

THE ORIGINAL MAGAZINE FOR MODEL ENGINEERS

Vol. 225 No. 4646 • 28 August - 10 September 2020

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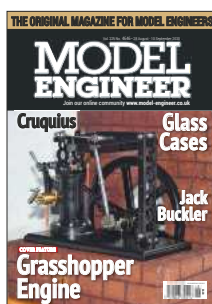
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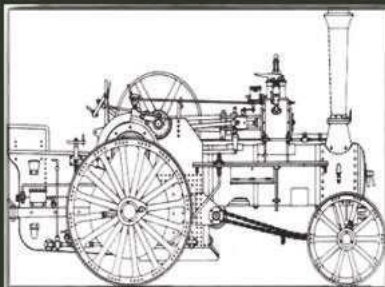


ON THE COVER...

The grasshopper haulage engine built by Stewart Hart and representing the third engine of his 'trilogy of engines' serialised in Model Engineer (photograph: Stewart Hart).

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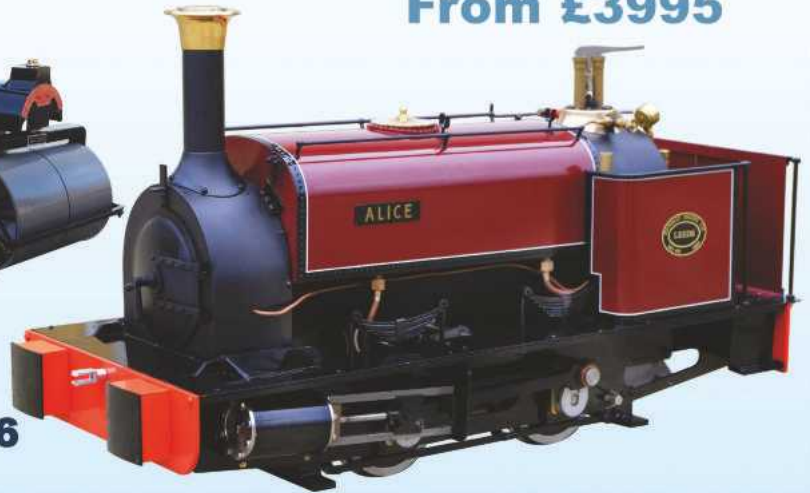
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Good With Your Hands

So – you’ve just emerged blinking from your unfathomable mine of never-failing skill and unveiled your latest miniature marvel. ‘Oooh!’, someone will say, ‘Oooh! You’re so good with your hands!’ Now, although this doesn’t actually happen to me very often, I have to admit that my reaction on these rare occasions is generally, ‘Me? No, really, I’m not.’

As a student, I felt I ought to do something a bit sporty but I lacked the manual dexterity to get involved in anything that required the ability to catch things or throw objects with any precision. Instead I took up rowing, where the only thing I was likely to catch was my death of cold sitting in the middle of the river in a racing eight, in the depths of winter, watching my fingers turn blue and the ice floes drift past. (You may think I’m exaggerating – I am not!)

No – if model engineering required manual dexterity I should have chosen an entirely different hobby, like train spotting or singing madrigals. After all, how much manual skill does it really take to turn the handle on my milling machine, or even to push a file across a slab of brass?

Perhaps one day someone will say ‘Ah, you’re so good with your head!’ Wouldn’t that be a much more accurate assessment of the nature of the skills involved? The true talent, it seems to me, is in knowing how far, and how fast, that handle needs to be turned, or how much pressure should be applied to that file and in what direction. Surely the skill in our hobby is mostly contained within our heads, not in our hands? What do you think?

Covid Cancellations

Sadly, the covid-19 lockdown has meant that most of the events we all look forward to each year have not materialised this year. The

Jack Buckler

We regret that we have to report the death of Jack Buckler, designer of the extremely popular *Sweet Pea* locomotive. He was 94 years old. We send our condolences and best wishes to all his friends and family. Phil and Jacque Owen celebrate the life of Jack and *Sweet Pea* on page 336.



latest cancellations that we have been notified of are the Rob Roy Rally, the International Model Boat Show and the Midlands Model Engineering Exhibition.

The Rob Roy Rally was due to be held at the Bromsgrove society on 23rd September but will not now take place. The society hopes to be able to run the rally next year, on a date yet to be announced.

Meridienne Exhibitions have regrettably decided to cancel both the International Model Boat Show, due to take place in November, and also the Midlands Model Engineering Exhibition, scheduled for October. They hope to be able to run the boat show in November 2021 and they will hold the next Midlands show on 14th-17th October 2021.

Chris Deith, Exhibition Director of Meridienne Exhibitions explained: ‘Like many other organisers we have been watching the criteria for events unfold. Venues are only currently planned to reopen from 1st October subject to successful outcomes of the mass gathering pilot studies. There are also ongoing government restrictions in place for the continuing management of this pandemic which are subject to change at any time. We are positive that considerable social distancing measures will need to be in place regardless. We feel these would have a significant impact on our ability to present these events to the normal size and format for everyone’s enjoyment. Therefore, we have come to the sensible and responsible decision to cancel the events until 2021. We are aware that our loyal supporters will be disappointed with

this decision but it would not be right to organise events that do not meet the high expectations that have been set over the last 42 years.’

The latest information about Meridienne exhibitions can be found on Twitter (@MeridienneEx) or Facebook (Meridienne Exhibitions LTD).

Cock-up Corner

I have been confidently claiming Robert Hobbs’s GWR *County of Devon* is a 2½ inch gauge locomotive. It isn’t though – it’s actually 3½ inch gauge! My apologies to Robert and all of our readers. I need to get myself a better pair of glasses.

Back Numbers

The first few weeks of the current pandemic had a negative impact on the reliability of overseas mail so it was decided that MyTimeMedia should suspend overseas mailings of *Model Engineer* magazine, amongst others. This meant that overseas subscribers will not have received issues 4636 to 4642 but should find that deliveries have now resumed. Subscriptions have been extended to cover the missing issues. The missing issues can be read online by going to www.model-engineer.co.uk/editorial/archive and following the instructions there. A subscriber number will be needed to access the digital issues.

I know that some readers really do want to have the print copies as they are needed to maintain their archives. In this case, please contact me and I shall arrange for the missing issues to be supplied.



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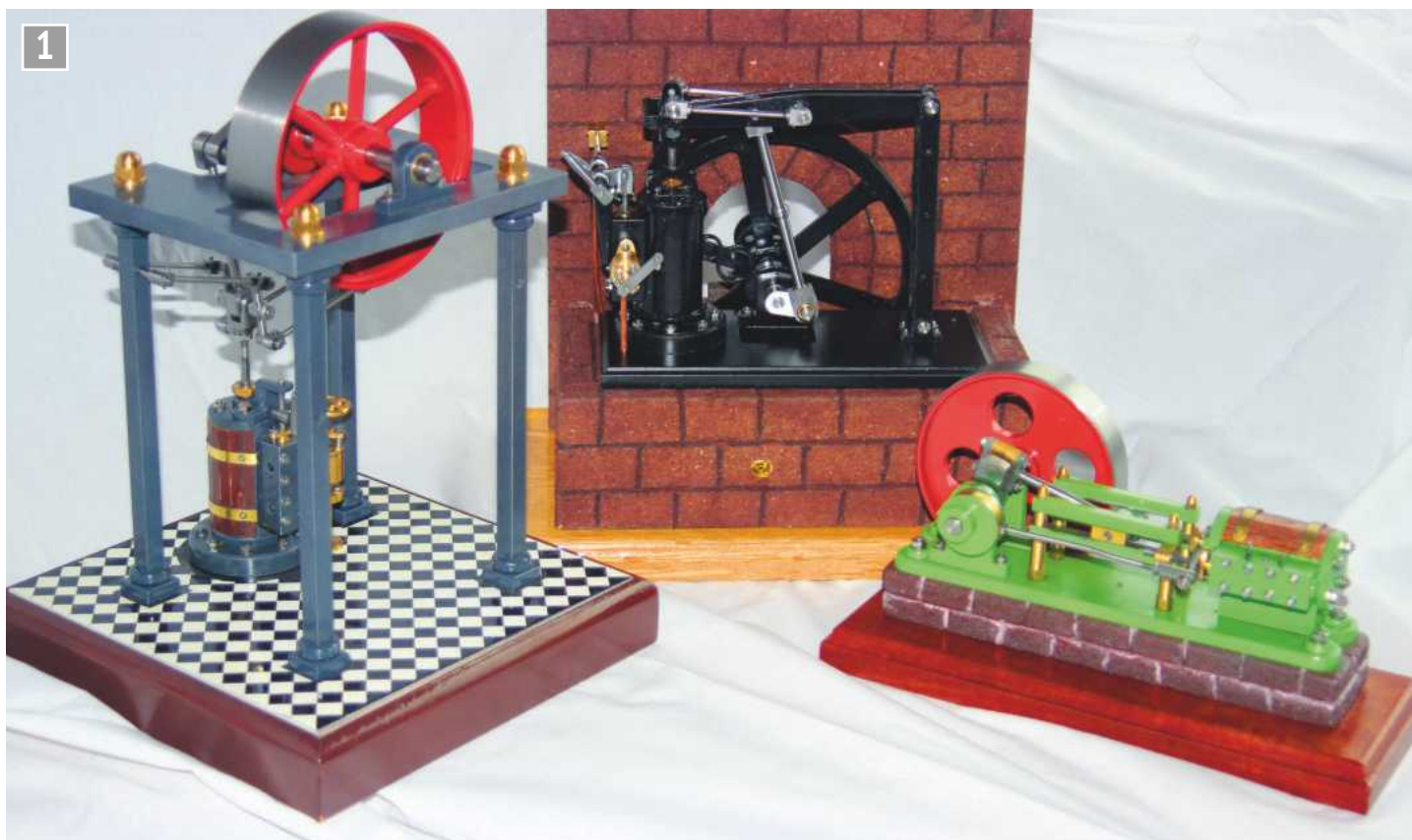


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A trilogy of engines.

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



PART 1 - FLYWHEEL Grasshopper Haulage Engine

A few years ago I set myself the task of designing and building a series of three engines that could be manufactured in a modestly equipped workshop by an inexperienced newcomer to the hobby. The designs would use standard bar stock sizes avoiding expensive copper based alloys wherever possible and would require simple basic machining processes. This is the final engine in the trilogy, the other two engines being the horizontal mill engine serialised in *Model Engineer* No. 4460 and the vertical cross single serialised in No.

4496. **Photograph 1** shows all three engines.

I assume that the modestly equipped workshop would have:

- * Lathe of about 4½ inches swing
- * Pillar drill of about 16mm capacity with drill vice
- * Bench vice
- * A selection of files
- * Other hand tools, hammers etc.
- * A set of drills - metric or number drills plus a few other drills
- * Some measuring equipment digital calliper, 0-25mm micrometer, steel rule

- * Marking out tools, scribe, odd leg callipers, centre punch etc.
- * Some taps and dies

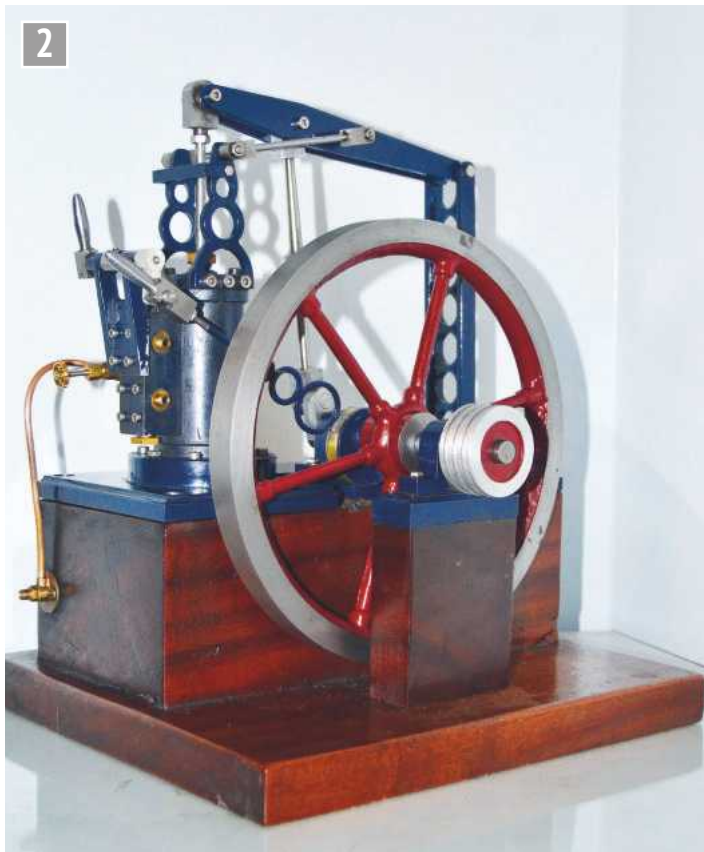
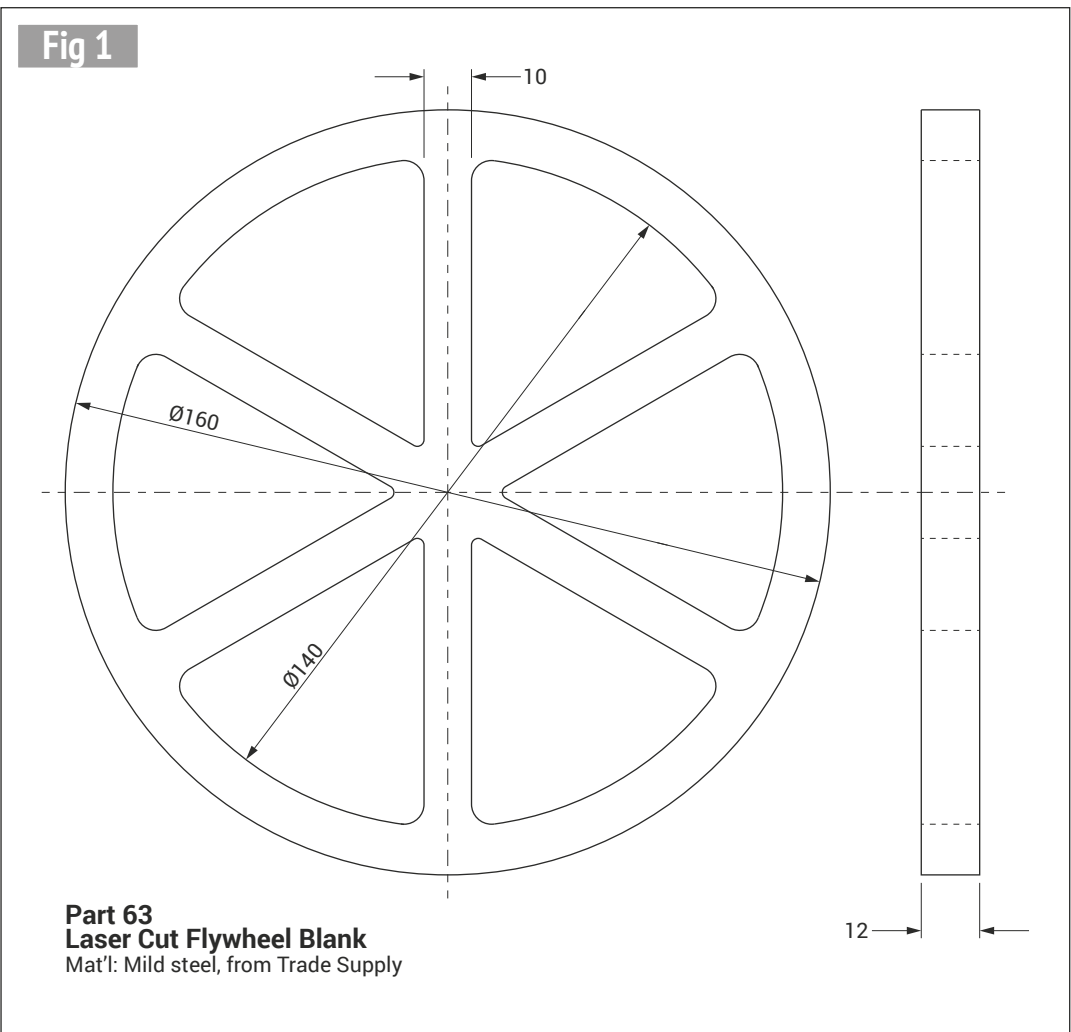
There is no provision for milling, not even a vertical slide for the lathe, the assumption being that the workshop owner would have limited experience and knowledge.

All three engines use a common design of cylinder and valve that is configured in different ways to depict the various engines, with the same basic techniques being used to make the non common parts. This being the last of the trilogy it is slightly

There is no provision for milling, not even a vertical slide for the lathe, the assumption being that the workshop owner would have limited experience and knowledge.

more demanding than the other two. I've used slightly more complicated processes in order to add some architectural interest to the design but I've given a choice of an alternative, simpler design for those who would prefer taking that route.

The engine is roughly based on an engine displayed at the Manchester Museum of Science and Industry. This engine dates from the 1850s and was used to haul minerals up an incline at an alkaline works. It can run in reverse by using a simple slip eccentric allowing it to haul in both directions.



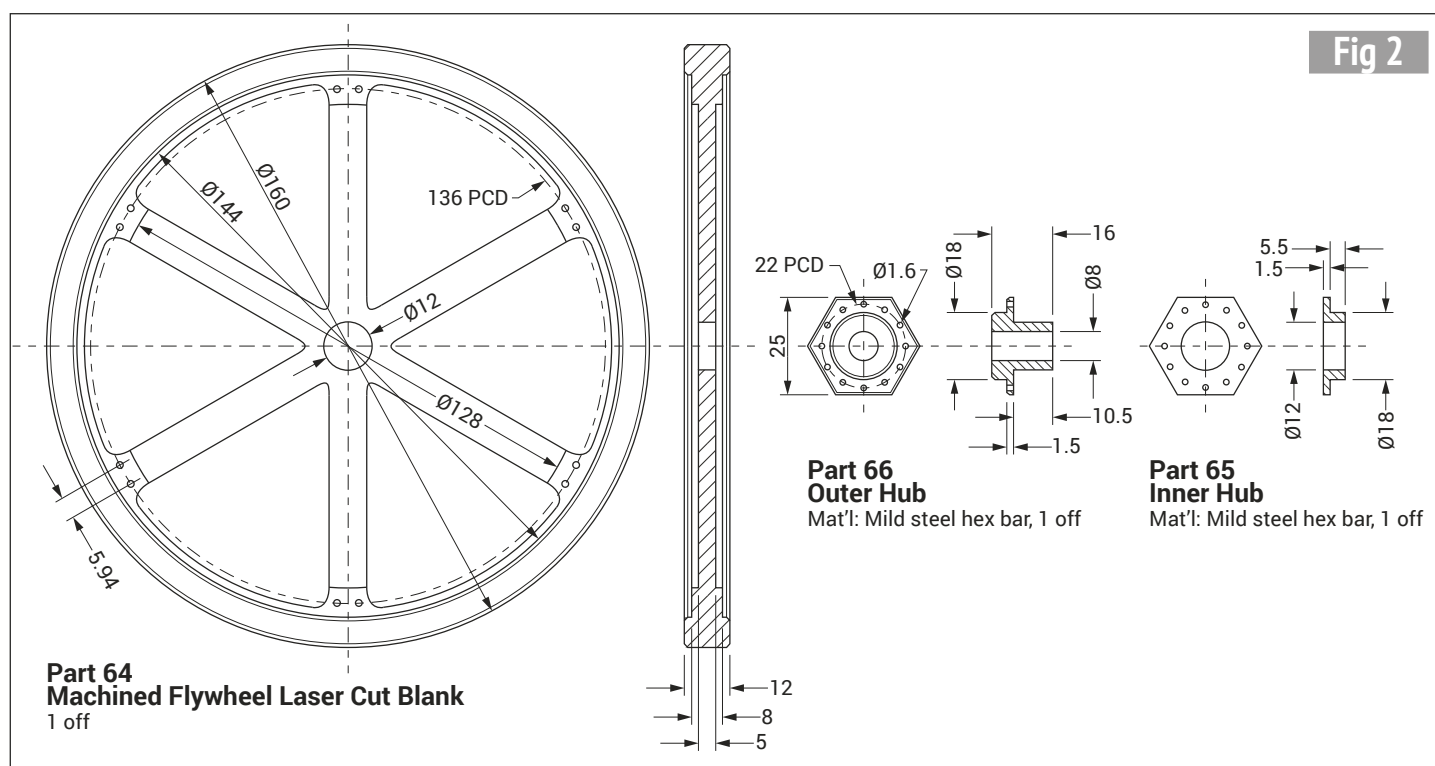
Engine built by Peter Nichols (photograph by Peter Nichols).

I had this engine in my sights for a number of years but I had a big problem in coming up with a suitable flywheel. I try to avoid castings wherever possible but engines from this period tend to have quite large diameter flywheels that are of light fabricated construction and none of my previous methods of fabricating flywheels would

produce a suitable flywheel. I toyed with various ideas but I felt they were all too complicated and outside my design constraints. Suitable castings are available from a number of different suppliers but they are only available as part of a set, the cost of which ruled out this option. I then hit on the idea of getting a blank fly wheel laser cut,



Laser cut flywheel.



so I contacted a firm called Laser Master who are based in Cornwall (usual disclaimer).

After first speaking to them on the phone, I sent them a CAD drawing (fig 1) of my requirements in DFX format, to which they quickly replied. The cost was comparable to a casting so I placed an order and five days later the laser cut blank was delivered, the whole process taking just over a week, and I was delighted with the results. Laser cutting firms can be found in your local trade directory and there are quite a few around. You will have to provide them with a sketch of the flywheel from which they will produce their own DFX drawing to program their machine.

If you would prefer using a cast flywheel a 10 inch wheel can be obtained from RDG Tools (usual disclaimer) but you will have to increase all the drawing sizes by 50%. A friend, Peter Nichols took this route and produced a very nice example of the engine that he successfully runs on steam (photo 2).

Machining the flywheel

The laser cut blank (photo 3) is machined in more or less the same way as you would a cast



Facing the flywheel.



Boring the flywheel.



