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Tel: 01795 662976
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EDITORIAL
Editor: Martin R Evans
Tel: +44 (0)7710 192953
Email: mrevans@cantab.net
Assistant Editor: Diane Carney
Club News Editor: Geoff Theasby

PRODUCTION
Designer: Yvette Green
Illustrator: Grahame Chambers
Retouching Manager: Brian Vickers
Ad Production: Andy Tompkins

ADVERTISING
Advertising Sales Executive: Angela Price
Email: angela.price@mytimemedia.com

MARKETING & SUBSCRIPTIONS
Subscription Manager:
Beth Ashby

MANAGEMENT
Group Advertising Manager: Rhona Bolger
Email: rhona.bolger@mytimemedia.com
Chief Executive: Owen Davies

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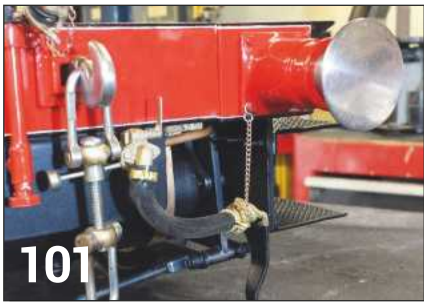

IN THIS ISSUE

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ON THE COVER...

The newly cast left-hand cylinder block for new-build 1:1 scale GWR 4709 locomotive Night Owl *(photo: John Arrowsmith).*

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Stolen Locomotive

A 5 inch gauge steam locomotive has recently been reported stolen. It's a Maxitrak SE&CR R1 locomotive belonging to Paul Kenny, from Southampton (see photograph).

The theft was clearly targeted and the thieves knew what they were looking for. Mr Kenny made a brave attempt to prevent the theft but eventually the gang of three men made off with the locomotive.

The 'getaway' car is reported to be a dark blue VW Golf with a licence plate starting 'YH04'.

So, if you come across a locomotive of this type, especially in the Southampton area, it may be worth enquiring into its provenance.

If you have come across any information about this theft, or if someone tries to sell you an R1, PC Mike Elwood of Hampshire police would be pleased to hear from you.

SE&CR R1 locomotive (photo courtesy of Maxitrak).

Workshop Offer

A reader has contacted me with an interesting proposal. Over a lifetime of model engineering he has acquired a very well-equipped workshop and is thinking about what will happen to it when he no longer needs it. He feels it should not be 'broken up' and disposed of piecemeal – it is too good for that. I suspect this is an issue for many of us! The workshop is quite comprehensive, including two Harrison lathes and a Drummond lathe, a Bridgeport mill, a Tom Senior mill and a Dore Westbury mill. Along with these are a surface grinder and a die sinker, plus a number of other machine tools. All these are comprehensively equipped, as is the rest of the workshop.

He wishes to donate this workshop, in due course, to a club who will make good use of it and, specifically, will use it for the training of young engineers. It is also a requirement that the workshop should remain intact. Clearly, to accommodate a workshop of this size will require plenty of space so this offer would only appeal to a limited number of clubs – those who have the space (or can create the space) but not the facilities. He also has a complete collection of *Model Engineer* magazine from 1962 onwards – also a great asset for any club.

The workshop is located in the West Country. It should be understood that this is not an immediate offer; the club would become a beneficiary of this gentleman's will.

If any club would like to investigate this opportunity further, please contact me.

Laurie Marshall

Brighton & Hove Society of Miniature Locomotive Engineers have informed me that their president Laurie Marshall died, aged 90, on the 9th June, doing what he liked best, gardening. Laurie was well-known as a railway photographer, tour guide and film-maker, in particular for his series of three DVDs on Indian railways, *Indian Steam Sunset*, in which he explores the Indian railway system from Madras (Chennai) to the Himalayas.

His wife Maureen died some years ago but he is survived by a son.

Price Increase

I am sorry to report that the cover price for *Model Engineer* goes up from £4.20 to £4.40, from this issue. The last increase was over two years ago and this, I'm afraid, is simply the workings of inflation.

Paradise Postponed

As I write, our friend in No. 10, Boris, has announced that our liberation from the scourge of covid is to be delayed, probably until the 19th of July. No doubt this will have put a bit of a dampener on the activities that some clubs may have planned for the summer and delayed the restoration of normal club activities. Every cloud, though, has a silver lining and what better excuse do we need to delay the emergence from our workshops – or 'unfathomable mines of never failing skill', as I prefer to call them – blinking in the sunlight? This is an unexpected opportunity to apply the finishing touches to that lockdown model or to give that slightly uncouth looking model a little wash'n'brush up. Then you can write about it for the entertainment of your fellow readers. How about it?

Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
07710-192953
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An Astronomical Bracket Clock PART 6

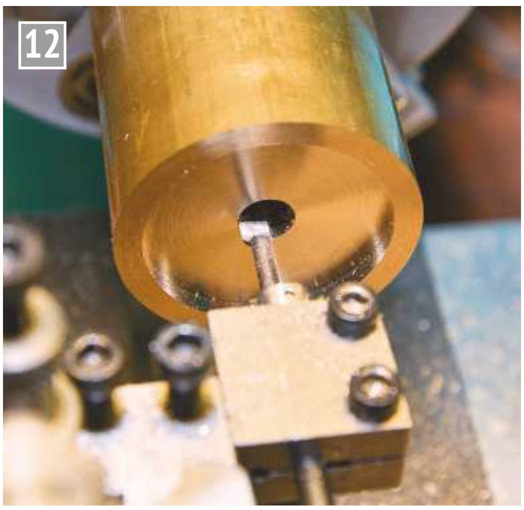
Adrian Garner makes a bracket clock showing both mean and sidereal time.

Continued from p.21
M.E. 4667, 18 June 2021

Fusée, maintaining gear and stop work (figs 8, 9 and 10)

The fusée was formed from a length of 2 inch diameter of brass. This was gripped in the three jaw chuck and the protruding end checked that it was running true to within a thou or so. With this size of material, the length of chuck jaw holding the work is relatively short compared to the work diameter and very light tapping of the outer end is sometimes needed to ensure the work is running true before final tightening. The end was faced by taking light cuts, centre drilled and drilled to about 1¾ inch deep with a 7/32 inch drill. The hole was then opened up with a 5/16 inch drill, bored and reamed 3/8 inch (**photo 12**).

Descriptions of making the fusée usually suggest that it is then parted off, the other end faced and the embryo fusée mounted on its arbor for turning between centres. This order of machining always seems to me to cause undue difficulty when it comes to boring the recess for the ratchet as well as drilling and tapping the holes to secure the ratchet and stop plate at the other end. I prefer to form the recess with a normal boring tool at this stage; it is then parted off, reversed in the chuck and the other end faced to length. In this state, without being attached to the arbor, it is easy to line up the ratchet and stop plate with a short length of 3/8 silver steel rod to drill and tap the needed holes without the arbor interfering.



Boring the hole in the fusée.

Purists will argue that the above must be less accurate than turning all faces between centres. They are correct but as the faces which bear against the great wheel and the internal ratchet wheel, plus the long hole for the arbor, were all formed at the same set-up, the error will be minimal. In any event a skim of a thou' or so can always be made when turning between centres across the face on which the great wheel bears. Great accuracy in true running of the stop plate at the other end is irrelevant as it is not even round!

The fusée arbor can now be prepared. A length of 3/8 inch diameter silver steel is cut about ½ inch over length. It is held in a collet for the ends to be faced, centred and »

Using a template to cut the fusée.

the basic machining done to within about 0.020 inch or so of the needed dimensions (the extra quarter inch at each end accommodates the centre holes). After ensuring all is clean and oil free the barrel arbor was secured in the embryo fusée with Loctite 603. This cures quickly but I left it to fully bond over night.

The bulk of the excess brass was removed by holding the arbor in a collet and setting the top slide over to about 20 degrees to form a cone shape (check to ensure the cone is the right way around!).

The method used to cut the fusee will depend on the shape of curve desired, how much time one is prepared to spend making jigs and tooling and your aversion to risk.

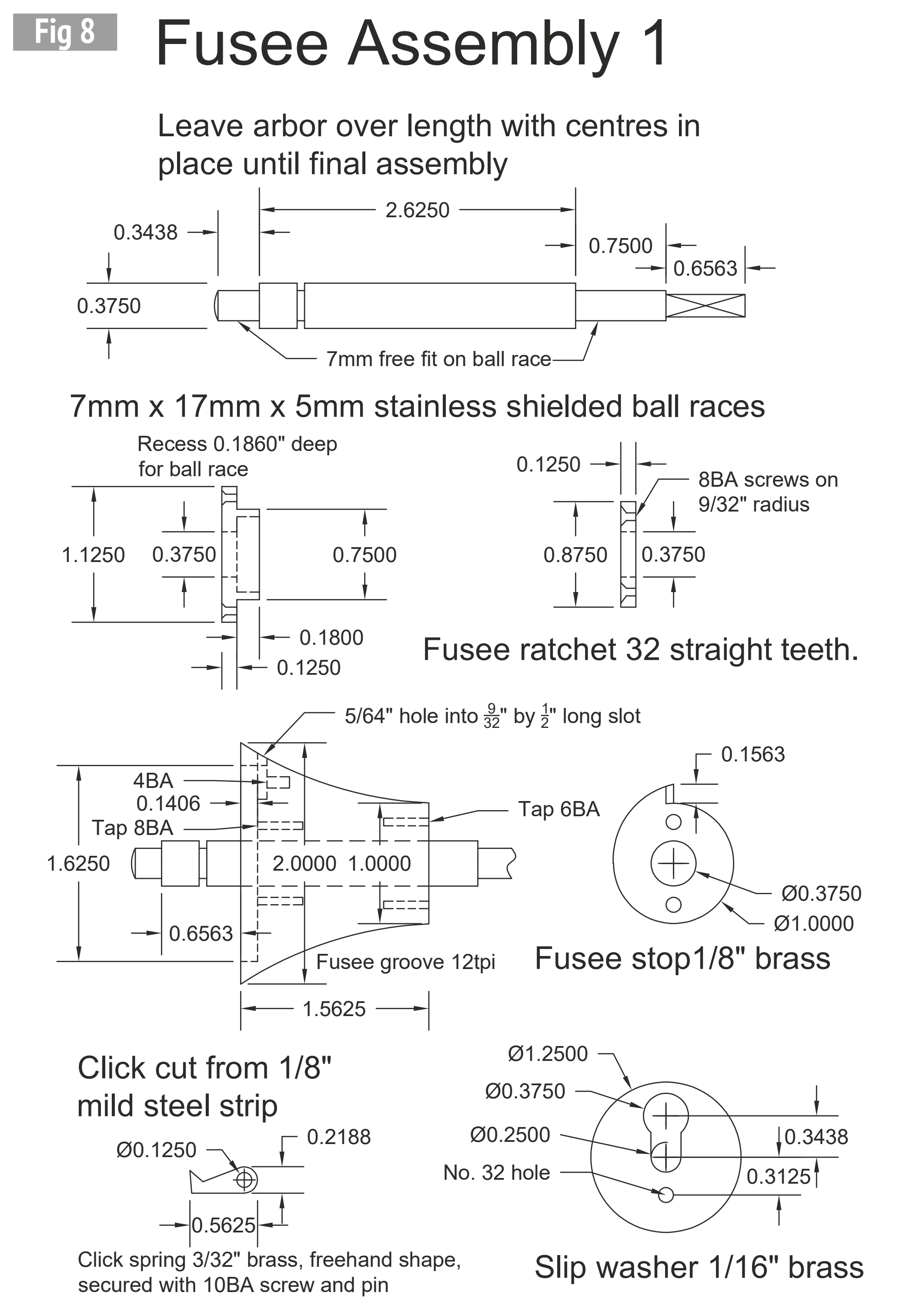
The simplest shape is a section of a circle and this can be cut as described by John Wilding by setting the tool an appropriate distance out from the four way tool post and pivoting the tool around the tool post. All other shapes require some form of profiling set up.

A number of authors have suggested that once the brass has been profiled, removing the hand wheel and leadscrew from the cross slide and relaxing the gib strips a little will allow the thread to be cut by feeding in the cross slide by hand. In my view this is a far from pleasurable process which risks digging in, an uneven groove etc. It is possible to do, and it certainly avoids making any special accessories, but as John Wilding comments, the result is likely to be chatter marks needing to be removed by files. Personally, I find this all too risky but many have succeeded.

At the other extreme it is possible to create a set-up where the movement of the cross slide is very controlled. This can be done mechanically but I would suggest CNC would be far easier, using stepper motors to drive both the leadscrew and cross slide. Such a set-up would require a possibly disproportionate effort to make if not used for any other purposes.

My solution is a halfway house (**ref 8**). As shown in the **photo 13** it consists of a brass template, a fixed pointer and light pressure on the cross slide to keep the two in contact. It is used to both form the initial profile and then cut the thread.

Fig 8



The brass template does get scratched by the hardened steel pointer in the process but this is easily smoothed with a fine file for its next use (and can be reshaped as needed). There are two easy improvements that could be made to my set-up:

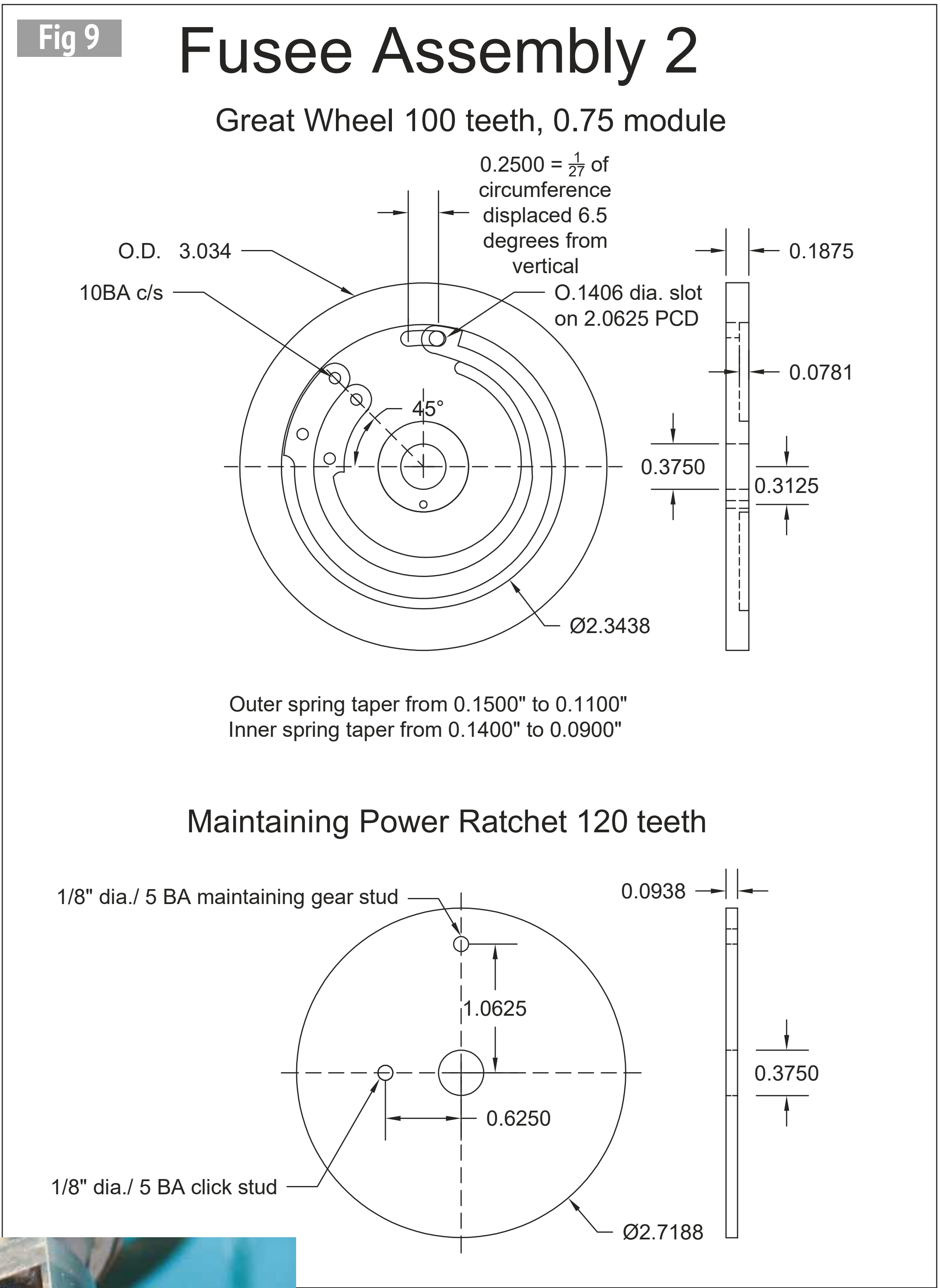
1. Making the template longer would allow two bolts to secure it to the cross slide; a more secure arrangement,
2. The ¼ inch cap head screw which holds the pointer could be replaced by a large knurled screw with indexing to allow the depth of cut to be determined more easily.

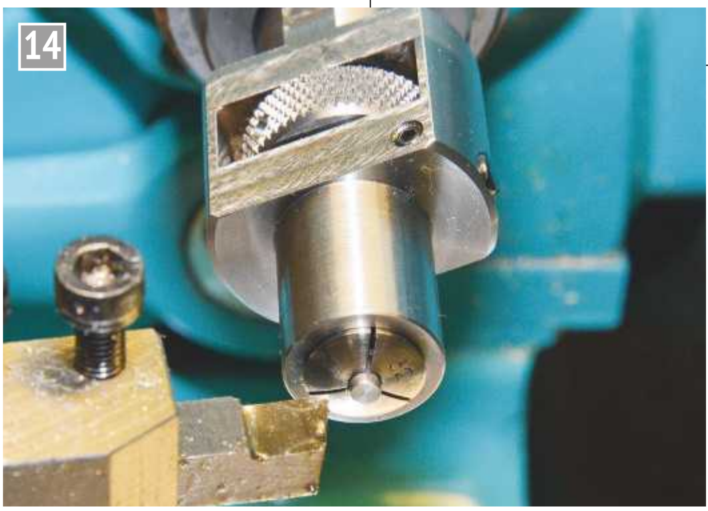
In any event the shape of the fusée curve needs to be determined. This can be done theoretically, by measuring the effect of your particular spring, excellently described by David Poole (**ref 4** - part 1, *M.E.* 4663, 23 April), or adopting a general hyperbolic shape between the small and large fusée diameters. Having reviewed many past articles the variations in shape are all very modest. The general view seems to be that a ratio of 2:1 or slightly more between the large and small end of the fusée is about right for modern springs.

To machine, I mounted the arbor and embryo fusée in a ⅜ inch collet at one end with the other end supported by a revolving centre. The curve was cut with the lathe running at about 300 rpm. I took small cuts whilst pushing on the cross slide to keep the pointer and template in contact and advancing the carriage with the hand wheel. Only a light touch with a fine barrette file was needed to produce a very smooth surface.

Cutting the thread requires a tool ground to form a 20 degree angle tip which is rounded to a radius equal to that of the line to be used plus a bit - say an extra 10%. The lead face should have 10 degrees relief whilst the trailing face only needs 5 degrees. Set the lathe to 12 tpi but do not use power, drive the lathe with a mandrel hand wheel. Take repeated cuts until the 'down side' edge of the grove at the 2 inch diameter end is equal to at least half the diameter of the wire. This will ensure the wire does not jump the groove. With only small cuts put on with the top slide I avoided all chatter leaving a near perfect finish.

Fig 9





Turning the end of the ratchet click peg.

With the fusée turned to shape the ratchet click was filed from a piece of ⅛ inch thick mild steel in which a ⅛ inch diameter hole had been drilled and reamed. The spring was filed from 3⁄32 inch brass plate. The peg on which the click rotates was made from ⅛ inch diameter mild steel threaded 5BA. After threading and cutting to length this is difficult to hold to turn the end. I used a No. 32, 8mm collet in a holder for the Myford lathe (**ref 9**) (**photo 14**).

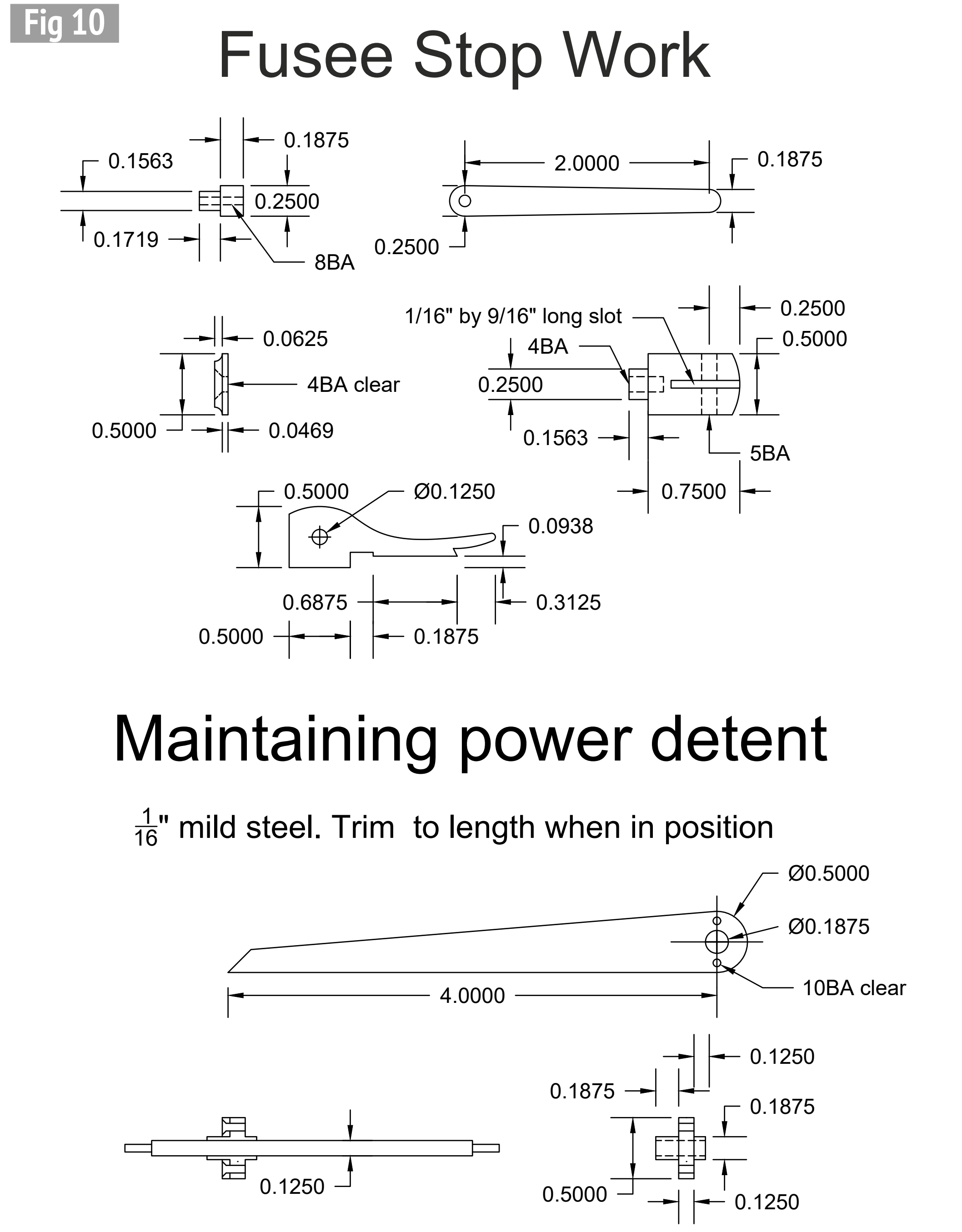
The end housings for the ball races are not complicated but again require accurate turning similar to that for the spring barrel.

The Harrison maintaining gear which keeps the escapement going whilst the clock is being wound consists of three items: an arm or pawl, a large fine toothed ratchet and a spring arrangement within a recess in the great wheel engaging with a peg on the ratchet. After the first wind of the clock the action of the barrel spring on the fusée is to turn the ratchet and hence turn the great wheel via the peg and thus the maintaining gear spring which becomes tensioned. Thereafter, on rewinding the clock, the teeth on the ratchet prevent it from rotating despite the temporary release of the pull from the barrel spring on the fusée and the tensioned maintaining spring, via the peg, keeps the needed rotational torque on the great wheel for sufficient time to wind the clock.

Construction of neither the arm nor ratchet should give rise to any problems. The arm was cut from 1⁄16 inch steel plate after milling a straight edge on one side. It fits onto a collet and arbor similar to those for the clock wheels. The ratchet has straight cut teeth.

