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Vol. 223 No. 4616 • 5 - 18 July 2019

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Tel: 01795 662976
Website: www.mags-uk.com

EDITORIAL

Editor: Martin R Evans
Tel: +44 (0)7710 192953
Email: mrevans@cantab.net

PRODUCTION

Designer: Yvette Green
Illustrator: Grahame Chambers
Retouching Manager: Brian Vickers
Ad Production: Andy Tompkins

ADVERTISING

Advertising Sales Executive: David Holden
Email: david.holden@mytimemedia.com
Tel: 07718 648689

MARKETING & SUBSCRIPTIONS

Subscription Manager:
Kate Hall

MANAGEMENT

Group Advertising Manager: Rhona Bolger
Email: rhona.bolger@mytimemedia.com
Chief Executive: Owen Davies

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ISSUE IN THIS ISSUE IN THIS ISSUE IN THIS ISSUE IN THIS

Vol. 223 No. 4616 5 - 18 July 2019

80 SMOKE RINGS

News, views and comment on the world of model engineering.

81 GOLDEN CELEBRATION FOR BRACKNELL RAILWAY SOCIETY

Chris Chugg reports on Bracknell's 50th anniversary, graced by the presence of not merely one, but two mayors.

84 A TRAIN IS BORN - BUILDING A SEVEN FOOT STIRLING SINGLE

Luker builds a 7 1/4 inch gauge model of a less famous relative of the eight foot single.

88 LATHES AND MORE FOR BEGINNERS

Graham Sadler explains how the wear on your Myford lathe can be eliminated..

90 GARRETT 4CD TRACTOR

Chris Gunn redesigns the lubrication system on his Garrett tractor.

94 POSTBAG

95 A NEW GWR PANNIER

Doug Hewson embarks on a mission to improve LBSC's half century old GWR Pannier Tank design.

98 STEAM TURBINES LARGE AND MINIATURE

Mike Tilby explores the technology, history and modelling of steam turbines.

102 WIND AND STEAM IN WHISSENDINE

Martin Evans takes a trip to Rutland to visit a steam rally and a working windmill.

105 SIEG SX2 PLUS MILLER CNC CONVERSION

Graham Sadler explains how he converted his Sieg milling machine to CNC operation.

108 THE BRUSHLESS BRUTE

Jon Freeman presents a powerful dual-gauge petrol-electric locomotive.

110 THE BARCLAY WELL TANKS OF THE GREAT WAR

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

115 SYNCHRONOME CLOCK REVISITED

Patrick Williams makes some improvements to his uncle Doug's synchronome clock.

118 3D PRINTING FOR MODEL ENGINEERS

Brian Marchant ventures into 3D printing by producing a set of brake hangers for his latest project.

120 SHOWCASE

Dennis Herbert's 7 1/4 inch GWR 'King' Class locomotive.

121 NATIONAL MODEL ENGINEERING AND MODELLING EXHIBITION 2019

John Arrowsmith completes his review of the prize winners at this year's Doncaster show.

124 CLUB NEWS

Geoff Theasby compiles the latest from model engineering clubs around the world.

127 DIARY

Forthcoming events.



ON THE COVER...

General Gough is a 6 inch Burrell Scenic showman's engine belonging to Mike Robinson and seen at the Whissendine steam rally at the beginning of June. (Photograph Mike Robinson.)

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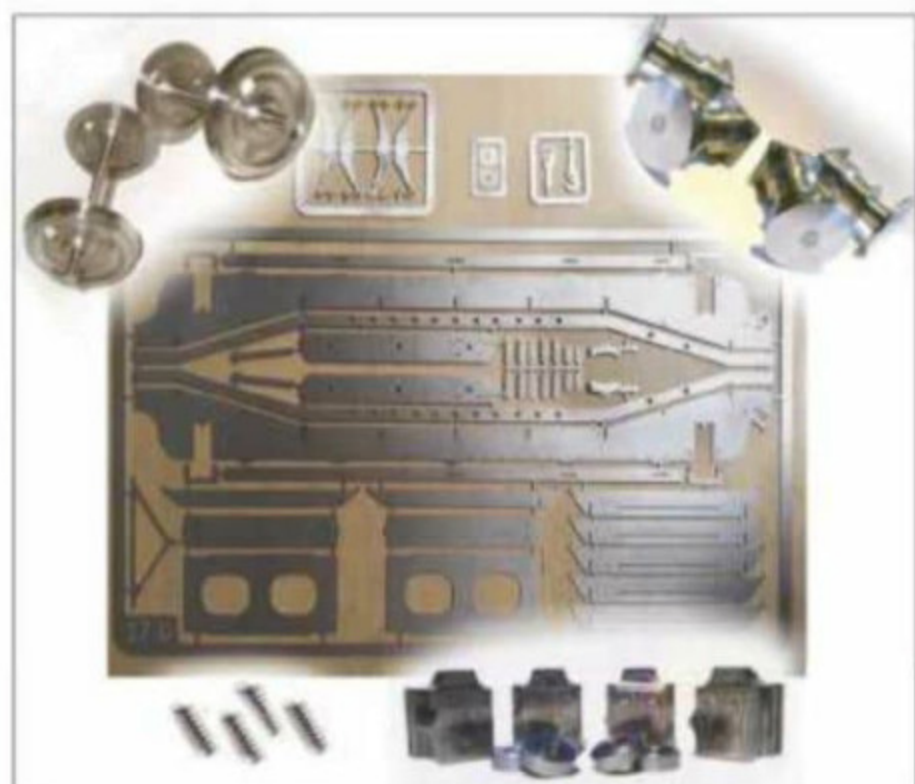
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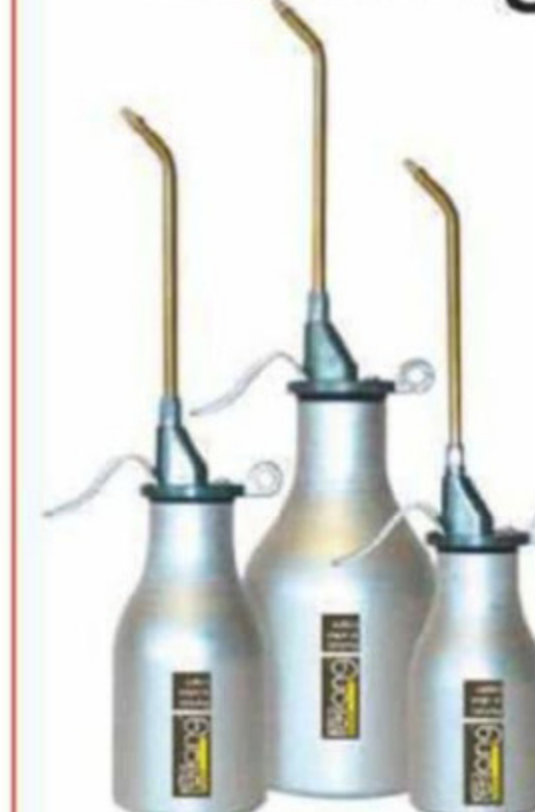
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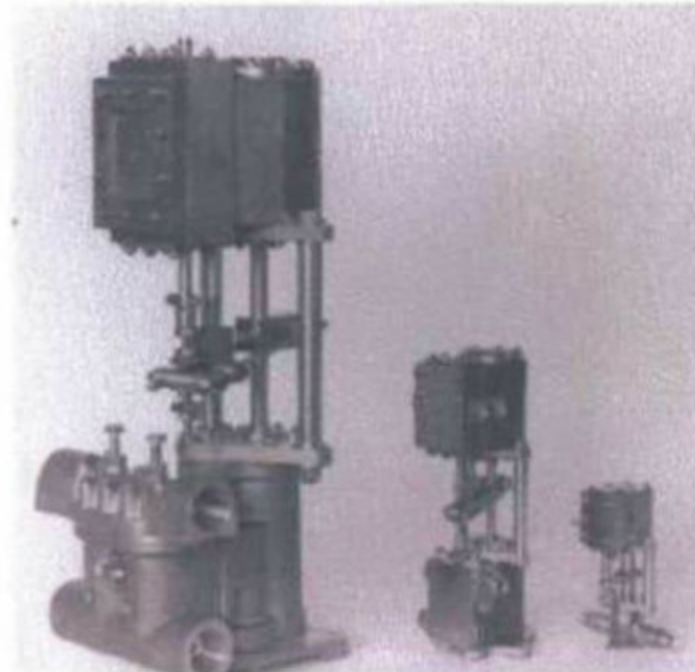
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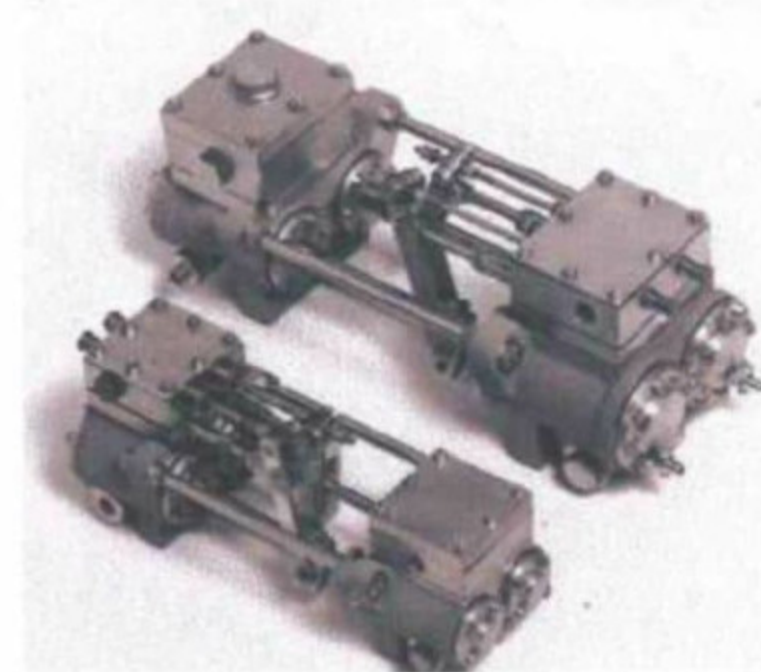
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Weeting Rally

The Weeting Steam Engine Rally and Country Show is, as far as I am aware, the largest of its kind in East Anglia and this year is celebrating its 51st year. It takes place at Fengate Farm, Weeting, Norfolk, on Friday, Saturday and Sunday, the 19th to 21st July. Weeting lies just on the Norfolk/Suffolk border near Brandon, in the district of Breckland.

This year promises to be quite spectacular, with the Brandon Club's miniature railway in operation, tractors (140 of them at the last count), traction engines, steam lorries, cars motorbikes, military vehicles and fairground rides. Add to that falconry displays, helicopter flights, Will's Working Spaniels, heavy horses, tank rides, archery and bouncy castles and you have a show that is not to be missed. On Saturday evening the outdoor stage will be the focus of the evening's entertainment, to



Whissendine

As you can see, your editor had a jolly day out at the Whissendine Steam Rally a month ago, including a road run on the star of our front cover, Mike Robinson's *General Gough*. His report on the event may be found on page 102.

include the 'D-Day Darling' Trio, the 'Heathen' rock band and even dancing girls!

Entry is £10 for adults on Friday and £12 on Saturday

and Sunday but parking is free. Space for camping and caravanning is available. Further information may be found at www.weetingrally.co.uk

Garrett Tractor

I'm afraid I misled our readers a couple of issues ago by suggesting that Chris Gunn's 6 inch Garrett 4CD tractor series had come to an end. It hasn't – there's yet more! In this issue Chris discusses the redesign of the engine's lubrication system. In future issues he will discuss painting the engine, cladding the boiler and some modifications to the canopy. He will then round off by relating some of his experiences with the engine on the rally field.



Hot Air

By the time you read this we will no doubt have a new Prime Minister. Your editor of course hesitates to whip out his crystal ball on this occasion or make any reckless predictions about the outcome of the party leadership election. However, this locomotive was seen recently by Roger Backhouse on one of his many days out, at Hotham Park, near Bognor Regis. He tells me that it is not a steam locomotive but a steam outline Diesel, so it is not quite as it appears, generates a lot of hot air and goes around in circles. Could this perhaps be an omen of Things to Come?

Martin Evans can be contacted on the mobile number or email below and would be delighted to receive your contributions, in the form of items of correspondence, comment or articles.
07710-192953
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IMLEC and the Years Between

Alan Crossfield looks forward to this year's IMLEC, to be hosted by the Leyland club.



IMLEC 2019 will take place over the weekend of 12 to 14 July at Worden Park, Leyland. This will be the 51st year of the competition and the sixth time Leyland Society of Model Engineers has played host, the last occasion being 2013. Since then, two major projects have been the focus of the LSME membership, the first of these being the construction of a new clubhouse. Discussion amongst the members revealed divided opinion, some preferring to embark on yet another upgrade whilst others favoured the more ambitious approach of demolish and rebuild. Eventually, plans were drawn up - and accepted by the local authority - for a completely new building.

Except for brick laying, all the work was carried out by LSME members during the winter of 2015/16 and the



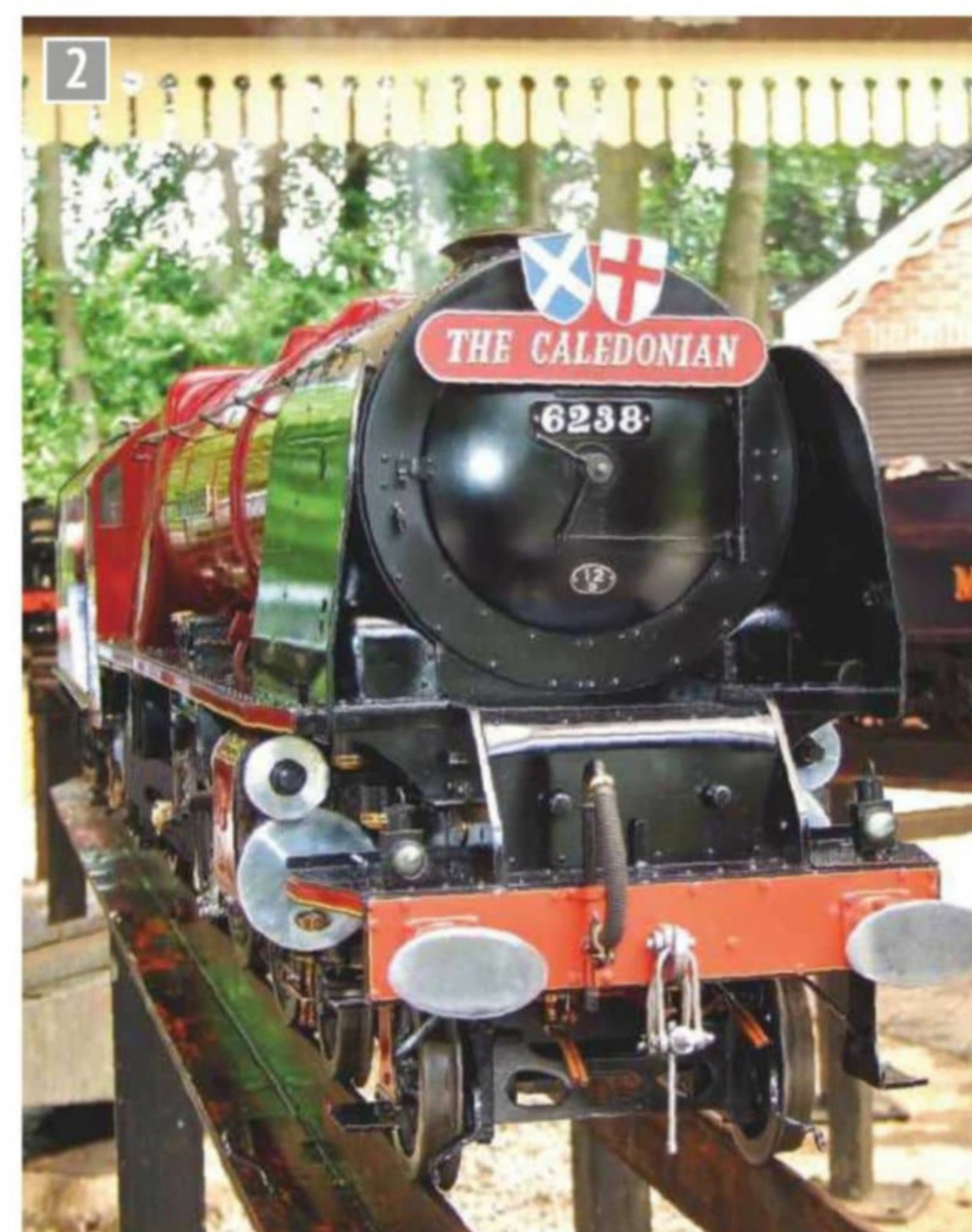
Roger Holland's A4, Wild Swan is a regular IMLEC competitor.

clubhouse formally opened in the presence of the South Ribble Mayor on 3 July 2016. Shortly after this event, expansion and development of the workshop facility became possible as the relocation of wash rooms to within the new clubhouse gave up space for more machine tools and a safer working area. The result has been achieved after removal of internal walls and the construction of an annex for grass cutting equipment. It came as no surprise, however, to find we had accumulated, by the end of 2018, a backlog of repair issues for other parts of the infrastructure so spring 2019 has seen working parties busy with track maintenance on both ground and raised level tracks. Both will be in full operation throughout the IMLEC weekend, the ground level 7¼ inch gauge providing rides for the general public whilst the raised 5 and 3½ inch gauges will host the competition.

A field of 28 competitors will challenge for the Martin Evans Trophy, starting at 1.00pm on Friday 12 July. Saturday's competition runs will be followed by an informal evening's running session on the raised track. **Photograph 1** shows regular competitor, Roger Holland's A4, 'Wild Swan' and **photo 2** shows

an IMLEC newcomer, Nick and Geoff Elliott's Princess Coronation class, *City of Carlisle*.

Distance and work output for all the runs will be measured by the Leyland dynamometer car. This works by digital technology with very few physical connectors, as the 'box of tricks' (connected to the dynamometer's drawbar) 'talks' to the observer's tablet via a Bluetooth link. Information displayed on the tablet is quite extensive and during the competition, this will be downloaded to a PC at the end of each run. However, because the tablet and the PC share a WIFI link, the information can also be seen prior to the download - as it happens in fact. For the benefit of the spectator, we once again plan to display the performance of each locomotive on a fixed monitor screen in real time, as the run progresses! In addition, and again for the benefit of the spectator, there will be a fixed line-side camera providing CCTV. So, lots of drama and steam action promised for the IMLEC weekend including steam road vehicles. Why not join us? We're just off the M6 at junction 28 (Sat-nav postcode: PR25 1DJ).



A promised new entry this year, City of Carlisle.



MARTIN EVANS
Editor



DIANE CARNEY
Assistant Editor



YVETTE GREEN
Designer



Here is the venerable locomotive which opened the track in 1969. For some reason Derek never got around to painting the locomotive and now it is so well known in the Club as Brasso that he never could add the livery. Little things that make up history.

Golden Celebration for Bracknell Railway Society

Chris Chugg describes the festivities at the Bracknell club's fiftieth anniversary.



Fifty years ago, Derek Alford drove his locomotive with the Mayor of Bracknell as a passenger to celebrate the official opening of the Bracknell Railway Society's new track at Jocks Lane. Remarkably, Derek, driving

the same locomotive, an appropriately golden colour and affectionately called *Brasso*, was invited back to take part in the 50th anniversary and indeed Derek's locomotive did complete a few laps. Although it performed well, it was too much to ask of the vintage

locomotive to pull a heavier train with VIP passengers. Instead the Mayor of Bracknell Town, Cllr Sandra Ingham and Cllr Alvin Finch, Mayor of Bracknell Forest Council were taken around by David Sheppard behind his Polly 5. David, an excellent driver, duly delivered his important passengers back safely after their one fifth of a mile journey around the now much extended and improved track.

Strictly speaking, the Bracknell Railway Society (BRS) was established a decade earlier and has grown to include several groups covering all aspects of railway interest. There is a very active small-scale modelling group

Here are the two visiting Mayors cutting the tape on the 50th anniversary run, Mayor of Bracknell Forest, Cllr. Alvin Finch and Mayor of Bracknell Town Council, Cllr. Sandra Ingham.



This picture shows Les Derbyshire opening the track in 1969 looking rather youthful and with Brasso as the engine used on the inaugural run.



Excellent shot of David Mayall's new locomotive - a Jubilee Class locomotive Gibraltar - based on a heavily modified commercially built ready to run locomotive from Silver Crest Models.

and a regular programme of specialist talks. Early on, a new section, the Motive Power Section (MPS) was set up to build and maintain a track at Jocks Lane for the steam enthusiasts. This was achieved with the generous help and support of the Bracknell Borough Council which gave the Society use of land in a public park that is still a much-appreciated amenity for the people of Bracknell. The MPS regularly runs the railway for the public once a month during the summer and has become a popular attraction at the park. The track was initially laid down in 1968/9 and was significantly extended in 2005 to its current size and layout.

The MPS can muster a large collection of steam and electric locomotives, both 3½ and 5 inch gauge, and on running days can easily carry 300 or more passengers in a few hours. On the day

of the 50th anniversary, 7th April 2019, the local council had arranged for many other attractions to be laid on as part of an annual event for the primary school children of Bracknell. Excited youngsters were there in numbers and on this day we carried nearly 500 passengers. So - a brilliant result for both the MPS and Bracknell.

Over the years the Jocks Lane site as well as the track has expanded considerably, adding storage and workshop facilities. Meeting every Thursday morning at Jocks Lane the MPS members exchange views, experiences and opinions on live steam model engineering and drink tea! Importantly, most maintenance work on the track, rolling stock and the site generally takes place then, under the watchful eye of Chief Engineer David Mayall. A mainstay of the Club,



It is always important to have a cake cutting ceremony at an anniversary and here are Cllr. Roger Meek and the two Mayors flanked by Club members. From left to right in the background: Brenda Irving, Les Derbyshire, David Mayall, Derek Alford and Francis Mayall.



David Mayall, Chief Engineer and Mayor of Bracknell Forest Council, Alvin Finch.

David brings wide ranging engineering expertise in building and running steam locomotives to the section. He and his wife Frances worked tirelessly to set up and run the anniversary event. Many members of the MPS turned out in force to help and many of the original members also came back to celebrate including Les Derbyshire who was Chairman at the time the track opened.

New members are always welcome at Jocks Lane, Bracknell, to join the vibrant club that has a 50-year history. Do get in touch and help us to aim for the Diamond celebrations in 2044!

Visit our website to learn more:
www.bracknellrailwaysociety.co.uk



David Sheppard stepped in to take our VIPs on a ride around the track using his Polly 5.



The complete locomotive.

A Train is Born – Building a Seven Foot Stirling Single

PART 5

Luker relates how he built a 7¼ inch gauge Stirling 7 foot single locomotive.



Continued from p.39
M.E. 4615, 21 June 2019

The previous instalment (p. 37, M.E. 4614) included a cross sectional illustration demonstrating the workings of a typical boiler. Unfortunately we failed to acknowledge the source of the illustration, which is 'Peter's Railway' by Christopher Vine. We apologise to Mr. Vine for this omission.

I really enjoy speaking to the visitors at the Rand Society of Model Engineering (RSME). If you want me to carry on for ages just keep the conversation technical and away from what the latest celebrity did to make the headlines. I had a gentleman ask me where the trains come from, to which I replied "the members generally build them". He then asked "but where do you get the parts?" I realized I should have said they *make* the trains, adding credence to the expression 'scratch built locomotive'.

Back to the build at hand; with most of the components made and the subassemblies tested and fitted I could start with the final assembly and painting.

General assembly

Most of the assembly is straight forward and not worthy of much mention, other than one point - I leave the copper pipework for last (after everything has been painted) due to the sheer number of different pipes. Most of them are bent into place on the job and that's where they stay. I have a home-made tube

bender for the stainless tubing and the more complex tight bends but the sheet metal forming machine works really well for large radius bends like on the front of the smokebox (photo 30).

Space is very limited for assembly and it is not uncommon to modify spanners or even make special tools for assembly. I never buy expensive spanners; my spanner turnover is too high. A tip on tightening: the further away from the bolt or nut you hold the spanner, the more torque you apply (for a given force). This is why larger bolts require longer spanners to tighten properly. If you are in a habit of stripping bolts, hold the spanner closer to the bolt.

Once everything has been fitted it's time to strip for painting. I like to paint in batches, with the frames the first batch and then the remainder of the locomotive.

Painting the locomotive

I would like to state categorically I am no expert in painting and the following is only how I go about it. I normally apply a self-etch primer to the bare metal then a

2k surfacing primer and finally a 2k top coat (photo 31). The 2k seems to handle the heat and cleaning reasonably well. For this locomotive I used the RB-10 high heat self-etch primer on the smokebox and boiler but after the first steam it bubbled in certain places so I have yet to find a self-etch primer that can handle the boiler temperature. In future I will probably stick with the 2k primer and avoid the etch primer in the high heat areas altogether.

I use an old larger capacity gravity feed spray gun from Adendorff that I bought close to a decade ago. It has sprayed three vintage bikes, two locomotives and numerous other projects. I even use it to spray the moulds when I do special castings and it's still going. For smaller jobs, I recently purchased a small touch-up spray gun and I am very impressed with how well it works.

I have found that filling the compressor the day before and clearing the lines helps with any moisture that would otherwise damage a perfect spray job. It's essential to have a filter and water trap

in line and the compressor needs to be sized correctly for the amount of spray painting you intend doing. I carefully measure and mix the paint in another container and pour the paint through a stocking into the gun. After every spray session the gun is thoroughly stripped and cleaned with thinners and blown dry with clean compressor air. It's pointless straining the paint if there's debris in the gun left over from cleaning. I've found that if I'm pedantic with the above I generally get a decent finish.

Now for the bit that's out of our control. Budget for some extra paint because the last coat on the final component is bound to be struck by a kamikaze *miggie* or a hair from an overeager best friend that requires a pat. Apparently it is unacceptable to convert the spare room into a spray booth so the best we can do is watch the time of day spray painting is done and avoid wind. Generally, I have found early morning is a good time.

As for mixing, number of coats, sanding, etc. the best is always to follow the manufacturer's instructions and ask for the data sheet when buying paint. The sales guys are also generally knowledgeable for the more common applications. Failing that, there are a couple of good books on spray painting techniques. Mixed 2k lasts a day in the fridge for touch-up; avoid domestic unrest by placing it in a sealed container to stop last night's quiche tasting a little tangy.

This specific locomotive required substantial lining which added to the complexity of painting. All borders were black with either a white or red line (photo 32). I managed to do this with fine line tape available from the automotive paint shop; it can be removed after the paint has cured leaving a clean line, unlike masking tape. The thin white and red line was drawn on using paint in an open syringe with the needle rounded on the end. For thinner paint the



Large stainless steel bend for the blower line in front of the smokebox.



