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MODEL ENGINEER

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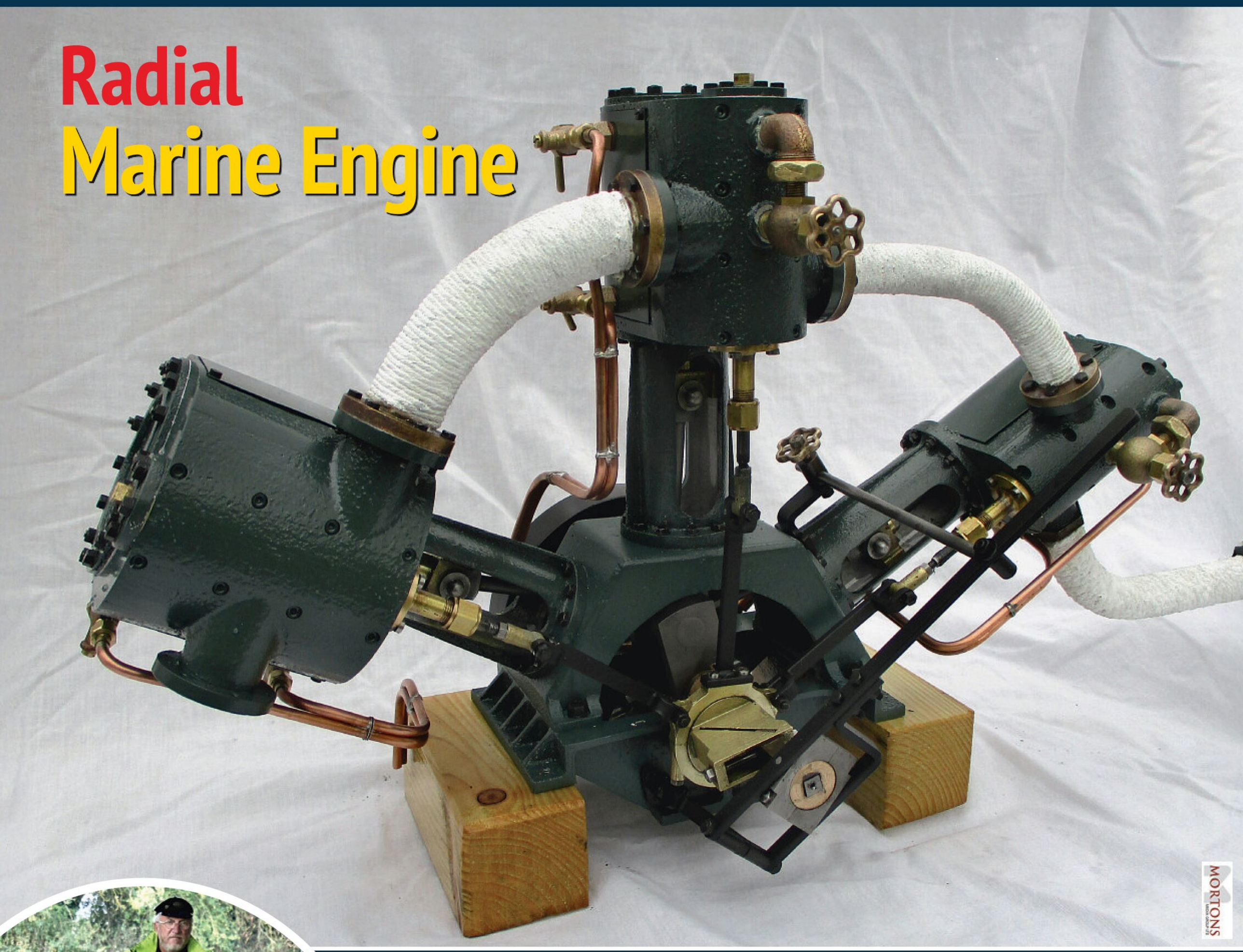
In steam after waiting 80 years

Radial Marine Engine



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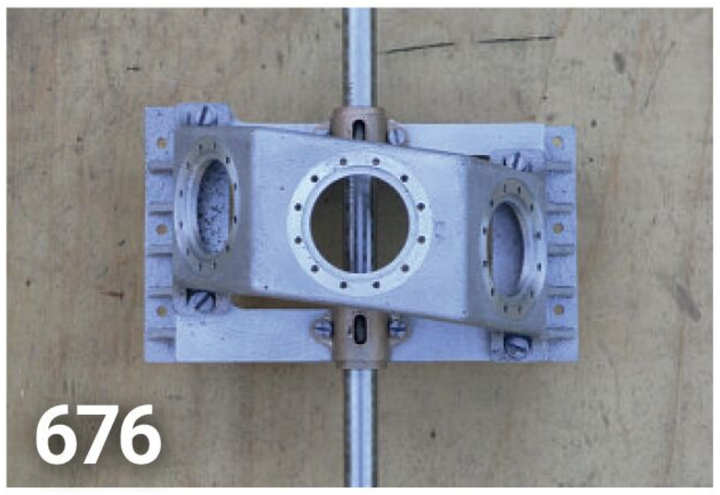

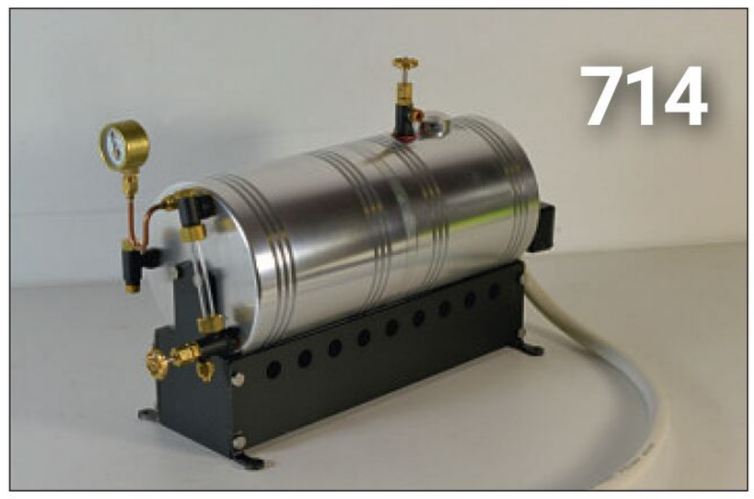

IN THIS ISSUE

Vol. 233 No. 4756 15 – 28 November 2024

ON THE COVER...

A rather unusual triple expansion marine engine, with radial cylinders, built by Ian Couchman (photo: Ian Couchman).

This issue was published on November 15, 2024.
The next will be on sale on November 29, 2024.

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SMOKE RINGS

MARTIN EVANS
Editor

DIANE CARNEY
Assistant Editor

Kennions

Freya Hempenstall's Nelly the Copter.

Midlands Show

I write this having just returned from the recent Midlands Show at the Warwickshire Events Centre. The event was well attended, as evidenced by the number of cars in the car park, and there were plenty of high-quality models to see. My first trip was to the EYEs stand to see Freya Hempenstall's *Nelly the Coptor* (**photo 1**), featured in *Model Engineer* (M.E.4753 October 4th). Freya was 9 years old when she made this and it was her first model engineering project. I think it is a very nice piece of work. You can read more about the EYEs, and how they fared at the show, in Patrick Hendra's article on page 686.

I am a bit of a sucker for the unusual and I had never seen a model of a Hansom cab before so I found this one particularly interesting (**photo 2**). It's clear that the Hansom cab was a highly evolved vehicle – very efficient at moving fare-paying passengers around London.The little hatch at the top was of course for passing the fare up to the driver. The original 'hop on, hop off' transport, perhaps.

Another object of particular interest was a hydrogen powered turbine on display at the Gas Turbine Builders Association's stand. Hydrogen burns very hot so the design of the turbine presented some serious challenges and it was very interesting to hear of the various ingenious ways these challenges had been met. I hope we may in due course include an article about this engine.

It was good to see EKP at the show after an absence of several years. Having recently acquired Kennions (see M.E.4734 January 12th) they now have a range of locomotives and other engines available. The latest of these is *Lara* (**photo 3**), an exhibition quality beam engine with a 9 inch flywheel, available as a set of castings and drawings – see www.kennions.co.uk.

Starting next time we will be including the usual reports on the show from John Arrowsmith.

Bradford Cup

As you may recall, this year's Bradford Cup, awarded for the best article or series in *Model Engineer* during 2023, as voted for by our readers, was won by Ron Fitzgerald for his *Steam Engine* series. The Midlands Show provided a perfect opportunity to actually make the presentation, which was done on the first day of the show. SMEE president Mike Chrisp made the presentation and our photograph (**photo 4**) captures the event for posterity.

One sixth scale model of a Hansom cab.

The latest engine from EKP/Kennions – beam engine Lara.

Ron Fitzgerald (right) receives the Bradford Cup from Mike Chrisp, president of SMEE.

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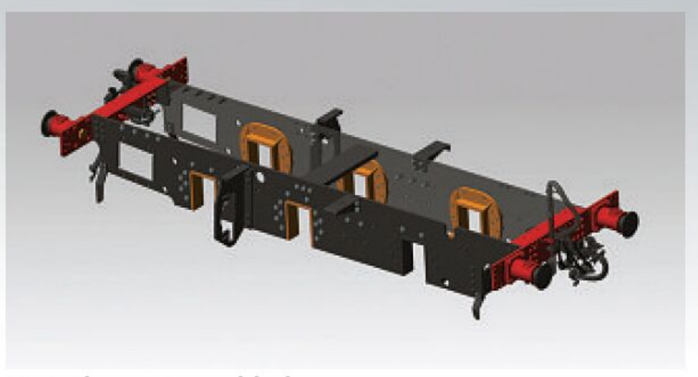
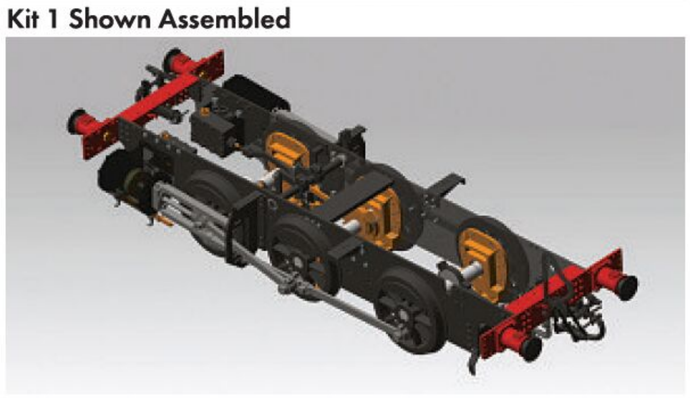
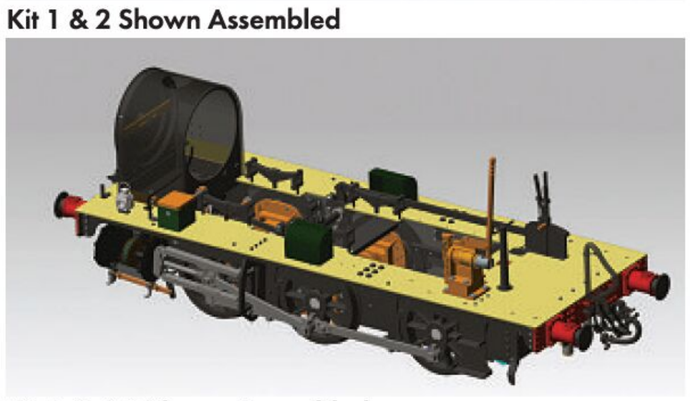


Kit 1 Shown Assembled



Kit 1 & 2 Shown Assembled



Kit 1, 2 & 3 Shown Assembled

Kit 1, 2, 3 & 4 Shown Assembled

Kit 1, 2, 3, 4 & 5 Shown Assembled

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- Reverser
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- Stainless steel motion and grate
- Sprung axle boxes with needle roller bearings
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- Safety valve
- Painted and ready-to run
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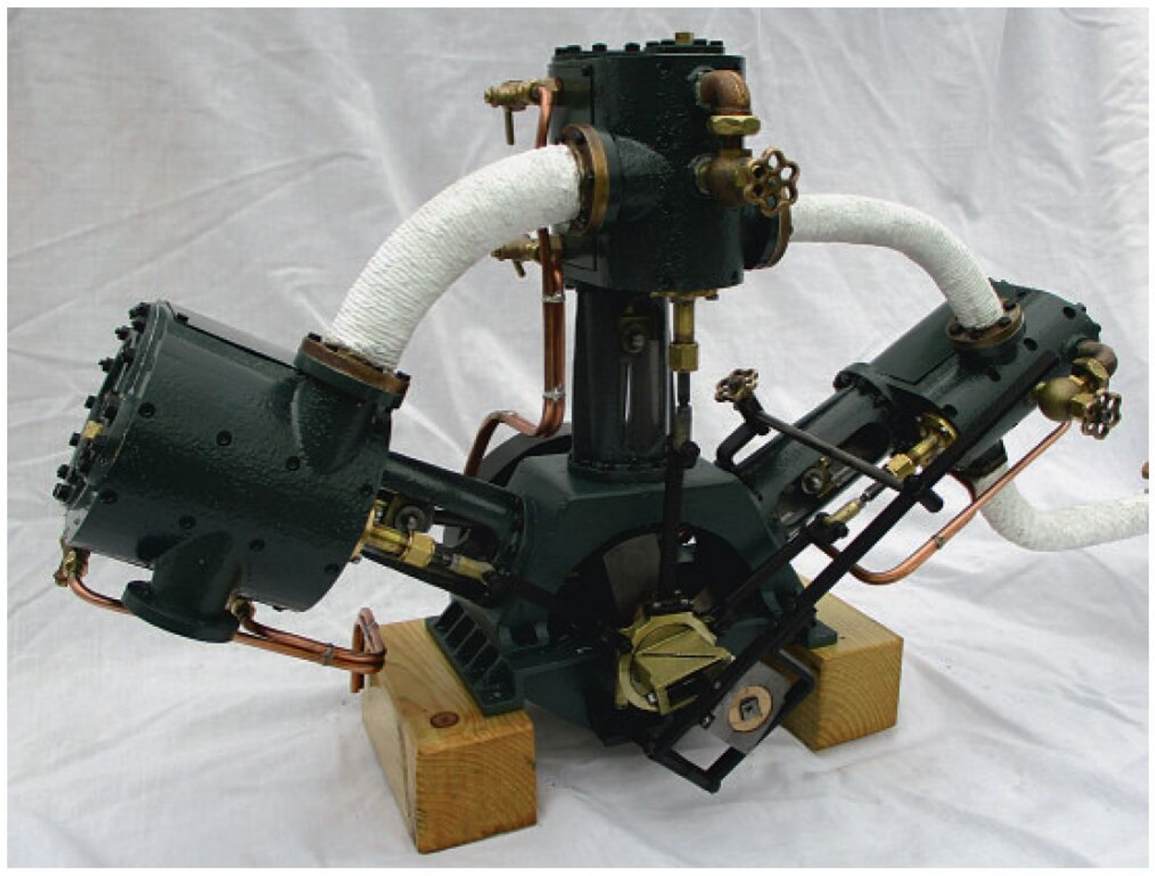
A Radial Marine Steam Engine PART 1

Ian Couchman builds a rather unusual ‘quasi radial’ triple expansion engine.

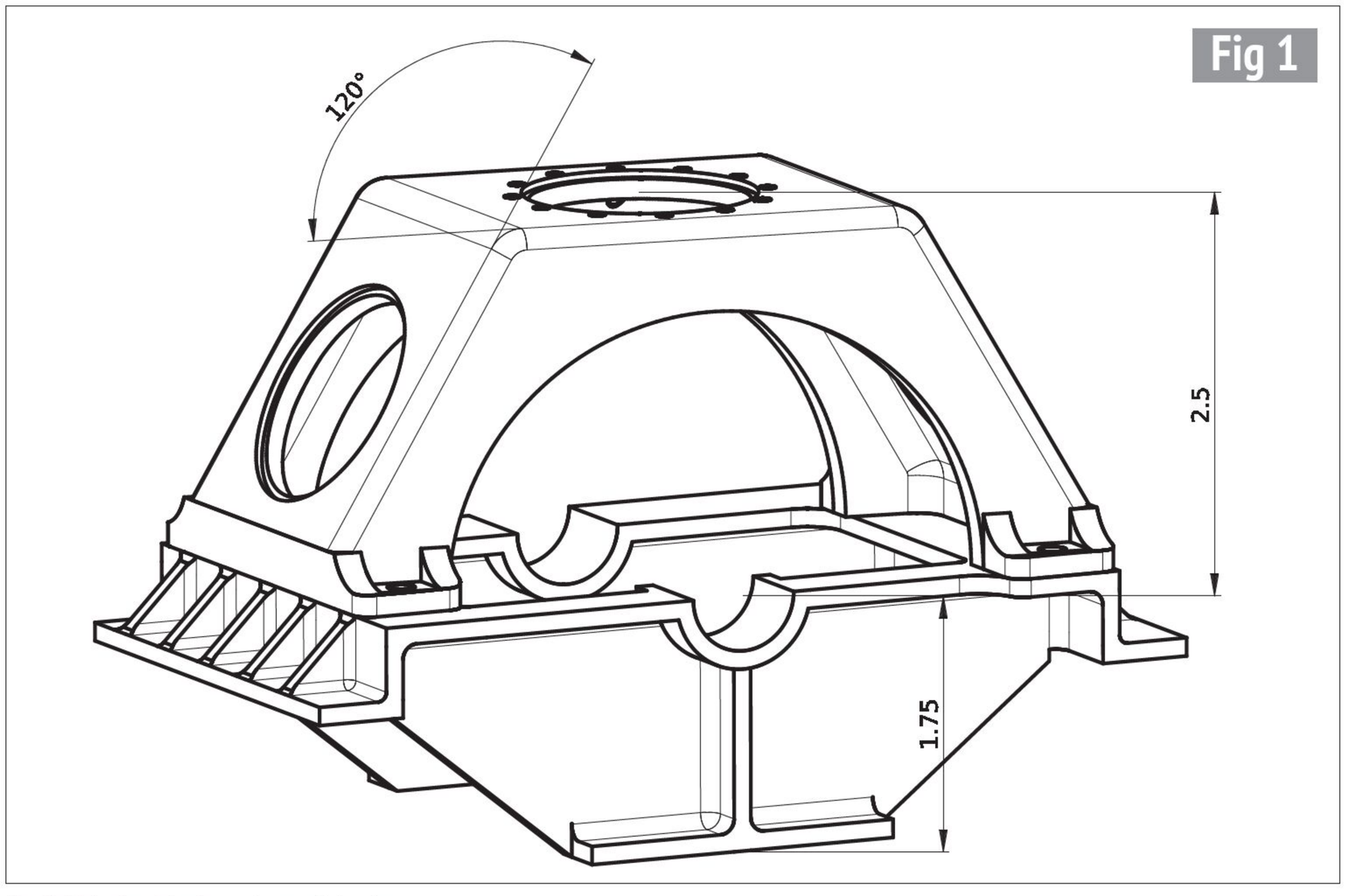


Radial Marine Engine

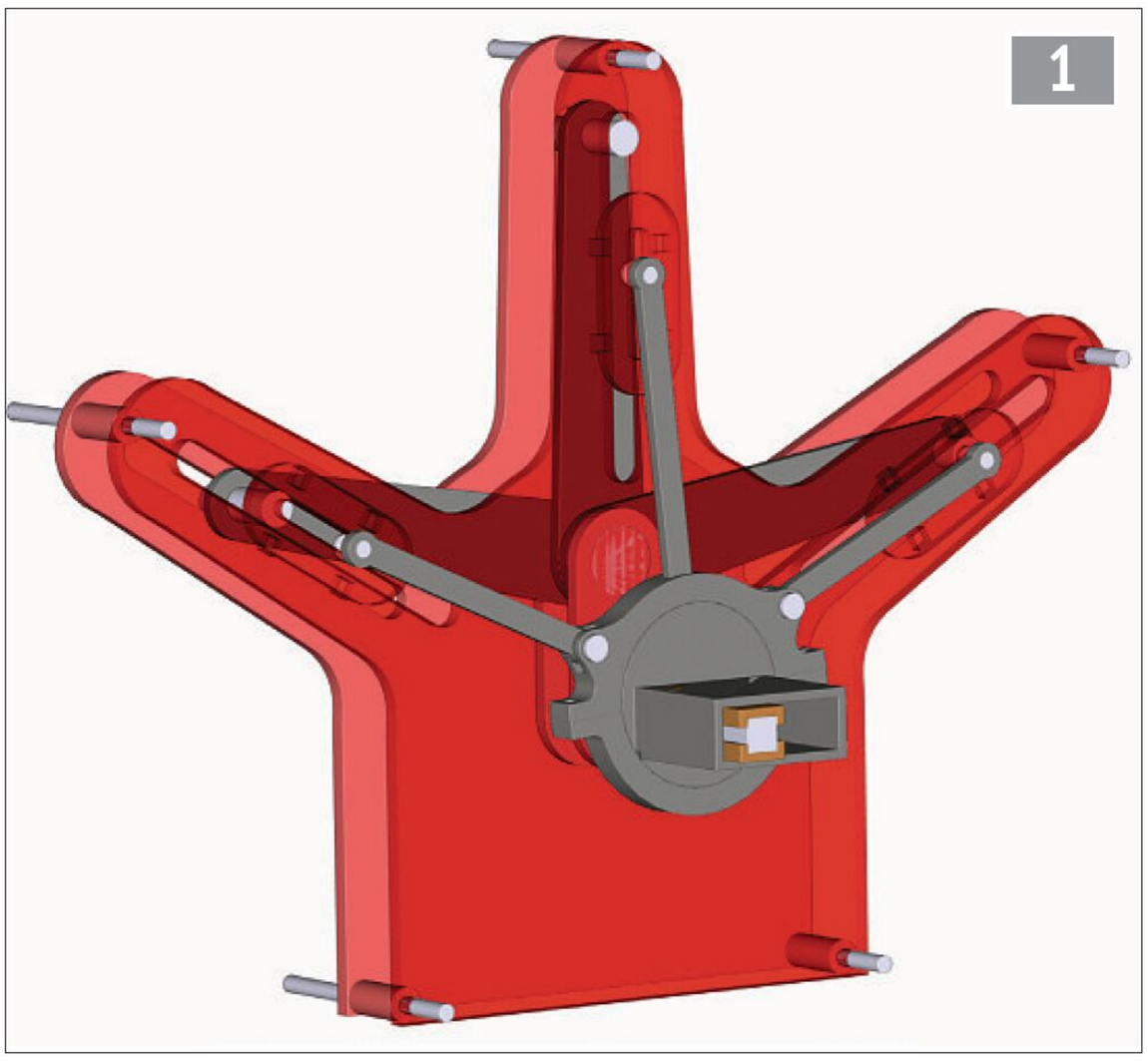
It’s been very quiet in the workshop lately. The traction engine has been steaming, the drum has been threshing, the elevator has been elevating and the hit and miss engine has been missing and hitting, but nothing has been made.

Inspiration arrived, however, in a video on Youtube in the form of a triple expansion, radial marine steam engine (youtu.be/Oh9LpKAodxs?si=PU1Ja57TDmbm_Rbj).

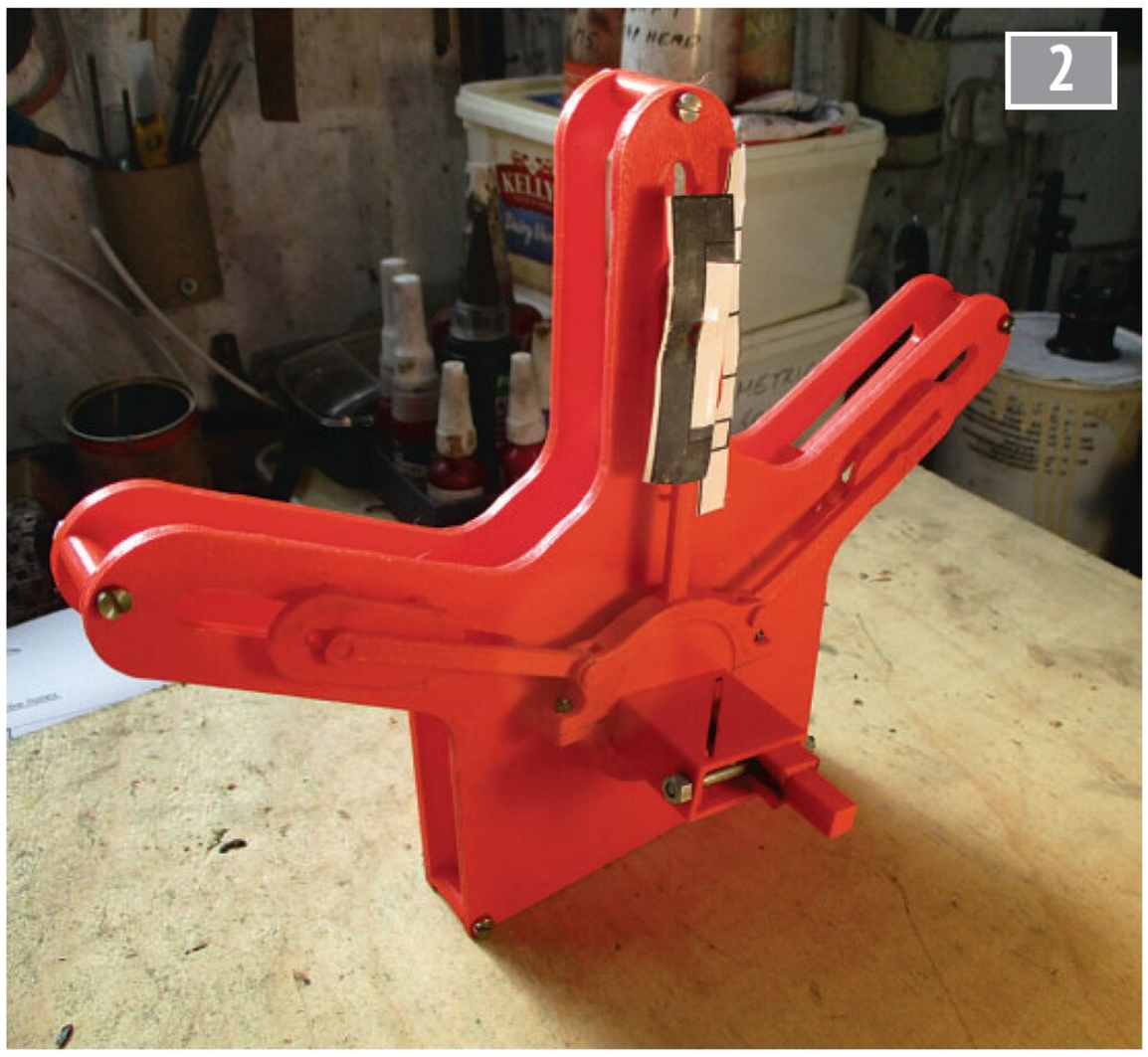
Okay, it’s not technically radial, more ‘W’ or ‘Broad Arrow’ but still a very interesting engine. The original was made in the early 20th Century, by Charles Ward Engineering Works, Charleston, West Virginia and was installed in a tug boat. What, then, makes it so interesting? Well, firstly the layout; three cylinders at 60 degrees spacing around the crankshaft. The three connecting rods share a common crank pin with the cylinders spaced by rotating the main housing by about 7 degrees (more about this later...). Next, there’s the timing. For a triple expansion steam engine you might expect to see two eccentrics per cylinder (one forward and one reverse)



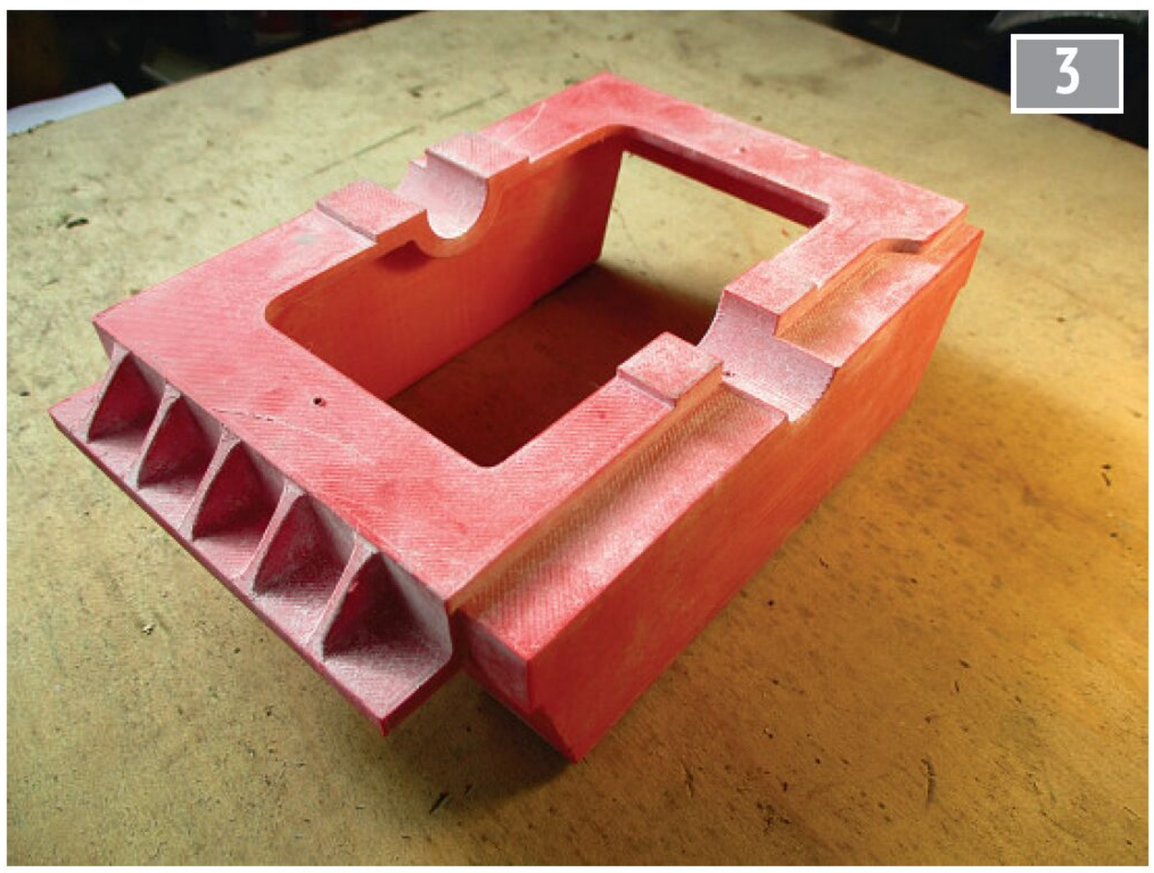
Radial Marine Engine – isometric view.



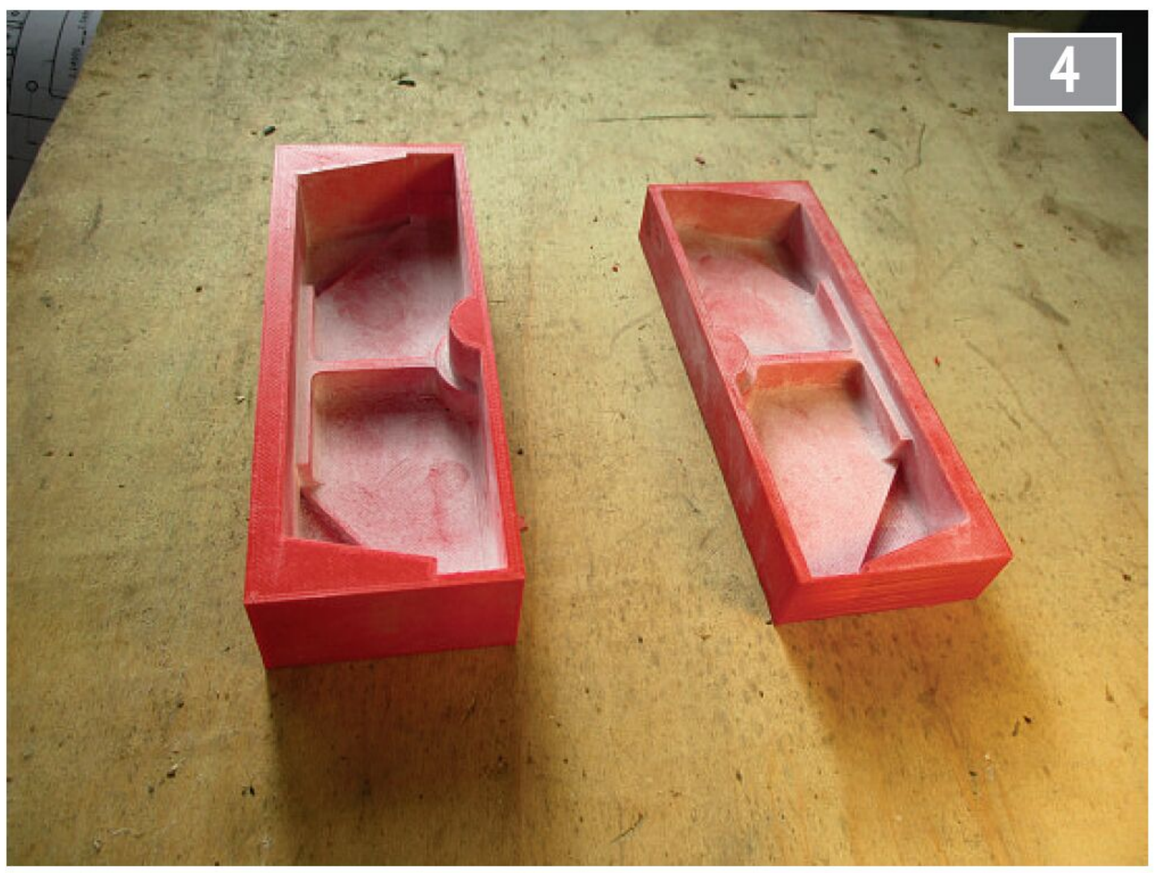
Isometric view of the mock-up.



The mock-up in reality.



Pattern for the base of the engine.



Core boxes for the base.

but this engine manages with just one eccentric for all three cylinders (including reversing). Wards described the engine as the simplest marine engine built and I'm inclined to agree.

So where to start? With no chance of drawings or seeing the prototype, I'm relying on the video, so it's going to be a lot of educated guesswork. Oh, okay, just guesswork...

Making plans

To get some idea of dimensions, I took a number of stills from the video. Guessing, from the height of the presenter compared with the engine, that the height to the top of the engine is about 5 feet, I decided on a scale of 2 inches : 1 foot.

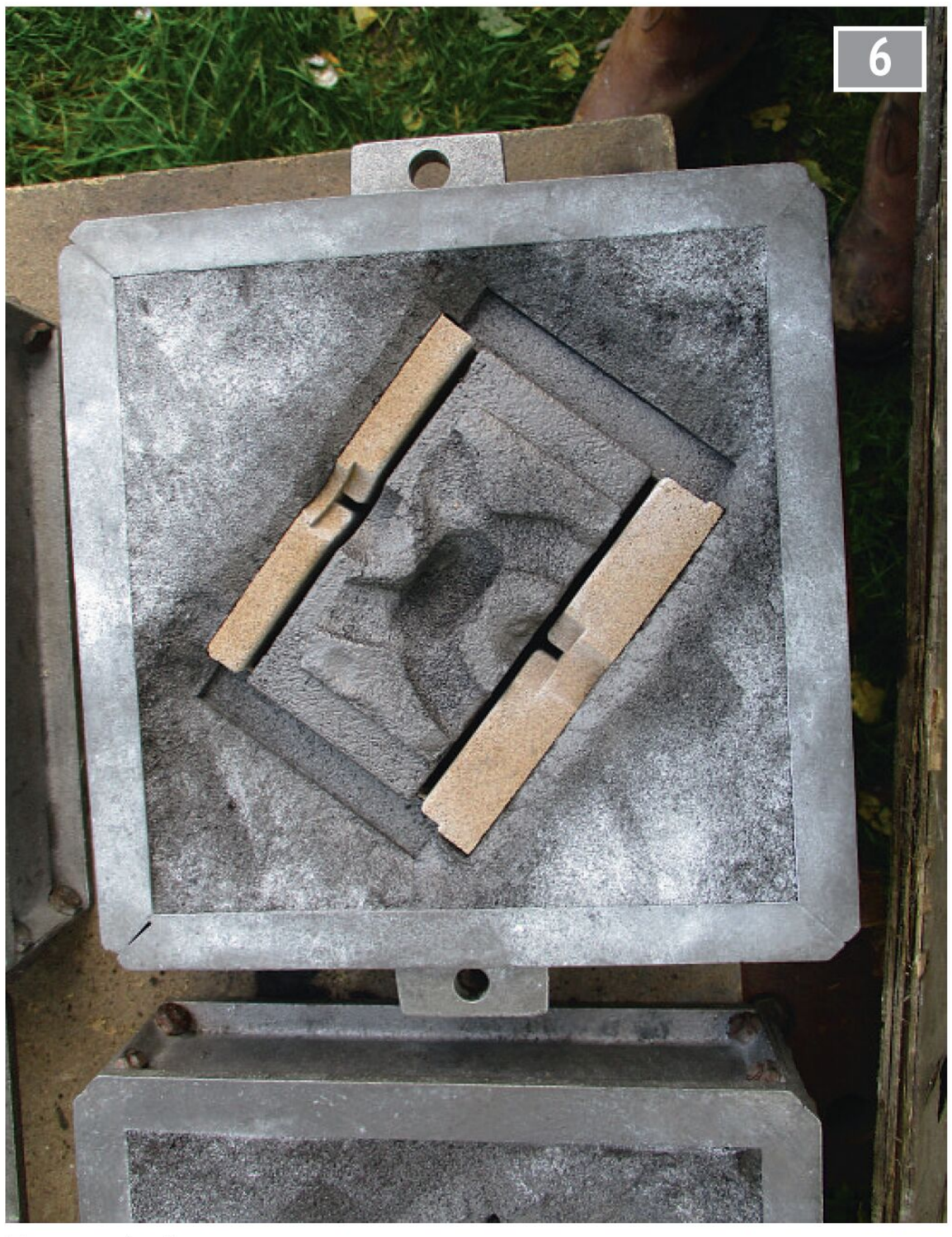
Using the 5 foot figure, I took a number of measurements from the pictures. Starting with the crank throw (1.125 inch), I can make a reasonable guess at the height of the crankshaft above the bottom of the base (1.75 inch). The height of the crosshead guide mounting face for the central cylinder will be 2.5 inches above the crank shaft (to allow clearance for the connecting rods) and the other two will be rotated +/-60 degrees from this (**fig 1**). From the stroke length I can have a good guess at the crosshead guide lengths - say 3.375 inches). Finally, piston size; starting at the high pressure cylinder, I guess 0.75 inch bore. From other information found online, it appears that Ward used a ratio of 1.75 for bore sizes, so 0.75 x 1.75 gives me 1.3125 inch - let's say 1.375 inch for the intermediate bore and 1.75 x 1.375 gives me 2.40625 inches - let's call that 2.375 inches.

Now, before I savage innocent lumps of metal, I want to make sure I've got the principles right, in particular the valve operation, so I printed up the mock-up shown in **photo 1** on the 3D printer, with the real thing in **photo 2**. The tatty bits of paper represent the valve ports and the valve. All seems to work! At this stage, I haven't decided if I'm going to use slide or piston valves. As long as I use outside admission, the timing is not affected. The video shows circular covers on the cylinder tops, which suggest piston valves. The locations of the exhaust pipes suggest outside admission.

The frame

This is in two parts. The lower section houses the crankshaft with main bearings and is the section which bolts to the hull of the tug. The upper section has the crossheads, with their cylinders, mounted on it. I cast these in aluminium, using 3D printed patterns. The lower section uses cores to form the webs on the front and back. **Photographs 3** and **4** show the pattern and the core boxes. ≫

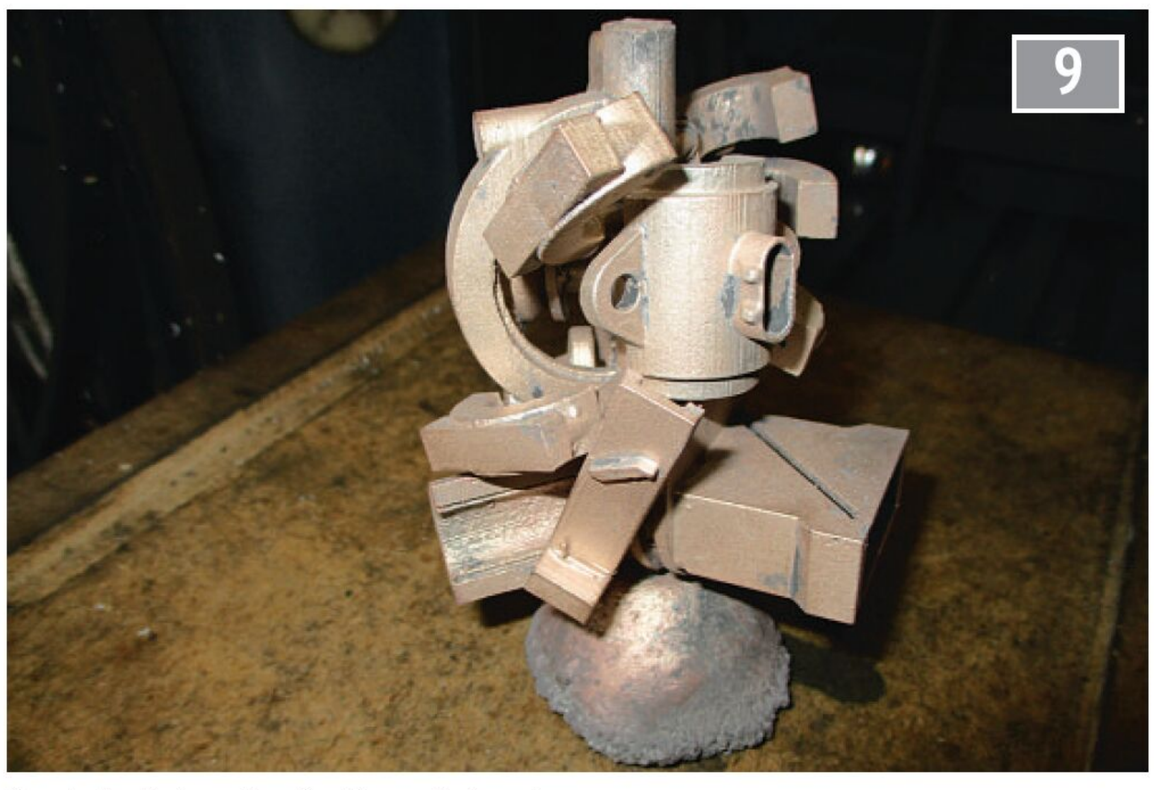
Flasks and cores ready for casting.



The cores in place.

Pattern for the upper section.

Ready for pouring the upper section.



'Lost plastic' casting for the main bearings.

The results of the 'lost plastic' process.

Photograph 5 shows the flasks rammed up and the cores ready to go in and **photo 6** has the cores in place just waiting for some unsuspecting metal to be poured in! The upper section is much simpler, using the pattern in **photo 7**, as you can see in **photo 8**, with the flask ready for pouring.

