display, from stunning locomotives, to horology and maritime models.

'Tickets are on sale NOW and must be purchased in advance at present via the website to guarantee entry to the show in 2022. The organisers are very hopeful that tickets will be available on the day of your visit to purchase, but this decision will not be made until 3rd October 2022 pending any changes to the Covid-19 restrictions.

'Why not be part of the show and enter your work in the 32 competition and display classes? Cash prizes and trophies will be awarded to the best entries. Closing deadline for all entries is Monday 19th September.

'See www.midlandsmodelengineering.co.uk to book tickets, for full competition details or further details of the show and exhibitors present.'

If you cannot wait until mid-October, the St Albans and District Model Engineering Society will be presenting a show on the weekend of September 24-25 at the Townsend Church of England School on the edge of St Albans. This is billed as the BIG model show and promises 'Models that Move'. These include a miniature railway (FREE train rides!), traction engines, model boats, radio-controlled trucks and aircraft. It sounds to me like a rather fine day out. Further information is at www.stalbansmes.com/the-big-st-albans-model-show-2022.

If all that is not enough, LOWMEX is back! After a three-year absence, by courtesy of covid, the Halesworth and District MES will once more be presenting the Lowestoft Model Engineering Exhibition. This year's show takes place at the Energy Skills Centre in Lowestoft on the weekend of October 29/30. This is a wide ranging and fun show, covering locomotives, traction engines, 'planes, boats and even steam punk! The show webpage is at **www.lowmex.co.uk**.

IMLEC/LittleLEC

In this issue, Dave Tompkins completes his report on this year's International Model Locomotive Efficiency Competition held recently at Guildford. We also provide a full list of the results. Next year's IMLEC will be hosted by the Bristol Model Engineers at Ashton Court, on a date yet to be determined.

This year's LittleLEC was held at Reading in June and we will include a report on that in our next issue. So stand by for further eLECtrification next time!

Roy Flowers drives his Polly 5 at the Isle of Sheppey rally.

Les Pritchard, frequent competitor and past winner at LittleLEC, wins the 3½ inch gauge category at this year's IMLEC with his LBSC 'Mona' locomotive. (Photo: Andy Ash)

Polly Rally

If you are the owner of one of the many popular Polly locomotives, you might like to take it along to the Polly Owners Group rally at the Urmston club on September 10. You can find out more by contacting Neil Mortimer on 07900 133201 or at neiljmortimer@gmail.com


Out in the park, Simon Mulford drives the superb GWR Small Prairie.

Inside the new repair and storage shop.

Dreaming Spires Rally

John Arrowsmith pays a visit to Cutteslowe Park.

This annual event is held at the City of Oxford Model Engineering Society (COSME) site in Cutteslowe Park in Oxford. I went on the Saturday of the three-day event and on a lovely warm summer morning the site looked immaculate; they must have a very dedicated team to keep this large area looking as it does. The club was already a hive of activity when I arrived and continued to be so throughout the day. The event was well supported by visiting clubs and members and, although it was not open to the public, the passing park visitors were able to see all the activities taking place. Of course, part of the main ground level line does run out into the park itself so visitors get to see the locomotives and trains up close (**photo 1**). The club house had been decorated and, in front, a couple of gazebos had been erected to provide some shaded seating for members and guests. Tea, coffee and cold drinks were available all day along with some excellent homemade cakes and savouries.

There are no allotted times for track use so everything is nice and relaxed and drivers can spend as long as they like enjoying both the elevated and ground level tracks. Since my last visit in April 2019 the old Park Aviary - which was adjacent to the track and had been acquired by the club at that time - has been transformed into an excellent drive-in workshop with access to the main ground level turntable, so they now have a superb facility for repair work and storage as part of their track site (**photo 2**). Comprehensive steaming bays with a range of loading equipment were soon in action as locomotives and stock arrived throughout the morning, proceeding then to a siding space ready for preparation and a turn on the track (**photo 3**). The activity levels continued to grow to the point of there being a wide range of locomotives and carriages making use of the excellent track. The host club have a large range of superbly built carriages both for the raised track and ground level and members and invited visitors were soon enjoying these facilities (**photos 4** and **5**).

Outside of the fenced track site the club have an extended ground level 7¼ inch system which makes a journey here


The elevated track steaming bays and unloading equipment.

>>

Dave Holland with his much modified Sweet William out in the park.

Part of the raised track carriages waiting for some passengers.

A passengers eye view as the train exits the main track into the park section.

Jeff Elliot from Bromsgrove and his Class 4 2-6-4 tank head back to the station.

rather special - plus the fact that visitors to the park can see the trains running and youngsters are able get close as well. Access from the main track is via an electrically operated barrier and signals. The train driver can choose whether they travel into the park or not, by pressing a line-side button on the approach to the point and from then on, the operation is all automatic (**photo 6**).

Once again, like at other similar rallies, the younger members get to enjoy the railway and all its different

The modern image in the shape of a Class 66 locomotive.

features. This gives them valuable experience as well as, to some extent, 'future-proofing' the club. At Oxford they do have a good team of younger members who handle most of the maintenance work and, as I said at the beginning, the whole site was immaculate and a real credit to the members and club officials.

On the raised track steaming bays a couple of locomotives were being prepared and the BR Std Class 4 tank belonging to Jeff and Nick Elliott caught my eye (**photo 7**). It was good to see one of these fine locomotives in steam. This was one of the recent proprietary built models which had been extensively re-modelled with lots of scale steam fittings added which really made for a fine looking engine. It performed very well and spent considerable time on the track. I was fortunate enough to have a turn on the regulator and really enjoyed the experience. In contrast to the Class 4 there were a couple of modern image diesels on show and one of these, a Class 66, had a most unusual livery depicting a map of the London underground. This unique finish was achieved by scanning a 4mm scale model and then, through some clever graphic design systems, a 5 inch gauge scale map was produced in vinyl and wrapped around the locomotive body, hence the name of *Harry Beck* who was the designer of the underground maps (**photo 8**). The other locomotive was a Class 50 in the GBRf livery and it was also performing well on the track in the hands of 10 year old Martin Holland

10 year old Martin Holland drives the Class 50 through the station, the canine passenger has a rover ticket! (Oh dear… Ed.).

Having just had a boiler test the Ffestiniog 2-4-0 Linda *is being steamed.*

Linda *cruises through the station with a short train.*

The superb example of a GWR Grange owned by James Duncan.

(**photo 9**). Tim Trotman, who is a fireman on the Ffestiniog Railway, was preparing a good looking example of a Hunslet tender 2-4-0 locomotive, *Linda* (**photo 10**). It looked a fine engine and performed well when it got going on the track (**photo 11**).

Over on the ground level steaming bay was a real mix of locomotives from large, narrow-gauge prototypes to a fine scale GWR Grange (**photo 12**). In addition to the Grange was a superb example of a GWR Small Prairie owned and built by James Duncan. This engine positively sparkled in the sunshine (**photo 13**). The other lovely thing about this locomotive is the fact that the two young sons of the builder are always involved in all aspects of the preparation. A small piece of cloth and the polishing starts in earnest, as well as going round the engine

Everyone's busy at the ground level steaming bays.

>>

Passing through the station this young man is enjoying being with dad on the footplate.

The younger drivers also get a turn and five-year-old Connor handles the Prairie with ease.

Dave Holland pulls up for some water from the main tank.

Alan Mitchell starts the process of steaming his L& B locomotive in the steaming bay.

Returning from the park is Alan Mitchell with his L&B 2-4-2 Baldwin tank Lyn.

with an oil can. I know many people will say that children of this age should be nowhere near live steam locomotives but these two are being shown by their dad just what is involved and the elder one is already a competent driver so he will no doubt progress in future years and, hopefully, will be a leading light in model engineering when we 'old uns' are just memories (**photos 14** and **15**).

Another member of the host club, Dave Holland, was preparing his much modified Sweet William for his track shift. Some of the mod's to this engine include five different ways of getting water into the boiler which makes for a very confident driving technique (**photo 16**). I think the farthest travelled visitor was Alan Mitchell from the Spenborough club in Yorkshire with his model of the Lynton & Barnstaple 2-4-2 *Lyn* (**photos 17** and **18**). Alan acquired the chassis – originally a Winsons kit - and then proceeded to add the boiler and all the other fittings. It went very well during the day. The Stirling Single (**photo 19**) owned by Martin Parham from the Maidstone club also looked splendid in the warm sunshine and just prowled round the track with no problems at all. A couple of members from the Mid Cheshire club at Blakemere were enjoying their track time with a pair of Scamps which at one time were coupled together to provide an unusual combination (**photo 20**). Another family group seen enjoying their time on the track was Dave Mills, his wife and daughter Ellie from the Romney Marsh club. Ellie kept their American outline F7 on the track for long periods (**photo 21**). Colin Walton from the Halesworth club had brought along two of his engines, a well made 57XX GWR Pannier (**photo 22**) and a popular model of a Southern 4-4-0 *Maid of Kent*. Both went well although the 4-4-0 did have an unusual smoke deflector (**photo 23**).

The final little ceremony of the day was the dedication of a new seat presented to the club by the family of member Keith Marr who had passed away recently. Chairman, Dennis Mulford addressed the gathering and the family unveiled the new seat which will be placed in a more appropriate position at the club (**photo 24**).

It only remains for me to say a big thank you to Dennis and all the members of the Oxford Society who made me most welcome. As usual the ladies of the club worked hard keeping everyone fed and watered so many thanks to them as well.

ME

Martin Parham from Maidstone with his GNR Stirling Single returns from the park.

Back to back Scamps with two members from the Mid-Cheshire club.

A nice family group; six-year-old Ellie Mills drives mum and dad behind the 5 inch gauge F7.

Cruising through the station with his 5 inch gauge Pannier is Colin Walton from the Halesworth Society.

Colin Walton's second engine was this 4-4-0 Maid of Kent with an unusual smoke deflector.

The family of club member Keith Marr gather round the new seat dedicated in his memory

Peter Seymour-Howell builds a fine, fully detailed model of Gresley's iconic locomotive to Don Young's drawings.

Continued from p.231
M.E. 4696, 29 July 2022

Painting by Diane Carney.

PART 41 – THE INSIDE CONENCTING ROD

Flying Scotsman in 5 Inch Gauge

Inside connecting rod

I now made a start on the inside connecting rod. My thinking is to get the inside motion done first as it's relatively easy – well, not in as far as the components are concerned but in relation to there being far fewer parts when compared to the outside cylinders. You may recall that Malcolm High (Model Engineers Laser) laser cut my blanks for me. I am in two minds as to whether this makes life easier or not - it certainly involves a lot less swarf but needs more care in setting up as you have no flat datum to start with.

1. Here is the blank as supplied. This particular blank is cut very close to the final dimensions, closer than I would like, which makes life a little harder and setup is crucial.

Forming the tongue and strap

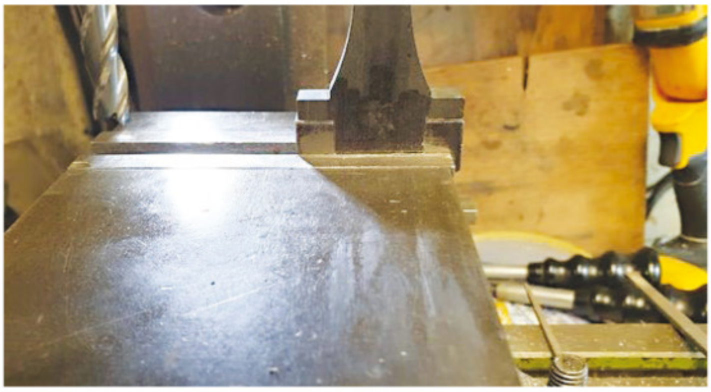
I began by splitting the two parts, scribing a line down the middle of the rod and roughly marking out the big end tab. Using the scribed line as a guide I held the blank level in the machine vice and machined the end tongue that will fit into the strap recess. The strap recess was then machined for the rod tab to fit into, and it needed to be a tight fit.

The next job was to drill through both parts and tap the strap 2BA for the studs, Next was to drill/tap the strap 2BA ready for the studs, which were Loctited into the strap and left to cure.

With the strap bolted up tight I clamped it down to the mill bed and started to rough out the thickness. The big end of course is the thickest part of the rod. The rest will be reduced much further but to be able to do that I first needed to machine all of the rod (both sides) down to a common

2. Here we have one side of the tongue near to size. I used a small engineer's square to line up the blank to ensure it was horizontal and tightened very tightly. The top of the tab has been left oversize for now and I'll finish this when the strap is attached. I also machined the front face of the tab leaving it 6 thou oversize for now.

3. The rod end is now machined to size. The strap is also seen here.



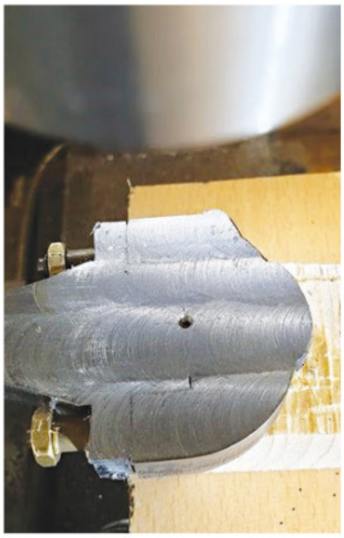
4. Here the rod sits a little proud of the strap. Once removed from the vice a small tap with a hammer made it a good fit.

5. The studs are Loctited into the strap and the strap assembled with the rod.

6. The rod after thinning down near to final size.

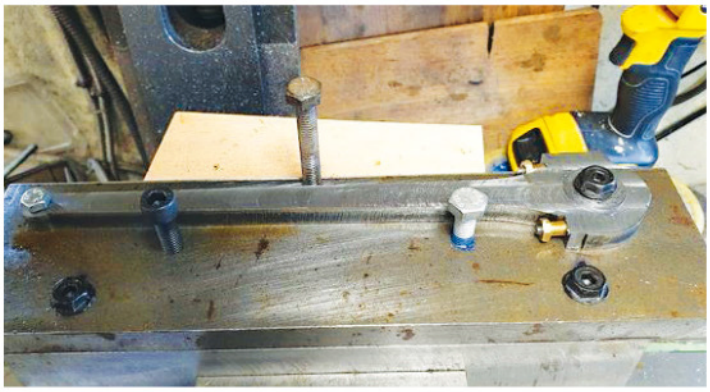
thickness. The thickness was left approximately 5 thou oversize to allow for final filing and polishing once the rest has been machined to profile.

The rod was then set up on the mill bed and both the little and big end holes drilled and, in the case of the big end, bored to size, ready for the next step.

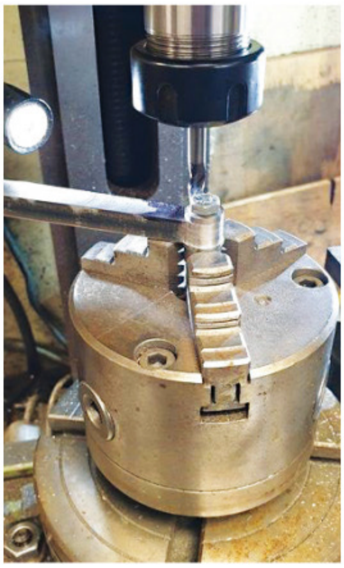


7. Centreing the big end ready for drilling and boring for the bush.

8. Here is the rod with both holes now to size. The big end hole was completed with the boring head and given a nice finish.



9. Here I have accurately machined the two spacers to hold the rod in place. Of course, all drilling was done square to the bed to ensure the rod runs parallel along 'X' once held in position. I have also drilled and tapped extra 8mm holes ready to clamp the rod down during machining.



LEFT: 12. Here is the shaping of the little end, which was very similar to the big end. RIGHT: 13. I have returned to the jig and moved on to the angle from big to little ends. The rod was bolted on to the jig in the vertical position and using the digital scales I checked it was level.

14. I then rested the scale on the rod to measure the angle - as can be seen, it's not very much.

15. Next, I measured the width of the small end neck, halved the difference with the required value and scribed the edge as a guide. I marked both sides but will only use the first, flipping the rod over rather than try to match the same 0.6 degrees on a swivel vice.

LEFT: 10. With the jig ready I turned my attention to profiling the two ends, beginning with the big end. As can be seen I made a start on machining the curve. The uneven part to the left is just where I have cut away excess metal ready to flair the curve of the strap into the rod itself - this to be done by hand. RIGHT: 11. I've included this picture to show how I held the work in the rotary table. There are two buttons with the lower one (seen here) having a spigot that's larger than the nut below. The spacer in the rod is also threaded so when all are tightened they are not going to come loose. The spigot was held tightly in the rotary table chuck and with the large button between both chuck and job it was very stable. I didn't bother hardening the buttons - I saw no point as they are a one-time only use.

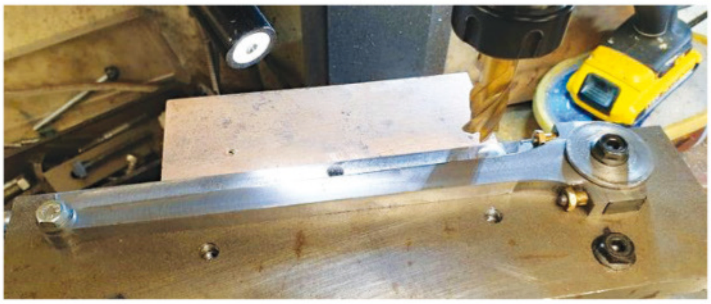
16. For the big end, I also needed to note where to stop cutting for the flare of the rod. The large cutter in the picture was used to line up the angles, not for cutting.

Machining the profile

The next job was to make up a jig including spigots to hold the rod securely for machining the profile. The same spigots are used to hold the rod in the rotary table for machining the two ends.

I machined the ends first, then the face profile while holding the jig flat. Once that is done the jig will be held vertically (on its side) for the side profiling. This is basically how I did the coupling rods and in fact I was able to reuse the same jig.

I fitted a large ½ inch thick plate to the old jig to hold the connecting rod. Two accurately positioned mounting holes were drilled and tapped to hold the rod. This set-up has had a little thought put into it to cover all



17. Profile almost complete. The step seen near the big end will be done by hand once I have machined the sides and the fluting.

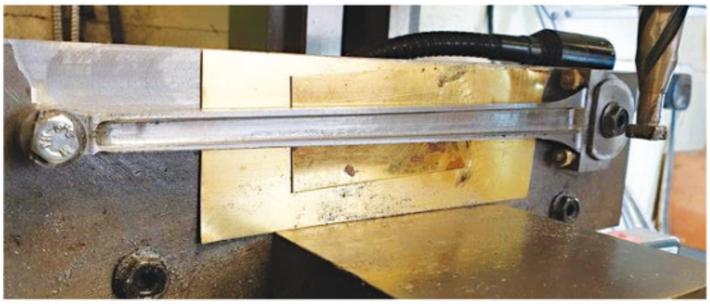
18. With the first side machined, before doing the other side I searched for some suitable shim to pack the back to stop any possible flexing. I may go 'off script' with the big end and add an oil cap with lid for two reasons - firstly to give a larger capacity of oil and secondly to make it easier to reach the oiling point once the locomotive is built. I can't see there being any height restrictions involved but will take a closer look later.

19. For the flutes, I first machined a section down the middle parallel to the middle of the rod. The picture shows the first side so machined, taking care either end not to go too far. For the little end, extra thought is required to allow for the fact that this end still needed to be machined to a thinner width. Once the first side was done I then removed the rod from the jig and flipped it to the other side, leaving the jig in place and thus set for doing either side.

the machining operations. Two buttons were machined to fit the big end and little end holes.

Before using the jig to profile the rods the rotary table was used to profile the ends.

Once all machining was completed, I still had some more shaping to do as the rod tabs needed rounding to flare them into the strap itself. I also needed to machine the top of the oil housing but I did this when the rod was set vertically in the vice.



20. The other angle was just a repeat of before but with the jig now tilted the other way.

Machining the rod sides

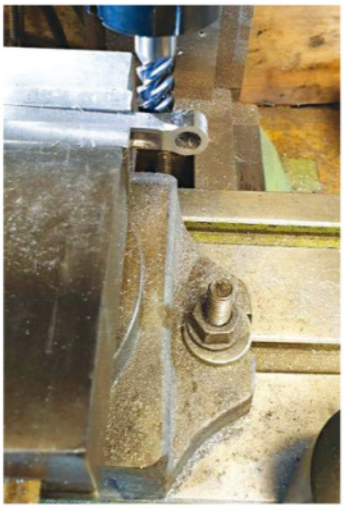
Fluting the rod was basically the same as for the coupling rods, for those who have been following the progress for a while, but I'll go through it again here for those who missed it.

The jig was set up vertically in the machine vice and checked to be true. For the stop points fore and aft, I went by eye first. Once happy with the positions and allowing for the fact that as the cut got deeper the distance would increase I noted the DRO readings and proceeded to cut metal. The aft position being most critical as the edge of the cut is in line with the rod tabs. Also worthy of a mention is that both buttons were trimmed so as not to interfere with machining.

The flute is not parallel so I adjusted the angle of the jig for machining the first angle. As with the middle, once the first side was done the rod was flipped for the other side.

With the machining finished it was time to get dirty – oh, and sore fingers - to complete the shaping by hand. I first scribed a line from the flute edges, top and bottom, around to where it meets the big end. With this done I then used a cutting disc in the Dremel and carefully cut a line just inside the scribed mark. Changing from the cutting disc to the sanding drum I began to form the concave shape. This took a number of goes, alternating between each side to keep them even. I cut the sanding drum insert down to half its width so that I didn't accidentally mark the other side. Once I was happy with the shape and that the previous marks from the cutting disc had been blended in I then changed to a floppy abrasive disc for the final shaping and polishing.

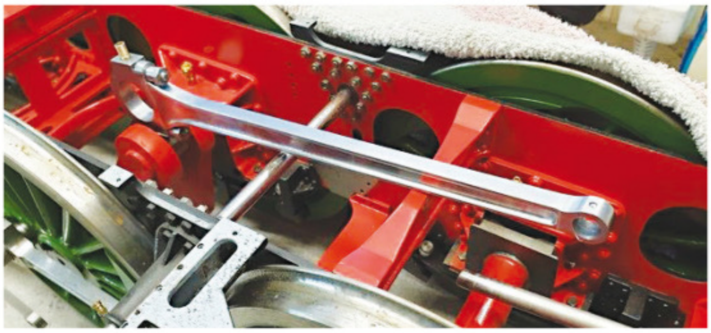
The last task, other than the tidying up, was to drill the oilways in both ends. For the little end, I have done my own thing. Don states to drill a No.41 hole, but I have drilled a No.57 and opened it out for a short depth using a No.41 to act as a reservoir. The big end was drilled and tapped 6BA for the spare oil cup that I had to hand. Later, I'll make a sprung lid for this cap to keep any grime/ash out. The idea being that if sprung I should be able to prise the lid open using the oil can nozzle to oil which will then close itself - considering the access to this I think this may be a wise move.



21. With the roughing out of the flute done this left the final machining operation of reducing the thickness of the little end. For this, I held the rod in the machine vice and reduced the little end, the metal being taken off equally from either side.

●To be continued.

22. Finally, here are the component parts that make up the inside connecting rod on a Gresley Pacific.



23. Side view of the connecting rod.

A Miniature Oscillating Steam Engine PART 9

Hotspur constructs a three-cylinder reversible oscillating engine.