Truing up the rim with the wheel mounted on a mandrel.



Drilling the flywheel for dummy rivets.

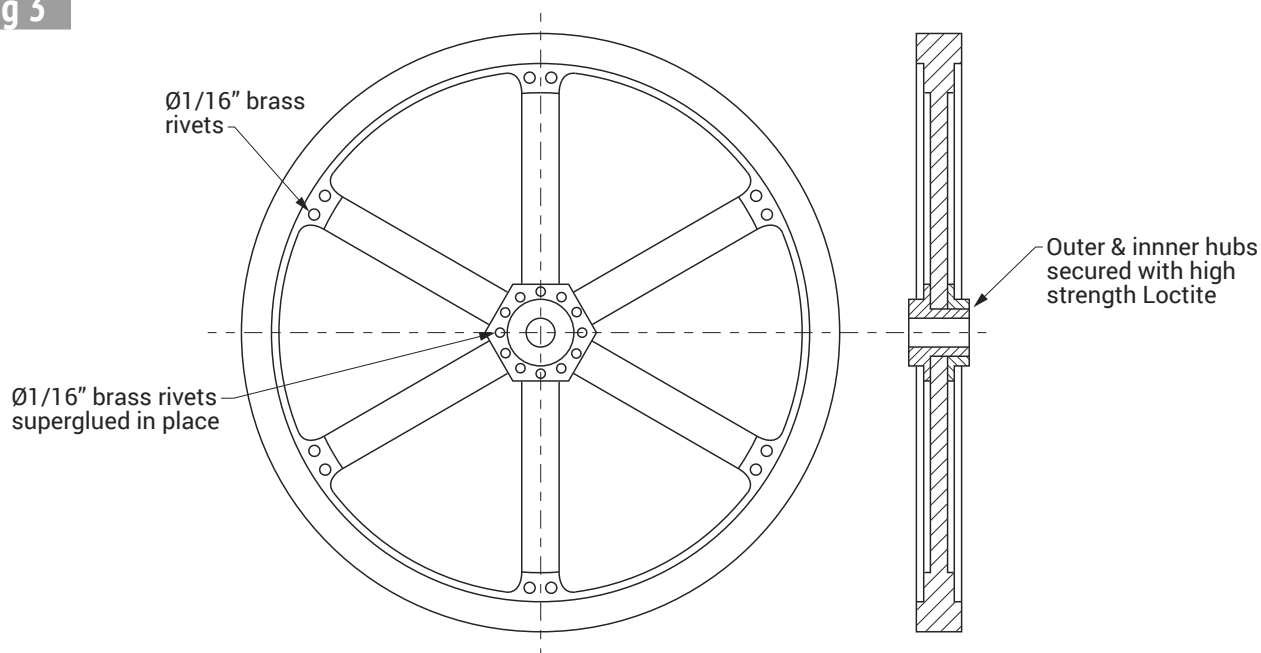
flywheel (fig 2). The first job is to clean away any flashing and burrs. Being laser cut there was very little of this and it was soon dealt with using a Dremel fitted with a rotary burr. I have a large 6 inch independent four jaw chuck. With the jaws reversed it easily held the flywheel, which was clocked up so it was running reasonably

true. It was faced up and the recess for the spokes turned out. Next, it was centre drilled and the bore rough drilled. It was then reversed in the chuck, the bore clocked up, faced and the spokes thinned (photo 4), and this time I bored the centre to the finished size (photo 5). I then turned up a mandrel a nice close fit on the bore and

bolted the flywheel to this for turning up its rim (photo 6). With the flywheel only being fixed at its centre this turning process made the flywheel hum musically but I got a good finish so it worked well.

If you don't have a large four jaw chuck you could quite easily mount it on a faceplate, moving the clamps around to

Fig 3



**Part 62
Flywheel Assembly**

gain access to unturned areas. If you are not too bothered about the flywheel looking quite so authentic, you could simplify the process further by not skimming the faces at all. The laser cut finish on my wheel was good enough to be left more or less as supplied with just a little bit of fettling. All that is needed is to drill the bore out so that it runs reasonably true.

Pushing the boat further into complicated waters - flywheels from this time were often fabricated from a number of cast parts and bolted or riveted together, so I wanted to simulate this. The end of the spokes were simply marked out and, using the mandrel with a chuck clamped to the drill table to hold the flywheel, it was rotated round and drilled for $\frac{1}{16}$ inch brass rivets (**photo 7**).

The hub is made up of inner and outer (parts 65 and 66 on fig 2). I had a short length of suitable 1 inch hex stock in my scrap box, but 1 inch round would have done the job just as well. The parts are easy enough to make - just concentrate on getting a close fit of the outer hub in the flywheel and making the inner hub a close fit in the



Drilling the hubs for the dummy rivets.

outer. No great precision is required to drill the holes for the $\frac{1}{16}$ inch rivets - just simply mark out using the lathe chuck jaws to guide the index for the marking out (**photo 8**), slightly countersink the back of the holes so that the rivets can



Flywheel assembled with Loctite.

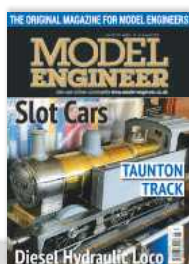
be peened over and filed off smooth. Assemble the hub to the wheel using high strength Loctite (**fig 3** and **photo 9**).

Because of my uncertainty about obtaining a suitable flywheel I actually made it before I had drawn up the rest

of the engine. Being extremely happy with the way it came out spurred me on to get the rest of the drawings done.

● To be continued.

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An Engineer's Day Out

The Cruquius Engine

Roger Backhouse enjoys a day out to Haarlem in the Netherlands.



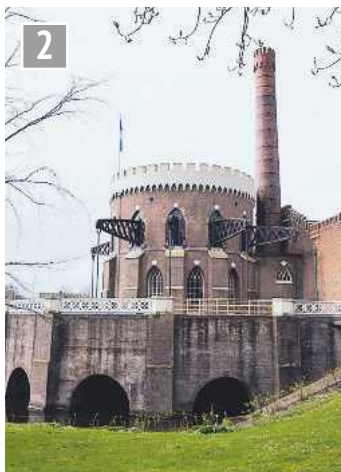
Cruquius stakes its claim as being the world's biggest steam engine (photo 1). This may not be entirely true, as the giant triple expansion compound at Kempton Park must be a strong contender. The Cruquius engine, however, has the largest diameter cylinder (144 inches or 3.66m) and is undoubtedly one of Europe's finest engineering sights (photo 2). It is the sole survivor of three similar engines built to drain the Haarlemmermeer, a lake between Amsterdam, Leiden and Haarlem.

Origins

King Willem the First appointed various commissioners to investigate draining the Meer. It was calculated that up to 160 windmills would be needed and drainage would take up to ten years. The commissioners visited Cornwall to view mine engines at work and, duly impressed, they recommended steam power be used exclusively. King Willem's successor, Willem II, backed them and the engines were installed during his reign. The Royal decree promised three pumping engines of 260 kilowatts (350 hp) each.

BELOW: Cruquius engine beams. The engine pumped from the polder level (brick arches) up to the collar launder floor marked by the cast iron balustrade whence it flowed into the Ringvaart canal.

RIGHT: Early painting of a Cruquius type engine. This probably represents the Leeghwater engine which had eleven beam pumps. It pumped water up from the polder on the right to the Ringvaart canal on the left where it flowed to the sea at Katwijk.



Cruquius engine tower and chimney, one of Europe's great engineering sights.

Building the engines

These engines were radically different from others by Cornish engine builders, though they operated on Cornish principles. They were more complex but proved to be an effective design. Detailed design was by London-based consulting engineers, Arthur Dean and Joseph Gibbs, but this was an international multi-company project.

Harvey and Co. of Hayle built the first engine, the Leeghwater, in 1843 but encountered problems with the cylinder casting as it was bigger than anything attempted before. Although it took only five

minutes to cast using 25 tons of iron, the first cylinder for the 144 inch engine was a failure. It was preserved for many years and a surviving photograph shows a man with his pony and trap inside.

Eventually the Leeghwater engine started work in 1845 (photo 3). As a result of experience, design changes were made to the next engines. Instead of eleven beams and pumps, Cruquius and the Lijnden had eight beams though with larger diameter pumps. Harvey's built the Cruquius engine but the Lijnden engine was made by Harvey's Cornish allies, Fox and Co. of Falmouth (Perran Foundry at Devoran) who also made the pumps. Van Vlissingen and Dudok van Heel of Amsterdam (later the famous firm of Werkspoor) made the beams and boilers.

The later engines were ordered in 1846 but it was 1849 before pumping work started. Besides construction problems, deliveries were delayed due to frozen Dutch canals so Harveys failed to meet deadlines. Thankfully the engines worked well and penalty clauses were set aside. ➤



Preparing the site and buildings

Considerable work was done to prepare the Cruquius site. Four hundred oak piles supported walls under the beam pumps. A thousand pine piles supported the rest of the building. The impressive boiler house and circular engine tower were designed by Jan Anne Beijerinck. It remains an attractive, neo-gothic building with elaborate cast iron detailing and castellations (photo 4).

Boilers

The boiler house stands between the engine and the Ringvaart canal (photo 5). The original six Cornish boilers operating at 45psi (3.1bar) included an unusual feature: at the end of the furnace tube four large smoke tubes extended in a diamond pattern to the end of the boiler. Though providing a large heating surface, connections to the furnace tube caused problems so these tubes were replaced with a single fire tube. Four more Cornish boilers were added in boiler house wings in 1860 but during 1888 all were replaced by six Lancashire boilers built in Belgium working at 65psi (4.5bar). As a steam surge occurred at the start of each stroke a 74 foot (22.5m) long buffer vessel was placed



Decorative cast iron work inside the engine house. This was a highly finished engine, built to impress as well as work.

across all boilers to even out the pressure.

Once the Meer was drained, Cruquius remained on stand-by and was used only occasionally as the other engines had sufficient capacity. When pumping ceased, boilers and the buffer vessel were removed after a final steaming in 1933. Space freed was used for the museum and a similar boiler front was obtained from Belgium which serves to give a good impression of the originals (photo 6).

One boiler feed pump was mechanically driven by the



The former boiler house first housed Cornish and then Lancashire boilers. It's adjacent to the Ringvaart to ease the unloading of coal. This now houses the museum.

main cylinder, taking water from the hot well, and there were two condenser wet pumps operating.

Operation

The Cornish engineer William Sims devised a tandem compound with broadly similar working principles but Cruquius is a unique annular compound, with a high-pressure cylinder inside the low-pressure one to reduce the overall height of the engine house.

In a classic Cornish engine steam pushes the piston down, lowering the inner end of the beam, lifting the pump rods

outside. With steam cut off, the considerable weight of pump rods in the mineshaft outside then pulls the outer end of the beam down. This is the pumping stroke, forcing water upwards as a plunger pump. The table shows the differences.

The high pressure cylinder has one 13 inch (0.33m) diameter piston rod but the low pressure cylinder around it has four. All piston rods attach to the great cap so pistons move simultaneously. The central (high pressure) piston rod extends above the great cap to the top of the engine house where it passes through



Re-erected Lancashire type boiler front obtained from Belgium gives a good idea of how the boilers once looked. These had twin flues.

Differences	Cornish mine pumping engine	Cruquius engine
Pumping	Usually from depth of several hundred feet (at least 100m)	15' (4.5m) pumping
Quantity pumped	Usually modest volumes	Large volume on each stroke
Pumping action	Pumping on downstroke of beam	Pumping on upstroke of outer end of beam
Weight	Weight of pump rods pulls beam down outside	Weight of great cap pulls beam down inside
Steam admission	Steam pushes piston down to lift pump rod (direct linkage)	Steam lifts piston and great cap. Linkage of piston to cap and beams to cap
Hydraulic lock	No hydraulic lock required	Hydraulic lock
Compounding	Usually simple expansion but sometimes Sims compound (tandem) or Woolf compound. (HP and LP cylinders side by side)	Annular compound
Beam	Single pump beam	Eight pump beams (Eleven on Leeghwater engine)

Cylinder top with high pressure piston rod to the left and two of the four annular piston rods to the fore and right. These lift the great cap above; the copper pans catching waste oil from the eight coupling rods to the arms are just visible. Controls to the rear.



a collar on four massive oak beams held together by iron straps. This helps stabilise the machine when the weight of the great cap is at the top of the stroke. The low-pressure cylinder is 144 inches diameter (3.66m) and the high pressure 84 inches diameter (2.15m). The stroke is 10 feet (3.05m).

Haarlemmermeer engines used steam to lift a great cap weighing 82 tons (photo 7). This functioned as a crosshead and linked to the inner ends of the beams. On the Leeghwater engine links rolled on the under surface of the cap but these wore badly and were replaced by direct links as seen at Cruquius. The outer ends of the beams forced pump plungers down. As the great cap descended under its own weight, assisted by controlled steam admission through the equilibrium valve, it lifted the bucket pumps outside (photo 8).



The great cap weighs 82 tons. Inner ends of the beams link to the cap which is lifted by both HP and LP pistons inside the annular cylinder.



Wooden model of Cruquius as it might have been with eleven pumps showing how pumps lifted water to the collar launder to flow through the sluice at the rear to the canal.



Pump set in the collar launder. Beams lift the bucket pumps with their D-shaped clack valves raising water to canal level.

Pumps

Engines pumped from the polder floor up to the collar launder (the 'terrace' level around the building). Water then passed through a sluice gate to the canal (the Ringvaart) and eventually to the sea at Katwijk (photo 9). Eight open topped pumps were designed by Antoine Lipkens. Each has a cast iron barrel 73 inches diameter (1.85m) with two 'D' shaped clack valves at the base hinged across the diameter. These open to draw in water from suction ports around the base. The lifting part consists of a piston frame with two weighted piston valves lifting water on the 10 foot (3000mm) upward stroke (photo 10).

Each pump could lift 1760 UK gallons per stroke (8000 litres) - for all eight pumps that was 14,078 UK gallons

(64,000 litres). Every minute 55,000 UK gallons (250,000 litres) were lifted through a height of 15 feet (4.5 metres). In service one pump was soon disconnected and remained unused.

Operating cycle

The cycle is similar to a typical Cornish engine, although at Cruquius the weight lifted is the cap indoors rather than pump rods outdoors, so the cycle is effectively reversed with the working stroke pushing the great cap upwards (photo 11).

At stroke commencement pistons are at their lowest positions. Valves are shut and there are vacuums within the condenser and beneath the annular piston. As the exhaust and steam valves are opened, steam above the pistons rushes into the condenser



'Working diagram' of Cruquius. Piston rods lift the great cap and the outer ends of pump beams are lowered. As the weight of the great cap descends the pumps are lifted.

where it is condensed by a cold water jet creating a vacuum above the pistons.

Boiler steam is then admitted under the central high pressure piston which, with a vacuum above, raises

it and the low pressure piston around it. Pump buckets descend and their bottom clack valves open. As the low pressure piston has vacuum below and above, it is in a state of equilibrium and cannot

contribute to the work done at the upward 'push'.

At a halfway point the steam valve closes but the exhaust valve stays open. Steam expands as the pistons move upwards but pressure decreases reducing the upward push so the engine slows. At the top of the stroke the exhaust valve shuts.

There follows a pause controlled by the cataract timing device to allow pump clacks to shut. The equilibrium valve then opens. Steam that has partially expanded under the high pressure piston now enters the combined space above both pistons. The great cap and pistons now start to descend by gravity helped by a pressure differential over the low pressure piston. Steam expands more during this stroke whilst the pump buckets lift water and polder water enters the pump barrels through foot valves. Then the next stroke commences.

Valves and controls

An engine this size needs large valves with the exhaust valve being 26 inches (0.66m) diameter. Harvey's developed a double beat valve needing just a small lift to open a large passage so that limited force was needed.

A Cornish engine control was known as the cataract, reminiscent of an early water clock (photo 12). A weight loaded plunger forced water from a cylinder through an



The cataract or timing device was derived from a water clock and enabled automatic operation.

adjustable aperture until a scoggan catch is tripped. ('Scoggan' is a Cornish term for a pawl.) Each scoggan holds the valve closed against a weight until released by the cataract.

There are clamps on the plug rods to close the valves. Opening and closing valves can be manually controlled, for example when starting. There are interlocks to stop any incorrect valve positions (photos 13 and 14).

The unique hydraulic lock

As the large bucket clack valves in the pumps are slow to close, this leads to difficulties at the top of the stroke when the mass of the pistons is raised by the elastic cushion of steam. When it slows this oscillates before stopping.



'The hydraulic' - one of the two columns visible through the beams. This held the great cap in position while pump clacks had time to close.



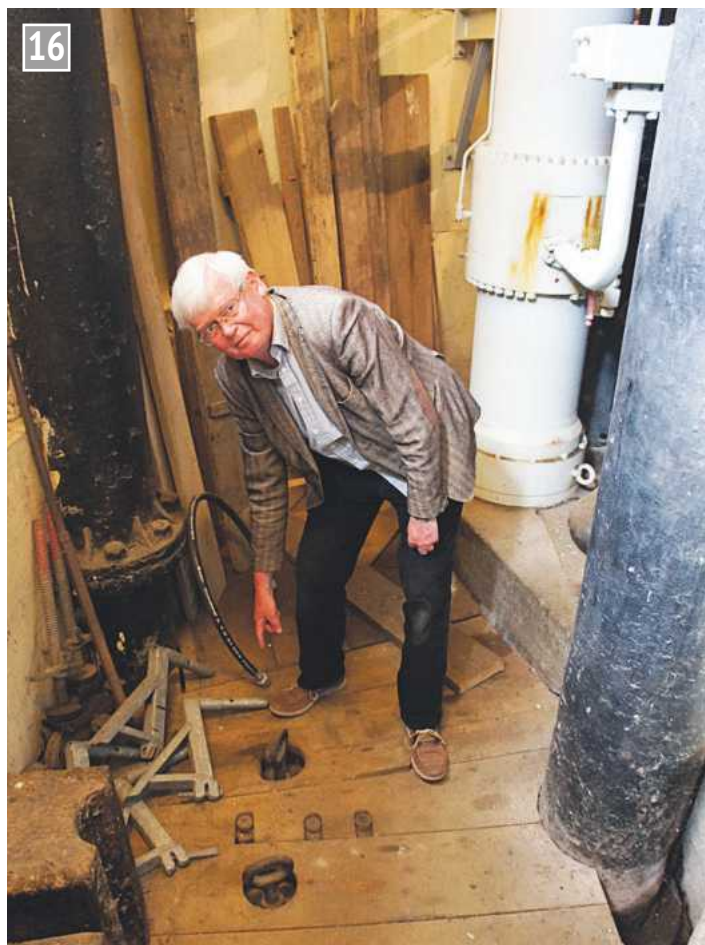
Controls are complex but in operation the engine worked reliably.

This oscillation or 'bobbing' is transmitted to the pumps which may slam the clack valves shut, risking damage. Whether this problem was anticipated by the consulting engineers or whether it was



For an engine as big as this, a model is sometimes the best way to show the controls and interlocks.

discovered in practice is not clear, but they developed an ingenious solution. Cruquius uses a water column to support the weight until clacks have closed. Two rams are affixed to 'lugs' on the great cap and on



Down in the 'catacombs', not normally shown to visitors, Adrian Strik points to the lifting lugs of one of the non-return valves for the hydraulic; one of the columns just on his left is attached to a lug on the side of the cap and the one on his right goes to a header tank at the top of the column. The rear, bulkier grey column is part of the modern hydraulic system for operating the engine.

the up stroke these draw water from header tanks through non return valves. As water is incompressible the water column supports the weight for a short time when it is then released at the same time as the equilibrium valve. This unique arrangement of rams, valves and standpipes is known as the 'hydraulic' (photos 15 and 16).

Condenser

In Dutch the term 'wet air pump' can refer to the condenser. There are in fact two condensers in the basement (or catacomb), both housed in a large hot well, an iron tank held together with square head bolts.

Cruquius in operation

Most work was done between 1849 and 1852 when all three engines worked almost continuously. Despite storm damage causing further flooding the Meer was completely drained by the end of 1855. It is a matter of opinion how far the Haarlemmermeer engines managed the maximum

economy of operation possible with compounds but all three worked reliably despite some mishaps.

Later, engines ran intermittently to keep the polder dry, as they do today, maintaining the water table near a constant level. A pump house indicator showed when other engines were at work. Harvey's installed three stroke counters including one high on the beams with locks to prevent any tampering (photo 17).

Afterwards

Previous polder drainage was financed privately with profits from trade with the East Indies. Haarlemmermeer drainage was publicly funded at a cost of 13 million Dutch guilders. To recoup costs land was sold, mostly to aristocrats who invited farmers from across Holland as tenants who then erected farm buildings in the styles of their home areas, thereby making the polder a museum of Dutch vernacular architecture. Now the land is some of the most expensive in the Netherlands. Schiphol

airport is on the bed of the former Meer, named from shipwrecks nearby, as the name means 'ship's hell'.

Preservation

Leeghwater and van Lijnden pump houses were radically altered when steam power was replaced by diesel centrifugal pumps. Following subsidence, Van Lijnden was rebuilt with vertical tandem compounds driving large Gwynne's centrifugal pumps. After several years as a stand-by, Cruquius steamed for the last time in 1933. Following interest by the Royal Dutch Institute of Engineers (Koninklijk Instituut van Ingenieurs), Cruquius was then preserved. Unfortunately, the sluice gates and other wooden parts of the laundry dried out and the engine could not be used.

Starting in the 1980s the *Storm Ploeg* ('steam team') began ten years of hard and dirty work restoring Cruquius to working order, though without the boilers. This team consists of retired professional engineers meeting on Mondays to do any technical



One of three stroke counters, this one was mounted high on the beams to prevent tampering.

work necessary. The engine now operates as a hydraulic system using specially made oil hydraulic components controlled by a computer system and thus operation can be demonstrated to visitors.