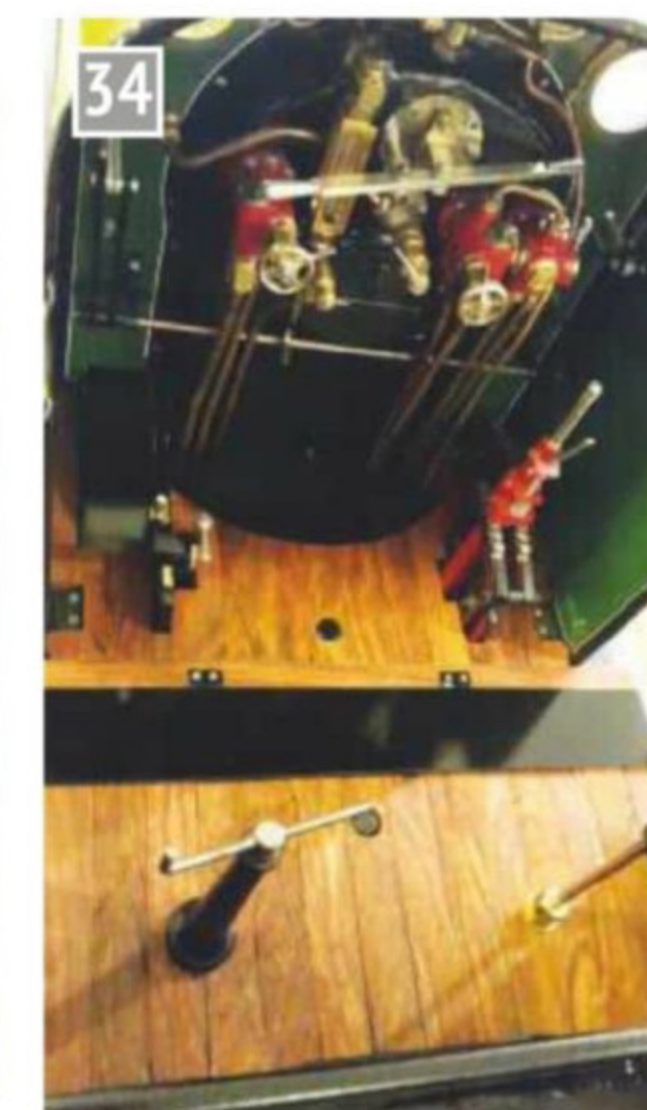
Main frames primed and ready for painting.



Lining on the tender frames and tank.



The painted tender.



Footplate woodwork.

needle needs to be longer and for thicker paint the needle shorter. This works on a similar principle to an art pen just much cheaper and it holds far more paint.

The stickers were then applied and coated with 2k clear coat to seal them in and for protection against cleaning and handling (photo 33).

Some woodwork

Originally these locomotives had wooden footplates and it would be a shame to do

something different with the model. I generally shy away from woodwork - even pattern making is a chore - but my Gran gave me a piece of sleeper wood that my Great Grandfather had in his workshop that I thought would do. To cut the thin strips reliably I bought a table saw and when I cut the outer edges off the block I found the most beautiful teak hiding below the degraded skin. I managed to cut 5mm X 20mm strips (in fact I managed 3mm x 16mm for

a smaller locomotive as well) with a fine blade - no sanding - just some linseed oil but - enough said - let the picture speak for itself (photo 34).

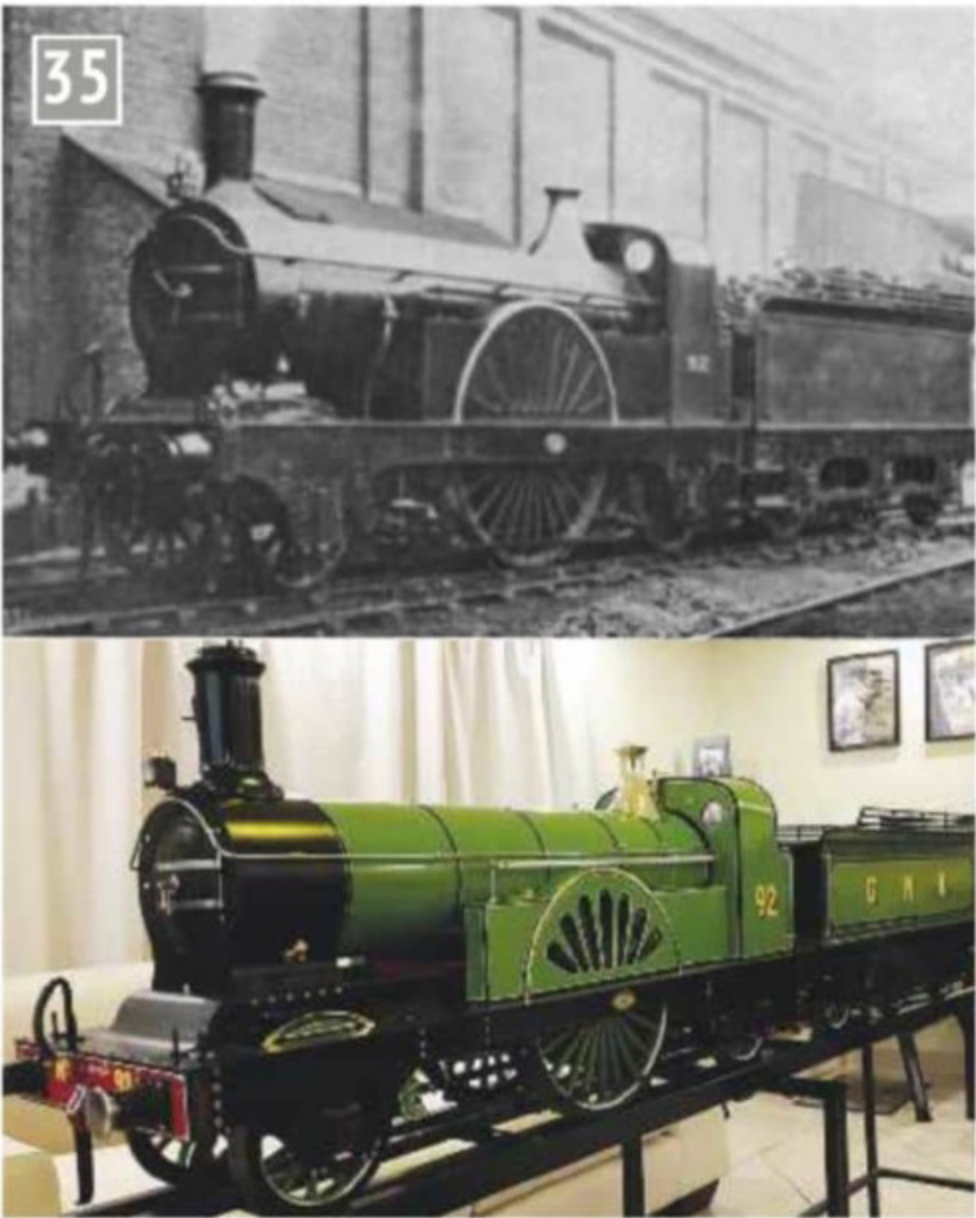
Posing for the camera

The locomotive was tested on air and then tested on steam. Surprisingly everything worked well without major issues. So, before the locomotive gets scratched and dirty from going round the track at RSME I thought it prudent to take some pictures (photos 35 – 40).

The conclusion

Subsequent to the photo-shoot the locomotive has been to the RSME club to put it through its paces. Day one was a disaster and I'm not ashamed to say I didn't get it to work the first day on the track. The locomotive steamed really well with every mechanical system working as expected but other than it wouldn't stay on the rails! The smallest curve would have it derailing. It turned out that the flexibles between the engine and tender were too tight, not allowing enough movement, and once this was addressed the locomotive and I flew around the track without any issues.

It's an interesting locomotive to run. Because of the size of the locomotive there are delays with everything that runs off steam like the regulator and steam brakes (just like the real locomotive, I might add). It is rewarding seeing how efficient my boiler design is; I kept the fire door open for most of the day to stop the safety valve from blowing off unnecessarily and I was never short of steam. It ran on

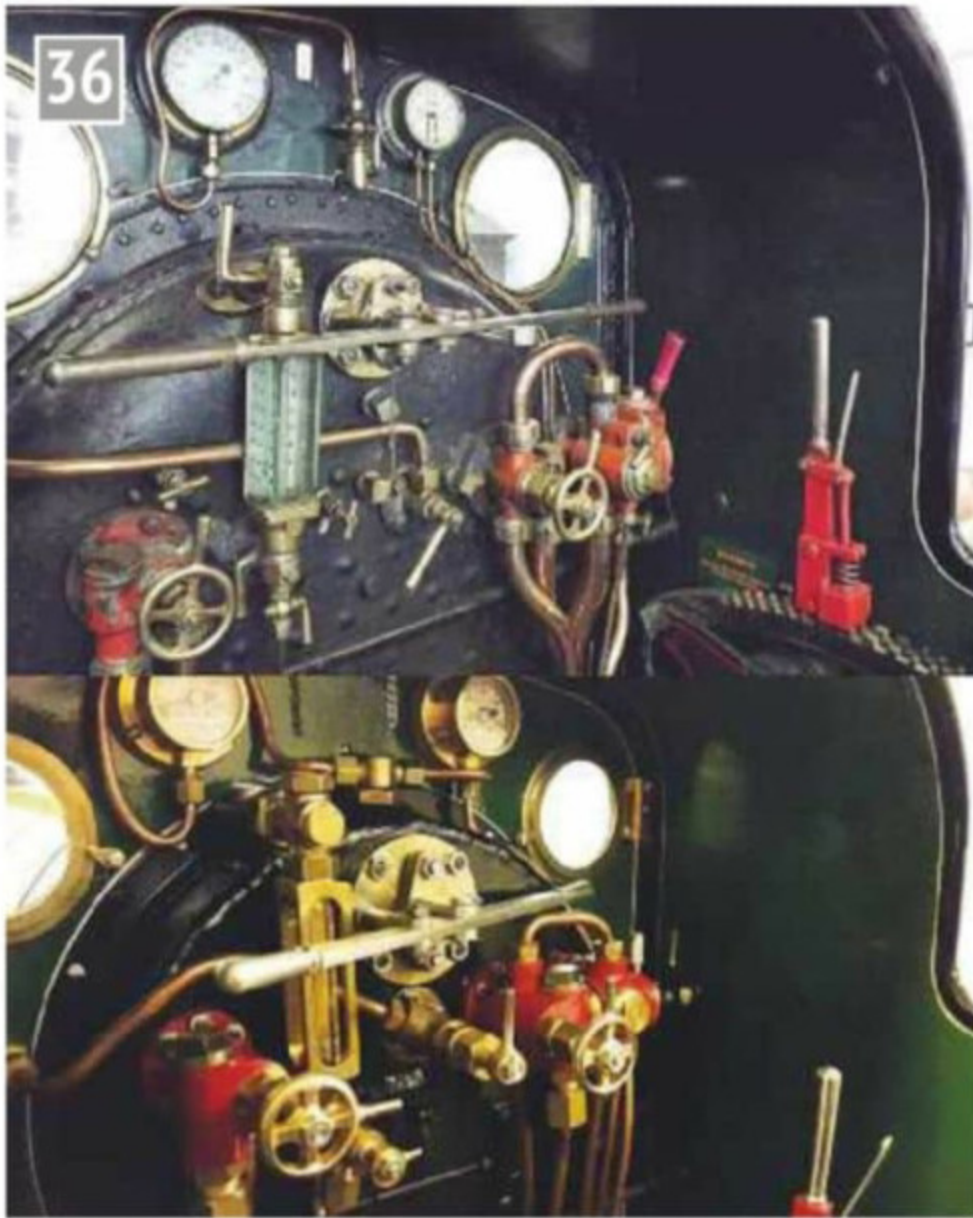


Comparing the prototype and the model.

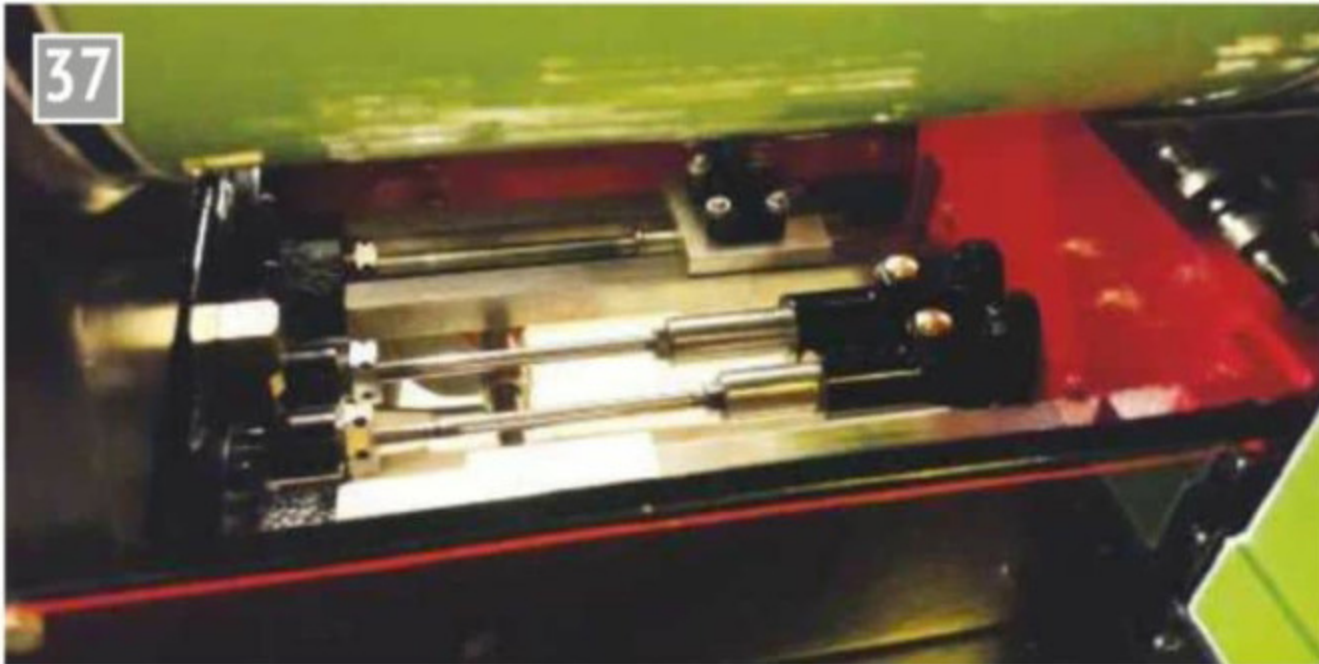
anthracite with the firebox less than half full - in retrospect I could have moved the fire door down further. For those familiar with steam trains this locomotive hasn't got a steam dome. Regardless, with my regulator design and super heaters in place I have yet to get priming.

Table 1 has a few statistics that might be of interest.

Table 1 - Vital statistics	
Total number of engine parts excluding fasteners/ rivets	380 est
Total number of tender parts excluding fasteners/ rivets	132 est
Number of unique patterns	36
Total dry weight of engine	140kg
Total dry weight of tender	44kg
Boiler volume	8.26 litres
Boiler pressure (design)	100psi (6.9bar)
Piston diameter	38mm
Piston stroke	82.6mm
Project timeline	June 2015 - Dec 2017
Largest casting	Main wheel 4kg
Smallest casting	Valve handles 7g
Smallest valve (ball size)	Whistle 2.5mm
Largest valve (ball size)	Safety valve 12.7mm
Smallest machined item	2mm drain cock shafts
Superheaters	Radiant type SS316
Lubrication	Cylinders – mechanical Other – oil pots
Valve gear	Stephenson's link



Backhead of the lifesize Stirling and the model.



Valve spindles.



Side view of the locomotive.



Back view of the locomotive.

Acknowledgements

I would like to thank the following people:

First and foremost, my beautiful wife who has more patience and tolerance than I deserve. She never lost it every time she found some container in the fridge that had no rightful place being there or tools beside the evening meal in the oven. In addition, my wife is always willing to proof read my articles and give me a helping hand with the photographs.

To Adendorff for their support in writing these articles - always willing to go the extra mile for their clients. Nearly all my machines were supplied by Adendorff and, as you can see from the articles, they have performed admirably. On the odd occasion when I have needed some assistance the sales guys have always impressed me with their willingness to listen to the problem and help me find a solution.

To everyone willing to take the time to read my articles and share my passion in manufacturing techniques, I hope you enjoyed this series!

To Alwyn Woest for machining the tyres. They were the only components that didn't fit on my lathe and I wouldn't have trusted anyone else to do it for me.

To Philip van der Meer for

all his advice on metallurgy, welding and our long engineering conversations.

To Leon, Uncle Nick and all guys from RSME who are always willing to help solve the latest engineering challenge, and are very generous with their experience and knowledge.

To Gavin Chan Yan for helping me cut the wood for the buffers and checking that the piece of sleeper wood from my Great Grandfather had no steel nails in it.

To Stephen Gwynn-Jones and Salim Essack for the 3D prints.

To Paul Malone, Danny Muller and the guys from TB who pointed me in the right direction with casting.

To all the companies (notably General Profiling, Theo's Metals, Non-ferrous Metals, Resistant Materials Services,



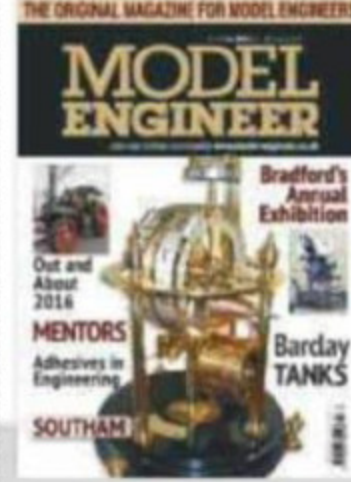
Front view of the locomotive.

Lilsales and Hydromobile) who supplied the materials etc. needed to complete this project. The quantities were generally small and the effort on their part was large.

Then finally, to everyone not specifically mentioned that contributed to this project. The smallest contribution moved the idea of scratch building a locomotive closer to a reality.

ME

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Lathes and more for Beginners

PART 43

Graham Sadler explains a procedure for removing the wear from your lathe.



If you have made all the projects I have outlined, you will have a sizeable quantity of kit, for holding taps and dies, tools, a clamping kit with the tee nuts, a tool-post and tool holders, soft vice jaws, a rack for your files, slitting saw arbor, centre height gauge, a height adjustable boring tool holder, a spindle hand crank, equipment for dividing, a grinding rest and the equipment to grind lathe tools, boring tools and even sharpen milling cutters. In addition we have covered a host of engineering terms and some of the important basic skills needed for success. Now it is time to examine ways in which they help achieving accuracy of work.

Setting up your lathe

The most important thing is how to set up the lathe correctly. I didn't cover this earlier, as there wasn't a lot of point, when the basic skills and knowledge of how to operate the lathe hadn't been covered. When we mounted the lathe a long time ago, we did an approximation of getting it level using a spirit level. Now it's time to do the job properly.

Before you start, give the whole lathe a thorough clean, service and lubrication including the head and tailstock centre bores. Most people will have pre-owned lathes so it is probably a good time to give it a good overhaul. Take care that keys are not lost and ensure plenty of clear space to deposit removed components and space for cleaning. Don't be afraid of this task as it will teach you a lot about your machine!

- Remove the screws holding the cross slide screw bracket and the nut and remove the cross slide.
- Remove the locknut at the end of the lead screw and remove the hand wheel.
- Remove the right hand lead screw bracket. This will mean moving the saddle to the extreme left so the lead screw can flex enough to pull the bracket off the dowel pins.
- Remove the gear train banjo and gear cover then remove the collar at the end of the lead screw.
- Lock the half nuts and move the saddle to the right to pull the screw out of both bearings then remove the screw. This is a lot easier for a non-gearbox machine.
- Support the apron underneath then undo the cap screws retaining the apron.
- Undo the bolts which hold the saddle lower guide plates onto the bed and remove the saddle.
- Remove the bed wiper assembly. This can be washed in paraffin by holding the end and squeezing between finger and thumb, sliding down the length. This will remove a surprising amount of tiny particles. The working face is scratched with a craft knife to remove any glaze. OEM felt wipers are expensive for what they are and this treatment will virtually fully rejuvenate them.

All parts should now be cleaned with wipes, then in a paraffin bath (use gloves and a face mask or the elf'n'safety bods will be after you) with

small nylon brushes to clean all parts fully. Take care not to disturb the stacks of shims bonded to the underside of the saddle - these appear to be solid but are 0.002 inch laminated shims.

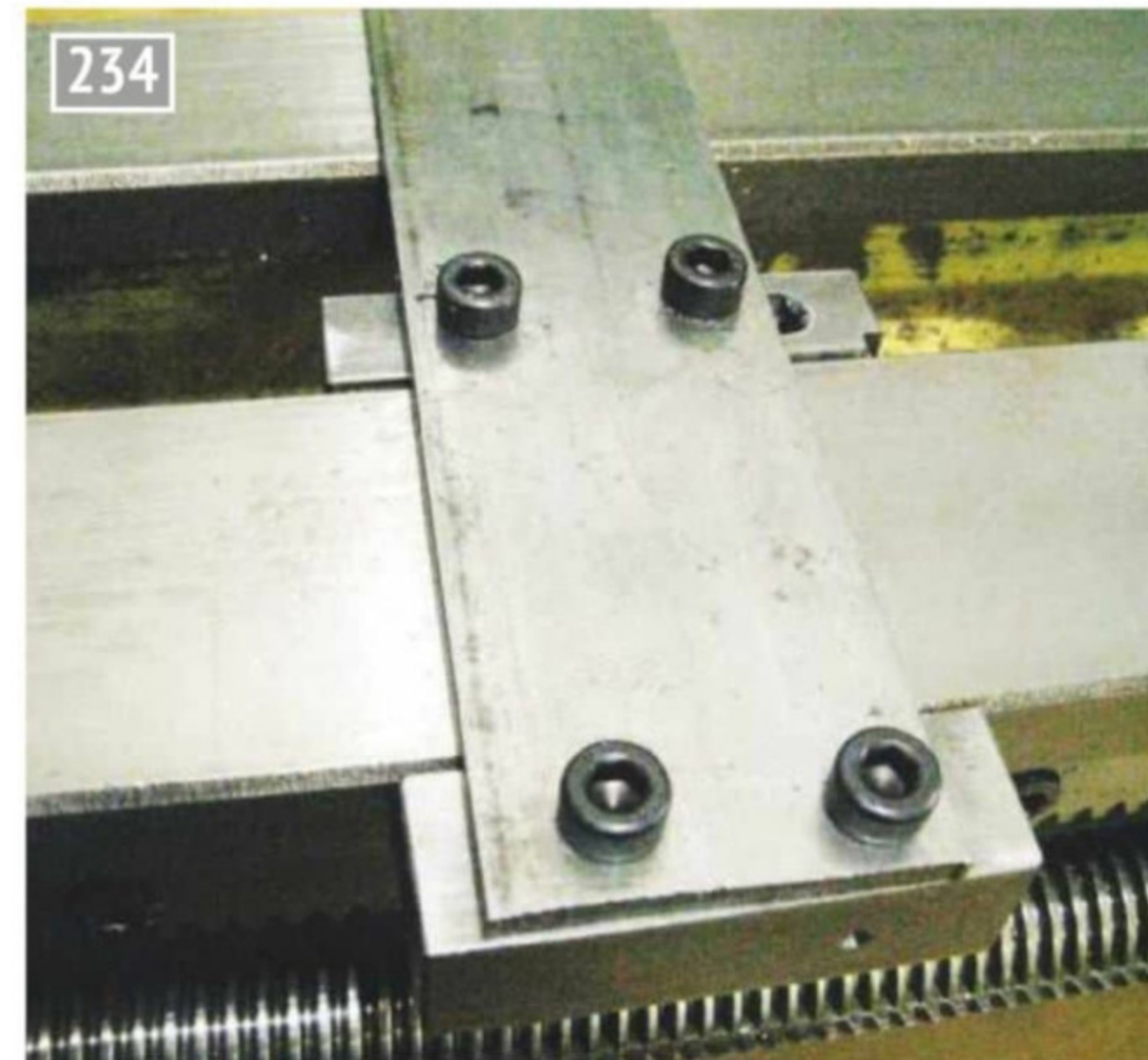
A symptom of wear

One problem does exist with older Myfords. They were designed to use the outdated narrow guide principle where the saddle was guided only by the front shear. All well and good in theory, when the machine is new, but the two working faces are of different lengths, the inner one being very short. Furthermore, the saddle hand wheel is on the right where the inner guide does not extend. The result is that the saddle will tend to twist during a cut towards the chuck, causing unequal wear, especially on the short inner shear. This will seriously reduce the accuracy of the machine.

If you take a big roughing cut, measure, then add a light finishing cut you may find that the shaft does not end up the expected size. The roughing cut will cause the saddle to twist more (clockwise) and thus cause the tool to dig in, the tool being over the left end of the saddle, while with the lighter finishing cut this problem will not be so severe. Later machines (including mine circa 1982) use the wide guide so that the outer edges of the bed are used rather than just the front shear, thus eliminating this problem.

Solving the problem

There is a well-known solution to this problem, which makes



The simple dummy saddle jig to check the bed shears, set up here to check between shear 2 (reference face) and the front, shear 1. Any adjustment for a wide guide lathe starts here, then works between shear 1 and 4. For narrow guide lathes, start with shear 4 as reference to correct no. 1 then true no. 2 from it. The device is surprisingly sensitive.

use of the unused machined back face of the saddle.

Measure the gap between the back shear and the back vertical face of the saddle. We now get a strip of steel to fill that gap but note, it **must be perfectly parallel**. Now the old step in the centre of the saddle is machined to get a clearance and the new strip of steel is bonded in place. This may throw the whole saddle forward but the front gib screws will take up any slack provided it is not too large.

On reassembly of the lathe, you will need to check that the lead screw has not been thrown out of line when the half nuts are engaged. Your DTI will tell you of any deflection but do check this several times. In this case it will be necessary to pack the lead screw brackets out with shims. With a gearbox machine, the box will also need to be realigned. This is achieved by supporting the box on wedges at each end then measuring the height of the lead screw at the tailstock bearing and checking that it is the same at the headstock. The top of the gearbox is removed to use the machined top face as a datum. The DTI is now put on a long bar so that the top of the box can be set parallel

to the bed. This task is quite straightforward but it must be correct or the wear will be rapid in the whole system.

The saddle retaining strips are matched to the thickness of the bed shears by a set of laminated shims, factory fitted, and these if required can be peeled off to reduce clearance using a razor blade - but tread carefully! Do not bend the shims when removing them as you may go too far and need to put one back. A kink in it will do no good at all.

