THE ORIGINAL MAGAZINE FOR MODEL ENGINEERS

Vol. 227 No. 4671 • 13 - 26 August 2021

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COVER FEATURE

Brit Cab

POLLY MODEL ENGINEERING LIMITED

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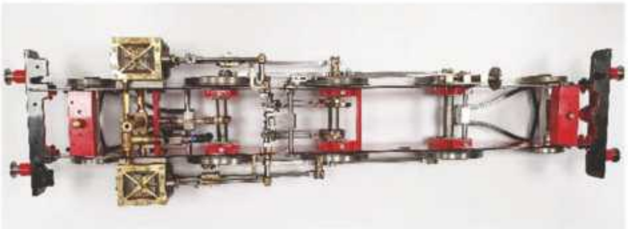

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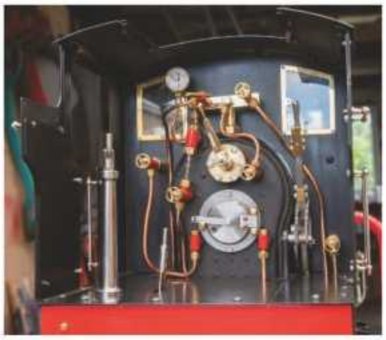

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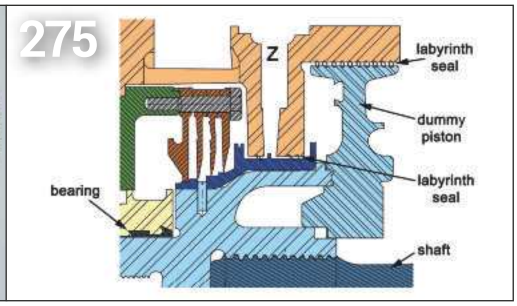

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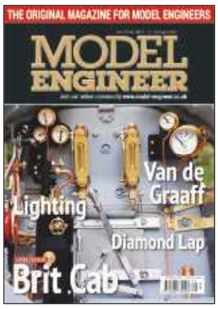

ON THE COVER...

The backhead of Norm Norton's rebuilt 5 inch gauge Modelworks Britannia locomotive (photo: Norm Norton).

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Midlands Exhibition

I have received the following from Avril Spence, organiser of the Midlands show:

'It is with deep regret that due to the ongoing uncertainties of Covid-19 pandemic; we have to announce the cancellation of the 2021 Midlands Model Engineering Exhibition which was due to be held at the Warwickshire Event Centre on the 14th-17th October.

'This difficult decision is taken despite a real determination by the Meridienne Exhibitions team, trade, clubs, societies, exhibitors and other supporters, all striving to continue to deliver the usual high quality and successful event during this very difficult time.

'Over the past few weeks, we have been in the excruciating position of considering every possible scenario to see how we might be able to proceed, but sadly the risks of holding the event now far outweigh the reasons for going ahead. The core decision is based on the escalating cases of COVID-19, and the risks that widespread illness and self-isolation could have on everyone involved. We have navigated our way over the past 16 months through obstacles, but now feel that the odds are stacked against us and we are no longer in a position to be able to proceed safely with the unknown government Covid-19 requirement for Autumn/Winter ahead.

'It follows that with our decision to cancel the Midlands Exhibition we have also, again regretfully, decided that it is not practical nor financially viable to proceed with the London Model Engineering Exhibition at Alexandra Palace in January 2022.

'Having presented model engineering and other exhibitions for well over 40 years these decisions represent a tremendous disappointment for all but hopefully the situation will be different in later 2022 and we may again present a model engineering exhibition.

'We look forward to seeing you all again soon.'

This is, for me personally, very sad news. I felt so confident that our very much missed shows would now be going ahead that I had booked my room at a nearby B&B. I suppose we shall have to be patient and hope that everything will be truly back to normal by the spring next year.

Bromsgrove

The Bromsgrove Society of Model Engineers is holding an open day for all model engineers on the 5th September. Please bring a locomotive! Virtually any size can be catered for – 32mm, 45mm, 2½, 3½ and 5 inch gauges. Free refreshments will be provided but donations would be very welcome. The club will be rather busy in September as, the following weekend, on the 11th September, it will be hosting the 2021 Rob Roy Rally.

The Bromsgrove Society's website (www.bromsgrovesme.co.uk) gives details of the location of the club. If you are interested in taking part in the Rob Roy Rally please contact Ian Horsfield (**meadowsend03@btinternet.com** or 01386-792628), Peter Maybury (**peter.maybury@outlook.com** or 0121-453-3691) or Rex Hanman (**hanmanr@yahoo.com** or 01980-846815).

Poster created by Martin Atwell.

Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
07710-192953
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Britannia Class 7 Locomotive in 5 Inch Gauge

A Modelworks Rebuild

PART 11 - CAB FITTINGS AND WHISTLES

Norm Norton takes a renewed look at this popular, kit-built BR Standard Pacific.

Continued from p.153
M.E. 4669, 16 July 2021

Oliver Cromwell *on the GCR, Loughborough in 2014.*

Cab fittings

This article looks at items that have been created for little reason more than they look, or sound, nice and will hopefully give enjoyment. Strictly speaking the blower valve is essential, a whistle is important, but engine brakes come a poor second to a well-designed driving trolley hand brake.

When I described the construction of a new cab back in Part 5 I did not mention an important design consideration of mine – it had to be strong in itself and firmly mounted so that if anyone pushed or pulled the engine from the cab roof it would not flex, break or come off! To achieve this, a reasonably thick backhead cleading sheet is attached to six M3 blind bushes that Modelworks provided in the boiler backhead and then the cab is fixed to this at the bottom by a substantial full width angle bracket under the floor with six 8BA setscrews. At the top front there is a similar but smaller bracket and another six setscrews into nuts soldered inside the heavy gauge firebox cleading. You can see this bracket in Part 9, photo 68.

I have designed all the cab fittings so that they can be removed in perhaps a morning's work, and then the cab taken off by undoing those twelve 8BA setscrews.

Steam brake valve

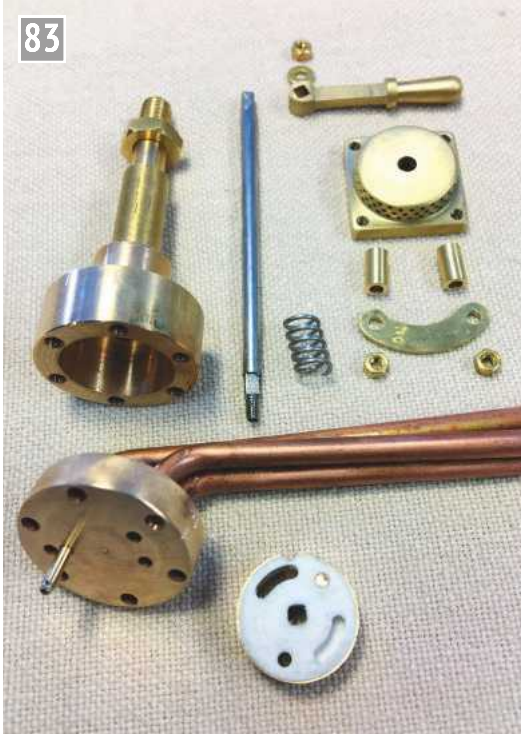
The prototype has a 'graduable steam brake valve' mounted on the backhead. On the top of the driver's pedestal is the vacuum brake handle, mounted on a visually striking drilled brass cap. I am not fitting vacuum brakes, which could in theory be piped back to any vacuum brakes fitted to a train, but I did want to make a functioning locomotive steam brake. I have therefore used the vacuum brake handle to operate a steam brake valve mounted underneath it. Perrier has shown a very similar valve on his drawing but Modelworks have an independently mounted valve on the backhead and no pedestal. On this design of mine a PTFE insert does the sealing against the bottom face that carries the three working pipes: steam inlet, connection to the steam cylinder, and a vent to atmosphere. The difficult part was getting those three ⅛ inch pipes to come out from the valve behind the pedestal. My solution was to mount the valve on a long stem and silver solder the pipes into the body so that they exited the pedestal near the bottom (**photo 83**).

>>

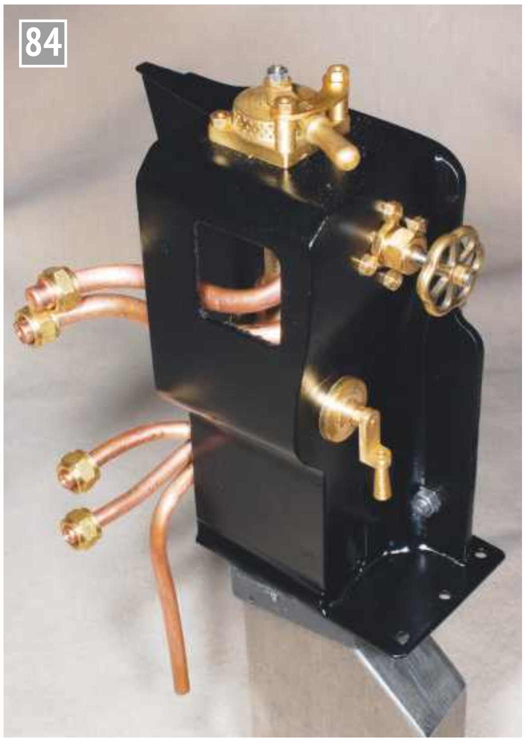
Driver's pedestal and blower valve

The steam brake valve needs to be at the bottom of the pedestal also to make room for a blower valve. This valve is in the same position as the prototype and is a conventional captive spindle design with a PTFE tip. The pipework here is a larger $\frac{5}{32}$ inch diameter since the feed pipe has to run all the way down the left side of the boiler, under the cleading channel, and into the smokebox. This long run will be insulated, but I think I will keep a small steam flow going all the time to avoid condensation and a sudden water spout when the blower is turned on.

These two valves make an attractive feature in the driver's pedestal and I think it well worth adding this feature to a Britannia (**photo 84**). Modelworks did not have one and Perrier shows just a narrower and smaller pedestal but many builders leave it off anyway. The detail for building one is shown in Doug Hewson's set of excellent Britannia drawings. I did take care to ensure that the pedestal can be removed by unbolting it from the cab floor and undoing the four pipe connections, so that the two valves can be serviced when needed.



Component parts for the steam brake valve. The base has been turned over in this photo to show the drillings that are opened by the PTFE insert.



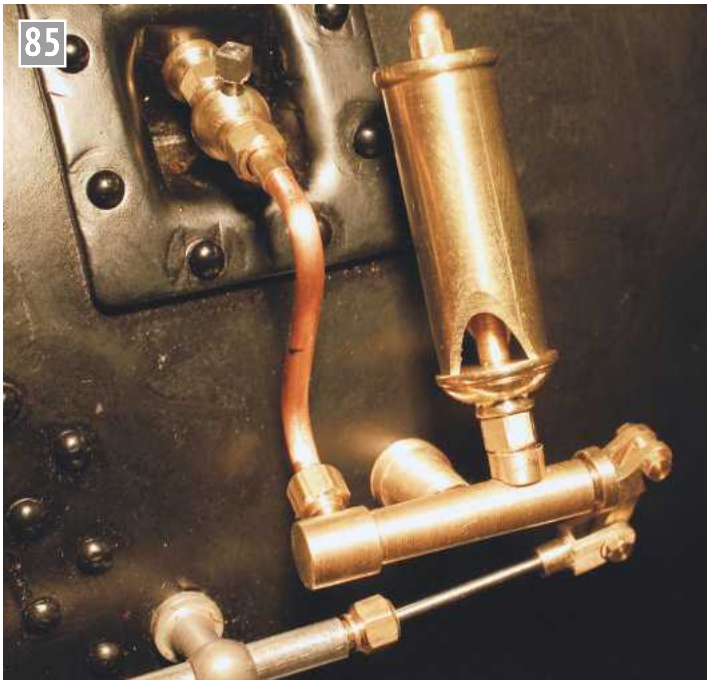
The driver's pedestal fitted with a steam brake valve handle at the top (actually the vacuum brake on the prototype), blower valve, and sander (dummy).

Chime whistles

The prototype Britannia has a three tone chime whistle mounted on the right hand side of the smokebox. The Perrier design has a replica of this whistle fed with steam for dramatic effect and a further steam pipe feeds a model whistle pair behind the smoke deflector (**photo 85**). Unfortunately, small steam whistles of ½ inch diameter and 4 inches or so length will always struggle to produce an acceptable sound.

The full-size Britannia chime whistle follows from LNER use which in turn was copied from American practice. I wanted to have a reasonable sounding whistle and decided that since there was no axle pump I might as well fill the space with a decent sized whistle mounted between the frames.

There have been several designs and suggestions regarding whistle pipe lengths in articles and on some drawings. I tried to find out as much as was available and there was some agreement that the tones wanted were A♭, F and C.

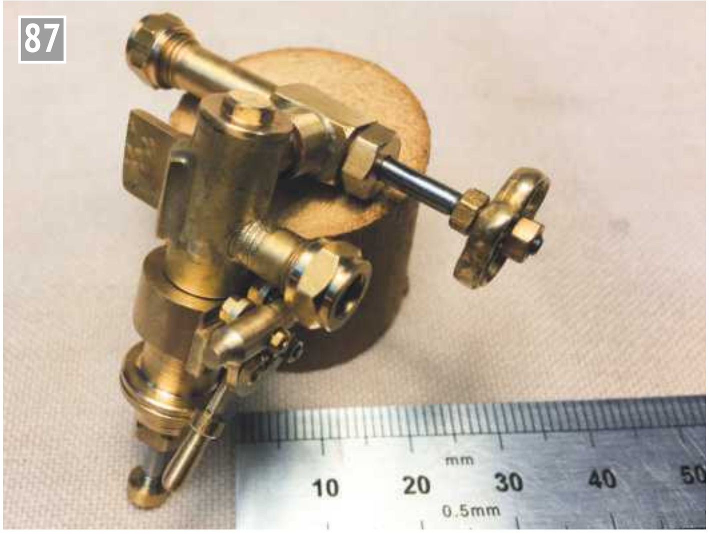


Dummy whistle mounted on the smokebox, to imitate the prototype.

Three whistle tubes mounted between the frames and above the middle wheelset, at the top is the rear wheelset (engine is inverted).

What lengths of whistle tube?

The problem I found was that for a scale model design authors were quoting different tube length sets for the same three notes. It is not the absolute length that matters but the precise ratio of all three to each other. Our ears happily accept the three frequencies rising and falling together as long as those ratios remain the same. To try and understand better how tube length affects frequency I read some online publications by R. J. Weisenberger, an organ pipe expert. The mouth opening height, or cut-up, affects the starting point for the quarter length standing wave that is measured to the inside of the top closure. When I compared



The cab steam whistle valve masquerading as a BR Standard graduable brake valve.

The whistle valve mounted on a regulator bracket extension. The actuating shaft can be seen at the bottom where a lever acts upon the pushrod to lift a ball from its seat. The large pipe on the right is the steam supply down to the whistle.

> Our ears happily accept the three frequencies rising and falling together as long as those ratios remain the same.

theoretical lengths with the internal (or undefined) lengths others were citing there were unexplained differences of some 0.2 – 0.5 inches. The difficulty is that pipe organs are using lower pressures than steam whistles and the cut-up (mouth) needs to be bigger (longer), but I could not understand why some sets of lengths were being suggested, especially when no theory or reasoning was given.

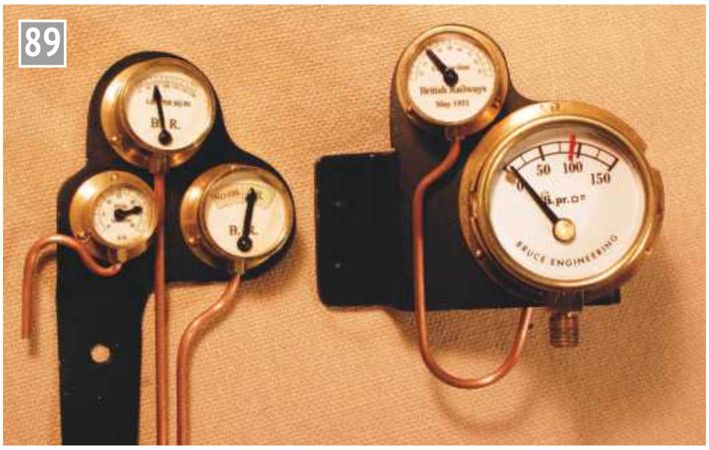
The best I can say is that the lengths of tube suggested by Alan Gent, whose 2003 whistle drawing has been used by some builders, were very close to theory and more helpful than others. His drawing shows tube lengths (internal lengths in inches from languid plate to inside of cap) for A♭ – 3.875; F – 4.750; and C – 6.187. Weisenberger's calculations for organ pipes, starting from the same A♭ tube length, would suggest A♭ – 3.88; F – 4.71 and C – 6.47. I cannot explain why the Gent C pipe should be so different in this sequence but it is clear that each length has been set to an imperial fraction. Note that you cannot simply rescale these lengths with a single factor as there is a constant in the calculation that is related to the cut-up size.

I have made a set of three large whistles from ⅝ inch tube and mounted them between the frames (**photo 86**). I have used a design that I found successful for small ½ inch tubes and these seem to work well on air. But I know that means nothing when compared to their performance with steam and I shall just have to see what happens.

Cab whistle valve

The Britannia has a BR Standard graduable steam brake valve mounted above the pedestal on the backhead. Rather than fit a dummy item, I made one to perform the function of a whistle valve (**photo 87**). A shaft rises up the centre to lift a ball from its seat. The steam entry is via a tapered shut off valve, that will allow regulation of the steam to the whistle. On the side is a dummy handle and mechanism to imitate items that the graduable valve carried. This valve is mounted on the regulator bracket (**photo 88**).

The whistle shaft across the backhead is prototypical as is the handle for the driver, although this one is larger to suit big fingers.



The set of four dummy gauges and the real ¾ inch boiler pressure gauge. The four have been set as if the locomotive is in steam and moving but the face designs have been reinterpreted to suit what can actually been seen at this scale.

Gauges – dummy and real

This assembly of gauges for the Britannia is as suggested by Hewson, rather than Perrier, but I have been slightly 'creative' with the dial images. In truth, you can barely see the scales with the naked eye. This macro photograph (**photo 89**) magnifies things considerably; that real pressure gauge is just ¾ inch in diameter.

The card faces were laser printed from a drawing program. The bodies are solid brass with the faces glued on top, then a 0.020 inch spacer ring, then a 0.040 inch thick glass (small watch glass from eBay), then a press-on bezel. Making the bezels wasn't too difficult,

≫

even though they are turned to 0.020 inch thickness. The pointers are glued to pins set in drilled holes in the body. It was when I was hand filing the 3mm long vacuum gauge needle that I thought that I had reached my limit. I am not sure how I would replicate the fine printing or needle of the commercial gauge which looks much neater; I am sure others could do a far better job. I am now very impressed with what the old-fashioned watchmaker would undertake.

The dummy dials are all set for an engine in motion! Even the cylinder chest gauge shows something.

Frame to hold ¼ inch letter punches mounted on the head of a milling machine.

Reverser indicator scale set in mid-gear.

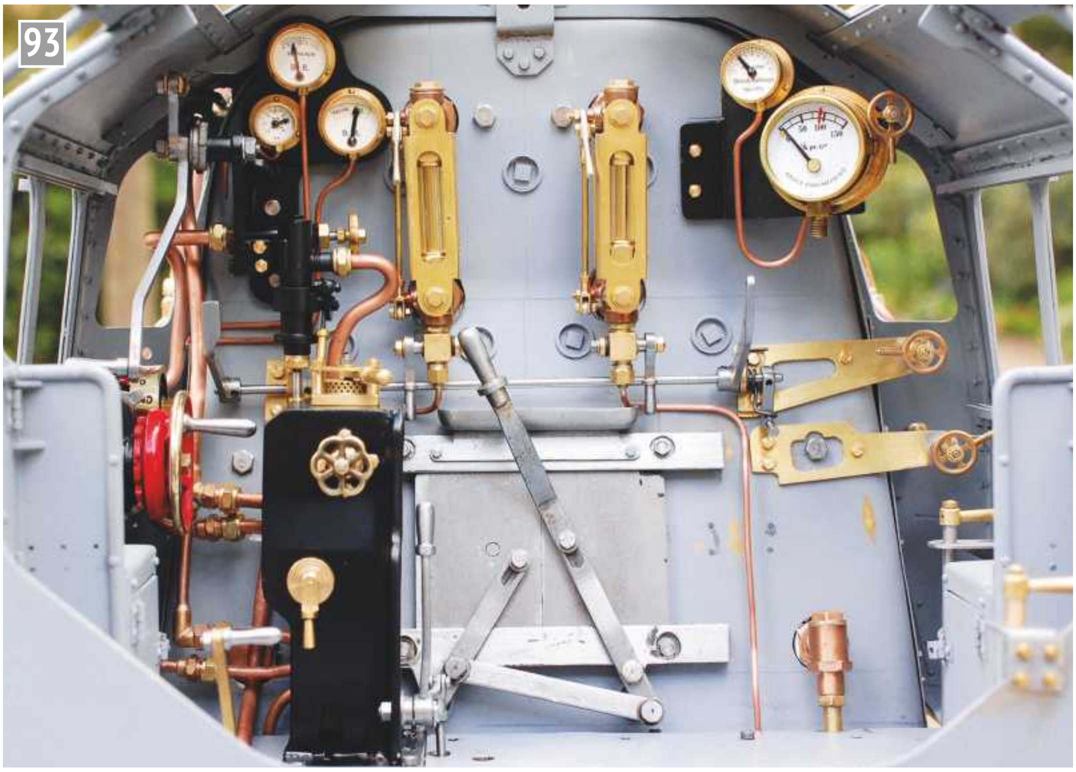
Reverser indicator scale

I wanted to stamp a brass scale to fit on the reverser indicator drum. The first need was to find some way of positioning ¼ inch letter stamps accurately. I made the simple frame in **photo 90** to fit a useful fixing point on the head of my milling machine. I discovered that it does need the upper and lower arms to keep the stamp to within a few thou of position. Using the DROs on the mill makes it easy to position the letters.

I knew where 70% cut-off was on the expansion link, forward and reverse, because the valve motion timing had been looked at in Part 1 of this series. I fitted small collars to the reversing screw that operated the weighshaft arm so that it would not be possible to move the motion beyond those 70% points. I then marked the indicator drum with the two extremes of travel, took it off, and measured the linear scale to be made.

The plate was stamped with numbers up to the maximum 70% forward and reverse positions, then curved to shape and fixed to the drum with epoxy adhesive. The stamp marks were painted and when the paint was fully dried and hardened rubbed down with wet and dry paper and water (**photo 91**). I chose to highlight the stampings in black for forward and red for reverse so that a quick visual check helps avoid a sudden departure from the station in reverse!

●To be continued.

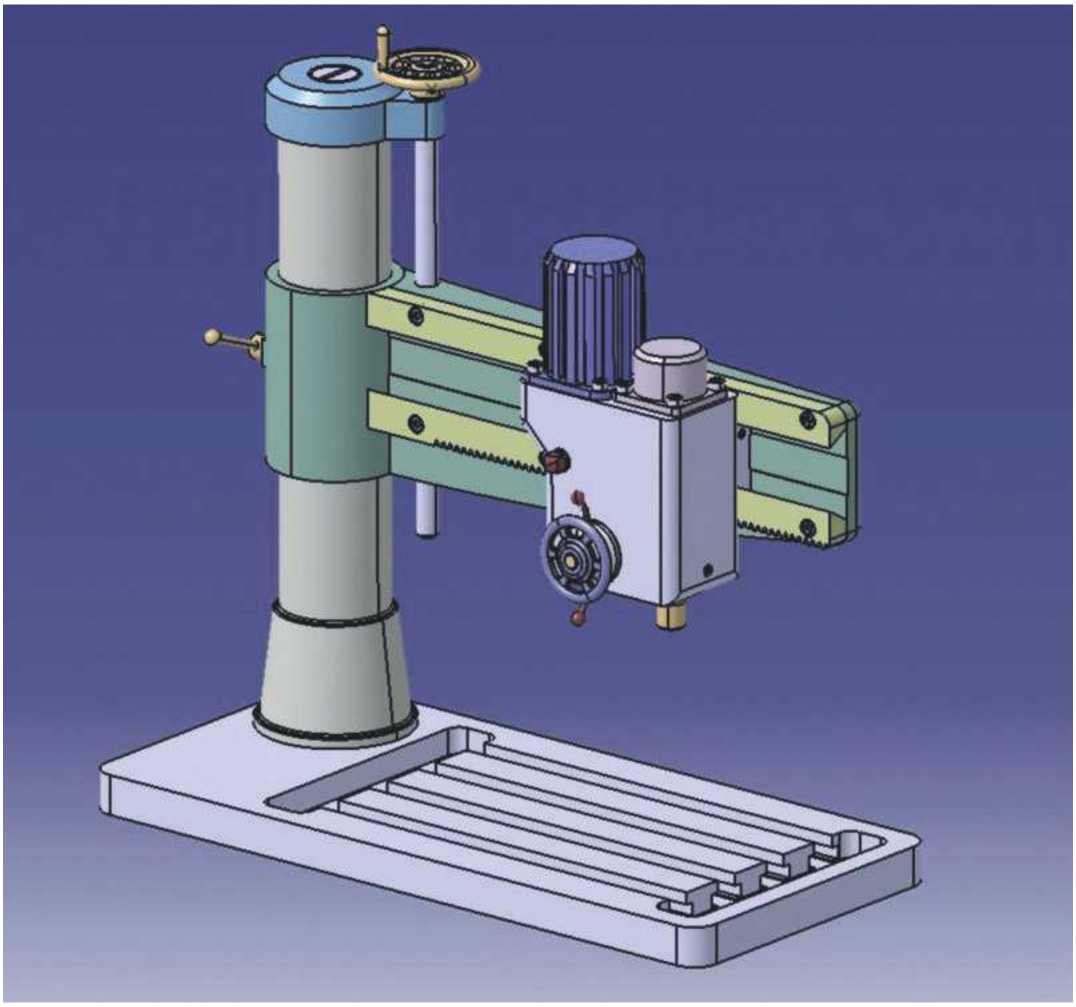


Fully fitted cab just awaiting painting. The fire doors, water gauge glasses and the real pressure gauge are the odd-looking items, each being about twice their true scale size. They tend to fill the otherwise empty backhead centre seen on full size Britannias.