The recess in the great wheel is accomplished by holding it in a three jaw chuck with outside jaws and soft card packing to protect the teeth. The slot for the peg was formed by drilling, piercing out the gap between them and fine filing. Alternatively it could be milled on a rotary table – it was just quicker by hand.

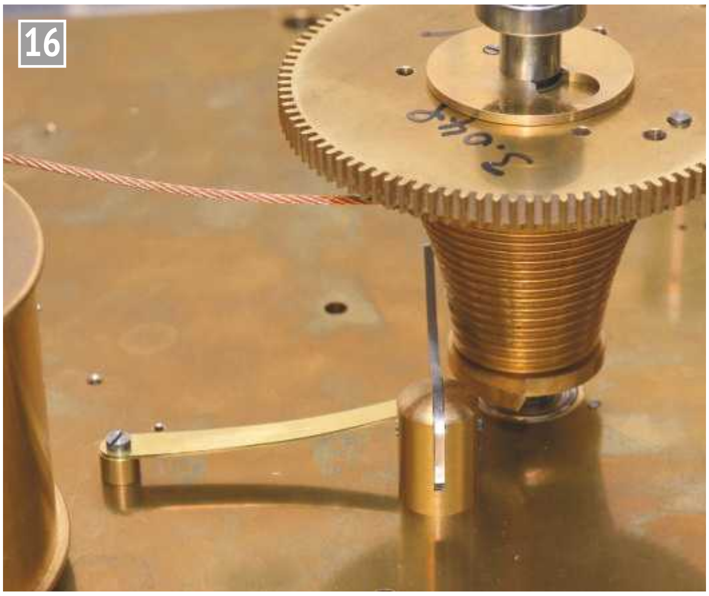
Fig 10



The difficult item is the spring that engages with the ⅛ inch diameter peg. Some authors have suggested using hardened and tempered 1⁄16 inch silver steel bent to fit over a fixed peg in the great wheel. In one case a small square section of silver steel is suggested to be bent to shape. In your author's view these methods have three drawbacks: the steel is difficult to bend to the correct shape, the bending process, unless carried out at red heat, will inevitably introduce small cracks leading to the item's failure and the bent metal often does not provide sufficient power to keep the clock going.

A more sure way is to cut out the spring from 1⁄16 inch gauge plate with a piercing saw and then file to shape. This avoids the stress and resultant micro cracks caused by bending. All corners, especially internal corners, must be rounded and the whole given a polish so that remaining scratches are along rather than across the spring. This will minimize the risk of cracking. The spring then needs to be hardened. Whilst the mass of the spring is small a surprisingly large flame is needed to ensure the whole ring reaches red heat before quenching in oil. If the whole ring is not heated evenly stresses may be introduced and part of the ring may not be hardened. The use of borax as a flux during hardening will minimize the build up of scale. The spring

Double maintaining spring.



Stop work.

must then be tempered. Re-polish the surfaces and for those who have made a bluing box, for example that described in the H.J. (**ref 10**), the temperature needs to be about 335 degrees C. If no temperature controlled arrangement is available heat until at least a deep blue is reached. It will be better to 'over' temper as not tempering sufficiently is likely to lead to spring failure due to cracking.

To position the 10BA holes in the great wheel use a ⅛ inch dowel through the spring hole and the right hand end of the slot.

A trial with just one spring indicated that it was not sufficient to drive the clock during winding. Making the spring thicker would have restricted its elastic action and encouraged cracking if bent beyond the elastic limit. I therefore opted for two springs acting rather like leaf springs. This was found to work well albeit, I suspect, unusual (**photo 15**).

The slip washer is a small piece of 1⁄16 inch brass plate. The three holes for the keyhole shape and securing screw were drilled first. I then cut out the circular shape with a piecing saw and mounted it on a mandrel to turn the outside to size. The slot was completed with a file.

Those who have made the Congreve clock to John Wilding's design will recognise the shape of the stop work which has been adapted to fit this clock (**photo 16**). I will add two comments: to make the brass washer that goes between the 4BA screw and clock plate, face a length of ½ inch diameter brass rod and take a light cut along its length for about ¼ inch. The ornamental curved corner is then cut with a round nose tool to match the pillar washers and the 4BA clearance hole drilled. If the hole is drilled sufficiently deep the countersink can be cut and tested with a screw to ensure the top of the screw is below the surface. Alternatively, the more complex route - which saves brass - is to only drill for a short distance, part off at about 3⁄16 inch thick and remount in the chuck with a lathe backstop to form the countersink with a small turning tool. Either way it will be necessary to machine the rear face to bring to the correct thickness. It will be found to be too thin to hold for this final operation even with the use of a backstop. As previously described the solution is to mount a short length of ⅜ inch brass in the chuck and to turn a short spigot that just fits the 4BA clearance hole. Superglue will now secure the washer against the shoulder whilst it is machined to thickness. A gentle heat in a gas flame will kill the superglue so that it can be removed (**photo 17**).

Machining the brass washer to thickness.

The other comment is that the spring is made from 1⁄32 inch thick brass strip hammered on an anvil to make it 'springy'.

Once the fusee is complete the length of the wire/cable needed can be assessed by winding a piece of string around its grooves. Fifteen turns are needed from where the cable emerges from the fusee. My string measured about 64 inches. This is equivalent to about seven and three quarter tuns on the barrel. Add about 8 inch to the cable length to allow for the distance between the fusee and the barrel and end fixings. Better too long than too short.

I suggest not fitting the line at this stage – wait until assembly.

●To be continued.

REFERENCES

8. *A Simple Guide for Turning a Fusée;* Adrian S. Garner, *Horological Journal*, October 2003, p 356.
9. *An 8mm Collet Chuck for the Myford Lathe*; Guy Gibbons, MBHI, *Horological Journal*, August 2010, pp 350 - 354 and *A Chuck for 8mm Collets*; Adrian Garner, *Horological Journal*, May 2014, pp 212 - 214.
10. *Making a Bluing Box;* Geoff Walker, *Horological Journal*, August 2013, pp 348 - 450.

A view of the polystyrene pattern before being used in the mould.

Another view of the cylinder pattern before moulding.

Casting Cylinders for *Night Owl*

John Arrowsmith witnesses the casting of a cylinder for the full-size new-build GWR 4709.

Readers will perhaps remember that back in early 2020 I reported on the manufacture and assembly of the polystyrene patterns (**photos 1** and **2**) for the new cylinders on the new Churchward 2-8-0 being built by the GWS based in Didcot. Many difficulties have ensued since that date including of course the dreaded Covid-19 pandemic, which curtailed lots of the activities which would normally have taken place to progress this project.

The patterns that I showed in my article were duly sent to the selected foundry - there are not many these days that would even consider the job, never mind actually do it. However, having received the patterns, the company was put into receivership, which meant the project team then had the difficult job of retrieving the patterns and then finding another foundry to do the work.

The finished left-hand cylinder casting awaiting heat treatment.

Eventually Boro Foundry agreed to take on the project and produced a complete and sound casting for the right-hand cylinder (**photos 3** and **4**). It was interesting to note

The main cylinder ports showing the sharpness and good surface finish of the cylinder.

Detail of the outside surface of the casting which has picked up the sealing tape marks of the pattern.

The first mix is poured into the ladle.

Removing the slag from the mix before it is poured into the ladle.

that on the outside surface of the casting there was evidence of where the pattern taping, which helped to keep it all together, had been in the mould (**photo 5**). Progress at last! - and this led to the next stage, the casting of the other cylinder at the Boro Foundry in Stourbridge. May 6th was the day I presented myself at the foundry to see the metal being poured into the mould and pattern for the left-hand cylinder for 4709.

The foundry has been in the ownership of the Norton Family since 1960 when it was bought by Mr. S. Norton and it was his great grandson Sam Edwards who is now the Operations manager who met me for the visit. Sam explained the details of the operation and how the procedure was planned to take place. They had had to overcome a manufacturing problem that had occurred that morning when one of the two melting furnaces developed a fault. This meant that the whole batch of iron would have to split into two before the actual pouring could take place.

The first melt was well underway by the time I arrived. Because it had to be stored until the second melt had reached the required temperature, the first batch was heated to 1600 degrees C and then poured into the ladle for storage (**photo 6**). It was covered with a Vermiculite insulating blanket in order to keep the metal molten while the second batch was prepared. The insulating blanket ensured that the temperature drop of the molten metal could be controlled ready for the second pour. This in itself was an interesting process to watch because the amount of slag on the first melt had to be removed (**photo 7**) before pouring in the second batch. The metal being used was a standard grade pig iron which, when re-heated, becomes the standard soft grey cast iron with which model engineers are familiar.

A second melt was started by loading the furnace with a suitable quantity of pig iron. The total poured weight required was 3500kg and whilst all this was ongoing my colleague Paul Perton from the '4709 Group' and I were treated

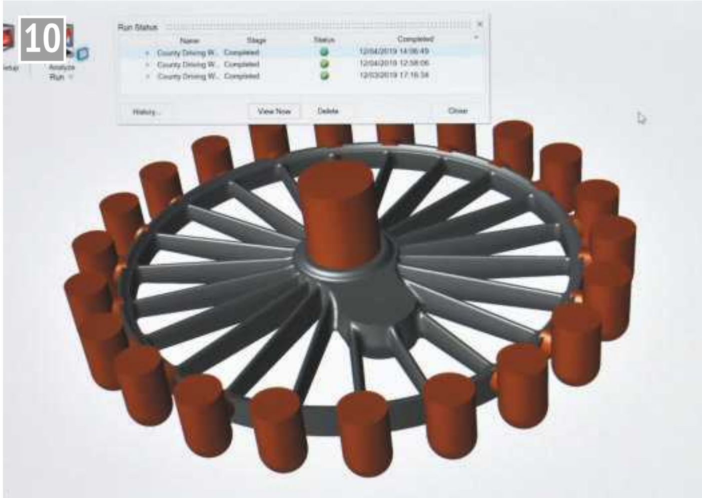
One of the bogie wheels for the new LNER P2 locomotive being prepared for ultrasonic testing.

to a visit to the heavy machine shop which the company also operates. Here the company is able to offer an excellent machining service for a variety of components. We were shown a variety of components either being machined or completed. For example, one of the bogie wheels for the new LNER P2 locomotive project *Prince of Wales* was being prepared for an ultrasonic testing procedure (**photo 8**). Also completed and stored in the shop awaiting delivery was a pair of side rods for the new GWR County class 4-4-0 (**photo 9**). In addition to the machining facility the company have a good technical ability, with a 3D printer for component feasibility studies and CAD programs to assist with getting a full assessment of the casting procedure for different components (**photo 10**).

Returning now to the foundry, the melt was just about ready and foundry staff were busy getting everything in place to pour into the ladle (**photo 11**) ready for the big pour into the mould.

The moulding boxes for this large casting measured 7 foot 6 inches x 7 foot 1 inch x 5 foot 3 inches (or if you prefer metric, 2.28 x 2.15 x 1.6m high) and with the large counterweights added to the top it seemed a huge structure (**photo 12**). The pattern itself is made of polystyrene and requires the application of a three-layer ceramic coating, which is a specialist job, before it is filled with the casting sand mixture. Another taxing job is getting the sand into every aspect of the pattern, I hope the photos convey the sheer amount of work needed for that operation (**photos 13** and **14**). The operators proceeded to remove the built-up slag on the second melt by adding a powder compound which causes the slag to rise to the top of the melt and so allowing removal (**photo 15**).

The completed coupling rods for the new GWR County 4-4-0.



A CAD image created to show flow ports for a locomotive wheel casting.

The total time to get 2646kg of cast iron into the mould was approximately four minutes.

The second mix being poured into the ladle.

The impressive moulding boxes waiting for the pouring operation to begin.

The pattern installed in the mould box awaiting additional sand (photo supplied by the Boro Foundry).

Packing the sand round the pattern (photo supplied by the Boro Foundry).

Removing slag from the ladle before pouring into the mould.

All these operations having been completed, the main pouring ladle was made ready for its positioning move over the mould box. The overhead crane was used to get the ladle into the right position and then to facilitate the pour the pouring lip bung was removed to enable the molten iron to flow into the mould (**photo 16**). As the metal entered the mould box the escaping gases ignited around the outside surfaces creating an interesting scene (**photo 17**). The total time to get 2646kg of cast iron into the mould was approximately four minutes. When this manoeuvre was completed the excess material in the ladle was then poured into waiting smaller moulds to solidify for future use.

The mould would be left for probably three or four days to cool down sufficiently to be able to remove the casting from the mould. When this has been completed satisfactorily the casting will then be inspected for defects and, assuming this is successful, both cylinder castings will be moved to another company for stress relieving before any machining can be started. The mould was thus left until Monday before the top of the casting was revealed and this showed good signs that the casting was sound. The remainder of the mould was removed on Thursday and to everyone's complete satisfaction the cylinder block was complete and in good order.

The machining is already scheduled to take place in the Midlands and hopefully will be the subject of a further article to complete the whole project, from pattern making through casting to a finished component ready for assembly to the locomotive frames. The only observation I can make on the machining is to say that it will take a bit more than a boring bar between centres on a Super 7 to get this casting completed!

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The pour begins into the mould.

The escaping gases ignite around the mould box.

The Barclay Well Tanks of the Great War

PART 76

Terence Holland describes and constructs two appealing, century old locomotives.

Continued from p.743
M.E. 4666, 4 June 2021

This constructional series addresses Andrew Barclay 0-4-0 and 0-6-0 narrow gauge locomotives supplied for use in the First World War. Built without the use of castings, the 0-4-0 design is described as two versions; as-built for the British Admiralty in 1918 and as rebuilt and currently running on the Talyllyn Railway as their locomotive No.6, *Douglas*. The 0-6-0 engines described were built in 1917 and operated on 60 centimetre gauge track at the Western Front in France. These were small, spartan machines of which only 25 were supplied and none have survived into preservation.

Valve gear

This particular design of Walschaerts valve gear is very exposed as the spartan nature of the engine allows all to be seen. The valve gear components and motion work fitted to later engines such as *Caledonia* (**photo 335**) and the Bord na Mona locomotives were even more basic with squared off rod ends, doubled

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Valve gear on Caledonia.

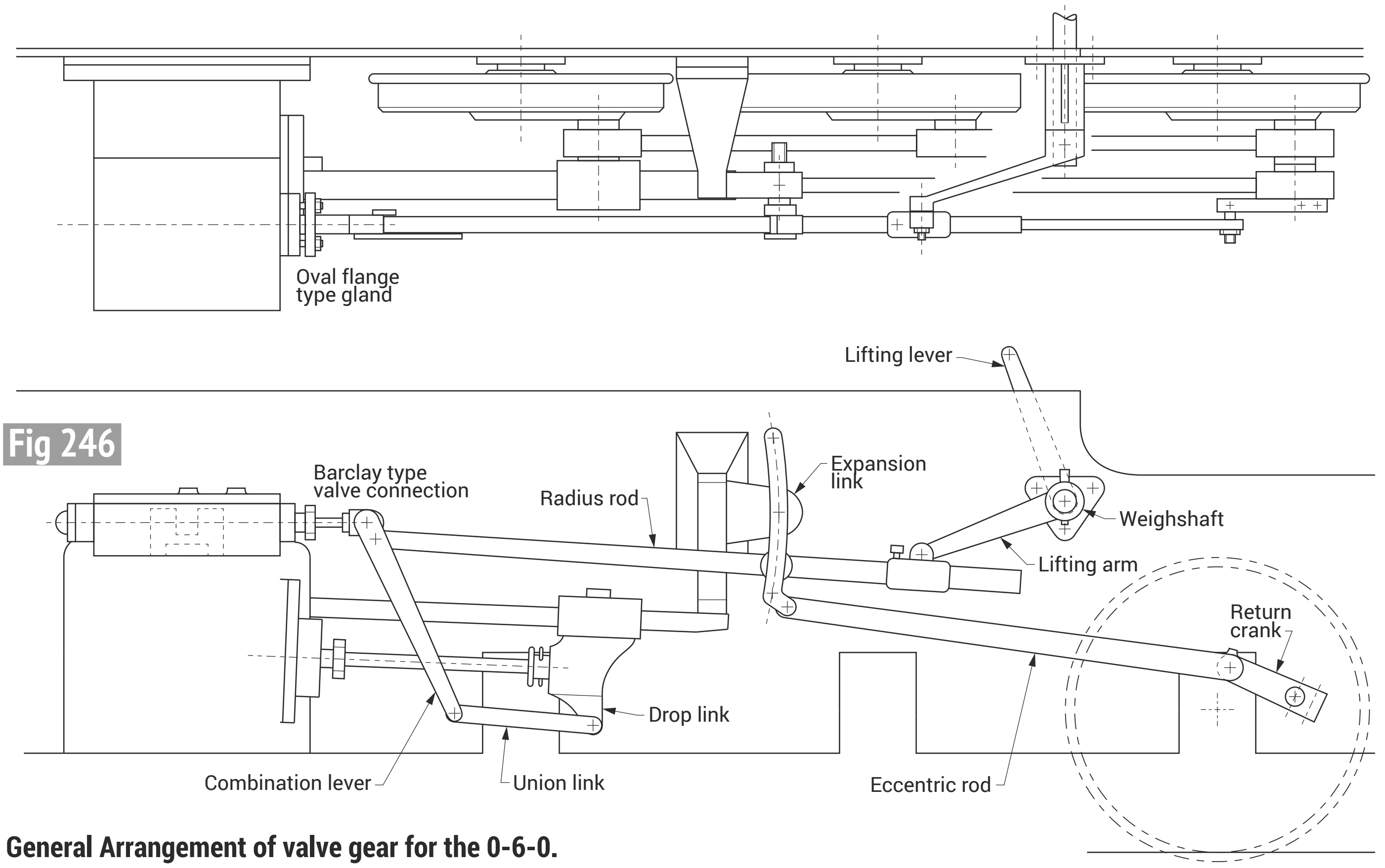
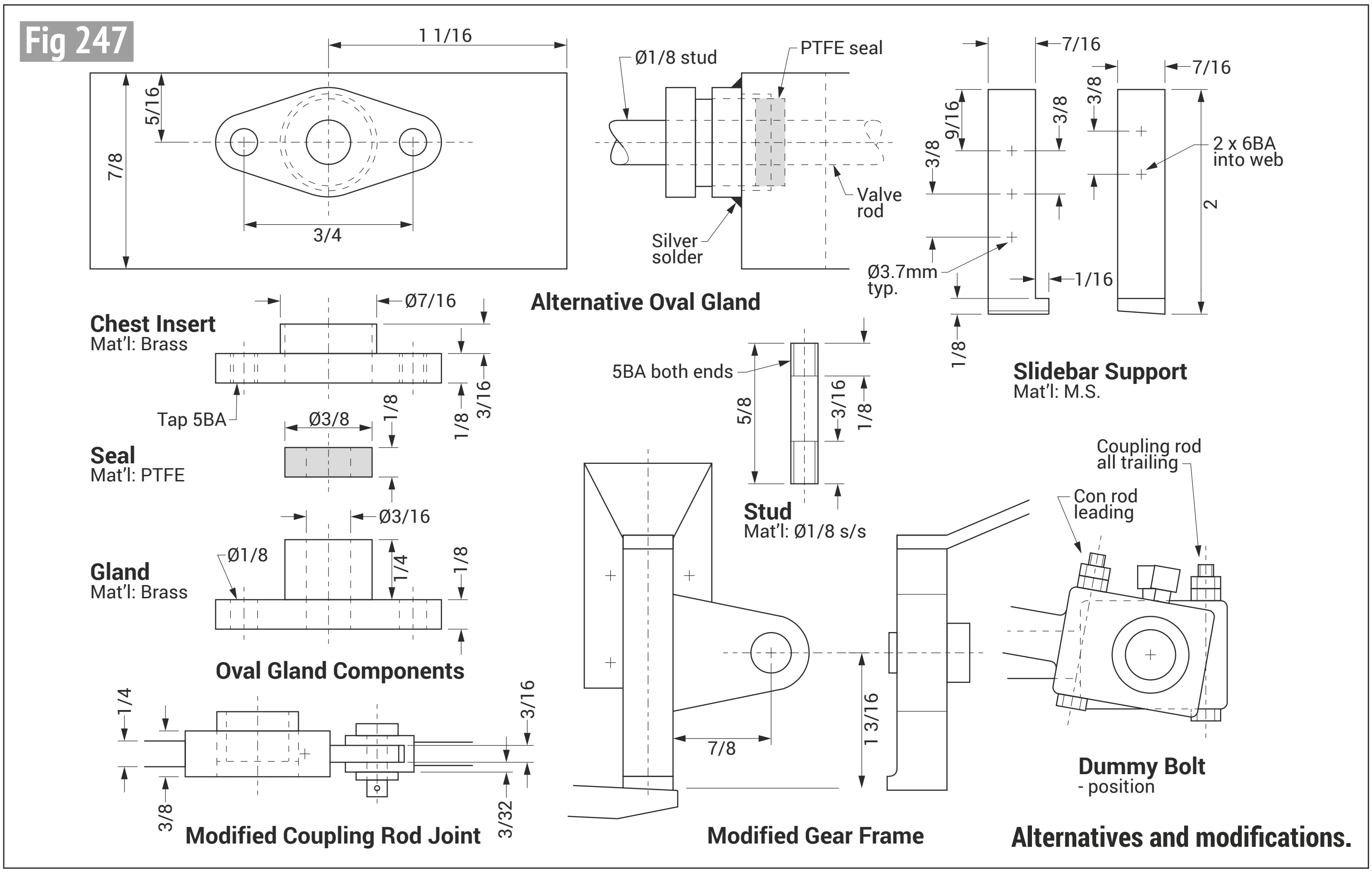


Fig 246

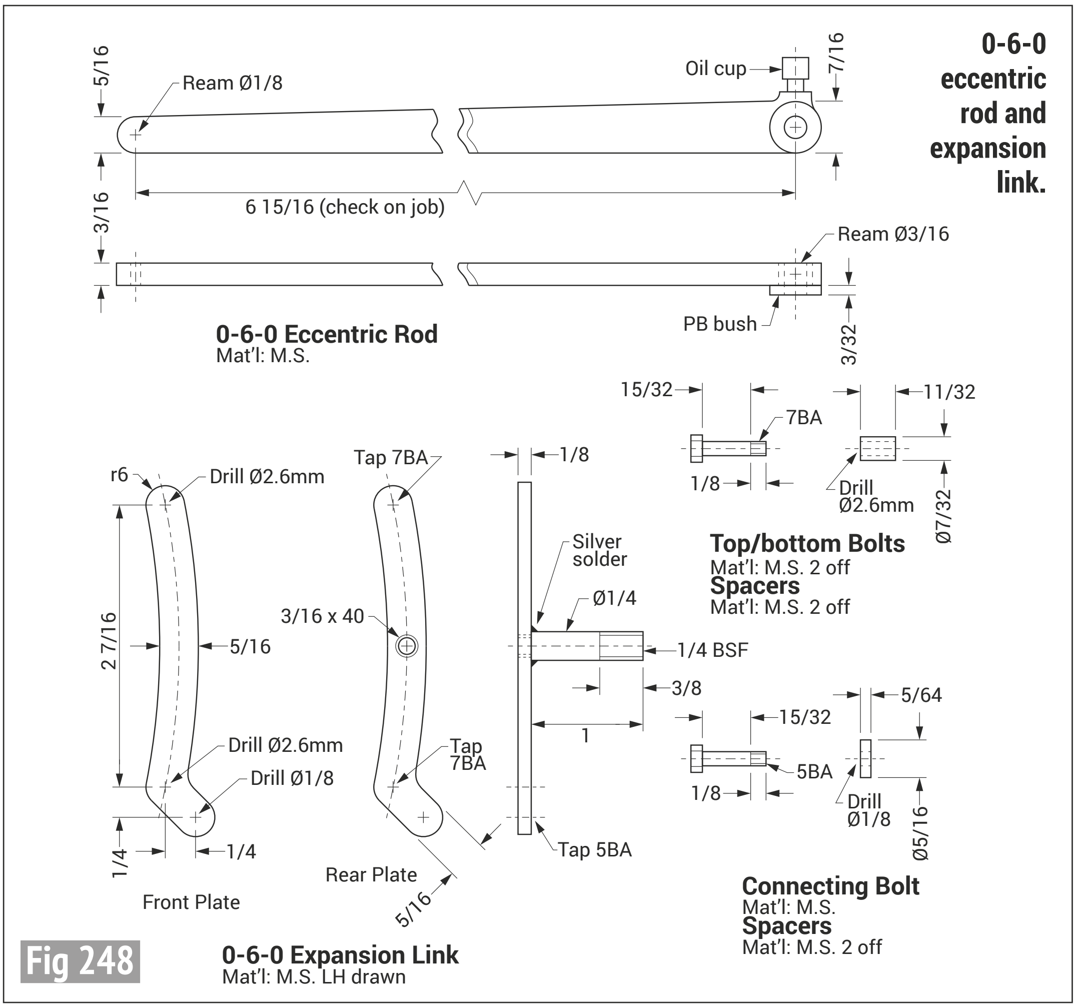
General Arrangement of valve gear for the 0-6-0.



up combination levers and round section connecting and coupling rods - see also photos 125 to 127 (*M.E.* 4571, October 2017).