Get a very, very fine file and very lightly rub it dead flat along the top of the bed. This is to detect the presence of any small raised nibs, caused by (say) dropping a spanner onto the bed. Any high points should be carefully removed. This of course is not required if you have a hardened bed. DO NOT attempt to remove any dents - just the raised crater rim. The hole itself will provide a nice oil reservoir... Check the inside face of the saddle for scratches caused by lumps of swarf, or worse still abrasive particles, and treat them in the same way.

Refit the saddle and adjust the gib. Set the outside pair first then bring the inner one into contact with the gib

strip but not causing any change to the movement of the saddle. Hopefully there will not be much difference in adjustment required at each end of the bed. The saddle at the headstock end gets most use and, when this is correctly adjusted, the saddle can lock at the unworn tailstock end. If there is, then the correction is not easy. Ideally, a large micrometer will be needed if your machine is originally a narrow guide version (although there is a way round this) and the unused pristine back edge of the bed will be used as a reference. A smaller one will be sufficient if you have a wide guide machine where the relatively unused inner edge of the front shear can be used. Only the tailstock slides on this and this is not moved much compared to the saddle. Measure the width from your reference face and record the differences every 25mm to get a clear picture of the problem.

Fixing general bed wear problems

Correcting any wear problems needs a lot of care but it can be achieved with simple kit. Firstly, make the tool shown in **photo 234**, which acts as an adjustable variable width saddle. The dimensions are unimportant but the end blocks need to be a minimum of 60mm long from $\frac{5}{8}$ inch or 16mm square stock as the bed shears are $\frac{1}{2}$ inch thick. These should be machined true on two faces or you will get false readings. Use M5 screws tapped into the

blocks passing through 6mm clearance holes to give plenty of adjustment.

Although drawn steel is square enough for most work, the faces may not be fully flat or at perfect right angles. Fixing this is a simple facing job with the blocks held under the tool post (**photo 235**). Ensure the finish on the working face is as good as you can get it. I used a dead smooth file to carefully remove most of the machining marks from the working face but take care or the face will be rounded.

Check that the cross mounting plate from 50 X 3mm steel flat is actually flat and does not have any dings on what will be the working face or they will cause it to rock in use. Use a fine file to draw file these away and check there is no rocking or twist by laying it on the lathe bed. The tool seems crude but when set up it is remarkably sensitive.

I will number the vertical shear faces 1 to 4 from front to back. Assemble the jig onto the bed of the lathe. Do this at the tailstock end, which will be the least worn. Tighten the reference face, then clamp the other block tightly against the shear. I used two small 'G' clamps for this, working on the blocks themselves. Now move it to the headstock end and see if you can measure any wear by using feeler gauges. This will give you some indication of the problem in hand and how much material will need to be removed from the tailstock end.

●To be continued.



Fly cutting the $\frac{5}{8}$ inch jig square end blocks true.

Garrett 4CD Tractor PART 58

in 6 inch scale

Chris Gunn
redesigns the
lubrication
system.



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



At the end of the rally season last year, a long running problem I had with the lubricator on my 4 inch Garret came to a head when the unit stopped pumping oil and I could do nothing with it to make it pump. I had had problems with the non-return valve in the system a number of times prior to this, enough to make me modify the oil inlet valve on the cylinder block. I redesigned the valve to incorporate a needle valve so I could shut off live steam to the oil line, so I could work on the lubricator in the field, with steam raised. This came in very handy as problems invariably happened at the most inconvenient moment. I was able to isolate the lubricator, clear the lubricator fault and then get going again. The lubricator also had an oil leak from the operating lever spindle, which meant the oil dripped down from the lubricator and dripped onto the hot cylinder, making an

ever present mess. In between rallies I always had a small oil puddle on the garage floor.

One of my fellow club members pointed me in the direction of an article from a back copy of the *Model Engineer* written by Eric Lindsay in the 23 August issue in 2002. The article described a modification to the lubricator, which incorporated a commercial oil pump element made by Interlube. These are often used on commercial vehicle automatic lubrication systems. Often a ring of these small oil pumps is mounted in a circle around an eccentric cam and as the cam rotates, each pump in turn will deliver a shot of oil to the designated oiling point. The pump element incorporates a tube connector, a non-return valve and the pump piston return spring all in one compact unit. I was also given a couple of the pump elements that came off a truck lubricating system that had been replaced with a new one.

I took the lubricator off the 4 inch scale engine and the pump element and had a good look through the article. I took the lubricator to pieces, which was not easy as it was very difficult to disassemble the shaft, as the $\frac{1}{16}$ inch pins had been poorly drilled and I found the boss of the hardened ratchet wheel was broken away around the hole. I finally did get it apart and then I could see the source of the oil leak, which was wear in the bore and on the shaft on which the ratchet and pump eccentric run. The problem with this type of lubricator is that the shaft is running in a short bearing in one side of the casing and the action of the pump causes a moment about the bearing, which will lead to wear in due course. After chatting with some of my fellow club members around the camp fire at one of the rallies, it turned out that I was not the only one with this problem.

When I took all this into consideration, I decided to bite the bullet and redesign my lubricator completely and hopefully eradicate the leaking problem and incorporate the Interlube pump as well. I figured that it would be as quick to start again as trying to bodge up the old one. As my engines do work during the summer season it is vital that the lubricator is in good shape and pumping oil.

I started sketching on graph paper and came up with a layout and some of the principal dimensions. Then I booted up my old version of Visual CADD to check this out on my computer, but the program kept crashing, as it was not happy with Windows XP. I tried a trial version of Visual CADD, which did work, but before the trial ran out I came across a 2D/3D version of Total CADD in the clearance bin at PC World for a tenner; I bought it and worked up the design on that.

I do sometimes wonder if some of these programs are unnecessarily complicated and have too many options and choices. When I was working I was an early adopter of computers and CAD but with a simple 2D version called Generic CAD, which worked on a DOS platform. This had enough choices to enable me to do all the design work on it and had enough features to do all I needed. It was quick to use as it did not have a lot of menus that I would never use. It also had a feature which I have not found on any of the newer ones (bearing in mind I am no expert and have only dabbled since I retired); it was possible to load one drawing on top of another, which was really handy when doing layouts for customers and saved loads of time.

Unless you are using one of these programs every day it is easy to forget which tool bar contains what, which makes it slow going when coming back to it after a six month gap.

Anyway, I digress, I set out the lubricator for the 4 inch Garrett and as I also needed

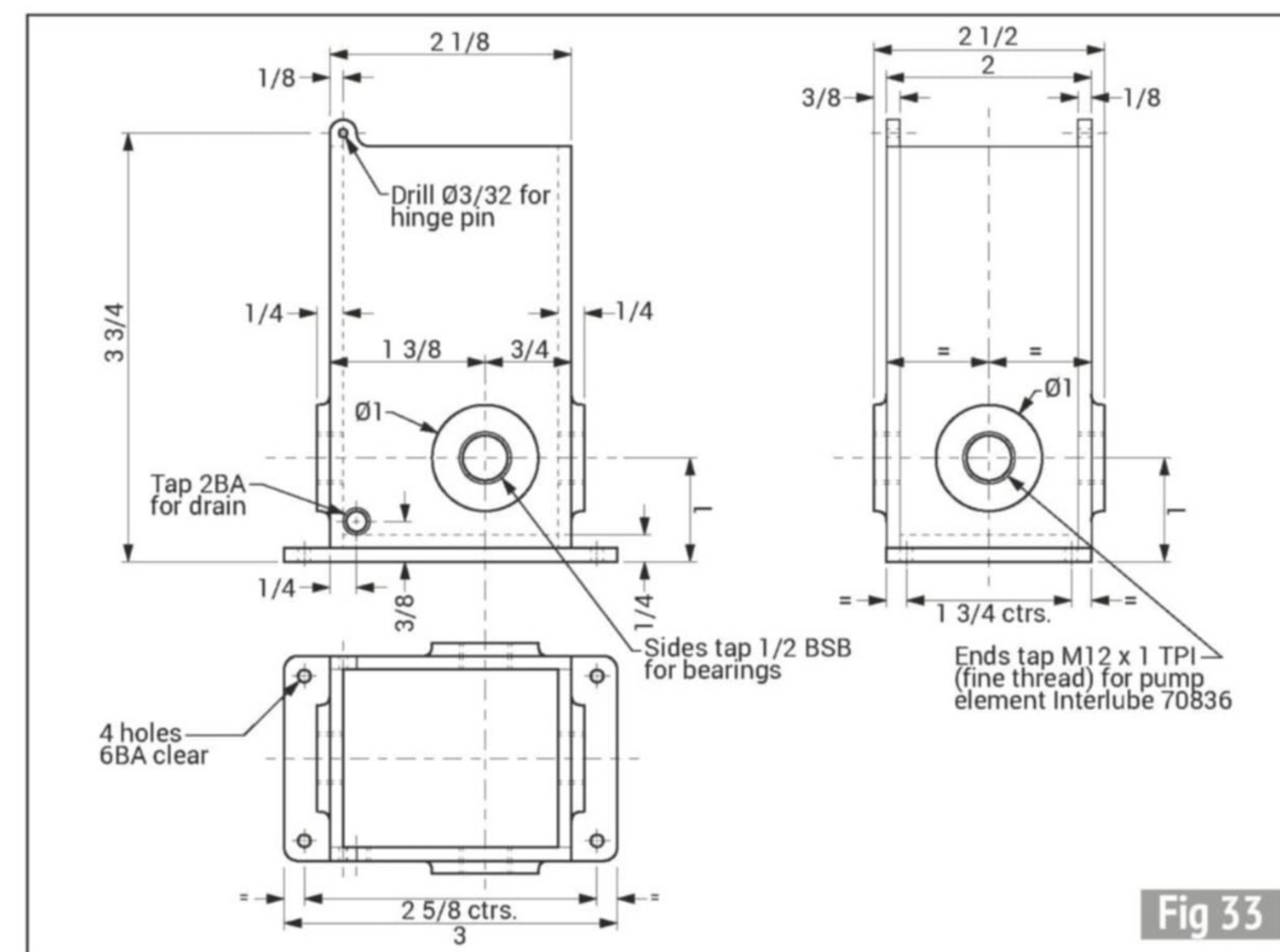


Fig 33

one for the 6 inch Scale 4CD, I did a scaled up version for that too. The main features of the lubricator were that I used the Interlube pump element and placed this as low as it could go in the tank. The pump was driven by a cam on a shaft which was supported by bearings on both sides of the tank. I would use a sprag clutch instead of a ratchet wheel and locate this in the operating lever. However, I would need a ratchet wheel to stop the shaft running in reverse. The size of this ratchet was not important.

I already had a couple of $\frac{1}{4}$ inch bore sprag clutches - which I had acquired 30 years ago at least, for some long forgotten project - and luckily I put my hand straight on them (who says my workshop is an untidy mess?). I also found these available on the internet from several suppliers, with $\frac{1}{4}$ inch and 6mm bores in various qualities. I had some ratchets which I had kept since I worked at British Steel in 1970. At the time our department was responsible for maintaining the old Leo computer and long after Leo was made obsolete the stores had a clear out and I was given a box full of useful

new mechanical spares that came from the printers and card readers, as they knew I built models. Amongst these were 4 ratchets and these duly came in handy after a 47 year wait.

The general arrangement drawing of the 6 inch lubricator body is shown in fig 33.

Figure 34 shows the components that make up the pumping section of the lubricator, together with the items that fit on the pump shaft. Figure 35 shows the components that operate the lubricator.

The drawing shows the main dimensions of the tank as I imagine that not everyone will want to make the tank in the way I did (which was driven by materials available to me at the time). Having designed the lubricators around the parts I had available, it was time to start making them.

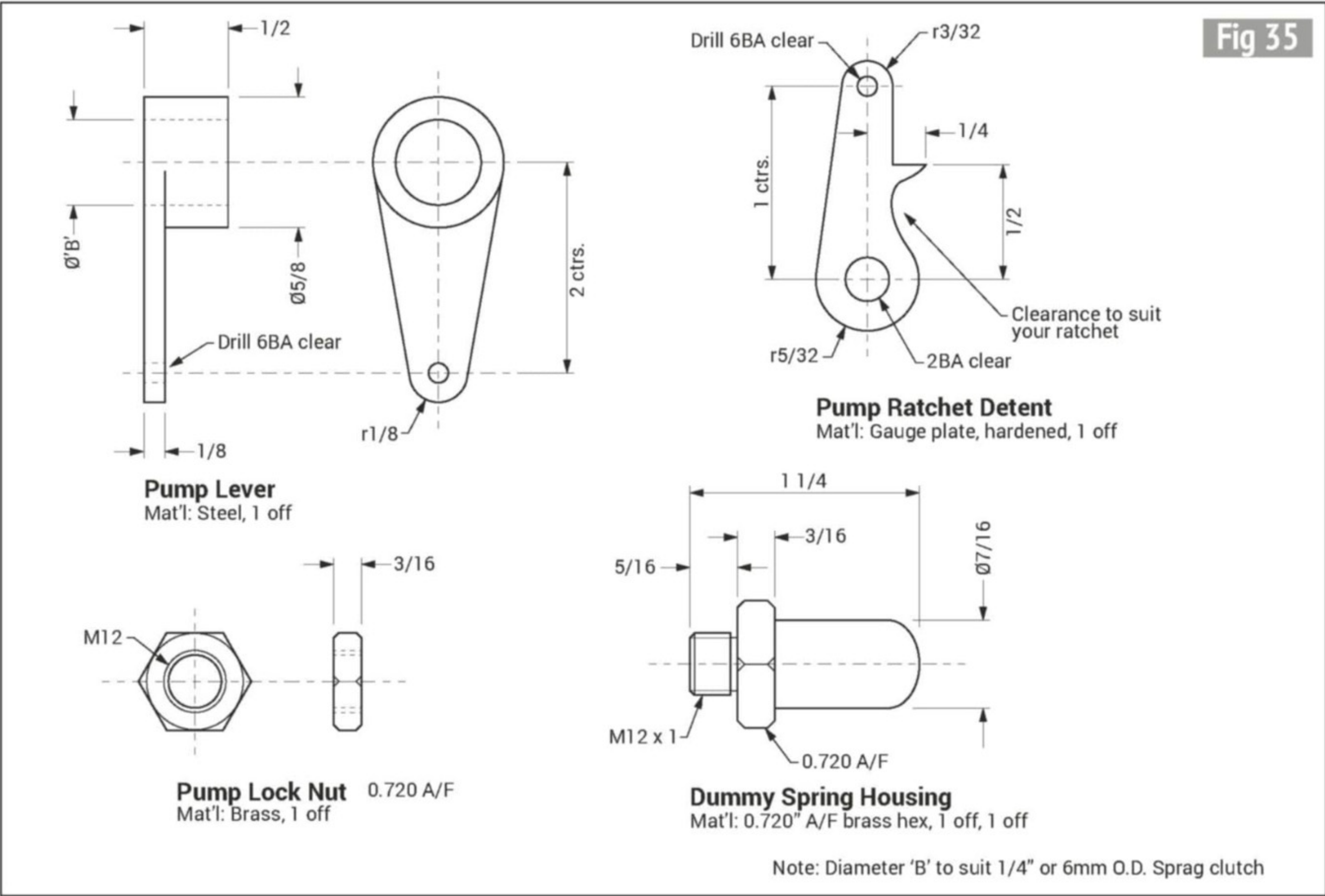
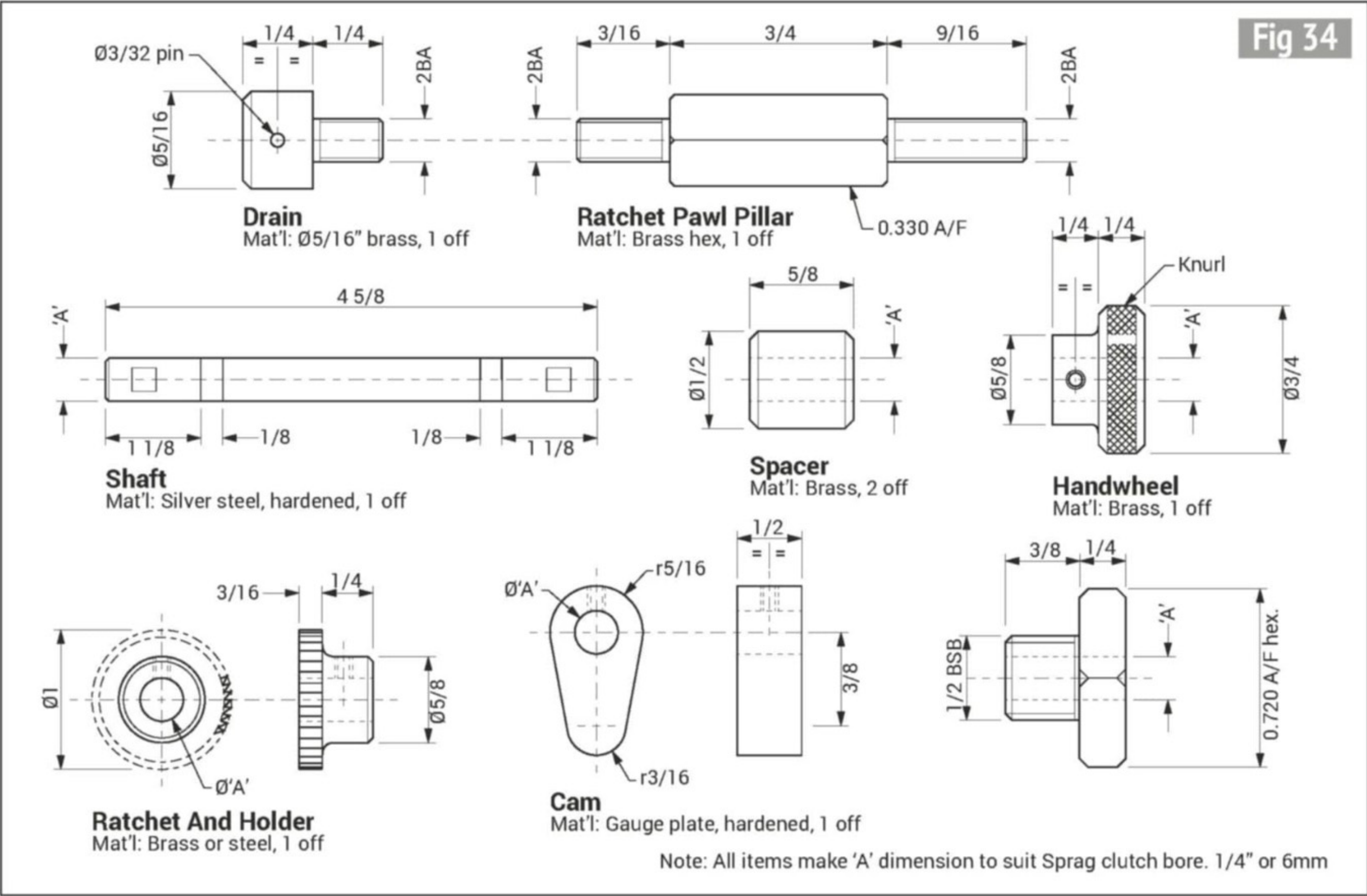
I decided to make them together as I needed the 4 inch scale version first, ready for the next rally season; the 6 inch version would be needed in due course. The 4 inch scale version and the 6 inch version shared some common parts and others were similar but of a different size. Some

commercially made lubricators use a cast tank, others use a tank fabricated from square brass tube. I did not want to get involved with a cast tank and could not find square brass tube big enough for the 6 inch version.

As the sides and ends of the tank need a boss for the bearing or pump, I decided to machine the tank sides from solid using some off-cuts of brass plate. I had a quantity of $\frac{3}{8}$ inch thick brass plate off-cuts from my working days so I decided to mark some of them out and turn the thickness down to 3mm, leaving the boss proud at $\frac{1}{4}$ inch long for the shaft bearings and $\frac{1}{8}$ inch long for the pump and dummy spring housing.

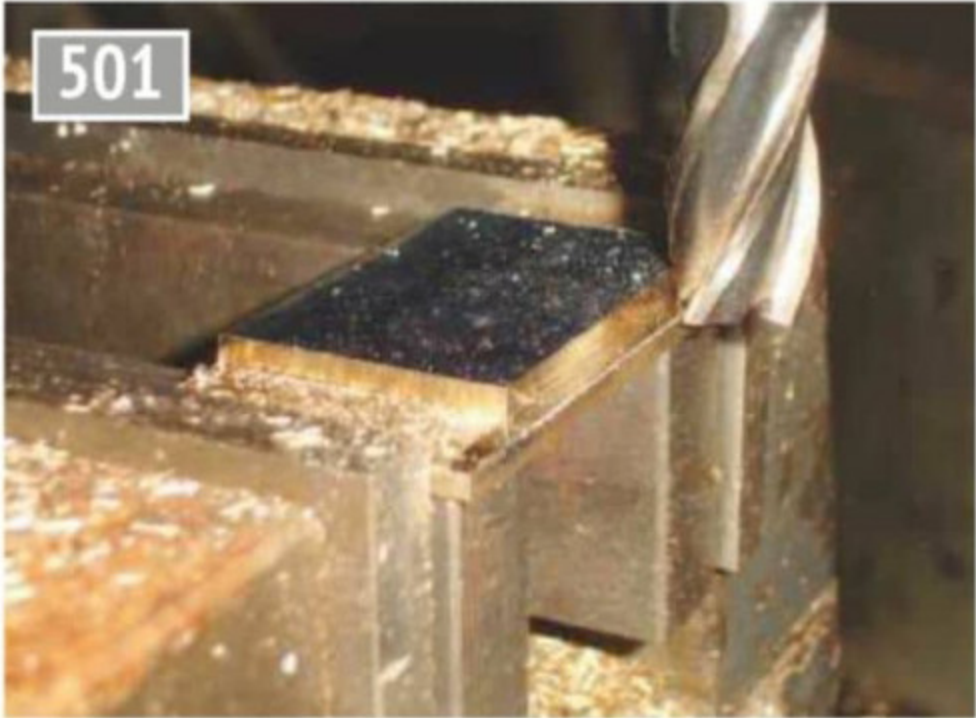
I made a base with a step around it and then silver soldered the whole lot together. I can imagine that this sounds like a lot of messing about to make the tanks, but it was surprisingly fast to do and I felt it made a good job. The brass sections were sawn off close to size and then milled square and to size, milling and drilling a pair of opposite sides or ends together. It is important to mill the sides of the plates

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

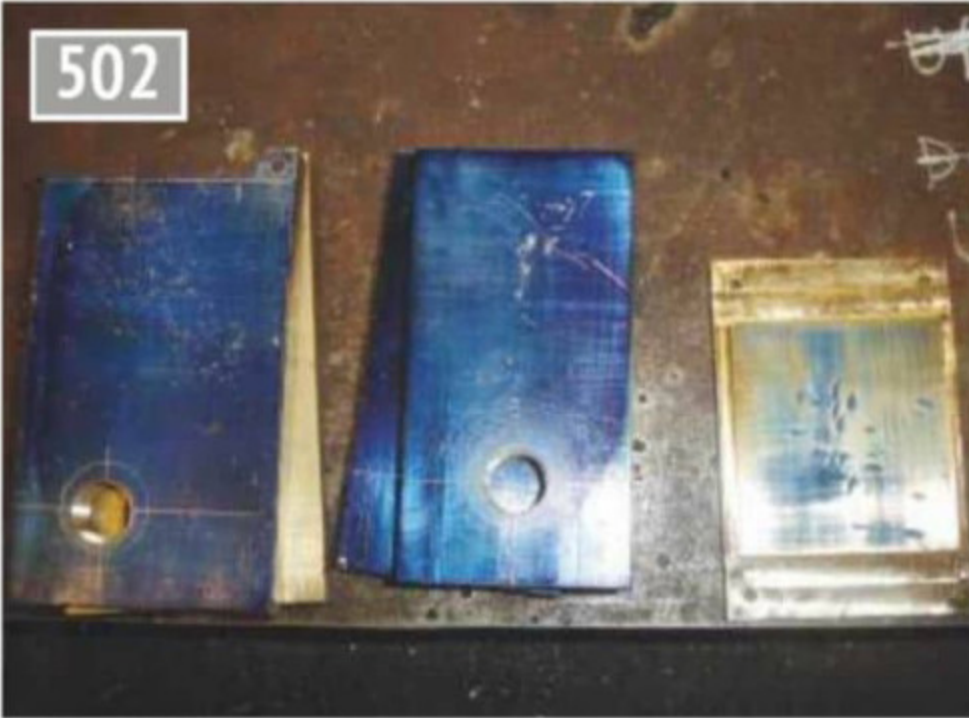


to match the upstand on the base, so when assembled, everything fits together nicely. I milled the top of the sides down to leave a small upstand which would contain the lid hinge pin hole.

The sides were drilled in pairs, drilling the holes for the lid pivot and another hole in the centre of where the boss would finish up and I drilled this and tapped it 1/2 inch BSB, a fine thread for the two shaft bearings. I had elected to fit separate bearings so these could be renewed at some point in the future, should this be necessary. I had decided to make the bearings from hexagon and these would be threaded in and screwed to the shoulder and then reamed in line. I would not normally advocate fitting bearings this way, as a poor thread could pull the bearings out of line, but in this application and material I felt this would suit. I also wanted to be able to change



Milling the lubricator base.



The tank sides drilled and tapped.

the bearings should the need arise and making them in this way meant I could unscrew the bearing and either bush them or make new ones. I did not want to press the bearings into the boss and then have to push them out again with the risk of bending the sides of the tank. Once the bearings were renewed it is a simple matter to ream them in line again.

The ends were just drilled and tapped in the centre of where the boss would be. The

'front' was tapped an M12 fine thread to fit the Interlube pump module and my fellow club member who donated the lubrication pumps also loaned me the tap. The 'rear' was tapped to take a dummy spring housing, which would be fitted to make the assembly more like the real thing.

The bases were also milled square and then a lip was milled all around creating a register for the sides and ends. The ends of the base were

drilled 6BA clearance for the mounting screws. **Photograph 501** shows the lubricator base being milled and in **photo 502** the tank sides are drilled and tapped.

●To be continued.

NEXT TIME
We continue by machining the bosses and bearings.

ISSUE NEXT ISSUE NEXT ISSUE NEXT ISSUE NEXT ISSUE NEXT ISSUE

- **Men In Sheds**
James Wells looks back at the aftermath of World War II and marvels at the ingenuity of the 'men in sheds' during the post war years.
- **Drax Power Station**
Roger Backhouse spends an Engineer's Day Out at the mighty Drax power station in Yorkshire.
- **C38 Locomotives**
Les Phillips describes the construction of a couple of Australian 5 inch gauge Pacific locomotives.
- **VMC Mill**
Peter Russell adds variable speed control to his Warco VMC milling machine.
- **Four Inch Burrell**
Alan Barnes tells the story of Derek Finch and how he was inspired to build his own 4 inch scale Burrell agricultural traction engine.