The full and busy driver's side of the cab. Many items and dimensions have been adjusted from what would be true scale from the prototype to make the engine more driveable. Bottom left is the non-prototypical ashpan door control, and to the right on the pedestal is the drain cock lever, that the prototype has on the left of the pedestal.

Philipp Bannik presents his own radial boring tool.

Continued from p.193
M.E. 4670, 30 July 2021



PART 2

A Radial Borer

The next job was to make blanks for all the gears (**photo 13**). I like to finish my parts without turning them around in the chuck. For that I use a tool which is able to groove and turn in any direction (**photo 14**). For the smaller parts I need an arbor to hold them in the chuck of the lathe or mill. After setting the cutter to the centre of the chuck, I true up the blank with a dial test indicator.

Assorted gear blanks.

Grooving tool in use.

That done - good music, a cold drink and a lot of patience is necessary. Over 100 teeth are to be milled, one by one. The brass gears are module 0.5 and the steel ones are module 1 (**photo 15**), including the spindle rack (**photo 16**).

The bigger brass gear drives the spindle and needs a keyway cut into it. For jobs like this I have a special self-made tool holder for my shaper (**photo 17**). The groove has a width of 3mm. I ground the shaft of a 3mm HSS drill in half and added a cutting angle on the face side. It is a small keyway but it does the job (**photo 18**).

The cap of the motor is made of steel. Aluminium

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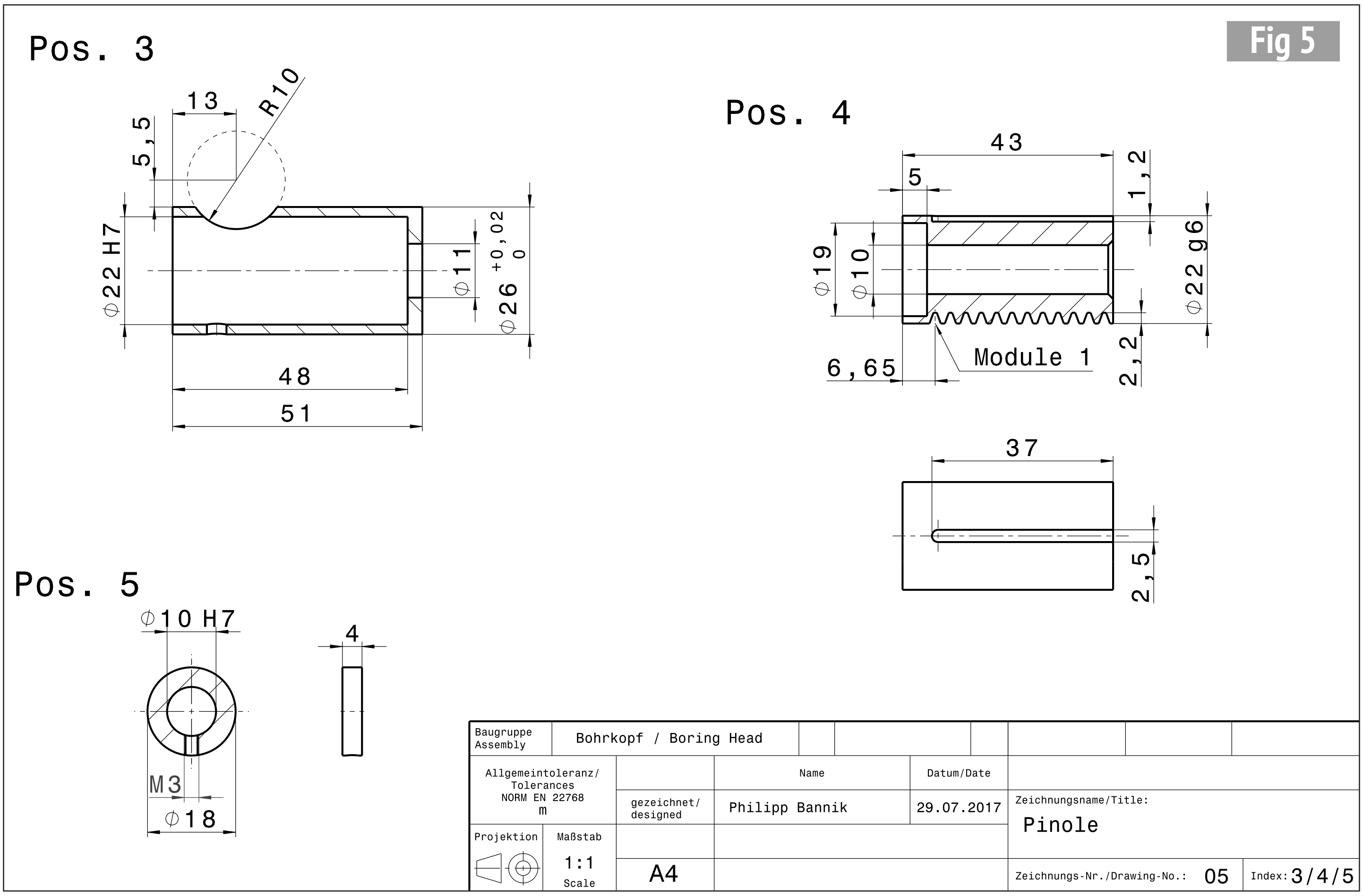
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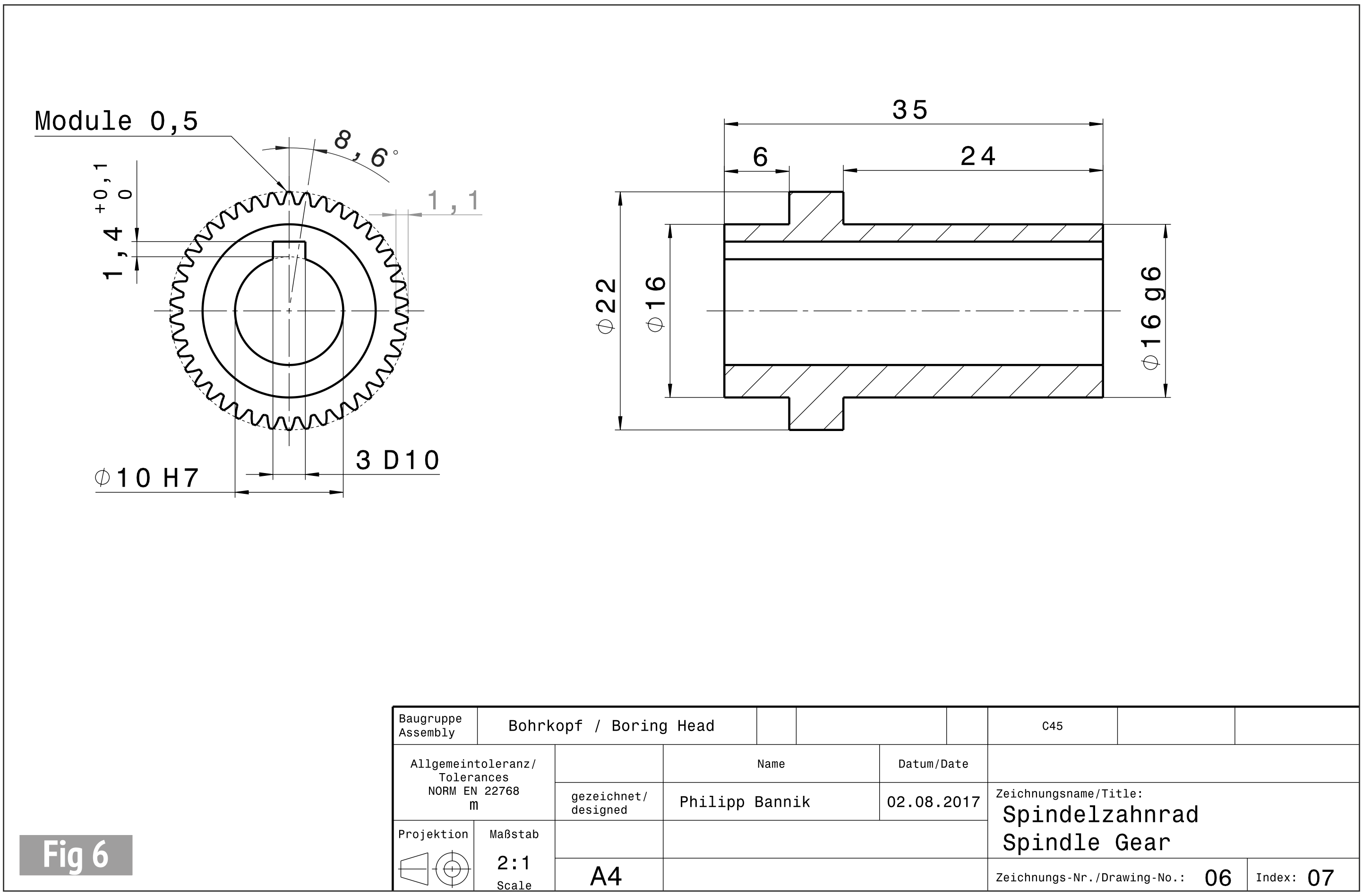
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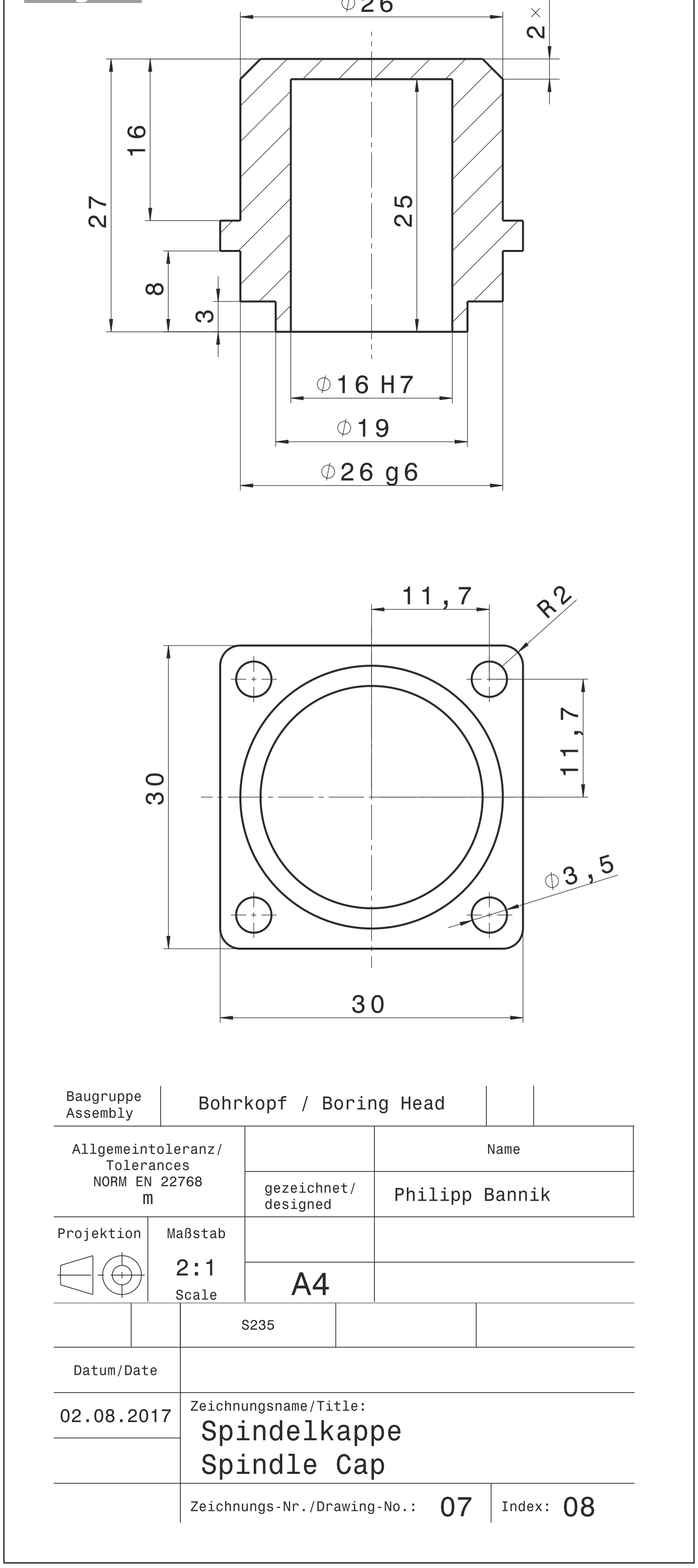
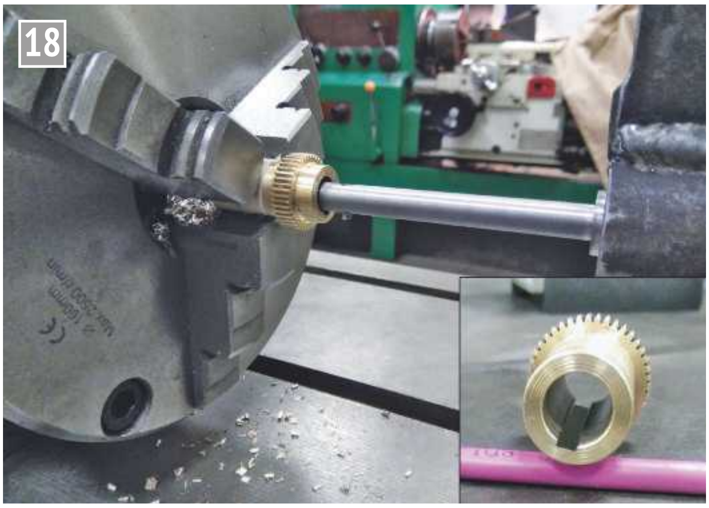
Fig 7



Finished gears.

Cutting the rack in the spindle.

Slotting tool holder.



Slotting the spindle gear.

would be better to conduct the heat away but there was no round stock of aluminium available in my shop. I was too lazy to make a fixture for the cap, for milling the cooling fins on the turning table. Therefore, I clamped it in the vice, determined the middle with an edge finder and attached a stop bar. The bar was an ordinary magnetic holder for a dial test indicator.

After milling the first groove I turned the piece 180 degrees and cut the second. The stop bar helps me to stay in the middle of the piece without having to find the edge again. Then I used a 45 degree angle to locate all the further grooves. After that I needed to square up the base, drill holes for the screws and the cap was done (**photo 19**).

The handwheel is quite simple. I only had to grind a special tool for the recess and turn a jig to hold it, while it was mounted in the chuck on the mill.

The finished motor cap.

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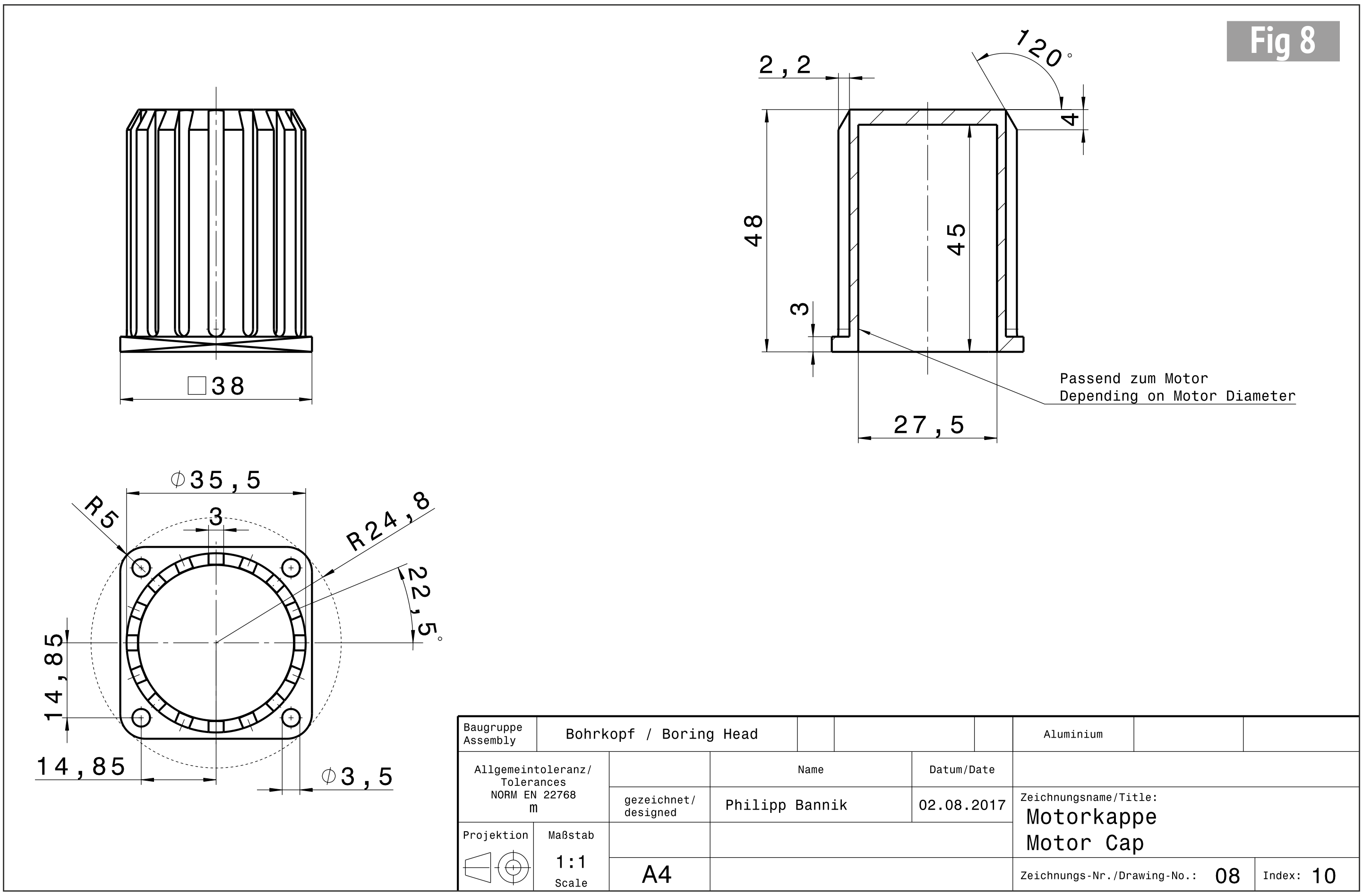
Fig 8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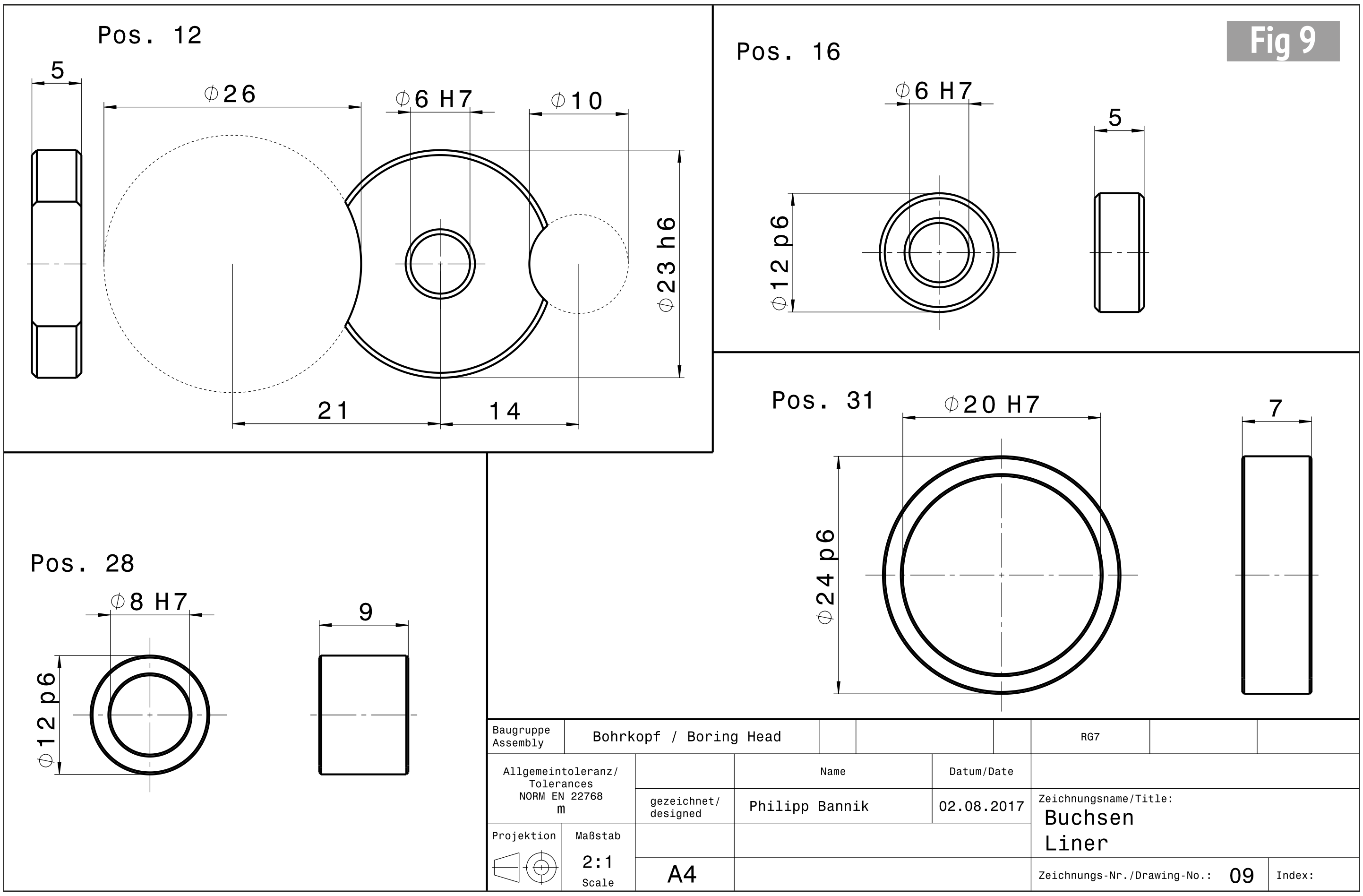
22,5°
14,85
14,85
ϕ3,5
Baugruppe Assembly
Bohrkopf / Boring Head
Aluminium
Allgemeintoleranz/ Tolerances NORM EN 22768 m
Name
Datum/Date
gezeichnet/ designed
Philipp Bannik
02.08.2017
Zeichnungsname/Title:
Motorkappe
Motor Cap
Projektion
Maßstab
1:1
Scale
A4
Zeichnungs-Nr./Drawing-No.: 08
Index: 10

Fig 9


Pos. 12
5
ϕ26
ϕ6 H7
ϕ10
ϕ23 h6
21
14
Pos. 16
ϕ6 H7
5
ϕ12 p6
Pos. 31
ϕ20 H7
7
ϕ24 p6
Pos. 28
ϕ8 H7
9
ϕ12 p6
Baugruppe Assembly
Bohrkopf / Boring Head
RG7
Allgemeintoleranz/ Tolerances NORM EN 22768 m
Name
Datum/Date
gezeichnet/ designed
Philipp Bannik
02.08.2017
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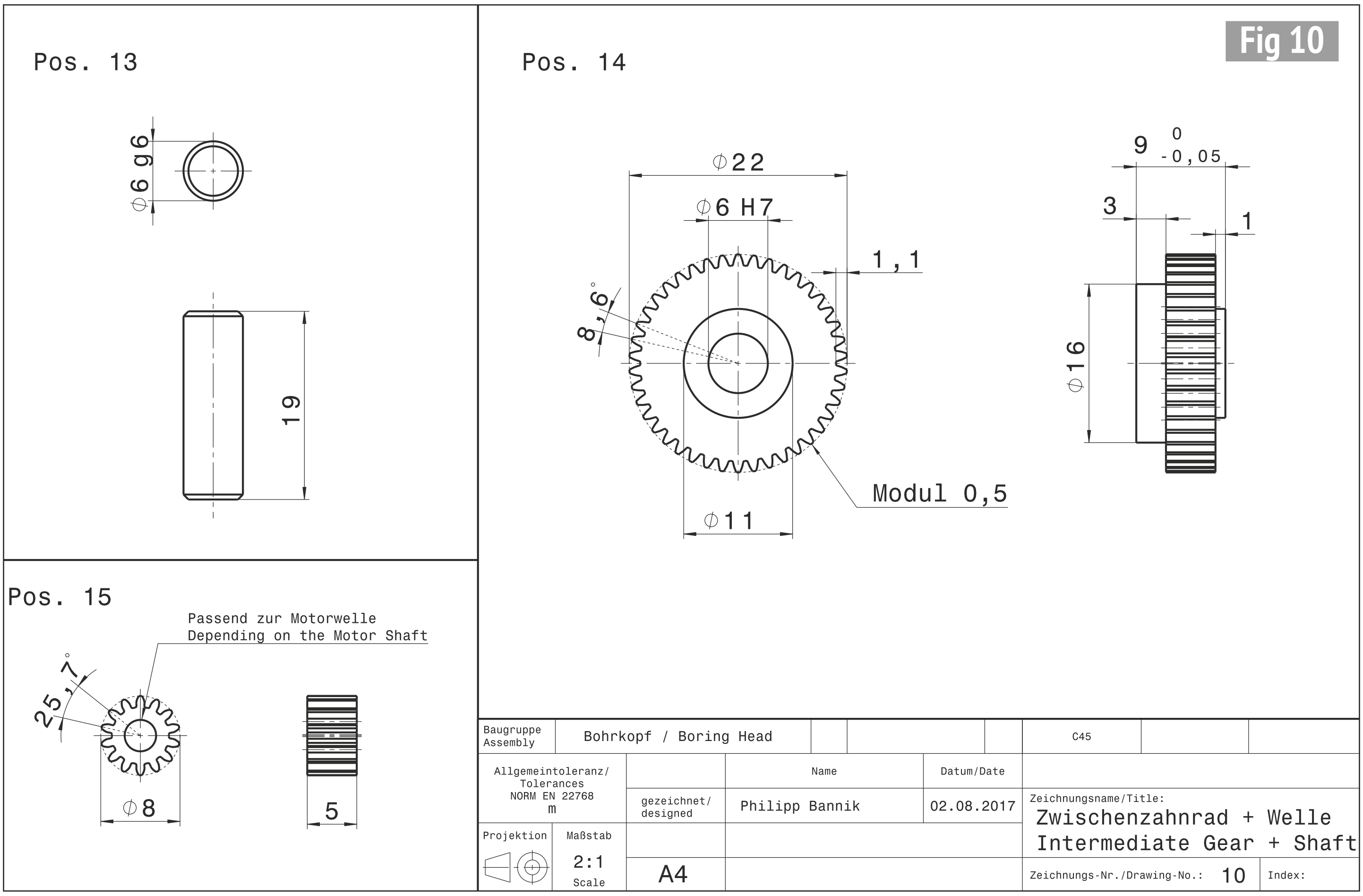