ME

VISITING CRUQUIUS

The engine working is an amazing sight and well worth the visit. The museum also has interesting displays about Dutch land reclamation engineering with many models. Given notice the museum can arrange guided tours in Dutch, English, German and French. Even without a tour, English language guidebooks and notices are informative. There is a museum shop and a tea room in the Foreman's House nearby. Cruquius is easy to reach on the No. 340 bus (Haarlem - Uithoorn) every ten minutes from Haarlem or Hoofddorp railway stations. Ask the driver for the Ringvaartbrug. Pay with credit or prepayment 'swipe' cards on the bus (Note: cash is not taken.) Other buses are available from Schiphol airport but may require transfer.

Address Cruquiusdijk 27, 2142 ER Cruquius, Netherlands
W. www.museumdecruquius.nl
 Tel. 31 (0) 23 5285704

Open:
 Monday to Friday 10am – 5pm
 (for winter openings please check Cruquius website)
 Weekends and Holidays 11am – 5pm. Closed on major festivals.

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D. B. Barton; *The Cornish Beam Engine*. Cornwall Books, reprinted 1989.

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 19 June 1991.
 Haarlemmermeer Cruquius. (American Society of Mechanical Engineers with Koninklijk Instituut van Ingenieurs and IMechE.)

Cruquius features with Timothy West, Prunella Scales and Adrian Strik in the Channel Four series *Great Canal Journeys* Series 5 episode 2. Available on YouTube.

Also an excellent Dutch and English language website developed by Robert Gisolf with detailed animations of Cruquius. See www.cruquiusmuseum.nl

THANKS

Thanks to staff and volunteers at Cruquius for their welcome. Special thanks to Adrian Strik, a Stoom Ploeg member, for a fascinating tour of Cruquius and providing technical information.

Martin Robinson builds a 7¼ inch gauge Diesel hydraulic engine intended primarily as a club locomotive.



Continued from p.273
M.E. 4645, 14 August 2020

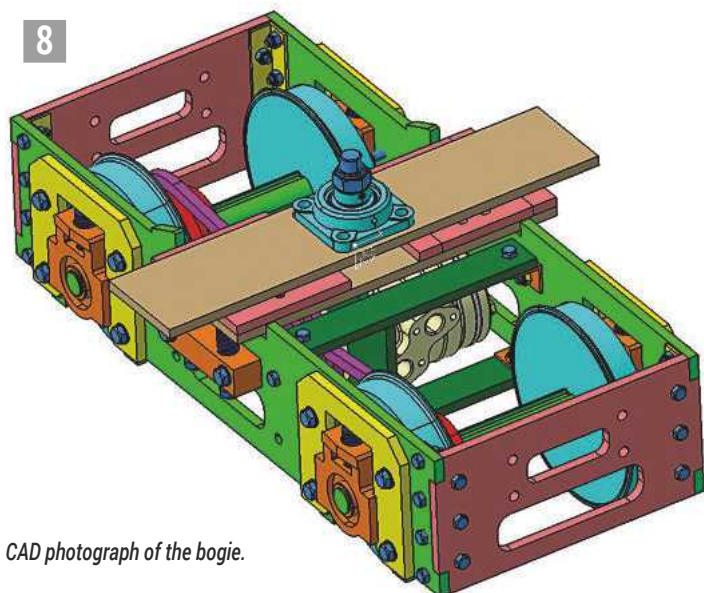


Finished locomotive at the Swanley New Barn Railway.

Building Queen's Messenger PART 2



The water cooled, two-cylinder Diesel engine used in Queen's Messenger.



CAD photograph of the bogie.

Engine, pump and motors

The locomotive is powered by a Kubota Z482 vertical, water cooled, two-cylinder 10.9 HP Diesel engine (**photo 7**). These engines are extensively used in commercial applications such as road diggers and generators, where they have proven their reliability over many years. They also come with a number of options such as a bell housing with a SAE mount that allowed the pump to be bolted directly to it. Engine mounts have also been developed specifically for this engine to reduce the natural frequencies of the engine through the chassis and into the body. The study of this in the vehicle industry is known as NVH (noise, vibration and harshness) and is something well worth spending some time on because if you can modify the noise and vibration characteristics of the locomotive you will not only change the overall sound of it but also make the driving experience a lot more enjoyable.

The engine drives a Hansa hydraulic variable displacement axial piston

pump which is bolted to the engine via a bell housing which eliminates the potential misalignment issues which you can get where the pump is remotely supported.

An option when ordering the pump was it incorporate a lever type bypass valve. This for me was a must as it allows the locomotive to be moved without starting the engine.

The pump in turn drives two 80cc/rev hydraulic motors, one on each bogie, then through simplex chains to drive the wheels.

Bogies

These bogies are a Bo-Bo arrangement (four axles in two individual bogies) which is the only thing that the rolling chassis has in common with the full size locomotive (**photo 8**).

They have primary and secondary suspension for added ride comfort and axle bearing durability. Both axles are driven through simplex chains and a double simplex sprocket on the motor located between the two axles, which is the only place the motor can

go if you use take up bearings as I have done here (photos 9, 10 and 11).

I've also done away with chain tensioners as the axles can be moved towards and away from the motor with this design of slotted take up frame.

The bolster plate that rotates and holds the bogie to the chassis rests on UHMW 10mm thick sheet. This is a self-lubricating thermoplastic that provides outstanding resistance to abrasion, impact and wear.

The springs are the die type that come in different load capacities, identified by their colour. Blue used here are a medium load spring.

Each bogie weighs a huge 73kg; this along with the big 8 inch diameter wheels have shown to reduce derailments caused by twigs and stones on the track and wheel slippage during wet running days. The wide wheel tread also helps reduce derailments if the track were to be slightly out of gauge.

Photograph 12 shows the locomotive with the cosmetic body removed. Another of my important design goals was to make it maintenance friendly. These are some of the features that meet this goal.

1. Single kettle type electrical plug disconnect on body then body lifts straight off.
2. Water and oil check without removing body
3. Changing light bulbs and removing battery without removing body
4. Easy access to everything when body off.
5. Removal of wheels and axles without touching the hydraulics.

The engine has been mounted rearwards allowing the pump with its hydraulic hoses plenty of room at the front of the locomotive to be routed as they are not that flexible.

With the engine in this orientation it's important, later, when designing the body that there's plenty of ventilation around the engine for the air



View of the bogie showing the chain drive.



Bogie suspension.



Placement of the motor.



Disembodied locomotive.

being sucked through the radiator.

With the chassis frame I've gone for U-section side rails opening to the outside. This gave a nice, tidy, safe place to route the hydraulic hoses; it's also easy for maintenance with the body off and boxed in when the body is on.

Laser cut bogie side frame

Photograph 13 shows one of the laser cut bogie side frames made from 10mm mild steel and cost £30 delivered (2019).

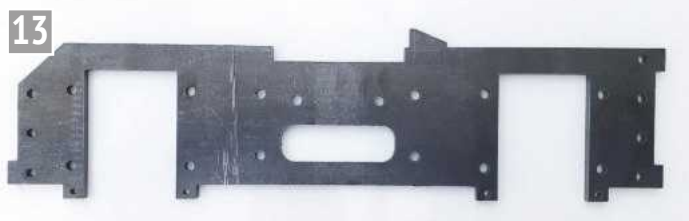
As the tolerance on the laser cut parts are + or - 0.2mm the supplier was able to supply them with holes pre-cut ready

for threading as there was no hardening around the holes, so proved no harder to thread than if I had drilled them myself. I believe that isn't the case with all suppliers so it's worth asking first.

The small triangular feature on the top edge is something I added to stop the bogie

rotating during a derailment to a point where it would hit the body or rupture the hydraulic hoses. Interestingly the bogies only rotate maximum of 10 degrees in either direction, even on the tightest of curvatures.

●To be continued.



Laser cut bogie side frame.

Garrett 4CD Tractor

in 6 inch scale

PART 73

Chris Gunn
finishes off
the perch
bracket and
the belly tank.



Continued from p.229
M.E. 4644, 31 July 2020

This article has been written to guide the builder through the construction of the 6 inch scale Garrett 4CD tractor designed by Chris d'Alquen. The writer has previously built a 4 inch scale Garrett and a 6 inch scale Foden wagon so has the benefit of considerable experience in larger scale modelling. Most machining can be done in the average home workshop but the supplier from whom the castings and drawings are currently available is able to provide a machining service for the largest items if required.

Once the lagging was done, the next step was the wooden lagging or cladding. I did not have any suitable material to hand lurking in any corners, so I set off to visit a local joiner who had supplied some material in the past and had seen pictures of what I was doing. He had no suitable offcuts close to the $\frac{7}{16}$ inch thickness I needed but he had a lot of short pieces of planed oak all 2 inches nominal thickness, in various widths. I could saw these to width and I came away with a lot of these pieces and two bags of kindling for a five pound note. The maximum length I would need would be 32 inches to allow for some final trimming.

The first thing I did was to crosscut these to length. Once the pieces were all sawn to length, I had to saw them into strips $\frac{7}{16}$ inch thick so the total thickness of wood and the fibre cladding did not



exceed $\frac{1}{2}$ inch. I did not have a bench rip saw which would have dealt with this in short order, so I decided to glue them all together to make a slab of oak. I duly applied the wood glue to the edges as shown in **photo 627**. After this picture was taken, I clamped them all together with a couple of sash clamps and left it to dry overnight.

The next step was to clamp this great lump of oak to my picnic table and then I was able to rip the strips of cladding off. I decided to leave them a touch over thickness so I could give them a going over with the cheap power planer I had bought for another job, and I must say it dealt with the tough oak very well. I carried on until the slab was cut into strips, discarding those which contained a glued joint and, by the time I had

successfully completed the job, I had more than enough to lag the boiler with some to spare which would come in handy later. I should mention that success was defined by one member of our household as not sawing a strip off the picnic table in the process.

I organised my kit for the next stage. I needed a workmate to hold the strips while I planed them or cut profiles in them, I needed the planer and a disc sander to put a radius on the ends so the radiused front band could fit, and I had some large worm drive clips which I joined to make even bigger ones that would fit around the boiler, plus pencils, tape and so on. I started off with the longest pieces, which fit under the boiler, and my modus operandi was to trim the end to length, plane the outside face of the lagging to clean it up, and then

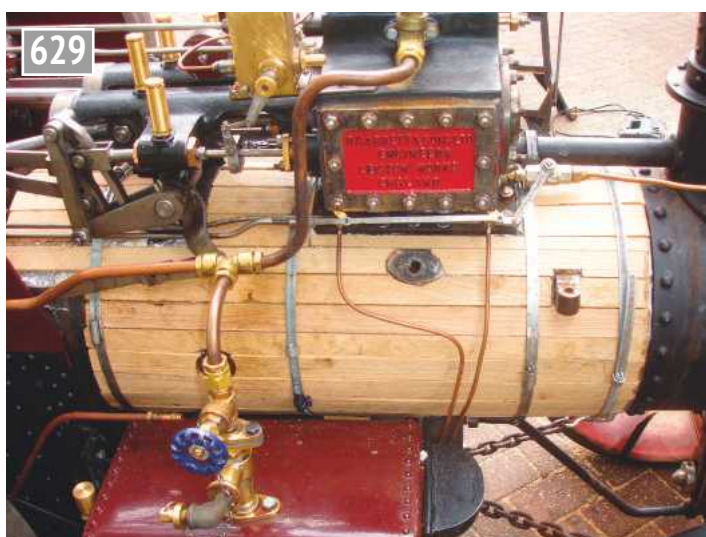
Drawings, castings and
machining services are
available from A. N.
Engineering: Email:
a.nutting@hotmail.co.uk



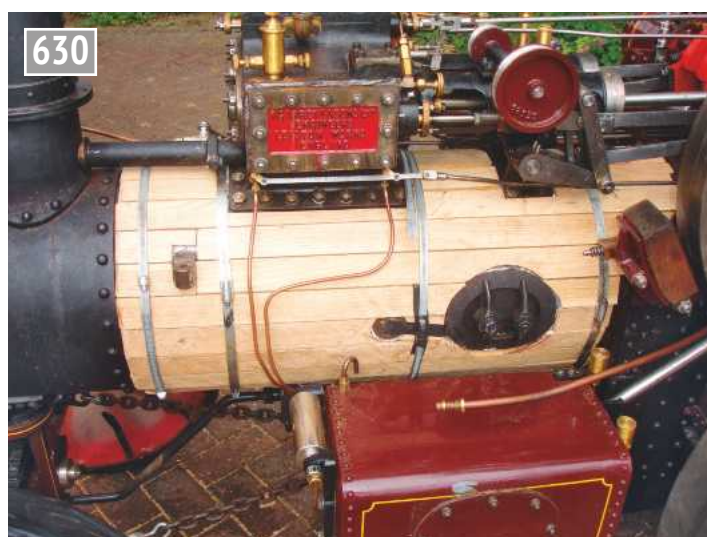
Glueing.



Fitting around bosses.



Finished right-hand oak cladding.



Finished left-hand oak cladding.

take a tapered cut off each side so the cladding would fit like the staves of a barrel. Then I sanded a radius on the front end and tried it in position, making any adjustments as required. I worked my way around the bottom, until I got to the bracket that holds the belly tank, and there I cut a narrow strip each side that filled the gap between the two sides of the belly tank supports. The next pieces each side that went on were notched to fit around the belly tank supports, as this was the easiest way to take account of the support and meant the adjustment was taken up on the outside of the supports.

As I added sections I began to encounter the clack valve bosses and the mud hole and I cut the strips accordingly. **Photograph 628** shows the

cladding being fitted around the injector clack valve boss on the right-hand side.

As I worked my way up, I had to fit the cladding around the block and the canopy supports. As work progressed the worm drive clips were loosened to allow the strips of oak to be added. Once the whole boiler was done, I tightened all the worm drive clips and then as the strips were squeezed together I found I needed to trim some off some of the edges to allow the strips to bed fully down.

Photographs 629 and 630 show the finished result with all worm drive clips tightened from the right and left sides.

In the meantime, I had taken my Plasticard patterns to our local sheet metal contractors, who I knew from my working days, and they were able to



First sections in place.

copy these in 0.5mm thick steel in return for a small contribution to their tea fund.

The next step was to roll the cladding. This was achieved using my Warco combined

bending rolls and guillotine and these were wide enough to handle the widest section. However, I started with the front two sections and these were easy to do.



Left-hand side almost complete.



Right-hand side complete.



Cladding in the raw.



Marked tape.

Once rolled I tried them on the engine and loosened the two front worm drive clips to allow them to be fitted. The clips at the other end of the boiler held most of the lagging in place. **Photograph 631** shows the first two sections in place.

It should be noted that the edge of the first section is about $\frac{1}{2}$ inch forward of the block. The second section of the cladding will butt up to the edge of the first section and the boiler banding will butt up to the edge of the block, leaving the joint well under the boiler banding. The rest of the sections were rolled and fitted, and **photo 632** shows the left-hand side almost complete and **photo 633** shows the completed right-hand side.

I had to trim the ends of the sections slightly to get the top joint on the centre line of the boiler for appearance's sake

and once I had got them all correct they were removed for cleaning up and painting. **Photograph 634** shows the complete set ready for the next step. It should be noted that the slots in two of the sections are to clear the belly tank support; these sections are fed in from the front, leaving the slots under the belly tank out of view.

At times fitting the cladding was a bit fiddly, but with a bit of patience and some bits of Plasticard to act as guides it all went in, as did the worm drive clips. These were the fiddliest items to fit mainly because there were several joints in them which always seemed to hook up on an edge until I taped them up with insulating tape, which helped a bit. The worm drive clips were left in position and tightened again when each section of cladding had been removed to hold all

the oak slats in position.

The next step was to paint the cladding. Before that they were cleaned up and deburred where necessary and wiped over with thinners. Then I primed them inside and out. I put a coat of undercoat on the inside and outside, all applied by brush. Once the undercoat was dry, I painted the outside with top coat several times, rubbing down between coats. Once the top coat was done, it was time to do the lining and it was useful to still have the Plasticard patterns, as I used these to check the lining and boiler banding positions. Then I transferred this to the cladding sections and I started out by sticking masking tape on the sections to show where the boiler banding would be. I marked the tape with pencil marks as shown in **photo 635** and then lined up the marks with the edge of the cladding

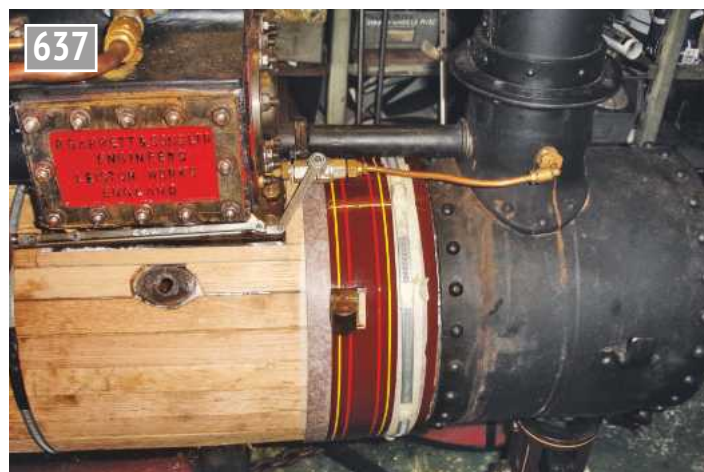
as I unrolled it, then cut off the excess with scissors.

Now that I had a position for the edge of the boiler banding, I could apply the $\frac{3}{32}$ inch lining tape for the lining. I applied two rows at the same time for each colour. **Photograph 636** shows the two middle sections masked and ready for lining.

Once the sections were all masked, I lined them one colour at a time, as described before, and let them dry overnight before the next stage, which would be re-assembly. The next day the sections were taken back out to the engine and once again I started from the front and the two sections in front of the block were dealt with first. The worm drive clips were loosened and removed and the cladding fitted, followed by the re-installation of the worm drive clips. These were fitted on top of the masking



Front sections masked.



First section on.



Second section protection.

tape that represented the boiler banding so as to avoid damaging the new paintwork. **Photograph 637** shows these in position. The pictures are a bit on the dark side as I must have had a rainy day as they are taken inside.

The second sections were a little harder to get in position without damaging the paint, so I resurrected the Plasticard patterns again and used these as a protective cover while the sections were slid into place. They were held in place with a few small pieces of masking tape, and when the section was in place I was able to pull the pattern away leaving the paintwork pristine. **Photograph 638** shows the section before fitting.

Once the section was in place and the pattern removed, I used a small piece to keep the cladding off the belly tank until the rear worm drive clip was

fitted. I now had two sections fitted with clips at each end of the section holding it more or less in position, so I then made and fitted the first boiler band. There seemed little point in adding worm drive clips and then changing them for the real thing. I had the boiler banding cut 1½ inches wide and over length, so I cut one to length and then made three sets of ends. I had some ½ by ⅝ inch thick brass angle which came from bottle labelling machinery way back when - the angles held the bottle labels and were too handy to scrap. I made three pairs of ends, one with M4 tapped holes and the other with clearance holes for M4 screws, and silver soldered them to the ends of the band. Then I fitted it and partly tightened it up enough to hold the cladding in position but still loose enough to allow the final positioning. I started



First band done.

out with some long screws and changed them for shorter ones when the band was pulled up. **Photograph 639** shows the first band in position.

I continued to add the cladding using bits of Plasticard to protect the

paintwork as shown in **photo 640**. I made sure that the overlap on each pair of sections of cladding was in the same direction.

●To be continued.



Adding cladding.

Prince of Wales Crank Axle

Graham Langer explains how the original crank axle design was improved for the new-build P2 *Prince of Wales*.

An article about metal fatigue in *Model Engineer* No. 4636 (10 April) made a passing reference to the failure of the crank axle of Gresley 'Mikado' Class P2 No. 2005 *Thane of Fife*. As a director of The A1 Steam Locomotive Trust, the charity building the next P2, No. 2007 *Prince of Wales*, I thought readers of *Model Engineer* might be interested in further information about the original problem which beset these powerful express passenger locomotives and how David Elliott, Director of Engineering for the A1 Trust, dealt with the issue.

Sir Nigel Gresley's P2s were conceived to haul heavy trains over the Edinburgh to Aberdeen road. The 2-8-2s were the most powerful express passenger locomotives to run in Great Britain and their mechanical innovations were matched by their bold outward appearance. The doyen of the class, No. 2001 *Cock o' the North*, was radically equipped with Lenz rotary valve gear, an ACFI feed water heater in place of injectors, a 50 square foot grate and streamlined steam passages to three cylinders which exhausted via a double Kylchap chimney. Externally the design hid the tapered boiler in a parallel, elliptical cladding running from a V-fronted cab to a muscular,

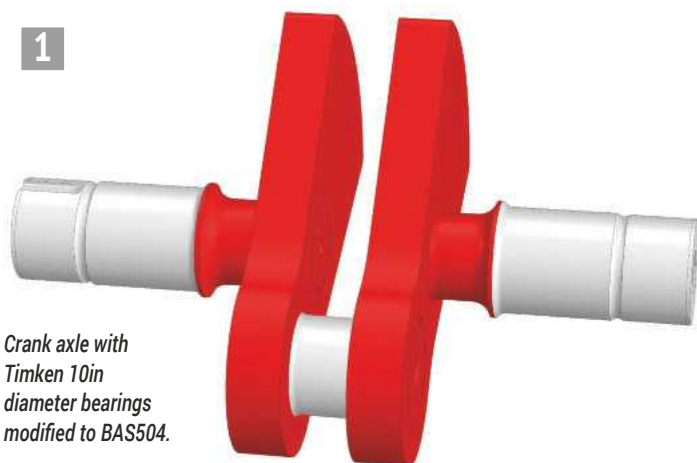
streamlined smokebox, the whole sitting on a high running board which exposed the 6 foot 2 inch drivers entirely. The 220lb/sq. in. boiler fed three 21 x 26 inch cylinders and the locomotive developed a nominal tractive effort of 43,460lb. All six members of the class differed in detail, being used as a test-bed for some of Gresley's latest thinking.

One of the problems experienced with the original P2 locomotives was fracture of crank axles and there were at least four occasions when a crank axle broke immediately behind the wheel. Whilst such occurrences were not uncommon in the days before routine non-destructive testing of axles by ultrasonic and more recently magnetic particle inspection, so many events on a small class of six locomotives over an eight year period is exceptional and would not be tolerated on today's railway.