Content may be subject to change.

Perpetual Motion

Dear Martin,
I was catching-up with *Model Engineer* issue 4583, pages 503-505, concerning Roger Backhouse's meander into the spooky realm of perpetual motion and thought I would like to comment.

You know, there's an old FBI saying, "you don't know what you don't know". I have always looked dismissively upon those who resolutely (and with resounding great authority) declare something to be impossible because of a particular artificially constructed rule - while a new, unexpected discovery lies in wait, ready to tip it into the bin - such is the accompanying state of denial that the adherents will usually disappear into the void clutching on to it by their fingernails!

A perfect example of closed minds if ever there was one!

A lot of the rhetoric is underpinned by trying to agree on exactly what definition you use to describe the concepts of 'Perpetual Motion' and 'Free Energy'. It is my view that the anti-PM/FE naysayers have a dilemma on their hands. If their position is to be secure then they must first pass this test - in so far as I know, no person has ever demonstrated or observed the spontaneous disintegration of a stable monatomic element, say, for example, Helium without any external nuclear process or other energetic agency being involved, essentially contained within a perfectly shielded box (an Albert Einstein 'thought experiment'). In other words, such atoms are, to all intents and purposes, *immortal* - 'perpetual', if you will. What discoveries from the LHC at CERN (Geneva) are telling us is that the equilibrium with stable elements is a *dynamic* equilibrium, i.e. the field effects due to the multi-particle constituents are interactive which implies that they must derive their energy from a source and since the

'Mystery Object'

Dear Martin,
Many years ago I was a typewriter service engineer and used one of these jigs when changing type slugs. On old style typewriters the 'type slugs' were fixed to the type bars with soft solder. If a typeslug got damaged and needed replacing, the procedure was as follows.



Remove the typebar from the basket and fit into the jig. The pivot end of the bar fits into the righthand slot and is retained by the pin on the end of the chain. The middle screw is adjusted to hold the typebar firm and the fancy part on the left is adjusted to align with the existing typeslug, both for angle and fore and aft.

The typebar can now be heated to melt the solder (we were issued with 'Valtec' blowlamps fired with methylated spirit), the old slug removed (use long nosed pliers) and the new slug soldered in its place.

In theory this method ensured the new slug was in the same position as the original. However, some adjustment was usually required; reheating and tweaking if a large adjustment was needed or using the usual type aligning tools if only a small adjustment was needed.

Mine was purchased from a company called 'Longs', who had an outlet in the east of the City of London (there were a lot of typewriters in the City of London in the 1960s).

Yours sincerely, Robin L. Saxton (North London)

atom is permanently stable it further implies that such a source of field energy must be infinite, if you will, *perpetual*. Some physicists have proposed that such similar disintegration phenomena might occur if matter were to reach absolute zero on the Kelvin scale and thanks to some fascinating experimental techniques (well worthy of an article all by themselves) some researchers have come tantalisingly close to within a microscopic whisker but so far, nothing shattering to report. In the meantime, physicists speculate, theorise, hypothesise, debate, argue and dream but still, no-one really knows.

It stands to reason that a verifiable proof of the *mortality* of such a stable element will give them righteous authority to declare "VICTORY!" and so I challenge the anti-PM/FE proponents to

present one proven example of a 'stable' monatomic element being observed to spontaneously disintegrate without due cause by any external agency.

My advice to the anti-PM/FE brigade is - don't get too smug underneath the heavy weight of your mantle of authority because the rest of us with open minds know that you only pretend to *know what you don't know!*

Kind regards, Andre Rousseau

Write to us

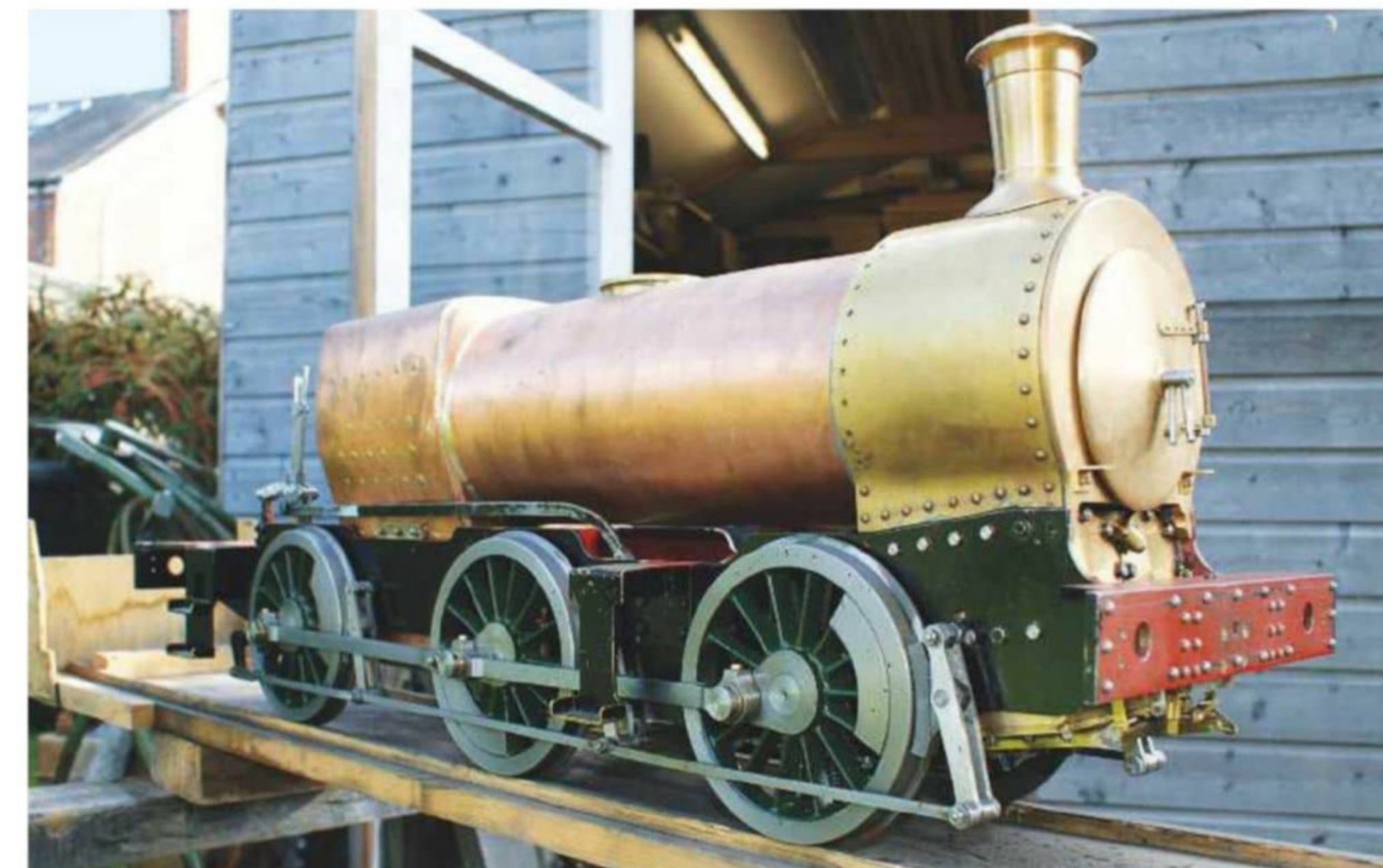
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A New GWR Pannier PART 7

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



Continued from p.851
M.E. 4614, 7 June 2019



Steam chests

Now, with the steam chests being underneath the cylinder block on this locomotive it means that I cannot take any meaningful photographs of course and I haven't got any of the machining either. I will therefore have to leave you with the drawings (see part 6 in ME4614) and hope you will cope with those all right. You will first of all need to machine both sides of the steam chest and make it $\frac{3}{4}$ inch thick. You can then make the two bores for the valve spindles and then open them up to $1\frac{1}{2}$ inch for a $\frac{1}{4}$ inch depth and tap each one $\frac{3}{8}$ inch x 32. The tail rod glands need tapping $\frac{1}{4}$ inch x 32 and make sure they align. Whilst you are at it you may as well make the tail rod glands which are just simple turnings from $\frac{1}{2}$ inch hexagon bar. First of all, face the end, centre and drill down $2\frac{3}{32}$ inch with a No.24 drill and then ream $\frac{5}{32}$ inch. Turn down $\frac{1}{4}$ inch to $\frac{1}{4}$ inch diameter and thread it $\frac{1}{4}$ inch x 32. Reverse it in a tapped bush and turn down the other end to $\frac{1}{4}$ inch diameter but leave a piece of hexagon on there $\frac{1}{16}$

inch long and turn another $\frac{1}{2}$ inch down to $\frac{1}{4}$ inch diameter. Finish it off by forming a nice rounded end.

Turning the wheels

You can now start on something a little more exciting and that will be turning the wheels. First of all, the wheels for Pansy are wrong - well, they were on the ones that I have seen, so I have had new patterns made which are correct. The cranks should be between the spokes.

First of all, you will need to make yourself a couple of little gauges from steel strip. One needs to be about $\frac{1}{4}$ inch wide and 3 inches long. At about $\frac{1}{8}$ inch from one end make a saw cut $\frac{1}{8}$ inch deep and another just under $\frac{3}{16}$ inch away. Cut the remainder out about $\frac{1}{8}$ inch deep and then file the slot carefully until it is exactly $\frac{1}{16}$ inch long. When you are facing the second side of the wheel you can use this gauge to poke through the bore to check the width of the centre boss. The other gauge is to check the tyre width and this needs to be a strip about an inch wide

and 3 inches long. Cut a slot in one end of it $\frac{1}{2}$ inch wide and about $\frac{3}{8}$ inch deep. Drill a little hole in the corner of each one and stamp them 'Wheel Gauges' when you have finished. You can then thread them on to a piece of florist's wire and hang them up in the workshop for future use.

Now, I have had to use the wheels from my Y4 to illustrate this article so hopefully you will bear with me on this, on the basis that a wheel is a wheel! There are several ways of turning the wheels depending upon the sizes of the lathe chucks you have. If your three jaw chuck is large enough (with the outside jaws in) to grip the wheel by the tread then fine. Measure the thickness of the wheel first to see how much needs taking off each side, particularly the tyre width.

Facing the back

Because of the casting process the back of the wheel is sometimes not quite concentric with the front and we need the front to look its best. So, if the tread will go in



Facing off the back of the wheel.



Reaming the wheel.

the three jaw chuck then hold it like that and using a round nosed tipped tool face the required amount off the back of the wheel. For this operation you will need to engage the back gear and use the slowest speed or, if it seems to be going well with little resistance to the tool, then you can up the speed a little. A good tipped tool will cut good cast iron like butter so don't be too scared to feed a good cut on. If you stall the lathe you know you have overdone it a little!

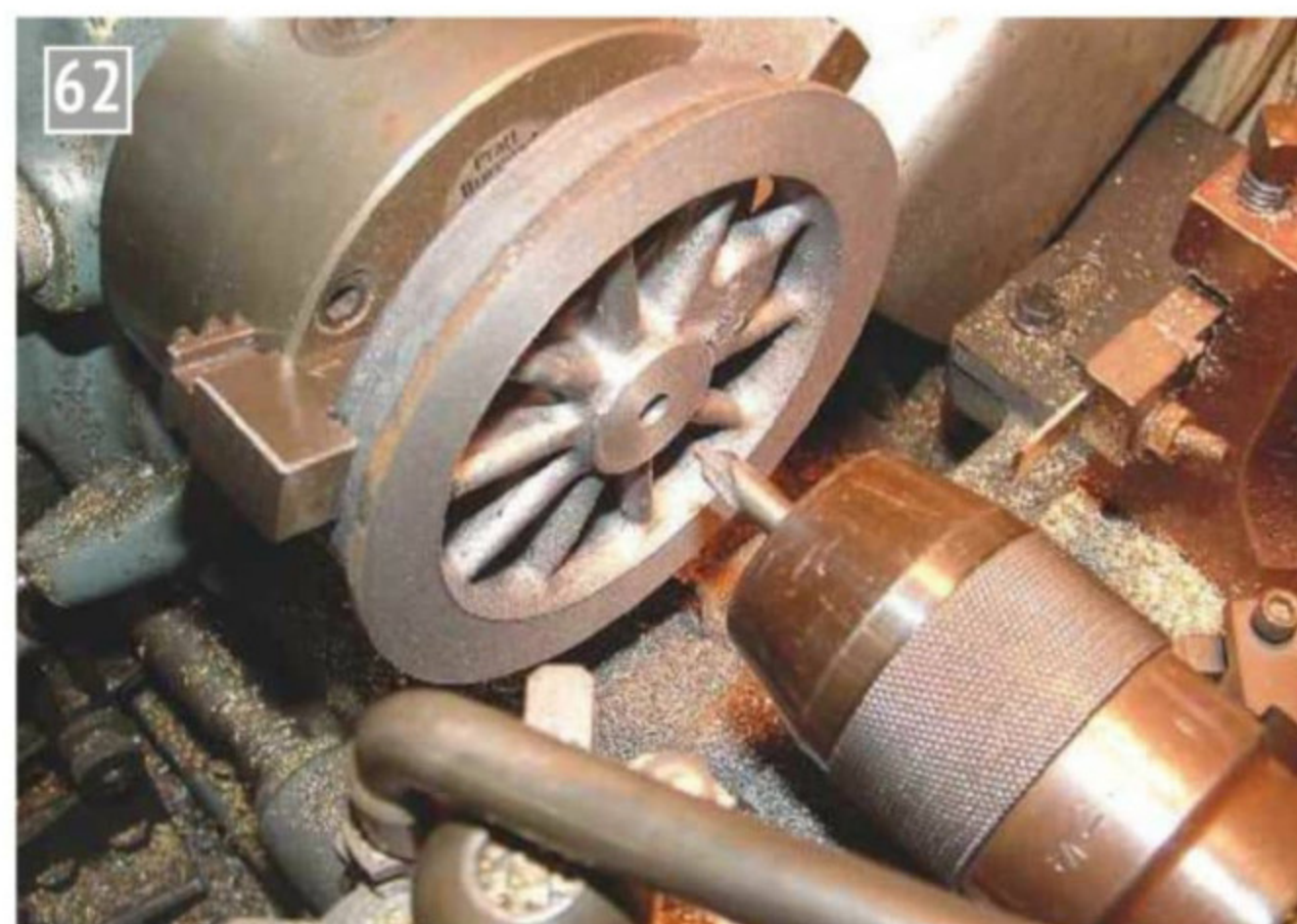
The first cut needs to be fairly generous (about 20 thou) to get under the skin of the cast iron. After the first cut you could use a slightly higher speed to get a better finish. Anyway, no need to rush things (photo 61).

Now centre the wheel (photo 62) and, using your $\frac{1}{4}$ inch drill with the sharp edges removed, drill through, then open up

to $1\frac{5}{32}$ inch and ream $\frac{1}{2}$ inch (photo 63). If the drill shows any sign of wandering stop immediately and use a smaller drill and finish off with a small boring tool using a gauge similar to the one described earlier. Best to make the gauge first anyway, just in case. The final operation is to turn the flange down to just over $5\frac{1}{4}$ inch diameter.

Facing the front

You can now grip the wheels the other way round on the newly turned flange and face the front of the wheel which should run reasonably truly (photo 64). However, it does help if you can insert some $\frac{3}{16}$ inch spacers behind the wheel flange so that it stands out from the chuck a little further and then you will be able to rough out most of the tread at one go (photo 65). Face the boss first and use your little



Centering the wheel.



The wheel mounted for facing the front.

gauge by poking it through the bore to see if the notch slips over the boss when the other end is hooked over the back of the wheel. You can use quite a bit higher a speed for this operation. Face down until your $\frac{1}{16}$ inch width gauge just clicks into place. Now, using the slower speed again, turn your attention to the tyre and face that down until your $\frac{1}{2}$ inch gauge just slides on the tyre. You can turn some of the tread down nearly to size but then we need to make a special face plate to finish the wheels off.

Wheel faceplate

To complete the wheels, you will need to make your own faceplate out of a blank disc of steel about $\frac{1}{2}$ or $\frac{3}{8}$ inch in thickness and $4\frac{3}{4}$ inches diameter with another disc of similar material approximately $3\frac{1}{2}$ inches diameter welded to

the back of it. However, first of all it is advisable to make the pin that goes into the middle of the plate on which to mount the wheel. You will need a piece of $\frac{5}{8}$ or $\frac{3}{4}$ inch free cutting mild steel bar and turn down approximately $\frac{1}{2}$ inch to $\frac{1}{2}$ inch diameter and thread it with whatever $\frac{1}{2}$ inch die that you have to hand, preferably something like $\frac{1}{2}$ inch BSF. Part off about 1 inch from the shoulder and then this can be screwed into the face plate once you are at the required stage.

Now, mount your faceplate in the four jaw chuck with the smaller boss facing outwards and centre it as best you can at this stage. I say this as if you have had the disc burnt out it will be a bit rough to go in the three jaw and that is common abuse! I use a height gauge for setting things up in the four jaw chuck and keep adjusting

the jaws until the scribe point touches most of it. It will be no good using a dial gauge as the surface will be far too rough for this first operation.

Turn the back (chucking flange) down to a reasonable finish though the diameter is not important and then take a facing cut across to true it up as this will be used as a register against the chuck jaws when you turn it round. You can now turn the plate round and hold it in the outer jaws of the three-jaw chuck marking with a pop mark alongside No. 1 jaw so that when you take the faceplate out you can replace it in the same position.

The faceplate now needs facing and for this job I use a replaceable tipped tool and I generally trail an old toothbrush full of cutting oil across the face as I am working although if you have a coolant supply, all the better. You can also take a cut across the outer rim just to tidy the job up and remove the burrs

with a fine file. On my own faceplate I relieved the centre with a 10 thou cut leaving a rim about $\frac{1}{2}$ inch wide so that when you tighten the wheel onto the face plate, it will grip on the flange and nowhere else (photo 66).

Next, centre drill and tap the centre of the plate to your favoured $\frac{1}{2}$ inch thread and screw in your part made centre pin. This now needs to be turned down very carefully until the wheel will just slide on with no shake. The outer end of the pin can then be turned down to your $\frac{3}{8}$ inch such that the shoulder is just slightly recessed in the wheel boss. This can then be fitted with a stout washer and a $\frac{3}{8}$ inch nut. Any thread will do.

Turning the tyre profile

Before you start on the next stage, you need a piece of 16swg brass strip, $\frac{1}{16}$ inch wide and approximately 1 inch long and on one end of it draw the wheel profile. This then makes

your everlasting wheel profiling tool grinding gauge.

You now need to grind the reverse profile onto the end of a piece of $\frac{3}{8}$ inch square tool steel and this again will make your everlasting wheel profiling tool and every time you sharpen it, you should use the brass gauge to check the profile. The front rake of the tool needs grinding to about 4 degrees but the top can be left flat. The remainder of the tread can now be turned down to size ($4\frac{15}{16}$ inch diameter). When you have turned the first one to the correct diameter set the dial on your top slide to zero and turn all the others at the same setting.

Turn all of the wheels to this stage and then with the last one still on the faceplate, set the top slide over 3 degrees (anticlockwise looking down on it!) and lock the cross slide and saddle so that only the top slide can be moved. Turn the tool holder about 3 degrees in the opposite direction so

that it is parallel to the face of the lathe chuck. In fact, the easiest way to do this is to press the tool up against the face of the chuck and tighten it in that position. This means that when you turn the cone on the wheel tread the tool will move across at 3 degrees but it will cut the profile to the correct shape which you have hopefully ground on your tool!

Take a small cut first so that the tool runs out about half way across the tread. Then take another cut so that it tapers the full width of the tread to the root radius, leaving the flange thickness at $\frac{3}{32}$ inch. If you have ground the tool correctly it will turn the tread taper, the root radius and the flange angle all in one cut (photo 67). There is another way to chamfer to edge of the wheel and that is to use a proper chamfering tool which is shown in photo 68.

●To be continued.



Spacers, allowing the entire tread to be machined.



Special faceplate, with slightly raised edge for gripping the flange.



Using the special tool to form the tyre profile.



A special chamfering tool.

Steam Turbines

Large and Miniature

PART 15

Tesla turbines - not as simple as they seem

Mike Tilby explores the technology, history and modelling of steam turbines.



Continued from p.856
M.E. 4614, 7 June 2019

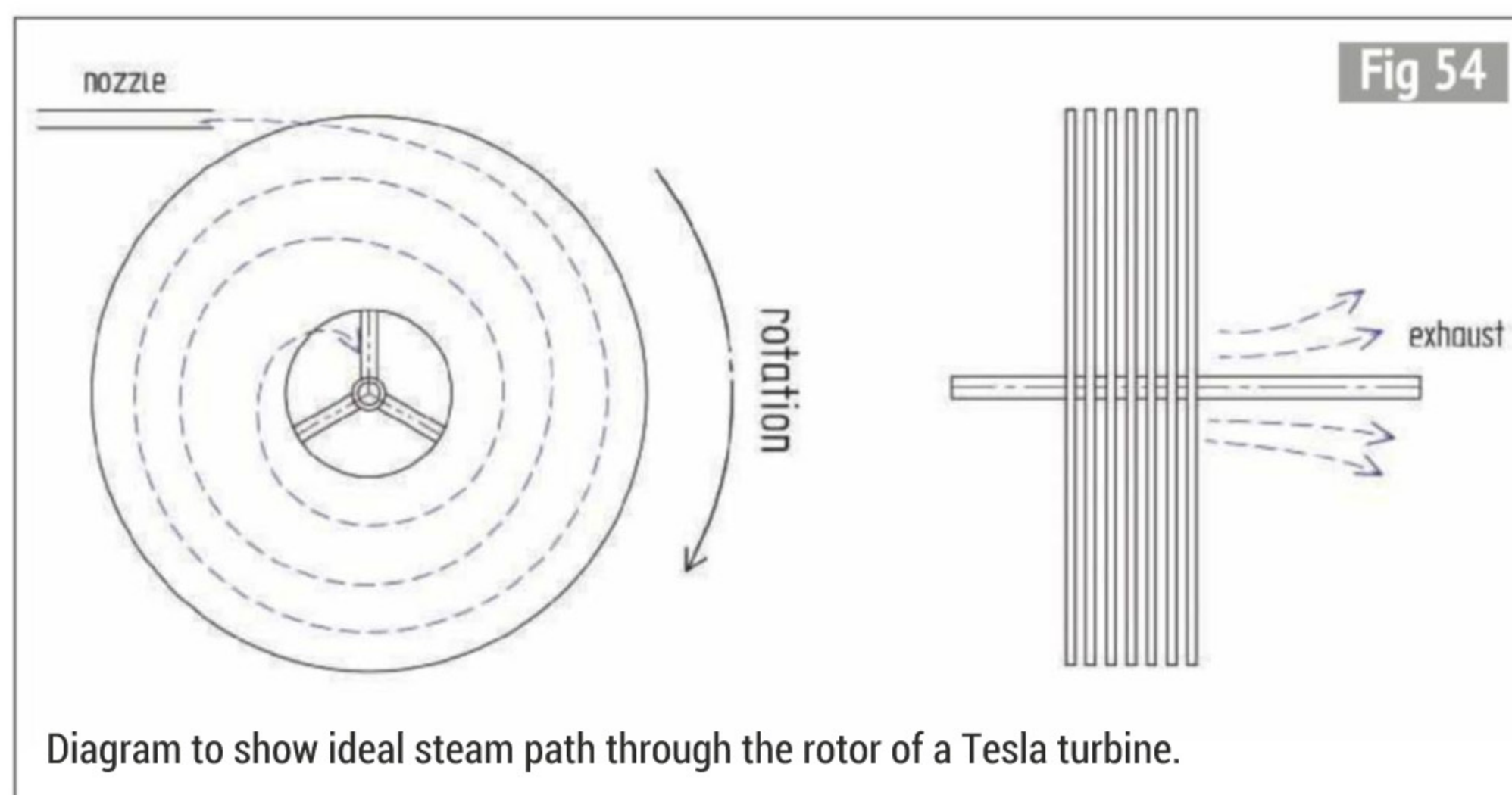


Diagram to show ideal steam path through the rotor of a Tesla turbine.

In recent decades Tesla turbines have become the subject of much interest amongst hobbyists. One reason for this is presumably that they are far simpler to build than conventional turbines. Another reason could be that miniature bladed turbines have a reputation for being inefficient whereas there is a lot of 'folklore' which attributes very high efficiencies to Tesla turbines. Also, Tesla turbines probably seem easier to understand than bladed turbines. However, although the process by which they transfer energy from steam to the rotor may seem straightforward, what actually occurs inside them is far from simple. Consequently, compared to bladed turbines, it is much more difficult to predict the optimum design for a Tesla turbine or to estimate its theoretical efficiency.

The most readily found sources of information about Tesla turbines are numerous articles written by enthusiasts, many of whom seem to have an unquestioning belief in the high efficiency of these machines. In contrast, the most *reliable* sources of information are the numerous research papers that have been published in relatively inaccessible technical journals. From my own career in scientific research (biological rather than physics/engineering), I know that publication of a report in even a well-regarded journal is no guarantee that its conclusions are reliable or can be generalized to different conditions. Therefore, an overview of several papers is generally appropriate. However, a major problem for any attempt to understand Tesla turbines is that, unlike the situation with conventional

turbines, there seems to be no established text book to provide an expert summary based upon theory supported by extensive practical experience.

A further complication is that many of the research papers on Tesla turbines are theoretical and use complex 'computational fluid dynamics' (CFD) programs to predict the behaviour of fluids within these machines. This leads to the concern that it is difficult for anyone not well versed in the particular program used to understand fully the limitations of the results. The theoretical papers on Tesla turbines generally do not explain details of the programs used or the limitations of the analyses and it is difficult for a non-expert, like myself, to assess them reliably. However, there have been a few studies in which Tesla turbines were actually built and their efficiencies

measured. These give a more tangible indication of what might be achievable in a model.

Before discussing any actual measurements it seems appropriate to describe how Tesla turbines work. I have not found a good overall summary of the processes involved in these machines and the following consists of information gathered and conclusions drawn, to the best of my ability, from numerous sources. So please bear in mind the issues and limitations mentioned above.

General working principle

As was briefly mentioned in part 3 (ME4592), the rotor of a Tesla turbine consists of a number of flat thin discs with narrow spaces between them and drawings of model-sized versions have been published (e.g. refs 30 and 31). A key feature of Tesla turbines is the presence of a large hole through the centre of each of the discs (fig 54). Steam is accelerated in one or more fixed nozzles and in this respect Tesla turbines resemble De Laval impulse turbines. However, these nozzles are positioned such that the steam jet is directed onto the edges of the rotor discs. The idea is that the steam enters the narrow spaces between the discs and makes its way towards the central hole, which is the exhaust passage. As it flows between the discs its velocity is reduced as a result of friction. This means that a force is exerted between the steam and the discs such that, as the steam slows down it tends to drag the surfaces of the discs in the same direction as the flow. In many explanations of how Tesla turbines work, the direction of steam flow from the nozzle is shown as tangential to the disc so the force is optimal for making the discs rotate. Also, the steam path is generally depicted as shown in fig 54 where it follows a gentle spiral as it moves towards the central hole. As it moves along this path, the steam is

assumed to gradually slow down as the result of friction while its kinetic energy is converted efficiently to shaft power. In reality things are not so simple.

