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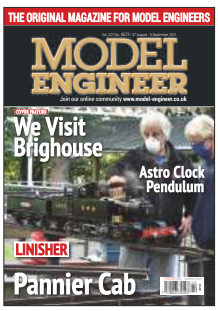

ON THE COVER...

John Cavalier (L) and Terry Longbottom (R) steam up an extended Simplex 2-6-2 locomotive at the Brighouse and Halifax model engineers' track (photo: John Arrowsmith).

MODEL ENGINEER

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Mick Wickens, B&DSME secretary, presides over the Brandon Burger Blaster.

Dave Moore, B&DSME chairman, demonstrates the scissors about to be used by Mr Parrott to inaugurate the new station canopy.

A Fair Wind

My own society, the Brandon & District Society of Model Engineers, was certainly fairly hopeful of such when they organised their first track day and barbecue (**photo 1**) for almost two years recently at Weeting, just over the Suffolk/ Norfolk border. Despite the lock down (and where permitted by Boris, of course), some of the members had been very busy, as evidenced by the very fine new station canopy and level crossing. The new canopy incurred a very low cost of construction and I was assured that lorries with loosely secured loads had absolutely nothing to do with it. At all. Society president, and landlord, Mr Parrott cut a ribbon to inaugurate the new canopy (**photo 2**). The boating pool had also been given a bit of a light dredging and the members agreed that it was now mostly safe to go back in the water (**photo 3**).

The club guarantees a memorable day for visitors to its track and boating lake (radio-controlled crocodile by courtesy of Geoff Ellis).

Metric Mayhem

Measurement and metrication appear to be 'Topic of the Month' and reader Mike Hanscomb offers the following to brighten the brouhaha.

The Ounce, the Pound, the Mighty Stone,
The Hundredweight and Ton,
Have served us well since time began,
When all is said and done.

The Inch the Foot, the Yard and Mile
Have run their distance now.
With Chain and Furlong in between,
Could they survive, somehow?

The cricket pitch and racing track
Shall surely metricate.
Another nail, another way,
To seal our nation's fate.

The Gallon, Quart, the Pint and Gill
Are going down the drain.
The litre and its milli-part
O'er all of us will reign.

The Metric Monster's here to stay,
'Tis spread throughout by guile,
Thus banishing for evermore
Our Heritage and Style.

Our legal system's in the dock,
The verdict's very clear.
Replaced by Continental law,
An oath you're bound to swear.

Our currency will sink or swim,
The Euro lurks nearby.
Common sense says "Keep the Pound",
Convert it, they will try.

Britannia seems so helpless now,
Her neck beneath their heel,
Whose treaties won a Nation State,
They could not win with steel.

This was originally written 20 years ago and things are a little different now, so your editor suggests the following additional verse:

But Britain, as she always does,
Cried "We have had enough!
Us metricate? Go fornicate!
We're made of sterner stuff!"

Philipp Bannik presents his own radial boring tool.

PART 3

A Radial Borer

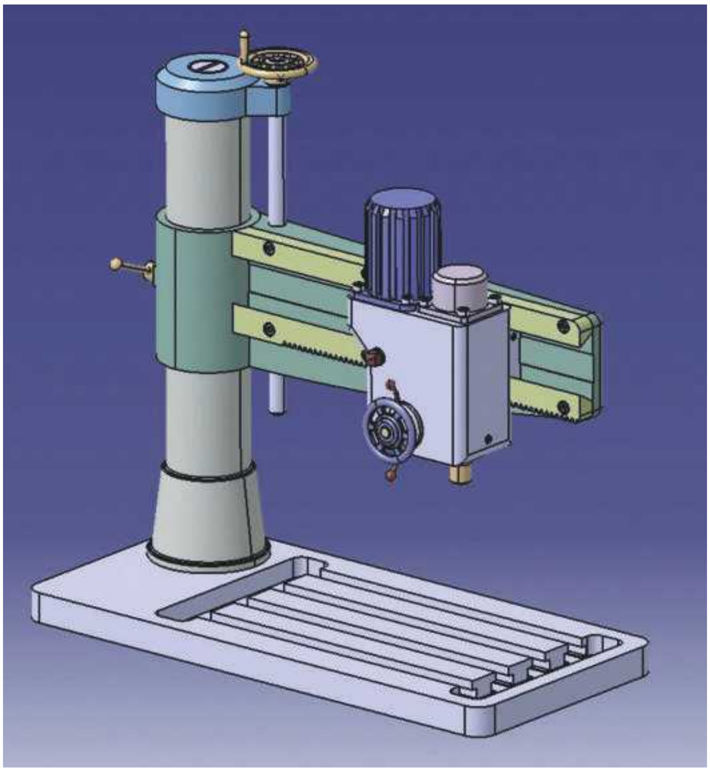
Continued from p.257
M.E. 4671, 13 August 2021

The rail

The next thing to tackle is the arm of the machine.

It is made of a 25mm thick piece of mild steel (**photo 20**). All six sides were machined on the shaper. For the curve on the bottom I printed my drawing, cut it out and drew the outline on my piece of steel. The cut was done on a bandsaw. To attach the column sleeve to the arm, I had to cut a radius on it. I did that with a boring head on the mill and a long tool. The arm has a slight taper to it on the back.

To machine strange angles, I scribe a line according to the angle on the part. Then I put a parallel in the jaw of my milling machine chuck and adjust the part to the line by eye. After getting the adjustment right I could then mill down to the line.



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Raw materials for the arm.

For the next job I used the shaper again. The dovetail guide rails were too long for my mill and the angle of the dovetail would normally be hard to manage too but it was reasonably straightforward on the shaper (**photo 21**). The lower rail needed several teeth cut to engage with the pinion of the boring head. The shape of the teeth on the rack is a simple 'V' shape. The tool needed was easy to grind and

21

Using the shaper to form the dovetail guide rails.

22

Cutting the rack.

23

Test fitting of the arm (base and column to be described later).

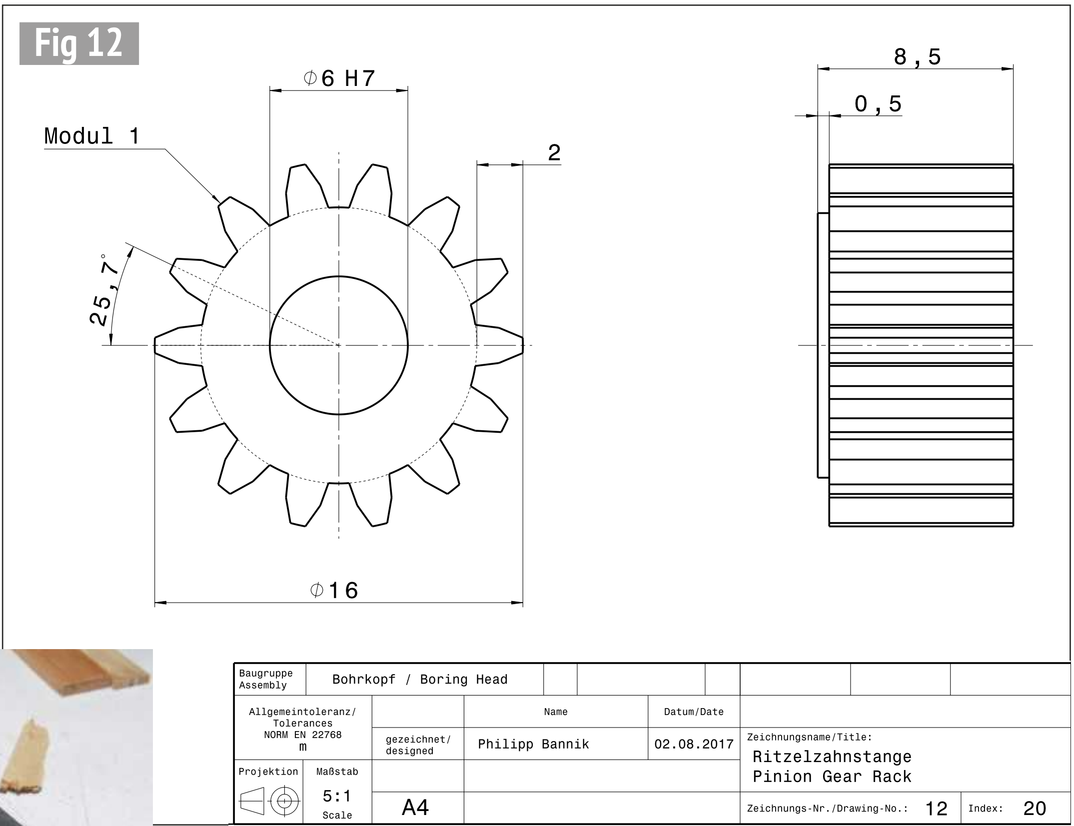
to adjust on my shaper. It was again, though, a long process (**photo 22**).

Test fitting

Photograph 23 shows the test fitting of the arm. (You'll need the column before you can do this yourself but I will describe that next time.) After filing some nice round edges to the arm (**photo 24**) I TIG welded it to the column sleeve. I used the column to transport the heat away and made just short welds to minimize the distortion of the sleeve (**photo 25**).

●To be continued.

Fig 12



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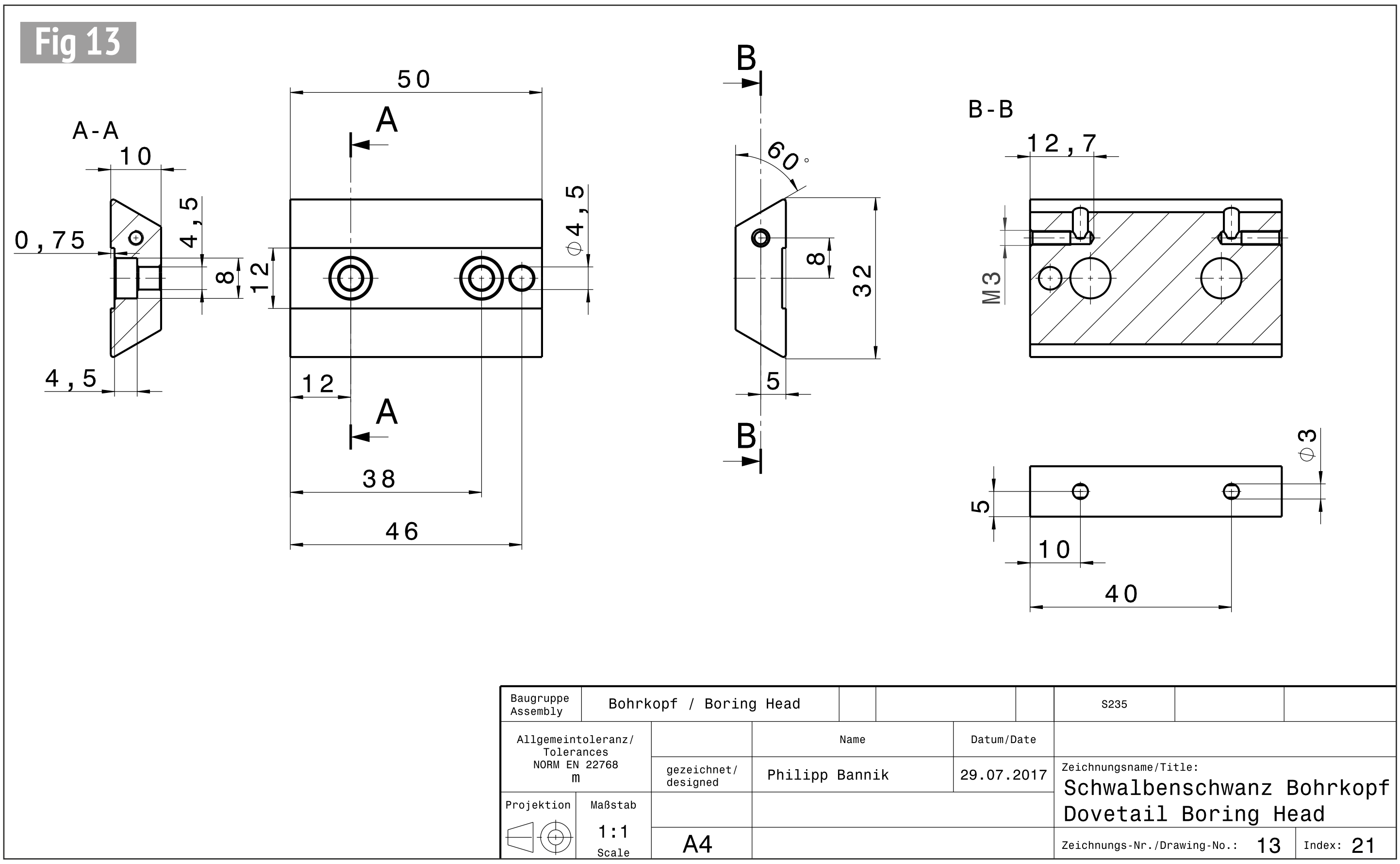
The arm is finished off with some nicely rounded edges.

NEXT TIME

We make the very substantial column for the borer.

Fig 13



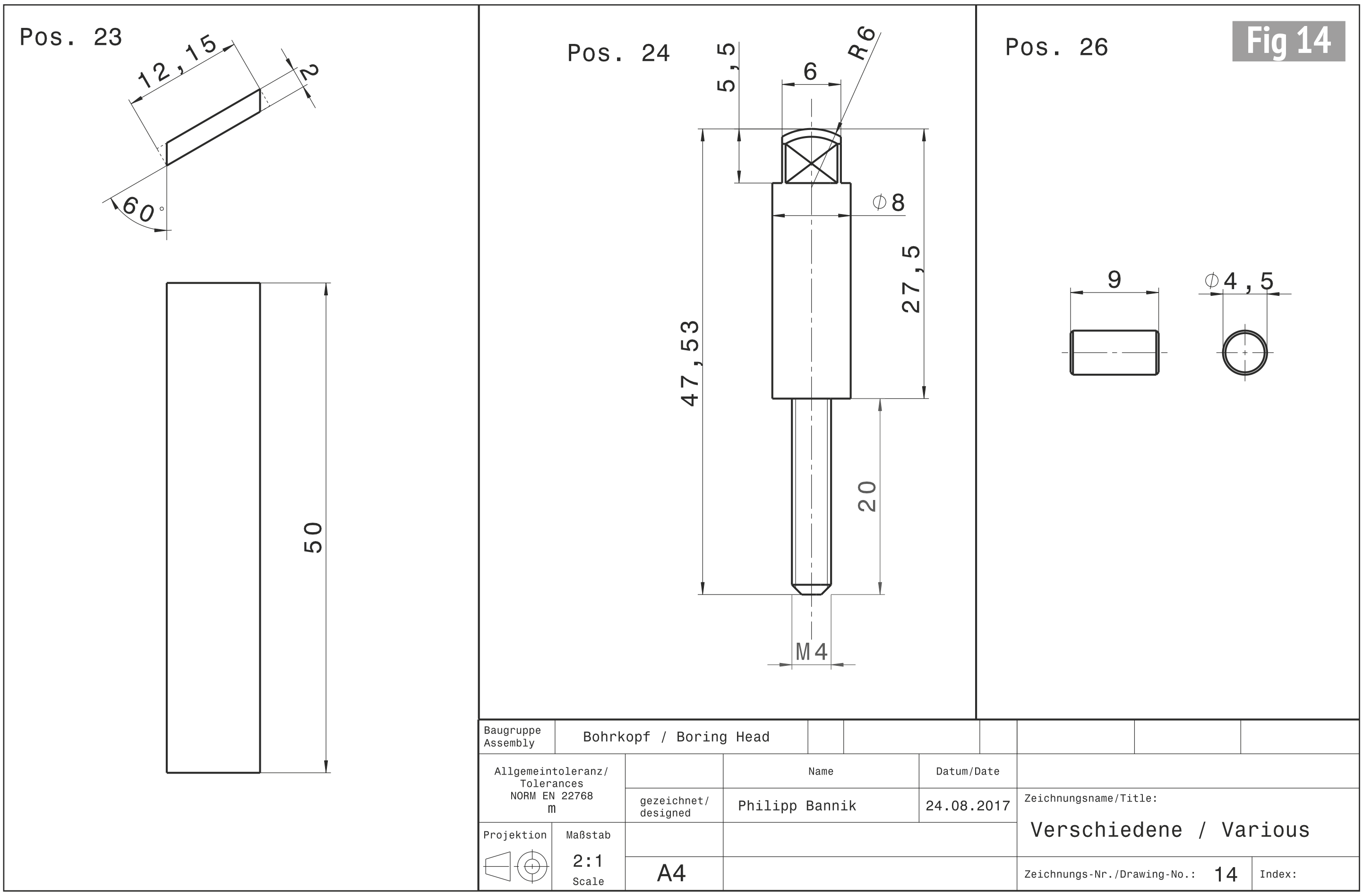

Pos. 23
12,15
2
60°
50
Pos. 24
5,5
6
R6
⌀8
27,5
47,53
20
M4
Pos. 26
9
⌀4,5
Baugruppe Assembly
Bohrkopf / Boring Head
Allgemeintoleranz/ Tolerances NORM EN 22768 m
Name
Datum/Date
gezeichnet/ designed
Philipp Bannik
24.08.2017
Zeichnungsname/Title:
Verschiedene / Various
Projektion
Maßstab
2:1
Scale
A4
Zeichnungs-Nr./Drawing-No.: 14
Index:

Fig 14

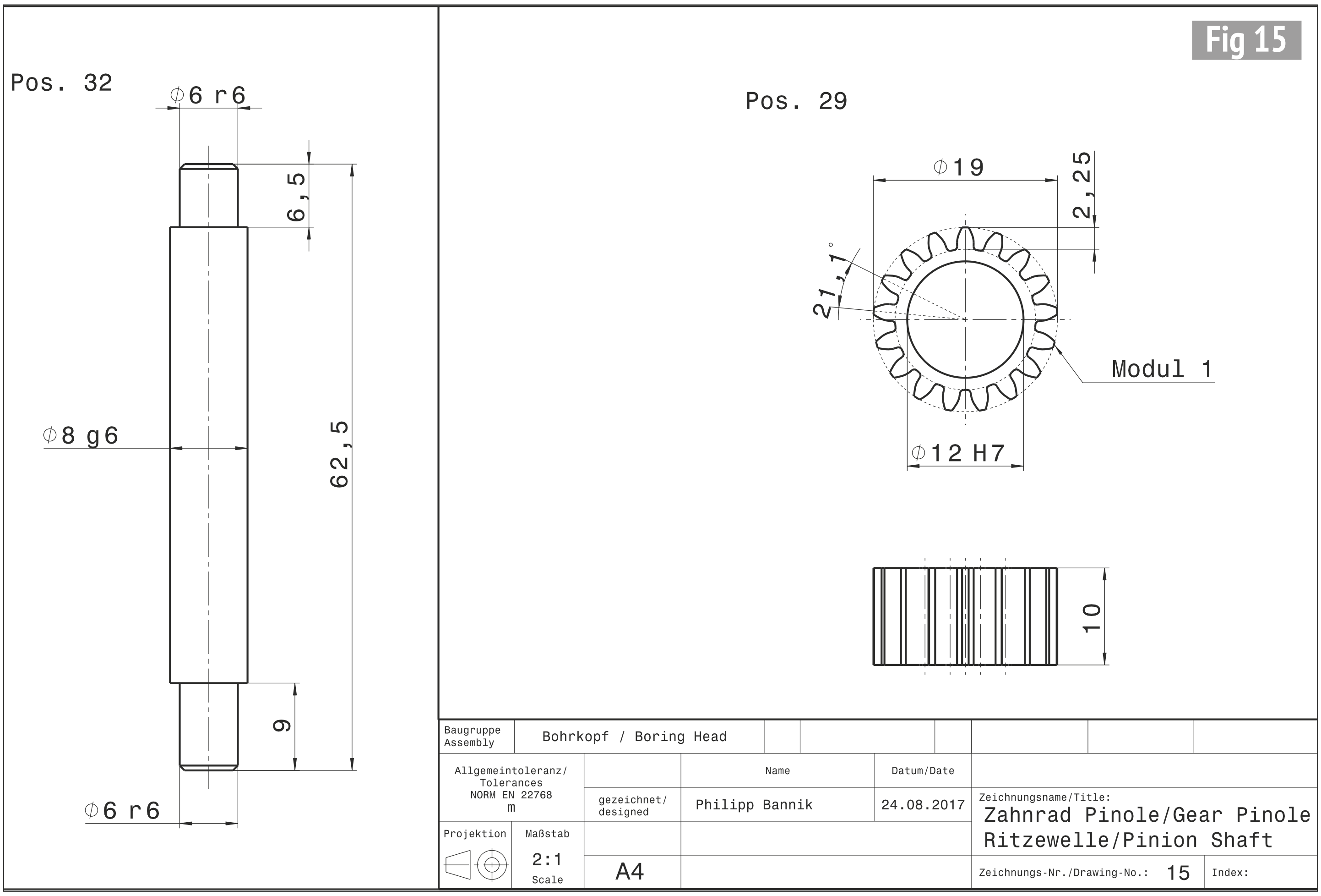
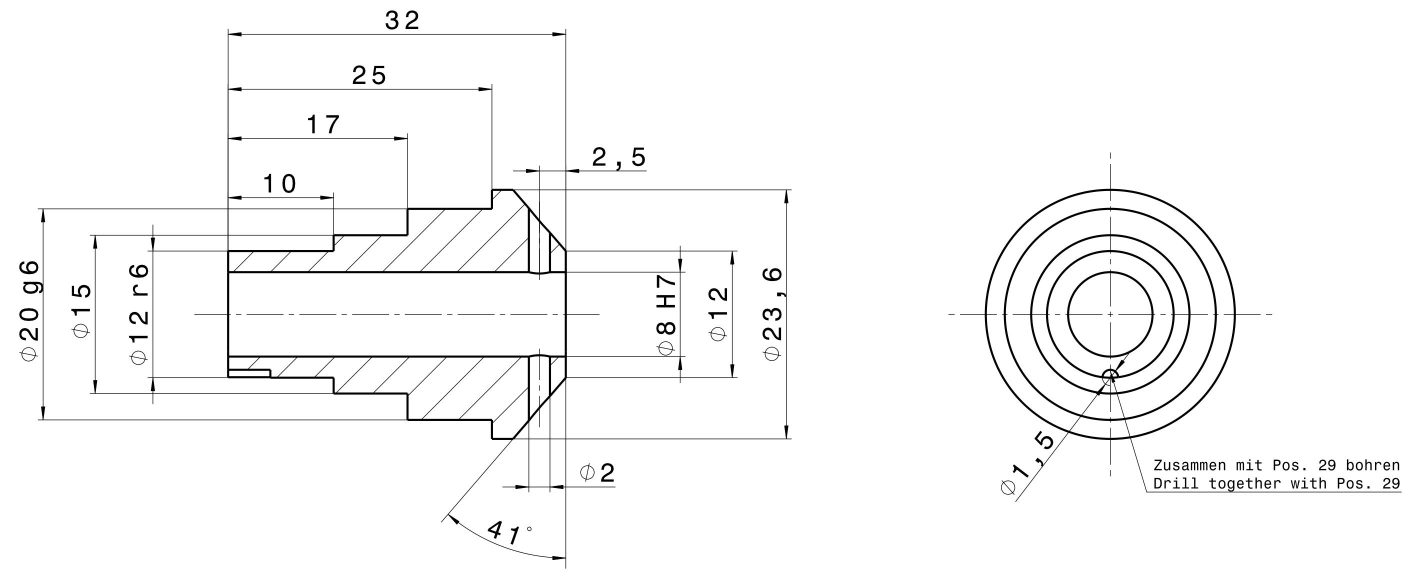