Fig 10

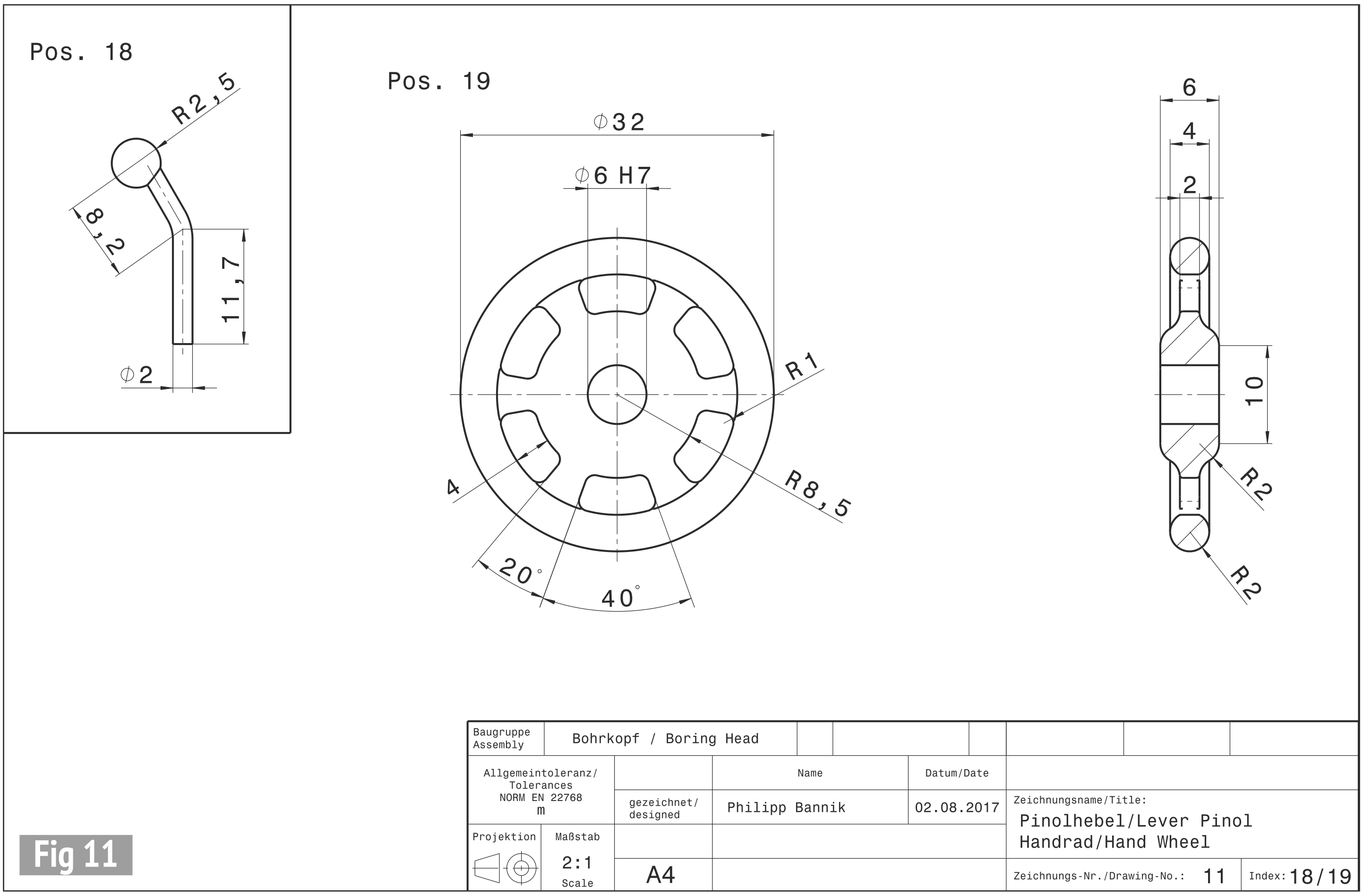


Fig 11

●To be continued.

The Stationary Steam Engine

PART 24 - THE SEEDS OF A BITTER CONFLICT

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

Continued from p.159
M.E. 4669, 16 July 2021

At the beginning of their association Murray had worked within Marshall's mills but shortly after the second patent was taken out, he established himself independently with another former Marshall employee, David Wood, who had trained as a blacksmith (**ref 131**). They took premises in the old industrial complex at Mill Green, Wortley, not far from Marshall's mills in Holbeck and on the 15th of August 1795 an advertisement appeared in the *Leeds Mercury:*

Mechanics Wanted.

Wanted, A Number of White-smiths, Joiners, Wood-turners, and Iron-turners, who will meet with constant Employment, by applying to Messrs. Murray and Wood, Machine-Makers, at Holbeck. Leeds.

These trades were all associated with textile machinery manufacturing and the impression that Murray gives at this time was that he was still primarily a textile machine builder. The next notice, which appeared six months later, shows a shift of emphasis:

The Leeds Mercury, Saturday 20th February 1796.

To Iron founders. Wanted immediately, Two Sober, Steady and Active Men as Green Sand Moulders. Any Person answering the above Description will meet with constant Employ and good Wages, by applying to Murray and Wood, Holbeck near Leeds, February 17, 1796. None but good Workmen, and of good Character, need apply.

The significance of this advertisement lies in the fact that it is specifically directed to the attention of iron founders. The amount of cast iron in early textile machines was too small to justify the inclusion of a foundry in a textile machinery builder's workshop and it was much more usual to send the patterns to a local jobbing foundry. That Murray's plans had extended to include ironfounding implied something more than textile machinery making. His wider intentions became apparent in a third advertisement placed in the *Leeds Mercury* in July 1796:

Murray and Wood desire to inform their Friends and the Public in general, that they have erected and Opened a Foundry in Water-Lane, Leeds, for the Purpose of Casting iron, viz. Engine Work of all Kinds, Ballance Wheels, Joints, Bosses and Steps, Crank and Octagon Wheels. Grate Bars, Bearers, Frames and Doors, Steam and Injection Boxes, Wheels, Segments, Tumbling-Shafts, Plummer Blocks, Coupling Boxes and Mill Work in general.---……….. Those who please to favour them with their Commands, may depend upon them being well executed and on the lowest Terms.

N. B. As they cast Twice each Day, any Gentleman may be accommodated with Castings on the shortest Notice, in Cases of Emergency.

This is the first public acknowledgement that Murray intended to manufacture parts for steam engines although there was nothing to show that these engines were anything other than common atmospheric engines. Soho however had received advance notice that Murray was intent upon skullduggery. In July 1795 Lawson, the Boulton and Watt engine erector, was in the Leeds area. He reported back to Soho:

I refer you to Mr. Southern who I suppose will be with you on Saturday ….as to Engines Erecting here both by Hurst & M. Murray (Mr. Marshall's man) who are now erecting several so as to be made double Engines so soon as the patent expires – one erected by Hurst I have seen it has Parallel Motion & Sun-and-Planet Wheels & the place for the Air Pump & condenser is contrived so as to be put in without altering anything—in fact the cylinder and nozzle is nearly a copy …..

In the same month George Hawks, the Gateshead ironfounder, wrote to James Watt junior following a visit to the Low Moor Ironworks in Bradford. There he had learnt that Low Moor was about to cast a cylinder and air pump:

… … ...on your principles… (intended for Messrs. Murray and Wood) … *a former agent of Messrs. Marshall and Benyon … …*

Hawks was led to believe that Murray had obtained consent from Boulton and Watt for the use of their patent. James Watt junior asked Southern to visit Low Moor and make enquiries which confirmed what Hawks had seen. After a legal consultation Watt jnr. felt that it might be possible to take out an injunction against Marshall & Benyon and Hird, Jarret & Co. of Low Moor Ironworks but notably no mention of prosecuting Murray was made.

Although Boulton and Watt had implicated Marshall in the

That 'Presbyterian Knave', Matthew Murray.

affair, the engine parts seen at Low Moor were almost certainly intended to power Murray's own works and doubtless the evidence was subsequently removed from public view. The difficulty that faced Boulton and Watt in pursuing matters further seems to have pushed them into a position of wait-and-see until two years later, in October 1797 when Rennie wrote to Matthew Robison Boulton that:

... *There is a Mr. Murray, an Engine Maker at Leeds, who is now erecting forty horse & sixteen horse steam Engines – this man makes very free with your patents – would it not be well to look sharply after him.*

Boulton junior felt that Rennie was referring specifically to the expired parallel motion and sun-and-planet wheel patents but he was equally aware of the danger that might arise from Murray adopting the separate condenser. He wrote to Lawson in Leeds instructing him to enquire further into Murray's activities but was forced to admit that should Murray be building engines with a view to adding the separate condenser after the patent had expired there was nothing that they could do.

Murray's strategy emerged more fully as Lawson pursued his enquiries. The 40 horsepower engine was for Messrs. Fisher and Nixon's factory in Holbeck. Fisher and Nixon were Leeds merchants who were extending their activities into cloth manufacturing. Their mill was to be second only to Gott's in size. The engine house was built at the time that Lawson wrote but the engine was not erected although the cylinder was on site by the end of the month. Lawson had also seen an air pump and several other engine components lying in Murray's works yard which he assumed were intended for Murray's own use at the works.

Lawson was now confirmed in his suspicions that Murray was planning to build the engines with provision for the separate condenser but leave the patent infringing parts detached at which point he would approach Boulton and Watt for a manufacturing license. If they refused, then Murray would argue that the machines were to be worked as atmospheric engines until such a time as the patent expired when the missing parts would be added. Lawson sensed deception; he realised that if the risk of detection was small then the condenser would be attached to the engine without waiting for the patent to end. In a subsequent letter Lawson told Boulton that Murray was offering his engines at half of Boulton and Watt's prices, that there was no premium and that Marshall stood surety for Murray. Boulton and Watt's reaction was to make clear that they had no intention of accommodating Murray in any way and that Soho would take legal action against the users of Murray's engines if there was any possibility that a separate condenser was to be used.

In December 1797, Lawson went to Hull and confirmed the details of the 10 horsepower engine built in Leeds. The customer was Charles Shipman who was spinning flax for sailcloth. The Murray engine was fitted for parallel motion and it was clear that the cylinder was to be coupled to a separate condenser although both the cylinder and the condensing apparatus had not arrived. Lawson particularly noted the lack of provision for injecting water directly into the cylinder, unequivocal evidence that the machine was not intended to work as an atmospheric engine.

Soho responded by bringing pressure to bear on Fisher and Nixon. Lawson was instructed to approach Fisher and although the existence and form of any documentary agreement between Fisher and Nixon and Murray was unknown to Boulton and Watt (Lawson was to attempt to extract full details) he was to infer the illegality of the arrangement. In the event of transgression being proven Lawson was to impress upon Fisher that he would be held legally responsible for any infringement and that a punitive sum would be added to any outstanding royalties retrospectively charged. To reinforce the legal threat Lawson was told to suggest that the engine could not be satisfactory at the price that Murray was charging and, to further undermine his confidence in Murray, he was to point out Fisher's inexperience in such matters and the risk that was entailed in trusting Murray, given the scale of his intended enterprise. He was to capitalise on the fact that if the engine were forced to operate on the atmospheric principle then the loss in efficiency compared to an equivalent condenser engine would amount to two thirds of the fuel used. As far as Murray was concerned, Lawson was to avoid a direct confrontation but if engaged in conversation, to extract as much information as possible and at the same time:

… tell him that his Engines will not be licensed, that his proceedings will be watched and the slightest encroachment upon our property inexorably punished. This delivered with becoming gravity, will at least render the fellow cautious and perhaps make Marshall more so, God willing, that Presbyterian Knave shall smart for this one day or other.

Under this onslaught Fisher's resolve wavered and Murray's clerk was instructed to approach Lawson offering £200 to meet the royalty costs. Fisher, … *a man of respectability* … according to Lawson, was now fearful of the forthcoming confrontation. At a subsequent meeting at Fisher's mill he confessed to Lawson that Murray was erecting a 40 horsepower separate condenser engine for him. The condenser was not fitted but Lawson saw the equipment at the mill. Fisher's defense was that the condenser was not to be fitted until after the patent expired and it was to run as a common engine on partial load until that time. Lawson however could see no facility for water injection into the cylinder.

In mid-December Soho rejected any application by Murray to grant a license and threatened legal action should any of his engines show evidence that they were to employ a separate condenser. Within four days, Fisher and Nixon replied disclaiming all intention of infringing the patent and insisting that the machine was to work as a common atmospheric engine with an output of 17 horsepower. Notwithstanding this, they offered Boulton and Watt £400 for permission to apply the condenser. Boulton and Watt dismissed the proposal, Fisher acknowledged defeat and in March 1798, the engine being virtually complete, he invited Boulton and Watt's representative to inspect it in order to confirm that no infringement had taken place. It was examined on 11th of June by a delegation consisting of George Lee, Peter Ewart, Benjamin Gott and Lawson on behalf of Boulton and Watt in the presence of Fisher and Murray. The engine incorporated the sun-and-planet gear and the parallel motion. Working as a common engine without condenser it used more fuel than Gott's engine and produced only 16 horsepower leaving three stories of the mill without power. Fisher's humiliation was increased by Watt's demand that the premium payable might be as much as £1,000 and possibly more. Fisher was cowed but Murray was not.

●To be continued.

REFERENCE

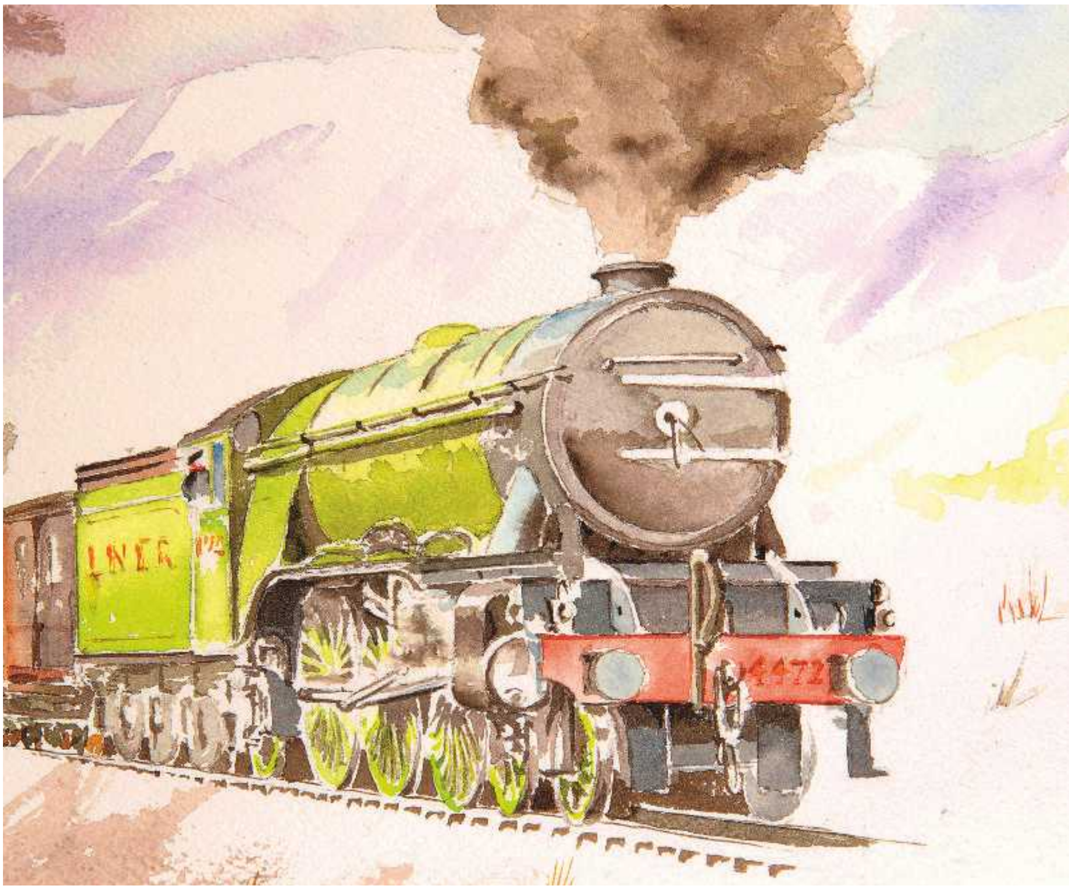
131. *Matthew Murray 1765-1826*...Thompson. Op.cit.

NEXT TIME

Playing the patent game.

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

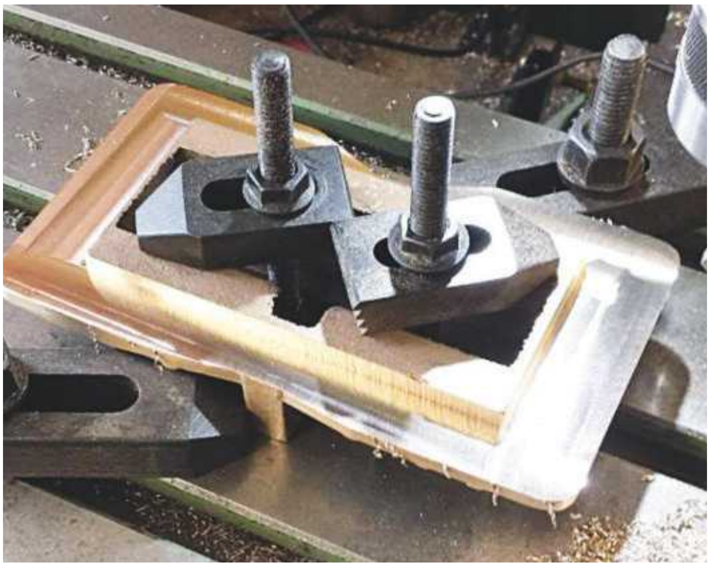
Continued from p.203
M.E. 4670, 30 July 2021



Painting by Diane Carney.

PART 16 - HORNS AND HORNSTAYS

Flying Scotsman in 5 Inch Gauge



1. The horns are first machined slightly over size and then filed for an exact fit in the frame slots.

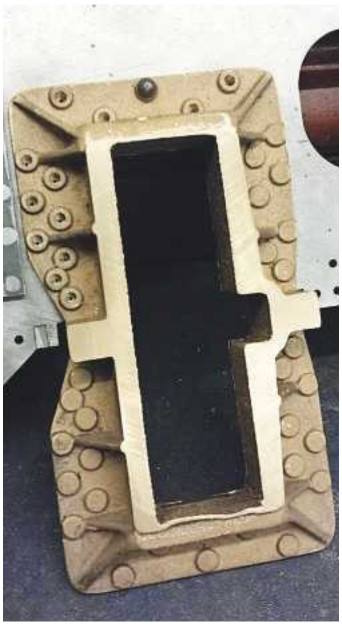
Horns and stays

First job was to file flat the top edge of each casting so that they could then be turned over and held flat on the mill bed, next was to machine the underside (the face that fits against the frames) down to the right thickness. With this done I then machined the spigots that fit between the frame slots, but the laser cut slots vary a little so I machined them slightly oversize and then filed down to achieve a tight fit. The next step was to machine the depth of the spigots down to the correct height from the rear face. The final job for the rear face was to machine the channel that the rear of the axle box runs in. I have left the inner slots and tops of the horns until they are fitted to the frames and followed standard engineering practice of machining both sides back to back to ensure axles are square and at their correct distance in relation to each other.

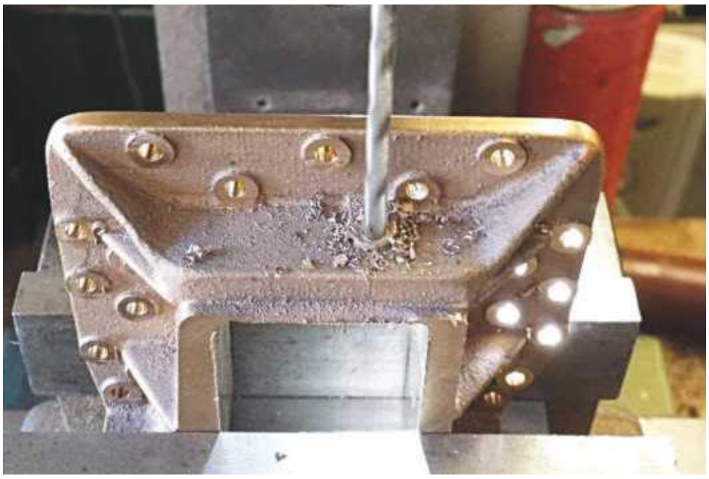
2. Here the front facing of the castings is being machined, using a fly cutter while holding them in the machine vice. I then turned over again and went back to the other faces that had been left slightly oversize to finish off.

3. I then needed to tackle the holes for riveting the horns to the frames. Normal practice is to transfer the holes from the frames to the horns but these horns have prominent raised bosses and it seemed more prudent to do it the other way around, wanting to have the holes central to their relevant boss. To help with this I made up a simple alignment tool as shown here. The two notches are to allow for clearance with webs/ adjoining bosses.

4. The first hole is drilled - close enough.

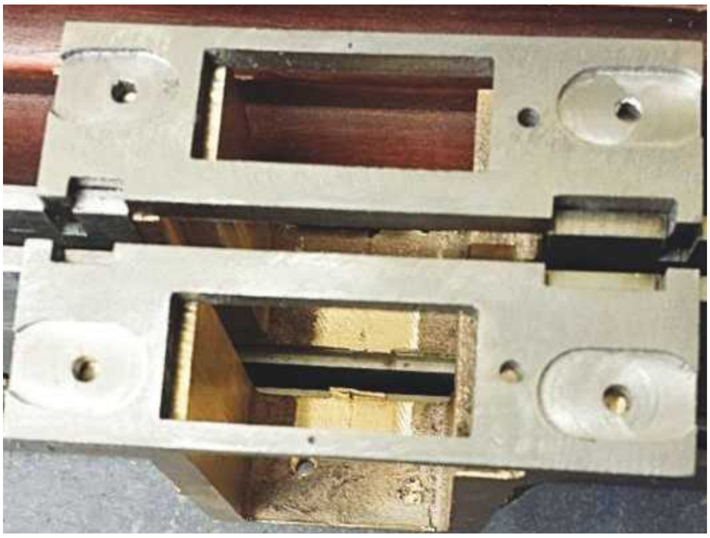


5. Here is the horn sitting in its frame slot with the central rivet pushed into place. The fact that the horn fitted tightly into the slot and that the rivet also fitted was rather reassuring!



6. Having finished drilling all of the holes ready for fixing to the frames I then parted the horn pairs and started to drill the remaining holes for the oil feed and the dummy wedge adjusting bolts. Here, the oil feed is being drilled.

7. Next I turned the casting over and drilled/tapped for the lower dummy wedge adjusting bolt hole. The bottoms of the horns still haven't been machined yet - I decided to leave these until the horns were riveted to the frames and the frames fixed back to back for machining of the axle box slots.



8. Here are the hornstays, with the two recessed areas around the stay bolts. These should have four flat sides instead of the three that I have machined, but it's much easier to use a large cutter in one move rather than a small cutter in a rectangle - and who will see?

Milling out the slots

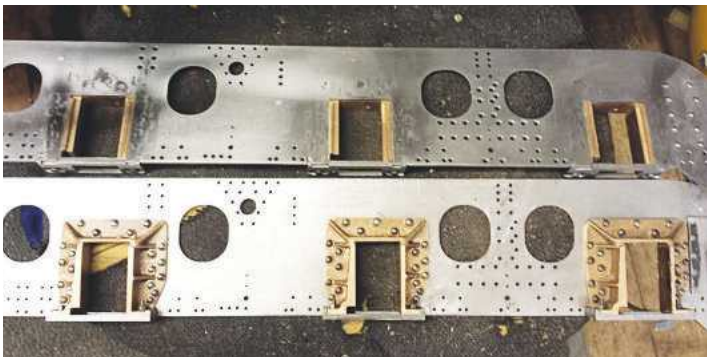
After a marathon riveting exercise I was ready for that most important of jobs, machining of the slots. I spent an entire morning setting this lot up ready for machining. It's very rigid and is using everything that I have for clamping the frames to the bed. I used three angle blocks which I fixed a steel square bar to and clocked to be true.
I cut up a set of Reeves spare frames to clear the rivets that hold the doubler plates. These had one of the lightening holes in the wrong position making them useless for their purpose. I used a couple of reference holes that were also cut through the spare frames to keep the two frames aligned correctly.

The frames were then rested on the bed and held to the angle blocks. More steel bar was added for extra rigidity - two long bars along most of the bottom edge and others at various places held tightly with clamps. The frames were then checked to be level with the bed and upright.

9. Here is the setup. Using a brand-new long series cutter I made a start on what for me was a very important machining exercise, probably the most important so far in the build at that stage. The cutting flutes had a cutting length big enough to cut the entire horn cheek in one go without needing to step machine. The first job was to find the centre point for the crank axle which was then my datum for all three slots. Having previously checked the accuracy of the laser cut slots it was easy to use them as my starting point, find the two edges using an edge finder, plot them and note the centre. This was then my datum point from which all others were plotted.

10. Here is the edge finder in action. Note that it's running along the frame slot, not the horn. With the cutter set at the centre point I machined the centre down to about 10 thou above its correct size for roughing out.

11. This picture shows the centre horn cheeks machined. They were at this stage 60 thou undersized for width and about 10 thou for depth. The plan was to machine the other two slots to this size for the roughing out stage, then find the centre with the edge finder again, just in case of any creep during the machining. It should then be a simple job to machine accurately to their correct size - 0.5 thou over for the final polishing of the horn cheeks.



