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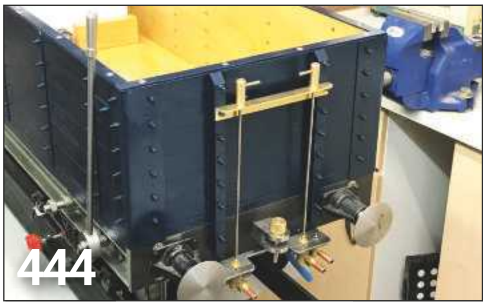

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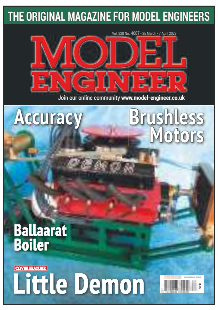

ON THE COVER...

A twin carburettor supercharged V8 internal combustion engine built by Mick Knights (photo: Mick Knights).

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Bassett-Lowke Rally

The Northampton Society of Model Engineers are pleased to announce a new event for 2022. They are holding a Bassett-Lowke Rally on Saturday 14th May. As Bassett-Lowke were based in Northampton, the venue is an appropriate one to celebrate the products and designs of this famous company.

The Society invites owners or enthusiasts of the products and designs of Bassett-Lowke and Henry Greenly to enjoy the extensive facilities of the NSME. Visitors can use their ground level track which has 7¼ and 5 inch gauges, the raised track for 5 and 3½ inch gauges and their garden railway for 45mm and 32mm gauges. They are hoping also to host visiting layouts for the vintage B-L Gauge 2, Gauge 1 and Gauge O. There is also plenty of room to display non-railway models and other railway items.

To register interest in bringing a model please contact the event organiser, Kevin West on **westkev58@gmail.com**

More Events

It seems 2022 is going to be a much better year than the two we've just had. Southport Model Engineering Club tell me that they have two events coming up soon. The first is a 'Small Gauges Day' for Gauge 1, 16mm and 2½ inch gauge locomotives. This will be held on Saturday 23rd April from 10am to 4pm. There will be bacon butties available to purchase, served from 11am to 1pm. If you wish to run you will need to come armed with your locomotive's boiler certificate and proof of cover under your club's insurance. The second event is a Diesel Day (for those of you of that persuasion), to be held on Saturday 22nd May from 10am to 4pm. Refreshments will be available. Again, boiler certificates and insurance will be required. For more information about either of these events see the club's website (southportmodelengineering.club) or email **gwenandderrick@yahoo.co.uk**

Over at the other side of the country, York Model Engineers are holding an Easter Open Day and steam-up on Easter Sunday, 17th April, starting at 10am. We're promised food, fun and prizes. Situated on the outskirts of York, at Dringhouses, York Model Engineers have nearly 5 acres of land with three different miniature railways, a traction engine track and an RC crawler track. It is landscaped in woodland grounds alongside the East Coast Main Line. An added attraction is that it is not far from the National Railway Museum.

More information about the club is available at www.yorkmodelengineers.co.uk

Silver Soldering

Martin Gearing writes to tell me that he has discovered a small error in his article on Silver Soldering which he wishes to correct. This is located in the article in issue 4668 (2nd July 2021), page 105, third column. At the end of the description of step soldering, after suggesting the three grades of silver solder that may be used when considering step soldering, there is a note which states that 24% silver solder is not permissible for boilers built to the Australian boiler codes. **This is incorrect.** The wording of the code (2.3.2.1) states that 'Silver brazing filler metals containing phosphorus and less than 15% silver shall **not** be used'. This seems clearly to imply that the use of 24% silver solder is allowable. My reading of this rule is that a silver solder that **either** contains no phosphorus **or** contains more than 15% silver is allowable. I've no doubt someone will correct me if that is wrong!

Martin suggests that all readers and club librarians that keep their copies of *Model Engineer* for reference should simply delete the note.

Machine Mart

Now that we are well into Lent, spring and Easter cannot be far away. No doubt you will want to buy a nice present for the model engineer in your life. It can be hard though to know what to give him (or her). This is no longer a problem! Just let them choose with a Machine Mart Gift Card or e-Voucher, which can hold any value from £20 to £500 and can be used in any of Machine Mart's 65 superstores nationwide. They are available to buy in store or you can order them online. An e-Voucher can be sent in a personalised email style, courtesy of Machine Mart, whatever the occasion may be!

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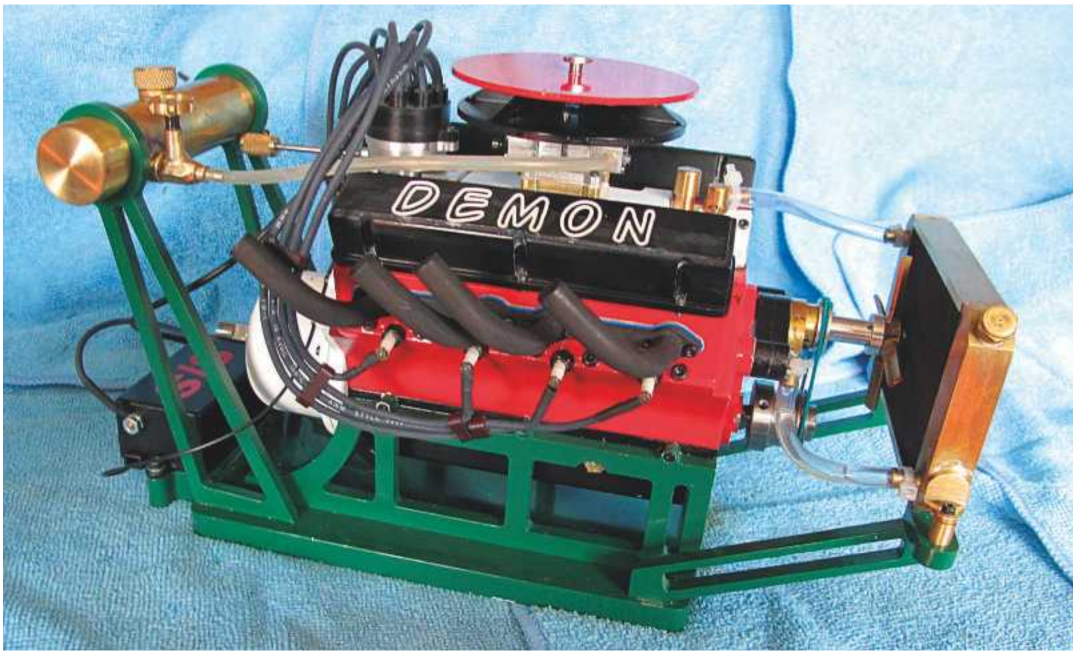
The *Little Demon* Supercharged V8 PART 1

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



Introduction

In the couple of years that have passed since the completion of my Bentley BR2 aero engine, the build series of which appeared in *Model Engineer* (odd issues, 4589 to 4625 inclusive), I've been trying to find another engine build that would offer the challenges and enjoyment of the BR2, unfortunately without much success.

Since I knocked a Spitfire flight off the bucket list, and in spite of the horrendous cost it would have involved, I've wanted to have a crack at building the Rolls Royce Merlin, but the only company I could find supplying a full set of castings and plans was in the USA and ceased trading several years ago. I've read some anecdotal posts online concerning the quality of the castings and the reluctance of any other foundry to take on the work, which would probably suggest why they're no longer available.

I did start a scratch build of the De Havilland Gipsy straight four but I really couldn't get into it fully and the partially machined components are currently under the bench, where I suspect they will remain.

During various trawls through online sites specialising in model engine plans one engine in particular kept cropping up; that was Steve Huck's Little Demon V8 and although I've already built a V8 (the Frank Whittle V8) the finished engine looked a neat piece of machining and as the set of drawings wasn't that expensive I ordered the downloadable plans.

There is a single carburettor version and a twin carburettor supercharged version. As the supercharger plans were about $30 at the time of writing, I included those as well.

Once the funds had cleared, the plans were available for download. The plans are very clear and concise and on first glance I could see there would be some interesting machining and plenty of it; with some » of the components being exceedingly small there would plenty to hold my attention. Any engineers that suffer from podgy finger syndrome might have a problem assembling some aspects of the engine. I refer in particular to assembling the rockers and valve gear.

There are no accompanying build notes, apart from a short description of how to set about the initial machining of the engine block and setting the timing. There is however a detailed account of how to machine the camshaft - more on this when we reach that stage of the build. I would also mention that, if a potential builder should encounter any problems during their build, Steve Huck, the designer, can be contacted via the email address in the plans or the HMEM forum and is very approachable regarding any problems the builder might encounter. I did contact him with a couple of questions regarding the camshaft, which as I've said we'll cover when the time comes. Steve did say that he treats the Little Demon like his third child and so not to worry about contacting him. Having said that I would consider that this particular build would be more suitable for the experienced and confident model engineer. I would of course never discourage any model engineer from stretching themselves by machining and building outside their comfort zone but there was more than one occasion when I needed to stand back and think about what I was trying to achieve.

The bulk of the milling will be done on my mill/drill but I will be using my little CNC milling machine for some of the smaller components that require the use of very small carbide milling cutters that obviously need higher speeds to work efficiently - the CNC mill is happy working at 7000rpm. All turned parts are as usual produced on my trusty Myford Super7.

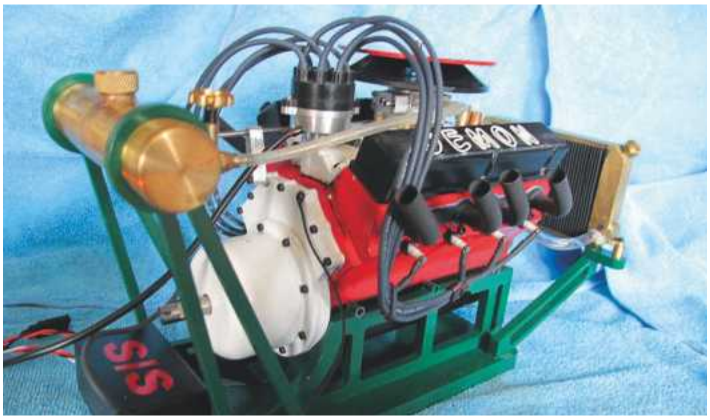
Regular readers will probably not be too surprised to learn that I will be deviating from the conventional and recognised methods of producing some of the more complex components such as the crank and camshaft, by fabricating both rather than machining from solid. To my mind the configuration of the cylinder block lends itself to the accurate fabrication of the crankshaft, while the method suggested to machine the camshaft from solid is just a bit too complicated, especially for a small machine such as the Super7.

The methods I use are of course my personal choice and in no way am I suggesting that this is the best method of approaching the construction. Any potential builders should adopt methods that best suit their own workshop facilities and abilities.

There's not so much of a preamble to this particular build, unlike some of my previous engines, so I hope everything will become clear as we progress. As usual, I will be mentioning material supplies as and when. There is a comprehensive list of suppliers for all the sundry items required included with the plans but they are all based in the States. I find it's more practical to source materials here in the UK and in most cases far cheaper. On one occasion in the past I had to import a ring gear from Boston gears in the States as that particular item wasn't available from stock from another supplier. The import duty and carriage over and above the initial purchase price on the ring gear was truly eye watering.

All the fixings on the engine are UNF or UNC. Although these are freely available in the UK I prefer to use corresponding BA and Metric sizes. For this engine the three main sizes of thread I used are 10BA, M2 and M2.5 - the difference between the UNF and UNC diameters and pitch are miniscule.

I use babolts.co.uk and modelfixings.co.uk for all the screws and bolts on this engine, both of whom I can thoroughly recommend for their stock range, prices and service.



I did source the spark plugs, which are just about the smallest that are readily available, and the CDI ignition system from Roy at cncengines in the States with whom I have had a happy working relationship for many years. Fortunately for Roy, but unfortunately for the rest of us, Roy and his wife ceased trading as from September 2020 in order to enjoy their retirement - I for one wish them both well.

As with all my other build series published in *Model Engineer*, and in order to observe copyright, I will not be using any drawings or dimensions that are the intellectual property of the designer, which could assist with a build without purchasing the plans, but I will as usual be including as many photographs as possible to illustrate the various machining operations and assembly. As with my other build series I hope some of my approaches to the various machining processes might help other engineers to tackle different aspects of machining on their individual projects.

In some of my previous builds I have talked about machining processes that haven't quite gone to plan, as I hope it demonstrates that even experienced engineers don't always get it right first time. This will again become evident when I start to build the radiator for the cooling system.

To accommodate the single carburettor version and the supercharger three identical carburettors had to be produced. I of course recorded the various processes but for reasons I don't fully understand I can find no trace of any photographs anywhere on my computer, so I regret that this part of the build won't be supported by photographs.

Most of the mating faces require 0.010 inch and 0.020 inch thick Teflon gaskets. Any potential builder will have to decide on the best method to produce them as some will definitely need to be machined. If you're going down the CNC route then they can be machined at any point by slightly modifying existing programs used to produce the various engine components but conventional machinists might consider making the gaskets at the same time as machining the individual components in order to utilise the existing machining set-ups. I will of course discuss my approach towards the end of the build.

A few simple jigs and fixtures will be required to aid some machining processes but nothing as elaborate as some of my previous builds.

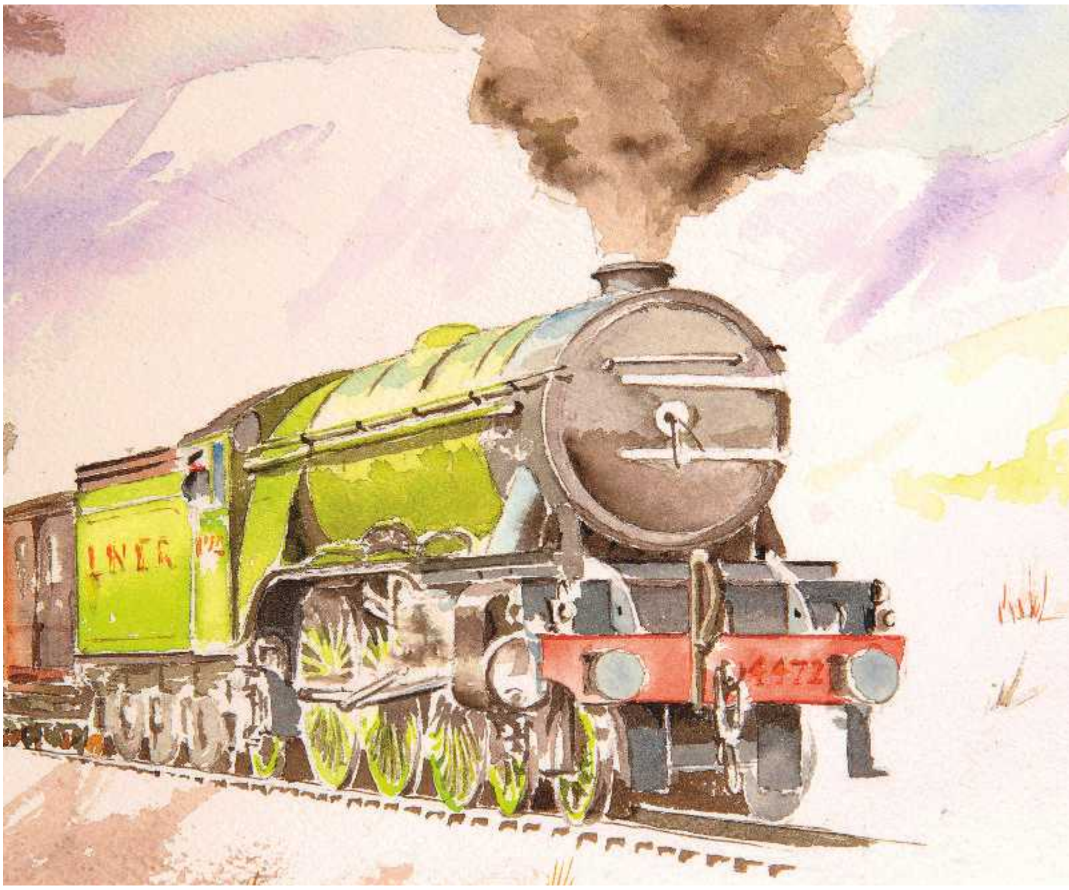
I'm acutely aware that the majority of readers being conventional machinists are not that bothered about the CNC aspects of my build and so I have kept it to a minimum, although on one occasion I felt some explanation was required.

Full sets of plans can be purchased and downloaded from the Executive Model Design web site - email: **doug@minicastings.com**

●To be continued.

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

Continued from p.379
M.E. 4686, 11 March 2022

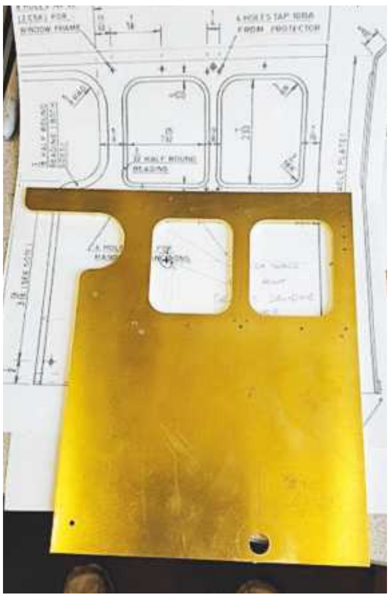


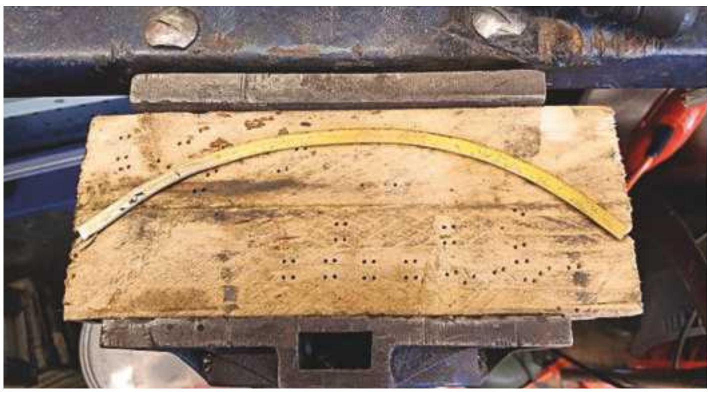
Painting by Diane Carney.

PART 31 - CAB

Flying Scotsman in 5 Inch Gauge

Now I made a start on the cab and again I have made use of Malcolm's laser cut parts. This cab when completed will be highly detailed and I plan to include everything which is humanly possible and it will all work. So I have set myself a heavy task and many years of work but it will be worth it in the end.





RIGHT: 1. Here are the side sheets double sided together to have all of the common holes drilled.

FAR RIGHT: 2. Using both formers to achieve the right curve on the front roof support.

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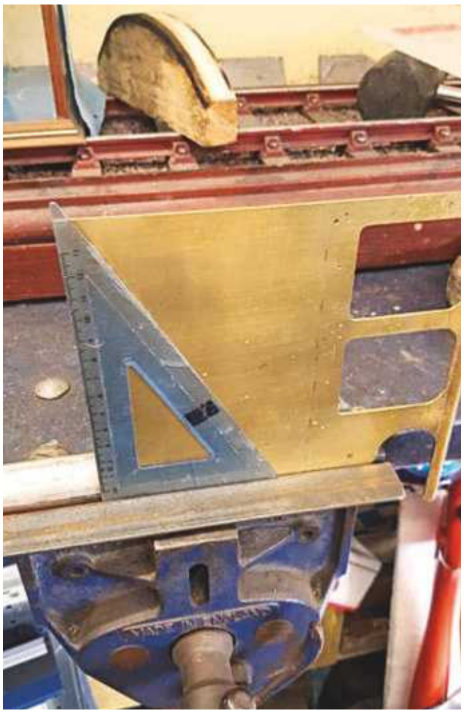


LEFT: 3. I then repeated this for the rear roof frame support. Here are both sections for the curved frames lying on top of the spectacle plate for size. These will be annealed one more time to reach the final shape.

RIGHT: 4. For the rear curved sections I reused the same jig that I made up for the tender sides many moons ago. I marked a line to help keep the curve even along the edge and as a final check used a square as a double check. Once happy with curve and with the brass still hot the formed outer edge tip was squeezed in the large bench vice to ensure a straight and un-kinked edge.

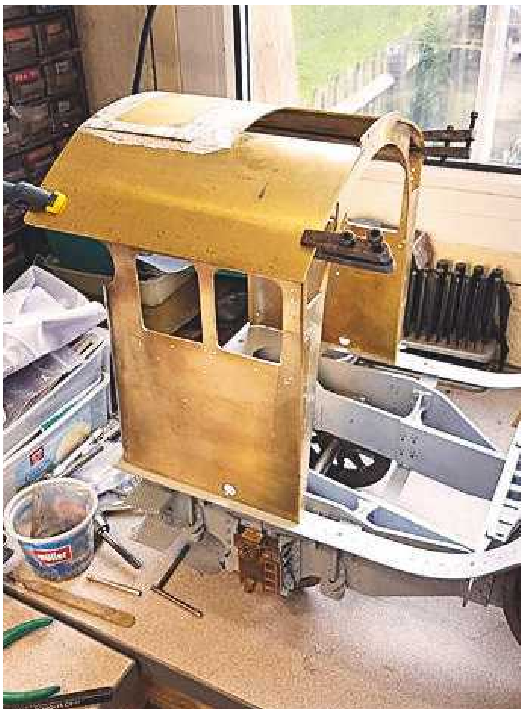
5. Here we see how the basic shape is coming together - it's just taped for now to check for which way I'm going to butt the edges together.

Side sheets and spectacle plate

First, both side sheets were double sided together to have all of the holes that are common to both sides drilled. Then a pair of wooden formers was made, using the spectacle plate as a template, in order to form the brass angle supporting the roof. The angle was annealed and persuaded to shape over the former using a small hammer, re-annealing as necessary. Finally, a couple of bends needed to be made in the side sheets, one for the roof return and another for the rear curved section by the cab door.

Roof

First, I rolled the roof to match the curvature of the spectacle plate. The service hatch (removed for driving) was taped in position so that its curve matches that of the roof. It took about 6 turns through the rollers to get the curvature right. I then fitted the angle to the spectacle plate and side sheets. The arch is riveted at the top middle and silver soldered at the outer ends above the windows where the angle has been cut away for the window and its frame to fit. I decided not to silver solder the sides on but to rivet them in place and use a high melt soft solder to caulk them for strength. I did, however, silver solder the roof butt joint first. I will also silver solder the rear roof supporting arch in place.



LEFT: 6. First, here is a trial assembly of the cab.

RIGHT: 7. The spectacle plate and side sheets are now joined using brass angle. The right angle along the bottom of the side sheets has been silver soldered in place with rivets along the side and four holes drilled through the bottom to take 8BA round head screws for holding the cab to the floor.

10. Here is the roof in place, with the service hatch supports. The plates that the service hatch bolt to will run on the inside of these supports.

LEFT: 8. Before silver soldering the rear roof arch I needed to ensure that everything was going to remain square while building the rest of the cab. The rear roof arch was then soldered in place. The picture shows the first joint completed for the driver's side. The trammel was used to ensure that the arch didn't bow in or out during brazing.

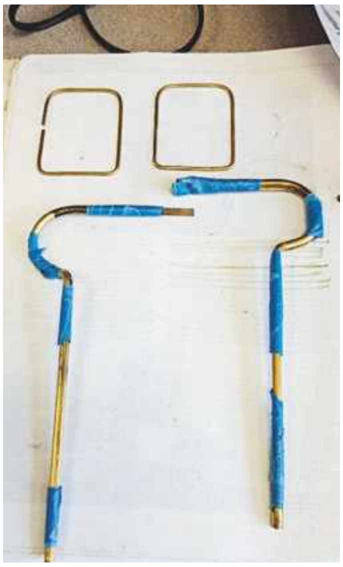
RIGHT: 9. Now I need to fix the supports for the service hatch. Here's the angle being brazed in place. I plotted where to place them and then used a large square to transfer the lines across the roof arches to ensure the supports run parallel.

Cab beading

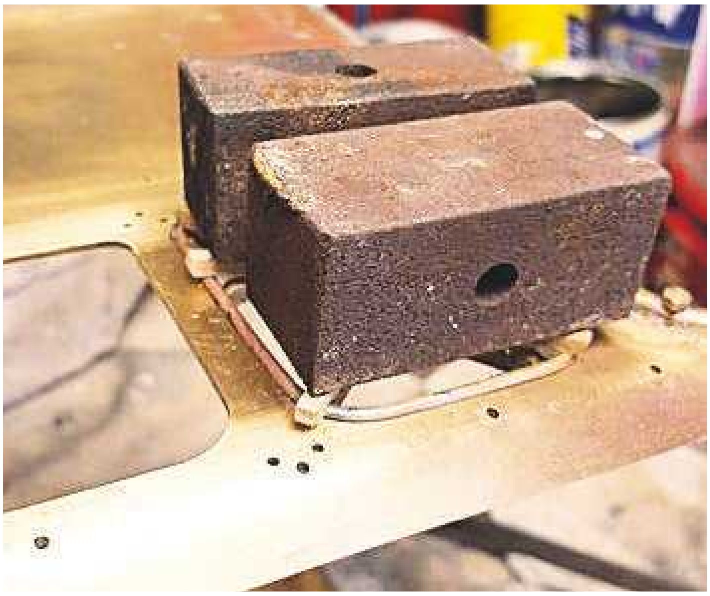
Now I needed to make the beading for the window surrounds and the cab sides. The half round beading for the cab sides is tricky to get right as the beading is on both sides of the sheet, same as on the tender. I approached this by doing the outside beading first, getting it to a shape that I was happy with and then doing the inside section, checking with both the cab and the piece of beading already done as the two needed to match.

The curves were worked by hand, annealing as necessary, using various sized BMS bar and flattened in the vice when beginning to twist. Having got the larger beading close to the required shape I then moved on to the window beading. For this I decided to build a jig with the first part being a heavy brass template of the window opening. Once I was happy with the template I used it to finish filing all of the windows so that they were identical.

11. Here we see the jig in action. Each corner is tackled separately and then held with a clamp before moving onto the next. Note that the template is offset sitting on one edge of the base plate; this is so that I can pull the ends around those outer corners and overlap ready for marking and then cutting using a Dremel disc cutter.



12. Here is some of the beading, ready to fit. The plan is to tin these and sweat them in place. The windows will be done by clamping and heating but the cab side sections will be drilled and tapped before tinning so that I can bolt them in place to the side sheets before soft soldering in place.



LEFT: 13. Here is the beading for the first window ready for heating. The beading is held correctly to the window opening edge via tiny (sacrificial) wooden pegs. The pegs hold the beading in its correct position while the weights keep pressure on the joint until after it has cooled.

ABOVE: 14. And here we have the cab after all of the beading has been attached, I will take care of any cleaning up/filling once I have sorted out the roof section.

15. Here we have the roof with all of the holes drilled and countersunk. Most are countersunk on the top except for the rain gutter strip holes which are countersunk underneath.

16. This picture shows the roof sitting on the cab with the gutter strips in place.

LEFT: 17. With the runners made, the mounting holes needed to be plotted and drilled. I used a thin strip of steel as a guide to keep the runner parallel with the window opening and also to give a small step up from runner to window. I clamped the bottom runner in place and using a fine marker pen marked the position for the holes through the mounting holes in the side sheet. Once happy that all was good I held both bottom runners together (back to back) in the machine vice and drilled through taking care of both sides in one hit.

RIGHT: 18. For doing the top runner I cut up a piece of brass sheet slightly taller than the window will be, tall enough so that the bottom of the top runner was just above the window opening itself, held in place with clamps and marked and drilled just as the bottom runners were.

Rain strips

To make the rain strips I needed to machine down some ¼ inch brass angle. I had considered annealing the angle first to reduce any distortion from machining but decided against as I was likely to get more distortion from the heat than from the machining, as it happens this proved to be a good decision.