The original valve gear for the 0-4-0 was addressed herein during 2017 - see *M.E.s* 4571, 4573 and 4575 (13 October, 10 November and 8 December 2017). However, for the valve gear of the 0-6-0 (**fig 246**) there are some modifications and minor corrections, which are dealt with below (**figs 247, 248** and **249**). **Photograph 336** is a close-up view of the valve gear on the prototype at Kilmarnock.

Figure 247 presents details of an alternative gland for the steam chest that is a prominent item at the rear of the prototype chest. The figure also details modified coupling rods, which are reduced in thickness to make them more compatible with the connecting rods. The drawing also clarifies the correct position of the dummy bolts on the rods. Finally, in keeping with advice from Anthony Simmons in Norfolk, the gear frame has been modified



to lower the centre of the expansion link to line up with the end of the radius rod and not with the valve rod.

Return crank

The return crank is exactly as shown in fig 86 (*M.E.* 4571, October 2017).

Eccentric rod

The eccentric rod for the 0-6-0 is shown in fige 248. It is slightly longer than that shown in fig 86 and simplified with a plain small end.

Expansion link/ die block

The original expansion link and die block assembly is shown in fig 87 (*M.E.* 4571, October 2017). Slight modifications to the design of the expansion link for the 0-6-0 are shown in fig 248.

Radius rod

The radius rod was detailed in fig 88 (*M.E.* 4571, October 2017). Minor modifications for the 0-6-0 are presented in fig 249. The lug on the lifting bearing (fig 90, *M.E.* 4575, December 2017) is slightly different; that is ¼ inch thick as opposed to the ⅛ inch thickness of the original. It would, of course be acceptable to use the original design with suitable spacers.

Drop link

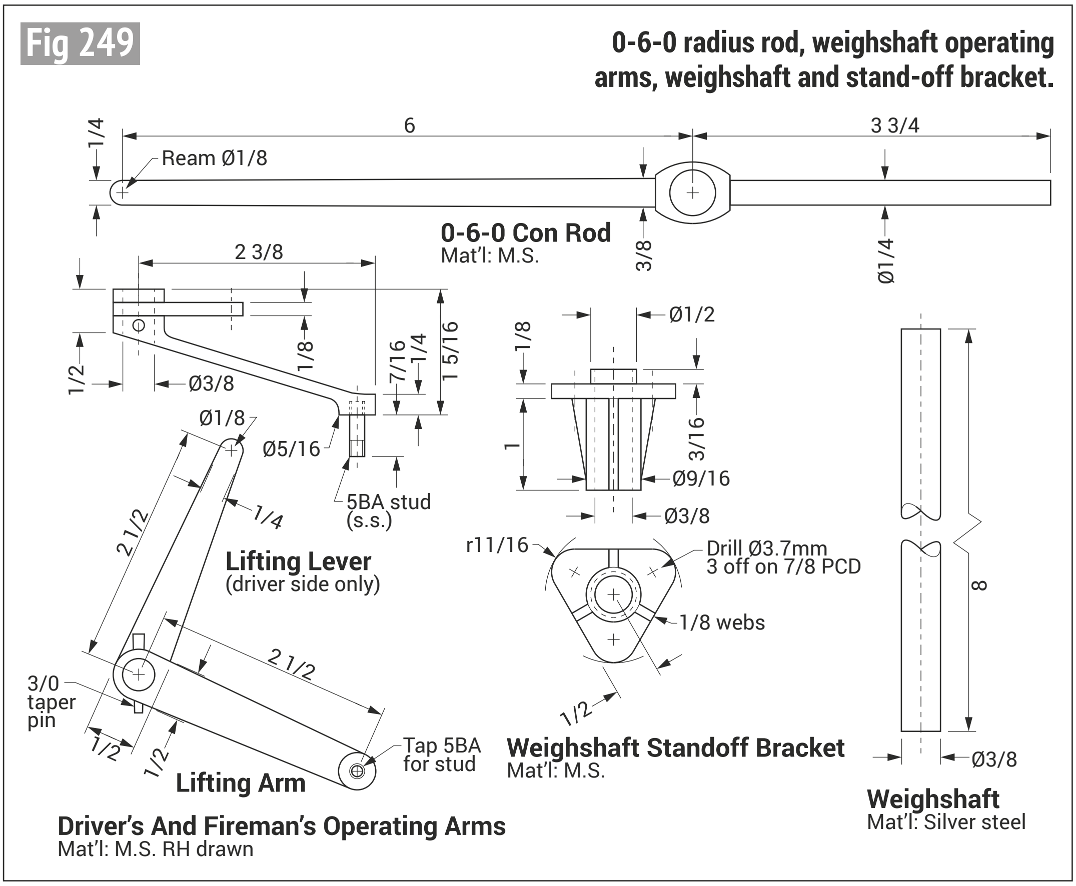
The drop link design is unchanged. It is constructed as part of the crosshead - see figs 62, 63 and 64 (*M.E.* 4551, January 2017).

Union link

The union link design is unchanged; see fig 89 (*M.E.* 4575, December 2017) where it is shown with the combination lever. It's probably the easiest part to make on the whole engine!

Combination lever

The combination lever design is unchanged; see fig 89 for the usual type of lever. The design is the same for either the conventional type valve connection or the Barclay specific design shown in fig 189 (*M.E.* 4634, March 2020).



Weighshaft, support bearing, lifting arm and lifting lever

These parts are all new to this design and completely different from those fitted to the 0-4-0s (fig 249). The flange, which bolts the assembly to the frame, is triangular with three ribs and three securing bolts – goodness knows why such a complicated casting was used for such a simple task on these engines; perhaps Barclay's had some in stock from the Victorian era? Note that the lifting arm/ lever assembly fits to the right hand, driver's side. The left hand lifting arm is similar but handed, of course, and has no lifting lever. Both units are located on the shaft with taper pins. Glands are not required, unlike those on the 0-4-0, as the weighshaft does not pass through a water tank. The driver's side lifting arm and lever can be seen in photos 335 and 336.

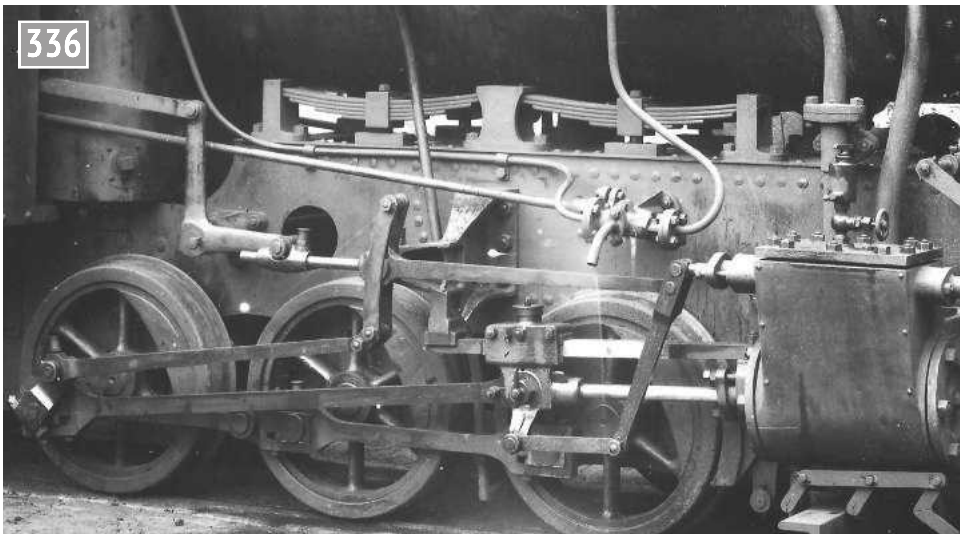
Reach rod

The reach rod design is similar to that shown in fig 91 (*M.E.* 4575, December 2017). The weighshaft end of the rod should be drilled ⅛ inch diameter and the overall length checked on the job.

Reversing lever and quadrant

These items are as shown in figs 92 (*M.E.* 4575, December 2017) and 167 (*M.E.* 4618, August 2019).

●To be continued.



Close-up of gear on the prototype. (Author's collection.)

Polygonal Holes & Rotary Broaching PART 4

Jacques Maurel discusses the process of making non-circular holes.

Continued from p.28
M.E. 4667, 18 June 2021

Rotary broaching attachment using rolling bearings

(**fig 20**, **photo 24** and the parts list, **table 4**)
This concept, shorter in length but bigger in diameter than the previous one, uses only two bearings - a needle thrust bearing (part **B5**) and an angular ball bearing (part **B8**). There is also an indexing ring (part **B3**). The spindle and bearing sub assembly (parts **B1** to **B10** and **B20**) is used with the 'plane contact' centring device (parts **B11** to **B18**) but the spherical link could be used instead (parts **9** to **12** of the previous concept), the stud (part **9**) having no offset as this offset is given by the tapped hole in part **B20**.

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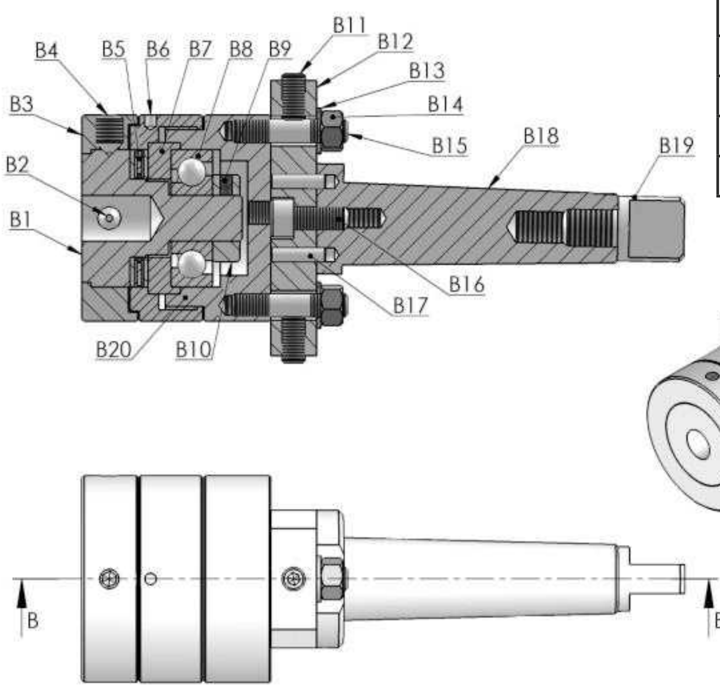
Rotary broaching attachment using roller bearings.

Ref	No.	Name	Material	Remarks
B1	1	Spindle (fig 21)	Steel	0.5% carbon
B2	1	Screw Hc M6-10	12-9	
B3	1	Indexing ring (fig 27)	FCMS	
B4	1	Screw Hc M6-8	12-9	
B5	1	Needle thrust bearing		Diameter 17/30 4mm thick
B6	1	Nut housing (fig 22)	FCMS	
B7	1	Spacer (fig 23)	FCMS	
B8	1	Angular ball bearing		Diameter 10/30 9mm thick
B9	1	Screw Hc M4-5	12-9	Set a brass pad under
B10	1	Adjusting nut (fig 25)	FCMS	
B11	6	Screw Hc M5-10	12-9	
B12	1	Fixed plate (fig 26)	FCMS	
B13	2	Washer diameter 5		
B14	2	Hex nut M5	8	
B15	2	Stud	Steel	0.5% carbon
B16	1	Screw CHc M5-12	8-8	
B17	2	Elastic pin diameter 3		12mm long
B18	1	Plate MT2 shank (fig 28)	Steel	0.5% carbon
B19	1	Tenon	Steel	0.5% carbon
B20	1	Screw housing (fig 24)	FCMS	

Table 4. Parts list



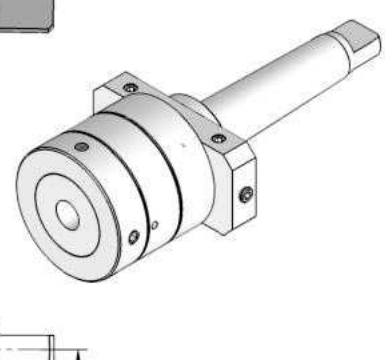
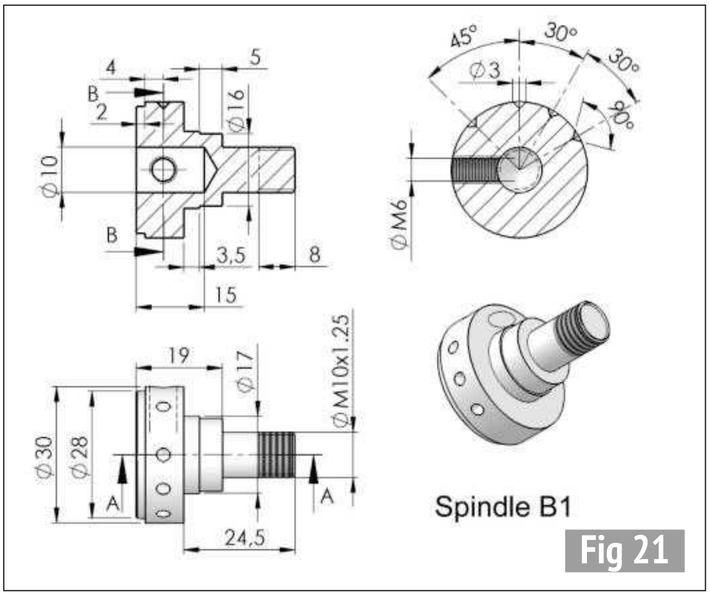


Fig 20

Making (figs 21 to 28)

***Spindle B1* (fig 21)**
See the making of 'spindle 1' for the previous attachment.



Spindle B1
Fig 21

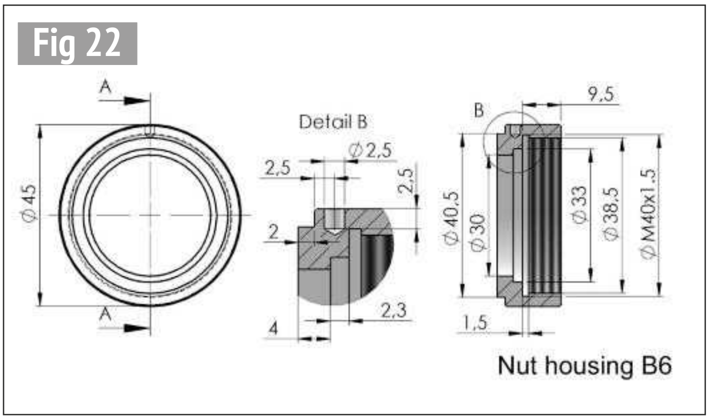


Fig 22
Nut housing B6

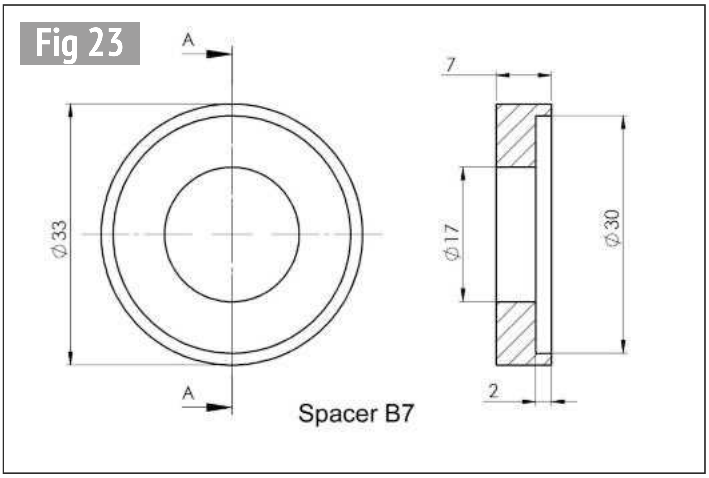


Fig 23
Spacer B7

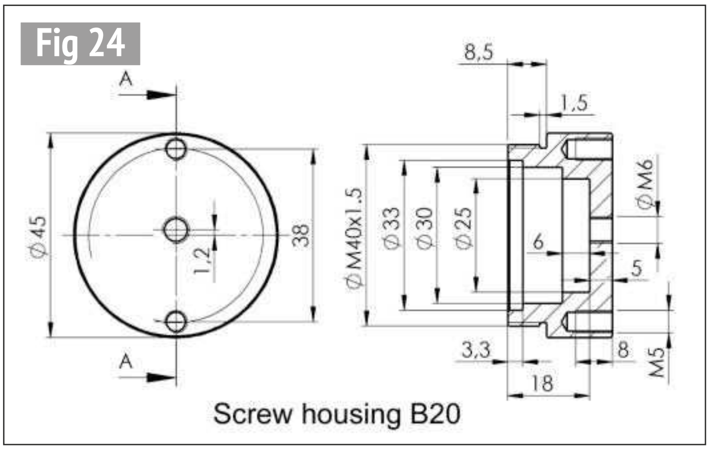


Fig 24
Screw housing B20

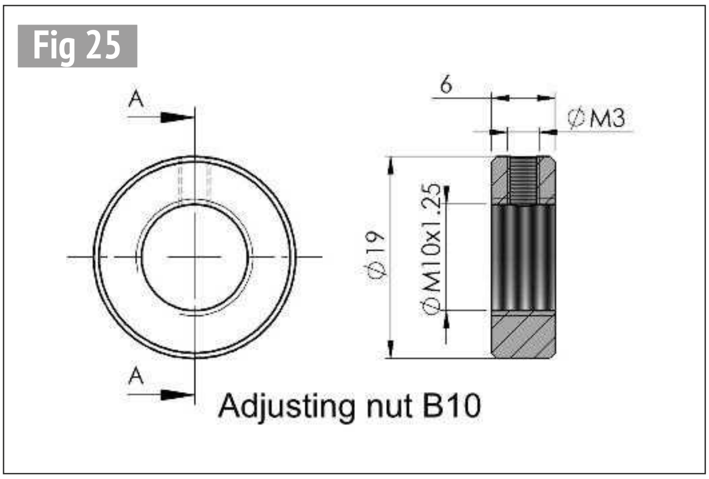


Fig 25
Adjusting nut B10

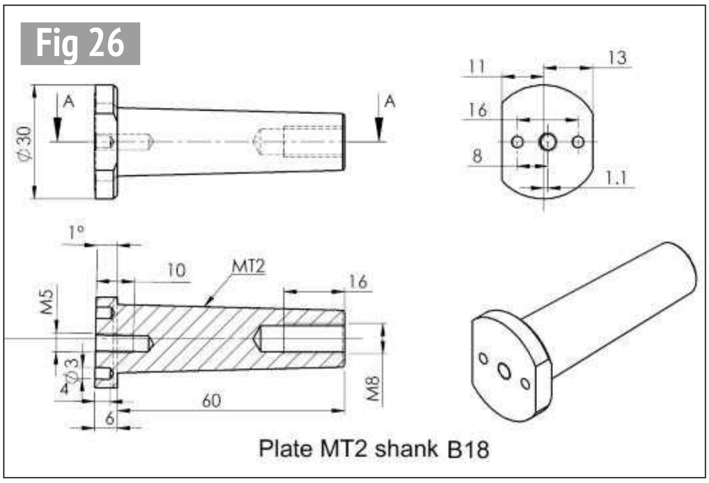


Fig 26
Plate MT2 shank B18

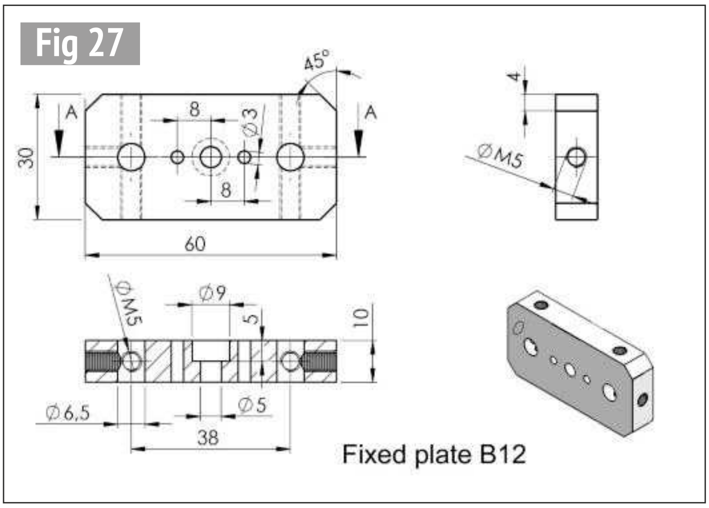


Fig 27
Fixed plate B12

***Nut housing B6* (fig 22)**
Turn all the surfaces at the same setting and part off to get the best coaxiality.

***Spacer B7* (fig 23)**
Same remark as for the part B6 - the plane surfaces must be accurately parallel.

***Screw housing B20* (fig 24)**
Same remark as for part B6.

***Adjusting nut B10* (fig 25)**
Same remark as for part B6 as the thread must be accurately perpendicular to the plane surfaces.

***Plate MT2 shank B18* (fig 26)**
Use an MT2 dividing block.
No problem for the other parts (**fig 27** and **fig 28**).

Setting up

On **B1**, set **B5**, **B7**, **B8**, **B10**, tighten **B10** by hand for no axial play and lock **B10** by tightening **B9** (put a small brass pad between **B9** and **B1** to protect the thread). Don't forget some grease for the bearings. Set the whole in **B20**, set on **B6** and tighten with a peg wrench.

No problem for the other parts.

Note about the XZN profile

This screw head profile is used by car makers (Volkswagen group mainly). I've found a useful chart on the web (**table 5**).

I machined an M12 XZN bore by indexing with an 8.2mm AF punch - **photo 25** shows the result and a M12 driving bit. I've made an M5 punch using silver steel. The machining method is as follows:

- Sharpen an end mill to get a 120 degree edge.
- After rough turning the punch cylinder diameter, go to the milling machine equipped with a dividing head. The milling spindle is tilted by 60 degrees (**photo 26**).
- Method for centring the mill edge (use a 10mm diameter FCMS part):

  * With a scribing bloc, scribe a line near the centre height on the front side (**photo 27**).
  * Turn the dividing head spindle by 180 degrees and mark another line on the back side (don't disturb the scribing block height setting).
  * Turn back the dividing head spindle by 90 degrees to set the two lines on the topside of the work (**photo 28**).
  * The mill edge is then centred between these two lines (**photo 29**).

- Tilt now by 2 degrees down the dividing head spindle to give the clearance.
- Tangent the milling cutter near the front edge of the punch blank and take 0.34mm depth of cut (0.1 x AF).
- Control the AF dimension (the caliper spanning 4 teeth) at the front edge (the punch AF must be 0.1mm bigger than the theoretical dimension for some play). The remaining depth of cut is the difference between the AF dimensions multiplied by 1.154.

A close up of the machined punch can be seen in **photo 30**. The punch is then quenched and tempered in the usual way and the front part sharpened. **Photograph 31** shows the driving bit, the machining punch and the resulting imprint in a screw head. ME

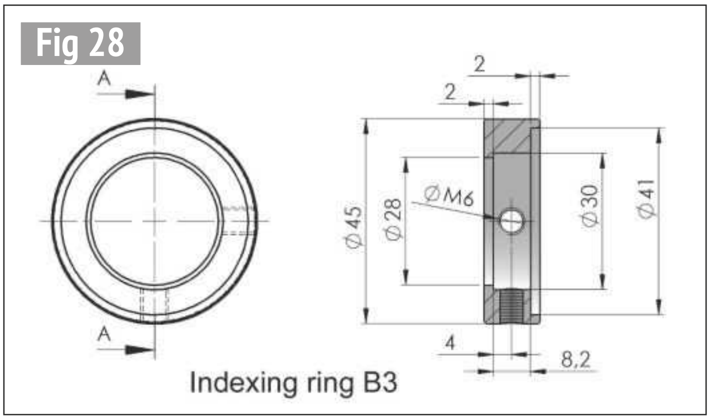
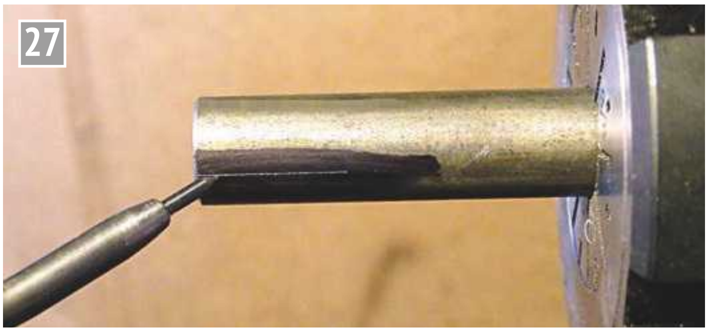


Table 5. XZN profile

XZN size	Across edges dimension	Across flats dimension
M4	3.6mm	2.54
M5	4.8	3.4
M6	6	4.24
M8	7.2	5.1
M10	9.7	6.86
M12	11.4	8.06

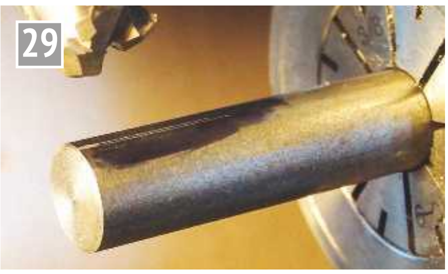
M12 XZN bore.