The forces acting on conventional bladed turbines can be understood and calculated with reasonable accuracy using fairly basic mechanical principles and, indeed, this was the basis for designing all steam turbines up to the advent of aerodynamic theory in the 1950s and, later still, the application of CFD. However, Tesla turbines cannot be analysed in this simple manner and the academic research aimed at optimising their design mainly started after aerodynamic and CFD methods had become established. Advanced computer programs are now used for designing conventional bladed turbines but efficient designs could be achieved by traditional methods and the computational methods result in relatively small further increases in efficiency. Such increments are important when generating huge amounts of electrical power but are less of a concern for our hobby. In contrast, it seems that the working of a Tesla turbine could not be calculated in detail without using advanced computation because, as we shall see, the behaviour of steam (or other working fluids) as it flows through the Tesla-type rotor is particularly complex. In one recent paper the authors reported that it took two days for a powerful computer to analyse each set of conditions for a theoretical rotor.

History of the Tesla design

The Tesla turbine was invented by the Serbian engineer Nikolai Tesla who is widely known for his contributions to the technology of electricity, particularly the use of alternating current. He developed his turbine ideas about 1905 and patented them in 1910 in the UK and in 1913



Turbine built by Nikolai Tesla. In the Tesla Museum, Belgrade.

(Photo by Stanislav Kozlovskiy - Own work, CC BY-SA 3.0,

<https://commons.wikimedia.org/w/index.php?curid=22226682>)

in America (ref 32) i.e. many years after the key patents of Parsons and De Laval.

Tesla built some small experimental steam turbines to his new design (photo 47). Larger machines were built by the Allis Chalmers Manufacturing Company of Milwaukee but they encountered technical problems and did not pursue the project. Tesla also proposed using the same disc friction principle as the basis for pumps. In these, the rotor was turned at high speed by a motor and fluid entering the centre of the rotor became accelerated as it moved towards the periphery of the discs. Despite claims made at the time for very high efficiencies, Tesla turbines were largely ignored until the 1960s when research papers started to appear in specialized technical journals. Since then there has been a steady flow of such papers, mostly published by research groups in universities.

In recent decades the hobbyist interest in Tesla

turbines has grown and a number of web sites and on-line interest groups have been established. Claims have been made that small Tesla turbines can attain very high efficiencies and much has been written about potential applications for such turbines. However, as far as I can see, the hobbyist arena shows little sign of any attempts to measure efficiency and relevant data in technical research papers is rarely mentioned. In the model engineering press the only careful investigation that I have found was by Werner Jeggli who built a very impressive Tesla turbine-powered model railway locomotive (ref 33). Mr Jeggli estimated the efficiency of the turbine and was disappointed with the result. He adopted bladed turbines for his subsequent models (refs 34 to 36).

Boundary layers and friction

The Tesla turbine is sometimes called a *boundary layer* turbine

and in order to understand better how it works we need to understand what is meant by this term. The idea of a boundary layer was first proposed in 1904 by the founder of aerodynamics, Ludwig Prandtl. To explain this idea, let's think about steam (or any other fluid) as it flows past a flat smooth surface such as a metal plate (fig 55). If we imagine that the steam consists of numerous thin layers moving parallel with the surface, then the layer adjacent to the surface is stationary, relative to the surface. This so-called no-slip condition was outlined and illustrated in part 11 of this series (ME4608). If one moves far enough away from the surface, then the steam flows freely, just as if the surface were not there at all. Between these two extremes there is a gradation in steam

velocity which results from the effects of viscous drag between adjacent layers in the steam. This region, where viscous drag has a significant effect, is called the boundary layer and it is generally taken as the region where fluid velocity is less than 99% of the free-flow velocity (fig 55). It is possible to calculate the boundary layer thickness but we need not worry about that since the main thing here is to understand the general principles.

The thickness of the boundary layer depends upon many factors, such as velocity, density and viscosity of the steam and the nature of the surface. It also depends upon the distance along the surface. To explain this last point, let's imagine that steam flows towards the edge of a thin metal plate (fig 56). As the steam encounters

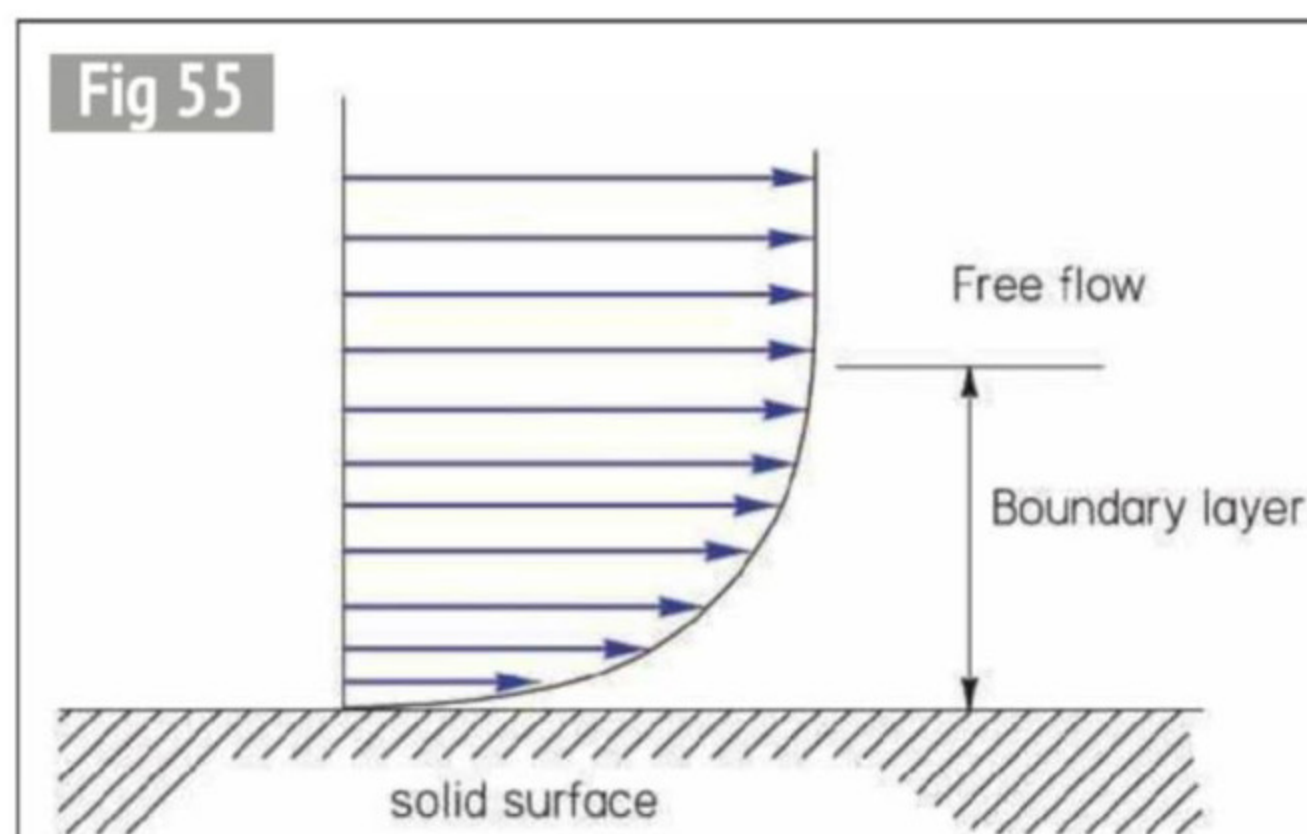


Diagram to illustrate the boundary layer in steam flowing across a solid surface. Lengths of the arrows indicate the distance moved by the steam in a fixed period of time.

the edge of the plate it will experience turbulence and possibly shock but in our imaginary world we can neglect such complications. At first, apart from the very

thin stationary layer, the steam continues flowing as if the plate were not there. However, as it moves further across the plate, the layer next to the stationary layer starts to slow down as the result of friction between itself and the stationary layer. Then this slower layer causes the next layer to start slowing down. This process is repeated such that the thickness of the boundary layer increases until a maximum is reached.

Within a boundary layer, steam can flow in either a laminar or a turbulent fashion and this depends upon the balance between viscous and dynamic forces, as was

described for flow through pipes (see part 11). However, even when most of the boundary layer is turbulent, there remains a thin laminar layer very close to the surface.

Viscous drag

Velocity of steam in a direction parallel to the plate surface is called shear velocity and the resulting viscous drag causes a force that is also parallel with the plate, i.e. a shear force (fig 57). The shear force that is exerted on the plate results from viscous drag between the stationary layer of steam on the surface and the layer of steam immediately next to it. As one moves away from the solid surface the steam velocity increases at a rate that decreases with increasing distance from the surface until the velocity is the same as in the free-flowing steam (fig 58). At any point along the curve of velocity its steepness (or gradient) tells us how quickly the velocity changes with change of distance from the surface. This gradient is called the rate of shear and in fig 58, examples of it are

shown by the short straight black lines. The steeper the black line, the greater the rate of shear. The strength of the viscous drag on the plate is determined by a) the rate of shear at the solid surface (line * in fig 58), b) viscosity of the steam and c) area of the surface.

In Tesla turbines kinetic energy in steam is converted into shaft power as a result of the steam doing work on the discs through the effects of viscous drag. For work to be done by the steam the disc surfaces must move through a certain distance as a result of the viscous shear force since: $work = force \times distance \text{ moved}$. If the plate moved at the same speed as the steam it would cover a large distance in a short time but there would be no drag force since the rate of shear would be zero. At the other extreme, if the plate were stationary then the viscous drag would be maximum since the rate of shear would be maximum. However, the work would again be zero since distance moved would be zero. So, for maximum work, it seems the

plate should move at a speed such that the rate of shear in the steam at its surface is somewhere between these two extremes. In an actual Tesla turbine, the steam velocity relative to the discs is constantly changing because the steam slows down as it flows relative to the discs.

A further complication is that the direction of flow relative to the rotor changes as the steam makes its

way towards the central exhaust opening. This and some other aspects will be discussed in the next part which will also describe some of the published results on theoretical and actual measured efficiencies of these machines.

●To be continued.

Fig 56

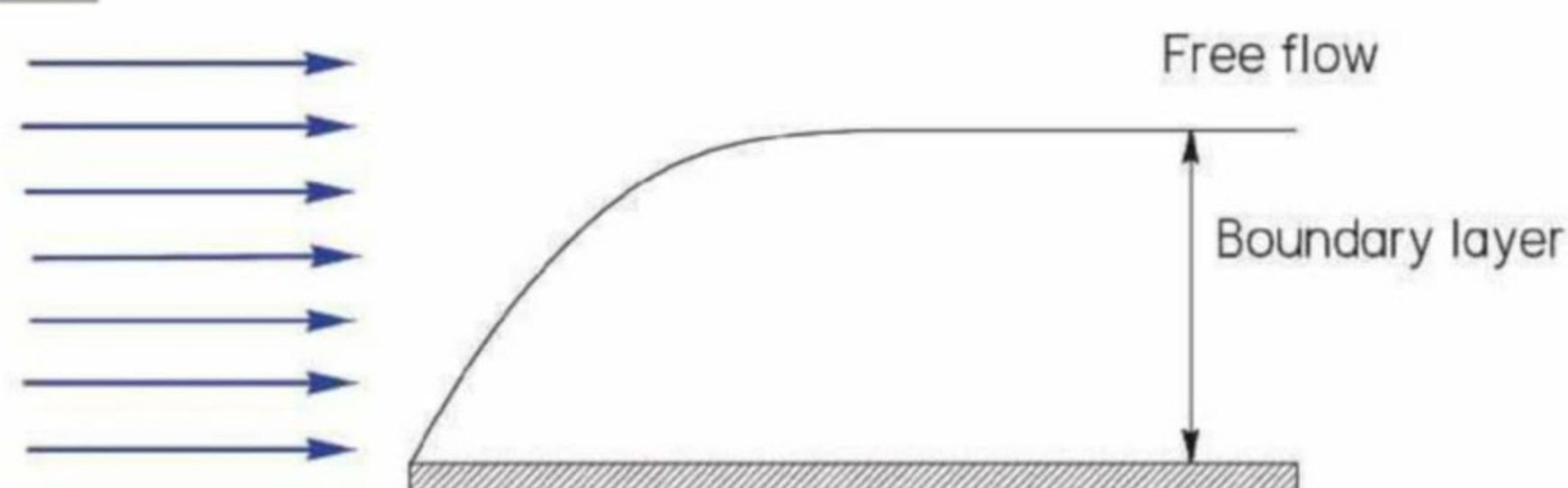
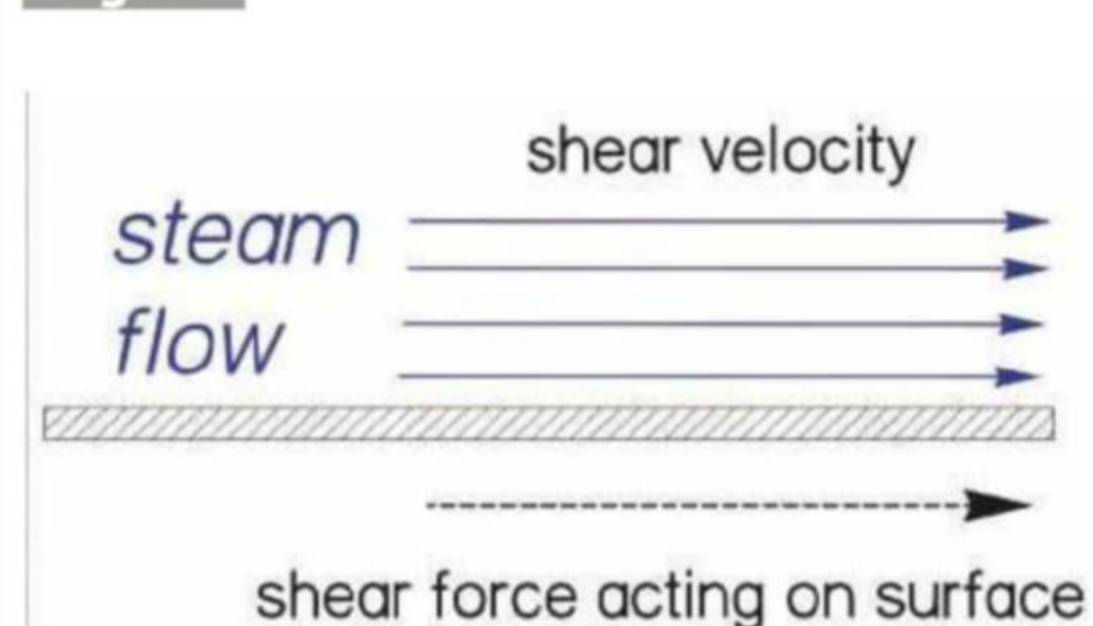


Diagram to illustrate build-up of boundary layer as steam flows past the edge of a plate.

Fig 57



Shear velocity and shear force in flowing steam.

Fig 58

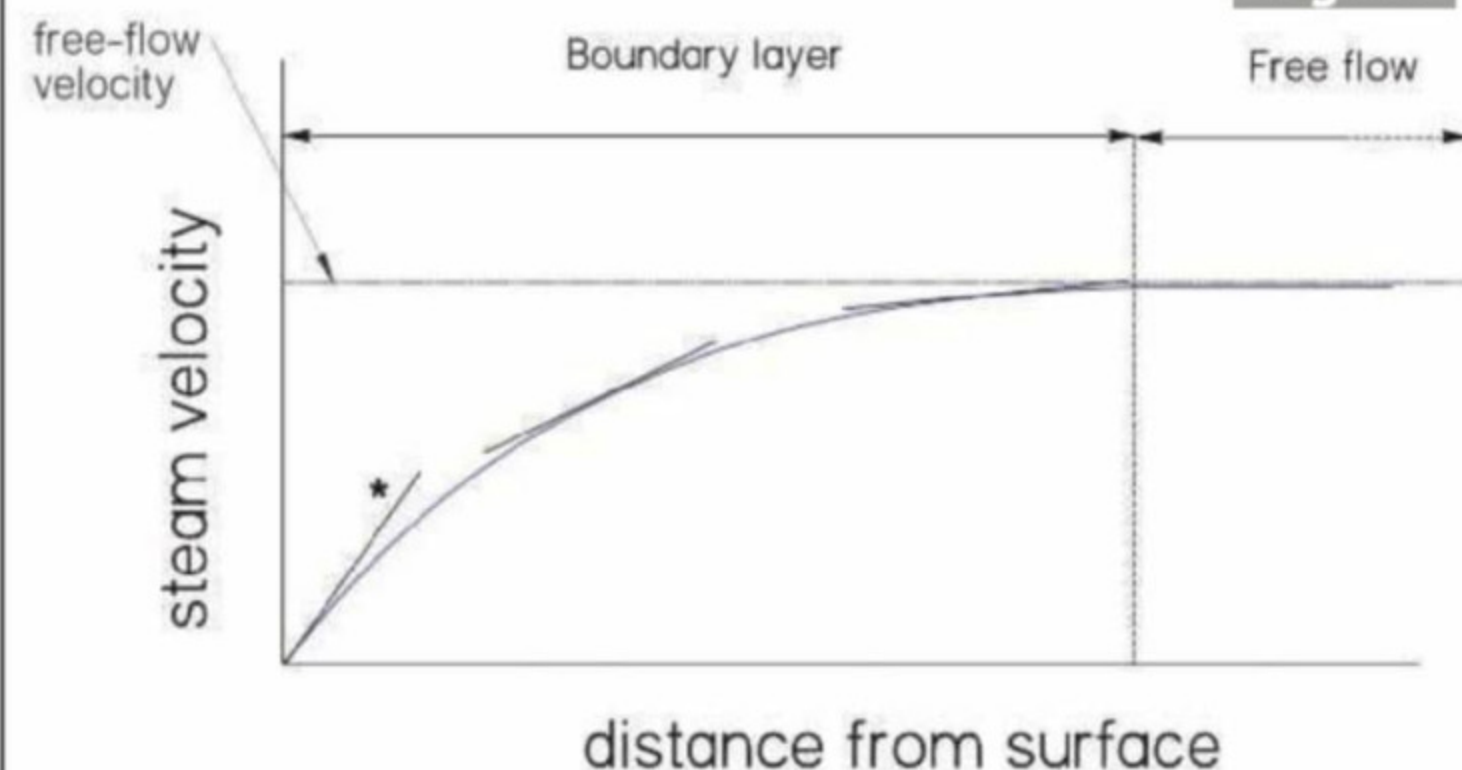


Diagram to illustrate the meaning of 'rate of shear'. The short black lines indicate, for three specific points, the rate at which steam velocity changes with change in distance from the surface. The line marked with an asterisk indicates the rate of shear at the surface.

No.283

MODEL ENGINEERS' WORKSHOP

August's issue, number 283, will once again be packed to the gills with more great workshop articles:



Brian Wood makes a drill over 2m long!



Peter Barker on mounting chucks on taper arbours



Eric Clarke cuts metric screws on a very Imperial Drummond Lathe

On Sale 12th July 2019

Wind and Steam in Whissendine

Martin Evans visits the county of Rutland, takes a ride on a 6 inch traction engine and climbs to the top of a working early nineteenth century windmill.



Small but perfectly formed

Thus is Rutland, England's smallest rural county, with its lovely pastures, a vast expanse of water and just two towns. It is also the most fecund, with each woman, on average, producing 2.8 children, compared with the national average of 1.8. It is hardly surprising then that, as far as I know, there are no model engineering societies in Rutland. There is one though in nearby Melton Mowbray, just over the border in Leicestershire (fertility rate 1.9), and they organise the annual steam rally at the Whissendine sports club, in Rutland.

So there I was, bright and early, surveying the scene. The field was lined with caravans and tents and, here and there, traction engines and tractors of various sizes were basking in the glorious sunshine and enjoying their first smoke of the day. Long suffering model engineer wives were attending to breakfast and marvelling at how early their



6 inch Burrell built and owned by Dave Pierce from Lincoln. (Photograph Graham Gardner.)

husbands could get up, given sufficient incentive. I wandered over to the railway track and discovered that coffee and bacon rolls were already on sale, which made a very good start to the day.

The sports club site at Whissendine hosts two buildings, at opposite ends of a large field; one is the sports clubhouse and the other is the model engineering society's clubhouse, which is surrounded by woodland and the two dual gauge railway tracks. The 550 foot ground level track accommodates 5 and 7¼ inch locomotives and the 300 foot raised track is 5 and 3½ inch gauge.

The occupants of the tents and caravans exhibited a range of road vehicles and stationary engines and the tents dotted

around the field contained tables, some with exhibits of various models, one selling bits and pieces and another, odds and ends. Polly Model Engineering had popped over from Nottingham and appeared to be doing a brisk trade. Rides were available at the track along with coffee, tea, rolls and cake in the clubhouse. Musical accompaniment was provided by a small fairground organ outside the sports clubhouse. All in all, most satisfactory!

Rutland road run

A fine tradition of the Whissendine Steam Rally is the lunchtime road run down to the local pub, the *White Lion*. This is absolutely not to be missed. Your lucky author was offered a ride on a very fine 6 inch Burrell Scenic



4 inch Burrell road locomotive taking on water. (Photograph Graham Gardner.)



One fifth scale Gloster Sea Gladiator by Trevor Main. This is propelled by a 3kW electric motor and two Li-Po batteries each 22 volts and 5800mAh.



7¼ inch 0-4-0 narrow gauge barn find owned by Steve Purves. (Photograph Graham Gardner.)



Polly 5 locomotive owned by George Dear and built from a kit in 2016.



6 inch Garrett, Pegasus built and owned by Adrian Nutting. (Photograph Graham Gardner.)

showman's engine, *General Gough*, belonging to Mike Robinson. The going is easy down to the pub, being mainly downhill. The engines can then rest in the car park while their drivers and passengers fortify themselves in the pub for the return journey. Being uphill,

this is a challenge at the best of times but gives the engines a good workout after their idle hour at the pub.

After the trip to the pub, Mike decided to take the *General* for a tour of Rutland, with your author occupying one of the passenger seats. We covered



Thomas Selby drives Norman Smedley's LMS Sentinel-Doble shunting locomotive.



Mike Robinson's fine 6 inch Burrell Scenic showman's engine *General Gough* takes a rest outside the *White Lion* pub.

eight miles of country lanes, which is probably most of the county, and returned quite nicely shaken up but in a state of breathless exhilaration – as I believe the phrase goes. The engine, of course, has little or no suspension but fortunately the passenger seats do!

To the windmill!

One of Whissendine's famous features is its windmill, which is reckoned to be the tallest stone windmill in the country. It was built in 1809 for the Earl of Harborough and restored in 1862. It was then damaged in a gale in 1922 and ceased

Sieg SX2 Plus Miller CNC Conversion



Whissendine windmill.

working. It was sold to miller, Nigel Moon, its current owner, in 1995, who restored it, including the building of a new top and sail, and brought it back into operation in 2009. The mill is a proper working mill, working all year round producing a variety of bread and pastry flours and animal feed.

Unfortunately, there was no wind that day so the windmill was idle but Nigel was in residence and allowed us to explore the mill. Getting to the top involves scaling half a dozen narrow and steep wooden ladders but the view at the top, both inside and outside, is well worth the climb. The scale of the machinery in the mill, and the size of the gearwheels and shafts, gives a good idea of the amount of power it is possible to extract from the wind. There are four millstones and three flour dressing machines within the mill, all driven, of course, by wind power.

A small octagonal building stands a little way from the mill, which is the mill office, containing plenty of pictures and information about the mill. "She's under there" said Nigel. 'Oh dear' I thought. He explained that it was his mother Ruth's wish to be buried by the mill and so her ashes were placed into the foundations of the little office when it was rebuilt a couple of years ago from the ruins. Right up until her death a few years ago, at the age of 95, Ruth had been helping Nigel to operate the mill. She used to say that this was what 'kept her going'.

Nigel Moon is a picture of perfect contentment, doing and living the only job he has wanted to do ever since the age of five, when he met, and fell in love with, his first windmill out in the Leicestershire countryside.



One of the millstones within the windmill.



Octagonal windmill office.



ME Miller, Nigel Moon.

Graham Sadler explains how he converted his Sieg milling machine to CNC operation.



Continued from p.797
M.E. 4613, 24 May 2019

Initial setting up

From the outset I want you to be aware that I am very much a novice to direct control CNC. I am explaining all the setup procedure and the problems I had to solve to get it to work. Old hands will probably read all the following with amusement but for some of them it's probably too far back to remember. In addition, as I designed all the elements of the machine and control box there was so much uncertainty about which was causing the problem - machine, electrical or software - unlike a purchased machine which with its pedigree will indicate correct function and having somebody at the end of a phone to help. There are simple solutions to the individual problems but only when you find the individual straw in the haystack! I hope to limit you to just one wheelbarrow full of straw. Reading the manuals made me think getting it all to work as intended would be fairly straightforward - it was not.

Getting the thing to work was a real pain and it took forever! Worst of all, and the very first stage, was getting the computer to communicate with the machine. Initially this was with the drive belts off - I just wanted the motors to turn.

Once the connection is made between miller and computer

(I explained about the LPT and USB problems solved by the UC100 earlier) there's still a long way to go. Firstly, the motors need 'tuning'. This is the process of setting the number of steps needed to move the axis a given amount. It's a mathematical constant and only needs setting once. For this system it was easy. The tuning is set to 800 pulses per mm of slide movement - here's how:

- Screw pitch = 4mm and the motor needs 200 pulses per revolution.
- So for 1mm of axis movement we need $\frac{1}{4}$ of a turn i.e. 50 pulses.
- But, as we used a 2:1 ratio on the drive connection, 100 pulses are needed to move 1mm.
- Micro stepping is set at 8 so 800 pulses are needed to move 1mm.

The Mach3 manuals which you download make this calculation strangely complex. These are essential reading but heavy going even with many of the early sections being explained in very easy steps aimed at the complete novice (like me).

In the Config > Motor Tuning section, you will also set the maximum speed at which each axis will travel. Keep this low until you gain confidence and knowledge.