Window runners

On the prototype, the window runners are fabricated from what looks like three main pieces, the middle square section and two flat plates, one either side, all held together I believe by the bolts that also hold each runner to the cab side sheet. In the interest of a smooth operating window, I decided it best to make each runner from solid, my chosen material being brass, whilst maintaining the look of the prototype.

Using some square brass section I machined it down to what looked close to the photographs and milled the slots that the rear window would slide in, remembering to make opposites for each side. Following normal sliding door practice, I milled the slots for the top runners deeper than those in the bottom, the idea being that I can fit each window without needing to remove either runner as there's not enough room to slide in from the rear.

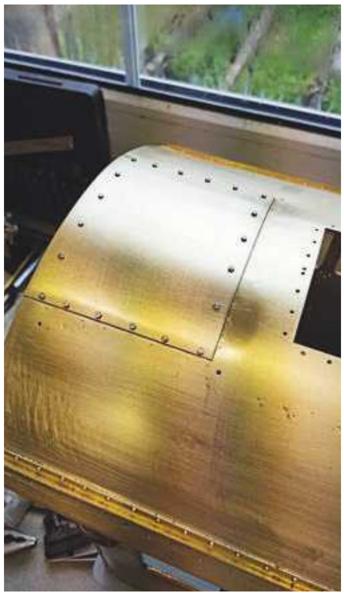
Fitting the roof

Fitting the roof involved lots of drilling and riveting, as one would expect. Having previously drilled the lines of holes in the roof itself the next job was to transfer these to the cab whilst keeping all square, not an easy task when talking of a flexible structure even when using a solid steel jig to hold the bottom square. With the cab on the jig I lined up the front edge of the roof with the cab front. Having lined up the front I drilled through at the top middle where the roof meets the ventilator and also diagonally from here to the rear corner of the roof and dropped in a couple of rivets to hold things in place. I could then check around the cab to see how things looked.

I then moved to the driver's side, clamped the roof in place, checked it lined up and began to rivet the lower edge, starting in one corner, the middle and then the other end. Happy that the roof was square I then drilled/riveted the whole line. I then worked my way up to the top of the roof and the

19. Here we see the roof in place ready for the fixing holes to be spotted through.

20. The service hatch supports have been fitted and rivetted in place.



21. And here with have the hatch fitted with its bolts ready for the next stage.

22. Here's the service hatch finished for now.

right-angled support that runs front to back either side of the service hatch.

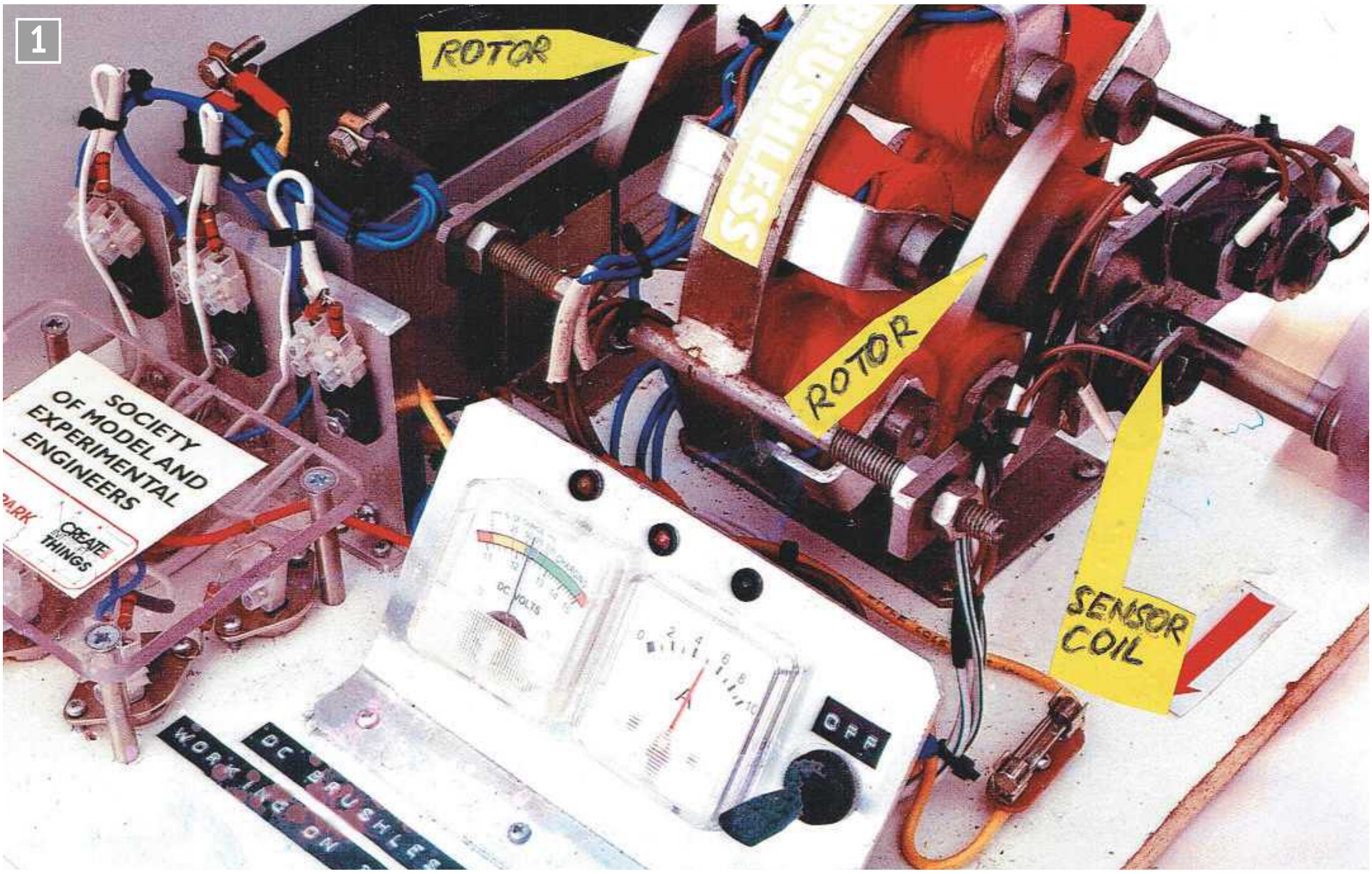
Service hatch

Finally, we have the fitting of the service hatch. It sounds so simple and quick... well, it is simple, I guess, but not quick. The first job was to fit the ledge support under the roof edge for the hatch to sit on. This involved a little cutting/machining as I didn't have any brass strip of the required size. The edge strips are flush riveted to the underside of the roof ready for transferring the mounting holes through - one thing that has pleased me is how rigid this structure is, very strong and with these strips added which in effect are laminating parts of the roof it's even more so.

The hatch was them rolled a few times until happy with how it sat in the recess. The next job was to drill and tap all of the 10BA holes and check the roof for fit.

It was then time to remove the rear roof support section. I first made two short arched plates and drilled four holes in each. These were then clamped to the roof support with the holes equal either side of the join. With the plates clamped I drilled through and tapped, held the plates via their bolts and trimmed and filed the inner arch. Once I had done this I removed the hatch, hack-sawed through the rear arch support and filed to finish. It was nice to see that due to the rigidity of the cab there was no movement whatsoever in the roof line.

●To be continued.



Sensored brushless motor.

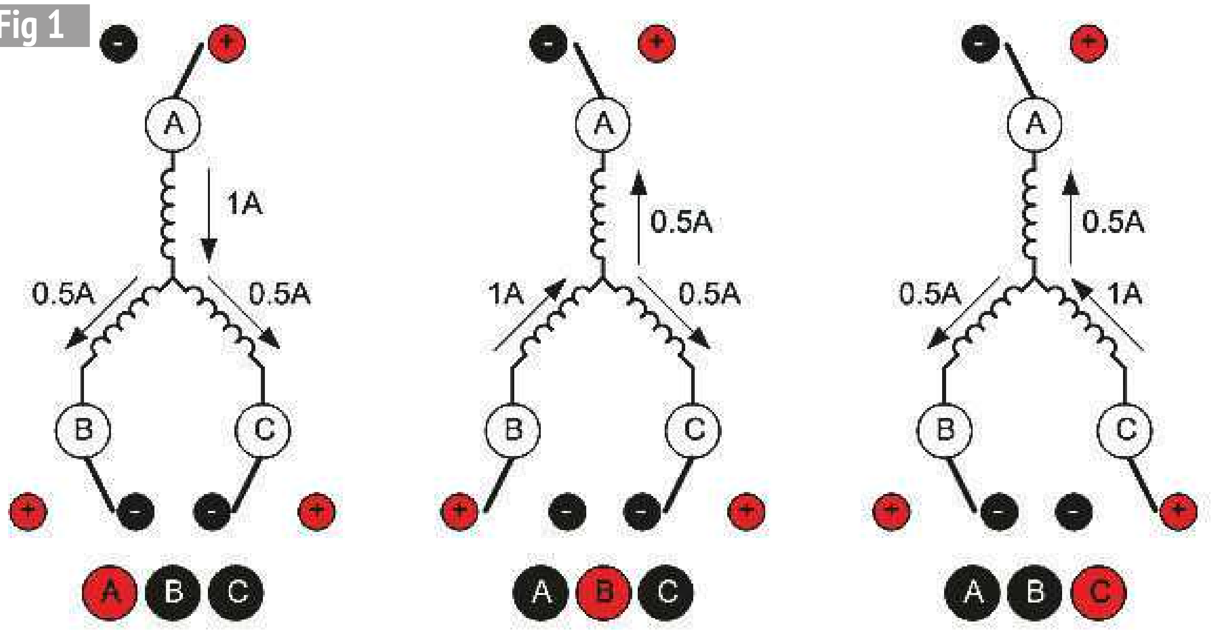
Brian Gawthorpe explores a variety of ways of driving brushless motors.

Experimental Scratch Built DC Brushless Motors PART 1

We are probably all aware that the majority of AC motors, known as induction or synchronous motors, are brushless so, if a DC motor is to be brushless the battery or DC generator electronics must simulate an AC circuit, that is, continually changing direction or polarity to operate a motor on the three phase AC principle. There is no difference between DC brushless and three phase AC synchronous motors. The DC driver circuit that is required to achieve this will also run AC induction motors, that are well known to be brushless. The driver gives the bridge circuit the necessary phase sequence to drive the motor.

The challenge therefore is to build a working driver circuit to do electronically the same as the mechanical switch analogy in **fig 1**. Although there could be various ways of building the driver circuit, I have put things together how I imagined it would work. Firstly, how is it possible for the DC motor to run without brushes? If you were designing such a motor, how could you bring this about? In the conventional DC motor, mechanical means are used to produce the alternating magnetic field needed to drive the armature round. This is done by brushes and a commutator which can be viewed as a mechanical switch continually reversing the coil current direction when the coil ends pass the brush box. This is known as the GNP or general neutral position and

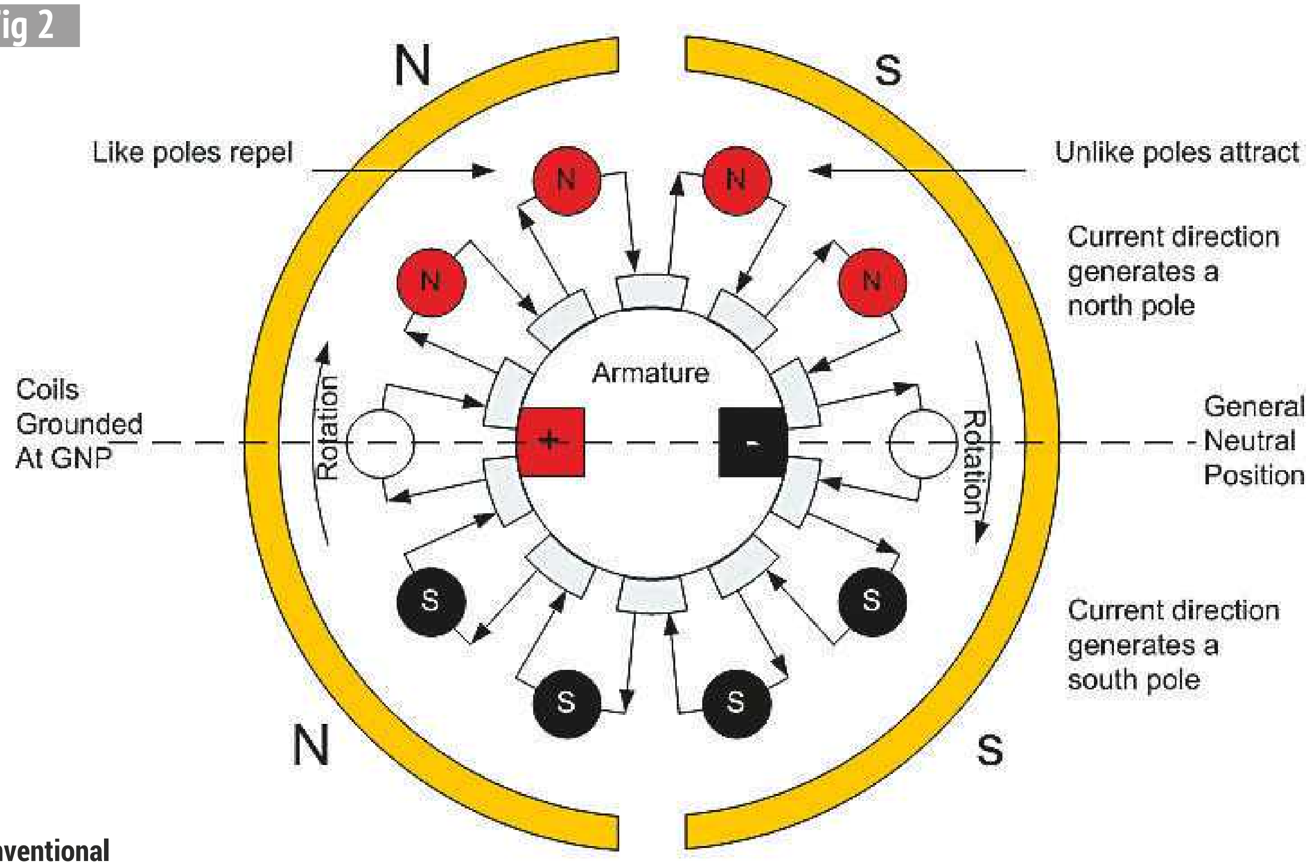
Fig 1



Creating a rotating field using switches.

A mechanical switch analogy of what is required from the driver electronics to simulate a rotating motor stator or magnetic field electronically.

Fig 2

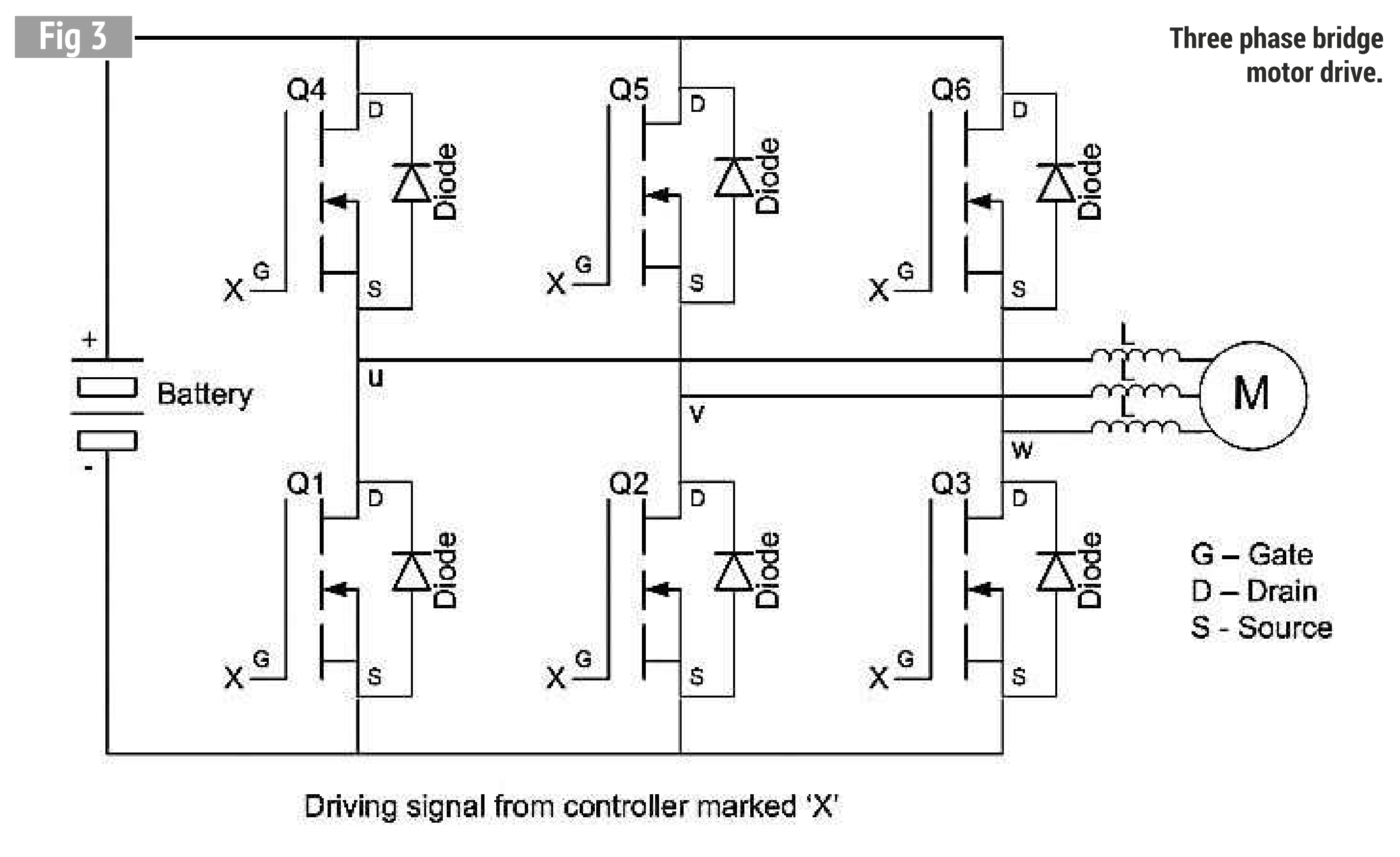


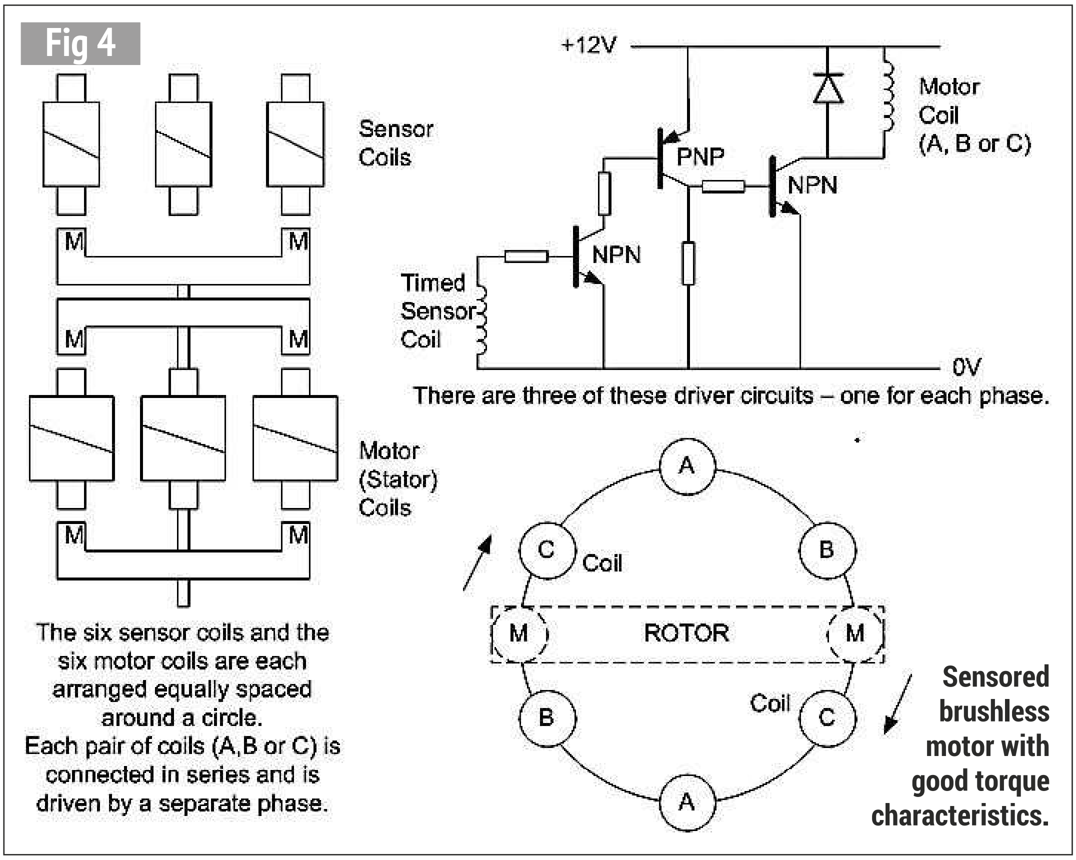
Conventional DC motor with commutator.

Stator field is created by a fixed permanent magnet

maintains the armature push/pull polarity (see **fig 2**).

A three phase DC brushless motor is typically driven by a bridge circuit driven by a set of control signals, usually generated electronically. Although plenty of text books illustrate the bridge circuit, there appears to be very little information available about the driver circuit. **Figure 3** shows a typical textbook bridge circuit and the 'X' symbols show where all the important driver circuit that





automatically controls the phase switching sequence has been omitted. The challenge is to fathom out and build a working model of the driver sequencing circuit.

I suppose it would be possible to acquire complex integrated chips containing many transistors that have been configured already, or plug together circuit modules, but this would not give a true insight into the working mechanism. I decided to build the driver circuit and bridge using individual transistors only. This makes the brushless motor projects described very bulky in appearance but the motors are for bench top demonstration running only.

There are two types of brushless motors, sensored and sensorless. My sensored motor (shown in **photo 1**) works similarly to a timed car ignition system but, instead of firing the ignition coil, six stator coils are fired in three phase sequence (see **fig 4**). This is achieved by three small coils that are placed at 60 degree intervals being induced by two shaft magnets at 180 degrees, for balance. The small current from the sensor coils is amplified before going to the stator coils, the rotor being a permanent magnet. This experimental motor runs at 12V and runs very quietly which just goes to show how much noise brushes create.

In my next instalment I'll discuss my work with a sensorless motor.

●To be continued.

A Geared Transmission for Westbury's Road Roller PART 3

Ted Hansen replaces Westbury's original with a more prototypical gearbox.

Continued from p.406
M.E. 4686, 11 March 2022

The input shaft and clutch assembly

The direction of travel is controlled by two clutches, one on either side of the transmission. The entire input shaft moves left or right to engage the desired clutch (**fig 7**). This movement is controlled by a ball bearing secured to the shaft and shifted left or right by the clutch fork.

Each clutch assembly consists of a cone and a combined clutch disc and input gear (**fig 8** and **photo 13**). An O-ring on the rim of the clutch disc serves as a friction material and the 14-tooth input gear is fixed into the hub of the disc. A good press fit plus Loctite or equivalent should be adequate to transmit the power but for added security the pieces are also pinned together with an axial pin at the outboard end of the assembly (**photo 14**).

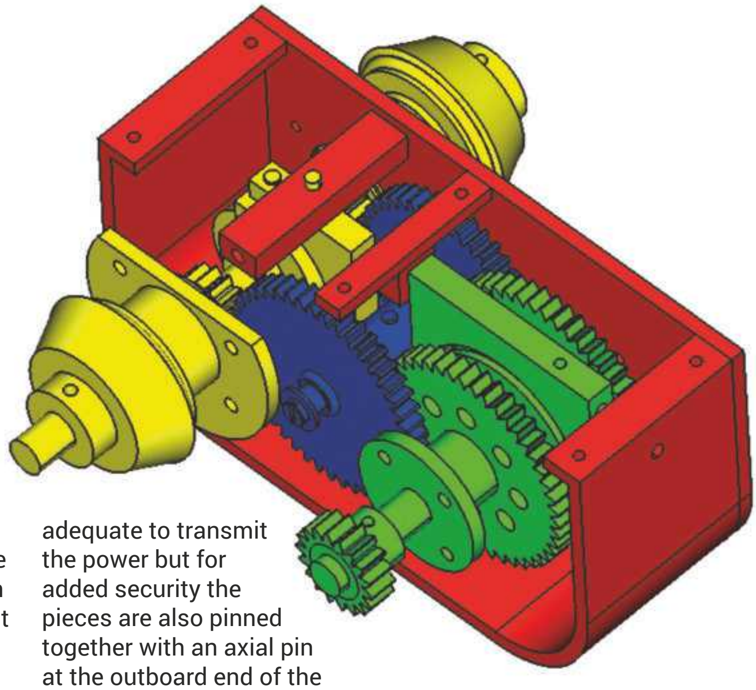
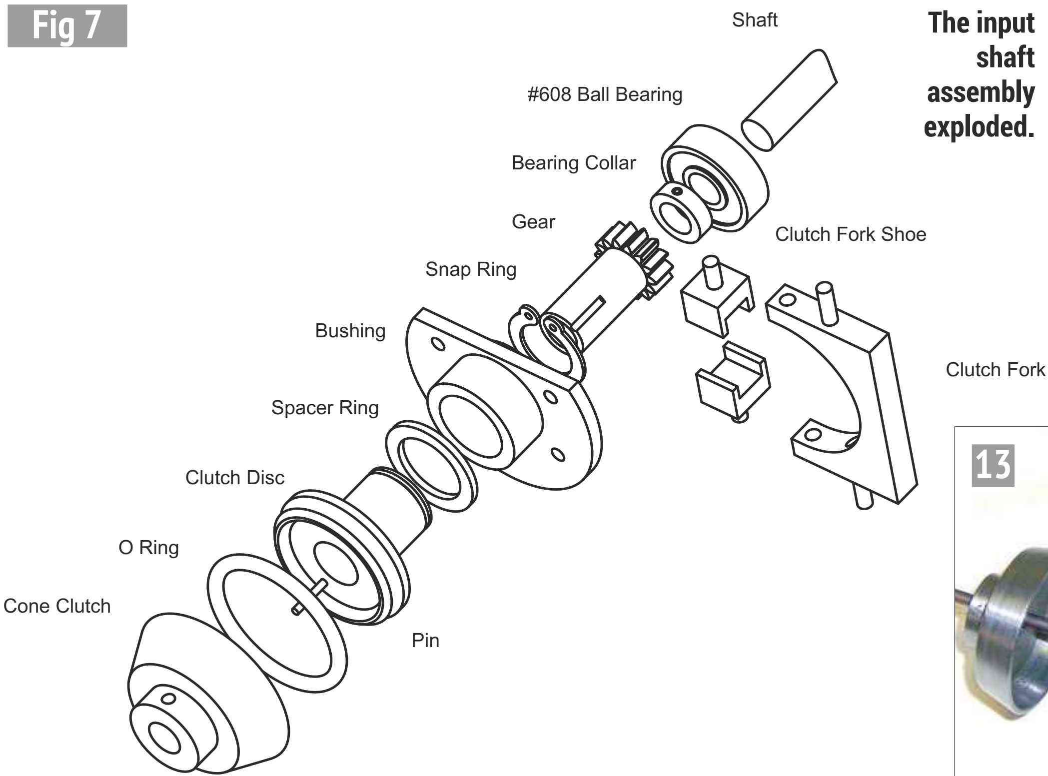


Fig 7



The input shaft assembly exploded.