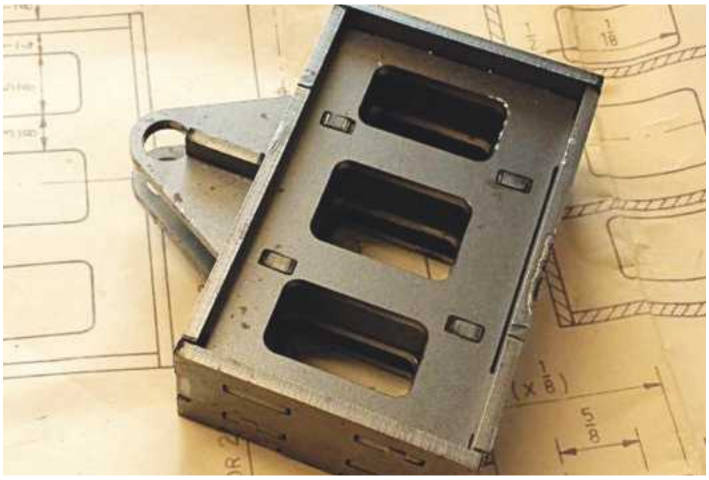
12. This picture shows the frames as they were at this stage, with horns and hornstays in place.

Erecting the frames

This is where I really did appreciate the wonders of modern technology with laser cutting. It didn't take too long to fabricate the following remaining parts (all the various stiffeners and spacers) for the frames. If I'd had to cut them all out by hand I'd still be working at it! I also doubt that I'd have the stamina to include all the highly detailed parts that make such a big difference to the model.

Once I had finished silver soldering the various parts together they were machined square and given a coat of etch primer. The stiffeners were clamped to the rear of the frames allowing space for the drag beam and their holes were spotted through. The spacers had to be done another way as they sit at an angle and thus I couldn't use a square to ensure correct orientation. I plotted two holes according to the drawings, tapped them and then held the spacer to the frame via these two points. I then used a suitable drill reversed in the chuck to spot each hole in turn and then drilled for clearance.

Now I could finally get back to erecting the frames. I reassembled the various stretchers made previously, held with the two bolts for each that I had drilled. I then worked my way through each stretcher, checking that it was square and correctly placed and then spotted through each hole in turn plus tapping all that required it. The frames were laid on their back first to check that they were sitting flat before tightening the bolts and this was then re-checked at each stage as I proceeded.

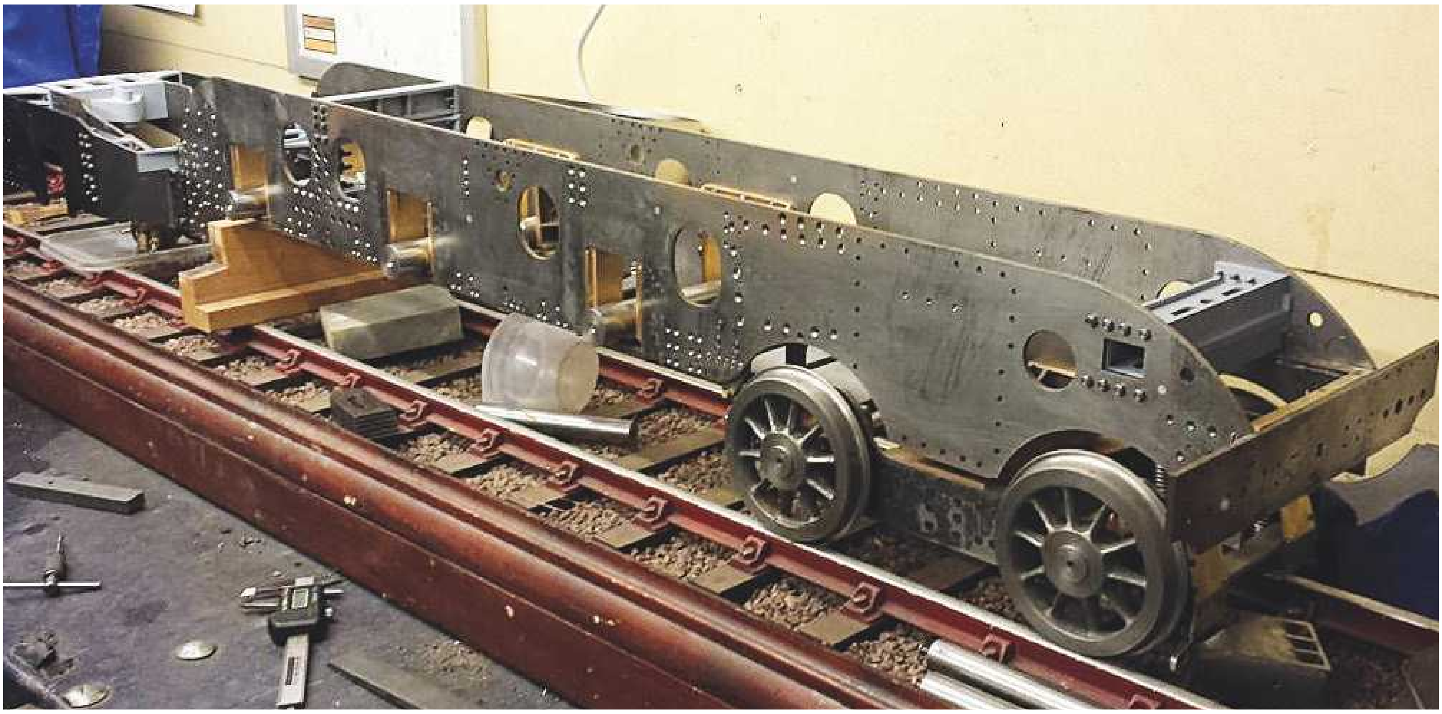


13. Here is the all-important dragbox. This is a piece of art and shows that Don's design will be capable of hauling very heavy loads. As can be seen it has three layers and will be very strong. Bits still to add are the pivot bush which I'll turn up before silver soldering everything together and the curved front that needs cutting, heating and shaping to fit around the pivot bush plates. All of the above will then be machined square and to final size.

14. It was sunny outside so I moved out into the fresh air/sun. The picture shows the trailing frames held in place with two bolts each to check all is going to plan. I bolted a piece of steel under the dragbox (or on top if the right way up) to keep the trailing frames level with the cab floor so that I could check they were of the correct length.

15 Here is the boiler stay, again another part nicely laser cut by Malcolm. Here's the finished article after being silver soldered together and machined to size. Once this little beauty was in place, the frames are very, very rigid and I still have more stays to fit, quite a few more in fact.

16. With the boiler stay fixed it was time to permanently fit the dragbox, stiffeners, spacers and finally the trailing frames. I have a lot more parts to do in this area though - dragbeam ends, steps, support gussets, trailing frame stay, rear frame stay, outriggers, spacer support, 'T' beam etc. etc... the list is very long and that's just at the rear.



17. To conclude this part we have the obligatory picture to show how things are progressing. She's beginning to look like a locomotive, a Gresley locomotive of which there are no better... yes, I can hear the gasps from Swindon now (Gasp! – Ed.) but, hey, I'm a Gresley man.

●To be continued.

Cheap and Cheerful Diamond Lap

Stewart Hart knocks up a very useful addition to his workshop.

Tungsten disposable tipped tools are the cutting tool of choice for industry where high rates of material removal is the order of the day, with very powerful, robustly constructed machines. These machines are knocking the material off, not slicing - just watch some machining videos to see what I mean. These tipped tools are designed with this aim; they have very little or negative rake with lumps and bumps that act as chip breakers and if you look at their cutting edge they are far from sharp.

If you've ever tried to use one of these industrial tips on a light home workshop lathe, you will find it cuts in fits and starts - only removing material when the loading builds up to a point where it knocks the material off. This overloading of your machine is not good. The answer is to use a sharp high-speed steel tool or a sharp brazed tungsten tool (**photos 1** and **2**).

Brazed tungsten tools are relatively cheap and readily available and will last a long time provided they are sharpened correctly. Being tungsten, they need very

Tungsten tip with holder and brazed tip tool.

little rake to prevent the edge from chipping and for home workshop machine they need to be nicely sharp.

They can be sharpened on a bench grinder fitted with a green silicon carbide wheel, specifically for tungsten. The only problem is that these green wheels are not much use for anything else, tying up one end of your grinder and being soft so they create a lot of dust. The answer is a diamond lapping machine as used in industry but these machines are costly.

Tungsten tips showing chip breakers.

I was shown a cheap and simple solution to this problem by Dave 'Stilldrilling'. Dave bought some cheap 2 inch diameter diamond cutting discs (**photos 3** and **4**) from his local market and mounted one on a wooden backing board. By powering the disc in his lathe he had a way to freehand sharpen his tungsten tools. I used Dave's method for a little while but I realised freehand really didn't give me the control required to get the best results; what was required was a lap with a rest.

The solution I came up with is based around a 12-24V 775W motor. These motors are readily available off the Internet, as are the 2 inch

2 inch diameter diamond cutting disc.

Disc mounted on a simple backing plate for freehand grinding.

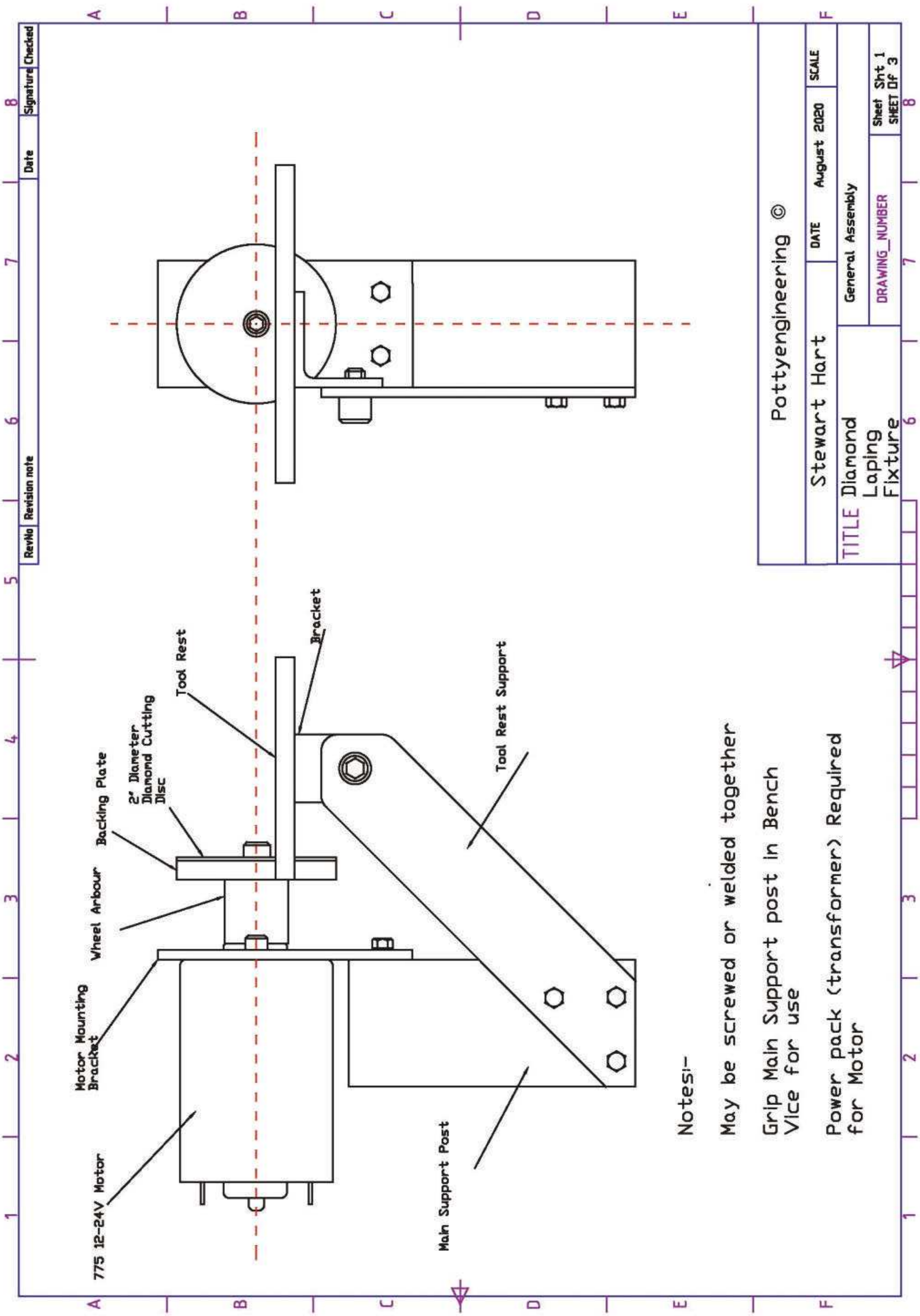

775 12-24V Motor
Motor Mounting Bracket
Wheel Arbour
Backing Plate
2" Diameter Diamond Cutting Disc
Tool Rest
Bracket
Tool Rest Support
Main Support Post
Notes:-
May be screwed or welded together
Grip Main Support post in Bench Vice for use
Power pack (transformer) Required for Motor
Pottyengineering ©
Stewart Hart
DATE
August 2020
SCALE
TITLE Diamond Laping Fixture
General Assembly
DRAWING_NUMBER
Sheet Sht 1
SHEET Of 3
RevNo
Revision note
Date
Signature
Checked

Fig 1

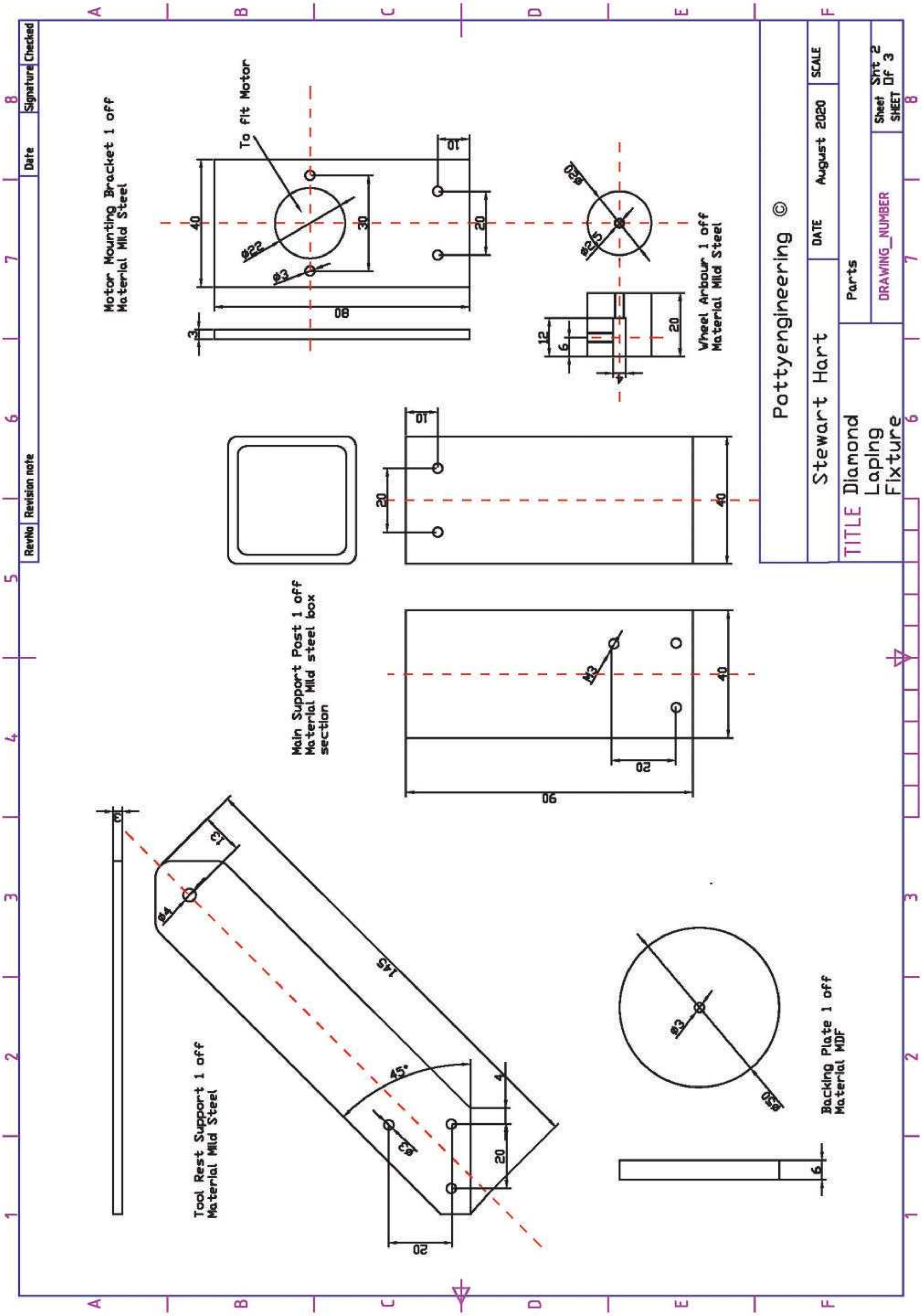

Motor Mounting Bracket 1 off
Material Mild Steel
To fit Motor
Ø22
Ø3
80
40
30
20
10
3
Wheel Arbour 1 off
Material Mild Steel
Ø20
Ø2.5
12
6
20
4
Main Support Post 1 off
Material Mild steel box
section
M3
90
40
20
10
Tool Rest Support 1 off
Material Mild Steel
Ø4
Ø3
145
45°
13
3
4
20
Backing Plate 1 off
Material MDF
Ø3
Ø50
6
Pottyengineering ©
Stewart Hart
DATE
August 2020
SCALE
Parts
TITLE Diamond Laping Fixture
DRAWING_NUMBER
Sheet SHEET
Sht 2 Of 3
RevNo
Revision note
Date
Signature
Checked

Fig 2

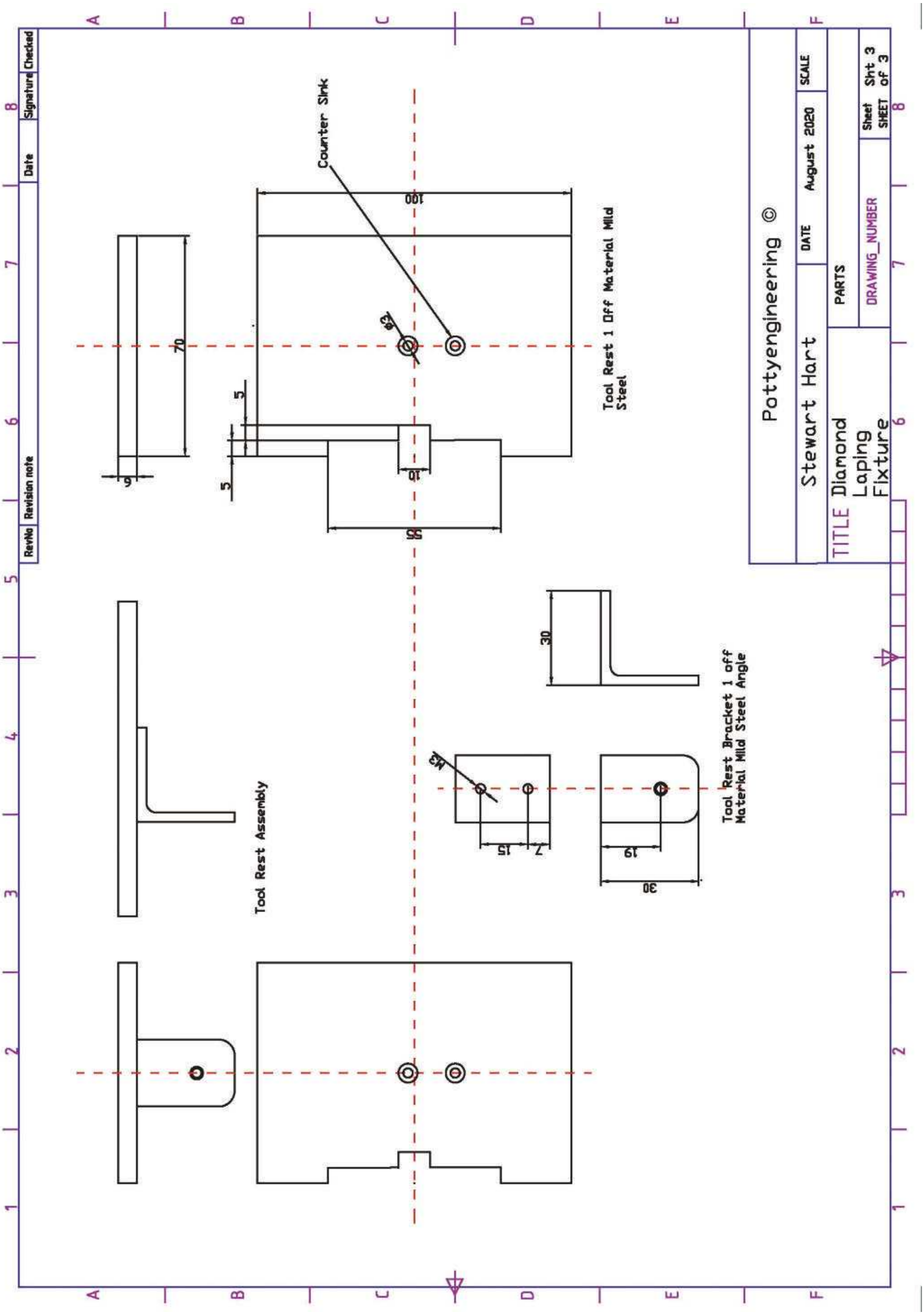

RevNo
Revision note
Date
Signature
Checked
Counter Sink
Tool Rest 1 Off Material Mild Steel
Tool Rest Assembly
Tool Rest Bracket 1 off Material Mild Steel Angle
Pottyengineering ©
Stewart Hart
DATE
August 2020
SCALE
TITLE Diamond Laping Fixture
PARTS
DRAWING_NUMBER
Sheet Sht 3
SHEET of 3

Fig 3

diameter diamond cutting discs. These discs are very cheap and, being double sided, will last a long time. Larger diameter diamond discs are available but I've found these 2 inch discs are more than adequate.

The general assembly drawing is shown in **fig 1**. You don't have to slavishly follow this drawing, you just need to follow the concept. I've constructed my rest from mild steel box section, angle and strip but a wooden construction would be just as effective.

Actual construction is relatively simple so I won't go into too much detail (**figs 2** and **3**). The first job is to cut your material off to length - a job made easy if you have a small band saw (**photo 5**). I actually inexpertly welded mine together; the welding looks like pigeon droppings (**photo 6**) but it holds together but you can just as effectively bolt it together, as shown in the drawing. The motor mounting holes and the wheel arbour may have to be adjusted to suit the motor you're using.
I cut the backing plate from a sheet of MDF using a tank cutter. Wear a facemask to do this as the dust is unhealthy (**photo 7**).

Cutting material with band saw.

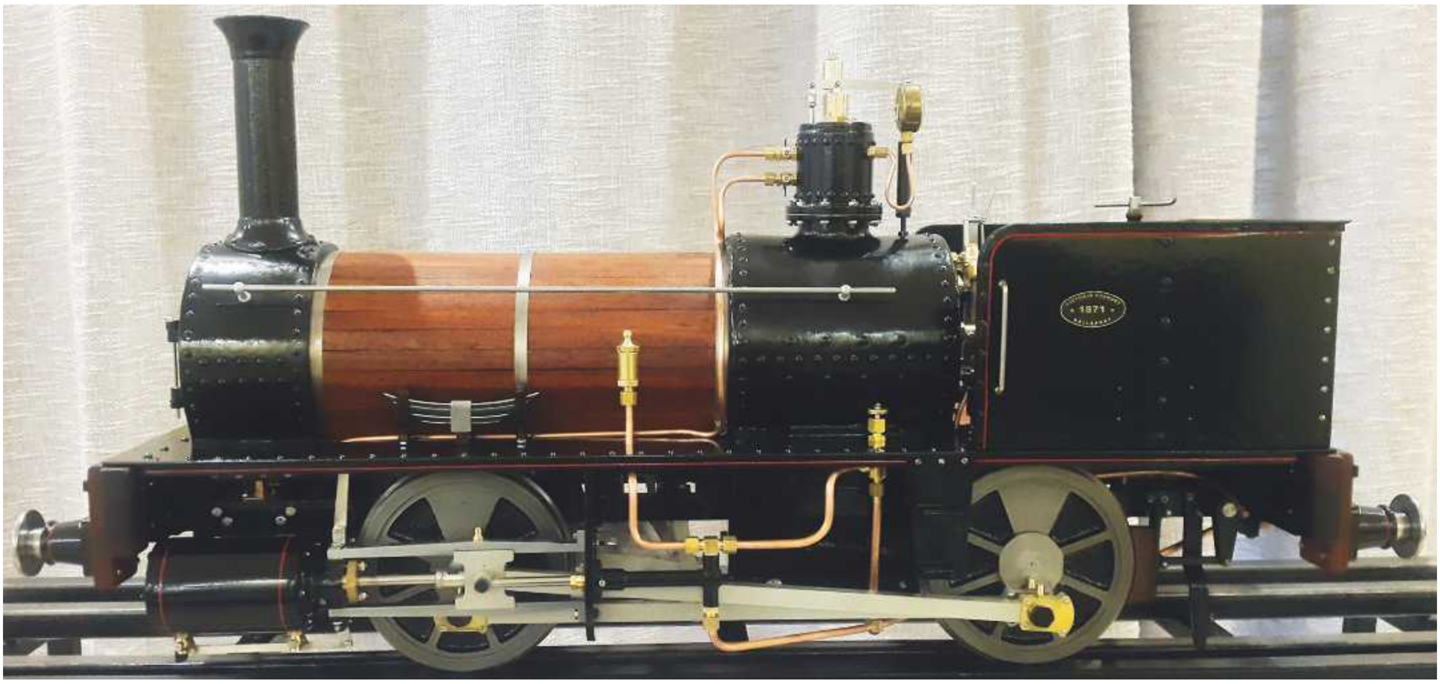
Parts welded together by pigeons.

Cutting backing plate using tank cutter.

Completed lap gripped in vice for use.

I use the power pack from an old lap top for the 12-24V motor. Simply clamp the unit in your bench vice, tilt the rest to an angle of about 3 degrees, switch on and away you go. I've been using my lap for some time know and it works well, helping me to get the best out of my brazed tooling (**photo 8**).

ME



Ballaarat PART 2

A 5 Inch Gauge 0-4-0 Aussie Locomotive

Luker describes a simple but authentic small locomotive.

Continued from p.134
M.E. 4669, 16 July 2021

Axle-box horns

Before the frames can be assembled there are a number of components that need to be made and fitted. As I go through the various components, describing how I would go about setting up the job and machining, I will avoid repeating certain steps. For example, I've described my method for scribing lines for drilling holes or lining up components so that won't be mentioned again.