The design of the P2 crank axle was essentially the same as that for the contemporary A3 Pacifics which were not prone to axle failure. The P2's larger cylinders would have resulted in higher maximum piston forces and hence torque in the axle and, whilst a Pacific will slip, dissipating the torque, the additional pair of coupled wheels on the P2s made them one of the most sure-footed classes ever used in Britain, resulting in higher sustained torque. That all these failures took place at low speed when the locomotives were accelerating hard had the fortunate consequence that none of the failures resulted in derailment. The photograph in *Model Engineer* No. 4636 showed the failure of the crank axle on No. 2005 *Thane of Fife* at Stonehaven in July 1939, indicating that a crack started from the sharp corner in the

end of the keyway for the key that locates the wheel on the axle. The crack had grown slowly until it was about two thirds of the way through the axle when it failed completely.

The axles to be fitted to No. 2007 differ from the original Gresley locomotives in having roller-bearings. The crank axle design on the Trust's first locomotive, Peppercorn Class A1 Pacific *Tornado*, incorporated several significant design improvements developed by the Timken company including a better keyway design and a stress relief groove, the surface of which was rolled to compress the material. These features enhanced the fatigue resistance by at least 60%, further improved by incorporating the BR BASS 504 wheel/axle design techniques. A Finite Element Analysis study of the P2 crank axle undertaken by Mott MacDonald at Derby demonstrated that, while the improved Timken based design was significantly better than the original, there was not a sufficiently comfortable margin of strength. Mott MacDonald were asked to re-run the study with the axle with the bearings increased in diameter from 9.625 inches to 10 inches (Timken can supply bearings of this diameter which will still fit in the P2 axleboxes) and this was the final design solution chosen (**photo 1**). The updated FEA study by Mott McDonald showed that the improvement in fatigue lives for the worst scenarios with the increased axle diameter and modified key ways was dramatic (of the order of a factor of at least 10) leading to the conclusion that the Trust will have little difficulty in demonstrating the minimum component life of a quarter of a million miles. Given the increased power of the P2 design and



Crank axle with Timken 10in diameter bearings modified to BAS504.

the problems found with the crank axle, there was also a desire to improve the material for the sweeps. Somers Forge proposed a stronger material which retained the toughness of the original EN8 steel and this was duly approved for use in the assembly of the P2 crank axle.

The crank axle was forged at Somers Forge of Halesowen, as were the webs, and all the components were machined by Unilathe of Stoke-on-Trent before being consigned to South Devon Railway Engineering, Buckfastleigh (SDRE) for assembly, which was the culmination of the FEA carried out by Mott MacDonald to eliminate the weakness in the original design. The assembly was then transported back to Darlington Locomotive Works for the Timken roller-bearings to be fitted. Having checked that the dimensions of the axle ends and the various spacer and thrust rings were correct, each component was heated to 110 degrees C using an SKF bearing heater and slid onto the axle in turn. The axle is typically 0.004 inch greater in diameter than holes in the rings and bearings, so as the components cool, they grip the axle (**photos 2 and 3**).

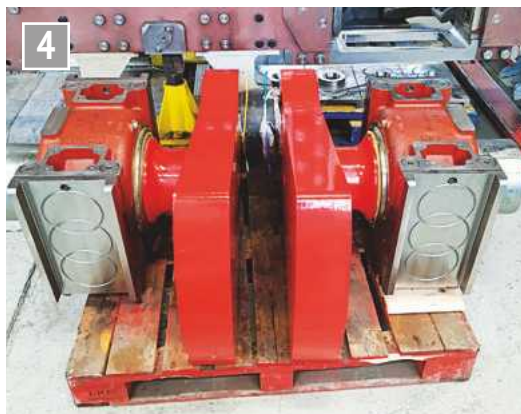
Once fitted with its bearings and associated cannon-boxes (**photo 4**), the crank axle was returned to SDRE to be united with its wheels (**photo 5**); with these in place, the crank pins were fitted using a quartering machine. The quartering machine is a special form of horizontal borer which can bore crank pin holes or turn crank pins (if already fitted) from both sides of the wheelset at the same setting; provided the setting is not altered whilst swapping wheelsets, this ensures that the distance between the crank pins and the axle centres and the angle between the crank pins is consistent for all four wheelsets which is vital for smooth running of the finished locomotive. The wheels, which had been cast by the Trust's principal



Assembling the crank axle at Darlington Locomotive Works (photo: David Elliott).



The crank axle fully assembled (photo: David Elliott).



The crank axle, with axleboxes, is shipped to the South Devon Railway (photo: Mandy Grant).



The crank axle wheelset is set up in the wheel lathe to turn the rims (photo: Rob le Chevalier).



Ian Matthews finishes off the wheels (photo: David Elliott).

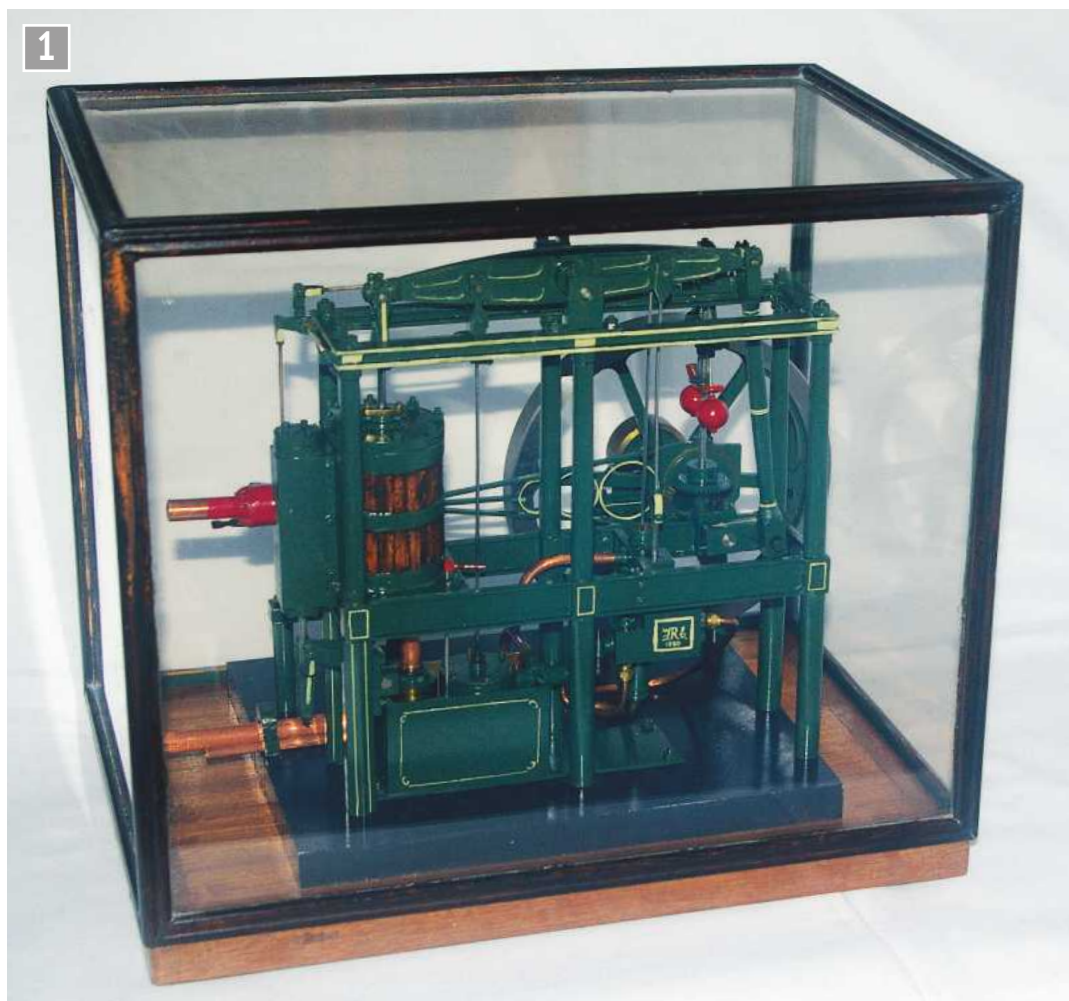
sponsor, William Cook Cast Products of Sheffield, then had their tyres shrunk on - tyre fitting is being done using the

ex-Swindon works tyre heating equipment. The completed crank axle was then returned to Darlington to be located

under No. 2007 to await the fitting of lots of shiny new motion (**photo 6**)!

ME

Frank Cruickshank shows that it is not too hard to make a nice display case for your model.



Model imprisoned in Perspex display case.

A 'Glass' Case for your Model

We all appreciate the challenges presented by making our models but, once they are finished and are put aside as we get on to the next one, they tend to gather dust. This is awkward to remove from their tiny crevices and combines with the oil to form a paste that has to be removed. Dusting the models is tedious and not something that I, for one, like to do. Accordingly, it is a good idea to provide a glass case for your model to

lessen the dust collection while allowing viewing of the model. The case should also provide a degree of protection.

The case that I shall describe requires the minimum of carpentry but does fulfil the above objectives. An example is shown in **photo 1**.

The glazing medium used is acrylic sheet (Perspex, Lucite or polymethylmethacrylate). I do not find polycarbonate sheet as good, since it tends to react with the glue to produce

a 'milky' finish which can be seen on the finished case. Use sheet that is at least 3 mm thick, since thinner sheet tends to move during assembly and can lead to warped sides or sprung joints. It comes covered on both sides with a peel-off film. This should be left on until the final assembly.

The frame of the case is wooden moulding, obtainable from D.I.Y. supermarkets. Two types are required; one is a right angle (inside) moulding



A suitably matching pair of wood mouldings.

and the other a quadrant section moulding which is the correct size to use as the interior part of the frame with the right-angled moulding on the outside, taking into account our sheet thickness. **Photograph 2** shows how these work together to provide a strong frame at each corner of the acrylic case.

Fortunately, the supermarkets frequently have these mouldings in suitable pairs. If it proves impossible to find the correct size of quadrant moulding, square cross section strips of wood or acrylic, cut to the required size, may be substituted. The total moulding length required is just greater than the sum of all sides of the finished case to allow for saw cuts and the width of the moulding. The acrylic case is held together with 'UHU Power' glue (usual disclaimer, but this does work well and is transparent when dry). This glue is also used on the wooden mouldings.

I will not give sizes because, of course, these depend on your model. However, it is essential to mark out and cut the acrylic sheet first, ensuring that the inside size of the finished case will accommodate your model and that the order of assembly has been determined. This last will determine which sides have to allow for the thickness of the sheet at the joint edges (see photo 2). The sheet may be cut with a circular saw blade (crosscut, for wood) with tungsten carbide tipped teeth

at about 3 teeth per inch (feed in slowly) or a hard point hand saw with at least 11 teeth per inch. Both should be used at a shallow angle (**photo 3**).

The assembly bench must be very flat and clean. It is best covered with cling film or similar, since this provides a clean surface and is easily liberated from any errant glue. I find it convenient to make the top of the case fit inside the sides. In assembly, the top is laid on the bench and becomes the bottom of the case temporarily. It is best to leave the peel-off film on for the lower face (eventual outside of the top), since glue may ooze under it on assembly and is then easily removed.

One word of advice about the glue. The acrylic sheet is a very good insulator and readily attracts static charge. If you try to use the glue inside the embryo case or near what will be the transparent faces of the case, a thin stream of glue can leap from the tube to the sheet where it will adhere and dry to form a non-removable and unsightly mark. Apply the glue



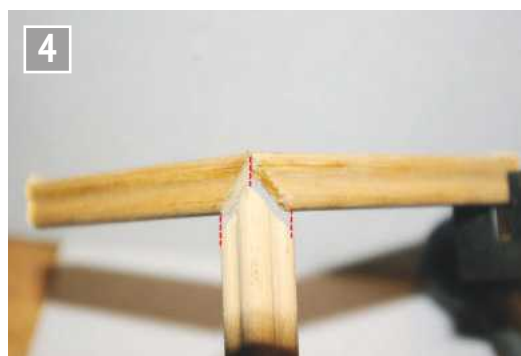
Cutting the Perspex sheet.

by holding the tube as a pen and use a very thin film of glue along the edges of the sheets.

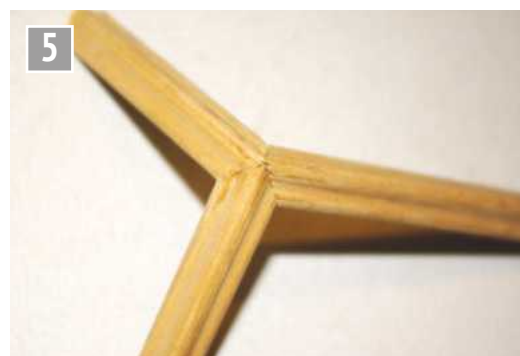
Following my order of assembly, one end (the same length as the width of the top sheet) is stuck to the top sheet. Again, only the outer peel-off film is retained. One side of the case is then glued in position (it will be as long as the top sheet plus twice the thickness of the sheet). Thus a complete corner of the case will have been formed. These pieces can be held in place with suitable, light clamps and weights on the bench to keep everything in place and the joints close together until they dry. The end and side will be square to each other as determined by the top sheet lying on the bench. The upright joint must be flush throughout and the flatness of the bench should ensure that this is easy to attain. At this point, I allow the case to dry overnight. On the second day, the remaining end and then side are glued in place thus completing the rather fragile, acrylic carcass of the case.

While the case is drying, the wooden mouldings should be painted the colour of your choice on all faces. I usually use black or wood stain. Only what will be the visible faces of the mouldings (outer, shaped faces of the right angle moulding and curved face of the quadrant moulding) should then be finished, either with gloss paint or varnish. This means that no untreated wood will be visible through the acrylic sheet when the case is finished and a great deal of tedious 'cutting in' with a fine paint brush is avoided. Attempts to paint inside the finished carcass suffer from the electrostatic problems that beset the glue.

The carcass of the case is now set up, correct way up, and all peel-off films remaining are removed. Angular mouldings are glued in place around the top face. These are mitred at the ends and the inner length of each strip is measured, in the angle, from the length of the case edge. **Photographs 4 and 5** show how to make the corner joint.



Forming a corner.



A complete corner.

The mitre is formed using a mitre box in my case but mitre saws or your preference may be used (**photo 6**).

Note that the mitres must be cut both ways, giving each strip a pointed end (**photo 7**).

Again, an overnight drying time is advisable. The angular mouldings on the vertical edges of the case are then mitred and glued in place. The strips of angular moulding, destined to become the lower edge of the case, are planed along one edge to reduce that side of the moulding, so that it will be flush with the acrylic sheet on the inside of the finished case (**photo 8**).

This raw edge is best finish-painted at this stage. After an overnight drying period, this lower edge moulding can be mitred and glued in place. If, at any stage, the mitred joints are unsatisfactory, they can be trimmed with a sharp chisel but only if they are over-long!

The case should be left to dry thoroughly at this stage. Overnight is usually sufficient but depends on the temperature and humidity. Finally, the quadrant moulding is mitred and glued in place, beginning with the inside of the top (now inverted again on the bench). This time, the overall length of the strips is equal to the inside length of the corners. The ends of these strips at the bottom of the case can be left flush with the bottom of the outer angular mouldings or be chamfered. When all the glue has dried, the case attains maximum strength and any bare wood showing (e.g. at joints) may be touched up, after finishing as necessary, with a long, fine paintbrush using very little paint on the brush and being aware of the electrostatic problem.

The glazed case now needs a base to sit on. It is best to arrange some sort of rebate



Using a mitre box.

along the edge of the base so that the case locates firmly on the base and so that maximum exclusion of dust is achieved. The base can be quite decorative. I prefer varnished wood finishes but attractive wood is expensive

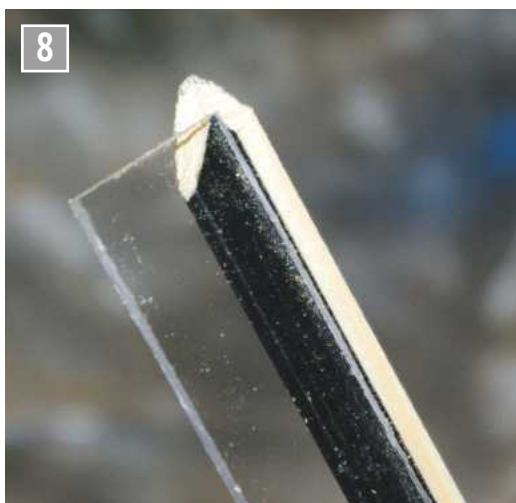
so I use something cheaper for the larger part of the base (e.g. veneered chipboard) and surround this with a mitred edging of oak or mahogany (**photo 9**). This is glued to the main base using waterproof P.V.A. wood glue and clamped until dry.

A rebate can be cut in this edging as in **photo 10** or, more simply, the model can be mounted on a thin sheet of, for example, plywood (suitably painted) which is smaller than the base by the width of the moulding at the bottom of the case, but overlying part of the edging and concealing the cheaper wooden base. If the inner quadrant mouldings were finished flush with the angular mouldings, it will be necessary to relieve the corners of the plywood to allow the quadrant mouldings to sit on the base. It is essential that the glazed case sits absolutely flat on the base and does not rock. If your assembly bench was flat this should not be a problem.

Finally, before the model in its case can be admitted to the domestic environment, padded, soft feet must be applied to the bottom of the base. If the model is not too heavy, stick-on plastic feet are suitable. Otherwise, screw-on feet are available, as used for electronics cabinets, or felt-covered wooden blocks might be used.



Mitre with nicely pointed end.



Getting the moulding flush with the 'glazing'.



Mitred edging of the display case.



Recess on the underside, with plastic stick-on feet.