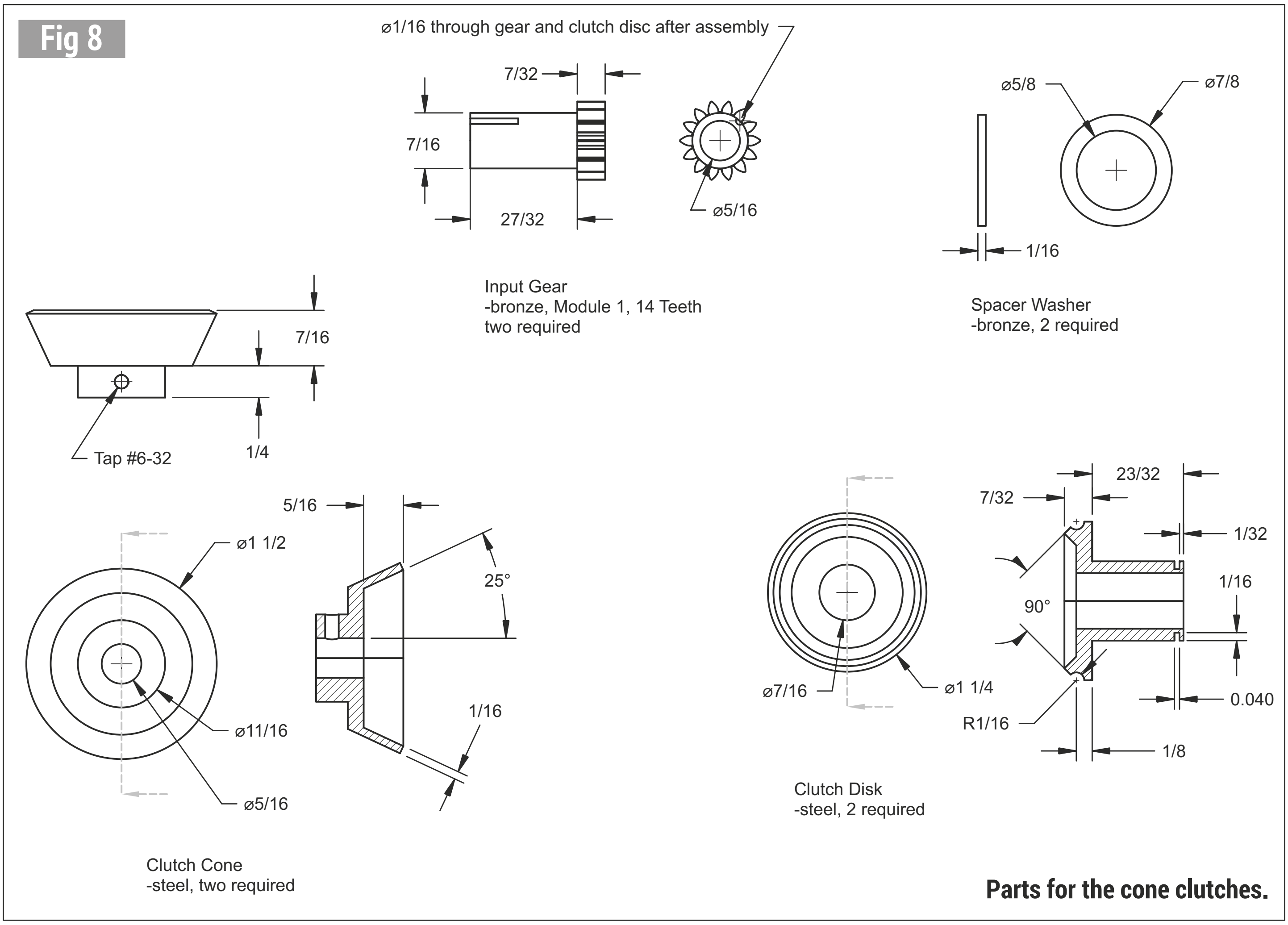
Construction

First make the input gears as described above, then make the cone and disc assemblies. Turn the outsides to dimension first, ream the centre hole, part off, reverse in the lathe and then finish off the end recess.

When making the bushings that locate the shaft in the case, drill the holes for the mounting screws only to tap size (3⁄32 inch for No. 4-40 screws) at first, then use the

13

Parts for the cone clutch assemblies.

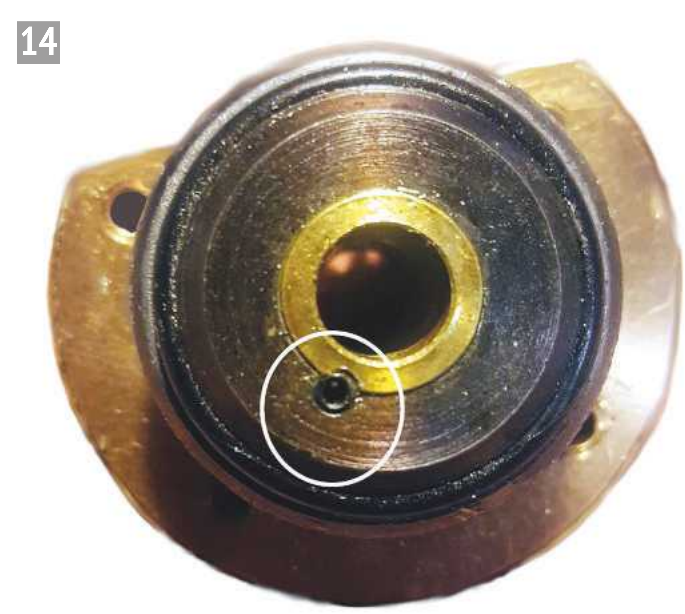


Parts for the cone clutches.

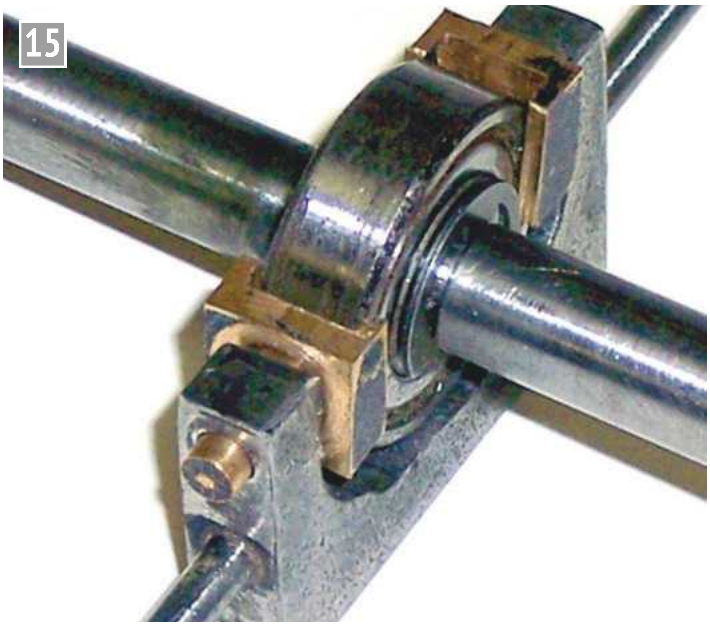
bushings to transfer the hole locations to the case. Tap the holes in the case and open out the holes in the bushings to clearance size for the screws.

The bore of the No. 608 bearing used to control the clutches is 8mm, which is approximately 0.003 inch larger than the 5⁄16 inch diameter shaft. Its only purpose, however, is to slide the shaft back and forth so this rather loose fit is not a problem. The bearing is located on the shaft by a locking collar on either side. If desired, snap rings can be used instead of the locking collars (**photo 15**). The clutch cones are fastened to the shaft by set screws and the shifter fork (**fig 9**) moves the assembly to one side or the other to engage either the forward or the reverse clutch.

The clutch shifter fork pivots are press fitted into the

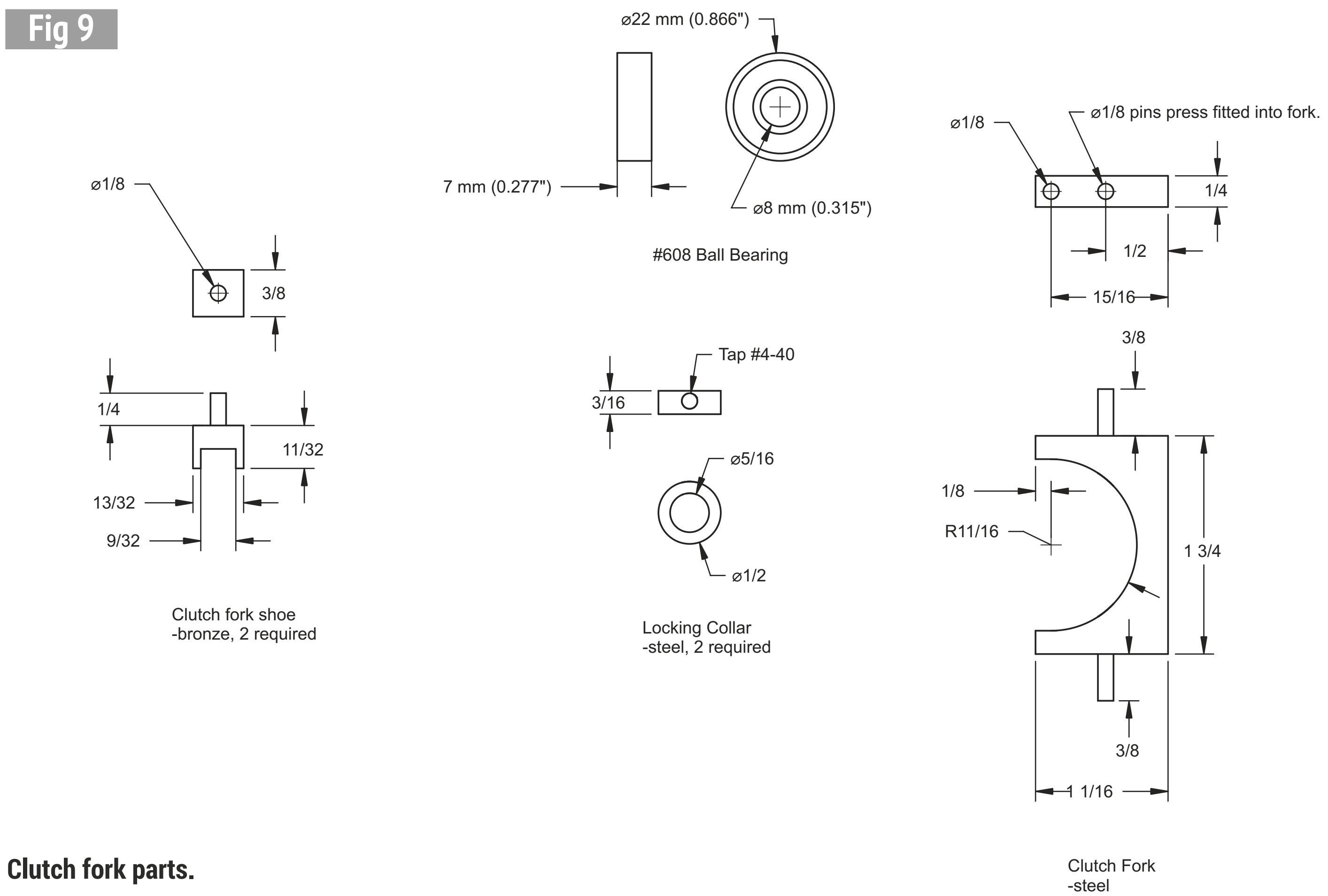


The input gear and clutch disk are pinned together as well as being press fitted.



Snap rings can be substituted for the ball bearing locking collars.

Fig 9



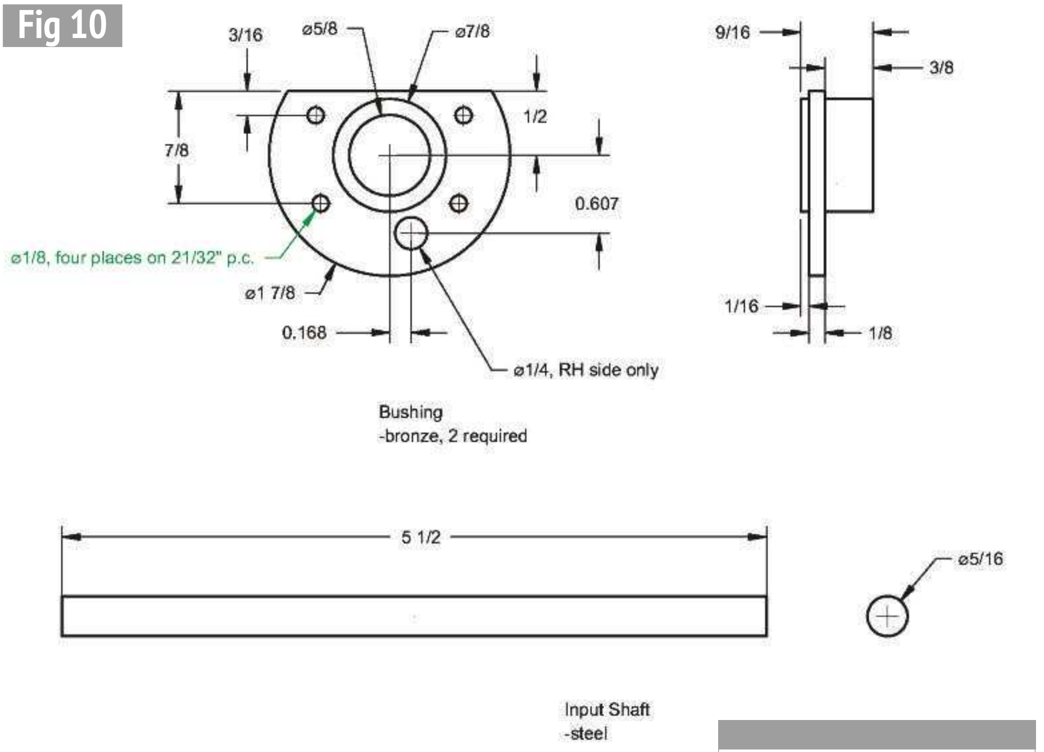
Clutch fork parts.

fork, then the inside edges are trimmed flush with the radius.

Permanently fit each input gear and clutch disc together using a press fit and/or Loctite, drill the 1⁄16 inch hole for the axial pin into the joint between the two parts, then fit the pin into place. Slide the spacer washer and the bushing over the gear and check that the bushing has a bit of axial clearance when the snap ring is installed. Adjust the thickness of the spacer washer if necessary. Note that the gear is nominally 0.629 inch diameter while the hole is only 0.625 inch so the gear might need to be trimmed a bit to fit through the bushing.

Temporarily assemble the input shaft (**fig 10**), the ball bearing and the clutch fork in place; position the removable cross member in location on the upper fork pivot then drill the holes to attach it to the case through both the case and the cross member. Drill these to tap size only then remove the cross member, tap the holes in it to No. 4-40, and open out the holes in the case to clearance size. Countersink these holes so that the screw heads are flush with the case sides.

Fig 10



The input shaft and bushing.

NEXT TIME

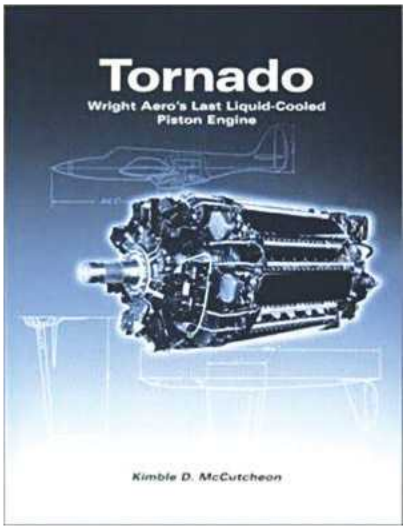
We add the intermediate gears and output shaft.

●To be continued.

Book Review

Tornado

Wright Aero's Last Liquid-Cooled Piston Engine



Kimble D. McCutcheon

Define 'complicated' ... answer: The WRIGHT Tornado T-42 aero-engine!

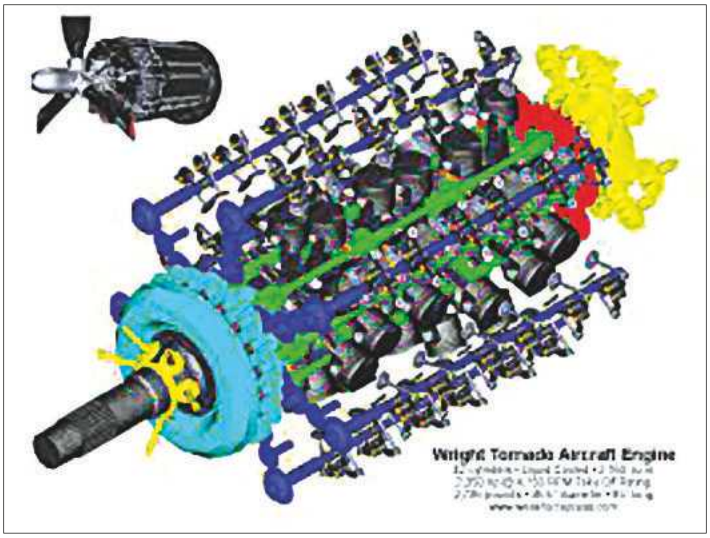
Define 'white elephant' ... answer: (see above)

In a more innocent age when engineers could dream great dreams and create mechanical marvels that today still shock and awe the WRIGHT *Tornado* R-2160 stands out as a stupendous technical masterpiece but a complete commercial dud. The first thing you need to know (some might say the only thing!) is that the CURTISS-WRIGHT Aeronautical Corporation (C-WAC) as it became after its final merger was actually run by a board of Wall-street capitalist speculators with not an engineering degree between them - hardly a surprise for what was to follow...

Kimble (Kim) McCutcheon lays it all out brilliantly in his wonderful book, some 200 pages long including appendices, but only 134 pages of 7 chapters of text-proper and much of that lavishly populated with numerous rare pictures and wonderfully detailed sectioned diagrams and drawings. On the face of it, it might seem to come-up a bit short when measured against other similar biographical dissertations but fear not, reader; it delivers!... thanks in no small part to the author's credentials. Kim is a very well-connected man. As president of the American Historical Engine Society (www.enginehistory.org) he, other than the principals themselves who were directly involved in the *Tornado* project, is probably the only surviving person in later times to be able to write authoritatively on this fascinating aero-engine.

His approach to the telling of the *Tornado* story is methodical. In Chapter 2 he provides biographical profiles of the principal staff who led the project and gave life to *Tornado*. Not the least of these was the lead engineer, German émigré Rudolf Daub, and a man who was to rise to become Curtiss-Wright's vice-president of engineering - and no mean designer himself in his own right - Wilton Lundqist. War and corporate internal politics almost claimed these two heads during the life of the project.

Daub's vision was that of a highly compact, power-dense aircraft power-plant at a then unheard-of power-level which dictated that this output would only be attained by employing a multiplicity of smaller cylinders leading to the (now) unbelievable veritable 'forest' of 42 cylinders but - "Uh-oh" - that was just the beginning; the T-42 was to beget the T-56.... then further down the track, the T-70! "Yes, that's right folks" -those numbers are cylinders, all laid out in multiple banks of seven radial cylinders (i.e. six rows for the T-42). He didn't have to dwell on the broad concept to immediately



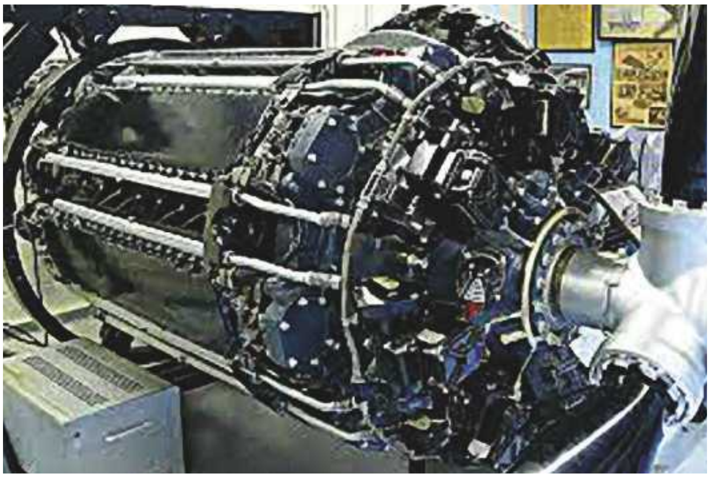
recognise that the likely induced torsional vibrations from an orthodox unitary crankshaft would cause the engine to self-destruct. His solution was crudely ingenious, rather like eating an elephant - never digested in a single bite, but manageable when broken down into smaller chunks - and so it was that each seven-cylinder bank was treated as its own individual power module with its output extracted via gearing to a layshaft such that the cumulative output of all six banks was conveyed to the propeller shaft at the front via additional reduction gearing. Now, didn't I begin this review with the word 'complicated'? ... and we haven't got to magnetos and accessory drives yet! Perhaps you can already see where this is going...

WRIGHT Aero's habit and naming practice of adopting the names of storms led to the christening of the 18-cylinder R-3350 as the *Cyclone* - recognisable as many other air-cooled major WW2 radial aero-engines but there the similarity ends. With the name *Tornado* newly conferred upon the shiny new star in the sky no crude air-cooling here - "NO, no, no" - it was to be a streamlined water-cooled engine, perfect for a fighter aircraft. Also unusual for the time, it was to be a short-stroke engine of 4.25 inch bore x 3.625 inch stroke, i.e. 720 in^3 displacement/cylinder. And, as for optional 'extras': turbo-charging (obviously) and also a two-speed reduction co-axial gear-box swinging up to a 20 inch diameter four-bladed propeller (later proposed for the HUGHES DX-2).

But Daub & Co. did not just dive right in, no-no, far from it. They were in new territory for which they adopted a cautious approach. The contract (AFP No.148115) was officially initiated on April 12th, 1939. The experimental program began with the T-14, a two-row proof-of-concept bench-tested prototype as the designation implies (two were finally built plus parts for a further two), and which was dynamometer tested from July to September 1940 during which many mechanical problems were shaken out and remedied. Generally, though, the engine under-performed against expectation, the best figure of ~600hp falling far short of the anticipated 800hp mainly due to excessive pumping losses.

Now for the 'main event'. The **T-42**. Five engines were initially ordered and a further five proposed. Ultimately, six were actually built plus a further 13 complete parts sets. The vertical 'A' bank cylinder group contained the master-rods, the seven high-speed lay-shafts carried each row's power forward to a 4.33:1 propeller reduction gearbox and the 12 inch diameter single-speed supercharger, driven at a 1:4.20 step-up ratio - consuming ~500hp in the process. No push-rod OHV for the *Tornado*! Gear-driven (from the layshafts) overhead camshafts, two valves/cylinder... The cooling system employed a 50/50 water/ethylene-glycol mix. The design goal was to achieve 2,365hp and an all-up weight of around 2,700lb - fairly lack-lustre by late-war standards. Bedevilled by constant program slippage, due in no small part to C-W's incredible lack of an in-house, experimental machine shop, i.e. all unique components were contracted out to custom fabricators.

"Great, great! - so where can I find one?" Well, not in any aircraft ear-marked for it, that's for sure! Nearly half-a-dozen aircraft projects were slated to incorporate the T-42 but in the end - and after the eye-watering expenditure of US$6.4 million (~US$65 million in today's dollars) - of which C-WAC picked up a US$6.17million tab, none were ever delivered for installation nor were even flight-tested. Indeed, only 1,632 hours of dynamometer bench-testing was ever completed; paltry when compared with, say the Pratt & Whitney R-4360 at ~15,000 hours. Program termination was formally advised on February 12th, 1944.



Nevertheless, miraculously there is still one in captivity. Prior to the establishment of the US Air Force Museum, Wright Field had become a *de facto* repository for any and all aircraft experimental artefacts and, amongst them, a sole *TORNADO* T-42. Receiving little custodial care, this weather-beaten nugget was gifted to the NASM and underwent restoration by a group of enthusiasts with several C-W employees amongst them from 1989 through to completion on March 11th, 1991 during which the restorers were pleasantly shocked to discover that under the grimy exterior the engine was internally pristine as it had apparently never been run. In an amicable exchange the one shining example of this *tour de force* of engineering prowess now resides on display in the Aviation Hall of Fame and Museum in New Jersey, U.S.A. "Oh, and what did they have to exchange it for?" - the CURTISS-WRIGHT RC-260-Y8 Wankel Rotary aero-engine - but that's a story for another day...!

For the lead engineers, principally Rudolf Daub and his right-hand man, Wilton Lundqist, *Tornado* was a triumph of imagination over common sense but for CURTISS- WRIGHT AERONAUTICAL the *Tornado* project was an incompetent failure of management. Sad, but the potential silver-lining is that as far as I know this obscure and rare beast has never been modelled. Any takers?

André Rousseau

Published by Weak Force Press, 2001
ISBN 978-0-97108-470-4
214pp, illustrated
Available as an e-book from WFP Home (**weakforcepress.com**)

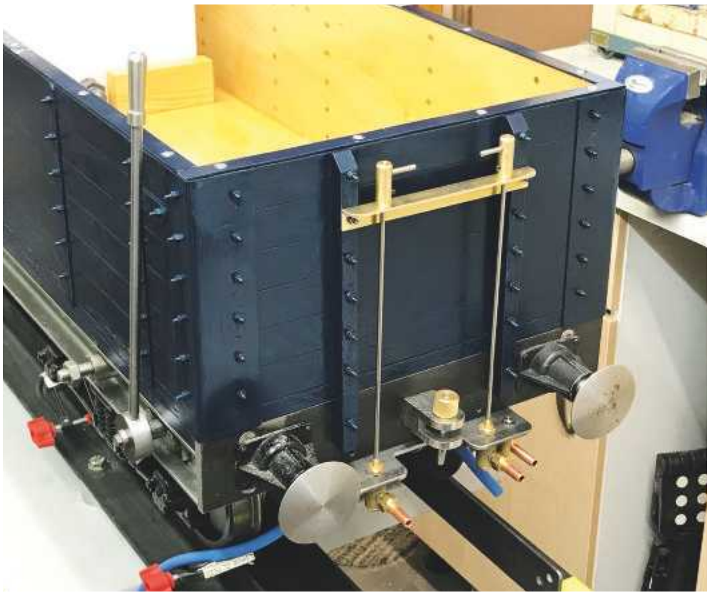
A 7¼ Inch Gauge Driving Truck PART 3

Tim Coles constructs a driving truck built for two, in true prototypical style.