I needed the main bearings to finish the lower frame, so I had another casting session, this time lost plastic (similar to lost wax but using 3D printed patterns printed using Polycast filament). The finish is not as good as wax, which is not a problem with the material but rather due to the limitations of the printing process. It's still better than sand casting, though, especially for small parts as seen in **photo 9** fresh out of the furnace. After removing the parts from the sprue (that's where I usually damage parts with the saw...) I end up with the selection of parts in **photo 10**: two sets of main bearings, parts for the eccentric assembly and three sets of big ends.

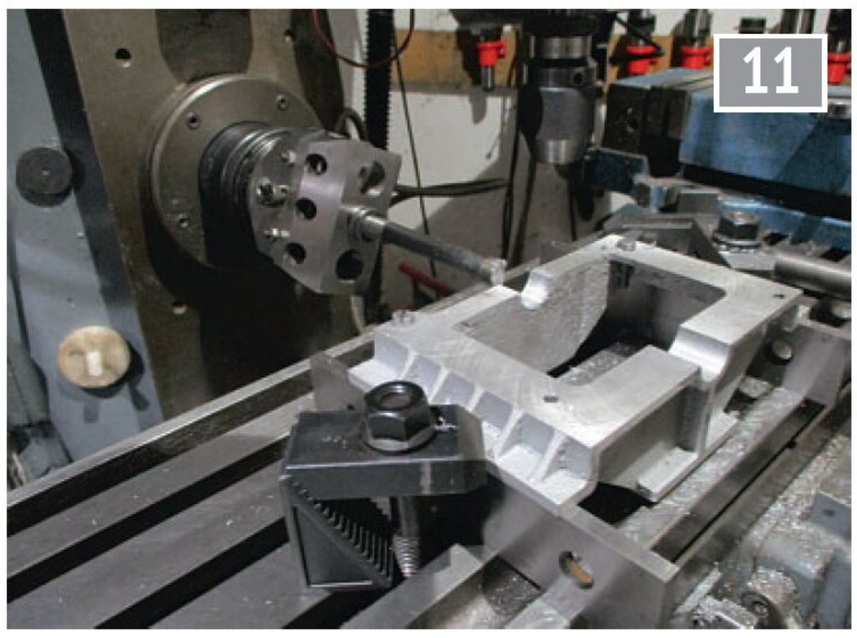
Now for some machining. The lower section of the frame was set up on the mill and the upper face was cleaned up, followed by drilling and tapping the fixing holes for the upper section. The recesses for the main bearings were cut with the boring head (**photo 11**). Without moving the casting, the main bearings were fitted and bored to size (**photo 12**).

After machining the bottom of the upper section and drilling the mounting holes, I have the makings of a frame (**photo 13**)! I mentioned earlier that the main housing was rotated by about 7 degrees. For quite a time I couldn't work out how the cylinders were spaced. Three big ends side by side on the crank pin but all crosshead guides apparently mounted centrally on the frame. How did they do it? Cranked con rods ...? Not nice. Little ends off-set in the crossheads ...? Also not nice. Then I spotted it (**photo 14**). The plan of the upper section of the frame is a parallelogram, not a rectangle, with the 60 degree faces parallel with the crankshaft. Simple!

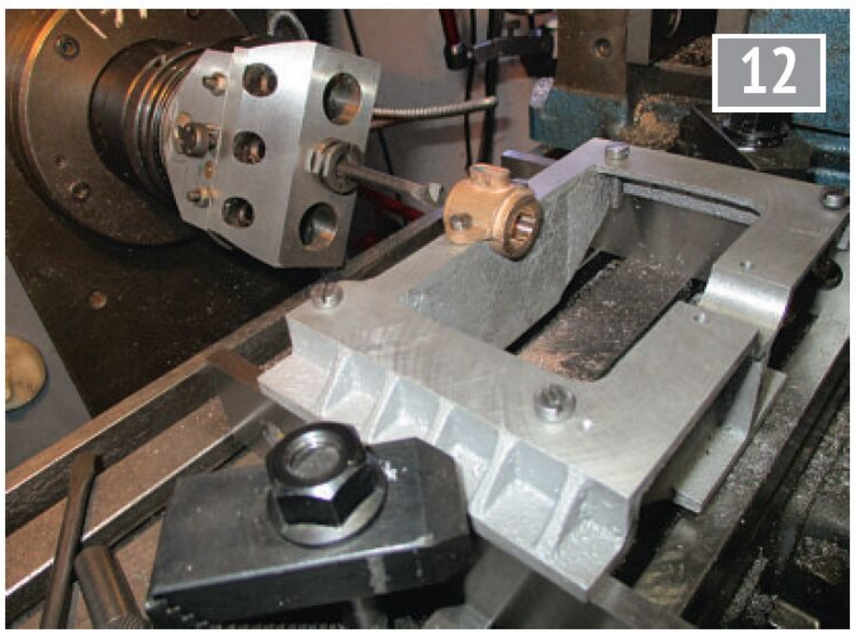
The next tricky bit is machining the mountings for the crosshead guides. Here's the set-up (**photo 15**). The silver steel bar is clamped in the main bearings by padding out the bearings with strips of paper. While this will grip the bar well enough to rotate the assembly, it won't be secure enough for machining, so the small angle plate is clamped to the base. The DTI on the top lets me see if anything moves while clamping or machining.

The Y axis on the DRO is centred on the bar and the X axis on the casting (*after* centring the Y axis!). The boring head is used to bore the main holes and the recess for the spigot on the crosshead guides, then the fixing holes are drilled and tapped using the function on the DRO (saves a lot of time!). The tapping attachment also earns its keep here (**photo 16**).

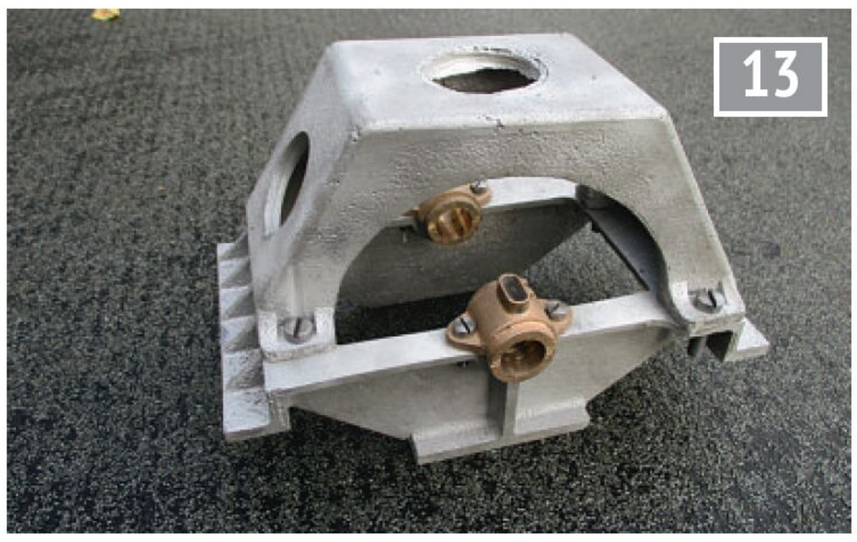
●To be continued.



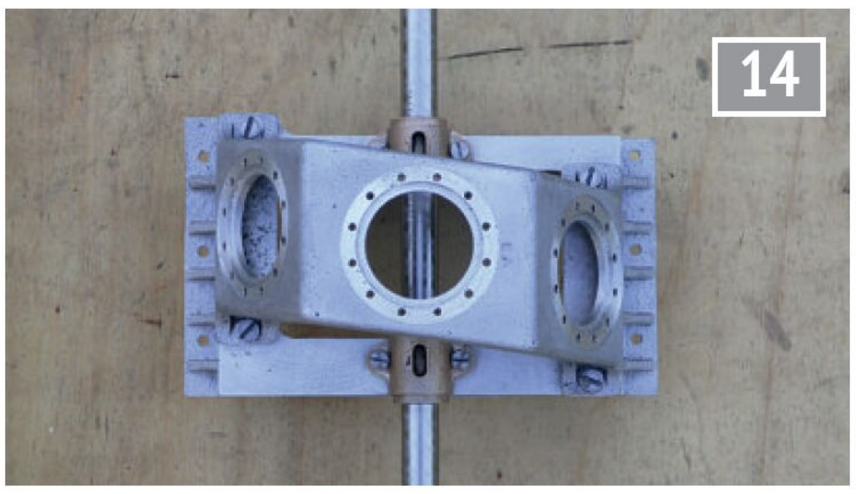
Boring the recesses for the main bearings.



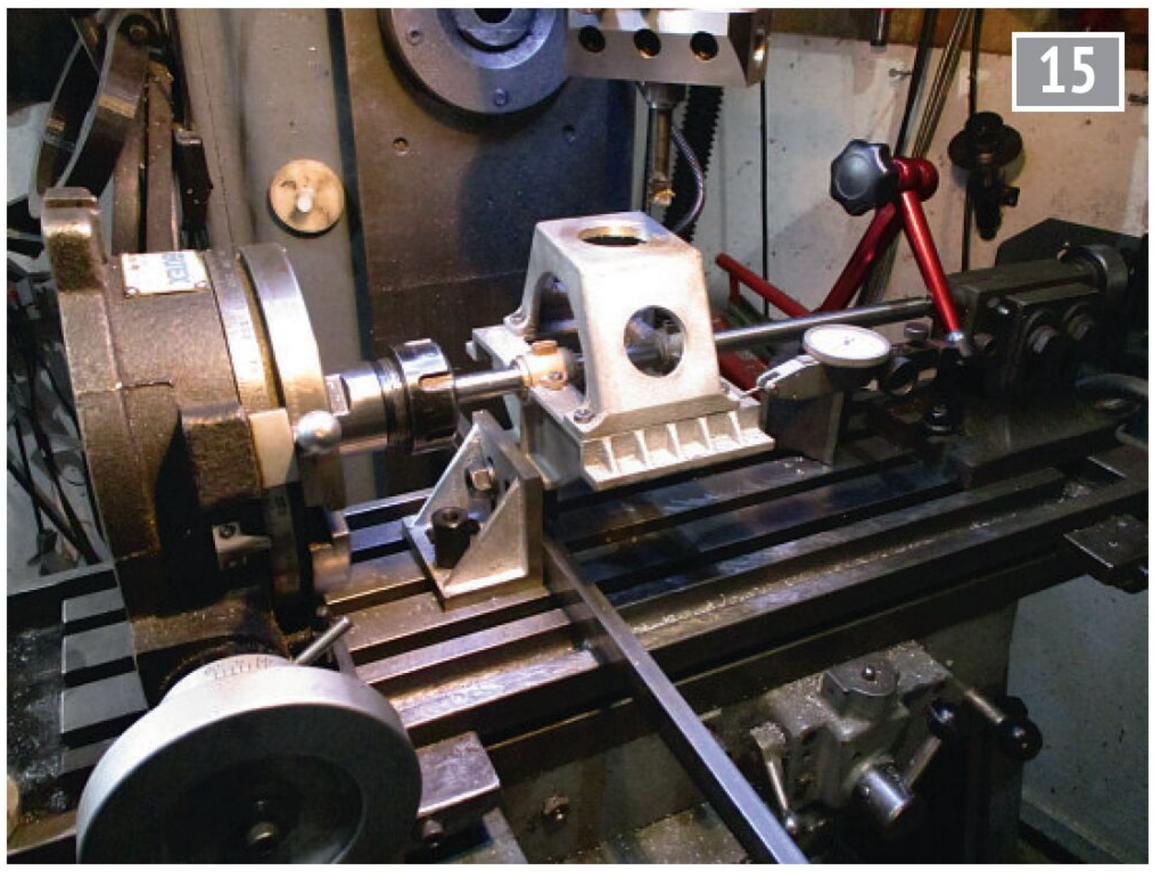
Boring the main bearings.



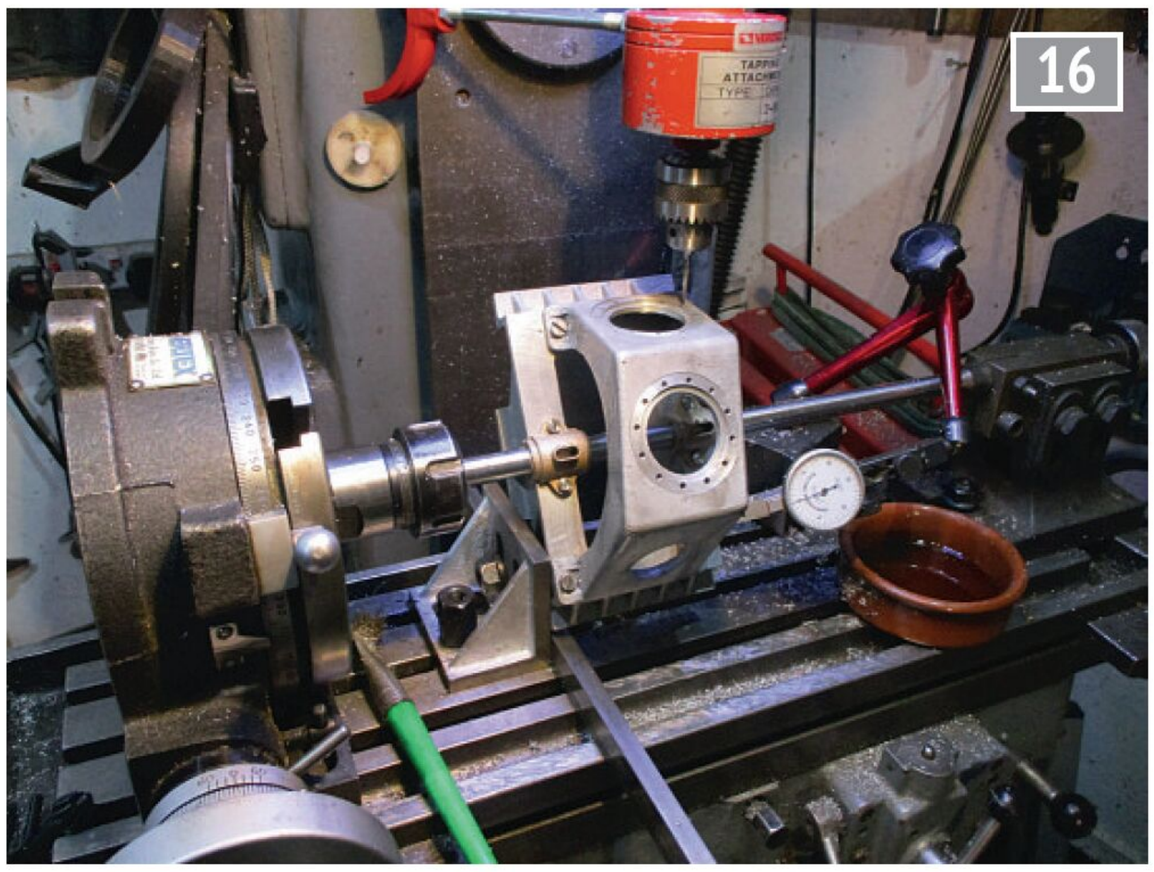
Trial fit for the frame and bearings.



Plan view of the frame showing the parallelogram arrangement.



Boring the crosshead guide mountings.



Tapping the crosshead guide fixing holes.

The 51st AGM **for the 7¼ Inch Gauge Society**

John Arrowsmith reports from the Rugby Model Engineering Society.

The 51st Annual General Meeting of the 7¼" Gauge Society was held this year at the home of the Rugby Model Engineering Society. The Rainsbrook Valley Railway has expanded considerably over recent years and was an ideal location for this prestigious event. Sixty locomotives were booked in for the weekend which started on Friday 20th September so the members of the Rugby Society were going to be kept very busy for the three days. Such was the organisation of the meeting that everything went off without any serious problems, well none that I saw anyway! The railway itself is a large single gauge ground level track about a mile long on a full circuit. It is well equipped with a large hydraulic lifting table for unloading which has a capacity of two tons and also traverses, so unloading heavy locomotives is not a problem. Adjacent steaming bays assist in the preparation of all sizes of engines. A further ground level steaming area is available as well for the really large engines like the Garratt and others (**photo 1**). The extensive raised multi-gauge track was not in use this weekend.

An outside view of the new clubhouse/café.

Adjacent to the Rainsbrook Central station the club have built a superb new clubroom and café (**photo 2**) which is now a real asset, as it has all the requirements for this type of event. Hot and cold drinks were always available along with biscuits and plenty of room to sit both inside and outside. A superb buffet lunch was served every day to members and visitors and was very well received by everyone. They have certainly raised the bar with that presentation.

The weather overall was quite good with Saturday being a lovely late summer day with plenty of sunshine. Sunday morning however, was another story with heavy rain and winds for some time, but that did not deter the hardy members from the 7¼ inch group from getting their waterproofs on and providing some dramatic steam departures from the station (**photo 3**). On the previous days a wide range of steam, electric and petrol driven locomotives were up and running all day, providing lots of excellent track time for everyone and opportunities for visitors to ride behind many of them. The large South African locomotives certainly caught the eye and this large track was a good opportunity to watch them in action (**photo 4**). Smaller 7¼ inch gauge models from the little single seater Scamps to standard gauge prototypes (**photo 5**) with all combinations of narrow gauge and freelance types all

The magnificent EAR 4-8-2-2-8-4 Garratt raises the flag as it is prepared for the day's operations.

Dramatic departures from Rainsbrook Central on Sunday morning.

The large 15F 4-8-2 City of Johannesberg *departs from Rainsbrook Central station.*

Matt Ranier gets his Class 2 going from Rainsbrook Central station.

mixed in provided an excellent atmosphere to be enjoyed.

I had a good chat with club member Phil Hancock regarding the coal crusher he was using. It has been fabricated from scrap material from around the site together with some new material for the crankshaft etc. The flywheel was originally the carry wheel from under the swing bridge at Foxton Junction on the Grand Union Canal which Phil found discarded in the undergrowth. Some good re-cycling going on here, I think (**photo 6**).

These meetings are a chance to meet old friends and make new ones and to make comparisons with various types of locomotives which perhaps at your own club are not seen. Rugby is a progressive club which has built this fine railway and they know how to enjoy it. Having built their new clubroom the old one is used like a drivers' mess room now as it is adjacent to the unloading facility and steaming bays - it all seems to fit together naturally. When I arrived on Friday the track was already busy with quite a number of locomotives trying out the system. The steaming bays had a wide variety in preparation and with the slightly damp atmosphere

Phil Hancock built the coal crusher to do its job during the weekend.

created that old but familiar scene of smoke, steam and hot oil. Of course the main objective of the meeting was the official AGM meeting of the 7¼ Inch Gauge Society.

Late on Saturday morning I had a chat with one of Rugby's young engineers. Harrison is 13 and attends regularly with his mum and dad to work on the railway where he can. His mum told me beforehand that he has started his own little business of repairing old lawn mowers. He was given an old one which he decided he would dismantle and repair. Dad helped him obtain the spare parts that were needed and Harrison soon had it going again during a morning's work. He promptly sold this one and used the profit to buy another one, which he said took him a bit longer to repair - two days! He again sold it for an even better profit which he used to buy a leaf blower. This in turn has led him to carrying out small garden maintenance work for his local neighbours to earn some pocket money. For a young man of this age, this a lovely little story which hopefully as he gets older and more experienced will make him become a real asset for the Rugby club. I am sure the club members will give him all the necessary encouragement so that he can develop his mechanical talents.

The AGM meeting had been arranged off site in Dunchurch Village Hall about ≫

John Dalton looks relaxed with his LT tank locomotive going well.

a mile away from the railway itself. This was a good venue to hold the formal part of the weekend. A good attendance ensured that the members could partake in the necessary procedures that are part of an AGM. Chairperson Janet T. Royston introduced the meeting and spoke about the successful year for the society and how the mini gatherings had been enjoyed. She noted that currently with members in 17 different countries around the world the 7¼ Inch Gauge Society was now a truly international organisation. She introduced the members of the committee who in turn introduced themselves and what their position entailed.

The official paperwork for the meeting had been distributed before the meeting so each section was duly considered and voted on by the meeting for acceptance. The only change to the committee was that Tim Morton Jones has stood down as editor of the *7¼ Inch Gauge News* magazine and Tim Coles and his business partner Helen have taken over. One notable item was that the subscription rate for members would stay the same. It has not been changed since 2009 and the chairperson commented that they must be doing something right.

In terms of the annual awards The Brian Reading award for the best engine on show as determined by the host club's judges, was presented to John Dalton for his excellent example of a LT 0-6-0 Hunslet tank loco of which only two originals were made (**photo 7**). Tim Morton Jones was presented with the Charles Simpson award for his services to the Society both with the magazine and the Proficiency Scheme. The Junior Award for the Young Engineer of the year was made to Mickcauley Myers from the Burnley Society for all his work at the club over the years (**photo 8**). Aubyn Mee, the chairman of the Rugby Society, received the Annual Plaque awarded to the host club every year. All these awards were met with the acclaim of the audience as a token of their appreciation for all the work they have done over the year. The meeting was concluded with thanks being given to all the participating members for attending and to the host club for their excellent facilities and organisation.

Meanwhile at the railway the members who did not attend had continued running so that on return from the meeting new and additional engines were in service. These operations continued to early evening when a hog roast was available to those members staying on site. Sunday morning was very wet but the intrepid members of the society were soon out on the track getting very wet but providing some spectacular steam and smoke effects in the wet atmosphere.

To conclude my notes for the meeting I would like to thank all the members of the Rugby Society, particularly Aubyn Mee the chairman, for their great hospitality and welcome and to the visiting members of the 7¼ Inch Gauge Society who made it such an excellent weekend despite the inclement weather at times. Finally I must mention the ladies of the club who provided constant refreshments and superb buffet lunches each day - thank you all for your efforts, it was appreciated by everyone (**photo 9**).

ME

Mickcauley Myers was awarded the Junior Engineer trophy.

The ladies who kept everyone fed and watered during the weekend.

A GWR Pannier Tank in 3½ Inch Gauge

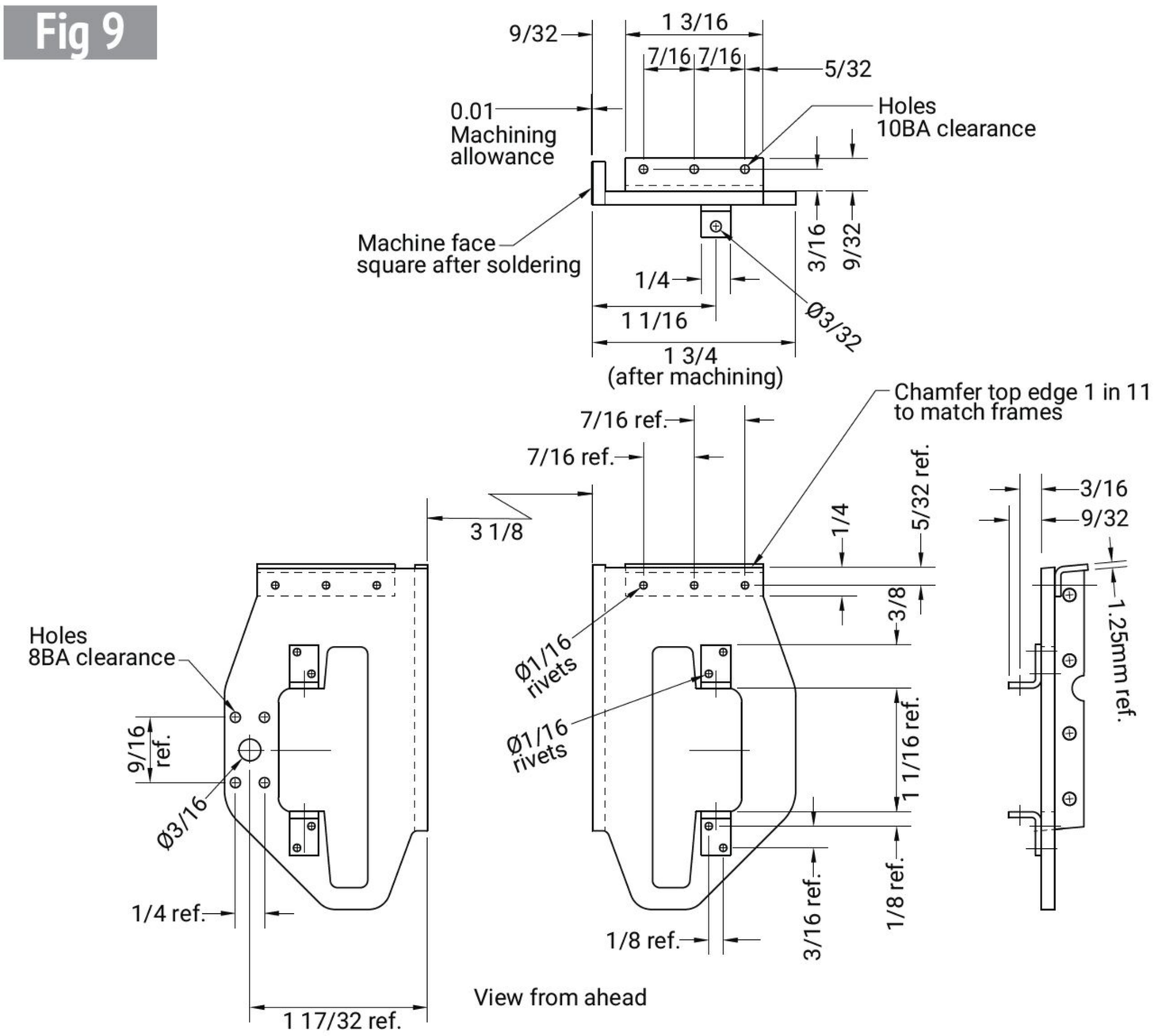
PART 5 – MOTION BRACKETS

Gerald Martyn decides to build a locomotive that he can lift.

Continued from p.655
M.E.4755 November 1

The motion plate (bracket) assembly is made from two laser cut parts, silver soldered together, and some small pieces of angle (**fig 9**). The laser cut parts are the main motion plate and its flange and they are located for soldering using tabs and slots. It should be possible to pop 6BA bolts through the flange and frame without any need to 'ease' the holes, such is the accuracy of laser cutting. Both plates are

Fig 9



Motion Plate Assembly
Plate & flange made from laser cut parts, silver solder joint
Machine bolting face after soldering
Angles cut from DIY store steel tube

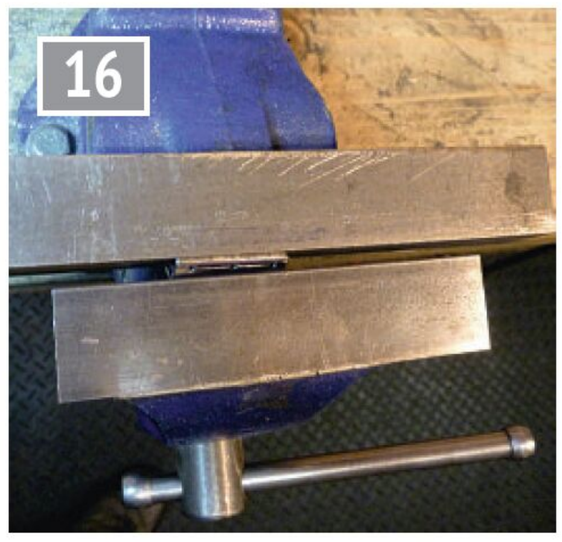
Motion bracket.

Brazing the motion bracket.

marked for drilling all the small holes but the required holes are different each side; the right-hand side plate has extra ones for the vacuum pump which will be re-purposed to pump water into the boiler. After drilling the holes as appropriate, assemble with the flanges and check to make sure they're correctly 'handed', with the frame attachment holes to the rear. To allow for solder penetration the tabs need to be a slack fit. If parts are on maximum thickness tolerance then a file may be needed to get them to fit together properly because to maintain accuracy I've not allowed all that much clearance in the slots. In order to hold the parts at a right angle (important) I drilled a small hole in the flange between the tabs and then through into the edge of the plate, then just popped an iron rivet in loosely. This gave just about enough stiffness to hold square. They were then cleaned up, plenty of flux applied and soldered together using Silverflow-55 (**photo 15**). After an overnight soak in citric acid they were visually checked to ensure a sound joint.

The forward edge of the flange is only there to surround the slots, so should be filed or machined away. The inner face of the flange needs to be machined flat and truly square to the plate and parallel to the outer edge, and for this there is a 0.010 inch machining allowance in the design. Pop it into the milling machine vice with the flange uppermost and the bottom (outer edge) of the plate horizontal (easy; sit it on the vice slide or a parallel). Machine back to achieve the 1 3/4 inch dimension. What is really needed is the 1 1/16 inch dimension to the cylinder centreline, but this is not something that can be measured so we must measure to something we can and rely on the accuracy of laser cutting to get things right. Note, also, that the cut-outs for the coupling rods leave plenty of space on the inner edge so that those who do not want to bother thinning the inner sides of the rods will still find plenty of clearance.

There is no ready source for the thin steel angle needed for the next bits. After much head-scratching the best idea I could come up with was to cut pieces from some square tube purchased in one of those large chain DIY and builders' merchants. Not much is needed but a metre of the stuff is not terribly expensive and what's left will undoubtedly find other purposes. Mine was 20mm square by 1.4mm wall. For the top edge angle, after drilling the holes, open the angle up a bit to match the 1 in 11 slope of the motion bracket to the top of the frame by squeezing in the vice with two pieces of steel angle stock as low friction jaw facings (**photo 16**). The top edge of the motion plate must be filed to the 1 in 11 angle to match the frame top. The little brackets for the slide bars can be made and fitted now, too, also cut from the square tube. I had thought to leave these to allow slide bar adjustment later, but getting in to fit the rivets becomes increasingly

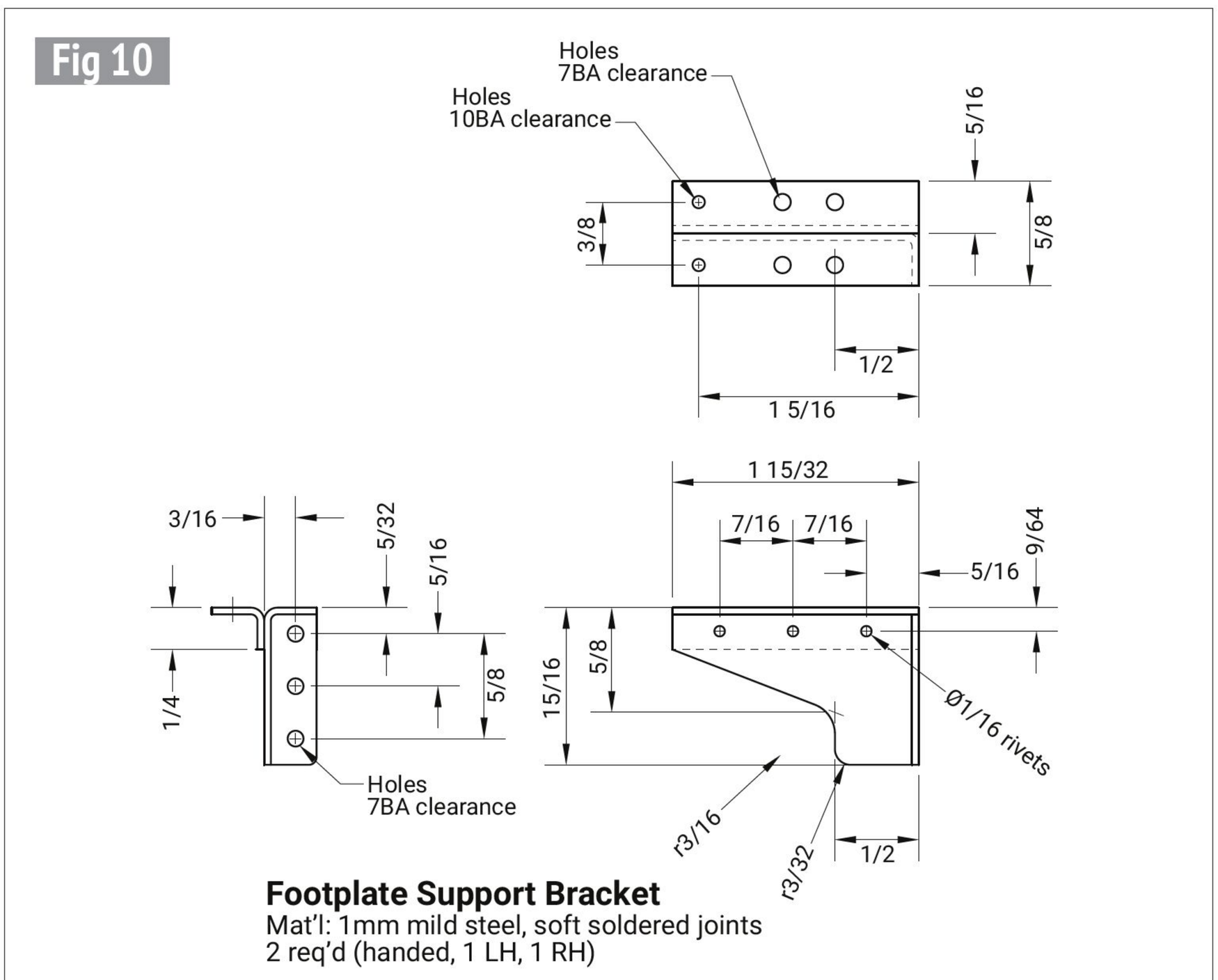


Squeezing some angle to make it un-square.

difficult as more and more bits and pieces get built and fitted into the frames. Slide bar adjustment will be by filing or shimming, as is often the case.

The plate support brackets (**fig 10**) may, at first sight, look ideal for laser cutting. However, the subsequent folding of the flanges would need to be carefully done to get everything just right. This would be made even more difficult if the holes were pre-drilled. Easier (general rule here?) is to cut some pieces of sheet over size, fold the flanges, then mark-out, cut and file to size and drill the holes. When cutting sheet metal then, clamp it flat to the bench

Fig 10



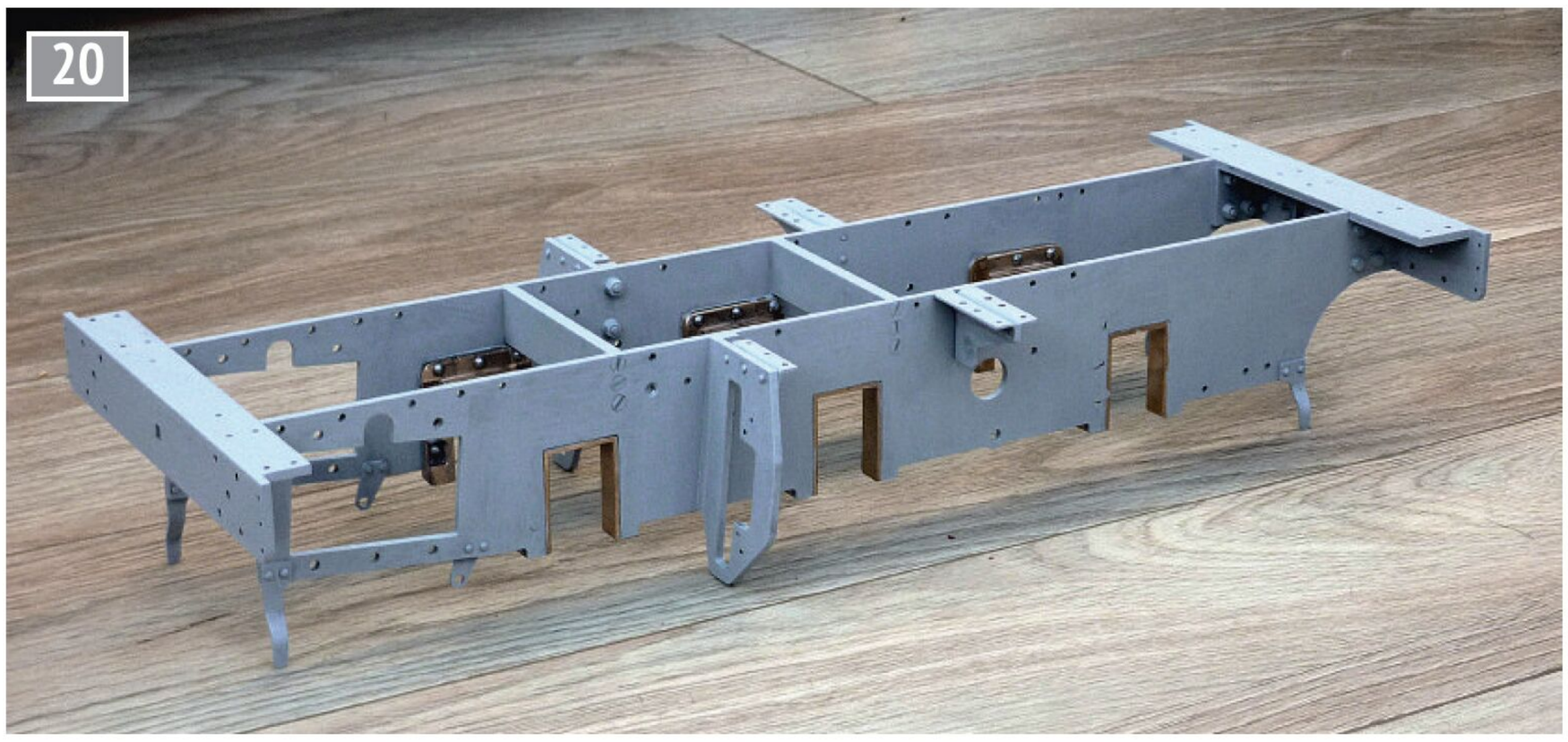
Footplate Support Bracket
Mat'l: 1mm mild steel, soft soldered joints
2 req'd (handed, 1 LH, 1 RH)

Footplate support bracket.

Cutting sheet metal on the bench.

Knocking over a footplate bracket.

Shaping the flanges.



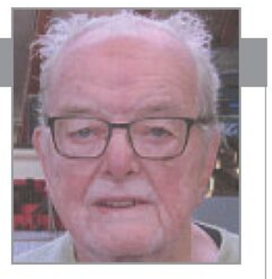
A finished set of frames.

and cut 'on the flat' (**photo 17**). Thin sheet clamped in the vice and cut down the thin edge tends to produce inaccurate and wandering edges. I don't have much in the way of special tooling for sheet metal work. For most things to do with bending and folding I use a couple of pieces of steel angle clamped in the vice together with a hammer and whatever bits of bar are handy. After doing the necessary corner cut-out, so the two folded flanges will overlap properly, for these little brackets I just clamped them between angles and persuaded them in to shape with a copper faced mallet (**photo 18**). Marking and filing to shape is then straightforward benchwork and doesn't take long. A toolmaker's clamp can be used to help with orientation when filing the flanges, otherwise they can be rather awkward to do (**photo 19**).

The motion plates and the brackets can now be assembled to the frames, but note that the motion plates will need to come off when it's time to mark out the axle box bearing holes. It's worth going over all the steel parts with a coat or two of primer. This makes it look great for when you take it down to the clubhouse to be admired. Of course, the paint will get damaged as the build progresses but it will still help keep the rust at bay and give it a more finished look (**photo 20**).

●To be continued.

Life Beyond Lego



Patrick Hendra of Eastleigh Young Engineers, says there is - or should be – life beyond Lego.

I am inspired to write this piece by the excellent article in M.E.4752 (September 20th) by Tom Parham where he describes the current and future situation in model engineering clubs.

My view of the future of modelling is rather bleaker than Tom's. For at least two generations the schools have **not** been teaching their lads and lasses how to make things. A declining number of parents are engineering practitioners - plumbers, machinists, electricians, welders - referred to today by the clean hand establishment as TIN BASHERS - especially those who have served apprenticeships. They are retiring and few are being replaced. The result is that the children DON'T MAKE ANYTHING because no one is there to provide tools and workshops and appropriate teaching and encouragement.

This doom-laden message is shared by many of the folks who came up to the Young Engineers stand at MMEEx 2024 at Warwick. It really is no exaggeration.

Where are the model shops? They are definitely a threatened species but it is fallacious to blame their demise on online shopping or COVID; they have gone because of a lack of demand. The demand has not dribbled away simply because the children are always on their mobiles, it is because there are *no modelling opportunities beyond Lego.*

Youngsters who have the urge buy ready-to-fly model planes or boats rather than make them from scratch. In a sense, this doesn't matter overall but it does affect the progress of the boys and girls who have a POTENTIAL interest in science and engineering and potentially to become MODEL ENGINEERS when they are much older.

My personal solution has been to run a club - the Eastleigh Young Engineers based in a village north of Winchester. Why Eastleigh? - all will be revealed below!

The Young Engineers Club has been operating for 13 years and had a stand at MMEEx2024 in Warwick where members did well in the junior class of the competition - a Second, a Third and a clutch of Highly Commendeds.

The Young Engineers are a small group who come to my workshop weekly for an hour plus a few sessions during school holidays. Terry Brown of the Eastleigh Model Boat Club and I teach the youngsters on a one-on-one basis. This is done for safety reasons. Including three members, who are not available except during holidays,the membership amounts to 13 and are aged between 9 and 17 years old - 6 girls and 7 boys.

Has the EYE Club produced any real live engineers? **Of course Yes!**

One of the first members was Angus French. He won the Turner Shield three times at successive Midland Model Engineering Competitions and is now a fully qualified engineer at Jaguar Land Rover. Angus can't stop modelling and has recently made a replica of a Formula 1 steering wheel which was Commended in the competition at this year's MMEEx. Another 'old' Young Engineer Ewan White is now a practising professional electrical engineer. Another EYE is an undergraduate at Exeter University and another one at Bristol University. Yet another is a fitter in the local boat-building industry and so it rolls on.

BUT is what I do relevant to the future of model engineering?

If we assume that the schools are not going to re-establish workshops and then find staff to teach in them, the only way ahead is for the model engineering clubs to do the job. You model engineering people have many members in your midst MUCH BETTER qualified and experienced than me who could teach some enthusiastic youngsters how to make things. The clubs often have the workshops, the materials, the skills - all that is needed is the will to do the job. The WILL can be a problem. Let me tell you of my experience and hence our name - the EASTLEIGH Young Engineers.

I started my work with children in 2011. At that time there was a thriving youth club in my village - Crawley near Winchester. The kids had nothing to do during August so I set up a scheme to teach as many youth clubbers who turned up on Monday, Wednesday and Friday mornings from 9.30-11 for four weeks. I bought a Keil Kraft-type kit and we made a R/C electrically powered plane from balsa wood and covering. 22 youngsters were involved. I might have 12 one morning and only three the next as they all went at various times on holiday. Unfortunately, I didn't realise how tricky it is to fly a model plane so the plane had

The launch of HMS Crane at Crawley Pond.

When we were still the Youth Section.

Assembling a ship's wheel –all made from scratch.

only three ultra-short flights - through hedges. The next year we built a R/C boat - launched on the village pond (**photo 1**) and then a Thornycroft lorry - both from scratch. These two models won a silver at the Model Engineer Competition at Sandown Park and then the youth club ran into the buffers.

I then accepted an invitation to let the Crawley-based youngsters form the Junior Section of the Eastleigh and District Model Boat Club. This club produces some of the very best model boats in the South of England and the members helped me up my game (**photo 2**). All went well until 2015 when a newly formed management committee decided that we must go because 'the youngsters don't make boats they make lots of other things.' By that time we were known for our involvement with the E&DMBC at shows so we departed but kept Eastleigh in our new title - the **Eastleigh Young Engineers** - the EYEs. The crazy thing about this sad little story is that a small group within the membership were really keen to build up the Junior Section AND ran a weekly class for the Eastleigh Scouts teaching the Scouts how to build boats from scratch and they still do today!