Continued from p.197
M.E. 4696, 29 July 2022

Hotspur may be contacted on 01600-713913 or **hotspurengines@gmail.com**

Designing the boiler

Some years ago I responded to an advertisement in *Engineering in Miniature* which offered a kit for a vertical test boiler. The cost was not enormous but when it arrived the materials had been worked upon and some of the workmanship was poor, to say the least. In addition, there was no drawing and I felt somewhat aggrieved by this deceitful act but kept the materials as I was sure I could do something with the parts at a later date. So, having brought the build of the new oscillating engine to a successful conclusion and demonstrated it on air, I decided to unpack the boiler parts and see what I could do.

The package of parts is as shown in **photo 59** and now I can comment on the tasks before me. The boiler barrel is an 8½ inch length of 4 inch outside diameter tube and the firebox is a 3½ inch length of 3½ inch outside diameter tube and each is of 16swg copper. Both of these tubes had been drilled and roughly opened out to make a fire hole opening so this set the position for the firebox door itself. The main barrel had also been 'notched' at the base to offer air inlet slots for the fire, but more of this later. The difference in diameter between these main tubes suggested that a foundation ring of about $^{3}/_{16}$ inch in width would be required and that this would be made from the already bent piece of rectangular copper bar included. These aspects were salvageable but the immediate difficulty was that all the 25 x $^{5}/_{16}$ inch outside diameter fire tubes had been very tightly assembled into both flanged plates and we know that this is not correct if a proper penetration of silver solder is to be achieved for the joints. The flanged plates themselves had been well formed so they may have been pre-finished in the kit. There was also a cast brass top cover for the boiler and a length of brass for the chimney.

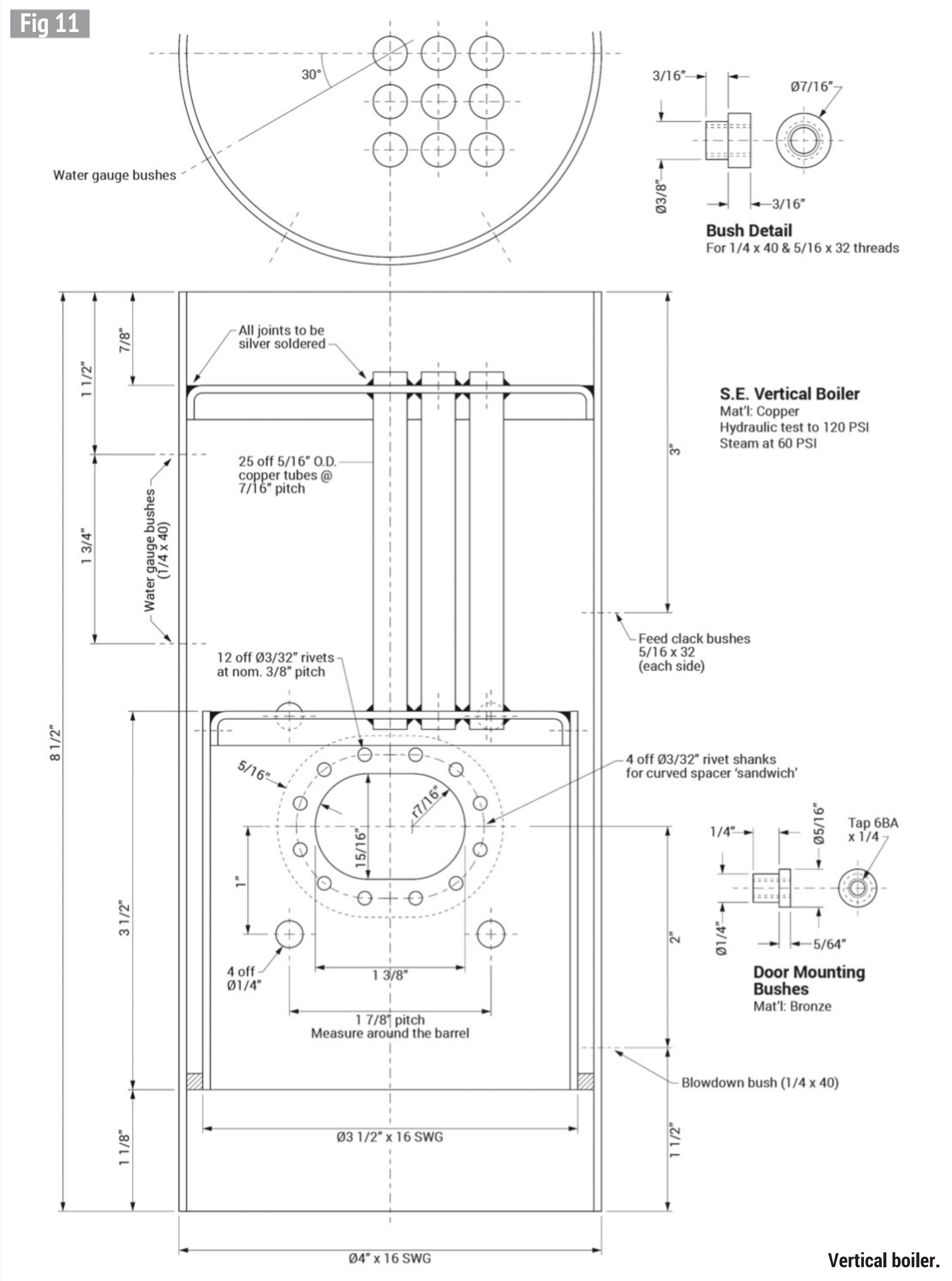
A general view of the vertical boiler kit of parts as received by the author.

The inner firebox flanged plate ready to silver solder the tubes in place.

The first thing to do was to scheme a drawing to work from and this is shown in **fig 11**. At this stage I had not decided on the number and position of the boiler fittings or whether I would arrange for the unit to be fired with either coal or gas – or both.

Before taking off the lower (smaller) flanged plate I put a notch on the outside of the flanges of both plates so I could re-assemble them with the same orientation but later I found this was not accurate. The lower, smaller flange was removed and cleaned and the holes opened up so that they had about 0.002 inch clearance around each tube ready to silver solder them into place. All the holes were given a small countersink each side as well to form a tidy fillet of solder. **Photograph 60** shows the stage reached with the nest of tubes checked for squareness and fluxed ready for the first soldering operation. It will be seen that my approach is to lay lengths of silver solder between the

Fig 11



Vertical boiler.

Soldering on the firebox barrel and note the aperture for the door has been placed with the nest of tubes in the same plane.

Two pieces of copper plate profiled and formed to be the sandwich spacer ring around the firehole door position.

Here the two parts of the door spacer have been hard soldered together.

tube ends to provide a feed as the heat is applied. Readers will note that the second flanged plate has not yet been removed from the tube stack and is firmly keeping them all tidily in place and square; just as we would do if assembling a locomotive boiler at the firebox end.

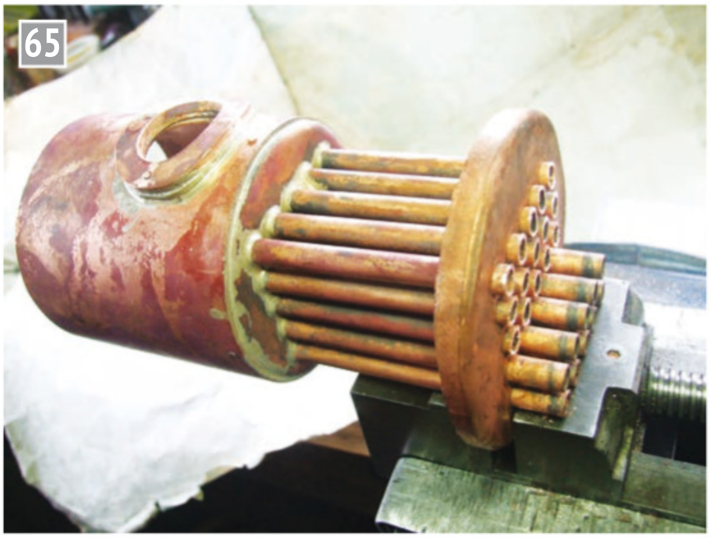
The inner firebox barrel was then checked for squareness on its ends and sitting the assembly on a drilling table allowed a steel rule to be used vertically to check that the top flange and the lower barrel were parallel all the way round. The two parts were then held together with a few rivets to keep the firebox tube in line with the fire tubes so the inner firebox flange could be silver soldered in place. The result is seen in **photo 61**.

The next task was to decide how to allow for a water space ring to be fitted between the two barrels so as to provide a seal around the firebox door opening. The two ragged efforts at filing the holes were tidied up and then two oval rings of copper sheet were cut out to form a sandwich that would match the intended foundation ring thickness. I did not have any copper plate of 3/16 inch thickness so a sandwich of two pieces of 3/32 inch thick material was used. **Photograph 62** shows the material in preparation and formed into a matching radius for the water space but note the two centre punch marks that identify which way round these need to be assembled.

At this point I had to decide on the number and spacing for the rivets that would hold this sandwich of plates in position so it would allow the use of four additional rivets for the assembly process. There was space on the centrelines in the north-south and east-west directions so four holes were drilled for 3/32 inch rivets and high temperature silver solder was used to join the pair together. Only rivet material was used for the alignment task to minimise the interference with the later rivet pattern (no heads were used) - see **photo 63**. The fabricated ring could then be added to the inner firebox barrel and silver soldered in place, so the north-south pair of rivets was drilled out and replaced by two more through into the inner shell. **Photograph 64** confirms this task as complete after a good clean up. The 3/16 inch square bar was straightened and then annealed and curved to form the foundation ring and here it was found to be 3/8 inch too short! A small block of copper was cut and hard silver soldered on to make up the difference.

My intention is to add a small coil of pipe to be a 'drier' for the steam in the hot zone above the tubes and to fit a safety valve and a connection that gives a blower feed and the tapping for the pressure gauge. To allow for this arrangement, it was clear that the tubes were too long so they were cut down by around 5/8 inch. **Photograph 65** shows this taking place and keep in mind that at this stage the fit of the tubes in the top flanged plate had not yet been eased. I was able to hold the top plate flange in the larger of my two drilling vices to progressively cut away the tube ends. The ends of the tubes were filed to remove the burrs from the saw cuts and the flange was removed to have the holes enlarged and the countersinks added as carried out earlier for the firebox flange. **Photograph 66** shows this aspect and everything was now ready to put the holes in the flange for

The door spacer added to the inner firebox barrel using just two of the rivet positions.



The tubes were found to be too long to allow space for the fittings inside the upper end of the boiler.

The second flanged plate is firmly keeping the tube stack tidily in place and square, just as we would do if assembling a locomotive boiler.

The upper flanged plate has been drilled out and chamfered for the final soldering operation.

the two top fittings. However, checking the assembly so far showed that, despite my earlier efforts, the top flange was not concentric with the firebox barrel when taking account of the fire hole spacer and the foundation ring.
The fault was traced to the positioning of the upper tube centres and I discovered that the original tube holes had not been located centrally to the diameter of the flange, so by measuring the offset and re-orientating the top plate all came true enough for the top flange to be soldered onto the tubes.

Firstly though, I had to locate the top steam outlet position and safety valve bushes and it was decided that they should be placed at each side. It was done in conjunction with the top boiler casting as this has two bosses cast onto it and they turned out to be at 1⁷⁄₁₆ inches radius so the holes for the bushes in the top tube plate were drilled at this dimension and bronze bushes made from ½ inch A/F phosphor bronze bar and given a starting thread of ⁵⁄₁₆ inch x 26 TPI. I always use robust threads for items that may have to be removed from time to time and the final tapping is carried out from the outside after the assembly is complete. The bushes were drilled to tapping size, the threads started and the two shoulders were added with a parting tool. Again, the clearance for the bushes is important for solder penetration and the use of hexagon material is simply because it can always be turned to be round when needed.Holding this section to tap a coarser thread is very reliable in the lathe.

Once the tops of the tubes were cleaned and the top flange was placed over the tubes a final check for squareness was made and the whole lot silver soldered in place. **Photographs 67** and **68** show the top surface after the soldering operation and the underside view to illustrate the solder penetration. As noted earlier, adequate fillets of solder can only be achieved if the tubes have been fitted with a clearance of about 0.002 inch.

My drawing also shows my proposed placings for the various fittings which include the water gauge, the blow down valve plus a separate hand pump inlet clack and either an injector or mechanical pump feed clack valve, and the blind bushes to attach the fire hole door plate assembly. The set of bushes which have been fitted to the barrel and protrude into the water space above the foundation ring are the two for the water gauge fittings which are threaded ¼ inch x 40 TPI and are high up to maximise the volume of water being heated. The two bushes for the hand and mechanical pump delivery check valves are threaded ⁵⁄₁₆ inch by 32 TPI and are also placed high up so cooler water is added away from the firebox heating surface. Note that I have deliberately made the bushes so that they stand proud by about ⁵⁄₃₂ to ³⁄₁₆ inch so that a layer of cladding can be added later.

From the plan view of the boiler it will be noted that I have deliberately placed all these bushes at 45 and 90 degrees away from the fire hole door as the completion of this joint will require significant heat to silver solder the three layers together. Readers may have noticed that I have placed the fire hole door in line with the front of the square of combustion flues. This means that the two bushes for the water inlet check valves are also presenting their water feeds into the maximum clear space available. Make all the bushes from phosphor bronze as this gives a stronger thread and prevents the chemical deterioration that can take place with brass. They were fitted, fluxed and silver soldered at one heating and **photo 69** shows the result. The pattern for the rivets around the fire hole has also been added to my drawing.

●To be continued.

NEXT TIME

I will assemble the boiler shell onto the firebox.

Here are two views of the soldering completed for the top plate with the main steam bushes added.

The set of bushes for the boiler fittings has been added and the barrel is ready for the two parts of the boiler to be assembled.

Rewinding a Two Speed Motor PART 4

Graham Astbury learns a lot about single-phase induction motors and describes 'The long and winding road that leads to a 2-speed single-phase motor'.

Continued from p.274
M.E. 4697, 12 August 2022

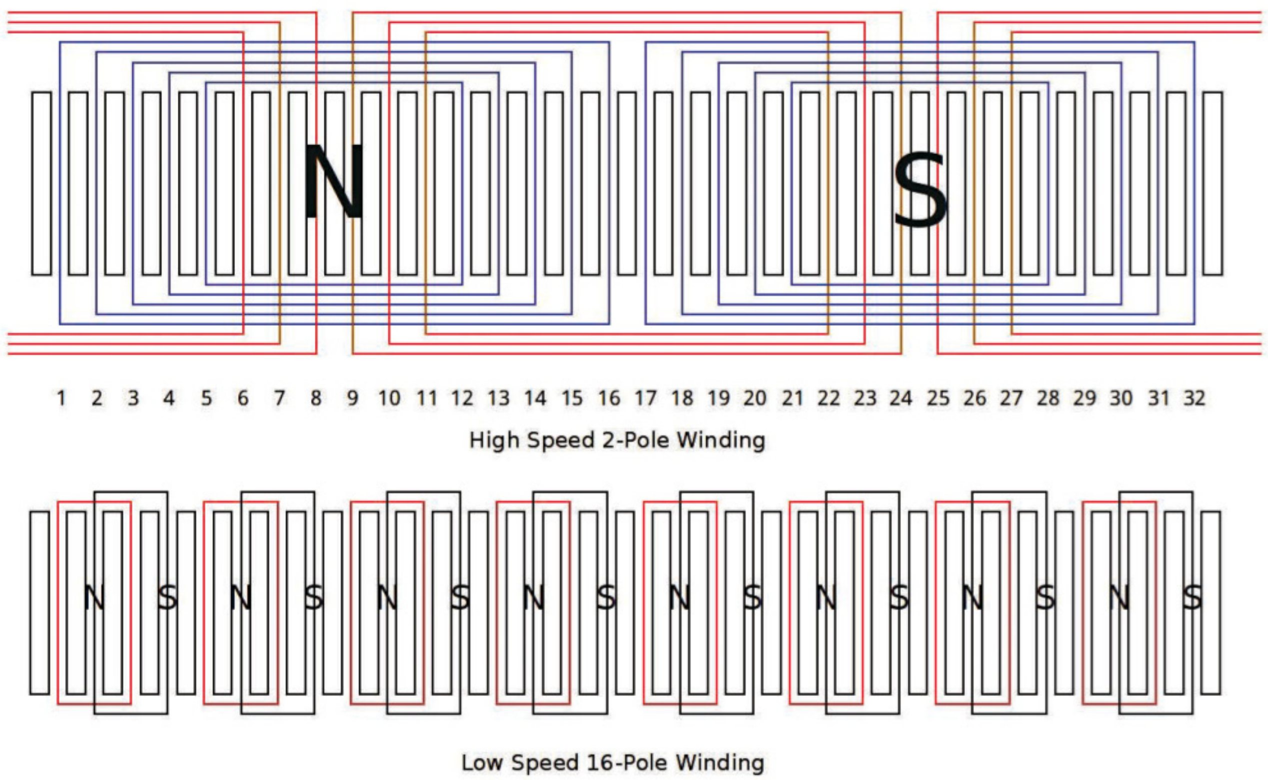
The existing windings

The windings for the 2-pole speed had been arranged such that the main winding for the first pole used slots 1, 2, 3, 4, 5, and 12, 13, 14, 15 and 16 for one pole and a similar pattern for the second pole. This is shown in **fig 11** as the blue coils. This gave the pole pitch as 16 slots (32 slots split over 2 poles) and the coil span as 11 slots. The coil span is defined as the average number of teeth enclosed by the coils - in this case the outer coil embraces 15 teeth and the inner coil embraces 7 teeth, giving an average of (7 + 15) / 2 = 11 teeth. This type of winding is known as a *fractional pitch* winding, as the coil span is less than the pole pitch. The coils are actually wound in opposite directions, so that, for example, the first pole is wound clockwise and makes a 'north' pole, the second pole is wound anticlockwise and so produces a 'south' pole. Similarly, the auxiliary winding, coloured brown, has a coil span of (11 + 15) / 2 = 13 teeth. These two windings have different coil spans but the same pole pitch.

Having stripped the motor completely of the original 2-pole windings, I was then ready to strip the 16-pole windings. The low-speed 16-pole windings are different from the 2-pole windings. The 16-pole winding used slots 1 and 3 for the first coil, slots 5 and 7 for the second coil and so on (red coils). Note that each phase only has 8 coils - not 16. The two phases are in red and black at the bottom of fig 11. However, the pole pitch is now 2 slots - 32 slots over 16 poles and the coil span is also two slots. This coil span is known as a *full-pitch* winding because the coil span is the same as the pole pitch. Each coil is wound in the same direction, so that each coil produces the same magnetic pole, in this case shown as 'north' poles. Since all the wound coils are the same polarity, but are spaced a full

Fig 11

Arrangement of the windings on the original washing machine motor.

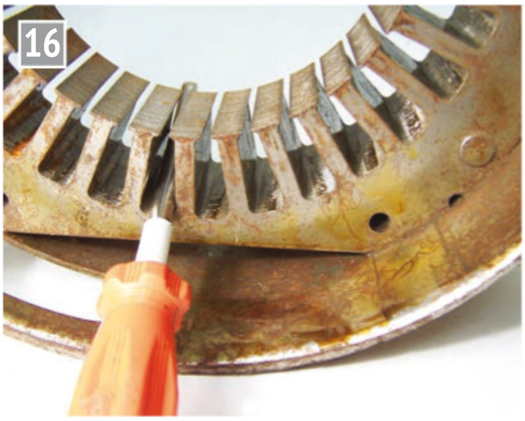


The original 16-pole winding - second phase visible - a full-pitch winding.

The original 16-pole winding first phase – identical to the visible winding in photo 13.

pole-pitch apart, the opposite 'south' poles are now located between the coils, making the full 16 poles yet only using 8 coils. The full-pitch winding is also known as a *hemitropic* winding (from the Greek - *hemi* meaning 'half' and *tropic* meaning 'turning', as it uses half the number of coils). As can be seen from **photo 13**, the 16-pole winding is a full pitch one, as the coil span is two slots (32 slots/16 poles) with the second phase (hidden behind the visible winding) being shifted by one slot. Having stripped out the first phase of the 16-pole winding, it left the second phase which again is a full pitch coil with two teeth inside the coil and two teeth between the coils (**photo 14**). The two teeth within the coil are obviously magnetised by the coil, with the two teeth between the coils being consequent poles – and they have the same number of teeth as the main coil poles. Again, I counted the turns as before. The turns counts for all the windings are shown in **table 3**.

Bolt cutters were just a bit over the top!



The slots in the two-speed motor stator.

Note that the conductors/ slot figures on the 16-pole winding are actually the conductors per *pair of poles* as the winding is a full-pitch one and there is an unwound consequent pole adjacent to it, so the turns per actual pole are 145. This gives the turns per phase as 145 x 16 = 2320 turns. This is shown in diagrammatic form at the bottom of fig 11.

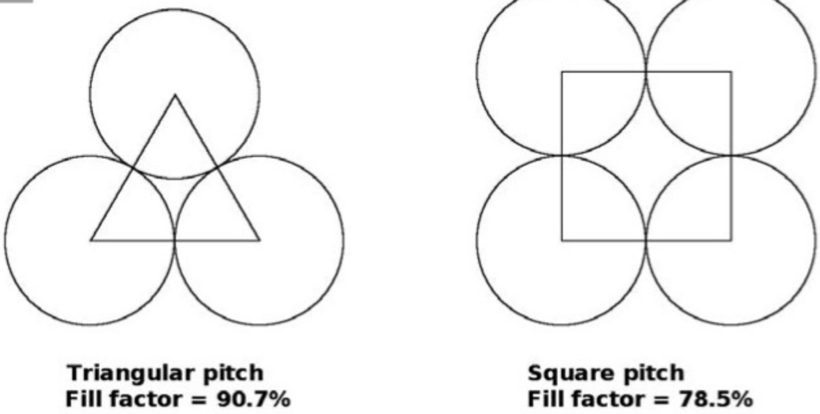
I did try using large bolt-cutters to cut through the final windings (**photo 15**) but this was not as successful as might be thought – the wire is a bit too thin to be cut cleanly by the blades, so it was back to the side-cutters nibbling through the wires a few at a time. Having stripped the stator completely, the empty stator slots are shown in **photo 16** and the small slot size is quite evident. The screwdriver shaft is only 6mm in diameter. Finally, I weighed all the enamelled wire that I had removed so as to know how much was required for the new windings. Clearly, it doesn't really matter how the new winding is done, as about the same weight of wire will be required irrespective of the winding pattern and the gauge of wire. The total weight was 1628 grams, so I concluded that 1kg of wire for the windings of each speed would be the right quantity,

Table 3. Turns count for the original windings.

	2-pole winding	16-pole winding
Main winding type	Fractional pitch	Full pitch (hemitropic)
Main winding conductors per slot	45	290
Number of slots used for main winding	20	16
Main winding turns per pole	225	145
Main winding wire diameter, mm	0.5	0.4
Main winding total turns per phase	450	2320
Auxiliary winding type	Fractional pitch	Full pitch (hemitropic)
Auxiliary winding conductors per slot	120	290
Number of slots used for auxiliary winding	12	16
Auxiliary winding turns per pole	360	145
Auxiliary winding wire diameter, mm	0.4	0.4
Auxiliary winding total turns per phase	720	2320

»

Fig 12



Winding fill factors for triangular and square pitch.

leaving a little spare in case I miscalculated.