Continued from p.375
M.E. 4686, 11 March 2022

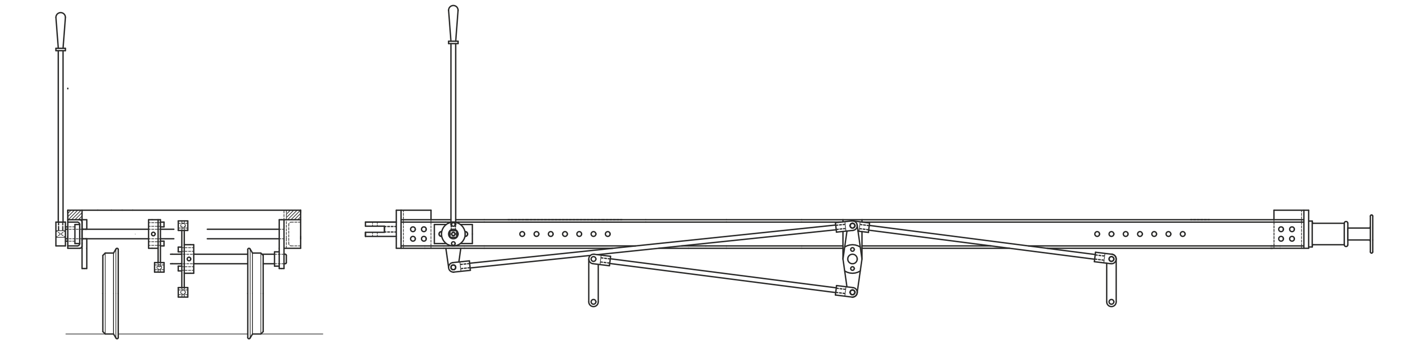
Brakes

The job of linking the brake lever, on each of the Aristocraft bogies, to a single driver's lever at the front of the truck was interesting. I put the hand lever shaft across the frames at the front and an intermediate shaft just below the main frame longerons, at the centre of the truck. It was then just a question of providing suitable levers on each shaft and connecting pull rods to link it all up. The various brake levers are secured to their shafts with taper pins, making the whole lot easily disassembled if the need arises. Our worthy editor gently questioned whether rotation of the bogies would cause a pull on the brake rods. However, the brake lever on each bogie is cleverly located quite close to the centre of bogie rotation and, in practice, this does not seem to be a problem: i.e. the brakes do not self-apply on curved track. In use the brakes have adequate stopping power for running with a light engine but they



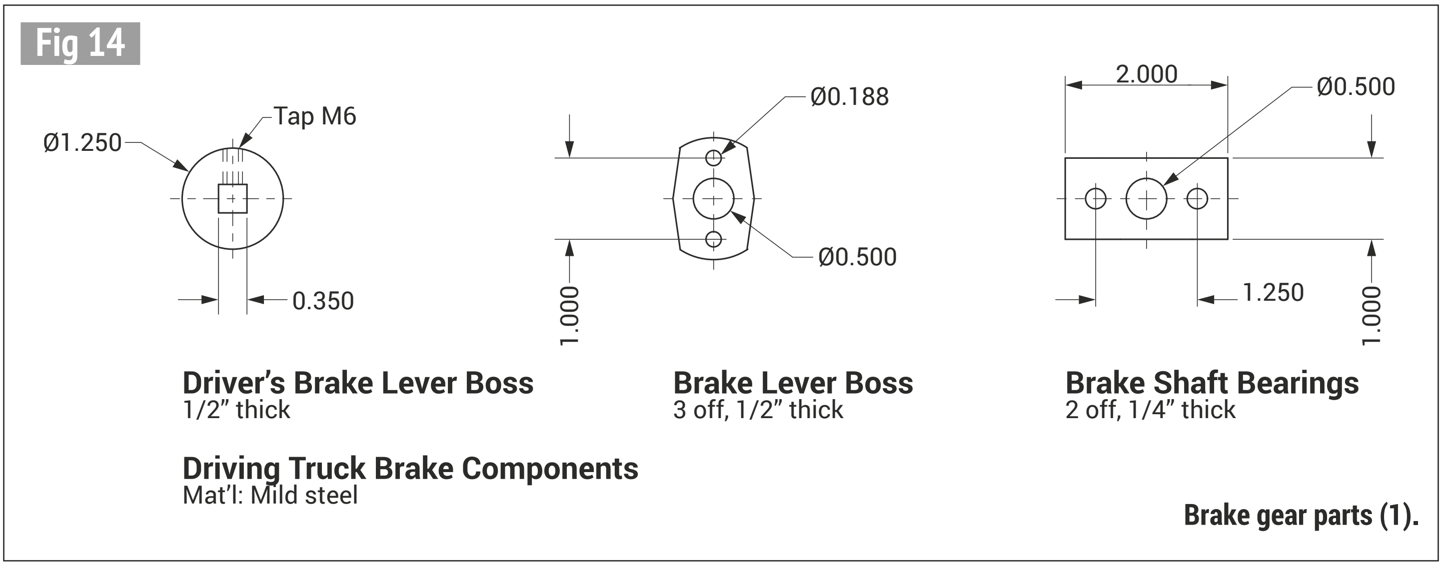
A view of the front end of the truck, showing the driver's brake lever and the injector water valves.

The central brake shaft. Note how the bosses are bolted to the levers and the bosses are fixed to the shaft with taper pins. The bosses could probably be fixed to the shaft with Loctite retainer. The pins provide a positive mechanical lock but one which can be dismantled if required.

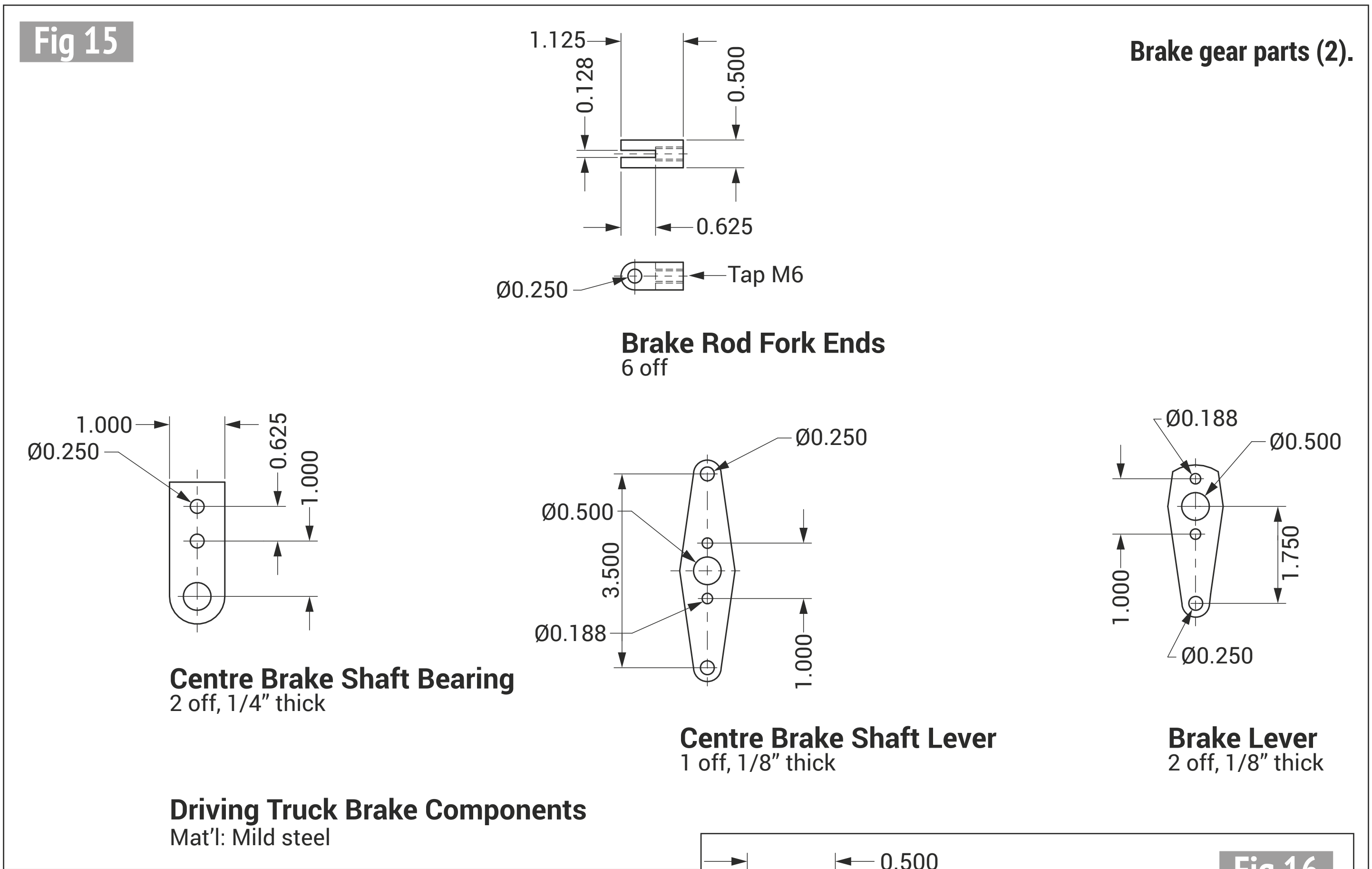


Driving Truck Brake Gear Arrangement

Fig 13



Brake gear parts (1).

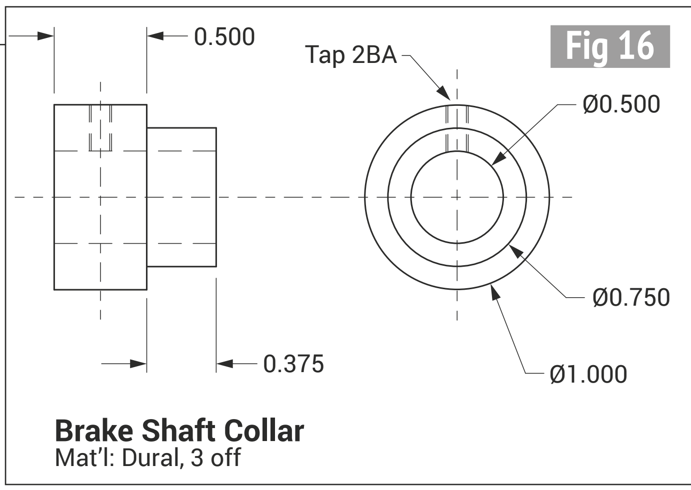


Brake gear parts (2).

would not stop a heavy train, so at some stage I plan to fit a battery-powered vacuum pump, gauge, and driver's valve into the space in front of the water tank, inside the box seat.

●To be continued.

The brake lever on each bogie is cleverly located quite close to the centre of bogie rotation and, in practice, this does not seem to be a problem.



NEXT TIME

We add a body.

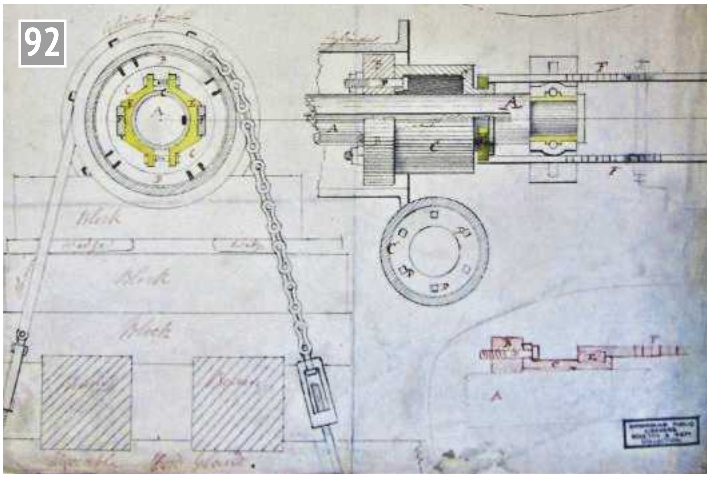
Ron Fitzgerald takes a look at the history and development of the stationary steam engine.

Continued from p.336
M.E. 4685, 25 February 2022

The Stationary Steam Engine

PART 31 - THE FIRST CYLINDER BORING MACHINE AT THE SOHO FOUNDRY

The name 'Soho Foundry' given by Matthew Boulton to the new engine building works was doubly misleading. In spite of James Watt Junior's ambitions that the firm should have its own foundry, the initial imperative was to deal with the problem of cylinder boring and both James Watt Senior and John Southern might have been content to limit the new site to little more than a boring mill. If Watt Junior eventually pushed the development in the direction of including iron-founding capacity, the Soho Foundry was ultimately to be much more than a foundry; it was to become an engineering works that included a foundry. That it grew in this way was largely owed to the urgency of the need to secure supplies of accurately bored cylinders. (The name Soho Foundry gave rise to a fashion for calling all engineering works Foundries. There were many Soho Foundries subsequently, few of which were foundries alone. Not only were engineering machinery works invariably tagged 'Foundry' but several carried the name when they were purely machine shops with no foundry.)



Design for a solid boring bar with external twin-rack drive (Boulton and Watt Collection, Birmingham Library).

Alternative suppliers were explored; Coalbrookdale had produced a number but delivery was unreliable and in response, Walkers of Rotherham and Banks and Onions of Benthall were considered. A letter to Watt Junior from John Southern following a visit to Banks and Onions' works provides a telling comment (**ref 159**):

...We went to Banks and Onions Works and saw their boring mill and some large cylinders for a blowing engine but they were not well done, nor do I think that they had aimed at accuracy. Their machine is the same as the Dale Co's except perhaps ½ inch dimeter of their rod which is less... I think their castings are as well done as the Dale Co's but their notions of accuracy from what I saw appear inferior to the Dale Co's and theirs are very short of Mr. Wilkinson's performances...

The conclusion was that if the standard of Wilkinson's work was to be maintained Boulton and Watt had to machine their own cylinders and the decision to build a boring mill must have been taken shortly after the visit to Banks and Onions' works.

The plans for the boring mill building on the new Soho Foundry site had been completed in August but the design for the boring machine itself remained unsettled. The machinery seems to have been considered the specialised provenance of the millwright and, where previously millwrighting skills had been called for, as at Albion Mills, John Rennie was contracted to undertake the work. Shortly after the construction of the Albion Mill commenced Rennie had secured some premises near to the corn mill but upstream on the east side of Blackfriars Bridge at Jamaica Wharf, Upper Ground Street, off Stamford Street (**ref 160**). It was from this site that he undertook the drawings and made the machinery for the Albion Mill and here, in 1788, he produced the new coining presses for Boulton's extension to the Soho Manufactory that was to become the Soho Mint (**ref 161**). Cyril Boucher, in his biography, extends to Rennie the responsibility for designing the first boring mill and other machinery for the Soho Foundry but it should more correctly be attached to the name of Peter Ewart, whom Boucher dismisses as one of Rennie's foreman.

Peter Ewart was born in 1767, six years later than Rennie and in Western Scotland, at Troqueer (Troquaire) outside Dumfries, whereas Rennie hailed from Phantassie in Haddingtonshire, eighteen miles to the east of Edinburgh (**refs 162** and **163**).

The point of contact between the two young men seems to have been Professor John Robison, a relation of Ewart, under whom Rennie had studied whilst Robison held the Chair in Natural Philosophy at Edinburgh University. In October 1781 Robison had written to James Watt seeking employment for Ewart. This did not immediately transpire and in the following year Ewart was apprenticed to Rennie, working on a mill in Musselborough (**ref 164**). When Rennie moved to London, Ewart went with him and was involved at Albion Mills.

In 1788 Ewart was sent by Rennie to erect the water wheel and rolling machinery for the Soho Mint and, shortly after, he appears to have been employed directly by Boulton to complete the mint machinery. From 1790 to 1792, Boulton and Watt engaged him to erect engines in the Manchester and Leeds areas as a subcontractor rather than employee. In 1791, Ewart independently established a workshop in Manchester employing several men but September 1792 saw him embarking upon a partnership with the Cheshire cotton spinner Samuel Oldknow, just at the point where Oldknow's fortunes had become extremely precarious. The relationship survived for only twelve months. Whether the Manchester workshop continued in parallel with the textile business is unknown but according to Dickinson and Jenkins, Ewart was still in business in Manchester in 1794, both as a millwright and erector of Boulton and Watt engines, when he was brought to Soho to design and superintend the erection of a boring machine (**ref 165**). This pre-dated the purchase of the new Soho works site although, in early September 1795, the Manchester mill owner George Lee was referring to Ewart as:

...holding the Office of Head Engineer at home (Soho)*...*(**ref 166**)

That Ewart rather than Rennie was responsible for the first boring machinery is confirmed by a series of drawings that trace the evolution of the design. Almost inevitably the derivation was from the Wilkinson's Bersham cylinder boring mill for which John Gilpin's drawing, undertaken on Boulton and Watt's behalf, has already been reproduced (**ref 167**).

The earliest drawing is for a boring head. It is dated May 1795 (**fig 92**), two months before the site for the new works had been agreed, and it was possibly drawn in connection with Southern's proposal to adapt the large lathe at the Soho Manufactory to cylinder boring. The head is intended for use in a horizontal machine and shows its paternity in Wilkinson's mill. The arrangement of chains and turnbuckles holding down the cylinder is identical to the Bersham machine but the boring bar and cutting head have been improved. The bar is now solid rather than hollow and has a longitudinal slot which engages a key attached to the boring head that rotates it with the bar. The Bersham arrangement of feeding the boring bar by a single rack passing through the interior of the hollow bar is replaced by twin racks attached to a loose collar running in a groove at the outer end of the boring head. Wilkinson's hollow boring bar containing the rack was prone to the swarf falling into the centre of the bar and becoming enmeshed in the rack teeth. The Soho arrangement avoided this problem as the racks were always clear of the cutters. The draughtsman is not identified on the drawing.

A month later, in June, a drawing of a complete boring mill had been prepared (**fig 93**). It departs radically from the Wilkinson precedent in that the bar is vertical and enclosed in a brick pit. Within the pit, tiered, radial timber props hold the cylinder in its alignment for boring. These props are located in mortice holes in the timber framing of the pit and screws attached to the clamping pads give fine adjustment in the vertical plane. The machine incorporates the twin-rack boring head. In the drawing the head is concealed within the cylinder but the slotted bar and the two racks are visible beyond the ends of the cylinder. The feed must be assumed to have been manually operated and probably uses the bob-weighted lever familiar from Wilkinson's machine and already in widespread use elsewhere.

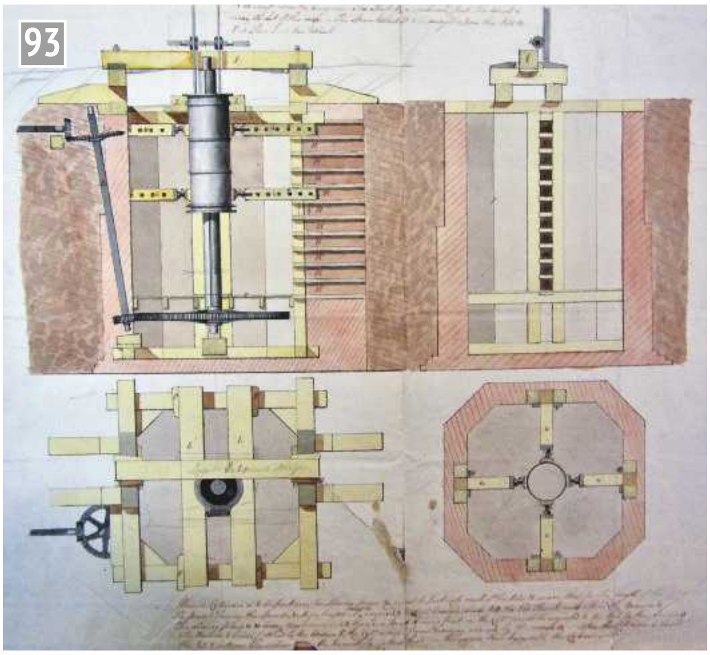
The boring bar is driven by a large diameter gear wheel mounted above the footstep bearing and this gear is rotated by a spur gear mounted on the end of a vertically inclined shaft, at the upper end of which is a second bevel gear drive from the power source. Swarf from the cutting tool falls onto a platform above the gear wheel, preventing it from coming into contact with the gear teeth. The influence of Rennie and the Albion Mill can be seen in that the gears and shafting are entirely made of iron. Elsewhere, the framing is of heavy timber.

Again, the drawing is not signed but it can be identified as Ewart's work by the letter which James Watt Junior sent for Matthew Boulton's approval on the 8 June 1795, the date on the drawing. The letter describes it as *...Peter Ewart's plan for Perpendicular Boring...* (**ref 168**). As a result of the consultation that ensued Matthew Boulton expressed a preference for a horizontal machine and the plan for a vertical machine was rejected. Ewart prepared a revised design. The boring mill was not ready to start work until the 1st of December when an attempt was made to bore a cylinder. The result was a bitter disappointment; the machine had severe problems with chatter and vibration.

By this time Ewart had moved away from the Soho Foundry. In 1796 he had joined with Samuel Greg at Styal Mills in Cheshire and was responsible for the extensive development that took place there over the next decade. Although separated from Soho, Ewart continued to correspond with Watt Junior and accepted a large part of the blame for the boring machine's failings but there seems to have been a consensus that responsibility was equally shared. James Watt Junior, in paying Ewart's final bill, attached no particular recrimination and thanked for him for his help more generally in preparing plans for the foundry and superintending its erection.

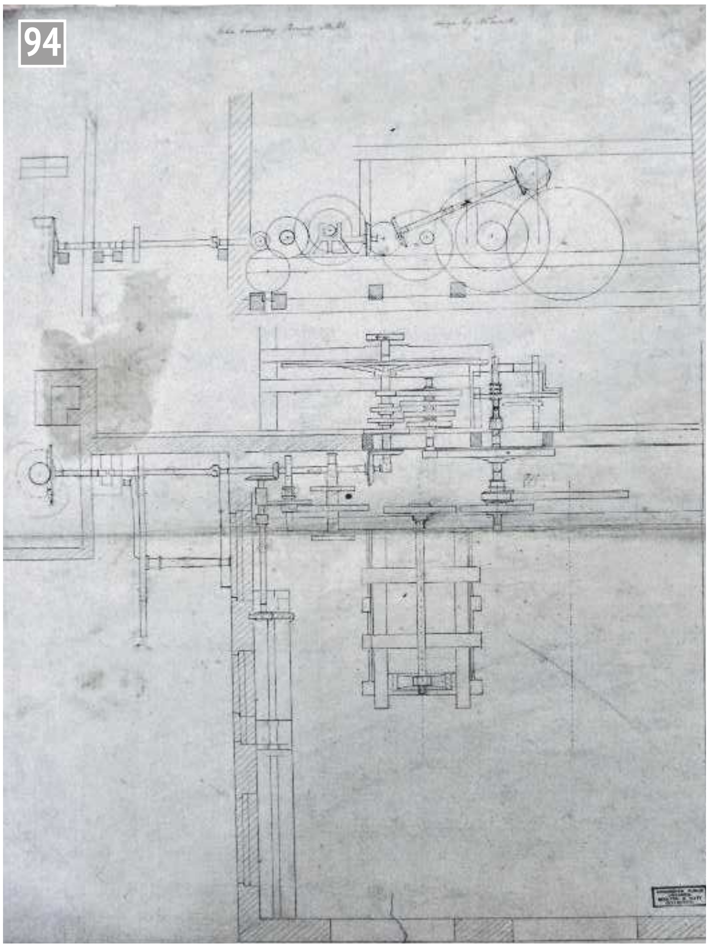
The boring mill continued to occupy their subsequent correspondence and, in

93



Design for a vertical boring machine with external twin-rack drive. Drawing dated 8th June 1795 (Boulton and Watt Collection, Portfolio 1379, Birmingham Library).

94



Soho Foundry boring mill. Design by Mr. Ewart (Boulton and Watt Collection, Misc Portf Box 5, Misc Portf Box 8, Birmingham Library).

February 1797, Watt expressed the view that the fault lay either with the gear wheel that drove the rod or with the rod itself (**ref 169**). Ewart agreed that the rod might be insufficiently rigid but also felt that the cutters might be moving in their sockets (**ref 170**). Whilst there may have been substance in these comments, modifications resulted in no improvement and it was increasingly apparent that the problem was more fundamental. Examining Peter Ewart's drawing of the boring mill machinery (**fig 94**) gives some indication of the source of the trouble.

The engine that drove the mill was a 14 horsepower machine with sun-and-planet gear. The flywheel is shown in the centre of the drawing with the sun wheel at the right-hand end of the flywheel shaft. Neither the cylinder nor the beam of the engine is indicated but their position can be identified from subsequent drawings; the cylinder would be in the blank area between the timber frame of the engine and the chimney which was part of the boiler house.

The engine's flywheel shaft extended across a gear chamber and terminated in a bevel drive in the boring mill building. The bevels drove a shaft which runs parallel to the engine house wall and eventually terminated in the boiler house, driving another pair of bevels and a vertical shaft beyond which there is no further detail. This shaft also powered, by gears, a crank located between the boiler house and the boring mill. This crank is believed to have been intended to operate the blowing cylinder for the cupolas. From the same shaft, within the boring mill, a drive for a long-bed lathe placed close to the north wall was taken by gears. Another set of shafts and gears drove a faceplate, probably for turning pistons.

Returning to the flywheel shaft, as it spanned the gear chamber it carried a change speed facility, three gears which could be slid along the shaft into engagement with three spur wheels mounted on an adjacent layshaft (four gears are shown on the layshaft but the there is no provision shown to drive the smallest of these spur wheels). The layshaft continued through the wall and terminated in a pinion that drove a spur gear on another, parallel shaft which, through further gears, provided the final drive to a boring machine, shown as a timber framework with the boring bar and its outer bearing. Adjacent and parallel to the first boring mill, there was provision for a second boring machine, indicated only by gears and a dotted centerline. The shaft for this second machine had gearing at its opposite end in the engine house but the purpose is not evident.

This examination of the drawing suggests that the central problem may well have been that too much was expected of the engine and the power distribution system. At least five substantial machines and an unspecified number elsewhere in the machine shop were to be driven by one engine, entirely by gears. Fifty years later, with greatly improved gear technology, this would still have been a demanding situation and even in such circumstances pulleys and belts would have formed a major part of the system giving a measure of resilience. Here the drive was solid and any intermittent or vibratory loading generated by the machines would pass backlash shocks through the system, made worse by the primitive level of gear development.

If the shortcomings of the design are obvious to the modern observer the contemporary context should not be overlooked. Experience of complex gear drives at this time hardly extended beyond the Albion Mills and there the operating conditions were far less demanding. That the boring mill was proved to be a failure was the price that Soho was paying for experience.

●To be continued.

NEXT TIME

We look at other boring machines installed at the Soho Foundry.

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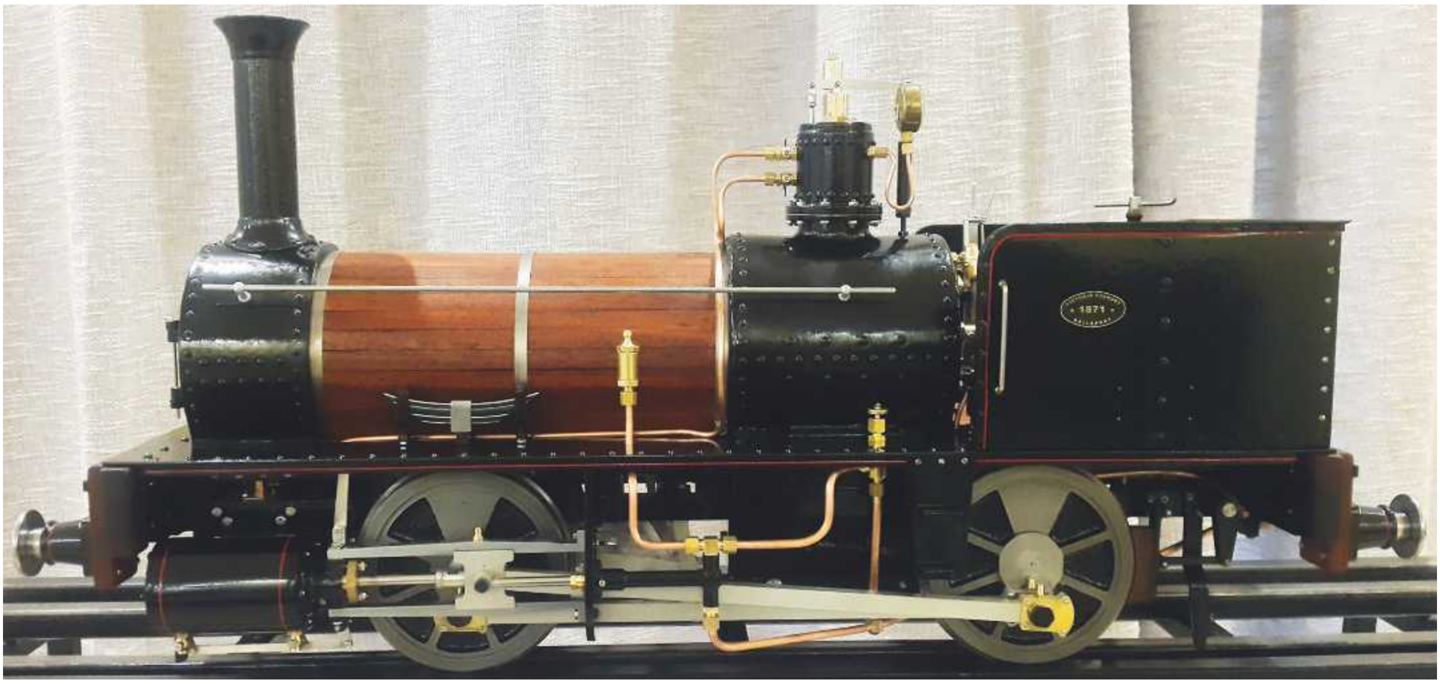
168. Matthew Boulton Papers 353/20; B&W Portf 1379.
169. Watt Junior to Ewart., B&W correspondence Feb 1797, Vol 19.
170. Ewart to Watt Junior, B&W correspondence, 26 March 1797, Parcel F/6.