Milling an M5 punch.



Marking the centre height.

Both lines marked and brought to the top.



Centering the mill between the lines.

The machined punch.

The complete tool and the end result.

Steam Turbines of the LMS Locomotive 6202

PART 2 - GENERAL DESIGN OF THE FORWARD TURBINE

Mike Tilby investigates the design of the LMS turbine powered locomotive 6202.

Continued from p.16
M.E. 4667, 18 June 2021

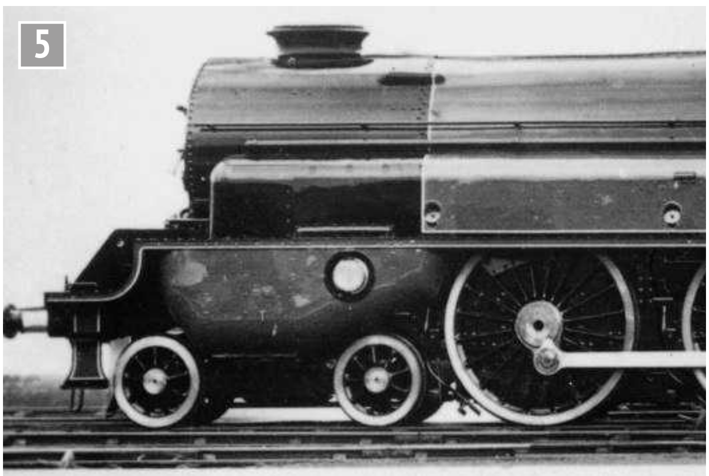
LMS No.6202 (Turbomotive) on arrival at Euston with an express from Liverpool Lime Street in c1935 (photograph: J.N. Hall/Rail Archive Stephenson at Rail-Online.co.uk).

It would be very interesting to know how the design of the turbines for LMS 6202 was developed. If Alf Lysholm was mainly responsible for the internal design my initial guess was that Guy, Stanier and Struthers were very much responsible for positioning the turbines and gearing in the places normally occupied by the cylinders, for designing how the turbines fitted into the overall plan of the locomotive and perhaps for specifying a separate reversing turbine – since this was not used in the earlier Swedish turbine locomotives. However, a document discovered more recently indicates that these aspects of the design were all due to Lysholm and his colleague, Gustav Boestad. This topic will be discussed in part 5 since it needs to be left until after the main features of the turbines have been described.

We do not know what was in the mind of Alf Lysholm and colleagues when designing the turbines for LMS 6202, although some of Lysholm's design ideas were described in a technical paper and in his patents. Description of these will also be left until later and the rest of this article focusses on the significance of various features of the design as they are generally understood in relation to other types of steam turbine.

Part 1 of this series explained that the forward turbine consisted of 17 pressure stages and was located in the position normally occupied by the cylinder on the left-hand side of the locomotive (**photo 5**). The first pressure stage was a velocity compounded impulse or Curtis stage with two velocity stages (see part 1). The remaining stages comprised a Rateau stage (**box 3**) and 15 reaction stages (**box 4**).

Velocity compounded stages generally have lower efficiencies than reaction



LMS No.6202 Turbomotive *from the left side showing the covers over the forward turbine.*

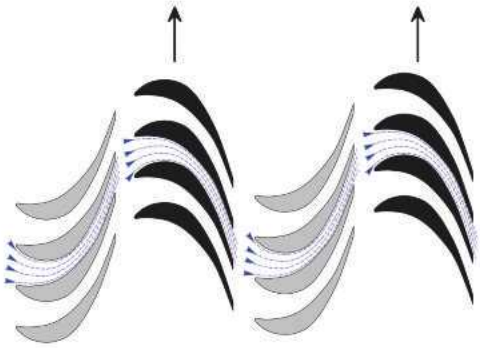
Box 3

IMPULSE (RATEAU) STAGE

The second pressure stage of the main turbine was a simple velocity stage, often referred to as a Rateau stage after the French engineer who pioneered that type of turbine (ref 16). In this stage, pressure of the steam dropped as it passed through the fixed nozzles where it was accelerated to a more modest velocity than in a Curtis stage. It then passed through a single set of rotor blades where its kinetic energy was transformed to shaft power.

Box 4

REACTION STAGE



In each of these, pressure of the steam dropped as it passed through fixed nozzles where it was accelerated to a modest velocity. It then entered between the rotor blades where its pressure dropped further as it accelerated again. As it accelerated in the rotor the reaction force on the rotor generated shaft torque directly (refs 20 and 21).

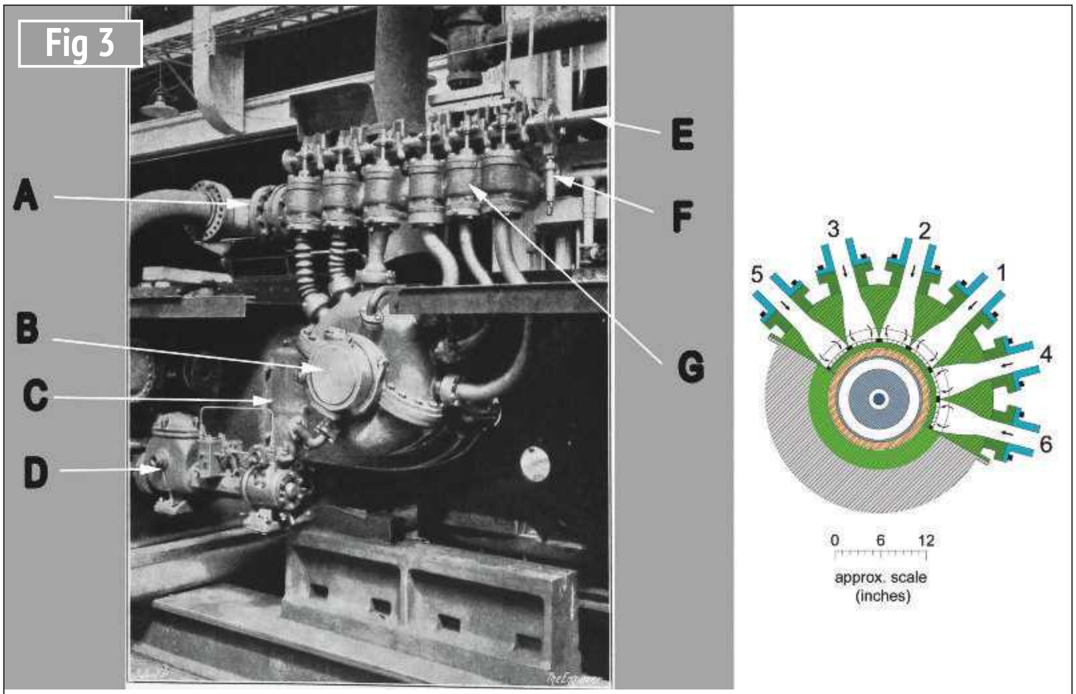
stages but that disadvantage is often balanced by several advantages. In a Curtis stage, steam undergoes a large drop in pressure and temperature. This means that the only part of the *Turbomotive* turbine that had to withstand the most extreme conditions of the inlet steam were the ducts leading to the first stage nozzles. Another benefit is that the large drop in pressure is achieved over a relatively short region of the rotor. This results in a saving of space and shorter rotors are easier to design for rigidity and balancing. Finally, and of great importance, it is possible for steam to be admitted over a small arc whereas in a reaction stage steam must be admitted all round the rotor. (For an explanation of this see **ref 16**). This makes it possible to vary the turbine power by altering the number of first stage nozzles to which steam is admitted, which is important for maximising efficiency. The reasons for this are described below.

The second stage of the forward turbine was a simple impulse stage. In this the pressure drop was smaller than in the Curtis stage but was still greater than the pressure drop that was possible for each reaction stage. This helped minimise the length of the turbine and further reduced the pressure that the rest of the turbine had to withstand.

In impulse stages there is no pressure drop across the rotor blades and so clearance between the ends of the rotor blades and the turbine casing is not critical. However, in reaction stages there is a drop in pressure as steam passes through each ring of blading on the rotor, as well as each ring of fixed blades. Therefore clearance between tips of rotor blades and casing must be minimised since it provides a leakage path for steam to by-pass the blades.

For optimum efficiency, each of the 15 reaction stages in *Turbomotive's* forward turbine could only drop the steam pressure by a smaller amount than each impulse stage. This means that more stages (and hence a longer rotor) were required compared to an equivalent rotor consisting only of impulse stages. Presumably this disadvantage, however, was balanced by the higher efficiency attainable in reaction stages. Also, there was another reason for combining reaction and impulse stages, but description of that is best left until later.

In turbines, it is important that the total cross-section area of the steam flow path is



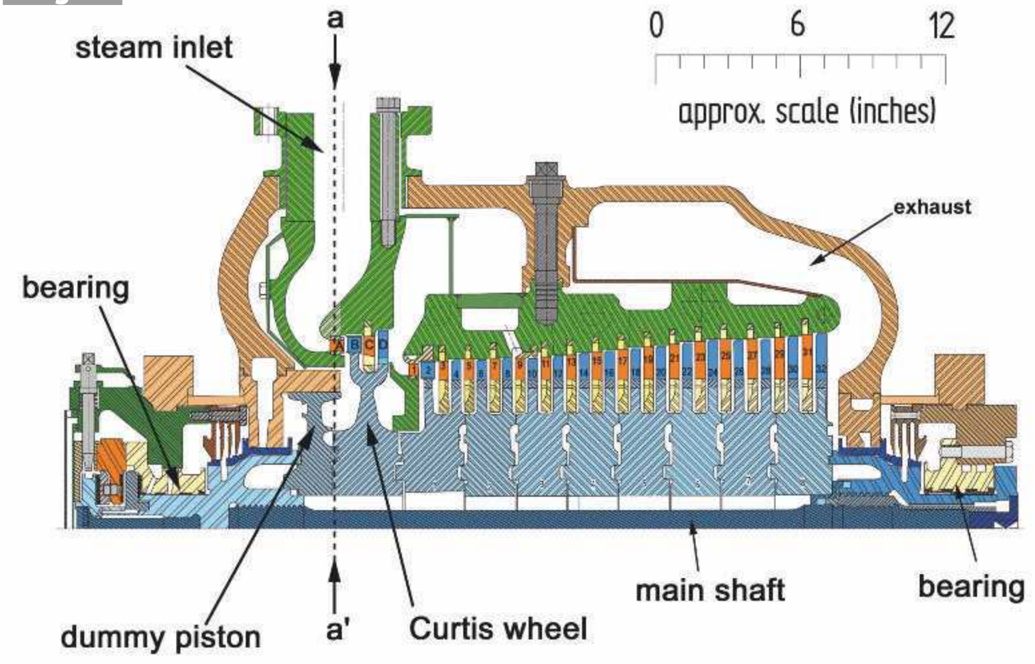
Left panel: High pressure end of forward turbine. A: Main steam inlet pipe; B: Cover over turbine bearing; C: Exhaust duct leading to smokebox.; D: Worthington Simpson reciprocating oil pump; E: Valve shaft from cab; F: Connection to be attached to valve that admitted cool steam to the turbine (to be described in article 5); G: Six main steam admission valves (adapted from ref 18).
Right panel: Diagram to show arrangement of steam inlets and the 6 groups of 1st stage nozzles in cross section through the turbine.

matched to the volume flow rate and velocity of the steam (**ref 17**).

(**eqn 1**) *Volume flow rate = flow area × velocity*

As mentioned above, in reaction stages the steam must be admitted all around the rotor. This means that, for any given rotor diameter, the flow area depends on blade length. Therefore, when the volume flow rate is small, blade length must be very short and in a reaction stage that means leakage around the blade ends is a significant fraction of the total flow. In *Turbomotive's* turbine, by the time steam reached the first reaction stage, the volume occupied by each pound of steam (i.e. its specific volume) would have increased considerably because of the pressure drops in the first two stages. Therefore the blades of the first reaction stages could be reasonably long.

Fig 4



Longitudinal section through upper half of the forward turbine of LMS 6202 (re-drawn from fig 16 of ref 20). Components coloured various shades of blue are parts of the rotor. Other colours denote components of the turbine cylinder and casing. Arrows a - a' indicate the position of the section shown in figs 3 and 5.

Size of the turbine

The only available drawing of the forward turbine carries no scale but it has been possible to make a rough estimate of its key dimensions. This was done using a drawing in **ref 18** which includes the driving wheels and also the high pressure end of the forward turbine. The diameter and gauge of the wheels are known and they provided a means to estimate the scale of the drawing. From that it was possible to estimate the diameter of the outside of the turbine casing and that was the basis upon which the scales shown in **figs 4** and **5** were derived. The maximum diameter over the rotor blades in the forward turbine is estimated to have been about 15 inches and the length of the bladed section of the rotor (i.e. excluding the thrust-resisting arrangements and journals) was about 22 inches. After conversion to a reciprocating engine No. 6202 had **four** cylinders each 16.5 inches diameter x 28 inches stroke. This illustrates the well established fact that steam turbines require much less space and weight than reciprocating cylinders of the same power output/ steam handling capacity.

Steam pathway

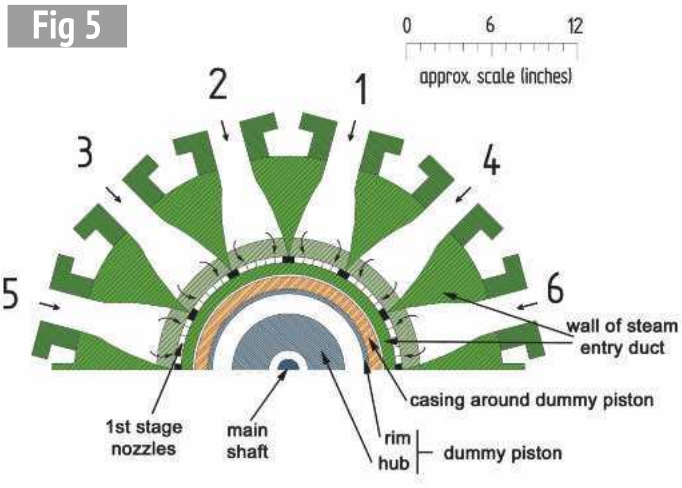
Steam was admitted to the turbine through a group of six valves, visible at **G** in **fig 3**. Each valve was connected via a curved pipe to a different set of 1st-stage nozzles as explained more fully below. The power of the turbine was controlled by the number of valves that were opened. Increasing the number of open valves increased the number of nozzles being fed with steam. This arrangement ensured that the nozzles actually in use operated at the full steam inlet pressure. Therefore, the turbine could operate at less than maximum power without any valves being only partly opened. Partial opening would have caused loss of efficiency through wire-drawing of the steam. Also, the resulting low steam pressure at the entrances to the first stage nozzles would have resulted in the steam exiting the nozzles at suboptimal velocities.

The pipe from each valve was connected to a flange on the turbine case and each of these led to an internal duct that conducted the steam to its nozzle group. The longitudinal section shown in **fig 4** passes through one of these internal ducts and all six are shown in **fig 5**. Opening of the six valves was controlled from the cab via a shaft (**E** in **fig 3**). With all the valves closed, rotating the shaft opened first valve 1 then additional valves were opened in the numbered sequence shown in figs 3 and 5. The approximate quantity of steam flow for each stage of valve opening is summarised in **table 1**. The maximum rate was about 33,000 lb/hr. As a comparison, the maximum continuous evaporative capacity of the modified LNER V2 class 2-6-2 was 30,000 lb/hr (**ref 19**, page 249). The maximum torque available when the turbine was stationary generated a locomotive tractive effort at start-up of 40,000 lb (**ref 20**, discussion).

Table 1. Approximate steam flow through the forward turbine of LMS 6202 at each stage of valve opening (data from ref 20).

Valves open	Approximate Steam Flow (lb/hr)
1	10,000
1&2	16,000
1&2&3	21,000
1&2&3&4	24,000
1&2&3&4&5	28,000
1&2&3&4&5&6	33,000

Steam turbines require much less space and weight than reciprocating cylinders of the same power output.



Cross section through upper half of the forward turbine at point a - a' in fig 4. The number and arrangement of the nozzles and the exact shapes of the steam entry ducts are conjectural.

Overview of the turbine stages

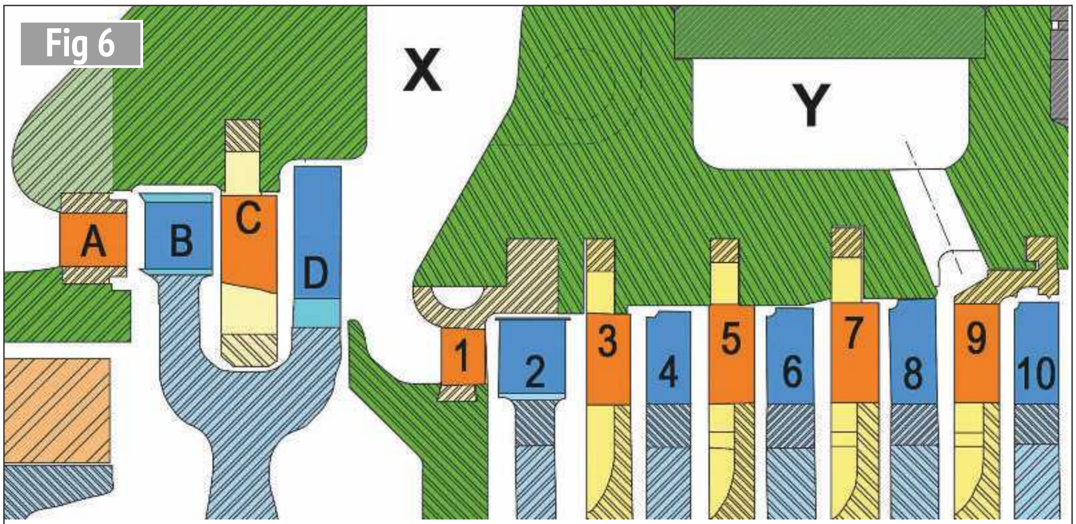
Some of the descriptions of the turbine designs provided in the two key papers published in 1935 and 1946 are imprecise. Regarding the forward turbine, *The Engineer* (1935) (ref 18) stated '*The ahead turbine has two Curtis stages and several expansion stages*'. As described in more detail below, the drawing provided by Bond (ref 20) clearly shows one Curtis wheel with two velocity stages while, overall, there were 17 different pressures stages.

Bond (ref 20, page 197) stated '*There are sixteen stages and the internal arrangement of the blading ensures maintenance of high efficiency over a wide speed range.*' The blades of the Curtis wheel are not numbered in the drawing but the fixed and moving blades in the largest section of the turbine are numbered 1 to 32. Maybe this is why Bond stated there were 16 stages rather than 17. However, in the written section of the discussion to the same paper he provided information given to him by Mr. Struthers which stated that the forward turbine '*comprises a 2-row velocity compounded stage, one impulse stage and a number of reaction stages.*' This is in perfect agreement with fig 4.

Pressure stage 1 – Curtis stage

As stated above, only one of the internal inlet ducts is visible in the section in fig 4. Similarly, only one nozzle can be shown in the section but there would have been a small number of identical nozzles forming a short arc around the turbine as illustrated in fig 5. In fig 4 all the rectangles that are coloured orange and without any cross-hatching are the blades in successive rings of static nozzles, i.e. attached to the casing. The rectangles coloured blue without any cross-hatching are blades in successive rings of blades attached to the rotor. **Figure 6** is an enlargement of part of fig 4 showing the early stages in the turbine. Upon leaving the first nozzles (labelled **A**) the high velocity steam jet passed, in turn, through the first set of rotor blades (**B**), a set of fixed blades (**C**) and then a second set of rotor blades (**D**). Blades **B** and **D** were attached to a disc that was formed as part of the main body of the rotor. The above steam path comprised a typical velocity compounded stage, commonly called a Curtis wheel. In the first set of rotor blades the steam would have imparted some of its kinetic energy to the rotor (assuming the turbine was rotating). It would then have exited those blades at a reduced but still high velocity and had its direction changed by fixed blades **C** with minimal change in absolute velocity. It was then able to enter the second set of moving blades (**D**) at the correct angle. There it imparted more of its kinetic energy to the rotor. After leaving the stage 1 nozzles (**A**) the pressure of the steam remained constant until it passed through the nozzles in next pressure stage (labelled **1** in fig 6). Nevertheless, it was necessary that the lengths of the blades increased from **A** to **D**. This was because, as the steam slowed down, a larger cross-sectional area of flow was necessary to accommodate the constant volume flow rate.

Since this pressure stage comprised two velocity stages, the blade speed for maximum efficiency was about a quarter of the velocity of the steam as

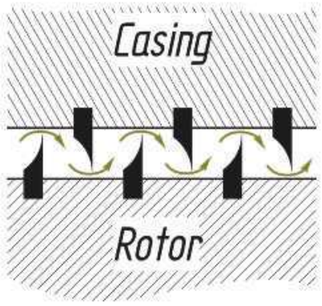


Detail from fig 4 showing nozzles and blades in the early stages. A: 1st stage nozzle, B and D: blades on the Curtis wheel; C: fixed blades; 1: nozzle for second stage; 2: impulse blade on rotor; 3, 5, 7 and 9: stationary nozzle blading for pressure stages 3 to 6; 4, 6, 8 and 10: reaction blading on rotor for stages 3 to 6. Cavities X and Y: connections for cooling steam inlet and bled steam outlet (to be described in article 5).

LABYRINTH SEALS

Box 5

These are used to minimise leakage of steam between rotating parts where high rotational speeds make it necessary to avoid any contact between the opposing surfaces. They consist of rings of thin metal attached to the rotor that alternate with similar rings attached to the casing. The clearances between rings and opposed surfaces are small but any slight rubbing will have minimal effect because the rings are thin. Steam will leak past each ring but with a series of rings the leakage rate is greatly reduced as a result of repeated wire-drawing (ref 21).



it left nozzles **A**. When 6202 was travelling at 90 mph the first stage blade velocity was about 900 ft/sec, however, as will be discussed in part 5, it seems that this Curtis-type impulse stage was designed to operate most efficiently at a much lower rotor speed than the maximum.

Upon exiting the rotor blades labelled **D**, the steam was in a chamber (labelled **X** in fig 5) which led towards the next fixed nozzles labelled **1**. The significance of this chamber will be discussed later.

Pressure stage 2 - simple impulse

The main section of the turbine consisted of 16 sets of fixed blades/ nozzles (coloured orange, odd numbers between **1** and **31** in figs 4 and 6). Each of these was followed by a set of moving blades (coloured blue, even numbers between **2** and **32**). The nozzles (labelled **1**) and all subsequent nozzles probably encircled the turbine completely, unlike the first stage nozzles. The cross-sectional area of the flow path would need to be somewhat larger than the total area of first stage nozzles because the volume per pound of steam would have increased following the substantial pressure drop in stage 1.

Blades numbered 1 and 2 have the appearance of an impulse stage because the design of the nozzles resembles that of the nozzles in stage 1. Also, the moving blade that is visible resembles the blades of the Curtis wheel, in that it appears to have a ring around the ends of the blades (i.e. a shroud ring). However, this stage was a simple impulse or Rateau stage (i.e. without velocity compounding) because a labyrinth seal (**box 5**) is shown between the rotor and the diaphragm that houses the next fixed blades. This indicates that a pressure drop occurred across this diaphragm. Thus the steam accelerated as it flowed through nozzles 1 and gave up most of its kinetic energy to moving impulse blades labelled **2**. This is all consistent with the information from Rupert Struthers and quoted by Roland Bond, as was mentioned above.