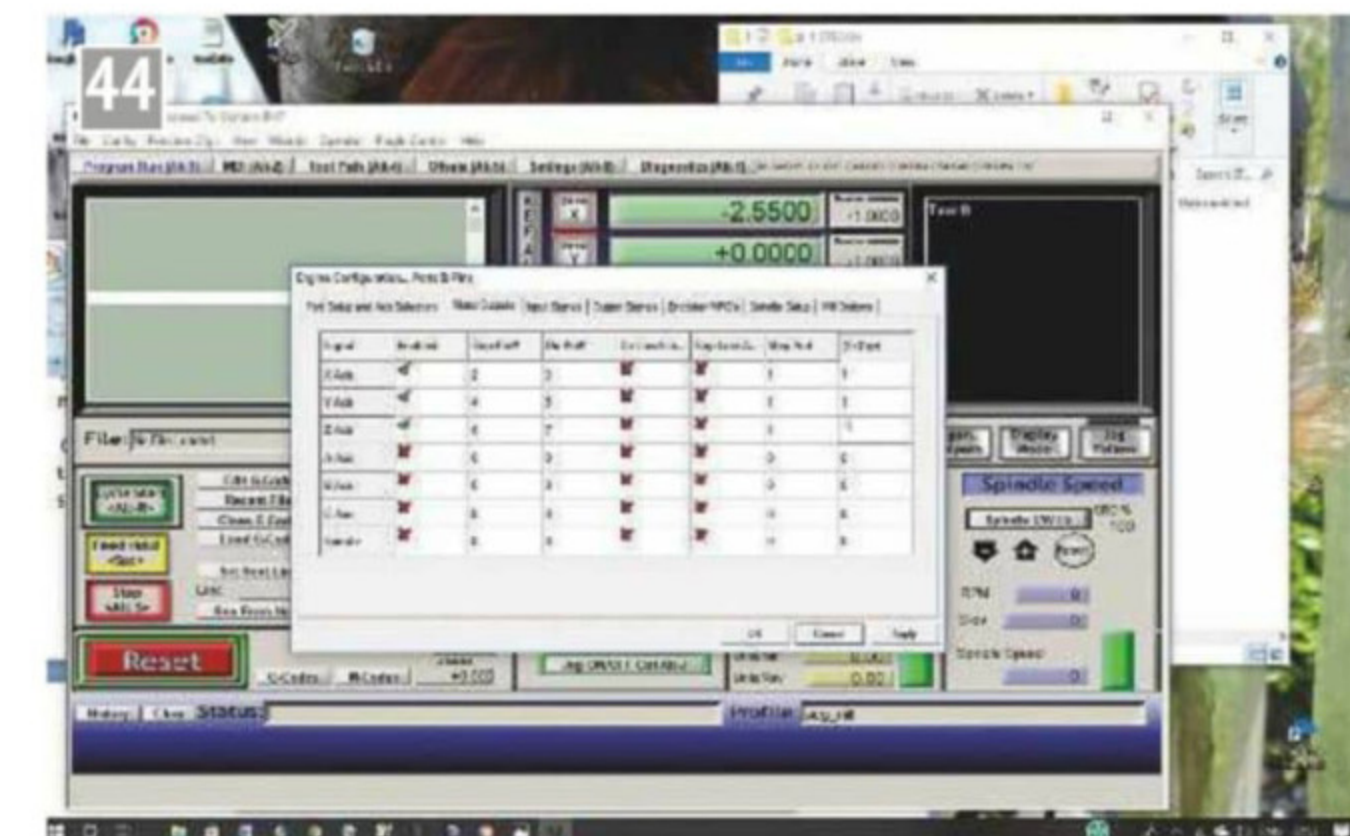
To test out your electronics I would advise just starting with the jog function and pulling both the plugs out of the Z and Y drivers to test just the X axis. Add the others one at a time once they are working. IMPORTANT - as you have seen earlier, switch off the power when connecting/disconnecting them and take care with the exposed mains section, so switching off at the wall socket is advised. Sensitive electronics don't like the possibility of massive spikes which can occur when some of the power or digital inputs are connected.

Getting the right directions

You will need to set the motor outputs in Config > Ports and Pins > Motor Outputs so that the direction pulses are sent to the right place (**photo 44**). Set the pin numbers for direction and step as shown in your BOB documentation, tick the enable box then hit apply (or it won't save the changes) and test the axis. If it goes in the wrong direction (with a 'plus X' movement moving the table to the right) go back to Motor Outputs and change the tick box in 'Dir Low Active'.

The 'plus X' part above seems counterintuitive but it is all about the movement of what is known as the *Control Point*. This is the position of the point of the centre of the machine spindle at the tip of the tool. It is also possible that your cursor keys will send it in the 'wrong' direction so when going X plus you should really hit the left key as in effect you are moving the control point right relative to the work and not the work relative to the table. The solution to this is to view the tool not the table and it is then simple, just like you automatically know which direction to turn a manual mill handle to move the table.

If the cursor keys cause movement in the wrong direction, go to Config >



Options screen.

System Hotkeys, then click the appropriate direction box (remembering what was in it) appropriate for X movement. A pop-up will appear and will ask you to 'Press any key' and its code number (37 or 39) will be put into the box.

Sticky moments

Then there's other simple annoying things totally unnoticed when you become familiar with using Mach3. When using the MDI (Manual Data Input) and you type your G1 X 10 command it is not necessary to put the G1 in for every line. It is known as a 'sticky' command which, once set, will stay set until another type of movement code is used. The slide moves then you decide to try to jog the axis and use the MDI again - nothing happens! Oh **** it won't work what have I blown/done wrong?

You close and restart Mach3 and find that the slide moves at a snail's pace (why is it moving so slow? What's wrong?). It will do this (a good Mach 3 safety

feature) until you put in a feed rate with something like **F300** (feed at 300mm per minute). I found this the hard way again. You try again and it still won't work. Panic. Silly - as when the MDI is activated by clicking in the command line, one has to press Enter/Return to enable/disable it, then it works... So simple when you know!

Another simple task is to hit Tab to bring up the jog control. Set it to step mode not continuous and the LED indicator will glow in the appropriate place. Now this is so easy - people in the forums say they have tool crashes forgetting which mode they are in. No need for this as when the shift key is pressed at the same time as the jog direction keys (cursor for X and Y, page up and down for Z) the mode is changed to continuous while the shift is pressed, so you rapid with both keys until close to where you want to be. Finger off shift then repeatedly tap the cursor and you will have easy and safe control. I would like to find a way to set the jog to

step mode at start up to save another task every day.

Hitting the limits

So now you have the X axis moving and in the correct direction. Next, you need to set up the combined home and limit switch.

First of all, jog almost fully to X minus (table fully right). Switch off the control box power then turn the X pulley by hand until it hits the end of the traverse. The pulley won't move very easily because of the holding torque of the motor. Now wind it back a full turn. Go to Mach3 Diagnostics or the UC100 control panel in the 'Plug In Control' tab. Slacken the screws holding the limit switch blade and adjust to find the exact point of activation and tighten in place.

Now wind back and forward by hand on the pulley to check the position and in the 'Plug in Control' menu observe the U100 status monitor and the X LED indicator which will show you the limit is working at the correct point. We now have a home position set and the knowledge that when triggered we still have 4mm of travel before hitting the end stops. This also at times allows a bit of over movement by overriding the limit position.

The limit switch blades are $\frac{1}{2} \times \frac{1}{16}$ inch brass angle for the X axis, located on the saddle flat (photo 45), and $\frac{3}{4} \times \frac{1}{8}$ inch aluminium angle for the Y axis. They are held down with screws located in slots, the angled ends providing a gentle ramp for the micro-switch. The blades can just be seen in photo 45 and they can now be reshaped if needed and cut down to a much smaller length. Zero the DRO display on X axis and repeat the exercise for the other end of the table, noting the final DRO reading. This will give you the full travel of the machine and help to set up the soft limits later. Incidentally, soft limits will not work unless all X, Y and Z have been referenced and the Yellow *Abnormal Condition* LED has turned green to *Condition Normal*.

When you set the soft limits to ON you must be within the soft limit range (another few hours and more hair pulled out to find the solution to soft limits not working - as I said there's a lot to initially setting it all up!). Finally, jog so the table is central and in Diagnostics click 'Ref X' - not the 'Ref X' or 'Ref All' on the main screen as we just want to test a single axis at a time.

Check that the travel is in the correct direction, if not go to Config > Homing/Limits and tick the Reverse. You will then see that the table moves fully to the right at maximum speed - a bit crude for exact positioning but Mach3 caters for this and as soon as the switch is triggered, the motor slows and goes a little past the trigger point. Then it will reverse direction to move the table slowly to the exact trigger point to reset the switch to the normal state and also remove any possible backlash which will exist in the system. This process fixes the home with considerable accuracy. With your new found knowledge, add the Y axis. Ensure that in Config > Homing/Limits the 'Auto Zero' is ticked. This will reset the DRO. While in this subject, you can type any value into the DRO values. For the Z axis, we only have a home switch at the top of the column, the trigger bar being a piece of bent 6mm bar which may need adjusting for fit (photo 46).

Imperial bad, metric good

One thing is certain, Imperial units are not good for CNC especially if you do your own G code programs. Consider this command with the table in the centre of its travel:

G0 X 0.375 (move X plus $\frac{3}{8}$ inch at maximum feed rate)

The metric version is G0 X 10 (or 9 - it's much better to redesign for full units). Simple, you think, but what happens if you put the decimal point in the wrong place or miss it out altogether? In the metric case that wouldn't matter but missing the decimal point out in the Imperial case now asks

the machine to move 0375 inches, or 31 feet 3 inches! The maximum table speed on my machine is 2000 mm per minute or 33mm per second so in the second or two before I can realise what's going on and hit the E stop, the tool has moved two inches. Disaster, and almost certainly a broken tool, vice, machine or at best a ruined part.

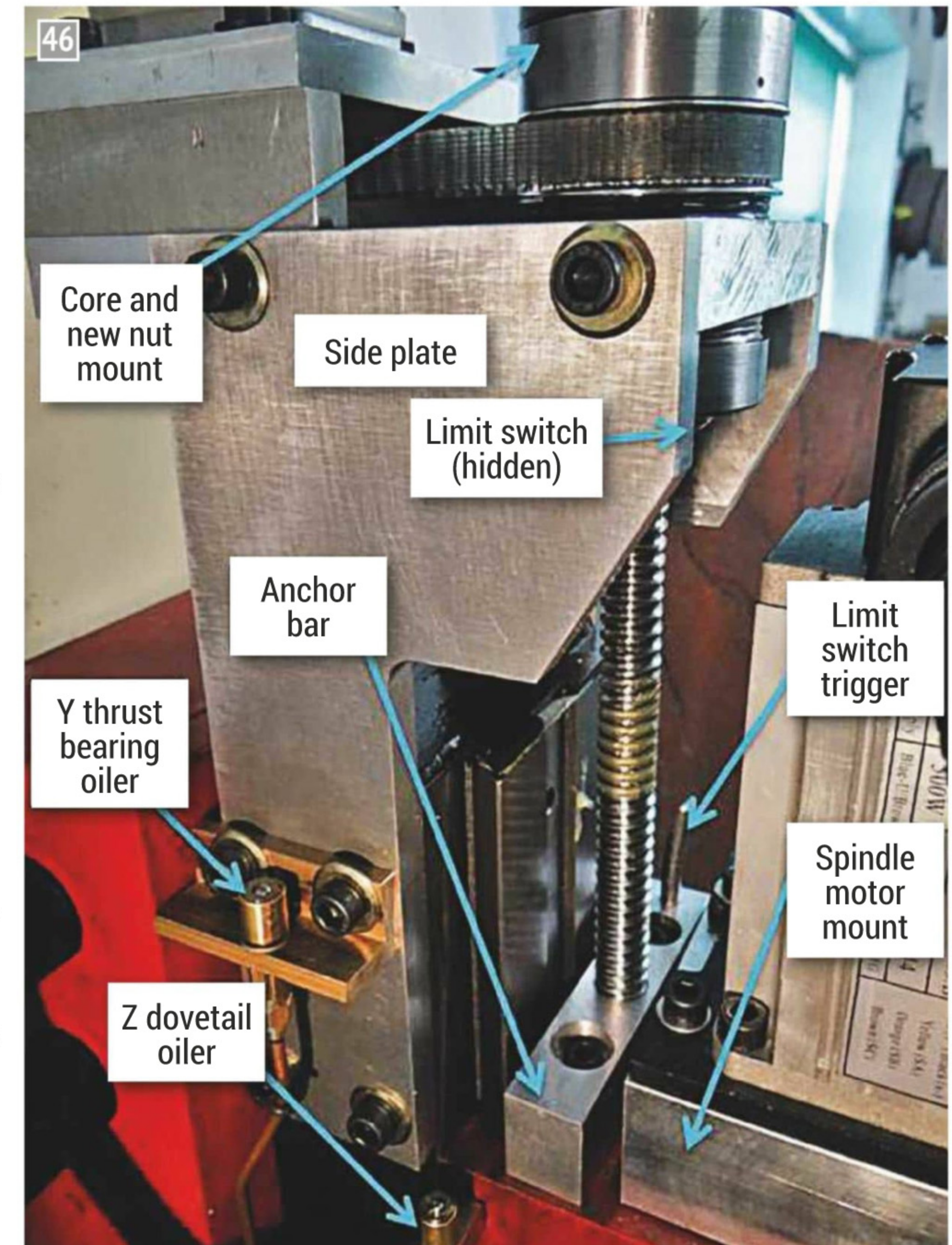
Easy errors like this are another reason why it's vital to have limit/home switches. Remember, this fantastic CNC machine is very obedient and it does exactly what you tell it to do. Don't blame the machine when something goes wrong!

It is possible to use Imperial units though, which just needs the insertion of the correct G code at the start of a program. A unit selection should always be included in the start up safety block for a program: G20 for Imperial units or G21 for metric units.

Matching coordinates

Another problem you will find early on is the co-ordinate system. Mach3 uses absolute co-ordinates, i.e. the zero for the X axis is at the extreme left with the table fully to the right, the machine zero. So, with the table in the centre of its travel you input G1 X 10 expecting a small move of the control point 10mm to the right. It won't! It will travel to the left towards the home position (very slowly unless a feed speed has been set) as you have in fact told it to go to machine zero plus 10mm. So, it really needs an input of G91 first, which sets *incremental slide movement* and then the machine will function as intended i.e. with the control point in the centre and the DRO zeroed the table will move 10mm only.

Later we will find out how to use work offsets to temporally move the origin from this machine zero to a position at, say, the corner of the fixed jaw of the vice making it easier to control, then the command above will work even when in absolute mode (which is set with G90). In this case, Mach3 adds the work offset to the



Z axis arrangement, showing limit switch trigger.

machine zero and you can view this by clicking the Machine Coords button. Zero the X DRO first and look at the difference. Don't forget, the machine is really stupid and will follow your instructions out *exactly* - it's up to you to tell it *exactly* what you want it to do but some of the steps needed are not obvious at first.

Great - now we can move and home all the slides - progress! In order to stop any possibility of all this causing

a problem there's a simple answer. In Config > General Config... look in the centre for the initialization string. Add these (just the G codes etc, not the text!):

G80,	Cancel motion mode
G91,	Incremental mode
G40,	Cancel cutter radius compensation
G49,	Cancel tool length offset
G50,	Reset scale factors to 1.0

G21,	Set to mm units (G20 for Imperial)
F200.	Feed to 200mm per min

If you write any of your own G code programs, these should also form the initialization at the start of the program. It will remove any problems caused by residual part programs which may have been used earlier.

●To be continued.



Saddle components, showing microswitch actuating blades.

The Brushless Brute

PART 3

Jon Freeman describes a powerful, dual gauge petrol-electric locomotive using brushless motors for tractive power.



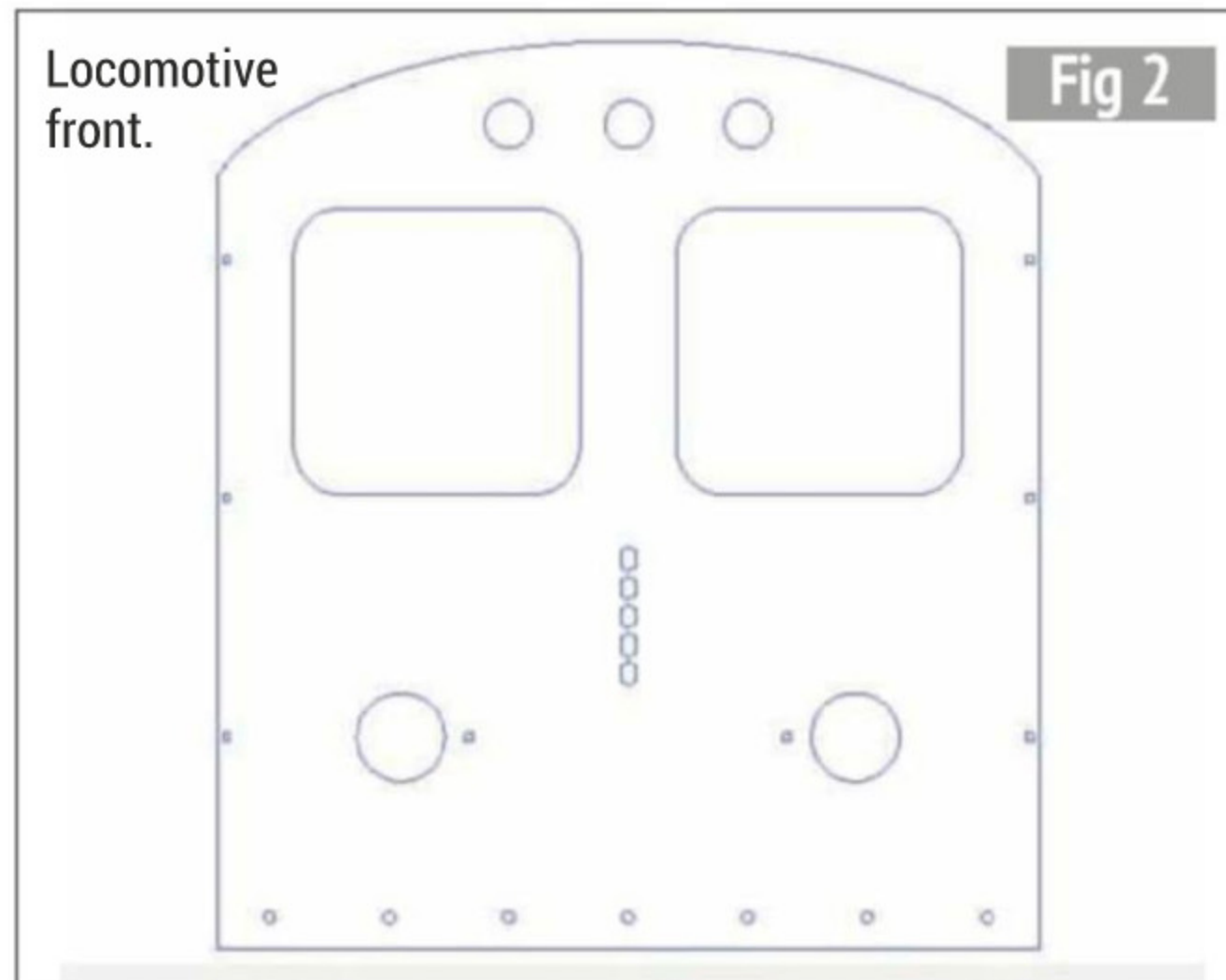
Model design – a start

This article concentrates on the engineering design process and the decisions made through each stage of the design, along with some of the logic and reasoning supporting design decision making.

A journey through any engineering project should begin with a clear objective. A good starting point could be a written specification with sufficient detail to describe the objective and sufficient clarity to avoid ambiguities. In real-world work situations a specification, 'The Spec', may be handed down in virtual tablets of stone, the rigid law to be obeyed. A more relaxed attitude is often workable and was deemed applicable to this, essentially a hobby project, with 'The Spec' being regarded as a source of guidance and inspiration, there to be revisited and revised along the way in the light of experience. In this way, at the end of the project 'The Spec' can be held up along with the tangible outputs of our metal-mangling machinations demonstrably meeting 'The Spec' in every detail – another glorious success!

'The Spec' began to crystallise: 'electric locomotive', 'dual gauge', 'efficient', 'powerful enough for heavy

Locomotive front.



passenger hauling', 'must fit car' and so on and at this point the first mechanical design decision was made. The family car parked outside was not new but nowhere near old enough to be considered for replacement. As the only means of transport available for the foreseeable future, and with the nearest track twenty miles away, the locomotive length was constrained to fit.

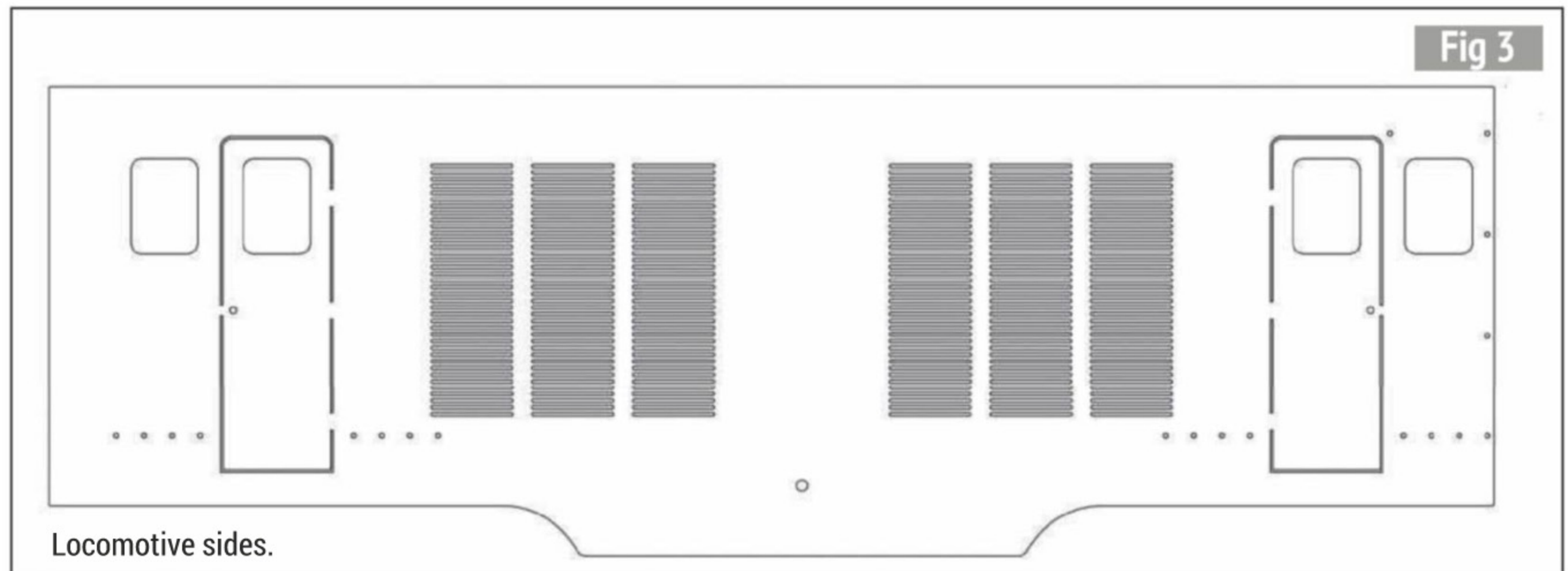
So - design decision number one is that the length must be no more than four feet nine inches.

Body shell design

Designs for a body shell were sketched early on but

completed only towards the end of the project. It seemed more sensible to create a box to fit what we ended up with, rather than designing a box at the outset into which a set of as-yet-unknowns might be fitted. Having fixed the length, the width and height were not so constrained and could be determined much later.

A locomotive front panel was designed, drawn on 2D CAD (fig 2). The part elliptical roof profile has a pleasing appearance, resembling any typical railway stock. The decision to include a pair of high-brightness LED headlamps could have been inspired by early memories

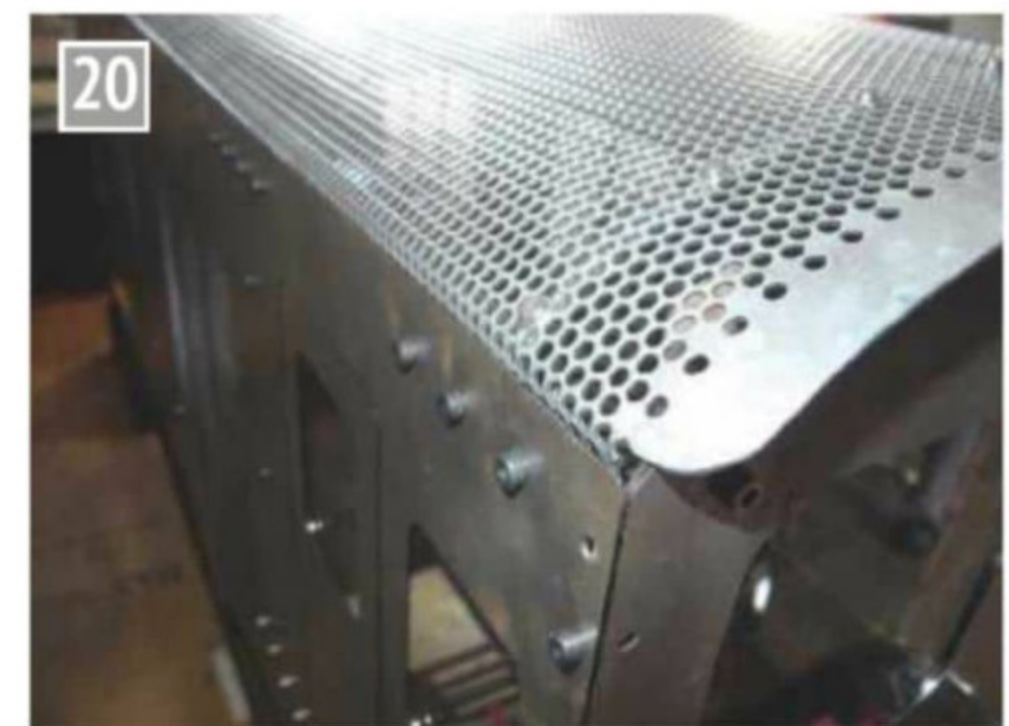


of 1967 Victoria Line stock being tested on the Hainault to Woodford loop of the Central Line. The rest was made up to be recognisable as 'a locomotive' of some sort. The width would be determined later to fit the widest element within the design (which turned out to be the petrol engine) and the final height would be found after scaling the front panel drawing to fit the width. Once final dimensions were determined this front panel was laser-cut from 2mm steel.

The side panels (fig 3) were drawn much later - not until after the chassis was completed and the first few trial-runs had taken place. With length and newly determined height now known, design details were pulled out of the air and the drawing completed. These were laser-cut from 0.8mm steel. The ventilation slots (photo 17), something over two hundred of them on each side panel, were perhaps not the best idea, playing havoc with all the internal stresses found in cold rolled sheet. Despite being screwed at regular intervals to a stout steel reinforcing strip near the bottom edge, and similarly fixed to angle irons running the length near the top edge, the side panels are not flat. Tightening down a screw over one bulge simply causes another to pop out somewhere else. It might have been better to cut out large areas with mesh fixed behind – but



The roof is screwed to the 'coat hanger' supports.