Ballaarat PART 10

A 5 Inch Gauge 0-4-0 Aussie Locomotive

Luker describes a simple but authentic small locomotive.

Continued from p.326
M.E. 4685, 25 February 2022

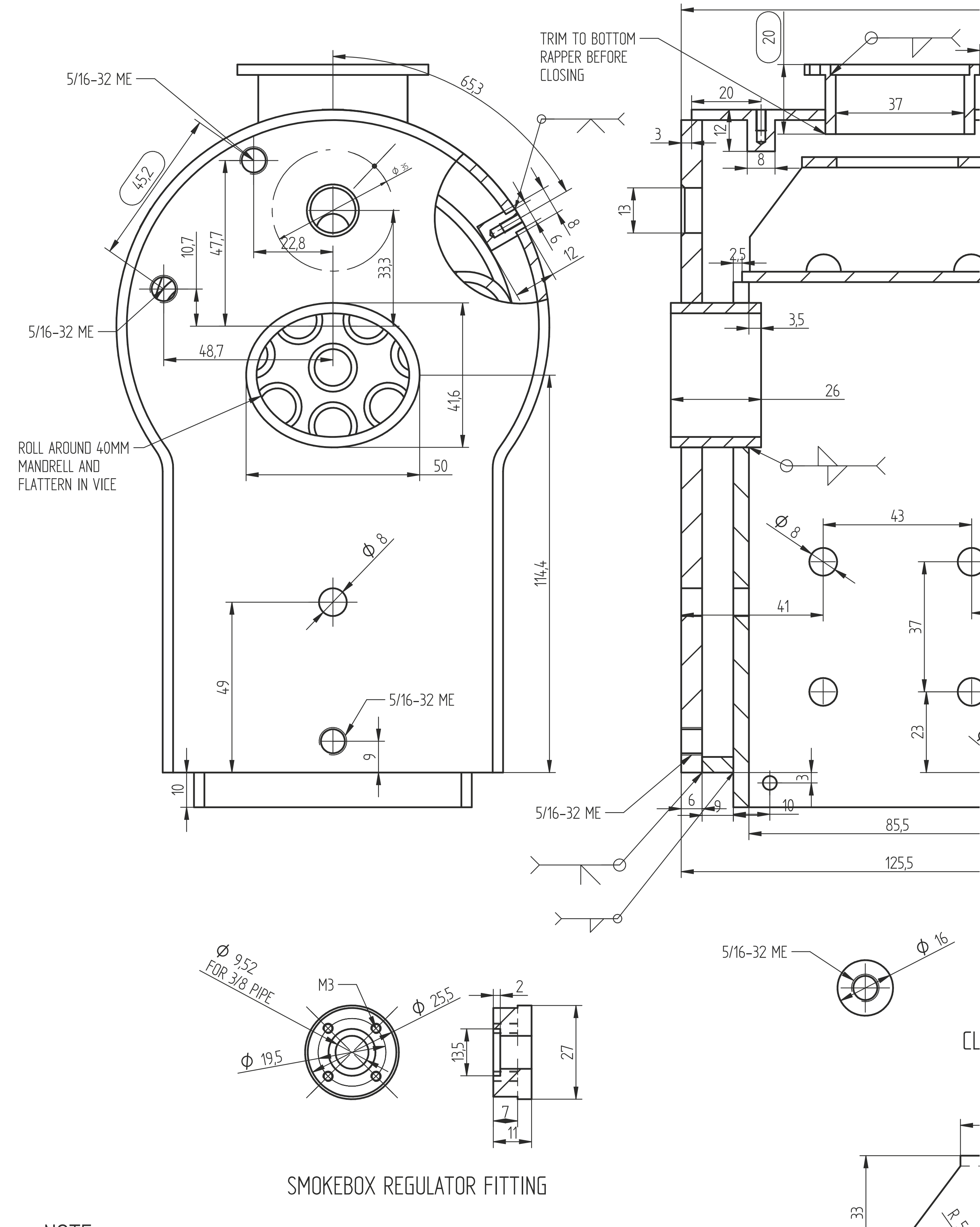
The boiler

Oh dear, we've come to the boiler part of the construction series again. I promised the young chap building the locomotive with me that I would weld up the boiler for him. For this design, as with all my other locomotive designs, I went for a stainless steel construction. (In the last issue – *M.E.* 4686, 11 February – I set out my case for steel boilers; now we'll actually make one!) Cost was the major contributing factor to this decision along with the overwhelming success of my other boilers. The actual cost of this boiler was £72 which is about what I paid for a meal and beer on a business trip in Norway. A copper boiler and, more specifically, the silver solder will cost a little more than that! On a side note, our club has a number of stainless steel boilers with the oldest, a 5 inch gauge Speedy that has been running for 28 years; the detractors (that are still around) are still waiting for a catastrophic explosion that will shift the Earth's rotational axis. Keep waiting …!

Having said, that a stainless steel boiler needs to be made carefully and like any other boiler it needs to be looked after. The most talked about issue is stress corrosion cracking (SCC) due to chlorides in the water. Basically, the chlorides in water react with the stainless steel surface forming a hard, brittle layer which cracks under relatively low tensile (pulling) stresses. The virgin material at the root of the crack 'reforms' this hard layer and the process is repeated resulting in a crack running through the material. Calculating the surface potential for this corrosion initiation is a complex calculation and well beyond the scope of a hobby construction series, but being aware of the issue is important. Normally, the initiation occurs at a sensitisation point, for example, at a weld root crevice. The three main factors that accelerate this process are temperature, magnitude of tensile stress and the concentration of chlorides in the water. If you eliminate any one of these factors the corrosion initiation process will be drastically retarded or even eliminated. It can take months or years for the process to cause a boiler leak depending on the conditions during operation, but considering the boiler is not used every-day all-day the time to failure for a hobby steam engine may be a lifetime.

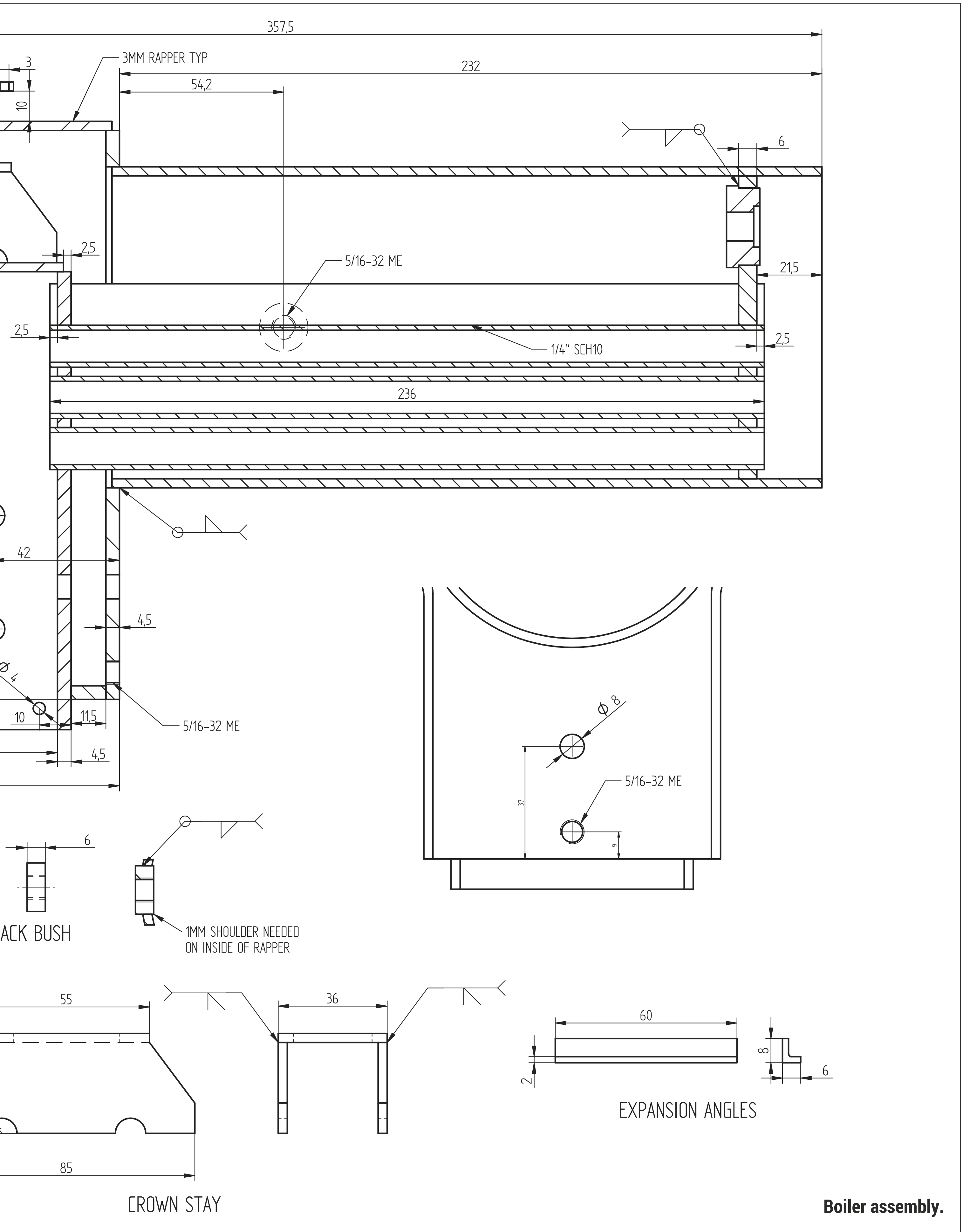
As a locomotive operator you can't do much about the temperature and stresses in the boiler; these calculations need to be done properly during the design phase. The welding should be done carefully to limit welding »

Fig 19



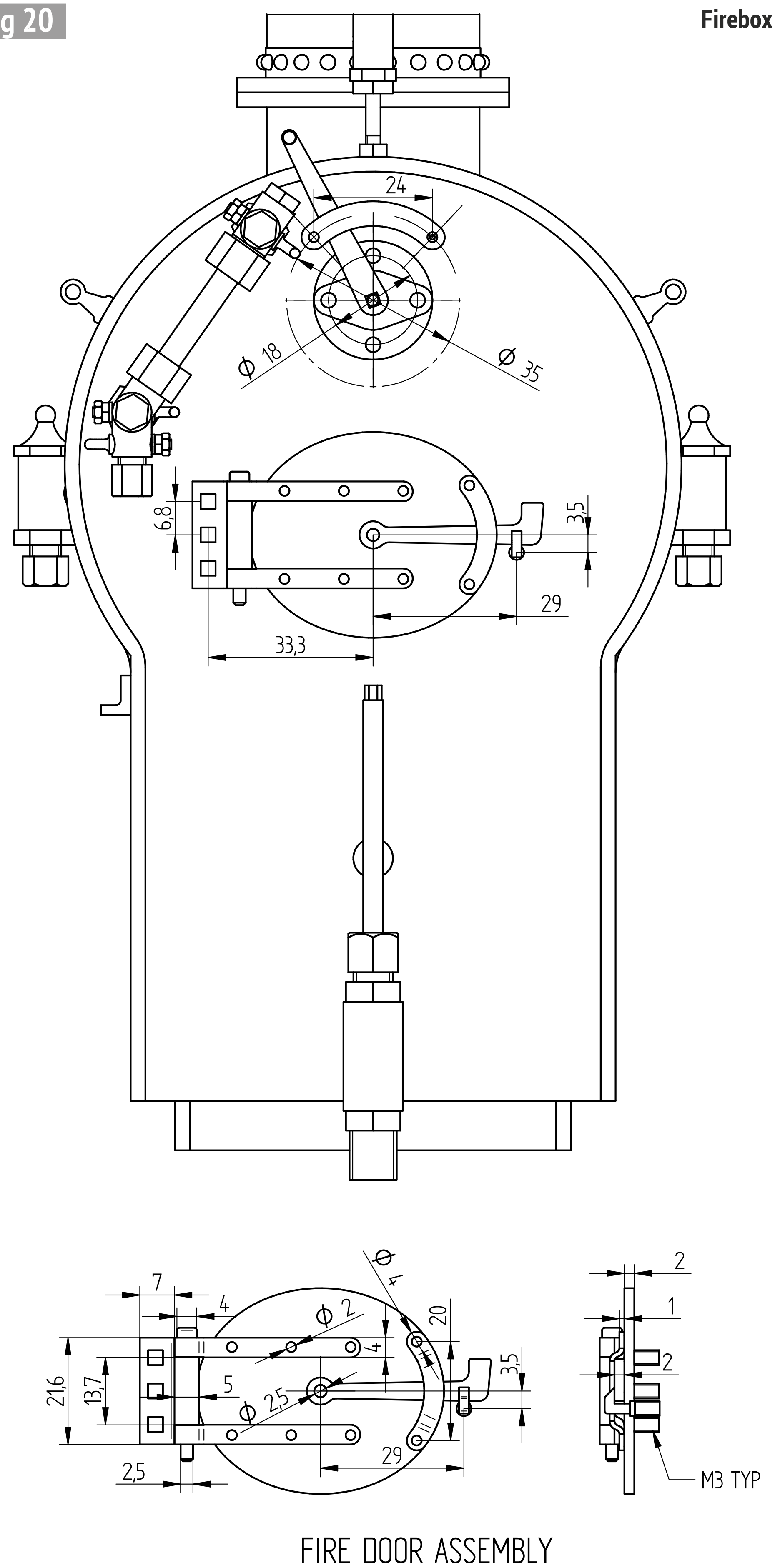
SMOKEBOX REGULATOR FITTING

NOTE:
ALL MOUNTING HOLES FOR FIREBOX DOOR AND REGULATOR BUSH ASSEMBLY
NEED TO BE PREDRILLED BEFORE FABRICATING



Boiler assembly.

Fig 20 **Firebox door.**



defects and the amount of heat input. By far the easiest and most practical method to manage corrosion initiation is to eliminate the critical environmental species (i.e. the chlorine in its various forms). An inline activated carbon filtration will do that job very effectively provided a little practical sanity is applied when in use. A very simple filter can be made from some PVC plumbing, a stainless steel pot scourer and whatever connections you use for your water supply. Just make sure to boil the carbon in a pot of water the night before to 'reactivate it' and wet the large surface area. A stainless steel reactor corrosion inhibitor additive will also retard the corrosion initiation, but availability in smaller quantities is limited.

The design for this boiler is material specific taking into account the issues associated with the specific grade of stainless (**fig 19**). Please note: the design cannot be used for copper as-is and will need to be modified.

Machining the bushes and fittings

All the bushes and fittings need to be made from the same material as the rest of the boiler to cope with differential thermal expansion. Unfortunately, stainless is not a very forgiving material to machine. Tipped tools last much longer than HSS, but you should still keep the cutting speeds to roughly half that of mild steel. A little cutting fluid on the material and the cutting tip improves the cut. The drill size for tapping stainless steel should be 60% thread engagement; this will limit tap blunting and breakages, i.e. 7.3mm for 5⁄16 x 32tpi and 2.6mm for M3. All the bushes must have a shoulder on the inside of the boiler with a seam weld on the outside; in this way the geometry takes the load and not the welds.

All holes need to be drilled and tapped before closing the boiler. This is to prevent scrapping the entire job should a tap break in a hole. The M3 holes in the back-plate can be drilled to 0.5mm short of the back side, leaving a dimple. Should a tap break the dimple can be centre punched and the hole drilled to the broken tap; with a little luck it can be wiggled out. The hole will then need to be tapped through and the stud sealed with plumbing thread tape or something similar (good luck with that!).

It's always a good idea to make the fittings and check how it all goes together before closing up the boiler and welding (**photo 73**). The only exception to this is the boiler sight glass which needs to clear the back springs, but I'll get to that later. The mounting holes for the regulator lever stops can be spotted, using the outside plate as a drilling jig, and then drilled and tapped. For the wet header and steam regulator flange I generally make drilling jigs that I use to drill both the component and the boiler; they make pretty good sealing caps for the pressure test.

The fire door (**fig 20**) was laser cut and fits perfectly in the backhead firedoor hole without the 3mm oval ring welded in place. This makes alignment for drilling and marking out a much easier exercise (**photo 74**). The hinges are made by drilling a 2.5mm hole in a piece of brass stock and soldering this to some brass sheet. The hinge is finished off by good old fashion hand tools, namely a hack saw and file. The hinge straps are held to the oval plate with rounded M2 pan head screws for effect. The latch was also filed to match the prototype with the catch bent using two pliers and a little patience. With the assembly completed the mounting holes on the backhead can be drilled and tapped. As with the prototype the firedoor is held in place with three square-head bolts. On final assembly some packing will be required behind the hinge to get a reasonably flat fit on the firebox hole.

Fabricating stainless

Please don't think you need fancy qualifications or training to weld stainless. Anyone with a passion for welding (or anything for that matter) that makes the effort to study and practise will have no problems welding a simple boiler like this. If someone tells you otherwise prove them wrong!

Giving an in-depth welding discussion will bore most readers; it's also not necessary as welding is described *ad-infinitum* on the web. I will, however, give a few pointers that will help you along. Before welding the boiler you would need to do some welding samples and jot down the welding settings (this is a procedure qualification record (PQR)). Make sure there is no over penetration with the settings used. The procedure should include sketches of the different weld types, base material, gas settings, filler and TIG rod size etc. The test samples should be bent in the vice to check the welds are good. If the club boiler inspector is a competent engineer (and keeps up to date with modern manufacturing techniques) this should be enough to get you the green light. You should make a data pack for the boiler including all the material certificates, all the weld prep photographs and your plan to manage material specific issues during operation (like SCC and CCR).

When welding stainless you need to constantly balance the heat input by moving from the one side of the job to the other to limit distortion. Welding with a high frequency DC pulse set-up avoids some of this distortion by limiting the overall heat input. All butt welds need to be properly prepped with 60 degree chamfers; this is typically the barrel and outer boiler shell. The fillet weld root shouldn't be larger than the thinnest plate, but it is critical to have an off-set between the thicker plates and outer shells to get a good fillet in. And please, all weld preps need to be clean with no contamination. This includes oil, suds and carbon steel dust from a grinder! By the way, carbon in stainless steel welds is generally bad and should be avoided - like COVID.


73

Backhead tacked with all holes predrilled.


74

Firedoor trial assembly.


75

Crown stay.

The fabricated boiler assemblies

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

The crown stay (**photo 75**) is a safer alternative to rod stays for stainless steel boilers but you need to check if your specific region will accept this method of construction. Based on the finite element analysis I've done on all my stainless steel boilers the normal arguments against this type of staying method are baseless, especially for a welded construction. The half-moon holes at the base of the stay are for differential expansion, so please take note of the size and spacing. An off-cut of 30mm square bar used for the buffers will work nicely as a spacer when welding the crown stay assembly.

The firebox tubeplate and tubes need to be tacked and welded with the smokebox tubeplate used as a brace to keep the tubes aligned (**photo**

>>

Inner welded assembly.

Tube welding.

76). The tubes are probably the trickiest item to weld (**photo 77**). You need a ~2mm fillet weld with no Vee-prep on the tube plates (this will cause burn through or over penetration on the tubes). Anything more than a 1mm tungsten TIG rod will make life very difficult when welding such thin material. Again, practice makes perfect!

It's unlikely Industry will roll the firebox hole and dome flange stub, but this is an easy job with a vice, hammer and a piece of round bar. Alternatively, you can be fancy and make a simple ring roller to roll all these smaller cylinders; there are a number of these designs on the web. To be honest, I slapped mine together from a simple sketch on the back of a match box using materials I had lying under the workshop bench (**photo 78**). The firebox wrapper should be kept as one piece and it can be bent over the firebox side plates with a vice and clamps tacking as you go. This requires a little brute strength, but little by little the wrapper can be formed (by bending, not hammering) around the firebox plates.

The steam dome flange and stub (**photo 79**) needs to be completed before it is welded to the outer shell and it should be welded with a dummy cover bolted firmly in place. The outer flange for the bolt holes can be pre-drilled, welded to the dome and then the sides and top skimmed on the lathe to get a good steam seal.

With all the sub-assemblies welded the boiler can be aligned, measured and tacked together (**photo 80**). The complete boiler is then seal welded, taking care to balance the heat input by alternating the weld areas.

Steam dome flange and stub.

Outer shell tack welded.

Testing the boiler

Finally, without exception the boiler should be pressure tested to twice working pressure for at least one hour (**photo 81**). If made properly you'll find that the dimensions taken before the pressure test are identical to the dimensions taken after. The top of the firebox should be checked to make sure the crown stay has done its job, but if welded properly that configuration is much stronger than the normal stay method.

●To be continued.

Simple home-made ring roller.

Hydraulic boiler test.

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Tools and Machinery

■ Large Chester Milling Machine. Power table, power head, power quill, swivel head. Table size 700 x 210mm. On cabinet stand with machine vice, v-blocks cutters etc.
T. 01388 815216. Durham.

■ Tom Senior E milling machine, £2,600. 3" capacity sheet metal folding machine, £290. Clarke bandsaw on wheels, £95. Linisher horizontal/vertical £150.
T. 0115 9872211. Nottingham.

■ Myford ML7B lathe c/w gearbox, clutch, vertical slide, F/R 4-jaw independent chuck, two 3-jaw chucks, faceplate, £1,700 ONO. Atlas lathe c/w 4-jaw independent chuck, 3-jaw chuck, powered cross slide, gears, stand, spare motor, £600 O.N.O.
T. 01352 711163. Holywell.

■ 240V lathe, Mark II Empire, 8 ¼ inches over saddle, 14 inches over the bed (swing), 4' 6" between centres. 1 ¼" hollow spindle. 6" Tudor Pratt chuck. 9" Bernard 4-jaw chuck, removable gap, 4-way toolholders, 1,2,3 and 4 micrometers, drills up to 1", lots of extras, £600. Vertical mill, 24 inch table, t-bolts and clamps, 8 inch rotary table, dividing head and tailstock dial gauges, 240 volts. £600. **T. 01566 86683. Launceston**.

■ Drummond shaper, hand powered , auto feed, benchtop mounted, very good condition, £175. RJH Trimtool lathe tool grinder, 240 volts. Tilting table, reversing switch, work light. £160.
T. 01617 614556. Greater Manchester.

■ Myford chuck, new in box with fully machined backplate, £55. Electric motor about 1/6hp, with starter box, £15.
T. 07551 478161. Bury St. Edmunds.

■ Cowells ME lathe in good condition, with three and four jaw chucks, tailstock, drill chuck etc.
T. 01986 835776. Norwich/Ipswich.

■ Model engineer's workshop, lathe, miller, drills, compressor, linishers, tooling, etc. **T. 07711 176 045. Dudley**.

Models

■ Part built Butch 5 inch gauge. New professionally built boiler, frames built up, cylinders, wheels, axles machined, raw castings, drawings. Contact for photos. £1,850. **T. 01781 7104554. Congleton**.

■ Horwich Crab Model Locomotive £3,950 ono. Part Horwich Crab chassis - a Don Young design Main running chassis essentially complete- frame, wheels, cylinders, all rods, pins and valve gear ready for stage of setting on compressed air. Don Young drawings, bench-to swivelling erection frame, Pony Truck, Tender (complete & painted), Smoke box wrapper incomplete, Cast iron for smokeless ring boiler(unfinished). Boiler lagging material, sheet steel suitable for general platework & cleading. **T. 01628 675392 Maidenhead.872675. Toddington, Bedfordshire**.

Parts and Materials

■ Box of aluminium offcuts, plate. £50.
T. 07551 478161. Bury St. Edmunds.

■ I/C castings and materials. Atom Minor, Sparey 0.63cc diesel, Titan 60 glow, Sugden Special crankcase casting, £120 lot, will split. **T. 0116 2866975. Leicester**.

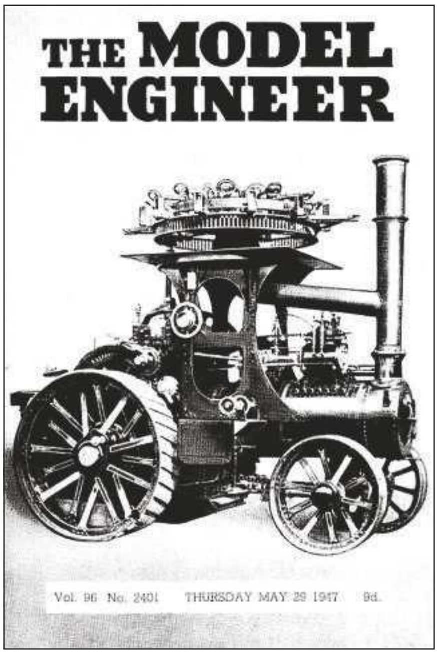
■ BUTCH 5" Gauge rolling chassis. Machined wheels axles cylinders. New commercially built copper boiler. Brass sheet for cab and tanks cut out. Many raw castings bronze and cast iron. Drawings. Photos available £1850.
T. 07817 104554. Congleton.

Magazines, Books and Plans

■ 3 ½" gauge Model locomotive plans, new unused "Mallard", A4 "Flying Scotsman" £68, post free. "Virginia" American style, £45, post free.
T. 01914 563806. South Shields.

Wanted

■ Castings for McOnie's engine, started or part assembled but complete please.
T. 01579 350343. Callington.



POSTBAG

Write to us

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3D CAD

Dear Martin,
I read the post by reader John Hannum in Postbag with the title 3D CAD in issue 4684.

As for the first part of the message, I fully agree it would be nice to have information about the software used to create the magnificent images published.

As for the second part, choosing software, I also had this thought for a while and so I searched the Internet for available software offers. After seeing the pros and cons of several ones, I ended up choosing Onshape. I believe it isn't the most advanced software but it was my choice. Based on this experience, I wrote the article *CAD and 3D Printing in Model Engineering* in issues 4676 and 4677, which I suggest could be read as an introduction to the topic.

As far as software selection is concerned, there is a constraint right from the start, which is the price of the software. Not everyone is willing to spend large amounts of money for occasional use.

Other details when choosing software, besides price, are features, ease of use, availability of tutorials, hardware requirements, vendor support, etc. Sometimes the differentiating factors of a more evolved software (and usually more expensive) are features that we will never use.

Everything I learned about CAD was exclusively based on the help menus of the Onshape software, and watching videos on Youtube, which other well-known CAD platforms also provide. Currently, almost everything I learn related to software is researched on the Internet, even the comparisons between different software packages. As can be easily understood, it is necessary to have a critical spirit and filter the results of Internet searches, because just as there is good information, there is also a lot of rubbish. Usually, good tutorials are made by the companies that sell the software and by experts who publish regularly on the Internet.

I send this message so that those interested in this topic can have some more information while we wait for the suggested article.

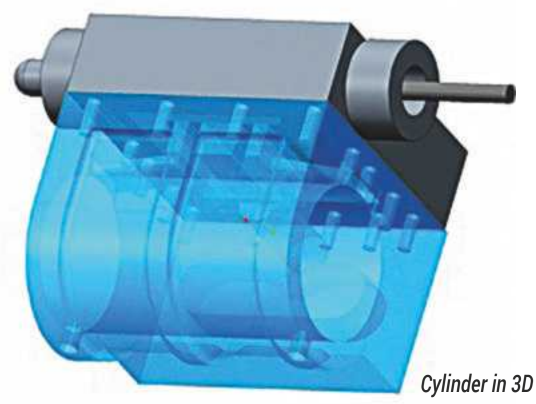
Best regards, Luís Augusto Trincão (Portugal)

Dear Martin,
Following several letters referencing computer aided design readers might like to know that extensive CAD software is available for all UK secondary school pupils and pupils across the Western World (16-18 years and university students) to download to home and school computers. There are examples of pupil work on the internet which may well startle even the most entrenched drawing board specialists and model engineers amongst us.