The axle-box horns are best done in the milling machine with the vice clocked to the fixed jaw. Failing a milling machine this can be machined on the lathe using a vertical slide, and failing that the tool post can be used (**photo 5**). After cutting the horns a couple of mills (1-2mm) longer than required, skim one end using the four-jaw chuck to neaten it up. Leave the block slightly longer so that it can be trimmed to the end of the frames after final fitment.

Scribe a line for the centre of the slot to line up in the lathe. Use shims (an automotive valve gap gauge works well and is cheap) to correct for the height with a turned centre in the chuck as the centre guide. The tool post should be checked for parallelism with the chuck by shining a light between the two with the toolpost brought up against the chuck (obviously with everything off!). When clamping the part in the toolpost you need to place a piece of scrap metal under the clamping screws to prevent the screws from damaging the surface and to distribute the load better. The clamping should be to the back of the part to prevent the ends closing in as the cutting progresses.

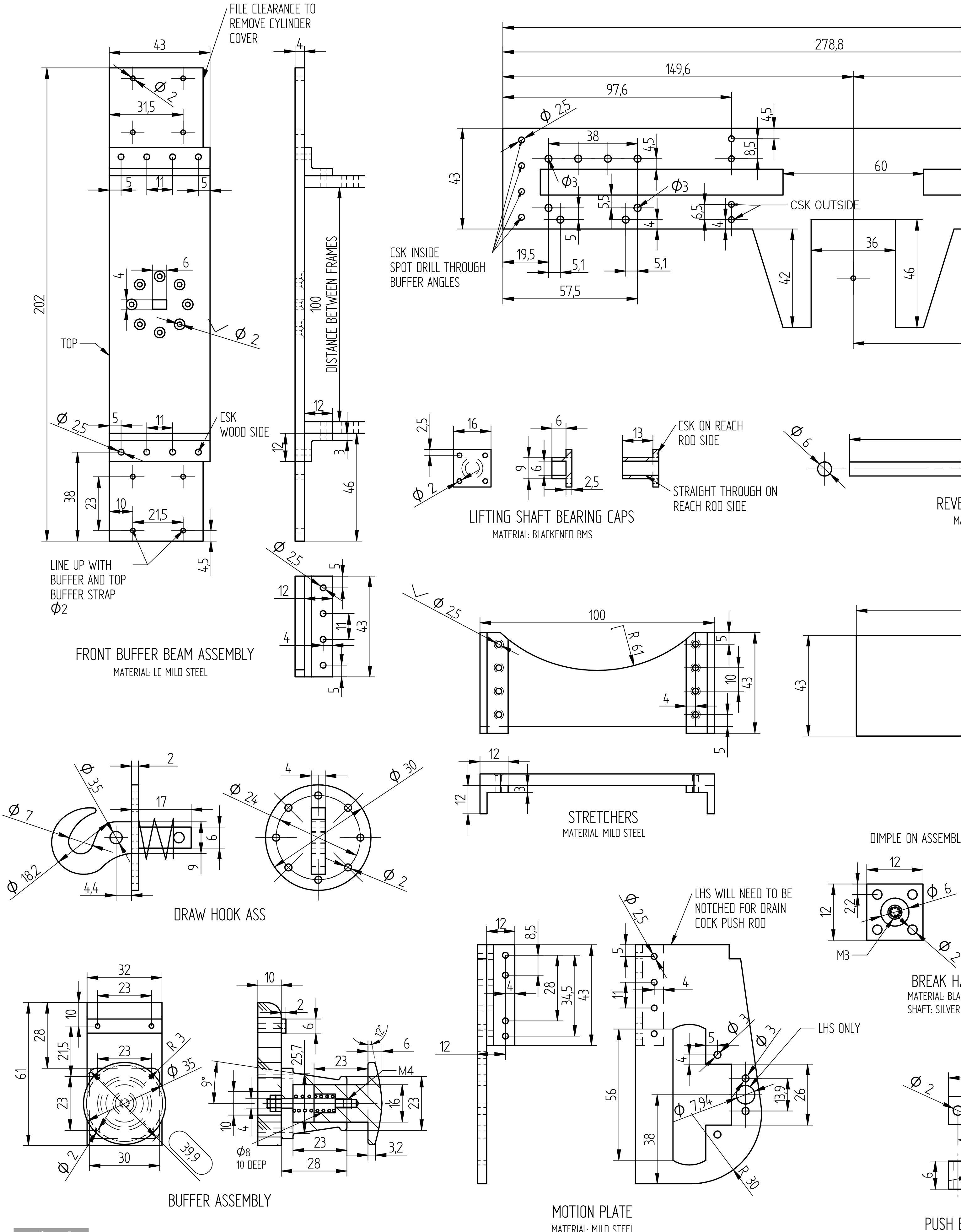
A 4mm slot or end mill cutter followed by a 5mm cutter will cut the slot close enough (**photo 6**). If you're lucky enough to have a collet that fits into the headstock spindle that is best but if you are just beginning this is a luxury, so the three-jaw chuck will have to do. If it's a newish chuck you should be okay but to be safe you'll need to take light cuts (<0.5mm) at a moderate speed (800-1000RPM). This will vary with your specific setup but it was my cutting speed.

5

Axle-box setup on lathe.

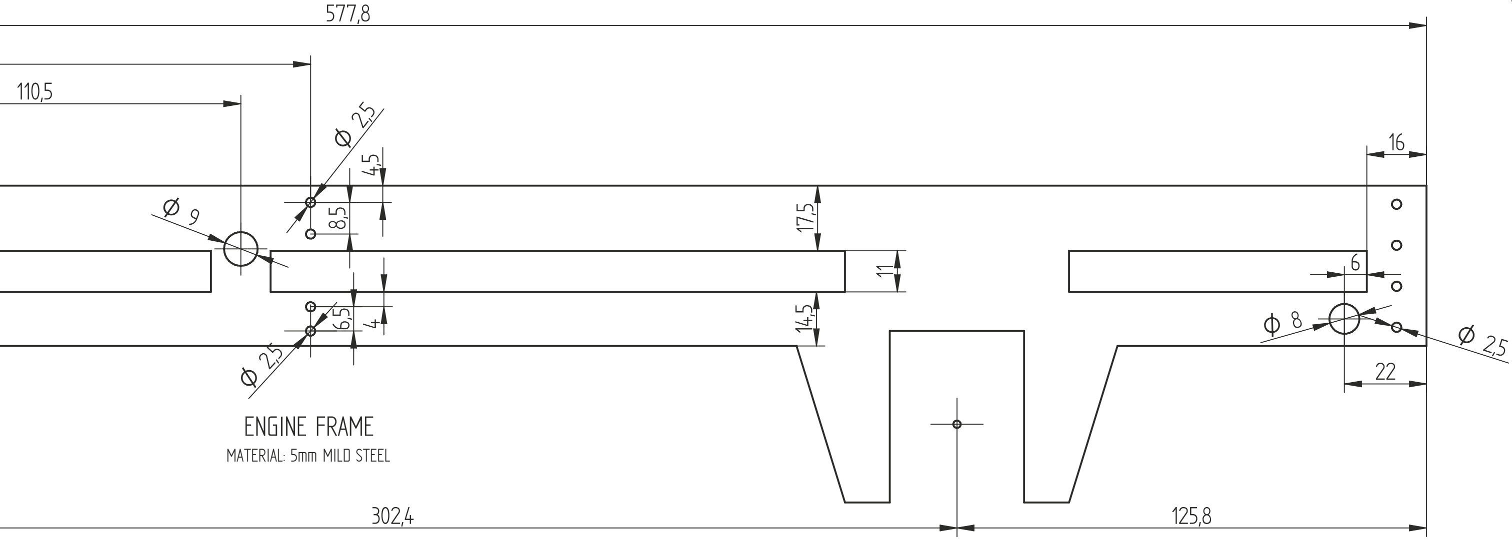
6

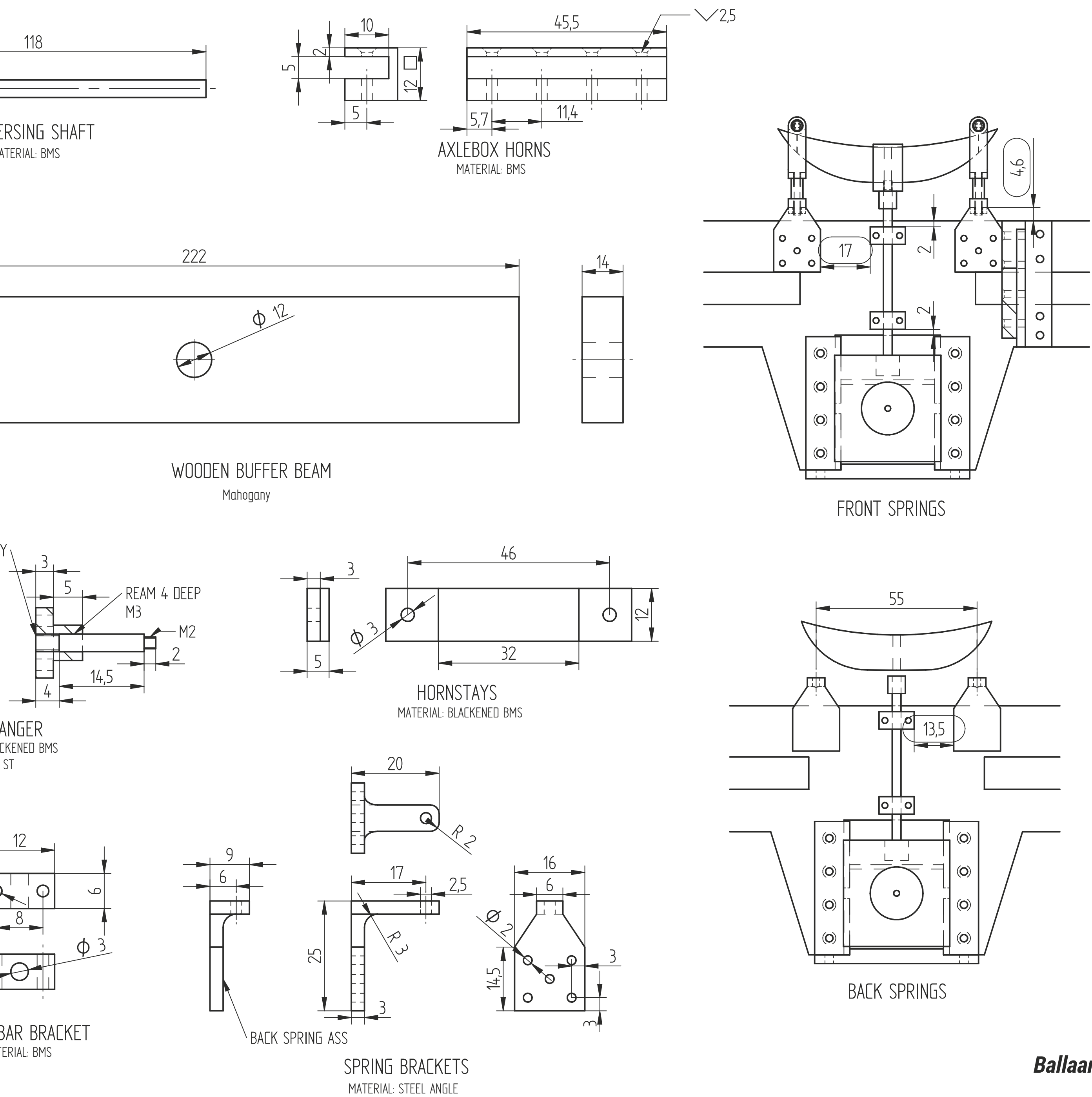
Axle-box frame slot machining.



FILE CLEARANCE TO REMOVE CYLINDER COVER
TOP
CSK WOOD SIDE
DISTANCE BETWEEN FRAMES
LINE UP WITH BUFFER AND TOP BUFFER STRAP
Ø2
FRONT BUFFER BEAM ASSEMBLY
MATERIAL: LC MILD STEEL
CSK INSIDE SPOT DRILL THROUGH BUFFER ANGLES
CSK OUTSIDE
LIFTING SHAFT BEARING CAPS
MATERIAL: BLACKENED BMS
CSK ON REACH ROD SIDE
STRAIGHT THROUGH ON REACH ROD SIDE
DRAW HOOK ASS
STRETCHERS
MATERIAL: MILD STEEL
DIMPLE ON ASSEMBL
BUFFER ASSEMBLY
Ø8 10 DEEP
M4
LHS WILL NEED TO BE NOTCHED FOR DRAIN COCK PUSH ROD
LHS ONLY
MOTION PLATE
MATERIAL: MILD STEEL
M3
BREAK H
MATERIAL: BLA
SHAFT: SILVER
PUSH

Fig 4





***Ballaarat* frames.** >>

The holes for the frame bolts should be punched with the horns firmly clamped in the vice to prevent the slot from closing. The rest is simple drilling operations on the pedestal, with a countersink on the wheel side of the holes.

Fitment of the horns to the frames requires some epoxy glue, a spacer guide (which is just a piece of round bar machined to size) and a few ‘G’ clamps. Smother the slots with some two-part epoxy glue and fit them to the frames with the cleaned edge facing upwards. Two sets of horns should be done at the same time with the frames clamped together and the third clamp clamping the horns to the spacer (**photo 7**). This ensures alignment of the axleboxes on the inside and outside surfaces.

Once the glue has set the drilled holes can be used as drilling jigs to drill through the frames. The screws should be screwed home with retaining compound in the hole making the assembly permanent. Interestingly enough, most of the locomotives I’ve built have had the horns riveted to the frames but this loco had them bolted (**photo 8**) which makes the assembly much easier for the beginner. The ends of the horns can now be filed or milled flush with the frame. The advantage of assembling the horns like this is you shouldn’t need to skim them in the milling machine - removing one rather difficult machining operation.

The hornstays are a simple marking, punching, drilling and finally milling or filing operation. If the first hole is correctly marked out and used to drill a mating hornstay, and that one is flipped like the buffer plates, all the holes will be identical and the parts will be interchangeable. The ends of the hornstays should be milled or filed back; this is to make life a little easier when setting the valves later on. Alternatively, they can be left 5mm and, when setting the valves, the axleboxes can be jammed to the running position. The hornstays are used to spot the bottom of the frames with the frames drilled and tapped for M3 screws. The tapped hole should be entirely in the 5mm frame; be incredibly careful when drilling and tapping these holes (make sure you stop short of the horn block bolts). This is not a place you want to break a tap or drill!

The drawing calls for oil blackened material but this is just my method to avoid painting all the small components black. Basically, all ferrous components, like BMS, can be heated to a cherry red and quenched in used car oil to give it a black hard-wearing coating. This is cheaper than painting and looks much better if done correctly. All components made with mill scale should be left in an acid pickling solution to remove the mill scale before oil blackening.

Frame fittings

All the frame fittings should be used as drilling jigs for the frame and to make all the components interchangeable they should be match drilled with only one component marked out. The machining of the square fittings can be done in the four-jaw chuck and I’ve found the easiest way to centre the bar is by using the cutting tool and dial gauge (on the hand wheel).

Starting with the lifting shaft bearing caps, centre the bar as best you can by using the best measuring instrument known to man, the eye. Then bring the tool tip (which should be set at centre height) to touch the square bar and zero the dial. Move the tool out and turn the chuck by 180 degrees and again bring the tool to touch the bar. The dial will show how much the bar is out with the offending jaw moved by half the amount on the dial gauge. You don’t need to guess when adjusting the jaws; backing up the tool post by half the amount and bringing the bar to just touch the tool will centre that set of jaws first shot (obviously you need to overshoot and advance the tool to take up any backlash). The same can be done with the adjacent jaws.

Finally, if the bar is remotely square touching all sides of the square bar should give the same reading on the dial. Here it makes sense to constantly zero the dial for each jaw set to make the halving arithmetic easier for those of us that didn’t grow up using the slide rule or abacus. I call this the **touch and en-gauge centring method** and those that follow rugby will get the inference. The rest of the job can be machined as normal and should give very few problems.

Machining intermittent cuts is best done with the hand feed, especially such short cuts. I also tend to take slightly deeper cuts with the first two cuts to minimise the impact on the tip of the cutting tool. For a beginner, parting off any component on the lathe with an intermittent cut is a daunting task and requires some practice. For these components I suggest using the hacksaw (off the machine!) to separate the part from the bar and facing the back end by clamping the cylindrical part of the component in the three-jaw chuck. Because a small surface is held in the chuck, take light cuts (TLC).

The clamping holes can then be marked out and all components match drilled for interchangeability.

The brake hanger requires a piece of silver steel fitted to the square flange. The shaft

Fitting the horns to the frames.

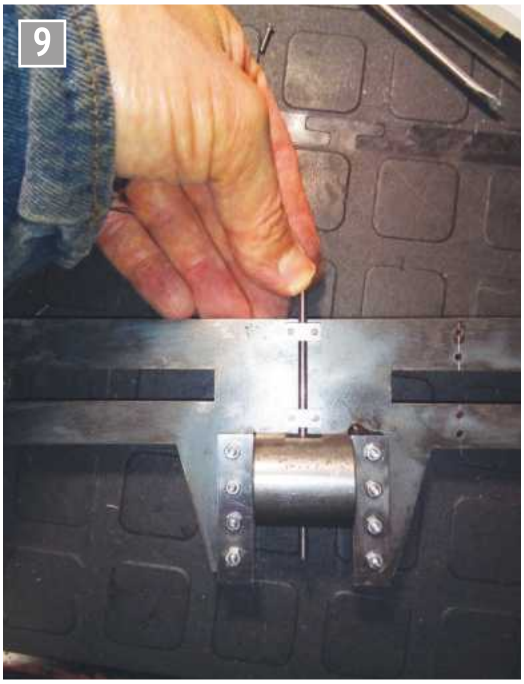
Ballaarat *inside frames showing bolting instead of rivets (see www.busselton.wa.gov.au).*

thread can be cut in the lathe with a tailstock die holder or by making sure the die and wrench is square to the rod by using the flat end of the drill chuck as a backing guide. Remember the **thread shortening** to save your tapping die; the amount is pitch dependent and can be read off the tapping charts. Advance the die for the first few threads by turning the chuck (by hand), applying a little pressure on the job to get it going.

The shaft should be assembled after the square component has been blackened (to keep it nice and shiny) with the back end peened or punched to make sure it stays put.

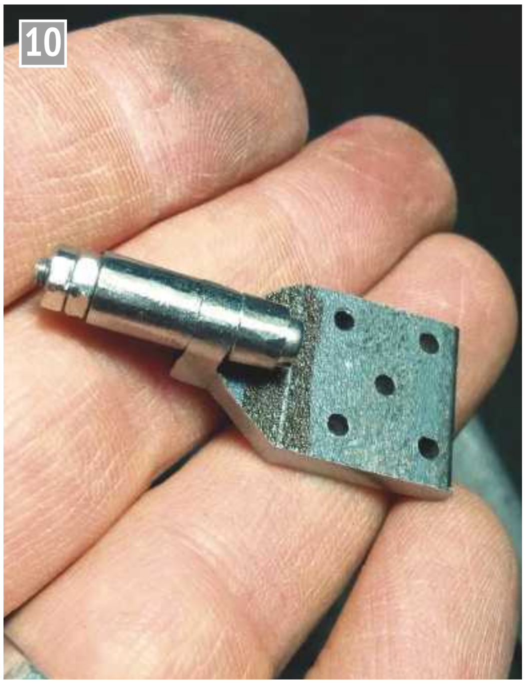
The push bar brackets for the leaf spring assembly are also a fixed assembly on the inner side of the frames. The machining of the brackets is a simple marking and drilling operation but they do need to be square to the inside of the axlebox horns and perfectly in line to prevent the rod from locking up. The jig used to glue the horns can be centre drilled and a piece of silver steel used to align the brackets with the horns (**photo 9**). All holes can be spotted through the brackets with the silver steel lightly clamped into position to keep it from drifting. After the holes are drilled some retaining compound should be added to the holes and beneath the brackets to fit them for good as these will not be interchangeable.

The spring brackets are a drilling and filing exercise. Using the vice as a filing guide (**fig 5**) will make the job easier and the end results will look much neater than freehand filing. Don't forget to protect the vice jaws with some aluminium angles. The marking out and punching follows the same methods described previously. The brackets are clamped to the frame with the stretchers fitted, to make sure there are no clashes, for spot drilling. The front brackets can be fitted against the stretcher if all the sizes are kept to drawing.



9

Lining up push bar brackets for frame drilling.



10

Using radius guides to round the spring bracket radius.

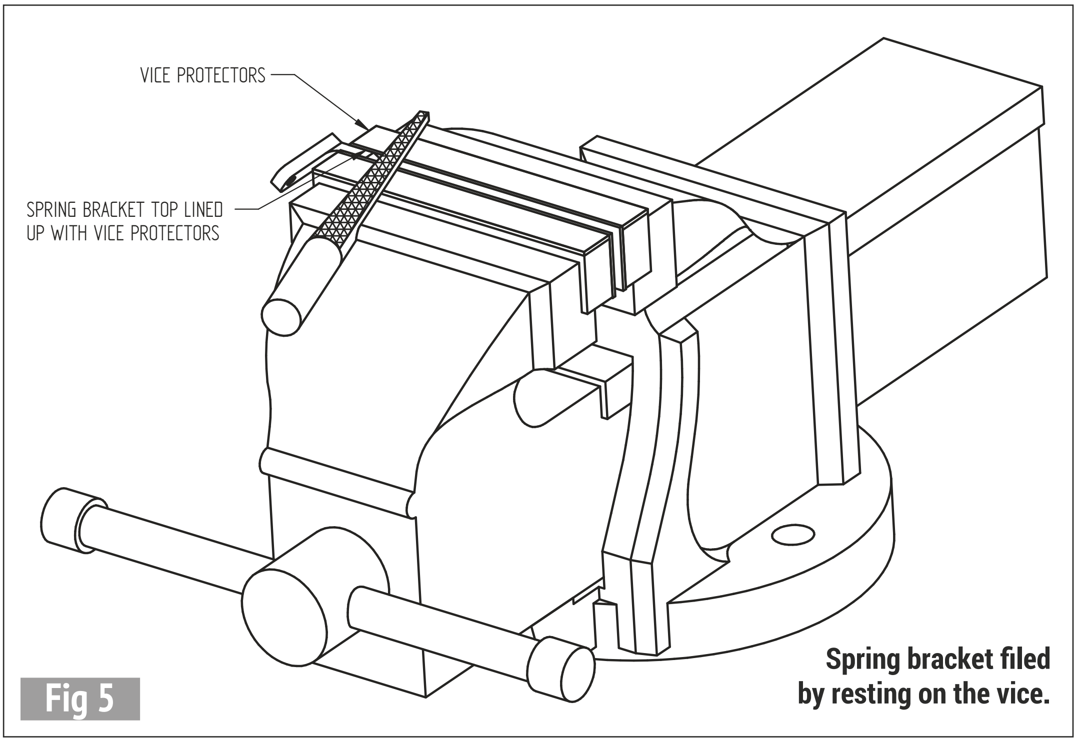


Fig 5

Spring bracket filed by resting on the vice.

The round end of the spring bracket can be filed using **radius guides** (**photo 10**), a technique I use frequently to round corners with a bolt hole at the centre. Two cylindrical guides are machined with the hole and outer diameter to match the component. This is clamped to the part using a suitable screw. The radius guides need to rotate freely allowing the file to brush over them without biting in and removing material. Contrary to popular belief these guides don't need to be hardened; any low carbon steel will work just fine. Keep all the radius guides you make; they can be used multiple times and after a few locomotives you'll end up with a small box filled with these helpful little guides.

The frames need to be assembled on a flat surface by first clamping the front and back buffers to the frames and spot drilling two holes through the respective angles and using temporary screws to hold the assembly together for the stretchers. Make sure to check squareness as you go, that the distances over the buffers are the same on the left and right side and that all components line up with the top of the frames. With the frames square and stretchers fitted in the correct position all the holes can be drilled through as an assembly.

>>

The buffers

The front buffers can be made a number of different ways. I have read of builders using hand tools on the lathe and others who make special ball turning attachments that fit to the tool post. I have found the easiest way to do the buffers is with an angle grinder but we'll get to that.

Chuck a piece of 35mm BMS bar and face the end. Centre drill the end and drill the cavity for the spring, then tap and drill the thread for the stud. Machine the shaft for the buffer and cut the bar off with an additional 1mm for cleaning up the mushroom part. I personally wouldn't part a 35mm bar off on my lathe because my parting off tool becomes too slender after 25mm, so it gets removed from the lathe and cut on the band saw or with a hack saw if you're looking for some exercise. Re-chucking the part on the machined cylinder, the end can be faced down to size and, using the taper slide set at 12 degrees, the beginnings of the buffer end round can be started (**photo 11**).

Buffers taper machined.

Buffers ground round with a flapper disk.

A temporary stud is machined to fit into the spring cavity with a threaded end and this is chucked in a standard hand drill. The hand drill needs to be safely held in a bench vice or something similar. With the drill turning at high RPM's, an angle grinder fitted with a fine flapper disk is used to shape the buffers (**photo 12**). Finally, some fine water paper is used to get the desired finish; you don't get easier than that!

The square part of the buffer assembly is a little trickier. Centring a 30mm square BMS bar using the touch and en-gauge method, the inner cavity can be drilled and then cleaned up to a nice sliding fit using a boring bar. Boring is one of those machining operations most likely to give tool chatter because the tool is relatively slender and the overhang is large. If you do end up with tool chatter the first thing to do is look for any flexibility in the system that can be removed, for example by using a sturdier boring bar or less of an overhang. Failing that, your best bet is to **decrease** the turning speed and **increase** the feed, which generally does the trick.

The outside is turned down to the largest diameter dimensioned in the sketch. Using a round nose cutting tool in the taper slide the taper is machined with the corner radius made free of charge. The fancy end of the buffer can be finished off with a forming tool. Don't be too pedantic with the dimensions as long as the buffers all look the same.

●To be continued.

NEXT ISSUE

We Visit Brighouse

John Arrowsmith's tour of Yorkshire clubs finds him at Ravensprings Park, home of the Brighouse and Halifax model engineers.

Flying Scotsman

Peter Seymour-Howell starts to hang various odds and ends onto his basic chassis, starting with spring hangers and the brake shaft trunnions.