Fortunately, we have restored excellent relationships with the Eastleigh Model Boat Club and they provide me with a steady flow of unfinished hulls and considerable help. In particular, Terry Brown, the club commodore and an expert at building shapes like hulls from planks and also sheet metal work teaches the EYEs regularly.

What would you have to do to run a successful Junior Section of your Club?

Members

You need one or two members who are prepared to give an evening or two each week during term time. If two members operate for two evenings each, you can support 8 Young Engineers. Most youngsters can be at your workshops either at 4pm or 5pm so the obligation should finish at 6pm. Note - one-to-one teaching is **absolutely** essential and parents must be **fully supportive** and **committed** to bringing the youngsters on time, all year.

I assume you have most of the equipment you need on site but you will have to buy materials the youngsters will use. The EYEs parents are expected to come up with a subscription of about £150 per year and that covers workshop expendables and paints, insurance and other regular costs. In addition, parents are expected to pay for items specific to their own Young Engineer's project - R/C transmitter and receiver etc. These are often one-off and usually not large. In my case, the subscription contributes to heating and electricity in the workshop. Some might think the cost is large - too high for hard-pressed parents. Check online and find the cost of courses offered by local authorities where hands-on work is involved. You will be surprised. Our sub is VERY small - mainly because Terry and I give our services completely free of charge.

What sort of projects should you try ?

No - youngsters cannot build another steam engine. *Kids Don't Have The Time*. Even including some holiday time in my workshop, the EYEs put in less than 50 hours per year. New members know almost nothing of any significance and can be as young as 9 years old. The new Young Engineer needs teaching how to measure and set out work and almost everything else BUT IT IS INCREDIBLE HOW RAPIDLY INTERESTED YOUNG PEOPLE CAN LEARN GIVEN THE CHANCE. By the end of a term, my youngsters can use the jigsaw, have had a go at silver and soft soldering, can operate a drilling machine and have learned how to tap holes in metal (**photo 3**). They will also have been using the Myford. New members are almost always given a scrap hull and asked to do something with it. They make a stand, a shaft and rudder from scratch, make couplings and install radio control - all in their first term and then become creative.

Once a new Young Engineer has built and sailed a R/C boat, I give them a choice of several projects. Each is intended to take about 50 hrs of workshop time and is timed to be ready for the next Warwick MMEEx Competition.

Let me tell you something of just three projects on display at this year's show (**photo 4**).

Over the last year, Sacha has been building a R/C jeep carrying a somewhat incongruous Gatling gun. He is now 10 and won a Second Prize. Freya built Nellie the Copter (not a boat!) as her first model at age 9 and reported it in *Model Engineer*. It was on our stand. She has just finished a R/C crane lorry. and won a Third Prize. Lyra (9¾) is a brand-new member and was given a scrap wooden hull. She is making it into a R/C tugboat.

Teaching methods

I teach in a very unusual way taking full advantage of the fact that I am teaching one-to-one. We use no pre-existing drawings - we work

Part of our Midland MEEx2024 display ≫

Tapping holes in the base of his F1 car.

from photos available online. As a result, the rudiments of sketching and scaling come in almost from the start. I have had my measurements taken sitting on a stool holding an imaginary steering wheel more times than I wish to remember.

In the workshop, I demonstrate every procedure. I demonstrate safely holding the object and then carrying out the process and then - I move the setup and watch the Young Engineer do the job him/herself. If necessary I repeat. The important feature is that the EYEs must understand and think before they act.

I have several basic principles upon which I insist: *Zero The most important principle of all - the Young Engineer must achieve progress at EVERY session. Kids run out of steam if they don't progress.*

1 We measure where possible using digital callipers rather than rules---never rulers. WE use set squares (unknown it seems in today's schools).

2 'Never use a hand tool if you can use a machine'. Grandpa used hand tools. We use machines because they are fast and accurate (**photo 5**).

3 'We work with metal to a hairsbreadth accuracy.' In their first session, the new member measures his/her own hair, typically 0.03 or 0.04mm.

4 When a Youngster is doing something he/she has done before, I will say nothing other than 'NO' if you are about to make a mistake. I watch everything.

5 Once they are a little experienced - '*decide and do it. Don't ask me, just do it*'. I will stop you if you are heading into trouble. This isn't school. And finally,

6 I don't answer stupid questions: THINK, THINK and THINK again.

OK - what are the difficulties

Almost none! You must work completely safely. Accidents must NEVER happen. Our club carries insurance but your club should be able to have your existing cover extended. You MUST emphasise that you will operate one-to-one and hence minimize the underwriter's assessment of risk so you shouldn't need to pay a massively increased premium.

The teachers MUST hold a valid DBS certificate. This is simple to arrange and is free to amateurs such as ourselves.

Having fun (photo by Elizabeth Deal).

Terry teaching (photo by Steven Brown).

You must have complete support from parents. I am NOT a babysitter. I expect a parent to deliver and then collect their child AND to see what he or she has achieved very frequently. I get particular satisfaction when a youngster explains how they did this or that on the lathe or mill knowing that the two of us know that the parent has little or no idea what their offspring is going on about!

And finally - JUST HAVE FUN. Teaching these enthusiastic children is a real pleasure (**photo 6**). Select projects that the youngsters find interesting and aim to compete with us at the next MMEx.

The kids give Terry and me (and the parents) THE reason for being model engineers. I have just heard from an excited 10-year-old shouting breathlessly down his Mum's mobile that he was at this fabulous show and won SECOND PRIZE at Warwick and he is on his way home. He wangled a day off school.

Just wait until he boasts to his pals at school tomorrow. I would love to be a fly on the wall.

Oh I nearly forgot. *The Young Engineers Club has a permanent member of staff THE TOOTH FAIRY. When disaster has befallen and ruin is clear to see, the little thing flitters in and by the next session the problem has just vanished. How could Young Engineers survive without her?*

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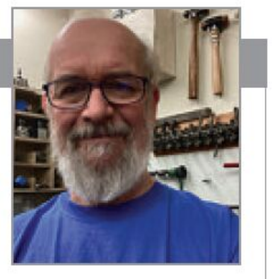
Demonstrating to his young sister.

SMEE News

The Forncett Steam Museum



Martin Kyte has the latest from the Society of Model and Experimental Engineers.

SMEE

Forncett

SMEE were delighted to be able to contribute exhibits to the Forncett Steam Museum's Model Engineering Day and Steam Up on the 6th of October.

This event has been running for a few years now at Norfolk's hidden gem that is Forncett Steam Museum. The museum is the lifetime result of owner Rowan Francis's fascination with stationary engines. Rowan had a career as an anaesthetist but inherited the steam bug from his father who got involved with narrow gauge railways soon after leaving the navy. Wanting to do something a little different, Rowan started collecting stationary engines and amassed a large collection of the great machines that powered the UK into the last half of the 20th Century.

Situated in the garden of Rowen's one time farm house, the collection has been transformed from the results of a personal 'hobby' into a full blown museum which can be enjoyed by the public. Unlike most museums where the buildings come first and the exhibits are installed later, at the Forncett museum the engines were installed and the buildings constructed around them in much the same way that many of the engines were installed when they were made. The result is a fascinating display of engines typical of their type that provided the motive power to drive the country. With steam provided by a vertical boiler fired by wood, each engine was run in succession throughout the day with a commentary provided taking the visitor through a tour of steam power from the early days to the last.

The entrance to the museum.

The SMEE stand at Forncett.

SMEE were happy to provide a display of some of the things that we do and we spent a pleasant day chatting to the visitors in the upstairs refreshment and display area with the Hopwas Beam engine in the background.

Model traction engines were in their own paddock and went for a run down the lanes during the day along with the steam carriage and a couple of vintage cars. A display of model boats added to the interest and there was also a rare Stuart Turner cold war generating set in action.

Forncett is perhaps one of our hidden gems as far as steam museums go. I've lived in East Anglia for most of my life and I only learned of it a couple of years ago when Rowan was kind enough to come and give a talk to our SMEE Engine Builders Group. I was fortunate

De Dion motor car.

The Dover engine – a triple expansion steam engine for pumping water.

The Hick Hargreaves engine – the oldest at Forncett.

to be able to attend last year's Model Day and loved it. They are open for static display and on Sunday once a month in steam May to October.

I have to give full marks to Rowan and the team of volunteers who have preserved this wonderful collection of engines and displayed them in fully working form for us to enjoy and marvel at for many years to come and hope that Norfolk's secret will become more widely shared.

I will leave you with a selection of images to whet your appetites.

The website for Forncett is www.forncettsteammuseum.co.uk and you can find more information on how to join SMEE at www.sm-ee.co.uk

ME

SMEE News The Selby Coalfield PART 2

Continued from p.597
M.E.4754 October 18

Coal extraction was by the long wall retreat method. For this highly mechanised form of mining typically two roadways are driven from the main roadway to the back of the area of coal to be extracted. A cross tunnel is driven to form the face. Ventilation is supplied down one of the roadways and back up the other with the face roof being supported by hydraulic roof supports capable of 'walking' forwards. Coal is removed from the face by a moving coal cutter with a rotating head containing 'picks' which break the coal off the face to drop onto a conveyor (**photo 4**). Once the coal is off, the roof supports move towards the face taking the conveyor with them. As progress towards the main roadway occurs the roof behind is allowed to collapse. With the distances involved moving personnel around the mine took time and was achieved by men riding conveyors or in some cases trains (**photo 5**).

Breaking the coal off the face.

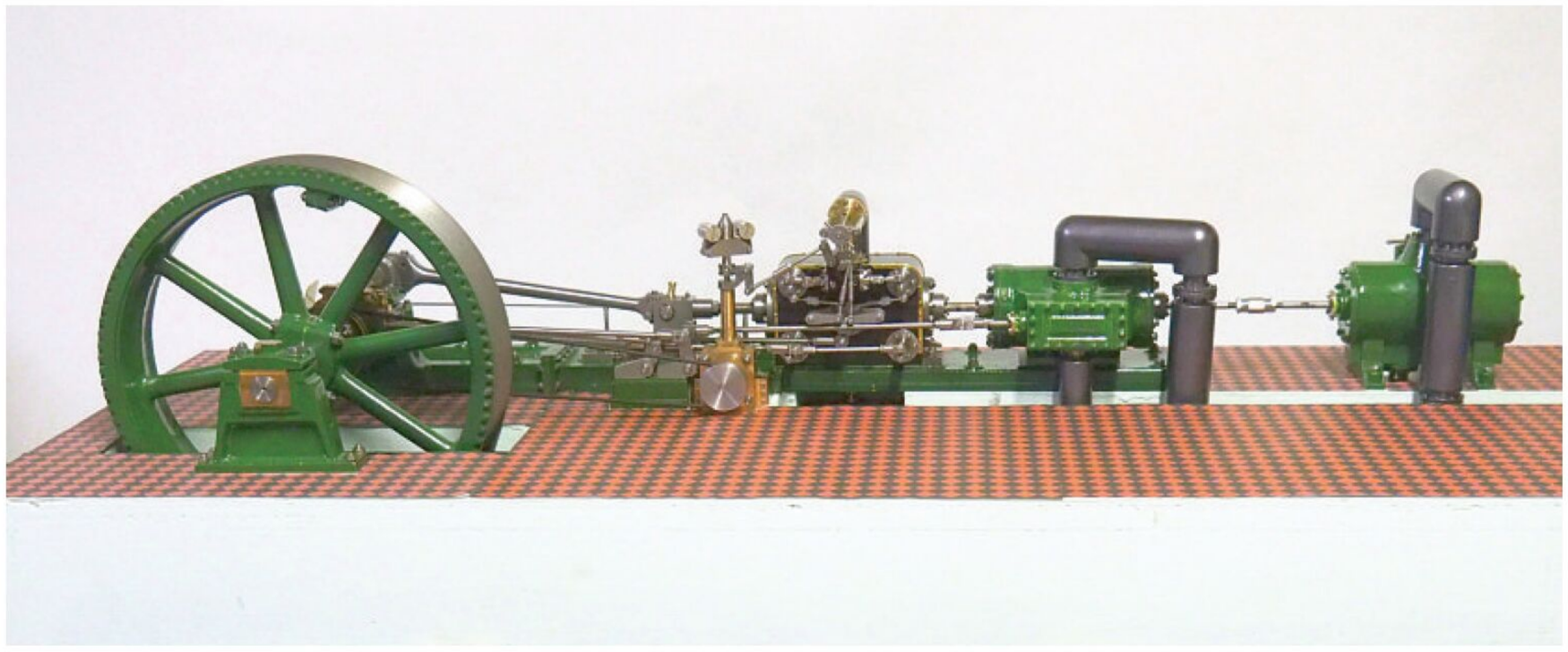
So we see, the development and production at the Selby Complex straddled the miners strike of 1984. Between 1983 and 2004 it achieved a total output of 121 million tonnes with a peak output in 1995 of 50 million tonnes, close to the intended objective. The mining engineering techniques that were employed were some of the best in the world and it was a truly vast undertaking, recovering coal from maximum depths of over 1000m. All in all I like to think Selby stands as a testament to the generations of miners and engineers who have supplied the UK with its energy need over many centuries and a superb demonstration of the high skills and achievements of the industry.

Riding the conveyor.

ME

A Tandem Compound Mill Engine

PART 7



David Thomas builds Arnold Throp's model of a Corliss mill engine.

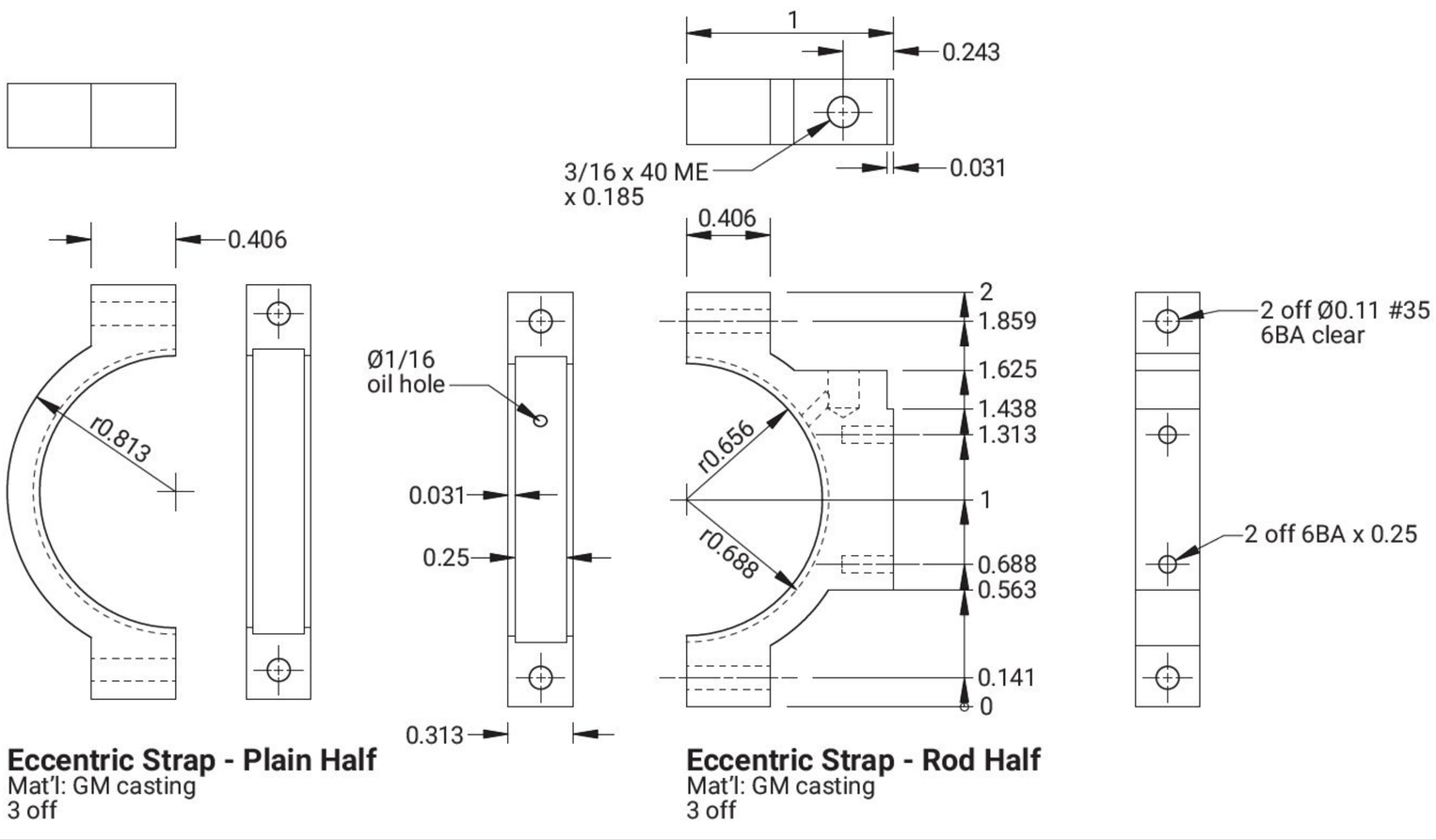
Continued from p.652
M.E.4755 November 1

For the author the motion of the rods and links of the valve gear is one of the most attractive features of any horizontal steam engine. This motion begins with the eccentrics and straps and in the case of the current model it is worth starting with the straps (**fig 18**) as these can then be used as gauges when turning the eccentrics themselves.

The gunmetal castings for the eccentric straps were the best quality of all the castings in the set with the cored hole close to circular and very close to the centre. A little bit of work with a half-round file removed some flash and then the castings were set up on the outside of the outside jaws of a three-jaw chuck (**photo 95**) to machine the outside faces. After that it was a matter of keeping the three parts clipped together and working around smoothing the outsides to size in the mill (**photos 96** and **97**). From here on the straps will accumulate individual differences so they were marked with felt tip pen so that pairs, and orientation within each pair, could be maintained. Centre punch dots replaced these marks after the eccentrics were made and similarly marked so as to keep everything together in the three sets. Each strap was drilled for the clamping screws and slit apart (**photo 98**), after that, things became a lot trickier.

Each pair of half straps was screwed together lying on a surface plate and with a parallel helping to align the halves across a diameter. In **photo 99** the machined inside surface indicates that I forgot to take the picture until after the first boring operation - my excuse is that after fiddling with packing (to preserve the finish) and adjustment of the four-jaw chuck I was very keen to cut metal. Getting the bore centre exactly on the split line of the strap halves is critical; get this wrong now and fitting

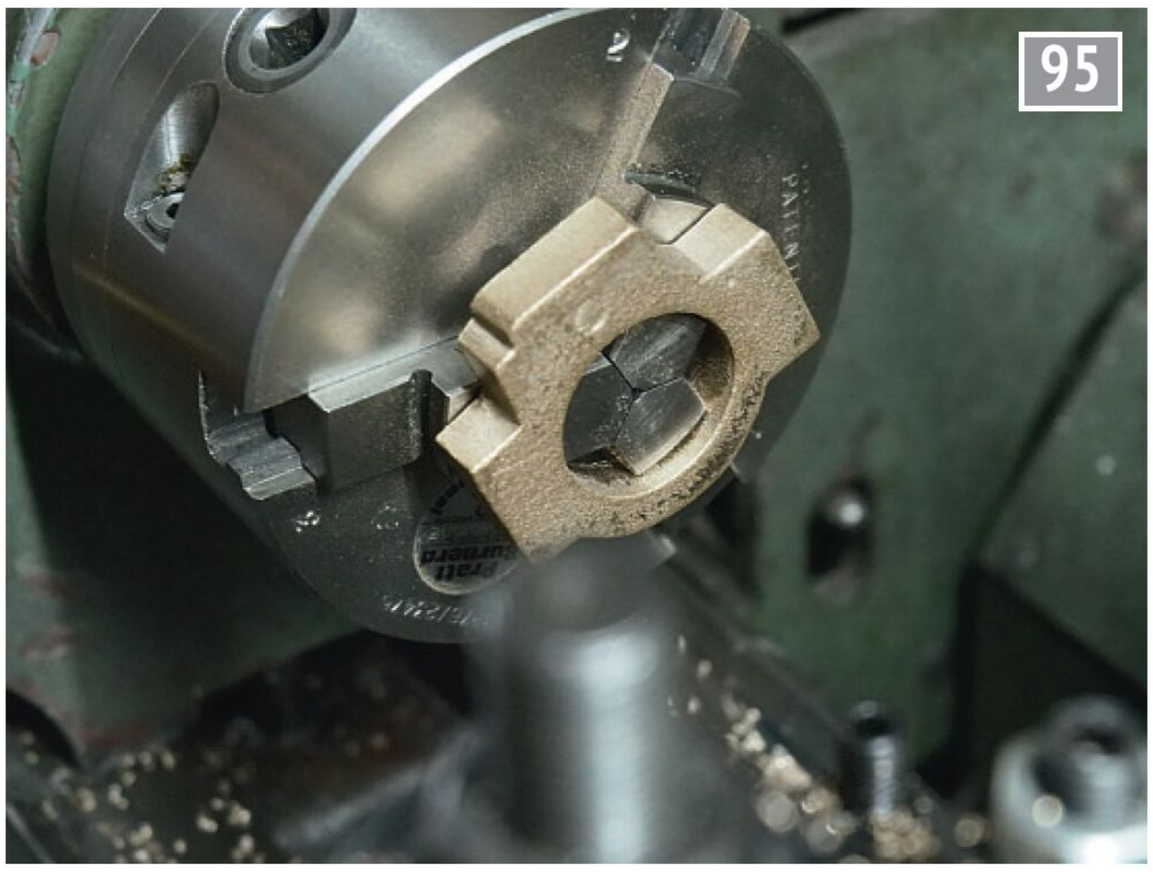
Fig 18



Eccentric Strap - Plain Half
Mat'l: GM casting
3 off

Eccentric Strap - Rod Half
Mat'l: GM casting
3 off

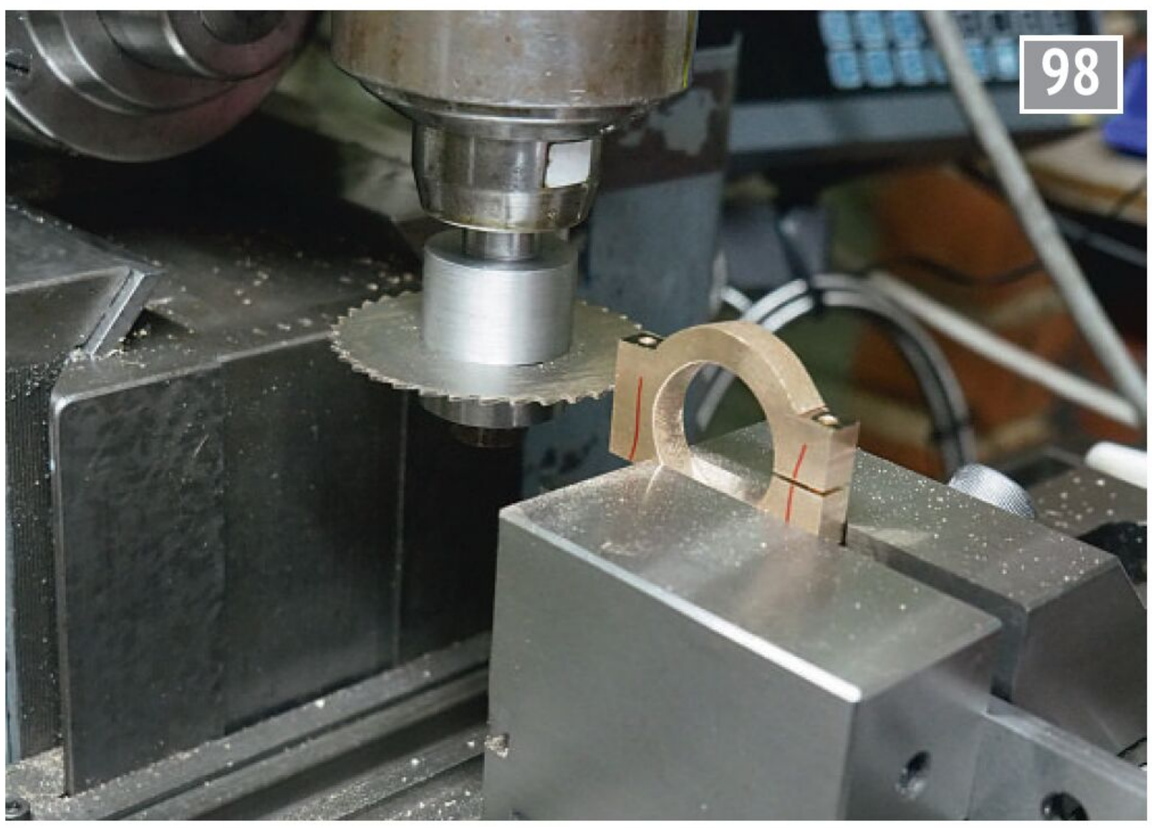
Eccentric strap halves.



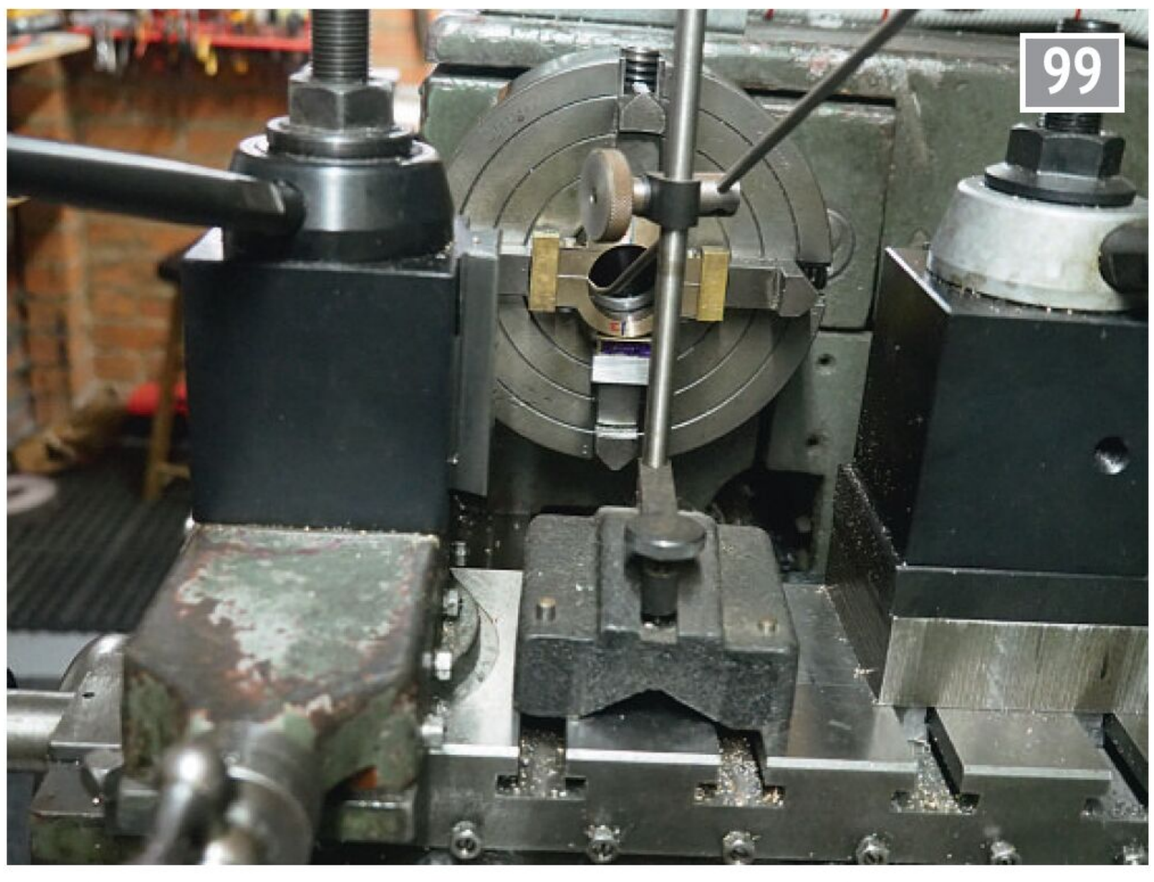
The three eccentric strap castings were very smooth and regular. For the first operation the inner surface was filed a little then held on the three-jaw chuck. Both flat surfaces were machined with this setup.

Cleaning up the edges of the clamping bolt bosses.

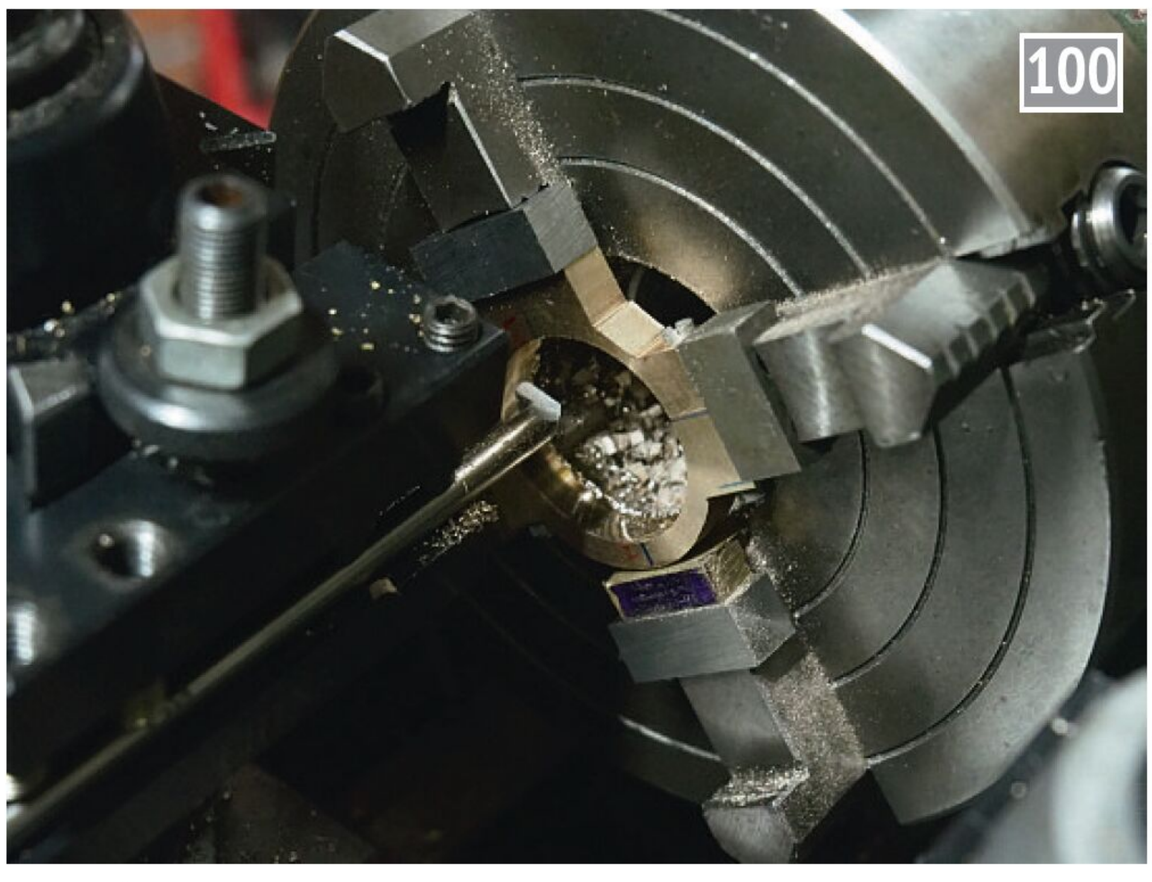
Milling the attachments for the eccentric rods.



Separating the halves of the eccentric straps. The bolt holes have been drilled and the parts marked for correct assembly.



Showing how the eccentric straps were set up for boring in a four-jaw chuck.



Turning in the locating groove for the eccentric.

the straps to the eccentrics becomes impossible (or will require a very poor fit to the eccentric). The scriber and stand, used with some magnification, helped to get the alignment spot-on for all three straps. **Photograph 100** serves to show both the initial boring and the cutting of the 1/32 inch deep internal groove. This is where the differences between sets of straps start to build up and each set must be kept together and identified to be matched with the eccentrics. ≫

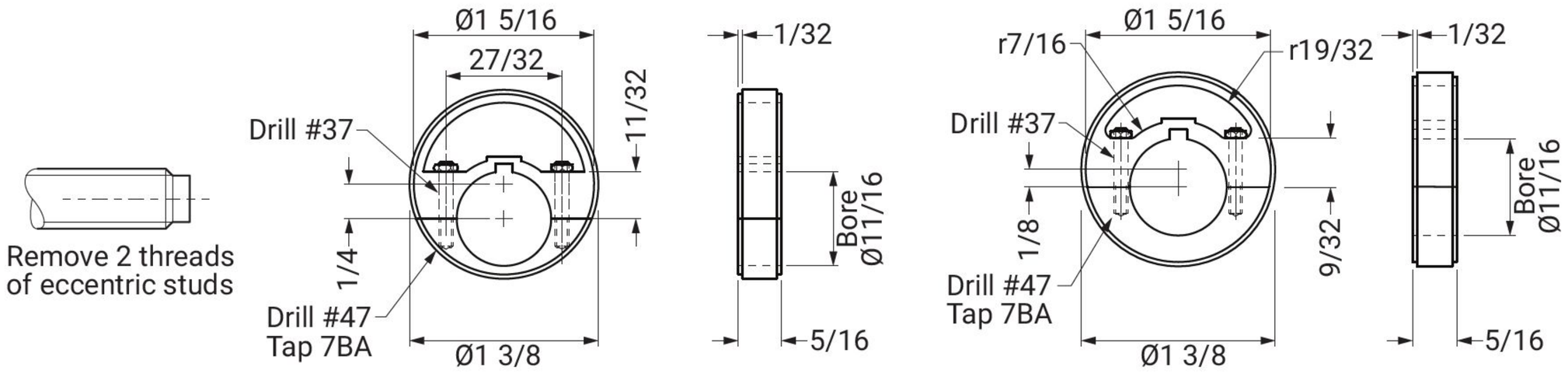


Fig 19

Original Throp/Southworth eccentric drawings (with the permission of Blackgates Engineering).

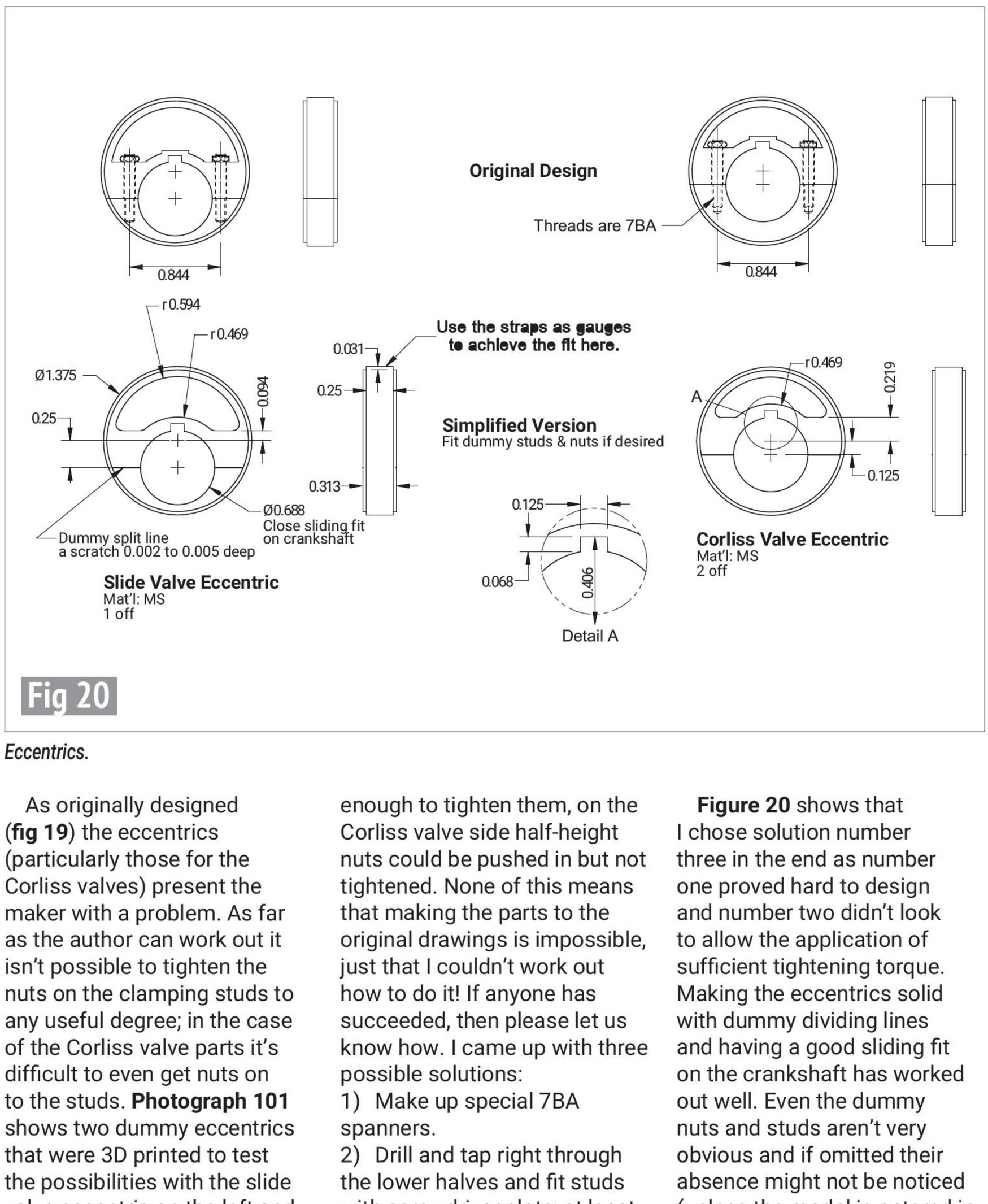


Fig 20

Eccentrics.

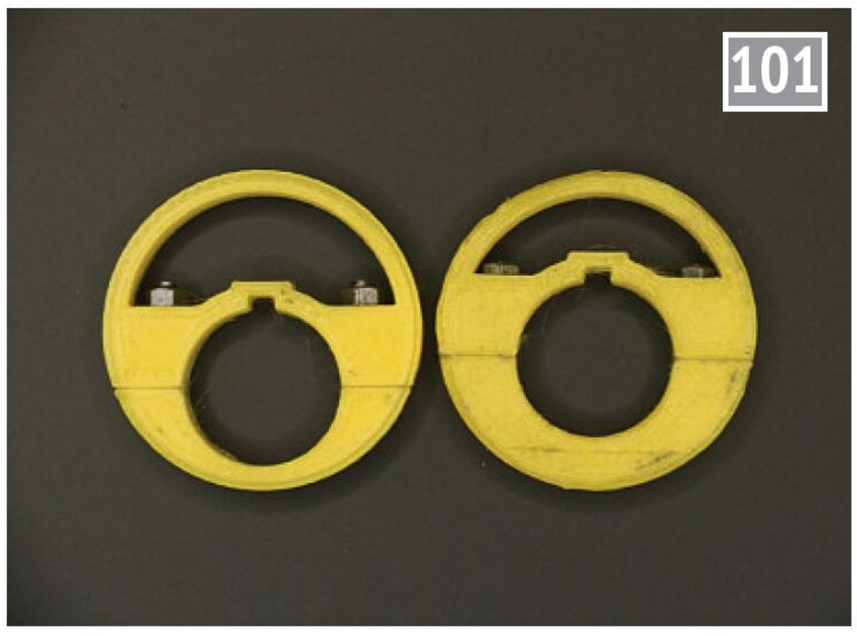
As originally designed (**fig 19**) the eccentrics (particularly those for the Corliss valves) present the maker with a problem. As far as the author can work out it isn't possible to tighten the nuts on the clamping studs to any useful degree; in the case of the Corliss valve parts it's difficult to even get nuts on to the studs. **Photograph 101** shows two dummy eccentrics that were 3D printed to test the possibilities with the slide valve eccentric on the left and the Corliss valve part to its right. In the case of the part for the slide valve the nuts will go on but neither of the available 7BA spanners would go in well enough to tighten them, on the Corliss valve side half-height nuts could be pushed in but not tightened. None of this means that making the parts to the original drawings is impossible, just that I couldn't work out how to do it! If anyone has succeeded, then please let us know how. I came up with three possible solutions:

1) Make up special 7BA spanners.
2) Drill and tap right through the lower halves and fit studs with screwdriver slots; at least then the spanner at the top only has to be held in one place.
3) Make the eccentrics solid and glue in dummy nuts and studs.

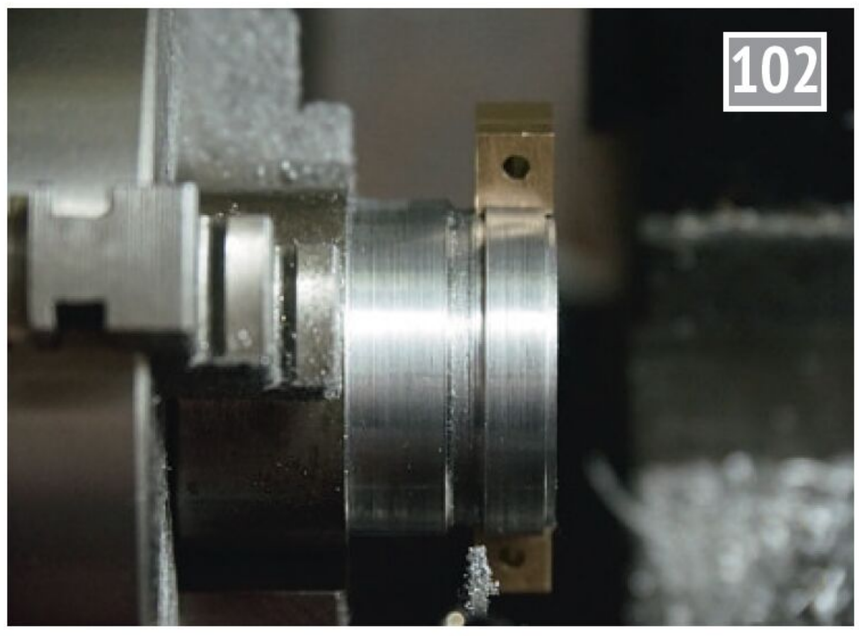
Figure 20 shows that I chose solution number three in the end as number one proved hard to design and number two didn't look to allow the application of sufficient tightening torque. Making the eccentrics solid with dummy dividing lines and having a good sliding fit on the crankshaft has worked out well. Even the dummy nuts and studs aren't very obvious and if omitted their absence might not be noticed (unless the model is entered in competition, perhaps).

The eccentrics were machined from a stub of FCMS, first turned to the nominal outside diameter and the outer step of the strap locating ridge sized by measurement which is one of the many, many places where a lathe carriage stop is useful in this build. A small parting tool was then used to bring the second step to depth (**photo 102**). This depth needs to be sufficient to allow a bit of radial clearance from the edge of the strap and all radial location is from the top of the ridge. Using a strap as a gauge, shallow cuts on the outside diameter and width brought the eccentric to a light running fit in the strap. From now on these are paired and need to be kept together until marked permanently. **Photograph 103** shows a final check of the fit of a strap to its eccentric.