Pos. 32
⌀6 r6
6,5
⌀8 g6
62,5
9
⌀6 r6
Pos. 29
⌀19
2,25
21,1°
Modul 1
⌀12 H7
10
Baugruppe Assembly
Bohrkopf / Boring Head
Allgemeintoleranz/ Tolerances NORM EN 22768 m
Name
Datum/Date
gezeichnet/ designed
Philipp Bannik
24.08.2017
Zeichnungsname/Title:
Zahnrad Pinole/Gear Pinole
Ritzewelle/Pinion Shaft
Projektion
Maßstab
2:1
Scale
A4
Zeichnungs-Nr./Drawing-No.: 15
Index:

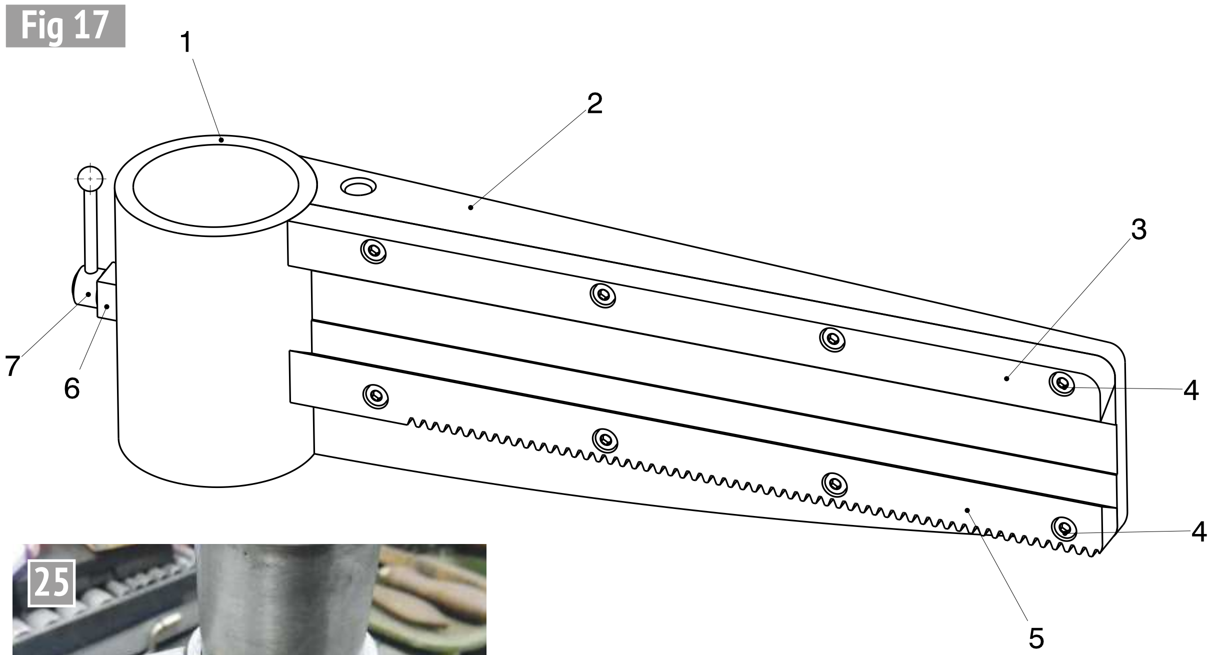
Fig 15

Fig 16



Baugruppe Assembly	Bohrkopf / Boring Head			
Allgemeintoleranz/ Tolerances NORM EN 22768 m		Name	Datum/Date	
	gezeichnet/ designed	Philipp Bannik	24.08.2017	Zeichnungsname/Title: Zahnradwelle Pinole Gearshaft Pinole
Projektion	Maßstab 2:1 Scale	A4		Zeichnungs-Nr./Drawing-No.: 16 Index:

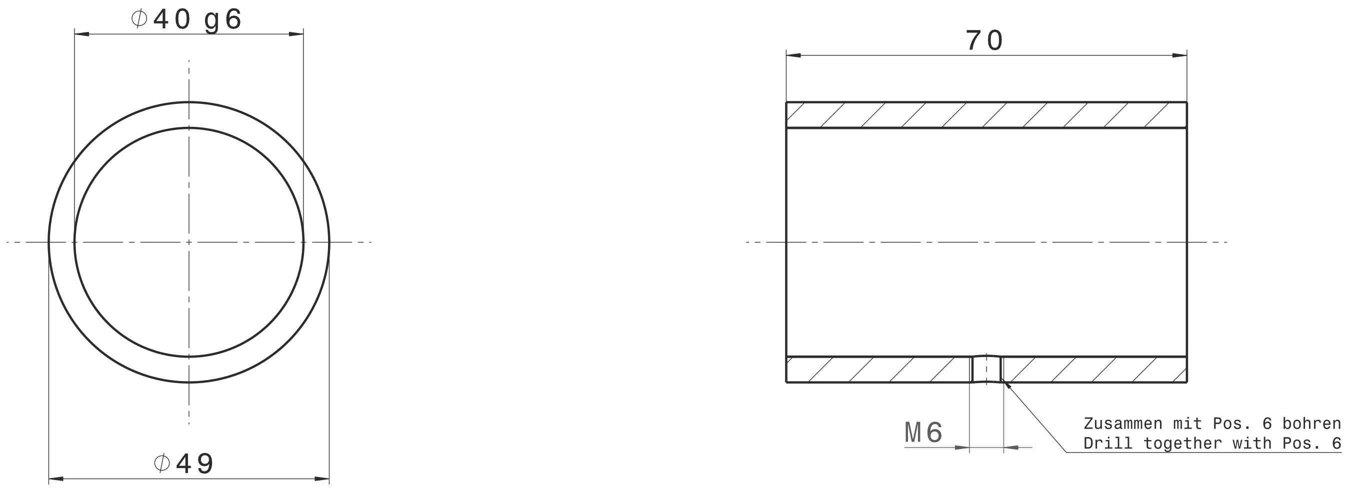
Fig 17



The arm is tacked to the sleeve.

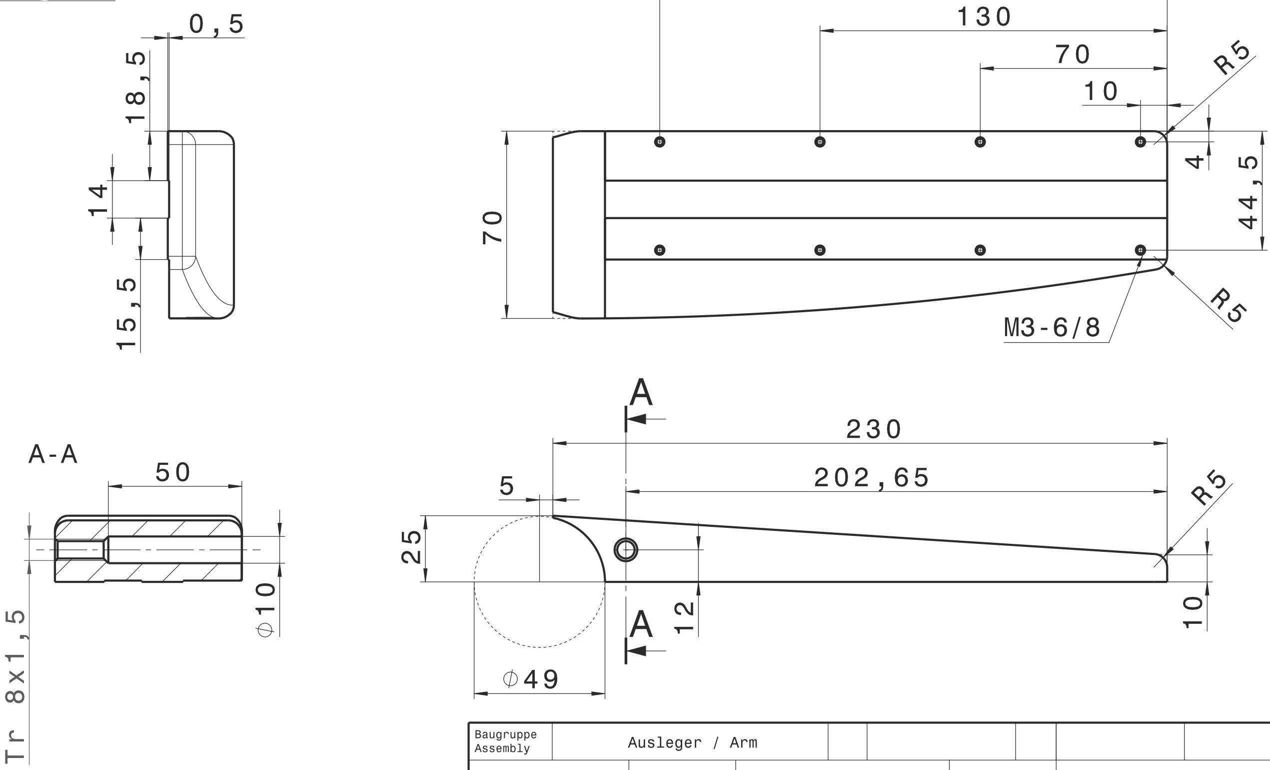
Allgemeintoleranz/ Tolerances NORM EN 22768 m		Name	Datum/Date	
	gezeichnet/ designed	Philipp Bannik	25.08.2017	Zeichnungsname/Title: Ausleger / Arm
Projektion	Maßstab 1:1 Scale	A3		Zeichnungs-Nr./Drawing-No.: 17 Index: 02

Fig 18



Baugruppe / Assembly	Ausleger / Arm			
Allgemeintoleranz/ Tolerances NORM EN 22768 m		Name	Datum/Date	
	gezeichnet/ designed	Philipp Bannik	24.08.2017	Zeichnungsname/Title: Huelse / Bush
Projektion	Maßstab 1:1 Scale	A4		Zeichnungs-Nr./Drawing-No.: 18 Index: 01

Fig 19



Baugruppe / Assembly	Ausleger / Arm			
Allgemeintoleranz/ Tolerances NORM EN 22768 m		Name	Datum/Date	
	gezeichnet/ designed	Philipp Bannik	24.08.2017	Zeichnungsname/Title: Hauptarm / Main Arm
Projektion	Maßstab 1:2 Scale	A4		Zeichnungs-Nr./Drawing-No.: 19 Index: 02

Fig 20

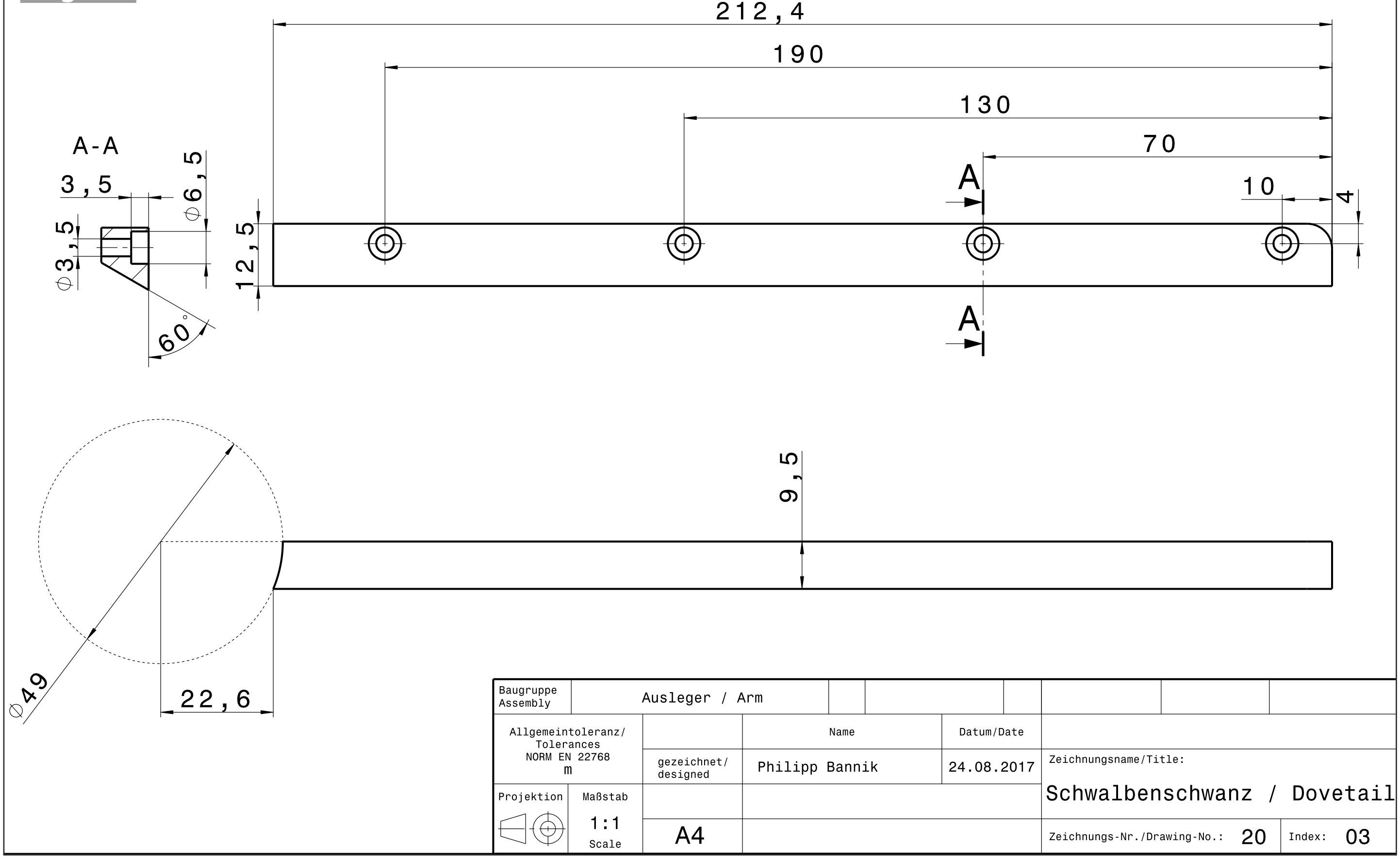
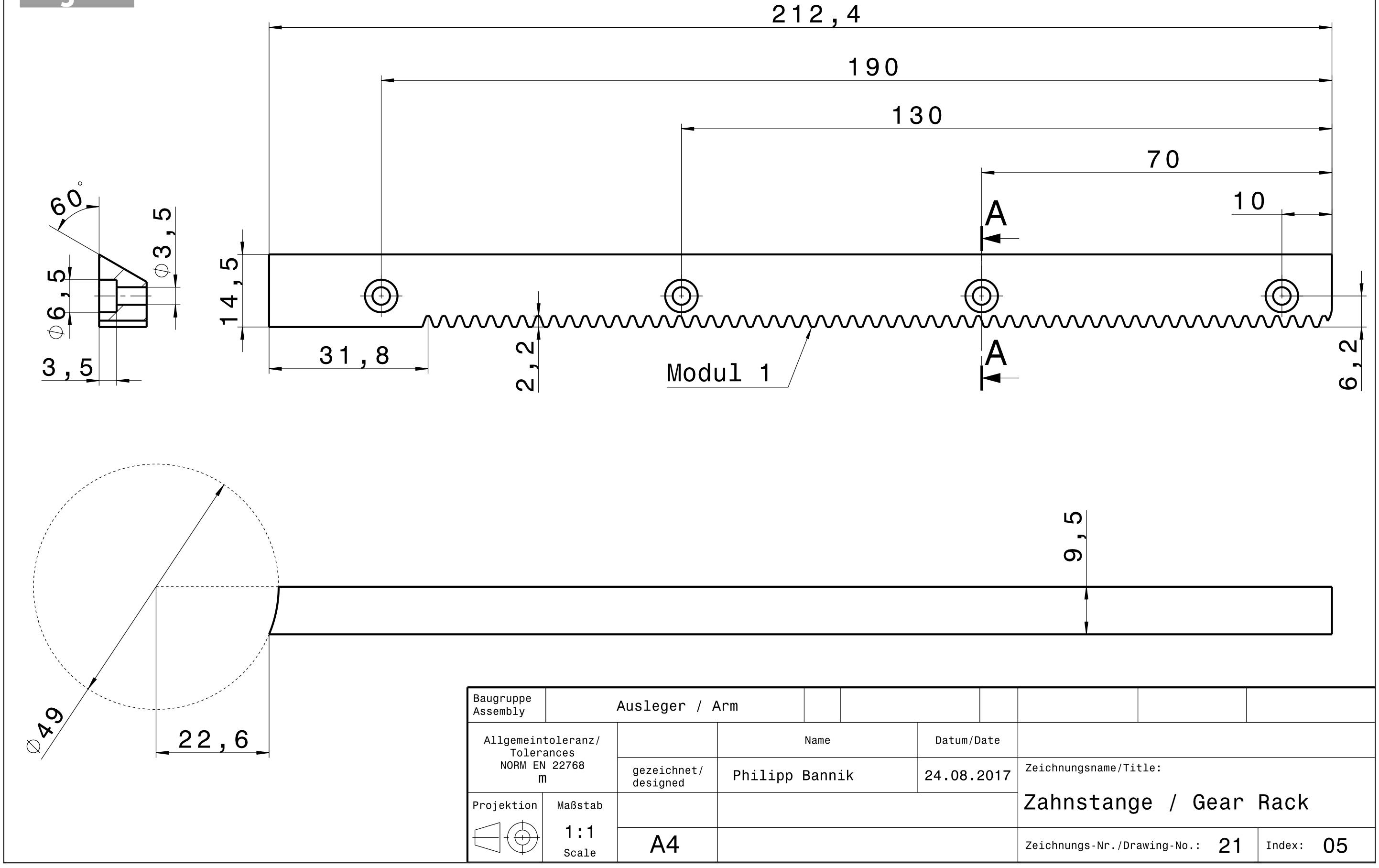

212,4
190
130
70
10
4
A-A
3,5
ϕ6,5
ϕ3,5
12,5
60°
A
A
9,5
ϕ49
22,6
Baugruppe Assembly
Ausleger / Arm
Allgemeintoleranz/ Tolerances NORM EN 22768 m
Name
Datum/Date
gezeichnet/ designed
Philipp Bannik
24.08.2017
Zeichnungsname/Title:
Schwalbenschwanz / Dovetail
Projektion
Maßstab
1:1
Scale
A4
Zeichnungs-Nr./Drawing-No.: 20
Index: 03

Fig 21


212,4
190
130
70
10
60°
ϕ3,5
ϕ6,5
3,5
14,5
31,8
2,2
Modul 1
A
A
6,2
9,5
ϕ49
22,6
Baugruppe Assembly
Ausleger / Arm
Allgemeintoleranz/ Tolerances NORM EN 22768 m
Name
Datum/Date
gezeichnet/ designed
Philipp Bannik
24.08.2017
Zeichnungsname/Title:
Zahnstange / Gear Rack
Projektion
Maßstab
1:1
Scale
A4
Zeichnungs-Nr./Drawing-No.: 21
Index: 05

Steam Turbines of the LMS Locomotive 6202

PART 6 - THE GEARED TRANSMISSION SYSTEM

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

Continued from p.279
M.E. 4671, 13 August 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).

Power transmission

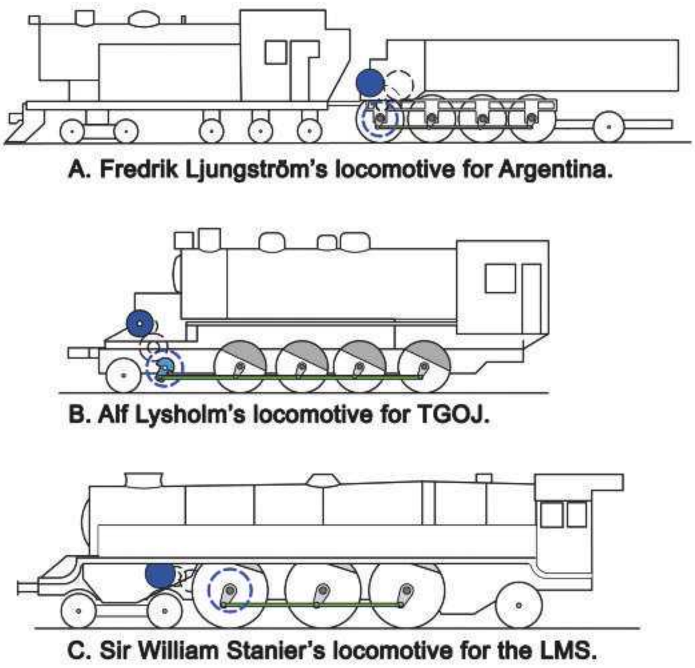
As mentioned in the previous article, before ending this series about Turbomotive's turbines I think it is worthwhile describing the mechanism by which power was transmitted from the turbines to the driving wheels because it entailed a number of very interesting features which have not been mentioned in books about the locomotive. These details clearly illustrate the inventiveness of Frederik Ljungström since they can mostly be traced back to locomotives and patents that were developed by him and his colleagues at ALA for their earlier turbine-powered locomotives.

The transmission system in Turbomotive had to achieve a number of objectives: **1.** Reduction of the high rpm of the turbine(s) down to the slow speed of the driving wheels. **2.** Reversing of the locomotive, **3.** Protection of the accurately balanced high speed turbine and its associated precision gearing from damage caused by vibrations resulting from poor track etc; **4.** Allowing the sprung axle boxes and axle to move vertically relative to the turbine whilst transmitting up to 2,600 hp between the gear train and the axle.

General features

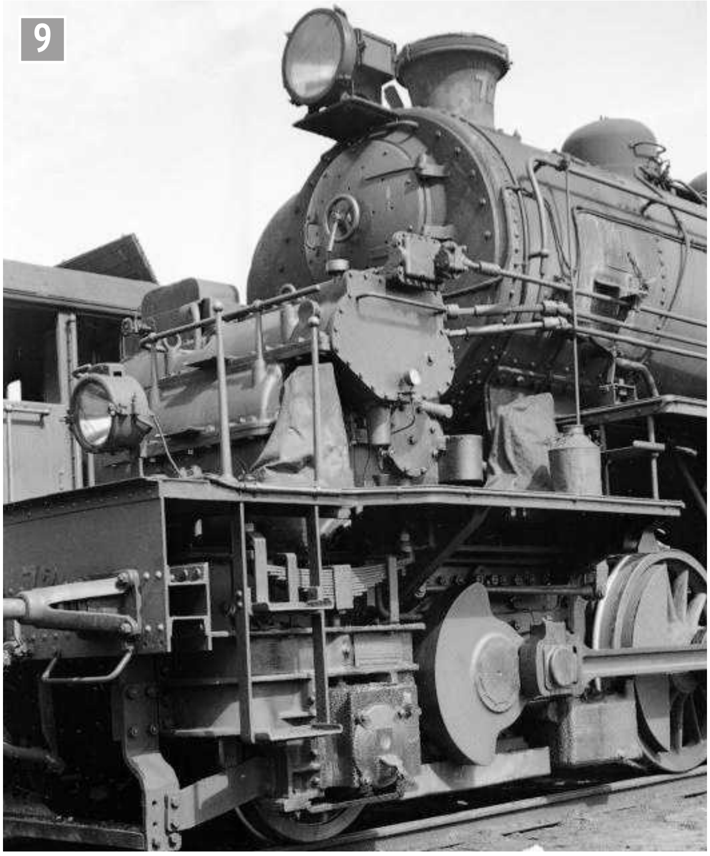
The three successful turbine-powered locomotives outlined in **fig 21** had various combinations of features in their transmission arrangements. **Figure 21a** represents the locomotive designed by Frederik Ljungström for the Argentine mineral railway. On the front of the smokebox it had a heat exchanger, patented by Fredrik Ljungström. This heated the incoming air which was forced into the firebox by a fan. The turbine exhausted into an air-cooled condenser maintained under vacuum. It was easier to make a gas-tight flexible connection for the relatively small diameter steam pipe than for a large exhaust duct and therefore the turbine was placed on the tender/condenser wagon which was also, therefore, where the driving wheels were located. The turbine was mounted transversely at the front end of this wagon. Thus the first half of the locomotive was just a boiler on wheels. Power was transmitted from the turbine directly to the leading axle on the tender/condenser wagon via a 3-stage gear train and reversing was achieved by introducing an extra (idler) gear into the transmission via a robust mechanism to move certain of the gear shafts. **Figure 21b** represents the »

Fig 21



Diagrams to show the basic pattern of transmission between turbine and driving wheels for three successful steam turbine-powered locomotives. For each locomotive the solid blue circle denotes the position of the main turbine, the dashed blue circle indicates the axle or shaft at which the gear train ended.