Over the last twenty years I have been responsible for training of over one thousand teachers, further education lecturers and post graduate students to use parametric, feature-based software.
I have found the greatest difficulty for the CAD novice to overcome, apart from strict file management and mouse control, is that of recognising new concepts in drafting areas they are already familiar with such as spatial awareness and conventions. In the 'olden days' products started life in two dimensions on a drawing board, with a pencil, but in CAD products start life in 3D and the 2D, fully dimensioned orthographic is generated by the software, usually in two mouse clicks. This is still a miracle for me and I've come to terms with the fact that it dispenses with a lot of my traditional drawing skills.

Well, that's not quite true because the 3D CAD creation does depend upon initial 2D drawings (drawing lines, which my generation are good at) and this is where we have an advantage over the current crop of pupils (in my experience) in that we are steeped in solid geometry (even at 'O' level GCE) and at least thirty two geometric theorems and 'lines in space' - remember them, well now that knowledge comes into its own when we move to CAD. Pupils don't seem to have this knowledge any longer and although acquiring the CAD skills presents few problems for them, spatial awareness and basic geometry do.

Research has shown that pupils find CAD software frustrating to use but a thoroughly enjoyable experience – almost a challenge akin to that of computer games. Research also shows CAD skills don't depend upon academic prowess but skills similar to those needed for riding a bike, driving a car and swimming - skills that can't be forgotten.



Cylinder in 3D CAD.

Big end assembly in 3D CAD.

I have witnessed amazing work from pupils 'hooked on CAD' and I wonder how many of our readers could tap into this expertise with their own children and grandchildren?

A free educational version of professional, fully associative CAD with .dxf and .stl outputs for CAM, orthographic drawing generation and render studio is obtained by students after creating an account and obtaining a licence file which is renewed each year. This software also has its own education support groups. See **www.ptc.com/en/products/education/free-software/creo-download**

On the previous page are two examples where I've used CAD to visualise how parts can be made and put together.

Bob Booth (Birmingham)

Injectors

Dear Martin,

What a good series of articles by Roger Froud (issues 4682 to 4685) - good to know someone is prepared to experiment. This might even tempt me to think about making an injector! Must be just coincidence that Mr Froud has almost the same surname as the Froude who was a significant hydrodynamics expert after whom the Froude number is based (all to do with speed and waterline length of boats I think).

Anyway, in the latest episode Mr Froud mentions he can't get SAE660 in ¼ inch diameter - you can get Colphos which is pretty much the same.

Regards, Duncan Webster

Help Needed

Dear Martin,

I am a retired engineer and wish to put together a small prototype steam engine (50mm bore by 80mm stroke) as part of the development of a small CHP plant.

Both local precision engineering/prototype businesses and model engineering clubs have approached but as yet I have been unable to locate anyone willing (with/without remuneration) to make components in brass for such an engine; in the former case too small a project and in the latter case probably wary of paid work.

Are you able to suggest any contacts or advise as to the likelihood of any of your subscribers being interested? I have not seen adverts for professional model machinists.

Yours faithfully,
Michael Heywood (Hexham)

Alan's 'Brighton Atlantic' alongside Ron Heugh's LNER B1 8301. Behind is the signal box where I made my home for the day.

A general view of part of Alan's railway with the station with Colin watching over Peter Layfield setting off with a long mineral train and standing by in the yard is Colin Garton on Ballan Baker's Y4 shunting in the West Yard. In the other platform road is the Britannia 70051 Firth of Forth *with a very lengthy van train (about thirty vans on).*

Signalling

Dear Martin,

In answer to Mike Hanscom's letter, which appeared in the letters this week, I know exactly what happened to the other part of the lever frame which Mike refers to! It went to Alan Stone's wonderful 5 inch ground level railway in East Lincolnshire and we as the LMS group spent many happy hours 'playing trains' on his railway where I regularly work the signal box. There were telephones to the other 'Bankside' box, the loco shed and several other strategic points on the railway. I very often had several locos under my control in that box, with shunting engines and main line engines calling in at the station. I just loved being in that box and this was another place where all of the language was pure 'railway' talk. Alan's wife always put on a good 'spread' over our lunch break.

He had amassed a good varied selection of rolling stock which was all of Southern origin, including a lovely set of Bulleid coaches, a lengthy van train and lots of seven plank coal wagons, plus all manner of other stock. What I loved about the lever frame was the magic sound of the levers crashing against their stops. I think that Brent Hudson also had another third of the lever frame and I also had the pleasure of working in his box too. Sadly, the whole railway was dismantled when Alan died but we certainly had some lovely days on his wonderful railway. I don't know what happened to the lever frame after that. I attach a couple of photos of his railway. I would certainly welcome more articles on ground level railways with proper signalling

Doug Hewson (North Lincs.)

An Astronomical Bracket Clock PART 25

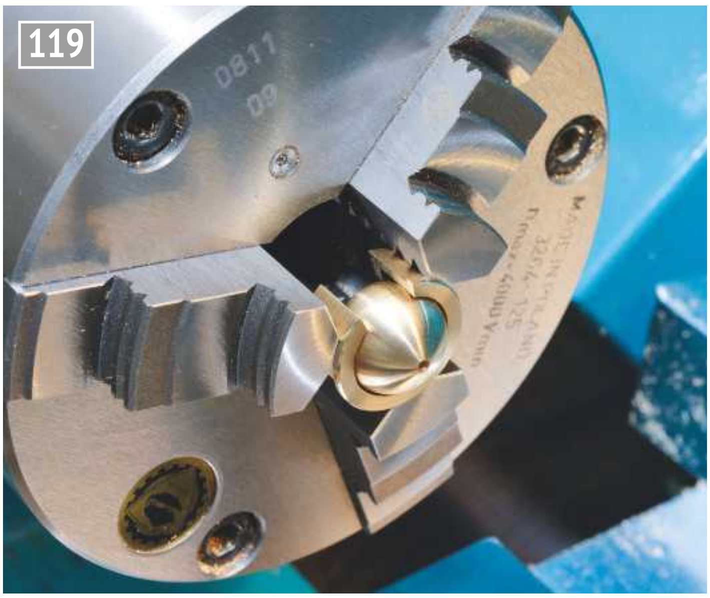
Adrian Garner makes a bracket clock showing both mean and sidereal time.

Continued from p.401
M.E. 4686, 11 March 2022

Sun and Earth

The sun was turned from ¾ inch diameter brass rod. Part off the ball leaving a ¼ inch diameter stem about half an inch long. If the ball is now held in a ball collet the stem can be gripped in the drill chuck to align the ball. Carefully cut off the excess stem (I used a piercing saw) and face the end. Only take light cuts of about 0.005 inch. Centre drill, drill and ream $\frac{3}{32}$ inch to a depth of about ½ inch (**photo 119**). Files can then be gently used to round off the end of the ball. Do not use excessive pressure as it is essential the ball does not come loose in the collet.

The sun ball is cross drilled and tapped 10BA for the pointer which also secures the ball to its $\frac{3}{32}$ inch diameter support. Small flats at each end of the support ensure alignment of the pointer and the Earth. After polishing I had my sun, along with the escutcheons, gold plated.



Drilling a hole through the sun using a ball collet.

The earth was made from a 12mm diameter dark blue bead. These beads are machine made and the bores are surprisingly central. I opened up the hole to $\frac{3}{32}$ inch by hand with a drill in a pin chuck leaving it a tight push fit on a $\frac{3}{32}$ inch brass rod. This allowed a Vee-groove to be cut on the equator. After removing the rod from the bead, a 12mm length of the rod was drilled $\frac{1}{16}$ inch to about half its length and then pushed into the bead. The $\frac{1}{16}$ inch diameter brass arm that supports the Earth at 23.4 degrees is a friction fit in this hole, the other end being soldered to the support (**photo 120**).

Ecliptic and Moon's plane rings

These were cut out from $\frac{1}{16}$ inch brass sheet and turned to size before sending away for engraving.

They are supported by 0.055 inch blued steel rods secured


120

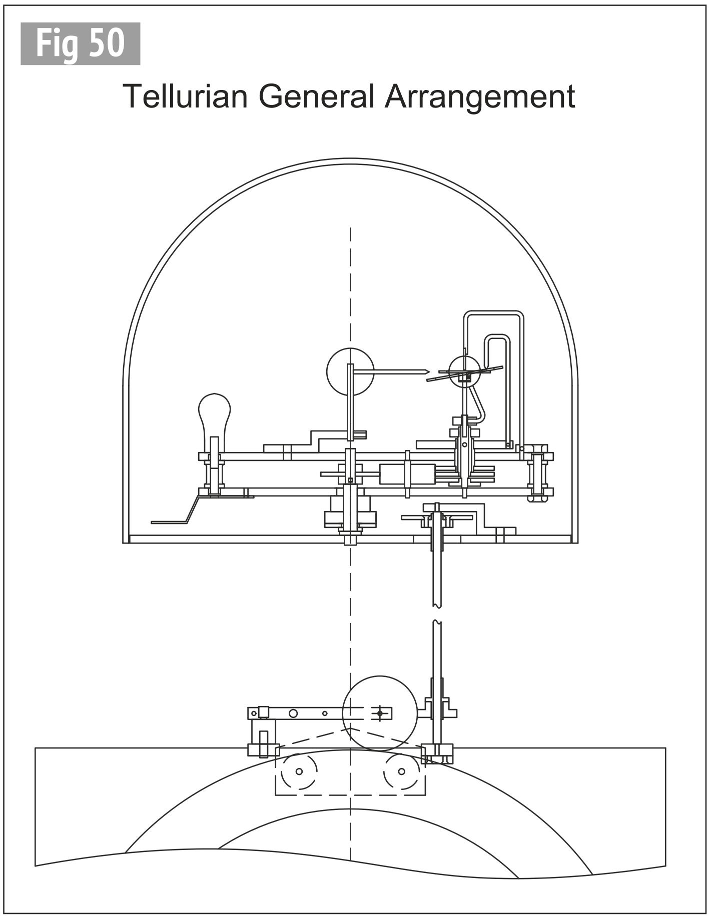
The earth is given its proper degree of tilt.

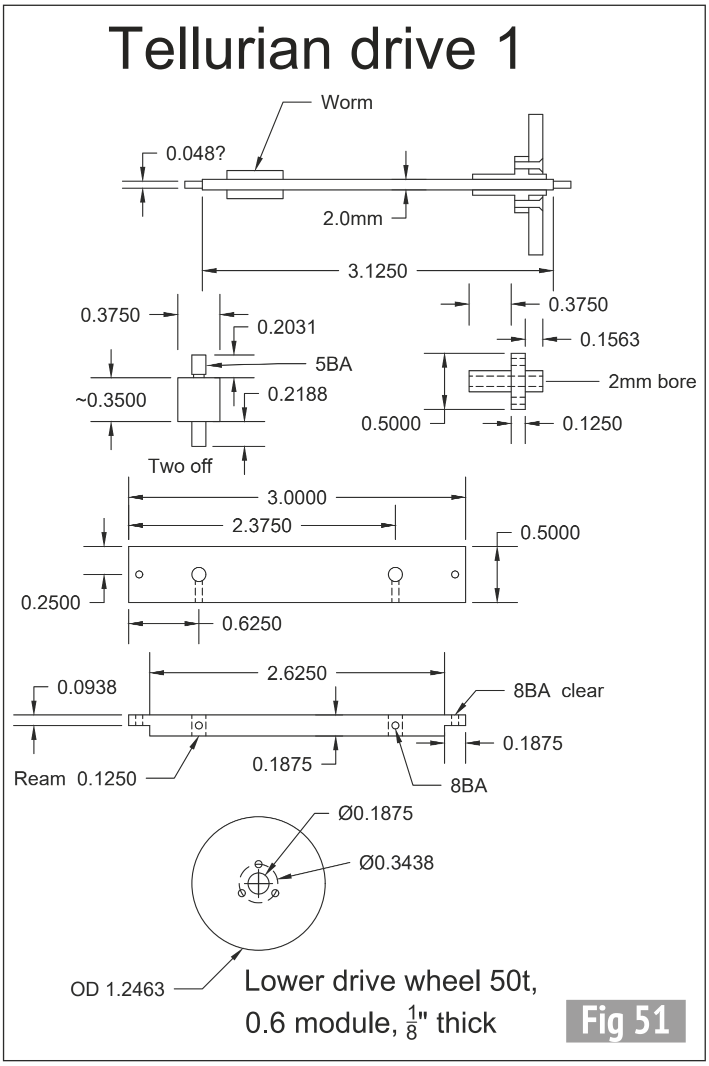

121

Accurate placing of supporting blocks.


122

Ecliptic plane ring.





with 12BA screws in small blocks soldered underneath the rings. It would be nearly impossible to position these blocks correctly in position individually. Instead, make a short beam with the holes tapped and drilled to the correct spacing with an additional 1⁄16 inch diameter hole midway between the outer holes. Then make a simple jig from a spare piece of Tufnol which can be turned to hold each ring and drilled with a central 1⁄16 inch hole to hold a steel pin to align the beam whilst soldering (see picture). After soft soldering, the unrequired sections are cut away knowing the holes are correctly positioned (**photos 121** and **122**).

Note that for the Moon's ecliptic plane the 1⁄16 inch hole in the beam needs to be displaced to allow for the 10 degree tilt. A little geometry showed that if the angled side of the cross beam was laid flat on the milling machine bed, the hole could be drilled square to the table but needed to be drilled 0.088 inch from the edge meeting the longest side. It is inevitable that the dimensions of your cross piece will be different.

The blued steel rods were cut to approximate length and then ground to precise length by holding in a pin vice and gently touching a slowing down grinding wheel i.e. after turning off. At full speed too much is removed!

The rotating pointer showing the position of the Moon's apogee is bent up from 1⁄16 inch straight brass wire. A jig could be made to ensure it is bent to the correct shape but I found it easier to bend up one pointer, note its errors and bend a

>>

another to a good fit on the tellurian; similarly for the fixed support for the half crescent showing day and night. The crescent is turned, bored and parted from ⅝ inch brass rod. It will be found easier to solder in place on the support as a complete ring and then cut and filed to size after soldering. Use soft solder. This is not as strong as hard (silver) solder but will avoid overheating the small pieces of brass and thus softening them.

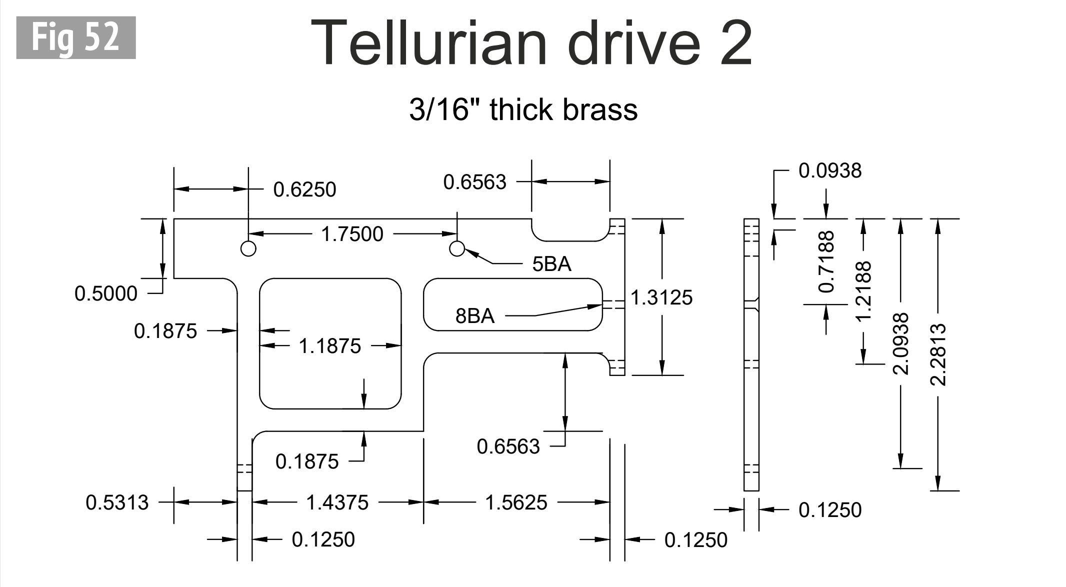


Fig 52

Tellurian drive

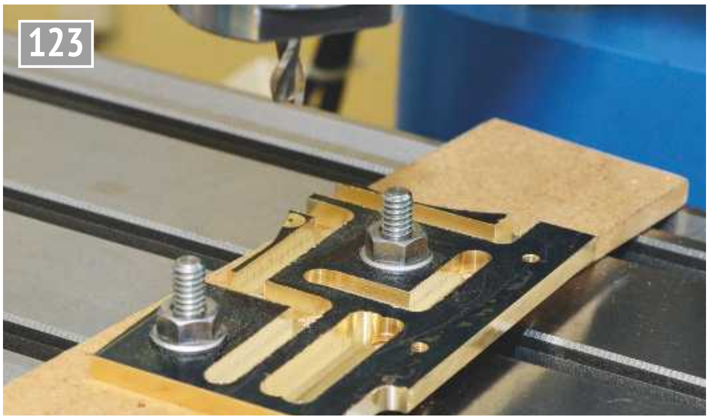
The drive is taken from the 400t sidereal wheel and uses a 20:1 worm and wheel drive available from Roxey Mouldings (**ref 19**). These are beautifully machined with a two start worm.

The drive requires two beams secured by screws to the top of the clock plates. The beams are made up as a pair and then split. After sawing out a piece of 3⁄16 inch brass plate, two long sides are milled parallel before milling the beam's shoulders. Whilst secured to the milling table drill the BA clearance holes in the shoulders that will secure the beams to the clock plates. Do not drill the pivot hole for the vertical arbor but do drill and ream the two ⅛ inch holes for the pillars on which the support plate is mounted. After cross drilling and tapping the securing holes saw the pair into two and mill the sawn sides.

The upper support plate is also formed from 3⁄16 inch brass. The shape is quite complex to reduce its weight but can be made by careful marking out, piercing and filing or, for those into CNC machines, it could be quickly milled to shape once the required code is written. Not having a CNC machine, I milled two reference edges, one long edge and an edge at right angles to it. The plate was then bolted to the milling machine table with the edges square to the axis to coordinate drill and mill using the handwheels and the DRO (**photo 123**).

The ⅛ inch x 3⁄16 inch side strip was from 3⁄16 inch plate. After milling one edge, saw off over size and secure by two 8BA screws through waste material at each end. The remaining side can now be milled to ⅛ inch thick. Secure the side strip with an 8BA screw to the upper support plate and add two taper pins to provide registration.

●To be continued.



Milling the upper support plate.

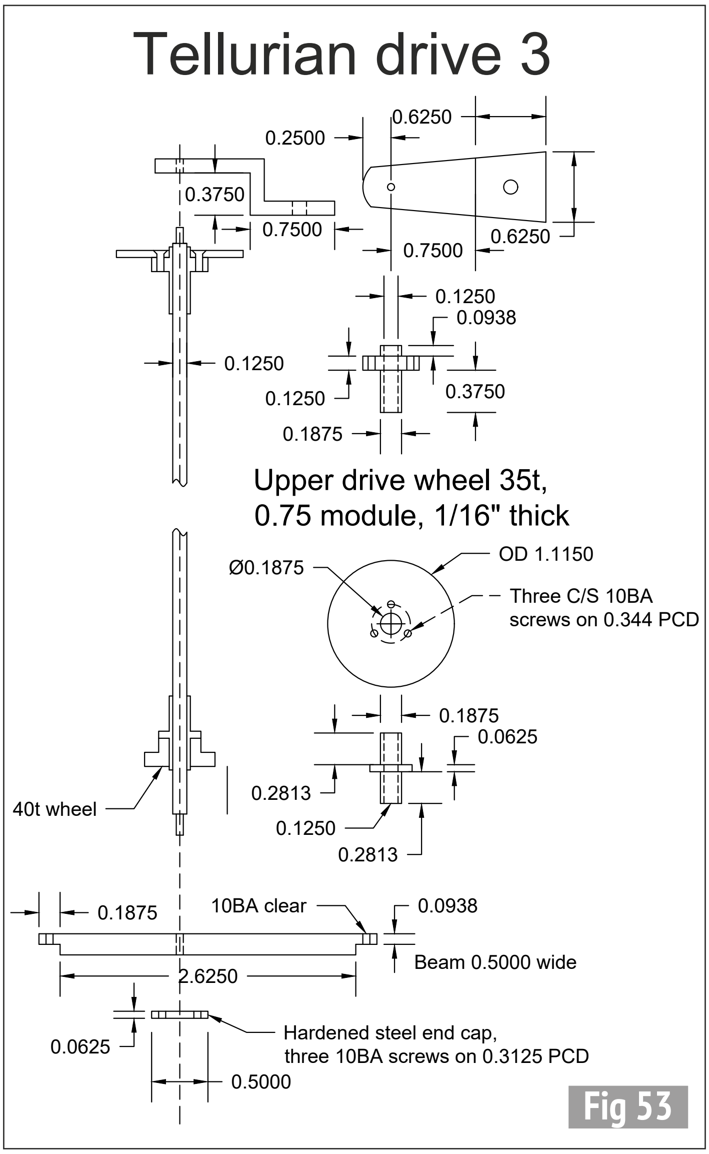


Fig 53

REFERENCE

19. Roxey Mouldings part 7G20-00 (www.roxeymouldings.co.uk)

Getting It Right PART 1

Rhys Owen looks at ways of achieving accuracy with a variety of measuring instruments.

I make no claim to be a craftsman - but I certainly get satisfaction whenever I 'get it right' e.g. when a set of frames lies flat on a surface plate or a steam engine works under air. So, let us investigate accuracy and precision, starting with their formal definitions.

Accuracy is the closeness of a measurement to the true value.

Precision is an indicator of how close the individual values in a set of results are to each other.

Ideally, we need both accuracy and precision. The usual analogy is that of shooting at a target. If the marksman aims for the bull's eye but shoots in a ragged circle around it then his shooting is pretty accurate - but not precise. If all his shots are grouped closely together but hit the wrong part of the target, then his shooting is precise - but not accurate. However, if all his shots hit the bull's eye then his shooting is both accurate and precise.

The process of checking a measuring instrument against a known standard is known as calibration. For example, a Class 1 sound level meter such as I would use to measure sound pressure levels in my profession of acoustician should, at the very least, be calibrated before and after a noise survey using a calibrator. Such a calibrator, when mounted on a ½ inch microphone, will give a particular value (usually either 93.8 dB or 113.8 dB at 1 kHz) to which the meter should be adjusted. The meter and the calibrator should also be sent to a specialist laboratory for calibration every couple of years.

The ancient world

The Ancient Egyptians aligned pyramids with the north-south line to a surprising degree of accuracy while the lengths of the sides of the Great Pyramid of Giza are said to be within 0.05% of each other.

In 1900/1 a corroded mechanism was found on the seabed near the Greek island of Antikythera. Analyses have shown this to be a form of analogue computer used to predict astronomical movements. Constructed more than 2000 years ago, the mechanism had more than thirty gear wheels that must have meshed well enough for the device to function.

The Ancient Greeks were also keen students of geometry (the word means 'earth measurement') which is very useful in engineering measurement - provided it is borne in mind that in the 'real world' materials deform under the action of forces.

The soldiers of the 'Terracotta Army' that guarded the mausoleum (built from 246 BC to 208 BC) of China's emperor Qin Shihuang were equipped with crossbows. After two millennia the wooden and bamboo parts of these crossbows have perished but their bronze trigger mechanisms remain largely intact. These triggers were batch-produced by casting and filing to an impressive degree of accuracy by 'production cells' of craftsmen. This accuracy was 'encouraged' by a draconian system of punishments (Qin Shihuang was a not a nice man!).

In Peru, Machu Picchu is a testament to Inca masonry because some of the stones fit so tightly together that a knife blade cannot be inserted between them, no mortar being used – this in a civilisation that did not use the wheel!

As mechanisms such as clocks, watches, pumps, guns, and looms became more complicated the need arose for accurate measurement. Early on, man progressed from using string to using rules, examples of which have been found by archaeologists in various ancient civilisations.

HENRY MAUDSLAY

Henry Maudslay (1771 – 1831) was born in humble circumstances at Woolwich and, at the age of twelve, started work at Woolwich Arsenal, initially filling cartridges with powder then progressing to the woodwork shop. At 15 he started an apprenticeship as a smith, in which trade he is believed to have specialised in the lighter, more complex, forge work. He probably encountered the horizontal boring machine that Jan Verbruggen installed a Woolwich Arsenal in 1772.

Maudslay was recommended to Joseph Bramah as someone who could build his patent locks and, despite his youth, made a very favourable impression, which was enhanced after he had reconditioned a worn-out vice on his first day. Maudslay worked for Bramah for several years, making a significant contribution to the success of the latter's business. After being refused an increase in pay, Maudslay left to set up his own business, one of his early commissions being to construct the block-making machinery that Marc Brunel devised for use in Portsmouth dockyard.

Maudslay was responsible for many innovations and, just as importantly, for bringing together other men's innovations. Although often attributed to Whitworth, it is believed that it was in fact Maudslay who devised the three-surface method of producing flat surfaces.

Although others devised the lathe slide rest and the lead screw, it is believed to be Maudslay who combined them with gearing and used them to produce standardised threads, which in those days were sorely needed. In his autobiography, James Nasmyth, who worked in Maudslay's works from 1828 to 1830, noted that: '*None but those who lived in the comparatively early days of machine manufacture can form an adequate idea of the annoyance, delay, and cost of this utter want of system, or can appreciate the vast services rendered to mechanical engineering by Mr. Maudslay, who was the first to introduce the practical measures necessary for its remedy. In his system of screw-cutting machinery, and in his taps and dies, and screw-tackle generally, he set the example, and in fact laid the foundation, of all that has since been done in this most essential branch of machine construction.*'

Maudslay set new standards for measurement accuracy, building a micrometer capable of measuring to one millionth of an inch. This device, known as the 'Lord Chancellor' was used to settle questions of accuracy in the workshop.

A man who does not receive the general recognition that he deserves, Maudslay died in 1831. His business, which became Maudslay, Sons and Field, specialised in building marine engines, eventually going out of business early in the 20th century.

One rule found at the Mohenjo-daro archaeological site in Pakistan is said to have decimal divisions of 3.35mm that are marked out to an accuracy of some 0.13mm - impressive for a measuring device constructed more than four millennia ago.

The industrial revolution

With the onset of the industrial revolution manufacturing moved from the work of individual craftsmen to mass production in a factory. While an individual gunsmith might make all the parts of a gun and fit them together to make a single weapon, mass production requires that the individual components be separately manufactured by machine tools to tight tolerances so that any one of a given batch of components may be used when assembling a gun.

One of the greatest pioneers in this field was Henry Maudslay a modest man whose contribution to industrial development – indeed, development in general – deserves to be more generally known. Sadly, engineers such as Maudslay, Whitney, Whitworth and other industrial pioneers do not receive the recognition they deserve.

A few aspects of this vast subject are discussed below.

Calipers

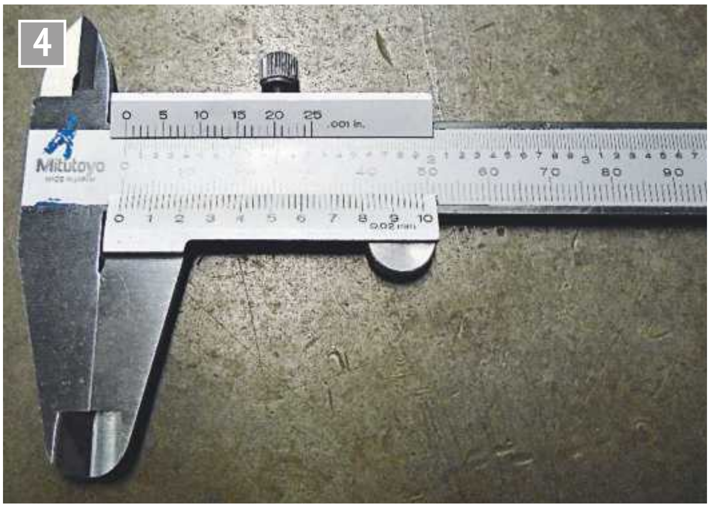
Calipers (**photos 1** and **2**) are devices with a history that dates back thousands of years to both Ancient Greece and Ancient China. The simplest calipers are the hinged varieties – inside, outside, odd-leg (or jenny) calipers – that require a certain amount of expertise and 'feel' to be used effectively. For example, the tips of the calipers' legs must touch the relevant surfaces closely and squarely enough for the measurement to be accurate and the caliper must touch those surfaces neither too tightly nor too loosely when measuring.