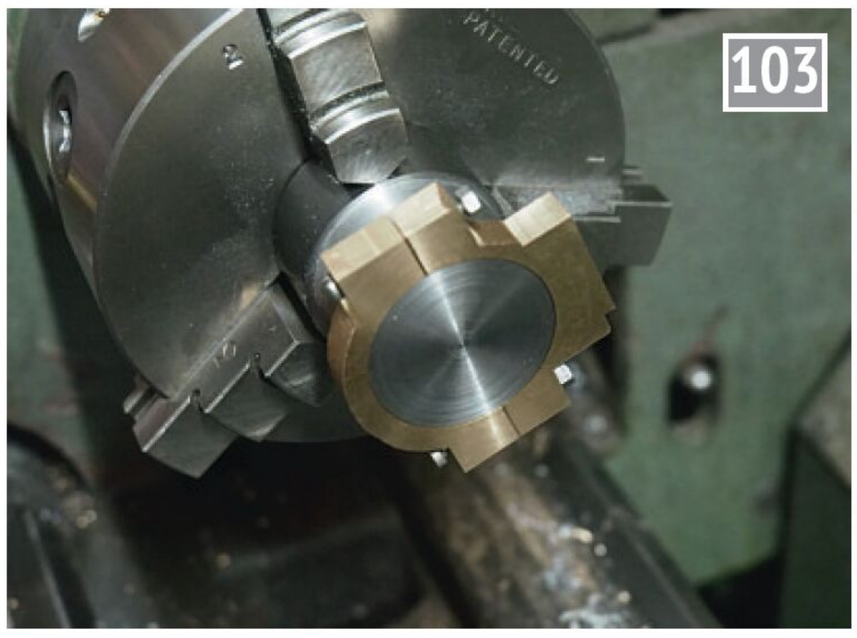
After parting off (**photo 104**) the parted off face needed cleaning up to thickness and I adapted an existing pot chuck to take the parts (**photo 105**). The next thoughts were along the lines of 'if you can use wax to secure the workpiece to a chuck, how about hot-melt glue?' (**photo 106**). As far as I can tell it doesn't work and only very fine cuts are possible. From there on I used cyanoacrylate as in **photo 107** where two diameters are being scribed in with the point of a lathe tool to give a centre from which the centre for the crankshaft will be marked off. The part has now been given two centre-pop dots for identification. After marking in the crankshaft centres, these were lined up for boring in the four-jaw chuck (**photo 108**) and bored to size using a gauge that was turned to size when



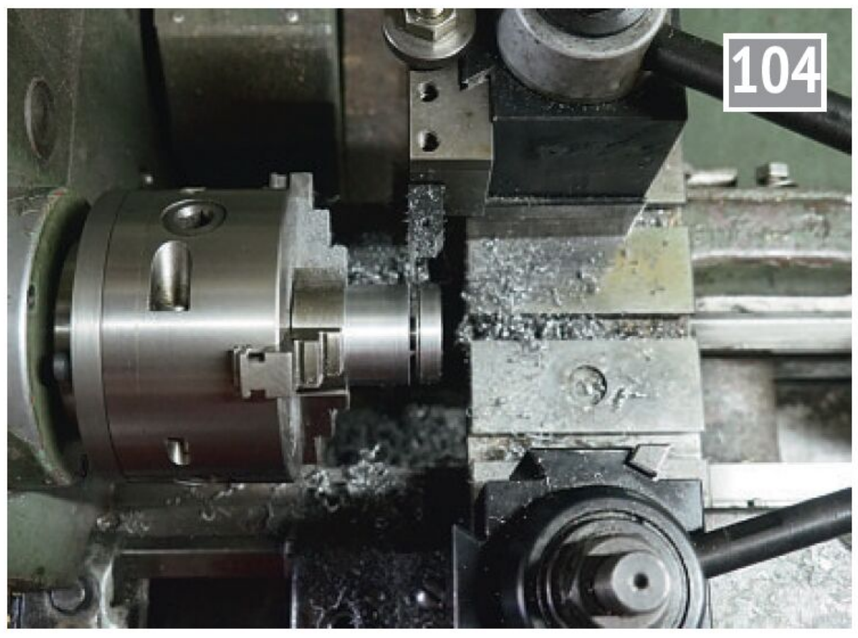
3D prints of eccentrics to the original design. Getting a spanner on the nuts was going to vary from very difficult to impossible.



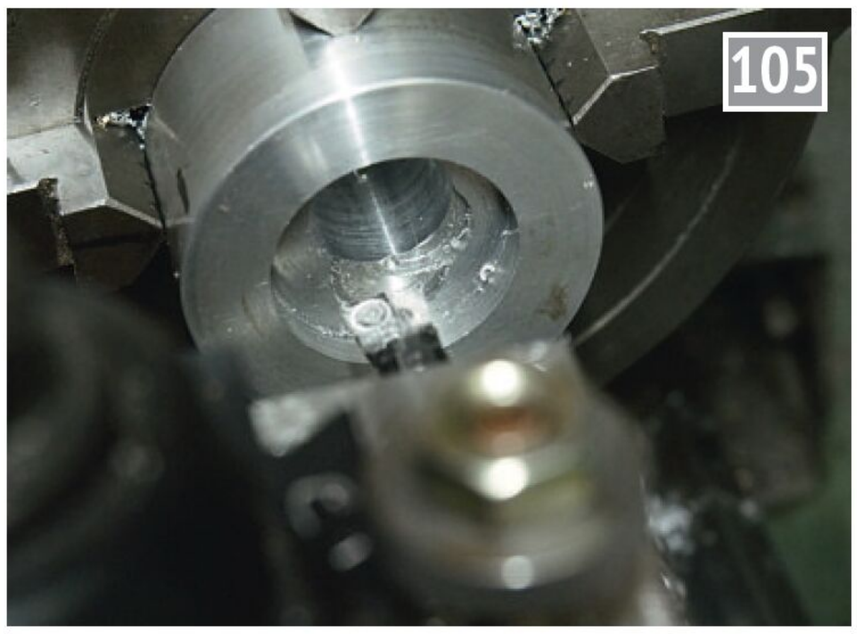
Machining the edges of the eccentrics using the strap as a gauge. This is much easier than doing things the other way around.



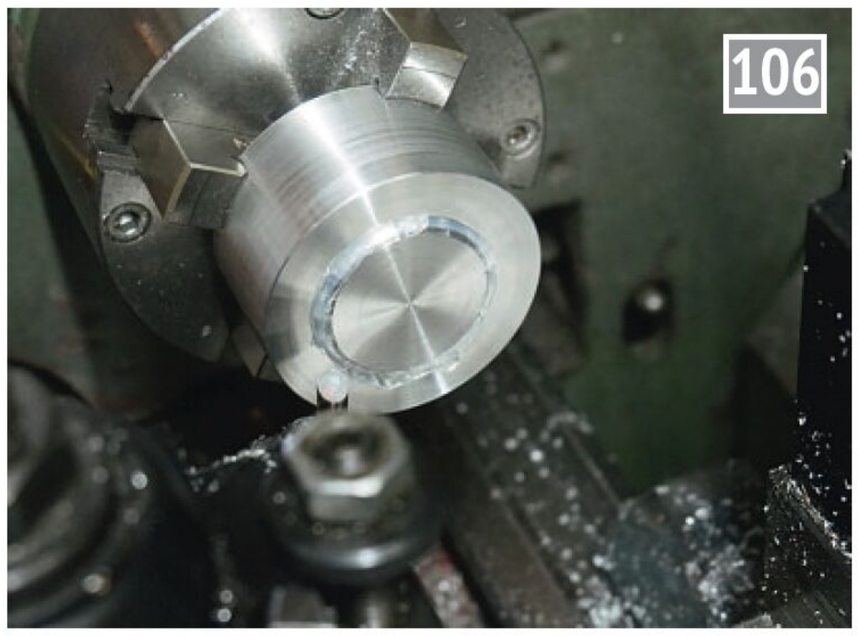
Temporary bolts used to check the fit between eccentrics and straps.



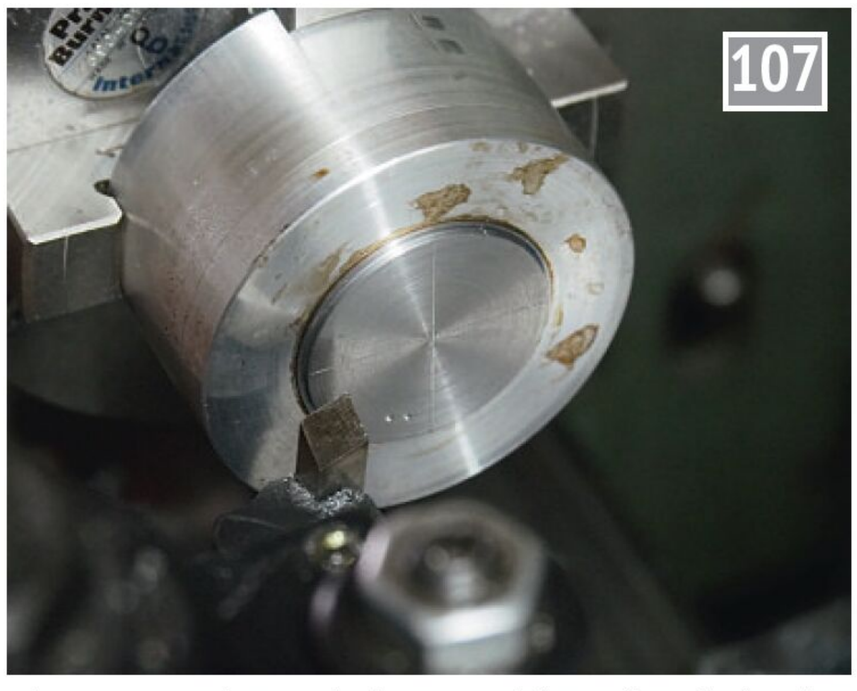
Parting off the first eccentric.



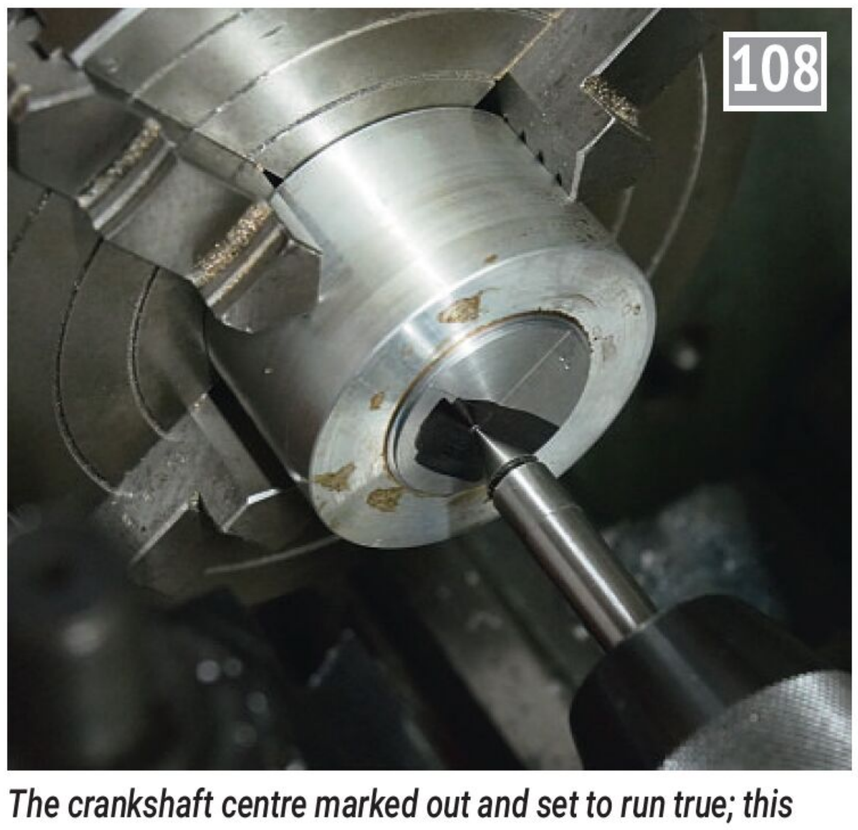
Adapting a pot chuck for holding the eccentrics for boring.



Hot-melt glue was worth a try…



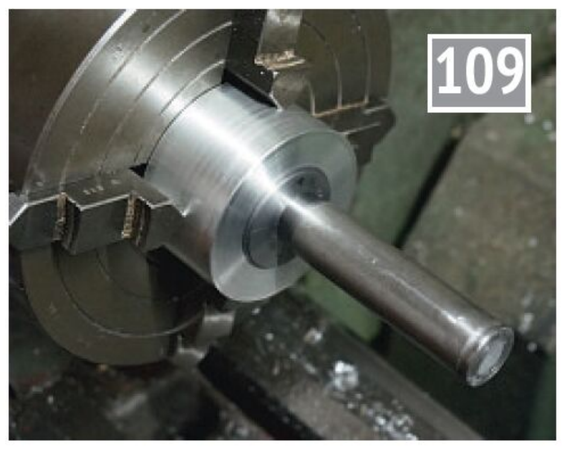
…but cyanoacrylate worked very much better for gripping the eccentrics for marking in the centre lines. Note that the chuck is a self-centring four-jaw, and also the identifying centre dots.



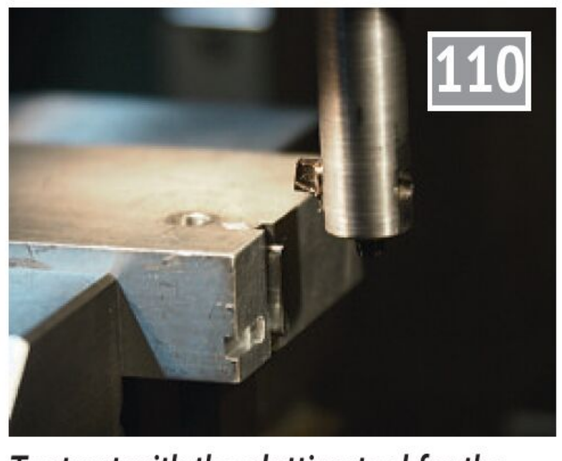
The crankshaft centre marked out and set to run true; this time the chuck is an independent four-jaw

the crankshaft was made (**photo 109**).

For me the most challenging bit of machining on the eccentrics was cutting the keyways as the chance I might be able to file a usable slot was small. In order to use a broach, I'd have to buy an arbour press, the broach and (probably the most difficult) find somewhere to put the press - so it was time to dig out the slotting head that came with the Aciera F3 mill. When this first arrived, it felt like it was seized but after a strip down it was clear that it was just that the old grease had thickened enough to prevent any movement. In fact, the condition was such that the unit might never have been used. What were needed to make the slotter usable were a tool holder and tool bit. The holder was just a length of 12 mm round bar with a 5 mm cross hole for an HSS bit and an axial grub screw to fix the bit in place. The cutting bit needed to be very close to size so was ground up using the Worden T & C grinder and then the whole lot was tested on the end of some scrap aluminium plate (**photo 110**). The key in the photograph was from stock key steel and having it push in and stay in the upright slot was very satisfying. The previously used pot chuck was modified with



Plug gauges had been made when the crankshaft was turned.



Test cut with the slotting tool for the eccentric keyways. The key is a light push fit.

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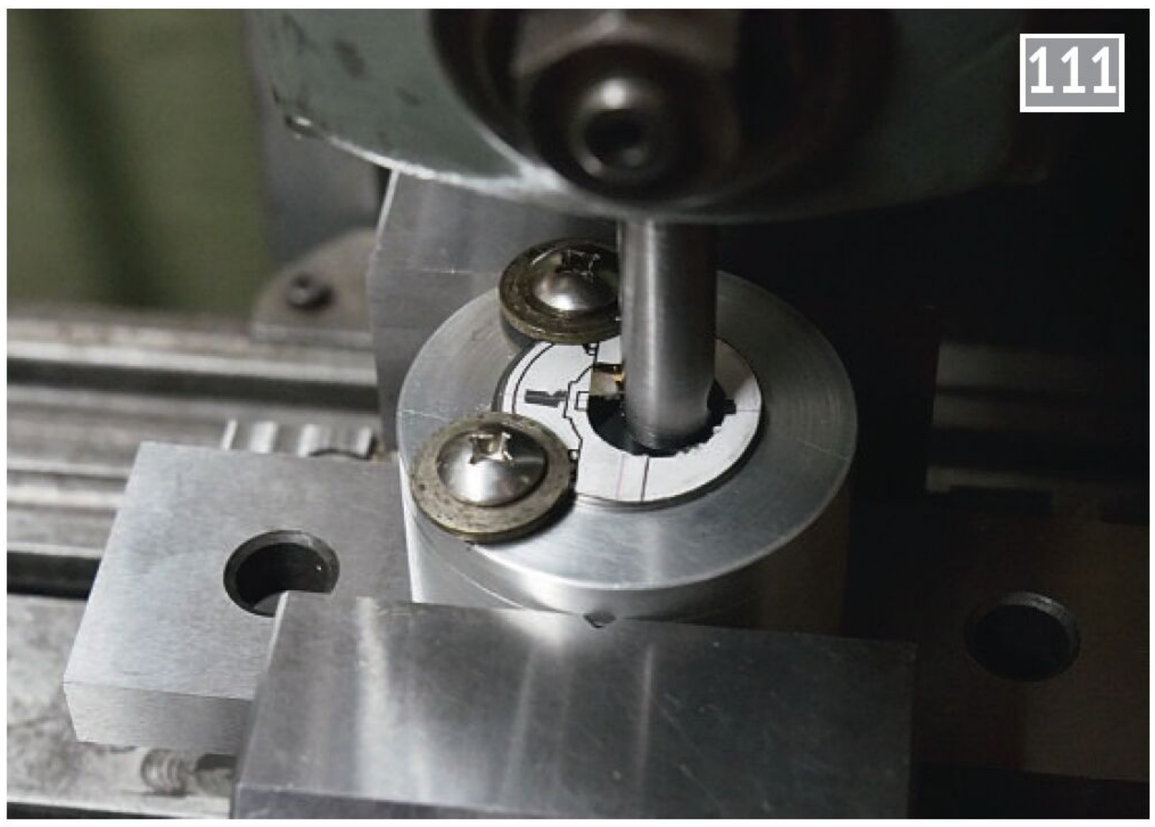
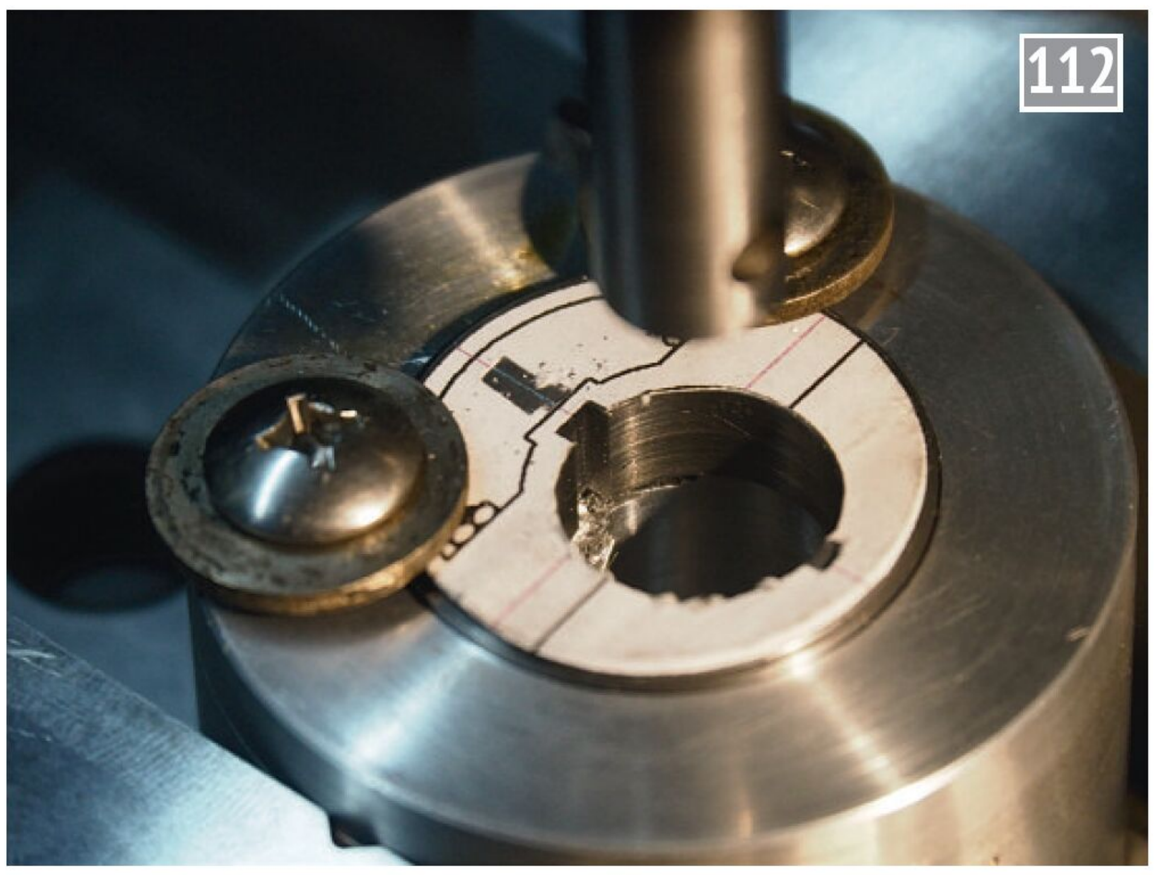


Two screws were added to the pot chuck to hold down the eccentrics. The slotting tool was aligned by measurement; the paper guide is a sanity check.

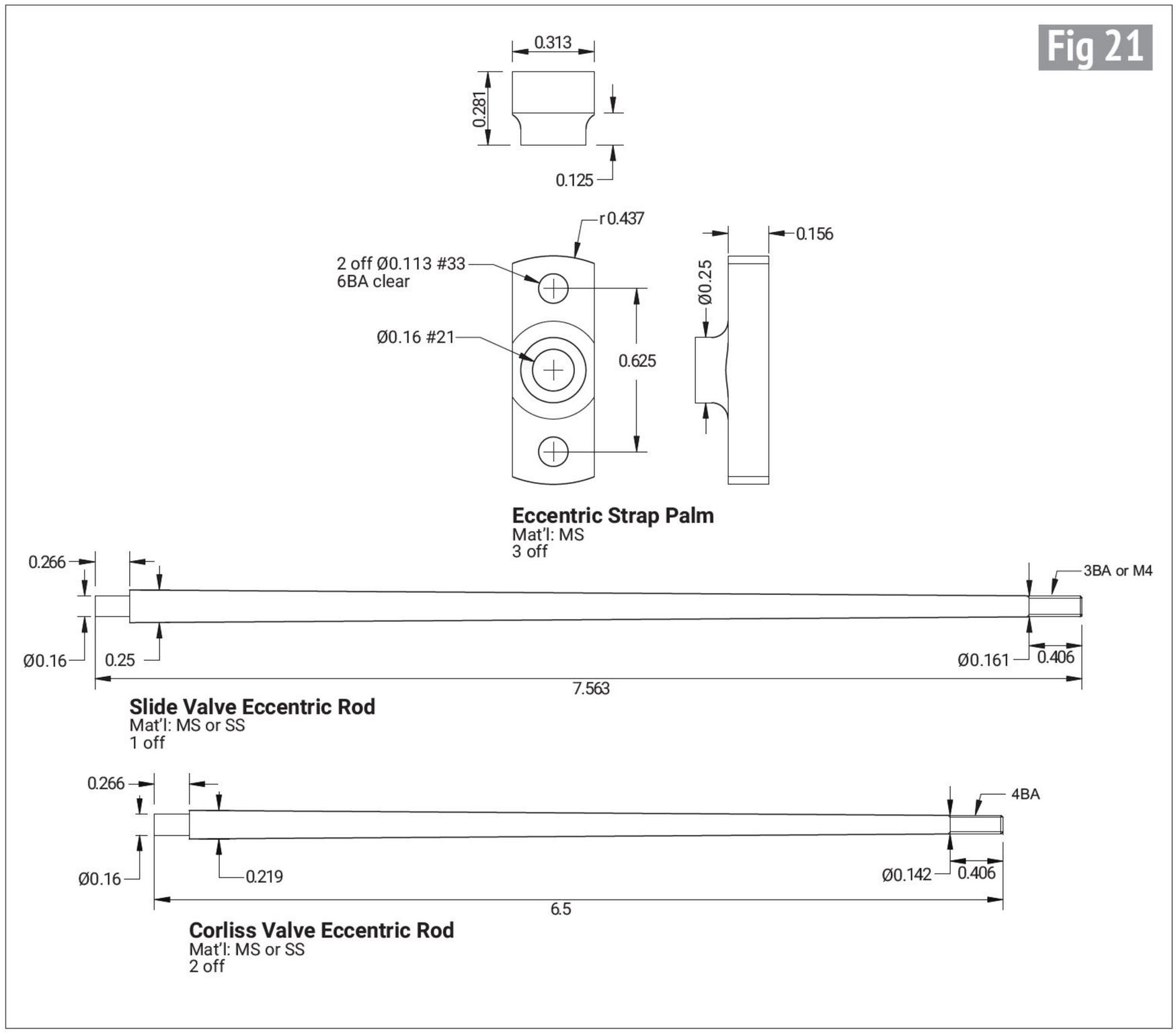


A successful keyway. Slotting these took only a few minutes.

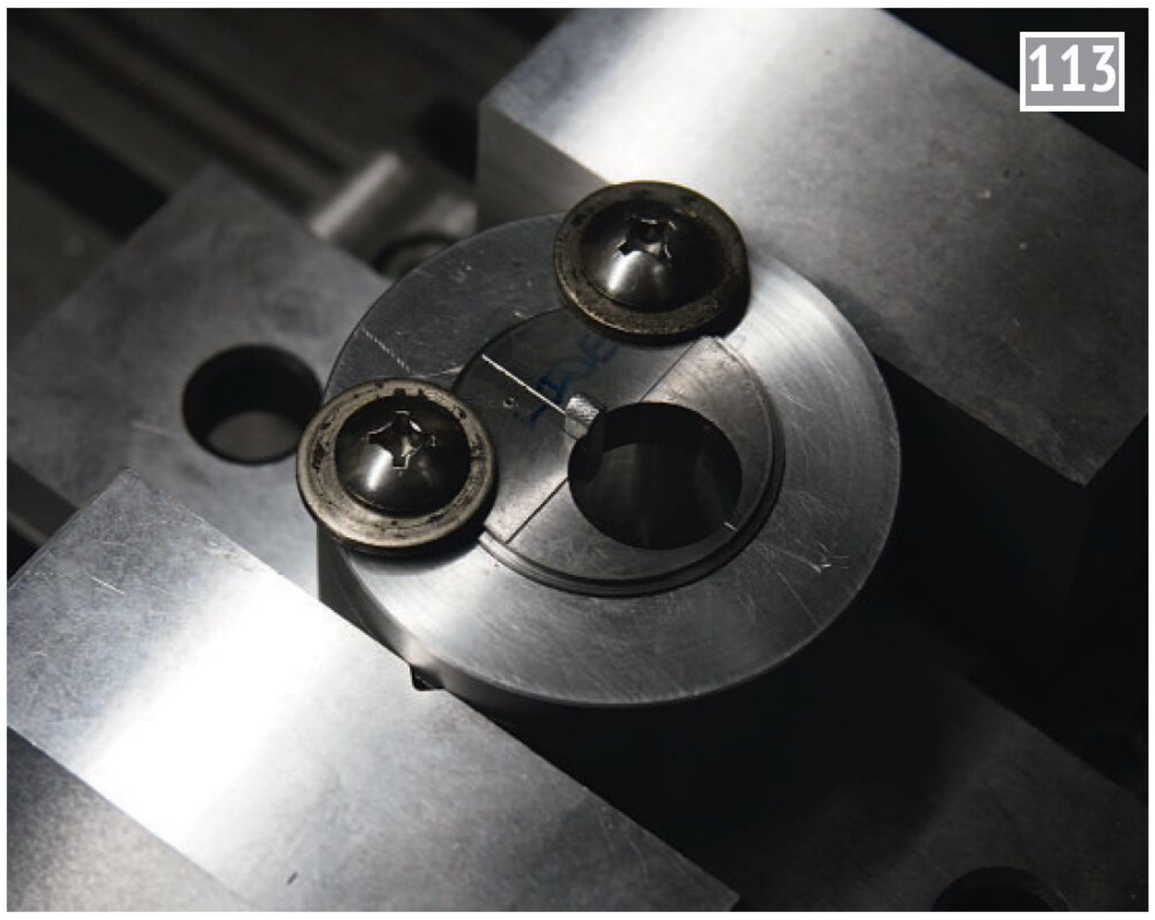
two 6 mm screws as clamps rather than trusting glue to take the shock loading and some more clearance turned in below the work piece for the slotting tool to run into (**photo 111**). The setup was aligned using the DRO on the mill, but the paper print was there as a sanity check. After setting the stroke length and table height the initial cutting speed (stroke rate) was estimated from the speed needed for turning with a ⅛ inch parting tool but this was too conservative. The setup was much stiffer than you could achieve on most lathes. The feed rate was set to give very small cuts (0.001 to 0.003 inch) which may well have been too conservative but resulted in a very clean accurate keyway (**photos 112** and **113**).

The eccentric strap palms (**fig 21**) started out being turned circular with the central boss and locating hole for the rod being created at this stage (**photo 114**). After parting off they were brought to thickness in soft jaws on a three-jaw chuck (**photo 115**). The central hole then provided a handy place for locating the part in the mill to cut away the sides and drill the stud holes (sorry, no pictures, I probably got distracted!). **Photograph 116** shows the assembled straps with some dummy oil pots that serve to close off the oil wells. I was unsure of how well the eccentrics would stay in place axially on the crankshaft and added a grub screw to each one to make sure (**photo 117** shows the appearance of the eccentrics at this stage including the grub screws). Further experience has shown that, with a good fit to the crankshaft, the eccentrics stay where they are put, and the screws can be omitted. **Photographs 118** and **119** show how much, or little, of the dummy studs and nuts can be seen. If I were to build the engine again (very unlikely), then I wouldn't bother including them.

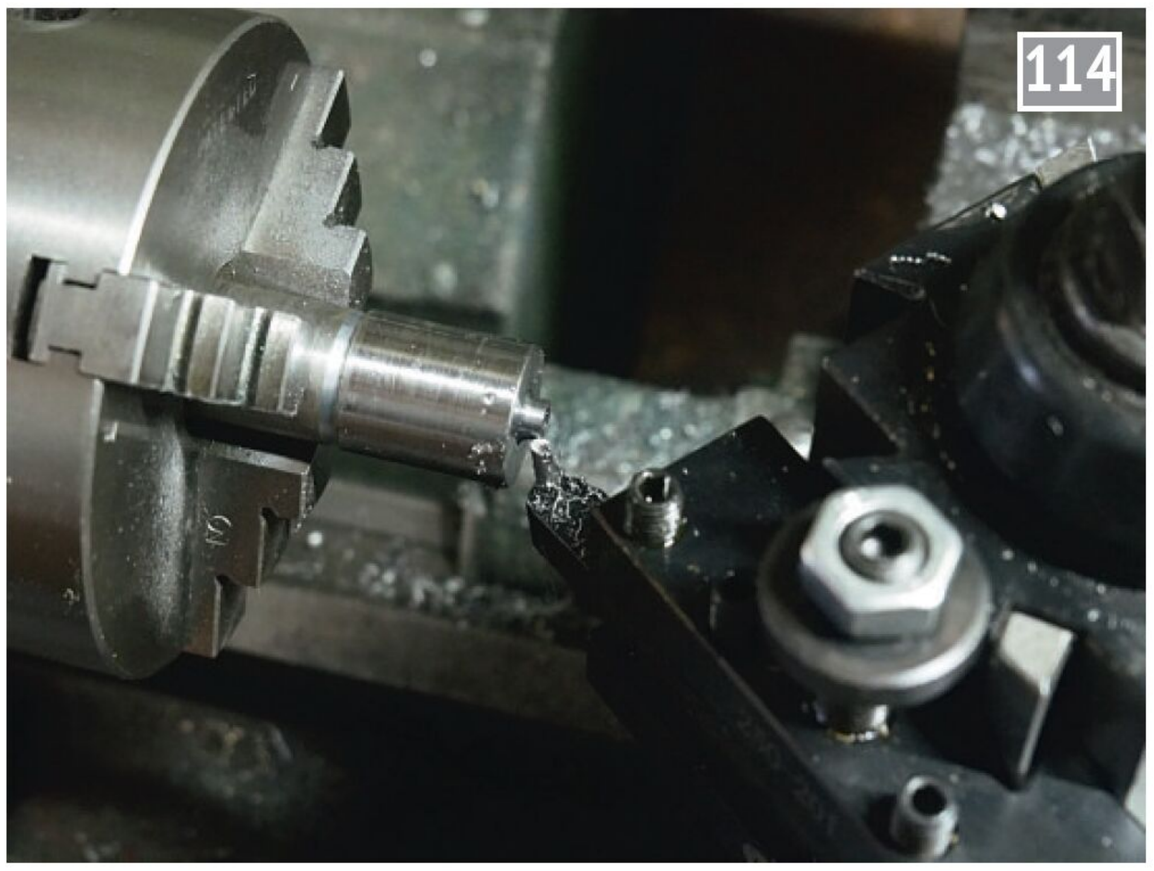
The three eccentric rods (also on fig 21) were the next challenge as I hadn't cut such a very long taper on such a very slender piece before. If there was a boring head on a #2 Morse taper in the workshop, I'd have used that but there isn't, so I bought in a cheap offsetting tailstock for the job. I found out the hard way that the centre wasn't hardened so in **photo 120** you can see that I've adapted a spare rotating centre to replace it. The two ends of each rod were prepared, one just turned parallel to size and the other threaded to take a rod end. The original drawings call for 3BA on the slide valve



Eccentric strap palms and eccentric rods.



Another good fit - these are very satisfying!

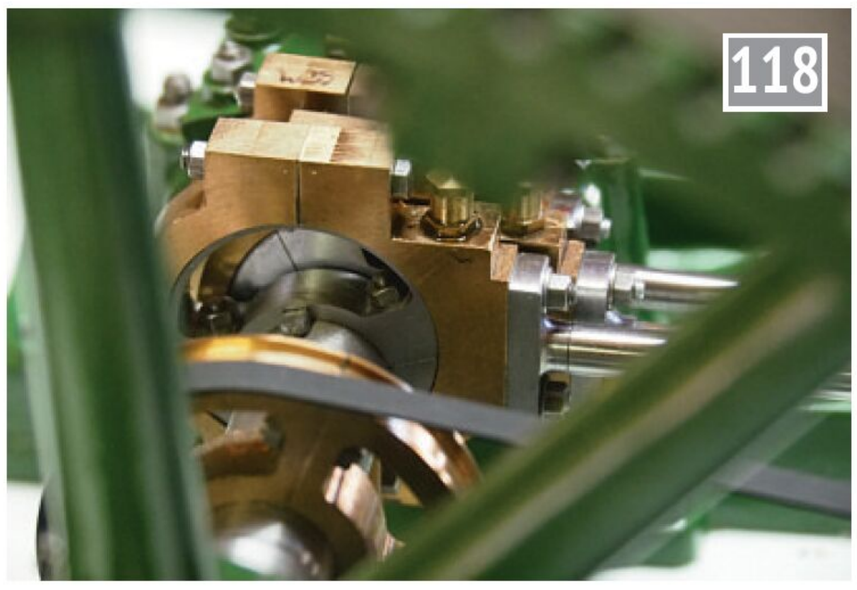


The three eccentric rod palms were formed and drilled on a stub of round FCMS then milled to width.

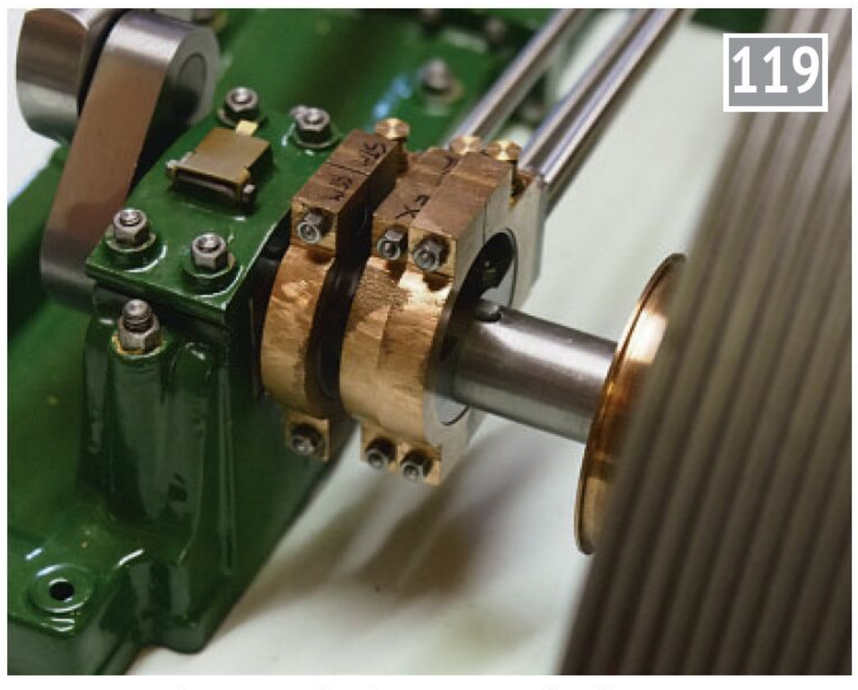
Cleaning up the parted-off face of a palm.

The three assemblies with studs and dummy oil pots fitted. All parts have been letter-stamped to prevent future errors.

In actual use the eccentrics stay in place on the crankshaft by friction but there was room for grub screws just to make sure.



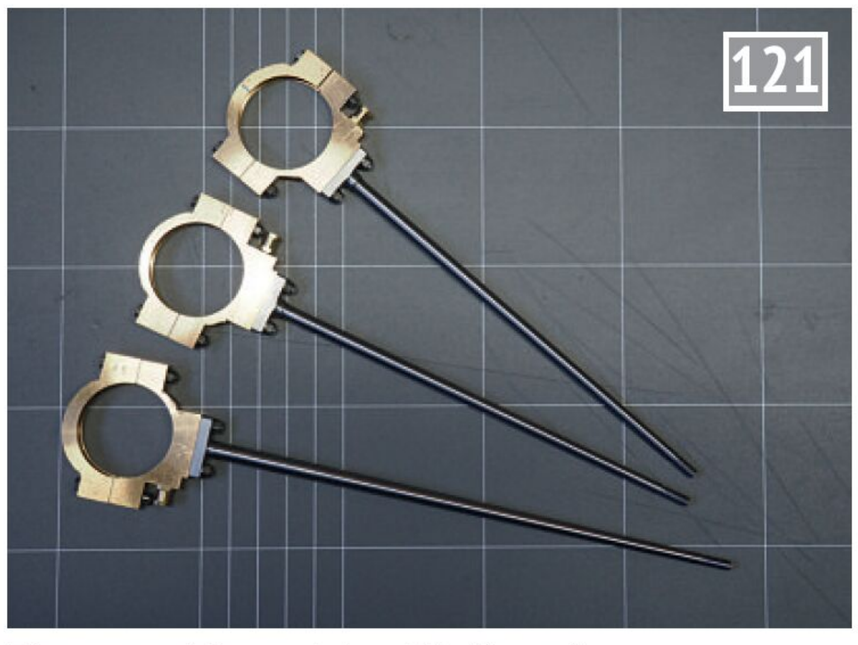
Eccentrics and straps as assembled to the crankshaft. The only way to get a clear view of the dummy nuts and studs is through the flywheel spokes.



From most directions the dummies are hard to see.

rod but M4 does just as well. A home-made lathe dog with a setscrew in the end was clamped on to the parallel portion (photo 120 again) and a DCGT tip used with fine cuts to remove the small amount of metal needed. The 'free cutting' stainless really was free cutting (not always the case in my experience) and one end of one tip did all three rods. I know these tips are meant for aluminium but I routinely us them for fine finishing on all sorts of ferrous metals. They don't last very long but the finish is very good. **Photograph 121** shows the three finished eccentric straps and rods, now properly stamped and dot marked for correct identification and orientation.

The taper on the three eccentric rods was achieved using a set-over tailstock.



Three assemblies ready to add to the engine.

●To be continued.

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■ Dore Westbury MK1, £350. Myford Super 7 on a stand, three and four jaw chucks, good condition, ready to use, £1200 ono.
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■ 5" gauge King, brand new, never been steamed, copper boiler, friend whom I ordered it for divorced now for sale 8,500 GB pounds, excellent workmanship free on board to any port the world.
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■ 7 ¼" GWR King. Complete chassis, professional boiler. Smokebox, platework, tender frames, wheels, axles. Practical Scale tender body. All castings to complete. Sensible offers please.
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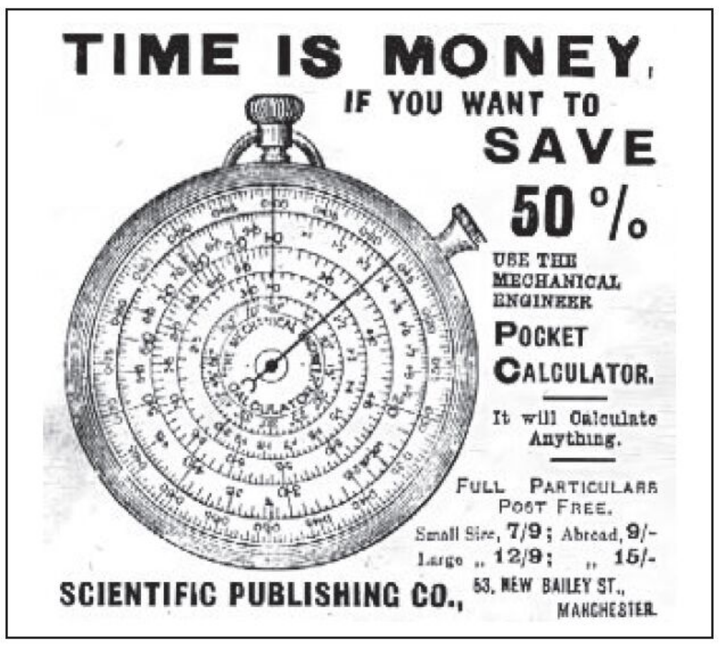
Wanted

■ Wanted: Model Engineer Volume 176 Issue 4015, 19 April 1996, or at least Eric Whittle's article on his V8 four-stroke aero engine.
E. bjsbyl@windstream.net.

Wanted: Manual to build a 5inch gauge TICH. **T. 01743 851446.**
E. derekdancey@icloud.com

Wanted: Drawings for E T Westbury's CRAFTSMAN petrol engine.
T. 01751 472712 Pickering.