9



Turbine housing on front of TGOJ locomotive designed by Alf Lysholm. (Image from https://digitaltmuseum.se)

Fig 22

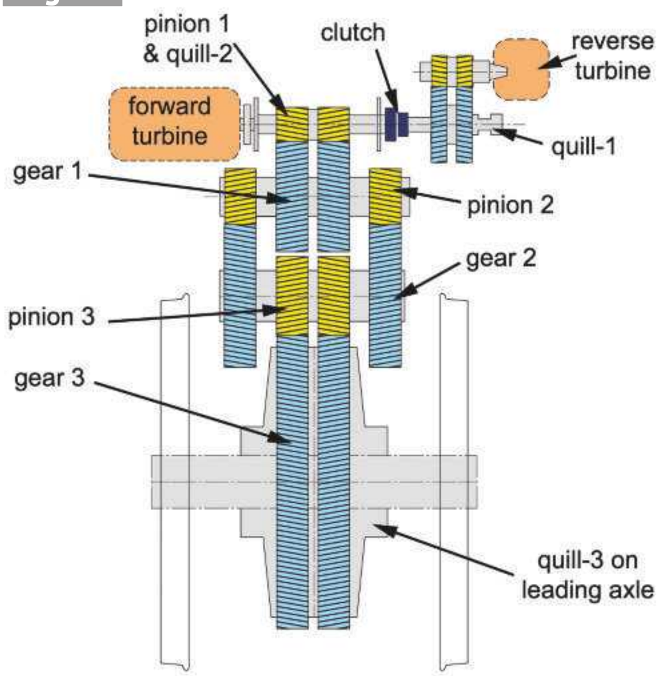


Diagram showing all components in the transmission between turbine and wheels of LMS 6202.

locomotives designed by Alf Lysholm for the TGOJ. This type was non-condensing and so the turbine could be located close to the boiler. It was arranged similarly to the Argentine locomotive (fig 21a) except that it was positioned in front of the smokebox where it was accessible and could easily exhaust via a conventional blast pipe. The transmission, including the reversing arrangement, was similar to that of the Argentine engine except the connection to the driving wheels reverted to a design used in earlier Ljungstrom locomotives in which the gear train ended at a jack-shaft with a disc crank at each end. Power was then transmitted to the coupled wheels via the leading coupling rods (**photo 9**). Turbomotive (**fig 21c**) had a design of turbine based on the TGOJ locomotive and a gear train and connection to the leading main axle based on the Argentine locomotive. The only fundamental difference was in the reversing arrangement. Positioning the turbine in front of the smokebox would have necessitated a radical departure from the Princess class design, but I assume that, by locating the turbine in the position normally occupied by the cylinders, any possibility of adopting the reversible gearbox design was ruled out due to lack of space.

Overview of the gear train

The forward turbine of Turbomotive was connected to the leading axle of the locomotive via a three-stage speed reduction gear train, giving a fixed overall ratio of 34.4 : 1. The pinion on the shaft of the reverse turbine drove a gear at a ratio of 2.24 : 1. When the reverse turbine dog-clutch was engaged, it coupled the shaft of that gear to the end of the forward turbine shaft (**fig 22**). Therefore the reverse turbine drove the driving wheels at an overall ratio of 77 : 1. Thus, for the same turbine rpm, Turbomotive could travel in reverse at less than half its forward speed, but the higher reduction ratio would have improved the available torque and hence the tractive effort that was available from the less powerful reverse turbine.

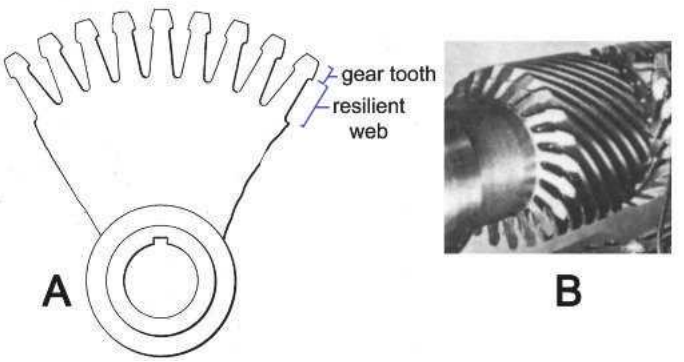
The forward turbine was permanently coupled to a double helical pinion which engaged a gear on the first of two intermediate shafts. The pinions of the next stage were located on either side of the first stage gears (fig 22) and these engaged gears on the second intermediate shaft. Finally, a double helical gear in the centre of this shaft engaged a gear surrounding the leading driving axle of the locomotive.

There are several interesting aspects of the Turbomotive transmission which were necessary because, as described in Part 1 of this article, railway locomotives are a particularly harsh environment in which to operate a steam turbine and its associated high-speed gears.

High speed gearing

In order for the turbines of Turbomotive and its predecessors to be made sufficiently powerful while being sufficiently small, they had to rotate at high speeds. That meant the first pinion of the gear trains had very high surface velocities. As is typical of high speed gears that transmit much power, all the gears in the transmission in LMS 6202 were double helical. Helical gears give smooth operation but they generate a lateral force which is balanced by having a double helical design with the teeth angled in opposite directions. Such a design must require high precision in the gear cutting procedures since, in addition to having accurate pitch and tooth form, the opposing sets of teeth must be at the correct angles. Also, they must be accurately aligned if power transmission is to be balanced between them. Use of high speed double helical gearing for the transmission of high powers was pioneered by Sir Charles Parsons, initially for use with marine and land turbines where the high rpm had to be reduced to slow speeds such as for turning large propellers. Parsons' early gears were cut using large gear hobbing machines made by Muir & Co. of Manchester. These gears worked well but were very noisy. Parsons discovered that the noise resulted from slight errors in the cutting process which he largely eliminated by inventing, in about 1912, a modification to gear hobbing machines which became known as the Parsons creep table. I assume that by the time Turbomotive was built other methods for machining gear teeth had also become more refined, although Parsons creep gear hobbing machines were still the preferred machine tool for cutting turbine gears for naval vessels during WW2. The gears of Turbomotive, however, had surface velocities much higher than those of Parsons' turbines.

Fig 23



a: Diagram adapted from Fredrik Ljungströms patent of 1920 (ref 42) showing the resilient web beneath each tooth. b: Photo of a pinion with resiliently supported teeth for a Ljungström locomotive.

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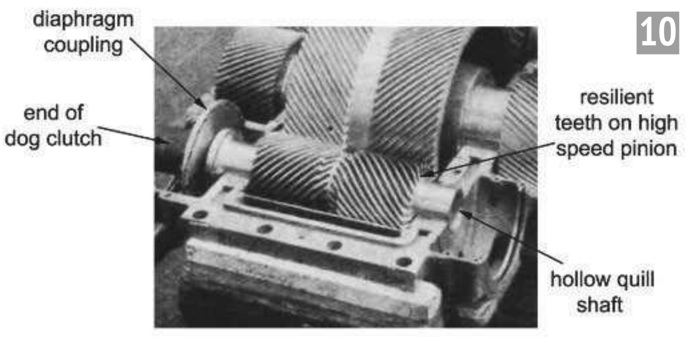


Pinion of the forward turbine of LMS 6202 showing the resilient teeth. (Small part of a photo on page 12 of ref 46).

Turbine pinions

The pinion on the forward turbine of Turbomotive was about 6 inches diameter (i.e. pitch circle diameter). The locomotive was designed to operate at up to 90 mph and, at that speed, the turbine rotated at 13,500 rpm. This meant the surface speed of the pinion and the first driven gear was up to 350 feet/second or 108 metres/second. At that time most gears ran at no more than 25m/s since, at higher speeds, the teeth soon became damaged as a result of impacts that occurred between mating teeth due to the unavoidable small errors in tooth pitch etc. To overcome this limitation Frederik Ljungström patented a new form of gear (**ref 42**) in which deep grooves were machined between the teeth of the pinions as shown in **fig 23a**. This gave a degree of flexibility to the teeth which allowed them to accommodate the small pitch errors. Also, it resulted in larger areas of contact between meshing teeth, thereby minimising surface stresses. Only one member of each pair of gears need have resilient teeth and only the very highest speed gears needed to be so designed. In slightly later patents (**refs 43** and **44**) Fredrik described a method to manufacture such gears and the benefit of extending the grooves either side of the teeth so as to improve the resilience of what he referred to as the 'webs' that supported the teeth. The patents specified that the groove should be rounded at its base to reduce stress at the point where it is maximum. He also stated that the web should be narrower than the thickness of the base of the actual tooth (as shown in fig 23a). **Figure 23b** is a photo of a pinion for a

Fig 24

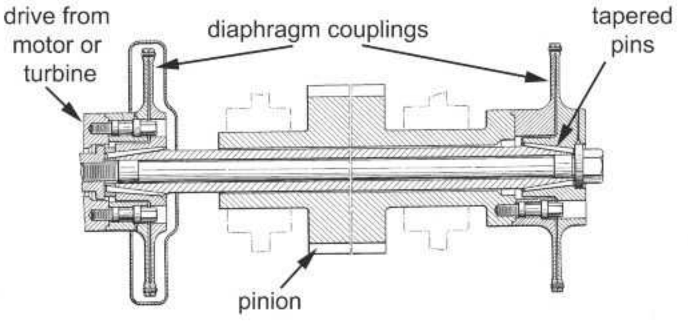


Diagram adapted from Fredrik Ljungströms patent of 1926 (ref 47) showing the diaphragm couplings either side of a high speed pinion.

Ljungstrom locomotive where this feature can be easily seen.

Drawings in the paper by Roland Bond (**ref 45**) show a distinct area below the teeth of the pinions of both the forward turbine (**fig 25**) and the reverse turbine (see Part 5, fig 19). These seem to represent the supporting webs as defined in Ljungström's patents and they are absent in all the other gears. A photo of the actual forward turbine pinion of Turbomotive is shown on page 12 of **ref 46**. Close examination of this (**photo 10**) reveals an identical appearance to that in fig 23b.

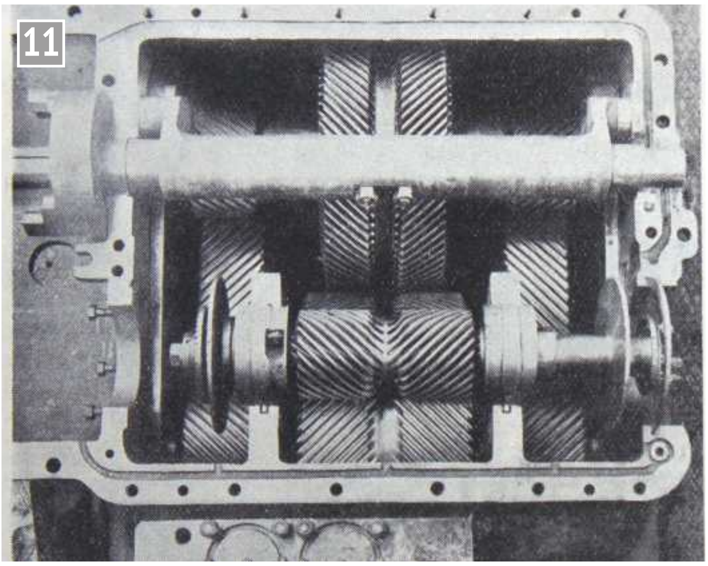
Coupling between forward turbine and its pinion.

The high speed pinion of the main gear train described above was driven by the forward or the reverse turbine via a coupling that provided a limited degree of flexibility to allow for slight misalignment between the turbine shaft and the pinion shaft. The previous article in this series described the first of three quill drives in the transmission of LMS 6202 and we now arrive at the second one which was of a type that had been invented and patented by Fredrik Ljungström in 1920 (**ref 47**). This drive was used in his turbine locomotives (e.g. fig 21a) and those of Alf Lysholm (fig 21b). The patent states that this coupling was developed because when a turbine gear train drives a locomotive via a crank and reciprocating coupling rods the resulting stresses cause slight changes in the geometry of the high speed gearing and so there must be a degree of flexibility in the mechanism. This quill drive employed a so-called diaphragm coupling which may also have been invented by Fredrik Ljungström. The diaphragm coupling consisted of two thin discs of metal, one on each of two separate shafts. These discs were joined together at their periphery and the flexibility of the discs permitted slight angular non-alignment between the shafts. Figure 24 is taken from the Ljungström patent and shows how he used two of the diaphragm couplings to allow for a small degree of both angular and lateral misalignment between the pinion and the axis of the turbine shaft. Transmission of power passed from the turbine on the left, through the first diaphragm coupling, through the central shaft and then to the right-hand half of the second diaphragm coupling. Then it passed through that coupling and back to the pinion which formed the quill. **Photograph 11** shows inside the gear case of the TGOJ locomotive in photo 9. The diaphragm couplings can be seen on either side of the high speed pinion.

Figure 25 shows the design of the drive between turbines and high speed pinion of Turbomotive. There is a clear similarity with fig 24 but in this version the reverse turbine connects to the right-hand end of the central shaft and so it drives the pinion via only a single diaphragm coupling.

The final part of the transmission involves some more innovations that originated in earlier Ljungström locomotives. These will be described in the next and final part of this series.

●To be continued.



High speed pinion with two diaphragm couplings in the gear case of the TGOJ locomotive shown in Photo 9.

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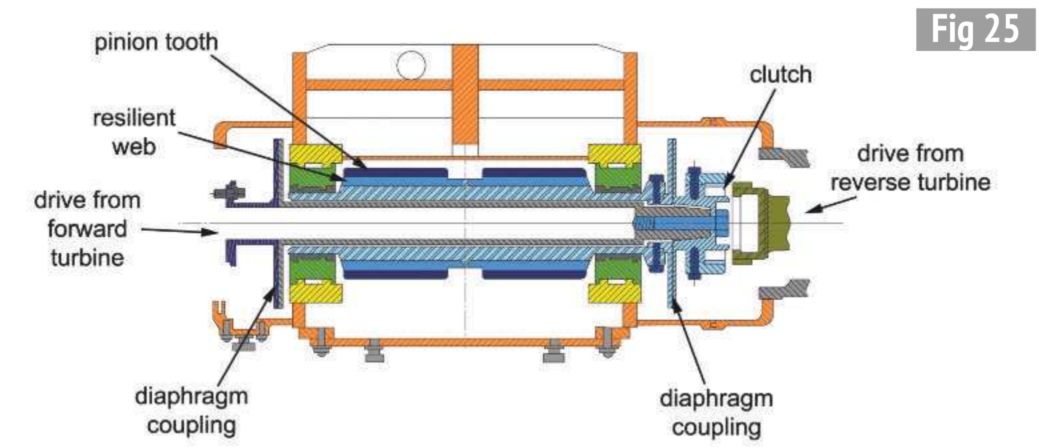


Section through the high speed pinion driven by the forward turbine of LMS 6202 showing the resilient teeth, diaphragm couplings and quill drive arrangement. (Re-drawn from figure 14 of ref 45.)

An Astronomical Bracket Clock PART 10

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

Continued from p.287
M.E. 4671, 13 August 2021

Pendulum and crutch

In a bracket clock a rating nut mounted below the pendulum bob to provide timing adjustment is often very difficult to reach. Tompion avoided this problem by suspending the pendulum in his bracket clocks from an upper block which could be raised or lowered and for the thin metal suspension spring to slide through and be held by a slit in a lower, fixed block. The raising or lowering, which changed the effective length of the pendulum, was carried out by a rack and pinion to one side of the rear of the clock, the pinion being on an arbor through to the front of the clock so that adjustment could be made from the clock face (typically from one corner). This system was refined by Brocot to form the suspension included on many French movements.

An alternative solution, which I have used, is shown in the book by W. J. Gazeley (**ref 13**). In this system the pendulum bob is not secured to the pendulum rod but is instead suspended from a short parallel rod which can be raised or lowered by a nut acting on a screw thread (**fig 19**).

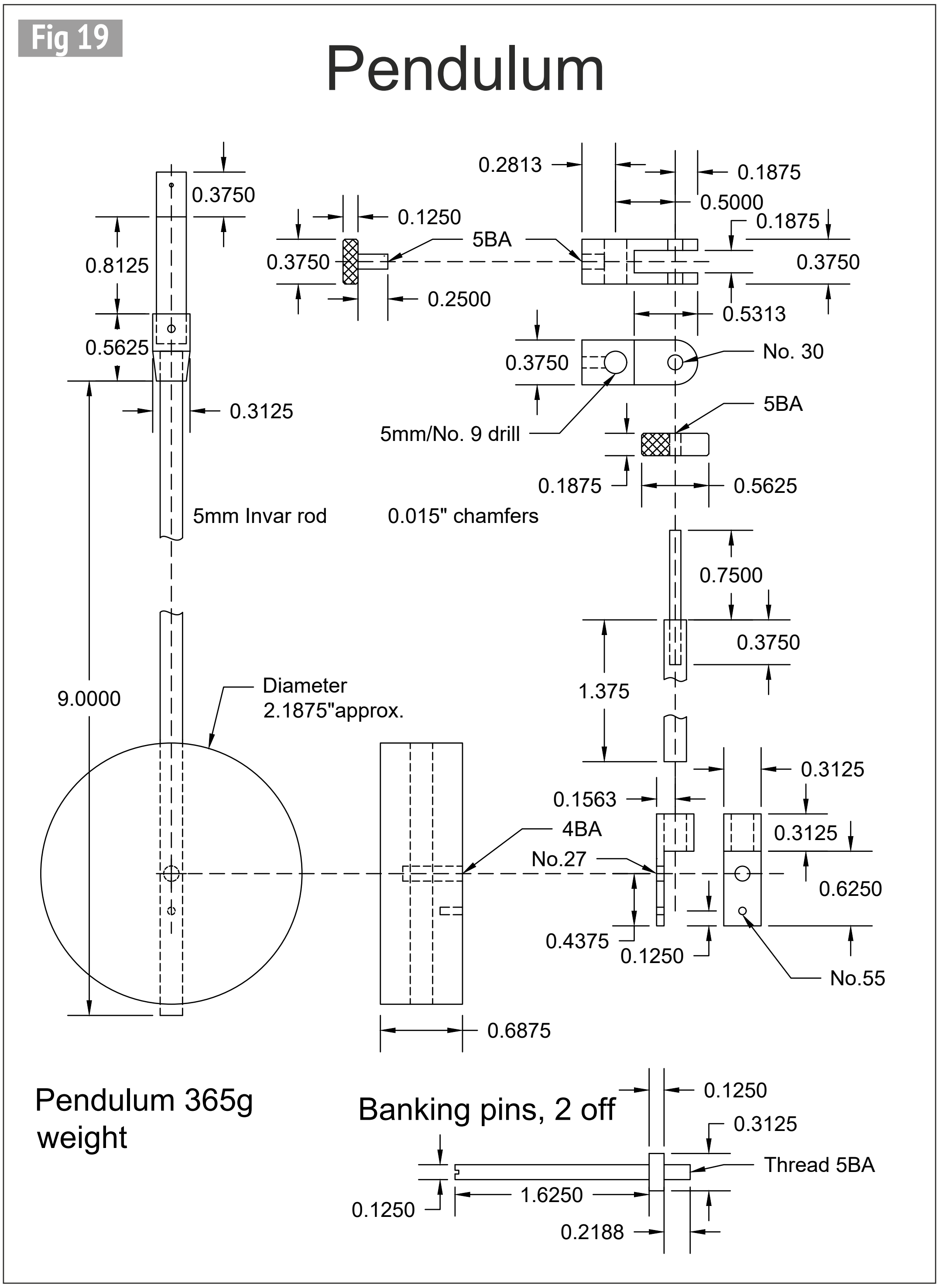
Start by turning, knurling and threading the brass 5BA nut which raises or lowers the pendulum bob. After parting off about 0.020 inch over size I left the parted off face to finish later so that it would be a close fit in the support bracket. Cut a 5BA x ¾ inch long thread in the lathe on a length of ⅛ inch diameter mild steel and check it is a good fit to the nut by adjusting the die clamp screws.

The required short length of 5mm Invar rod was sawn, faced and drilled ⅛ inch to a depth of ⅜ inch to match the unmachined portion of the above thread and secured with Loctite 603. Invar is not nice material to machine. It can be sawn with a hack saw without much difficulty (at least in the sizes we are dealing with), but it is far from free cutting and is very sticky. I ran the lathe at about 400 rpm and used a normal tool ground for steel with plenty of cutting oil. I have been told that a higher rake angle would improve the cutting but this was not tried or found necessary. After centring, the drill requires frequent removal from the hole to clean off the swarf, plenty of oil and some careful continuous pressure. Do not let the drill dwell as the Invar rod will work harden. The drill gets hot even at this speed and size. The material seems to flow rather than cut but a hole to reasonable tolerances can be made.

I opted for 5BA thread on the knurled locking screw as it is easy to turn to ⅛ inch for threading but 4BA would be just as good. The upper bracket can be made from a length of ⅜ inch square brass by holding horizontally in a machine vice whilst the top and bottom of the slot for the nut is cut with a 1⁄32 inch slitting saw.

Rounding the end of the upper bracket.

Pendulum bob mounted in the chuck and supported from the tailstock.



At the same setting the 5BA clearance and 5mm holes can be drilled. After removing from the vice, a piercing saw and files finish the slot. The block was then cut to length and held in the four jaw chuck to face the end and drill and tap the 5BA securing hole. The other end was rounded on a small milling table which was to hand but filing buttons could have been used (**photo 45**).

The small block to secure the short section of invar rod to the bob is best made from a length of 5/16 inch thick rectangular bar (I had to mill a 3/8 inch square section to size). Set up the brass in a four jaw chuck using a dial indicator to ensure it is centered. Face the end, centre drill and drill 5mm (or No. 9) to a depth of about 7/8 inch. Remove from the lathe, saw away the excess metal that is not needed and mount horizontally in the mill. Use light cuts (~0.005 inch deep, 0.060 inch wide) with a sharp end mill of about ½ inch diameter to clean up the sawn area. This is much quicker than filing. Then drill the No. 55 hole for the registration taper pin and the 4BA clearance hole at the same setting. After sawing to length, the remaining end face can be filed or milled square.

It is probably worth mentioning at this point that the easiest way to remove the inevitable milling marks is to mount a fine, and preferably worn, No. 6 flat file in the vice. Hold the component between the fingers and carefully rub it against the file; i.e. do not rub the file against the component. At all costs do not let the part roll in the fingers as the crisp milled edges will be damaged. Only a few strokes should be needed.