Turbomotive

Mike Tilby, having explored the turbines of *Turbomotive*, now takes a look at the power transmission.

Using a Linisher

Tim Coles shares his experiences with a new linisher and finds it a very useful addition to his workshop.

Content may be subject to change.

ON SALE 27 AUGUST 2021

Steam Turbines of the LMS Locomotive 6202

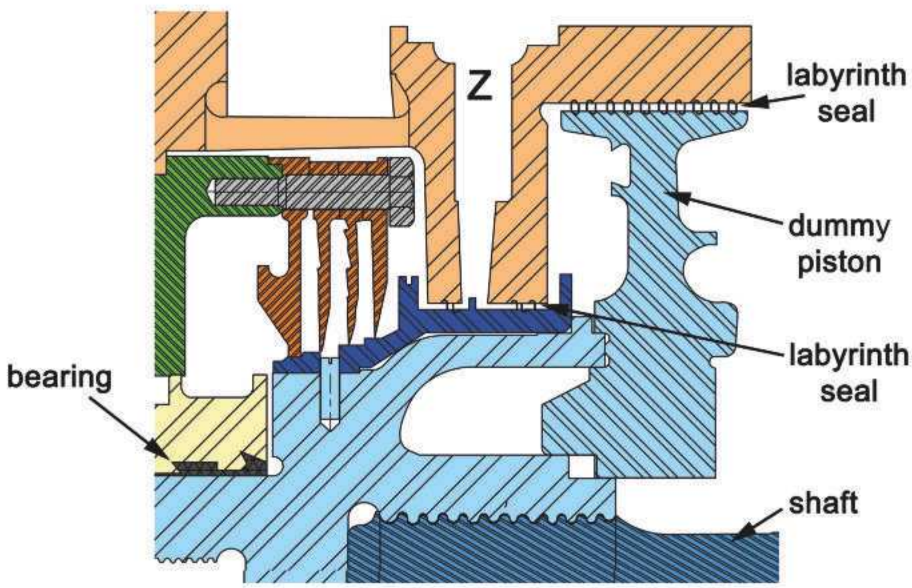
PART 5 - ADDITIONAL FEATURES AND THE REVERSE TURBINE

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

Continued from p.198
M.E. 4670, 30 July 2021

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

Fig 17



Section through the high-pressure end of the forward turbine (re-drawn from ref 37).

Labyrinths and leaked steam

As described in Part 3, labyrinths are non-contact seals and they always allow passage of some steam, albeit at a very low rate. Where the labyrinth is located between high pressure steam and a bearing, even a small rate of steam leakage is undesirable because condensed steam forms an emulsion with the oil and this interferes with oil re-circulation and with its lubricating properties.

In the forward turbine of *Turbomotive* the circumference, and hence the leakage area, of the labyrinth around the dummy piston was relatively large. Also, there was a large pressure drop across it. These factors presumably explain why this seal contained more rings than any other in the turbine - ten rings on the rotor »

Fig 18

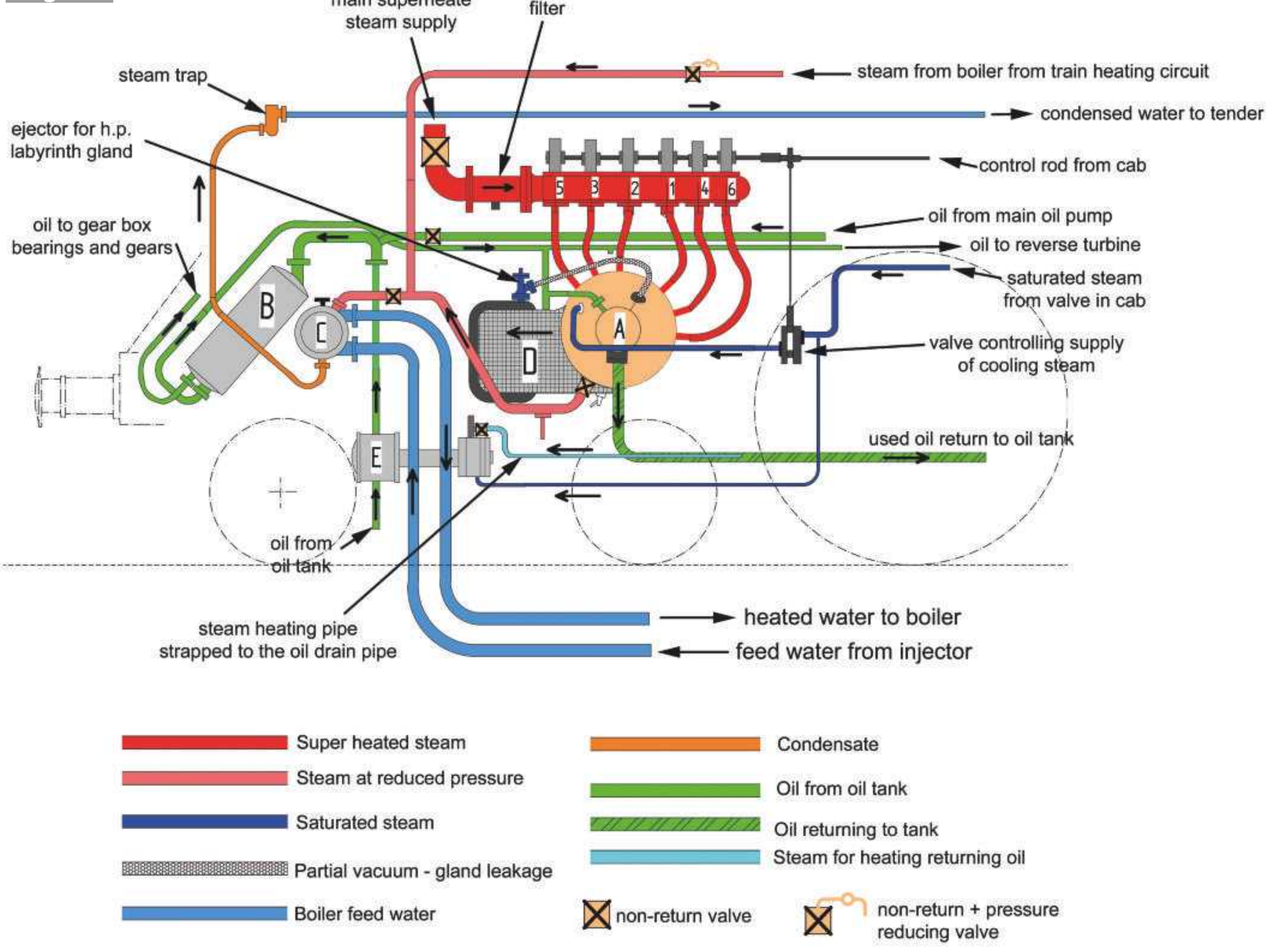


Diagram of the pipework connected to the forward turbine (re-drawn from ref 38). A: Turbine; B: Oil cooler; C: Feedwater heater; D: Exhaust duct; E: Worthington-Simpson oil pump.

alternating with ten on the casing (**fig 17**).

To further reduce the amount of steam that made its way into the oil, an ejector applied a partial vacuum to a suitable point between the dummy piston and the bearing. It is difficult to make out all the details from the sectional drawing in **ref 37** but, judging by a photo of the outside of the turbine, I believe the ejector draws air and vapour from the cavity labelled **Z** in fig 17. On either side of this cavity there are at least two further labyrinth rings around the shaft. A similar arrangement was provided at the low-pressure end of the turbine and that had its own ejector. The ejectors exhausted into the main turbine exhaust duct. Additional thin barriers surrounded the shaft adjacent to the bearing at each end but I do not know their function. They do not appear to act as labyrinths because there are no rings on the shaft between these projections and such rings are needed for a labyrinth to function. Maybe they are to exclude dirt or retain oil. I'd be interested to hear if anyone has any other suggestions.

Despite the above features, steam still made its way into the oil at the rate of about 0.75 ounce per mile so that a gallon of water was drained from the oil tank each day. Tests on the ejectors showed they were not so effective as had been thought and modified versions were to be fitted (ref 37).

Feed-water heating using bled steam.

In power stations it has long been normal practice to pre-heat cold boiler feed-water using steam taken from an intermediate stage of the turbines. This is because the laws of thermodynamics indicate it is more efficient to heat cold water using partially expanded steam than to use very hot gases from the fire for this purpose. This principle is not a practical possibility for reciprocating engines but it was adopted in LMS 6202 where partly expanded steam was bled from an intermediate stage of the forward turbine.

Two positions are apparent in the sectional drawing where the steam could have been abstracted. These are cavities **X** and **Y** in fig 6 of Part 2. I believe the feed-water heating steam was bled from cavity Y, cavity X being used for injection of cooling steam (see below). The bled steam was conducted to the feed water heater via the pipe indicated in **fig 18.** The boiler feed injector forced water from the tender through the heater before it went to the boiler. In the heater, steam condensed as it transferred its latent heat of evaporation to the feed water. The condensate left the heater via a steam trap and then drained back to the tender.

Cooling the turbine using steam

Under normal forward running conditions, steam at the highest pressure and the highest temperature was confined to the entry pipes and the internal ducts that led to the first stage nozzles. As discussed before, the temperature and pressure would have dropped considerably in those nozzles as the thermal energy was converted into kinetic energy. However, it seems that there was concern that damage could be caused by excessive temperatures in the main sections of the forward turbine because when the reverse turbine was operational, the forward turbine remained connected to the locomotive axle via its gear train. Thus, all the time the locomotive was moving in reverse the forward turbine was forced to rotate backwards at high speeds.

This would have made reverse movement very inefficient because of the friction generated as a result of the many rotor blades spinning in the steam and/or air within the forward turbine. That friction would have resulted in heat build-up inside the turbine. In marine turbines forward and reverse turbines were generally on the same rotor. However, in those, there was very little wastage of energy because marine turbines invariably had condensers and the section of a rotor that was not in use would rotate in a vacuum because it was always positioned at the exhaust end of the section of turbine that was in use.

In the case of *Turbomotive*, it was thought that heat generated by friction in the forward turbine while operating in reverse could cause damage since Bond stated in ref 37: '*when running in reverse, the ahead turbine is also rotating, and to ensure adequate cooling, steam is fed into its casing from the reverse turbine steam chest.*'

Another potential cause of over-heating could arise when the locomotive started up. While the locomotive was moving the turbine was rotating and then much of the kinetic energy in the steam was transformed into mechanical work. However, if the locomotive was stationary or just starting up, although the torque and hence tractive effort was very high, little or no energy would be transformed to shaft power and so the high velocity steam would have slowed down within the turbine through friction. This would cause an increase in temperature within the turbine. However, in the discussion to ref 37 Bond stated that the time interval between admission of steam to the turbine of a stationary engine and the engine moving was small and there was no prolonged heating.

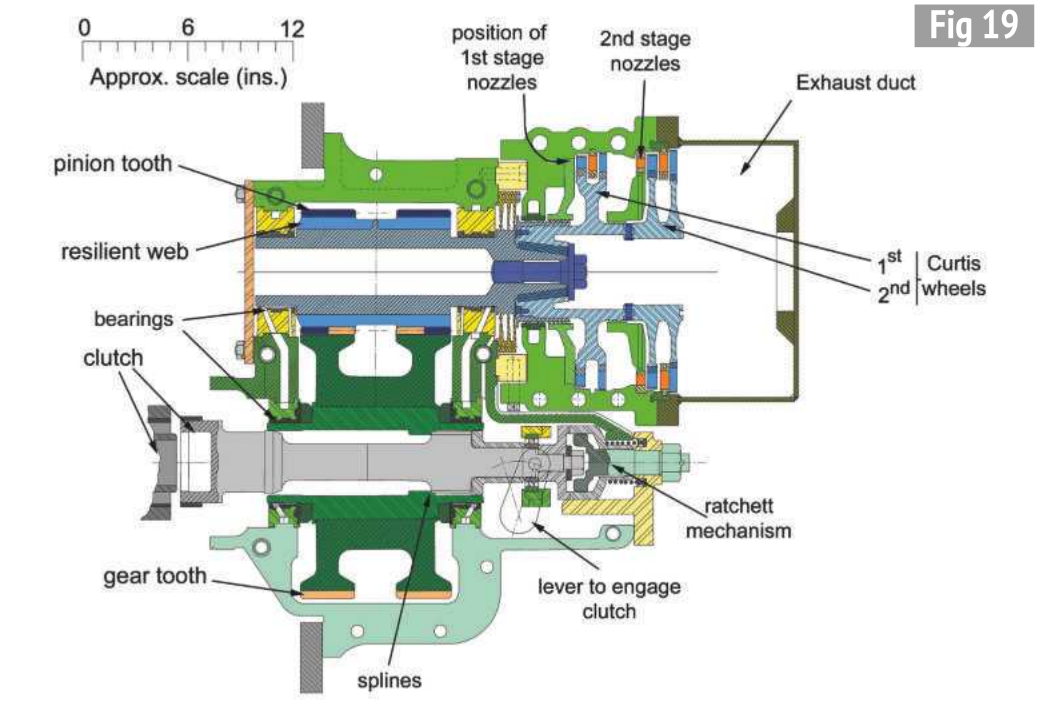
The pipework diagram (fig 18) shows that a supply of cooling steam was delivered to a point at the high-pressure end of the forward turbine. However, this was saturated steam from the supply to the Worthington-Simpson oil pump of the forward turbine rather than steam from the reverse turbine, as stated by Bond. Steam from the reverse turbine would have been super-heated and it seems more appropriate that saturated steam was used for cooling. Supply of the cooling steam was controlled by a valve which was operated by a cam on the shaft that controlled the six main steam admission valves. The cam connection is visible at **F** in **fig 3 of Part 2.** Judging from the position of the inlet connection for this supply, as shown on the pipe-work diagram (fig 18), this cooling steam seems to have entered the turbine near the high-pressure end and probably via cavity **X** in **fig 6 of Part 2**. It seems likely that cooling steam would have been made to flow through the majority of the turbine blading. However, it would be inefficient to use steam for heating the feed-water until after it had been allowed to expand considerably, as would have been the case if it was bled from cavity **Y**.

Reverse turbine

As was mentioned previously, efficient steam turbines can only operate in one direction and so, when purely mechanical drives are used to connect the turbine to the wheels, for a locomotive to reverse it is necessary to either use a change in the gear train or to use a separate reverse turbine. With gear changing it is simple to attain the same power in reverse as when going forwards but the gear change mechanism has to be robust and a special design of gear was necessary, as will be described in the next article. With a separate reverse turbine, equal forwards and backwards power would require the reverse turbine to be as large, as heavy and as expensive as the forward.

When designing LMS 6202 it was decided to use a separate reverse turbine which differed from the forward turbine in being smaller and much simpler. However, this meant it was much less powerful and less efficient. These weaknesses were seen as an acceptable compromise

Fig 19



Longitudinal section through the reverse turbine and associated gearbox of LMS 6202 (re-drawn from fig 17 of ref 37). Components coloured various shades of blue are parts of the rotor. Other colours denote components of the turbine cylinder and casing.

Preserved steam turbine-powered locomotive for the TGOJ, designed by Alf Lysholm at ALA and built by NOHAB. (Photo kindly provided by Ingvar Arvidsson).

since reverse running would invariably be as a light engine moving relatively slowly and only over short distances. The forward turbine was permanently connected via a gear train to the wheels but the reverse turbine was normally disconnected and was only connected, when required, by engaging a dog clutch (**fig 19**). The permanent connection of the forward turbine was another cause of poor efficiency when running in reverse since power was wasted in making it rotate backwards. The power wasted must have been significant because, as described above, precautions were taken to avoid over-heating of the forward turbine during reverse running. Backwards rotation of the reverse turbine while the locomotive was running forwards would have been unacceptable - hence the clutch.

The reverse turbine (fig 19) had only three inlet control valves leading to three groups of first stage nozzles. These are not visible in the section represented by this drawing. The nozzles delivered steam into a Curtis wheel with two velocity stages. The rotor blades were attached to a disc similar in overall shape to the Curtis wheel in the forward turbine (**see Part 2 fig 4**). However, there was only one further pressure stage and that was another Curtis stage. This also had two velocity stages but the shape of its disc was different.

The construction of the reverse rotor was completely different to the forward turbine rotor. Since it only had four blade rings, it was sufficiently short that it could be made so as to overhang the right-hand bearing, as can be seen in fig 19. The turbine discs were attached via a keyed taper to the right-hand end of the pinion which was positioned between the two white metal bearings. These features greatly simplified the overall design as did the absence of reaction blading since that avoided any need for a dummy piston and meant that only two labyrinth seals were necessary.

Reversing clutch and quill drive

The reverse turbine's pinion engaged a gear on a hollow shaft that was aligned with the centreline of the forward turbine. That shaft had internal splines at its right-hand end (see fig 19) and these engaged a central shaft that carried half of the dog clutch at its opposite end. Near its right-hand end this central shaft carried a ball race that supported an outer ring which was acted upon by a short lever, shown in outline in fig 19. Rotation of the lever via controls from the cab caused the central shaft to slide towards the forward turbine such that the dog clutch engaged its opposite half which was on the right-hand end of the forward turbine shaft.

This arrangement can be called a 'quill drive' and it is the first of three examples of such drives in the *Turbomotive* transmission. In a quill drive, a hollow shaft (the quill), drives (or is driven by) a shaft that passes through its bore. The two shafts are linked together by various types of mechanism which allow them to move relative to reach other either radially or axially. In this case the movement is axial and resembles the quill drives found in many types of drilling machine.

If, on attempting to engage the reverse turbine, the teeth on the two halves of the clutch did not line up, the attempt would fail. However, it is stated in ref 37 that a ratchet inching mechanism was provided for inching the shaft round manually. The original drawing upon which fig 19 is based shows a second arm and ratchet-like teeth on the components at the far right-hand end of the shaft. The finer details of this region are not reproduced in fig 19 but it seems that this was the inching mechanism.

Who designed the turbines?

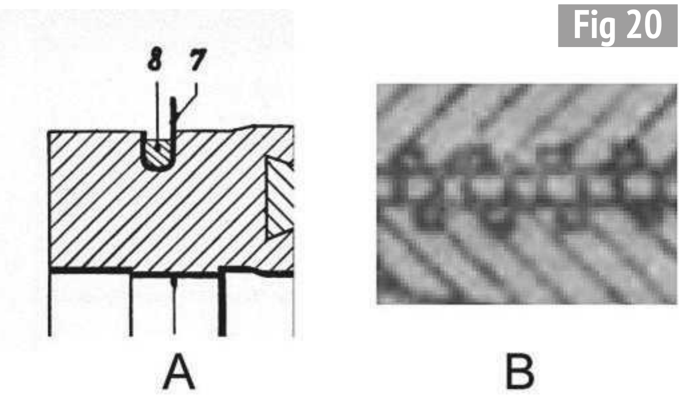
The first article of this series explained that Alf Lysholm was mainly responsible for

Box 8

GUSTAV BOESTAD

In 1944 a test flight of a V2 rocket ended when the missile crashed near the Swedish village of Bäckebo. Gustav Boestad wrote a highly confidential technical report about the missile which the Swedish government passed to the British, giving them fore-warning of the new weapon that was about to be unleashed by Hitler. Much later this report was made public and is now freely available on-line – search on Google for 'Boestad Bäckebo V2'.

Fig 20



Comparison of labyrinth seal construction (A) as used in Ljungström turbines and (B) detail from the section through forward turbine of LMS 6202 (A from ref 39, B from ref 37).

Table 3. Features that were identical for the reaction drums of the turbines in the TGOJ locomotive and the forward turbine of LMS 6202.

Method of blade manufacture	Milled
No. blade rings	32
Average blade diameter	338 mm
Average blade length	32 mm
Average blade width	10.0 mm
Average aspect ratio	3.2

the design of the turbines of LMS 6202, as evidenced by statements in **refs 38** and **39.** Having now described the turbines in more detail it is possible to look at other evidence indicating that he and colleagues were responsible for designing the whole turbine arrangement, including the geared transmission.

Many features of the forward turbine of LMS 6202 are clearly derived from earlier turbines designed by Fredrik Ljungström for powering locomotives and many such features had been patented by him, for example, the inter-locking disc structure of the rotor and appropriate use of combined impulse and reaction blading. Many more of his inventions will be seen in the next and final article in the series which deals with the transmission system. Other features found in LMS 6202 were patented by Alf Lysholm, such as the round nosed blade form described in Part 4. Of particular interest is a patent first filed in 1933 in Germany by Lysholm, and Boestad (**ref 40**).

Gustav Boestad was a Swedish engineer who worked at ALA for many years until, in 1943, he became a professor at Stockholm's Royal Institute of Technology (see **Box 8** for an anecdote). The patent by Lysholm and Boestad describes a general design for turbine powered locomotives and details many features that were present in LMS 6202 but not in earlier locomotives designed at ALA. For example: a) the use of a separate reverse turbine located on the opposite side of the locomotive to the forward turbine, b) an explanation of the principle that the reverse turbine could be made smaller than the forward to save space, weight and cost; c) a dog-clutch to couple it to the main transmission.

This patent was filed at a time close to when Guy and Stanier visited ALA to learn about the TGOJ locomotive. I have no idea how long it took them to compose and finalise the patent application but it seems likely that the process at least started before the visitors from England appeared. Over the many years during which engineers at ALA had been immersed in designing turbine-powered locomotives, many design possibilities must have been discussed and the fact that no Metrovick person was a co-author on the patent indicates that Lysholm and Boestad had developed these ideas independently. It seems possible that the timing is a pure coincidence but I wonder if it could be that filing the patent was accelerated by the interest shown by Guy and Stanier with the ALA engineers wanting to protect their ideas at a time when major companies from the UK were becoming interested. I had assumed that although the inner design of the turbine was by Lysholm, the plan to use a separate reverse turbine on the opposite side of the locomotive might have been down to the British engineers. However, this patent indicates that was not the case.

The great similarity between turbines of LMS 6202 and the TGOJ locomotive was shown in the paper given by Lysholm in 1939 (**ref 41**) that was discussed in Part 4 of this series. Data taken from that paper (see **table 3)** show several details and key dimensions were the same in both turbines. Another example that shows how much design detail in the *Turbomotive* turbine was derived from ALA can be seen in regard to the labyrinth seals. Different companies used different designs for these components. The construction used by ALA seem to be unique and very different from that is found in Metrovick turbines. The available drawings of the *Turbomotive* turbines clearly show the typical ALA design (**fig 20**).

Although Metrovicks had much experience in building steam turbines, there were so many specialised features to the Turbomotive turbines and transmission that it must have taken a large effort to ensure the turbine was constructed properly. So, it is not surprising that, as mentioned in Part 1, Mr Struthers spent many months working alongside the ALA designers before returning to Manchester to continue working on the *Turbomotive* project.

This article completes my efforts at describing the specialised turbines of LMS 6202. Transmission of power from the high-speed precision turbines to the rugged, low speed driving wheels was an equally specialised and important part of the design and the next and final article will look at the many interesting features in this aspect of the locomotive.

●To be continued.

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POSTBAG

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Parametric Instantiations

Dear Martin,
Patrick Hendra in Postbag (M.E.4667, 18th June) has put in perspective Ian Martin's 'Abstract' of his parametric article (M.E.4664, 9th May) by likening it to a typical explanation by good old Sir Humphry to his bamboozled Minister.

I too had a bit of a problem in understanding Ian's article - and I'm a bit experienced as mentioned later - and did wonder about the practical use to the average model engineer apart from a technical explanation into how 3D renditions can be produced.

Ian, from his Introduction, gives some insight into his technical expertise and gives an outline of how I use parametric design using Autodesk Inventor and how from a 2D sketch I can create a 3D object. The evolution - even in my last 40 years - from draughting on a board to programmes like Inventor is startling.

In the good old days, when one was draughting on a board to draw some object by a series of lines, the following was a possible sequence of steps:

* Draw a line - in the required direction - to the desired length by marking the distance from a scale 'ruler' (read here a pantograph draughting machine with two scales set at 90 degrees).
* To dimension the above line, you would:
  - a) Draw two short lines - at each end of the said line to dimension - at 90 degrees away from said line. These are called extension lines.
  - b) Draw parallel to said line another line near the outer ends of the extension lines. This is the dimension line.
  - c) Place arrows at each end of the dimension line, terminating at the extension line and place the - scaled or calculated - dimension above the dimension line.

All a bit long winded, but that is how things were done for centuries. At some time in the late 1970's to early 1980's electronic draughting appeared on the scene and a few of the above steps were eliminated.

You still - on the screen by use of a tablet and cursor or a mouse - drew the line and via the keyboard typed in the length. By using the dimension menu, you picked the line to dimension and placed by a single mouse click where the dimension was to appear. Most of the dimensioning sequences as set above were eliminated. For industry this was a major productivity increase but probably the average model engineer isn't really bothered about this type of increase in productivity.

At some stage Autodesk in their AutoCAD programme - and I assume others - introduced a further tool that made life easier and quicker. This was parametric sketching, where you would roughly draw your shape or feature. By using a set of constraints, you could then set your lines to be parallel with each other, symmetrical about a centre line, tangent to a curved surface, at right angle to another line etc. From the dimension tab, you click on the line to be dimensioned and just type in the dimension and the shape would alter accordingly till fully dimensioned. Although this sounds time consuming, it is a lot quicker than as outlined above.

With the introduction of Inventor - and similar programs - the only sketching tool is parametric. Any 3D shape starts off as a 2D sketch using the parametric tools as just described above.

One of the great features of 3D modelling is the ability to introduce different fixed shapes in the model. These can be bolts - not BA, BSW (use UNC) or BSF, well not in my experience - nuts, washers, socket cap head screws, rolling element bearings, machine cut gearing, hot rolled structural shapes to various national standards and much more, which are contained within libraries within the programs or from on-line libraries. The development of all these libraries is along the lines as outlined by Ian. This is where his explanation can best be understood by those model engineers who dabble in a bit of 3D modelling.

You can also develop your own libraries. I've only done this a couple of times in recent years. It is called - in Inventor at least – 'authoring'. Simply put, you draw the required shape and extrude it. From within Inventor you can create a table - like a spreadsheet - with all the required major dimensions. To create similar shapes of the same family, you fill out further lines of the spreadsheet. Each shape of the family has a 'name' that identifies it. Essentially, for a family of hex head metric bolts for instance, any bolt diameter and length you choose is created from a table based on a single 3D model. Some of these tables can be edited - if you know what you are doing, I don't - from within Inventor or by Excel.