A word of warning!

At this point the calculations become a little more complex as, by this time, I had learned a lot about induction motors – particularly single-phase motors - and I had a much greater understanding of the problems and their solutions. I am conscious that the rest of the article beyond this point will get more theoretical but I hope that my explanations make it comprehensible to at least some readers. I expect that many readers will not contemplate rewinding a motor but, if this spurs at least one reader into rewinding a motor, then I have achieved at least some success. I am taking somewhat large liberties with both the mathematics and the engineering by simplifying it as much as I can. I am not an electrical engineer, so some of the following may not be correct and my assumptions may be wrong. However, what I got with my simplified approach was a motor that actually worked but may not be the best design nor have the greatest output possible. So here we go...

'Reverse engineering' the existing windings

The original data which was available from the nameplate was for power consumption - for washing at 250 W and for spin drying at 540 W. Further data derived from measurements on the motor are that the synchronous speed for washing was 375 rpm (corresponding to a 16 pole motor) and a synchronous speed for spin drying of 3000 rpm (corresponding to a 2-pole motor). The capacitor value for both speeds was 10μF at 450 volts AC. From the rotor and stator measurements, the stator is 37 mm long x 100 mm internal diameter. This is the only known obvious data.

Derived data by calculation

Slot utilisation factor

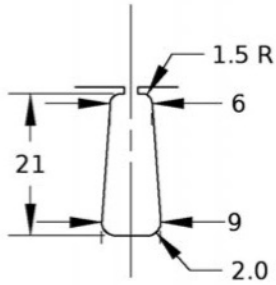
The total cross-section of the wire for the windings can be calculated. Clearly, the wire cannot fill the slot entirely as there are gaps between the wires. The theoretical maximum would be for wires wound on a triangular pitch, at 90.7%, but on a square pitch it reduces to 78.5% (**fig 12**). The actual diameter of the wire is 0.06 mm larger than the nominal wire size due to the enamel insulation. The main winding for the 2-pole speed is 45 wires each 0.56 mm overall diameter, with a total cross-sectional area of $45 \times 0.56^2 \times \pi / 4 = 11.1\ mm^2$. This is placed in the same slot as the 16-pole winding of 290 wires each of 0.46 mm overall diameter, with a total cross-sectional area of $290 \times 0.46^2 \times \pi / 4 = 48.2\ mm^2$ so the combined total cross-sectional area of the windings is $59.3\ mm^2$. For the 2-pole auxiliary winding, the cross-sectional area of the windings for 120 wires is $120 \times 0.46^2 \times \pi / 4 = 19.9\ mm^2$ giving a total cross-section of the windings in the slot, including the 16-pole winding, of $68.1\ mm^2$, showing an imbalance in the quantity of copper in the two windings. The slot dimensions are shown in **fig 13** and equate to an approximate slot cross-sectional area of $130\ mm^2$ after allowing for the slot liners and closers, giving a worst-case slot utilisation factor of 68.1 / 130 = 0.52. This is somewhat greater than is usual for motors of this size, as it is difficult to fit the wire in easily. A more usual value would be 0.4 or 40%.

These windings are shown in diagrammatic form in fig 11. From this it can be seen that it would not be possible to wind the 16-pole winding in anything other than a full-pitch winding as the pole pitch, calculated as the number of slots divided by the number of poles, is 32 / 16 = 2 slots, which allows one phase winding to be wound round two teeth, using the intermediate slot for the second phase.

16-pole speed

Although there is no data available for the power factor for the original motor, an assumption has to be made which can be based on experience. According to Bailey (ref 4 – see M.E.4695, July 15) the power factor for permanent capacitor motors of about ¼ hp (180 watts) is better than 0.85 and Trickey (ref 13 – see M.E.4697, August 12) suggests that it should be above 0.9. Being conservative, a value of 0.85 can be assumed. Therefore, the line current taken by the motor on the 16-pole winding with an input power of 250 watts at 240 volts can be estimated at $250 / (240 \times 0.85) = 1.23$ A. As the two phases of the 16-pole motor should be at quadrature (90 degrees) to each other when at full load, the phase

Fig 13



The slot dimensions.

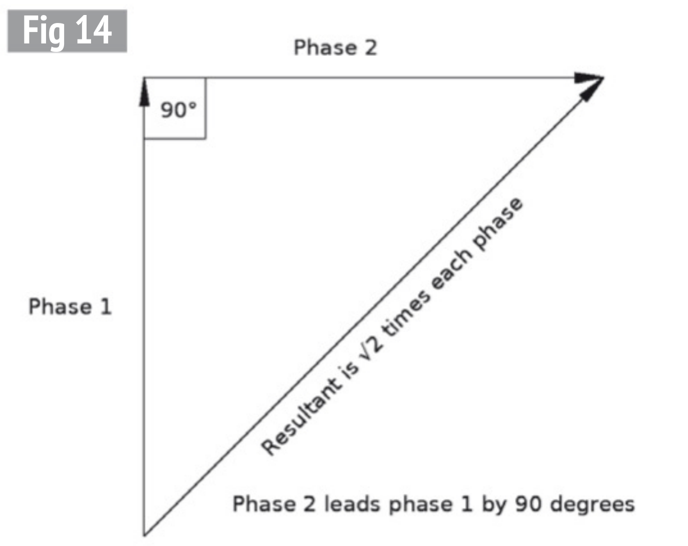
current should be the line current divided by √2, which is $1.23 / \sqrt{2} = 0.87$ A. The reason for the √2 in the equation is from simple geometry, or by the addition of vectors which is a bit beyond me. This is shown in **fig 14**. As this winding is 0.4 mm diameter wire, the current density is $0.87 \times 4 / (0.4^2 \times \pi) = 6.9\ A/mm^2$, which is a little less than the typical value of 7.5 for a totally enclosed fan cooled induction motor. For the 16-pole speed, the current passed though the capacitor can be estimated from the current in that phase of 0.87 A. The impedance of the 10μF capacitor can be determined as $1 / (2 \times \pi\ 50 \times 10 \times 10^{6)} = 318\ \Omega$, so the voltage across it will be $0.87 \times 318 = 277$ V at full load. Under no-load conditions, the voltage across the capacitor is likely to rise above this.

2-pole speed

Looking at the 2-pole windings, the two windings should again be at quadrature but, as the total turns are less on the auxiliary phase than for the 16-pole winding, some simplifying assumptions will have to be made. Firstly, the same 10μF capacitor is used for both speeds. As the 2-pole auxiliary winding has fewer turns than the 16-pole winding, it can be assumed that the current drawn by the 2-pole auxiliary winding should be greater than that of the auxiliary winding of the 16-pole speed but it is still fed though the same capacitor.

As the overall power factor on the 2-pole speed is unknown, it can be assumed again to be 0.85, so the current drawn on the 2-pole speed is 540 / (240 x 0.85) = 2.65 A. Again, the two phases should be at quadrature but, as their turns per phase are different, an assumption will have to be made as to the way the current is shared between the two windings. According to Trickey (ref 13), the currents drawn by each phase of a capacitor motor, where the turns are different for the main and auxiliary windings, is the inverse of the ratio of their turns so the current in the auxiliary winding will be 450 / 720 = 0.625 times the main winding current. As a cross-check, taking the same current density for both windings, the auxiliary winding current to the main winding current should be in the ratio of their cross-sectional areas of the wire, so it will be in the ratio of their (diameter)² which equates to $(0.4 / 0.5)^2 = 0.64$ times which is similar to the 0.625 for their turns ratio. The voltage across each winding will be the same as the ratio of their turns, so the auxiliary phase voltage will be 240 x 720 / 450 = 384 V. As the capacitor current is the same as the auxiliary phase current and the impedance of the capacitor is 318 Ω, the capacitor voltage will be 1.40 x 318 = 445 volts, which is just below the capacitor's maximum voltage rating.

As the total current drawn has been estimated at 2.65 A, the currents for each phase will be at quadrature, so the resultant for the two windings carrying current in the ratio of 1 to 0.625 will be in the ratio of $\sqrt{1^2 + 0.625^2} = 1.18$ which must equate to the 2.65 A line current. Therefore, the main winding current will be 2.65 x 1 / 1.18 = 2.25 A and the auxiliary winding current will be 2.65 x 0.625 / 1.18 = 1.40 A. This current for the auxiliary winding is considerably higher than that of the 16-pole winding, despite the wire size being the same, so the current density will be $1.40 \times 4 / (0.4^2 \times \pi) = 11.1$ A/mm², compared to 6.9 A/mm² of the 16-pole winding. Although this appears somewhat high for continuous operation, the spin-drying spin cycle takes around 15 minutes so the current consumption can be allowed to rise as the 2-pole windings are not in continuous use. Also, during manufacture, the 2-pole windings are wound into the stator *after* the 16-pole windings so are directly in the flow of air from the cooling fans. Since the 2-pole speed is eight times that of the 16-pole speed, the cooling effect will be much more than eight times and more probably around 64 times – i.e. the cooling will increase by a factor of (speed)², so such a high current density will be acceptable. Recent data from Karnavas & Chasiotis (**ref 15**) suggests that for an open-frame small motor, such as this one, current densities in the order of 9 to 12 A/mm² are acceptable.



Vector addition of two phases with a 90 degree phase shift.

Electrical loading

The electrical loading is the ampere-conductors per millimetre of stator circumference and is a measure of the power loading of the motor. In the case of the 16-pole windings, the conductors per slot are 290 with 32 slots and a current of 0.92 A and, since the stator bore is 100 mm, the electrical loading is 290 x 32 x 0.92 / (100 x π) = 27.2 ampere-conductors per mm. This is high but, according to Karnavas & Chasiotis (ref 15), the electrical loading for small permanent capacitor motors of this sort of size should be somewhere between 5 and 45 A/mm so a value of 27.2 is not excessive. They also state that high values of electrical loading result in increases in the copper losses, reduce the overload capacity and lead to an increase in motor temperature. Also, it is pointed out by Upadhyay (**ref 16**) that motors with many poles have excessive fringing of the magnetic field around the pole tips as the pole span is very small compared to the tooth width. This leads to low efficiencies and high currents which could explain the high electrical loading on the 16-pole speed. As a comparison, a 1.1 kW 415 volt three-phase motor that I have has an electrical loading of 24 ampere-conductors per mm, so 27.2 would not seem to be excessive. Fringing is where a proportion of the magnetic flux goes directly to the adjacent pole without going through the rotor. The flux should all go through the rotor to the next pole, but instead goes directly to the next pole across the top of the slots and the tooth between the windings. Where there are only three teeth on the pole, the fringing becomes a significant part of the total flux compared to where there are seven teeth on the pole.

For the 2-pole winding there are two separate windings. The first main winding has 45 conductors per slot carrying 2.25 A through 20 slots – which equates to 45 x 2.25 x 20 = 2025 ampere-conductors for the main poles – and the second auxiliary winding which has 120 conductors per slot carrying 1.40 A through 12 slots – which equates to 120 x 1.40 x 12 = 2016 ampere conductors for the auxiliary poles – giving a total of 4041 ampere conductors. With the periphery being 100 x π mm, the mean electrical loading works out at 4041 / (100 x π) = 12.9 ampere-conductors per mm which is just less than one half of the 16-pole winding loading. This seems a far better loading so is likely to be a better basis for a new design. However, the actual windings are not symmetrical with regard to the number of slots used, so the actual electrical loading for the main winding is 45 conductors carrying 2.25 A through 20 slots which is actually only 20 / 32 of the periphery of 314 mm, equalling 196 mm so the loading is 45 x 2.25 x20 / 196 = 10.3 ampere-conductors per mm. For the auxiliary winding, the periphery occupied by it is 314 x 12 / 32 = 118 mm. This

>>

gives an electrical loading of 120 x 1.40 x 12 / 118 = 17.1 ampere-conductors per mm. Whilst these are slightly imbalanced, it is all based on educated guesswork, so the results are not wildly outrageous.

Flux per pole

The flux per pole is calculated from the ampere-turns per pole using the equation given by Kemp (ref 10 – see M.E.4696, July 29) $B = V / (p \cdot f \cdot n)$, where B is the magnetic flux per pole in Webers, V is the supply voltage, p is the number of poles, f is the supply frequency in Hz and n is the total number of turns per phase. For the 16-pole windings, the flux per pole is 240 / (16 x 50 x 2320) = 0.000129 Wb or 0.13 mWb. For the 2-pole main winding, the flux per pole is 240 / (2 x 50 x 450) = 0.0053 Wb or 5.3 mWb. For the auxiliary winding the flux per pole is 240 / (2 x 50 x 720) = 0.0033 Wb or 3.3 mWb. If you have no idea what Webers are, but I understand they are the magnetic equivalent of amps - basically the flow of the magnetic flux through the stator.

Flux density

The flux density is calculated by taking the flux per pole and dividing by the pole area. Effectively, the pole area is the number of teeth enclosed by the coil divided by the total number of slots (or teeth) in the stator multiplied by the total area of the inside of the stator. The stator has a length of 37 mm and a bore of 100 mm, so the inside surface area is 37 x 100 x π = 11624 mm². For the 16-pole speed, the number of teeth enclosed by the coil is 2, so the pole area is 11624 x 2 / 32 = 726.5. Therefore, the flux density is 0.13 x 1000/ 726.5 = 0. 18T, where T is the Tesla or magnetic flux density in Wb/m². The factor of 1000 is to convert the flux density units to Tesla. For the 2-pole main winding, each of the coils encompasses 15 teeth and, as the flux per pole is 5.3 mWb and the pole area is 11624 x 15 / 32 = 5449 mm², the flux density is 5.3 x 1000 / 5449 = 0.97 T which is quite high according to Kemp (ref 10) who suggests a maximum air-gap flux density of about 0.8 T. As Kemp was using materials developed in the 1930s and magnetic materials have probably improved since then, the figure of 0.97 T is probably not unrealistic. The auxiliary winding also encompasses 15 teeth and has a flux density of 3.3 x 1000 / 5449 = 0.61 T which is quite acceptable. This is a rather simplistic view of the motor but serves the purpose well enough.

TBC

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Book Review

Robinson Eight-coupled Locomotives

Jeremy Clements

John George Robinson is one of the less studied locomotive engineers of the late 19th and early 20th centuries so this book about his most influential design is welcome. Although built for the Great Central Railway his 2-8-0 influenced other railways including some abroad.

Robinson came from a railway engineering family and was apprenticed on the Great Western in 1872. Then he worked on the Waterford, Limerick and Western Railway where he achieved his first locomotive design in 1892-93 before moving to the Great Central Railway in 1900 as Locomotive Superintendent. The author gives helpful background to Robinson's work there. It was an ill-assorted railway suffering from former chairman Watkin's over ambitious plans. Working with the enterprising General Manager Sam Fay he had a hard task to equip the line with the locomotive power it needed. After completion of the Great Central London extension it fell behind other companies in passenger receipts per mile but partly thanks to the Robinson/ Fay innovations led other companies on freight income per mile.

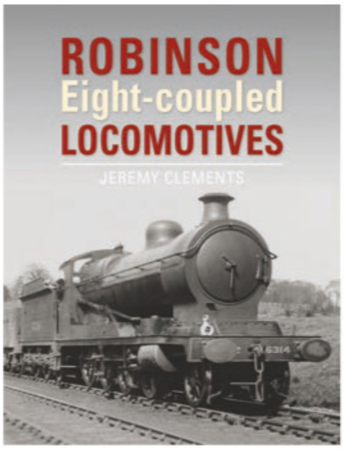
On the Great Central he designed some smaller engines and then introduced 0-8-0's nicknamed 'Tinies' in 1902. He then tried three cylinder compound Atlantics, not a great success but more economical, and then the massive 0-8-4 tank engines for shunting at the new Wath marshalling yard, a railway wonder of the age. Some were later fitted with booster bogies.

His best known locomotive came in 1911 with the prototype 2-8-0. It was a robust design with extensive cross bracing between frames, clearly built to last. Primarily it hauled coal trains on the competitive route from South Yorkshire to the major London market. It retained inside Stephenson's valve gear, as did most locomotives of the time. Engines also had superheaters of Robinson's own design though there was a legal challenge by the owners of Schmidt's patents. Later Robinson managed a good deal with those owners earning more in patent rights than in annual salary!

His 2-8-0 performed well in service and was chosen for service abroad in both First and Second World Wars. Numerous similar locomotives were built for the Railway Operating Department from 1916. Unlike the rival Great Western 28XX class the GCR engines claimed all line capability and had a simpler boiler than the GWR types. After post war disposal some even reached China.

The design was developed later in several ways, though not with any great result. For the Worsborough incline Baldwins suggested a massive 4 cylinder 2-10-2 and Gorton produced anglicised designs that were never built. Instead the GCR opted for a Garratt built under LNER auspices, rather against the preferences of Nigel Gresley.

The book has extensive tables of locomotive histories showing that some of his engines lasted in service until 1965. Appendices include the evolution of common user agreements for wagons, not something that normally fits in a locomotive book but the author clearly thought



it relevant, a breakdown of Railway Operating Department motive power and the Robinson superheater. There is an appendix about the use of Gresley's conjugated valve gear overseas plus one about the 2-8-2 tank engines of the Richmond Vale Railway in New South Wales, clearly derived from Robinson's design.

For a model engineer the one problem with this book is a lack of technical information useful in building a model. Drawings included are helpful but surely more could have been included?

Despite that caveat this is a well researched book with much here for anyone interested in locomotive development. Robinson's engines fully deserve this study.

Roger Backhouse

Published by Crecy, 2022
ISBN 978-1-9108-0968-6
£25, 224pp, hardback

William Spence PART 13

Cliff Almond continues his description of a potential unusual narrow gauge 0-4-0T for 7¼ inch gauge.

Continued from p218
M.E. 4696, 29 July 2022

Initial thoughts on the split axle boxes

As I mentioned previously, on the prototype, the bar frames and their associated wheels, axles and axle box bearings could be removed from the locomotive as an assembly, simply by removing four pins, and the locomotive could then be hoisted clear of the assembly for maintenance. Carrying this forward into the model would mean that the whole locomotive would have to be assembled in a similar way and, whilst it isn't ever going to need to be carried out, it became apparent that the assembly would have to be assembled upside down, unless I could lift the locomotive up in the workshop to assemble everything!

Therefore, it is easier to turn the locomotive upside down for the wheels, bearings and bar frames to be assembled (**photo 13**). Then the locomotive can be turned up the correct way and the boiler mounted, and so on…

With the fabricated bar frames now trial assembled into their mountings and alignments made, my efforts turned to the manufacture of the split bearing housings for the ball-race bearings.

My initial thoughts were guided towards having these cast in either iron or aluminium, with eight identical parts being required i.e. an upper and lower part, machined as pairs and bolted together, sandwiching the ball-race bearing. This seemed the most logical and cost-effective way forwards, with ready access to some two inch square hardwood timber that had been laying around the workshop and previously used as sleepers.

The only alternative was to purchase similarly sized billets in either cast iron or aluminium and spend time boring out, only to end up throwing around 50% in the swarf bin! A quick look at stock material prices turned my thoughts quickly back to having them cast and to make my own pattern!

My knowledge of patternmaking and sand casting comes from two sources. The first was from my time as an 11/12-year-old schoolboy. I can vividly remember an early metalwork lesson, gathered around a furnace containing molten aluminium on a very hot summer's afternoon, whilst my metalwork teacher took us boys (girls, in those days, had to do home cconomics, of course) through a 'crash course' in pattern making and sand casting. The lesson was (from memory) only one hour per week and, with time short and the sand boxes assembled, one boy was 'volunteered' to help the teacher pour the molten metal into the mould.

I can remember it being something like the second or third metalwork lesson in secondary school, as we all had on our newly purchased and crisp white aprons, that were the only things protecting us from the 630 degrees C of molten aluminium bubbling only a few feet away from the class! Under this, we had our new school uniforms and polished black school shoes for further protection! This was the early 1970s and I suspect we were all wearing nylon shirts and trousers, these being the new material of the time.

Looking back on that (and similar experiences in metal and woodwork lessons), I wonder how there were never any accidents! One theory I have for this is that we all had a very healthy respect for danger and diligently followed a teacher's instructions. The alternative to the latter was to duck the blackboard rubber, hurled by some teachers of the day, at a pupil not paying attention! I must have paid attention because, to this day, I can remember the whole process, the tools used and the methodology!

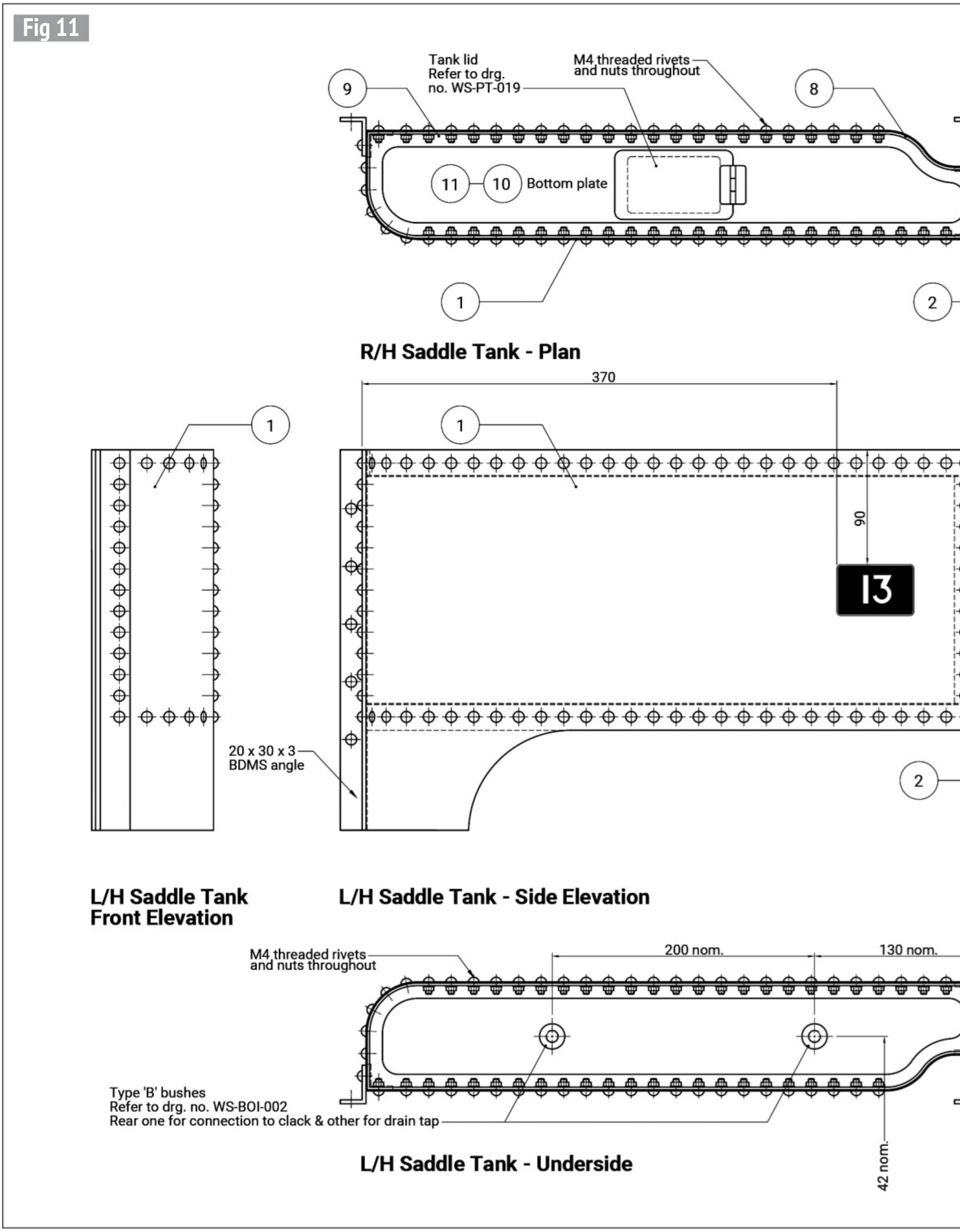
My second knowledge of the subject comes from a construction project I was working on in Bristol towards the end of 1999, known as *@ Bristol*. Goodness knows who dreamt up the name! Being the relatively early days of email and IT, some 'clever' person in Bristol City Council probably thought it was 'of the time'! This project had a very large water feature, with cast bronze sections of 1m x circa 20cm high, which had to be set out around the edge to a tolerance of around plus or minus a few millimetres, so that the water cascaded evenly over the entire length and was then recirculated.