Accurately setting such calipers using a rule or transferring a measurement

Inside calipers with screw adjustment

Outside calipers with 'stiff joint'.

Vernier caliper.



This Vernier caliper reads zero when fully shut.

USING A VERNIER

The vernier scale is named after the French mathematician Pierre Vernier (1580-16). It permits an accurate measurement to be taken between two graduation marks on a scale.

The basic principle is that, to the main scale of a measurement instrument, a secondary scale is added, the gradations of which vary slightly from those of the main scale.

For example, for the normal Vernier caliper the main scale is marked out in millimeters while the vernier scale attached thereto is marked out so that it has 50 gradations, each of length 0.98mm so that the whole length of the vernier scale is in fact 49mm.

Suppose that Vernier caliper is measuring a dimension of 31.16mm. In this case the zero mark on the vernier scale goes beyond the 31mm mark on the caliper's main scale by an extra distance of 0.16mm – how does the vernier scale determine this?

Since the zero mark of the vernier scale goes beyond (i.e. to the right of) the 31mm mark on the main scale by 0.36mm it will be found that the 8th mark on the Vernier scale will align with one of the millimetre marks on the main scale (in fact it aligns with the 39mm mark on the main scale). We then know that the extra distance is (0.02 x 8 =) 0.16.

How does this work?

Since the Vernier scale is marked out at intervals of 0.98mm, when the 8th graduation of the Vernier scale aligns with the 39mm graduation on the main scale (**fig 1**) we have:

So the vernier scale enables us to read off the extra distance by multiplying the 8 gradation marks by the length of 0.02mm (8 x 0.02mm = 0.16mm).

Note that in the above the value of the 39 graduation on the main scale is entirely irrelevant. What is important is which graduation mark on the Vernier scale coincides (or is closest to coinciding) with a graduation on the main scale.

from inside calipers to outside calipers (or vice versa) calls for considerable skill.

If calipers are 'stiff-jointed', then fine adjustments are made by lightly tapping one leg on a hard surface. Fine adjustment of spring-loaded calipers is made by using the adjusting screw that joins the legs.

Vernier caliper

The Vernier caliper (**photo 3**), is a versatile instrument that can be used to measure internal dimensions such as diameters, external dimensions, depths and step heights.

However, the Vernier caliper does not conform to Abbe's Principle and its accuracy depends to a certain extent on the user. It is also limited in various ways – for example, measuring the outside diameter of a tube is only possible if the caliper jaws can straddle the tube.

It is worth checking that the Vernier caliper reads zero when it is fully shut (**photo 4**). This is also true for other measuring devices.

The Vernier principle is also used in the Vernier height gauge which is used in conjunction with a surface plate (**photo 5**).

Micrometer

The micrometer (**photo 6**) conforms to Abbe's principle because the spindle on which has been cut the screw thread that takes the measurement is in line with the gap between the end of that spindle and the anvil.

To ensure accuracy, the length of this screw thread is limited, usually to a range of 25mm or 1 inch so that six different micrometers would be required to measure over the same range as a normal Vernier caliper (some 150mm or 6 inches).

Some micrometers have a cover to shield the frame from the heat of the user's body which, otherwise, would make the frame expand. Since most materials expand when heated, accurate measurement requires that changes in temperature be prevented or, at least, allowed for. Indeed, to do really accurate work the temperature of the workplace must be controlled.

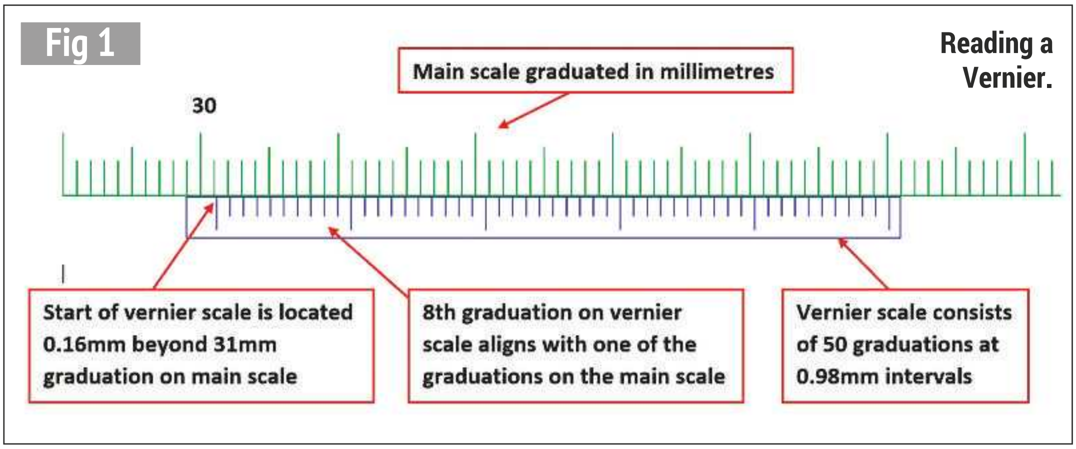
The ordinary micrometer shown above only measures outside dimensions. If an internal dimension such as a diameter needs to be measured then, if space permits, a special internal micrometer may be used. If the internal diameter is too small to allow this then a special 'telescoping gauge' or similar instrument must be used to 'record' the internal dimension and this instrument can then be measured using an ordinary micrometer. A telescoping gauge is a 'T' shaped gauge, one or both of whose upper 'arms' can retract like a telescope.

The internal diameters of tubes may also be measured using a special three-point micrometer.

Depth gauges that measure using a micrometer screw are also available.

The user's influence on a micrometer measurement can be minimised by use of 'force

Fig 1



ABBE'S PRINCIPLE

Abbe's principle was stated by Ernst Karl Abbe, a professor at the University of Jena, Germany, and a partner in the firm founded by Carl Zeiss, which is now Carl Zeiss AG or Zeiss International.

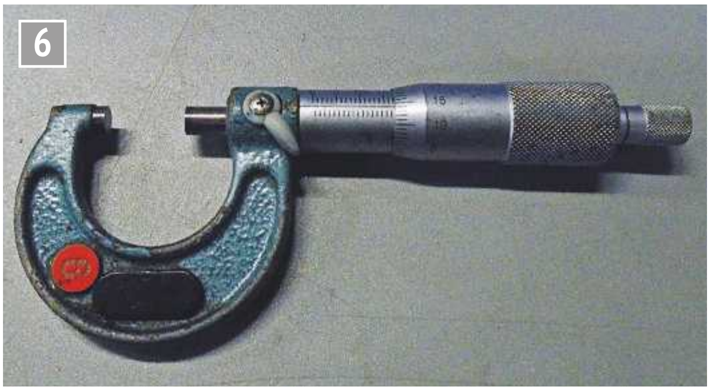
The principle can be stated as follows: *'To improve measuring accuracy, the object being measured and the scale of the measuring device must be placed so that they are collinear in the measuring direction'*. That is, to achieve a high level of accuracy when measuring length, a measurement device should be so constructed that its scale is in line with whatever is being measured.

Neither the Vernier caliper (apart possibly for measurements of depth) nor the height gauge conform to Abbe's principle. In both cases the parts of the instrument that touch whatever is being measured are moveable and project from the scale at right angles. In the case of the Vernier caliper one jaw moves on the scale and there must be a tiny amount of freedom ('slop') in the device to allow this movement.

The micrometer, on the other hand, does conform to Abbe's principle because the primary scale is located on the sleeve (or barrel) in which the screw is located. The screw is co-linear with the object dimension being measured and the sleeve surrounds it symmetrically so that even when the spindle and anvil of the micrometer touch an object to take a measurement there is no force that tends to distort the reading.

5

Vernier height gauge on a surface plate set so that zero reading can be verified.

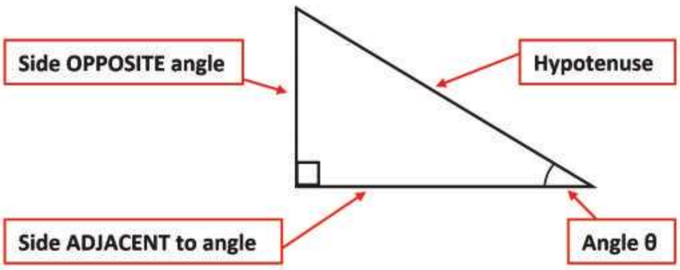


6

Micrometer.

Fig 2

The various components of a right-angled triangle.



A set of gauge blocks.

limiters' such as a spring-controlled ratchet.

Except in the case of an electronic gauge, in each of these cases – rule, Vernier caliper, micrometer – the reading must be taken with the eye immediately above the relevant scale mark. This avoids the effect of parallax.

Gauge blocks

One method of accurate measurement uses gauge blocks (**photo 7**).

Gauge blocks (also known as slip gauges, Johansson blocks or Jo blocks) were devised in 1896 by the Swedish inventor Carl Edvard Johansson, who worked in an arms factory and sought a way of calibrating workshop equipment more accurately than the methods then current could achieve.

Each block in a set of gauge blocks is manufactured to have two parallel faces that are a very accurate distance apart, the two measuring faces being manufactured to a high degree of flatness, parallelism and surface finish. This is done by using high-quality alloy steel, ceramics or cemented carbides, grinding being followed by 'ultra-micro-lapping' to ensure that the measuring surfaces achieve a very flat surface finish. If steel is used, at some stage in the process the blocks are heat treated and aged so that they possess good wear resistance.

The blocks in a set can be combined to achieve a very accurate distance, sets of gauge blocks being specified to various grades of accuracy and precision. They should be used at a specified temperature (usually 20 degrees Celsius) to avoid errors due to expansion.

Blocks are 'wrung' together to achieve a required distance (to avoid error, it is best to use as few blocks as possible to achieve that distance). Wringing means that when an additional block is added to a stack of blocks it is firstly placed 'cross-wise' to the existing stack and then twisted into place so that the non-measuring sides are parallel to the other blocks in the stack.

Blocks that have been wrung together stick together quite strongly although the reason for this is not entirely clear. The effect has been attributed to air pressure, the wringing process being assumed to squeeze air between the blocks. However, gauge blocks stick together in a vacuum so this cannot be the whole story.

Another possible reason is inter-molecular attraction arising because, thanks to the lapping process, the two blocks' molecules are very close together. Surface tension arising from water vapour and oil between the blocks may also play a part.

Great care must be taken to look after these blocks so that they retain their accuracy. Specially hardened blocks may be used to 'book end' the stack to protect the other blocks. The stated dimension of a block includes an allowance for a very thin film of protective oil.

The dimensions of gauge blocks can be checked by interferometry.

Gauge blocks can be used to set a sine bar (**photo 8**) at an angle to a surface plate.

The above illustration shows the essential point about a sine bar, which is that it consists of a flat top surface and a bottom surface that has two notches located an accurately measured distance apart. Into these notches are fixed rollers (identical lengths of circular section) that are parallel to each other and at exactly right angles to the top surface. The line between, and at right angles to, the centres of these two rollers is parallel to the top surface of the sine bar.

To set the top surface of the sine bar at a given angle to the surface plate or machine table the sine of that angle must be determined. Recollect that the sine of an angle θ when it forms one angle of a right-angled triangle (**fig 2**) is given by:

sin θ = Side Opposite / Hypotenuse

When the sine bar is laid on the surface plate the top of the sine bar will be parallel

A sinebar.

Vernier caliper inside jaws.

Fig 3

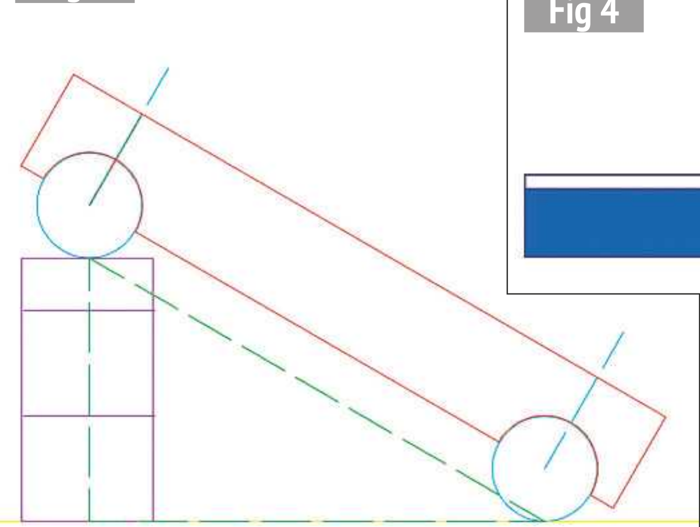
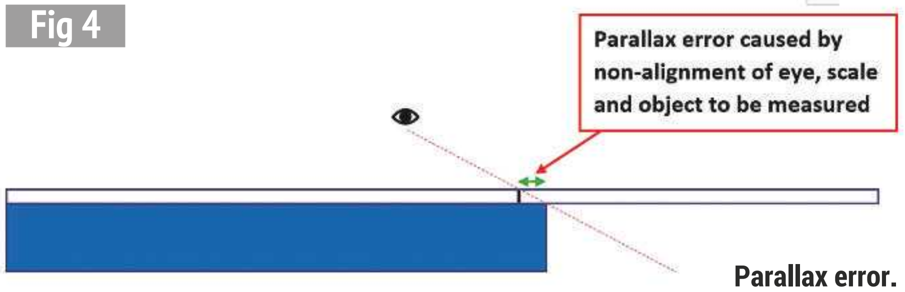


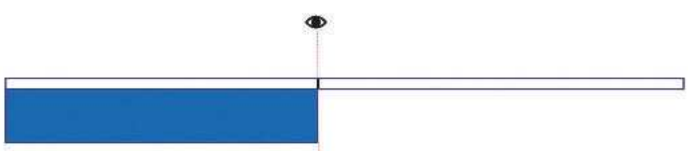
Diagram showing a sine bar set up to give an angle of 30 degrees.

Fig 4



Parallax error.

Fig 5



Avoiding parallax error.

to the surface of that surface plate. To incline the sine bar at an angle θ the first step is to determine the value of the sine of the angle θ (i.e. sin θ) using tables or a spreadsheet (depending on the function chosen the angle may need to be entered in radians so it will be necessary to convert degree values into radian values by multiplying by π/180). For example, if we want to set the sine bar at an inclination of 15 degrees then this is:

15 degrees = 15 x π / 180 = π / 12 = 0.261799388 *radians*

Note that in Excel spreadsheets, π is input as 'Pi()'.

If you are using tables, you are unlikely to get the value to this many places of decimals! It is not, of course, necessary to write this down if one is using a spreadsheet.

This radian value is now input into the function SIN() to obtain the value of sin 15 degrees which is 0.258819045. Again, it is not necessary to write this down but simply 'call' the value as required - if you are using a spreadsheet it is worth checking your calculations using, say sin 30 degrees (using radians this is sin(π/6)) which is 0.5.

Spreadsheets are wonderful – but it is easy to make a careless mistake!

If the distance between the centres of the two rollers on the sine bar is 200mm then this is the hypotenuse. So, to determine the Side Opposite:

sin 15 degrees = Side Opposite / Hypotenuse
0.258819045 = Side Opposite / 200

Multiplying both sides by 200 and swapping the sides over gives:
Side Opposite = 0.258819045 x 200 = 51.76380902*mm*

Clearly this level of accuracy is not obtainable in practice.

A stack of gauge blocks is assembled to give a total height as close as possible to the above value (**fig 3**).

Sources of Error

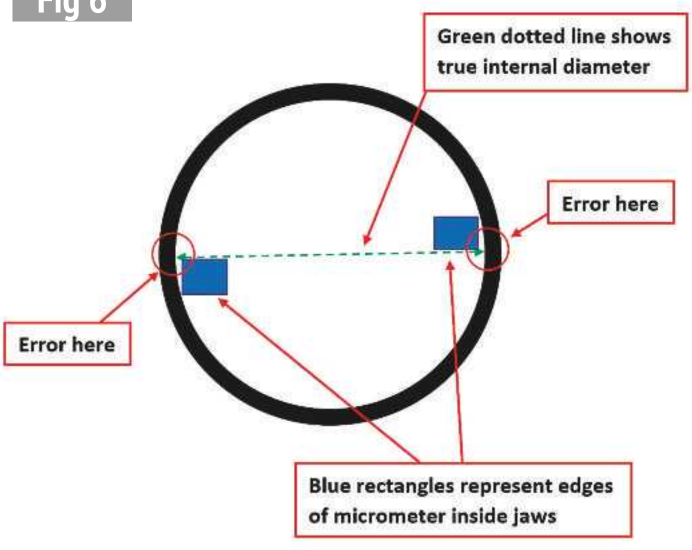
There are numerous ways in which measurements can be affected by error. One of the most common is parallax error, which occurs if the eye is not immediately above the relevant point of the scale. Note that the edge of the scale is not razor-thin!

Figure 4 shows how an error occurs if the eye, the scale and the end of the object to be measured are not in line. The way to minimise such an error is to take pains to ensure that the eye, the scale and the end of the object to be measured are precisely in line, as shown in **fig 5**.

Another potential source of error arises from the width of the measurement device components. For example, when taking a measurement of an internal diameter the width of a Vernier caliper's internal jaws may cause an inaccurate measurement. This occurs because the edges of the internal jaws, even though chamfered, are not infinitely small. The internal jaws are circled in **photo 9**. **Figure 6** shows the effect on the measurement of the width of the inside jaw edges. Although the chamfering is not shown in the above illustration it should be clear that, because of the width of the outer edges of the internal jaws, a small measurement error will occur.

●To be continued.

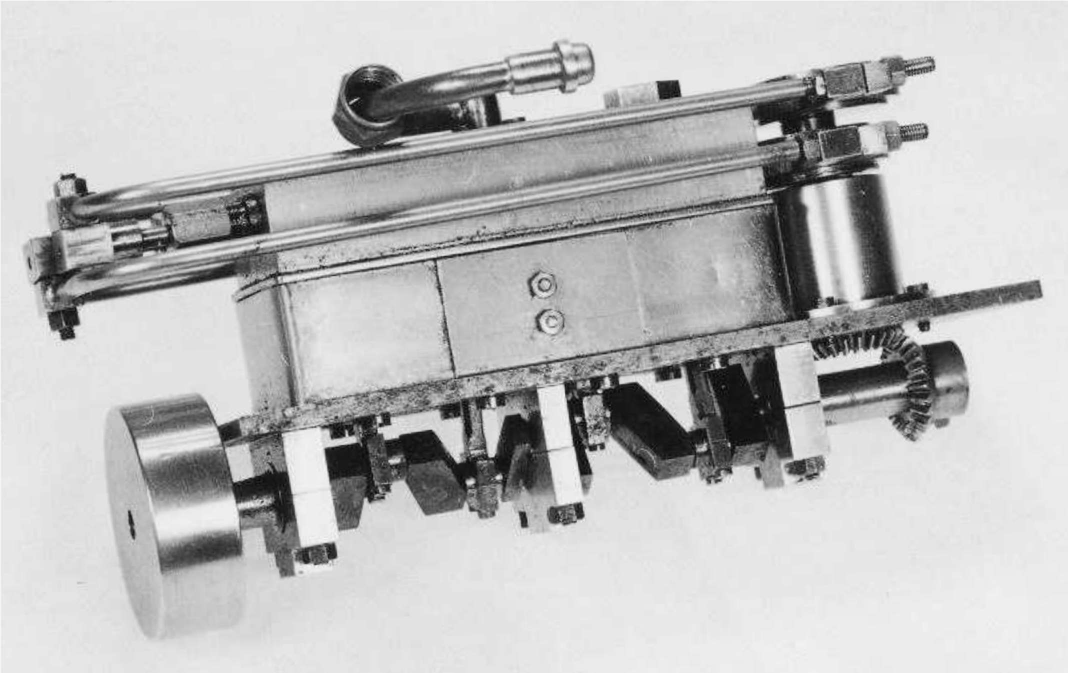
Fig 6



Error using inside jaws.

Hotspur constructs a three-cylinder reversible oscillating engine.

Continued from p.397
M.E. 4686, 11 March 2022



The writer's first experimental engine was a single acting four-cylinder unit with a common steam chest housing the two slide valves but there were no extra facilities and no reversing mechanism.

A Miniature Oscillating Steam Engine PART 3

Making the special springs

The three springs are made from 5⁄16 inch wide spring steel strip only 0.028 inch thick that is let down to be easily worked and this is simply done by heating the strip to red heat and letting it cool naturally. The material can then be cut into lengths of 1⅞ inches, flattened and marked out to drill the holes for the cylinder pivot stubs and the retaining screws. Carefully take off any burrs and sharp corners then shape the material to the outline given **fig 3**. I formed the strip over a ¼ inch diameter drill and the upper arch of the spring should be both flat and directly over the hole for the pivot stubs. For the cylinder mounting plate separation distance of 29⁄32 inch, the overall height of the spring needs to be in the tolerance band of 0.415 – 0.420 inch but if the distance varies then some adjustment to the spring dimension will be needed.

When satisfied that the shape is bent in an arc parallel to the base, heat treatment can be carried out. Heat each spring to red heat and drop it into a bath of cutting oil. Do not attempt to flex the spring or it is likely to snap. The tempering operation needs each spring to be carefully cleaned on the top and bottom faces so these are bright and then with a gentle flame each spring should be reheated slowly from one end till the surfaces show a blue tint and then they can be returned to the oil. Heat treatment will very slightly close the spring but this has been allowed for. **Photograph 16** shows the finished springs.

The next task is to make the three sets of steam inlet and exhaust blocks for the back of the relevant plates which I have

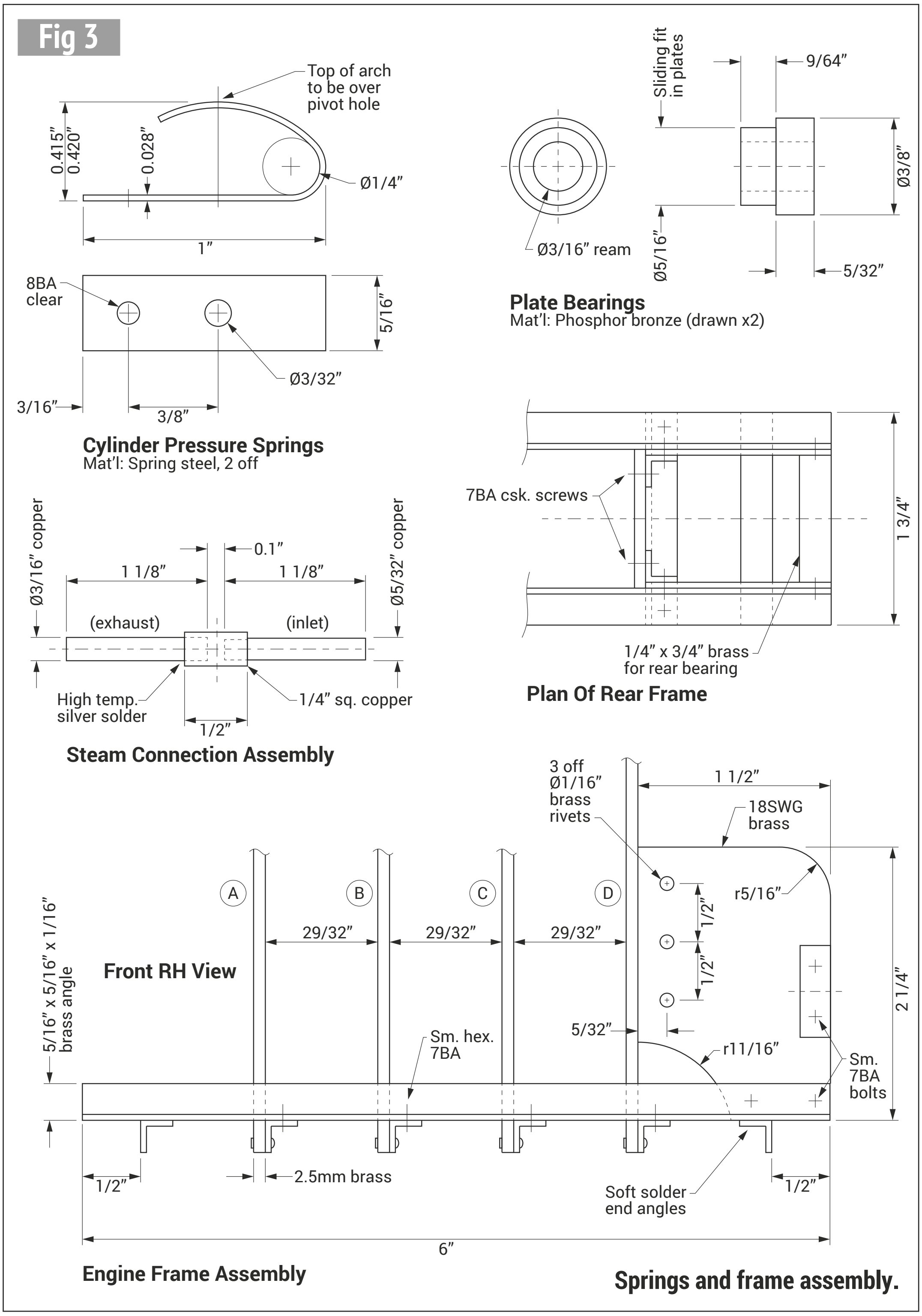
These are the three completed springs made from 5⁄16 inch wide clock spring; the drawing gives the details.

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

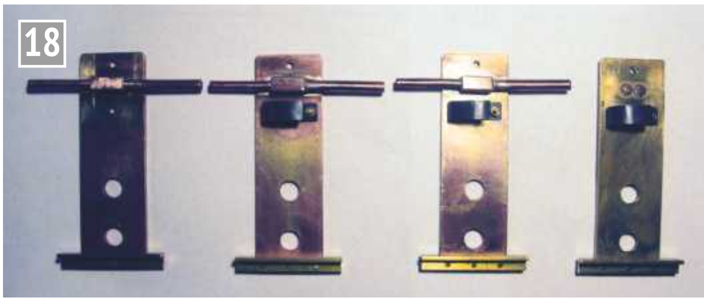
designated B to D. Each steam block is cut from a length of ¼ inch square copper bar to be ½ inch long and the holes are drilled centrally 0.20 inch deep into each end for the 5⁄32 inch steam inlet and 3⁄16 inch exhaust pipes. I used a suitable slot drill to give the holes a flat bottom at a depth of 0.20 – 0.21 inch then the pipe stubs were silver soldered into the holes with a high temperature solder for these joints as the blocks are then silver soldered with the usual lower temperature grade onto the backs of plates B-D behind the two steam port holes. Some scribed marks for alignment and a simple gauge to check they are in the right place are a good idea during this operation. Do make sure that the pipes are all fitted to the correct sides of the plates and the inlet and exhaust pipes are the same way round! Once the joints have been made check that the front faces of the three plates have remained flat for the cylinders to seal properly.

The heating process may distort the mounting plates slightly and, if so, rub the working face on a piece of fine emery tape on your surface plate, as suggested for the cylinder ports, to smooth the surface. As a final aid to correct seating each cylinder block can be lapped into its working position with fine valve grinding paste or 'Brasso' but do thoroughly wash the parts afterwards to remove all traces. Each cylinder block should also be identified with the relevant plate letter at this stage. When the best condition has been confirmed, drill the steam and exhaust ports through into the blocks. If necessary, any stray silver solder that has migrated into the steam ways can be carefully drilled out down the copper pipes as well. **Photograph 17** shows the result.