Pressure stages 3 to 17 - reaction

The drawing in ref 20 shows the presence of a labyrinth seal in the central bore of each set of fixed blades, indicating pressure drops in each case. The information provided by Mr. Struthers (ref 20) confirms that these were all reaction stages and the presence of the dummy piston (to be described in the next article) is consistent with the presence of numerous reaction stages. The available drawing indicates a very small clearance between the ends of the rotor blades and the turbine casing, as is expected for reaction stages. However, from that drawing it is not possible to make out if any special sealing arrangement was present at the blade tips, as was the case for many types of larger reaction turbines built by various manufacturers.

In these reaction stages the steam accelerated in the fixed nozzles and it then entered the moving nozzles where it accelerated further, imparting the reaction force on the rotor. Pressure dropped as steam moved towards the exhaust end of the turbine and therefore the volume occupied by each pound of steam increased. In order that the volume flow rate could increase without an excessive increase in average velocity (see eqn 1), it was necessary that the cross-section area of the flow path be increased. This was achieved by increasing the length of the fixed and rotating blades, as is apparent in fig 4.

In fig 6 it can be seen that there was a passage that connected a cavity labelled Y to the space between blades 8 and 9. The function of this will be explained in part 5.

The next article will discuss further aspects of the design of the forward turbine.

●To be continued.

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A New GWR Pannier PART 33

Doug Hewson decides that LBSC's well-known GWR pannier tank design needs a make-over.

Continued from p.751
M.E.4666, 4 June 2021

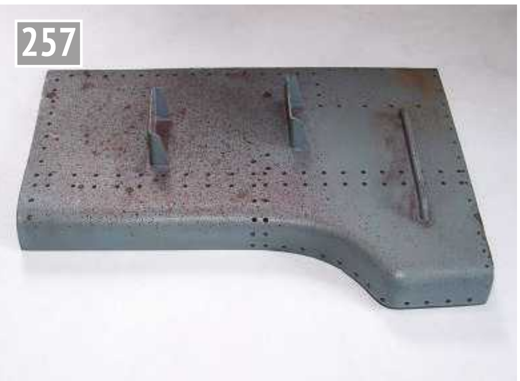
Hopefully you will have now picked up all the details of the tanks and cover plates from my drawings, so I think it must be time to introduce you to the cab and bunker. All the details for the cab are on one laser cut sheet. I am only going to describe the cabs for the 5700 and the 8750 locomotives, i.e. the 5700 with its round widows and the 8750 newer cab which has the square windows. I have had to draw out four different cabs for these locomotives as there are the two for my scale Pannier and two for the two Pansy's which are ⅜ higher to suit the overscale boiler. Just be careful when you are ordering the laser cut kits for these and specify exactly what you are looking for, that is which cab you want and which type of cab window that you want.

First of all, you will need to make two formers for the left hand and right hand bunker corners. These rear corners will just 'make' this locomotive if done properly, and you can use the same formers for all of the of these pairs of corner plates. I tried making these corners in the proper manner, by dividing the plate part way up the corner, but I had great difficulty in holding the plate properly to form the flanging. These are shown in **photo 256**. I would suggest that you just scribe a line around the corner whist the plate is still in the flat. I have now altered the plate to make it so that it can be flanged in one piece which I found so much easier to do and, what was more, I did not have any problem with kinks around the corners. **Photograph 257** shows the combined plate. As you will see I made some card mock-ups of the bunker plates for the 8750 Class to make sure that everything went together properly. There is a ⅜ inch wide strip which Frank had to insert into the cab sides to lift the roof to fit the overscale boiler but, as mentioned, I have now drawn up a new set of plates for Pansy to accommodate this. They should be available from G & S Supplies and The Steam Workshop.

My mock-up photos are shown in **photos 258** and **259** and then the real things are shown on Frank's locomotive in **photo 260**. In the laser cut set of parts you will also find the two steps which fit on the slots. They should work by forming then over a 20mm former. There are also some vertical stiffeners to fix on the back of the bunker and they need riveting on. The other thing which needs doing is to rivet on two more of those lifting rings which are inside the bunker on both sides. They are very similar to the rings for lifting the tanks. One thing I forgot to show on the drawing is the fire iron rack which is riveted to

256

Bunker flanging plates.

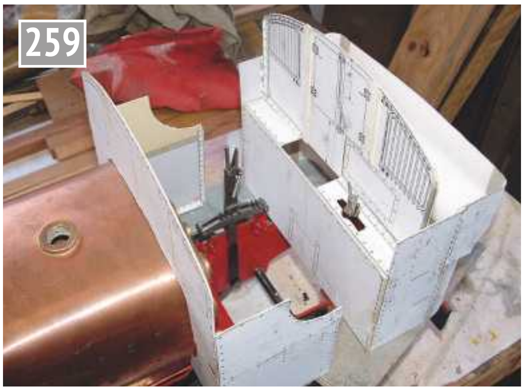


257

A one-piece flanged plate for the bunker.

258

Bunker mock-up - exterior.



259

Bunker mock-up - interior.

260

The finished article (later style of cab and bunker).

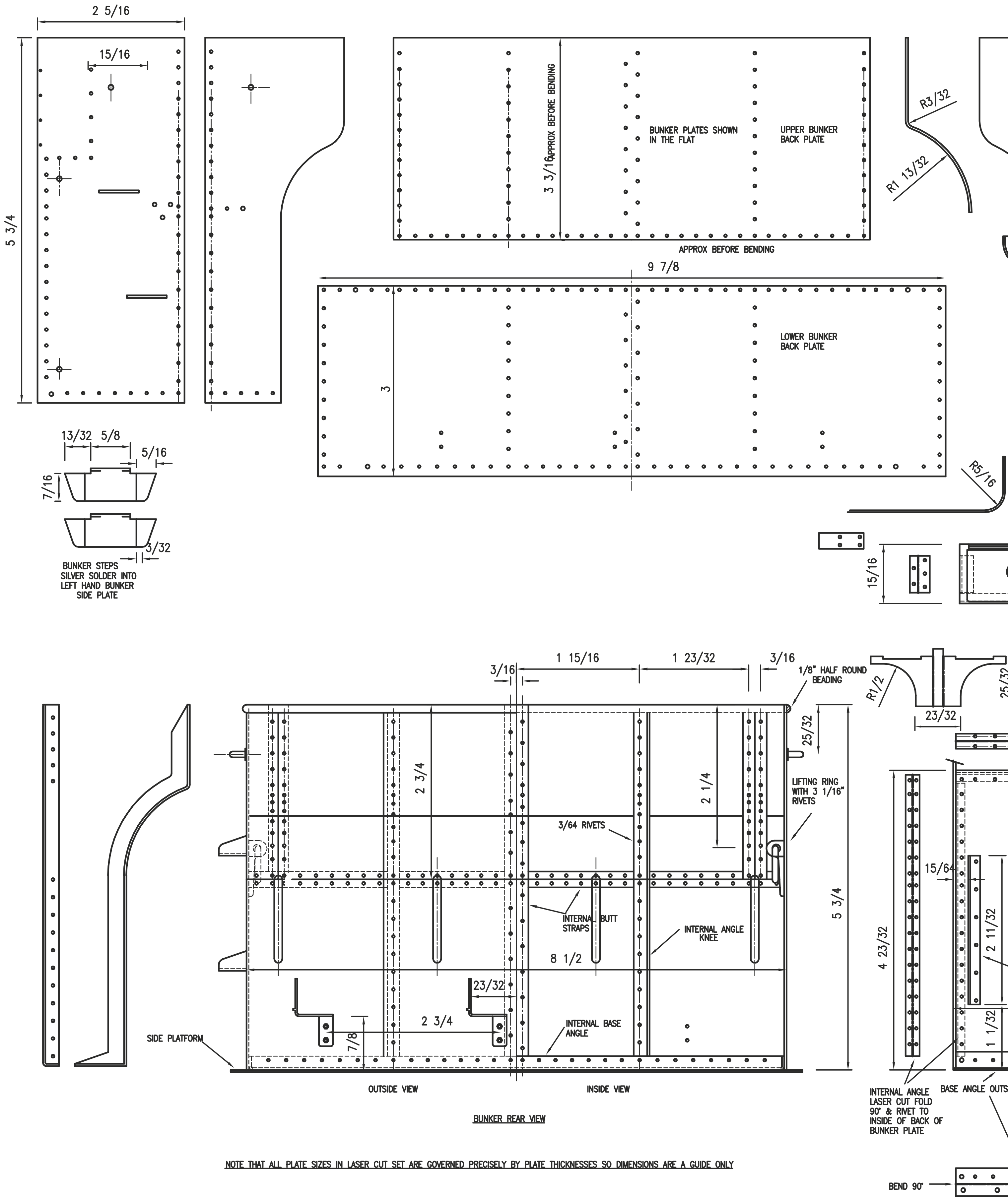
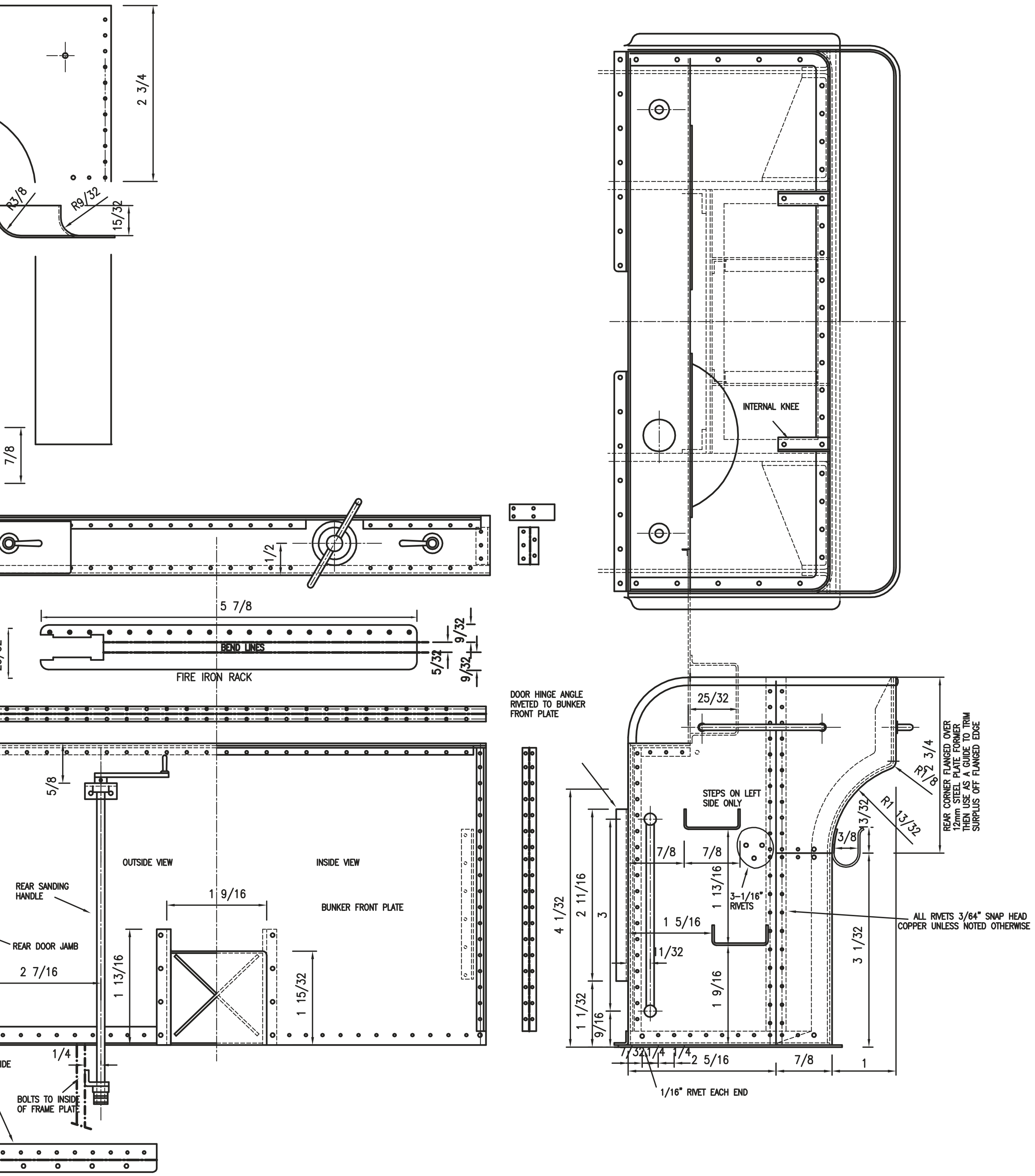

2 5/16
15/16
5 3/4
APPROX BEFORE BENDING
3 3/16
BUNKER PLATES SHOWN IN THE FLAT
UPPER BUNKER BACK PLATE
APPROX BEFORE BENDING
9 7/8
R3/32
R1 13/32
LOWER BUNKER BACK PLATE
3
R5/16
13/32
5/8
5/16
7/16
3/32
BUNKER STEPS SILVER SOLDER INTO LEFT HAND BUNKER SIDE PLATE
15/16
3/16
1 15/16
1 23/32
3/16
1/8" HALF ROUND BEADING
R1/2
23/32
25/32
2 3/4
2 1/4
LIFTING RING WITH 3 1/16" RIVETS
3/64 RIVETS
INTERNAL BUTT STRAPS
INTERNAL ANGLE KNEE
8 1/2
5 3/4
15/64
4 23/32
2 11/32
1 1/32
23/32
2 3/4
7/8
SIDE PLATFORM
INTERNAL BASE ANGLE
OUTSIDE VIEW
INSIDE VIEW
BUNKER REAR VIEW
INTERNAL ANGLE LASER CUT FOLD 90° & RIVET TO INSIDE OF BACK OF BUNKER PLATE
BASE ANGLE OUTS
NOTE THAT ALL PLATE SIZES IN LASER CUT SET ARE GOVERNED PRECISELY BY PLATE THICKNESSES SO DIMENSIONS ARE A GUIDE ONLY
BEND 90°

Fig 55


INTERNAL KNEE
FIRE IRON RACK
BEND LINES
DOOR HINGE ANGLE RIVETED TO BUNKER FRONT PLATE
OUTSIDE VIEW
INSIDE VIEW
REAR SANDING HANDLE
BUNKER FRONT PLATE
REAR DOOR JAMB
BOLTS TO INSIDE OF FRAME PLATE
STEPS ON LEFT SIDE ONLY
3-1/16" RIVETS
ALL RIVETS 3/64" SNAP HEAD COPPER UNLESS NOTED OTHERWISE
REAR CORNER FLANGED OVER 12mm STEEL PLATE FORMER THEN USE AS A GUIDE TO TRIM SURPLUS OFF FLANGED EDGE
1/16" RIVET EACH END
5 7/8
2 3/4
R3/8
R9/32
15/32
7/8
1/2
9/32
5/32
5/8
1 9/16
2 7/16
1 13/16
1 15/32
1/4
25/32
R1
13/32
3/8
4 1/32
2 11/16
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1 5/16
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1 9/16
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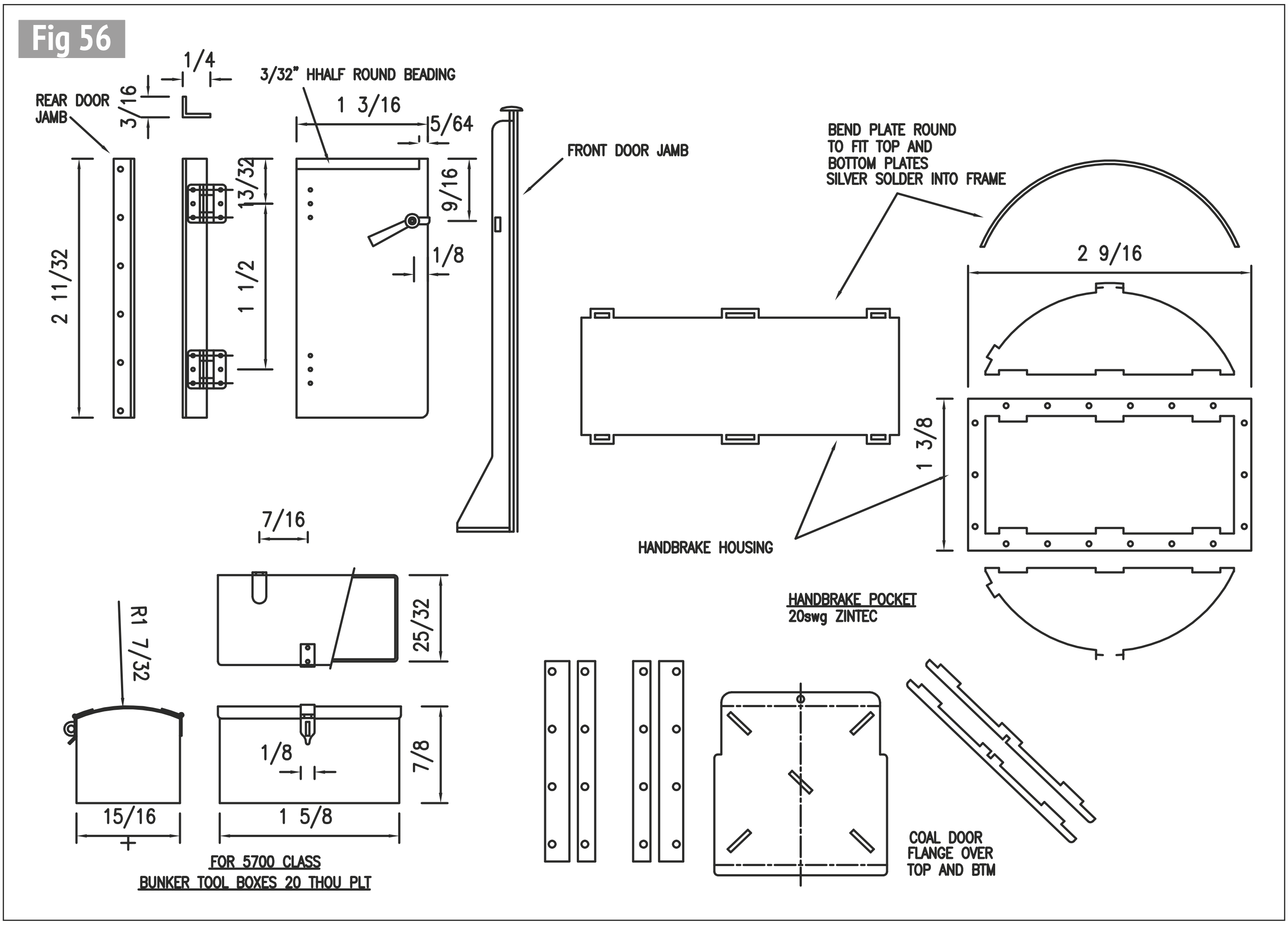
3 1/32
7/32
2 5/16
1



Right-hand end of the fire iron rack.

Left-hand end of the fire iron rack.

Rear view of the earlier style of cab and bunker.

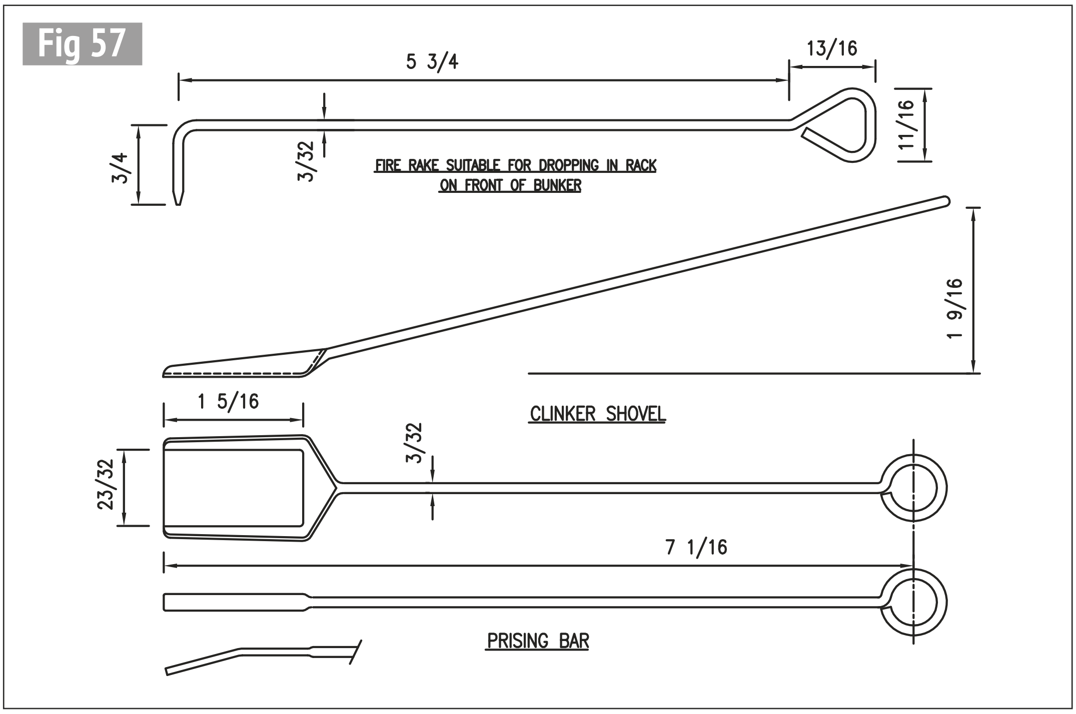
Firing iron racks on the rear of the bunker.

the front of the bunker inside the cab. Its purpose is so the fireman can drop his poker into the trough whist it is still hot and it is well protected. **Photographs 261** and **262** show both ends of this (I couldn't get everything in one photo). I have included the firing tool rack in the laser cut kit and on the drawing. I have also drawn up for you a set of suitable firing irons for the job (**fig 57**). They include the aforementioned one which drops in the rack at the front of the bunker and I am sure that you will also want some to adorn the racks on the back of the bunker. One of the others is a clinker shovel and the final one is a prising bar which is made for breaking up the clinker. Now, I was told that all these different firing irons had to have different shaped handles (this is so that you can distinguish which is which in the dark, which must be very important when firing a tender engine, especially

Internal bunker stay.

Cab door.

Coal door.



Hand brake cover on the earlier cab.

when they are stored in the fire iron tunnel on the tender!) but I don't know whether this applies to the pannier tanks; I can't see why not! Anyway, back to the plot … **photograph 263** shows the rear bunker of a 5700 and **photo 264** shows the four racks on the back of the bunker; they are doubled back on themselves and then have a tail sticking down with a couple of snaphead rivets in them.

Photograph 265 shows a stay across the bunker and also the angle stiffeners which are riveted inside. **Photograph 266** is the cab door with its dolls house type hinges and what I can only think is a split brass tube across the top, and **photo 267** is the coal door which needs a bit bending over at 90 degrees top and bottom and this also needs a cross of 16 swg steel silver soldering on the front. There is one more piece to make and that is the hand brake cover and looking at **photo 268** you will see that it has a notch out of in at the top left hand corner just to miss the window. I will try to show the bunker of the 8750 Class in the next instalment.

●To be continued.

NEXT ISSUE

Ballaarat

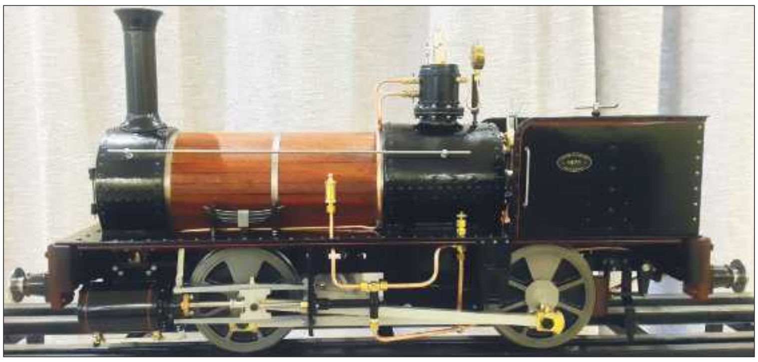
Luker introduces a small 5 inch gauge locomotive, true to prototype but suitable for a beginner.

Wash Monster

Noel Shelley says "If you thought a WWII DUKW amphibious landing craft was big, just wait until you see one of these!"

Parklands Railway

Brian Baker looks back at this year's Parklands Railway Week in Hemsby, near Great Yarmouth.



Content may be subject to change.

ON SALE 16 JULY 2021

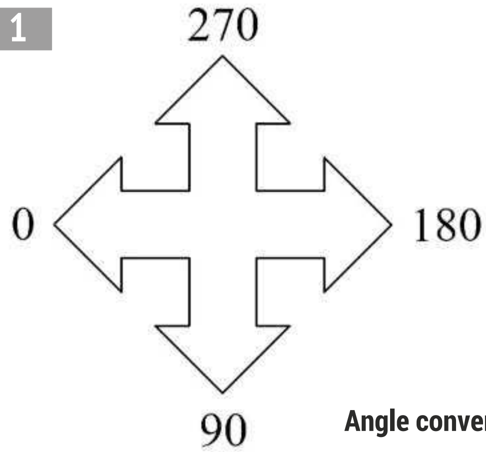
Machining a Curved surface using a DRO

Robert Walker makes good use of the facilities offered by his digital read-out.