All of the shapes as shown by Ian in his article can also be created in Inventor by the method I have set out above. Usually most of the shapes that I have used have come from an already existing library; it has only been the odd occasion where I have had to create my special family of shapes to go into my special library for the specific project I'm working on.
Tony Reeve (Tasmania)

Boilers

Dear Martin,
At the time of writing - early July, 2021 – M.E. 4666 had just been delivered to my letter box. Scanning Postbag, I found some letters concerning boilers. I would like to add

my industrial experience in the manufacture of three saturated boilers for 1067 mm (3 foot 6 inch) gauge rack adhesion locomotives operating a tourist railway on Tasmania's rugged west coast.

The locomotives were operated over a 40 km track by a copper mine and ceased operation in the early 1960's and the rails were removed. The original boilers (probably not the originals) were flanged and riveted and were oil fired, converted sometime after WW2.

Beginning in 2000, two of the locomotives were to be rebuilt as part of a Federal and State Government project to reinstall the railway as a tourist line, complete with two of the original late 1890's locomotives. New boilers were a feature of the contract (oil fired using diesel). The design was up to us, the mechanical contractor, I being the mechanical engineer responsible.

It was decided that all corners were to be square, i.e. not flanged in relation to the steel firebox, backhead and throat plate. There was some concern from so-called experts – "not been done before" - well probably not in Australia, there being not much of a market for locomotive boilers - "and all boilers traditionally have flanged plates" - well, they were all riveted back in the day, and needed something for the rivets to go into!

The design life had to be for 25 years and the first locomotive entered service in 2001 and the second about nine months after that. The third locomotive entered service about five years later.

The design was completed in the UK to the Australian boiler code AS 1228 and the design calculations had to be verified by another qualified chartered engineer in Australia. I don't recall any particular stress calculations being done for square corners or any FEA being done. As an aside, final year mechanical engineering honours students from the University of Tasmania some years ago did do some FEA of the firebox tube plate due to some issues being experienced - can't remember what now - on one locomotive but not related to the square corners.

Fleeting thought was given to flanging and we realised that the cost would be horrendous and it was outside our capability - the only place that probably could do it would be one of the large forging companies on the mainland. AS 1228 allows for both unflanged flat end plates welded to shells and flanged end plates butt welded to shells. So square corners it was to be and, as Mike Willerton says, they are now the industry standard.

The Australian welding code – AS 1554 - allows for certain butt joints to be prequalified. That is, the material and weld filler material have to be to certain standards and traceable - which also has to satisfy AS 1228 - and also for, say, a prequalified complete penetration single 'V' butt weld, the standard will give for the welding process (electrode, MIG etc) the root gap, bevel angle etc. All square corner joints were to show complete penetration, along with the barrel longitudinal seam. Relevant non-destructive testing (where possible X-Ray) of all joints was done and where required - for instance if porosity was found - the weld ground out, rewelded and retested.

The Australian model boiler code for steel boilers (AMBSC Code Part 2), which also is referenced and comes under the umbrella of AS 1228, allows for square corners that are to be complete penetration. This makes life a bit easier and less expensive to manufacture than flanging. However, a steel boiler under this code has to be welded by a welder who is qualified to AS 1796 (Certification of Welders and Welding Supervisors). I can MIG weld - sort of - but I would never be classed competent to tack up - let alone weld up - a pressure vessel. The AMBSC code allows for pressures up to and not exceeding 700 kPa, a maximum barrel outside diameter of 356 mm and water capacity not exceeding 50 litres. If you want to operate at a higher pressure or outside the other parameters, the design has to be to the boiler code AS 1228 and all that entails.

AMBSC has a further code - Part 4 - which is for boilers made from duplex stainless steel, or more specifically, duplex steel ferritic austenitic type (SAF 2205). For plates, ASTM A240 (US specification) is acceptable. AS 1228 also references this material and for, say, at a temperature of 250°C the design strength is 108 MPa, whereas for standard carbon steel boiler plate (AS 1548) at this temperature the design strength is 125 MPa. The design criteria for stainless boilers is as for steel boilers.

Not having silver soldering experience - other than reading *Model Engineer* over many years - I would have thought that silver soldered square copper joints may not have the strength that a flanged joint would perceive to have. We need some clever model engineer with access to FEA to do some studies on this.

It will be interesting to see if Tim Coles's vacuum process for copper boilers performs in not only the hydrostatic test but also under frequent cyclic steam testing for fatigue failure. Obviously at this time, this method of construction of copper boilers would not be favoured due to possible cost by the average model engineer building a copper boiler at home but to a commercial manufacture may give some economy in boiler construction.

Regards, Tony Reeve (Tasmania)

Rivetting

Dear Martin,

I found *Luker*'s article entitled *A Rivetting Article* (M.E.4667, 18th June) interesting, where he adapts a DIY Pneumatic tool set to use it as a rivetting tool. Looking through a recent Machine Mart catalogue you can buy such tools here for quite a reasonable price but obviously you need a compressor to run them. His idea of using a nail as a source of material for making rivets, especially for cosmetic appearances, is a good idea, although whether they would be strong enough to stand the pressure of a boiler is another thing entirely. His use of old motor engine oil as a quenching medium is also quite common - indeed I used it myself when I worked in my secondary school as the workshop technician. I used to make the department's centre and nail punches. I had a stock of octagonal cast steel of unknown specification of both ½ inch cross section and also ¼ or 5⁄16 inch or so as well. To make the nail punch I put a piece in the chuck of a lathe, put the compound slide over to about 5 degrees or so, and to make the dent in the end I used a centre drill and just went in till the small parallel part started. I then turned it until I got a very slight rim, i.e. not a sharp end. I then turned the other end at the same taper to form the hammering end and then heated it to a bright cherry red and quenched. The first quench in water actually cracked it so after that I used the old oil. I used to temper them on a steel plate about ½ inch or so thick and heated that to black heat. After cleaning the scale off the punch I ran it to a med/dark straw, and the other end turned blue, and then dropped it into water.

Yours sincerely, J.E. Kirby (London)

A Working Van de Graaff Generator

PART 1

Frank Cruickshank finds a novel way to surprise his friends and relations.

As a quick scan of the 'interweb' will show, there are many ways to construct a Van de Graaff generator. The purpose of this article is to provide some data on the essential parameters for a successful, operating model. The model described here (**photo 1**), as an example of the *genre*, was designed as a quiet, table-top affair of pleasant appearance. While it will give a substantial spark discharge, it is not optimised for spark size, although I will give some suggestions on how this could be achieved, if deemed desirable.

The Van de Graaff generator, invented by Robert J. Van de Graaff in 1929, is an electrostatic generator and it must be stressed immediately that it will not work in a damp environment. Everything around the generator must be absolutely dry, since a high degree of insulation is required and many insulators will conduct electricity at the voltages generated (up to hundreds of kV), if they are damp. For those of us that like figures, the model will run successfully at an ambient temperature of 21 degrees C and 50% relative humidity i.e. a warm summer's day. It should also work well on a frosty day, since these tend to be of low relative humidity.

The generator operates by using a moving insulator belt to carry charge from a comparatively low voltage area to a hollow metal globe. The charge accumulates slowly and so any leakage will destroy the attainment of the high voltage required. The model described will produce sparks with a potential difference of over 30kV, giving a spark about 1cm long between the globe and a spherical electrode.

Please take great care not to discharge such sparks or operate the generator anywhere near electronic equipment. Computer chips can be easily destroyed by electrostatic charges. Likewise, persons with pacemakers or illnesses susceptible to electrical problems (e.g. atrial fibrillation) should not play with this generator. It must be treated with the respect that 30kV demands. The author will not be responsible for damage caused by the use of this generator. If you are unsure of the safety measures required, do not build this item!

The belt must be a very good insulator and various rubbers can be used but beware of black rubber, since this is often a filled polymer that is not a good insulator. I used red silicone rubber. This was cut from the rim of a virtually cylindrical pie dish found in the kitchenware section of a local supermarket (**photo 2**) and is about 30mm wide ('about' because my scissors work did not allow exactly parallel edges!).

The search for such a rubber is not easy and so the belt should be sourced before work begins, since it determines the length of the column as well as sizes related to the width. Another item that may be difficult to find is the metal globe at the top of the column. Mine was a copper 'ball' from a ballcock (**photo 3**). These are often discarded now with the demise of the cold-water tank when 'combi' boilers are fitted. These are particularly useful, since they are usually made from two hemispheres and, with some heat, can be opened up easily along this seam without much damage to the globe. Although they often look 'distressed' they can scrub up well! The upper comb is connected to the lower hemisphere via a length of copper shim soft-soldered to it (**photo 4**).

It is essential, for one mode of operation, that the pulleys, top and bottom of the belt, are made from materials

1

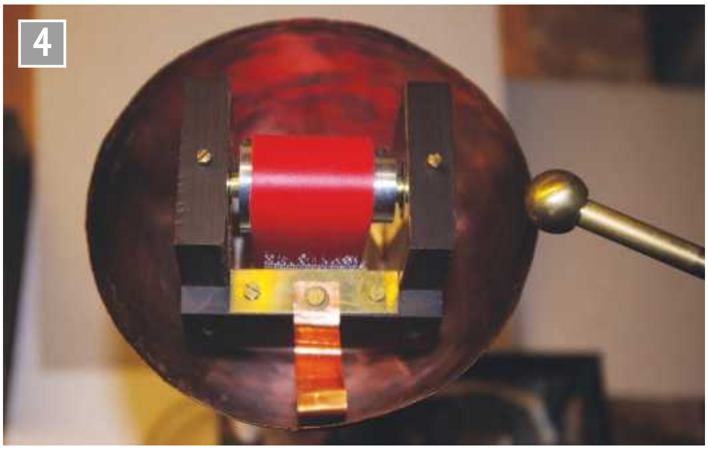
The Van de Graaff generator.

2

A slice of pie dish makes a good belt.

3

A copper ball-cock float makes a good top sphere.



The upper comb picks up the charge from the belt.

TABLE 1
An example of a triboelectric series; see *Engineering Materials Science*, Milton Ohring, Academic Press (1995), p 771.

Most Positive	Rayon
Air	Poly (methyl methacrylate) [PMMA]
Skin (dry)	Amber
Phenolic resin [Tufnol]	Poly (ethylene terephthalate) [Mylar]
Glass	Celluloid
Mica	Epoxy Resin
Human hair	Natural Rubber
Nylon 6,6	Sulphur
Rock salt	Polyacrylonitrile [PAN]
Wool	Poly (bisphenol A carbonate) [Lexan]
Silica	Poly (vinylidene chloride) [Saran]
Lead	Polystyrene
Silk	Polyurethane
Aluminium	Polyethylene
Paper	Polypropylene
Cotton	Polyvinyl Chloride
Steel	Silicon
Wood	Teflon
Sealing Wax	Silicone Rubber
Hard Rubber	**Most Negative**
Nickel, Copper	
Brass, Silver	
Gold Platinum	

at the opposite ends of the triboelectric scale. The further apart, the better. An example of this scale is shown in **table 1** but it must be realised that the exact positioning of each member is in some doubt, as examination of various presentations of the scale, on the 'interweb', will show. Some authors place poly (methyl methacrylate) higher than glass, for example! Materials at the top of the scale readily lose electrons by being rubbed and materials at the bottom of the scale readily acquire such electrons. However, the scale quoted is sufficiently accurate to allow a choice of materials at opposite ends of the scale, from which pulleys can be made.

Photograph 4 shows the upper pulley and gauze comb, while **photo 5** shows the lower pulley.

The bearings were ¼ inch bore ball bearings held in place by setscrews, clearly visible in photos 4 and 5. **Photograph 6** shows the lower comb.

The supporting brackets were made from ½ inch Tufnol sheet but any high quality insulator (e.g. Perspex) would do. The combs were made from stainless steel gauze of 1mm square mesh cut from an old household sieve. A few strands were removed at the edge next to the belts to produce the 'teeth' of the combs. They do not touch the belts but are about 0.5mm from (or closer to) them.

Modes of operation

Mode 1

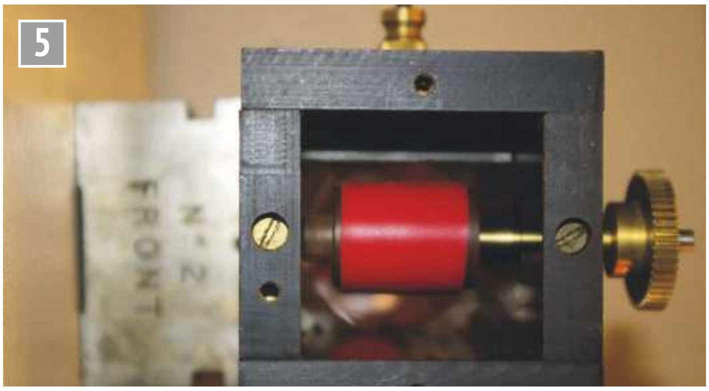
The generator may be operated in two different ways. My model operates, principally, by triboelectric generation ('mode 1'). Friction between the belt and its lower pulley generates the charge which is transported to the upper pulley and thence to the inner side of the globe. However, the charge immediately moves to the outer surface of the globe (Gauss' Law) and builds up there. The use of ball bearings in the model is probably counter-productive of charge, therefore, by reducing the rubbing action between belt and lower pulley. Hence, one modification to optimise the spark would be to use plain bearings in the upper supports. Minimum belt tension commensurate with a consistent, faster drive would also help. However, this would probably require a more powerful motor. My motor was just what I had available and was a 26.5W synchronous motor, geared down by a factor of two from 3000 rpm to 1500 rpm to match the motor to the load.

Mode 2

In many practical uses of such a generator, a high voltage is created on the belt at its lower end by attaching a separate power supply to the lower comb and it is this that is transferred to the globe. My model makes provision for this by having the lower comb attached to a terminal post to which an independent voltage source may be applied relative to ground.

I will describe the construction of my model in the coming parts, although many sizes are not critical. Nevertheless, some of the methods used may be useful for constructors of this or other models.

●To be continued.



The lower pulley.

The lower comb.

An Astronomical Bracket Clock PART 9

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

Continued from p.226
M.E. 4670, 30 July 2021

Cocks

There are a lot of cocks mounted on this clock. These can be made in three ways: milled from solid brass, fabricated or, if you can find them, machined/filed from castings. I opted to fabricate all but those related to the escapement wheel assembly and those on the Tellurian which were machined from solid.

The fabricated cocks were made from ¾ x ¾ x ⅛ inch angle brass and ⅛ inch brass plate. A length of angle was secured to the milling machine table with small dog clamps before cutting the individual sections to length. An end mill was used to square the top edge and, where necessary, reduce the height to ⅝ inch for the lower cocks. Sections of the milled angle were sawn off about ¼ inch over length for each of the cocks and pieces of plate brass (about ⅛ inch oversize all around) were cut to silver solder together to form the cocks.

To ensure alignment whilst silver soldering the angle and plate sections were held together by two brass taper pins fitted at each end of the angle in the waste ⅛ inch wide material (**photos 33** and **34**).

After soldering they were pickled in concentrated citric acid for a few hours (easily obtained from wine making suppliers). The word concentrated is important as a weak solution of citric acid will not effectively clean the work. To make a concentrated solution just keep adding the crystals to water until no more dissolve.

Once clean they were brought to final shape with an end mill (**photo 35**).

In all the above operations it will be found that supports positioned under the outer end of the cocks will be helpful whilst silver soldering and the final milling to shape (see photographs).

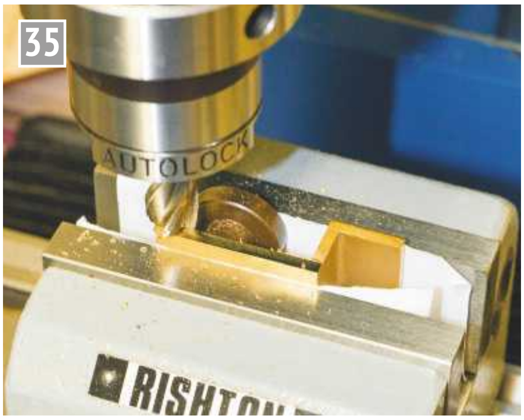
Drilling a cock for the taper pins.

Silver soldered cock.

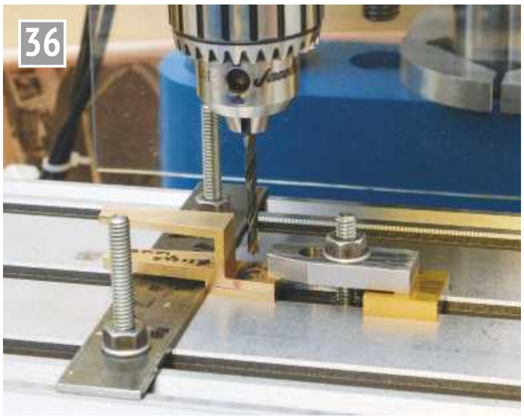
A change of approach was needed for the cock that mounts on the Remontoire swing arm. This was silver soldered up from 1/16 inch thick angle and 1/16 inch thick brass plate. The angle I had available was oversize (⅞ x ⅞ x 1/16 inch angle was in my supply box) and I therefore needed to saw it to near size before milling with light cuts whilst it was mounted on the milling table. It is not possible to use pins and a brass support for this thickness of material; a simple jig was therefore made consisting of a steel strip with clamps to hold the work whilst soldering.

The exceptions to fabrication related to the escapement 'double' cock assembly and the tellurian.

The 'double' cock supports the concentric pivots of the escape wheel and the Remontoire swing arm. The larger upper cock was fabricated as above. The lower cock, however, was milled out of a length of ⅝ x ⅝ inch brass bar. (It would have been less wasteful if I had a stock of ⅝ x ½ inch bar.) The first job was to saw away the bulk of the waste metal leaving a length of about 2⅛ x ⅝ x 7/16 inch extending from the brass bar. A steel bar with suitable holes was then bolted parallel to the milling machine table to act as a fence for aligning the brass bar. After clamping, the sawn surface was cleaned up with an end mill (½ inch diameter running at 700rpm) leaving some 10 to 20 thou over the final dimension of 0.406 inch. The outer section was milled down 3/16 inch as per the drawing. The bar was



Shaping the cock.

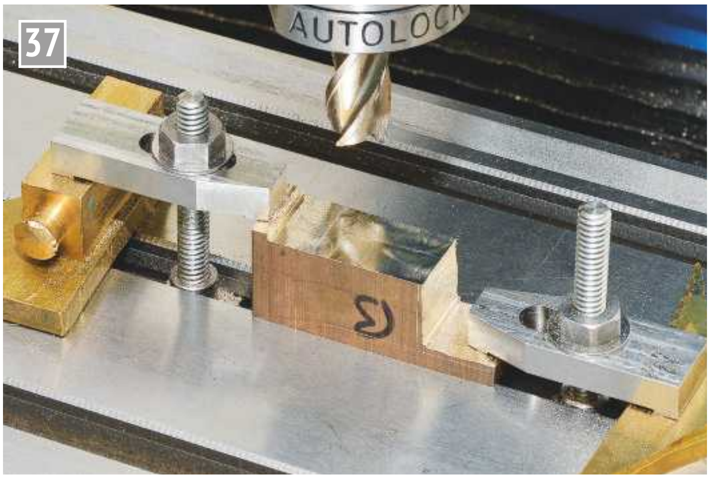


Drilling for the 4BA securing screw.

then turned over for the rear face to be brought to size and shape. I needed to use a small shim to ensure the faces were parallel. Take the cuts needed across the whole work piece to bring to 0.406 inch before milling away the section nearest to the main bar.

The lower cock must have the same side profile as the upper cock. This was achieved before parting the embryo cock from the main bar by mounting the bar in the machine vice with the upper cock clamped to the workpiece. The angle of the bar was adjusted to set the side of the upper cock parallel with the milling table. Very light cuts can now be taken with the mill to machine the edge. I took 0.005 inch cuts with no problems.

To drill the clearance holes for the 4BA screws securing the cocks to the plates a 1/16 inch thick by 1 inch steel strip at was bolted at right angles across the milling table against which the base edge of the cock was butted to ensure it was square with the table (**photo 36**). It was then clamped in place over a



Milling one of the tellurian cocks from the solid.

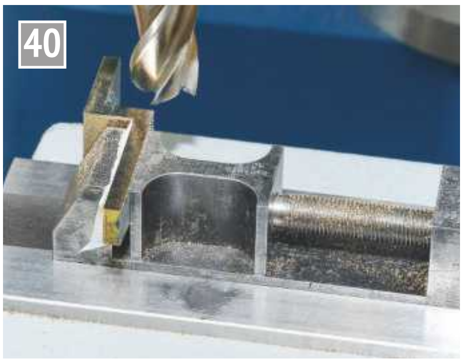
Tee slot gap to allow the 4BA clearance hole for the securing screw to be drilled.

The No. 56 holes for the taper pins were drilled holding the cocks in a finger plate.

Note the taper pins are placed at different positions on each cock (diagonally, straight across etc.) so that they only fit in one place. A great help on reassembly.

The two cocks relating to the tellurian were also machined from solid. Sections were sawn off a 2 x ½ inch brass bar about ⅛ inch wider than the height of each cock. One sawn end of each cock was faced with a ½ inch end mill with the brass held in a machine vice supported by parallels. The other ends were then milled parallel by securing the faced ends to the milling table (**photo 37**). Sawing off one of the two waste sections of each cock made them easier to mount on the table.

After milling the end faces the remaining waste sections were sawn away. The sawn areas were then milled to size by holding in appropriately sized machine vices (**photos 38, 39** and **40**).



Milling a tellurian cock to final shape.

>>

Bridges

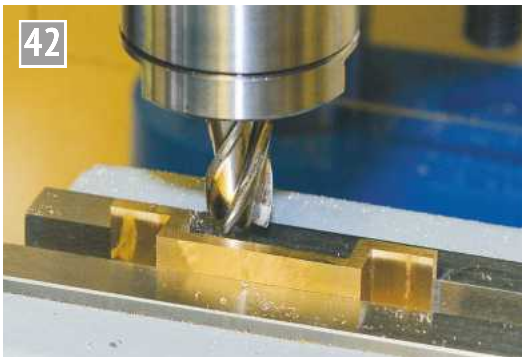
The motion work bridge could be milled from solid but I fabricated mine from ⅛ inch brass angle milled to size (as for the cocks) and ⅛ inch plate brass. It is important that the angled brass sections are parallel and their bases in line when silver soldering. They were therefore mounted on a simple jig - just a metal strip as shown in the accompanying picture (**photo 41**). The bridge was brought to size on the mill (**photo 42**).

The pendulum bridge consists of two pillars and a small ⅛ inch thick plate. The small plate was cut and milled to shape before forming the reamed holes for the pillars. To ensure the holes for the pillars in the rear plate and on the bridge were aligned I machined them on my mill using the DRO. Careful reference to the hand wheel settings would be as good. Do not cut the hole for the adjustable collet at this stage.

41

Fabricating the motion work bridge.

42



Milling the bridge to size.

Moon work

The 115t idler wheel and 69t moon wheel are unexceptional provided one can index these wheel counts. The digital dividing head is invaluable for this type of work. The combination 30t/32t wheel with its three pins drives the 400t sidereal wheel, the moon work and notches forward the ratchet for the solar work. The 32t wheel was made with a shoulder which was then used to hold the item in a small dividing head whilst the three pin holes are drilled. The 30t wheel is bored to fit this shoulder and secured with Loctite 603 after the pin holes have been drilled (**photo 43**) (**figs 14** and **15**).

43

Finished parts for the moon work.