ME

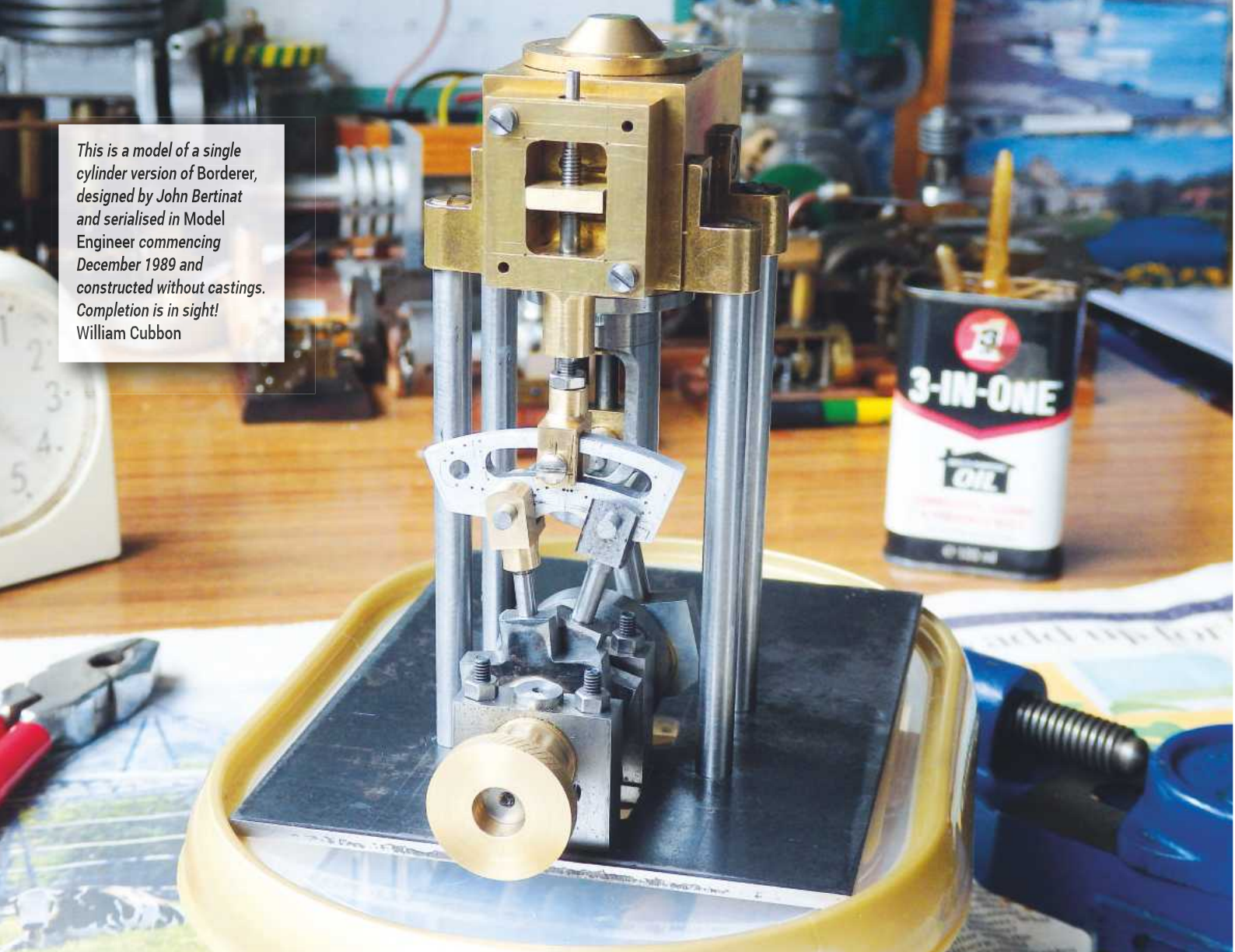
Lockdown Showcase



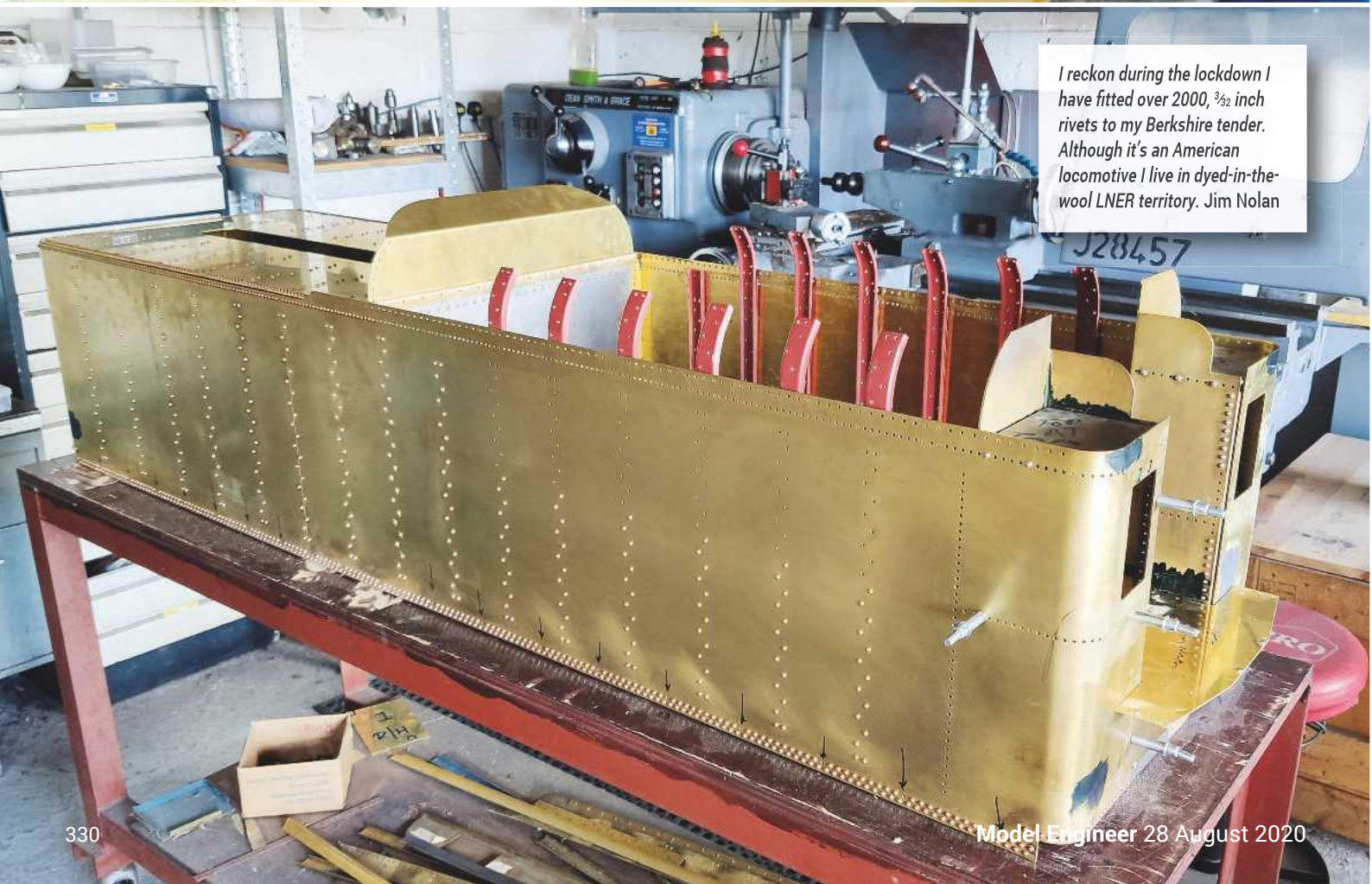
This is a truly international control panel. The parts have come from quite a few different countries: the box is from Ireland, the rotary switches are from Austria, the toggle switches are from Taiwan, the indicator lamps and the no-volt release are from China, the socket outlets on the side are from England, the relay base inside the panel is from Switzerland with a UK relay, the other relay inside is from Germany, the control transformer is from Japan and the labels are from Spain.
Graham Astbury



This is my Rob Roy which is being finished in the style of Rowland Emmett. During lockdown I have fitted the smokebox, made the tanks and started on the spectacle plate. This is a slow project that has been slowly ticking over on the back burner as a plaything for the kids.
Martin Parham



This is a model of a single cylinder version of Borderer, designed by John Bertinat and serialised in Model Engineer commencing December 1989 and constructed without castings. Completion is in sight! William Cubbon

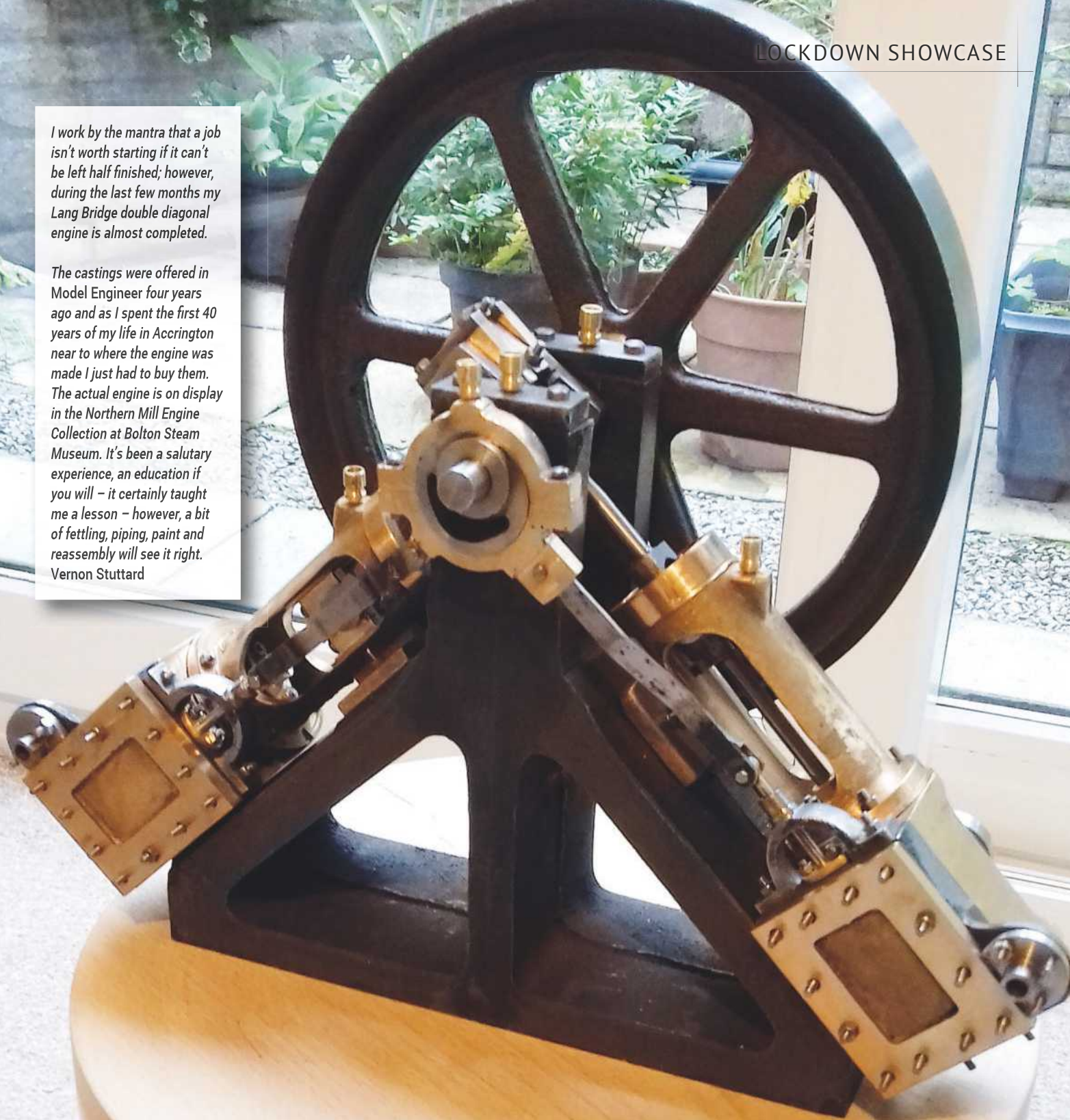


I reckon during the lockdown I have fitted over 2000, $\frac{3}{32}$ inch rivets to my Berkshire tender. Although it's an American locomotive I live in dyed-in-the-wool LNER territory. Jim Nolan

I work by the mantra that a job isn't worth starting if it can't be left half finished; however, during the last few months my Lang Bridge double diagonal engine is almost completed.

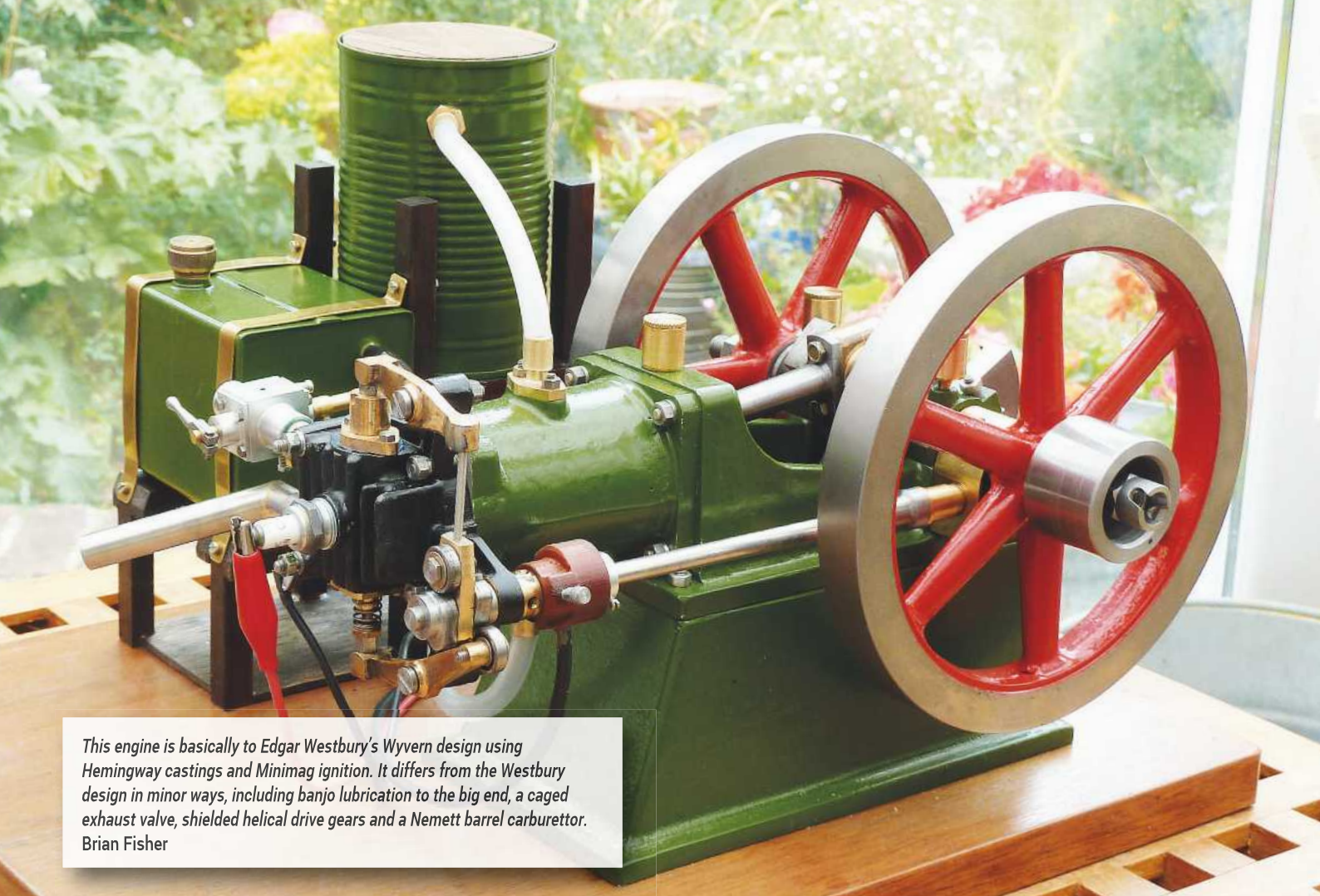
The castings were offered in Model Engineer four years ago and as I spent the first 40 years of my life in Accrington near to where the engine was made I just had to buy them. The actual engine is on display in the Northern Mill Engine Collection at Bolton Steam Museum. It's been a salutary experience, an education if you will – it certainly taught me a lesson – however, a bit of fettling, piping, paint and reassembly will see it right.

Vernon Stuttard



This is a 7¼ inch gauge model of a Sentinel 100hp shunting locomotive, to a scale of 1/6.6 (the full size is a very small locomotive so I scaled it up a bit from the usual standard gauge 1/8th scale). The idea is that as the full-size engine is chain driven, I can build a working chassis and power it with an electric motor, then at a later date convert it to steam power. That way I would have a working locomotive to use while I build the steam engine and boiler for it.

Dave Breeze



This engine is basically to Edgar Westbury's Wyvern design using Hemingway castings and Minimag ignition. It differs from the Westbury design in minor ways, including banjo lubrication to the big end, a caged exhaust valve, shielded helical drive gears and a Nemett barrel carburettor.
 Brian Fisher



The lockdown was a good time to catch up on my backlog of Model Engineer magazines. Also, I bought some parts a while ago for the Model Works Tiger tank and the lockdown has given me the opportunity to turn them into a fully working model.
 Gavin Oseman

A New GWR Pannier PART 22

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



Continued from p.216
M.E.4644, 31 July 2020

There should be a nice little casting for the regulator (fig 37), and it should have a pad on either side so that you can fix it down to the dome ring bush inside the boiler. That will mean that there is no need to make any drillings on the boiler barrel which to me is a no-no. It will need a couple of holes drilling and tapping 6BA in it and then you will need to counterbore the holes with a $\frac{3}{16}$ inch

counterbore so that the screws have a nice flat surface to bear down on. The regulator is the typical Stroudley type and I find this type very reliable and leak proof.

You need to bore the hole for the main steam pipe cleanly so that the steam pipe will just slide into it with its 'O' ring on it. A bit of moly grease on the 'O' ring might help. That should give you a nice steam tight joint without having to match any threads up in the front of the regulator. All of my locomotives have this kind of main steam pipe fixing which means that all you need to do is to undo two nuts and the superheaters will just slide out - simple!

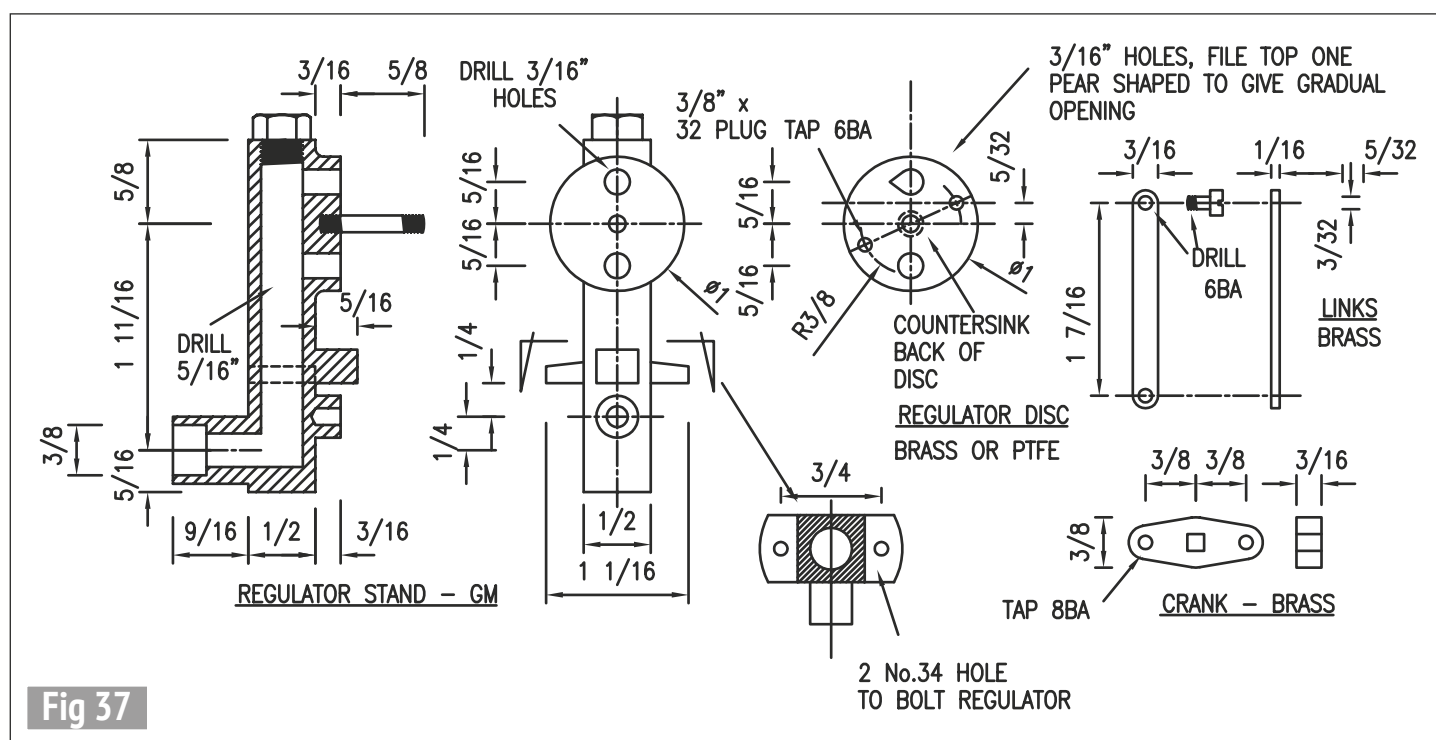
The main disc of the regulator needs machining in the four-jaw chuck but it will be all a bit lop-sided so just be a bit careful with that. It will need a hole drilling in the middle of it and tapping 5BA. It is as well if you can relieve the centre part of this face by a couple of thou or so, so that the valve disc will seat well. Once machined you will also

need to face the disc with wet and dry paper down to about 1,000 grit to make a good seal. To make the actual regulator disc you will need to use a piece of brass and this will need facing similarly. It is as well to give one of the holes a bit of a lead in as I have shown on the drawing to give a gradual opening. You can also give this disc a little relief in the middle but make sure that you do not encroach on to the two holes. Rub this down the same way as the disc on the regulator and then just put a little bit of spit on the disc and see if it sticks together (am I allowed to say that?!) Anyway, you get what I mean.

I don't think that the two yoke bars will present any difficulty, and neither will the crank, save to say that you need to make the square in the middle a really good fit on the regulator rod. The disc needs assembling with a light spring on the pivot and then it should work very well with no shake. The crank is shown in **photo 169** and the disc is in **photo**



Making the regulator crank.



170. Photograph 171 shows the back of the regulator disc with a very slight countersink inside the hole so that there is no snagging.

Photograph 172 shows the very similar regulator in my new Y4 boiler with the steam pipe from the turret sticking up in front of it.

The regulator shaft (**fig 38**) should be made from $\frac{5}{32}$ inch diameter stainless steel rod (316), 10 $\frac{5}{16}$ inches long I think, and you can turn one end to $\frac{1}{8}$ inch diameter for a length of $\frac{3}{16}$ inch and then you need to mill it or file the next $\frac{3}{16}$ inch to a $\frac{1}{8}$ inch square or as near to a square as you can get it. You need to mill another square on the other end but not before you have poked your rod into the boiler to check the length of it. To do this you will need to make a collar to go near the end. This should be $\frac{3}{32}$ inch diameter with a $\frac{5}{32}$ inch hole through it and when it is firmly in the regulator body and with the turret in position you need to pop a $\frac{5}{16}$ inch 'O' ring in the hole too and measure it from there. You will also need room



Getting the regulator disc flat.



The back of the regulator disc.

for the regulator gland on there too. The remaining $\frac{3}{8}$ inch needs to be $\frac{1}{8}$ inch square to fit the handle. When you are satisfied that it is correct you can then silver solder the collar on. **Photograph 173** shows the forming of the square on the end of the shaft and **photo 174** shows me measuring up the depth to the 'O' ring so that I could cut the rod to length.

Now for the regulator handle (**fig 39**). You will have to do a nice little bit of fabrication work on this to make a proper job of it. First of all, you can tackle the boss which will be $\frac{1}{4}$ inch diameter parted off at $\frac{3}{8}$ inch long. The next thing you

need to do is to use a $\frac{3}{16}$ inch end mill or slot drill to make the recess to fit the next piece into it. You then need to add a piece of $\frac{3}{16}$ inch by about $\frac{1}{4}$ inch rectangular bar which needs rounding off down one side of it to fit into the boss of the first piece which you made. Silver solder this piece in and then file it or machine it to a near flush fit top and bottom.

Now, if you want your backhead to look a proper job you will need to fit the vertical arm to the handle where you will be fitting the dummy jockey valve. I am sure that you can do that as it will enhance your footplate no

end and there is not a lot to it either! I have produced the drawings for it, so the ball is in your court. Anyway, the handle also needs silver soldering on the boss. All you need then is to drill a No. 43 hole in the vertical part you have added in and then cut a slot all the way along with preferably a slitting saw, or even a thinner one. I have a very nice little one which is 15 thou thick. The regulator handle is shown in **photo 175**.

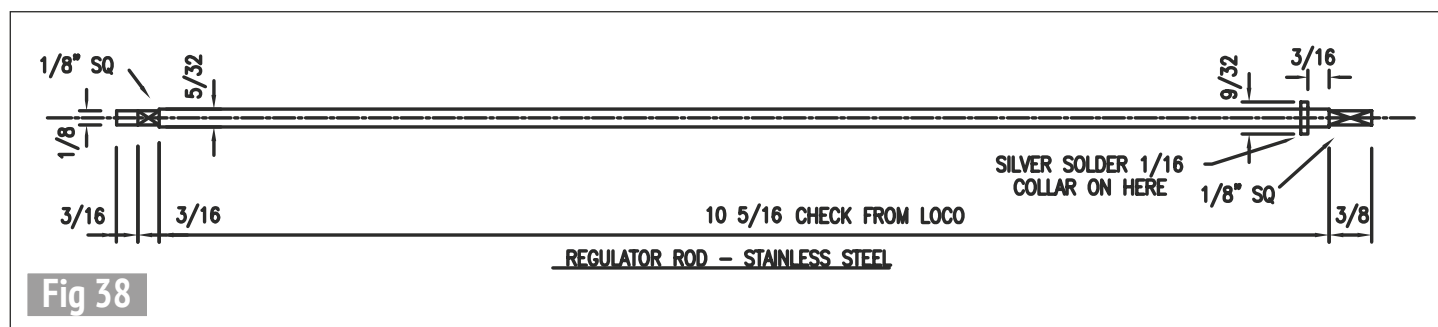
Now, no one can fail to notice that there is a bit more to the regulator handle than just the handle. Here I have produced the bits that go with



The regulator installed in the author's Y4.