Introduction

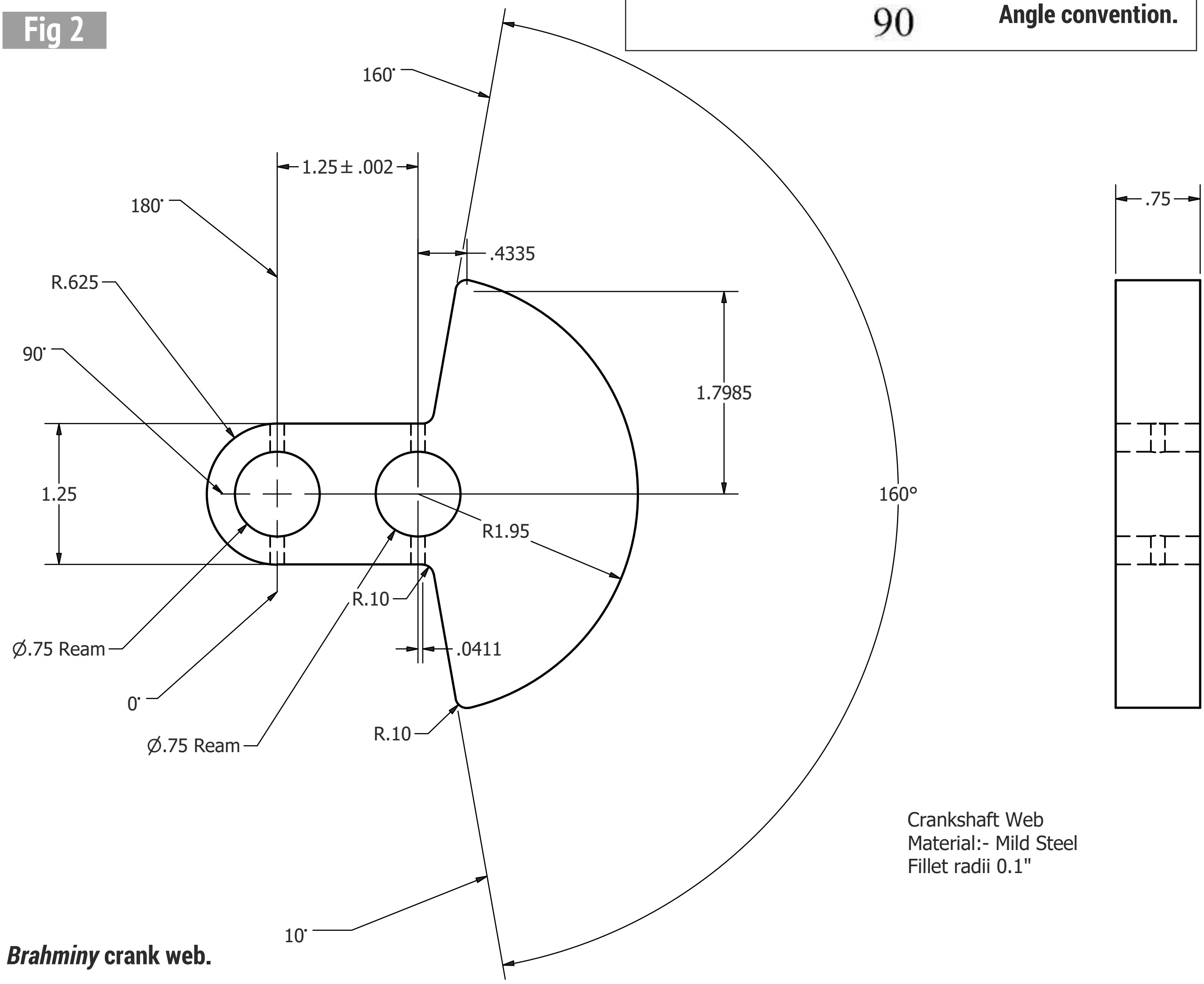
A number of articles in the *Model Engineer* mention using a Digital Read Out (DRO) to drill complex hole patterns but none suggest using the feature for milling a curve on the work piece. My DRO is a fairly basic model retro fitted to my Myford VMC and I have now used it a few times to generate a curved surface on a part. It does have a few eccentricities that

Fig 1



Angle convention.

Fig 2



***Brahminy* crank web.**

need to be taken into account when setting up but with some experimentation these can be overcome.

My method of checking is to mark out the component and then run through the program with the tool stationary, above the work (without cutting metal) all the time making sure that the tool is roughly where it should be in that program. My theory is if a program or CNC code looks roughly right it is probably accurate. If it is not right it will be completely obvious.

The method of operation is this. The DRO calculates a series of points on the curve and you move the slides, in my case X and Y, until the display shows X0, Y0 and then take the cut. You then call the next co-ordinates and again move to X0, Y0, repeating until the end of the program is indicated on the display. The finished part has a series of small cusps that can be finished with a file.

It is a long process so patience is essential and plenty of time is needed to ensure the job is not rushed. I think the idea is that the tool remains in cut while moving the slides but this has a high risk of an error that can result in a scrap part. I move the X and Y to the new position with the tool retracted and use the quill to take the cut – the cut is only a few thou! If the first cut is into solid metal, then the table feed may be best as it is more rigid and a pilot hole reduces the stress on the machine. Once you have a start the quill can be used as it is faster and not such hard work.

Setting up

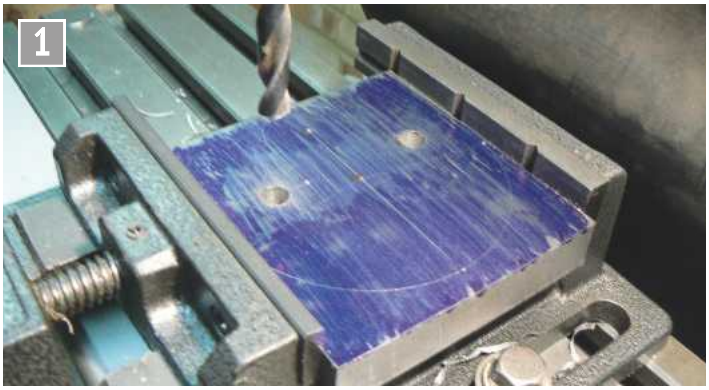
First, clarify what you want to do e.g. start angle, finish angle, radius to be cut, its centre and size of tool. Also - is the tool inside (R-) or more often outside (R+) the curve.

On my DRO the angles are defined as shown in **fig 1**. Yours may be different so this will be your first of many experiments. Also, mine works (mostly) from low to high i.e. anticlockwise but sometimes it does not and what I had to do was start the curve at 90.1 degrees and end at 269.9 degrees passing through 180 degrees as I required. The 0.1 degree error is soon taken off with a file.

The next eccentricity was defining the radius centre according to the manual. You should be able to define the centre X and Y position at any point - but not on mine! I move the slides to the centre point and zero X and Y at that point and it is then happy.

Example 1

My first example is the crank web for the steam engine *Brahminy*, as described in *Model Engineer* from M.E.4554 to M.E.4564. (To see the engine in use search for 'Steam Launch Brahminy' on YouTube). The drawing of the crank web is shown in **fig 2**. As can be seen, four radii must be machined - one 1.95 inches, the second 0.625 inch and then the two 0.1 inch radii at the end of the balance weights. **Photograph 1** shows two slave holes drilled in the marked out blank. The slave holes are used to bolt the



Marked out blank and two holes drilled.

Setting up the blanks - two required.

blanks to the milling machine table (**photo 2**).

The setting to machine the 1.95 inch radius for mine was:

* Ensure machine is set to correct units – inches in this case
* Move to centre point of radius and zero X and Y
* Select radius function on DRO
* Select X-Y plane
* Centre position X0, Y0
* Radius to cut 1.95 inches
* Tool diameter 0.5 inch
* Maximum cut 0.005 inch
* Start angle 10 degrees
* End angle 160 degrees
* R+ machining outside of radius.

The DRO (**photo 3**) will then display the calculated start point so move the slides until X = 0 and Y = 0. On mine I use the down cursor key to display the next point to be machined. So, before starting, press the down arrow a number of times and move to X = 0 and Y = 0 and check that the tool is where it should be each time and that is hasn't gone to some point known only unto itself – not where you think it should.

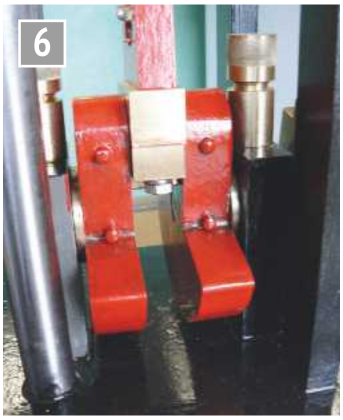
The key point when machining a complex part, as shown in **photos 4** and **5** is knowing where the current centre point is in relation to

My DRO.

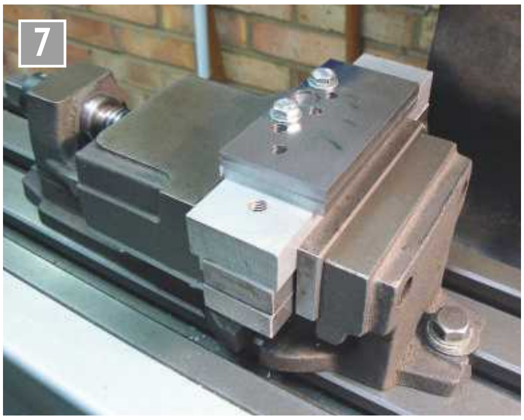
Radii machined and the two 0.75mm holes bored and two small holes for corner fillets.

Semi-finished blank, prior to cutting out on the bandsaw.

>>



Completed crankshaft assembled into the engine.



The two links in their simple fixture.

The finished curved slot.

the next centre point in the machining sequence. In this case two on these centres coincide with the two 0.75 inch diameter holes that need to be bored. **Photograph 6** shows the end result of the exercise.

Example 2

My next example is a pair of reversing links for a Stephenson's valve gear for a 3 inch scale steam wagon to my own freelance design.

Figure 3 shows the outline of the link and a simplified drawing to enable me to drill the holes, plus two holes for the corner fillets. A 0.5 inch slave hole was also drilled in a known position to use with the corner finder so that I could move the slides to the radii centres.

All the radii machined.

The right-hand link finished and the left-hand after machining. As can be seen the ends of the slots have not been finished yet - a job for a rainy day.

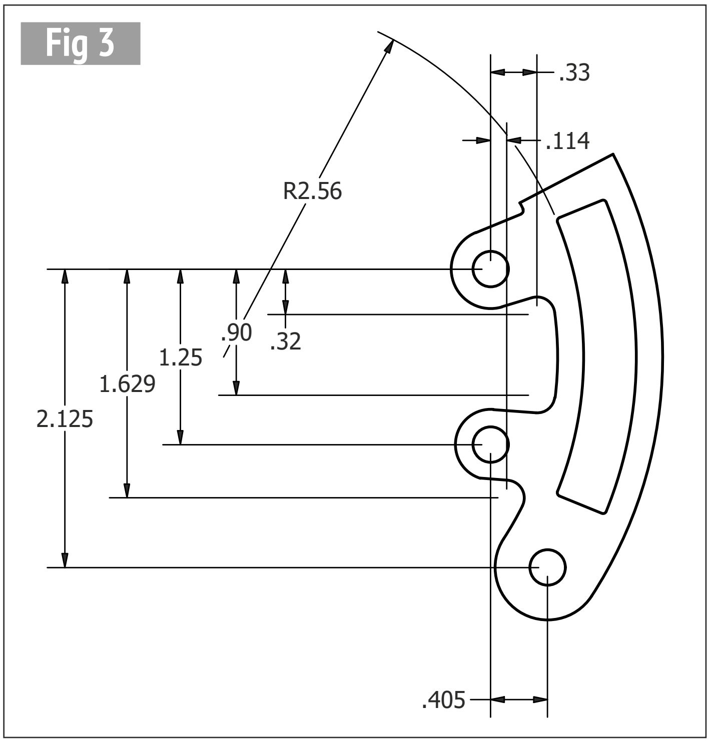


Fig 3

Photograph 7 shows the pair of reversing links in their fixture with the holes drilled ready to machine the radii.

When producing a slot with flat ends you must take account of the cutter radius when defining the start and end angle. A bit of trigonometry is required! The inside radius of the slot was 2.56 inches, the tool was 0.5 inch diameter and the cut was 0.010 inch. The tool was programmed to be outside the 2.56 inch radius, the start angle was calculated to 157.5 degrees and the end angle 197 degrees. The first cut was taken by feeding the table into the tool but all subsequent cuts of 0.01 inch were made with the quill.

A similar set of set of plans was calculated for each cut until all the radii around the three small holes were completed, as shown in **photo 9**.

The angle at the top of the drawing was then milled and lastly the radii were blended in. The only complication with the radii around the bolt holes securing the part to the fixture was its inability to pass through zero degrees so I had to machine from 320 degrees and end at 359.5 degrees, for example. Then I restarted the rest of the radius at 0.5 degrees, hence one of the blends had to be filed.

As can be seen the ends of the slots have not been finished yet; a job for a rainy day.

Conclusion

I hope this will encourage readers to take advantage of the facilities of their DRO - as they have paid for them. The key thing to ensure success is good planning, to lay out the data required in the order it needs to input into your controller and to check that it is generating the path you want before you start cutting metal. You also need to ensure that the tool is not too big and doesn't machine areas that you do not want to machine. If you are not using CAD and making small parts you may need to make an enlarged drawing to find all the start and end angles. I also found that it is helpful to drill pilot holes at the starting point. I used a 0.25 drill as the pilot and it made the initial cut a lot less stressful for the mill. ME

Luker spotlights one of South Africa's leading model engineers.

Tea in Peter's kitchen.

Master Builders of South Africa
Peter Batistich

Some background

South Africa has its fair share of problems and keeping a hobby like model engineering going can be challenging to say the least. The biggest problem is availability of items needed to build any fine model. Even stainless steel balls for clacks cannot be found locally for love nor money. The lack of resources can often lead to despair with most builders throwing in the towel, but some persist, finding innovative ways to tackle the problems and finish that illusive 'perfect model'.

I pitched the idea, to our esteemed editor, of a few articles showcasing some of the master builders here in South Africa and how they've managed to overcome insurmountable odds and build just astonishing models.

The guidelines were simple; each builder needed to have built at least five working steam-driven engines. With the average 5 inch gauge locomotive taking roughly 5000 hours to build, and Malcolm Gladwell's rule of 10000 hours to master a task, this results in a high level of mastery with a 'safety factor' of 2.5. Each article would showcase the unique aspects of how they tackle a build. The articles would be more of a 'this is possible' than a 'how to do it' simply because pictures would be a problem; some of the builders built their locomotives before cameras had batteries (and they were more likely to spend the money on tooling anyway).

My visits were sneaky, not allowing any time to clean the workshop. I did this because a cluttered workshop is a sign of genius and some builders are virtuosos! Most builders here are incredibly humble and generally shy away from any form of praise, which makes telling their stories a delicate endeavour. Then, of course, condensing decades of passion into a few pages is a daunting and challenging task, one which I'm personally looking forward to. In the end it's unlikely I can do these fine builders the justice they deserve.

Uncle Peter: the man

Visiting Peter Bat-ist-ich (hyphened for phonetic pronunciation) is a simple matter of jumping onto my bicycle and riding along a bandit infested river path; dodging taxis up and down a few hilly roads and then I'm at his front door with a little spinach and some carrots (from my garden) as enticement for the opportunity to tell his story. Peter boils the kettle for a cup of Rooibos tea while I pat Marley, his best friend (a large Labrador), and take out some of the articles I have written for *Model Engineer*, for him to have a look at.

The kitchen cabinet tops are lined with steam paraphernalia including stationary steam engines, cannons and numerous SAR pressure gauges (**photo 1**). While sipping on the Rooibos with shortbread biscuits on hand, Peter tells me how his amazing model engineering journey started when he was an apprentice working at a firm where Ron Etter, a famous model engineer, was his manager. In those days the trade test required three years of hands-on work, which allowed more than enough time for Peter to learn from one of the old masters, who was also kind enough to supply some of the rough components for his very first locomotive.

It seemed as though in those days, there was time to do the odd side job for the locomotives being built at home. One of the more interesting items that was made in company time was a mechanical roller to make the chequered plating for steps or running boards (**photo 2**).

Peter has been involved at the Rand Society of Model Engineers (RSME) since before they were at the current site. Not only was he involved with the development of the club to what it is today - Peter's locomotives were passenger haulers, generating much needed income for the club, allowing it to expand and grow to the proud establishment it is today. He also allowed the youngsters to drive his locomotives, giving them a feel for the hobby and of course generating interest for the next generation. Peter tells me that of his four kids and grandkids none are particularly interested in getting down and dirty in the workshop but all enjoy taking his fine locomotives around the track (and allowing their dad to do the cleaning up afterwards!).

By this time the biscuits were down the hatch and the tea was finished. I asked if I could take a few pictures of his locomotives and workshop. Peter swiftly called one of the apprentices he is imparting his knowledge to to uncover the locomotives for a few pictures.

Specially rolled chequer plate.

He was quick to point out that he makes his locomotives to work; they're not showpieces and most of them have hauled hundreds of passengers hundreds of times around the RSME track; oh, and that he hates painting! I had of course seen his locomotives and knew there was no need for the forewarning; the locomotives are fine models that anyone would be proud of.

So off we went to the shed where the locomotives are kept and the workshop, with faithful Marley in tow.

Uncle Peter's locomotives

Peter has been collecting all manner of items for a long time, with a Jeep, beach buggy, machines and all sorts of treasures collected for possible use in the near future.

To picture all the locomotives would require considerable re-sorting and unpacking of the treasure collection but luckily for me the three locomotives which were at the edge of the pile were the locomotives of particular interest. Sadly, the locomotives have gathered a little dust and haven't run for over 6 years but even with the layer of 'time' covering them it was clear the painting was good and after all these years they are still handsome engines.

Peter and two other gentlemen, Frank Mundel (sadly no longer with us) and Bill Mitchell, combined forces when building their locomotives to decrease build time and cost. The division of labour was fluid but generally Peter made all the components (enough for three locomotives), Frank did the fabricating and silver soldering (he was a refrigeration technician, masterful with soldering), and Bill did the assembly. The boilers were made by both Frank and Peter. An interesting way to make locomotives at an alarmingly quick rate.

Royon, an 0-6-2 tank engine (**photo 3**) sports green-lining with the livery and side tanks painted a golden colour beautifully contrasting with the black boiler, fittings and chimney. No castings were used when constructing these locomotives, in fact other than the Sweet Pea's wheels most of the components were

Master builder specifications

	Measure	Reference
Full name of builder	Peter Batistich	
Year of birth	1938	83 young
Year of starting ME	1954	As an apprentice under Ron Etter
Number of builds	10	
Favourite build	'Love them all'	
Most difficult build	A modified 0-6-0 saddle tank sweet pea.	Originally this locomotive was made with a steel boiler but ended up being a poor steamer. Was later changed to a copper boiler.
Longest build	7 years	'Needed to make money to survive'
Shortest build	1 year	
Occupation	Master machinist	Mostly specialised private work

Royon, *an 0-6-2 tank locomotive.*

Royon's *built up sander.*

fabricated, rolled, machined and beaten into shape due to the exorbitant cost of castings here in South Africa. The sanding box, for example (**photo 4**), is a combination of a rolled 'washer' welded to a piece of pipe with the top cap hammered into shape over a mandrel and welded to the bottom assembly. The beading is soldered to the bottom 'washer' and any excess material is cleaned up to give the look of a uniform, neat part. All the cylinders were machined from standard cast iron bar, with the flange bosses and rounded sections machined using a rotary table. The safety valve cover of *Spick* required a lofted bottom section to match the boiler. The gradual blending of the curves was done by 'hacking away' (Peter's words) with an abrasive cutter on a hand drill. Not a trivial task to be sure!

The **Super Sweet Pea** (**photo 5**) is a variation on the more common Sweet Pea having a six-coupled wheel arrangement rather than the more common four-coupled wheel configuration. This little locomotive is apparently an incredible hauler, which I can believe. All that additional weight with the longer boiler and saddle tank is well used with the additional coupled wheel set for traction. The Hackworth gear and all the plumbing makes for an interesting looking model – and easy to work on because everything is accessible. The chimney is another example of a rolled and fabricated assembly with a machined brass cap that will look superb when all polished up (**photo 6**). Peter tells me this was one of his favourite models to run with the controls easily accessible with the open cab.

Super Sweet Pea 0-6-0 saddle tank.

Super Sweet Pea's built-up chimney.

Spick, *an 0-4-2 tank engine.*

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Spick (**photo 7**) and ***Span*** were two of Peter's last locomotives to run on the RSME track. Some of the detail is shown in the photographs including the filler cap (**photo 8**) and the large spark arrestor type chimney (**photo 9**).

One thing I noticed on all the locomotives is the numerous oiling points, with most of them properly capped or with the oil-hole hidden behind a sprung ball to keep the dust out. Each and every sliding surface or bearing had one of these oiling points, and even though the sliders were now rather dusty and the locomotives had done their fair share of work these sliding surfaces looked incredibly good.

All Peter's locomotives were heavy passenger haulers generating much needed funds, but Peter admits that in retrospect having only the larger locomotives made loading and unloading a chore as the years unfolded - even with all of the locomotives on dedicated wheeled frames for easier movement.

Uncle Peter's workshop

Peter's workshop is the workshop equivalent of a cluttered desk but he knows where each tool is and most of the machines have a specific set-up for some commercial machining job he is busy with to finance the next build. He likes to say the workshop is to be used; it's not for show! There are more specialised tools in that one workshop than I thought existed. I suppose that's one of the joys of collecting those prized tools for more decades than I have been on this planet! The workshop, at first glance, looks cluttered but there was no swarf lying around with the chip trays filled with all manner of cutting tools and hand tools. Unfortunately, there is very little space for storage with the machines and tooling taking every inch of wall space.

The two photos are stitched (16 photos in total) panoramic views of the small workshop which is roughly the size of a small bedroom. One view is of the left-hand side (**photo**

Spick's *filler cap.*

10) when walking in through the door and the other, the right-hand side (**photo 11**). The lathes are standard 1m tool room lathes, with just one person filling up the available standing space.

Peter tells me that when he's busy with a job Marley lies in the doorway waiting for the next friendly pat and he wouldn't have it any other way! Incidentally Marley seems to have an affinity for all technical people, enjoying the apprentice's company as well. He must be a good judge of character.

Special thanks to Uncle Peter

I have been fortunate enough to visit Peter on a few occasions; he's always happy to stop what he's busy with to make a cup of tea at short notice (I normally give him a call to ask if I can pop round and if I get the green light I jump on my bicycle and I'm on my way). Speaking to the

Spick's *built up chimney*

wiser generation is something I have enjoyed from a very young age, especially when they are willing to impart years of hard-earned knowledge, and Peter is no exception. I cannot thank Peter enough for setting some time aside for this article and of course all the other visits.

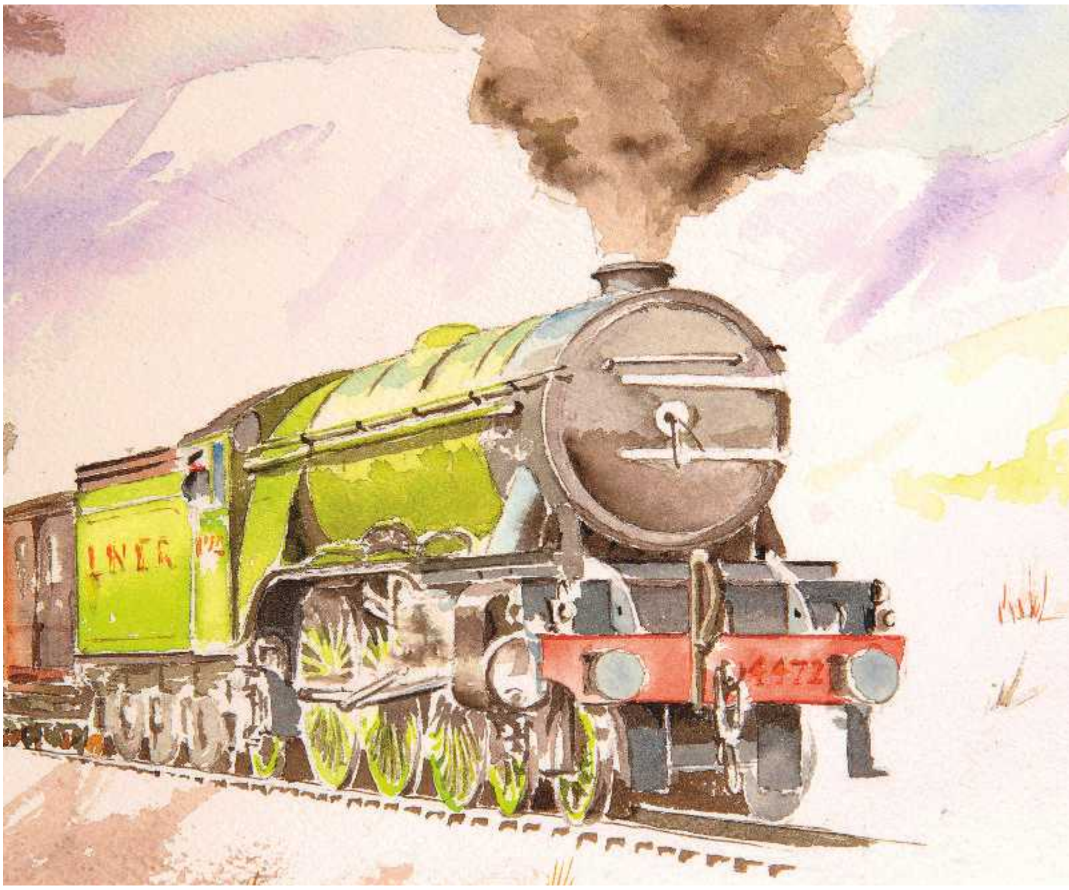
ME

Left-hand side of Peter's workshop.