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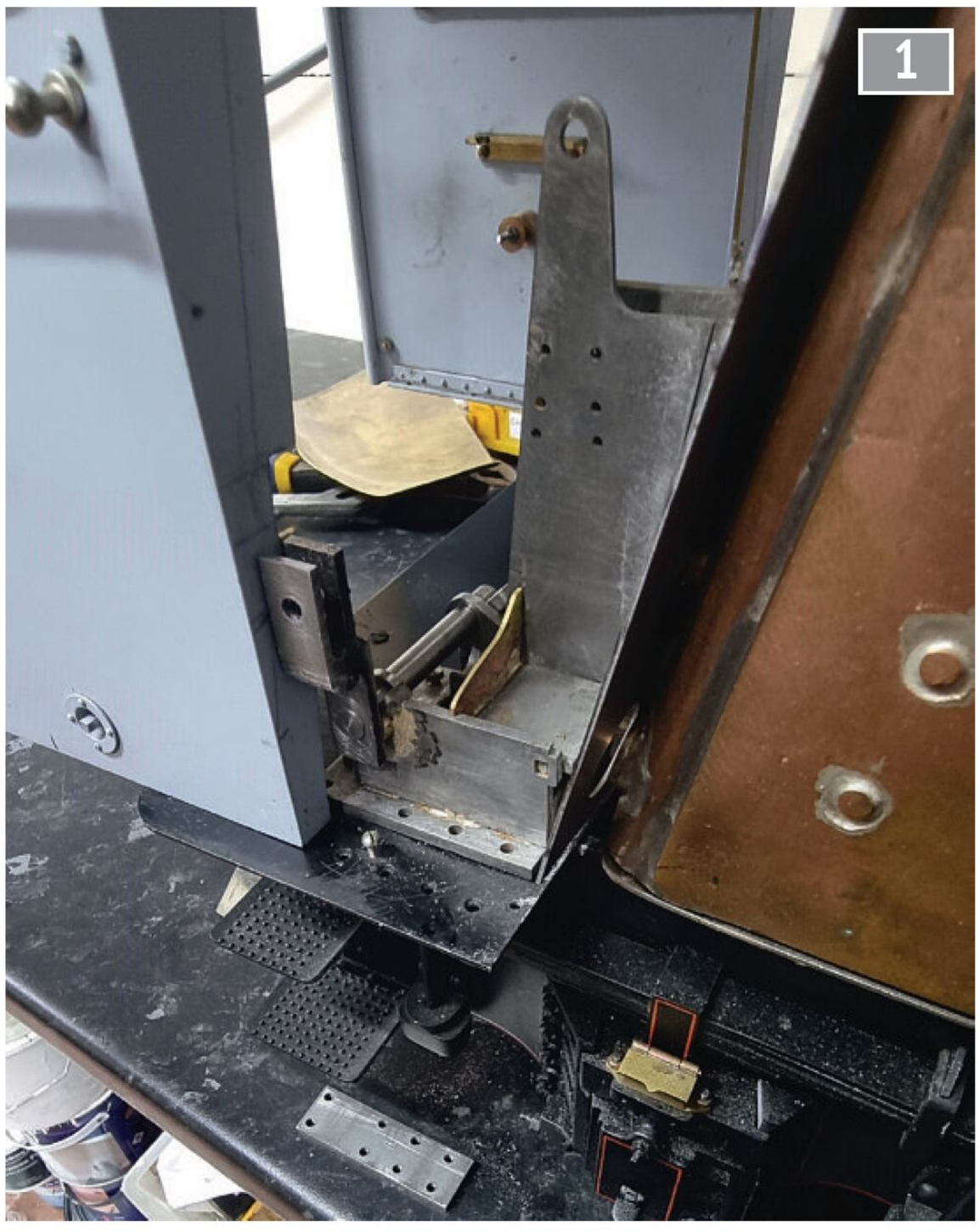
Flying Scotsman in 5 Inch Gauge

PART 61 – REVERSER STAND (CONTINUED)

Painting by Diane Carney



Offering up the cab to check the spectacle plate against the stand.

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

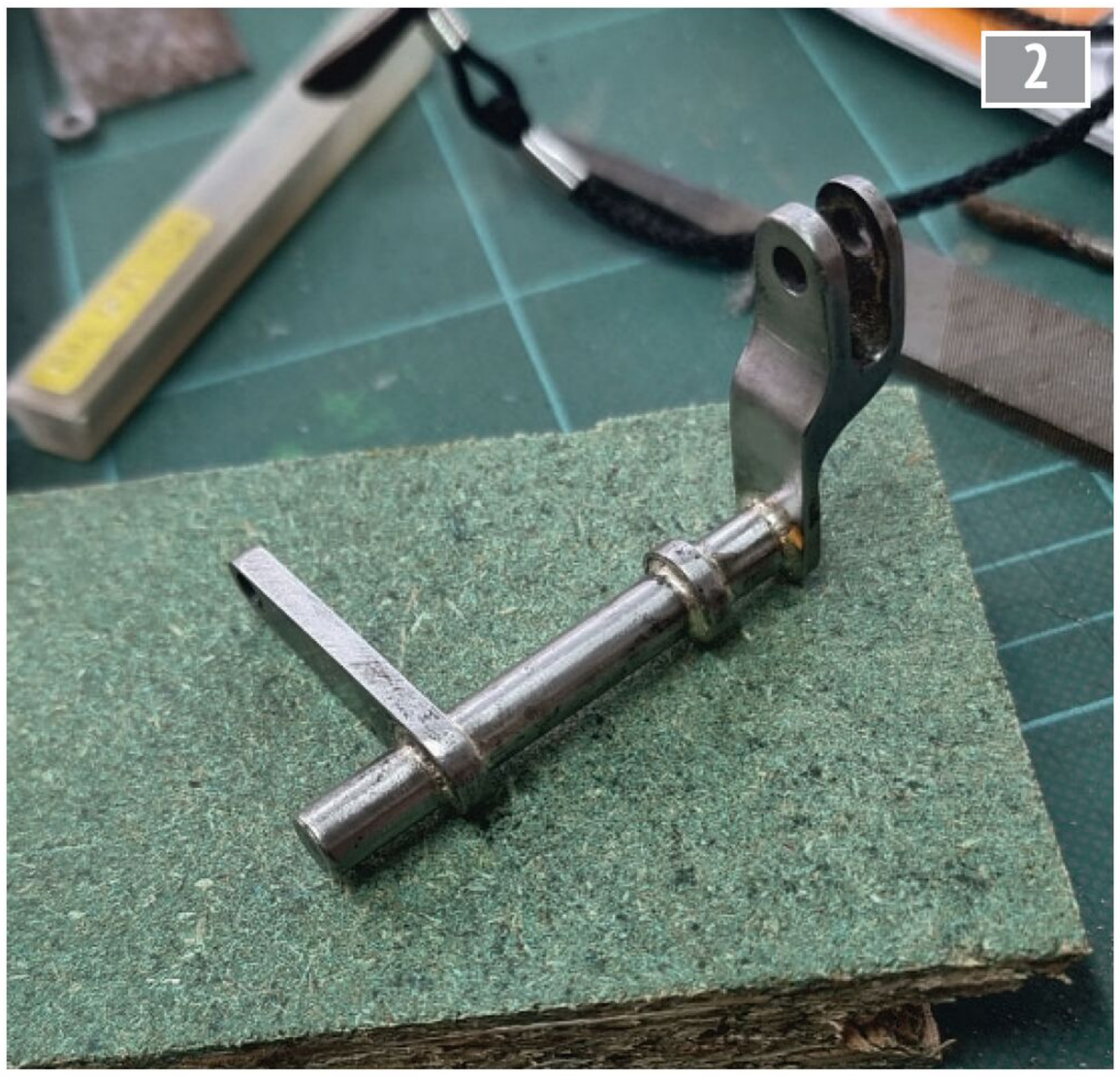
Continued from p.83, M.E.4746, June 28

In this update I'll cover the fabrication of the reverser shaft including the extra checks that I took when assembling the parts thus ensuring no issues further down the line. This will be nothing new to most of you who probably do the same checks but is worth pointing out to those new to the game.

Reverser shaft

Following Don's method of construction the reverser shaft comprises of 4 parts, a 2 inch length of ¼ inch steel rod, a length of flat bar to make the arm, a ⅜ inch diameter collar and a length of bar for the fork. The first job was to make the arm that will connect to the reverser screw, which is simply our piece of flat steel bar, with two holes. This is slid over the 2 inch steel rod and I left the final position until the other parts had been made and after trial assembly to the stand.

Next was the fork; for this, I used an offcut of black steel. The fork is 5/16 inch wide with a 5/32 inch slot down the middle. After machining the slot I roughly marked out the shape as a visual aid for the next stage. Before making a start on the final shape I checked the shaft along with the fork blank loosely attached for clearance along the firebox, bearing in mind that the cleading still needs to be formed around the backhead corner. I then removed the excess material from the fork, first chain drilled followed by step machining close to the profile.



The completed reverser shaft.

For peace of mind, I dug out the cab from its storage box to get an idea of its position compared to the fork (**photo1**). Note the slot cut into the spectacle plate, I did this when aligning for cutting the slot into the running boards for the reach rod to pass through, I will adjust this if required once I can check against the reach rod itself, The reach rod shape dips down past this area and is hidden behind the firebox cleading.

It was then time to silver solder the shaft parts together. Parts were thoroughly fluxed before assembly, a small broken number drill was used to get the arm sitting level and a simple jig was made using an old helping hands stand with a length of 5/32 inch steel rod to hold the fork upright and clock the arm to fork at 90 degrees. **Photograph 2** shows the completed shaft and **photo 3** shows the shaft in position on the stand.

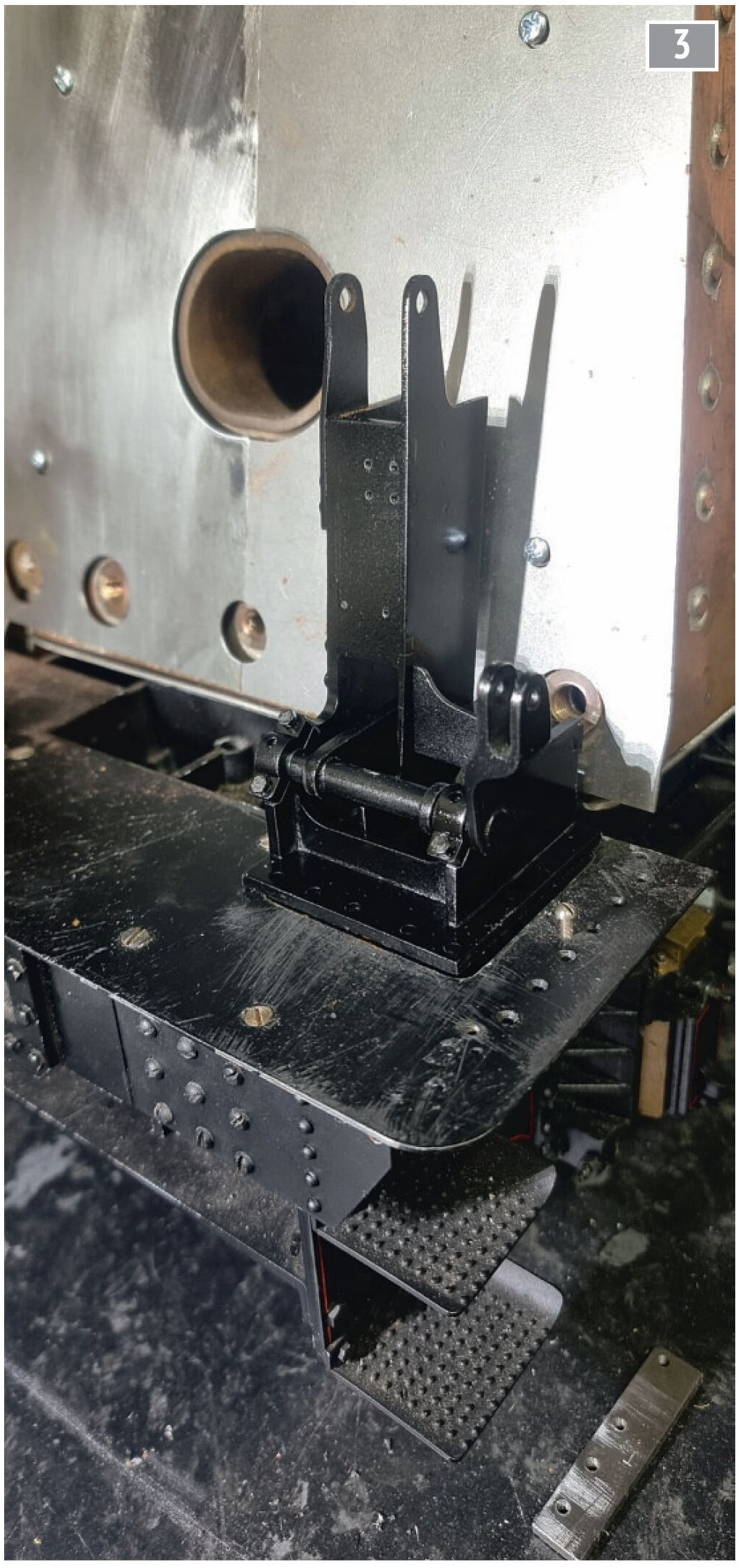
One final check to see if things looked right was to sit the shaft on the lower bearing blocks and hold a rule alongside the shaft and the lifting arms up forward. All looked good with the rule crossing the main running board bracket just where there will be another smaller bracket which the reach rod has to pass through. Some last details to the stand before painting were to drill/tap some 10BA holes for the sanding valve and an oil box to bolt to. The oilbox feeds the shaft bearing blocks below. These positions were taken from photographs although they are reversed as the photographs used were for an A4 and thus left-hand drive.

Reverser stool

In the last article, we had the reverser ready for brazing but we're not ready for that stage yet. We first need to transfer the mounting holes to the reverser stool which, of course, hasn't yet been made and then work out the exact position of the stool which will sit in between the main and trailing frames.

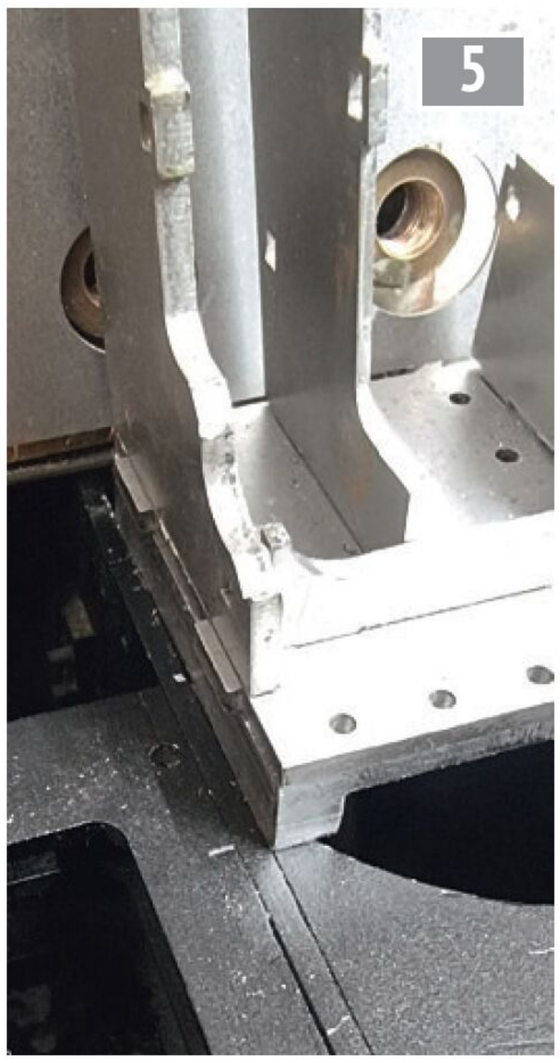
The stool itself is a simple rectangle of 2 x 1⅜ inches (made to fit) from a length of 7/16 inch steel. Not having anything close to that size I machined from the closest size in stock which was 75mm x 50mm x 12mm.. a wee bit of machining required. I used a grinder to get close to size and then machined to size and thickness, not a five-minute job. With the stool machined/squared to size, the next stage was to machine a channel into the underside creating a 'U' channel. Don states to machine a channel leaving ⅛ inch on the side to the trailing frame and a little wider on the other side to give enough metal to tap into once this side has been tapered to match the main frame (**photo 4**).

To work out the taper I first needed to take into account the reverser's relative distance back from the backhead to allow for heat expansion; Don advises to allow for 5/32 inch.



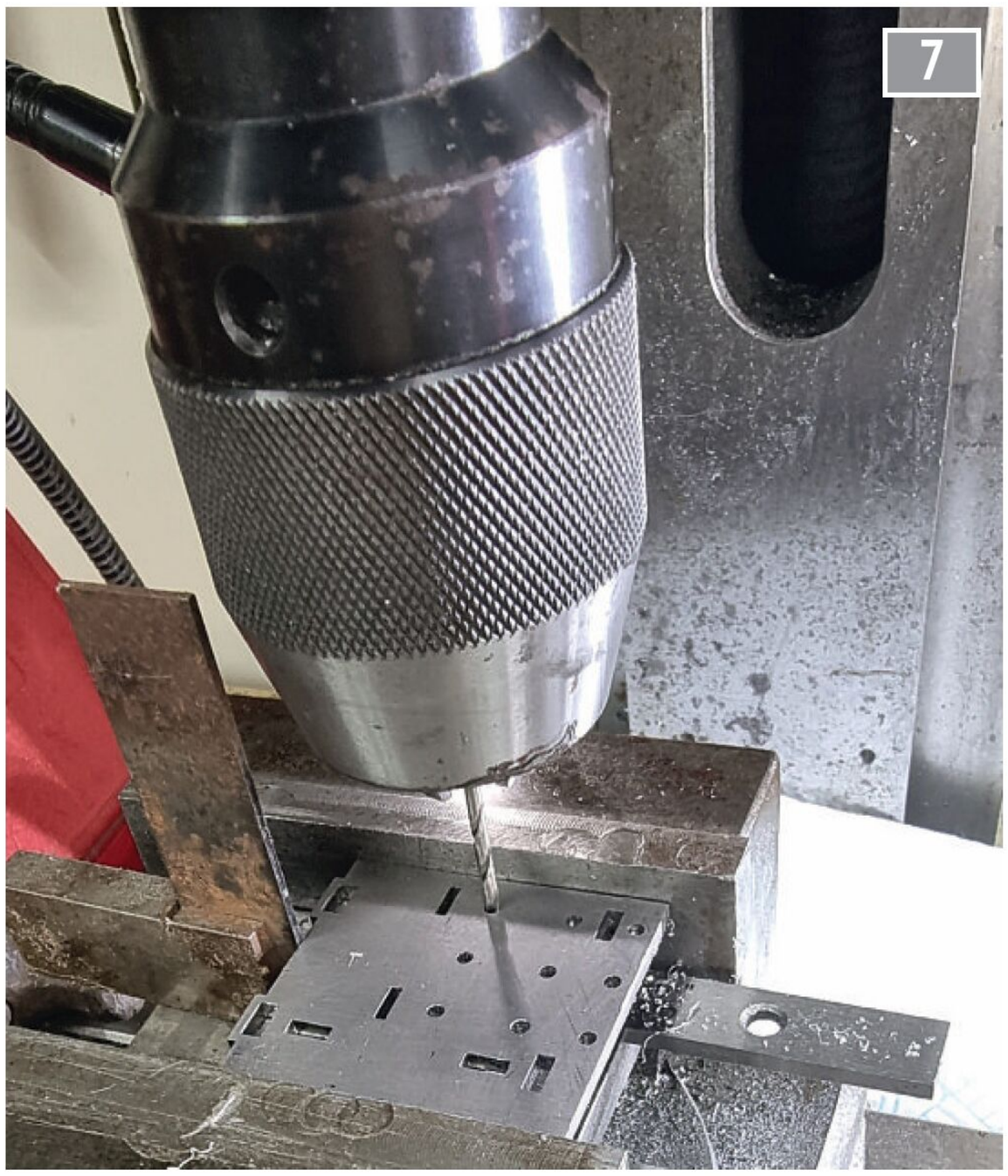
The reverser shaft in position on the stand.

Initial machining of the reverser stool.

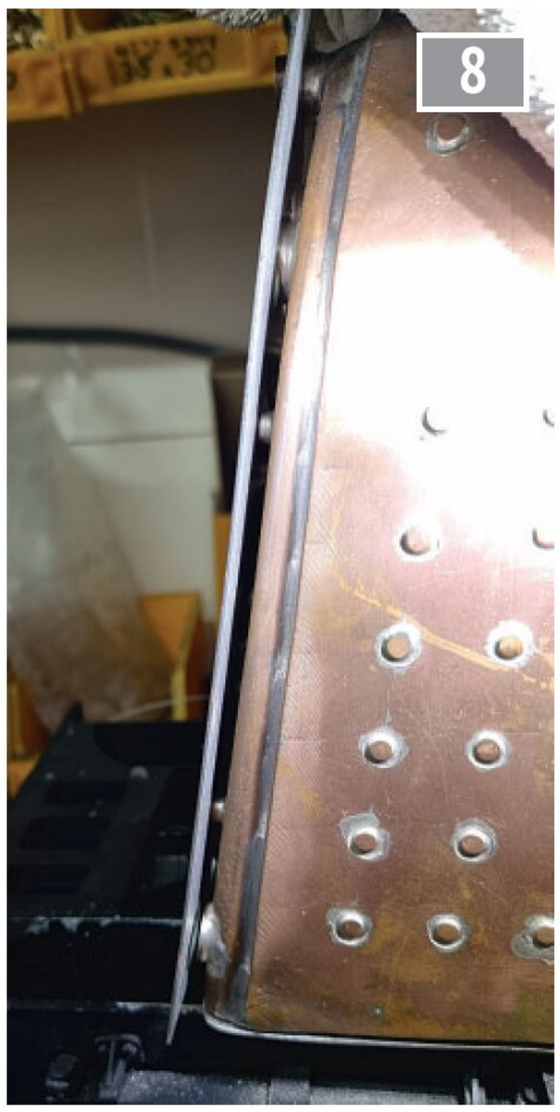


Checking against the main frames for the taper.

Adjusting the stool for the taper.



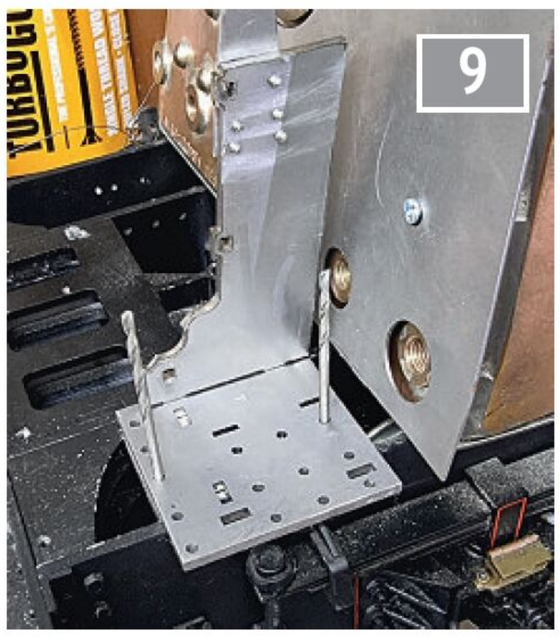
Spotting through into the stool.



Clearance between the cleading and the boiler.

Pointy screws are easier to insert.

Marking the stool fixing holes.



Checking the gap between the cleading and the stand.

Before I can do this I needed to place the backhead roughly in position. The backhead sections were cut from steel by Ed (Model Engineers Laser) some time ago and at the time I thought the plotted holes might need moving but now that I've had time to look at this more closely they just needed a little fettling to fit.

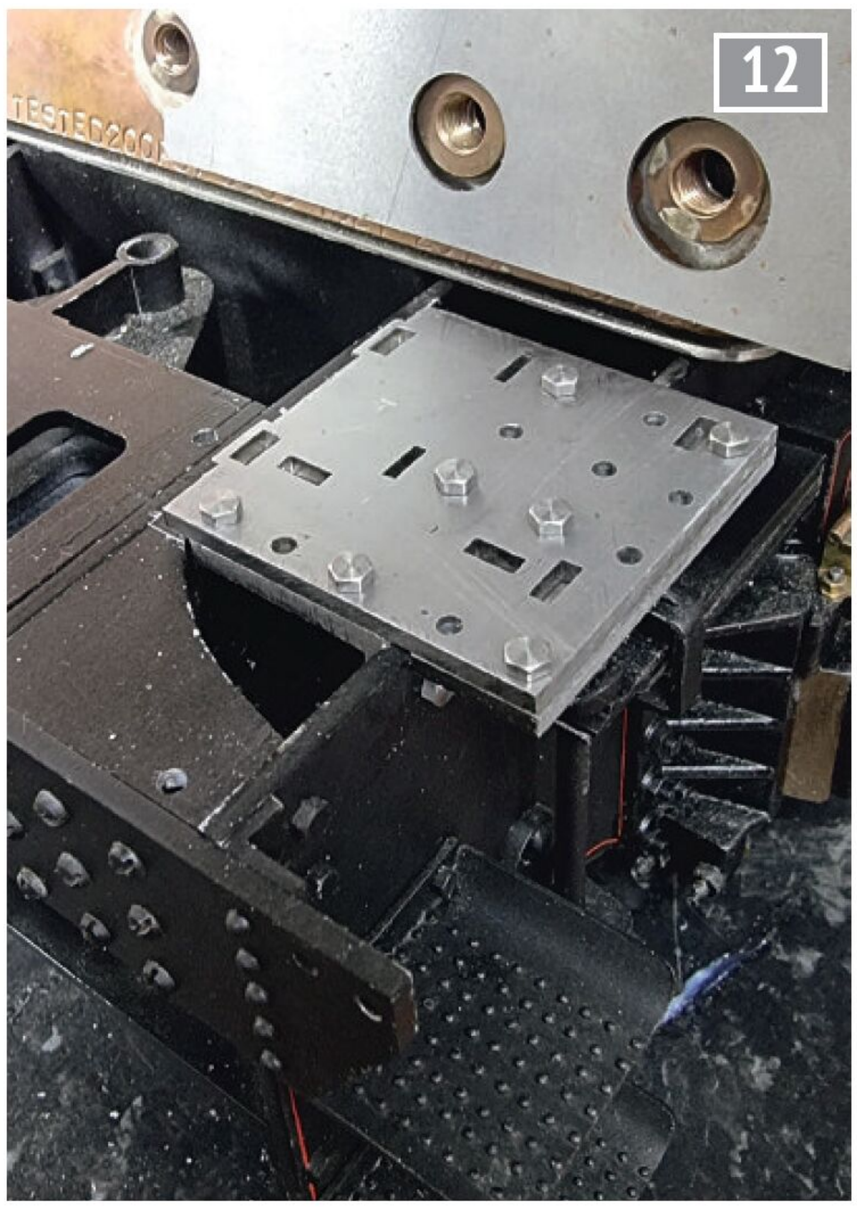
With the backhead positioned, I could then place the stool roughly in place and sit the reverser on top; I had left drilling the mounting holes into the stool until this stage just in case I had missed anything. I can now see that I can drill said holes ready for mounting the reverser (once brazed), more on that later. Here in **photo 5** I have rested the stool with its finished edge up against the inner trailing frame edge allowing the 5/32 inch (4mm) gap between the reverser and boiler. Note that the two tapped bushes at the bottom will be fitted with blanking plugs with the corner bush being fitted with a washout plug for boiler cleaning.

With the reverser in place, I could see/judge the taper required on the main frame edge - as can be seen in the photograph, it's not a lot. I also noted that I need to either remove a little from the frame stiffener or the stool - I'll opt for the stool. I then marked the edge that requires tapering, the plan being to first achieve the correct taper and then remove metal until the stool fits between the frames. As you can see in **photo 6** there's not much to remove and thus I did so with a hand file.

I then needed to transfer the reverser mounting plate holes to the stool. To do this I held the stool in the machine vice along with the mounting plate sitting on top. I drilled the first hole from this plotted at zero, and then the rest using the DRO (**photo 7**).

It was now time to decide on the reverser's final position while checking for Don's suggested expansion allowance gap. I also needed to be mindful that the backhead cleading will have some insulation sandwiched between it and the boiler. There's not a lot of room so have left the cleading mounting bushes as supplied which gives just enough room to clear the copper stay heads and allowance for some insulation material (**photo 8**).

With the stool in position, I placed the reverser on it using a couple of No. 42 drills to hold it in place while I checked the gap. The gap here is just under

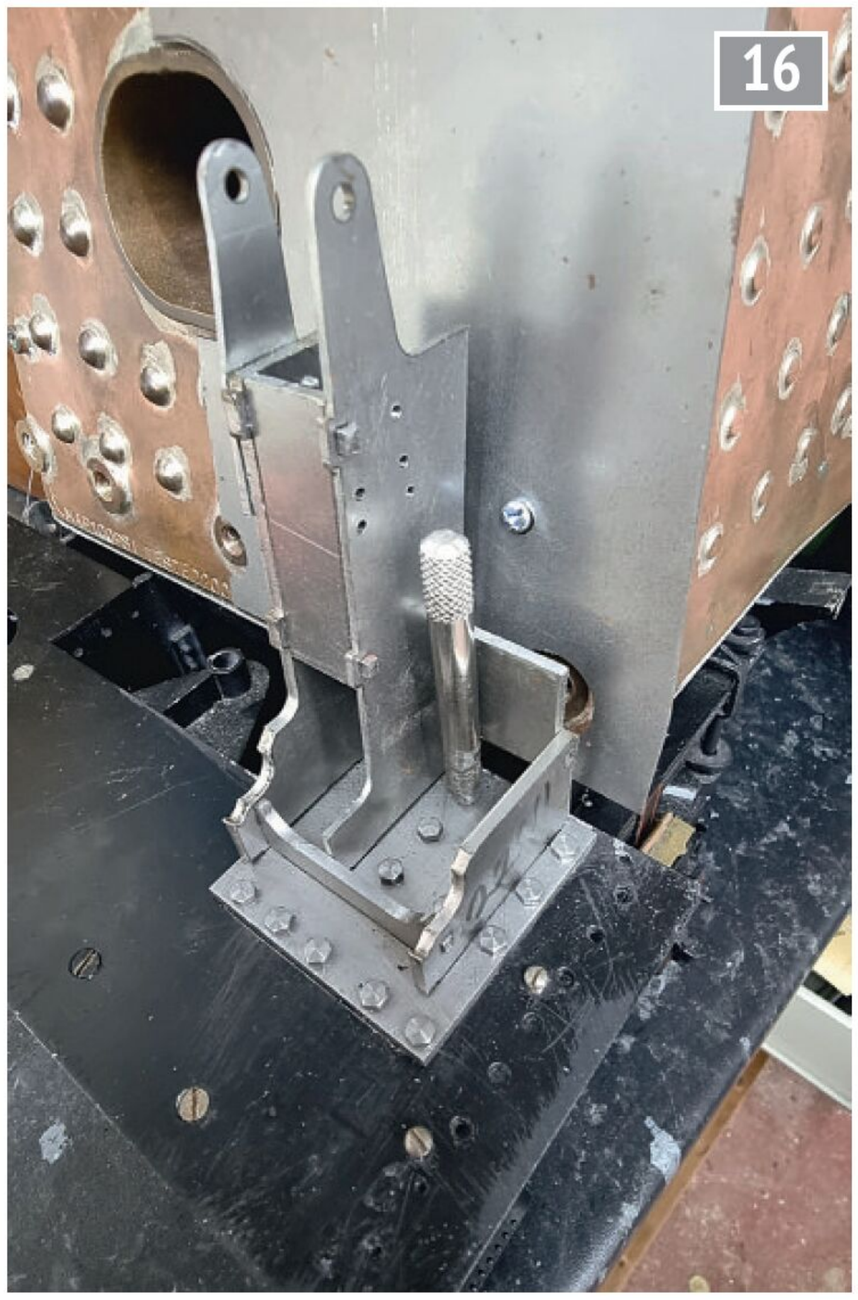


The reverser base mounted on the stool.

Initial mark for the cab floor cutout.

Clearance slots in the cab floor.

Cunning plan to ease access to the fixing screws.



The cunning plan in action.

5mm so a little larger than Don stated (**photo 9**).

To transfer the inner bolt holes I first marked the holes with a fine point pen (not easy to reach this area, thus transferring holes in the normal way is not possible) and then set the stool up to use the DRO for drilling the holes to match those in the mainframes. With the holes drilled and tapped I made life a little easier by putting a point on the 6BA bolts as shown in **photo 10**.

Before taking the base off I first transferred where the holes should be and then marked the frames down from the top edge 9/32 for where the outside holes need to be drilled (**photo 11**). I chose to mark where the holes would best be avoiding the spring guards which Don left off his drawings.

Lastly, we see the reverser base on its stool which is securely mounted and sandwiched between the mainframes and trailing frames (**photo 12**).

Cab floor

The next job was to cut some slots in the cab floor to allow the mounting screws to pass through. Before cutting anything I lined up the floor and marked approximately where to start machining. After taking a few measurements I marked where the hole in the top right centre of the base will be. **Photograph 13** shows where I will set the DRO to zero when held in the machine vice.

After chain drilling rows of holes I used an endmill cutter (perhaps a little too large) to create slots which gave me far more clearance than I should ever need (**photo 14**) - my reverser now has a gear gate…

Do you recall me mentioning a cunning plan for following the prototype more closely but still being able to get access to the mounting bolts? Well, I plan to have the shelf that sits above the bolts hinged so I can get at them. My modification simply involves filing the shelf fitting tabs round so that the shelf becomes hinged – simple (**photo 15**). And here I show the shelf raised with a box spanner on one of the more difficult bolts to reach (**photo 16**). It would be too difficult to reach with the shelf fixed.

All being well, the next update will finally show the stand brazed together with some of the extra details applied.

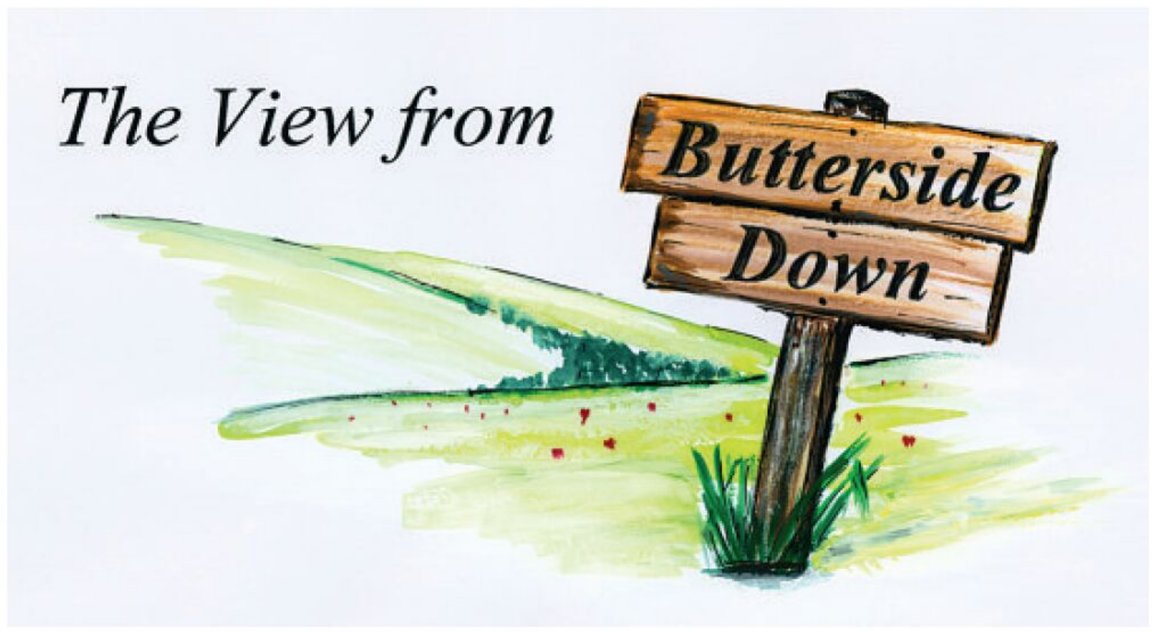
●To be continued.

Part 24: The Wonders of Technology – Part 3

The Best of Them All

Steve Goodbody takes a random walk through model engineering.

Continued from p.618
M.E.4755 November 1



Having established that our model engineering creations are especially beneficial if we overcome our shyness, determined that a big-box hardware store is an inappropriate destination for a baby's birth, no matter what your car may tell you, and examined a high-mileage passenger vehicle's door for a surprisingly long time, I am sure that you, bemused Reader, have given up all hope of predicting where we are going next. And I for one don't blame you, for it's been quite the ride, hasn't it?

Orbiter Discovery – our *space shuttle - occupies top billing at the Udvar-Hazy Museum near Washington DC.*

Catching up with old acquaintances

You know what it's like: you stand there, waving goodbye as a friend or relation departs and rounds the corner and get a nagging feeling you will never see them again. It's happened to me on a few occasions but, on that late February day in 2011, with *Discovery* disappeared from view and entering orbit for the final time, my young daughter Emma, tired and eager to return to the air-conditioned bus and its enticing DVD player but knowing that I'd waited a long time for this day, tugged at my arm, assured me that I mustn't worry because the shuttle would be okay, and concluded that we could visit it again once it returned to earth. As we packed the remaining paraphernalia into a rucksack and returned to our more mundane transportation, I knew that, yes, she was quite correct, we would assuredly reacquaint ourselves with *Discovery* sometime in the future.

It took a while however, but several years later, just as Emma had foreseen, we walked into the cavernous Smithsonian Air and Space Museum's Udvar-Hazy outpost near Dulles Airport in Virginia and there she was – *our* space shuttle – sitting squatly on her undercarriage, bravely bearing the scars from her final mission and knocking even the infamous *Enola Gay* and the sleek but decidedly menacing SR-71 *Blackbird* off the museum's top-of-the-bill slot (**photo 128**).

As we wandered around and examined her from every available angle, I noticed that the much-publicised ceramic tiles - vital for keeping heat at bay during re-entry but habitually falling off before launch in the earliest days of the shuttle program - covered only certain portions of the orbiter, the regions subjected directly to atmospheric friction. Her upper sides and roof, less directly impacted by the blast-furnace heat, were encapsulated in what (to me) looked more like an array of sewn-together welding blankets. I'm sure they weren't, but that's one of the good things about seeing something in the flesh - there are often surprises.

Wandering up to the hanger's balcony for a better view of the entire craft, I recalled once reading that the shuttle orbiters were affectionally referred to as *flying bricks* by their pilots and, surveying its stubby wings and slab sides it wasn't difficult to see why. While a technological marvel, as aerodynamic flying machines they had a shape

From an aerodynamic perspective, it's a shape that only a mother could love.

that only a mother could love (**photo 129**).

While we were of course glad to see *Discovery* once again and to be able to examine her close-up for the first time, and daughter Emma thoroughly enjoyed telling all-and-sundry that she had herself witnessed her final launch, as is so often the case with museums I left with a distinct feeling that the display was a cold reflection of reality, one which sadly failed to capture the dramatic spectacle we had witnessed at her launch several years prior. But, I admitted to myself resignedly, when dealing with a space shuttle, what other options are there? After all, the museum can't stage a mission for every visitor that walks through the door.

And with that question left hanging in the air, let's turn our attention back to Florida's Kennedy Space Centre once again.

The pinnacle of perfection

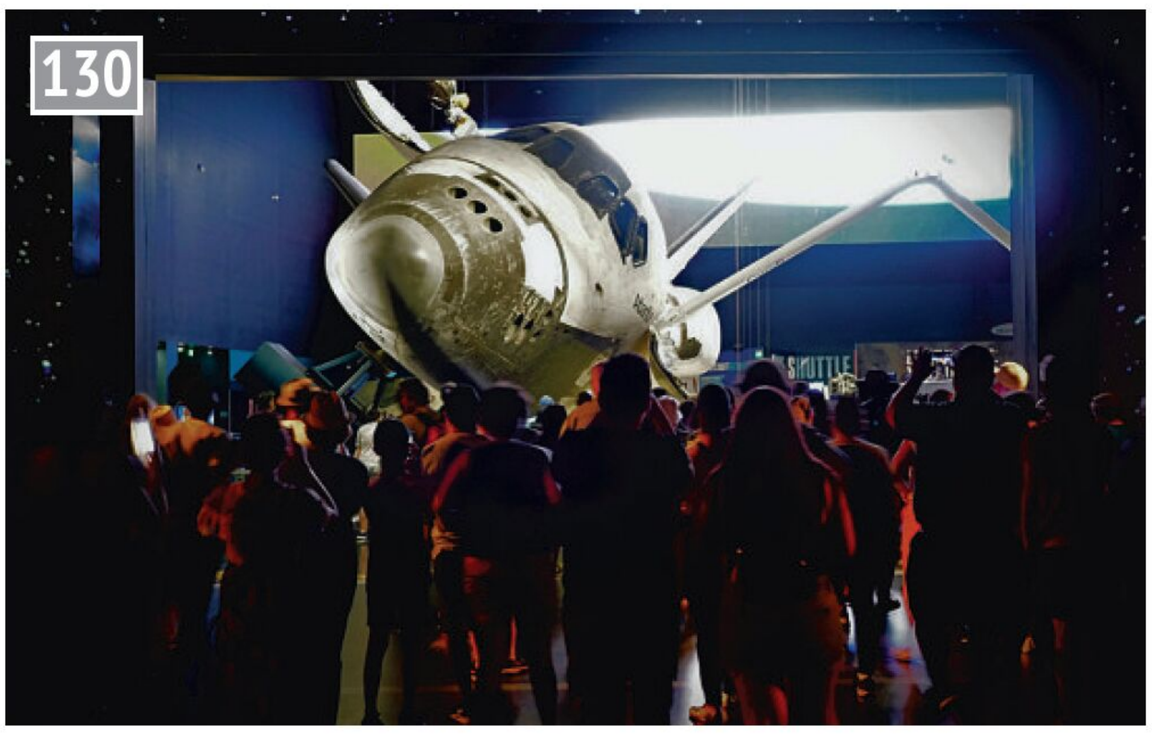
Now, at this point in time I have a dilemma. Should I reveal some key delights of Kennedy's *Atlantis* shuttle museum to our readership, or would that spoil the surprise for those who intend visiting for themselves? Tum-de-dum, what to do? Well, being unable to keep a secret for very long (as you will recall from the story of Miles and Alyssa) and knowing that there's little which isn't already depicted on the museum's own website or covered elsewhere on the internet, let's go ahead and hope that I don't ruin things for too many people.

It all starts peacefully enough; we queuing visitors enter a large and darkened room in accordance with our timed tickets and, eventually, with everybody inside, the doors close and an impressive and well-produced audio-visual show begins, its images beamed to front, ceiling and sides to create an enveloping spectacle. As the uplifting surround-sound music reaches its crescendo, the wall behind the front-most screen discretely raises and, as the projectors slowly dim, shuttle orbiter *Atlantis* magically and unexpectedly appears directly beyond, her load-bay doors wide open and the robotic arm extended outwards. The audience gasps, for the entire craft is at eye level, tilted at a dramatic angle, and the scene is lit by a portion of earth's shining blue disc beyond (**photo 130**). We, drawn from the theatre by this vision, hurry to inspect the almost-within-reach orbiter, its spacious load-bay in full view and the spindly robotic arm suspended above our heads, a view most of us never expected to see. I certainly didn't.

Now, given that I had earlier that day spent over fifteen minutes peering closely at an Apollo capsule's door mechanism, you can be sure that I spent a very long time taking in as many of *Atlantis's* many details as possible. But sometimes I need a break, so every now and then I wandered to the upper viewing platform and reflected upon the big picture, so to speak, which is so imaginatively and cleverly displayed in this museum. And, during those moments, I noticed something odd as I watched a succession of audiences leaving the theatre at roughly twenty-minute intervals after their big reveal. In every case, these people, regardless of age or gender, were *happy* - their faces beamed with pleasure - and excited children tugged at parental arms to hurry them along, eager to see the exhibits and ride the launch simulator which they knew was included in the ticket price and is a very effective recreation of the sights, sounds and vibrations of the real event.