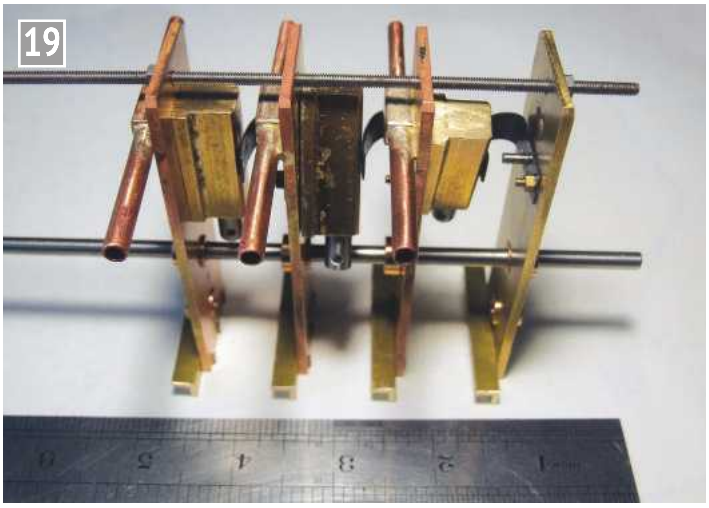
At this point the four lengths of ¼ x ¼ inch brass angle can be cut to be 1¾ inches long and fitted to the base of each cylinder plate. It is absolutely essential that these angles are fitted squarely across the base of each plate. The four pieces were made to be fractionally longer than specified and held onto the plates with small toolmakers clamps and checked for alignment with a square. It is essential to keep the edges of the angles level with the lower edge of each plate as well. Spotting through from the holes in the plates and adding 1⁄16 inch brass rivets was straightforward and **photo 18** shows the finished plates ready to have their bearing bushes added. Take great care to ensure the angles and bearings are fitted to the correct side of each plate.



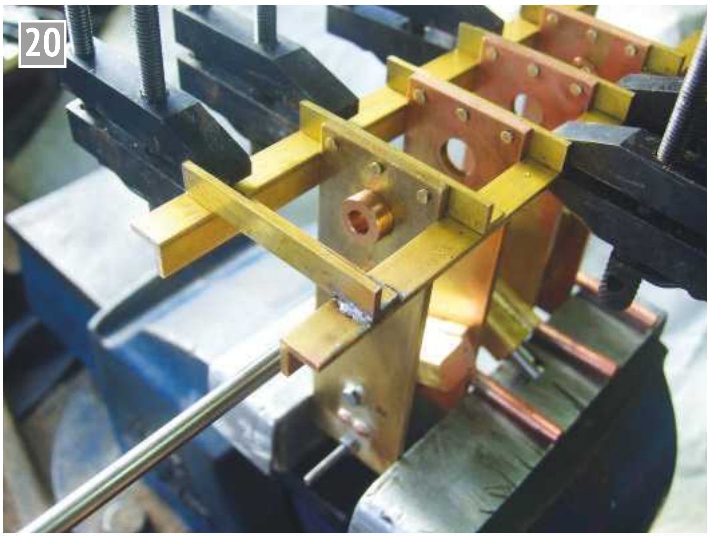
Adding the steam inlet and exhaust block and pipes by silver soldering may slightly distort the working face slightly but a rub on fine emery tape on a surface plate or drilling table will correct matters.



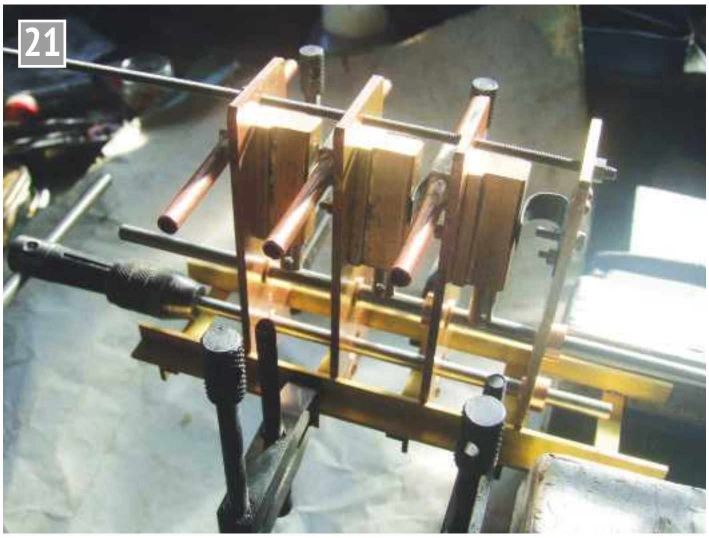
Here the four mounting plates for the cylinders have been completed and it is very important to make sure each is made with the additions the right way round.



This is a preliminary view of the parts once the bearings have been added to show the order of assembly and confirm the layout.



Soft soldering the additional cross beam angles to the main supports at both ends of the frame.



Lengths of steel rod are inserted into both drive shafts bearings to make sure they will turn easily. I find a 'T' handle is useful for this check.

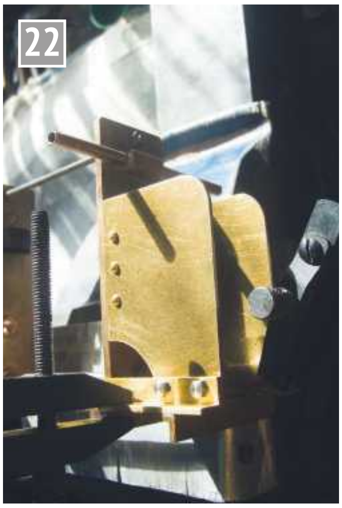
Machine and fit the six bronze bearings from ⅜ inch diameter phosphor bronze bar – these were given shoulders of sufficient length that allow them to protrude through each plate by around 1⁄32 inch, which acts as a spacer for the crank discs. Note that for the crankshaft assembly the first bearing is fitted from the face side on plate A whereas the next 3 are fitted from the reverse side of plates B, C and D. The same applies to the two additional bearings that are fitted in a similar manner into the lower holes on plates A and D. Small chamfers are added to the plates to ensure the bearings are fully seated and they can be attached to the frame plates with Loctite. To show the progress, I have loosely assembled the parts made so far and added the length of 6BA studding along the top which will be to maintain squareness. **Photograph 19** shows the appearance and gives an indication of the size.

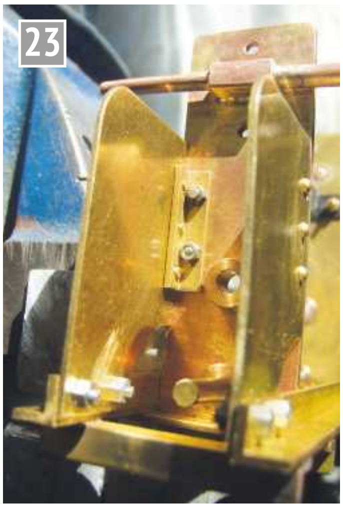
Beginning to assemble the parts

The base of the frame can now be fitted and is made from 6 inch lengths of 5⁄16 inch brass angle with two additional cross-members of ¼ inch brass angle the same as those that are fitted to the lower edges of the four vertical plates. As indicated on my general assembly drawing, given in the first article, the frame is the support for all the main drive items and will have additional bearings added each end for the main shafts. The engine assembly was placed in the bench vice and the two 6 inch lengths of 5⁄16 by 5⁄16 inch brass angle were positioned on each side and clamped to the plate angles (**photo 20**). They were arranged so that the length of angle at the rear of plate D was protruding by 1½ inches. Another cross beam was placed at ½ inch in from the outer end and held square with another clamp. The unclamped side was soft soldered to the 5⁄16 inch angle and, after checking again that it was square, the clamp was removed and the second side was soft soldered as well. The same process was carried out at the other end and a further check was made to see that both the intended drive shafts would turn easily. **Photograph 21** shows another view of the assembly. This was reasonably satisfactory but it was found that the cylinder plates were not as rigid as they needed to be, so the extra brackets for plate 'D' were added and these will double up as supports for the worm drive shaft for the water pump.

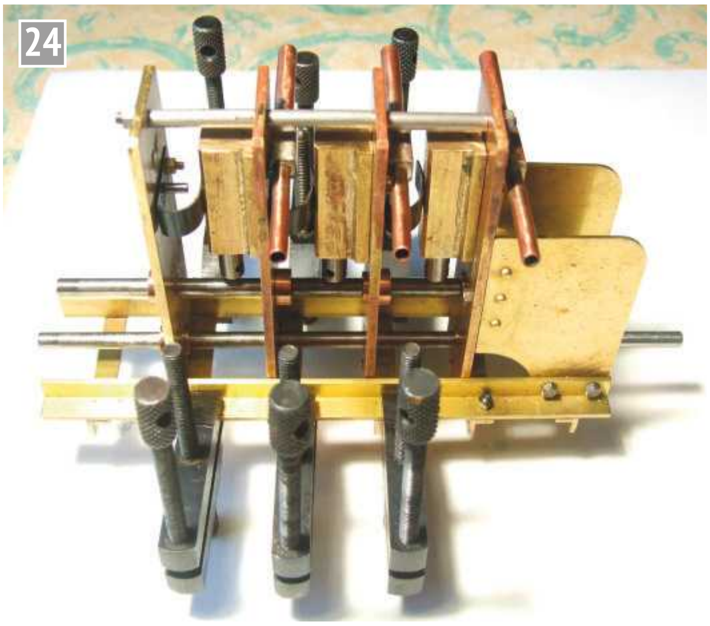
My drawing (fig 3) shows the two simple side plates that are made from 18swg brass and riveted to two small vertical ¼ x ¼ inch angles to ensure each plate is fitted squarely to the back of cylinder plate 'D'. **Photographs 22** and **23** show the plates assembled and their four 7BA small hex fastenings but the two lower bolts on plate D were later replaced with countersunk screws to clear the crank discs. The lower edges of the plates are attached to the main beam angles with additional 7BA small headed bolts and nuts.

At this point the spacers were added to the threaded rod support to ensure all the angles could be bolted squarely to the main frame beams. Cutting the stainless





Two views of the rear plates showing the way they are attached to plate D and the lower frame angles.



The front three mounting plates are still only held with small clamps and two 3⁄16 inch shafts are used to check the alignment of the bearings.

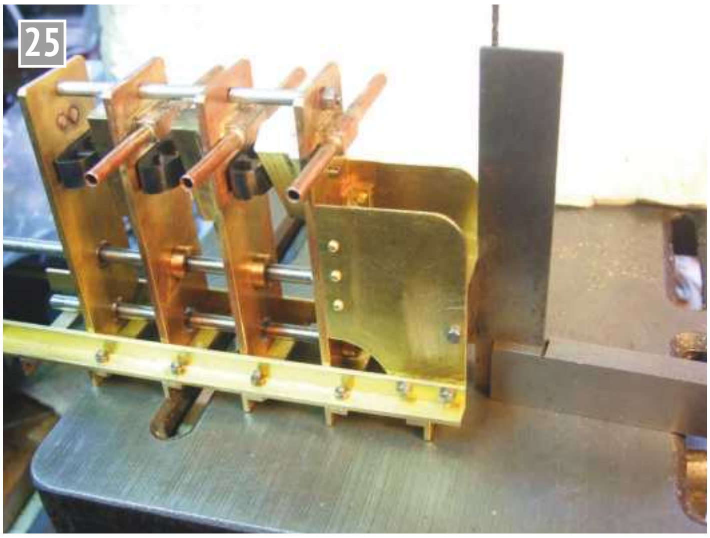
steel tube spacers to length was easy enough and they were machined in the lathe to be 29⁄32 inch long so as to give sufficient pressure from the springs and keep the cylinder port faces in close contact with each plate. Later I marked all three spacers with small nicks with a file to indicate which went where as they were all very slightly different lengths. Clamps were used on each side to check that the two plain shafts would turn smoothly and **photo 24** shows the position reached. Once absolutely satisfied with the fit of the parts and the smooth turning of the shafts then additional bolts can be added to the end of each angle as the clamps are removed. The whole structure will need to come apart later to fit the elements of the crankshaft, but this will give a measure of achievement so far.

The last task is to fit the brass block bolted between the two rear support plates for the bronze bush and my drawing shows the arrangement. The block was machined to fit between the rear plates and with two of the intended four 7BA bolts in place it was checked in both planes with a square (**photo 25**) before the second pair of bolts was added. Sharp eyed readers will note that here all the main frame parts have been bolted together using the small hexagon headed 7BA bolts and nuts and care needs to be taken to drill the holes slightly away from the flanges of the two angles concerned so the hexagons can turn and spanners can be used. My choice of bolt size was marginal but I think 8BA would have been too small. A test rod with the pointed end was passed through all the bearings to make a centre mark on the new brass block. The housing was then removed and a proper Slocombe drill used to make a full centre. Then the two centres method was used to set the housing up in the four-jaw chuck to machine it. A reamed 5⁄16 inch diameter hole was made for the outer bronze bearing, which was fitted with Loctite. **Photograph 26** shows the final result.

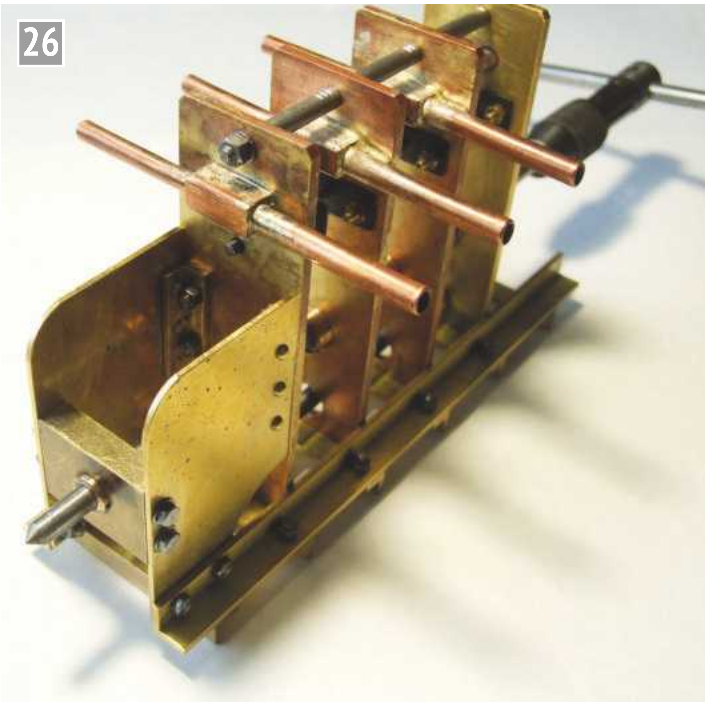
●To be continued.

NEXT TIME

The additional front main shaft bearing will be added.



The rear bearing block held with only two of the four short bolts to be checked for squareness.



All the fastenings are in place and the structure is rigid with the shafts turning easily.

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

I received a Useless Box for Xmas, which was great fun. An old idea rejigged for today, using laser cut, flat pack plywood, make it up yourself, D-I-Y design *and* exemplary instructions (Chinese producers take note) but … not entirely without fault. I noted that the instruction text did not agree with the relevant photographs, being shown from a different angle and the assembly of some parts in layers did not explain the order in which they were assembled. As it is mostly glued together, this could cause problems. It will join the other items in my cabinet of curiosities, like my pet rock, luminous ABC Minors badge and monogrammed ashtray from Baron Rutland.

Plastic Henge, *Sheffield.*
(Photo courtesy of Deborah Theasby.)

In this issue, Henges, Zoom, radio-controlled kits, Ernie's 'hairpiece', a Volvo, a Yesteryear build, chimney talk, mugshots and a knitting raid.

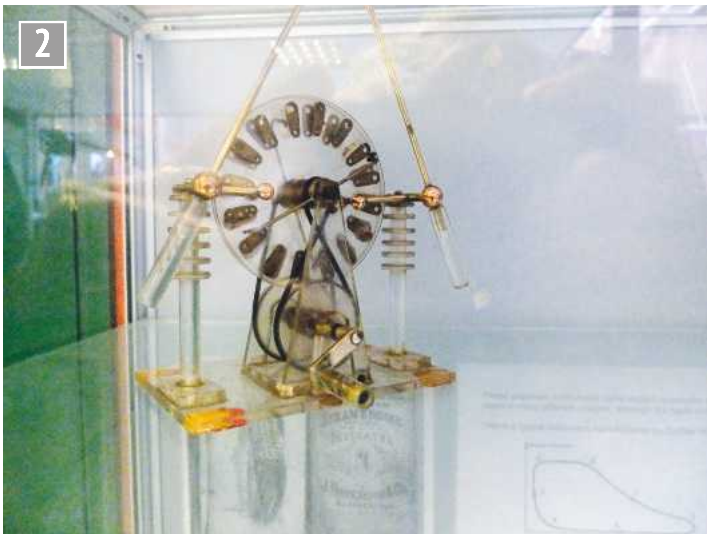
At various places in Wales there are stone circles with no signposts so I was puzzled as to why they are not marked. I later found out that most of them are artificial and mark where the National Eisteddfod was once held. So, ever since we have been Henge Spotting, including an important electricity substation near Meadowhall, which Debs called 'Electric Henge'. So imagine my delight when Motoring Correspondent, The Very Rev. Counter, (a man of the chequered cloth) spotted this temporary feature, which I immediately called 'Plastic Henge' (**photo 1**).

A gratuitous picture of an original Wimshurst machine at Bolton Steam museum (**photo 2**).

Bradford & District Model Engineering Society's *Monthly Bulletin* for December begins with president, Jim Jennings contemplating introducing virtual meetings online, via Zoom or similar. A few weeks ago the members were lukewarm about the proposal, now Jim wonders if the question should be reconsidered. (My amateur radio club has done this and it provides ample opportunity for banter and leg pulling, as in a 'live' meeting – Geoff.) Ron Fitzgerald writes on the Dodge brothers of America, automotive engineers since 1901 and making their namesake cars since 1914. R. Finch conceived and made a simple attachment for his mill, which makes the drawbar easy to tighten or release. It appeared in MEW Jan 2022. David Jackson in Road Vehicle News notes that nowadays more r/c vehicle kits are bought than steam wagons, traction engines or road locomotives. This is not surprising, as BR ceased to use steam in 1968 and many middle-aged people have never seen a preserved locomotive on the main line and have never visited a steam preservation venue. John Shelton had some complimentary travel tickets on the KWVR and so George Myers and his family took a trip behind Midland Railway Class 4 43924. Please note right hand drive unlike most of its sisters (**photo 3**).
W. www.bradfordmes.uk

Gerald Weare writes from **Waushakum Live Steamers** to say that the editor was unable to continue due to health matters and has not yet been replaced, hence the delay since we last heard from them. The president has been circulating a few emails to keep members up to date with essential maintenance and forthcoming meetings but New England in winter is not conducive to outdoor activities. Nevertheless, a Steam Up was held on 1 January, always a popular event despite the weather.
W. www.waushakumlivesteamers.org

Steam Chest, January, from the **National 2 ½ inch gauge Association** adorns its cover with a fine picture of Terry Neale's *Nettesha,* about which Des Adely writes briefly and Terry more extensively within. (I can't see the join… - Geoff) and in the subsequent 44 pages, Cedric Norman discusses his experience with digital readouts, after being quite happy with the graduated dials with which his machine tools were originally equipped.



Wimshurst machine at Bolton.

43924 at KWVR. (Photo courtesy of Dawn Myers, via Graham Astbury.)

Part 3 of Narrow Gauge Liveries refers to the railways around the Maginot Line, parts of which are preserved and open to inspection and parts of which are not. There are several YouTube videos on fitting DROs to your equipment and prospective buyers are recommended to watch them before deciding. (In this respect, I spotted a sea fort outside Copenhagen on one of our cruises which set me off on another quest. Details of Baltic sea forts appear not to be readily available, or documented, but the little I learned led me to YouTube videos, usually under the name of each fort. The most prominent were Oscaberg on the approach to Oslo and those around Kronstadt near St Petersburg.) Neil Heppenstall writes on his first lathe, a 1¾ inch swing Wizard by Lane & Son of Houghton, Co. Durham. Prior to this Meccano had been tried, without success He also built, aged 14, a tolerably good wooden lathe which he still has. Another use for neodymium magnets has been devised by the above Cedric Norman, followed by a report on the Rugby Rally. The Rugby club's track is reputed to be the longest 2½ inch gauge track in the UK. A fire-damaged *Helen Long* has been donated to the Association. This picture shows the monumental task ahead of its restoration. Perhaps it could be renamed *King Alfred* (**photo 4**)? A letter updates readers on the revamped Kennions model engineering business. Ian Gordon found his way into model engineering via a coincidence: idly monitoring 'Live Steam' on eBay, as one does, speculating on the details of owning a live steam model, he saw a 'Kingette' for sale, in his own town too! The coincidence was too great and it was acquired and run often at Chesterfield. Mike Twombley's Californian house was destroyed in the 2021 fires; nothing left more than a couple of feet above ground and he sent a picture, annotated to show the location of his bedroom, pickup, shed, lathe, etc. How soul destroying… However, his hot-rod Volvo 144 survived!

W. **www.n25ga.org**

The **Ryedale Society of Model Engineers** December *Newsletter* reports that a chimney has been removed from the village hall as cracks were appearing and it was beginning to lean. 'Raindrops are falling on my head' is one thing, but anything more substantial like the Quality of Mercy, is a definite No-No. Jamie produced this fine snowplough, but this item has no connection with the previous notes… (**photo 5**).

W. **www.rsme.org.uk**

Halesworth & District Model Engineering Society begins with a fine picture of a model van that Richard Bethel made for his sons. He explains, "In 1981 - my two boys, being young at two and three years old - my brother and I decided to make a van for them to drive at steam rallies. It was scaled up from a Matchbox model of 'Yesteryear'. The chassis was made from an old bedstead, the body from hardboard, the wings were modelling ply, wired together with copper wire and fibre-glassed underneath. We made a pattern for the wheels from a plastic BMX rim and made wooden spokes and hubs before we had the wheels cast in alloy and machined them. The motor is a 1936 invalid carriage motor that we acquired and the steering rack is from a Hillman Imp. We spent a few hours a week over five years making it and we decided to make its reg. number BN 86, which were my sons' initials and because it was finished in 1986. It has been to dozens of steam rallies

Helen Long - fancy a go? (Photo courtesy of Cedric Norman.)

Jamie's snowplough at Gilling. (Photo courtesy of Dan Holbrook.)

>>

and fetes over the years and has always created attention and interest." Lowmex 22 will take place in October at an exciting new Lowestoft venue, East Coast College. This event has grown and grown of late, so if you can get there, do so. Barry Lane updates us on his cyclecar, *Baz.L.* - see *M.E.* 4667. He took it to the 'Rocking Beach Cruise' at Saunton Sands in North Cornwall, where 'specials' of all kinds are exercised, arriving too late for food, but was helped to find a meal by the owner of a hot rod who took them on a three-mile 'terrifying' circuit. He enjoyed the trip immensely - his wife thinks he's mad…

W. www.hdmes.co.uk

Sandstone Estates updates us with a 'Journal of the Plague Year' in which the major achievement was returning NGG16A No. 155 to steam. Painted a cheerful pillar-box red, it appeared at the well-attended Cherry Steam event. Some of the 3 foot 6 inch gauge locomotives have been relocated; in the case of the GMAM Garratts this was a 200+ tonne load. See https://www.youtube.com/watch?v=cALKH4CWv4k for a visit to Sandstone.

W. www.sandstone-estates.com

Maritzburg Matters, December, arrives from **Pietermaritzburg Model Engineering Society,** another group which has weathered the vicissitudes of the last two years. They have plans for 2022 as do several members who are beginning new projects. Frank Holland writes on petticoat pipes. Not a musical instrument but a device to make the smokebox more efficient. Some regard the effect as a sort of music; 'chimney talk'. Some local trivia, of interest to us Sheffielders too, a factory in Pietermaritzburg is known to all as SOMTA (Samuel Osborne Mushet Tools, Africa). Quondam President, Charles Polkey wrote on the cleanliness of engine rooms, switchboards etc. which were kept extremely clean and polished, as the enginemen had little to do as long as everything was running smoothly and so kept it all tidy (**photo 6**). This continued as notes about workshop safety and being able to find items quickly. (Geoff inspects the ceiling and whistles innocently…) An item on the use of stainless steel in boilers makes interesting reading. Now, for aeromodellers, try this: *https://www.spitfireinmyworkshop.net/?fbclid=IwAR3z6Wwi3gPZ03EetbrsIzw_C_kVIgJcl8jaPp38gUF-VoHk_X2RLK1c7Jc*

W. www.pmes.co.za

Centurion Smokebox, January, from **Centurion Society of Model Engineers** says that a new trophy has been donated to the Society for 'Model Maker of the Year' and awarded to chairman, Leon Kamffer for his wonderful SAR Class 5, *Karoo.* The originals were built by the Vulcan Foundry and entered service in 1912.

W. www.centuriontrains.com

In *Offcuts*, January, from **Bromsgrove Society of Model Engineers,** editor, David Fort praises his many contributors for their submissions. 'Keep 'em coming', he says. Noting that 2022 is the 40th year of the Society's existence, celebrations are the order of the day. Two significant requests have been made, that the dates of the Queen's Platinum Jubilee be avoided and that the excellent volunteer kitchen staff also have those days off. It is also the 60th Anniversary of Avoncroft Museum of Historic Buildings. (This is a new one on me, but it looks fascinating – Geoff.) A new member has proposed that mugshots of the club officers be included in *Offcuts*, as otherwise the only chance he has to identify them is by studying the 'Wanted' posters at his local Bridewell. Editor, David has duly done so, the photographs must have been taken on a cold day as almost all are wearing hats, scarves and heavy coats. If readers are looking for videos of more interesting fayre, look at 'Roy Boy danny 1' on YouTube. Mike Clarkson explains how his A3, *Papyrus* was built (over a period of 60 years). Mike Wilson has acquired a 26 year old, lucky him! (A locomotive, *Peveril*, I must point out...) He pays tribute to all his fellow Bromsgrovians who helped him with advice, tools and materials.

Switchboard at Bolton Steam Museum.

W. www.bromsgrovesme.co.uk

York Model Engineers, *Newsletter*, January, opens with a picture of a locomotive I have travelled behind many, many times - *Triton*, on Scarborough's North Bay Railway. Sister engine, *Neptune* - both A3 outline and 15 inch gauge - were built by Hudswell Clarke of Leeds and were the world's first diesel-hydraulics. Poppleton and Millfield Lane post boxes have been 'Yarnbombed'. The miscreants, possibly a raiding party from Dent in the mountainous wastes of the North Riding. Author, John Hannavy has written on a rather esoteric subject; Governors. In an interesting diversion, Mr. Hannavy mentions Christiaan Huygens, pendulums (-a?) windmills and so on, where the running speed must be regulated (… and rotary dials on telephones…?). 'Clangers' were not in evidence in this issue, but a gentleman built a three cylinder steam locomotive, ran it for several years and then in a major overhaul discovered that the middle cylinder had never contributed…

W. www.yorkmodelengineers.co.uk

And finally, a young woman was asked why she would not marry either of her engineer or lawyer boyfriends. She replied that, "the engineers make advances and add no detail, the lawyers argue details and make no advance".

CONTACT

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Metric thread	(18) 0.2–3.5 mm/rev
Inch thread	(21) 8–56 threads/inch
Longitudinal feed	0.07 -0.4mm/rev
Tool holder	4-Way
Tool holder Dimensions	12 x 12mm
Maximum cross support travel	70 mm
Maximum transverse support travel	110 mm
Maximum longitudinal support travel	650 mm
Tailstock Quill Diameter	30 mm
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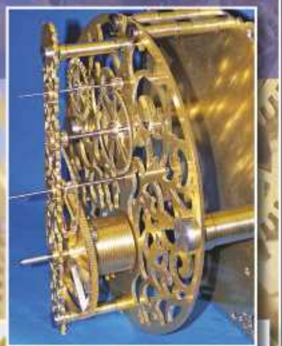

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