Right-hand side of Peter's workshop.

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

Continued from p.26
M.E. 4667, 18 June 2021



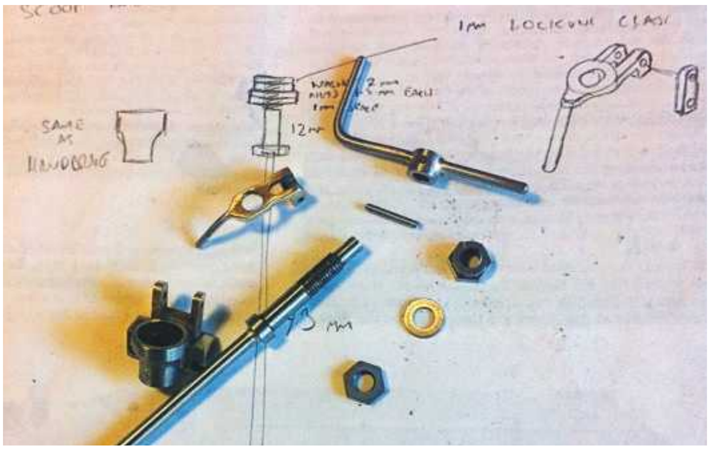
Painting by Diane Carney.

PART 13 - ADDING DETAIL TO THE TENDER

Flying Scotsman in 5 Inch Gauge

We go back to the tender now to add a few details and to paint a lot of the small, fiddly parts.

We'll start with the scoop. I mentioned previously that the scoop has been left off for safety reasons but the apparatus that operates it is a very distinct part of the tender coal wall and thus important to include.



1. Here I have broken down into component form the various parts that make up the scoop handle. They consist of, spindle, bearing housing that includes the bracket for the locking pin, washer (no PTFE bush needed here) two locking nuts (one with collar), locking pin clasp and finally the handle.

2. This picture shows the various handles fitted. At this point I still had work to do underneath so hadn't refitted the wooden base yet in this picture - this would be the new wooden base with the planking oriented correctly.

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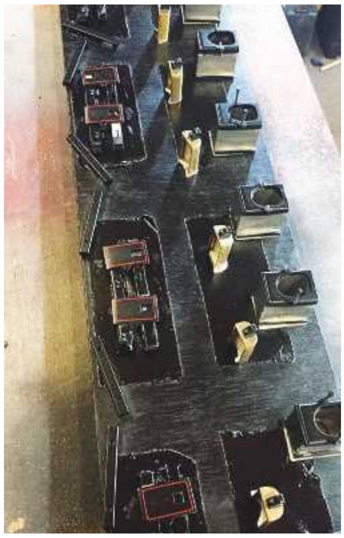
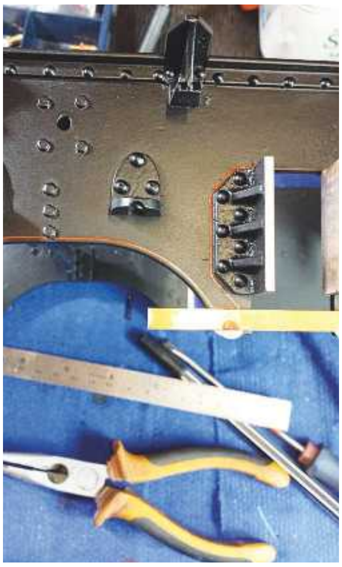
3. Here is the spacing adaptor I made for my 'Bob Moore' lining pen.

4. Here are the spring holders - for these I used my modified 'Bob Moore' pen.



5. Next were the axlebox covers - these were done again using the pen but this time using a template as the guide.



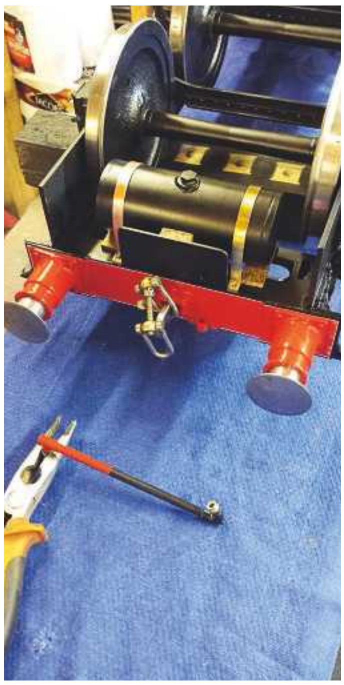
6. Here I have completed the first stage of lining the vermilion on the chassis, showing how the lines can vary at this stage of the process. What I have learnt though is that after the paint has settled and dried it looks a lot more even, so I leave it till then and use a small brush to sort out any bad parts. Also, before the paint dries I use a cotton bud or tooth pick soaked in white spirit to remove any unwanted paint.

7. Things seen here are beginning to look the part, I was amazed at how long it took me to get the spring gear back on the chassis.

Painting and lining

I then took a look at how I was going to tackle the lining for the chassis and decided my best bet was to make an adjustable spacing tool similar to what I remember seeing in Chris Vine's book *How (not) to Paint a Locomotive*. It didn't take long and means I can now set the pen for lines up to approximately 15mm depth from the edge. It's a simple design that I came up with, based on some suitable square brass stock. At one end I drilled a hole for the 'Bob Moore' pen's stylus to fit and then I machined a slot for the adjustable pins. I made two pins of different lengths so that they can be locked in the slot at any position needed. I also put some paint on the wheels which were then ready for refitting. I had been shocked at how much rust had built up on these over the two years of storage, I'm pleasantly surprised at how well they came out.

It was then time to consider how I was going to paint the brake gear. I decided that paint may not be the best way as these are close fitting moving parts and so went the 'Chemical Black' method. I



8. I refitted the vacuum reservoir tank after checking that it was leak proof, by taking it to 100psi with no signs of a leak from the tank or its fittings. I them etched it, primed and top coated it. I decided to leave the holding bands unpainted for no other reason than I like it like that. I had now rigged all of the brake pipework ready for the vacuum test. I sucked on the tubes and could certainly get a vacuum on the main 3/16 inch pipe by blocking the pipe to the vacuum cylinders. In doing this I was able to check that the Doug Hewson hose was sealing properly which I'm happy to say it was.

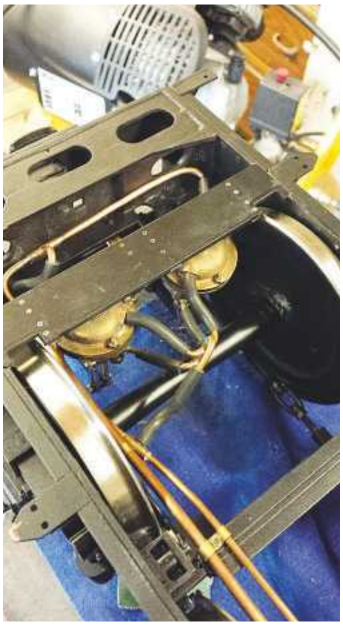
spent a day getting to grips with chemical blacking and have to say I'm sold. I didn't know what to expect in either finish or durability but, so far, I'm very impressed. What amazed me was that I could handle items immediately after the blacking process without rubbing any off.

Reassembly

Having painted most of the small fiddly parts it was time to get the chassis back together, painting the remaining parts as I went.

The steps were finished and refitted to the chassis along with the guard irons. I'm glad that I spent the time on these as they would have looked a bit plain if leaving them without rivets and to me they look so much better, practical and more prototypical. There are 1238 0.79mm holes (or, for those imperialists among us, 1/32nd) that were drilled and countersunk in one move using a BS0 centre drill, then rivets cut, hammered and finally filed flat.

●To be continued.



9. A close up of the vacuum cylinders.

10. I fitted a Doug Hewson heating hose. I had to fit it a couple of mm lower than is seen in some photographs so that the fixing stud cleared the 8BA bolts that hold the shield on but I doubt if it's noticeable.

11. First view from the back - nothing much new here but included just to show all views at this point in the construction.

12. A close up of the front. There's been a few changes here. I have finally redone the wooden planking. New items include a lamp bracket, seen on the left side as viewed, handle for locking the coal door closed, safety hoops that sit over the cab/tender doors, the two side shields fitted to the coal scuttle, the water gauge has had some of its holes filled to follow the prototype closer and there is now the water tap that is below the right hand (as seen) locker.

13. Finally we have the fitting of the bucket that sits in the wooden floor. I found one of a suitable size from a doll's house supplier on eBay. Once I had cut off the over scale handle and its brackets and made up some new parts it looked much more to scale.

Successful Silver Soldering

Martin Gearing looks at approaches to silver soldering which should result in an increase in quality and a reduction in wastage.

Introduction

Before becoming self-employed I had always found employment in the maintenance, experimental, development or training areas, where the questioning of 'Accepted Practice' was an acceptable if sometimes unpopular route to making improvements.

My main interest has always been in things that Suck, Squeeze, Bang and Blow between 60 and 5000 times a minute - anything going slower or faster I can't afford.

Basically, if it gets hot or is oily or goes round whilst doing something useful - then I'm interested. My greatest pleasure is to be found in successfully making a mechanism or process function a little bit better, easier to use or understand by someone who wanted to learn.

Having seen the results in industry of the automated processes and the work done by highly skilled professional coppersmiths in addition to amateur individuals involved in silver brazing (soldering) items together, I've seen the very good, the indifferent and occasionally very bad results of using the silver brazing process (in the UK better known as silver soldering) as related to pressure or stressed vessels.

Before going on further, it may be of interest for some to know a little history and learn the meaning of what are, to be honest, some fairly nebular definitive terms.

Technical terms/ descriptions

Brazing is defined by the British Standards Institute as 'A metal joining process in which a molten filler is drawn into the space between two closely adjacent surfaces by **CAPILLARY ATTRACTION**'.

Soldering takes place **below 450 degrees C.**

Brazing takes place **above 450 degrees C.**

Both processes occur **below** the melting point of the metals being joined.

Silver Soldering/Hard Soldering (terms used in the UK along with several other countries) are synonymous with **Silver Brazing (not** Soldering)

Silver Brazing is the accepted (and more correct) term used in the USA and takes place between **600 degrees C** and **900 degrees C.**

(However, as this article is being written in the UK I shall continue referring to the term Silver Soldering and not the technically correct Silver Brazing, but I'm certain US readers will make allowances!)

Brazing and **Bronze WELDING** use a filler metal with a **lower** melting point than the parent metal and use a copper-based filler, melting **above 850 degrees C** and **dot not** rely on capillary action.

If you found that slightly confusing you can be assured that you are not alone!

Early personal experience

My interest in this subject began sometime in the early 1960s whilst in the secondary school situation attending metalwork classes. Joining metal was by use of air/town-gas torches and brazing filler rod.

This created a general fear - caused by the intense noise and heat and accompanied very often by disappointment caused by the inability to actually get the work hot enough to melt the filler rod.

This continued later in the amateur situation at home:

* A fear because of the intense heat, produced by a five pint and sometimes a smaller paraffin blow lamp, causing filler rod to melt randomly often by inadvertently waving the filler rod around.
* The use of a heat shield, although helping, required a high degree of accuracy, because of the length of rod protruding from the other side of the shield.

So, nothing much had changed, except it motivated me to use oxy/acetylene if I had any brazing to do. But more often I used oxy/acetylene for welding my rotten cars back together as they were necessary to get to work, with very little requirement to silver solder anything other than for making up band saw blades for the owner of the oxy/ acetylene set!

Sources of Information

This is the point where people with experience and those who enjoy reading already have an understanding of what is required to actually silver solder.

For those that don't have that advantage there is a lot of excellent information available in all the related magazines such as *Model Engineer*, *Model Engineers Workshop*, *Engineering in Miniature*.

Looking at specific articles and books that cover the subject in greater depth, an article (**ref 1**) on 'Silver Soldering' by David Banham and (**ref 2**) a guide to 'The Art of Silver Soldering' by Kozo Hiraoka in the appendix of his book *The Pennsylvania*

History

There is evidence of brazing a wide range of metals 5000 years ago. In the tomb of King Tutankhamen pictures on the walls show the process of step brazing. This makes the process over 3375 years old.

REFERENCES

1. *Silver Soldering – A Comprehensive Guide*, David Banham in three parts, published in *Model Engineers Workshop*, May, June and July 2017.
2. A guide to 'The Art of Silver Soldering' by Kozo Hiraoka in the appendix of his book *The Pennsylvania A3 Switcher*, 2001, ISBN 987-0-941653-62-6
3. *A Guide to Brazing and Soldering*, Keith Hale of CUP alloys - this company that Keith founded also has a lot of useful information on their website at the time of writing.
4. *Soldering and Brazing*, Tubal Cain, book 9 in the 'Workshop Practice Series', 2002, ISBN 987-085242 845-0
5. Johnson Matthey (www.jm-metaljoining.com) – Several useful PDF's are available on their website, including one entitled *Silver Brazing Alloys and Fluxes*, describing the company's products and their uses in detail.

A3 Switcher are to be recommended. Perhaps one of the best up to date books available is (**ref 3**) *A Guide to Brazing and Soldering* written by Keith Hale of CUP alloys. This company that Keith founded also has a lot of useful information on their website at the time of writing. Also, (**ref 4**) Book 9 in the 'Workshop Practice Series' by Tubal Cain and finally one of the oldest suppliers in the UK (**ref 5**), Johnson Matthey, whose website has information covering all aspects of their products. Between them these sources of information will answer virtually any question and offer a solution to any problem likely to be encountered practically.

Practical requirements for silver soldering

The process can be broken down briefly as to what is needed to silver solder.

* Fire extinguisher - hopefully never needed!
* A source of heat – nowadays, for most people, propane is used. Generally, the professionals use oxy-acetylene or oxy-propane, and small sets of oxy/MAPP are available.
* A heat resistant area on which to work - best with subdued light and **very good ventilation**. This is best made from refractory bricks. Alternatively, fire bricks from builders' merchants or - if cost is a major consideration - aerated concrete blocks (trade names Celcon and Thermolite) can be used. **Note - Do not** use blocks out of night store heaters. They are designed to **ABSORB** heat not reflect it!
* An **understanding** of what is required.

You also need to be fully aware there will be:

* **A LOT of noise.**
* **An ENORMOUS amount of radiated heat** - around 70 to possibly 150kW if involved with the average boiler encountered.
* **A potential for damage** caused by the heat that will be **rising** above the work area - something I learnt the hard way (sad to admit - twice!).
* And that a large amount of oxygen **will be consumed** in the heating process demanding that there is good ventilation.

Summary - what is essential to Silver Solder with success

* **Cleanliness** – **No trace** of any **oils** – **No** residue from **lead soldering** can be tolerated. **Prior to heating** pickling in 10% sulphuric or citric acid is advised and also filler material as well if old stock is used.
* **Correct joint preparation** to ensure that capillary attraction can take place; this generally requires 0.1mm (0.004 inch) separation of the surfaces to be joined. This may be created by the use of a centre punch, foil type filler material (of the correct thickness and grade), knurling, machined cavities or reduced diameters/areas.
* Understanding and appreciating one of the unique properties of the silver soldering process, which is the increase in the remelt temperature of the filler material in a previously flowed joint. Put simply, when silver solder flows on a metal a partial alloying takes place, correctly described as **Inter atomic bonding** (this could be a question in a pub quiz for those interested in such things). This results in a previously flowed joint needing to be heated to a higher temperature for any flowed silver solder joint to remelt. From personal experience I would estimate the increase in temperature to remelt a previously flowed joint is about/between 10 degrees C to 20 degrees C but I can find no definitive figures as it is related to the mass of the object being joined.
* An additional method of working when involved in a job being made up of multiple parts in close proximity to one another, is to use **STEP SOLDERING**. This is possible because of the differing melting point created by the different percentage of silver contained in the filler rods available. **Low Temp 55%** - 630 - 660 degrees C. **Medium Temp 40%** 650 - 710 degrees C. **High Temp** (alternative see below) **30%** 675 degrees to 735 degrees C. **High Temp 24%** 740 - 800 degrees C. **Note:** 24% silver solder is not permissible to be used in boilers built to comply with the Australian boiler regulations where no silver solder having a silver content of less than 28% is permitted, 30% being the nearest freely available in the UK.
* **Important** - it is essential that all previous joints in the vicinity of a new joint are coated with the correct flux used to maintain the integrity of any previously flowed joints should they come close to or actually begin to remelt.
* Use of the correct flux for the temperature and materials and length of heating involved.

The choice of flux is related to the silver solder grade being used. For low (55%) and medium (40%) temperature silver solders, which will cover the needs of the average job, only one type of flux is required, known as **Easy Flow** or **EF** (depending on the supplier.) This is easily removed by prolonged soaking in plain water (overnight is ideal). If you intend to use high (24% or 30%) temperature silver solder then a flux known as **Tenacity 4A** should be used. This is only partly removable by soaking in water (see following). Alternatively, if you require to silver solder **stainless steel,** a flux known as **Tenacity 5** or **HT5** (depending on the supplier) is used. This can be removed by soaking in 10% sodium hydroxide solution (readily available in pharmacies and some supermarkets as caustic soda). This solution is also very effective if using **Tenacity 4A**. All fluxes are mixed to a paste with water (the consistency of a stiff yoghurt) before application usually with a small artist's brush (mix with methylated spirits should you need to limit the spread around the joint when heated). **Note:** do not use a brush made cheaply of low quality bristles because these break off in use and when heated carbonise in the filler material. This **will** cause a leak when the joint is tested. The extra cost of a reasonably good quality brush will be more than repaid by not having to repair such leaks.

* And perhaps the most important consideration in undertaking the silver soldering process - **the method** that the filler rod is applied and heated to the point of flowing into the joint. The commonly accepted practice is to heat the work and apply the filler rod (sometimes with additional flux called 'Hot Rodding') to the joint area when hot enough. This method, if using heat sources other than oxy-acetylene, can require asbestos arms, hands and eyebrows (probably helps if you have little or no sense of pain when it comes to larger jobs) and incredible psycho-motor control.

Bear in mind the average domestic room heater puts out between 2 – 3 kW and the average central heating boiler around 30kW. But here you have the potential of using a propane heat source putting out anywhere between 0.25kW for jewellery work all the way up to over 100kW, and that's just from a single burner from the Sievert standard range. Things can get very serious if you can find a friend or have a wife you can **really trust** and work with two burners on bigger jobs – do the maths!

With a great deal of experience this can produce acceptable results but more often than not, bits of filler rod that have melted off on their way to the joint are evident all over the job!

So, next time we'll look at ways of producing good quality results with no loss of eyebrows.

●To be continued.

3D Resin Printing

Malcolm High tries out a different kind of 3D printer.

I am currently building a rake of mineral wagons to go behind my Gauge 1 9F. The majority of the parts are 3D printed and the rest are a combination of laser cut parts and some turned components. My filament printer struggles to get sufficient resolution on the smaller parts, especially the axle boxes and springs. I heard of resin printers through a good friend of mine and decided to get one. The print volume is not large, 115 mm x 65 mm x 165 mm high, but it would be quite adequate for my needs. This is my experience with the machine.

How does it work? The resin hardens under UV light - one reason why it comes in a thick plastic container. On the printer the resin is held in a vat which has a transparent base. The base is actually an FLP (flourinated ethylene propylene) membrane which is held taut across the vat by a number of screws. Under the vat is an LCD screen and below that is a bank of UV lights - I suspect these are LEDs.

To harden a section of the resin the LCD becomes a mask; some of it is black and other parts clear. This is done by polarising portions of the display electronically. The portion above the clear section goes solid. That is the principle but of course there is much more to it than that.

The machine arrived very well packaged and it was soon on the bench, but no instruction book! The only one I could find was in Chinese and it did not appear to be very comprehensive. I found instructions on the internet and followed those only to find out later they were on the stick included in the packaging.

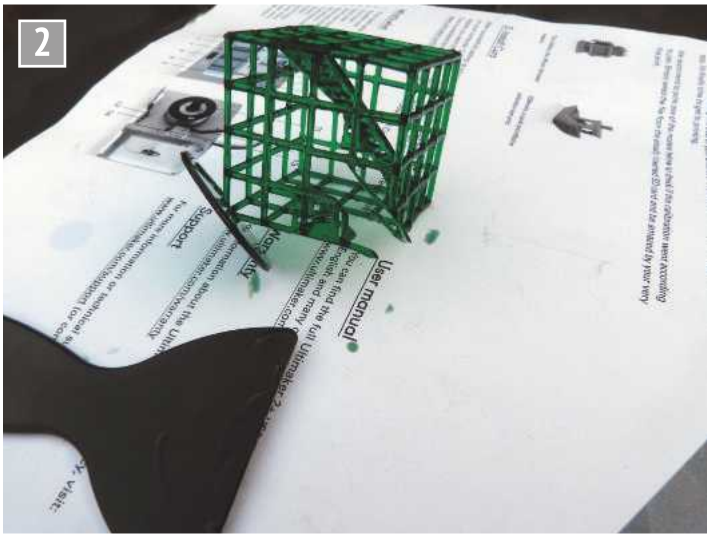
First impressions were very favourable (**photo 1**). It looked well-made and the mechanics seemed to be robust enough to ensure the accuracy required. The door was the only part I found flimsy and I suspect it can easily be broken.

The machine as supplied with the vat in place.

The first operation was to level the build plate. This I was to find out is crucial to the operation of the machine. The build plate is lowered until it almost touches the LCD screen; there are plenty of warnings in the instructions about hitting this expensive unrepairable screen! The fixing of the plate is quite ingenious. It must be parallel to the LCD screen so the plate has to be able to move in two planes. This is achieved by having a large ball turned on the end of the arm and a box on the plate. When the plate is on the LCD screen a grub screw in the box is tightened up which locks the plate to the arm. It is very simple and, since there is no load on the plate, adequate. At this point it is possible to set the vertical position Z to zero.

With the build plate lifted up to almost the top, as shown in photo 1 the vat can be filled with resin and placed over the LCD screen. Cleanliness is essential. According to the data supplied the machine will work in temperatures as low as eight degrees centigrade. Well it was the middle of January when I was out in my shed putting the machine together. Although I could get the room temperature up I suspect the resin was too cold so that now has to stay indoors. It also recommends you shake the bottle before use. The vat was filled to a third full and we were ready.

The component is built upside down. The build plate goes into the vat of resin ending up 0.05mm, the layer thickness, above the membrane. The mask is shown



The trial piece did not come out as I expected.

Only four of the test pieces came out, the others were stuck to the vat floor.

on the LCD screen and the UV light is switched on. For the first three layers this lasts for a whole minute but after that it is around eight seconds. To produce another layer the plate lifts up and then back down such that it is at the layer thickness off the membrane and the process starts again. Simple then - well not really, it has its pitfalls.

There is a trial piece on the stick. It is simply a matter of putting the stick in the USB port, selecting 'print' and watching it go, for five hours! It is not fast but to make a number of the same component only takes as long as making one. The trial print was not a great success. Parts appeared to be missing and a number of the legs were broken (**photo 2**). Because it took so long it did not finish printing until late in the evening so I left it on the machine overnight. This may have been a problem but I am not sure. So the next morning I cleaned off the component and emptied the vat. The kit comes with a number of funnels fitted with filters to ensure the resin put back into the bottle is clean. Small particles of solid resin can be left behind during the build process and I certainly found a few of those. What to do next.