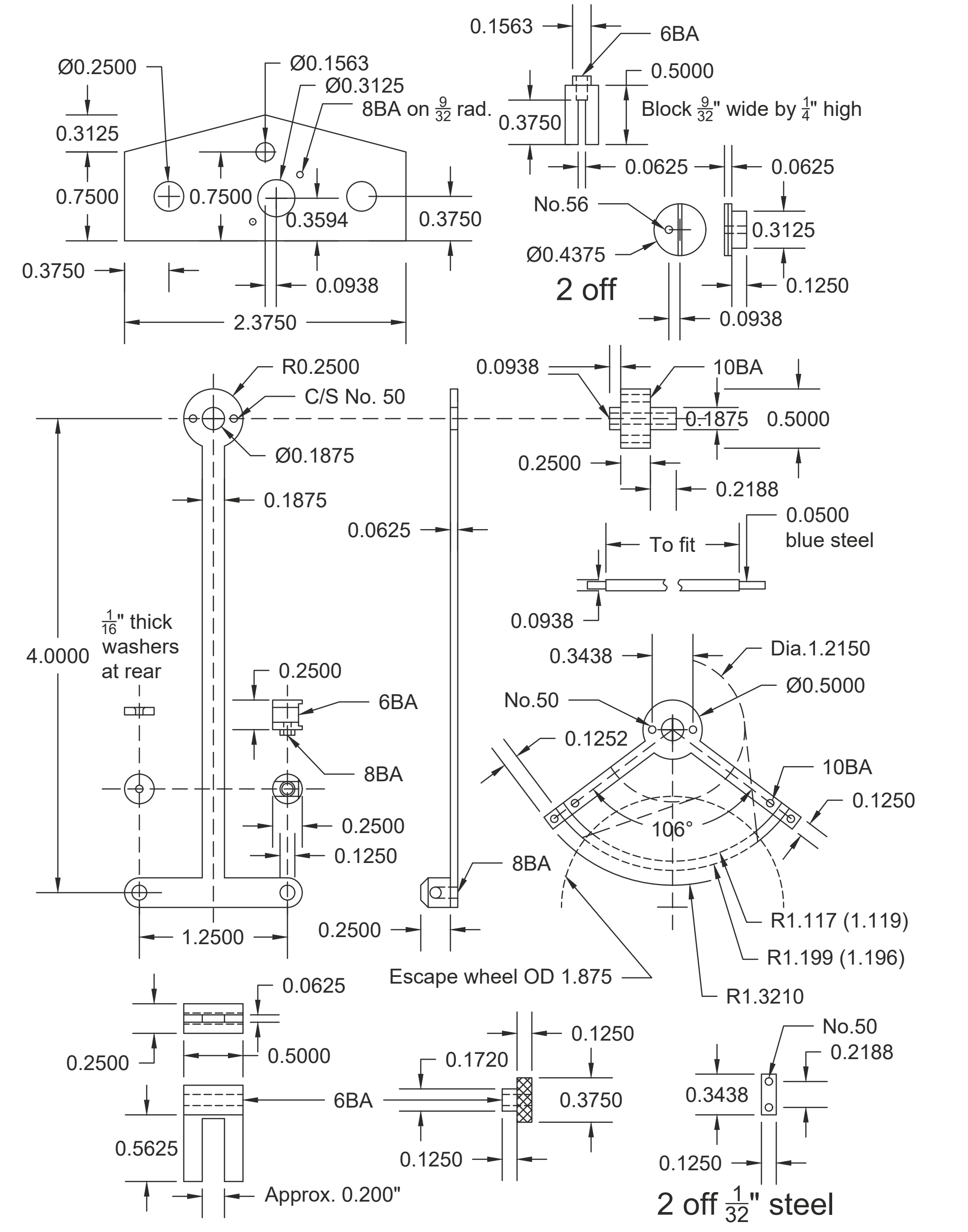
I turned the pendulum bob from a 2½ inch diameter by ¾ inch thick brass blank. A 2¼ inch diameter blank would have been less wasteful as the final diameter was 2 3/16 inch. The two faces were turned first by holding the blank in the reverse jaws of a three jaw chuck. On one face a hole was drilled No. 27 and tapped 4BA to a depth of about ½ inch.

Turning the outside diameter is a little more tricky. In the three jaw chuck I faced, drilled and tapped a short off-cut of brass rod 4BA and mounted the bob with a large brass washer on this with a short length of 4BA studding. This was sufficient to provide the 'drive' for light cuts but clearly not rigid enough to prevent any movement. The solution was to provide support from the tailstock but without marking the surface of the bob (**photo 46**). To this end I mounted a rotating centre in the tailstock which pushed against a little fitment I use to support the plastic. It consists of a 1⅛ inch long by 1½ inch diameter section of aluminium rod. One end is faced and drilled with a centre drill. The other end is drilled and bored to take a rubber door stop leaving about ¼ inch protruding (**photo 47**). A light friction fit on the stop is fine. In use the tailstock is wound out to compress the stop by about ⅛ inch. It works surprisingly well and allowed the outside diameter of the bob to be safely turned, despite only being mounted on a 4BA thread.

The long cross hole was drilled with a No. 9 drill. A 5mm drill would have been just as good. With such a long hole it is essential that the rake angle of the drill has been backed off to stop it grabbing whilst deep in the hole. The quill on my mill does not have enough movement to allow this hole to be drilled in the usual way. I had to lower the head as well as use the quill feed. This does not matter (provided your mill maintains alignment) but it is essential to wind out the drill regularly to rid it of swarf. I used a drop of cutting oil during drilling the last part of the hole to reduce friction. This is not normally necessary with brass but this hole is unusually long.

If all has gone well the bob should end up weighing around 340 grams. When added to the rate adjustment parts the total should be around 370 grams. Clocks of this type typically have bobs weighing around 365 grams in total.

Fig 20 Bridge, crutch & pallets



The last job on the bob is to drill the hole for the registration pin. To position the hole, put both the pendulum rod and the short length of invar rod through the bob and the securing bracket respectively and use a tool maker's clamp to hold them in alignment whilst the No. 55 hole is drilled through the hole already made in the bracket and into the bob.

The top end of the Invar rod is Loctited into a collar which hangs from the suspension spring. The collar was made

A view of the fitment providing support for the bob.

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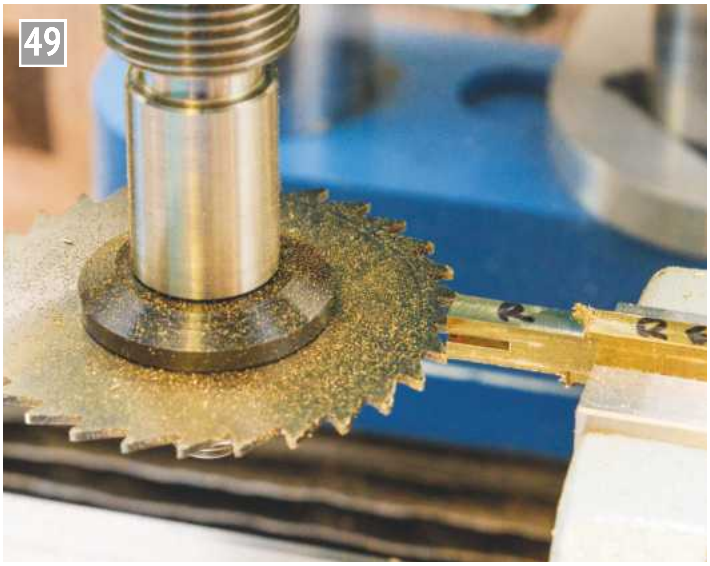
The suspension spring.



Forming the slot in the pendulum bridge.

from brass rod. After facing one end it was held in the machine vice for cross drilling the No. 53 hole (just under 1/16 inch) and forming the slot for the suspension spring with a 0.006 inch circular saw. It was then turned to 5/16 inch diameter, parted off and held in a Myford collet to drill the No. 9 hole for the invar rod. The drill hole should be taken just into the portion that has been slotted.

The suspension spring, with its upper brass section pre-drilled for the cross pin, was purchased from Cousins. It will be necessary to cut it to length (I use an old pair of scissors rather than tin snips) and the 1/16 inch diameter hole punched for securing to the lower collar. I am always surprised how easy this is to do. Bend a small piece of 1/32 inch brass strip and squeeze it to fold flat in the vice. Drill through 1/16 inch. Face the end of a ½ inch length of 1/16 inch silver steel rod, harden and temper to blue. Position the spring in the 'sandwich' and give the hardened pin a dull thump with a heavy hammer through the hole (**photo 48**). *Voila!* The only difficult bit is positioning the spring in relation to the hole in the folded brass. I usually file the folded brass so that it just fits the spring in width with the hole central to ease the positioning.

The last action is to pin the suspension spring with a 1/16 inch diameter brass pin and to use Loctite 603 to hold the Invar rod in place. This is done with the suspension spring in place so that the Invar rod can be pushed home to butt up against the bottom of the spring to prevent it rotating.

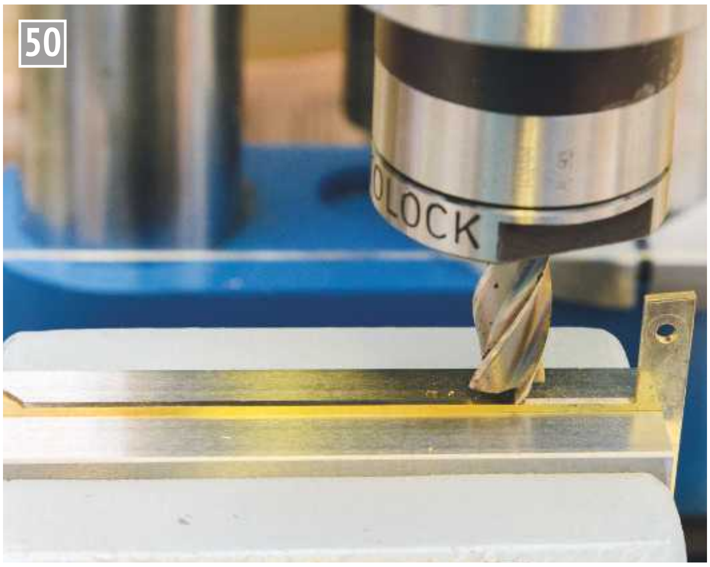
The 9/32 inch by ¼ inch block on the pendulum bridge was made from 3/8 inch wide stock milled to width and then slotted a close fit to match the upper brass section of the suspension spring (**fig 20**). I used a 1/16 inch slitting saw which left a 0.006 inch gap between the jaws of the block and the upper brass suspension (**photo 49**). I could have made the gap thinner and tried to file it more precisely but it would be difficult to not round the edges. I cheated by using Araldite to adhere a small shim to the side of the upper brass block to prevent excess movement.

The block had a short spigot turned on the end and drilled and tapped 6BA for about 3/16 inch. It was secured to the pendulum bridge with Loctite and a counter sunk screw.

For the crutch, I suggest the two tiny ¼ inch diameter supports for the 6BA thread are made first. The ends that fix into the crutch can be turned, drilled and tapped 8BA easily in the lathe but do not part off. Transfer the rod on which they are turned to the dividing head on the mill so that the cross hole can be drilled and the small flat milled with a 3/16 inch slot or end mill. The flat only needs to be about 3/16 inch wide. The part can now be returned to the lathe for parting off and the top surface turned to length.

The two washers should also be made at this stage. After turning and drilling, part off over length and turn the rear face. As previously described, this is easily done by using Superglue to mount them on the end of a turned rod with a small appropriately sized spigot. They adhere in seconds and are easily removed by heating.

The pendulum crutch was cut from 1/16 inch brass plate. I clamped a piece of plate to the milling machine table with 10mm MDF underneath. I coordinate drilled all the holes in their correct relative positions. If you do not have a DRO (and I recommend such a system) it will be necessary to mark out all the holes or do some careful counting. Once drilled the shape can be laid out on the brass with a scriber for piercing to shape. The two supports (above) can be positioned to help align the ruler. I milled the two long straights on the crutch (**photo 50**) and used buttons to help file both the ½ inch diameter upper section and the two lower end curves (**photo 51**). The time taken to drill and part off two 1/8 inch thick diameter discs of steel of an appropriate diameter plus a short piece of round rod is minimal and with the brass sandwiched between them, filing curves becomes a doddle.



Milling the straight edge of the crutch.

Using a filing button to form the rounded end.

Milling the moveable block.

The moveable block with its arms that capture the pendulum was made from ¼ inch brass plate about 1¼ inch or so long. Two sides were milled parallel, ½ inch wide, and one end milled square. The 6BA cross hole is a little more difficult for two reasons. Firstly, it is likely that your taps are only just long enough. Work from one side alternating between a taper and bottoming tap. The thread should show at the other end before you run out of length of tap. In my case inserting the taper tap from the other end was just needed to clean the hole, it picked up the partly cut thread without a problem. The other problem relates to the position of the tapped hole. It needs to be in the centre of the ¼ inch plate and in theory ⅛ inch from the end so that the block bears against the crutch arm surface which prevents it rotating. I suggest, however, that it is drilled and tapped about 0.140 inch from the end and then small amounts (say 0.002 inch) removed at a time on the mill provided you can reposition it with sufficient accuracy. If in doubt, carefully file. Either way it should just fit and move without any unneeded rotation.

The block is finished by milling 3/32 inch off the top and bottom of the plate leaving 1/16 inch thickness (**photo 52**). The extra length of the plate allows it to be clamped to the milling table for this process. The slot for the pendulum rod was cut with a piercing saw and carefully filed to just allow the 5mm (0.197 inch) Invar rod to hang freely. I filed mine to a gap of 0.200 inch.

●To be continued.

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NEXT ISSUE

Astronomical Clock
Adrian Garner adds the remontoire and escape wheel to his astronomical bracket clock.

Engineer's Day Out
Roger Backhouse pays a nostalgic visit to Liverpool and discovers a much-changed city.

Great Wealden Railway
Paul Carpenter celebrates the life and times of a wonderful miniature railway in Kent.

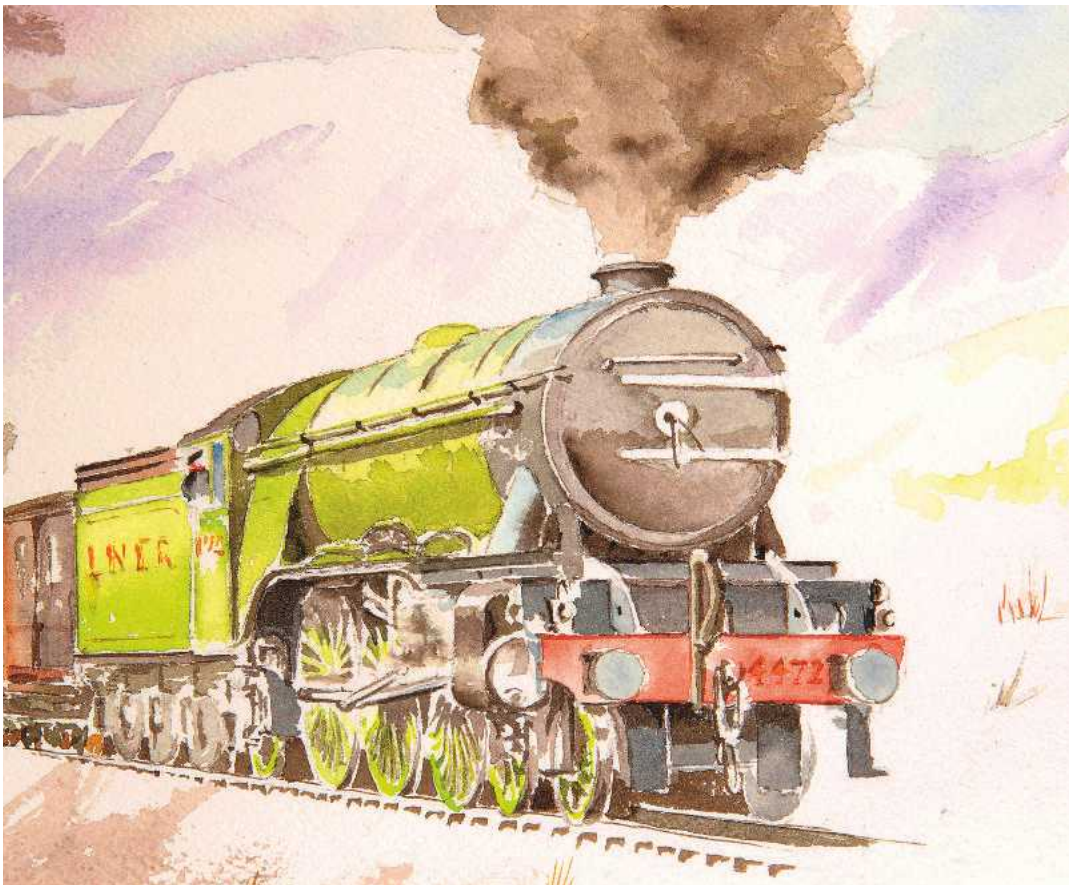
Ballaarat
Luker makes the springs and axleboxes for his 5 inch narrow gauge Australian 4-4-0 locomotive.

Content may be subject to change.

ON SALE 10 SEPTEMBER 2021

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

Continued from p.263
M.E. 4671, 13 August 2021



Painting by Diane Carney.

PART 17 - SPRING HANGERS, SMOKEBOX AND SADDLE

Flying Scotsman in 5 Inch Gauge

1. Here we have the two castings having been split apart. As with the horns etc. the two trunnions are cast as one. Before parting they were first machined to overall thickness and then had the $\frac{1}{16}$ inch rebate machined in the centre before sawing in half to give the two castings as seen in the picture. The next job was to clamp each one of the castings in its correct position on the frames and transfer the hole positions across.

2. The holes were then drilled on the first marked casting, which was then bolted back to back with the other, held in the machine vice and the holes drilled through to the other casting, giving two castings that when riveted to the frames will be in the exact opposite positions. Clamps were used to hold the two castings together with a $\frac{1}{8}$ inch piece of steel flat bar used to space the centre machined section and thus keep everything square. With the mounting holes drilled, the two castings could then be bolted together using suitable bolts for machining of the remaining sections, sides and tops.

3. The bearing journal faces were then machined flat and the holes drilled ready to accept the brake shaft bearings.

4. This picture to shows the trunnion so far. Note that I have worked the outside profile a little using files and a belt sander to bring it closer to the drawing. I could have done more here to centralise the bearing hole but decided to do the two bearings first and use them as a final guide to the outside profile.

5. After turning the bearings they were transferred to the rotary table for drilling the three securing holes at 120 degree spacing. The unwanted material between the spigots was then machined away. I cheated here. I didn't see a reason for setting up an index but also didn't want to rely on the dial markings alone so went for using a spacer positioned in each hole and just machined up to the spacer - not the engineer's way but good enough for the eye in a non-critical situation.

6. Here I am checking on how things are fitting together - as can be seen I still had a lot more work to do on the trunnion bearing housings before they matched the bearing profile. The mounting holes were then transferred onto the bearing housings.

7. The last machining job for the trunnion was to drill the holes for the spring hanger bolts to pass through, which were drilled at 15 degrees to the vertical. This was a job for the tilting vice and the digital angle scales. This just left the final profiling of the brake trunnion around the bearing housing to finish.

Brake shaft trunnions

These are one of those tricky castings that are prevalent in a Gresley Pacific, the spring brackets being another favourite - tricky in how to hold the things for the various machining operations. Such things are dictated by the tools/equipment that one has to hand but this was my method which worked well.

Spring hangers

The castings for these were terrible - a mixture of a bad pattern mixed in with poor foundry work, with the two halves not matching. I needed to find a datum somewhere. Normally when dealing with two halves joined together I would machine the ends square to give me a starting point but this wasn't possible due not only to the shapes not matching but also due to them being of different sizes due to shrinkage. I chose to use the upright ridge section of the casting as the datum even though these weren't great. Having split into two the halves they were then held back to back in the machine vice, using a square sitting on the vice top edge to square up the casting ready for machining. The two halves were lined up by their lower front toe and the central ridge in the casting, ignoring the shapes of the faces that mate against the frames.

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8. Once the ten spring hangers had been drilled they were again placed back in the tilting vice in pairs to have the holes drilled.

9. The recessed grooves for the shock absorbers to locate were also cut at this stage.

Next, I tackled the 15 degree toe angle, using two pieces of steel bar to hold the castings via the central ridge. A couple needed shims due to the ridges being slightly deformed but the object of the exercise was to get the castings sitting in their correct positions to ensure that they all matched to a set Z axis reading.

I was then able to position the first of the fixing holes on each half and then transfer the hangers to the frames for spotting through the other holes.

Smokebox tube and saddle

I obtained the smokebox tube from my suppliers machined to diameter but left oversize on the stock tube length for me to finish later. I could then hold the tube securely in the chuck without crushing by clamping it by the non-machined section and part off to size at 6³⁄₁₆ inches. In theory.

Next time I have something this size that needs machining

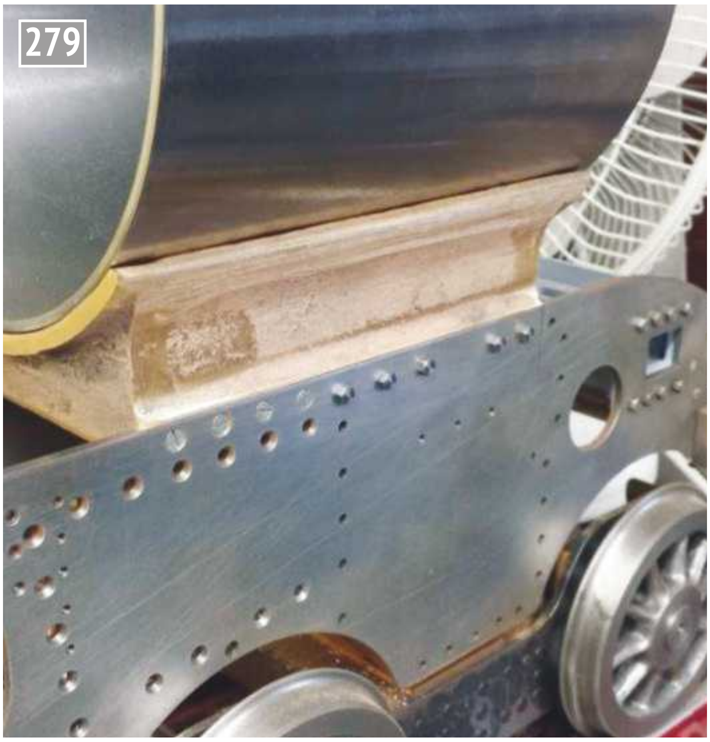
10. And here we have the chassis with brake trunnions and spring hangers in place. Note the brake shaft steel bar is only a temporary item for alignment which I'm happy to report is good, as is the brake cylinder alignment. There's still a lot of riveting to be done here but it was getting there slowly.