I was despatched to visit the Foundry in Bristol where these sections where being cast. There were two reasons for this, one being to check on progress and the other to stock take and arrange delivery in small batches. Bear in mind these castings were worth a fair sum and would not have hung around long on site if they all had been delivered in one batch and left on pallets!

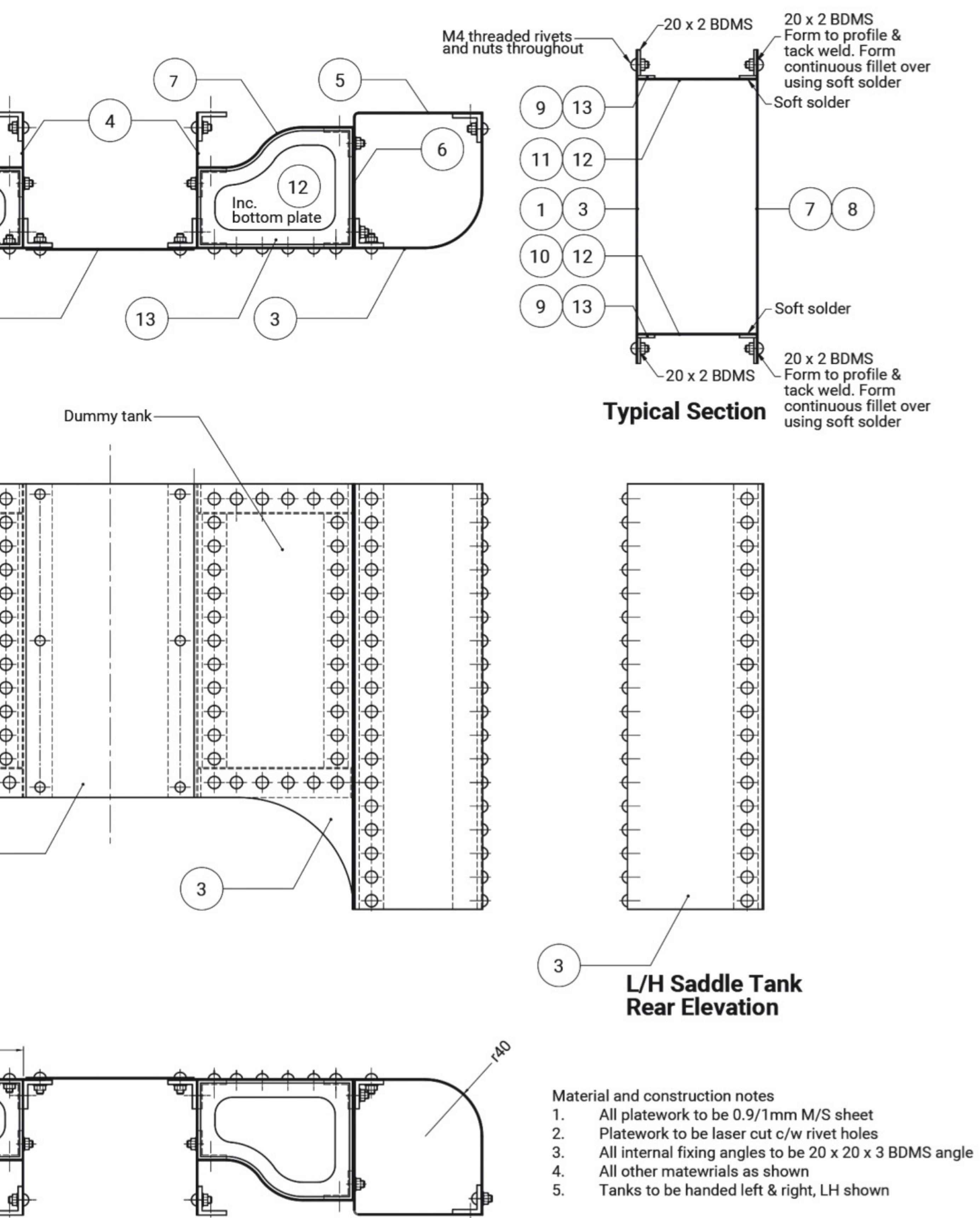
The name of the foundry escapes me now but the »


13
Assembled bar frames.

Fig 11



Tank lid
Refer to drg.
no. WS-PT-019
M4 threaded rivets
and nuts throughout
9
8
11
10
Bottom plate
1
2
R/H Saddle Tank - Plan
370
1
1
90
13
20 x 30 x 3
BDMS angle
2
L/H Saddle Tank
Front Elevation
L/H Saddle Tank - Side Elevation
M4 threaded rivets
and nuts throughout
200 nom.
130 nom.
Type 'B' bushes
Refer to drg. no. WS-BOI-002
Rear one for connection to clack & other for drain tap
L/H Saddle Tank - Underside
42 nom.



***William Spence* working drawings – water tanks.**

Split axle box pattern.

manager who showed me around told me it was one of the last surviving foundries still with a large pattern shop and using traditional methods. They were specialists in their field and I recall being shown exquisitely crafted wooden patterns for a classic car cylinder block for which they had a commission for, as well as a storeroom full of Stuart Turner patterns and being told they were the suppliers of all the castings for their range.

Suffice to say, I 'strangely' had to make many visits to the foundry and managed to pick up a lot of information on pattern making and the sand casting process! All for the good of a 'millennium' project of course!

Armed with this information, I decided to make my own pattern – the result of which is shown in **photo 14**.

I sent the drawing and photograph of the completed pattern to obtain a quote. Not knowing what sort of price to expect back, I was quite taken aback when I received it! How (when I was supplying the pattern), could eight identical castings cost so much more than buying stock-size material? Suffice to say, I quickly returned to the idea of spending more spare time boring-out from solid! At least I have a pattern, should anyone else be interested in building this engine in the future.

I will return to the machining of the split axle boxes and the fitting of the roller bearings at a later date.

Platework – water tanks

Having successfully fabricated the saddle tank on my 7¼ inch gauge Hunslet from laser-cut parts, which I rolled and tack-welded together before soft soldering the joints and dummy rivets, I decided to repeat this methodology for the water tanks on *William Spence* (**photo 15**).

The water tanks are fixed to the sides of the frames, with an open section vertically through them to take the vertical connection rods from the crankshaft to the rear axle pins, making four individual tanks, connected via balancing pipes.

The capacity of these tanks was not particularly large on the prototype, their size being constrained by the maximum permissible width of the locomotive, in order for them to pass through the spiral tunnel that once connected the two areas of the brewery. Similarly, on *William Spence*, their capacity is quite small, compared to the saddle tank on, say, a Hunslet.

For this reason, my intention is to carry a supply of water in the driving truck. In addition, one usually finds that water in tanks carried on a locomotive often gets too warm for it to be used for injectors and is best reserved for the emergency hand pump or mechanical pump.

I decided to construct the tanks as close to the original design as possible i.e. individual sections of sheet metal with angle iron corner sections inside. On the prototype, number 13, these are riveted together. However, this would be all but impossible in 7¼ inch gauge so I pre-formed all the rivet holes to take dummy rivets. The assembly will also be tack-welded and soft soldered throughout.

As one would expect, the tanks on the prototype eventually rusted through. Therefore, over the years these little engines were in service, they were patched up or replaced, with at least one example being rebuilt with welded alternatives.

In addition, I have taken the decision to make only one of the water tanks on each side to hold water. The other two can be dummies, given the already limited capacity and need to carry water elsewhere. This will allow the tanks to be constructed as close to the prototype as possible but only having to make two of them water-tight and with their inside surfaces coated to stop rust.

On the subject of surface protection, with the cost of brass making it very expensive to use on larger projects, the use of mild steel not only replicates full-size practice but is also considerably cheaper. However, when used for water tanks, rust quickly becomes an issue with injectors, pumps and small-bore pipework. The relatively simply option is to consider coating the inside faces with an anti-rust treatment and to consider the fitting of removable filters.

I believe there are a number of proprietary coatings that could be considered for rust protection. However, I have previously used a bitumen-based paint to good effect, simply by pouring this into the tank, after sealing all outlets and protecting threads, then moving the tank around until all surfaces are coated. Then the excess is poured out and left to drain and dry over a period of time until hard.

Another significant advantage of steel is that it takes paint very well, unlike brass.

I was lucky enough to have a detailed original drawing of the water tanks (**fig 11**). These were used as a back-drop in CAD, allowing the general arrangement to be developed using a combination of the dimensions on the drawing and tracing smaller details. This enables various items, such as the compound curves making up the top sections, to be reproduced. This is all carried out at full-size i.e. the back-drop (usually a PDF image), is scaled-up to full-size before being scaled to 1/3rd size. Once this has been done, each part can be extracted and made into individual parts with curved or folded parts being developed, including the accurate setting out of all rivet holes.

Unfortunately, many of the images I have of the prototype drawings do not reproduce well for publication with the water tank drawing being a typical example. The reason for this, I was advised by the curator of the Guinness Brewery Museum in Dublin, was that the brewery site suffered some significant flooding many years ago and the original drawings were flood damaged.

●To be continued.

Water tanks on the prototype.

Roger's Ramblings on Measurement

PART 2 – WE SHOULD HAVE HAD MORE FINGERS

Roger Curtis gets the measure of the countryside.

Continued from p.283
M.E. 4697, 12 August 2022

At the end of Part 1 of this article I suggested that there were two fundamental flaws in the metric system, one of which is down to the French surveyors who invented it and the other is down to human anatomy. In this part I will explore these issues and muse about what might have been.

The flaw that is due to the French surveyors is their choice of their basic unit of length which is, of course, the metre. It is a most inconvenient length in terms of day to day use. I find that if I try to pace it out I look like someone from the Ministry of Silly Walks made famous by John Cleese. Its preferred subsidiary of the millimetre is little better because, as others far more eminent than me have said, it is far too small for engineers and far too big for physicists and for every day use Joe Public would rather use the centimetre which is not one of the preferred SI units, these being kilometres, metres, millimetres and microns, each one being 1/1000 of the one before.

The metre is also inconvenient for measuring land area and those who decreed the SI system had to break the convention that only factors of 10^3 should be used and declared the hectare to be 10,000 square metres and not 1,000 square metres as would fit the rules. 10,000 square metres is, of course, 100m by 100m which again are not preferred SI units.

So why was the metre chosen? Well it basically comes down to the processes used in very large scale surveys and in navigation, though when surveying on land it is obviously possible to be much more accurate than when you are bobbing about on the water.

In the Imperial system angles are measured in degrees, there being 360 degrees in a full circle with 60 minutes of arc in a degree and 60 seconds of arc in a minute. (The most accurate theodolites - which are basically just protractors used by land surveyors and civil engineers - measure angles to one second of arc which is the angle subtended by about 6 thousandths of an inch at a distance of 100 feet.) Navigational distances are measured in nautical miles, a nautical mile being the distance on the surface of the earth subtended by an angle 1 minute of arc at the centre of the earth and is equal to about one-and-one-seventh imperial miles (6080 feet). This broadly means that if the elevation of a star, as measured with a sextant on a ship, changes by 1 minute of arc the ship's latitude has changed by one nautical mile. A speed of one nautical mile per hour is one knot.

Those who devised the metric system decided to metricate the circle along with every other type of measurement and decreed that the right angle should be divided into 100 grads (or grades) and that each grad should be divided decimally. (I have used a theodolite graduated in grads though the grad seems not to have been widely adopted for everyday use.) They then set about determining the distance from the North Pole to the equator measured along the longitude of Paris. By definition this distance subtends an angle of 100 grads measured at the centre of the earth. The kilometre was then defined as being the distance on the earth's surface subtended by and angle of $1/100^{th}$ of a grad. This of course means by definition the circumference of the earth is 40,000 km. It also means that if the elevation of a star as measured from a ship with a sextant changes by $1/100^{th}$ of a grad the ship's latitude has changed by 1km.

But the real problem that the French and the rest of us are stuck with is that we have only ten fingers and thumbs. If only we had twelve, how much easier our arithmetic would be. There is no reason whatever that our counting system should be based on a unit of 10 other than the fact that we can count to 10 using the things sticking out of our hands. There are many other bases that have been used including 2 (the binary system used by computers), 8 and my favourite 12 which is known as the duodecimal system.

Ten is divisible by two and five – big deal. Twelve is divisible by two, three, four and six which is much more useful. To make the duodecimal system work we need to use the digits 1 to 9 plus two additional ones that represent the quantities that we now call ten and eleven. The symbol 10 would then represent a dozen and the symbol 100 would represent a gross. The quantity that we now call thirty would be written as 26 (two dozen and six). We could multiply and divide by 12 by moving the decimal point as we do with the decimal system so that 260 would give two gross and six dozen and 2.6 would be two and a half. I hope that is not too confusing – it really is very simple when you get used to it.

If we were to use this system the writing of most of our fractions, especially the useful ones, would become so much simpler as we can see from the table. (Note that the letter A has been used as a symbol to denote the quantity that we now call ten.)

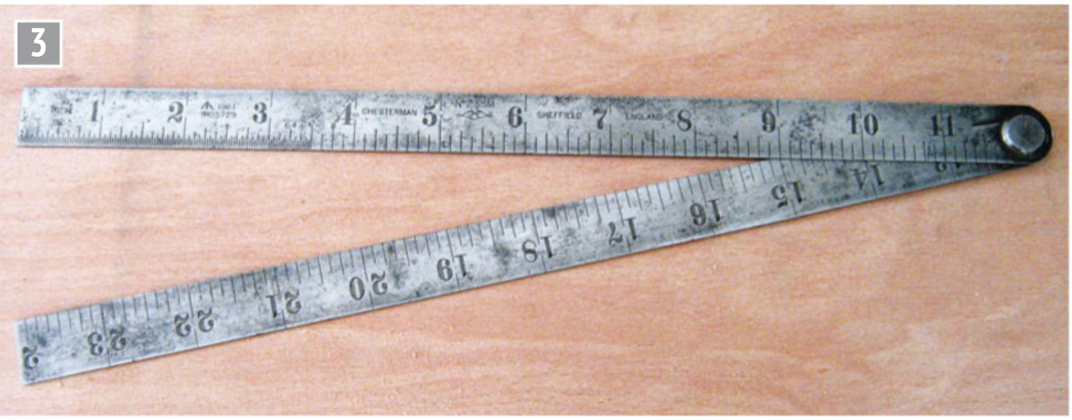
It is only the tenth and fifth that are simpler in the decimal system and we normally have little need to divide by those in everyday usage *except as a function of the decimal system itself*. An everyday example of this is that we buy eggs in half dozens because it is impractical to pack five. I know that I have missed out three tenths, four tenths, etc but again the only reason that we ever need to use these is because we are working to a base of 10. If we were to work with a base of 12 we would never ever want to consider such silly quantities as tenths. It could only be worse if we used a base of seven or some other prime number.

Please don't think that I am advocating that we change to the duodecimal system – can you imagine how difficult it would be to get it across to Joe Public and the confusion and chaos that would reign as a result of trying to do so?

However, on my allotment I do use a very convenient compromise that takes full advantage of the benefits of duodecimal system. I do my measuring using a wooden batten seven feet long ('cos that's what fits in my shed) that has a shallow saw cut across it marking every foot. I use this both for marking out my rows and for spacing the plants along the row. The plants that need to go in 3 inches apart are spaced four to the foot; those that need to go in 4 inches apart are spaced three to the foot. It can also be used to space things at 6 inches, 8 inches, 9 inches, 12 inches, 15 inches, 18 inches, 20 inches, 21 inches and lots of others. There is no way of making such a simple device as this using metric units. Fortunately, most seed packets still show the optimum spacing in inches. **Photograph 2** shows my measuring batten in a double row of broad beans that were sown 8 inches apart.

Comparison of Fractional Notations in Decimal and Duodecimal Systems		
Fraction	**Decimal Notation**	**Duodecimal Notation**
Twelfth	0.083333333	0.1
Tenth	0.1	0.12
Eighth	0.125	0.16
Sixth	0.166666667	0.2
Fifth	0.2	0.24
Quarter	0.25	0.3
Third	0.333333333	0.4
Three eighths	0.375	0.46
Half	0.5	0.6
Five eighths	0.625	0.76
Two thirds	0.666666667	0.8
Three quarters	0.75	0.9
Seven eighths	0.875	0.A6


Measuring batten.



Shipwright's folding steel rule.

I also use the two very convenient measuring devices attached to the ends of my legs, especially when planting spuds which go in a foot apart.

The advantages of the very convenient and human scale base-units and duodecimal benefits of the twelve-inch foot are so great that I would never even consider using the SI system when gardening. The twelve inch foot with its duodecimal benefits was also ideal for joinery, cabinetmaking and every other traditional construction processes along with most of our other day to day measurements as well as for building and civil engineering works, none of which have the need for millimetre accuracy.

The need to measure to an appropriate degree of accuracy was brought home to me whilst working with a shipwright as a student apprentice. One day during a tea break, he turned to me and said, "Let me show you something". He then took his two foot folding steel rule out of the pocket specially sown onto the thigh of his overalls for it. This was standard issue and all shipwrights had the same rule and pocket and used them all the time. **Photograph 3** shows the one I was given.

He then said, "This rule is two foot long and when folded in half it is one foot long. If you look at it you will see that each foot is divided into twelve inches and midway between the inch marks there are other marks which are the half inch marks. If you look closely there you will see that there is another mark half way between the inch and half inch marks. Those are the quarter inch marks. And that is all you need to know when using this rule".

After a pause he then he said "But you are a bright lad so I will tell you … if you look half way between the quarter inch marks you will see other marks and they are the eighth of an inch marks. *But they are only for draughtsmen."*

What he would have made of millimetres I will never know.

The fact that, sixty years later, I still vividly remember this shows what an important lesson on practical accuracy it was.

As an aside it would be quite impractical to create a metric version of this rule. If it was a meter long and folded in half it would act like a splint on the leg and if folded into three it would be 333.3mm long when folded and how useless is that?

Whilst talking about shipwrights, the thickness of steel plate used in shipbuilding in those days was defined in terms of its weight. Steel plate that is 1 inch thick weighs 40lbs per square foot so ¼ inch thick plate was known a '10 pound plate' and '20 pound plate' is ½ inch thick. In shipbuilding where weight is always an important consideration, this was very useful.

Anyway, back to the measurement of lengths.

The practicality of the inch versus the millimetre as a basic unit of length is clearly demonstrated by the standard dimensions for brickwork. Under the imperial system the standard was 4½ x 3 x 9 inches including joints. That for the metric system is 112.5 x 75 x 225 including joints. Can anyone actually believe that bricks are made and laid to a tolerance of half a millimetre?

It is my view that in devising the twelve inch foot, our forebears were in fact very clever indeed and not at all arbitrary. It is based on two very convenient units of length for everyday use and has many of the benefits of duodecimal system.

It was, in fact, only with the development of mechanical engineering and its widespread use that the need arose to work to very small fractions of an inch which can be a little irrational. And as far as I can see this is really the only reason that there was for changing from the otherwise very sensible and easy to use Imperial system of measurement of lengths to the metric system.

If only we had twelve fingers and thumbs!