There is no way I was going to use the trial part again unless there was no other option so I decided to make one of my axle boxes. These I had on my computer as it is the same .stl file I use on my filament printer. The resin printer slicing software is free to download and is very comprehensive. If you have used a 3D printer in the past the commands will be very familiar but there are a number of variables you can change.

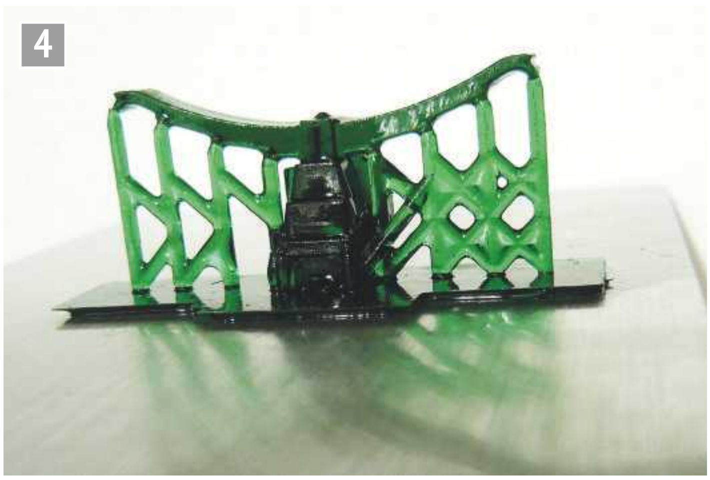
The .stl file was imported and laid flat on the bed. I chose the auto support feature, which puts in any support for overhanging parts. There are a number of options on this too but I stayed with the default settings. The software indicated it would take nearly an hour to print so much better than the five hours of the test print. With the file on a stick and inserted into the machine it was time to see what it would do. The results were, how shall I put it, not what I was expecting. Basically all I got were the first ten layers or so and these were on the bottom of the vat not on the build plate. So - try again and exactly the same result.

There is another file on the stick provided with the printer; this one produces a matrix of eight squares. The idea is that the time the resin is exposed to the UV light is varied by one second across the parts, so top left might have 4 seconds per layer and bottom right is 12 seconds. It allows you to decide on the exposure required for the resin you are using. So, I tried this and although four of them came out fine there was no sign of the other four (**photo 3**). These of course were still in the vat - again only the first few layers had been built. My friend Alex kindly offered to test my axle box file for me and it came out perfectly. So what was I doing wrong? Again, Alex to the rescue – 'what firmware are you using?' No idea!

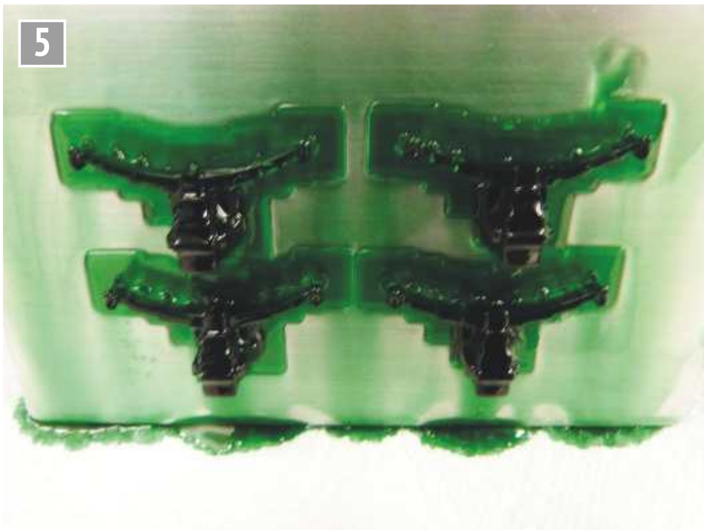
The firmware runs the machine; basically, it is the software and this is updated regularly by the manufacturer. Eventually I found it on the machine and I was on version three but the latest is version five. On YouTube there is a video of how to update this, which I followed to the letter and that seemed to be fine. I then levelled the build plate again but this time I put more pressure on the LCD screen. I think after all the warnings in the instructions I had been too tentative in doing this. I also found these 'expensive' irreparable parts on eBay for £25. Maybe not that expensive then!

So, with freshly shaken room temperature resin in the vat we were off again and success; I got my axle box and, yes, the detail is superb. The resin supplied with the machine was translucent green, terrible for taking photos and looks just as bad in the flesh. At £30 a litre though there is no way I was not going to use it.

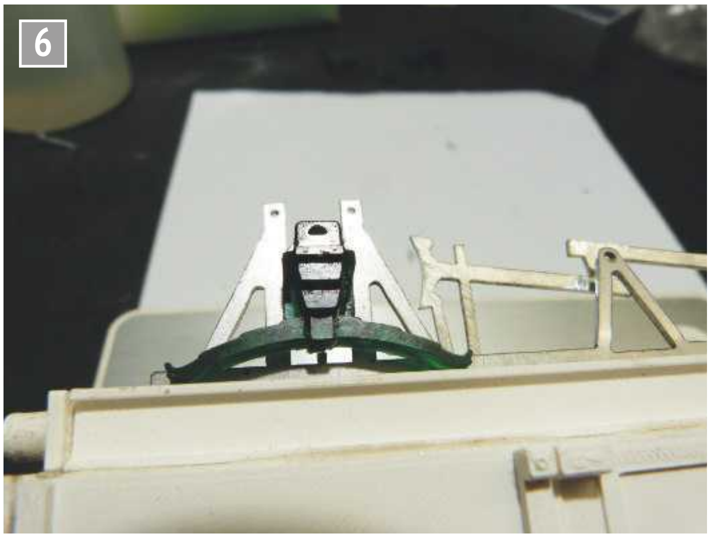
The part is printed with a raft to ensure it sticks to the build plate; this has to be removed. The print is pliable except for the first 3 layers which are much more brittle. These of course had been exposed to the UV light for one minute, whereas for the rest it was only 8 seconds. By exposing the print to UV light it would all become hard. On a sunny day it can be left outside and



An axle box printed vertically.



Four axle boxes still on the build plate.



A completed axle box and spring mounted in the W irons.

the sun will do this for you. In January that was not much of an option.

Many years ago, I used to make my own PCB's and the etching process requires a UV light box. I found this up in the garage loft - just as well I didn't throw it away! A couple of minutes in this and all the print became hard. I found it very difficult to remove the unwanted raft and support without damaging the print itself. So - next idea - print it vertically not horizontally. This would involve a lot more support material and take half as long again to print since it would be higher on the build plate.

So, we were off again and, yes, it printed fine (**photo 4**). Removing the raft was still an issue though; the detail at the bottom of the axle box was covered by the raft and got lost while removing the excess material. So, back to the drawing board.

The solution I came up with was to build the part on eight one millimetre diameter pillars, one and a half millimetres high. These would keep the print off the raft and I could now go back to printing it horizontally, so the print time would be shorter. This proved very successful and it is a technique I have employed since on other components (**photo 5**).

There is a lot of cleaning up to do once the printing is complete and gloves are essential for this. Three pairs are provided with the kit but these do not last long. The prints themselves are covered in resin and this needs cleaning off using a solvent, with good ventilation required. The build plate also needs cleaning if you are changing resins - plenty of kitchen paper needed for this. The resin can be left in the vat for a couple of days but it seems to me to be good practice to empty it into a bottle so it is not exposed to light. I bought a purpose-built stainless steel funnel with a filter, as the resin has to be extremely clean. Finally, the vat itself needs cleaning out but there are lots of videos on YouTube showing how this should be done. All in all, a very messy business.

The FEP film on the bottom of the vat needs changing fairly regularly. Over time this becomes cloudy and damaged. These are not cheap. I found to my cost that cheaper versions do not appear to work as the print sticks to them rather than the build plate. There are a number of videos online as to how this should be done - it is not too demanding. Similarly, the LCD screen becomes less effective but it is only a half hour job to replace.

If you have a filament printer already then much of the software and hardware will be familiar to you. The major difference of course is the resin, which takes some getting used to. Another thing is that you cannot actually see what is happening and you have to wait until the build plate is higher than the vat before the print can be seen. Overall, I am pleased with some of the results I am getting (photo 6) and I think it will be a valuable tool for producing some of the small more detailed parts.

ME

POSTBAG

Drawings

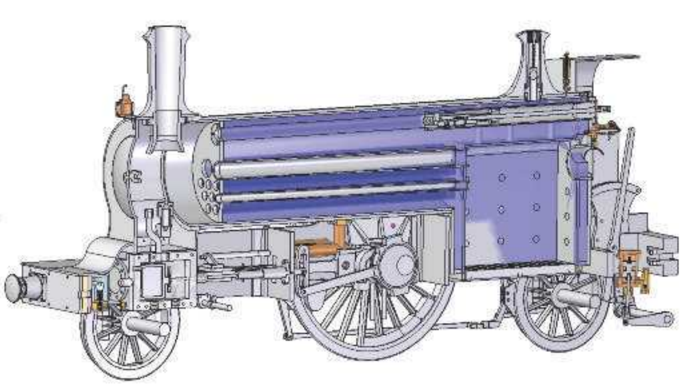
Dear Martin,
I read the letters about drawing practice in M.E.4664 (9th May) with interest. My first reaction was to find out how difficult it is to metricate a drawing. I chose a 2D CAD drawing with both fractional and decimal inch dimensions (it was not a final drawing), ordered it to use metric, and was presented with the metric equivalent, complete with fractional millimetres. A little work on the attributes of the dimensions and the fractions were transformed into decimals and the requisite number of decimal places appeared. The program in this case was 2D Turbocad Designer Version 20.0, of which I am merely a satisfied user.

My personal feeling is that if one wanted to metricate a drawing one would start with a CAD version using the original dimensions to avoid transcription errors since redrawing would be indicated in any case. This was called a soft conversion, now referred to as a substitution. When one has the design in metric it should easy to spot dimensions that should be changed to permit the use of standard metric materials. That would be what was called a hard conversion, now just called a conversion.

There was also reference to adherence to standards. I have been working with a 4th year aerospace engineering project class for 20 years now as an outside engineer. The student work includes having the machine shop make some of their designs from 2D shop drawings. The students have one course in engineering graphics in the first year and have forgotten most of that by the fourth year, not to mention that there is no time to cover the *minutiae* of mechanical drawing in detail. My approach is thus to ask them to consult the older standard textbooks for the basics and look at examples on the web. The results are variable on the first pass and after two or three reviews the drawings will usually pass muster in the shop. I have to explain lots of detail, for instance, taking into account available cutters and avoiding dimensions in series. After the first review the students usually feel a little overwhelmed but after the next review they are catching on, often enthusiastically. What I do not do is to demand any particular detailed conventions. I ask that the drawings be accurate, complete, and comprehensible by the shop. (The one thing I do not want to see is the practice of using the number of digits after the decimal point to indicate tolerances. It is not compatible with CAD programs and inexperience.) The programs they use are up to them as long as these programs can produce drawing exchange (.dxf) files.

The students also have access to CATIA, a suite of design programs from Dassault that is used by Airbus and Boeing, among others, to design new aircraft. The structures group uses CATIA but its steep learning curve detracts from hoisting in the basics of detailed mechanical design.

Without my model engineering experience I might be as lost as the students at times and I can assure them that the niggly details are important as I have 'been there and done that'!
Best regards, John Bauer



Parameterisation

Dear Martin,
With regards to the recent series on parameterisation by Ian Martin, I found the article very informative from a technical point of view and I applaud Ian for keeping the methodology and examples simple. I have read and heard many a complaint about old drawings that contain numerous errors and even designs that physically will not work. 3D modelling, including parameterisation, vastly improves the quality of the models by essentially building the model virtually before machining any components.

The attached example is of a loco I built with a great number of the components parameterised and linked. To show the value of such a model - if I decide to change the admission, the eccentrics are updated along with the valves and rod lengths. I then turn the wheels in the model (virtually) and make sure nothing locks up while checking how the valve ports behave. I have similar parameterized algorithms for my injectors, boilers and smokebox design for draughting (although some of these algorithms come from numerical solutions and are not necessarily tied to the geometry).

New ideas, materials, methods of design and construction all contribute to this amazing hobby and I commend Ian for throwing parameterization into the lime-light!
***Luker* (South Africa)**

Write to us

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Martin Evans, The Editor, Model Engineer, MyTimeMedia Ltd, Suite 25S, Eden House, Enterprise Way, Edenbridge, Kent, TN8 6HF
F. 01689 869 874
E. mrevans@cantab.net

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Responses to published letters are forwarded as appropriate.

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

Debs and I went to a hanging recently, complete with her knitting a la Mme DeFarage, and we enjoyed the event and its results. This is perhaps as well, or it would have been curtains for both of us.

In this issue, a railbus, Colchester, music of French railways, a brake?, a runabout, and clocks.

Blast Pipe, April, the joint newsletter of **Hutt Valley & Maidstone Model Engineering Societies,** reports that Maidstone member Ben has built a toolbox in the form of a 3½ inch gauge boxcar. This sounds like a neat idea and a preliminary photograph looks interesting, though roofless **(photo 1).** An email arrived, via the club website, from Jose Esparza, a railway enthusiast in Cordoba, Spain. He refers to a collection of photographs, shot at Estacion de Obejo, which is most interesting. The text is in English and I can recommend it.
W. www.hvmes.com

Romney Marsh Model Engineering Society, *Newsletter*, April, bears a picture on the front page showing a meeting at their track in 2015. The sun is shining, the sky is cloudless and the crowds and the busy railway encourage us to think that 2021 will be very different from 2020. Chairman Brian Remnant found that the water meter was measuring flow, even when the track was closed. Investigation pointed at a water column, fed by a blue pipe. However, the pipe at the column end was black and the intervening area was concrete! Out with the Kango hammer, dig nine holes, finally, in the last hole! - a split pipe. (Well of course it's the last hole, you wouldn't go on digging after finding the leak, would you? - Geoff) Brian also built an *Ellie* for the Garden Railway.

Allegedly, the pictured locomotive bears the operating company's crest, motto: MES, which is Latin, *Mobili Exemplum Spiritus*, meaning 'Mobile Model Spirit-fire'. Oh yes it does! As for the 'crest', it bears no such thing! John Hardy writes on his 16mm *Lilla* to the Ross Harrison design. John rebuilt the valve gear, opting for a split eccentric, improving its slow running and reverse behaviour. Richard Linkins' autoprofile tells of his career spent at Dungeness power station (where, from most locations on that site, Derek Jarman's Prospect Cottage is not visible – Geoff). Richard says his most rewarding time was that spent revealing the entrails of the steam turbines, like a giant puzzle, with the parts weighing tens of tons. Then, Brian Holyland relates his life in railways.
W. www.rmmes.co.uk

Offcuts, spring, from **Bromsgrove Society of Model Engineers,** begins with Pat Cross making another Victorian favourite, the Kaleidoscope. Very different from the triangular box of mirrors we remember from childhood, but a sophisticated optical device. Richard Tayloe continues his 'Polly' locomotive, whilst Alan Larigo makes a Donegal railbus (**photo 2**). Technical information is next, from 'Pansyman', regarding wheel/axle separation, and the not altogether separate mending of broken wheels. His method of repair is so good, he says, that anyone may inspect the results from a distance, on a dark night, to ascertain his skill. A timed and dated corollary to this item reminded us that Sir Nigel Gresley used this substance with great success, and consequently named one of his A4s after it*. (Rearrange some letters into a well-known phrase or saying, frequently heard in early April.)
W. www.bromsgrovesme.co.uk

On Track, April, from **Richmond Hill Live Steamers,** opens with the 'news cupboard' being bare, so Grant Will recommends this instructive video from Canada Science & Technology Museum (imagescn.techno-science.ca/railways/index.cfm?id=3&index=1) and Craig Chapman sends this half hour video about Colchester lathes (www.youtube.com/watch?v=nQaAKUAzK0w).
W. www.richmond-hill-live-steamers.tripod.com

Model & Experimental Engineers, Auckland's March *Newsletter* starts with a Bulle

Ben's Boxcar, Hutt Valley & Maidstone MES (photo courtesy of Calcott).

Co. Donegal railbus by Alan Larigo (photo courtesy of Alan Larigo).

electric clock which has been a constant concern to Michael Cryns for some time. Mike Jack has finished construction of the bending brake he began in order to make the frames for his BR tank engine. (Something I always puzzled over, why a 'brake'? Cue Mr Google: according to The Fabricator, 600 years ago, a brake was a machine for crushing or pounding, and the word morphed into a general term for machinery. - So, there! The things we learn… - Geoff) Ray Brown has been concentrating on the road gears for his Fowler ploughing engine. Graham Quayle has a couple of clock movements which were found in his Mens' Shed, the ownership of which clocks no one knew. Being loth to throw them in a skip, he passed them on to clock specialist Michael, see above, in the hope they can be resurrected. Another clock has a Hermie floating balance, very difficult to set up, as Murray discovered some time ago. I don't pretend to follow the workings of that device, it being above my pay grade. Graham Bell has some tools of his late father, who was apprenticed in the 1920s. They were used to laterally compress tongue and groove floorboards before nailing them down. Brian Baker is rebuilding a rose engine, which looks quite promising. Brian is a professional swordsmith, selling worldwide (greetings from Sheffield, Brian). Murray sings the praises of modern power supplies, having acquired one for his Alexander mill. It is smaller and lighter than the old 'battery charger' unit which is attractive. However, it is a switched mode circuit, not a 'linear' version, having no transformer to isolate it from the mains supply. Properly made, they perform well but radio enthusiasts sigh at the level of electrical noise produced by many such devices.

Steaming Ahead, spring, is the newsletter of **Crowborough Locomotive Society** in which 'The Management' discuss the forthcoming relaxation of government restrictions and how best to reintroduce public running on the Crowborough Miniature Railway, built by the hard-working members. Graham Fry fitted linear digital scales to his mill and discussed the pitfalls in so doing. Editor John Wood describes some classical music compositions, like *Pacific231* by Arthur Honegger, inspired by the Nord Pacifics of Andre Chapelon. Georges Asselin, later CME of the Nord, wrote memorably on the Nord locomotives and de Glehn compounds, and David Wilson uncovers the mysteries of the bypass valve in steam locomotives.

W. www.crowboroughminiaturerailway.com

Welling & District Model Engineering Society, *Newsletter*, April-May, begins with a Farewell to Falconwood, their current site, and Hello to Hall Place, their new one. TV broadcaster Daniel Farson visited the club in 1959, (*Model Engineer*, 12th November 1959) with a film crew from Associated Rediffusion and asked the usual non-specialist questions. How long did it take to make? "3 years". What did it cost? "£50". Does it work? The reply to which is not recorded… The report was broadcast on 19th November under the title 'The British and their Love of Trains'. Tony Riley encountered the terms 'Fettler' and 'Gantlet' in a railway context, of which he was not aware. Research showed the former to be an Australian term for a tracklaying gang labourer and the latter as interleaved track, often where there is a width or weight restriction. Gauntletted track, yes, but not 'gantletted'. This developed into a lengthy item on gauntletted track with photographs. 'Handy-Andy' Houston found a *Daily Telegraph* report in March, on management changes at Shoe Zone, where a Mr Terry Boot became finance chief after Mr Peter Foot left. Headline: 'Boot steps in for Foot at Shoe Zone'. In an item on Deptford Works and Bricklayers Arms, we are informed that one William Curtis, who had, along with other ideas, invented a braking system in which a cam, on being lowered to the track, raised the wheels from the rail and the friction betwixt cam and rail brought the train to a halt. I bet the Civil Engineer was overjoyed at that abuse of 'his' track!

W. www.wdmes.co.uk

Maritzburg Matters, April, from **Pietermaritzburg Model Engineering Society,** says that they managed only two running days last year, one of which was rained off. They have had no income and no social interaction with visitors but at least the financial situation is okay. Ray Teichmann has built a new petrol-electric locomotive and has written an item on how to drive it, which may be helpful to those with only steam experience. Next, a picture of a traction engine, dwarfed by a huge steam accumulator it is moving in 1930s Scotland. The solid-tyred multiple-wheel trailer used two drawbars and it was skidded (very slowly) round corners but if it encountered a granite sett the sett would crack with a sound like a pistol shot. For some jobs, the new-fangled internal combustion engine just would not do. A team at UCL has uncovered a little more about how the Antikythera Mechanism works. However, we still do not know how it was made without a lathe and, having constructed a working model, which shows the movements of the planets, as then known, why did the Ancient Greeks not go on to develop the clock?

W. www.pmes.co.za

Last December, I wrote about Ian Welch's garden railway, following a piece by Phil Drummond in the December *Blast Pipe* (M.E.4657). I have now, finally, received good .jpgs of the pics I requested, and what pics! A Garden Railway par excellence (**photo 3**).

Durban Society of Model Engineers, March, says that Mike Thorne has developed a DSME simulator, and designed some striking posters to entice visitors in, when the track is allowed to reopen.

W. www.dsme.co.za

Debs and I visited Doncaster, ostensibly for the market, but also to investigate the new Danum (Roman name of Doncaster) Gallery, into which Sir Nigel Gresley's V2 locomotive *Green Arrow* has recently been moved. These were known as 'the engines that won the war', having performed sterling service yet never famous like their A4 etc. brethren. They were powered by steam, unlike the 'other', petrol-jet engine name-sharers of the same era. The Gallery was closed but now we know how to get there. The Wednesday market is currently very poor, having substantially declined since the council revamped the market square. However, there were several positives; the weather was fine, sunny and warm and the station car park, previously nondescript, has been pedestrianised, with the names of A4 locomotives (racehorses) on stone pillars. It looks much bigger now. The Cafe Alfresco in the Waterdale shopping centre makes tasty hot pork rolls and we encountered a young female busker playing classical violin, a change from bad saxophone soloists or their fellow tune-murderers. I don't normally give money to strange women in the street but this was worth a couple of denarii. We also saw this little runabout, a Nissan GT-R Nismo. What this £200,000 Formula 1 car in sheep's clothing was doing in run-down Doncaster is hard to guess. Anyway, it inspired the following: 'The Nismo sign means Happy motoring, Happy Motoring, Happy motoring…' (**photo 4**).

Nissan GT-R Nismo in Doncaster.

The Prospectus, April, from **Reading Society of Model Engineers**, has a memory by

Ian Welch's Garden Railway (photo courtesy of Phil Drummond).

Alec Bray, regarding an item in the previous *Prospectus*, of a model railway in the vicinity of Heelas' department store, now John Lewis). One year, no railway, but a Minic Motorway, a model type since consigned to Oblivion. Terry Wood writes on restoring an old Mamod steam engine.

W. www.prospectparkrailway.co.uk

PEEMS, March-April, the newsletter of **Pickering Experimental Engineers & Model Society**, provides an excellent read with this issue, thanks to a concerted effort at a time when many clubs claim they have nothing to report. Ken Hillier comments, re: the item on LCC trams in the autumn issue, that he was tempted by the kit in question but has a 12th scale Routemaster to complete. Most LCC trams went for scrap at a specially built 'tramatorium', adjacent to Charlton works. PEEMS member, Brian Rees, built a new 24cc i/c engine, shown at the Doncaster Exhibition in 2019, a flat four, for which his local club, Sutton Model Engineering Society, awarded him their Sir Malcolm Campbell award, their highest honour. The model was not without teething troubles, in that not only did it leak oil everywhere, no doubt meeting with OPEC's approval, but (he says) it was his first engine to exhibit no compression at all. Brian uses Wellseal gasket material, but only after rectifying the above faults, for which he suspected the valve timing was responsible. Another PEEMS member, Mike Sayers, has been working on his Delage lubrication system. One feature he has not seen elsewhere is a dual pressure system, low for the camshaft bearings and high for the crankshaft, with extra for periods of high acceleration, when it will do most good. The springs for the regulating valves were found after spending two days sorting through a box of assorted springs and testing them on Mrs S's kitchen scales. Because of the design of the engine, major dismantling is required in order to remove the sump, so he designed a test rig. Subsequently, nothing would go as planned! Oil pipes larger than scale solved the first problem and, over five months, the rest, although Mike estimated 20% of this period was *ad hoc*, 'suck it and see' work, perhaps not a good metaphor as it took ages to clean up the 1½ pints of Castrol GTX sprayed over him from the engine on test. This was also the time he abandoned any idea of videoing the model on his wife's new iPad… ("*Apres moi, le Delage*" - Oh, sorry, we've done that one!) Alan Martin took up woodcarving on retirement, with excellent results. His article takes up 20 pages of the newsletter, in a well-illustrated and detailed explanation, to which I cannot possibly do justice here in Club News. Join PEEMS and read it yourself!

And finally, The weight of an evangelist's influence in Heaven? One Billy Gram.

* Spearmint.

CONTACT

geofftheasby@gmail.com