11. Here is the smokebox tube being parted off. The white tape seen was to reduce chatter.

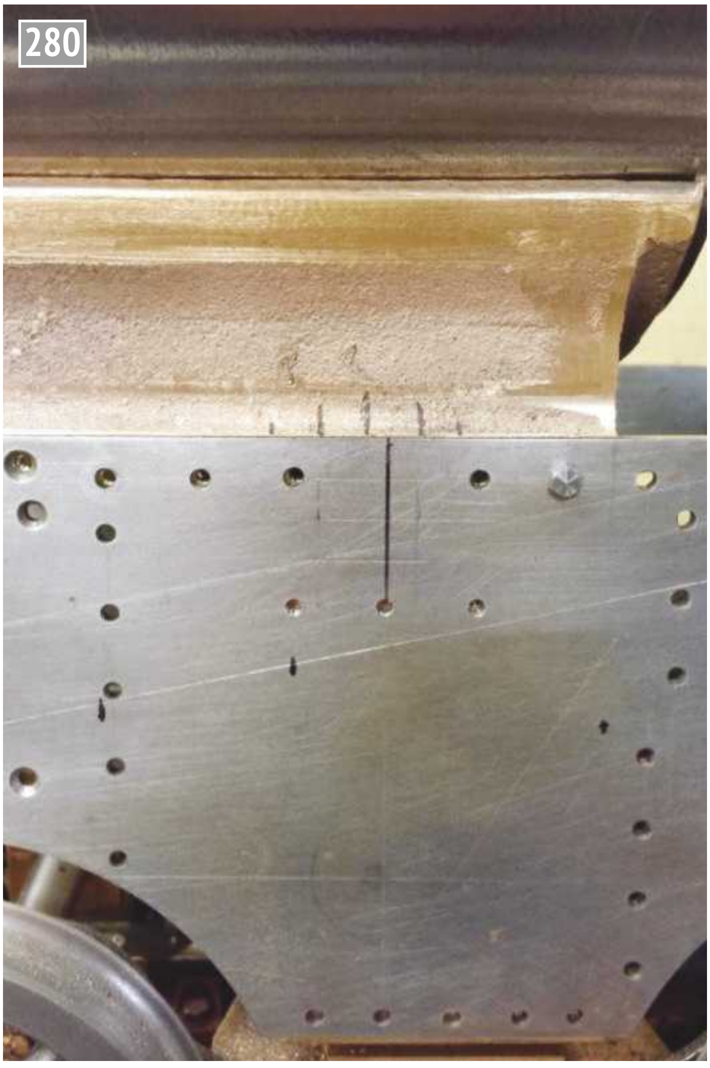
12. The saddle casting lined up on the milling machine table, ready for machining.

13. Once lined up, the saddle casting was machined roughly to size. The casting has a ⅛ inch overhang to sit along the top of the frames, which is cut 1¼ inches from the bottom edge of the exhaust port tabs (top as seen in the picture) and as a check it also needed to be ⁵⁄₁₆ inch from the rest of the saddle base. Here the casting proved to be very good - both measurements were spot on. It was also very reassuring to find that when machined both sides were identical. proving that the saddle was sitting level.

14. Next the casting was up-righted and the side and front edges machined square, removing all of the flash in the process. This, as can be seen, only just fitted in the machine vice. With both sides done I had just enough movement on the table to do the front edge, the rear was cast without any flashing so easy to finish with a file.



15. I next drilled and tapped the 18 6BA holes that take a mixture of countersunk screws and small head hex bolts for the saddle fixing points.



16. Here is a close up showing the marks for lining up the exhaust opening. The long black mark on the frames is where the centre of the opening should be according to the drawings, which conveniently lines up with the lower bolt hole. The first line to the left of this line on the casting is the centre of the actual opening with the saddle in this position. I have also scribed lines for top and bottom and marked the side lines faintly with pen.

I did a few more checks, measured back from the drag beam and checked the fit of the firebox crown over the boiler stay and all looked good - perfect in fact - but I'm still a little puzzled by the exhaust positioning. I have checked the cylinders and the opening will make no difference here as the cylinder has a very large elongated opening about three times longer than in the frames. The cylinder flange that is a separate item will need its opening moved to match but looks like it will fit between the various mounting holes.

So I spent another few hours checking what's what... Anyway, I've convinced myself that I have put the saddle in its correct position even though the marked position for the exhaust openings doesn't line up. Why this is the case I have no idea but I've decided to just get on with it. Having said that I did check the position of the centre cylinder as from what I can see this is the only item likely to be affected if what I think is the saddle's correct position interferes with Don's design.

I'll get someone else to do it, as my machine is at its very limit for something of this diameter and length. I couldn't part it from the front - it was just too big - but I could part it by positioning the tool on the other side (more room) and running in reverse. I cut the groove until nearly through and then finished with a hacksaw, reversing in the chuck to finish.

Now a job that still needed doing to the frames was to cut out the exhaust passage slot that connects the outside cylinders with the saddle that has the cast port passages within it, again, as in the prototype. Before I could tackle this job I first needed to machine the saddle casting to fit between the frames and machine its edges square so that I could line it up to accurately cut the exhaust port openings.

I decided to sit the casting upside down on two lengths of ¾ inch steel bar which in turn sat in two of the bed 'T' slots - this takes care of getting the casting central along the X axis, just requiring the casting to be level along Y, for which I used the digital angle. Having

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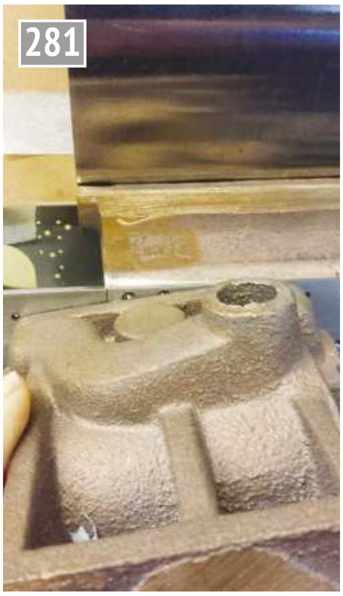
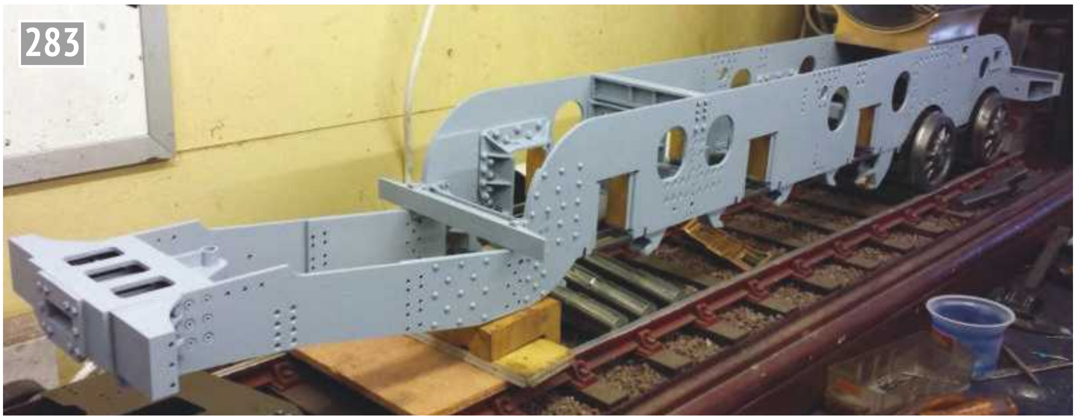


17. Here, I am holding the cylinder roughly in position to check that the steam/exhaust openings don't foul the saddle's rear face. As can be seen it's close, but then it is on the drawing and if I moved the saddle forward to match the exhaust positions this would be even closer, perhaps fouling the rear of the saddle with its ⅛ inch thickness. It all looks good though so I left the saddle as it was. I tried to check all possibilities and think way ahead but I had to decide and that I now did. Later, much later I realised where the ⅛ inch error may have come from - there's a ⅛ inch difference in mounting position between the two bogie types. Perhaps Don didn't allow for this on his drawing?

18. Finally, I bit the bullet and cut some metal, only on one side so far but here was the result. I do like Don's design, love how the slot is angled to match the casting, which should help in the free flow of the exhaust gases. I've cleaned up the inside of the exhaust opening a bit but will do a little more - I need to make something up to reach in further as there's a flash line along the upper length of the tube between the two cylinders that needs removing.

I finished drilling and filing the openings through the frames for the outside cylinder exhaust ports and I also spent a number of hours grinding and filing the saddle down to scale proportions. I took more than half the flange thickness off (which is why it took so long) and filed smooth the front/back and side faces and rounded off the flange corners. I then drilled through the lower three exhaust port flange holes (oversize for ease of assembly). It seems that it allows bolts to screw through from the inside as the frames are tapped 6BA here rather than the saddle. Looking at it this may be to allow easier access to remove the saddle/smokebox otherwise the two outside cylinders and all of the motion would need dismantling first.

The saddle still needed a lot of work but nothing that effected the rest of the frame erecting which was my main aim then. Here, I had a lot still to do as to date everything done on the frames was very much a rough and ready pre-assembly stage. This could now change as I have now received my order from EKP for a few hundred 6, 7 and 8BA x ¼ inch screws in both small hex head and countersunk types - lots of work to do there then.



19. There was then a marathon session (I seem to have a lot of those), stripping everything down, painting with Acid 8 and reassembling with small head bolts for scale. This took many hours but I think the end result speaks for itself.

been levelled, the casting was packed up along one edge to maintain the level and held down using two clamps, tight but not too tight, risking deforming of the saddle. I then clamped a piece of steel flat bar along one edge and clocked it to check alignment.

I drilled and filed (a lot of filing) a temporary hole in the smokebox for the outside cylinders exhaust exit so that the smokebox could sit squarely on the saddle to check the fit. Later I followed the full-size version and opened up the entire lower section of the smokebox so that it was sealed along the saddle flange itself.

The next job was to plot the exhaust opening in the frames, drill and file to shape and then tidy up the saddle casting. The flange needed thinning down by a fair amount and the rough casting itself needed smoothing out a little too. I had checked the height of the saddle which was as it should be for the correct height of the boiler and the saddle's position along the frames was also checked against the general arrangement drawing. One thing that is becoming very obvious is that this chassis is now getting to an uncomfortable weight for me to lift and that's without the front bogie attached yet. There is no way I will be able to lift it with wheels and cylinders fitted, so better start thinking about a building jig...

Well it was one of those days for this stage...I didn't get much of what I had planned to do done. The reason being that I spent all day measuring and then remeasuring the saddle and boiler positions as something wasn't adding up. The reason why will become clear shortly... so today's question was 'is the saddle in its correct position?'... Well, not according to the exhaust openings as marked it's not. I scrapped all my plans for the day and decided to investigate thoroughly what was going on. The first thing was to check the position of the saddle against the drawing and (more importantly to me) against the prototype. After checking copious numbers of photographs online looking for squared side on views (difficult) Don's drawing looked correct. You have to be careful though when looking at preserved photos as 4472 was given a new smokebox in the early 80's which is different to the original; one glaring difference which commercial models seem to get wrong is no Gresley Pacific had rivets around the rear of the smokebox tube as seen today, Hatton's new 'O' gauge model being a classic example.

●To be continued.

A New GWR Pannier PART 35

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

Continued from p.212
M.E.4670, 30 July 2021

278

Pannier tank 7754, with the earlier type of cab roof.

We now come to making the cab. There are the two types: one is for the 5700 and the other one is for the 8750 class. However, they were changing these cabs as they went through the shops so that means a bit of research on your part as quite a lot of the 5700s ended up with a cab that looked like an 8750 Class, but it was still a 5700! In fact, they were all called 5700s in my 1961 Loco Spotter's books. The 5700 cab had the round windows and quite a flat roof. The 'roof hatches' on both locomotives were very similar and I have termed them thus as it was no coincidence that they were placed directly above the lifting holes in the frames, so they were *not* called 'sunshine roofs'. They were the slinging hatches and were used for rerailing the engines if they fell off the track.

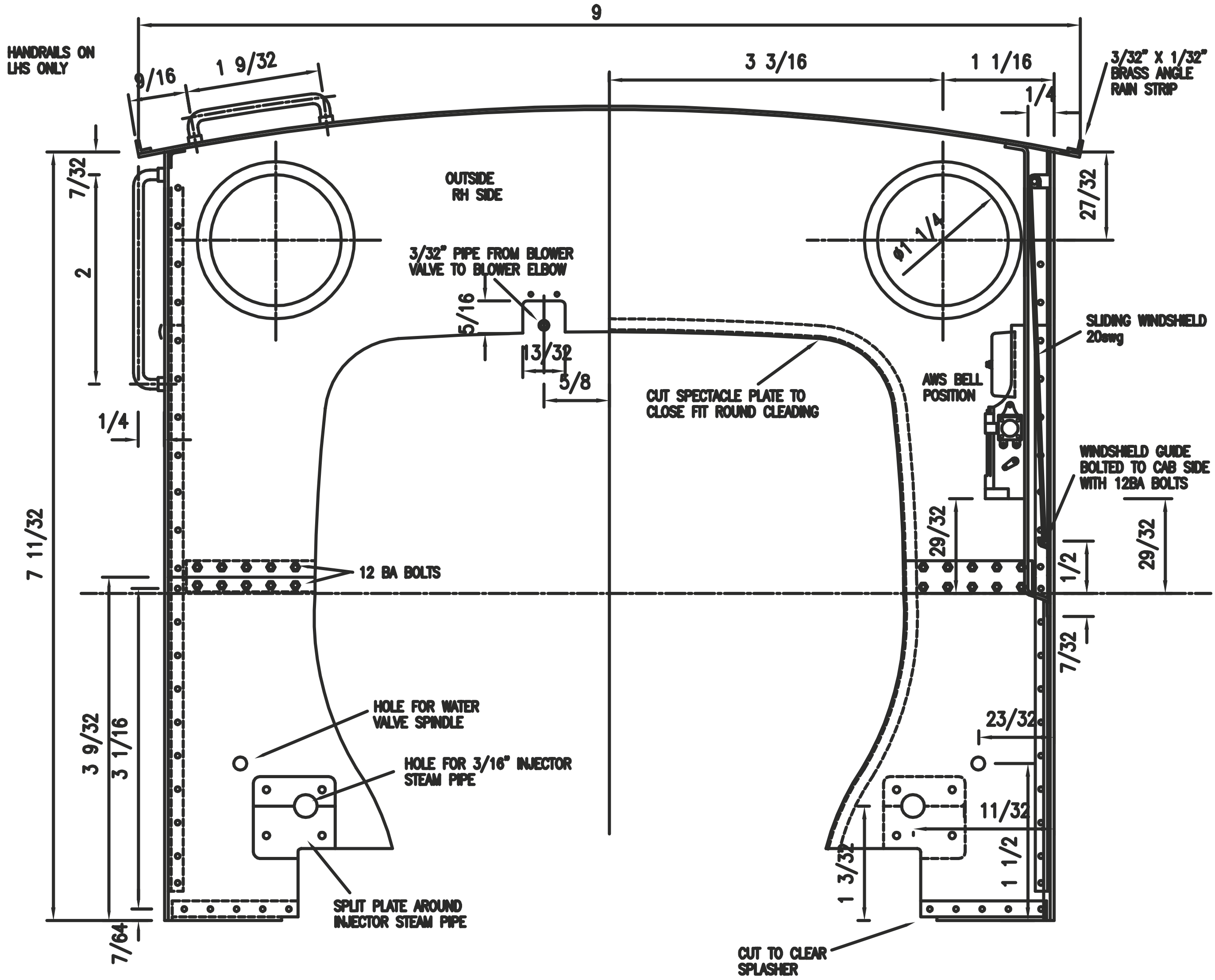
There are laser cut kits for all four engines and these include my two scale locomotives and the two different Pansys - and I am sure that there will be plenty of people still building those. Whichever one you choose to do they are both very nice little engines. If you chose to buy any of these kits I will be out of a job anyway.

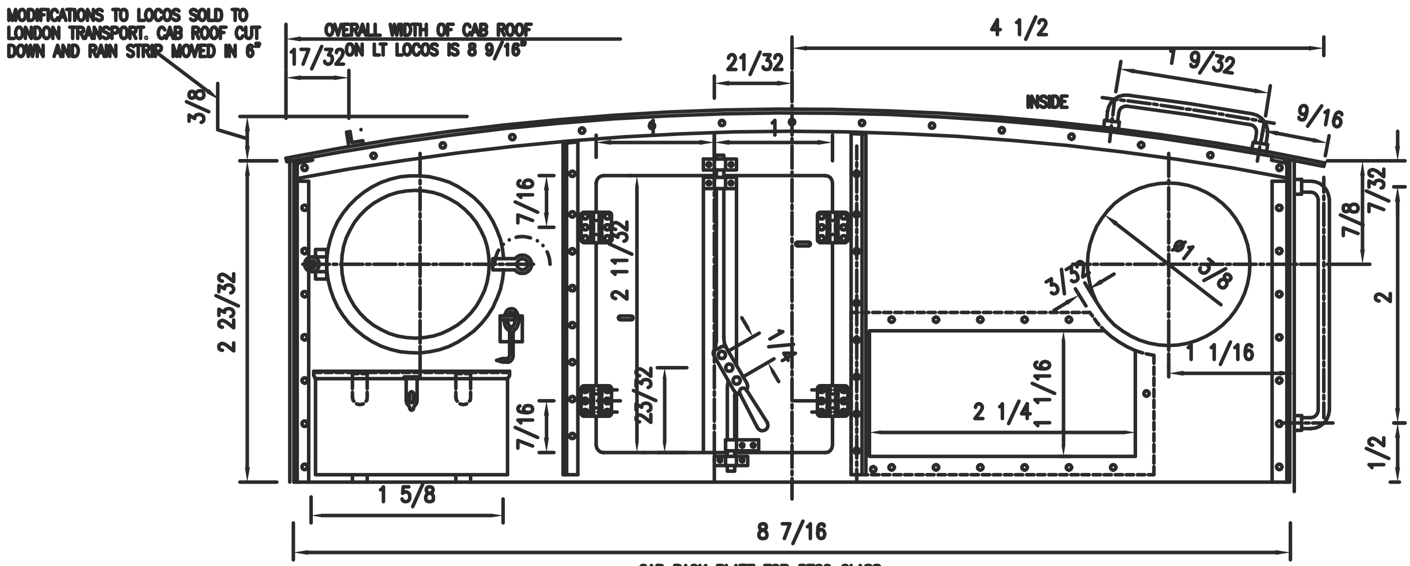
We have already dealt with the bunkers, so this is now just a matter of the front and rear spectacle plates for the two types of engine. I have made the laser cut plates to what I hope will be a good fit around the boiler but you will need to fit a surround to the firebox from ⅛ x ⅛ brass angle, similarly for the $^{3}/_{32}$ brass angle for the roof rain strips. This is available from Eileen's Emporium (www.eileensemporium.com) but you must anneal it before you try bending it round the firebox. This is fixed to the cab front sheet and not to the firebox. **Photograph 278** is a good view of one of the Panniers with this type of cab on it. Note how the sides have been clipped off as this engine was one of the London Underground locomotives and was made to fit in the tunnels; similarly with L99 for which Guy Harding has also supplied photos.

When it comes to making and fitting the windows for the front and rear of the cab, there is, first of all, a steel ring which is riveted into the front of the cab spectacle plate. It is

279

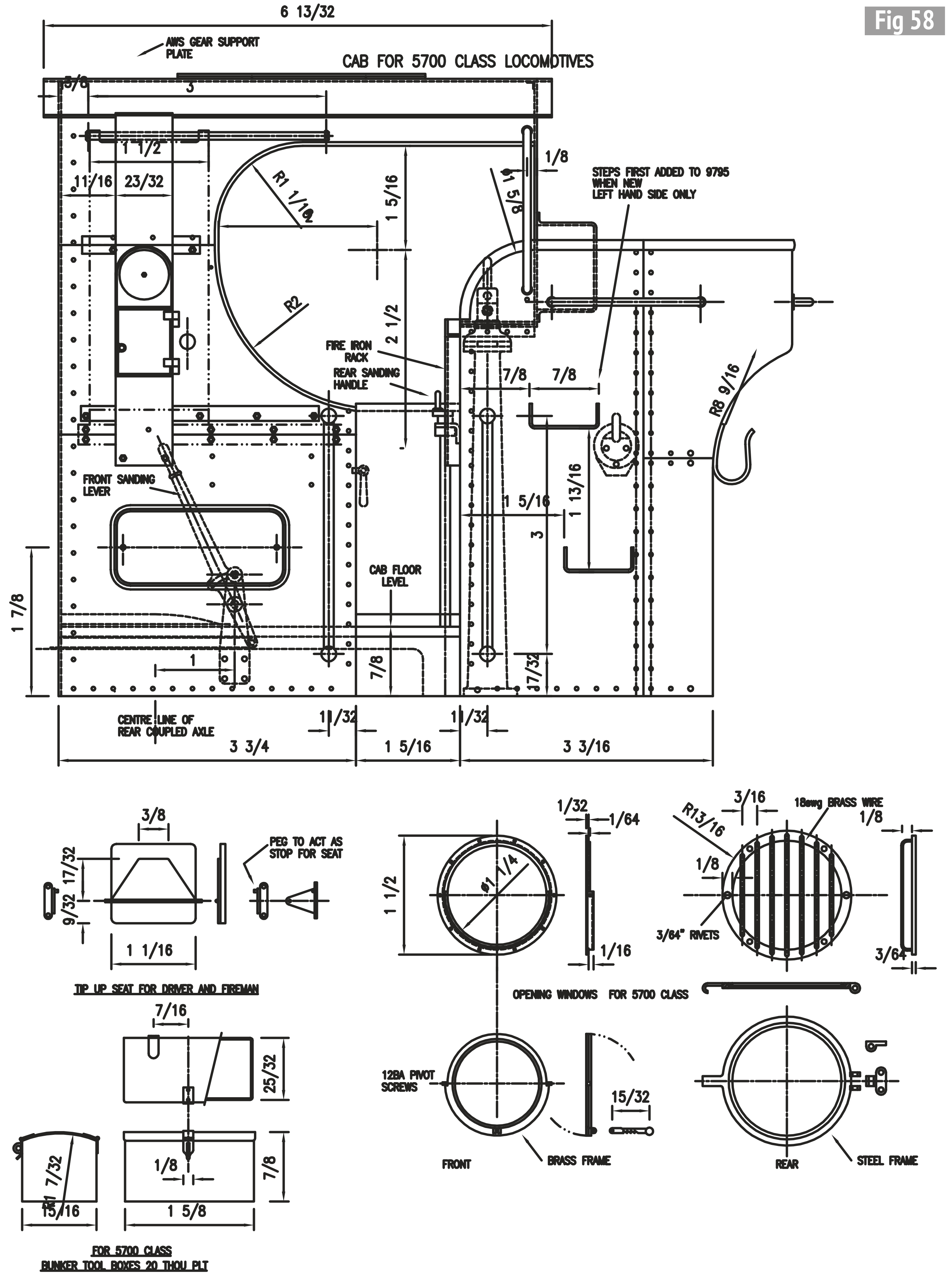
Interior view of the cab window frame.