The edge of the roof is folded in to give a neat finish.

then these imperfections are inconsequential and barely noticeable from a distance. The panels were laser cut by Luffman Engineering Ltd of Tiverton (www.luffman.co.uk).

The sides are fitted with clips that locate across the frame tubes, fit snugly just behind the front panel and are held in position lengthways by restraints fitted to the back panel. The top edges of the sides are held in place by four dowel pins on the roof panel locating in holes in the angle irons - the roof thus lifts off quickly and easily. With the roof off, the side panels may be simply lifted out. This quick and easy panel release is useful to reach the engine controls and starting cord.

The roof was from a sheet of galvanised perforated mesh from Fine Mesh Metals of Telford. With no means of rolling this to shape, many hours were spent bashing with a rubber mallet into and over wooden formers until the rough shape was close enough

to allow fixing to four 6mm thick laser cut coat hanger shaped stretchers (photo 18). The sheet had a plain margin which looks good as a clean strip at the front edge. The rough mesh edges to the sides are folded down and tuck just inside the side panels giving a clean finish (photos 19, 20 and 21).

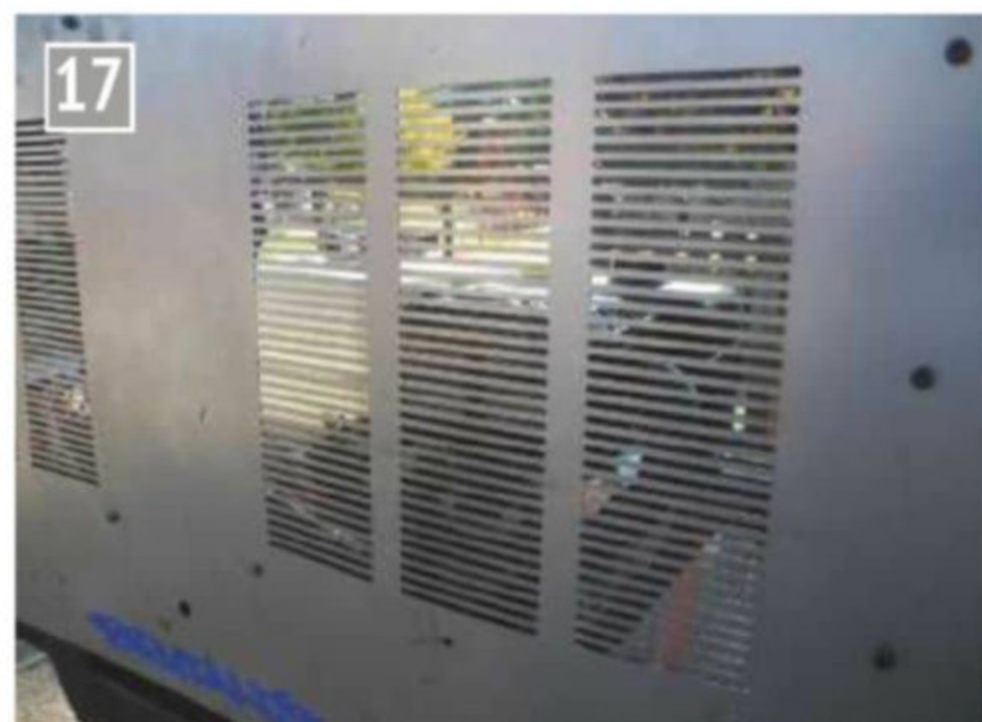
And so ends the account of

the later stages in completing the design of the largely empty body shell.

●To be continued.

NEXT TIME

We look at the details of the rest of the design.



Ventilation slots.



Front view – through the windows can be seen the 'coat hanger' supports for the roof.



A view inside the body shell.

The Barclay Well Tanks of the Great War PART 50

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



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 Talylyn 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.

Up a siding

I was thinking of progress recently and realised that getting large drawings scanned and copied tends to hold things up and, of course, it adds to the overheads – in fact anything over A4 gets a bit tricky! With a locomotive

this size, most drawings cover subcomponents and they can be done on an A4 or even an A3 drawing board, but there are some, such as the GAs, the cab views and the boiler, which need to be sized to A1. I've got no problems drawing 'em, but need to go to Gibraltar

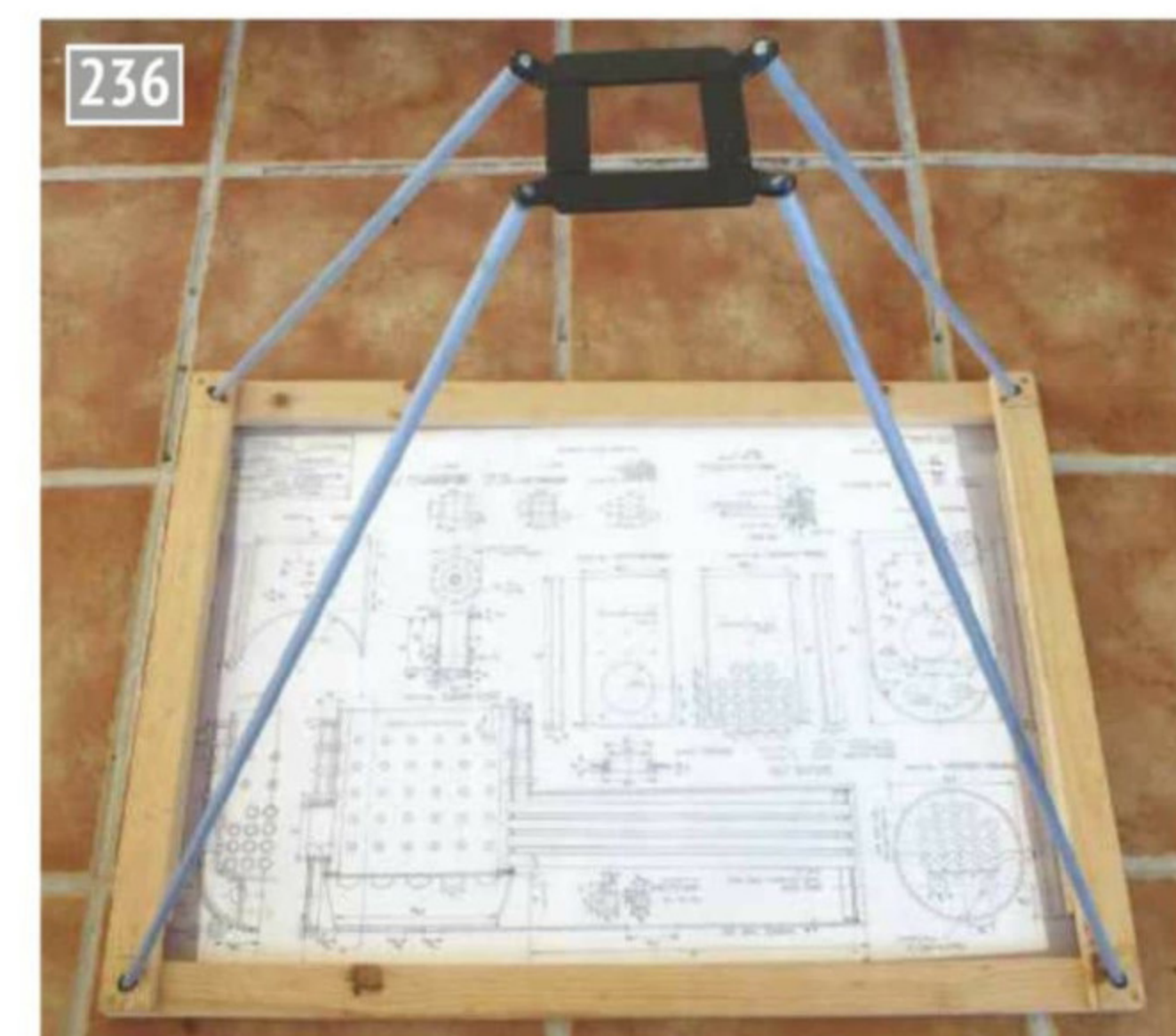
to get them scanned - and 'er-indoors and I only venture 'that far abroad' about four times a year. So I got to thinking ... all these problems could be overcome by using a camera stand.

In the past I've copied drawings a few times using

the common or garden digital camera with reasonable results – the main problem was that of parallax which causes unwanted and significant distortion. I thought the easy way would be to search the web, but I could only find stands suitable for size A4. The only answer was to invent one - and then construct it!

It was necessary to provide a framework in which to sit the camera, which would ensure that it would be in the same plane as the drawing (but see later regarding the time-honoured spirit level). The frame conveniently fixes the distance between the drawing and the lens.

electronic cameras the exposure/focusing 'eye' of the camera needs to be able to see the drawing. Also, due to its large size, the stand needs to be demountable and so I designed it to break down into three main parts; a wooden base, four suspension rods and the camera plate. These components are shown in **fig 156** and need little more explanation. The dimensions given are for a Lumix Panasonic DMC-1225 – which (like me!) was once state of the art but now it's a bit long in the tooth. To take a picture the assembly should be situated in a well-lit but shaded area and the shutter operated using the camera's



Copying frame.

To avoid parallax, it is important to ensure that the camera and the drawing are on the same axis, i.e. the base and the camera platen should be checked, and adjusted if necessary, with a spirit level.

Obviously the 'fine tuning' of the design will depend on the type of camera in use and the critical dimensions are the height of the camera bracket from the base and the design of the bracket itself. Note that with modern,

time delay. The wooden base is used to hold down an A1 drawing, which, if a tracing, should be placed on a white backing sheet. **Photograph 236** shows the device in use sitting over the Barclay boiler drawing. No camera, of

course, because it was being used to take the picture!

Note that, to avoid parallax, it is important to ensure that the camera and the drawing are on the same axis, i.e. the base and the camera platen should be checked, and adjusted if necessary, with a spirit level.

Back on the main line

Before going much further, it's worth republishing the general arrangement drawings for *Douglas*, the construction of which is nearing completion (**figs 157, 158 and 159**). Front,

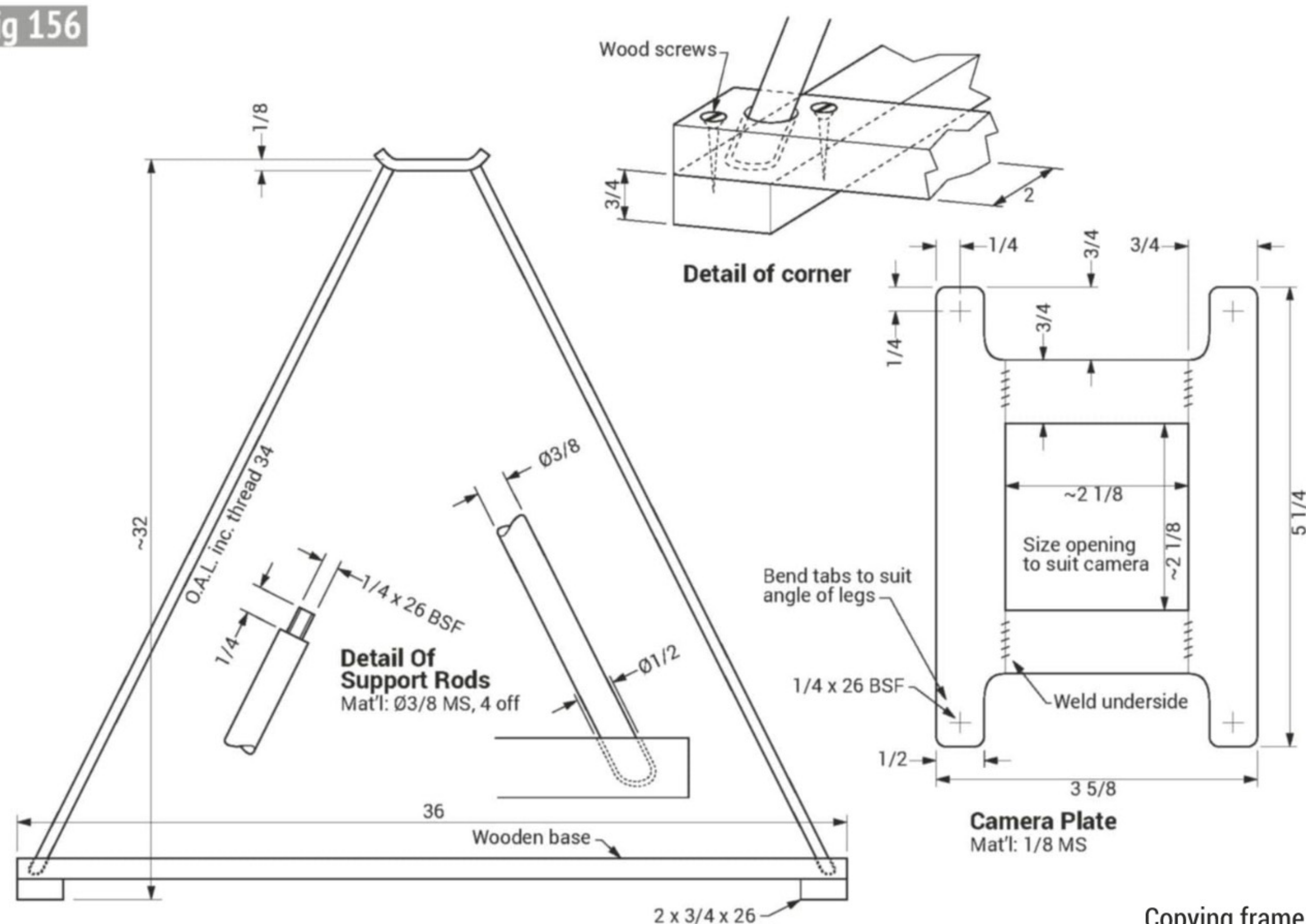
rear and side elevations of *Douglas* were published at the start of the series but a lot of water has passed under Dolgoch viaduct since then! Later, and before addressing the modifications necessary to turn out No. 1431 in its original condition, I'll include the GA side elevation for ACC No. 1.

I was thinking of preparing new drawings covering front and end elevations for ACC No.1, but apart from the central buffer/coupling and lack of running irons, there is no major difference to figs 158 and 159. Note, however, that the rear elevation would show the boiler and fittings above the bottom rear plate, as there is no rear spectacle plate on the original locomotive. It should also be noted that the GA's are not necessarily composed of detailed, individual drawings and, therefore, should not be scaled.

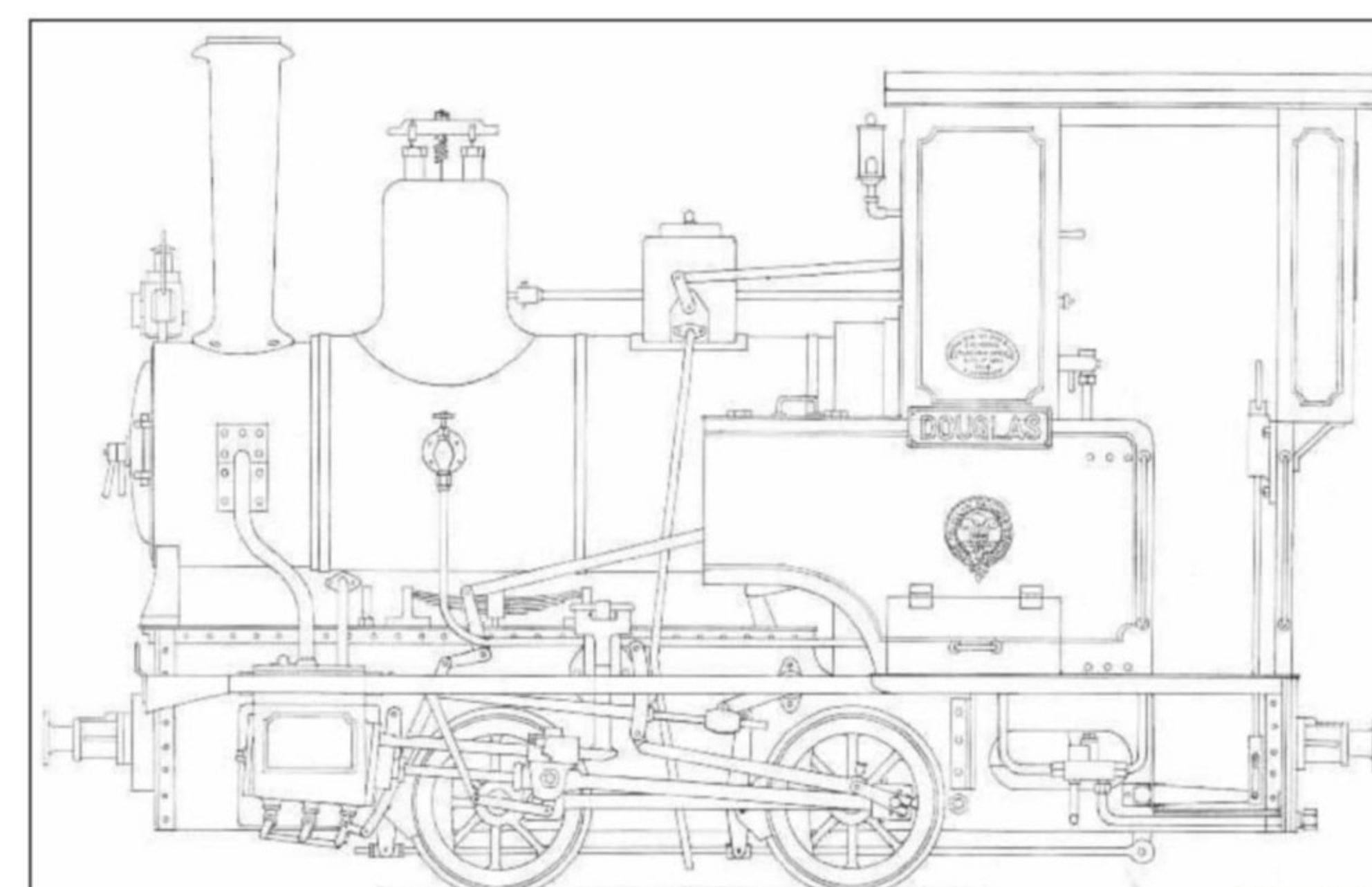
Tidying up a few loose ends ...

As we are coming to the completion of the main subject of this series, that is the construction of *Douglas*, it's a good time to address a few corrections and modifications. These will also apply to ACC No. 1. The WD 0-6-0 is a different beast with a more complex frame/motion design, although it uses many features of the 0-4-0 engines.

Fig 156



Copying frame.



General Arrangement of Douglas - side view.

Fig 157

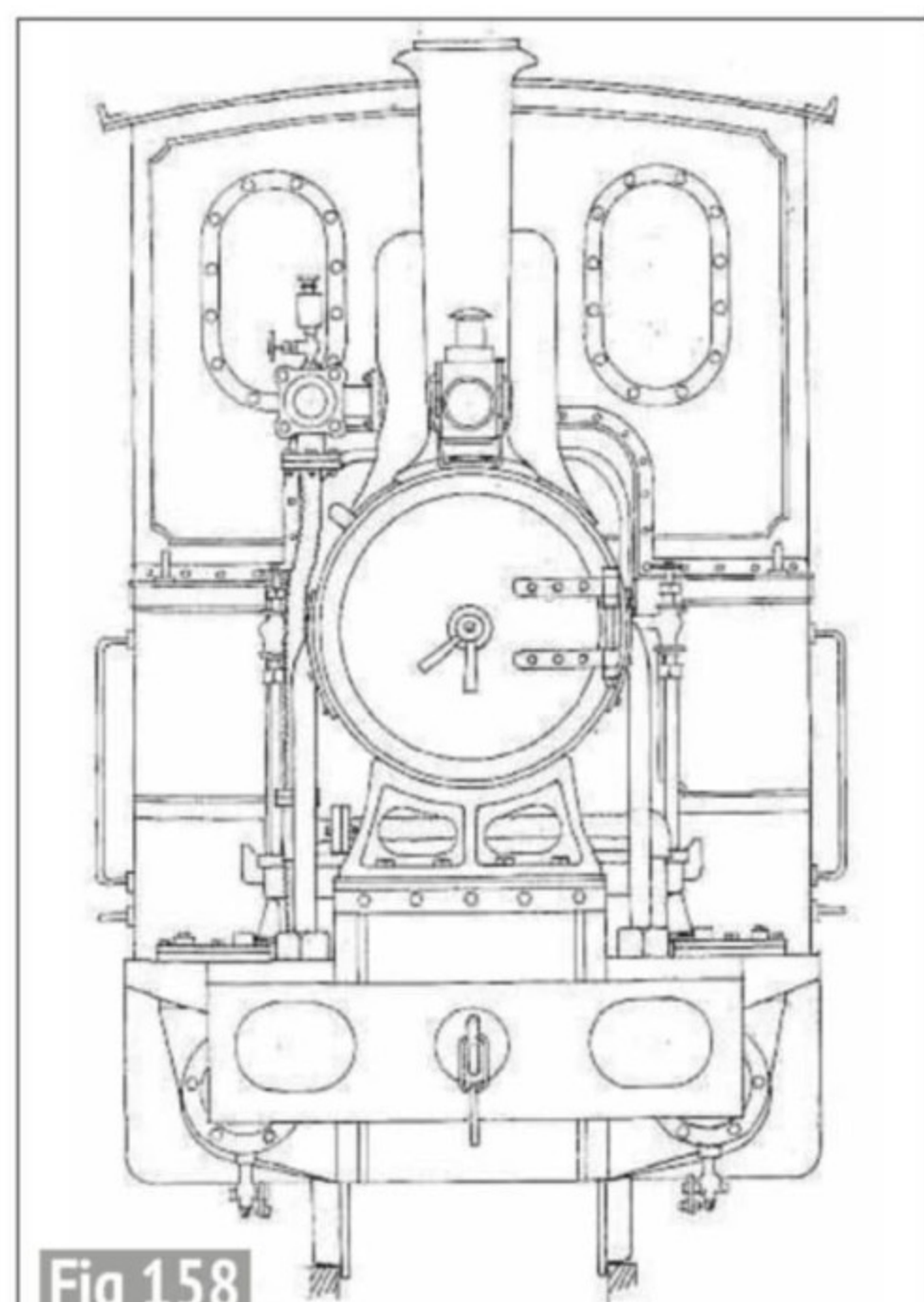


Fig 158

General Arrangement of Douglas - front view.

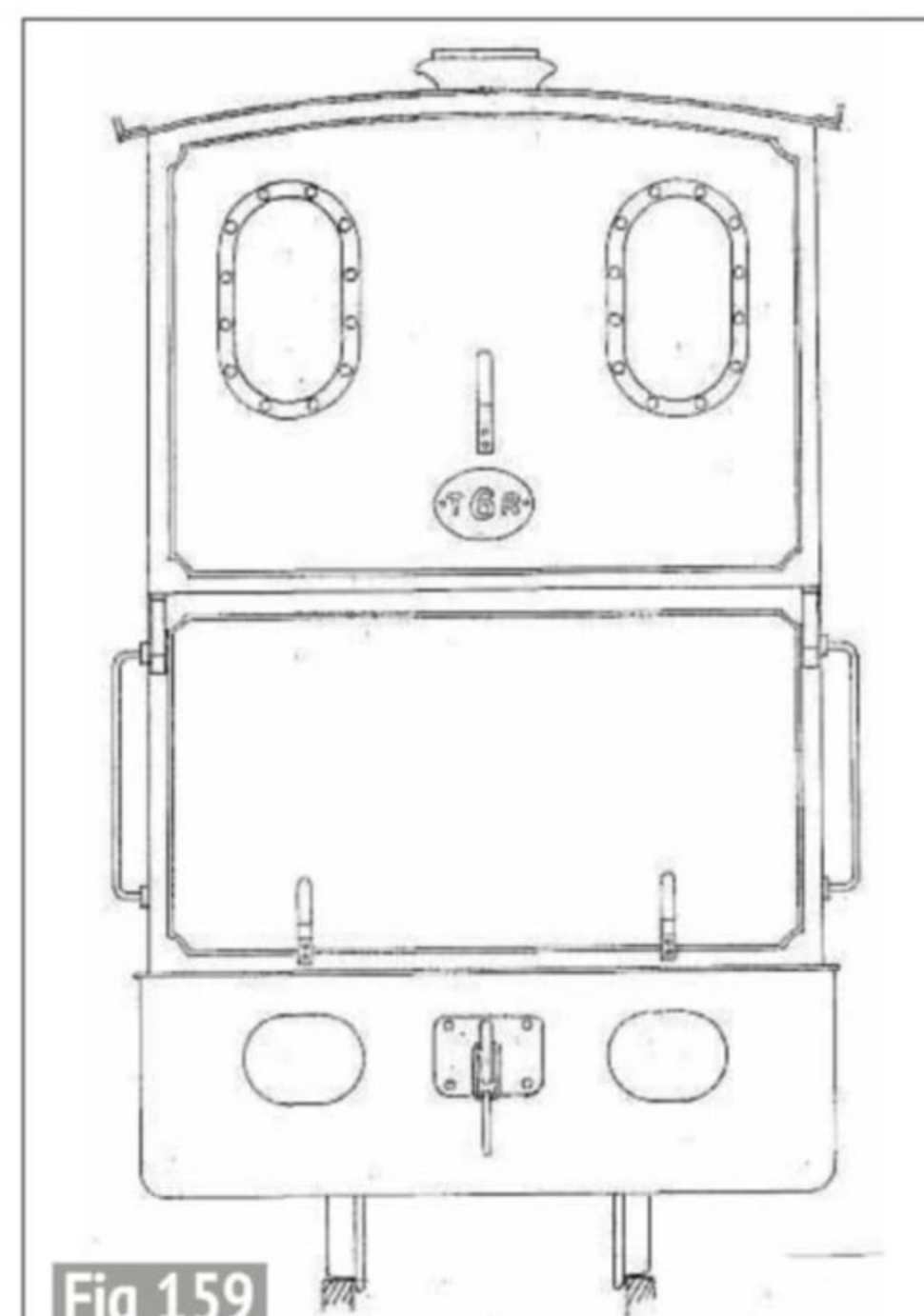


Fig 159

General Arrangement of Douglas - rear view.

Looking back at previous work it has occurred to me that fig 85 would benefit from a top view so the modified drawings are included here as **figs 161 and 162**.

Corrections

1. On the main frame drawing, the bottom row of mounting holes should be $\frac{3}{8}$ inch up from the bottom of the frame and not, as stated, $\frac{5}{16}$ inch (fig 60). This ensures that the base of the cylinder backplate lines up with the bottom of the frame.