Putting the square on the end of the regulator shaft.



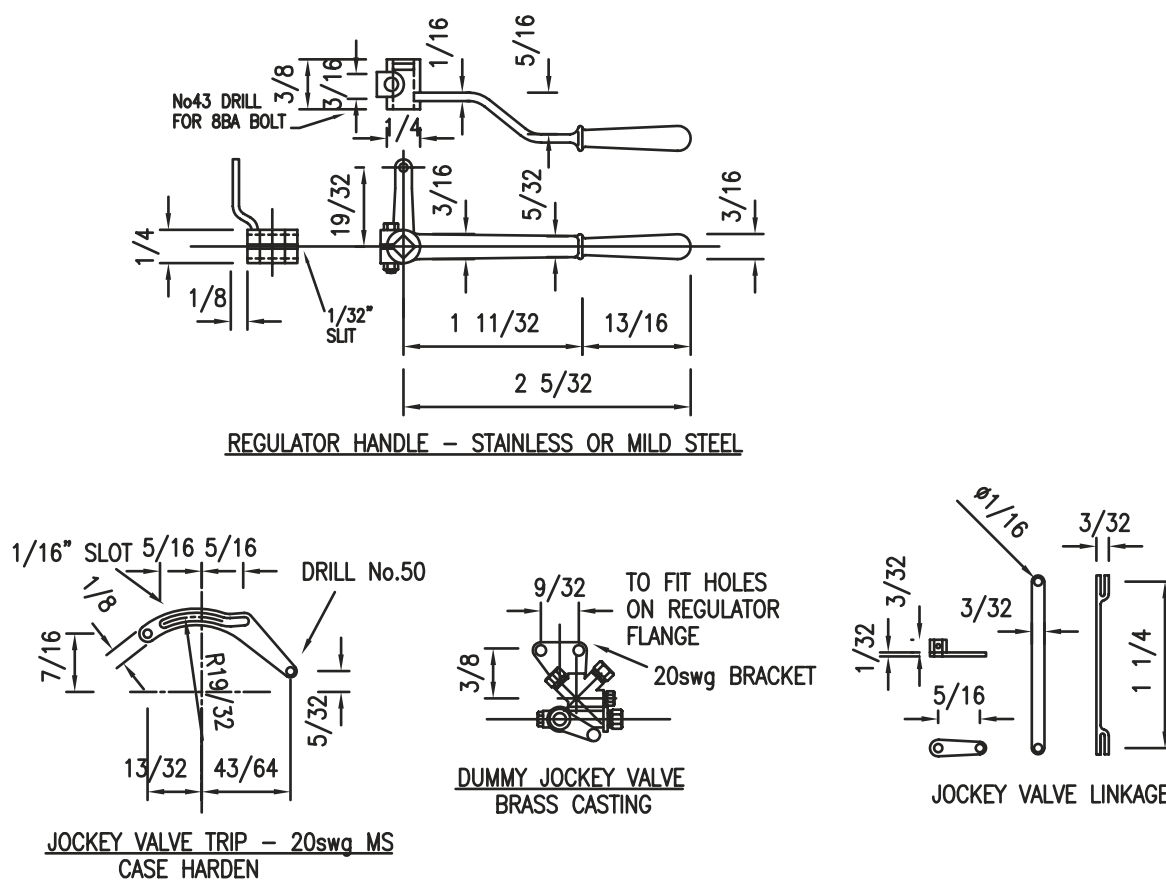


Checking the length of the regulator shaft.



Regulator handle.

Fig 39



the handle. Yes, I know that you will want to be getting on with the pannier and get it in steam but it would be very nice if you might just consider the other bits and pieces to go with it. I have made a pattern for a dummy jockey valve so I do hope that someone will use it. The linkages are simple to make and people will be very impressed with your attention to detail! There are then some small pieces of $\frac{1}{16}$ inch pipework required to go with it but I think that it will look

very nice and you can get the details off the photographs.

Photograph 176 was given to me by Guy Harding and I just thought that it would help you with the pipework.

● To be continued.

NEXT TIME

We go to the other end of the boiler and look at the smokebox.



A close-up view of some of the associated pipework.

Obituary Jack Buckler

Jack Buckler passed away on 8th August aged 94 following a stroke.

Jack would be known to many as the designer and builder of his very famous 5 inch gauge *Sweet Pea* narrow gauge locomotive. He first approached Blackgates Engineering in the mid 1970's to see whether castings could be obtained for a model he was building for his friend and GP, the late Dr. Roger Jackson. This was the beginning of the long association between Jack and Blackgates and subsequently *Sweet Pea* was born as a commercially available design. It used to irritate Jack when people said this was a model of Reverend Teddy Boston's *Pixie* locomotive, which it was not. He followed this design with a 3½ inch gauge version (*Sweet Violet*) and a 7¼ inch gauge version (*Sweet William*). Many hundreds of *Sweet Pea* locomotives have been built and it is rare to see two that look the same.

An annual rally is hosted by clubs around the country, starting with the first at the Leeds club at their Eggborough site in 1993. Jack was often in attendance and was extremely proud to see his offspring performing on the track; there can hardly be a track anywhere that hasn't seen an example.



Phil Owen and his 7¼ inch gauge 'Sweet Pea' Jacque O (photo: John Arrowsmith).



Jack Buckler (right) and Roger Jackson at a Sweet Pea rally in 2013 (photo: Brian Holland).

The design was published as a series of construction articles in *Engineering in Miniature* and this was followed by a book a few years later.

Jack was an electronics engineer by profession but a steam man by inclination. For many years he operated his own electronics company with his younger brother Peter.

I first met him when an invitation was extended to interested parties to visit a 2 foot gauge line near Leeds. This turned out to be about 230 yards of single-track line running from the rear of Jack's house and along the top edge of a valley. This was designed and built by Jack and Roger Jackson. They frequently steamed a quarry Hunslet Locomotive called *Allan George*, that they successfully bid for in 1965 when the Penrhyn quarry railway was dismantled. Together they rebuilt the locomotive (it took 5 years to restore) and ran the Howden Clough Light Railway with a small band of helpers

until it all got a bit too much for them. The railway helpers were often rewarded with a glass of Jack's (very potent!) home brew. The railway's trucks and locomotives were sold to the Teifi Valley Railway in Wales in 1983. Today the only trace remaining is a girder bridge built by Jack and Roger.

Jack's intention was to lay a 5/7¼ inch gauge track in place of the two foot gauge but this never happened. A Garratt type of *Sweet Pea* was on Jack's drawing board for some time and he even had the two chassis well on the way. He took great delight in solving technical problems and spent a great deal of time designing an articulated joint for the steam pipe to the cylinders. Typically, Dr Jackson (Roger to his friends) was not impressed and commented that a flexible pipe connection would have been easier.

Jack will be sadly missed by all who knew him.

Phil and Jacque Owen

Richard Williams converts his 5 inch gauge 'Black 5' Stroudley regulator to use a process ball valve.



An Improved 'Black 5' Regulator PART 2

Continued from p.279
M.E. 4645, 14 August 2020

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Machining the main regulator body

You will need to refer back to fig 1, supplied in the first instalment (M.E.4645, 14 August). The general arrangement of the modified regulator is shown in fig 2.

Take a bar of 1 inch diameter bronze and turn to 1¾ inches in length. Centre each end. Note that the centre on the right-hand side (looking at the drawing) need not be a deep centre hole, as it is merely a datum point for marking out one of the important dimensions. Next, turn the spigot on the left-hand side (looking at the drawing) to ⅝ inch diameter, for ⅞ inch length, then drill the spigot as follows; first drill down 1⅜ inches depth using a ⅜ inch drill. Ensure you drill no further than 1⅜ inches or this will cause problems later. Now drill 1⅝ inch for ¾ inch depth, and tap as near to full depth as you can get, using a ½ inch 26 tpi tap, to match the main steam pipe thread. If you have the steam pipe out at this stage, you may want to check that ½ inch 26

tpi is indeed correct for your locomotive. That's about it for the lathe operations, unless you use your lathe for milling work.

Otherwise, transfer to the milling machine, and mill a flat on the remaining 1 inch diameter section of the round bar ⅜ inch depth at the centre. This will be the bottom of the block. Now using this bottom flat to help reposition the block accurately, mill a parallel flat on the opposite face, down by ⅝ inch at the centre, but forming two ⅝ inch wide shoulders either side. One of these shoulders helps secure the boiler fastening and the other provides space for the regulator rod location hole. Now do not remove the block out of the milling vice yet, but find the absolute centre between the two top shoulders and drill a ⅜ inch hole down through to join the horizontal hole through the centre of the block. Finally, use a ½ inch 'D' bit and cut a ½ inch rebate into the top of the hole, ⅞ inch depth, for the spigot to locate into.

Next you need to cut the slot in the left-hand shoulder (looking at the drawing), which will help firmly secure the arm section to the boiler. If you are using the existing arm from the Stroudley block, measure the thickness and cut a slot across the left-hand shoulder to suit. I used a ⅜ inch slot drill for this job - if you get it right, it acts as a press-fit to hold the arm in place for soldering. To create the arm section which attaches to the boiler, I simply carefully cut the arm off the Stroudley regulator and silver soldered it into position on the new regulator. However, you can of course make a new arm but the advantage of using the old component is that you know it is aligned to one of the important dimensions I spoke of earlier – the boiler top to the steam pipe and, more importantly, it is aligned to the two securing holes in the boiler.

Now looking at the right-hand end of the block (looking at the drawing), there is a centre column which needs to be cut to allow the bolts on the linkage to move freely up and down, from fully open to fully closed regulator. Mill the end of the block ⅜ inch deep, leaving only a ¼ inch strip in the middle. The width of ¼ inch may need to be very slightly narrower, depending on the actual construction of the linkage on your locomotive, and you will only be able to check this once the machining is completed, the ball valve mounted and regulator rod in place. Finally, be careful machining this column or you could end up breaking into the main horizontal hole within the block if you cut too deep.

Before leaving the milling machine, you need to profile the bottom of the block by

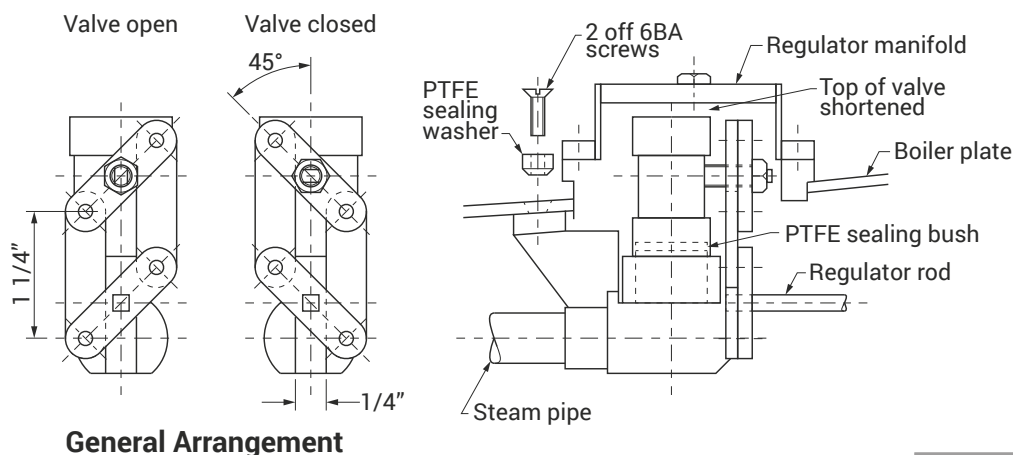


Fig 2

Finally, take a pair of dividers set at $\frac{5}{16}$ inch and mark across the column on the right-hand end of the block, using the light centre hole created at the beginning of the machining process as a bench-mark. This marks the position of the regulator rod $\frac{1}{8}$ inch hole. However, do not drill this hole yet as we need to confirm the $\frac{5}{16}$ inch dimension, once the ball valve is assembled on the block.

Machining the ball valve spigot

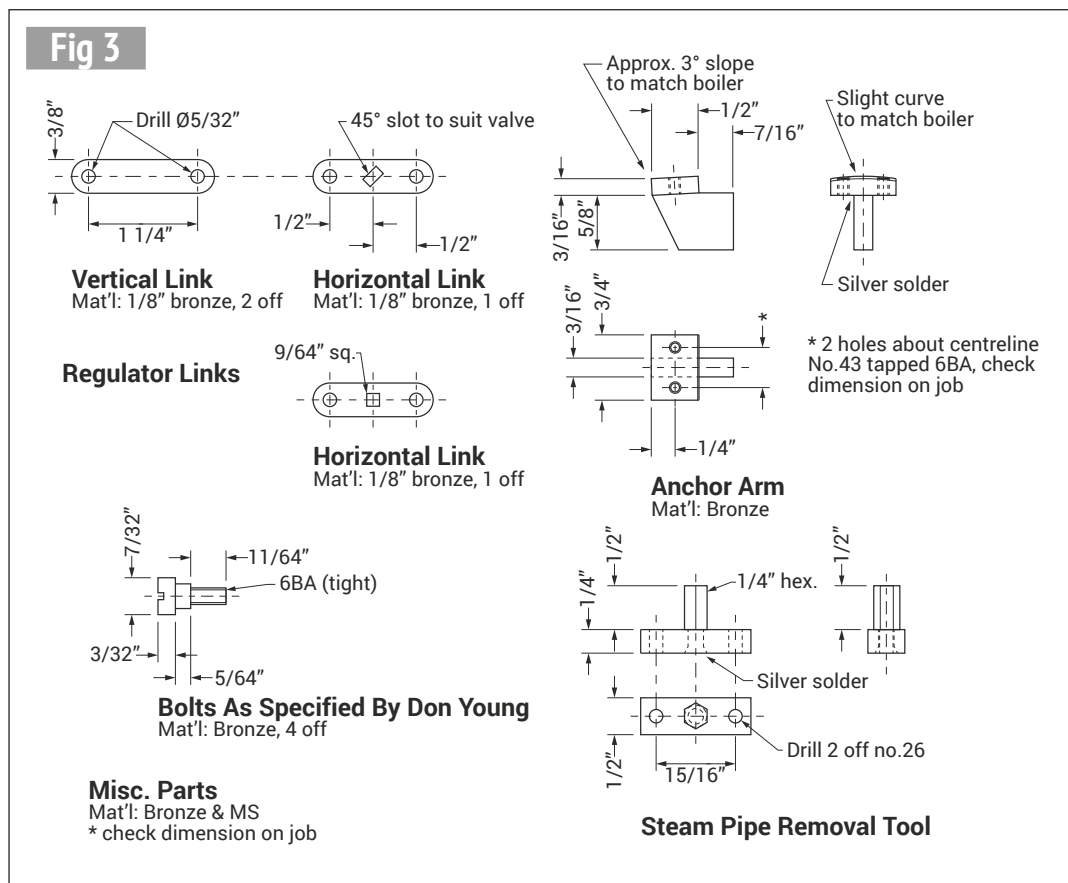
Now chuck a piece of $\frac{3}{4}$ inch round bronze in the lathe, face off and centre and cut a $\frac{1}{2}$ inch 14 tpi parallel pipe thread for the ball valve.

Now a word about BS pipe threads. A ½ inch thread actually comes up at ¾ inch, not ½ inch, which all seems a little strange. I am no expert in this area but one site on the Internet helpfully explains; the way to determine the size of the thread needed is to take the outside diameter of the thread you want and subtract ¼ inch, which makes a ½ inch thread ¾ inch when finished. Understand the logic? I'm sure you do!

The full form of the thread is, I believe, a sinusoidal shape. However, I used the lathe to cut this thread rather than a die and found no problem in perfectly mating with the ball valve, by cutting the thread using a circa 55 degree angle point on the cutting tool,



The completed block.



presenting the point at 90 degrees to the work.

Having cut the thread, check the ball valve screws onto the spigot freely. If it binds, just run the lathe and take the sharp edges off the top of the thread by lightly rubbing with emery paper. Next cut a ½ inch diameter shoulder ⅛ inch in length, to make a transition fit into the main block. This will help accurately position the spigot when silver soldering the two components together. Silver solder the spigot to the main block, ensuring a good seal between the two components; quench, pickle, and clean up.

Creating the anchor arm

The next task, if you are not using the original for some reason, is to create the anchor arm which fastens the regulator to the boiler. **Figure 3** shows the design of the arm. I find a problem is getting hold of bronze strip, which you will need to make the two elements of the arm. An important aspect of this arm is the fact that the top piece is both slightly rounded to suit

the radius of the boiler, and also slightly tipped forward. There is otherwise nothing too difficult about this, so follow the drawing as shown. Note however that the securing bolts used on the locomotive were specified at 8BA but I decided to open them up to 6BA, drilling out the holes through the boiler to 6BA clearance.

Before soldering the arm to the main block, double check the distance from the top of the arm to the centre of the steam pipe, which needs to be 1 ¼ inches. Silver solder the arm in place, quench, pickle, and clean up. It is really important to get this aspect of construction correct, as a failure to align correctly will result in the main steam pipe not fitting correctly. **Photograph 3** shows the completed block.

Mounting the ball valve onto the body

Screw the ball valve onto the main block until the centre of the operating spindle of the ball valve (facing towards to the right side of the block)

is $1\frac{1}{4}$ inches from the centre mark for the regulator rod hole. This, as I noted earlier, is particularly important if you are re-using the operating mechanism. Once you have it positioned at $1\frac{1}{4}$ inches from the spindle to your earlier mark, confirm that mark, and drill down $\frac{3}{32}$ inch using a $\frac{1}{8}$ inch drill. This activity is actually quite tricky, as the thread on the stub is coarse so getting the ball valve to come down to precisely the distance to match the earlier marking is not easy. We can however assume that given the length of the regulator rod, there is a small amount of latitude in the vertical position of the locating hole on the main block, so if the confirmation mark is, say, $\frac{1}{16}$ inch out, this will probably be okay. I actually managed to get it more or less spot on.

It should be possible to secure the ball valve onto the stub using some form of jointing compound but I decided to create a PTFE bush using Fluorosint, which is a high performance PTFE, drilling a $\frac{3}{8}$ inch hole through it, to fill the void between the top of

the inside of the ball valve and the top of the spigot. This took quite a bit of patience - some simple calculations following measurements, emery paper, and endless attempts at assembling and de-assembling the ball valve from the spigot. Eventually I got it so that when the ball valve was screwed down, it touched the top of the spigot and sealed with the ball valve spindle facing exactly the right way for the linkage to attach. As the ball valve has to be assembled somewhat blind, onto the body of the regulator in the boiler, I thought this would greatly assist getting the ball valve spindle into the right position - which, I can confirm, it did.

You finally need to deal with the height of the ball valve. The ball valve obviously has to sit below the top of the manifold with the lid on, and in its original form it is too long. The easiest way to achieve this is to first fully close the ball valve so no swarf can get in, then simply cut the top of the body off using a hacksaw. I cut $\frac{1}{4}$ inch off the top of the ball valve opening. This should then create about $\frac{1}{4}$ inch clearance all round, below the lid of the manifold. This needs checking on the job, particularly if you are using a different manufacturer of valve.

Operating mechanism

From the old regulator block you should retrieve and keep the second moving disc, the two arm linkage and the bottom strip, which has the square hole for the regulator rod to pass through. If you have achieved that critical $1\frac{1}{4}$ inch dimension from the regulator rod hole to the centre of the ball valve spigot, you need to cut a slot in the centre of the disc. Marking the position of the slot accurately is important. Now because of space constraints, the linkage goes onto the operating spindle the opposite way around to the way it came off the original regulator. This means the arms of the linkage face towards the block.

When the ball valve is closed, the slot is horizontal, and, when open, vertical. So to get maximum movement out of the linkage, set the ball valve fully closed and then position the Stroudley disc so that the linkages are right-hand arm fully high and left-hand arm fully low. This is where you may need to cut the width of the column on the right-hand end of the block a little thinner if need be. You need enough movement out of the linkage to move the slot from horizontal, to vertical (when fully open).

4



The complete replacement regulator.

Once you have the slot marked, fashion the slot, using either a file or, as I did, in the milling machine with a slot drill. Go carefully here though, as with all mechanical linkages, play in the various links soon adds up and becomes a real problem, resulting in the first part of control lever movement achieving nothing. Those of you who remember setting up rod brakes on early cars will know exactly what I am speaking of here. So make it a tight fitting slot.

Finally, you will need to make a simple bronze collar to go over the valve spigot and hold the linkage the correct

distance from the valve. This collar should be $\frac{1}{4}$ inch long, although this will vary with different valves.

Figure 2 shows the general arrangement drawing of the linkage, and valve body, and **photo 4** shows the completed set-up. Note I retained part of the original disc rather than making a new link.

●To be continued.

NEXT TIME

We fit the new regulator to the locomotive.

No.296

Look out for the August issue, number 296

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The Barclay Well Tanks of the Great War PART 65

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



Continued from p.225
M.E. 4644, 31 July 2020

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

Having dealt with the history, we can now make a start on construction. Normally, when starting a new locomotive, I make the oil pump first – just a quirk of mine, which has become a bit of a tradition, although 'er-indoors reckons it's more of a fixation! In this case, however, I already have one or two bits 'oven-ready' (to use a fashionable catch phrase) that came off my locomotive *ACC No. 7*, which has been rebuilt as the Tallylyn engine, *Douglas*, along with two mechanical oil pumps from *Fairlie Complex*, the four cylinder engine which sadly ended up being recycled into other projects. I note that mechanical oil pumps are a 'modern' addition as the original engines were fitted with tallow cocks and

displacement lubricators (as outlined below).