But the point is this: just like the crowd watching *Discovery's* final departure in 2011, everyone entering that museum was excited, enthusiastic and *happy*! When was the last time you could say that about a museum's entrants?

No indeed, the *Atlantis* Museum is special;



The Atlantis *Museum's big reveal. In the author's view, this sets the bar for the best-displayed and most inspiring technological exhibit of any kind, anywhere.*

A succession of visitors enter the museum with happiness on their faces. When was the last time you saw that in a technological museum?

simultaneously the best example of both a technological museum and a 'dramatic reveal' that I have ever seen, anywhere (**photo 131**). Yes, I know it's a long way for most of our readership, but I cannot recommend it highly enough to model engineers everywhere and regardless of their interests. It really is staggeringly good, and a credit to the un-named curators, designers, engineers and artists who thought it all up and put it together so well. In my eyes at least, they've created a whole new paradigm for what a technological museum can, and arguably should, be in the twenty-first century.

Compare and contrast

It's interesting, isn't it? In this final *Wonders of Technology* episode I have summarised two identical technological artefacts, *Discovery* in Virginia and *Atlantis* in Florida, both displayed in museums and both inanimate.

In Virginia, *Discovery* sits on her wheels in a giant hanger surrounded by aerospace-centric but otherwise unrelated exhibits. Display boards cover the basics and tell some of her story but – and I hate to say this given my personal tie to this spacecraft – it's sadly all a bit dull. You see, there's nothing dynamic, dramatic, or engaging to bring her story to life for those who did not witness a launch, and there aren't any interesting mechanisms or details made accessible which can be pondered beyond her landing gear and heat shields. No, she's just one exhibit among many, and once you've looked at her for a short while you'll probably be ready to move on to the next. I am sure ≫

you could draw parallels with other closer-to-home museums without difficulty.

In stark contrast, *Atlantis*, dramatically introduced, magnificently displayed, and supported by a selection of relevant, well explained, well presented and superbly lit accoutrements all telling an exciting story – **photo 132**, for example - is an absolute triumph; it captures its visitor's interest from the start, puts a smile on their faces, and whets their appetite to learn more.

Furthermore, in Florida, *today's* technology, imaginatively harnessed to stimulate emotions for *yesterday's* technology, leads to real interest and enthusiasm. Admittedly, it doesn't *"…. stage a mission for every visitor that walks through the door…"*, to quote myself yet again, but with its dramatic introduction, its main exhibit in full orbital configuration and its passenger-seat simulation of an actual shuttle launch, it certainly delivers the drama and excitement of a mission nonetheless. At the risk of repeating myself and garnering accusations of gushing, museums really don't come better than this.

So why are these two museums so different? Well, I'll bet that money probably has a lot to do with it for, unlike the Smithsonian Museums – of which the Udvar-Hazy is one - the Kennedy Space Centre's Visitor Complex - which encompasses both the *Apollo* and *Atlantis* Museums and several others on site - is largely independent of the government and charges a fee for admission. Indeed, with a hundred million dollars reportedly spent on its construction in 2013, it seems reasonable to assume that the *Atlantis* Museum's superior offering is directly related to a superior budget; things tend to work like that.

A shuttle engine, up-close and personal.

Of course, this certainly begs another question for, if the purpose of a museum is to preserve, present, educate and engage the public about its contents and subject, and if direct comparison between a government-funded technological museum and a for-profit counterpart demonstrates such a yawning gap in achieving that goal, then is the price of government ownership and free admission simply too high for a technological museum? I know I've said something similar in these pages before, but I think it's a question worth repeating, and it only took me a few thousand words and two space shuttles to explain why.

For want of a magic wand

"Okay, smarty pants", I hear you cry, "so what can be done about it?"

Well, that's a fair question and, since I have not yet been elected Supreme Ruler of the World, I suppose we'll have to think of some options which don't rely on a global dictatorship model, however benign it may be. It's a shame, but there we are.

Furthermore, I'm not in the museum business and have only my own inexpert observations on which to base a few thoughts and I plainly don't know the constraints and pressures against which each museum strives although I'm sure they abound and that many are unique. However, let's put all that aside for a moment and try some idealistic blue-sky thinking.

Step 1: I'd pick the key decision-makers behind each nationally-significant technological museum – people who really care about their museum's subject and its success – and put them on a plane to Florida. Once there, I'd hand them each a ticket to the Kennedy Space Centre Visitor Complex and tell them to have a good look around and note their first impressions.

Step 2: The following day, I'd tell them to go around again and focus on some details, for there are plenty on show and, besides, I thoughtfully provided two-day passes and dislike waste in all its forms.

Step 3: With their heads and notebooks now filled with excellent examples of how today's technology, coupled with imagination, artistic design and a selection of accurate models and effective simulations can stimulate both interest and excitement in *yesterday's* technology, I'd sit them down with the folks that designed and created the *Apollo* and *Atlantis* museum's displays and encourage them to imagine what might be accomplished at their own institutions given a similar level of investment and creativity.

Step 4: Next, I'd lock them in a room with the business folks who took over Kennedy's Visitor Complex from the US government in 1995 and successfully turned a typically humdrum museum into the hugely successful jewel that it is today.

Step 5: And finally, I'd whisper in the government's ear that, while they mustn't *sell* the publicly owned treasures in the national collection, they could perhaps *rent* them to a suitably go-ahead for-profit museum, subject to appropriate conditions and safeguards, and thereby receive income from the artefacts without the administrative burden of running the institution in which they are housed.

And, while I'm certainly over-simplifying things, the surest proof that something *can* be done is that it *has* been done, and Kennedy Space Centre's Visitor Complex provides this proof in spades.

Touchdown

When I began to write this *Wonders of Technology* segment of *Butterside Down,* it was to be a one-part standalone episode, essentially a stopgap while I awaited our building inspector's interim approval of my ongoing basement construction project. Now at its end, with only the final titivating remaining, I confess that more than a week has passed since our inspector's visit and, while I have installed the basement's ceilings in the meantime, *The Wonders of Technology* has also expanded further and covered more ground along the way.

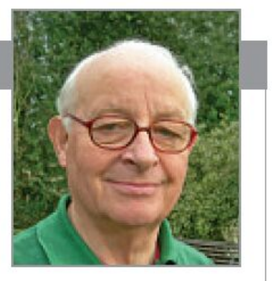
In retrospect, I realise that this extended version may not be everyone's ideal cup of tea – it is perhaps more heavily weighted towards historic American space hardware than model engineering – but despite this, I hope that you enjoyed some of its content.

Furthermore, in my defence and to wrap this series up with a neat little ribbon, I strongly believe that this subject is important and that a direct connection exists between a nation's future prosperity, the quality of its technological museums and a miniature steam engine pulling a trainload of children around a public park, for example. And should you think that a little far-fetched, then consider this: if youngsters do not become interested in technological mechanisms, then they won't become engineers, certainly not *good* engineers, and without good engineers a nation cannot successfully create. And an uncreative nation is at best a service nation, and, in the author's view, service-heavy economies are generally not conducive to either sustainable growth or long-term prosperity. So, while we model engineers can (and should) do our bit to educate and entertain our younger visitors about the wonders of our technology, in the grandest scheme we are but a drop in the ocean. No, national technological museums can do far more and should be much better at inspiring our youngsters *en masse*, and if investment is the barrier to making that happen then Kennedy Space Centre's Visitor Complex shows that this is a problem with a proven solution.

I've seen it with my own eyes, and it really isn't rocket science.

●To be continued.

Myford Carriage Depth Stop



Roger Castle-Smith makes a simple carriage stop for his Myford Super 7 lathe.

Some time ago Les Phillips wrote an article on a lathe carriage depth stop (*A Simple But Effective Depth Stop*, M.E.4642, July 3rd 2020). This is for his Myford which appears to be a Super 7 with gearbox just like mine. I strongly agree with him that a depth stop is an indispensable accessory. I also made one many years ago so I offer this article as an alternative approach. In so doing I hasten to add that I am not critical of his approach, which does the job perfectly well.

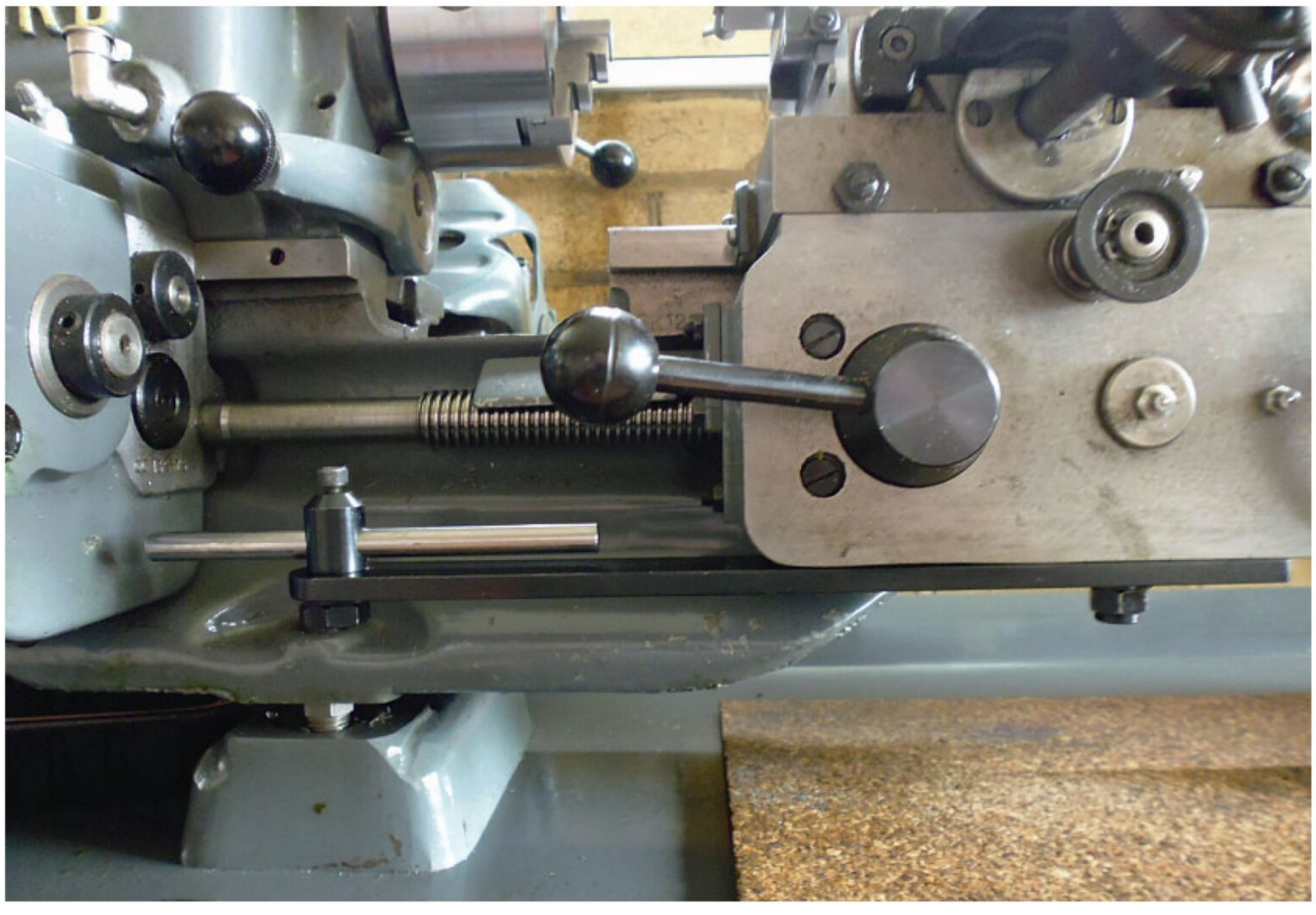
However before presenting my alternative there is one thing which puzzles me. Les uses two cap head bolts to secure his fitting to the lathe. My lathe bed, though, does not have two tapped holes, as can be seen in my photograph. Instead, it just has one tapped hole on the front of the bed, as can be seen just below the back gear lever knob. This contains what is named in the manual as 'A thrust screw'. It locates the headstock before the main holding bolts are tightened. I purchased my lathe new in 1982. So why the apparent between difference between our lathes? There is no mention in Les's article of him needing to drill two holes in the bed followed by tapping. This would have been very difficult to do especially with the gearbox *in situ*. I would be very interested if he would kindly comment on this point.

The photograph shows my stop which is so simple that it doesn't warrant a drawing. The horizontal bar is ¼ x 1 × 10 inch mild steel strip. The stop rod is ¼ inch silver steel which runs through a $^{5}/_{16}$ inch diameter pillar. Les's rods have a flat to prevent the locking screw damaging their running surfaces. This is good but my alternative to avoid having to produce flats on longer rods is to insert a short acetal (Delrin) pad between the rod and the end of the screw. This produces more than adequate friction.

Finally, the mounting. There is a vertical hole in the apron just below the oil nipple which can be seen at the right-hand end of the photograph. This contains a ¼ inch BSF screw which secures a gear cluster stud in place. As good fortune would have it, the distance between the end of the screw and the bottom of the apron is about ¾ inch. And the diameter of the hole is just right to take a 5/16 inch BSF thread! With care I managed to tap the hole using a collar pressed against the underside of the apron to ensure that a taper tap started straight.

Just two points of refinement. The screw fixing the strip has a few threads turned off its end. This makes starting the screw easy. Then I like to black all the parts which I make for my lathe.

If a Super 7 owner has a lathe without a gearbox then it would be easy to make up a bracket for the rod to butt against. The gearbox mounting holes could be used to secure this.



ME

Kinematics PART 5

Rhys Owen presents a readers' guide to the laws of motion.

Continued from p.629
M.E.4755 November 1

Calculus can be used to derive formulae for various engineering phenomena. Earlier we mentioned the equations of rotational motion, observing that whereas in linear motion the mass of an object is a measure of its inertia, or capacity to resist linear acceleration, for rotational motion the moment of inertia is used, being a measure of a body's capacity to resist rotational acceleration.

The moment of inertia depends on which axis of a body is assessed – it takes little torque to twist a drum-major's baton around its longitudinal axis but much greater torque to twist it at around its middle. In the latter case most of the mass of the baton is further away from the axis of rotation and is thus able to exert more leverage.

The moment of inertia *I* of a point particle of mass *m* rotating at distance *r* around a pivot is given by the following formula:

$I = mr^2$

Clearly, the larger the radius *r* the greater the moment of inertia of the particle. This is why a traction engine flywheel is constructed with most of the metal close to its perimeter.

If we had a system made up of a number *n* of point particles, each of mass m_i and distance r_i from the pivot then the total moment of inertia of the system would be the sum of the individual moments of inertia. Thus:

$$I_{system} = \sum_{i=1}^{i=n} m_i r_i^2$$

But we recollect that the sign ∫ was used by Liebnitz to represent a sum and we shall now show how the formula of the moment of inertia of a disc can be derived by integration.

First, we can see from the above formula that the moment of inertia of a particle is proportional to the square of its distance from the pivot.

But we should also bear in mind that the number of particles in each 'ring segment' of a disk is proportional to the distance of that ring from the centre of the disk (which, of course, is also the pivot point). We are looking at the overall moment of inertia of all the particles in that segment.

So, we find that the moment of inertia of a ring segment will be proportional to the cube of the distance between the pivot and the ring (**fig 16**).

Assuming that the disk is *b* metres thick, the increase in the moment of inertia caused by the increase in radius from *r* to *r + δr* is given by the following expression (a more exact expression for the area of the red circle could be derived but this would complicate matters and it is unnecessary):

$$\delta I \approx 2\pi r b \rho \delta r \times r^2$$

Remember that *δI* means a small increase in *I* and *δr* means a small increase in *r*!

Gathering the terms together we get:

$$\delta I \approx 2\pi r^3 b \rho \delta r$$

Dividing throughout by *δr* we get:

$$\frac{\delta I}{\delta r} \approx 2\pi r^3 b \rho$$

We can now say:

As δr tends to zero,

$$\frac{\delta I}{\delta r} \approx 2\pi r^3 b\rho \text{ tends to } \frac{dI}{dr}$$

$$= 2\pi r^3 b\rho$$

So, with a bit of rearrangement of the order, at the limit we get:

$$\frac{dI}{dr} = 2\pi b \rho r^3$$

In case you are getting a bit 'symbol-happy', the above equation says that the rate of increase of the moment of inertia with respect to the radius of the ring is equal to 2 times π times the thickness of the disk times its density times the radius cubed. This is a bit of a mouthful – which is why symbols are so useful!

If we now want to get an expression for *I*, the moment of inertia, we integrate the above expression with respect to the radius *r*. In other words, we 'anti-differentiate' by reversing the differentiation rule and adding a constant. Thus:

$$I = \int \frac{dI}{dr} dr$$

$$= \int 2\pi b \rho r^3 dr$$

$$= 2\pi b \rho \int r^3 \, dr$$

The *2πbρ* values go in front of the ∫ sign because these terms are constant and do not vary as the radius increases.

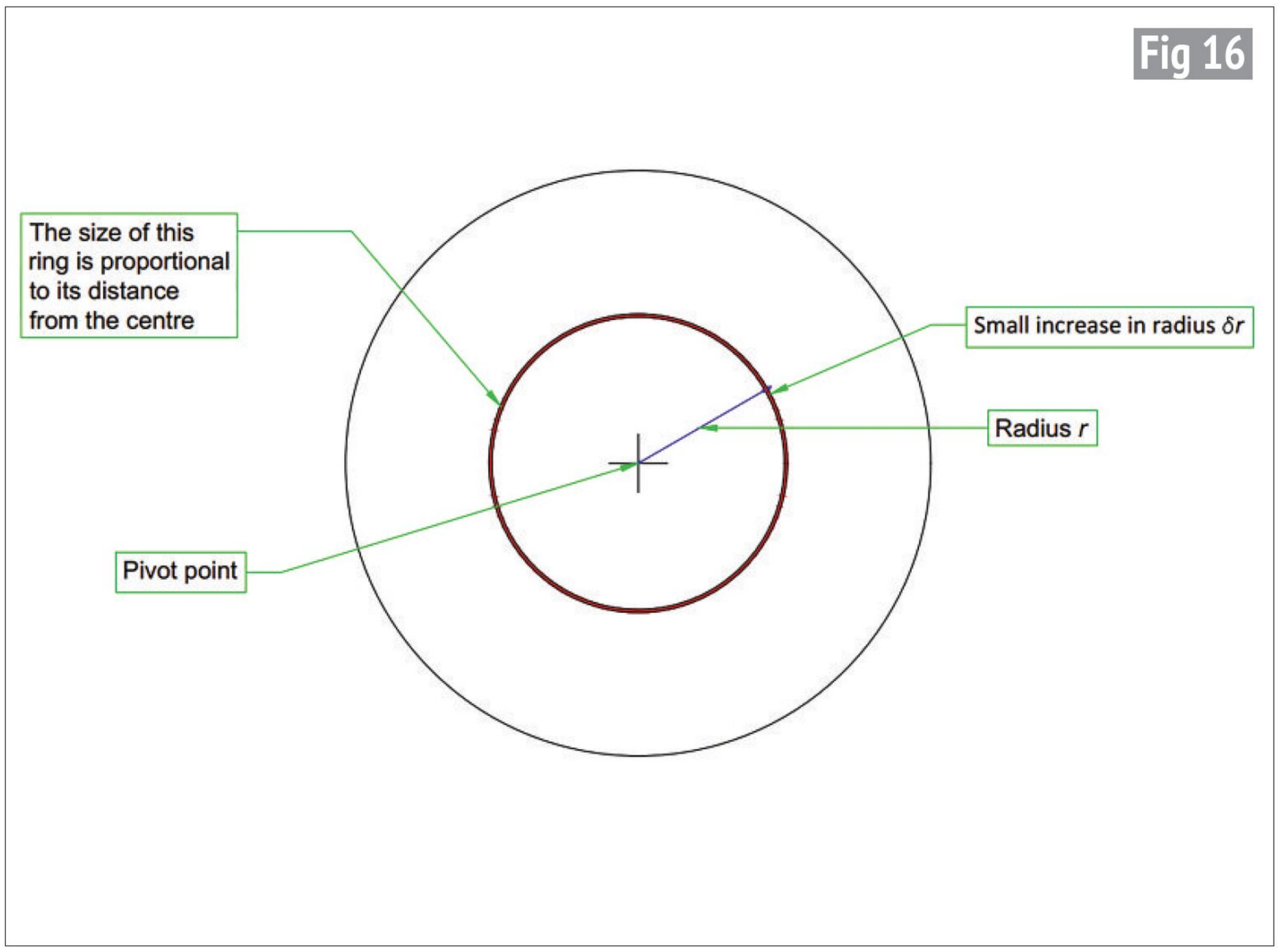
We now remember the relevant differentiation rule which we established earlier:

$$\frac{d(x^n)}{dx} = nx^{(n-1)}$$

Changing x to r in the above rule gives:

$$\frac{d(r^n)}{dr} = nr^{(n-1)}$$

Dividing both sides by n gives:



Determining the moment of inertia of a disk.

$$\frac{1}{n}\frac{d(r^n)}{dr} = r^{(n-1)}$$

So, anti-differentiating:

$$\int r^{(n-1)}\,dr =$$

$$\frac{1}{n}r^n + CONSTANT$$

Or, by substituting n for n - 1:

$$\int r^n\,dr =$$

$$\frac{1}{n+1}r^{n+1} + CONSTANT$$

This is not true when n = -1 but this is not relevant to the current discussion.

If we now go back to the expression that we derived for *I* and integrate (i.e. anti-differentiate) we get the following:

$$I = 2\pi b\rho \int r^3\,dr$$

$$= 2\pi b\rho \frac{r^4}{4} + CONSTANT$$

$$= \pi b\rho \frac{r^4}{2} + CONSTANT$$

So, how do we use the above to find the moment of inertia of a disk of a definite radius *R* and thickness *b* about its own axis?

First, we evaluate the constant by looking at the situation where *r* = 0. Clearly the disk will have no mass so there will be no moment of inertia. We start with the expression just derived:

$$I = \pi b\rho \frac{r^4}{2} + CONSTANT$$

When r = 0 this becomes:

$$0 = \pi b\rho \frac{0^4}{2} + CONSTANT$$

Which is:

$$0 = 0 + CONSTANT$$

Hence:

$$CONSTANT = 0$$

So, we can remove the constant from our equation and set *r* = *R* where *R* is the radius of the whole disk:

$$I = \pi b\rho \frac{R^4}{2}$$

In fact, we could have expressed the integration expression above as follows:

$$I = 2\pi b\rho \int_0^R r^3\,dr$$

$$= \left[\pi b\rho \frac{r^4}{2}\right]_0^R$$

$$= \pi b\rho \frac{R^4}{2} - \pi b\rho \frac{0^4}{2}$$

$$= \pi b\rho \frac{R^4}{2}$$

But we can go a step further!

We know that the definition of density is:

$$\rho = \frac{M}{V}$$

Where ρ is density, *M* is mass and *V* is volume. From the above we get:

$$M = \rho V$$

We can see density ρ within our expression for *I* above – can we also find *V* in some way?

A disk is just a flat cylinder, and the volume of a cylinder can be derived as follows:

$$Volume = C/S\ area \times length$$

For our disk the cross-sectional area is given by πR^2 while the height of the cylinder is in fact the breadth of the disk so that:

$$V = \pi R^2 b$$

So that the mass *M* is given by:

$$M = \rho\pi R^2 b$$

Now we look again at our expression for *I* and split it up:

$$I = \pi b\rho \frac{R^4}{2}$$

$$= (\rho\pi R^2 b)\frac{R^2}{2}$$

$$= M\frac{R^2}{2}$$

So, using the integral calculus, we have derived the following expression for the moment of inertia *I* of a disk of constant breadth:

$$I = M\frac{R^2}{2}$$

The above formula would be used by a designer when designing, say, a flywheel. If the design were constrained by mass, then one would get four times the moment of inertia for a given mass by squashing the flywheel so that its radius was doubled. Alternatively, by doubling the radius of the flywheel one could reduce the overall mass of the flywheel by four and still get the same moment of inertia.

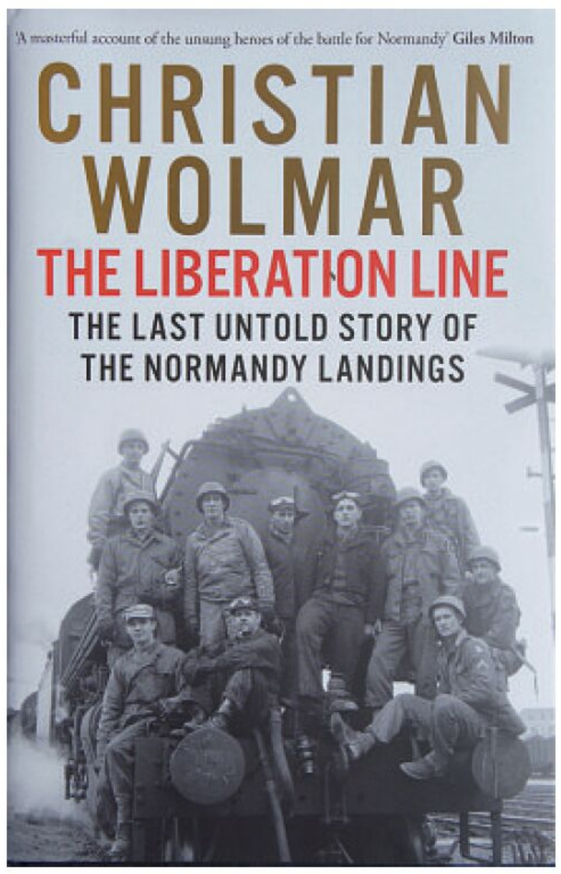
I hope that you have enjoyed this look at the use of mathematics in engineering!

ME

Book Review

The Liberation Line: the last untold story of the Normandy landings

Christian Wolmar



Published by Atlantic, 2024
ISBN 978-1-83895-752-0
368pp, hardback, £25

Given the number of books about the Normandy invasion it is surprising the role of railways has been particularly neglected, notably those rebuilt in France soon after D-Day. That neglect is remedied in this welcome book.

Early invasion planning recognised railways would need reconstructing soon after the invasion. Engineers showed ingenuity, for instance by adapting tank landing craft for railway stock and laying tracks directly on beaches, shown in an impressive photograph. The first train ran just thirty days after D-Day.

The book's main focus is on the United States Third Army, commanded by George C. Patton, a general who liked to keep his army moving fast. That emphasised logistics with Patton demanding rail transport keep up with his troops. Incredibly, railway engineers managed what he asked for, despite damage previously caused by the German retreat, Allied bombing and sabotage by the French Resistance. Apart from hazards of working under fire or encountering booby trapped equipment, operating trains on hastily reconstructed tracks in blackout conditions crews caused its own dangers.

Many American engineers were from US Railroads - both the Louisville & Nashville and Chesapeake & Ohio Railroads sponsored repair and operating companies. Their secondees were classed as military personnel but usually received little army training. They managed incredible repair feats, for example bringing a poor quality secondary route of 143 miles into use in just 3 days. Unfortunately the largely black workforce was shoddily treated by a US Army segregated until 1948.

Although the breakout from the Normandy lodgement was slower than anticipated, engineers continued these feats well beyond, supporting advancing armies to the Paris region and on into Lorraine where tracks were less badly damaged. After the capture of Paris the only delays occurred due to logistical problems. Armies simply outran their supplies but in later stages of the campaign showed remarkably rapid progress.

Ironically the more limited use of motor trucks, including the celebrated Red Ball Express using nearly 6000 vehicles, received far more attention than the greater role of railways. Even during the German Ardennes offensive rail transported supplies were critical to holding off the Nazi advance. Thankfully the author has put the record straight.

Criticisms? More about UK rail operations before D-Day would have been interesting. For example US boxcars were assembled at the future Hainault Central Line depot. How were supply trains to ports managed? An Austerity locomotive with an exploded boiler is blamed on poor construction, but some US built 2-8-0 locomotives had gauge glasses that were notoriously difficult to read causing fireman errors and boiler failures.

There could have been more detail about engineering techniques involved in, say, bridging a river using a Bailey Bridge. British engineers trained using Bassett-Lowke made models as well as at a training school near Ripon. Perhaps dealing with these and other issues would have made a very long book.

The story of British railway battalions is underplayed though an appendix lists the names of some constructors who died in service. However they are credited as the best at building temporary railway bridges - their Bailey Bridge was a versatile creation. British teams constructed over four miles of bridges - 122 in total. To show the work involved they built five miles of new line to the new Spyck bridge. That had 34 spans yet it was completed in a month.

Despite these minor criticisms Christian Wolmar always writes a good story and this is a well researched and lively account of a lesser known Second World War military success. It is impossible to read this book without a sense of awe at what was achieved in hazardous conditions.

More seriously, veterans of that conflict are now, at least, well into their 90's and yet as they pass on Europe is at increasing risk of war, accidentally or deliberately started. Modern armies do not fully appreciate the role of railways and, as the author points out, have run down their railway units. Yet the Ukraine war shows important use of trains to move both equipment and people. A lack of suitable wagons for tank transport hampered a recent NATO exercise. Hopefully this book will be read with contemporary needs in mind as much as for its value as a historic record.

Roger Backhouse

Note

Christian Wolmar is willing to give talks to model engineering societies about *The Liberation Line*. Contact Christian Wolmar on christian.wolmar@gmail.com.

The MGWR Works' Last Loco

An 80-plus year story

Callum Christie completes his great-grandfather's locomotive project.

This story begins, 80 plus years ago in Dublin, Ireland.

Hello there, my name's Callum Christie and this wonderful story is about my late great grandfather James Christie who was a foreman in the blacksmith shop and the boilersmith shop in the Midland Great Western Railway (MGWR) works, Broadstone, Dublin, Ireland from roughly the 1930s until 1957, having served his apprenticeship in the MGWR from 1907 to 1912.

One day in the year 1939/1940 my great-grandfather, now a foreman in the blacksmith and boilersmith shop, started building a 3½ inch gauge 0-6-0 miniature steam locomotive in the MGWR railway works. My great-grandfather continued to build this steam locomotive in the railway works throughout the 1940s and 1950s. After many years my great-grandfather had the locomotive built up to about 99% but unfortunately in 1957 he retired from the MGWR works, aged 65.

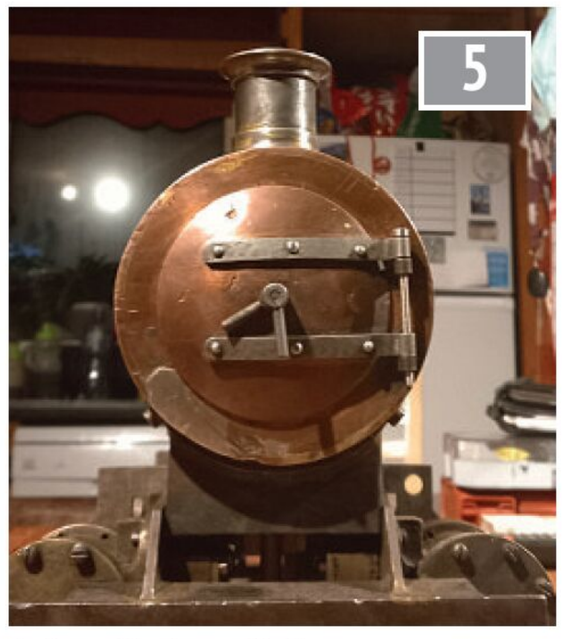
A few months after he retired he was contacted by a company called Hubbard Brothers, who were an engineering company in Ardee Street, Dublin. They said they were looking for someone to start up a blacksmith and engineering shop in their works and they had been told by former colleagues of my great-grandfather that he was exactly the man they needed to build their shop up from scratch.

My great-grandfather built the majority of the tools for the workshops by hand but during his time working for Hubbard's my great-grandfather had to stop working on the miniature steam locomotive as he wasn't allowed to be caught working on his projects during his work hours. So he had to put the locomotive on the back burner and from 1957 until june 1969 my great-grandfather didn't get to work on the engine very much – only on a Sunday as he was in work from monday until a half day Saturday. He'd be too tired to go out to his workshop after he came home on a Saturday so didn't get anything done. When he did a chance to work on the locomotive he couldn't do much as his workshop at home only had hand tools to use as he couldn't afford power machines. So when he did work on the locomotive it was slow work given that he had no power machinery. Unfortunately he never got the steam locomotive finished although he got it 99% complete.

Sadly, on the 20th June 1969 my great-grandfather James Christie died aged 77 and ≫

A collage I made of my great grandfather and a picture of me driving his engine at our local minature railway in May 2024.

My great grandfather's locomotive, recently completed, at a minature railway in Llandudno North Wales in July 2024.



A picture of the locomotive when I inherited it from my Great-Aunt Margaret, his daughter, on July 8th 2023 after it had been sitting in her attic from 1969.

from 1969 until July 2023 this 80-plus year old 3½ inch gauge miniature steam locomotive sat in my great-aunt Margaret's attic in Palmerstown, Dublin.

From the 1970s until 2023 my father Finin always loved the locomotives his grandfather James built. My dad was 5 when his grandad died so my dad remembers him and from the 70s until 2023 my dad tried many times to get the locomotive from my Auntie Margaret but she would never give it to him for some reason. In May 2023 though I invited my Great-Auntie Margaret and Uncle Charlie to our house to show them all the parts of her father's engines which my dad had kept safe and brought to every house he moved to since taking them from his house in Palmerstown when he moved out in 1991. I asked her if she could look for the lost engine of her father's and she told me "Oh Callum, how many times have I told you - that engine got robbed from my house years ago". So i went off upset as I've dreamed my whole life of getting my great grandfather's engine and I thought now it was gone. So while i went outside upset Auntie Margaret was talking to my dad asking him where I went and my dad explained how she upset me and that the locomotive was all I've ever dreamed of and now she said it is probably gone that it broke me. Auntie Margaret was upset and as she left she told my dad that she and Uncle Charlie would look for it. From May until July I heard nothing - I thought they had fobbed me off - until on the 8th of July I called in with my dad to Auntie Margaret and Uncle Charlie's house. I walked in and my Auntie Margaret said "Callum, can you please pick up the bags of old rubbish I left on the stairs and bring them down" so I went up and lifted up the first bag but before i could pick it up a smokebox fell out of the bag. I looked in the second bag and a steam locomotive chassis was in it - straightaway i knew it was my great-grandfather James's lost steam locomotive and from the 8th of July 2023 my dad and I took on the project of completing the loco. We got a lot done and in November/December 2023 I got put in touch with our now great friend Keith Wood. Keith kindly agreed to take on the challenge of getting the old 80-plus year old relic on the rails for the first time and that he did. So on the 18th of February 2024 Keith took my great-grandfather's locomotive to his workshop and started work. Keith had to renew solder on the copper boiler and put in firebox stays and he had to fix the timing on the chassis of the locomotive.

On the 16th of March 2024 we went up from County Wexford to our model engineering club Drumawhey Junction Miniature Railway in Donaghdee, County Down, Northern Ireland. So, for the first time ever, after 80-plus years since my great-grandfather James started building this loco in 1939/1940 it finally had a fire in its firebox and off Keith went, on what would be my great-grandfather James's locomotive's first run ever.

From that moment on my dad and I have been enjoying driving my great-grandfather James's locomotive at Drumawhey Junction Miniature Railway and we've run the locomotive over in the UK at two miniature railways. The first was at Wrexham model engineers and the second was West Shore Miniature Railway in Llandudno, North Wales. We hope to run at many more miniature railways in the UK and we're really enjoying celebrating such a great man and a great grandfather and I hope to celebrate him even more by entering his locomotive into the miniature steam locomotive IMLEC competition in the UK next year in June at the Fareham Miniature Railway. My dad and I will be traveling over to the UK from Ireland to enter the event. I will be driving my great-grandfather's locomotive and I'm not worried if I don't win - I'm just happy to be entering the competition and honouring my late great-grandfather James Christie and his miniature steam locomotives.

I hope everyone enjoys reading this and best wishes from the great grandson of the late James Christie.

Good luck, Callum, at IMLEC and I shall look forward to meeting you – Ed.

ME

The 16th of March 2024 - the day we got the locomotive finished and it passed its steam test and it ran for the first time since he started building it in 1939. A big thank-you to our best friend Keith Wood who was instrumental in getting my great-grandfather's engine finished and helped my father and me get the engine over the finish line and up and running.

POSTBAG

Views and opinions expressed in letters published in *Postbag* should not be assumed to be in accordance with those of the Editor, other contributors, or Mortons Media Group Ltd. Correspondence for Postbag should be sent to:

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Public Running

Dear Martin,

Oh dear, what a curmudgeonly letter from Malcolm Sadler (M.E.4753 October 4th) on how clubs operate! He has a point, in there somewhere, but I fear misses others.

His letter is ironically in the same edition that describes a society with a very fine miniature railway indeed, all paid for entirely by its members as its local council will not allow public running. We are not told why but the 'discreet' location suggests limited road access.

My own society has a decent length of track allowing multiple laps, but a much simpler, less sophisticated layout and a compact but cosy club-room. We also cannot normally operate publicly by being within the grounds of a school, which naturally restricts access times for us, and indeed for the sports clubs who use the school's pitches. We operate a portable track a few times a year purely as a money-earner, but most of the society's activities are as Mr. Sadler would prefer – just for our own fun.

Income apart, he misses the fact many clubs have big, well-appointed railways because their members obviously want better than just a plain oval.

It is wrong to think that public running is all such clubs exist to do – of course they have their own social side too, some with capacious club-rooms, and a few even have well-appointed workshops for members' use.

I think Mr. Sadler may be right that public running could become a burden, though.

Financially, I fear an 'arms-race' between hard-pressed clubs trying to protect their future, and insurers trying to bankrupt their own employers - their customers - though claims by public visitors *are* made – and not all are bogus, either. It is no use running for club funds if the insurance to do so negates the income.

I greatly admire Erewash for having built such splendid facilities by its own efforts and subscriptions. Outside of model engineering, I belong to a major club which funded large-scale facilities improvements by interest-free, voluntary loans of £100+ from members, repayable over a few years. We found many members did not miss the money when it matured and treated it as a donation.

Secondly, 'having' to operate publicly, regularly for whatever reason, may risk this falling to a dwindling few members, if others lose interest in providing more for the public than themselves. Besides, we all have lives outside of the hobby.

On the other hand, public running might inspire a very few newcomers – though off-hand I cannot recall this. It attracted one or two established model engineers who did not know of the club's existence, perhaps, but few if any real newcomers. Also, and not only in model engineering, some people join a club, are enthusiastic for a few years then just… 'disappear'.

Broadly, Malcolm Sadler says public running is against the ethos of a club as a CLUB (his capitals). Why? It may not appeal to all members but for others both the operating, private and public, and all that railway building are very much part of their own club's social bond.

Nigel Graham
(Weymouth)

Dear Martin,

I am surprised and sorry that my article about publicity for model engineering societies should have incensed Malcolm Sadler (Postbag, M.E.4753, October 4th). My intention was to suggest ways in which societies could publicise themselves better and while attracting passengers to track running was part of the story it was certainly not the whole.

There must be many potential model engineers who could be persuaded to join a society for the type of model engineering that Malcolm rightly loves. That's one reason why I featured SMEE, a society which has no permanent track.

While some SMEE members enjoy making and running model locomotives that is far from their reason for existence as their website and journal will confirm. In my experience most societies include a mix of interests and I hope that continues.

York's society created more tracks over many years to satisfy demand from members who enjoy running trains. And why not? While fare paying passenger's money is welcome more income was certainly not the reason for building tracks and I doubt if it is for most others.

I remain surprised by the number of societies who appear to do nothing to publicise themselves even by something as basic as sending newsletters to Geoff Theasby. That is likely to lead to stagnation and even decline in our numbers.

May I reassure Malcolm Sadler that I am not a train operator either - though I still aspire to such one day - and remain interested in many aspects of this great hobby. Model engineers need to think about and try a variety of methods to attract *and retain* newcomers.

Yours sincerely,

Roger Backhouse
(York)

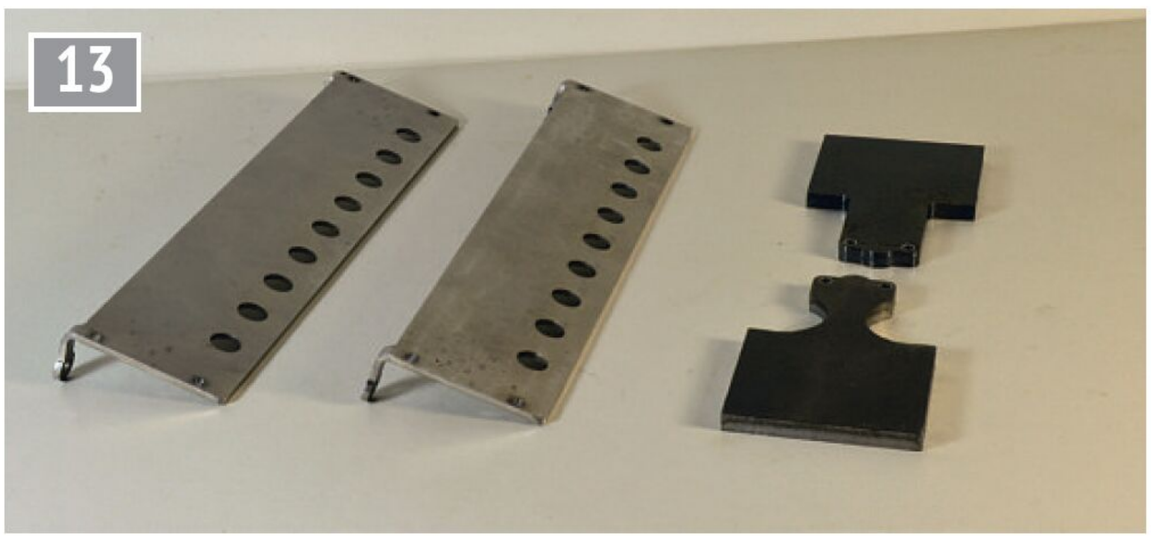
Another Steam Plant PART 2

Ian Beilby builds another steam plant, this time with an electrically 'fired' boiler.

Continued from p.658
M.E.4755 November 1

In the first part of this article on the assembly of a small steam plant driven by an electrically fired steam boiler I discussed my reasons for making the plant and looked at the assembly of the engine. We are now going to look at the boiler and some other accessories I intend incorporating on the plant. The boiler I chose to use is sold by Chiltern Model Steam and is fueled by an internal heating element and sold as a kit of parts.