ME

Club Diary 25 August - 25 September 2022

August

25 Guildford MES
Open Day, Stoke Park, Guildford 10:00 – 13:00.
See www.gmes.org.uk

25-29 Great Dorset Steam Fair
Tarrant Hinton, Blandford Forum. See www.gdsf.co.uk

28/29 Bristol SMEE
Public Running, Ashton Court Railway, BS8 3PX, noon – 17:00. Contact : secretary@bristolmodelengineers.co.uk

28/29 Cardiff Model Engineering Society
Public running, Heath Park, Cardiff 13:00 - 17:00.
See www.cardiffmes.co.uk

28/29 North Wilts MES
Public Running, Coate Water Country Park, Swindon 11:00 – 17:00. Contact: Ken Parker, 07710 515507

28 York Model Engineers
Open Day. Contact: Bob Polley, 01653 618324

September

3 Southport MEC
Small Gauges Day, Victoria Park 10:00 – 16:00.
Contact: Gwen Baguley, gwenandderrick@yahoo.co.uk

3/4 Sutton Coldfield MES
Federation of Model Engineering Societies Rally, Little Hay, Lichfield.
See www.scmes.co.uk/rally or contact: Martyn Cozens, scmessec@gmail.com

4 North Wilts MES
Public Running, Coate Water Country Park, Swindon 11:00 – 17:00.
Contact: Ken Parker, 07710 515507

7 Bradford MES
September Meeting, Saltaire Methodist Church 19:30.
Contact: Russ Coppin, 07815 048999

7 Bristol SMEE
Wilton windmill restoration, Begbrook Social Club BS16 1HY.
Contact : secretary@bristolmodelengineers.co.uk

8 Cardiff Model Engineering Society
Talk: Medieval Cardiff, Heath Park, Cardiff.
See www.cardiffmes.co.uk

10 Bromsgrove SME
Autumn Open Day, Avoncroft Museum.
See www.fmes.org.uk/events

10 Cardiff Model Engineering Society
Steam-up and Family Day, Heath Park, Cardiff.
See www.cardiffmes.co.uk

10 Urmston and District MES
Polly rally. Contact : Neil Mortimer on 07900 133201 or at neiljmortimer@gmail.com

10 York Model Engineers
Evening Talk – 19:00.
Contact: Bob Polley, 01653 618324

11 Ayesha Centenary Rally
Rugby MES 10:00 – 17:00.
See www.n25ga.org

11 Bristol SMEE
Public Running, Ashton Court Railway, BS8 3PX, noon – 17:00. Contact : secretary@bristolmodelengineers.co.uk

11 North Wilts MES
Public Running,cCoate Water Country Park, Swindon 11:00 – 17:00. Contact: Ken Parker, 07710 515507

17 Bromsgrove SME
Rob Roy Rally, Avoncroft Museum. Contact: Rex Hanman, 01980 846815

18 Bradford MES
Running Day, Northcliff Railway 13:30 – 16:00. Contact: Russ Coppin, 07815 048999

18 Bristol SMEE
Public Running, Ashton Court Railway, BS8 3PX, noon – 17:00. Contact : secretary@bristolmodelengineers.co.uk

18 Cardiff Model Engineering Society
Public running, Heath Park, Cardiff 13:00 - 17:00.
See www.cardiffmes.co.uk

18 Guildford MES
Open Day, Stoke Park, Guildford 14:00 – 17:00.
See www.gmes.org.uk

18 North Wilts MES
Public Running, Coate Water Country Park, Swindon 11:00 – 17:00.
Contact: Ken Parker, 07710 515507

21 Bristol SMEE
ZOOM Meeting – 'World's Crane Makers'.
Contact : secretary@bristolmodelengineers.co.uk

23-25 East Somerset SMEE
Open Weekend at the Bath and West Railway near Shepton Mallett. See openweekend@essmee.org.uk or contact: Michael Malleson, 01747 860719

23-25 Llanelli and District Rally
Pembrey Country Park, Llanelli.
See llanellianddistrictmodelengineers.wordpress.com

LNER B1 Locomotive

PART 9 – BUFFER BEAMS AND SLIDE BAR SUPPORTS

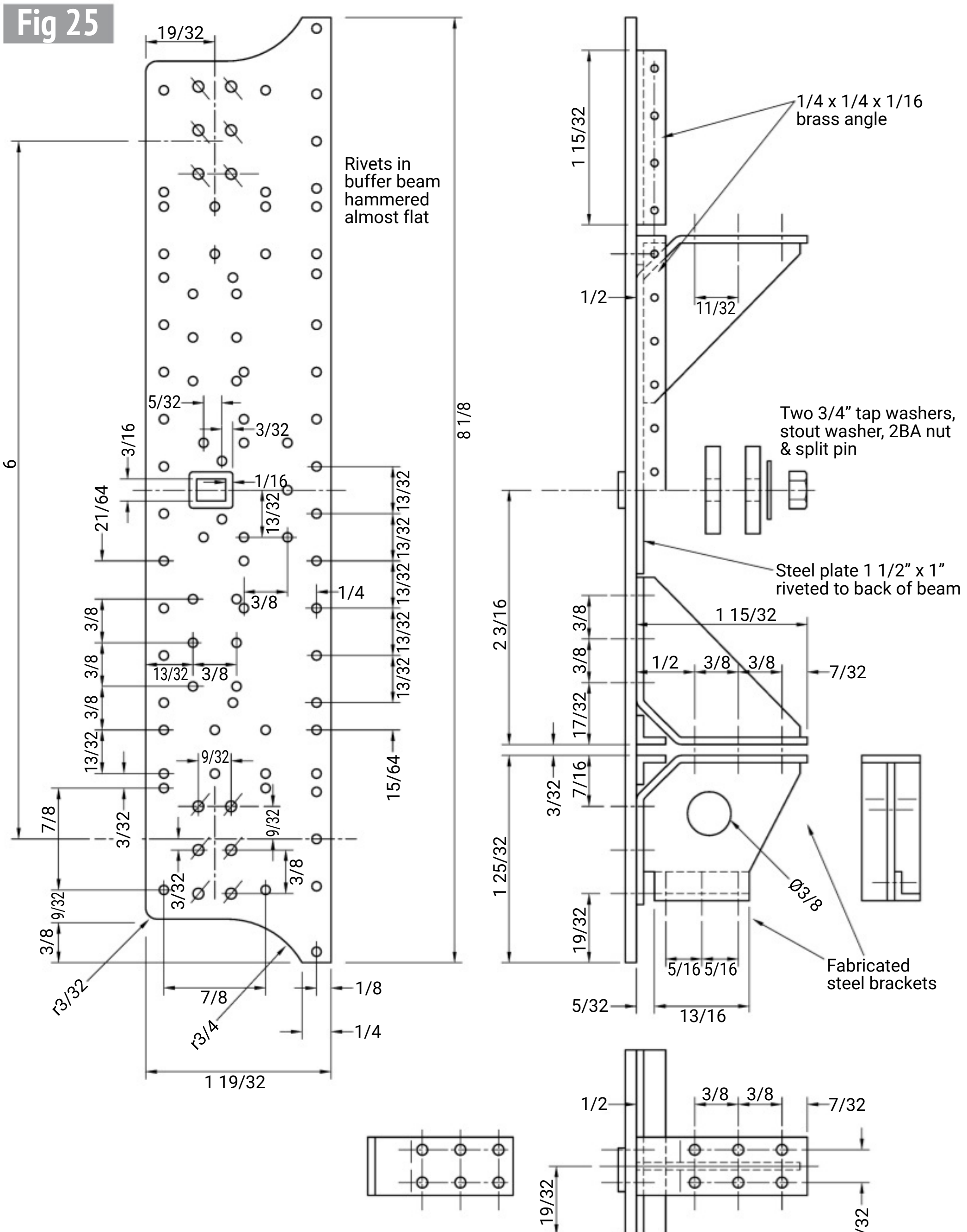
Doug Hewson presents an authentic 5 inch gauge version of Thompson's most successful locomotive.

Continued from p.211
M.E. 4696, 29 July 2022

Well, we now come to the main event, the locomotive. The two different frame plates appeared in the 13 January issue of *Model Engineer* so we will now get on with the buffer beams (**fig 25**).

The problem is that some have all the snap-head rivets showing but some are devoid of visible rivets. I haven't noted the details of which have and which have not. However, as you can see in the photo of 61002 (**photo 57**), *Impala* is without, and so is *Klipspringer*, so I would suspect none of the first ten B1s had visible rivets. I also have a good photo of 61376 which is also devoid of any rivets on the buffer beam. However, lots of the B1s did have visible rivets on

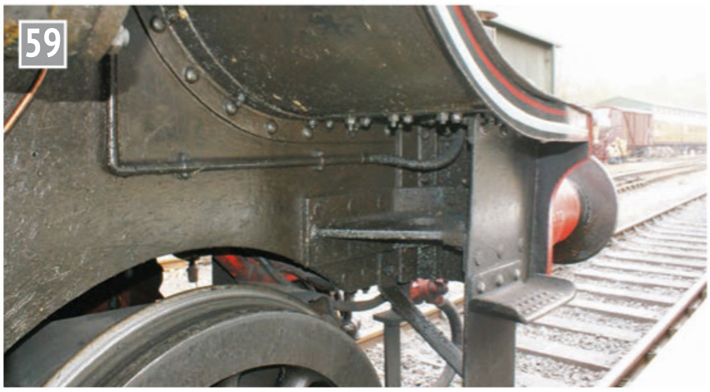
Fig 25



Buffer Beams And Brackets

LNER B1 61002 Impala.

B1 seen at the Tyneside Exhibition.



Buffer beam bracket with countersunk rivets.

Rivet detail on the front buffer beam.

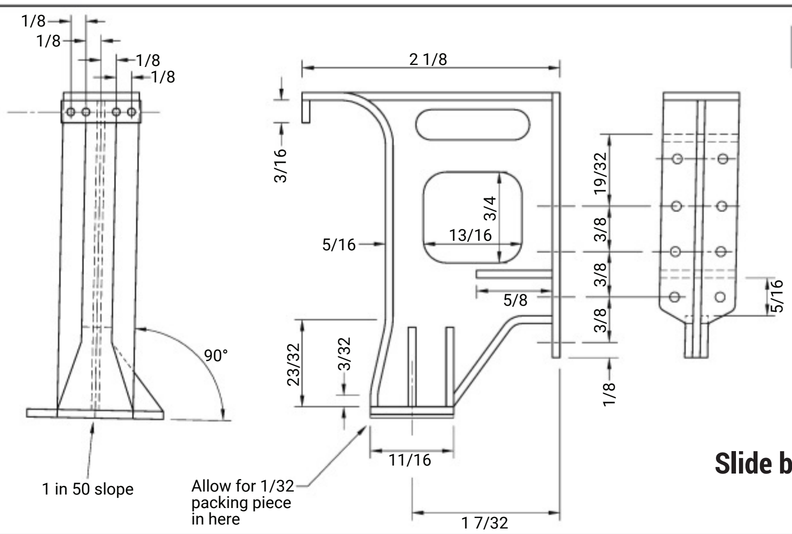
the front so therefore it will be a question of pick and mix. I have been making a list of engines which had no visible rivets on the front buffer beam so if anyone wants the list, please let me know and I will try to oblige!

Note that the green B1s had white lining edged in black and they had a red line towards the bottom of the side valance. I just had to insert another photo in here (**photo 58**) which shows a beautiful B1. It was on the Tyneside Exhibition stand at Harrogate a few years ago and the gentleman who built it certainly must have taken lots of measurements of the full-size B1s to get all this detail correct. The thing is, it takes no more effort to get it all right as to build it all wrong. There is also a very good piece of film of this particular locomotive on YouTube - note that it also has the correct tender on it too. The minute I set eyes on this locomotive I just said 'Wow' to myself 'This B1 definitely looks like a B1'.

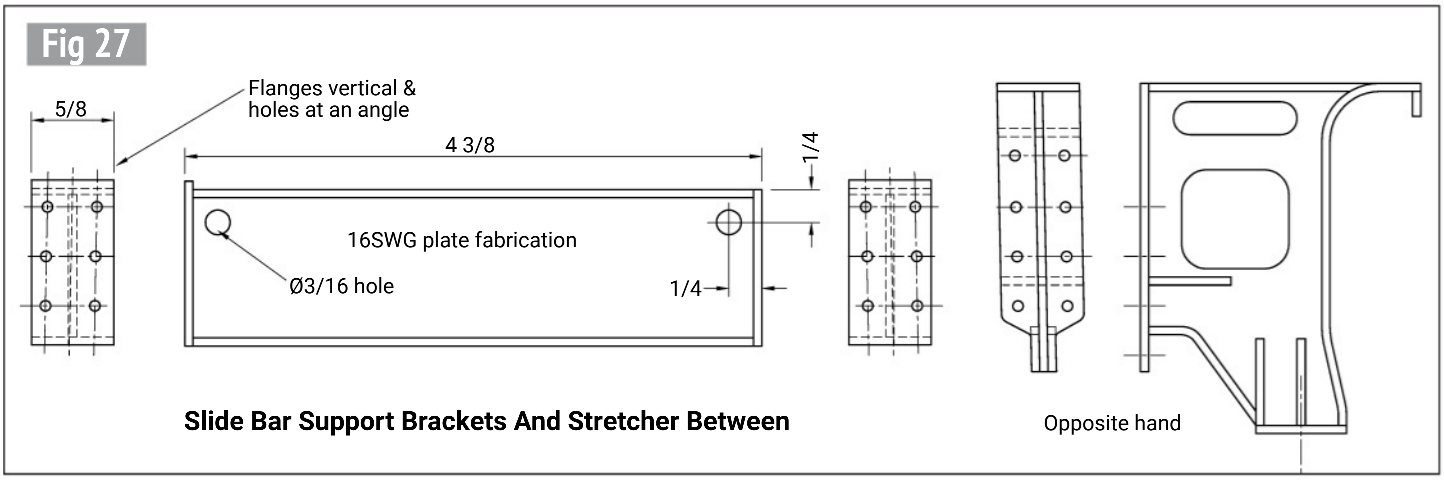
Now to some serious business. The buffer beams are 3/32 inch (2.5mm) plate and the four holes on a 7/8 inch square grid pattern at each end are for fixing the buffers. As I said for the tender buffers, they are No. 43 holes for 8BA bolts and must have the nuts on the outside and should have 1½ threads showing. All the remaining holes are No. 45 for 5/64 inch rivets which should be available from Geoff Stait or from Katy at The Steam Workshop. At the centre of the buffer beam you will need to silver solder a surround to 1/16 inch wide for the draw hook. The draw hook can be fitted with a couple of ½ inch tap washers and a steel washer.

There are several pieces of angle and I would suggest these are milled out of square steel bar rather than brass as I have said on the drawing. I always think it is far nicer riveting steel to steel rather than brass. There isn't a lot of it to make and I just think it will make a far better job. There are four brackets to fabricate and these are made from ½ inch by 16swg steel plate (if you can get it nowadays!) with a triangular piece of plate to form the right-angle. Note from **photo 59** there is only a hint of these rivets showing so hopefully they will be countersunk. Note also, that there is a piece of angle beneath the platform plate and this needs milling down from ¼ inch angle to 7/32 x 7/32 x 1/32 inch and this is easy to make »

Fig 26



Slide bar support brackets.



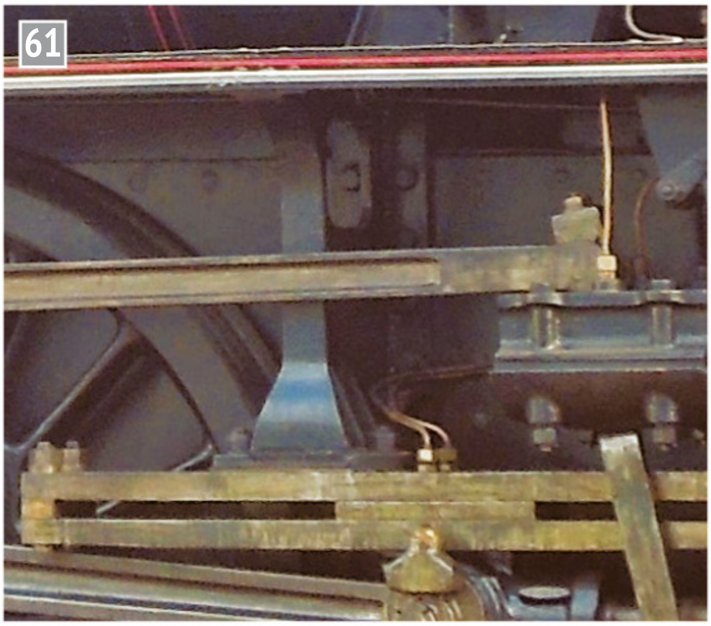
as you can just mill a little bit off the backs of the angle. The chances are that it will not be very square anyway. It is easy enough to bend this angle round a former once you have annealed it but I would not recommend trying to bend it without the heat! Also worthy of note is the conduit which goes to the electric lamp on the buffer beam above.

I have a nice photo which I took of the front buffer beam of 61264 and just have a look at those rivets. I would say that they are almost countersunk or have a very shallow oval head on them, but they look to me as if they have been hammered over on the buffer beam face. I think that **photo 60** shows this very nicely.

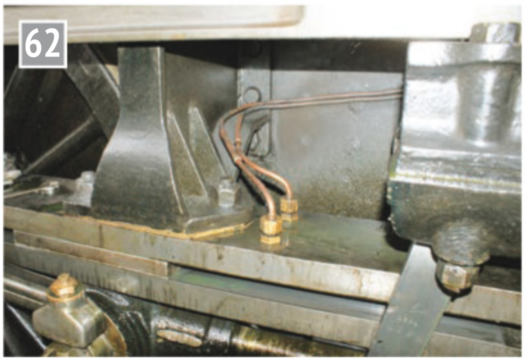
We now come on to the brackets which support the slide bar brackets (not guide bars please!) and the beam which goes between them (**figs 26** and **27** and **photo 61**). Starting with the two brackets, these are all fabricated and they should be included with the laser cut kit. Remember, the bottom of this needs to slope up towards the cylinders at 1 in 50 and the top needs to be level.

Make sure you get the base plate the correct way round! The bottom of the right-hand bracket is shown in **photo 62** and note the packing under the base plate. It is a good idea to make allowance for this so that if you are fractionally out with your bracket you can use a packing plate to adjust the height. At the top of the bracket are four countersunk rivets where the side platform is joined, and these are shown in **photo 63**. In our case I would use 10BA countersunk bolts and if you use brass ones you can simply fill the slots with a little blob of soft solder. Mind you, I have made thousands of these for my open wagons from 1 inch panel pins held in a small collet and it does not take very long to knock a hundred of those up. It will be just as well to make quite a few of these anyway as I can see at least another 50 or so just counting those on the other platform joints.

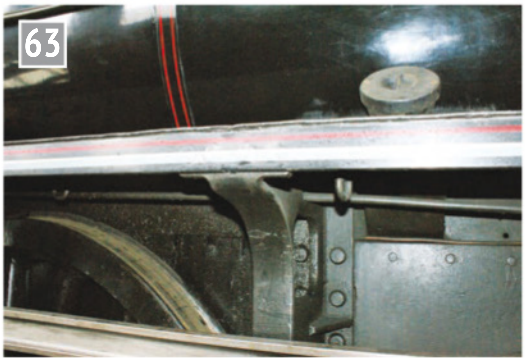
It's a good idea to make this joint correctly as it means that the section of footplate can be lifted out if necessary, not forgetting, of course, that the atomisers will be under there! I have included two little tabs on the outsides of these brackets where the platform breaks. The holes in the main plate are all copied off the works drawings. Note, also in photo 62, the split pins in the bolts which hold the slide bars in place. If you can't make any split pins small enough, just try scribing a deep line across the end of a piece of bar, lay a wire tie from a freezer bag in there (with the plastic stripped off, of course!) and then with a small scraper you can scrape it down half the diameter, roll it round a very small number drill and there you will have a 15 thou diameter split pin. I learnt this little trick many years ago from one of the Malden members, Jim Scrooby, who was an instrument maker by profession. He had come to see me about making some proper patterns for a scale GWR 1500 he was building at the time. I have made hundreds of such split pins using this method for a number of engines I have built and it gives me great pleasure every time I think of Jim. I



Slide bar support bracket.

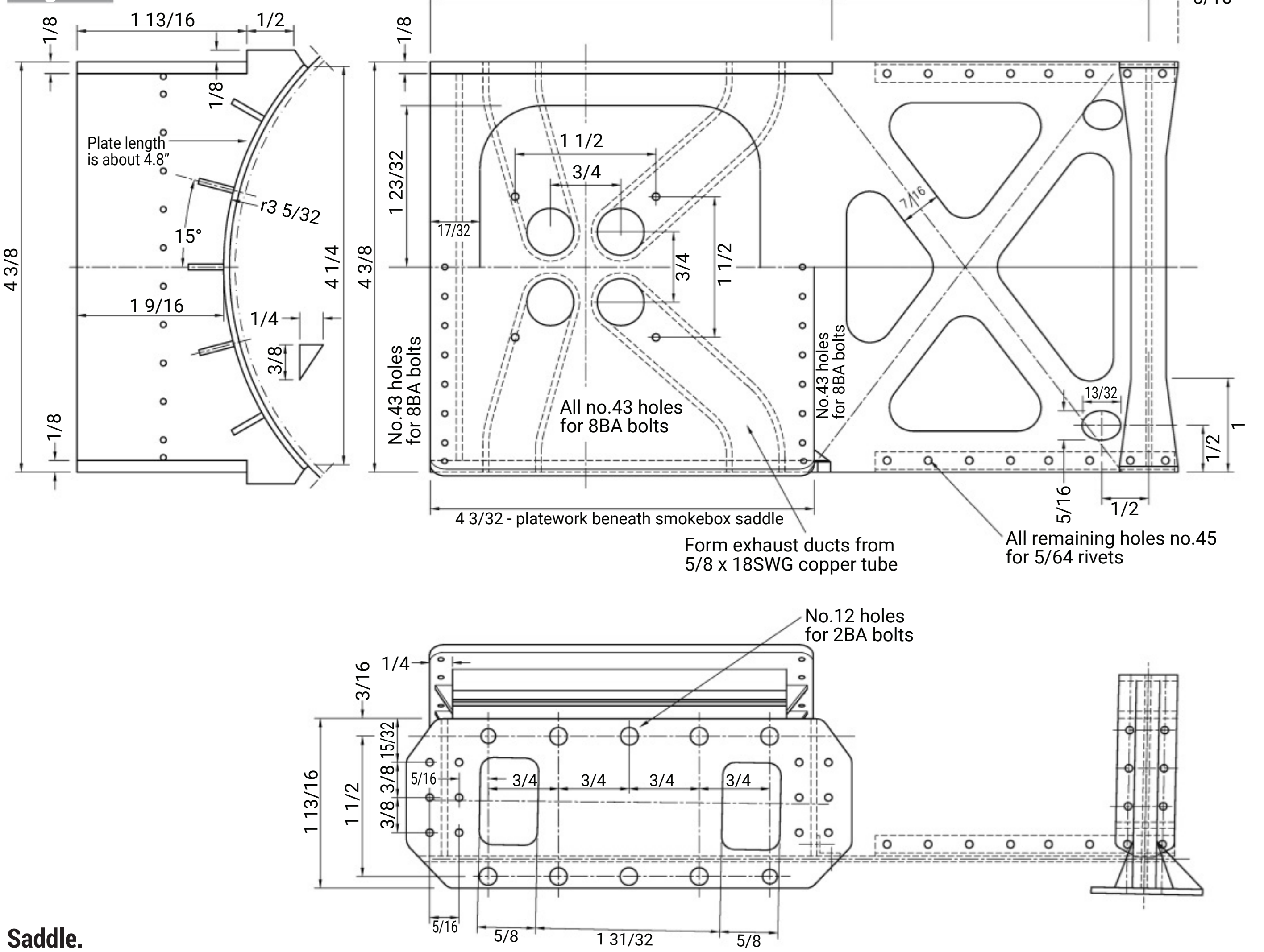


Lower end of the support bracket – note packing.



Upper end of the support bracket.

Fig 28



Saddle.

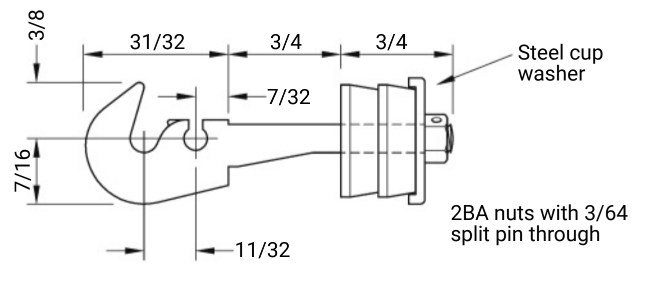
have used lots on my wagons too where they need split pins fitting through 12BA bolts!

To crack on a bit, I have also shown the smokebox saddle (**fig 28**). This will need some thinking about, as it did with me, and so I have shown it with four copper tubes which require a bit if forging to open them out to fit into the ⅛ inch side plates of the saddle itself. I would make the bends in the pipes first and I have shown the side plates with ten 2BA set screws at either side so that the cylinders can be bolted on securely. I have also left a large hole underneath so that hopefully you will be able to get at them.

I have shown the exhaust pipes in **photo 64** so you will have to do your best with those. You may have to adjust the positions of the front and back plates of the saddle but beware, you might have to fit other things in with these. Hopefully, I have drawn something that you can understand. Sorry to say that the photograph of the exhaust pipes was taken a bit far forwards so unfortunately it doesn't show the rear plate which forms the back of the saddle. Photograph 61 was the best photograph I could get of the right-hand bracket.

I had a little spare space so I have included a drawing of the front draw hook (**fig 29**) but you can buy these from Katy at The Steam Workshop. They are cast in stainless steel.

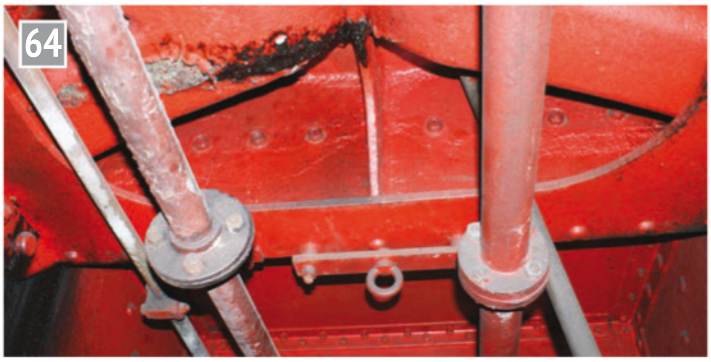
●To be continued.