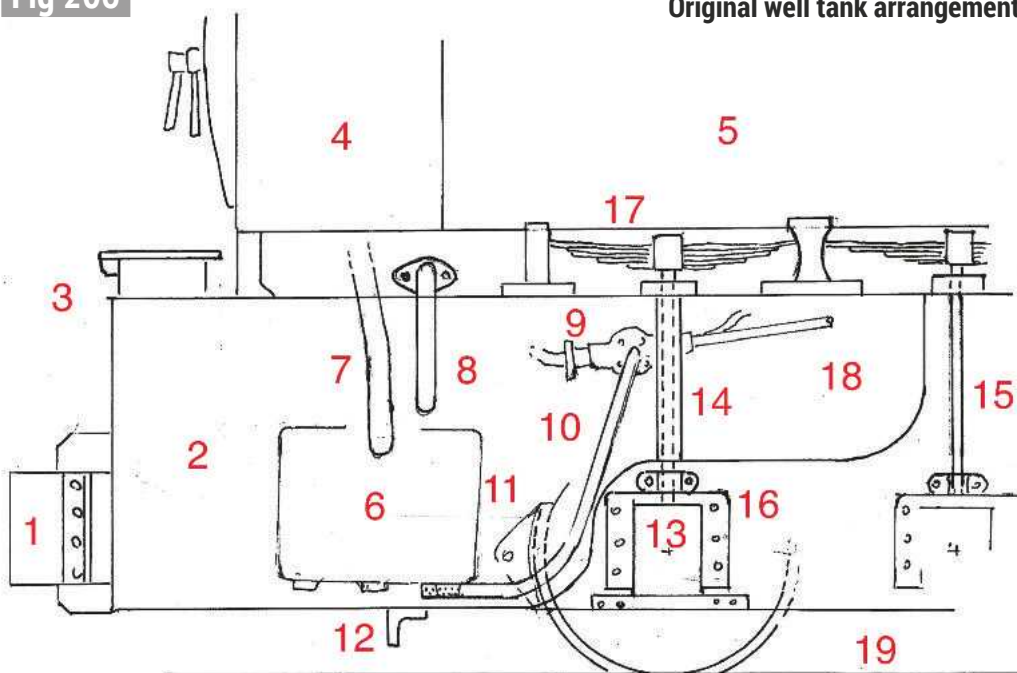
Items already available in my case are the lever brake gear from the cab, the two displacement lubricators and the tallow cocks – all from the conversion of *ACC No. 7* to *Douglas*. I also have the set of six drain cocks made earlier and, as referred to above, a couple of spare oil pumps (not to mention the new set of cylinders, chimney, dome and one wheel!).

As addressed above, the original 0-4-0 engines and the WD locomotives were not fitted with oil pumps. I know this sounds a bit confusing, but a mechanical oil pump, even though not fitted to the prototypes, is an essential item on these 5 inch gauge models and almost certainly represents how their big cousins would have been fitted had they survived into the present era. I would point out that many full-size narrow-gauge locomotives, such as *Douglas* on the T.R., which have run a significant mileage in preservation, have been retrofitted with mechanical lubricators, so it shouldn't be too much of a problem for the purist. For the 0-6-0 there is no need to describe an oil pump, as the pump design described earlier for *Douglas* (Part 25 - M.E. 4567, August 2017) will obviously be adequate.

It is possible, of course, to build scale, working displacement lubricators but the small volume of oil they contain becomes a problem. For example, a full-size lubricator containing 100mls of oil would, at 1:5 scale, contain less than 1ml, so not a lot of use! To overcome the

Fig 206

Original well tank arrangement.



appearance problem, I fit what I call 'semi-dummies', which are correct in outline and have drilled bodies with removable tops. They can therefore be used to inject oil as required, on shut down for example.

So, after all that nattering, let's get down to business and start with the construction of the frames. Again, as with the 0-4-0, they are heavy-duty and a bit more complicated than a conventional locomotive with side or saddle tank, due to the well tank, which needs to carry water. They are slightly less complicated, however, than the 0-4-0 with its pair of well tanks and balance pipe. In this case the volume of water in the single well tank is about three litres (or just over half a gallon) – but this, of course, will be supplemented by considerably more carried in the driving tender.

Note that the original, single tank extended over the first set of wheels, but I have truncated it somewhat to simplify construction at the expense of a small amount of water storage. **Figure 206** shows the original Barclay arrangement. Note the pair of risers, which allow dry passage through the tank for the suspension push rods; redundant, of course, with the simplified tank.

The basic cab provides further simplification, with only a lower rear sheet and no spectacle plate/windows to worry about. I have to say, however, that I'm not sure about toolboxes, as there is no photograph of the right hand side of the engine and no sign on the drawings, so it is

possible that there may have been a single box on this side for the driver's bits and pieces.

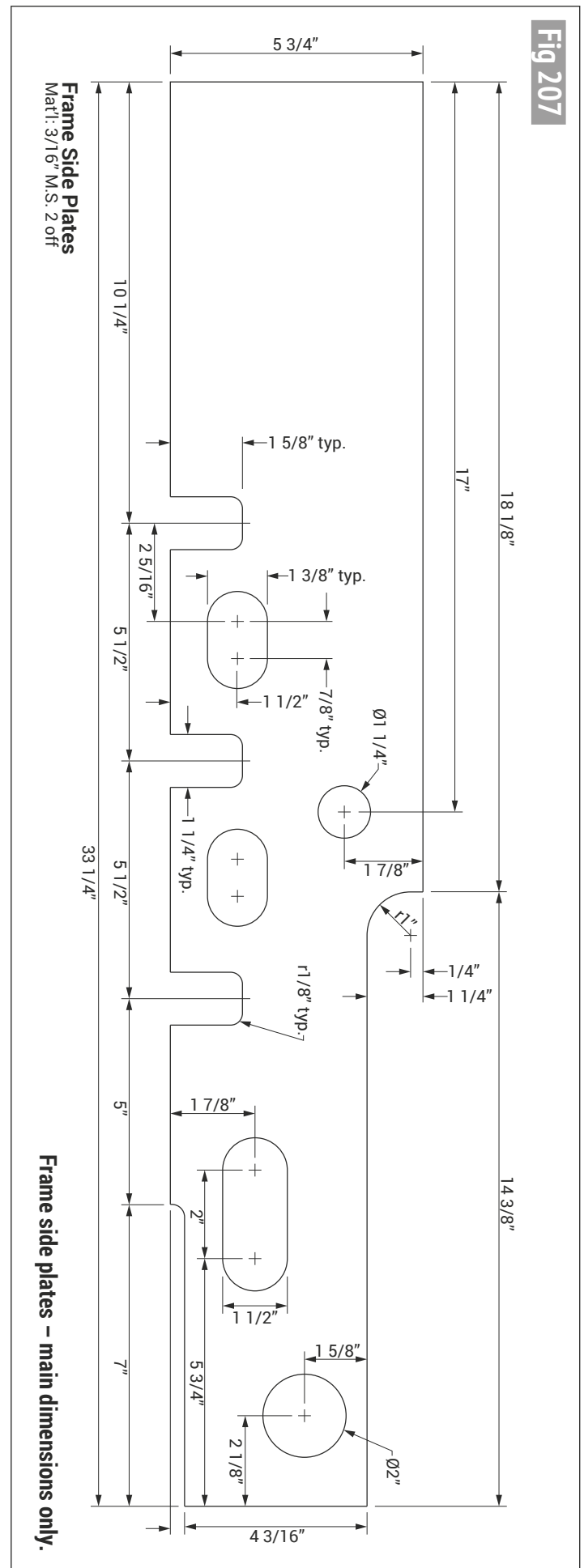
Frames, rear beam, railing irons etc.

The frame side plates (**fig 207**) are cut from $\frac{3}{16}$ inch thick steel, or the nearest metric size which is 5mm. The thickness provides extra weight where it's needed, lowering the centre of gravity and also affording a degree of corrosion resistance for the well tank. Cutting this thickness of steel is not an impossible task with a nice new hacksaw blade, cutting compound and plenty of elbow grease. I intend to cheat, however, and get mine laser cut, along with the $\frac{1}{4}$ inch (or 6mm) thick rear beam. Note that **figs 207, 208, 209** and **210** detail major dimensions only, sufficient to allow cutting by laser or elbow grease! More detailed drawings will be published later. If the frame plates are cut from 5mm steel they will each be 0.009 inch thicker than the specified $\frac{3}{16}$ inch steel. Therefore, the stretchers and rear beam fixing will need to be reduced in width by 0.018 inch to bring the overall width of the frame assembly to $4\frac{3}{8}$ inch (i.e. 4 inches between the frames). Fortunately for us it's easier to reduce a component in size than to lengthen it!

These stretchers are simply flat plates and there are three of them. The front tank stretcher is $\frac{3}{16}$ inch thick and forms both the front of the locomotive frame and the well tank. It will be fitted to the

Table – Key to figure 206.

1	Drawgear	11	Brake Block
2	Front Section of Well Tank	12	Front Rerailing Iron
3	Well Tank Filler	13	Leading Wheelset
4	Smokebox	14	Pushrod Tube through Tank
5	Boiler Barrel	15	Pushrod for Second Wheelset
6	Cylinder	16	Axlebox Assembly
7	Exhaust	17	Front Spring Assembly
8	Steam Inlet	18	Rear Section of Well Tank
9	Lifting Injector	19	Railhead
10	Injector Suction		

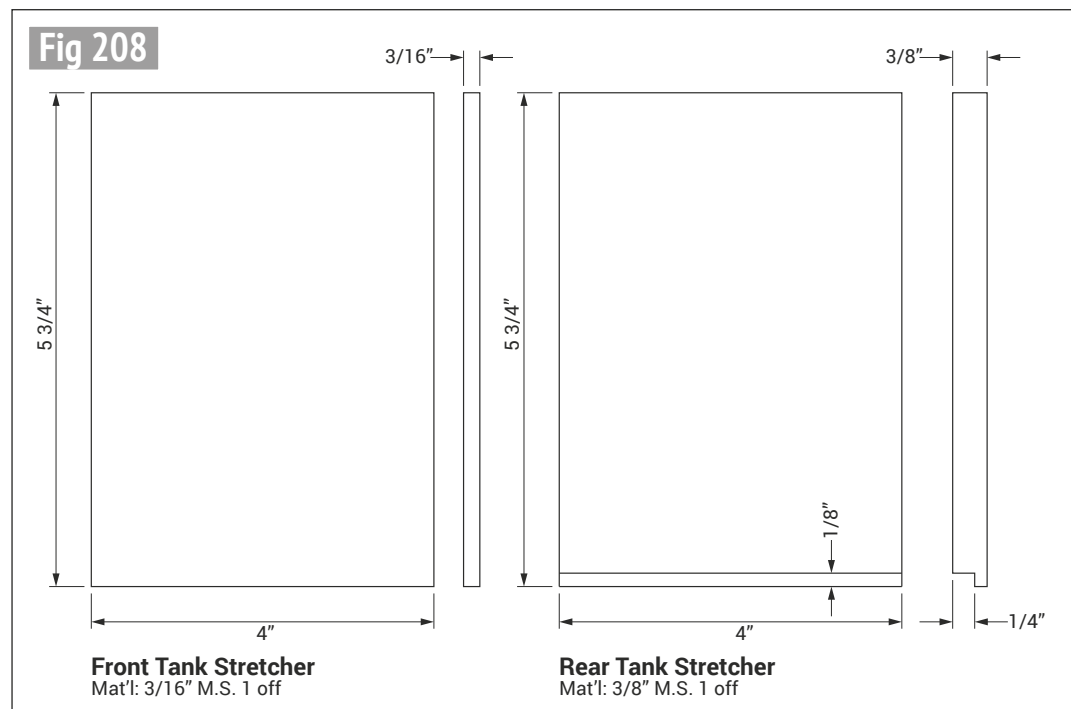


frame using $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{8}$ inch steel angles. The rear tank stretcher is thicker at $\frac{3}{8}$ inch as it acts as both the end of the well tank as well as one of the horn plates for the middle set of wheels. This stretcher will require a rebate in the base to accept the $\frac{1}{8}$ inch thick tank baseplate. The rear spring stretcher is also $\frac{3}{8}$ inch thick as, again, it acts as one of the horns for the rear set of wheels as well as the support for the rear cross spring, hence the threaded hole. Its height is reduced to allow plenty of clearance for the ashpan. Both rear stretchers are fitted with bolts, spotted through from the frame plates.

Rear beam

As far as beams go there is only one to worry about. The rear beam (fig 210) is a straightforward affair cut from $\frac{1}{4}$ inch thick mild steel. The sweeping curves, however, give it some semblance of elegance! Note the small oval hole above the draw gear; presumably designed so that the fireman can access the ashpan.

The $\frac{1}{4}$ inch radius curves on the bottom of the beam are not shown on the original Barclay drawings, but become obvious on inspection of the photos – someone at the factory has added a bit of artistic licence on the way! A front beam is not

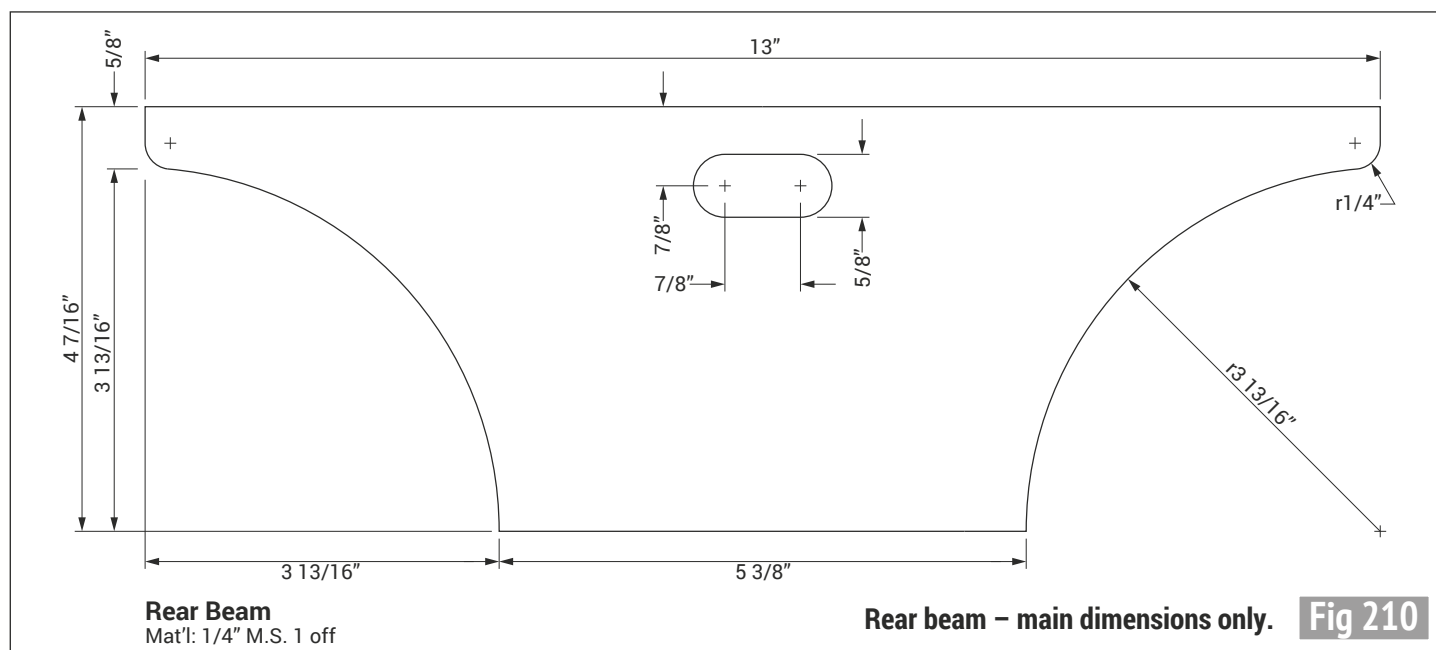
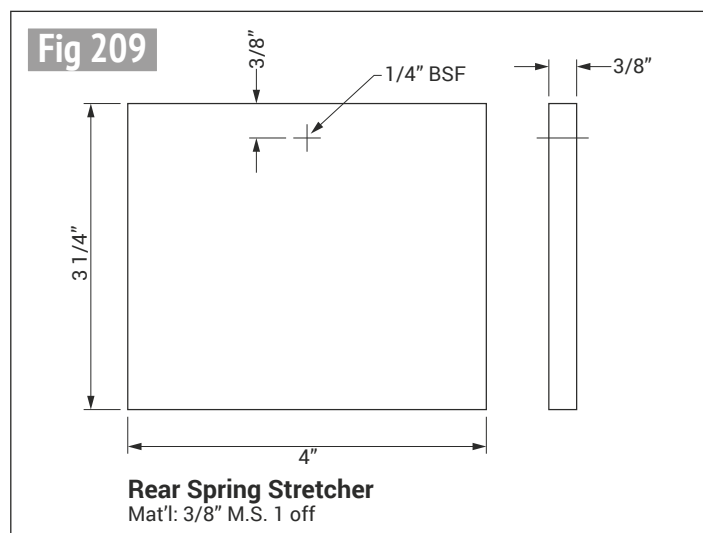


required, just an end stretcher which forms the front of the well tank, as can be seen from the front view drawing. Again, note that overall dimensions only are shown in figs 207 to 210 to allow for laser cutting. More detailed drawings will be published later.

● To be continued.

NEXT TIME

We move on to the springing and drawgear.



Musgrave Non-Dead Centre Compound Steam Engine

PART 3



The Musgrave engine in the Bolton steam museum.

Helmut Heitzinger constructs a model from photographs of a mill engine of an unusual type.



Continued from p.284
M.E. 4645, 14 August 2020

HP and LP columns

First the slide channel for the crosshead was machined to finish size using the narrow straight body for clamping in the milling vice locating off surfaces A, B and C. Attention has to be paid to the top and lower mounting flanges - some shimming in the vice was required to move them into a closer position for cleaning up later. Note: at this stage the columns are no longer identical. To proceed further a special holding fixture was made out of aluminum. It also had a tooling hole to be used as a pick-up for all milling and drilling operations. The purpose of this fixture was to clamp both columns in the final position (**photos 16 and 17**). The columns were

bolted onto the fixture using the crosshead channel for location. All outside surfaces can be re-machined to align with the mating parts (top, side and bottom).

Now it was time to drill the top mounting holes including one 0.125 inch dowel hole in each column to aid the final alignment to the HP and LP cylinder assembly. All holes at the top must relate back to the datum, as do the holes already drilled in the lower column assembly including the 0.125 inch diameter dowel holes. I relied completely on the DRO as spotting is difficult or impossible.

After all milling and drilling was done the holding fixture was used to align the combined column assembly

onto the aluminum base plate. The already finished 0.125 inch dowel holes at the bottom of the column did not align with the holes in the base plate due to a small misalignment due to silver soldering. As a result, I had to increase the dowel holes to $\frac{3}{16}$ inch diameter (from the bottom only). The $\frac{3}{16}$ inch dowels are bolted to the lower column base.

The major items are now almost completed and put aside (**photo 18**).

HP and LP rotary valve assemblies

Next in line are the rotary valve assemblies. The HP and LP valves, other than sizes and steam inlet holes, are the same in concept. The valve lining sleeve is made out of



Column holding fixture.



Picking up the position on the fixture.



Initial assembly of the major items.



Rotary valve sleeves – note extra hole in the LP sleeve.



Machining a rotary valve.



Valve operating linkage.

660 bearing bronze and needs to be a good sliding fit in the valve housing. These are removable and located by a small pin. The steam passages

(three) in the sleeve were machined on the turntable and must be to size according to the drawing. Note: the LP valve sleeve has one extra

hole for the steam coming from the receiver (**photo 19**). These openings had also been machined on the front end of the sleeve ($\frac{3}{32}$ inch deep) to the same exact dimensions. The purpose of them is that this is the only way to align the valve later with the sleeve and to verify the valve motion.

The valves themselves are made out of continuously cast iron. This material is easy to machine and free of any impurities. I machined the valves on the lathe to a diameter that allowed them to rotate freely in the sleeve. The slots on the valves were machined on the rotary table. These same slots are also needed on the front end; exact machining is a must here or there will be trouble down the road (**photo 20**). The valves are not mounted on

a spindle or shaft - that way the steam pressure will push the valve against the sleeve. The partial valve rotation is accomplished with an offset crank pin in a corresponding slot in the opposite end of the valve (**photo 21**). The critical dimensions are the same as the already proven sizes on the concept model. There are no 'O'-rings on the valve so any steam leaking to the retaining end cap will prevent any binding to it (I hope).

HP and LP piston components

The upper cylinder retaining cover plate is made out free machining steel; so is the lower cylinder cover plate including seal retainer. Both pistons are made of cast iron and the piston rod is stainless steel (**photo 22**). The



Pistons and piston rods.



Machining the crosshead.



Setup for machining the rocker arms.



Machining a link.



Two links at different stages of machining.



The yoke mounted on a fixture for machining.



Machining a sheave.



Machining a strap.

crosshead is cast iron and it is a bit of a challenge to make. I made it a nice sliding fit but in the end I had to loosen it up quite a bit (**photo 23**).

The rocker arms are a straightforward machining job but some touching up by fine filing is required to do the ends (**photo 24**).

The links require a bit of caution as they all have to be the same size so that the wedges for the bearings don't require to be fitted individually (**photo 25 and 26**). The oil

cups are made larger than they should be but at the time I could not obtain a smaller sight glass. The yoke is made out of continuous cast iron. After squaring it up, drilling the pivot holes and tooling holes for mounting it to a holding fixture, the yoke was finish machined on the turntable (**photo 27**).

The crosshead sliding channel cover rails are made of cast iron and ground to fit. Here I encountered a clearance issue between the links and

some bolt heads for the rail cover plates. To remedy the problem I had to reduce the screw head height.

To progress further I made a temporary base out of wood so I could proceed with the fitting of the major components in their proper positions. The two sheaves are made out of oilite material (**photo 28**). For the two eccentric straps I used free machining steel 12L14. The HP eccentric strap is quite different from the LP eccentric strap but represented no difficulties

to make (**photo 29**). These are connected to the valve actuator via long adjustable rods. The rear valve end cap houses the valve actuating shaft which is supported in an extended bearing support (see photo 21).