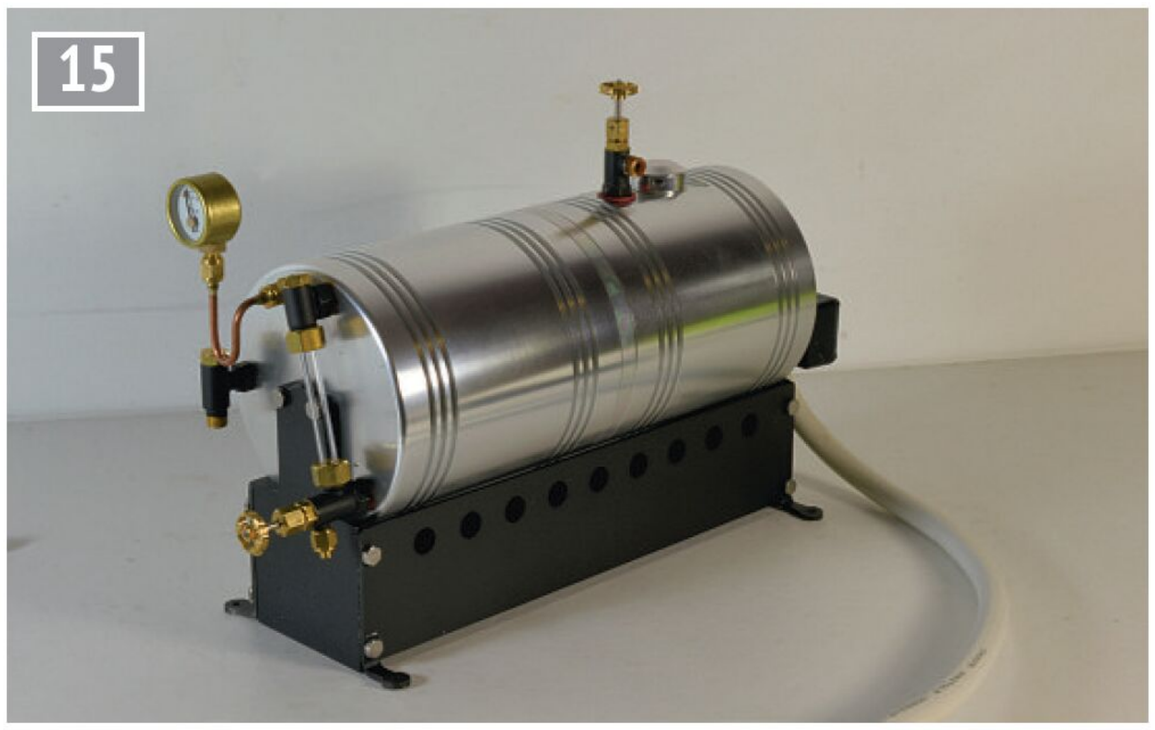
The 3 inch boiler is made from aluminum alloy and has a working pressure of 20psi. The boiler has to be taken apart and, though straightforward, the wiring and installation of the heating element completed by an electrically competent person before the boiler can be used. It is the customer's responsibility to provide the mains lead and make sure that all the electrical connections are made watertight, securely and correctly. The boiler must be earthed and a working RCD circuit-breaker must always be used in the electrical circuit that powers the boiler. I would strongly suggest that a professional electrician be engaged or consulted to do the wiring and that the boiler be PAT tested before connecting to mains electricity.



The boiler supports.

One of the main benefits of using an electric boiler is the longer running times available. You are not likely to run out of heating fuel/gas as is often the case with other means of firing a model steam boiler. However, an automatic trip is not fitted to the boiler, so you must ensure that the water level does not drop below one third of the water capacity and ensure there is sufficient water covering the heating

The boiler shell and heating element.



The assembled boiler.

The boiler voltage control unit.

The water tank.

The condenser.

element. If you intend running the boiler for a long period of time an ancillary water tank and feed pump are well worth considering.

The basic boiler kit is comprised of the boiler, safety valve, steel support sides and ends, steam outlet valve, brass water fill plug and an electric heating element. The boiler comes with a test certificate and has been tested to two times the working pressure, i.e. 40psi.

Other optional items are a 220V AC voltage regulator, steam pressure gauge and water level gauge with a boiler draw down valve.

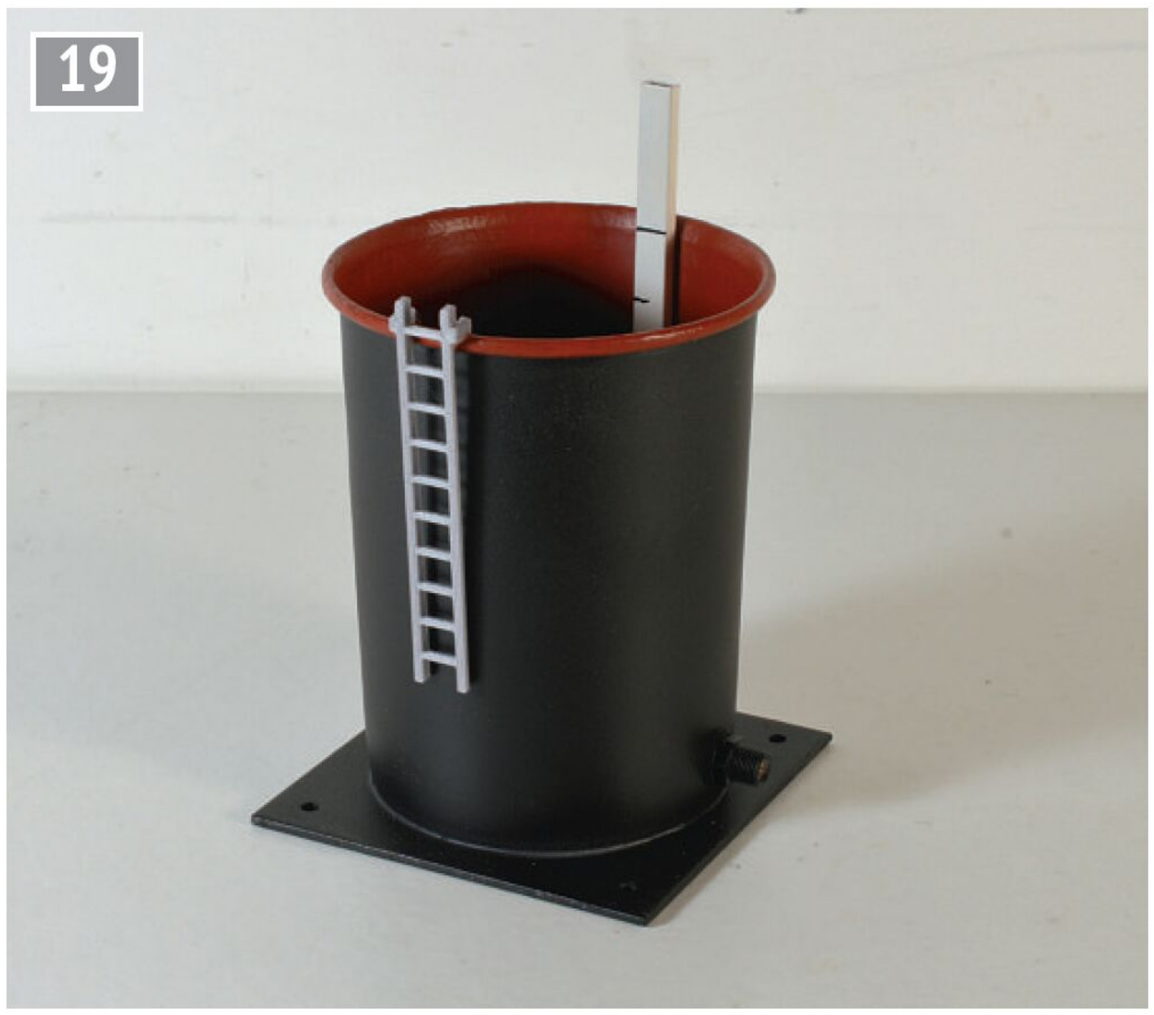
As my steam plant was to include an ancillary water tank, I specified a boiler with a clack valve, steam pressure gauge, water level gauge and 220V voltage regulator. I personally consider a steam pressure gauge and water level gauge to be essential items on any form of steam boiler.

If the optional pressure and water level gauges are ordered along with the boiler, they are supplied ready to fit or already fitted to the boiler respectively.

Photos 13 and 14 show the dismantled boiler support sides and ends and the boiler kit before the heating element is fitted. In **photo 15** you can see the finished boiler I purchased now completed with the optional extras and wiring in place.

In order to control the heat output of the boiler heating element, a voltage control unit shown in **photo 16** is used.

The boiler's water capacity is 450ml but the boiler should only be filled with 400ml of distilled water in order for there to be a space above the water and allow steam to be raised. The water is initially heated at full power until the water has boiled and the factory fitted preset safety valve starts to release at 20psi. It is important to check at this initial stage that the valve does release pressure as expected. This is the working pressure of the boiler and this should not be altered or increased. Once steam has been raised, the voltage controller can then be turned down, depending on how much steam is required to drive the engine. The boiler must not be used if the water level drops below approximately one third, i.e.150ml of water, otherwise the boiler will be damaged.

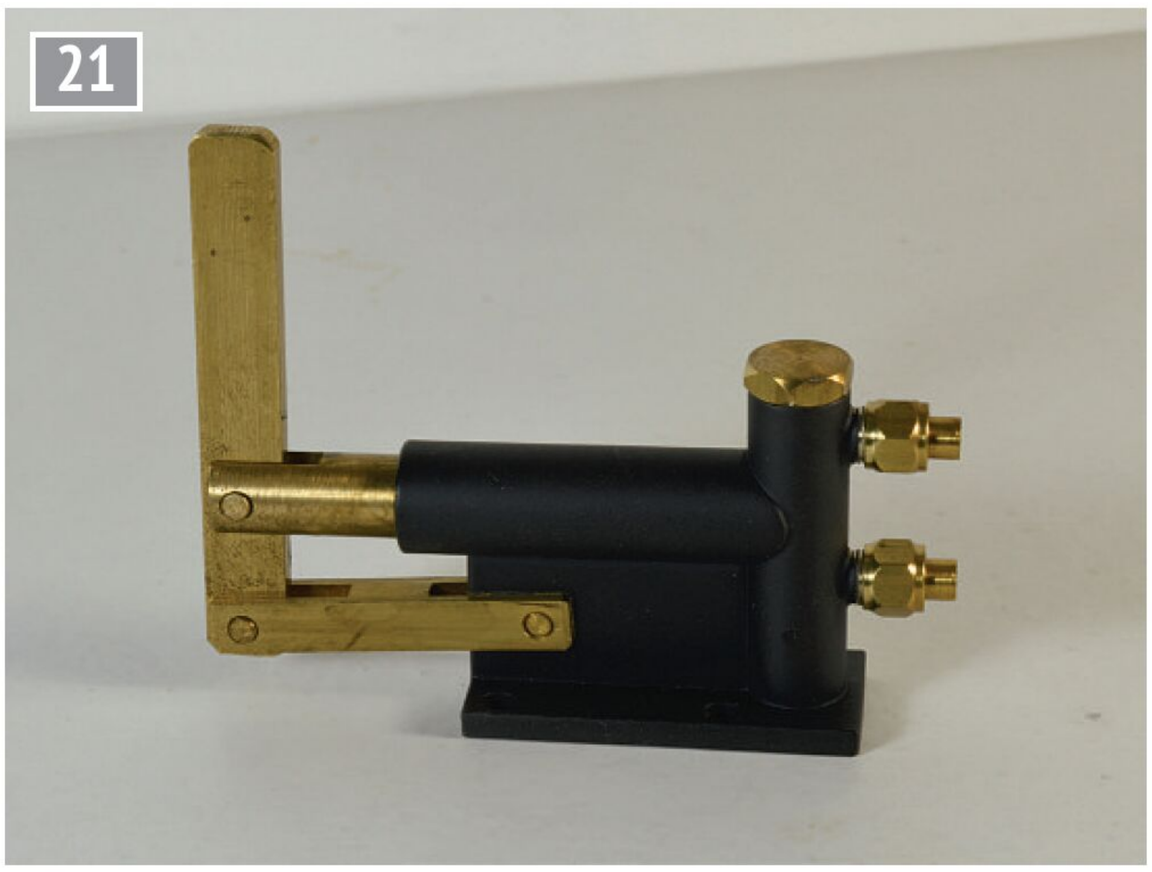


Water tank with accoutrements.

Elegantly dressed condenser.

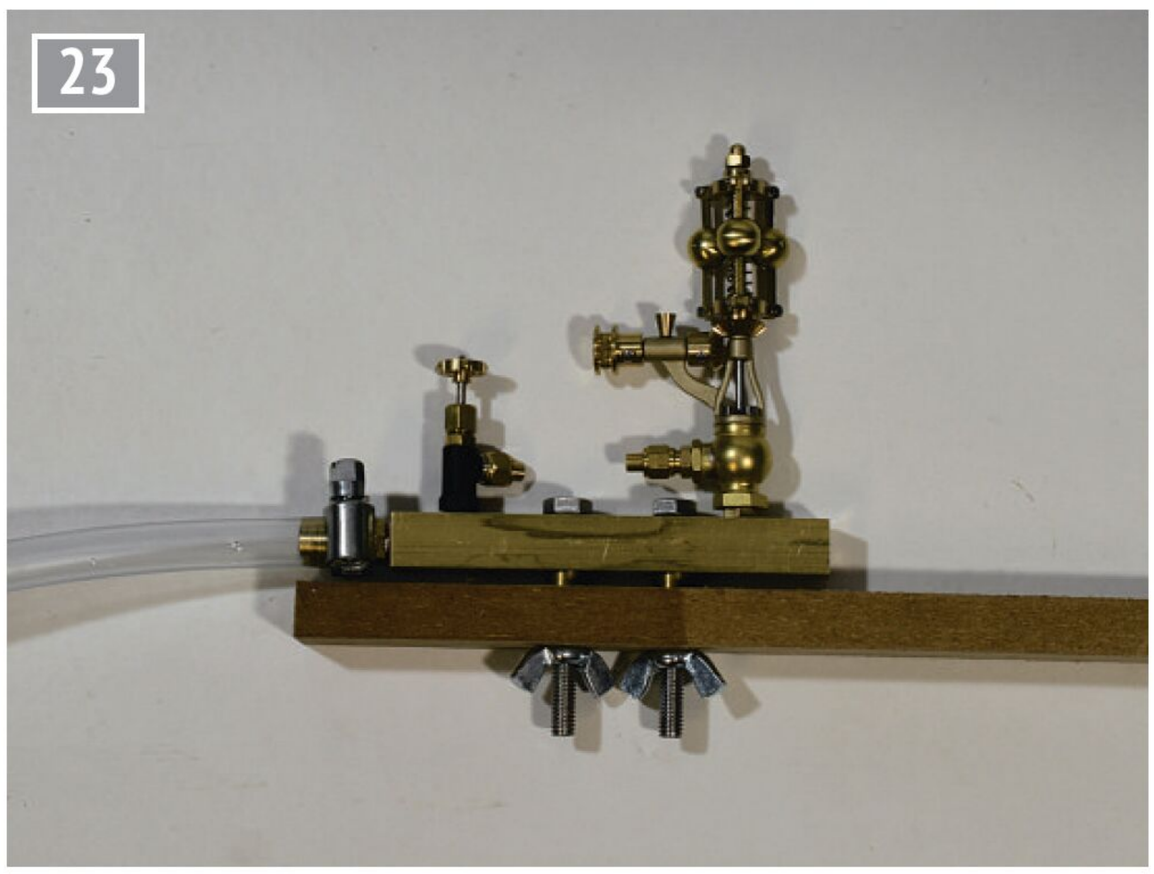
The water tank and condenser, also sold by Chiltern Model Steam, that I am using are shown in **photos 17 to 20.**

I want to make the steam plant look interesting and as can be seen I have painted the water tank and planked the condenser to add interest. They can of course be left unpainted if so wished but the measuring rule in the tank is most useful in operation. When topping up the boiler with the hand pump ≫

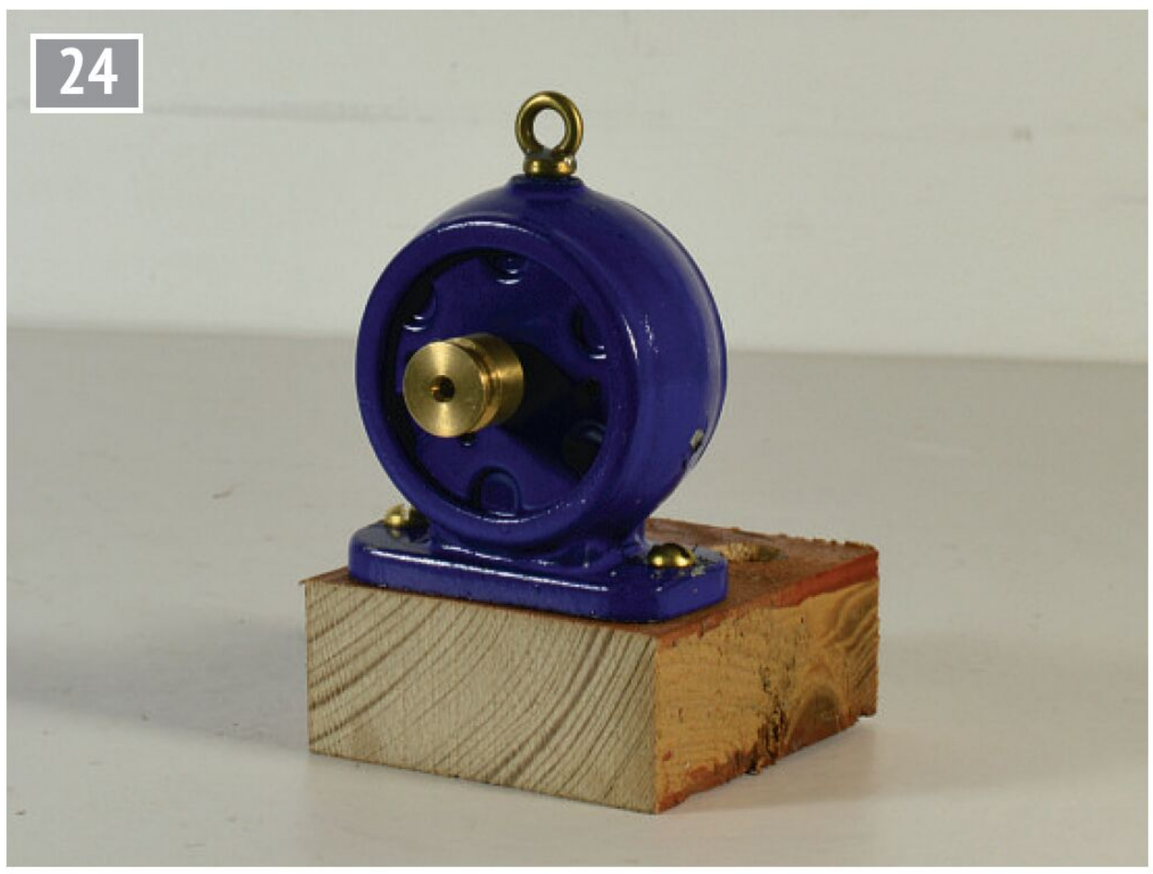


Water hand pump.

Making a start on the steam turret.



The finished turret complete with governor.



Electricity in, electricity out – the dynamo.

shown in **photo 21,** you can clearly see the water level in the tank dropping and visually register how much water is being used by the boiler.

The condenser doubles as a steam exhaust chimney and condenser and is most useful in gathering and disposing of the oily exhaust steam. To empty the condenser, you simply place and hold a wet rag over the top of the chimney. The exhaust pressure of the engine forces the condensed water out of the tank and down the drainpipe. A word of warning…the condenser and chimney become very hot in use and heat resistant gloves should be worn as well as using a wet rag to block the chimney.

Quite often stationary steam engines were fitted with a speed governor. The most common type being the centrifugal governor which regulates the speed of the engine in response to changing load conditions. The governor is driven by a belt from the engine flywheel and controls the amount of steam that passes from the boiler to the engine. I have seen several of these miniature steam governors available on various Internet websites and decided that I would like to include one on this plant. A governor will make an interesting practical and visual attraction and another mechanical point of interest on the plant.

The governor is normally attached to the engine, adjacent to the steam input port, but given the design of this engine I had to come up with a different configuration for the governor and decided to mount it on a separate steam turret that could be placed between the engine and boiler.

The steam turret was made from a length of ½ inch square brass bar as shown in **photo 22**. The governor is shown mounted on the turret in **photo 23.** As can be seen, the steam turret is also useful in providing an entry point for a compressed air feed which can be very useful when testing or demonstrating the plant without firing the boiler.

With careful measurement it was possible to site the governor close to the engine flywheel, which I also wanted to use to drive a small 12 volt electric dynamo and light. The flywheel I am using is 2¾ inches in diameter and with two groves machined in the periphery of the wheel the engine should be capable of driving both accessories under light load. The small 12 volt dynamo is shown in **photo 24.**

In the next part of his article, I make a ‘dummy board’ and start the actual layout and assembly of the components as well as soldering and connecting the pipework.

To be continued.

NEXT TIME

In the next part of his article, I make a ‘dummy board’ and start the actual layout and assembly of the components as well as soldering and connecting the pipework.

A BR Standard Class 4 Tender Engine

PART 7

Doug Hewson describes
a 5 inch gauge version of the BR Standard 2-6-0 tender engine.

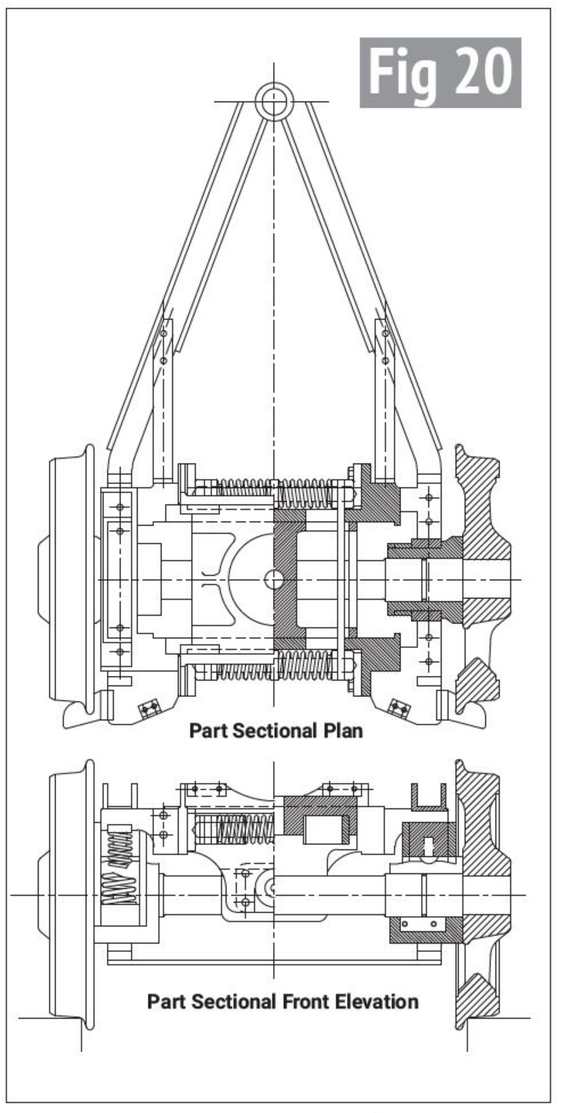
Continued from p.622
M.E.4755 November 1

I think we will get on with the pony truck now, before you lose interest (**figs 20** to **26**)! I have shown all the photographs I took whilst building my own 4MT and that truck is identical to the one on the 76. I have obviously illustrated all the drawings. All of the castings should be available from The Steam Workshop.

Beginning with the laser cut 'A' frame, we will first have a look at that. You may be able to buy one of those from the same place. There should be holes in it for the tie bars to the stays. Before you go too much further you will need to do a little 'brazing' (I use this expression to save writing silver soldering every time!) as there are a couple of pieces of 3/16 inch brass angle at each side. They need machining from ¼ inch angle. I used a pair of 0.54mm oil pipes each side which I used to sell in my shop, but failing that, use some 1/16 inch pipe. The pipes which I used work wonders as one little squirt from an oil can and the truck is oiled for the day.

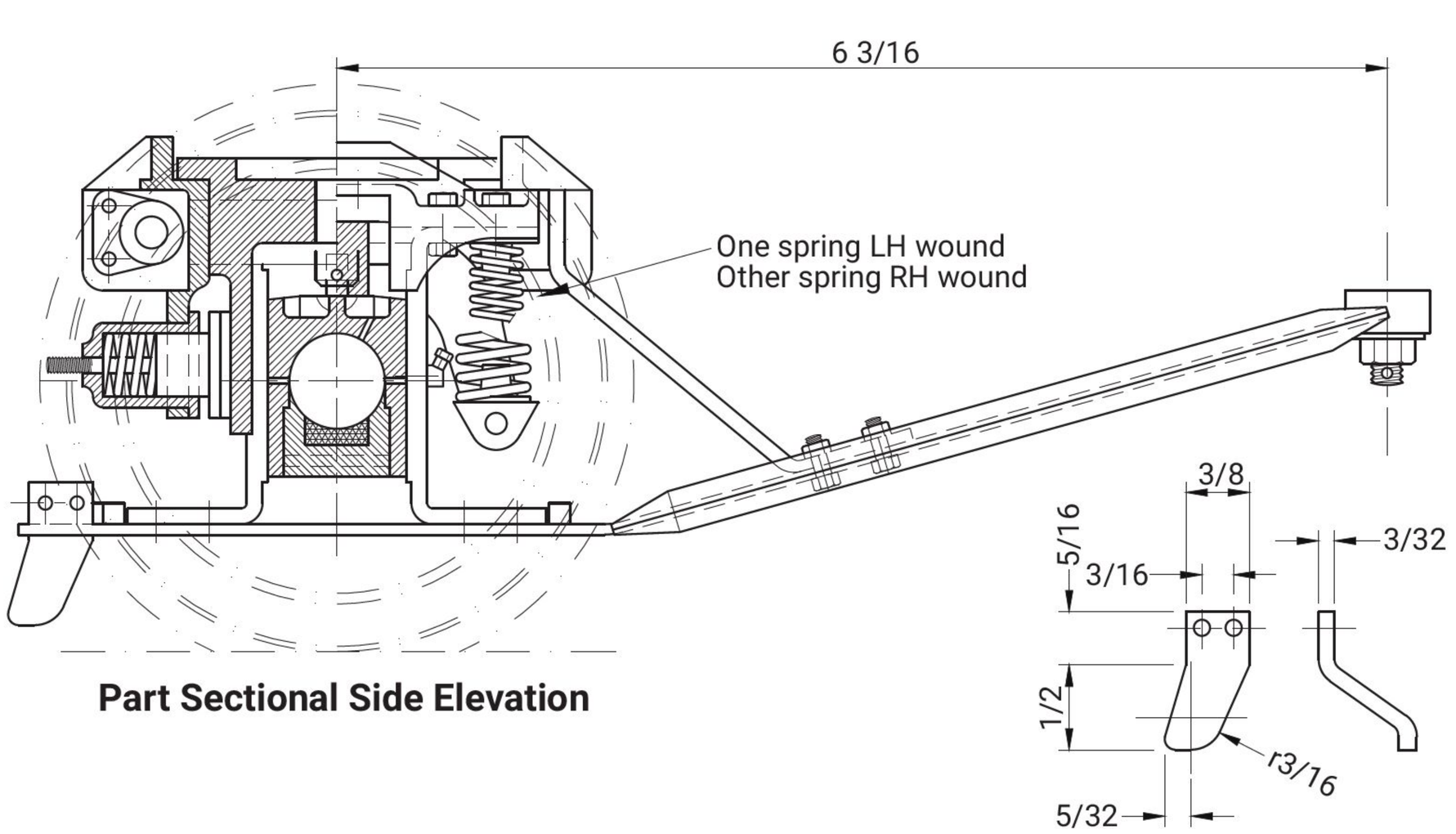
It is a shame that no one else took it over but we had a mill in Birmingham, which ran as a one man band, and he was brilliant. He used to draw all sorts of pipe for us, all of them thin walled tube including 7/32 inch diameter, which is what is required for all 5 inch gauge injector delivery pipes. Anyway, the pipes need to be there otherwise it will spoil the look of your lovely engine. Some years ago, a friend of mine and myself re-assembled the pony truck of 92214!

Fig 20



Pony truck – top view and front elevation.

Fig 21

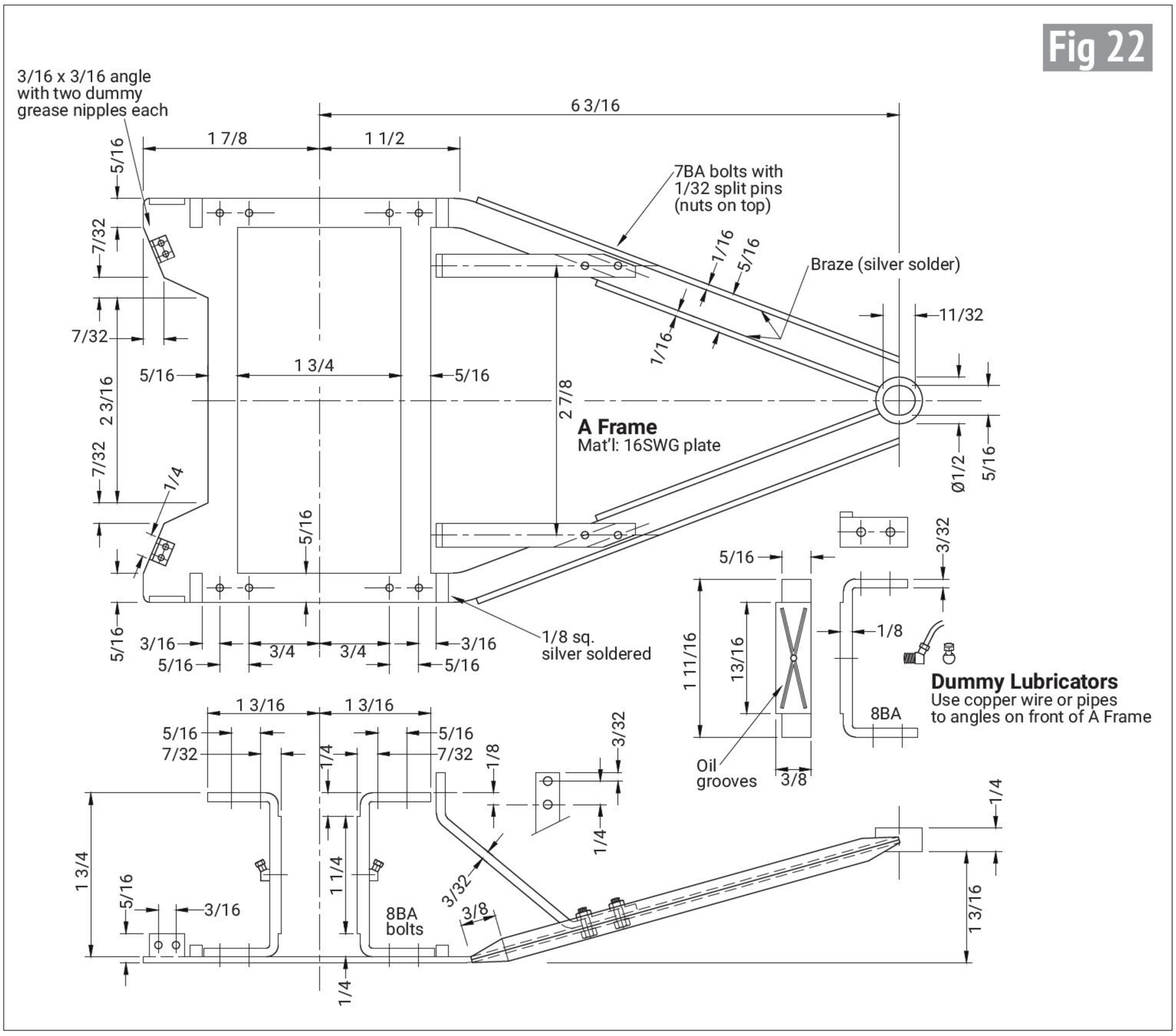


Part Sectional Side Elevation

Guard Irons
One pair req'd

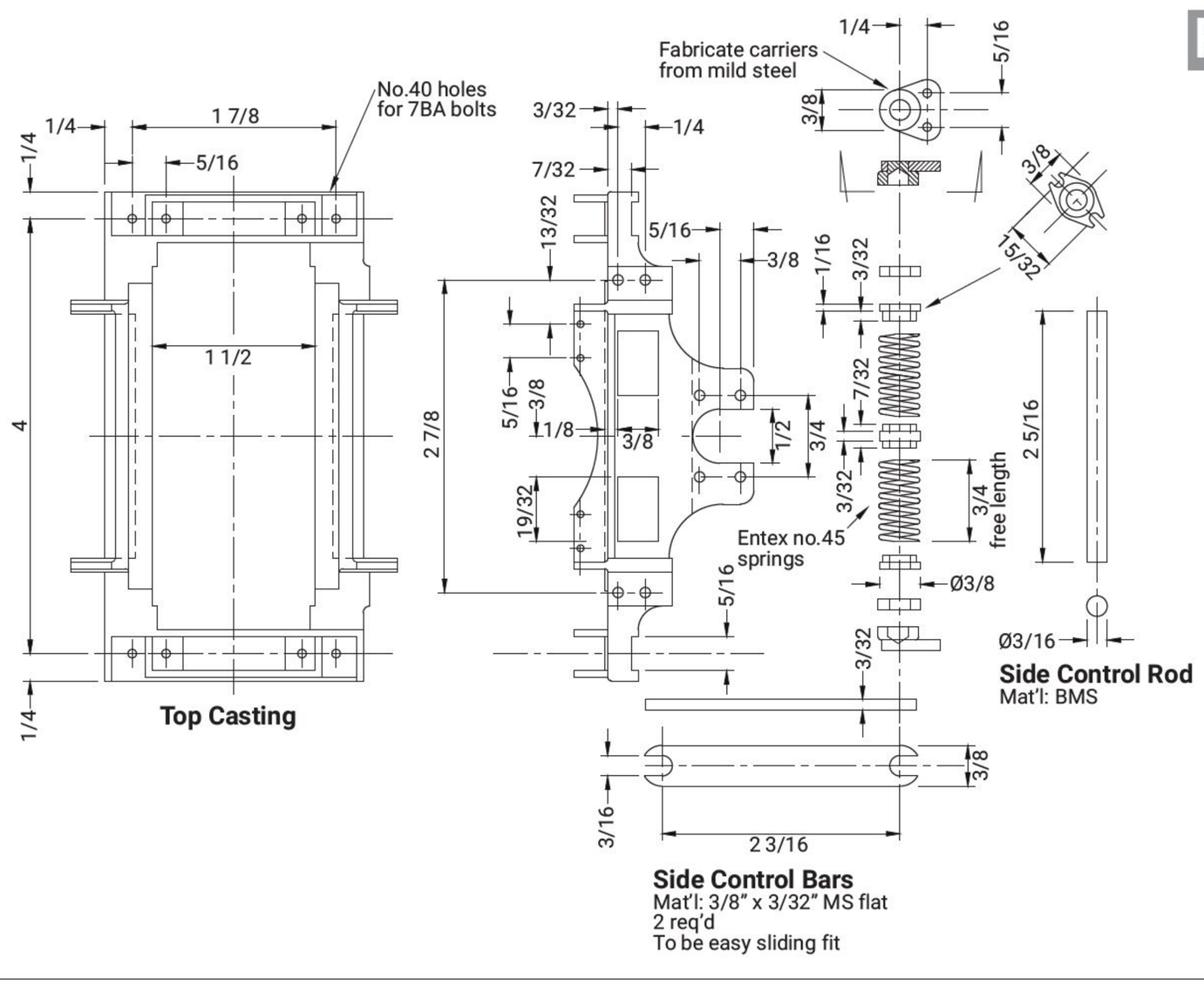
Pony truck – sectional side elevation.

Fig 22



Pony truck – frame.

Fig 23



Pony truck – side control.

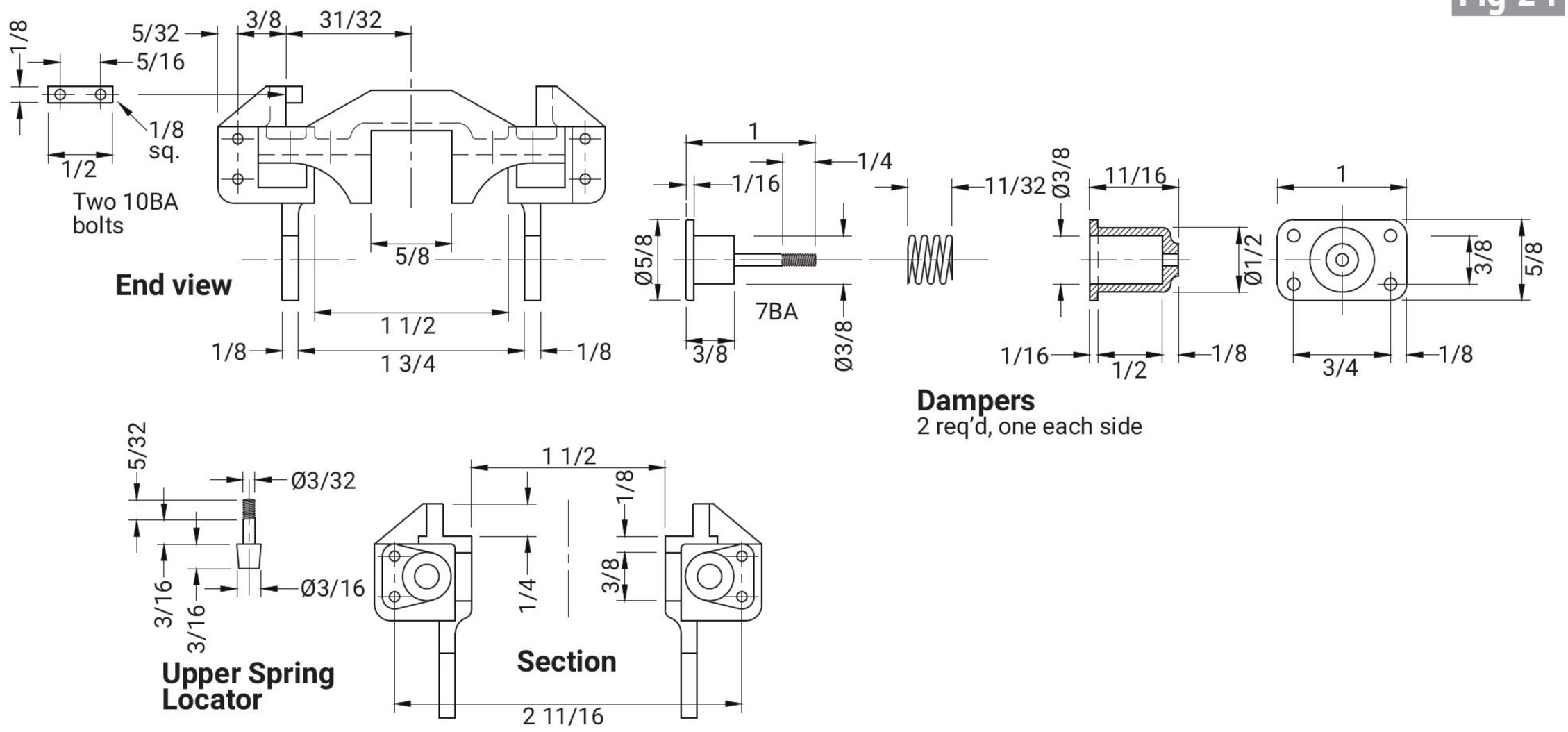
There are also a couple of tabs need sticking on to the front of the truck to carry the guard irons and a couple of stops for the axle guards. These stops need to be ⅛ inch square and 5/16 inch long, but you would be advised to pop a screw in the bottom to hold them steady whilst brazing. **Photograph 37** shows the pony truck for my 4MT and as you will see the 3/16 inch angles are there for all to see. The two pipes sticking up are from the oil boxes on the outside of the frames and the pipes have extensions on them so that the pony truck is easy to remove. **Photograph 38** shows all the parts of the truck. You will see in this picture that I had to use much thinner springs for the side control and they worked perfectly.

The horn cheeks are made from four pieces of ⅜ x ⅛ inch flat BMS bar (always available from 'M' Machine) and I found that I could just manage to bend it nicely to the 'U' shape required. There is a little machining you need to do first, and that is to reduce the ends a little before you bend them. You also need to make a tapping in the centre of each face to screw in an oil connection. These of course run from the centre of these horn guides to the angles on the front end. Before you bend anything, it would be as well if you machined the oil groves in the faces of the wearing areas. **Photograph 39** shows me machining, working on these, well before I bought my milling machine. The thing was that I used the vertical slide something like a 'shaping machines to perform this operation, but it worked very well. The grooves only needed to be about 10 thou deep.

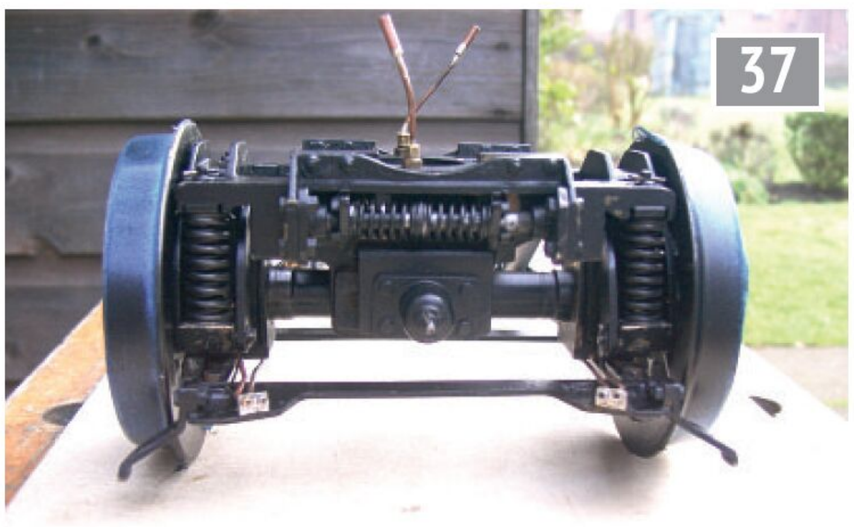
I had to make a special bending jig for bending the horn cheeks, not only to ensure that they ended up all the same length but also to see that they were all the same shape. I bent the horn cheeks over a simple that which I made which consisted of a piece of BMS bar ⅜ x ¾ inch thick and rounded the corners off. **Photograph 40** shows this in my vice being bent. It is well worth making simple jigs for everything you do like this as replacements are much easier to make should you ever need one (**photo 41**).