Solar work

The solar work is driven from three pins in the rear of the moon work wheel which bear on a pivoted arm acting as a pawl on an 80t ratchet wheel. The solar arm is interesting in that it has teeth around only part of its periphery. To make, the arm was sawn to approximate size using the Hegner and then mounted on a small rotary table to allow the toothed section to be milled

Fig 14 Moon work 1

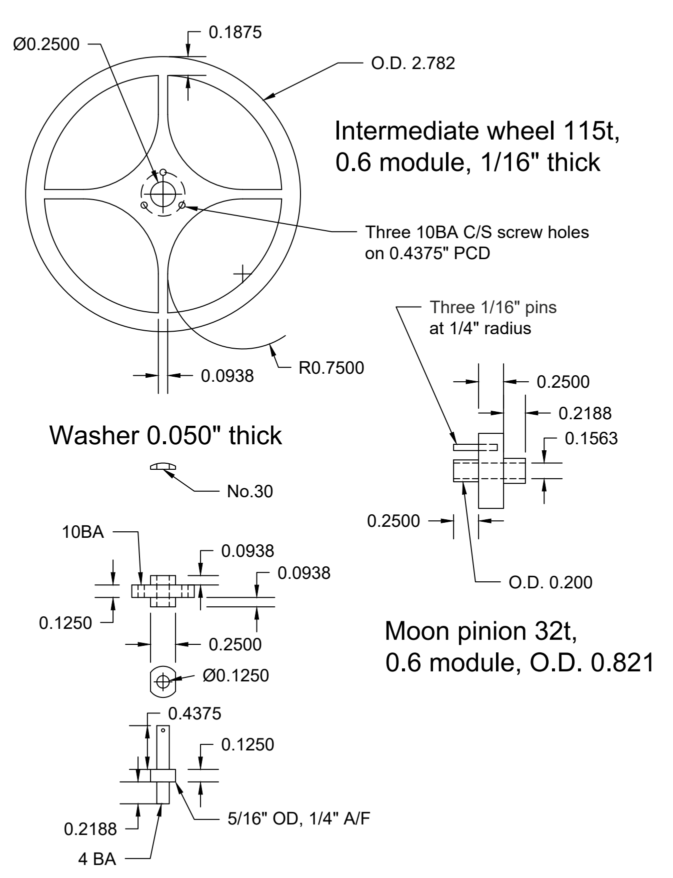


Fig 15 Moon work 2

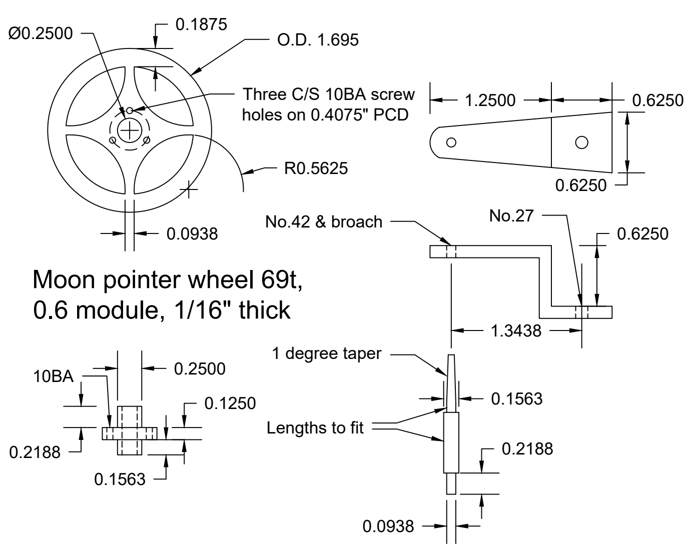


Fig 16 Solar Work 1

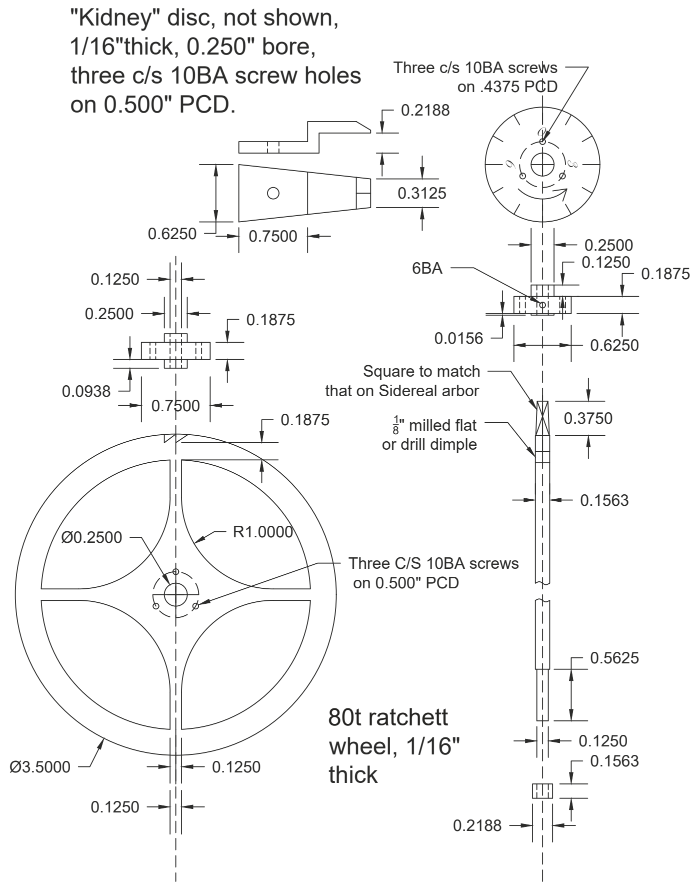


Fig 17 Solar Work 2

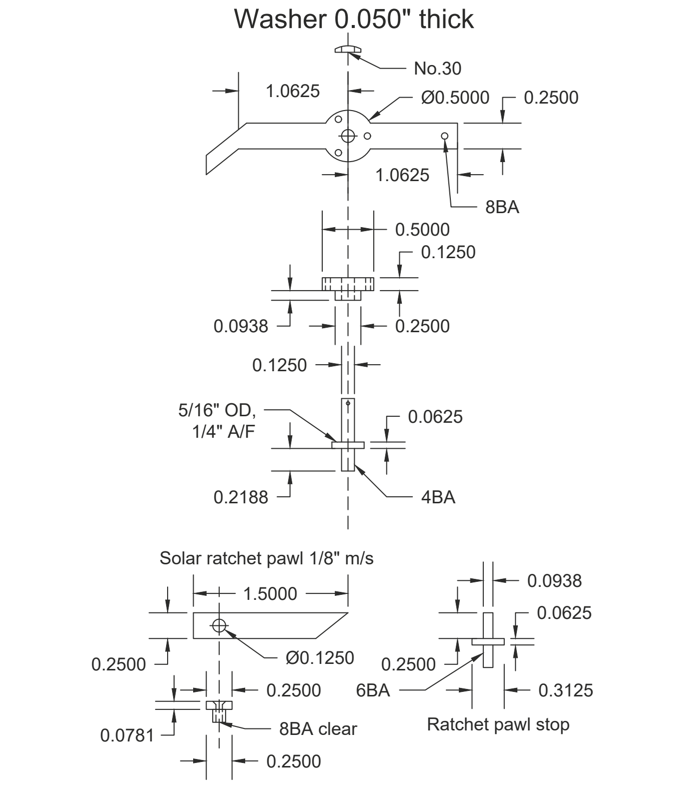
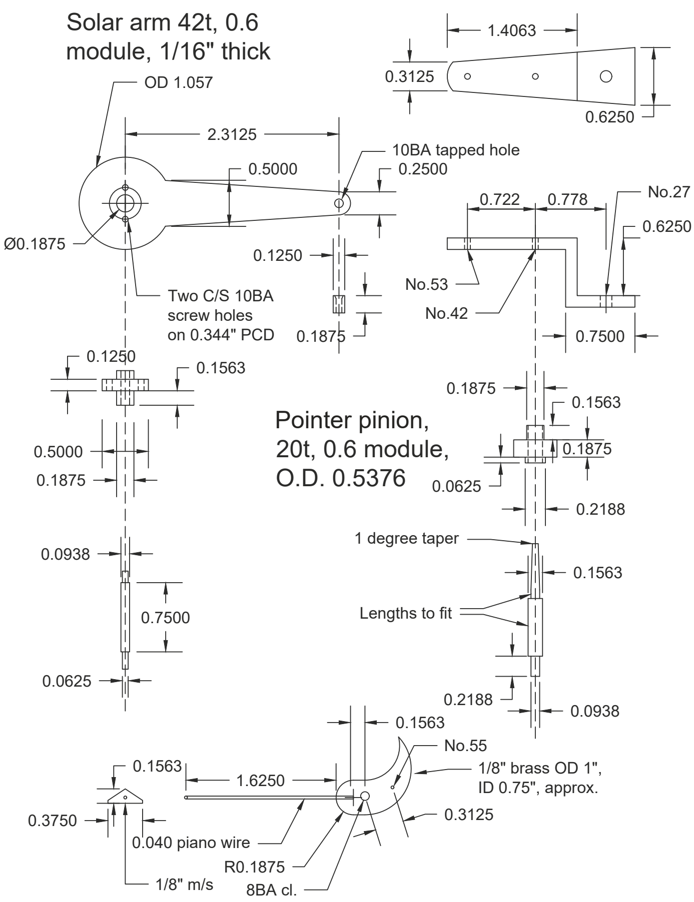


Fig 18 Solar Work 3



44

Finished parts for the solar work.

to the correct diameter before mounting on the dividing head to cut the limited arc of teeth.

The method of making the solar cam has been described in the *Horological Journal* (**ref 12**). This and the disc at the rear of the clock which shows the month need to always be put back in the same place on their collets. With three possibilities in the way each is mounted (each is held by three screws) I punched a dot on the rear of the cam and disc with a corresponding punch mark on the collets to avoid error (**photo 44**) (**figs 16, 17** and **18**).

●To be continued.

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12. *Making an Equation of Time Cam*, Adrian S. Garner, Horological Journal, October 2019, pp13-15.

Lighting a Mill

Martin R Evans improves the illumination of his milling machine.

Many model engineers probably use a similar setup to mine for lighting the work on their milling machine table. In my case, I have a Myford VMC machine lit by a single lamp on the end of a swan neck, which is clamped to the body of the machine (**photo 1**). The lamp often gets in the way of the work, or the clamping arrangement, and can easily cast a shadow over what I am trying to do. My friend, the ever-inventive Steve, was visiting my workshop and, after some thought, announced that he had a cunning plan for improving the situation. When Steve warns of an incoming cunning plan I always prick up my ears as it is usually worth listening to.

"You know those circular white LED lights that some people have in their headlights to make their cars look 'cool'?", he said, "One of those would be quite good for lighting your mill, wouldn't it? They're called *Angel Eyes*". I'd never heard of them but I looked them up on eBay, saw what they were and immediately bought one – about £10.

All had to do now was to attach it to the end of the quill. The Angel Eye consists of a circular 'U' channel, containing the LEDs, with three clips arranged at equal intervals around the periphery for securing the gadget within the headlamp (**photo 2**). The mill didn't oblige with a suitable groove for engaging the clips so the obvious thing to do was to make some kind of adaptor ring to fit the end of the quill, onto which the Angel Eye could be attached. I searched the workshop for a suitable ring-shaped offcut of brass but without success so I decided this might be a good opportunity to do some 3D printing and make an adaptor in plastic.

I don't have a 3D printer (yet…) but Steve does. My only problem now was to draw up my adaptor ring and to do this I had to discover how to use a 3D draughting package. I was recommended a free package called FreeCAD so I downloaded that. The only obstacle now was to learn how to use it.

3D draughting is done rather differently than normal 2D draughting. The latter traditionally involves drawing lines and circles on a flat sheet, representing solid objects. 3D draughting uses a radically different approach though, in which solids are manipulated directly and placed within a 3D space represented, necessarily, on a 2D plane.

1

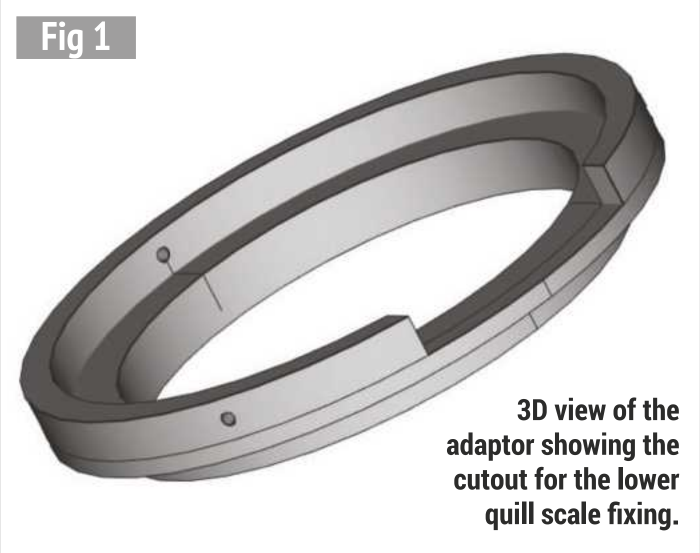
The old lighting setup.

2

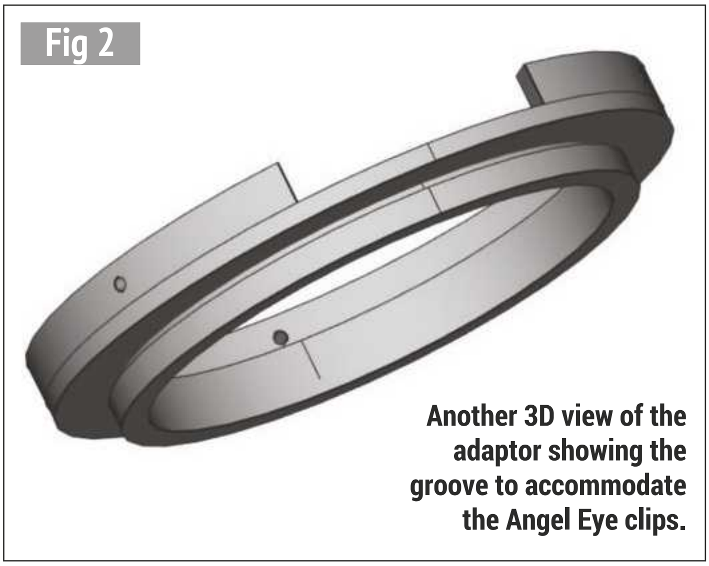
Angel Eye.

There are two things to get used to here. First you need always to be aware of where your viewpoint is – i.e. in which direction you are looking: X, Y or Z. Secondly you need to get used to manipulating solid elements rather than lines and circles on a flat sheet of paper. At first the learning curve seemed steep but a couple of tutorials online got me up and running with the basics literally within fifteen minutes.

Another 'paradigm shift' to get used to is the way that the basic shapes are created. In 2D draughting a line is drawn of the right length, generally using the on-screen ruler or grid, and joined to other lines to form the outline of the shape required. In FreeCAD, the basic shape required is selected from a menu and appears in the working space (is 'instantiated', to use the technical term). Associated with it is a window containing the various parameters for that shape, including orientation, position and



3D view of the adaptor showing the cutout for the lower quill scale fixing.



Another 3D view of the adaptor showing the groove to accommodate the Angel Eye clips.

dimensions. These are then filled in for the shape required, resulting in (dare I say it…) a 'parameterised instantiation' of that shape.

Most solid objects can be constructed from a small number of basic shapes, principally a rectangular slab and a solid cylinder. The 3D drawing package allows these, and other, shapes to be manipulated in the 3D space and combined to form more complex shapes. Combinations can include the addition of shapes (merging them together) or subtraction (cutting away one shape at the intersection of another shape). Merging slabs and cylinders in this way allows most shapes to be generated from very simple elements. Custom shapes can also be made by drawing an outline in 2D and then 'extruding' it.

> Most solid objects can be constructed from a small number of basic shapes, principally a rectangular slab and a solid cylinder.

My adaptor ring was constructed by placing four rings of different sizes next to each other. Each ring was formed by placing a cylinder into the workspace and intersecting it with a smaller coaxial cylinder. A 'cut' operation then removed the inside of the larger cylinder, leaving a ring. This was done four times, at four different sizes, and the four rings placed next to each other. A cut-out was formed in the top ring to clear the lower fixing of the quill scale. This was done by intersecting the ring with a slab of the appropriate size and performing a further 'cut' operation. Finally, three fixing holes, 6BA tapping size, were 'drilled' at 120 degree intervals around the composite ring (**figs 1** and **2**), again by performing a 'cut' operation using cylinders intersecting the ring.

The finished 3D drawing of the adaptor was then 'sliced' and converted to a .STL file using Ultimaker Cura (also free) before being sent to Steve's 3D printer to be made (**photo 3**).

The resulting adaptor ring was impressively accurate, forming a snug press fit on the end of the quill with no fixing screws required and the Angel Eye clipped neatly into the groove of the ring. Finally, I rolled a strip of brass to form a shade around the ring and attached it using the three holes formerly intended for the fixing screws (**photo 4**).

Photograph 5 shows the new milling machine lighting, which is a great improvement on the original arrangement. It doesn't get in the way, produces a bright, uniform light and casts no shadows on the work.

ME

New lighting installed on the milling machine.

Adaptor ring.

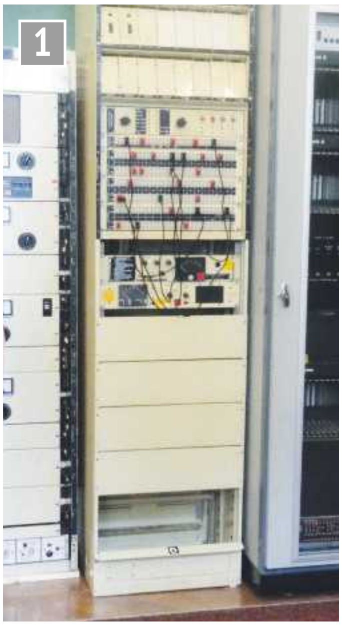
Adaptor assembly, complete with shade.

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

The antilog (not prologue this time) - which, in the nature of an anteroom (an adjacent place) - reminds me of Jake Thackray, who thought that logarithms were things that scuttled about in attics. (Tenuous thought process there…)

I bought a multirange meter - in 'as is' condition - by a prestigious maker, for a very good price. Used, working examples fetch £250+ on eBay but I paid about one-tenth of that. Researching the device online told me that the readouts frequently fail and there were no direct replacements. There was a known modification using another display which took so long to fit that repair was uneconomic so it was sold off quick. When it arrived at Theasby Castle, I saw the modification had already been done! Being non-standard and modified by persons unknown, it was not an economic proposition for a business to deal with and they could not sell it in the usual way. I, with my usual tyke's attitude to spending money, am quite happy with its non-standard appearance and, so far, I have not been able to find any other fault with it. Yippee! I fire the Starting Gun, this time with the now dumbstruck Speaking Clock (**photo 1**).



One of the old Speaking Clocks at Upton Hall, now all electronic.

In this issue, clouds, balls, not a twit, a Dandy, Saracens, neat and tidy wiring, Meccano trams and meters.

Steam Whistle, May, from **Sheffield & District Society of Model & Experimental Engineers** says things are hotting up. Their first Open Day for two years was on 4 July, for which I was unavailable - visiting foreign parts (Derbyshire!). Alan Cooper has been busy testing boilers, seventeen on one day, ready for the onslaught. Mike Peart writes on the longevity of some locomotives, in this case, dock shunters built in 1891 at L&SWR's Nine Elms. Two of these are still with us, B4s 30096 and 30102 at the Bluebell Railway and Bressingham Steam Museum respectively. The Signals & Telegraphs department is installing a new train detector system after previous schemes proved unreliable. Murray's *Thought* concerns wind turbines of various types. **W.** www.sheffieldmodelengineers.com

Worthing & District Society of Model Engineers' summer contribution to the genre includes one point decidedly 'off topic'; a striking photograph of unusual 'mammatus' clouds… Dennis Holmes relates the tale of his lockdown project, a Westinghouse pump for the footplate of his Adams O2 and his decision to design his own. Meanwhile, Brian Hunt has begun a Greenly steam tractor and Kevan Ayling has installed LED lighting in his workshop. Geoff Symes built a Pickering governor and said it was difficult making it work because his balls weren't big enough. W. www.worthingmodelengineers.co.uk

Raising Steam, April, from the **Steam Apprentice Club** of the National Traction Engine Trust has chairman, Nick Bosworth rebuilding a Garrett living van, in particular the wooden chassis beams. There should have been another Twitter steam rally on 1 May but not being a twit, I haven't seen any mention of how it went. The lack of driving days so far has left a hole in the photographs file but McGivern's (sic) Gigantic Pleasure Parks, powered by a Fowler Showmans engine like this one, DP 4418, gives an opportunity to remind us of the glories to come. David Smith, leader of NTET Technical Services unit, discusses the new regulations on the burning of coal. This may cause many small coal merchants and even their suppliers to leave the market, so negotiations are ongoing to try to forestall an availability problem. Elijah Bell has produced more pictures from his archive including a rare Burrell steam wagon, only 15 of which were supplied to showmen. Another Fowler from history was the 3 wheel version but it was not a success here in the UK, although it did meet with more success across the Atlantic. **W,** www.ntet.co.uk/sac

Sydney Live Steam Locomotive Society's May *Newsletter* opens with Chris Denton's very fine steam plant, from a Bolton No. 3 kit from E&J Winter (see below). He also bought a lathe, learning how to use it 'on the job' and making the boiler from K. N. Harris' 1970s book. Then, finding he needed it inspecting, he approached a club not a million miles away but was not impressed by them, nor they him, and it cost him A$15 for the privilege of establishing this. Then he discovered SLSLS and here we are (**photo 2**)! Andrew Allison, having finished his *Ellie,* began a NSWGR 26 Class ROD 2-6-2 in Gauge 1, with a view to publication in *Australian Model Engineer*, which has now closed (**photo 3**). Ross Bishop built a ploughing engine to John Haining's 1984 design and after five years it is now almost complete. It incorporates a W. C. Church patent slide valve, about which Mr. Church became quite obsessed. E. & J. Winter have opened a new Bolton Scale Models showroom, releasing Ben de Gabriel's house for domestic life again!

The Society is to host a Small Gauge Festival on 29/30 October and the Interclub Visit on 31 July, roughly when this edition should hit the newsagents.
W. **www.slsls.asn.au**

Trackerjack, May, from **Teeside Small Gauge Railway** has editor, John Palmer's photo compilation of the progress of building a NER 'T' Class 0-8-0 in 2½ inch gauge.
W. **www.tsgr.co.uk**

North London Society of Model Engineers sends the April and May issues of their *News Sheet*. In the first's 44 pages, much is devoted to official business before Nigel discusses safety in respect of compressors we often have in the workshop. How long since you last serviced or even checked yours? Michael bought a 1956 BSA Dandy in 1969, thinking it would soon be restored to working condition; he pushed it home to his garage, where it remained unloved and neglected for the next 50 years… In the fine tradition of the British motorcycle industry, the crankcase had to be split to set the ignition points, the engine overheated and the 70cc bike was very heavy. Gerald built a freelance, twin flywheel, horizontal mill engine from *objets trouvés* during lockdown, whilst Martin built a classic sports boat from an Aeronaut kit. Alan, meanwhile, is finishing his Peppercorn Pacific. In 1951, 'Bookworm' read in *Model Engineer* of a car heater for 10 shillings. Many cars of that era had no heater, so it was read with interest. Basically, it diverted some warm radiator air through a flexible tube to the driver's footwell. Treasurer, Mike, in his report, mentions the Duke of Edinburgh Challenge Trophy, suggesting that more be made of this magnificent and imposing award. I saw it at the last M.E. Exhibition, along with the other trophies about to be distributed. For the first Zoom meeting of the NLSME, Owen showed a series of old photographs and the 21 attendees had fun identifying those members now 'gone before'. These photographs can also be viewed by searching online for (TinyURL): tinyurl.com/33hc9ndx. Ian reviews a book on Firing in the Fifties, including the operation of unbraked freight wagons. He describes quite graphically how, on starting, as each coupling took up the few inches between the trucks, the train grew a little longer until the guard was quite violently jerked as the whole train then began to move. Peter, in News from the Garden Railway, mentions their youngest member, Master Freddy, who, at age 12, is already 5 feet 11 inches tall and training to play for Saracens - and he's very handy to have around us old-timers when hard physical work is required. Peter says he is glad that Freddy is on 'our side' and he doesn't need to feed him… Peter updates us on the *Flying Scotsman* boiler which was professionally built. Some excellent photographs show that the inside is immaculate. It will never look so clean and tidy ever again!
W. **www.nlsme.co.uk**

Steam plant at SLSLS. (Photo courtesy of Warwick Allison.)

NSWGR 2-6-2 as above. (Photo courtesy of Warwick Allison.)

Centurion Society of Model Engineers, May, *Centurion Smokebox* has secretary, Imogene Groothuijzen, getting stuck in ‘leaves on the line’ and wondering if some sort of ‘cowcatcher’ might be devised to help keep the track clear. The Tuesday Gang are never short of work, but it was a bit much when even the maintenance truck kept derailing.

W. www.centuriontrains.com

Grimsby & Cleethorpes Model Engineering Society sends *The Blower* for May, with, hopefully, a view of the near future; several gents preparing their locomotives in the steaming bay. Geoff Hoad, in part four of his ‘New Loco Build’ describes, in a lengthy article, the electric controls for his diesel-outline locomotive and how, after some thought, this preceded the body construction for ease of assembly. Sir, I congratulate you on your construction standards - a very neat layout, even though most of it will be unseen. Neil (editor), I wrote the above before I read your tailpiece, with which I wholly concur.

W. www.gcmes.com

Gauge 1 North, Yorkshire Group, May *Newsletter* says Gauge 1 North in Bakewell has been cancelled. Alan Bullock is recommencing running of the Don Valley railway in Sheffield.

W. www.gauge1north.co.uk

Stamford Model Engineering Society, May *Newsletter* contains a picture of a Meccano model, 2.5 metres long and remotely controlled by a key fob of the new Tyne & Wear Metro cars due into service in 2023. The 12 inches to the foot trams are built by Swiss company, Stadler who helped builder, John Herman, with some details. John, who built the model in three months, is chairman of the North East Meccano Society. I have no photograph, for copyright reasons, but it looks good.

Melton Mowbray & District Model Engineering Society are holding a gathering at their site in Whissendine on 7/8 August. John Collingwood of the Committee also sent this: *“Everybody’s mad except me an’ thee and I’m non too sure about thee”*.

W. www.mmdmes.wixsite.com

Model & Experimental Engineers Auckland says that Michael Cryns broke part of a customer’s clock in dealing with a fault elsewhere, so had to make a new part at his own expense. (Even the mighty are fallible… - Geoff.) He also showed some electrical meters, which Murray Lane viewed with interest as a quondam technician at the NZ Electrical Department. (You got meters? I got meters!!!) So, for meter men and meter maids everywhere, I give you these, including a suppressed zero voltmeter, bottom right, which is interesting as it uses a stronger return spring than usual, so by choosing the spring carefully, the scale can start wherever required, in this case 10 volts rather than 0. Nowadays, using a simple zener diode is a much more elegant solution (**photo 4**). Chris Radcliffe had some padlocks used for keeping secure missile components, which were uncuttable and one had a magnetic key. He also had a CURTA mechanical calculator of the type I used in a previous job. Bruce Lawson showed two high powered radar valves from WWII and could not identify them using the Internet. (I suspect they are Klystrons but the science was expanding rapidly in that field and they may not have been properly documented, or may have been an unsuccessful design – Geoff.)

Odd meters. (See MEEA.)

East Somerset Society of Model & Experimental Engineers *Newsletter* arrives from East Somerset Society of Model & Experimental Engineers. Frustratingly, no mention of who ESSMEE are until a photo on page 3 mentions ESME at the Sherborne Castle Country Fair in 2003. Here, the locomotive - Michael Faraday’s ‘get up and go’ - got up and went, mid-circuit. Oh calamity! All was happily diagnosed and repaired in time for some serious and busy running, so not the disaster it could have been. Michael Malleson attended to his American clocks. These (like mine) were made in vast quantities, some selling for $1 each and according to a book I just read, were directly responsible for the demise of the long-case (Grandfather) clock.

W. www.essmee.org.uk

Our Motoring Correspondent, Pete Only-Lager, writes, “Passing an hotel recently, I spotted this Barugzai conveyance, in darkest black. Being a new name to me I researched it to find that it is a Bradford company, offering body kits for luxury cars, including Rolls-Royce and so exclusive that one was photographed apparently on the Ribblehead Viaduct... This puzzled me, since, when buying a Royce, you can specify its fixtures and fittings anyway. Allied to which, to my mind, such fittings do not enhance their often aggressive-looking vehicles’ appearance. Were I in that market, I would prefer David Linley (**ref 1**) to work his magic on my car and not this company (**photo 5**)”.

And finally, how many bureaucrats does it take to change a light bulb?

Two; one to issue a statement saying that the job was properly tendered for, the responsible people are ethnically diverse and everything is proceeding to plan. The other to try to screw it into a water tap.

Barugzai ***Range Rover in Sheffield.***

REFERENCES

1. https://howmanymade.co.uk/2016/10/31/range-rover-linley/

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