● To be continued.

NEXT TIME

I shall machine the flywheel and go on to look at the steam valve and governor.

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City of Stoke on Trent.

GWR County Locomotive PART 3

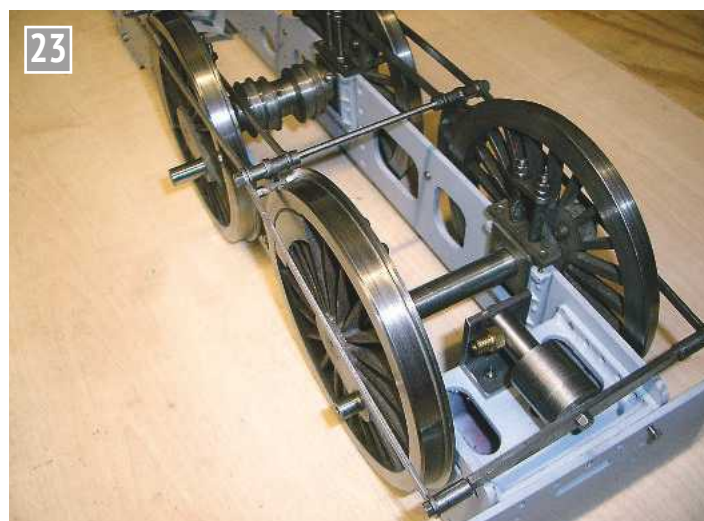
Robert Hobbs builds a 3½ inch gauge model of a GWR 4-4-0 County Class locomotive.



Continued from p.257
M.E. 4645, 14 August 2020

Having successfully sorted the brake system on the tender the locomotive brake system was tackled. In the past the brake shoes have been slotted by turning the brake ring casting in the lathe to form the hanger slots. However, I now believe the best way to form the slot is to use a Woodruff cutter in the vertical mill with the cast ring held horizontally in the machine vice.

Photograph 23 shows the loose assembly of the locomotive brake components. The numerous spacers on the brake beams enable the pull rods to pass either side of the coupled wheels to an angle bracket fixed to the rear drag box. The brake operating



Trial assembly of the locomotive brake gear.

piston is mounted on this bracket and also supports the cylinder that operates the locomotive brakes.

Castings for the eccentric straps were purchased from A. J. Reeves and were roughed out in the mill, before splitting. The boring was undertaken in the trusty Myford using a four jaw independent chuck to hold the straps. **Photograph 24** shows the stages required to produce an eccentric strap. The outer profiles were finished in the vertical mill using the rotary table fitted with a self-centring chuck; this set up is shown in **photo 25**. When using a tilting

rotary table be very careful to ensure the table is fastened tightly in the required operating position. The large red ball is on the end of a tube that fits over and extends the small clamp arm on the table, adding useful leverage to ensure the table is firmly fixed. This extension tube was originally made to make adjusting and locking the table on my bench press drill secure.

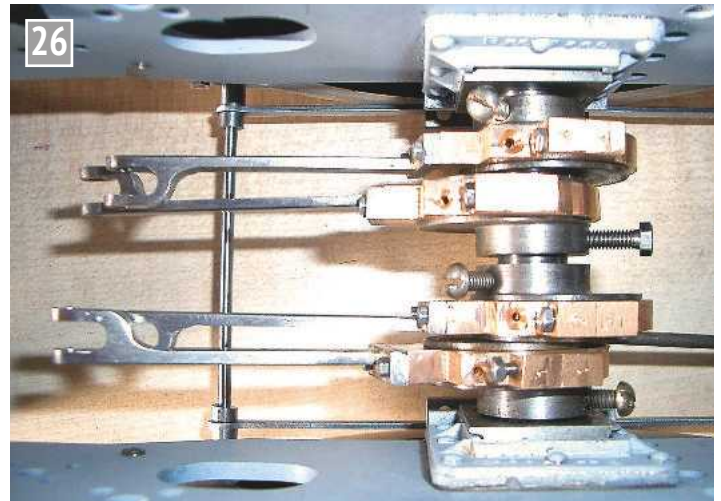
Avoid climb milling like the plague when using the rotary table in the mill by checking the direction of tool and table rotation; otherwise if the table is loose it could lift the table and ruin the component. ➤



A casting becomes an eccentric strap.



Shaping the outside of a strap.



Trial assembly of the eccentric straps and rods.

According to Murphy's Law this always happens during the last operation on a complicated piece of work to which you have already devoted hours of skill. (Guess what had happened to me?)

The four arms with their fork ends, for the eccentric straps, were milled from bright mild steel stock and the mounting flanges silver soldered at the strap end. These are shown in **photo 26** on an early trial installation - the fixing screws are temporary.

When reviewing the material requirements for the next items for attention the boiler configuration shown on the drawing looked vaguely familiar to an old part of a boiler which had arrived some ten years earlier and was in my material bin. In the past I have not placed too much confidence in coincidence but in this case it had to be accepted and a dummy boiler will be constructed for this County incorporating the tapered barrel shown in **photo 27**. (Waste not want not.) The boiler throat plate was made in two sections from copper sheet and the fire box wrapper and the back plate were from brass sheet. The wrapper was formed over a wooden pattern which was also used to form the flanges on the straight edges of the back plate. To clean up the barrel it was spun in the lathe by mounting the large end in a self-centring chuck and a wooden plug fitted at the small end to take the revolving centre. The barrel was carefully filed down at a slow rotating speed and the end cleaned up. **Photograph 28** shows the revived boiler barrel. The smoke box was rolled from steel plate and trimmed/sized and fitted to the barrel which in turn was fitted to the firebox and faired in with car body filler and rivets fitted. **Photograph 29** shows the main boiler assembly ready for painting.

The front ring was turned in the lathe, from a four inch aluminium bar offcut, the door



Boiler barrel dredged out of the scrap bin.



Old boiler barrel given a new lease of life.



Complete boiler assembly.



All made from bits of scrap!

also being machined from a brass bar offcut, as were the safety valve casing and its mounting ring (**photo 30**). These offcuts were purchased for a few pounds from the local scrap yard/recycling centre whilst the chimney (**photo 31**) was a new casting from the extensive casting range from A. J. Reeves.

The smoke box saddle looked a challenging sheet metal and silver soldering project with the final assembly being shown in **photo 32**. The holes for joining saddle and the smoke box were also marked out and drilled pilot size at this stage. The door assembly was furnished with two strap hinges, a hinge pin and the dart assembly. The smoke box (**photo 33**) was finished off by fitting the two rows of rivets at the boiler end and riveting the front ring in position, first ensuring the hinge pin was vertical. The chimney was positioned on the smoke box and the securing rivet holes drilled very carefully (**photo 34**).

●To be continued.



Machined chimney casting.



Smoke box saddle fabrication.



Smoke box door fitted.



Chimney fitted.

ISSUE NEXT ISSUE NEXT ISSUE NEXT ISSUE NEXT ISSUE
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- **Stress Corrosion**
Robert Walker explains how materials can experience corrosion as a result of being stressed.
- **Kinver**
John Arrowsmith pays a visit to the Kinver and West Midlands Society of Model Engineers.
- **Brakes**
Rhys Owen traces the history and development of the railway brake.

- **Musgrave Engine**
Helmut Heitzinger makes the flywheel and rope pulley for his Musgrave compound steam engine.
- **Two Engines**
John Merrett tells how he kept himself busy during the recent covid-19 lockdown by building a pair of oscillating steam engines.



Content may be subject to change.

ON SALE 11 SEPTEMBER 2020

Geoff Theasby reports on the latest news from the Clubs.



Reader(s) may add to their list of your scribe's accomplishments, that of paper conservator! At a time when I was otherwise occupied (on't wireless, sithee) someone who shall remain nameless spilt tea all over my newly arrived *Model Engineer*! This heinous crime resulted in a combination of tea and tears to make pulp of Percival Marshall's finest, unless I was quick off the mark. A little Googling revealed the suggestion to interleave each page with a paper kitchen towel and leave overnight in a warm place. It works! (Gloss and semi-gloss paper is loaded with clay to enhance the photographic quality, but if it gets wet, it reverts to its natural state) (photo 1).

Visiting foreign parts (Chesterfield) I found this item on sale (photo 2). I fail to appreciate the need for such an odd possession in land-locked C. although I suspect it's a replica; all those I have ever seen have been copper. Neither can I suppose that it will be of use in plumbing the depths of my humour. Going down now, Sir!

Another 'find' in the Big C was this clock (photo 3). Research tells me it is a Jerome & Co., New Haven 30 hour alarm clock, in full working order, including winding key. The dial is stamped Feb 187[5] and on the back, 'serviced F. Griffith 26/10/1916'. An antique! These clocks were made in their millions by Jeromes and its various incarnations and sold for \$1 at the time. They struggle to reach three figures today. Looked after, they are good for 100 years and probably 100 more. Reassembling the bits back home, I set it going. Stopped after 10 minutes! Inspecting the entrails, I discovered evidence of recent oiling. Those who know about such things say that the average sewing machine oil, or 3-in-1 is too viscous for clocks and will almost certainly lead to its stopping. Highly probably it has been soaked with WD-40 too. The remedy (one of) is to spray liberally with the said WD-40 to loosen up any deposits left behind and then wash out with Kenny Everett's Degunge-o-prene, Fred Wedlock's handier household help, *Best Universal*



Wet mag.

Grease Grime and Effluent Remover, or Coleman fuel (for camping stoves M'Lud) whereupon, it should then be gently lubricated with a small drop of clock oil on the pivots only, from your friendly, neighbourhood clock 'oil-er' retailer. Not having the necessary SAE 0.0005, I tried it without and it still stopped after 10 minutes. So, after watching several videos and clock servicing websites (I like *Horologica*) I measured the pendulum swing as 35 and 30mm either side of 'neutral'. Then, gently bending the 'crutch' (technical term)



Dive helmet by Siebe Gorman.



It works!

in the direction of excessive swing, set it off. This time it went until the spring ran out of puff the following day! Thus encouraged, I let it go for a day or two, then tried adjusting it for timekeeping, successfully, to within several minutes a week, this is 200-year-old technology here!

Andrew Fiderkiewicz writes regarding my mention of *Cruquius*, the multi-beam pumping engine in Holland. He wrote an item on this very juggernaut for his club, **Newton Abbot & District Model Engineering Society's** occasional newsletter back in 2015. Being a naturalised Cornishman, he reminds us that it was built by Harvey's of Hayle (photo 4). (Read all about it on page 313 - Ed.)

W. www.nadmes.org.uk

In this issue : levity, a kit, speeders, charity, a steam bicycle, two chests, early Gauge 3, a missing tender, blacking and a Limerick.

The Cam, from **Cambridge & District Model Engineering Society**, 'the cultural centre of the known universe', says Co-editor, Tim Coles. (As opposed to Theasby Enterprises, Intergalactic Centre of Levity – Geoff.) The society has a date for reopening their site, which will be history by the time this issue of *M.E.* appears. 'The grass is mown, some members is/maintaining the track for when the visitors is' (I claim poetic licence). The new H&S rules for passenger-carrying miniature railways have been published, HS2020. It seems little different from existing practice. Apart from a sizeable photo gallery, there is little else to mention.

W. www.cambridgemes.org.uk

Goodwin Park News, summer, from **Plymouth Miniature Steam**, says that Chairman, Ian Jefferson, who has been restoring locomotive *Hernia* over the past year, finds that the main assembly is over quite easily, but dealing with the little niggles, or snagging list, has occupied the major part of the time. As a private venture to give relief from the above, he bought a wagon

kit, which came without instructions and a request for help was not answered. His official address this time ran to nine pages, setting an example for the members? A new dome casting for *Hernia* to replace the existing, gold-painted aluminium version, required about 6kg of brass scrap, following which, John Briggs writes on railway Speeders (Wickham trolleys in UK). The concept dates from 1893 when the (US) Sheffield Velocipede Co, produced a primitive petrol-powered vehicle for railways. Later sold to Fairbanks Morse, the design was taken up by others in the US, primarily Fairmont, who eventually made 73,000. Tom Pawley tried making leaf springs for his 7¼ inch gauge *Highlander Black Five*. Never again, he says, after relating a tale of woe. Glyn Buttfield designed and made a coolant system for his Boxford lathe, using a 12 volt submersible water pump, available from caravan suppliers, and an old paint can.

W. www.plymouthminiaturesteam.co.uk

Nigel Bennett writes regarding his 'Fearsome Instrument' mentioned in *M.E.* 4640. He concocted the company name 'Amalgamated Megawizzo' in response to a supplier's website which insisted on a company name. Being computer driven, it didn't recognise a leg-pull. In the same spirit, his workshop is named, 'Hoapit Works'.

Then, *Shoulder to Shoulder*, June-July, from the **UK Mens Sheds Association** has Patron, Chris Fisher waxing lyrical about clean workshops and tool care. White vinegar, tea tree oil and beeswax are mentioned, all alternatives to harsh chemicals. Broadstairs Town Shed has been awarded the Queens Award for Voluntary Service, to be presented by the Lord Lieutenant of Kent and an invitation for two Shed delegates to attend a Buckingham Palace Garden Party. The Co-op asks for local groups needing funds,



Cruquius. (Photo courtesy of Andrew Fiderkiewicz.)

an opportunity several model engineering clubs have already taken up. (I must resurrect Geoff's Aged Volvo Fund, now renamed Aged Geoff's Volvo Preservation Society.) The activities of several other Sheds are covered too.

W. www.menssheds.org.uk

Maritzburg Matters (there's a name to conjure with this summer of 2020), the June newsletter from **Pietermaritzburg Model Engineering Society**, contains a piece from Editor, Martin Hampton who writes that the grounds are in beautiful condition, now that winter has arrived, closely followed by autumn [sic]. Les Cloete is building a Marshall portable engine, making his own castings. Bob Richardson has eschewed metal in favour of wood, despite his dislike of woodworking, to make a model *HMS Victory*, which is

nevertheless taxing his skill and ingenuity. A well planned and executed project is The Ruscombe Gentleman's Steam Bicycle and the soundtrack is also most interesting.

<https://www.youtube.com/watch?v=yvS8wtNqz4W> W. www.pmes.co.za

Also from South Africa, *The Workbench*, June, from **Durban Society of Model Engineers**, noting the worldwide lack of activity, features Chairman, Mike Thorne's 3D animation of Avonside Kellaway Hall, which is very detailed.

W. www.dsme.co.za

Model & Experimental Engineers, Auckland, tells us that Murray Lane has completed his book on the history of Auckland Society of Model Engineers, which he began in 2013, over 400 pages of A4! Graeme Quayle has begun a new model, featured in *M.E.* Jan 2006, as fitted to *HMS Gorgon* in 1837. Richard

Street has bought a kit-built tool chest in Black Walnut. It looks very fine (photo 5). Murray has been reorganising his workshop, including parting with some machinery. The Hardinge lathe has been sold. It took him two days to move it from the workshop into the garage. It weighed 800kg and all was done with a couple of hydraulic jacks and rollers. Not bad for an 80 year old guy who all the specialists and doctors called 'a frail old man who should be using a walking aid to get around'. Perhaps his ancestors were Egyptian pyramid builders? Next was an F1 Boley, jewellers lathe, quite a contrast!

Stockholes Farm Miniature Railway owner, Ivan Smith was very sorry for having to cancel the spring activities, especially as the team had worked in some appalling winter weather to prepare the site. He says also that he has done more model engineering in the last months than in a similar period of years and also several items of civil engineering to improve the site. Member, Steve and wife Pauline have produced a scale Midland Railway signal box which will be situated at Sully Steps High Level station.
W. www.sfmr.co.uk

Cedric Norman, Editor of the **National 2½ inch Gauge Association** newsletter, *Steam Chest*, June, has produced an excellent 48 page publication this time with a veritable myriad of subjects. In an item first published in 1976, Ernest Steel reviews the first 80 years of 2½ inch gauge railways. He wrote that the first mention of the gauge was in *M.E.* of September 1898 and the true gauge was 2⅝ inches; standard dimensions were not agreed for another decade. Will Powell suggests investing in a pair of parallel-jaw pliers, he finds them very useful. Cedric followed up a train of thought after watching a YouTube video which eventually led him to www.disused-stations.org.uk That should keep readers happy for



Richard Street's tool chest. (Photo courtesy of Richard Street.)

some time! Peter Shaw built a powered driving trolley, in the form of a flatbed bogie truck which is helpful if you are testing an engine of uncertain performance. I found several useful tips therein. I also note that he uses shearpin drive, as do I, a very convenient and easy way of manufacturing a positive power transmission system. Dave Wooten bought a locomotive with a non-standard tender, which languished under his bench until, idly flicking through back numbers of *Steam Chest*, he noticed a reference to the original tender for another engine, which was thought to be lost since it converted to coal firing. He thought the picture of the missing tender looked familiar and after investigation and correspondence with others, his was found to be the errant vehicle! How amazing that it survived undamaged since 1926!

W. www.n25ga.org

Stamford Model Engineering Society June newsletter arrives. Editor, Joe Dobson offers us a diverse range of items (see also photo 1). Member, John, has made a replica 'Siam Soo' automaton which works from the movement of a 78 rpm

gramophone record. The real thing is very collectible and rare (see YouTube, under its name). Patrick Austin built a model railway from scratch in his loft. After many, many hours of research, including lengthy periods on YouTube (necessary, in-depth research, you understand! After all this is work, not fun...) he built a simulacrum of Winchester Chesil station and rather fine it looks too. This is followed by a bit of lateral thinking from Joe. Next time you are in a station, especially a recent one, in the construction of which every expense has been spared, drag your attention from the surrounding railwayana and look down. Paving slabs, tarmac, concrete or fibreglass, or even expanded polystyrene? This last is easy to shape and modify and to protect it from physical harm, sheets of a cement-like material enclose it. It is, however, sufficiently rigid to act as a substrate for walking on.

Offcuts, June, from **Bromsgrove Society of Model Engineers**, begins with a piece by Pat Cross on the blacking of brass using a non-hazardous, chemical process. Some photos of the process follow, although we are

assured that the prominently featured bottle of wine was not involved until afterwards! John Pagett writes of his time spent in his day job, working on railway braking systems. In his first tests, involving the controlled release of a slip coach, the driver of the test train, unfamiliar with the practice, went to apply the brake which could have had serious consequences, had not the footplate inspector intervened. On an earlier test this had actually happened, when the slip coach brakes failed, wrecking the test coach but causing only minor injuries.

W. www.bromsgrovesme.co.uk

And finally, a Limerick, sent to *Maritzburg Matters* by Greg Pastoll of Pietermaritzburg MES -

A boy said to
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■ Warco Super Major 40 mill drill. DRO, Vertex div head. Myford Super 7 gearbox. Fully tooled. Meddings floor pillar drill. Chester floor band saw. Security cabinet, surface plate, digital height gauge. Various items to sell. Job lot. **T. 01248 724507. Bangor.**

■ Seig C3 lathe £350. X2 milling machine £300. ZYM R8 universal cutter grinder (never used) £400. Warco Bench sander £50. Wolf bench Grinder £50. **T. 01297 22661 (mobile callers add a 0). East Devon.**

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■ Dore Westbury Mk1 with stand. 3 digital readouts (X, Y & Z). M/C vice, bench light. 2 parallels. Milling chuck. Manual. £400. Buyer collects. **T. 01908 641036. Milton Keynes.**

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■ Axminster BV20M engineering lathe. 140kg. 4" three and four jaw chucks. Width 650 length 915, height 560, with stand and tools. Six speeds, separate gears plus new motor. To be collected. £550. Little used. **T. 02088 508215. London.**

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Magazines, Books and Plans

■ Set 1 1/2" Allchin drawings. TE11. Sheets 1 – IT + TE15 accessories and TE1 & TE2 GA, £60. Pair Allchin rear wheels, £100. + Shipping. Building the Allchin £20 + P&P. **T. 07779 304808. Coventry.**

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■ Reasonable new Cowells ME precision lathe with accessories etc., lathe tools, etc. **T. 01986 835776. Norwich.**

■ Do you have a copy of Model Engineer issue 4635 (27th March)? If so, I would pay £5 for it, plus postage. **T. 07710 192953. Cambridge.**

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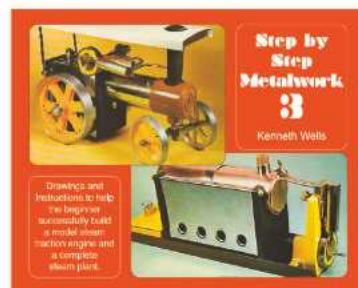
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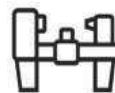
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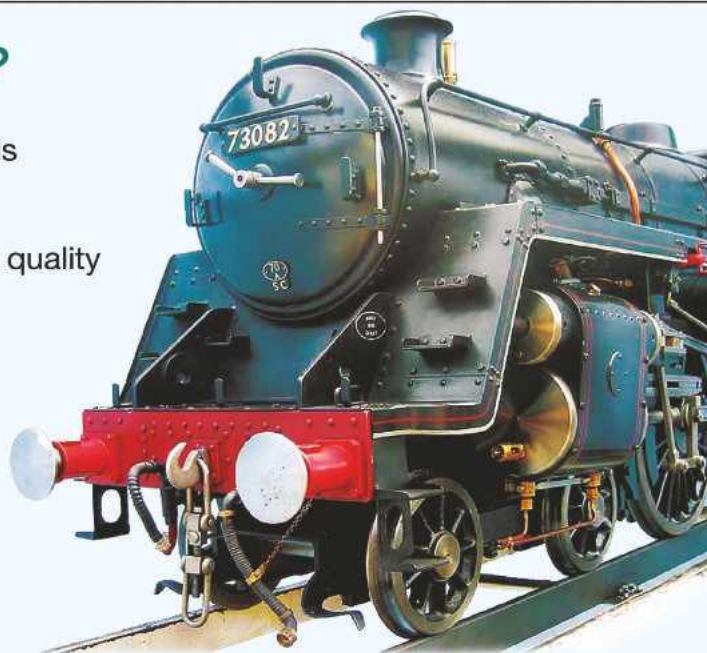
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