The top casting is the *pièce de résistance* as everything relies on the machining of this piece of the jigsaw. The horns bolt to this with 8BA bolts and that will give the job a bit of rigidity. I had to reduce the strength of the side control springs on my 4MT as when I tried it it wouldn't go round corners very well - well not

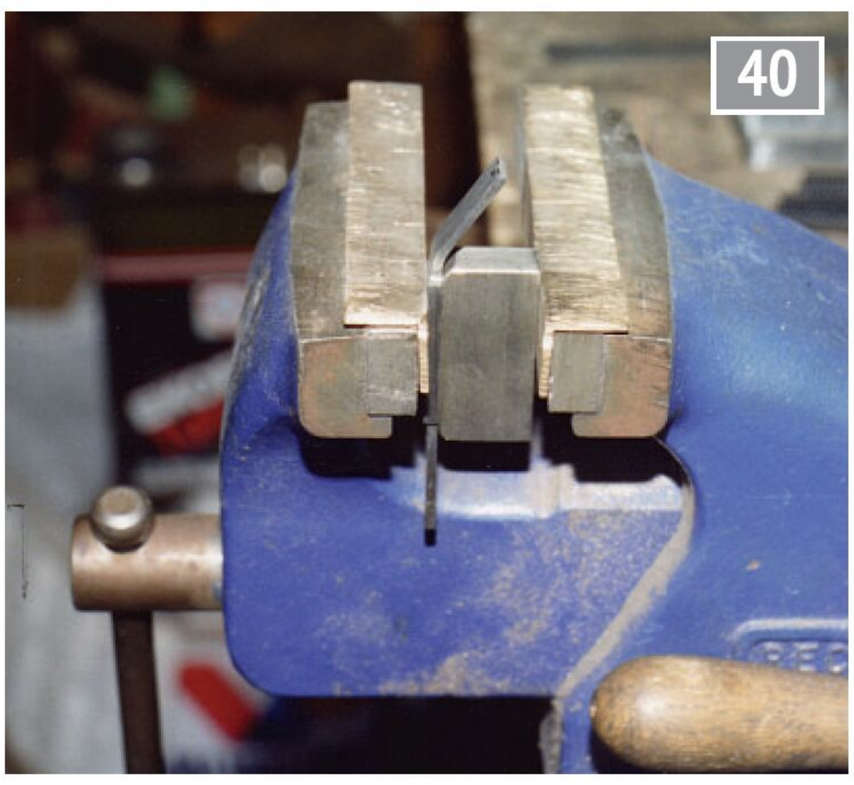
Fig 24



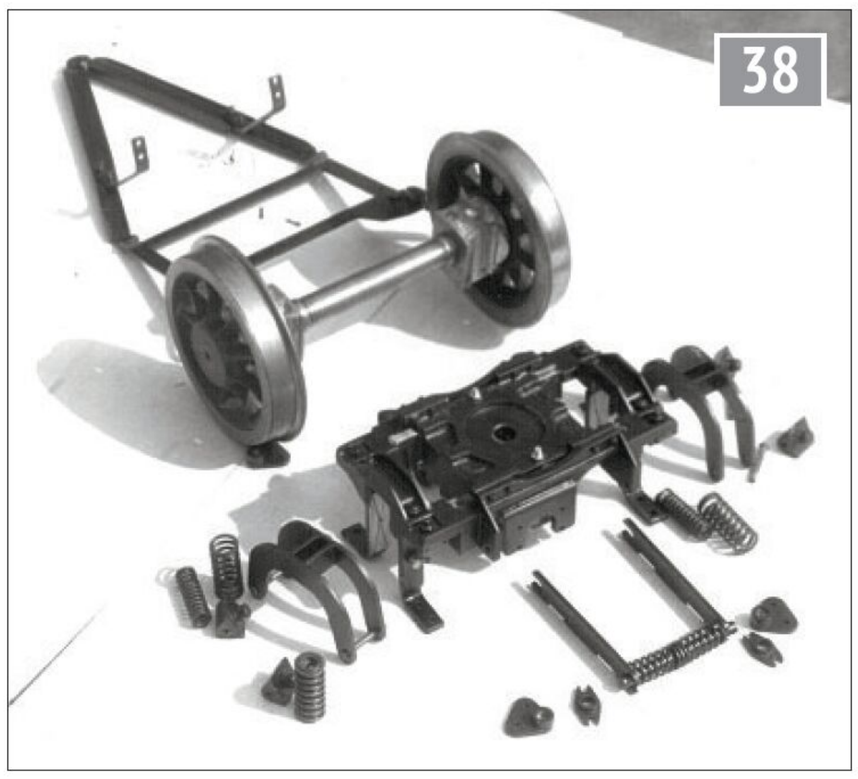
Pony truck – dampers.



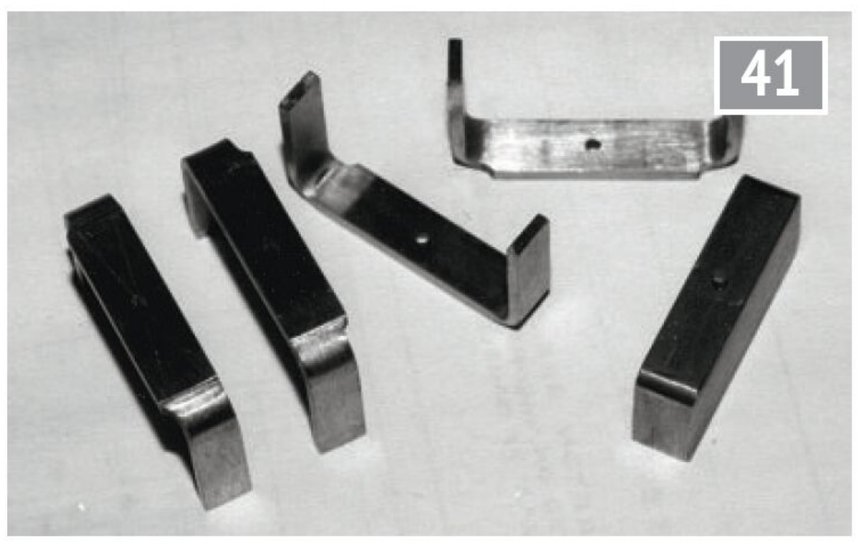
Front view of the pony truck.



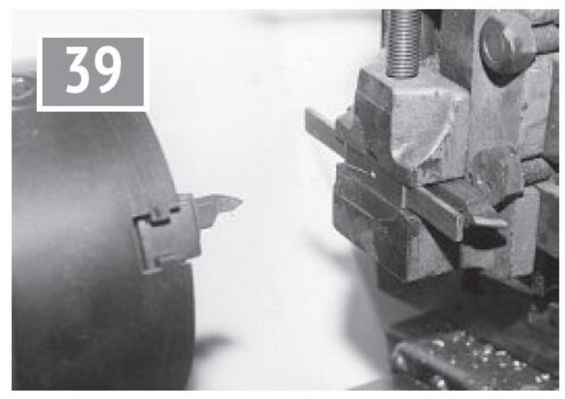
Bending a horn cheek over the former.



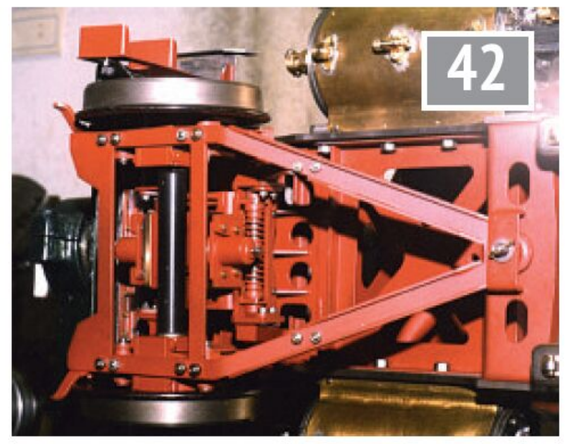
Exploded view of the truck.



Formed horn cheeks and former.



Machining the horn cheeks.

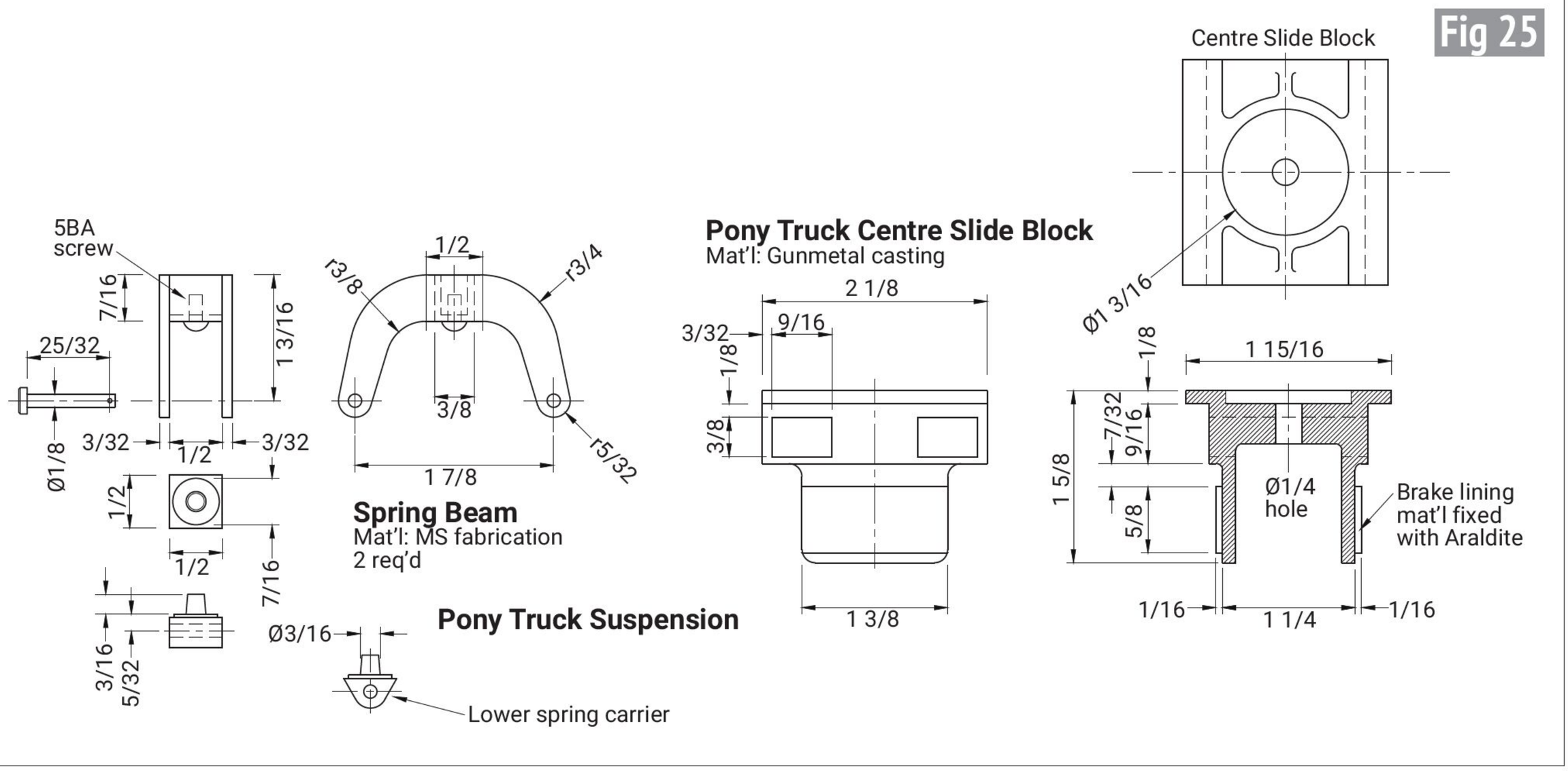


Underside view showing the side control springs.

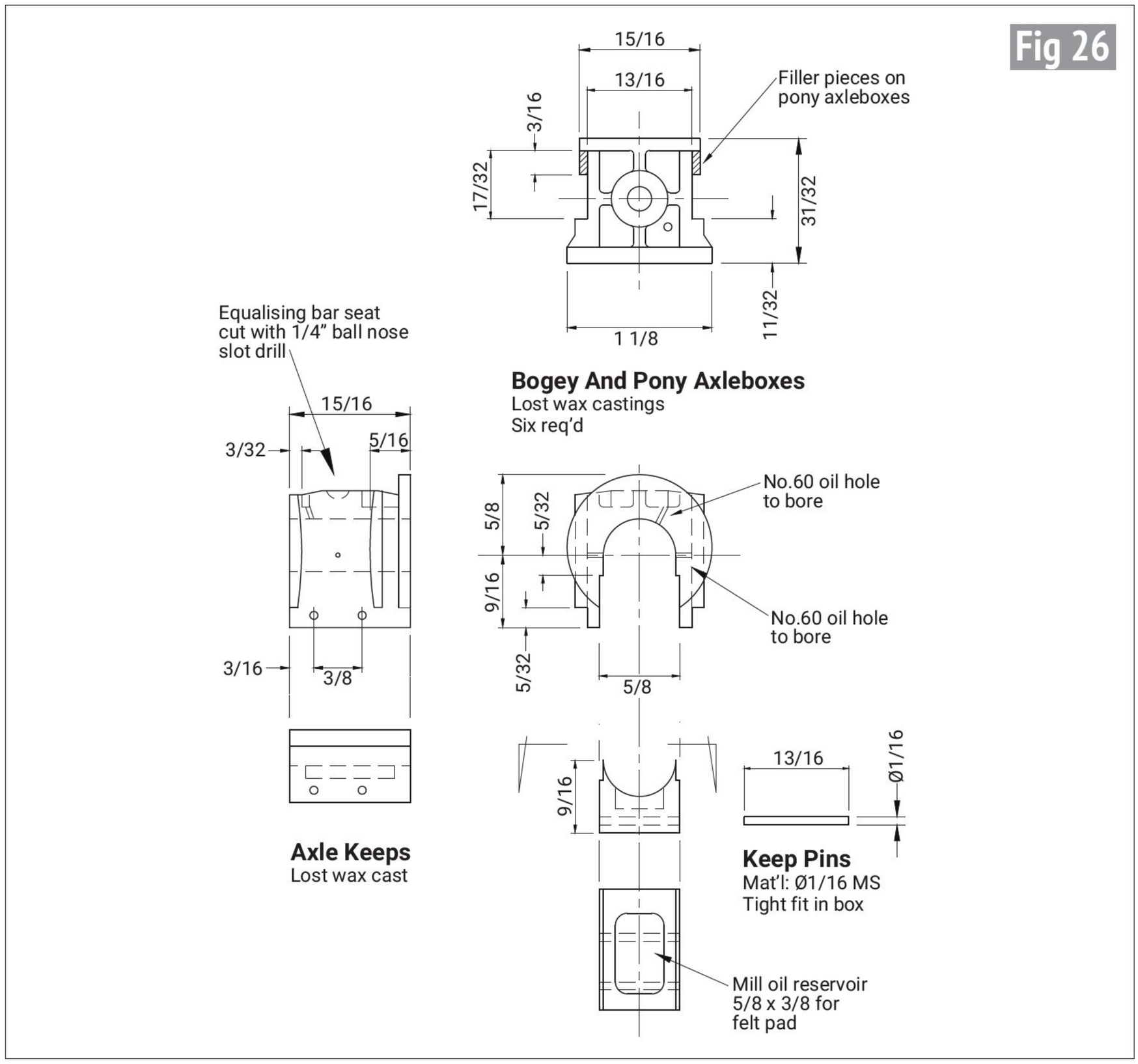
Usual portrait snap – this time no. 76031.

at all to be frightfully honest (**photo 42**)!

I reduced the strength of those to ones with 22g wire and they worked fine. On the full size pony truck, the springs are a rectangular section and my mate on the job rigged up a screwed rod with a plate on each end to get them in. There is also a small damper on the front of the pony truck which also has a similar lightish spring in it, and I would recommend that you also look for a piece of old brake shoe to put on your damper plate. Ours came off a discarded brake shoe from an 'HAA' merry-go-round wagon when they were still around. You only need a small disc glued on with some 'Araldite' or something. My friend Don was also building a 9F at the same time as I was working on my 4MT and he worked for the Railways at that time so that meant easy pickings. ≫



Pony truck – centre slide block.



Pony truck – axleboxes.

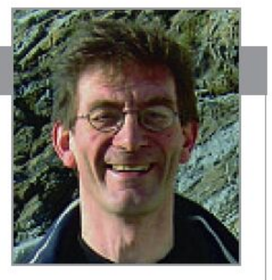
others are wound the opposite way otherwise they are most likely to get tangled up. I think that the centre slide block is a fairly simple exercise in machining and the only thing I need to say here is to make sure that the block just slides into the slot with about 5 thou clearance.

The pony axle boxes also need to be a very good fit with about 2 thou clearance all the way round and that is one thing that needs the 1/16 inch oil pipes to the underkeeps. The boxes are fed from a tiny oil hole in the top of one of the boxes - but don't over do it. One more thing is that the boxes also need a No. 60 hole into each side of the box so that the oil makes its way down to the felt pad at the bottom of the box. In any case you should always walk round your engine with a piece of rag in your pocket when oiling your engine to wipe any drips up before they get on to the ground, and more importantly, the track. One thing that is the bane of our lives is people over oiling engines, by the ton! Or tonne if you must.

Now you have a little bit of fabrication to do and that is to make the two yokes which hold the main springs of the pony truck. They should come laser cut in one of the kits and if that is the case all you need do is to braze them together with a little 'U' shaped fabrication between. One thing that you must insist on is that the outer springs are wound in one direction and the

●To be continued.

Unseizing a Beam Engine PART 3



SMEE's **Mitch Barnes** gets to grips with an ME Beam Engine steam plant, which had become seized up at some point in its past.

Continued from p.663
M.E.4755 November 1

SMEE

This series is a transcript of a talk given to the Engine Builder's Group at the Society of Model and Experimental Engineers (SMEE) in May 2024.

To remove the entablature I had first to carefully disconnect the parallel motion's radius rods. Once they were off, the main links (the droplinks that connect the piston rod, through the crosshead to the beam end bearings) could come off. I didn't have to remove the back links (the pair of droplinks closer to the beam centre) but I did remove and bag the beam centre bearing caps which enabled me now to swing the beam out of the way and liberate some working space. This would confirm whether anything else was *stuckski*.

Luckily, nothing was. As one could almost expect from such a finely made engine, the rest of it turned over like a sewing machine. Thank goodness for that, so there was only one major issue to resolve - the seized cylinder and piston. Hooray, one bit of luck. Perhaps I might now be on a roll - I should keep the luck thing going and go out to buy a lottery ticket.

Beautifully made drop link partly dismantled revealing a tiny oil reservoir in the top half of the lower bearing. Oil is fed in through a tiny 0.8mm hole just visible at the base of the decoratively turned distance piece.

The drop links were so carefully made and fitted that I needed to make darn sure I didn't mix any of the bits up, one side to the other, though they were so exquisite that I half expected them to be interchangeable (**photo 13**). To get them off they come down to their individual parts and looking at them revealed the builder's knowledge of full sized engines. The upper halves of the lower bearings (which enclose the crosshead shafts) have tiny pockets milled into them, as in full size, to act as oil reservoirs, which are fed from tiny oil holes above them. Lovely work and what a craftsman! I thought I was being a smart4ss by incorporating those into my Major Beam's new fine scale parallel motion – this chap had done so forty years and more earlier! The fit of all these parts was absolutely faultless – it would be impossible to put so much as a sheet of bible paper between their mating surfaces. Each one was carefully reassembled and stored in a clearly labelled resealable bag. I notice that the same precision applied to the connecting rod's yoke straps.

≫

One can only guess at what a lovely ornate engine this superb cylinder came from… Considering that there are no nuts present apart from two holding it onto its stand; it's amazing that it has stayed together this much.

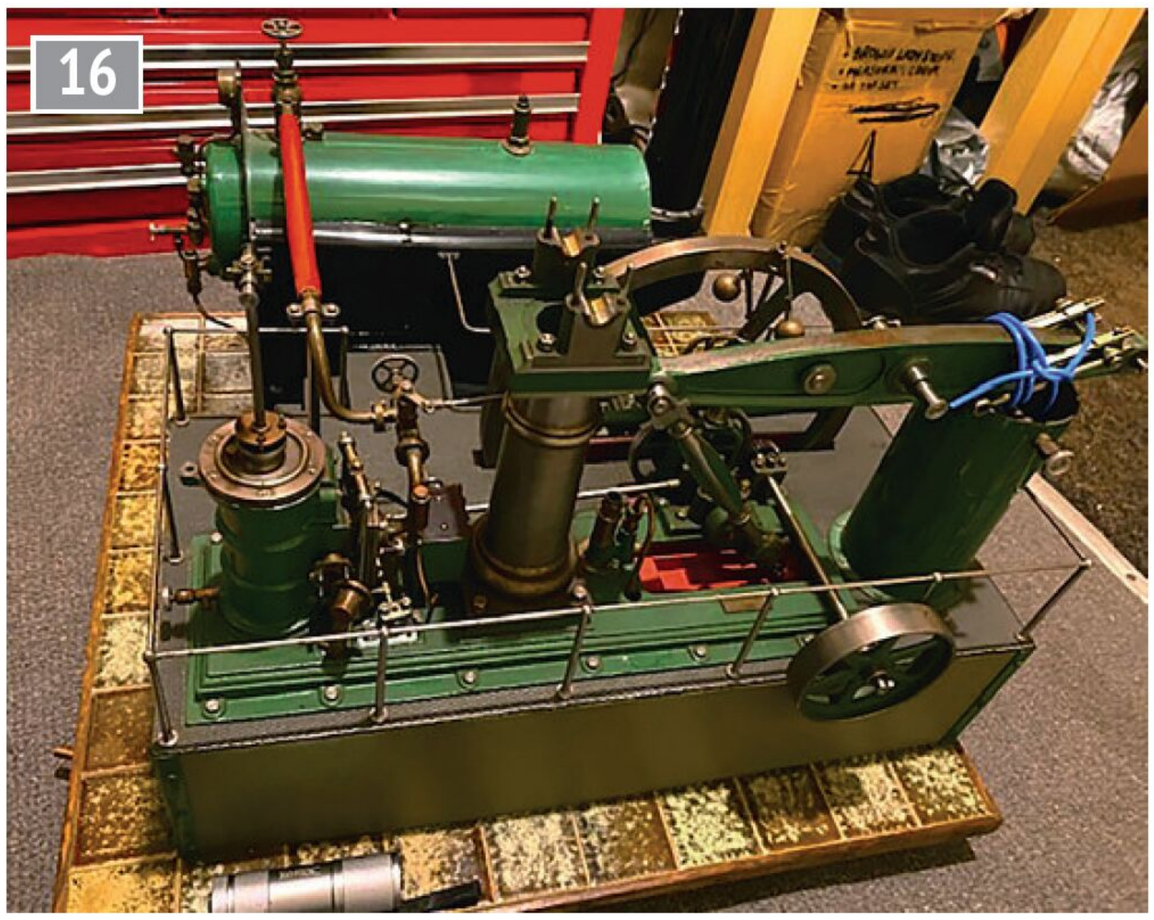
My procedure when removing anything from a model is always to put the bits into clearly labelled resealable bags – and with small assemblies like droplinks, I put them back together first. Sometimes repairs and restorations like this get interrupted, the chap doing that work loses interest and if not labelled and packed, the bits can go astray, as a previous *Inquisitive Fiddler* article I wrote covered in some depth. Suffice to say, a lot of incomplete models show up on FleaBay and other sites, requiring much otherwise unnecessary work, just for the sake of keeping all the bits together. Sometimes only the separated bits show up, leaving one to wonder what on earth they came from, like this stray cylinder… (**photo 14**)

The droplink's upper bearings, which encapsulate the end studs of the beam, were lubricated as per a full sized small beam engine, by oil dripped into the tiny hole visible at the top of the strap. In full size practice and especially on larger engines or those that ran for days on end without stopping, these oil holes might have a small wick feed oil cup screwed in. Either way, the oil reservoirs are all filled prior to the start of a day's running and at the end of the day, the wicks, if present, are pulled out to stop this 'total loss' oil system leaking its oil everywhere. Power House Rule No1: Whoever leaves the wicks in at night gets to wipe up all that oil in the morning!

With the parallel motion now dealt with, the U-shaped entablature component can be removed. It's held in place in three locations: the top of the rear column and the two screws that connect the open end of this part to the rear face of the column top (**photo 15**). On every ME and Major I have ever worked on, these two studs have always been the devil's own job to remove. You can't just remove the nuts and leave the studs, because the rear column prevents you sliding the extension out and you can't take the rear column out until the two studs (or hopefully bolts) have come out.

Even with the beam swung out of the way, there's precious little room to move a spanner in there so just accept that it'll take half an hour or so and some cramp in the hands to remove each one. As it was studs on this model and not bolts, (more difficult … perhaps I wasn't on a roll after all so I'll delay the purchase of that lottery ticket) I used the old trick of threading another nut onto the stud, tightening it up against the first nut and then winding them out together, thus

Those two studs at the open end of the 'U' are the devil's own job to remove…



With almost all the external stuff now removed, we can start to unbolt the cylinder.

removing the stud. It's basically the same principle as a locknut and is an early millwright's trick - but more on this a bit later to clarify for neophytes to model engineering.

Once those two studs were out, I could lift the whole entablature assembly off.

… Err, why isn't it coming off? Oh yes, undo the nut at the base of the rear column! Having put that lot aside in another bag and with the nuts included, I removed the pump rod, whose boss is located between the beam centre and the connecting rod. I swung the beam out of the way and secured it temporarily to the now conveniently located water tank with wire, as in the photo, to keep it under control while I worked on the engine - I didn't want to snap the beam end or connecting rod and give myself a whole lot more work! One day I might suggest relocating that tank to somewhere less dominant as it spoils the view of the engine.

Next, I removed the 10BA nuts and bolts on the steam inlet and exhaust flanges, also placing them into their own plastic bags. For this fiddly task I used a box spanner although to get the nuts to engage I had to turn down the box spanner's business end to within an inch of its life, because on both pipe flanges, the pipes were in the way!

Before the cylinder could come off, the valve gear had to come out as its yoke locates on the steam chest valve shaft, imprisoning it. Luckily its studs were easy to get to underneath. This was taken off as a single unit, Mr. Evans having used collars on the ends of the yoke and the crankshaft, held in place with tiny round pins. They looked tricky to remove so it was easier to take the assembly off in one piece and be careful to not upset the position of the yoke on the valve shaft because otherwise the valve setting would be compromised.

Lastly, the mechanical lubricator needed to be disconnected, which was simply a case of undoing the two pipe fittings and carefully storing the pipes in another bag. One large brass nut with a washer dealt with the lubricator itself: two tiny 12BA bolts passing through its foot and into the bedplate turned out to be only locating pins. The owner wasn't too keen on this mechanical lubricator as he thought it spoiled the lines of the engine so I'd not, for now, be putting it back in place. We'll sort out a displacement one in due course.

The engine was now ready to have the cylinder removed (**photo 16**).

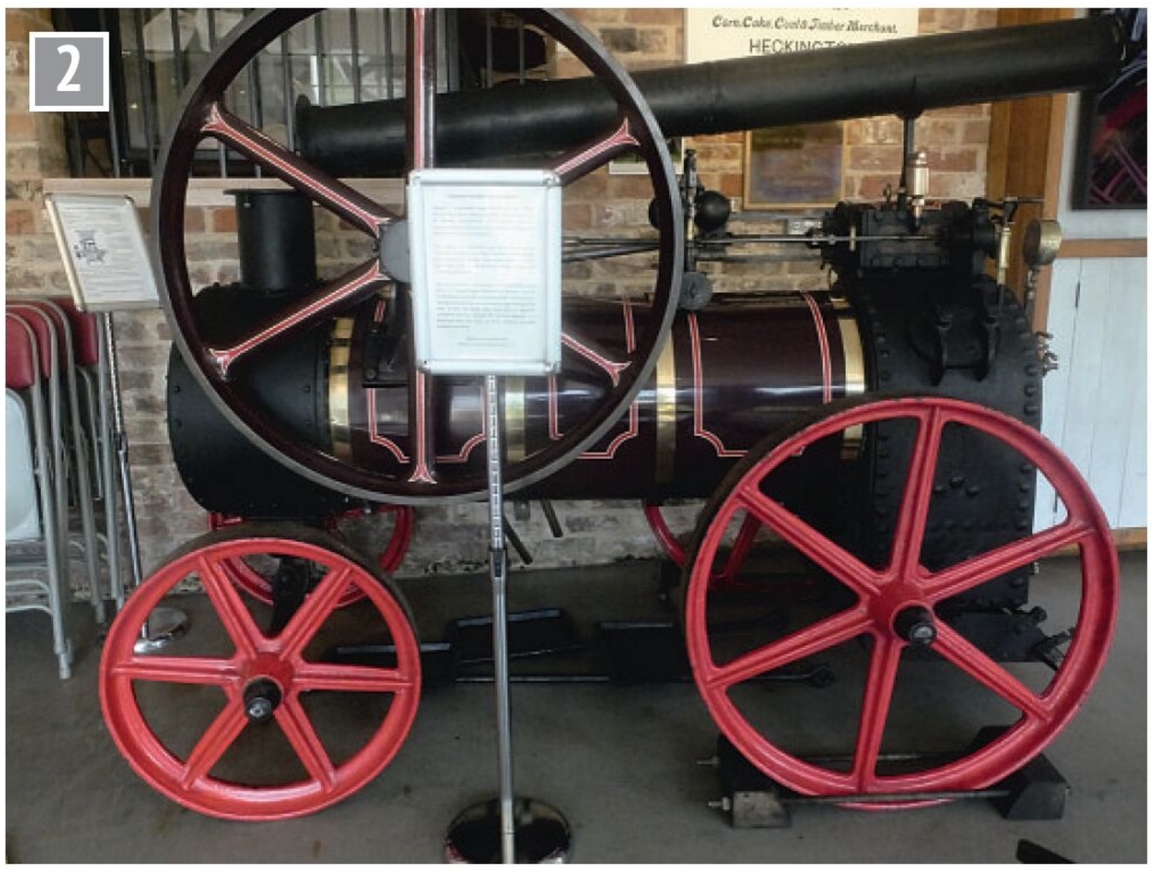
●To be continued.

CLUB NEWS

Geoff Theasby reports on the latest news from the clubs.

Well, après moi le déluge… In the last fortnight, I have visited several locations, which will become apparent idc - the East Midlands rally, Heckington windmill, a Radio Club junk sale, National AR Hamfest, Gainsborough Old Hall, a classic car rally, and I took 65 photographs. My 'Luggie' ran out of charge, and why do people throw money into fountains? Whatever it is, they pale into insignificance compared to those who treat a mediaeval loo as the Trevi Fountain (**photo 1**)?

In this issue: two windmills, an amateur driver, wheel-less in Welling, a rare car and a Charity Day. Visiting the Broadcast Equipment Conservation Group in Lincolnshire, we also detoured to Heckington Windmill, a Grade I listed building near Sleaford, dating from 1830. Following my assertion in M.E.4747 that we had been nearby and not called, I received an invitation from engineer, Jim Bailey, to see it when we were next available. So, when we went to a radio rally in Beckingham (not the palace) we rectified this error. The mill has had a chequered history, suffering storm damage in 1890, and was rebuilt as an 8-sailed mill, using machinery from another mill. It is now the world's only working such mill. In the entrance is a Tuxford portable steam engine (**photo 2**).



Tuxford portable No 1131 of 1883 at Heckinton Mill.

W. www.heckingtonwindmill.org.uk

We found this in the car park, what might be called a wind-powered Dalek… or a giant Deborah (**photo 3**)! The Boston Bubble car museum will have to wait. The following weekend another radio rally loomed, attended by the very opposite of people seen at knitting and crochet events. And their children - Hamlets? Even the café food choices were different. A fine and disparate choice of goodies, new and used, DIY kits, computers, components, aerials and such, to suit all tastes. Attendance might have been lower than it otherwise would but the similar and bigger National Rally was only the following weekend and prospective visitors may have been saving their cash and enthusiasm. This was also possibly the reason for the lowish attendance at the Sheffield & District Wireless Society 'Junk Sale' three days before. We returned home via Gainsborough and its famous bridge, with both toll houses still extant at one end. Furthermore, we can recommend the Queen's Head at Kirkby La Thorpe for a good lunch. Readers may be interested in learning that Gainsborough sits directly over an underground lake of crude oil. Obviously, drilling in the town centre was not acceptable, so the oil is pumped out from wells just next to the railway station. Extraction is at a rate of 300 barrels per annum.

Money down the drain?

The National HamFest in Newark was all that I expected, being the premier radio amateur show in the UK. Staying overnight, we had a table in the restaurant, and when the waiter asked if we had any allergies, I said I drew the line at cannibalism. Later that day we went to see Gainsborough Old Hall, at which my electric invalid scooter declined to take part, as I had omitted to charge it up overnight. However, I had bought at that morning's radio rally a hand-wound mobile phone recharger, 'à la Trevor Bayliss'. I had visions of bowling merrily along winding the handle like fury as I

Wind powered Dalek and Debs.

Gilbern Invader.

rumbled about, hither and yon. However, the buggy is propelled by a lithium ion battery and my hand generator was not compatible… That's my story, and I'm sticking to it! I reflected upon this fact as I laboriously pulled the dead scooter back to the car. On the way we passed this rare GIlbern Invader (**photo 4**).

Secretary Brian Lamb, from Urmston & District Model Engineering Society, writes to say that while model engineers visiting other club tracks is quite frequent, there is one that will not I suspect become widespread. Michael Sutcliffe of Queensland, Australia, a member of two miniature railways in Oz, visited the UK, and UDMES, and was allowed the privilege of driving several locomotives. Here he is driving Jim Moyles' 'Saint' Redgauntlet. He says its a relief not to have to check for poisonous spiders every day (**photo 5**).

W. www.udmes.co.uk

Welling & District Model Engineering Society's October-November newsletter reported on a Running Night which was held on 8th August, when there were three trains to occupy observers for most of the evening. Editor Tony Riley was reminded of a tale from 1865, where our scribe was waiting at Deptford, opposite a small engine shed, in which lived a small shunting engine. A small boy appeared, in his Sunday Best, looked around, then climbed on board. Intent on 'playing drivers' he eventually pulled the regulator and, to his surprise, began to move. Startled, he closed the regulator and 'scarpered', before anyone noticed. Bob Underwood, back in the glorious, sun-kissed days of early spring, said he expected warm, bright, long days and evenings, but this is England so what we got was trench foot, pneumonia, and flooding. Enduring the period of hibernation imposed on his locomotives in the winter, he decided to modify parts of the valve gear, whereupon his workshop was filled with the clucking chickens of Nemesis. Next, we have a railway running on wet rails. In the mid nineteenth century, a Mr Girard produced a 'railway without wheels', or rails even. The runners, like a sledge, ran in water filled troughs, replenished 'on the go' from on-board tanks. The vehicle therefore ran on a this film of water beneath the slides, much as it does under the blades of a skater. This train was demonstrated at the Great Exhibition, Crystal Palace, 1851, and the Chicago Worlds Fair of 1893. Movement was initiated by reversible nozzles bearing on the water-filled trough walls. Little was further heard of this mode of transport until now, when it was reimagined as the Alpine roller coaster down Swiss mountains, without the wooden troughs of water. Mr Girard envisaged harnessing the cool mountain streams* to supply water, which could later be turned in to the water supply network. Problems? Well, despite the various uses that such a concept brings to mind, in the intervening period, like the development of hydro-electricity, electric railways, and the tendency to be lifted out of the trough by

Michael Sutcliffe on Redgauntlet *at UDMES.*

BECG camera crane.

water pressure, not much… A similar 'ice railway', also shown at the 1893 bash, relocated to Coney Island but the higher ambient temperature and the inadequacy of the refrigeration facilities put paid to it. Simon Dawe, on being told that the use of semaphore signals had ceased on Network Rail in 2020, begs to differ, having just travelled into York from Poppleton, seeing them still in use. Also Harrogate, and the editor adds, 'Hastings' too. I (I also add, the Hope Valley line from Sheffield to Manchester, but that has already been slated for much required improvement – Geoff.)
W. wdmes.co.uk

Steam Whistle, September, from Sheffield SMEE, September, reports that the Society raised £4650 for Sheffield Children's Hospital with their Teddy Bears Picnic. In 2013, a train was named 'Sheffield Children's Hospital' by Owen Wilkinson, accompanied by Sheffield's Michael Vaughan (a cricketer, M'Lud). Owen had a serious fall at school and, in an emergency operation, SCH surgeons removed a blood clot from his brain. Normally three nameplates are made, two to the train, and the spare presented to the relevant organisation. Subsequently, the charity decided it was surplus to requirements and presented it to the Society, where it now resides in the clubhouse, above the ticket office window. (I hope it is securely fixed, as if it fell, the afflicted might need the hospital again - Geoff) Editor, Mick Savage, writes on the evolution of the Trans-Pennine railway.
W. www.sheffieldmodelengineers.com

Model & Experimental Engineers, Auckland, September, revealed that Graham Quayle has been unable to persuade the small vertical boiler, referred to in last month's report, to steam. He machined out the various sloppy joints but it was unwilling to run until he changed the cotton piping cord 'wicks' to cotton wool balls. These will run the engine for a short while. More of Murray's models have been passed on to new owners. His last was a Stuart 10H which he gave to editor, Graham, whose display cabinet is very full. Murray has said he will not be attending any more meetings. Cameron Webb had acquired a 'Helzapoppin' lathe with several parts missing, and he will attempt to make replacements. Micheal Slee sent a flyer for the public running days next year, at Guildford Model Engineering Society.
W.www.gmes.org.uk

Stamford Model Engineering Society, September, informs us that Keith bought a Bowman M122 steam plant. Bowman traded from 1926. Sid mentioned the demise of Mamod and Graham said he had seen a Mamod model sell on eBay for £1618! Keith Holderness, building a steam trawler, found it very difficult to fit the planks of the hull under the 'cruiser' style stern. He reckons it should have been made with narrower strips of wood.

Roger Backhouse asks if Lancaster and Morecambe Model Engineers had ever featured in Club News? Not under my tenure, as far as I recall, but they have now! He says that on September 29th, the Model Engineers would be open for Public Running, at which there would be an amateur radio display, explaining the fun and learning they could have taking part in the activity event, 'Railways on the Air'. They they will try to contact as many amateur radio stations as possible, similarly set up on that day.

In *PEEMS,* September, from Pickering Experimental Engineering and Model Society, Ray Smith provided a fascinating insight into North Sea Search & Rescue and the several moves he made within the industry, including the various helicopters in use. His article fills the rest of the newsletter, 16 pages, with photographs. One tale of woe concerned a Sikorsky S-92 helicopter in the Sea of Okhotsk, They were hauling goods each and every day, from 8 am to 6pm - food, equipment and supplies. Just as it was practising landing on a rig, the SatPhone went off. Very loud, with no volume control. Concentrating on his landing, the pilot pulled the circuit breaker to silence the alarm. Unfortunately, this also stopped the automatic positioning software and GPS, so the coastguard radar couldn't 'see' it anymore. Replying with trembling voice they were assured that their new £20m helicopter had NOT just been lost. *Shoulder to Shoulder*, September, tells us that actor Miriam Margolyes visited Cowes Shed. With 163 members, of both sexes, it has acquired aa prestigious following. A plot of land in Felinfoel (Near Llanelli) was offered to the Mens Sheds where Ifan, a former collier and rabbit catcher, lived in a wooden cabin for over 30 years. The site is now overgrown and his family are keen to see it restored and preserved for future generations, so they asked Mens Sheds Cymru if they would take it on.

Amesbury council were keen to set up a shed in the area. Now, work on a new building for the Shed is nearly finished. As Shedder, Alan Smith, said, (nearby) 'Stonehenge is the oldest settlement in the UK, we should have a shed by now'.
W. menssheds.org.uk

The Link, July – September, from Ottawa Valley Live Steamers and Model Engineers, tells us that Len Winn has built a 3D model of Rocket, scaled down from the Julius de Waal originals to fit his display cabinet. He is impressed by the dimensional accuracy of his printer - the model needed very little fettling.
W. www.ovlsme.com

And finally… A priest, a minister and a rabbit go to the doctors. Asked for their blood groups, the rabbit said, I think I'm a Type 'O'.

* Consulate cigarettes?

ME

CONTACT

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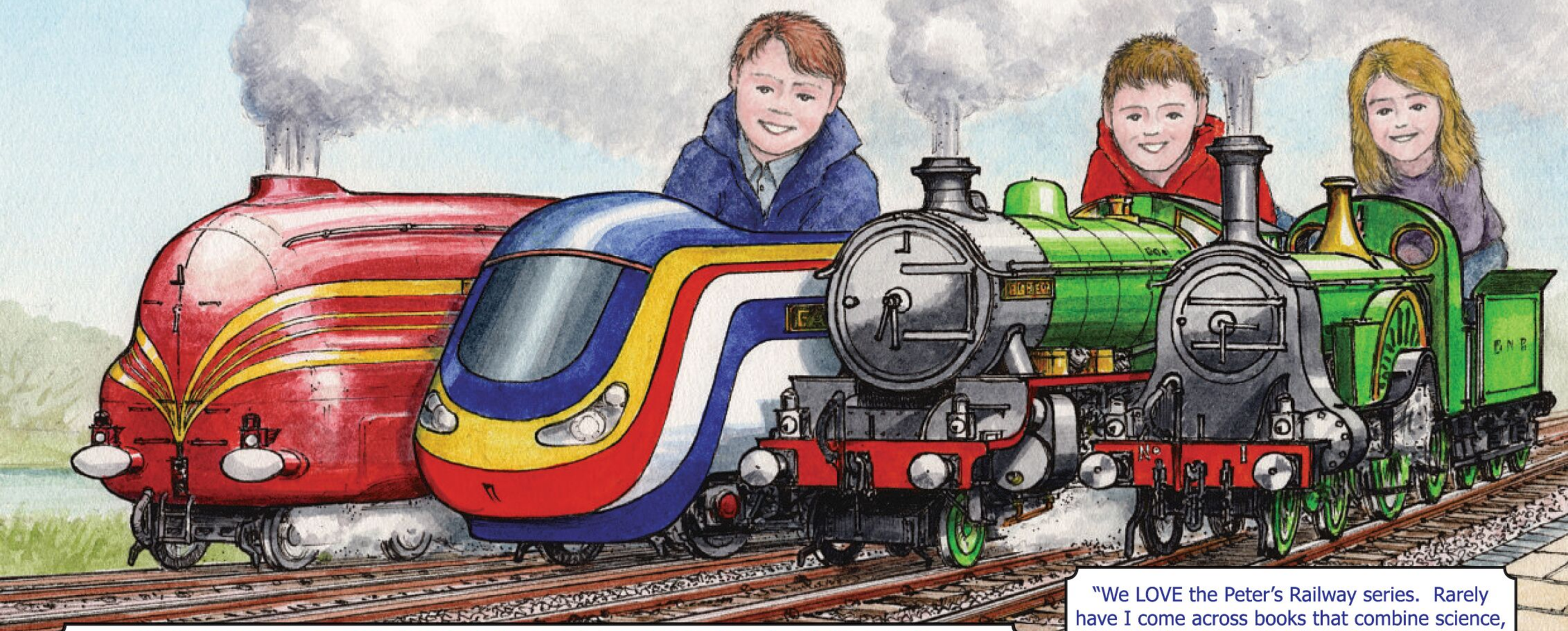

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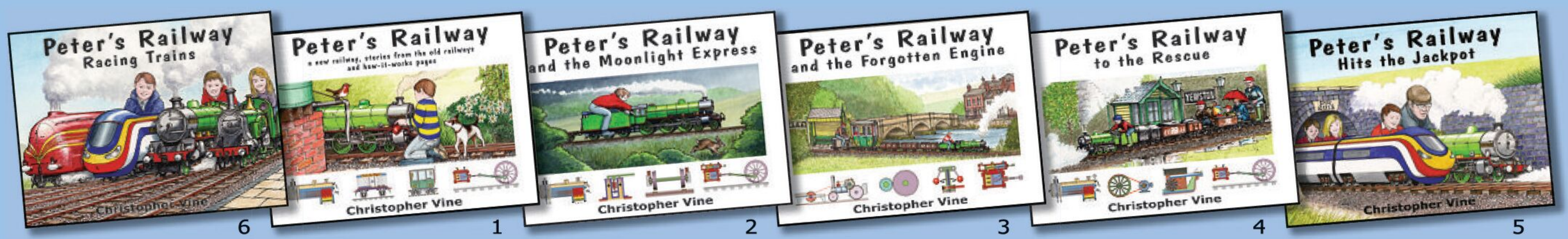

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