CAB BACK PLATE FOR 5700 CLASS

Fig 58


CAB FOR 5700 CLASS LOCOMOTIVES
6 13/32
AWS GEAR SUPPORT PLATE
STEPS FIRST ADDED TO 9795 WHEN NEW LEFT HAND SIDE ONLY
FIRE IRON RACK
REAR SANDING HANDLE
FRONT SANDING LEVER
CAB FLOOR LEVEL
CENTRE LINE OF REAR COUPLED AXLE
3 3/4
1 5/16
3 3/16
R1 1/16
R2
R8 9/16
TIP UP SEAT FOR DRIVER AND FIREMAN
PEG TO ACT AS STOP FOR SEAT
OPENING WINDOWS FOR 5700 CLASS
18swg BRASS WIRE
3/64" RIVETS
R13/16
12BA PIVOT SCREWS
FRONT
BRASS FRAME
REAR
STEEL FRAME
FOR 5700 CLASS
BUNKER TOOL BOXES 20 THOU PLT

$1\frac{1}{2}$ inch external diameter, $1\frac{1}{16}$ inch internal and $\frac{1}{32}$ inch thick. These rings are riveted flush to the front and rear plates with 8 rivets countersunk inside and out. **Photograph 279** shows this as best I can. **Photograph 280** is the brass frame with the opening light and the little stay at the bottom to hold it open. **Photograph 281** is 5764 on the Severn Valley Railway which also shows the window open and once again, being a LT locomotive, it also has the roof clipped off at both sides. **Photograph 282** shows the roof of the pannier tank to good effect and shows how the hatch opens sideways. There is also a good view of all the rivet detail with the different size rivets. **Photograph 283** shows the rear left hand window and with all the scrapes and battered window bars it is good the see why they were needed. This is also why the window opens inwards but note that it is mounted at right angles to those on the front. **Photograph 284** shows the cab window on 5764 and it is similarly battered but not quite so badly as that in the previous photo - but notice how this one has only six rivets to fix it, as the top and bottom ones are missing because of the close spacing of the bars. **Photograph 285** shows the window hinged horizontally and the little catch on the inside to hold it shut. Now a word of warning here; just be careful with your 14BA taps for holding the two parts of the window frame together. What I can tell you is that for a 14BA tap you will need a 0.8 mm drill! However, do make sure that you clean out the glass rebate so that there is nothing in there that will cause the glass to break when you tighten up the screws. When I fitted the glass in one of my 2-6-4 tank front cab windows, I obviously didn't do this properly and there was a little tell-tale 'click' … and after cutting them dead to the correct size it was very annoying! **Photograph 286** shows the right-hand side draught screen which just slides back on the runners.

Showing how the cab window is hinged for opening.

Outside view of the open cab window on pannier tank 5764.

The hatch on the early cabs opens sideways.

This view shows why the rear windows have bars!

A slightly less battered rear window on pannier tank 5764.

The rear windows are hinged differently from the front windows.

The draught screen in the cab of pannier tank 5764.

The driver's seat in Frank's pannier.

The one thing left to do now is make the pair of cab seats (**photo 287**). These are just very simple, almost triangular little seats with a piece of $\frac{3}{32}$ tube silver soldered across. The photo was taken from a long way off (as you might have guessed from the quality!) and is of the seats made for Frank's engine. I am sure that he introduced a little coil spring into the mounting to keep them out of the way when not in use. The supports are just made from a fabrication of 20 swg mild steel and they are bolted to the cab sides with a couple of 10BA bolts.

●To be continued.

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■ 5 inch gauge 0 6 0 Simplex with riding trolly, ground level and raised track. Transport box for loco included. Boiler - Western Steam. Hydraulic 10th April 2025. Steam 10th June 2022. Photos available. £3250. **T. 01638 515363. Near Newmarket**.

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T. 01438 712585. Welwyn, Herts.

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■ Four unmachined cast iron Sweet Pea tender wheels and a block of un machined cast iron (5"x2"x1") to make Sweet Pea tender axle boxes. £80. **T. 07920 8335446. Didcot, Oxfordshire**.

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■ Cowells Model CW90 lathe. Must be in first class condition with accessories.
T. 01522 722374. Lincoln.

■ Manual for Myford Super 7 serial number SK9435 (mid 50s, I think). New to model engineering. Photocopy would suffice. All expenses paid.
T. 087 2275266. Portlaoise, Ireland.

■ Instruction booklet for Sussex Steam Co's James Watt model beam engine. I can return it.
T. 0161 368 2840. Manchester.

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A Working Van de Graaff Generator

PART 2

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

Continued from p.283
M.E. 4671, 13 August 2021

Lower column support

Dimensions for this are given in **fig 1.**

The height of the driven shaft is determined by the choice of driving motor and so this dimension (37mm) must be altered to suit your motor if it is desired to keep the two shafts at equal heights above the baseplate. The Tufnol 78mm x 130mm blanks were cut from sheet material and the edges finished to size with a ¾ inch end mill. Tufnol consists of resin impregnated cloth or paper and my sample was the paper variety. It is particularly important with this type of material that cutting be carried out parallel to the laminations of paper (e.g. when milling the edges of the blanks to size). Otherwise, the material is prone to chipping at the edges.

Opposing sides were clamped together and all holes, present in common, drilled and, in the case of the holes for the ball bearings, bored after a starter drilling was achieved. The Tufnol 'box' was then assembled and the recess for the Perspex column carefully bored as shown in **photo 7**.

Boring out the recess for the Perspex column.

Fine cuts were taken (0.5mm) and the boring head was lowered slowly many times until the 20mm deep boring at 2.5 inches diameter was achieved. It was unfortunate that the boring head was a 2MT tool and the mill had a 3MT spindle, hence the need for a Morse taper converter as shown in the photograph. It would have been better not to have the boring head overhung as a result of this.

With the box complete, and before final assembly with 4BA brass cheesehead screws (recessed), the 20mm x ¼ inch Tufnol strip was attached with its lower edge 40mm from the lower edge of the base. On top of this strip, a brass strip (¼ inch x 50mm) was secured by two 6BA brass screws 5mm from each end. This, in turn, clamped both the gauze comb and a copper shim which was bent at right angles and held by the terminal post 4BA screw on the side of the box. The exact design of the terminal post is not, of course, critical. Mine was from the scrap box.

The column

This was a 200mm length of 2½ inch diameter Perspex tube with a wall thickness of ¼ inch. It was retained in the base by four nylon 2BA countersunk screws centred on each side as shown in **fig 2**. It should be noted that the column length depends on the length of the belt selected.

The Van de Graaff generator.

The silicone rubber that I used is not very elastic and so the column length was quite critical in my case.

The upper bearing support

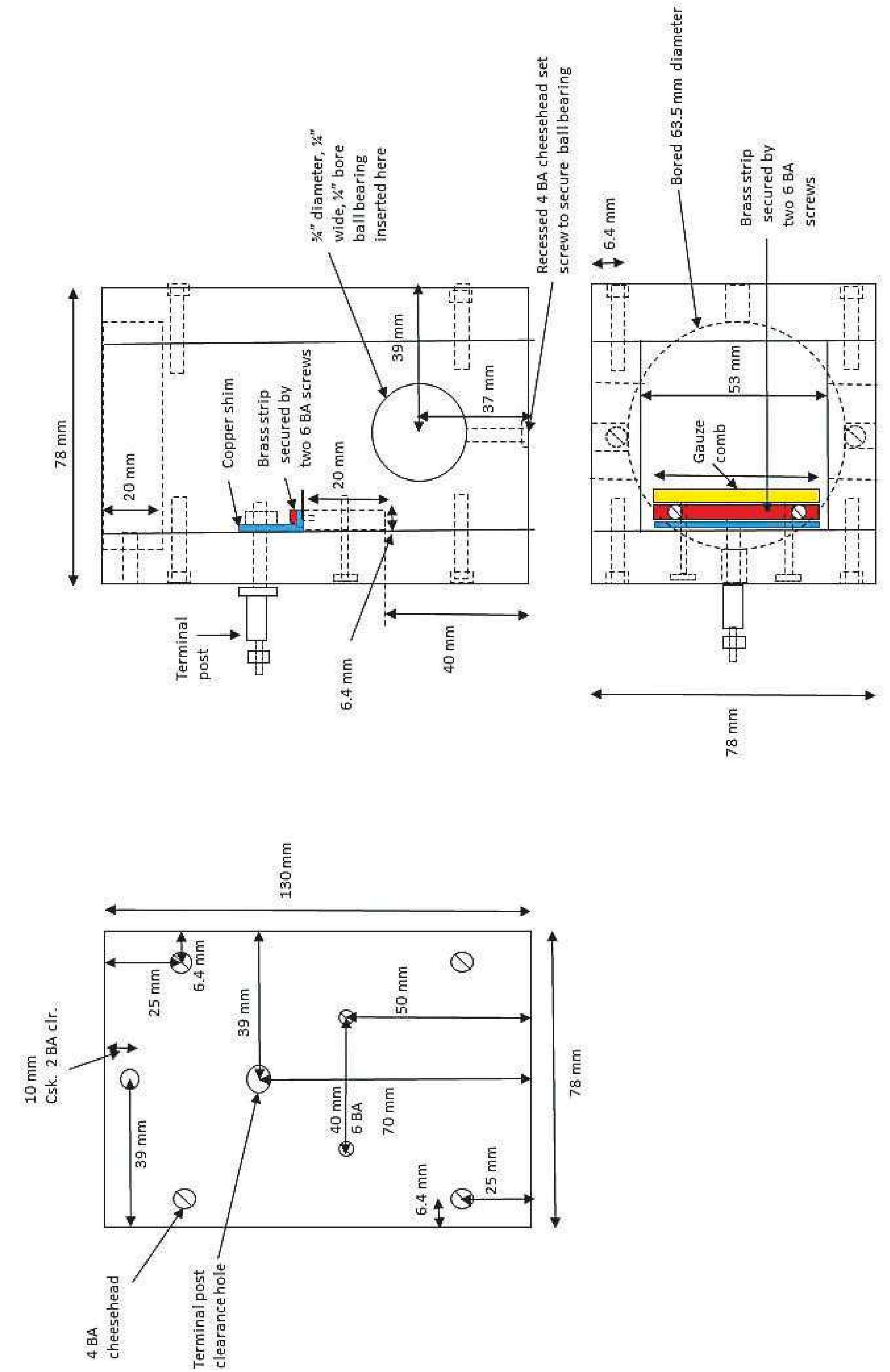
The dimensions are shown in fig 2.

The two 300 x 50mm sides in ½ inch Tufnol were finished as for the base unit. The lower edge of each side was rebated 2mm deep and 12mm high. The inner rebate acted as a location for the aluminium base ring that attaches this unit to the column. The outer rebate was part of the clearance required for the lower, copper hemisphere.

The aluminium ring was finished from a 30mm length cut from 2 inch square section HE30 alloy by turning in the four jaw chuck to face to size. The outer 15mm of this length was then turned to fit the inner diameter of the column (50mm). This was followed by boring the entire length at 45mm diameter in the lathe using a stout boring bar after an initial centre drilling followed by a ⅞ inch drill. All edges of the circular part were rounded.

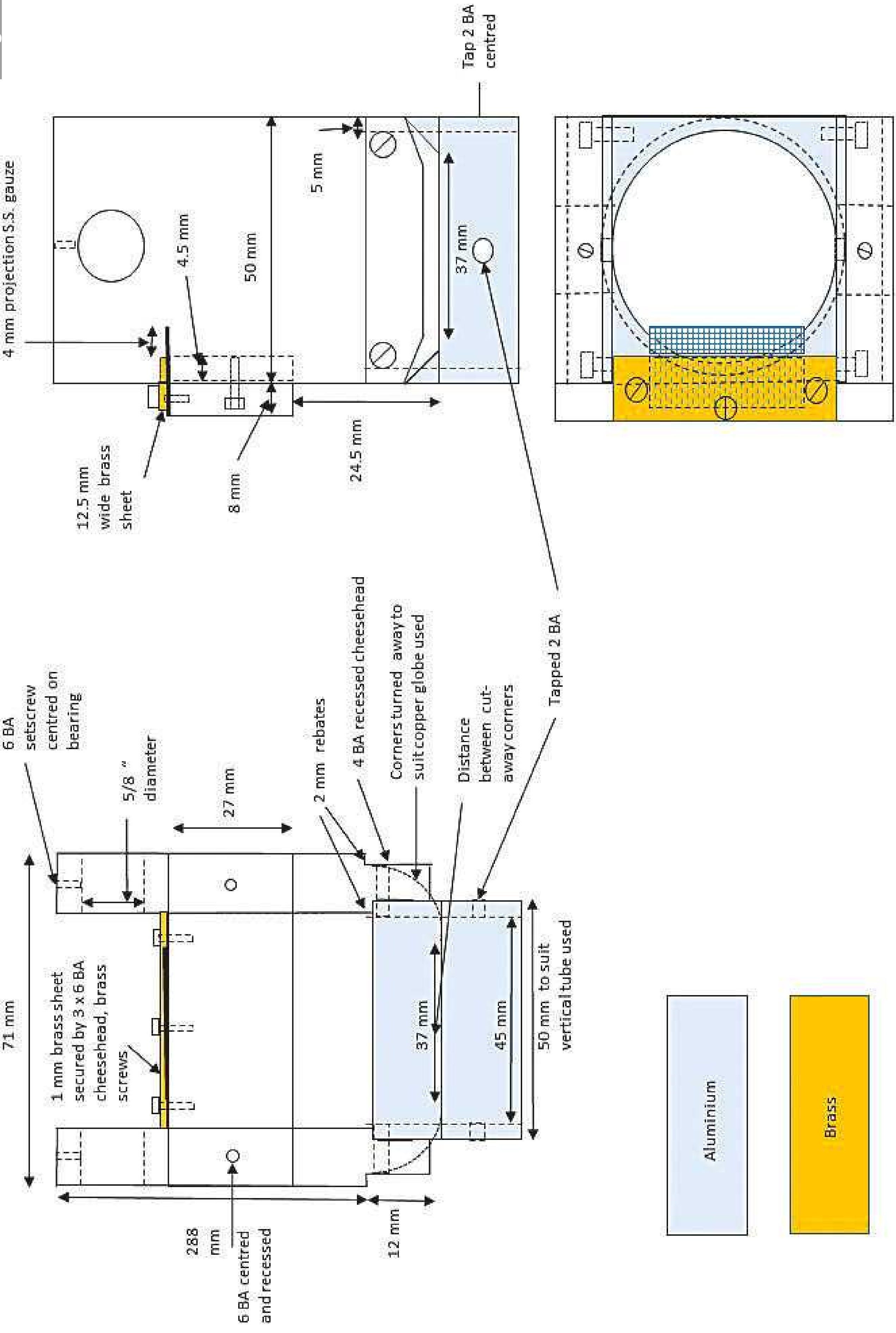
Each side was attached to the upper 12mm of the 2 inch square section of the aluminium ring by two, ⅜ inch 4BA brass cheesehead screws deeply recessed such that the top of the head of the screw was 3mm from the Tufnol

Fig 1



Lower column support.

Fig 2



Upper bearing support.

8

The lower copper hemisphere.

9

The lower shaft assembly.

surface in the rebate. This was necessary to clear the copper hemisphere. The rebate helped to keep things square.

A 27mm width of the ½ inch Tufnol was finished at 71mm in length by milling and then rebated 4.5mm deep across the width by ½ inch. This was secured to the sides by two 6BA brass cheesehead screws with its lower edge 24.5mm from the lower edges of the sides and, again, the rebates helped to keep the assembly square and the sides parallel.

This piece was topped with a ½ inch x 46mm brass plate 1mm thick held by three 6BA brass cheeshead screws. This acted as a clamp for the gauze upper comb. However, in order to totally clear the inner surface of the lower copper hemisphere, it was necessary to hold the entire assembly (minus comb and clamp) in the three jaw chuck and turn the composite Tufnol and aluminium corners away leaving a 37mm straight length on the lower edge of the 2 inch square part of the aluminium. This left 4.3mm of the shoulder between the square and circular part of the aluminium. It was this shoulder that would hold the lower copper hemisphere against the top of the column. It was prevented from rotating simply by the copper shim soldered to it and held in the comb clamp.

The upper bearing support assembly was secured to the column with two 2BA nylon countersunk screws tapped into the aluminium ring (see fig 2). The ball bearings were ⅝ inch outside diameter this time, purely because that was all I had in stock.

The copper sphere

No further fixing was required for the lower copper hemisphere, which was bored out to 50mm diameter using fine jeweller's snips after marking out round the bushing which originally held the brass rod when it was part of a ballcock **(photo 8).** This ensured that the hole was truly centred on the hemisphere. The copper shim, soft-soldered to the hemisphere, is also shown. The upper copper hemisphere required no treatment (other than a good polish, which applied to the entire sphere) and it was clipped on to the lower hemisphere by its original seam. The two hemispheres were secured by 19mm wide brown PVC insulating tape.

The lower shaft assembly

This is shown in **photo 9**.

The lower shaft was the driven shaft and was made from 103mm of ¼ inch silver steel, mounted in ¾ inch ball bearings ¼ inch wide. The lower pulley was made from Tufnol (the cloth impregnated variety this time) and was 34mm wide not including the boss which is 7mm wide and fitted with a 6BA Allen set screw.

The pulley was turned with a 'crown' which served to keep the belt centred on the pulley in traditional fashion, the diameter varying from 24mm at the sides and 25mm in the centre. The shaft was also furnished with 12.5mm long brass spacers (8mm outside diameter), placed either side of the bearing next to the gear, ensuring that the pulley was centrally placed between the bearings which are located, with the setscrews centrally in the Tufnol supports.

> Tufnol consists of resin impregnated cloth or paper and my sample was the paper variety. It is particularly important with this type of material that cutting be carried out parallel to the laminations of paper.

The gear was turned from brass and was cut in the milling machine following the procedures laid down in Ivan Law's book (*Gears and Gear Cutting*, Ivan Law, Argus Books, 1993). It was also secured with a 6BA Allen setscrew. Where set screws were used, a small flat was filed on the shaft, to avoid the setting up of burrs which make the removal of pulley and gear difficult.

The upper shaft assembly

This is shown in **photo 10.**

As for the lower shaft assembly, the shaft was made from 78mm of ¼ inch diameter silver steel. The pulley was made of aluminium HE30 alloy of uniform diameter (25.4mm) and 36mm wide with additionally, a 7mm wide boss fitted with a 6BA Allen setscrew. Brass spacers (10mm and 3mm long) also ensured central positioning of the pulley relative to the ⅝ inch outside diameter ball bearings held in place by the setscrews in the Tufnol supports.

●To be continued.

10

The upper shaft assembly.

We Visit the Brighouse & Halifax Model Engineers

John Arrowsmith's next stop in Yorkshire is at Ravensprings Park.

My visit to Ravensprings Park, home of the Brighouse and Halifax Model Engineers, was another interesting and very pleasant visit. Chairman, David Firth showed me round a very well established and complex site with so many things to see. I think the first thing that strikes you is the location which is in the upper part of the town so that there are views across the landscape on one side and built-up areas on the others. Tucked into this space the railway has lots to offer both passengers and drivers.

The club was first formed in 1932 when a group of local, likeminded men decided that they needed somewhere to enjoy their hobby of model engineering. Eighty eight years ago this was quite a novel idea with one of the group, a Mr. Douglas Miller offering his works as a place where they could meet to discuss their hobby. Some of the group are believed to have won prizes at different model shows held in Halifax and Huddersfield at the time. This level of activity continued until 1939 when the Second World War severely restricted their pursuits.

A very nice club house overlooks the large picnic area inside the raised track.

Ravensprings Low Level Station.

The club re-established itself in 1948 when Mr. Miller offered them a piece of land on which to build a permanent track and club house. This was duly taken up and a raised track of 3½ and 5 inch gauge about 600 feet long was built using old railway sleepers as the longitudinal bearers between concrete posts with aluminium section used for the rails. This track lasted for around 40 years before being rebuilt. Locomotives at the time were mostly 3½ inch gauge but Mr. Miller started building a 7¼ inch gauge Duchess so a 7¼ inch gauge ground level track came next, built around the outside of the raised track. David told me that this locomotive, which was built in the 1930s, is still in existence today which means it must have been a first class build to have lasted this long. As was the norm in those days, a portable track was built to use at various fêtes and galas in order to raise funds for the club. Public running on the permanent tracks started when the members were happy that the site was safe and ready for the public. There was a charge of three old pence (3d) for admission and another 3d for a ride.

In addition to the railway, the club built a boating pond in the middle of their site so that local children could sail their boats during the open days. This too was very successful until, of course radio-controlled boats started to be used and they needed more water for their operation. The demise of the pond came when it developed a serious leak which would have been too expensive to repair so it was demolished and the ground returned to normal. 1966 was a momentous year for the club because the freehold of the site was offered to them by Mr. Miller and was duly accepted, thereby affording them their future security. These days they consider themselves to be very fortunate in having the security of tenure that owning your own site brings. The raised track has been re-built about three times over the years and has now been fitted with plastic

3

The substantial turntable on the raised track.

4

The very large 7¼ inch gauge American articulated Y6B Mallet 2-8-8-2 locomotive.

5

Another American locomotive was this 2-8-0 shunting engine.

6

Chairman, David Firth built this excellent example of an A1 Class 4-6-2 LNER Pacific.

7

A very nice Hunslet 0-4-0 on shed.

sleepers; the ground level track has been extended to over 1000 feet. This is how I found it for my visit.

This well established club has a superb site in Brighouse and I was impressed both with the complex track layout and the number of high security buildings they have for operational and storage uses. Every bit of space that can be usefully used has been … and this provides the members with a super set-up. At the moment, work is ongoing to improve the unloading facilities for the raised track. As it stands members have to cross the central grassed area to get to the unloading area and in poor weather conditions this makes it difficult, so a new two ton lifting platform is being installed which will eradicate the problem. The raised track also has excellent locomotive servicing facilities with a substantial turntable (**photo 3**) and traverser along with ample steaming bays. The storage facilities are excellent and with some very large locomotives they are really secure. For example, the biggest steam locomotive on site is a 7¼ inch gauge American Y 6 B class articulated 2-8-8-2 the original of which was part of a class of 30 Mallet locomotives built for the Norfolk and Western Railroad and were used for freight duties. In 1959 this locomotive hauled a ‘Farewell to Steam’ excursion before being scrapped (**photo 4**).

On the adjacent track another American, a 2-8-0 shunting engine, showed just how big these locomotives are for such mundane duties (**photo 5**). Stored alongside these American giants a superb example of an LNER A1 class Pacific, *Hal O The Wynd* (**photo 6**) was built by chairman David Firth using scaled up 5 inch gauge drawings along with Doncaster drawings. The loading gauge difference between the three locomotives was quite striking.

The 7¼ inch gauge Hunslet (**photo 7**) in the same shed was another excellent model of this popular locomotive. I mentioned above the storage facilities at Brighouse and I was again surprised when David showed me what I can

≫

The hydraulic lift and traverser in the storage locker room.

One of the secure storage sheds on site.

Impressive facilities include this large turntable and two large engine sheds.

The complex departure side of the main station.

only call the 'locomotive locker room', a dedicated space with a double row of steel faced lockers each holding 3½ inch and 5 inch gauge locomotives. The bay was serviced with a hydraulic hoist (**photo 8**) so the locomotives can be pulled from each cabinet onto the hoist and then positioned to leave the shed for the steaming bays. I have not seen a facility of this size at any other club except the Isle of Wight which has a small storage section like this. One of my photos (**photo 9**) shows a secure four road engine shed on the low level part of the track; adjacent to it is another locomotive shed on the higher level which is serviced with a traverser. This shed was built onto the ground retaining wall which is part of the four road shed and, with an extra side wall and roof, they have yet another storage shed. These, of course, are in addition to the other ten and four road sheds located by the main turntable (**photo 10**). I don't think I have ever been to a club site that has such great facilities for members to store and service their engines. Also incorporated into the layout are a couple of large carriage sheds which can house about 24 carriages.

Carrying on round the track there are some interesting track formations to provide plenty of interest for both drivers and passengers, all built to an excellent standard (**photos 11**). The new Kitson tunnel (**photo 12**) built in 2017 as a memorial to a long standing member, Keith Kitson who unfortunately passed away after suffering with motor neurone disease, has traditional stone portals built into an almost Gothic Arch shape and was built entirely by members. The materials list makes for impressive reading: 56 cubic metres of concrete and 4500 nine inch

This well established club has a superb site in Brighouse and I was impressed both with the complex track layout and the number of high security buildings they have for operational and storage uses.