Front Draw Hook
Steel casting

Fig 29

64



Exhaust pipes.

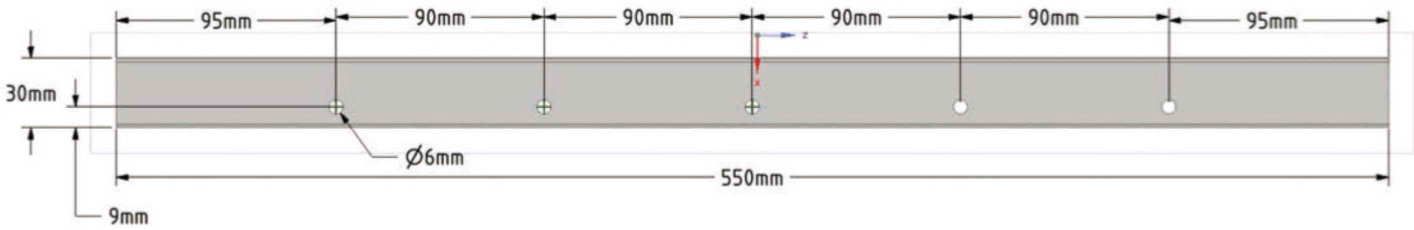
18+

WHAT IS AVAXHOME?

PART 3

5 Inch Gauge Timber Frame Driver's Truck

Fig 18 **Side planking base rail.**



David Allen makes extensive use of 3D CAD and laser cutting to make a timber framed driving truck.

Continued from p.259
M.E. 4697, 12 August 2022

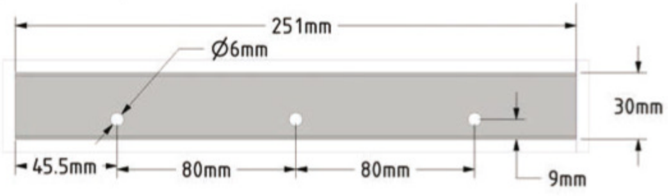
Making the side panels

For the side panels I wanted to capture the style of a five plank wagon so I used five strips of 12 x 30mm hardwood for each side.

Figures 18 and **19** show the base side planking; the first row is dowelled to the birch ply base with hole positions shown on the drawing. Transfer the holes from the sides to the ply base board. It's a good idea to number the parts front and back to identify where they go so the dowel holes fit to their respective sides.

A small hand plane was used to prepare the edges of each plank adding a bevel, then cleaned up afterwards with sandpaper. Each plank was dowelled to its neighbour using 6mm dowels (**photo 12**).

Fig 19 **Front and rear planking.**



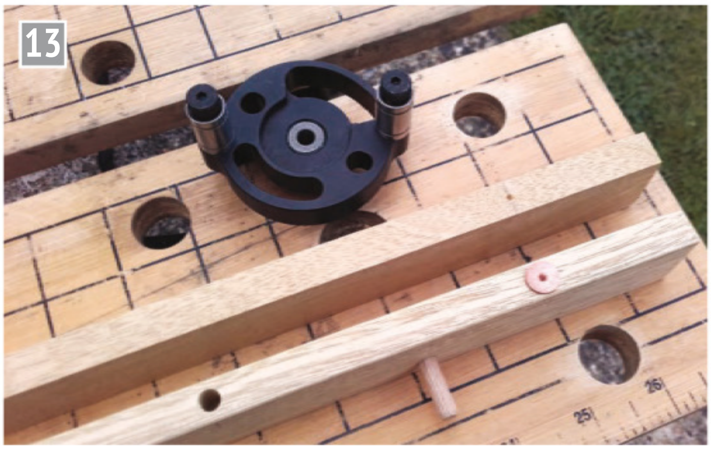
This might seem daunting and I'll admit I'd never dowelled anything before that wasn't a kit of bedroom furniture where all the holes were pre-drilled! However, using a dowel jig (**photo 13**) made the task quite easy and these can be obtained for as little as £7.

At this stage it's a good idea to practise on a piece of scrap before committing to drill the parts, not only to check alignment issues but also the fit of the 6mm dowels (**photos 14** and **15**).

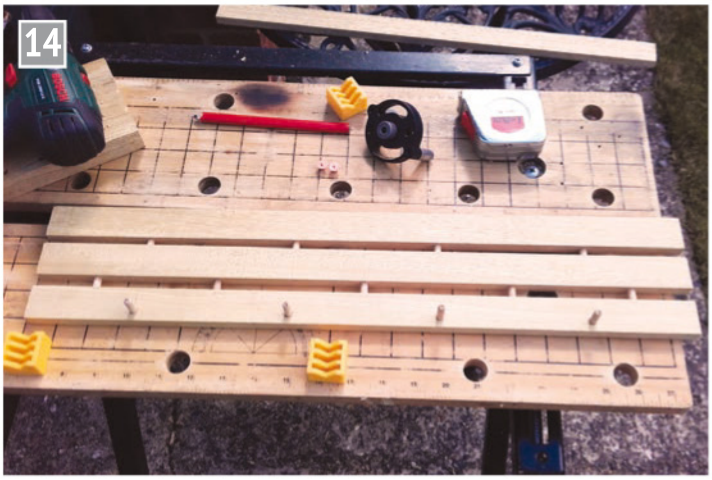
Once all the sides are drilled, glued and dowelled, clamp on to a flat surface using greaseproof paper to stop the assembly becoming permanently attached to the table top then leave to dry overnight.

With the completion of four sides, these can now be

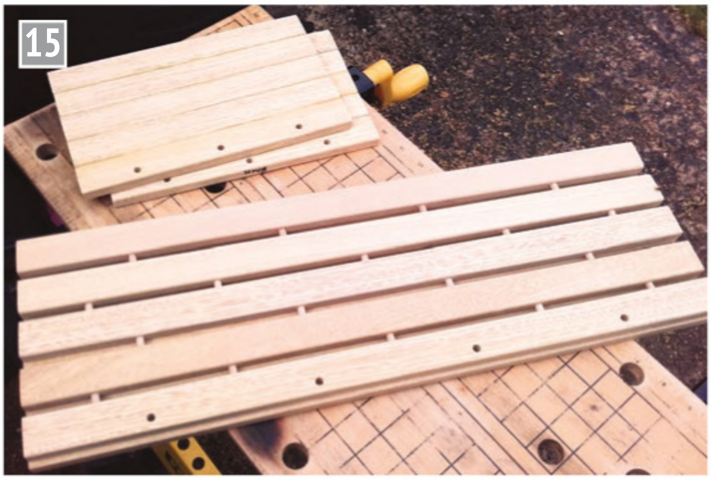
Dry run of the side planking, first row dowelled to the base board with 6mm dowels.



Dowel jig and transfer centre plug in use.



Work in progress on the first side panel; bottom plank with dowels dry fitted to align with base board.



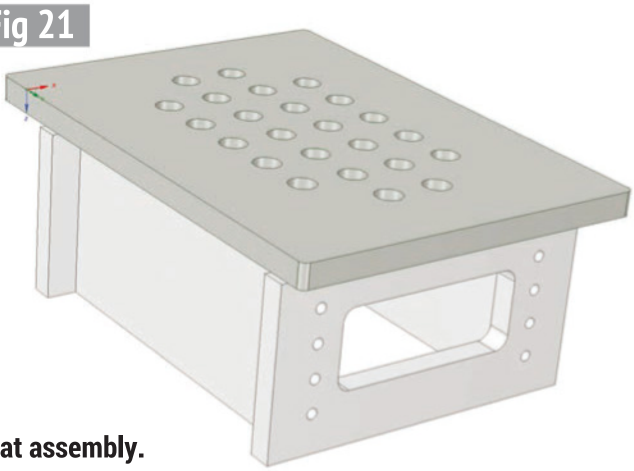
Two of the completed end panels and a pair of side panels before gluing and clamping.

Side planking corner bracing.

Fig 20

Footrest running boards (2 off, 15mm thick hardwood Idigbo).

Fig 21



Seat assembly.

secured to the baseboard. The dowels on the side panels, once tapped and glued home, should be raised from the side planking by about 6mm. These will be cut flush, when the glue has dried, with a joiner's saw which has zero set teeth so that it doesn't damage the surface. To finish off the side planking, the corners are supported with 3mm x 25mm angle iron on the inside and aluminium angle on the outside, thus hiding the joint (**photo 16**). Both are cross drilled then bolted together sandwiching the sides as shown.

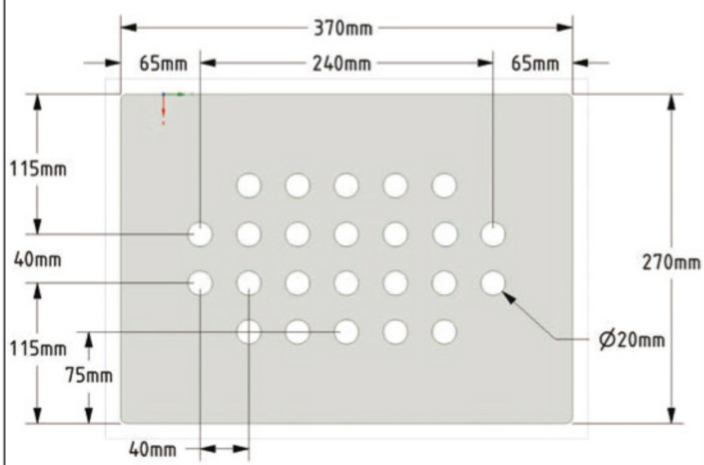
Fasten the headstocks, buffer plates and footrest brackets to the frame and baseboard assembly, then mount and transfer the holes to the footrest boards (**fig 20**). I found that the running boards are best made to fit between the angle iron footrest brackets before transferring the holes. The footrest boards can then be secured with M6 x 25mm button head bolts.

Drivers truck seat assembly

Figure 21 shows the seat assembly which is designed so it can be removed from the wagon base. It's a fairly simple arrangement, is constructed of 18mm birch plywood and use is made of 8mm dowels to hold it all together. The cover is made of faux leather fitted over a foam support. Having built a carriage in 5 inch gauge some years previously, experience tells me that it's important to get the thickness and build-up of foam right to get a comfortable seat that doesn't fatigue the driver too much. To this end I used a 75mm base of HP reconstituted ultra-high

Fig 22

Seat base.



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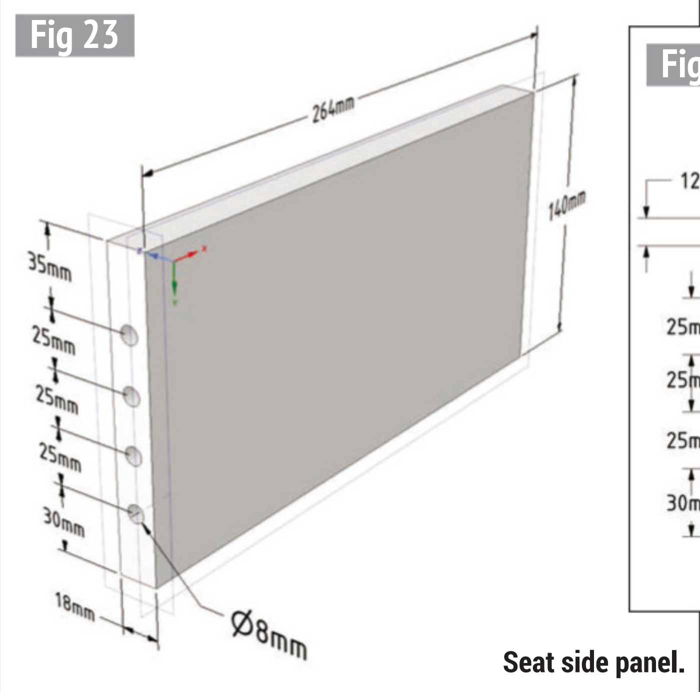
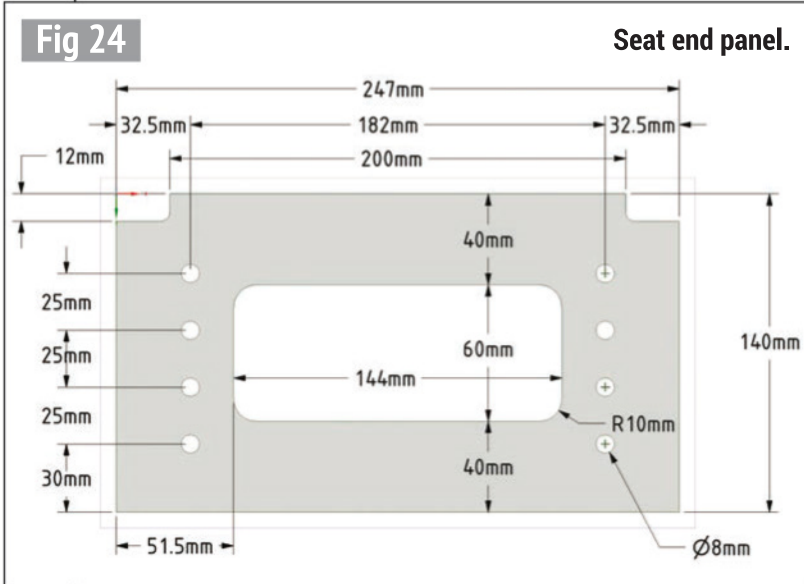
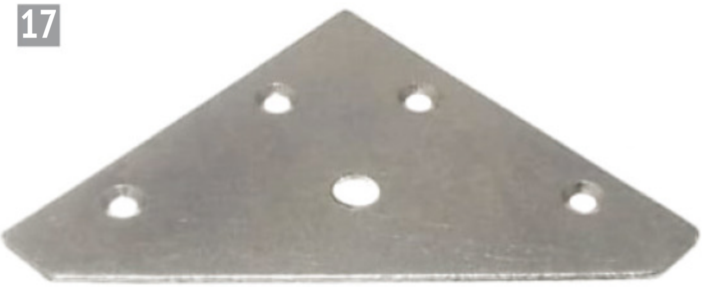


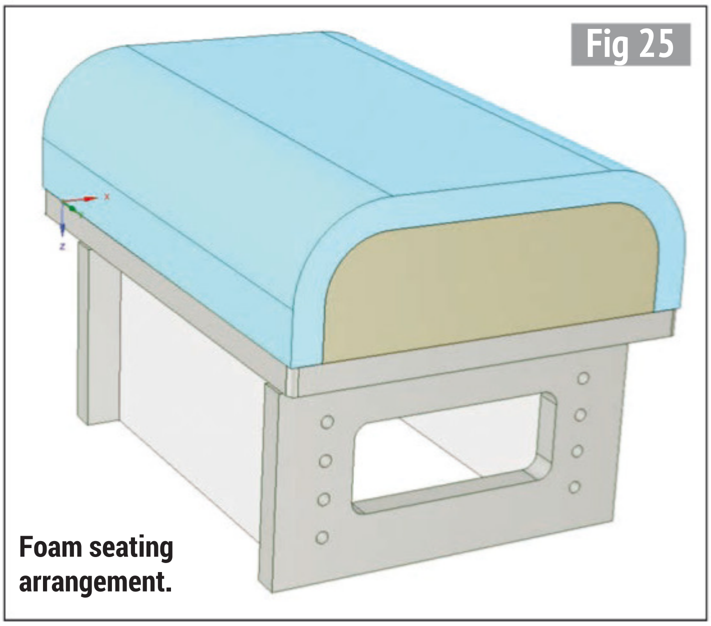
Seat side panel.



Seat end panel.



Seat angle plates.



Foam seating arrangement.

density foam and this was shaped with a Surform to round the edges. I then applied a 20mm high density medium firm foam over the top of the shaped base. These two parts were glued together with an aerosol adhesive specifically for use with polyurethane foam.

Figure 22 shows the base board cut from 18mm birch plywood (the thickness allows for 8mm dowels on the edge of the side panels). Note the holes through the top; this allows air to be expelled from the foam. I found the best way to cut these holes was with a Forstner boring bit which gave excellent results cutting through plywood.

The seat side panel is shown in **fig 23**; again 18mm birch plywood was used. The holes should be drilled 15mm deep.

The seat end panels are detailed in **fig 24**. If the dowel holes have been cut correctly it should all match up and can be glued together with 8 x 40mm fluted dowels. Check the sides are at right angles to the front and back when you clamp it up and allow the glue to dry overnight. Once the glue has set the dowel pins can be trimmed flush with the sides using a joiner's flush cut saw and then sanded for a neat finish.

The notches on the front and back panels are to allow the fabric over the edge of the baseboard so the fastening staples can be kept out of sight under the seat. The larger cut-out serves as a handle to lift the seat in and out of the wagon. This was cut out on a fretsaw and cleaned up afterwards on the milling machine to get the edges nice and square and achieve the 10mm radii in the corners.

Foam specification for the seat cover.

Base layer, HP Recon Ultra High Firm 75 x 230 x 370mm

Top layer, HP High Firm Blue V38, size 20 x 400 x 370mm

Figure 25 shows the foam seating arrangement with medium density foam glued on a high density recon foam base. The base was prepared by cutting the edge at 45 degrees with a suitably sharp knife and then rounded using a Surform shaver tool. It's a good idea to make a template of the curve so you maintain the radii over the length of the edge. It's not too pretty when the surface is roughened up with the Surform - I've even seen, on YouTube, foam being sculptured with an angle grinder which gives good results but covers everything in the workshop as the dust it creates is considerable. Despite a rough finish, depending on how you approach it, the addition of the top layer keeps the round edge nicely contoured. Glue the two foam pieces together with an adhesive suitable for polyurethane. Cover the foam with 12oz Dacron fibre wrap to soften the edges and then cover with faux leatherette made to fit - something the lady of the house might help with and may even rise to the challenge!

The seat was finally secured to its base using 'off the shelf' flat bright zinc plated steel corner plates, 83 x 83 x 0.9mm (**photo 17**). These are available

Completed drivers' truck on the home track.

from retail hardware stores and Amazon in packs of four. These were screwed into the corners and the central holes used to secure the top board.

Photograph 18 shows the completed five plank wagon driver's truck with a seat fitted on a rather chilly mid-November morning. A few embellishments to the side panels were made from aluminium strip and painted up. Timber was left natural with several coats of varnish.

The suspension worked extremely well with about 10mm compression of the axle box springs with a 250lb load. That seems to tie up well with the specification for the springs which was about 12N/mm. (1N = 0.102kg or ~0.225 lbs). All that's needed now is to finish off my locomotive project over winter so I can try it out in the spring. ME

My thanks to:

The Midland Railway Study Centre for inspiration in the design - http://www.midlandrailwaystudycentre.org.uk/
J. Bradnam and Sons Ltd., Timber Merchants of Haverhill for supplying the pre-cut hardwood etc.
Lasered Components Ltd., Braintree, Essex for supplying the profiled steel work.
M-Machine for supplying the EN3 wheel blanks.
Halstead Electro-plating Services, Essex for zinc plating the finished W frames.
Mark Harris Upholstery Ltd., Taunton, Somerset for seat foam materials cut to size.
Lastly 'The Bolthole' Powerdrive Systems Ltd. of Haverhill for my numerous trips to purchase all the nuts and bolts etc used in the Truck.

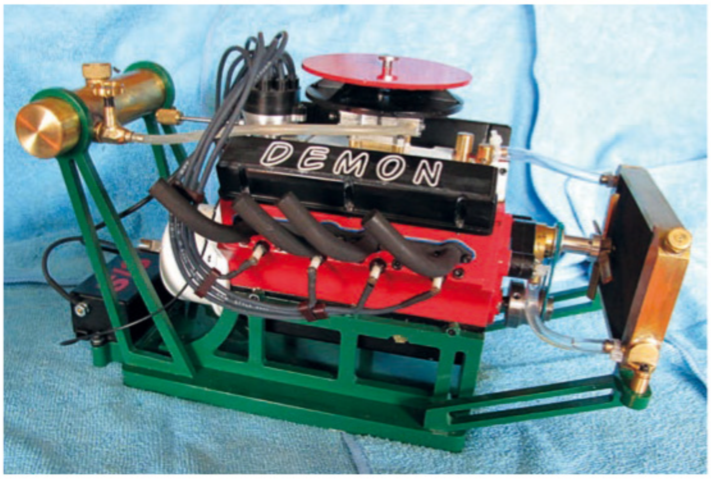
The *Little Demon* Supercharged V8 PART 12

Mick Knights describes the construction of a supercharged V8 internal combustion engine.

Continued from p.271
M.E. 4697, 12 August 2022

We now move onto the cooling system, where my first attempt at manufacturing a radiator proved interesting.

I'm reasonably confident that I can come up with a machining process to produce most components that come my way; my fabrication skills, however, could do with a little more polish in certain places and when it came to my first attempt at manufacturing the radiator, soft soldering proved to be one of them. The last time I can remember doing any serious soft soldering was back on day release at college, well before the advent of electric soldering irons but when there were gas ovens on the benches to heat the solid soldering iron to the correct temperature, which was indicated by the colour of the flame around the tip of the iron. Since then, soldering the occasional electrical connector has been about the extent of it all.



128

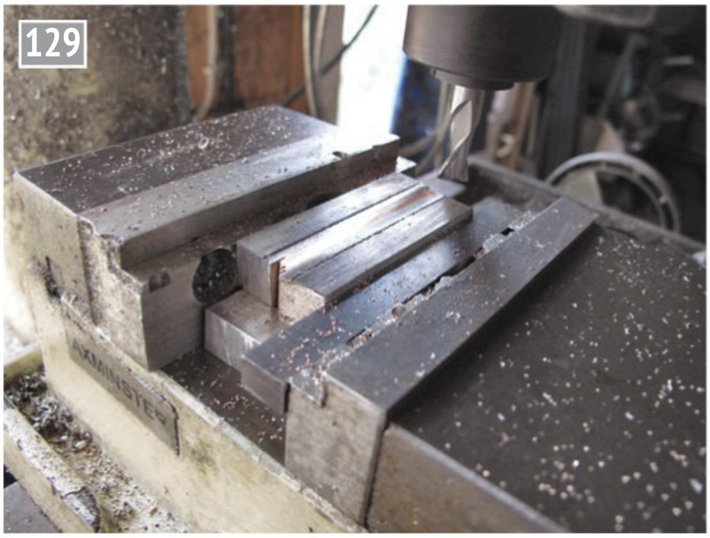
Radiator fins - first operation.

The radiator for this engine consists of fifteen 5⁄32 inch diameter brass tubes, thirty-two 0.015 inch thick brass fins and two 1⁄32 inch thick brass back plates that connect the assembly to the end tanks. The plans do show an assembly fixture that is intended to hold all the loose components together at the correct spacings. However I couldn't really see how it could be used as a soldering fixture as the gap between two fins is only 0.062 inch and each fin needs to be soldered to all of the fifteen vertical tubes to keep the entire fin in line, leaving very little room to solder the fins to the tubes, which in my case would involve using a conventional small electrical soldering iron. I'm sure that after publication a reader will tell me how the fixture was intended to be used.

I decided that in order to present every fin horizontally in line each fin would have to be soldered to all the fifteen tubes before placing another above it and repeating the process.