The new Kitson Tunnel portal.

solid building blocks with the top two courses being hollow to take the reinforcing bars. The roof consists of 50, thirty ton Bison beams topped off with 12 inches of reinforced concrete. It has supported a 38 ton lorry that was visiting the site without any problems. The appearance of the tunnel at each end belies the tremendous amount of work and materials that have gone into its construction. It was a most impressive structure. It was built alongside the original tunnel which was a bit too narrow for the larger engines. This old tunnel was not discarded, it is (of course) yet another storage area! The thing that fooled me was the secure doors which are covered in a vinyl print that looks like a tunnel entrance; in fact, it is a photograph of the other end before it was blocked off.

The club have six or seven young members and David said they were all keen on being part of the railway. This is always an encouraging sign and I hope they maintain their interest. On the raised track a couple of members had steamed up an extended Simplex with a 2-6-2 wheel arrangement (**photo 13**). It was going very well and I enjoyed a ride round the track with the driver. I was struck by how well it rode; obviously built to a good standard. Whilst this was taking place another member arrived and retrieved his 5 inch Britannia from the storage lockers (**photos 14** and **15**) and started preparing for a run. I had a good chat with this member, Dennis Wainwright, who is currently building his twelfth locomotive, *Lion* in 5 inch gauge. He produced a list of locomotives he has either built or been involved with over his 40 years' or so membership and this totalled over 20. That is some build rate! The Britannia he was steaming has an interesting history having been built in 1975 by Cherry Models (**photo 16**) but only steamed in the last two years. It cost new £5950 but I expect today that sum would just about cover the boiler cost.

The club have six or seven young members and David said they were all keen on being part of the railway. This is always an encouraging sign and I hope they maintain their interest.

Dennis went on to tell me about a number of the other locomotives he has been involved with and this gentleman certainly has a good model engineering history. I do remember reporting on one of his fine engines at the Doncaster exhibition a couple of years ago.

To round off a very pleasant chat, Dennis produced a batch of freshly baked Eccles cakes he had made and very nice they were too! Apparently, he brings a different selection every time he attends, just for the lucky members at Brighouse.

That just about sums up my excellent time at this club and my thanks to David Firth and Dennis Wainwright, plus the other members I spoke to, for their information and, as usual, their good humour and friendship. This is certainly a club to visit if you are in the area; you will receive a warm welcome and have a very enjoyable experience.

ME

13

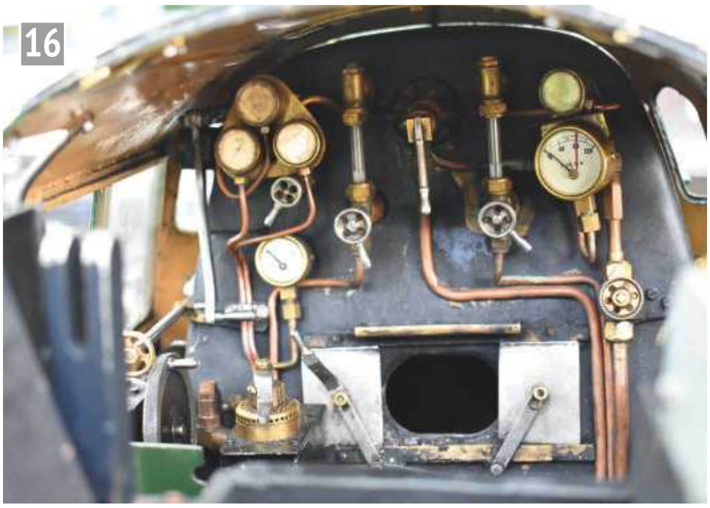
The extended Simplex 2-6-2 being steamed up on the steaming bay for the raised track.

14

Dennis Wainwright's Britannia emerges from the locker room.

15

The Cherry built Britannia on the steaming bay.



16

The workable cab layout on the Britannia.

Dome casting being shaped on the linisher.

The Belt and Disc Sander

A Useful Machine Tool for Model Engineers

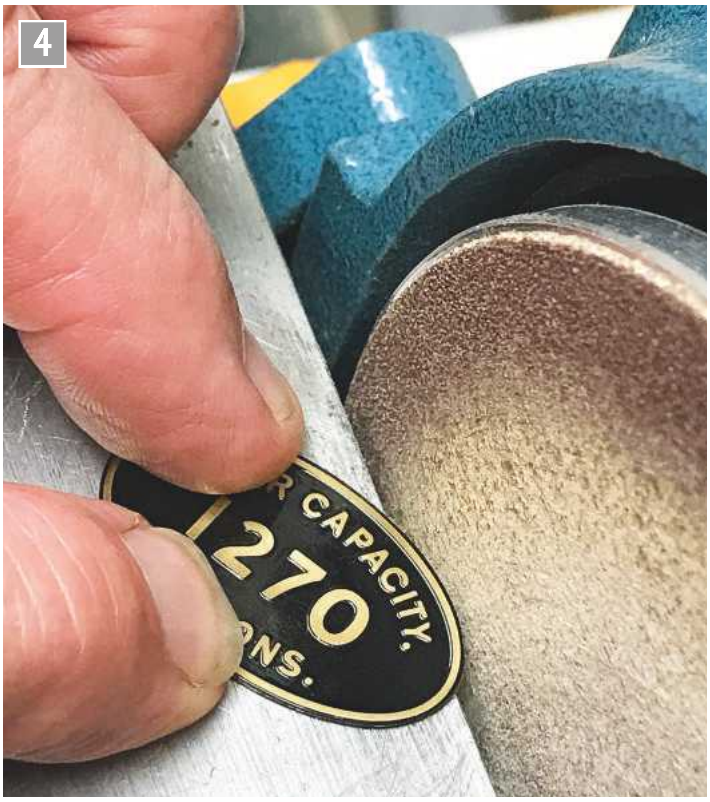
Tim Coles finds his new workshop gadget is a great time saver.

I was interested to read that Hotspur (M.E.4649, 9th October 2020) encountered a problem with hard spots in an iron dome casting. I had exactly the same issue, a year or so back, with a dome casting for my 7¼ inch gauge Jinty tank project.

The casting was quite accurate, having come from a 3D printed pattern, but the base flange needed some fettling. I was about to get the propane torch out from the garden shed to attempt to anneal the base flange when another idea occurred to me. Could my recently-acquired, brand new and shiny belt sander tackle the hard spots? A trial run quickly showed that the sander could not only deal with the hard spots but, with careful handling, could do most of the shaping needed to finish the casting (**photos 1 to 3).** This included the rounded base to fit the boiler barrel, so I didn't have to set up the lathe or mill for a tricky fly-cutting operation on the base radius. No special belts seemed to be needed as the standard belts that came with the machine coped nicely. Eye protection is mandatory of course, with such operations, and gloves are advised. Also, cover up any nearby machines to stop the abrasive grit getting into the works.

The belt sander, or 'linisher' as some call it, has provided a solution for a number of operations in the workshop. Like many of these machines,

Dome in place on the model.



Oval plate being shaped.

Link end being rounded off.

Wood strip shaped to 45-degree end.

mine combines a sanding disc with the belt, adding to the versatility. I used it most recently to profile the little etched brass makers plates and tank capacity plates, made for me by our own Diane Carney (usual disclaimer).

The plates were etched on a single sheet of brass and I had to make each one into a neat oval. Holding the thin material in the vice and filing wasn't going to work. Carefully offering the plates up to the disc sander worked well though (**photo 4**). A moderately-worn sanding disc made the job less touchy than a brand new and sharp disc. The only snag was that the plates got hot quickly, so limited sessions were necessary, continuously swapping a hot plate for a cold one! I couldn't really use gloves for this delicate operation, so caution was applied, and my fingers are all still intact - just as well for an occasional guitar player.

The sanding disc is also handy for jobs like rounding the ends of links, such as those found on brake gear and valve gear, in materials up to about ⅛ inch thick (**photo 5**). In addition, the protractor device supplied for the disc table makes it easy to cut set angle bevels across strip material, if required (**photo 6**).

Of course, the belt sander is not a high-precision machine tool but it is useful for a lot of work needing a cosmetic accuracy, rather than micrometer accuracy, and a particular example of this comes in the building of models such as wooden wagons. Following the teachings of 5 inch gauge scale railway guru, Doug Hewson, I have made a number of 5 inch gauge wooden wagons using ash, or ramin, for the chassis and individual hardwood planks for the bodies. In one madcap venture, I made six three-plank wagon bodies in a batch (**photo 7**). This required as many as seventy-two of some of the wooden bits!

My previous old belt sander, despite having no disc sander, still came in handy for bringing all these wood components to length, with a nice square end and no splintery bits. An adjustable fence fitted at one end of the belt made it possible to present the workpiece vertically down on the belt. As a matter of general interest, the Cliffdale Mining Company, named on the side of the wagon in the photograph, was owned by my great-grandfather, although the company did not actually own any railway wagons, as far as my historical research extends.

So, if your nearest and dearest don't know what to get you for Christmas/birthday/peace offering, I can recommend a combined belt and disc sander, as a useful and relatively inexpensive addition to any workshop.

ME

Red 'Cliffdale' wagon.

The Barclay Well Tanks of the Great War

PART 78

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

Continued from p.223
M.E. 4670, 30 July 2021

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

The boiler and its fittings

At this stage, the difficult task of designing the boiler would normally be undertaken but, fortunately for me, the basic boiler design (based on the 0-4-0) has already been done. I should perhaps reiterate that the steam dome for the 0-6-0 is squatter and it sits further forward on the barrel; see figs 213 and 214 (M.E. 4650) .

The construction of the boiler for the 0-4-0 was addressed in the following Model Engineer magazines:

ME 4579 – 2nd February 2018
ME 4582 – 16th March 2018
ME 4584 – 13th April 2018
ME 4586 – 11th May 2018

In ME 4650, 23 October 2020, the boiler drawing was updated and dimensions of the two domes clarified. Some corrections were dealt with and a new drawing presented for the firebox tubeplate.

And so all that is needed here is to deal with the boiler fittings.

WD lifting hooks

One unusual feature of these utility engines was the fitting of lifting hooks to the front and rear of the boiler/smokebox. This strange lifting arrangement consisted of a pair of handed hooks fitted to the smokebox with a similar pair fitted to the Belpaire firebox. These would most likely have been made of mild steel fashioned in the blacksmith shop.

If the rear hooks are tapped 4BA they can be attached via the boiler cladding and, therefore, will not require screwing into the copper firebox.

The original steel boiler barrel, of course, was integral with the smokebox, making it safe to lift the boiler (and possibly, the locomotive) at these points. For our purposes, however, lifting in this fashion would definitely not be a safe procedure, with a completed locomotive weighing some 80 kilos and a separate smokebox!

The most obvious application for the prototype engines would be that these hooks provided a convenient means of lifting the engines onto ships for transport to France/Belgium; either across the English Channel from Dover or directly from nearby docks such as Glasgow or Liverpool. If this were the case, however, provision would have had to be made to securely fix the boiler firebox and smokebox to the frame. They may, of course, have been simply for lifting the boiler from the frame during heavy maintenance. In fact, the more I think about it the more confused I get…

Once these engines were in service, large lifting frames were used at maintenance depots, where the hooks would have been useful for jobs such as rerailing, boiler removal etc.

Only two variants of the 60 cm gauge 'shunting' locomotive were supplied to the WDLR. The bulk of these was provided by Hudson Ltd. of Leeds (**photo 308**), although construction was undertaken by Hudswell Clarke and Co. Ltd. However, the 25 engines to similar specification built by Andrew Barclay seem to be the only ones that had these hooks. I've searched all my reference material and have concluded that the 'Hudsons' were 'hookless' for want of a better word.

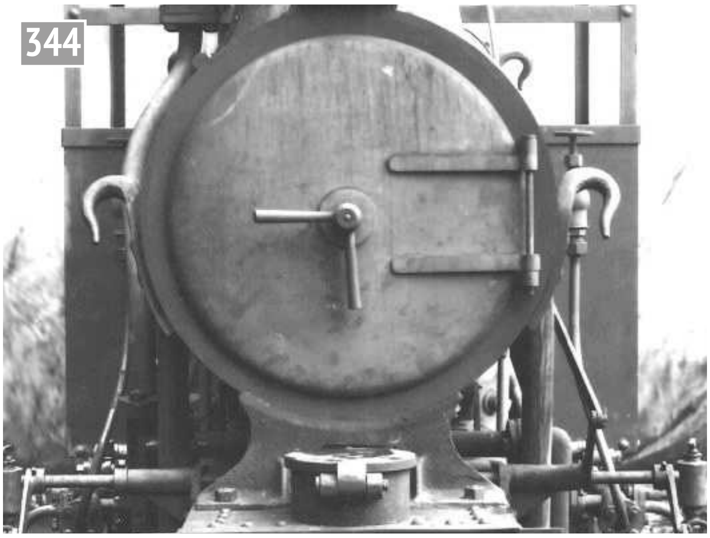
In 1977, the Narrow Gauge Railway Society published comprehensive listings of the Hudson's (**ref 69**) and back issues of their quarterly magazines can be viewed on the Internet. The centre page of their magazine No. 75 from 1977 provides an excellent general arrangement of a Hudswell/Hudson locomotive and with a bit of imagination much of the current series would be applicable to building a Hudson. One particular feature, the lack of a Belpaire firebox, would provide significant simplification with the boiler work - but good luck with those 'sticky out' cylinders!

The Barclay engines present us with a dilemma. These hooks are such a prominent feature that they have to be fitted, but there is no way they can be used as they stand. **Photograph 344** shows just how prominent the front hooks are and offers a glimpse of the rear hooks. It would be possible to extend the rear, Belpaire hooks under the cleading where the ends could be bolted to the frame. The front end would be more difficult unless the smokebox to barrel joint and the smokebox saddle fixings were substantially made - using high tensile steel bolts for example.

Photographs 345 and **346** are close-up views of the front and rear hooks taken from an original works photograph. In photo 344 the three rivets that fix the hooks to the smokebox are obvious, but note that the top rivet is countersunk so that the head does not reduce clearance for attaching the slinging gear. Also visible on the left of the photo is the right-hand exhaust pipe and some of the bolts that fix the plates sealing the pipes in place on the smokebox barrel.

As can be seen in photos 344 and 345, all four lifting hooks are similar but the smokebox mounting extensions will require slight bending to suit the smokebox radius. Note that they appear to be angled towards a central lifting point. In photo 345, screwed lagging plates cover the fixings for the firebox hooks, which sit next to a manhole opening. This manhole is not replicated on the model as it would serve no useful function. Barclay tracing number 40029 shows that they were fitted each side of the firebox. These could however, be represented by a suitable cut-out in the Belpaire lagging box.

Note that if the idea of extending the rear hooks to bolt into the frame is adopted, the rear hook brackets will need to be much longer.



Front lifting hooks (Author's Collection)

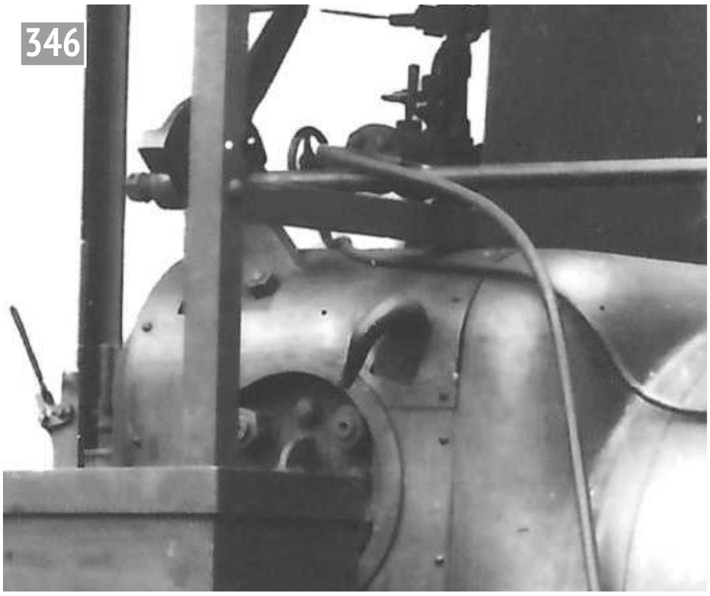
Front lifting hooks close-up. (Author's Collection.)

Constructing the hooks

Handed pairs are required but these are not easy to make by the usual means. It would be possible to make patterns and cast them in steel – I say steel and not iron because cast iron is weak when used in tension. Additionally, expense would probably be excessive. So now's the chance to exercise those blacksmithing skills using pieces of mild steel bar!

Start with pieces of $\frac{3}{16}$ x ½ inch steel flat about a foot long, hot forge about 2 inches of one end to a point and then bend up red hot over the horn of a small anvil. Carry on 'eatin', a-beatin' an' a-bashin' until the shape of all four hooks looks close to that shown in the photos. Once this is achieved the unforged ends (i.e. the bolting brackets) can be finished off using more conventional means.

●To be continued.



Rear lifting hooks close-up. (Author's Collection.)

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69. The Narrow Gauge Railway Society: *The Narrow Gauge* No. 75, Summer 1977. Available to view on their web site: www.ngrs.org

POSTBAG

Minimills

Dear Martin,
Guilty as charged, yer honour! With reference to Mr. Dave Cox's letter to Postbag (M.E.4665, 21st May 2021) I have to agree with him that I was harsh in my criticisms of the SIEG-type Micro Mill (*Trials and Tribulations with a Mini Mill*, M.E.4654 and M.E.4656, January 2021).

When my machine stripped its nylon gears, not long after purchase, I replaced them with a USA-sourced, belt drive system and it ran on for many years without problems. In fact, it was much easier to use than my Myford-Rodney set-up. The straw that broke the camel's back, however, was when the 'electronics' burnt out and I realised a new control unit was required.

As I live in the south of Spain, out in the 'sticks' and well away from the *Costas*, I have to practise a policy of 'make do and mend' - I can't just pop down to the local Machine Mart because there isn't one! And so, the idea of replacing the DC motor and its complicated electronics was born. However, my solution (even though it functions well) is quite noisy and, having revisited the design, I realise I could have omitted the gears and connected the motor directly to the belt drive. Hindsight of course is a wonderful thing. So, forget 'back to basics', it's time for me to get 'back to the drawing board'!

I note that the currently available SIEG SX2 mill is supplied with a toothed belt drive, thereby eliminating the gearbox and its delicate nylon gears.

Sincerely, Terry Holland (Malaga, Spain)

Weldments

Dear Martin,
In the Postbag pages of M.E.4614 (June 2020) there was some comment on heat treatment of weldments by Jeremy Buck and Robert Walker. I am - from industrial experience - able to offer the following comments that some model engineers may find of interest.

From my reading of *Model Engineer* over several decades, electric arc welding has not really featured as a method of joining parts together to manufacture an item, part or assembly. For this, usually silver soldering has been the normal process. Apart from a locomotive boiler made from steel - that must be welded - there are few other parts that a model engineer would weld ('welding' here means any process using electric arc such as stick, MIG and TIG) and subsequent heat treatment in probability wouldn't be needed or happen.

Welding has given the industrial designer considerable flexibility in designing weldments such as base plates for electric motor and gear reducer base plates, electric motor and industrial pump base plates and the like. Having spent over 20 years as a mechanical designer in a newsprint mill, we as designers used hot rolled shapes such as universal beams, universal columns, channels and angles in conjunction with various plate thicknesses to position the pump or gear reducer in respect to the drive motor in two planes. These bases were never stress relieved by heat soaking or any other method.

On a motor/pump base, only those surfaces where the motor and pump were mounted would be machined flat with usually a plus tolerance - could be plus 0.5mm - on the height difference between the motor and pump. The pump is fixed to the base and the motor shimmed to suit. In days of old the coupling alignment was done with a 300mm (back in my workshop days, 12 inch) steel rule, feeler gauges and possibly a dial indicator. Nowadays laser alignment is used which has led to an increase in the life of the bearings in both the motor and pump or even in the gear reducers. The sorts of motor we are talking about here are four pole rated at several tens of kilowatts.

A weldment - whether it is to be machined or not - will have induced stresses due to shrinkage caused by the welding process. There are several ways of relieving these stresses in the weld region - peening by a hammer, shot peening (possibly in a wheel abrator chamber) or by heating in a controlled environment - usually the more common method. In structural fabrication work, it is not usually required to do any sort of stress relief as the design codes give the necessary guidelines in calculating the maximum allowable stresses and it would be prohibitive in cost and practicality.

For weldments that are to be machined, in my experience, stress relief didn't occur too often and this would cause problems, viz. movement or distortion and hard areas.

The movement/distortion would come about as the outer 'skin' was broken by the cutting action relieving the stresses - other residual stresses would take over and movement would take place, albeit small, measured in decimal places of a millimetre. The hardness would be in the areas of the heat affected zone. A machined surface would show a bright shiny surface at the edge of the weld where it joins the parent material. This - depending on the material and weld process and filler material - can blunt a newly sharpened HSS cutter in no time. Even machining with modern inserted tip cutters, they can have their life shortened when machining in this weld area. The heat affected zone can be hard enough to push the cutter off leaving a slight ridge that can be detected by your fingertips.

One trick in machining a weldment that has not been stressed relieved is to rough machine all over where required leaving an allowance for final light machining of all the surfaces with a freshly sharpened HSS cutter or with new inserted tips.

Important weldments are most likely to be stress relieved by heat treatment in a

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controlled environment. This normalises the weldment so that when machining takes place, there is no distortion due residual stresses and the hardness of the heat affected zone has been removed making machining easier.

Working for my last employer - best job I ever had - we built three steel locomotive boilers for 0-4-2 by 1067mm (3 foot 6 inch) gauge rack adhesion locomotives. The boilers were designed by the Ffestiniog CME for us to the Australian Standard Boiler Code AS 1228. These boilers weighed less than four tonnes - the cranes in our fabrication part were rated as four tonnes - and were built with square corners between the back plate and firebox wrapper and also with the throat plate. The first boiler has been in service for 21 years and the other two not far behind. They are saturated with a design pressure of 14 bar and steel tubes are welded to both firebox and smoke box tube plates in accordance with the relevant clause in AS 1228. The code in several clauses mentions heat treatment. I can't quite remember whether it was us or the inspecting authority but each boiler was stress relieved by heat treatment for which we had to have a certificate and a trace report of the treatment process. The AMBSC steel boiler code advises that after welding and before fitting copper tubes, the boiler can be normalised.

As mentioned above, most model engineers probably won't be bothered or affected by a weldment not being stress relieved. There has over the years been mentioned in the pages of *Model Engineer* the problem of distortion when machining cold drawn flats. Some have resorted to some form of heat treatment (probably ineffective) before machining takes place but others haven't bothered.

Why am I writing about this now, about a year later? Due to COVID, mail just didn't happen for a while and I missed six copies before normal service resumed. Three of those missing copies for April/May 2020 turned in my mailbox about 13 months later and I've just recently read them.

Regards, Tony Reeve (Tasmania)

Is It a Fake?

Dear Martin,

At the time of writing this M.E.4669 (16 July) had just arrived in the mail box a few days earlier. Perusing the said edition, and notably 'Postbag', I noticed the letter by J.E. Kirby on 'Is It a Fake' and in particular my interest was raised in relation to that grand old lady, *Flying Scotsman*, Doncaster works No. 1564 of 1923.

You may have already received some correspondence on this from others who are more knowledgeable on the matter than me, however, I would like to throw in my two bobs' worth, if I may!

I do agree with Mr. Kirby that probably very little remains of the original 1923 build. Indeed, one of my references - Haynes *Flying Scotsman Owner's Workshop Manual* (bought from the NRM shop while in York in 2018) - mentions that by the time she had turned 40 the locomotive had carried 15 different boilers, the main frames replaced probably after 10 years and had several tenders.

One aspect of Mr. Kirby's letter, I believe, contains an error. From his letter I get the feeling that, from new, she was fitted with a corridor tender - I believe not so. It was fate that due to a broken piston rod she just happened - running No. 1472 and at that time un-named - to be chosen to be put on display at the British Empire Exhibition at Wembley in 1924/1925. For this occasion she was named *Flying Scotsman* and renumbered 4472, and was coupled to a short, six wheel tender.

The corridor tender came later, 1928, according to O.S. Nock who, in April of that year whilst travelling from Leeds to King's Cross, saw at Doncaster two Pacifics (4472 *Flying Scotsman* and 4476 *Royal Lancer*) to be fitted with the new tenders. Nock also relates a story from one of Gresley's daughters of how the corridor tender came about. Gresley had arranged a line of chairs in his dining room with backs to the wall and said if he can get through the space so can the drivers, Gresley being tall and well built.

The King's Cross to Edinburgh non-stop service began 1 May 1928 with 4472 *Flying Scotsman* leaving King's Cross and 2850 *Shotover* leaving Edinburgh.

As at 2006 - according to the *Owner's Manual - Flying Scotsman* had a coupled wheel showing a cast date of 1949 and trailing carrying wheelset with a cast date of 1923.

In recent times (this century) so much of the locomotive has had to be replaced - frame stretchers, smokebox saddle, new front ends (cylinder mounting) for the frames with full strength butt welding to what remained of the frames, along with a major rebuild of the boiler. Where once some of the replaced parts were cast, the replacements are welded steel replacements.

So, it is possible that in its nearly 100-year life there may still be an original part - well at least from the year 1923 - of the original locomotive but I doubt it. And maybe also the nameplates which she received in 1924 are perhaps the originals. The provenance of the nameplates or the 1923 trailing wheelset will never be proved beyond reasonable doubt.

In its life *Flying Scotsman* has had no fewer than six running numbers so it's conjecture as to what really constitutes an original locomotive and one's perception as to what is considered to be fake. Is it the name only or the machine the name represents?

To most the name *Flying Scotsman* is a grand old steam locomotive that has won the hearts and minds of not only railway buffs but of the wider community.

Long may the steam locomotive *Flying Scotsman* keep steaming on.

Tony Reeve (Tasmania)

Measurements

Dear Martin,

In response to Jonathan Edney's comments about aliquot parts of an inch (Postbag, M.E.4670, 30 July), I would like to offer a simple method for translating such measurements in to an SI equivalent that I was taught many years ago.

Repeatedly multiply top and bottom of the fraction by two until the number on the bottom (the denominator) is equal to 256. Then the number on the top (the numerator) is equal to ten times the dimension in millimetres (with an error of less than +0.8%).

For example, consider ¼ inch (6.35mm):

1/4 = 2/8
= 4/16
= 8/32
= 16/64
= 32/128
= 64/256

Divide numerator by 10:
¼ inch = 6.4mm (Error = 0.05mm, 0.002 inch)

This works because the conversion factor for inches to mm is 2.54, which is very close to 256/10.

The conversion can also be done the other way by doubling the top and bottom of the fraction until the bottom (the denominator) is 256. The top (the numerator) is then divided by ten to yield mm.

Even I can multiply by two in my head (I know - a pretty low bar and nothing to boast about really) but the 2, 4, 8, ... 64, 128, 256 binary powers sequence is known by most young people from computer familiarity and most people 'over a certain age' are familiar with the traditional fractions on Imperial rules and measuring equipment.

Yours sincerely, Ian Newman (Corsham, Wilts)

Zen and the Art of Model Painting and Lining PART 2

Luker tackles the task from first principles.

Surfacing (or high build filler) primer

I'm particularly fond of using a high build filler (2K) primer on all my jobs. It fills all those nasty scratches from manufacturing and tends to hide defects from the filler if used. It's especially effective in hiding any welding that was used during the manufacturing of platework, especially spot welding. Unfortunately, it does hide any detailing but there are a number of tricks to get around that little hurdle, tricks that deserve a little more discussion. For smaller jobs that don't warrant the use of a filler primer, I either paint directly onto the etch primer (but I make absolutely sure it's properly dry) or I separate the etch primer from the 2K paint with a normal 1K primer, which is thinner than the filler primers. The primed frame is an example of a 1K normal primer (**photo 7**).

Final coat

For the final coat I generally use 2K automotive paints and by this stage the surface needs to be free from scratches or defects. Don't bother spraying if any scratches are visible. If you need to apply loads of paint to fill the previous layers defects, the final coat will just end up being too thick and you're bound to have problems later.

Stirling frames, primed.

Roughing or flattening the various stages in the paint build-up

As the paint build-up progresses, each layer needs to be flattened or sanded; normally to flatten high spots, but it does help to clean and prepare the surface for the next coat. The closer you get to the final coat the finer the paper needs to be. I've attached a table (**table 1**) for reference, but this is to a large extent a matter of preference.

I have read on many occasions to wet flatten (sand) paint to prevent the sand paper from clogging. As a general rule I will not wet any paint or filler that contains talcum powder; the likelihood of moisture being absorbed and trapped under the next layer, only to raise its ugly bubble head at a later stage, is just not worth the risk. Most fillers, including the filler primers, will have talc as a bulking agent.

Mixing paints

This sounds boring but a lot of painting problems creep in with the mixing of the paint. Firstly, follow the data sheet instructions; don't deviate with the base and hardener quantities. You don't need to buy all the special, once-off mixing containers and measuring sticks; I normally use a kitchen measuring jug or party cardboard cups to mix the paint. A wooden dowel or piece of metal rod can be marked and stood upright in the jug or cup to measure out the paint.

Be careful using certain plastic containers. I'm referring specifically to the once-off land-fillers. Sometimes the

Table 1. The uses of various grades of sandpaper

Sandpaper grit	Description
36-80	Bare metal roughing for body filler (DRY)
60-80	Shaping the body filler (DRY)
150-180	Smoothing filler for 2K surfacing primer or second coat (NORMALLY DRY)
600-800	Smoothing primer for 2K paint or second coat/repair (WET for 2K COLOUR COAT)
800-1500	Smoothing for clear or removing minor imperfections for polishing (VERY WET)

solvents in the paint can react with the plastic and cause orange peel or other defects. If you're unsure, preferably don't use it! On that note don't use disposable plastic (medical) syringes to measure out paint. Using syringes is a sure fire way of contaminating the paint, especially if small quantities are measured out.

When I first started painting I used to thin the 2K paint using normal no-name thinners; I still have that bike and the paint is just fine. Unfortunately, the quality of thinners has decreased drastically and I only use 2K thinners (or reductant as the paint guys like to call it) to thin the 2K paints. The amount added depends on the paint and I have had to thin a particularly cheap paint by double the recommended amount just to get it to spray. Considering that that paint was on a smokebox and is still there as good as new, I don't think any harm was done.

The filter that comes with the spray gun is useless and I normally spray without it. All paint that goes into the gun is filtered using the filters from the paint shop or some fine stainless steel gauze I use for my tender tank filters (depending on whether I feel like cleaning the stainless gauze). I used to use old stockings but I was never sure if the local nail, hair care and repair department had done some ladder repairs.

After mixing the paint I generally tap the container on the edge of the table to get all the bubbles out. When pouring it into the gun through the filter I tend to pour slowly onto the side of the reservoir and I try to avoid making too much turbulence and bubbles. I then let the gun stand upright for a minute or two for those last few bubbles that may have crept in during pouring.

Mixing colours

After my unfortunate experience with a disgruntled worker contaminating the paint he mixed for me I have started mixing my own colours. It takes a little trial and error but with a simple colour chart (available from the Internet), the base colours and black or white as a toner, you can mix pretty much any colour needed in model engineering. Most of my paints are different brands and I have had no issues mixing them to the colour I was looking for, provided of course you mix the same paint types! The Lake colour used for the Stirling frame is a combination of the dark maroon I used on my Ariel Huntmaster I painted many years ago, toned with some black to the correct hue.

My basic set-up

I have a 150 litre upright compressor, two spray guns and a simple cheap filter/water trap, and that's it! At one stage I wanted to convert the spare room into a spray booth but apparently that is just being ridiculous. For the most part I spray outside the workshop with no special precautions other than blowing as much of the dust away an hour or two before starting the painting.

I always fill the compressor the night before; I've found this decreases the amount of water in the line. I also have a loop in the airline to help prevent any moisture that got past the filter from making it to the gun. The pressure regulator on the filter is set to the maximum working pressure of the gun.

I am particular about what is in the shed with the compressor. There is no diesel generator, volatiles or any other form of contamination that could cause issues with painting through the air supply.

Buying a spray gun

Firstly, I must admit I didn't buy the most expensive gun; actually, it was rather cheap. My first spray gun was retired about five years ago because it started to dribble and that was after three bikes and one and a half trains. It probably would have lasted a little longer if I hadn't experimented with spraying different ceramic mould coats but let's not dwell … Most of the guns are HVLP (high volume low pressure); this is mainly to comply with environmental regulations (HVLP has less overspray and thus less waste). Most of the guns commonly available are gravity feed and they're probably the best for smaller jobs like our models. The bottom suction type guns require a certain amount of paint in the reservoir to work properly and will invariably result in paint wastage.

8

My spray guns.

Money doesn't always buy quality, and cheap doesn't necessary mean it's rubbish. My current two guns cost less than the paint for the Stirling, but I spent some time in the shop stripping the gun and looking at the quality of the components. If the proprietor has a problem with you doing that, buy somewhere else. The main paint needle needs to be polished and there shouldn't be any machining marks. All the seats for the various valves should be clean with no machining burrs and the jet holes should be open and machined cleanly, then you know you have a good product. The chance of there being a design flaw in a high volume item like a spray gun is remote so you should be okay there.

The nozzle size determines the type of paint the gun is suitable for or how much paint thinning is required. A touch-up gun is excellent for model engineering but the nozzle is generally too small for most of the primers, especially the filler primers. I suggest visiting a paint shop and asking for the data sheets of the paint system you want to use before buying a spray gun; the recommended nozzle size is always listed in the data sheets for the various paint systems. My two spray guns have different nozzle sizes; the large one a 1.4mm nozzle and the touch-up gun 0.8mm. The larger gun is used for all the priming and the high build paint layers with little to no reductant or thinner. The touch-up gun is used for the low build layers and smaller components with the reductant additions at the upper end of the recommended range. As you can see I look after and clean the guns properly, and that may be one of the keys to a good spray job (**photo 8**).

Okay, that's the boring bits. The true art of painting lies in the spraying techniques used and, for the model engineer, how to save the detail from paint build-up, but more on that next time….

●To be continued.

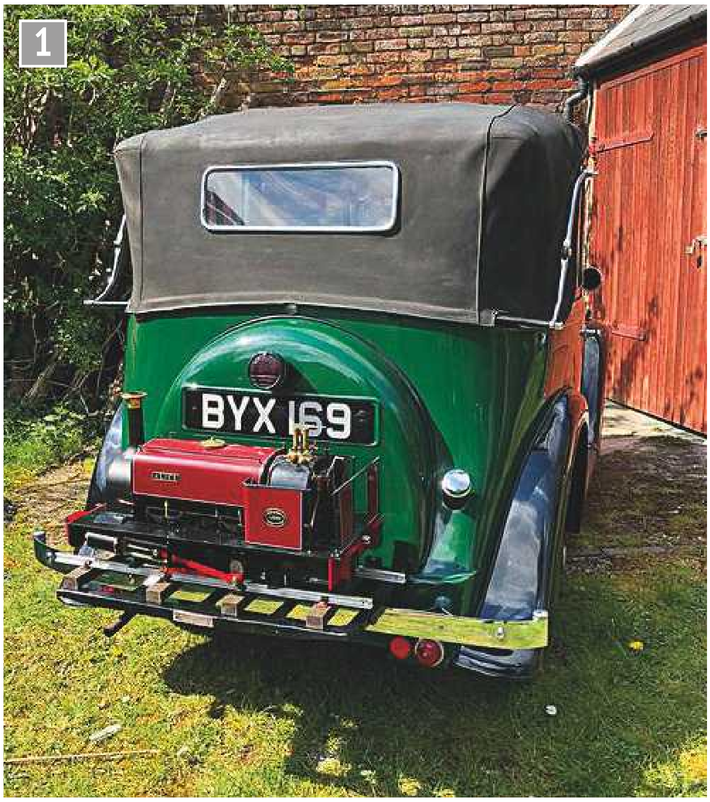
CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

Here goes with another thrilling instalment of Mission Ineffable. And, to whet your appetite, in the next issue, I report from Derbyshire.

In this issue: gauge and scale differences, Whitby Town, a wreck, smoke and smoking, a loo with a view, exercises, a mystery locomotive, verniers and a bridge.

The Oily Rag, from **Taunton Model Engineers**, has editor, John, informing us that some are complaining that the club does not support their special interests. His response is predictable… start a section on it! This issue began with an idea for producing a Small Engines edition, so on with the show… A replica signal box has been donated, courtesy of a local resident. Taunton's Priory Road station is being modelled, after the original on the Somerset & Dorset railway. Ian Turner of the G3 Society explains the origins of Gauge 3, when the five main gauges were recommended by the SME in 1899. Bassett-Lowke imported several models from Bing and Carette, originally quite simple models, but by 1911 they were becoming rather more sophisticated. Interest has declined in O, 1 and 2 gauges (but see later! - Geoff) but G3 remains of interest and Ian notes the differences between the G3 Society and the National 2½ Inch Gauge Society, the former attempting to be true scale, UK-type models and the latter, passenger carrying, therefore concentrating on the larger and more powerful locomotives. Janet Royston asks 'Model engineering or playing with trains?' with respect to her domestic garden railway, currently being constructed. John Pickering, in '*Pour Encourager les Autres*', discusses the benefits of the smaller gauge, for beginners venturing into cutting metal and making swarf. This issue closes with a very different photograph - a 1935 Austin 7 Pearl, owned by Andy Probyn, (AP=AP?) bearing, on a boot-mounted rack, a miniature steam locomotive in place of the more usual bicycles (**photo 1**).



A locomotive rack - will it 'catch on'? (Photo courtesy of Andy Probyn.)

W. www.tauntonme.org.uk

Welcome back to **Otago Model Engineering Society**, absent from these pages for too long. The front page features Keith's model of *Turbinia*, the boat that started it all. Then president, Stuart Reid, updates us on the scale railway, which is extending the 1/72 scale circuit. The new rail is unique in that it uses track the same gauge as N scale but the trains that run on it are still 1/72 but scale narrow gauge - it is called 009. (I hope that's clear, there will be a short examination next period - Geoff) Ian produced a panelbeaters' tool found in the bodywork of his car. It had been causing a rattle, costing lots of time and money whilst various mechanics failed to correctly diagnose the problem. Yes, it really happened! The Engineering Group has been, variously, collecting old scooter batteries, emptying the container of scrap, painting a 'Sweet Pea', dismantling a printer, fitting a 'Doris' with PTFE seals on the valve bobbins and working on a beam engine. The Boat Group has been making a plesiosaur, a Riviera speed boat, working on a smoke system for a dredger, building a Dogger boat and repainting a 'Sparrow'.

W. www.omes.org.nz

Model Engineering Society of Northern Ireland have to be clear of their site by autumn and negotiations regarding a new home are ongoing.

The always reliable **Gauge 1 Model Railway Association** summer *Newsletter & Journal* has lots of items, of which I can pick only a few from its 94 pages. Editor, Rod Clarke, begins with a picture of Whitby Town Station. No, not the one just North of the NYMR but the one on Lake Ontario. It closed in 1863, and the nameboard disappeared in about 1944 but recently surfaced at an auction 170km away. Rod challenged the Vintage Whitby Facebook Group to buy the nameboard for the local museum and was successful. Howard Hines built a P2 during lockdown, including the Holcroft conjugated valve gear. Lawrence Bold-de-Haughton,

in a tongue-in-cheek piece, relates the tale of his garden railway which was wrecked by a classic car! - a 1955 Ford Panel truck no less, the driver of which was not at his customary position. Invited by Lawrence (through gritted teeth) to view the effect caused by his wayward classic, he seemed oblivious to the significance of the damage, much as he was to the fate of the bed of strawberries he was thoughtlessly trampling underfoot. Ignoring the street party atmosphere developing over the fence, Lawrence established that the wayward vehicle wouldn't start, so the driver applied some percussive maintenance to the starter solenoid, which woke up and did its job. Thus was the sequence of events. After the absentee driver of the not fully automatic chariot admitted responsibility, Lawrence received a settlement, and a lasting mistrust of 1955 Ford panel trucks… Charles Simon of Switzerland ran a survey of the membership, which has nothing to do with this great photograph, except it is his locomotive, beautifully presented and spotless (**photo 2**). Richard Donovan built a 3 ft 6 inch gauge WAGR carriage to 1:24 scale. The starter frame in an early picture in the article gives no indication of the finished appearance of the carriage (**photo 3**). Phil Shrimpton made a smoke unit for diesel locomotives, using an e-cigarette vaping device.
W. www.g1mra.com

Criterion, June, from **High Wycombe Model Engineering Club,** has a very smart LNER 2-6-2 tank, 2910, on the cover, built by Ian Boulter during lockdown from a part complete project, a **Martin Evans I** design, to resemble a V3. This is followed by a picture of a lavatory cubicle within the structure of the Forth Bridge. It seems that it never had a door… The aforementioned bridge may resemble a giant Meccano project but David Savage describes two crystal sets marketed by Meccano in 1922 (nice link, what?). The No. 1 cost £1/10/0 or about £90 in modern currency. The No 2 cost £2 and was (slightly) more sophisticated.
W. www.hwmec.co.uk

Whistlestop, summer, from **Hereford Society of Model Engineers**, has editor, Martin Burgess, discussing the vexed question of mathematics, in which certain illogical contradictions can occur. I studied Calculus (a minor Roman Emperor, m'Lud) at school, but never used anything more complex than square roots since leaving the benighted place behind me, despite spending many subsequent years in the Inland Revenue ('so that's why…'). Ahem. Two junior engineers have been appointed to apprenticeships at important engineering companies - we wish them well. Richard Donovan writes on Barry Docks, explored with his brother in his youth. He recalls one of the last fully-rigged sailing ships, *Pamir* in 1950, still working the Australia wheat trade. Sold in 1954, it sank off the Azores in a 1957 storm with heavy loss of life. A sister ship is preserved in Germany. Callum Powrie describes a 7¼ inch gauge locomotive weighing machine, using scales from Argos, and capable of dealing with a whole engine or just one axle. In checking his own engine, it revealed gross variations in axle weights, which have been rectified, so here's hoping its performance improves when allowed out on the track.
W. www.hsme.co.uk

2

Charles Simon's SBB A3/5 in Gauge 1. (Photo courtesy of Charles Simon.)

St Albans & District Model Engineering Society *Newsletter*, May, opens with secretary Roy Verdon's unusual request. In amongst all the pent-up demand to get out and about when lockdown ceases, spare a moment for a little light exercise, so that the forthcoming days' activities do not overwhelm readers. Suggestions – write out cheques for your club subscriptions, order those engineering books, and read them, start the day gently – open one eye at a time, now, both together, when focus manifests itself and double vision ceases, call for your breakfast in bed and decline the subsequent advice. Ten years ago, Mike Joseph wrote an item on reconditioning dial test indicators and, for those who didn't see it, here it is again! Two books are reviewed, *Model Steamer Building*, one of a range of *Model Engineer* booklets from the Percival Marshall days (9d) and a Hornsby oil engine catalogue, which, it is suggested, may be built using Stuart Turner castings. I also learn that ST was founded by Sidney Marmaduke Stuart-Turner in 1906. A detective story next, not by Raymond Chandler, but Roger Stephen, amateur sleuth. At a recent meeting, Guy Lucas produced a 4-4-2 locomotive of unknown provenance. Roger accepted the challenge, and opened the sleuthgates. The model is of a Great Central 8B, No 192. Not by Henry Greenly or Bassett-Lowke, but may have been made from James Carson castings after 1905. A similar model was made by a Mr Aynesworth Harrison and published in *Model Engineer* in 1913. James Carson closed at about that time and its assets were taken over by B-L.
W. www.stalbansmes.com

3

Richard Donovan's Gauge 1 WAGR carriage. (Photo courtesy of Richard Donovan.)

The **Gauge 3 Society** *Newsletter* also has a good crop of interesting photographs, before which Don Crouch writes a short piece about SR headcode discs, which I found very informative. Sean Underhill built a Z4 0-4-2T for very little expense, using a Bachmann chassis, Plastikard and resin fittings (**photo 4**) whilst Barry Lane made a GNR 6-wheeled brake van with a Cleminson underframe, to be run with his train of Pullman coaches (**photo 5**). To end this cornucopia of visual feasts, Dave White rescued and renovated these Carette singles (**photo 6**). (This is the first time I have ever seen what such locomotives looked like when new – Geoff) It must be very exhausting, collecting such rare models. (I am reminded of Sheila Hancock's 1963 record on giving up smoking, "Just one more (Cig) Carette..."

W. www.gauge3.org.uk

Sean Underhill's Z4 G3 from bits. (Photo courtesy of Sean Underhill.)

Welling & District Model Engineering Society, June-July *Magazine*, says they have finally left their old Falconwood site and begun work at Hall Place. First things first, no, not the kettle, but laying the track! Forty years of growth at Falconwood is revealed by dendrochronology, the section of a cut down tree showing a remarkably steady expansion of the arboreal life. In 1654 Pierre Vernier was born, son of an engineer and scientist, Claude and his anonymous wife, who was thought not important enough to name but no doubt contributed…. Working as a surveyor 20 years later, he became dissatisfied with the accuracy of his instruments, measuring to no better than half a degree and invented his eponymous scale, which could now be read to an accuracy of 1/60th of a degree. Author, Bob Underwood, goes on to describe a simply made vernier scale for a lathe and mentions vernier rockets (thrusters) in spacecraft and small variable capacitors to boot. Lastly, a short item on the electric steam engines of Swiss Railways. Due to a wartime coal shortage, some 0-6-0T steam shunters were converted to boil water electrically and one is preserved at Sursee-Triengen but without its electrical system.

W. www.wdmes.co.uk

Barry Lane's GNR Cleminson Brake for Pullman train. (Photo courtesy of Barry Lane.)

In **Norwich & District Society of Model Engineers**' summer *e-Bulletin,* Mike Forha describes a steam wagon seen at Leighton Buzzard a few years ago. It began life as a dump truck by Road Machines of Drayton. It was fitted with a steam boiler and a Reader horizontal mill engine, installed athwartships, and it was completed in 2001.

The Mathematical Bridge in Cambridge is discussed. A clever design, but not without its myths; it was not designed or built by Sir Isaac Newton, who had died some years previously, and it was not constructed without bolts. It appears to be an arch but is made entirely of straight timbers. Analysis shows that these timbers are all entirely under tension or compression, by design.

W. www.ndsme.org

And finally, from W&DMES. In Genesis, Lot was told to pack up his wife and flee, as danger loomed. His wife looked back, despite being told 'eyes front', and was turned to salt. Young James (4) asked "what happened to the flea?".

Dave White's Carettes in Gauge 3. (Photo courtesy of Ted Sadler.)

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