First, to produce all the parts. I had some concerns that 0.015 inch thick brass, being no more than shim, may not stand up too well to all the drilling and eventual soldering without distorting so I decided to use bronze sheet to produce the fins, which I hoped wouldn't be quite so flexible as the specified brass. (0.015 inch bronze sheet sourced from Macc Models.)

The tool of choice to cut the fins would, of course, be a treadle guillotine, but not having access to one my tin snips had to do. Needless to say, even cutting to a scribed line all the blanks turned out at different widths with some crinkly edges which needed flattering out with a soft mallet before any machining could take place. As the fins would need to fit into a drilling fixture, all the widths had to be as close to 0.500 inch as possible. The first couple of operations were to achieve a uniform 0.500 inch width on all the blanks and **photo 128** shows the first step with a number of blanks clamped



A batch of fins machined to width.

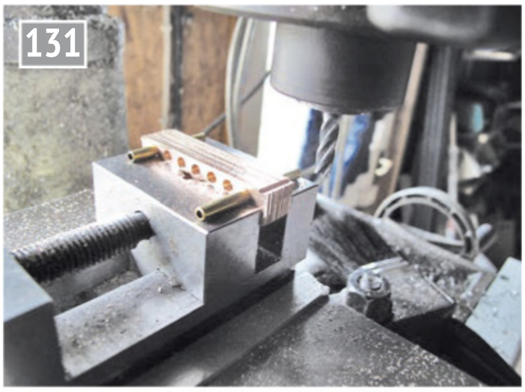
Machining fins' lengths and first rebate.

between two pieces of ½ inch square aluminium, which acts as a distance indicator. In the second photo (**photo 129**) the previous faces were tapped down on a parallel strip and machined to finished thickness.

The lengths are also critical, not only to fit the drilling fixture, but to allow the radiator side plates to fit flush on assembly. I machined both end faces at the same setting to ensure all fins were exactly the same length and completely square to each other. Also at this setting, the first side plate locating rebates were machined (**photo 130**). The second rebate was machined at a later stage after drilling (**photo 131**).

Next step was to produce a drilling fixture that would hold ten blanks at a time. Two convenient pieces of aluminium were screwed together and a pocket with relieved corners was machined (**photo 132**). The cover plate is secured with countersunk screws to ensure the drill plates' alignment to the pocket holding the fin blanks. The guide holes were bored using a 'chain' of cut circle programs to ensure accuracy (**photo 133**).

To digress slightly for non CNCers, the term 'chain' is used when any number of conversationally generated programs are joined together to create an unbroken machining cycle to produce any number of different



Second rebate machining operation.

Drilling fixture pocket.

Fixture cover plate being bored.

Fins being drilled.

Completed batch of fins.

Cutting the tubes to length.

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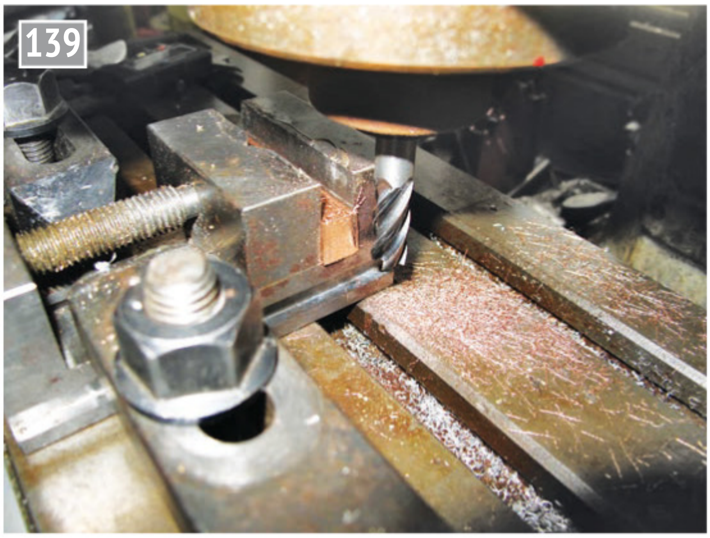
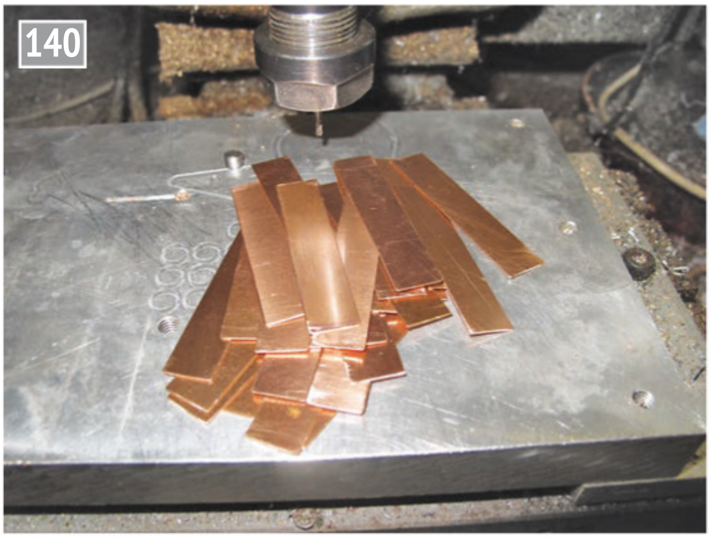
All a bit of a disaster!

Cutting strips to the correct width.



Facing operation.



Finished batch.

machined features. With my Mach3 control this only allows different operations to be chained together if the same cutter is used for all of them.

All the tube holes can then be drilled at one setting (**photos 134** and **135**). The tubes were cut to length using a pipe cutter set to length with a depth gauge, while the surplus stock was held in the chuck, which was rotated by hand after each new application of pressure from the pipe cutter. If the budget will allow, it always pays to buy a good a quality pipe cutter for neat work (**photo 136**).

So far … so good - but it all started to go south when I attempted to solder each fin at fifteen positions using a small electric soldering iron. I just couldn't generate enough heat, concentrated at a point where the fin meets the tube, to neatly melt the solder.
I kept on assembling the radiator in the vain hope that I could tidy things up once the assembly was complete, but the awful state of the radiator after only soldering fewer than half of the fins demonstrated that the only place it was heading was straight in the bin (**photo 137**). Time for a rethink and starting again.

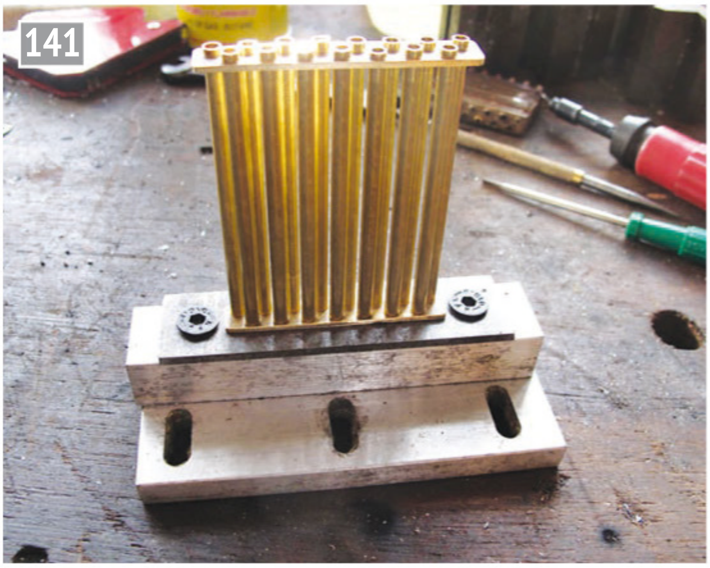
The second attempt at most things usually throws up ideas that you should have really thought about the first time round, starting with blanking the fins.

I've produced several sets of 6mm reamed holes in the mill's sub table which accept different height silver steel pins. These provide instant square alignment beneath the spindle in the same way tenon blocks do on a conventional milling machine.

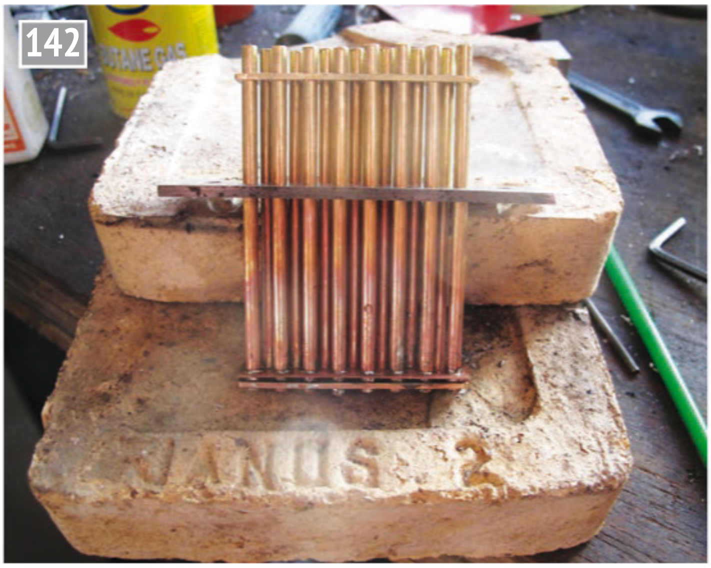
With the bronze sheet located against a set of pins I made a simple strip clamp that would span the whole sheet. Then, using a 1.5mm diameter solid carbide cutter, machined all the strips to dead size (**photo 138**). The fins were faced to length in the same way as before, but this time without the first side plate rebates (**photo 139**). A complete batch of fins was produced a lot quicker than the first set with the added advantage of no distortion or crinkled edges to flatten out (**photo 140**).

When I started the 'prototype' radiator I silver soldered the pipe ends into the first water tank back plate. The thinking behind that was I didn't want the tubes to come loose with the heat when I started to solder the completed tube assembly to the water tanks. The only heat source I had at the time was my plumber's butane blowtorch which, on reflection, put too much heat onto some very thin brass tubes which caused a few to distort; this in turn presented a few problems loading the first few fins over the upstanding tubes.

The solution to my soldering problem came from an unexpected source. One evening we were watching my wife's favourite television programme, *Repair Shop*. The resident silver smith was repairing an old metal toy car and was doing some very precise soft soldering using a small butane torch to deliver the required heat to a very small area of metal. Looking



First operation: soldering the back plate in position.



First fin soldered.

Removing 0.1mm from all drilled holes.

Assembly progressing.

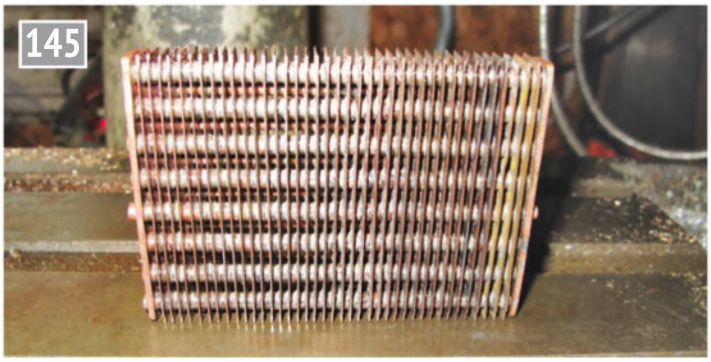
on a well-known online auction site I was spoilt for choice and bought a torch head and two butane canisters for around the ten pound mark which, on reflection, was cheaper than my electrical soldering iron.

This proved to be money well spent as all the soldering from this point onward has been considerably neater and stronger as the flame can be regulated to provide concentrated heat to a very small space and just enough to melt the solder in that area, hopefully leaving previously soldered joints on the fin beneath intact. In this game you're never too old to learn a new technique.

I strengthened the mounting backplates from 1/32 inch to 1/16 inch thick in order to give greater stability when assembling. The assembly itself took a slightly different direction. To solder the first backplate I positioned all the tube ends into the drill jig to hold them in position (**photo 141**). Also, when soldering the fins in position, the drill jig cover plate was positioned at the half way point while the second backplate held the tube ends in position (**photo 142**). This eliminated any tendency of the tubes to distort, as I applied the naked flame.

To ensure the fins passed over the upstanding tubes, but stayed in their positions for soldering, I enlarged every hole by 0.1mm (0.004 inch). This was just enough to allow the fins to be gently tapped down on to a couple of spacing strips positioned between the previous fin and the one being assembled. This also supplied the correct amount of interference for the fin to stay put after the spacing strips had been removed and the fin soldered to all fifteen tubes. To minimise any burrs the fin was drilled above a previously drilled size hole in a piece of surplus aluminium (**photo 143**). To make sure the fin slid squarely down the upstanding tubes I used the drill jig top plate to keep the fin flat and even during its journey down the tubes - as a 0.015 inch thick fin can easily snag and become distorted if unsupported (**photo 144**). I'm not 100% happy with the end result but it's a lot better than the first. Some remedial work was still required on the fins to even out a couple of spacings and a first coat of matt black heat resistant paint it should improve the end result even more (**photo 145**).

●To be continued.



End result.

David Mayall – 5 inch gauge 0-6-0 'Speedy'.

Luke Bridges – 5 inch gauge Polly 'Trojan'.

Chris Dore – 5 inch gauge LNER B1 Nyala.

John Cottam – 5 inch gauge LNER P2 Wolf of Badenoch.

David Tompkins reports from this year's International Miniature Locomotive Efficiency Competition at the Guildford society's track in Stoke Park.

Continued from p.253
M.E. 4697, 12 August 2022

IMLEC 2022 PART 2

Sunday

On Sunday bright and early in the steaming bay was Dave Mayall with his 5 inch gauge 'Speedy', preparing for the first run of the day. His locomotive has the Don Young valve gear modification and a coal wagon for water that has extension rods from the regulator and steam valves and a neat slotted rod coming from the pole reverser so the locomotive can be notched up on the run with ease. A 'Speedy' with its bunker in place is not an easy model to fire, hence the coal wagon. I first met Dave and his wife Frances at the 1995 IMLEC when he was running a *Torquay Manor*. He hasn't changed much - still some laughter In his voice. The run itself was another puzzle and, like so many from the previous day, it was struggling from the start to round the tight inclined curve that drivers soon faced from moving off and then climbing towards the summit near the club house. If the club's organisers had hindsight we would have chosen a different, more easy downhill start for competitors to begin their run. Even up to a month ago it wouldn't have been that much of a problem but lately the track becomes so greasy quickly after it has been cleaned. It's something the club hasn't had to deal with before and right now we don't have the answer. So Dave was slip sliding right from the start, even with a smaller load that would be well within that locomotive's capabilities. There were several stops with set backs and offloading of passengers with more attempts to at least complete the first lap before the locomotive managed to find its feet and finish a disappointing run. I went with a smile on my face and asked Dave what did he think of his run. His reply was 'everything went right while in the steaming bay'.

It was now Luke Bridge's turn with his 5 year-old Polly 'Trojan'. I asked him - please have a

Steve Eaton – 5 inch gauge German DB 2-8-0 Voldemort.

David Kerry – 5 inch gauge BR 9F Evening Star.

Billy Stock – 5 inch gauge Britannia William Wordsworth.

The performance of each entrant is carefully monitored.

good run that I could write about rather than the slipping. Shrewdly, I think he took my advice as he took a light load and started motoring from the start. For one of the smaller locomotives running on Sunday it was racing round. It was even offering those who got close while in the steaming bay a shower as it was blowing off far and wide from the safety valve!

So we moved on to the second B1 locomotive in the competition. Again, it is to the Martin Evans design but with the boiler having the tube layout similar to the designer's later 'Enterprise' design. The B1 design known as 'Springbok' is an excellent model to make and run and its driver Chris Dore told me it has no trouble climbing the 1 in 80 gradient with a load at his home club of Fareham. And yet again it was a run that suffered from slipping right from the start. It was probably the worst affected one of the day - ten minutes passing and yet not one lap completed. With a load of just four in total the locomotive was still having to set back several times to get a run at the gradient but after 18 minutes its driver decided to call it a day and retire.

So there was now a slight pause before John Cottam brought out his 5 inch gauge LNER P2 locomotive to its waiting train full up of IMLEC groupies. By that I mean past winners and families who come and attend the yearly gathering of IMLEC. I do have a certain envy of those that can produce such fine models as this one is but then I read that he has a greenhouse in his workshop to do the painting so that's where I might be going wrong - I'm not really into gardening of any sort! As his locomotive was backing onto its train I noticed the crowd gathering round just like they do for the full-size but not quite so many. Express steam locomotives will I think always have an attraction for the public. At first the locomotive was slipping without moving and I thought I can't believe this! But it was just a case of the trolley brakes having been knocked on. Once sorted, it was a fine run to watch. And afterwards I found out that John had bought his shoes from Sports Direct. This came out in discussion as during the run when he was passed a water bottle he didn't use it to fill the tender, he tipped it out onto his shoe that was on fire! The locomotive was a bit of an arsonist and several track fires had to be put out while he was having his run. The run itself was effortless, that is until John came up to the clock with it almost showing time. As the needle was dropping I was surprised that he didn't end his run but decided to go for the extra lap while running down the fire. Strewth! With the pressure dropping to just 5psi as he topped the summit it was now downhill most of the way to journey's end, the finishing line.

The next hopeful was Steve Eaton from the Chesterfield club. Steve had entered a most interesting design of his own and was doing well at IMLEC with it. It's heavy and it's solid and it has eight driving wheels and it has a habit of priming. This was probably the fastest run of the competition - he was bombing around! It got to the point where I thought it's going to be a uneventful run so I'm going for a drink and chat in the refreshment tent. That was when the run stopped. The priming coming from the locomotive virtually put the fire out by coming back through the fire tubes. Much time was lost looking like it might be a retirement but Steve did well, pulling round a wet firebox, and continued to finish his run albeit at a rather slower speed. »

The Guildford MES dynamometer.

Activity in the steaming bays.

Alan Crossfield and John Cottam discuss the finer points.

Les Pritchard receives the 3½ inch gauge prize.

The competition was now coming to its last two entries as it had been decided to finish early on the Sunday so that those who had travelled a fair distance would be getting back home not so late at night. That meant just seven runners for the day and number six was Dave Kerry with his 5 inch gauge *Evening Star*. Dave told me that he went with a friend to an exhibition, saw a model steam locomotive and was instantly hooked. This can happen and there isn't yet a cure. So his friend told him that as he's good at making things from wood he should be able to make a model steam locomotive - after all metal isn't that much different from wood (I'm not sure about that bit) so after making a 'Simplex' Dave spent the next 15 years making *Evening Star*. By chance, the way the runs had been chosen it meant that the last four runs of the day were going to be performed by four good locomotives being driven by good drivers. Dave got off to a steady start and continued to add up the laps without much fuss, the locomotive pulling a load well within its capabilities.

So now it came to the last run of the day. The previous year's winner has, if he wants, the choice of running last. Billy Stock with his 'Britannia' chose this option. Now it's going to be hard to write about this run, as not a lot happened. It was just as good has it could be. It was more or less a demonstration run, the driver being the locomotive's master from start to finish. The only problem Billy seemed to have was wanting to delay the presentation while he went to wash his hands.

The presentation itself was made by Martin Evans, editor of *Model Engineer*. And I was pleased to see Les Pritchard collect the best placed 3½ inch gauge locomotive prize as it also runs at the LittleLEC competition - and I like LittleLEC!

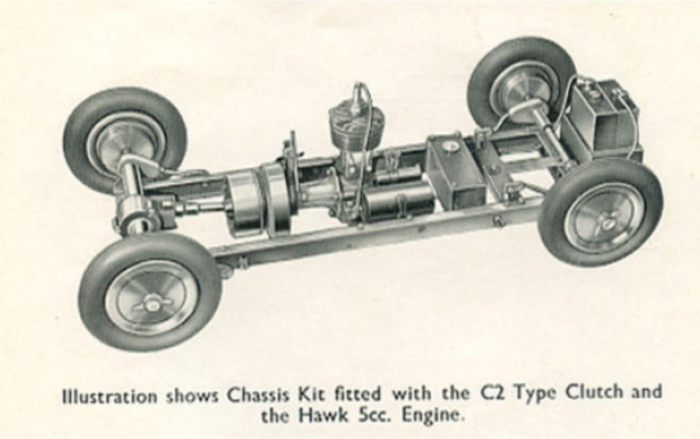
So IMLEC is over for another year until it goes to Bristol for 2023. At least that's how it's planned at present. Running the event was done by a good number of Guildford members, from several months of planning to the long weekend itself, and I think they all did very well, working hard while I just watched the world and the model trains go by.

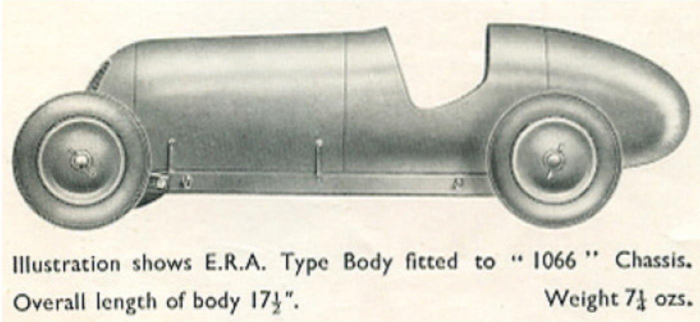
All photographs were taken by Andrew Neish.

ME

Billy Stock receives the 1st prize and trophy.

Driver	Locomotive	Gauge	Laps	Distance	Work Done	Coal Used	Speed	Efficiency	Position
		Inches		ft	ft.lb	lb	mph	%	
Billy Stock	Britannia William Wordsworth	5	12	19,710	273,120	1.34	6.0	1.804	1
Steve Eaton	German DB 2-8-0 Voldemort	5	11	16,900	300,000	1.68	6.3	1.582	2
Ben Pavier	LNER Q5 1032	5	14	19,730	228,200	1.41	7.2	1.437	3
Tom Parham	LNER A1 Tornado	5	9	12,680	246,800	1.85	5.6	1.185	
John Cottam	LNER P2 Wolf of Badenoch	5	12	16,870	313,900	2.51	6.4	1.109	
Robert Hurst	S&DJR 7F 53807	5	8	14,270	222,300	2.06	4.0	0.956	
Glen Davies	Simplex Janine	5	12	17,060	199,100	1.93	6.6	0.915	
Dave Kerry	BR 9F Evening Star	5	12	16,860	221,560	2.15	6.2	0.915	
Simon Batten	Don Young 0-6-0ST Jack	5	12	16,850	121,640	1.41	6.2	0.767	
Matt Butler	LNER B1 Gazelle	5	10	14,780	165,300	2.07	4.9	0.707	
Alan Crossfield	Ex LMS Patriot 4-6-0	5	5	12,190	149,420	1.95	2.5	0.679	
Andy Healey	Britannia Apollo	5	11	15,460	197,310	2.63	6.8	0.666	
Roger Holland	Gresley A4 Wild Swan	5	8	12,970	193,000	2.66	4.1	0.643	
Les Pritchard	0-6-2 Radial Tank Loco Mona	3½	9	12,640	56,920	0.90	4.4	0.563	1
Luke Bridges	Polly Trojan PLA No.53	5	12	16,890	93,530	1.70	7.1	0.489	
Nick Feast	Q1 0-6-0 Tender Loco Charlie	3½	7	10,670	52,515	0.96	3.7	0.485	
Nicholas Jackson	LBSC Speedy 1501	5	5	9,320	99,100	2.54	2.9	0.347	
David Mayall	0-6-0 Pannier Tank 'Speedy'	5	3	9,490	67,660	1.90	1.5	0.315	
John Williams	Nigel Gresley 2-8-0	5	6	10,890	72,300	2.28	3.2	0.282	
George Winsall	Hunslett Lilla	3½	5	7,030	38,150	1.40	2.9	0.241	
Andy Nash	Gresley A1 Pacific Spitfire	3½	1	3,140	10,100	0.47	2.7	0.192	
Chris Dore	LNER B1 Nyala	5	1	4,530	21,240	1.04	1.0	0.182	
Dave Shepheard	Polly 5	5		2,230	21,910	1.12		0.174	
Danny Hayward	2-8-2 Locomotive Mustang	3½	1	7,310	18,305	1.06	0.6	0.153	
Tom Taylor	Derby 4F 44589	3½	1	2,450	8,000	0.51	1.3	0.139	





Body fitted to the '1066' chassis.

Tether car '1066' chassis.

Henk-Jan de Ruiter looks back at the model car world of a century ago.

Tether Cars

A long time ago, before the emergence of slot cars, there existed another phenomenon, the tether car or 'spindizzie' as Americans like to call them.

For over a century, toy companies produced model cars to scale to resemble their 1:1 equivalent.

Sometimes these toy cars were also made to promote the sales of the real car and of course how nice would it be if these model cars could be motorized. Often these first model cars used a clockwork or some electric accumulator as a powerplant. When however the first miniature internal combustion engines were built in the 1920's-1930's period, to power model aeroplanes, some people in the USA, tired of picking up damaged model aeroplanes, started to look for an alternative use of them in model cars.

Small model engines of between 1cc to 2.5cc displacement were built and it is supposed that the American Dooling brothers made the first model car with an internal combustion engine in 1937. It didn't take long to come up with the idea of lining up these cars on a track attached with a rope to a pole, making the model car go around in circles and tethered car racing was born. Before this, straight (wooden) tracks were often used for rail racing.

A whole industry evolved around it, with companies often originating from the aircraft industry. Besides Dooling, other legendary names like B.B. Korn, Colonel Alexander, Whirlwind, McCoy come to mind.

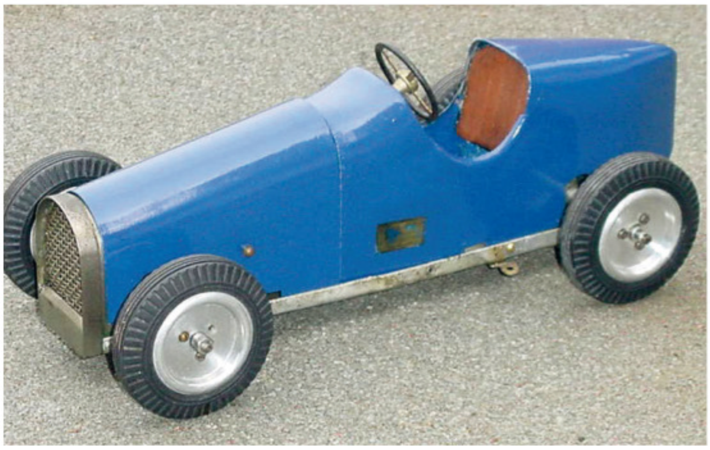
Soon this sport gained huge popularity and drew massive crowds. Race-tracks were formed all over the USA and got organized in the AMRCA - the American Miniature Race Car Association. England also did its fair share and the Model Car Association was founded. After its demise, when interest temporarily flagged, the BTCA, the British Tether Car Association, took over with a fresh start in 1978.

Several British companies got involved, starting to make specialist tether car parts, such as wheels, model engines, gearboxes and later sometimes complete tether cars. Some famous names producing model internal combustion engines in the UK were Oliver (as a matter of fact, that company still exists today - www.joliverengines.co.uk) and ETA.

One of the first British tether cars was designed and built by Bob Curwen in 1939 with a wooden chassis. An article was written about it in *Model Engineer* magazine around that time (see issues 2100 and 2119, in 1941).

By 1952, things got pretty serious and the FEMA was formed - the Fédération Européene du Modélisme Automobile (www.speedmodelcar.org) – and rules and regulations were listed and licences handed out to competitors.

Tether cars are categorized into five different classes, depending mainly on engine displacement and weight.



Tether car 'Wasp2'.

Tether car 'DG79'.

Safety is another important factor, specifically regarding the quality of the joint of the string attached to the tether car, called the bridle, and for the drivers and the spectators.

Other countries soon followed - France, Italy, Germany, Sweden, Australia and Switzerland - where enthusiasts gathered in clubs. Some of them still exist up to this day, for example the Swiss SMCC, the Swiss Model Car Club. There were also model car builders in Russia and Ukraine, where mechanical engineering is of a very high standard.

The original tether cars looked a lot like the real racing cars of the time but the later tether cars got a more modern design.

While the hobby grew to a significant size, popularity waned in the late 1960's/early 1970's. Some people say that this was because the cars got more powerful and were able to achieve very high speeds and so the tether cars were more difficult to follow on the track. The first tether cars had a maximum speed of 40 miles per hour but the latest tether car speed records are measured above the 200 mph benchmark.

For the diehards this has a charm of its own - in the world of today the focus is more on speed records where futuristic designs, body aerodynamics and engine tuning and tweaking become more important. Therefore, the use of 'new age' materials became popular and today exotic materials like titanium, magnesium, beryllium-bronze and carbon are often used for producing specific parts for the tether car to make it light and fast - but also more expensive.

Some very interesting books have been written about this subject, e.g. *Spindizzies* by E. Zausner, *Vintage Miniature Racing Cars* by R. Ames and *Model Car Manual* by G.H. Deason. The latter was also the builder and designer of the British tether car *Kitten* which was described in an article in *Model Maker* magazine in 1951.

Original vintage tethercars are collectable and can fetch high sums, which leaves room for new replicas which are available at significant prices.

If you would like to see what tether cars look like these days, check them out on YouTube under 'Tethercar Speedstory'.

I had much pleasure consulting the following websites and therefore would like to thank them for their information:

www.speedmodelcar.org
www.speedmodelcar.com
www.onthewire.co.uk
www.tethercar.net
www.mitecars.com
www.adriansmodelaero engines.com

Special thanks go to Mr. David Giles of the BTCA and Mr. and Mrs. Hugh and Lynn Blowers for supplying the photographs.

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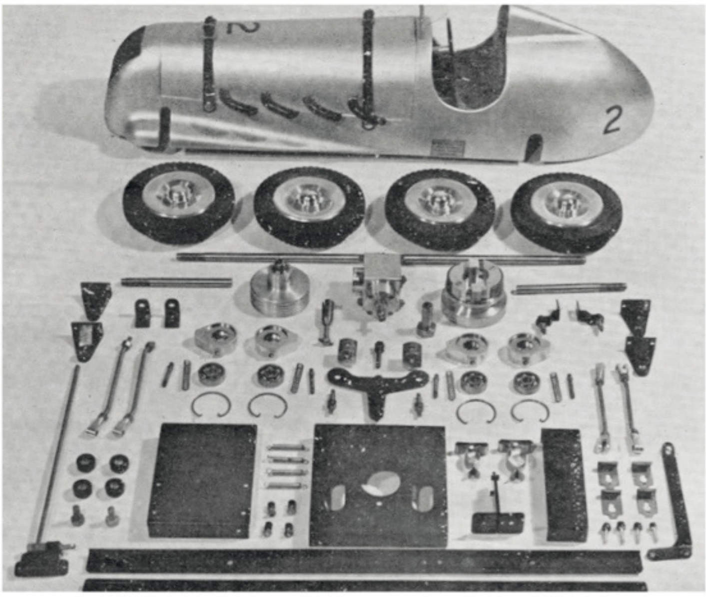
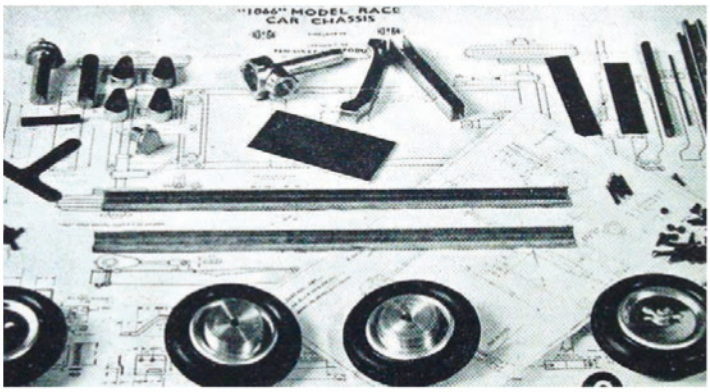


Tether car kit 'ready to assemble'.



A kit of parts.

Tether car advert.

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

I've been limbering up ready for the onslaught. On the engineering front, progress is like swimming in treacle but I try to do a bit every time I enter the garage.

In Amateur Radio, apart from collecting better test gear (now sporting the products of Marconi, Fluke and Racal-Dana), my Morse code (or in my case Norse Code?) has reached the exalted heights of 'absolute beginner.' So, -... . ... - /-... . -. -/.-- .. .-. .// ('best bent wire' – our version of the 'quick brown fox' - listen to the rhythm, on YouTube).

A new addition to Firth Park Shed is a trainee dragster in the form of an electric mobility scooter. Mike Gibbs greeted my arrival at the club track by asking if this was my latest 'flying bedstead'. It is indeed. The dragster epithet is because the rear wheels are larger than the front, and it has small 'wheelie bars' at the back. I am therefore thinking of souping it up, with go faster stripes and flames issuing from the tyres. I could have a 'Festival of Sloth'. I also know what to sing as merrily we roll along*. **NO,** not 'the wheels on the bus...' or 'three wheels on my wagon' but, inspired by a friend of mine, who hates folk music (cups hand over one ear), 'I am the Captain of a Luggie' (**photo 1**). Also at the SSMEE Open Weekend, I was pleased to see Alan Thorpe's collection of Mamod vehicles, including a scratch-built modification of their roadster into a WWI Rolls-Royce armoured car (as used by Lawrence of Arabia) which he acquired at auction together with the Haynes Manual of that vehicle. Serendipity (**photo 2**)! Another scratch-built model was this remote controlled 25 ton railway crane, containing five motors

Luggie dragster? (Picture courtesy of Deborah Theasby)

Alan Thorpe's Mamod/R-R (top shelf centre left).

25 ton crane at Sheffield.

and five electronic chips, all well concealed (**photo 3**). A short video of it in operation is at my YouTube channel. To my eternal regret, I did not ask the name of the creator of this gem but photographed his name badge. However, the gremlins got there first. My apologies, kind sir.

W. www.sheffieldmodelengineers.com

In M.E.4697 I referred to a 'pedalino', by Tom Williams of Hereford Society of Model Engineers. Here it is 'in the flesh'. What I took to be an electric motor at the bottom bearing could well be a Sturmey Archer epicyclic gearbox (**photo 4**). (It is – *Ed.*)

In this issue, a 'dragster', a track cycle, changes of name, the use of track circuiting, a poppy, auctions, signalling arriving 'on time' and farewell to a stalwart.

Blast Pipe, from **Hutt Valley & Maidstone Model Engineering Societies**, June, has had two successful running dates this year but more volunteers are needed or the railway cannot run. Havelock North Live Steamers is now to be known as Keirunga Park Railway. Maidstone member, Nathan, has acquired another locomotive for his stud. Based on the 'Phantom' design it has been made to look like a NZR Class J of 1874.

W. www.hvmes.com

Another change of name is Cleveland Association of Model Engineers which is now **Stockton & Darlington Model Engineers.** The change was overwhelmingly voted for by the members and lines up nicely with the coming 200th anniversary of the opening of the original S&DR.

W. www.tcmrail.co.uk

On Track, from **Richmond Hill Live Steamers,** in Canada, June issue, says Ed Helmich has generously donated a Hornby 'O' Gauge tinplate clockwork locomotive and three carriage set to help raise club funds. The tornado over nearby Uxbridge left little damage to the club, fortunately. Not so York-Durham Heritage Railway, which had significant damage, which will stress their resources at a time when rebuilding after Covid is also requiring urgent expenditure.

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

Gauge 1 North, Yorkshire Group, advises that Gauge 1 North in Bakewell is to be on 23 July. Their layout, *Moordale*, may be offered a home at Peak Rail - talks are under way. The portable track also had a profitable outing to Leeming Bar on the Wensleydale Railway.

W. www.gauge1north.org.uk

Ryedale Society of Model Engineers May Newsletter carries a detail from *The Times*, in which Bill Sharp is featured driving his Pacific locomotive at Gilling, in a feature on village halls in use as polling stations. I can't quite read the details however. The May Rally was a success - one visitor hailed from the Antipodes - and the day left everyone tired but happy. Bob wrote it up, as the usual suspect had contrived to be on holiday at the relevant time. On the 29th, John Cook was overlooked by the duty signaller due to lots of parked cars and only reference to the track circuit indicator board reminded him of John's presence.

W. www.rsme.org.uk

Welling & District Model Engineering Society Newsletter for June/July has been already covered by my colleague John Arrowsmith but the virtual 'red tail lamp' signifying the end of this missive uses a picture of a poppy striving for life betwixt the rails of their running track. This prompted Tony Riley to wonder if Mr Wordsworth might have commented. (Wordsworth, no, Theasby yes…) 'Platelayer, platelayer, think of me do, as your tons of steel crush me to goo. For a brief moment, my bright red was telling and then I appeared in a missive from Welling'. (We'll call you… *Ed.*)

W. www.wdmes.co.uk

A vast quantity of mainly '00' gauge model railway items offered at Sheffield Auctions on 7 July also included lot 358, a Swegway two wheel hoverboard; lot 381 a Bing '0' gauge clockwork locomotive; lot 412, a Hornby '00' gauge, clockwork, No 2 Special, and lot 535, a 'Designoscope' (an optical toy, M'Lud), plus an Atom scooter (made in Sheffield), a chemistry set, and so on - the interest palls after so many interesting items in one place. The following day, more domestic collectables, including a Leica M3 (Est. £500/800), several Bowie knives (the design originated in the US, I understand, but most were made in Sheffield), cast metal railway plates (repro) and a miscellaneous bunch of other stuff.

Bournemouth & District Society of Model Engineers *BDSME News*, June, begins with editor Brian Merrifield starting his 2nd year as editor and saying how hard it was to get his 'mechanical' brain to think in 'Desk Top Publishing' mode. He thanks all who offered help. Cornwall's Moseley Heritage Trust museum near Redruth has, and runs, several mines locomotives. It isn't big but it is interesting, on a subject many of us wot not of. Chris visited the North Bay Railway in Scarborough and refers to turning the locomotive at

Tom's pedalino at Hereford. (Picture courtesy of John Arrowsmith)

>>

each end of the trip. At Scalby Mills, a turntable is used but it was originally a balloon loop in a tunnel. Following growing awareness of diesel fumes on the drivers' health, the hill was removed, and the track lasted in this condition for many years before the turntable was installed. Back at the club, whilst putting a boiler through a steam test, the injector clack stuck and could not be persuaded to desist. As the boiler water level fell, the drop grate stuck in sympathy and an amount of persuading/pressure from the shovel broke that implement. Finally, a rag was stuffed in the chimney and, with the blower full on, the fire was quelled. All this happened faster than I could write this. Be Prepared!
W. www.littledownrailway.org

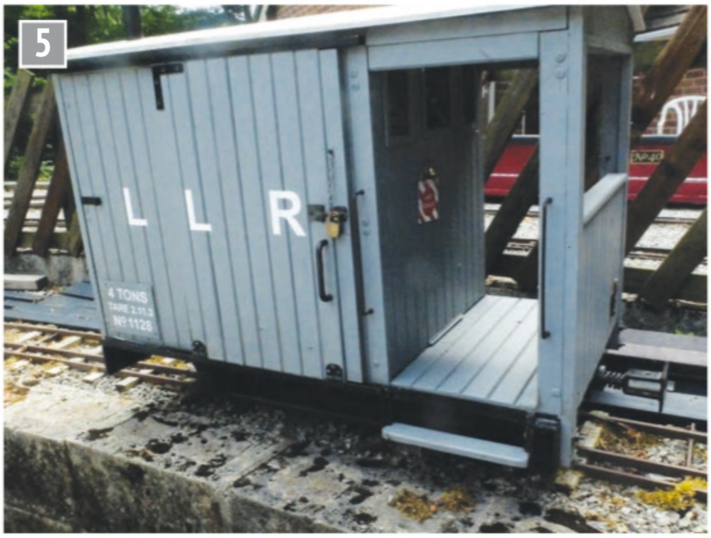
Crowborough Locomotive Society's, *Steaming Ahead,* spring - editor John Wood apologises for the sparse content but still provides ten pages for me to review. The new signalling system was ready for the Open Day, beating the promised deadline. Well done all. Many visitors commented that they had not been aware of the club's existence and would return. (Advertising is expensive, so how can we generate more publicity?- Geoff) Two new carriages have been bought - they replace two old ones which have given sterling service over the past 30+ years and would have been expensive to upgrade. Malcolm Place comments in 'Back on the rails'. That it is not just the vehicles that are worn - the same applies to the drivers. He noticed this when resuming driving his 'Polly' after the Covid interregnum - he found certain aspects of driving more difficult than 'twas once the case.
W. www.crowborough miniaturerailway.com

Centurion Society of Model Engineers, *Centurion Smokebox,* June, has for sale various parts, complete and incomplete models to dispose of. Would consider overseas sales.
W. www.centuriontrains.com

Andover & District Model Engineering Society, *The Centre Punch,* June, has an unusual subject discussed by Jon Godfrey, of workshop air lines. (Worksop Air Lines? - No!) Piping up, location of outlets and uses for - all very useful. 'Minimal Mania' in April was great. Visitors came from all over the country and no accurate count was made of motive power, there were so many. Peter Beaver's 4 inch scale double Fairlie *Y Sgwar* was by far the largest seen on the Andover track nor would they like to see any more. Doug Rundle said he could hear its whistle from home! Martin Gearing writes on the difficulty of finding an exemplary blacksmith. Many skills have been lost and Martin says that even knowledge of how a job can be done is no guarantee of success. Welding castings? Then, Jon and Doug Rundle write on diamond tools, first developed in Australia, followed by comments on ACF-50, an anti-corrosion substance used on aircraft. It can also lubricate and protect from ice and snow, and is safe on electrics. It is currently in Amazon for £12 per 369 ml aerosol. A photograph in the archives, taken 30 years ago, is topical, because the current owner of the locomotive is asking to join A&DSME as his own club has closed.
W. www.admes.org.uk

Graham Copley of **OVLSME** has received a query from Oz. A gentleman has enquired about oil firing Don Young's *Marie Estelle.* He can't find any info. locally - could OVLSME help? Graham says that 'LBSC' devoted 12 pages to oil firing in his *Live Steam Book*, based on a 2½ inch gauge model and throws open the question for his members consideration.

MEEA Newsletter, from **Model & Experimental Engineers,** Auckland, informs us that Mike Jack is to build a number of BR Standard class 3 locomotives, in which all the parts are made from computer drawings that Mike made from original works drawings. These are not models, they are miniature replicas of the originals. Graham Quayle's Foden lorry is taking shape. Steve Day found that drilling the boiler for the steam chest was challenging, breaking several drills due to the sharp angle required. However, all is well. Graham is also making a Stuart turner 'Sirius'. Ray Brown is working on a traction engine cylinder block, whilst John Brown is learning how to cut threads with a lathe - he was taught at night school but has not used this skill for many years. Murray's wood turning lathe now sports a chuck but he had to make an adaptor for the spindle as the chuck thread is not standard.



LLR brake van.

BCSME are sad to announce the passing of Lindsay McDonnell, at 82. A long-term member and past President of BCSME, Lindsay encouraged many people in their model engineering. A post-funeral family photograph shows his extended family clustered around Lindsay's ⅛th scale 'Britannia', with the youngest member, Emma, sitting in the cab. A file of Lindsay's collected writings for *The Whistle* has been placed in the club library. It runs from 2000 to date and just the index occupies three pages! That publication, *The Whistle*, July-August, says that on Easter Saturday the Garden Railway set a new record of over 1000 visitors.
W. www.bcsme.org

On Sheffield SMEE's Open Day, I spotted this brake van hiding in a siding (**photo 5**). *Steam Whistle* editor Mick Savage told me that the van (and visiting locomotive *Tarn Beck*) belong to Mike Cave, who has the Littledale Light Railway in his garden near Lancaster. Built on a sloping site leading down to a deep gore with Tarn Beck running through it, he has a tunnel, bridge over a lake and even a 'ruined abbey' folly.

This electronic ID bracelet from our cruise looks like a railway detonator next to my radio synchronised watch (**photo 6**).

And finally, Gravity. What do you get without it? Gravy...

*Kaufman & Hart, 1934

Detonator?

CONTACT

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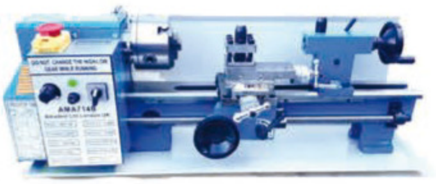
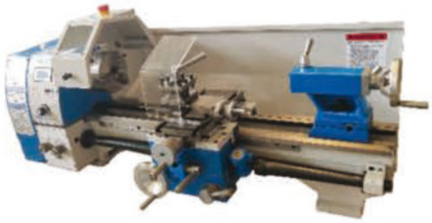


AMA714B Mini lathe
Brushless Motor

SPECIFICATION:
Distance between centers: 350mm
Taper of spindle bore: MT3
Spindle bore: 20mm
Number of spindle speeds: Variable
Range of spindle speeds: 100-2250mm
Weight: 43Kg

Price: £694



AMABL250Fx750

SPECIFICATION:
Distance between centers: 750mm
Taper of spindle bore: MT4
Spindle bore: 26mm
Number of spindle speeds: Variable
Range of spindle speeds: 50~2500rpm
Weight: 140Kg

Price: £1,904
W 2 Axis DRO - Price: £2,280

AMABL290VF Bench Lathe (11x27) - power cross feed - BRUSHLESS MOTOR

SPECIFICATION:

Distance between centers: 700mm
Taper of spindle bore: MT5
Taper of tailstock quill: MT3
Motor: 1.5kw
Weight: 230Kg

Price: £2,395
W 2 Axis DRO – Price: £2,787

AMAVM25LV

SPECIFICATION:
Model No: AMAVM25LV (MT3) / (R8)
Max. face milling capacity: 63mm
Table size: 700×180mm
T-slot size: 12mm
Weight: 120Kg

Price: £1,360.00
W AXIS POWERFEED - Price: £1,659
W DRO – Price: £1,730
W DRO + PF - Price: £2,045

E3 Mill R8 Metric Brushless Motor

Direct drive spindle.
No gears. No belt

SPECIFICATION:
Max. drilling capacity: 32mm
Max. end milling capacity: 20 mm
Max. face milling capacity: 76mm
Motor: Input- 1.5KW
Packing size: 1050x740x1150mm
Net weight: 240kg

Price: £2,560.00

AMAVM32LV

SPECIFICATION:
Model No: AMAVM32LV (MT3) / (R8)
Max. face milling capacity: 76mm
Table size: 840×210mm
T-slot size: 14mm
Weight: 240Kg

Price: £1,962.00
W AXIS POWERFEED - Price: £2,081
W DRO – Price: £2,363
W DRO + PF - Price: £2,856

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