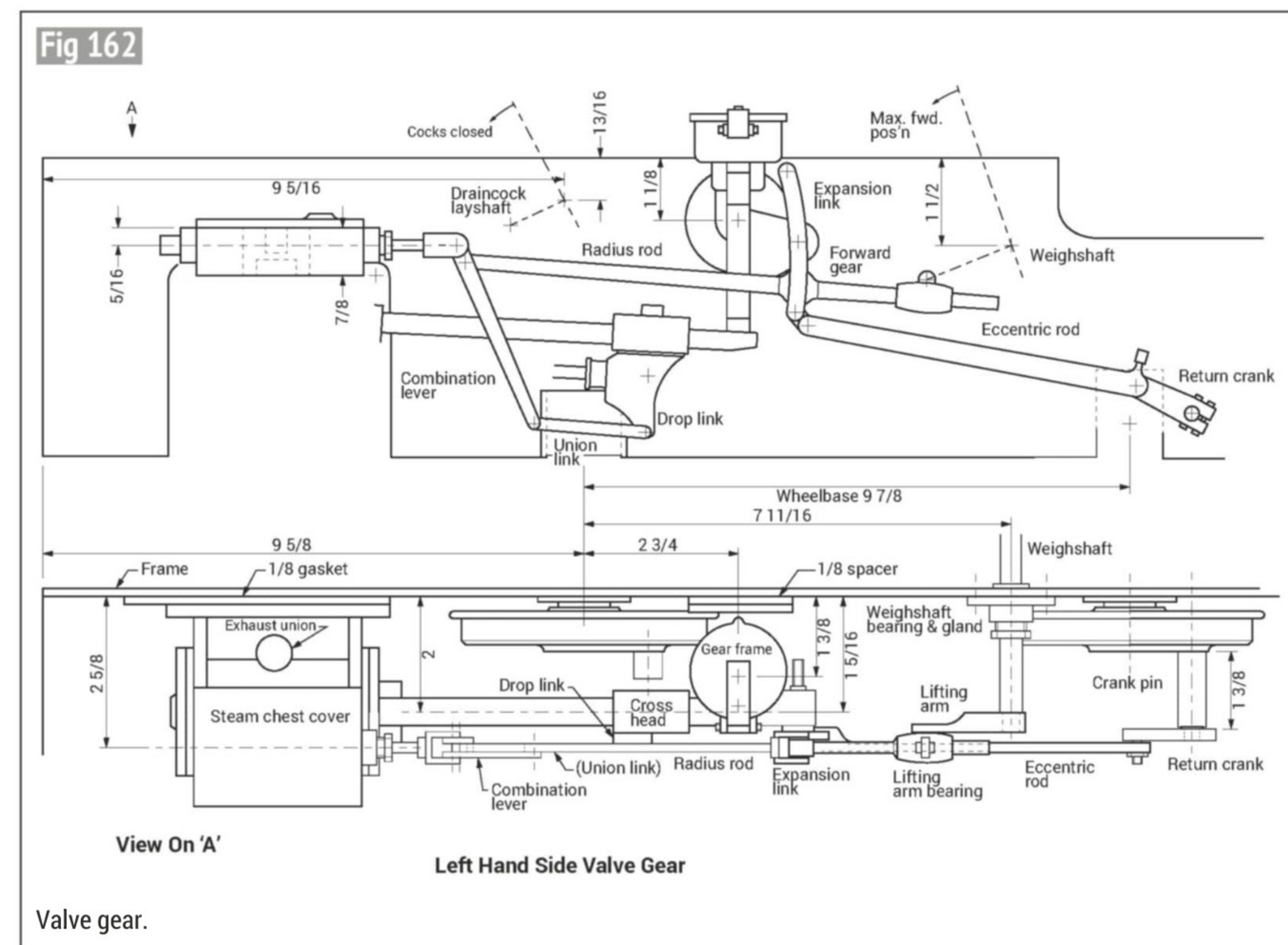
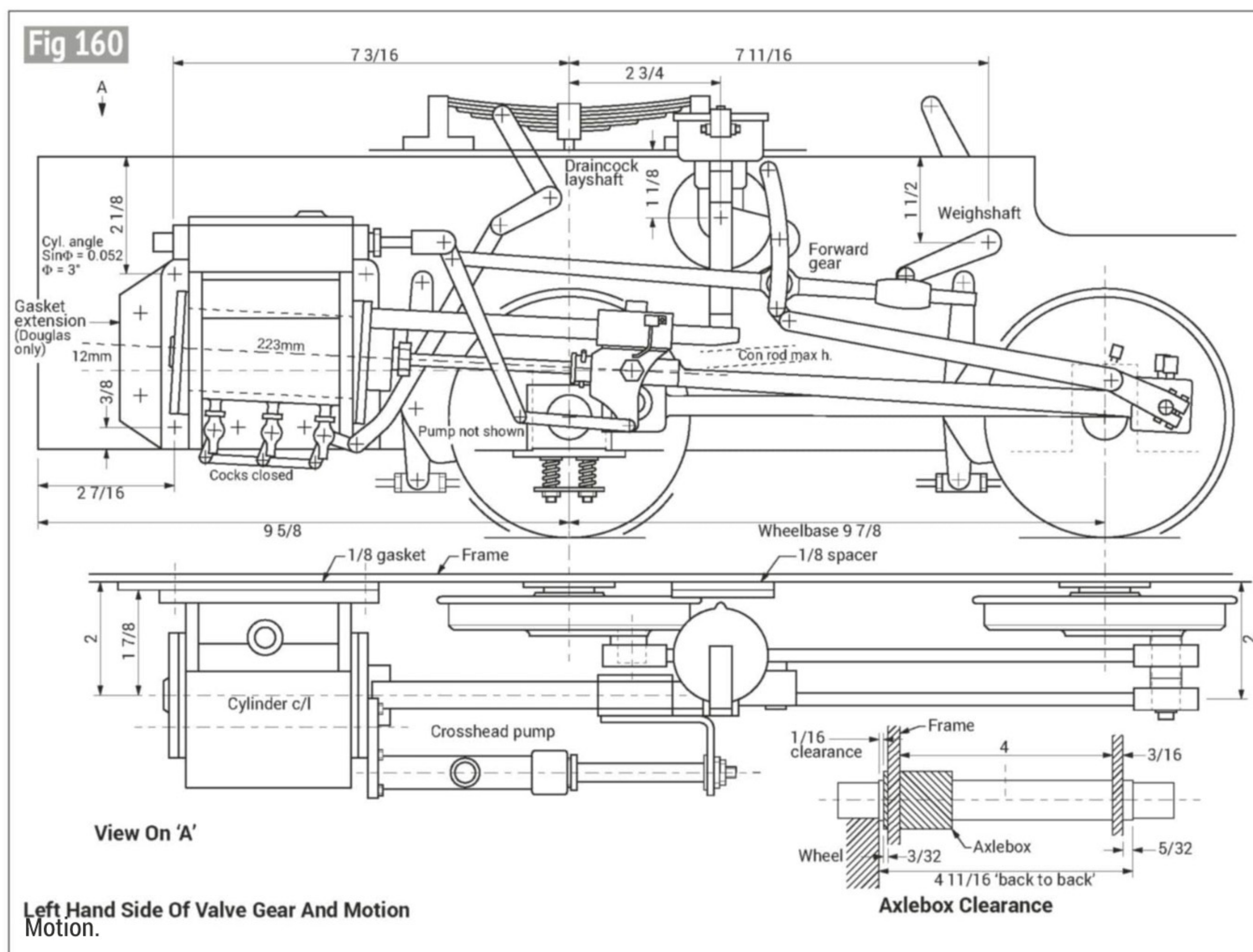
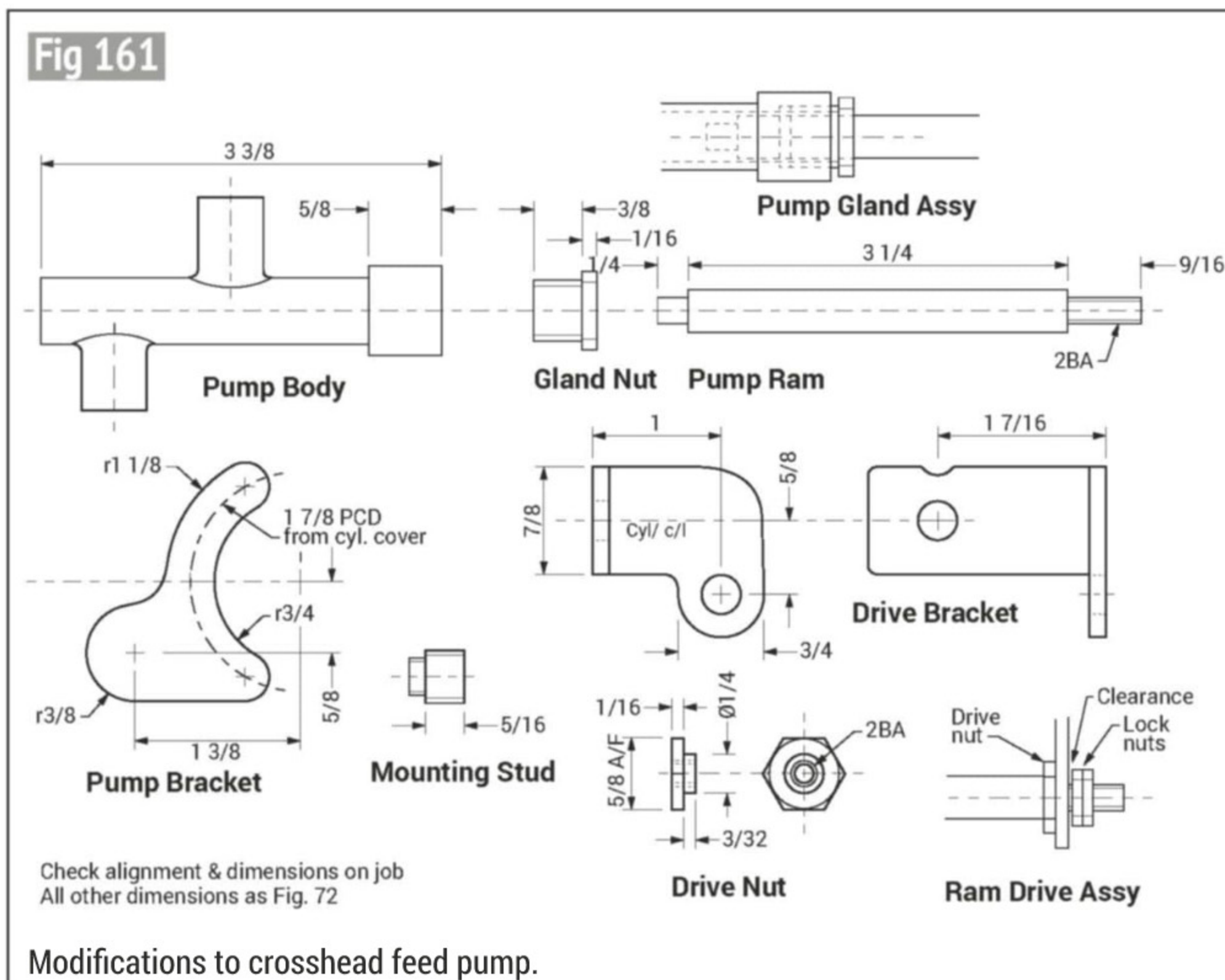
2. One important item, which is not shown on the drawing, is the tapped hole that needs to be in place for the crosshead feed pump suction. This should be on the left hand side between wheel sets at the base of the tank. It should be sized to take a custom-made brass bulkhead fitting for the $\frac{3}{8}$ inch diameter suction to the

pump. It should be possible to drill and tap a suitable hole at any time during construction or even after completion.

3. In fig 160 note that the distance from the front axle centre to the weighshaft is correctly marked as $7\frac{11}{16}$ inch (this was dealt with as a correction earlier in the series). That is, **not** $7\frac{5}{16}$ inch as shown on the original frame drawing.

4. In fig 14 the frame centres are not marked but should be $4\frac{3}{16}$ inches. The rear buffer beam should be slightly narrower so that the footplates overhang each side by $\frac{1}{16}$ inch (photo 52 and, later in the series, fig 169).

5. In fig 22 - the outer footplate - the overall length should be $11\frac{1}{8}$ inch and not $12\frac{1}{8}$ inch as stated on the drawing.



6. In fig 39 - the coupling rod - the bearing length should be $\frac{5}{16}$ inch and not $\frac{5}{8}$ inch.

7. In fig 66 the distance from the centre of the filler to the base of the flange is incorrectly marked as $1\frac{1}{4}$ inch when it should be $1\frac{1}{2}$ inch; the proportions of the motion bracket on the drawing, however, are correct.

8. There is a small correction required to fig 92 in that the height of the tank top was drawn incorrectly. This is dealt with under 'bunkers/side tanks' below.

9. In fig 160 I have included a side view of the crosshead feed pump and as a result have made some correction and modification to the design. This improves the insertion length of the piston into the pump body as well as resolving an alignment issue (fig 161). Note that the dimensions shown in fig 161 are different from those given in fig 72. All other dimensions in the original figure are unchanged and the dimensions associated with alignment should be checked on the job. The pump displacement is almost 4 millilitres and therefore the pump will deliver approximately one litre every 250 revolutions, which is equivalent to 300 foot travelled and approximately $\frac{1}{16}$ th of a gauge glass.

For drawing my attention to most of these corrections I have to thank M.E. subscriber, Mr. Anthony Simmons, who is currently constructing a *Douglas* in his Norfolk workshop. He and I are regularly in touch and I hope to publish some of his photos later in the series, showing the meticulous results of his engineering.

Modifications

1. A simple modification can be applied to the weighshaft (fig 91) which avoids using spacers; reduce the $\frac{1}{4}$ inch stubs at each end from $\frac{5}{16}$ inch to $\frac{3}{16}$ inch in length (fig 162);

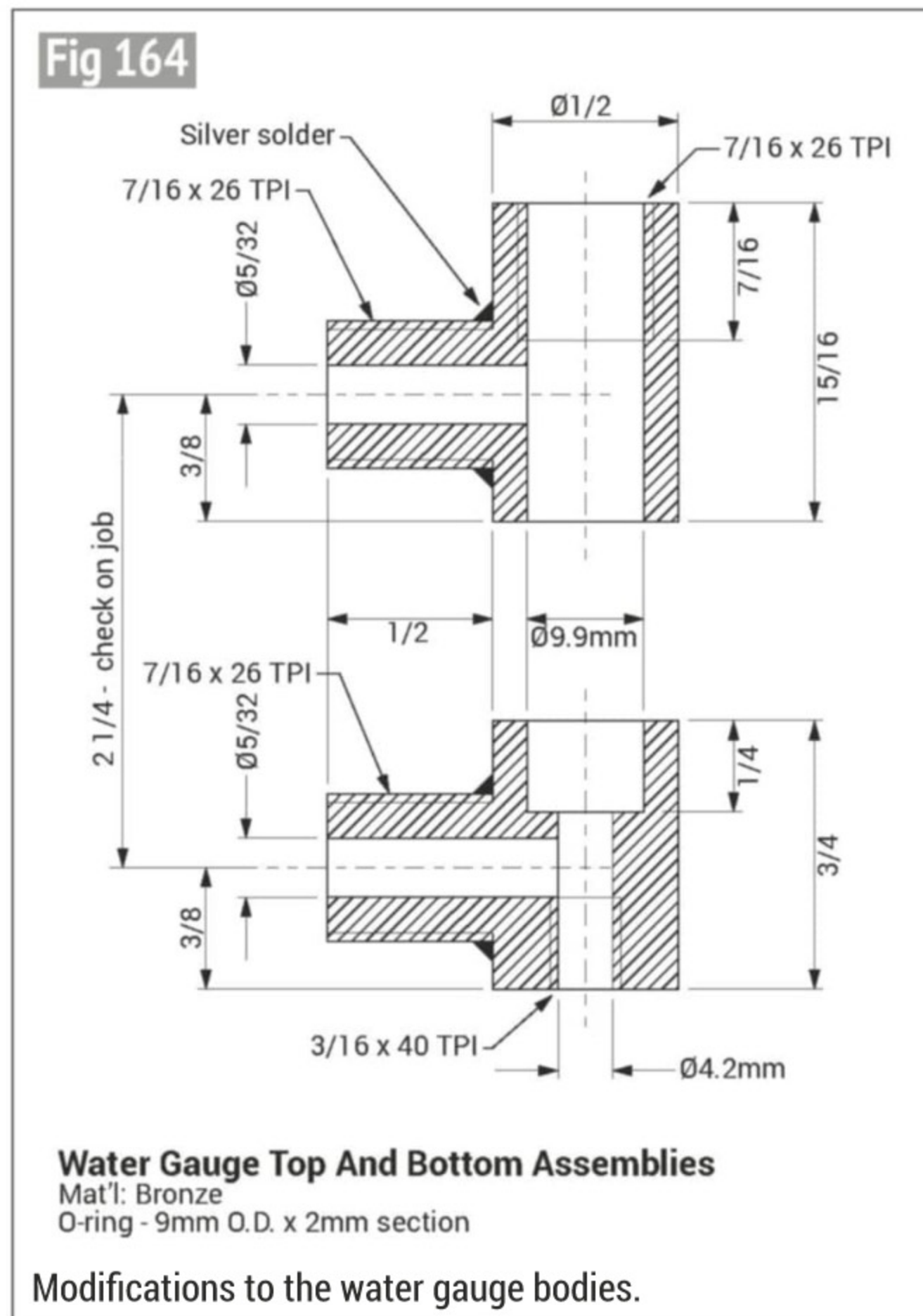
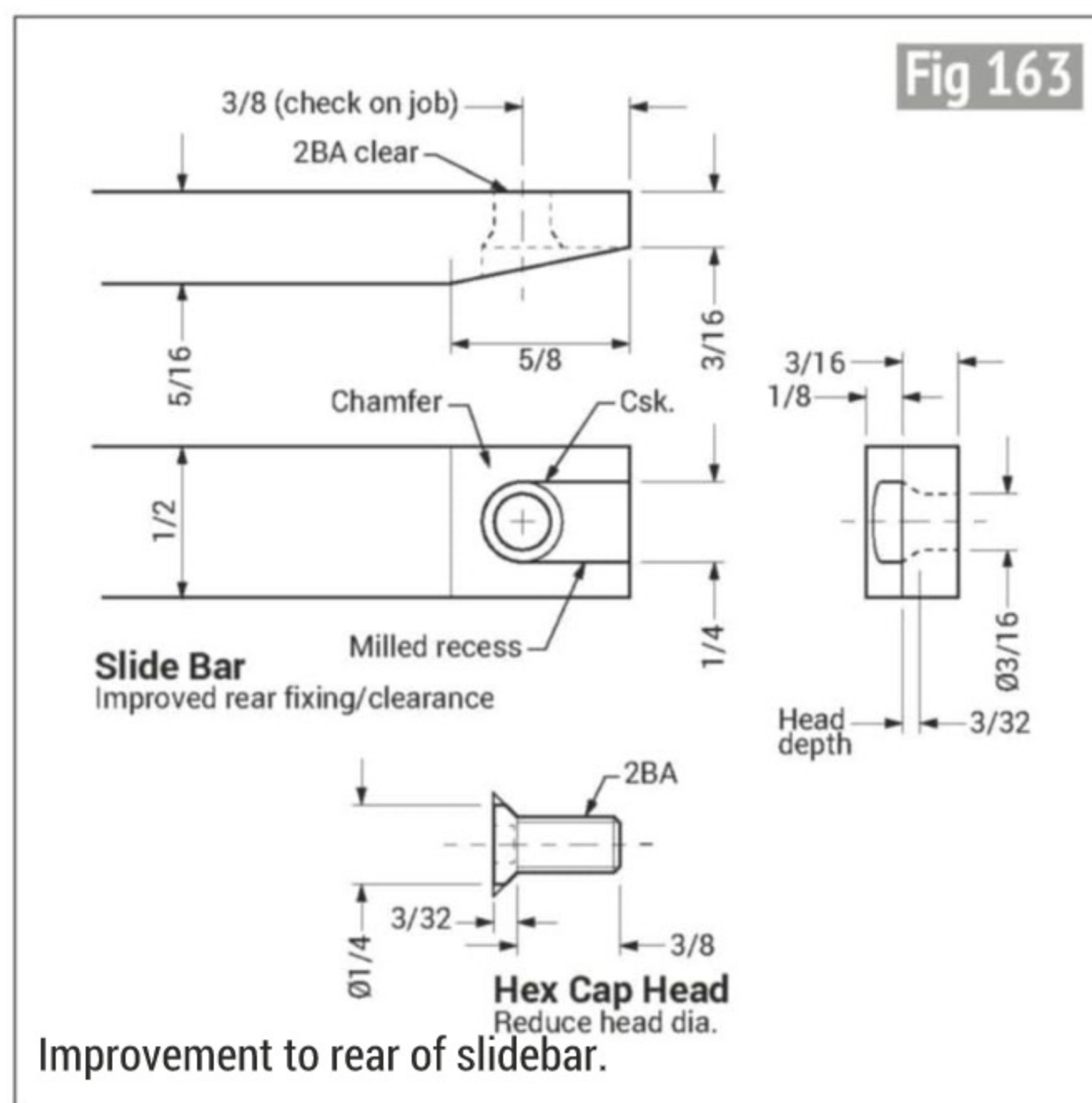
the overall length of the shaft remains the same. The lifting arm spindle, which engages with the lifting arm bearing, may need slight extension but its length is best checked on the job.

2. Minor improvements to the rear fixing point on the slide bar (fig 61) will provide extra clearance between the connecting rod and the rear of the slide bar (figs 160 and 163). It also makes for a better-engineered solution to the fixing point. If countersunk, high tensile 2BA hexagon-headed screws are not available it is possible to use cut down 2BA cap heads, countersunk into the underside of the bar. The slot in the bottom of the slide bar should be easy to mill when the job is set up to machine the chamfer.

3. The water gauge body parts have been slightly modified and these are shown in fig 164. The method of fixing prior to silver soldering is left to the builder. The 9.9mm clearance for the Pyrex glass tube allows for some non-uniformity in the diameter of the glass and, at the same time, is the tapping size for the $\frac{7}{16}$ inch x 26 tpi thread. Some slack is acceptable here because the seal is made on the end of the tube and not on the diameter. All the other components shown in fig 142 are correct.

4. A modification to the combination/valve rod arrangement will be dealt with later under the modifications needed to turn out the engine as *Airservice Constructional Corps No. 1*. This specific Barclay design (the valve rod to the combination lever connection) is a bit simpler than conventional Walshaerts as it does not have a forked end on the valve rod. The modification can be applied to *Douglas*, of course, for authenticity, but fig 162 shows the conventional arrangement, which is partly hidden by the running irons.

●To be continued.



Modifications to the water gauge bodies.

NEXT TIME

Tidying up over - we get on with the job.

Synchronome Clock Revisited

PART 1

Patrick Williams completes his Uncle Doug's synchronome clock and adds a few further improvements.



In my article in the *Model Engineer* issue ME4281 of September 1st 2006 I stated that there were still a couple of things to be done before the clock could be considered completed, these were:

- Change the aluminium bezel for a brass one.
- Remake the pendulum top end suspension.

I had also to decide the extent of any other changes I would make to the clock. Up to now I had kept them moderate but reviewing pictures of factory-made clocks on the internet I could see that it was not possible to confuse Uncle Doug's clock with a factory product, so I determined to do whatever was necessary to make the clock function on a permanent basis. I wish to point out, that not being a clockmaker, I would employ purely engineering solutions.

Photograph 1 shows the current status of the clock. I will describe the changes I made in the order in which I made them, starting with the two above.



New brass bezel.

Change the aluminium bezel for a brass one

The aluminium bezel was really out of place in a clock which was predominantly made of brass fittings, so I looked again for a suitable bezel, which needed to be hinged to simplify setting the clock. The firm SELVA, which offers an extensive catalogue of parts for the hobby clockmaker and which I had recommended to Uncle Doug when he was still alive, again failed to come up with a suitable bezel.

I wrote to a couple of engineers offering their services in advertisements in the *Model Engineer* to have a bezel made but none was able to make one to the dimensions required, so once again it was do-it-yourself, where my problem was the inability to turn a brass bezel of the diameter required on my lathe. I found a bezel in the Selva catalogue which could be used but it would require an adapter piece to bridge the gap between the silvered dial, which I wanted to retain, and the inside part of the bezel, as it was larger in diameter than the dial.

Although I couldn't turn this adaptor in the lathe, I did have a six inch rotary table and, if this was increased in size with a sturdy platform of 19mm MDF, I could 'turn' the appropriate diameters. Starting with a large square of 6mm aluminium, with a great deal of handle winding the adaptor piece was made and the 3 or 4mm of aluminium adaptor between the dial and the silvered bezel inner ring is not at all noticeable (photo 2).



Synchronome clock current status.

Because of the curvature of the glass required to clear the hands the bezel has to stand away from the wood of the clock case by about 3mm on the outer edge. To hide this unsightly gap, I took a piece of brass angle of the right dimensions, bent it into a circle, and riveted it to the aluminium adapter piece. As the 'L' section would not possibly curve to the diameter required without very much distortion I made regular saw cuts prior to bending using a very fine saw guided with a steel jig. These saw cuts closed up on bending and as they are only seen when the bezel is opened, they look, in fact, quite intentional - see photo 3 and a cross section of the new bezel and adapter configuration in fig 1.



Aluminium adapter piece for the bezel.

Remake the pendulum top end suspension

The original suspension was a foil inserted in hexagonal brass cheeks and fixed with screws, which meant that to remove the pendulum meant removing the clock and face and loosening the trunnions. To make adjustments easier I made the brass cheeks from square stock such that the top cheek of the pendulum could be easily lifted off the cross pin of the suspension foil.

This arrangement can be seen in **photo 4**, and assembled in **photo 5**. It was difficult to make adjustments to the pendulum position, which usually involved loosening the trunnion screws, moving the pendulum support bar on the frame by eye left or right and then tightening the screws again. This was mainly because the fore and aft position was altered unintentionally while moving the trunnion left or right. To solve this problem, I made a plywood template of such a

size that the pendulum support bar could be pushed back against it, thus maintaining the fore and aft position during adjustment. See **photo 6**, in which the template can be seen protruding on the right. Removing and replacing the pendulum needs care and it is easy to damage the delicate foil in the suspension, which I did often, and **photo 7** shows three different versions of the foil.

Further improvements

Before I go on to describe the modifications which were later implemented, it is probably best to insert here a description of the way the clock works and to provide a picture of the parts named to make the modifications easier to understand (**fig 2**).

Most of the names of the components given in the figure have been taken from the original leaflet 'Instructions for Erection and Management of Synchronome Electric Time-Circuits' issued by The



Final suspension parts.



Pendulum suspension assembled.

Synchronome Co., Ltd. and, I assume, provided with the clock kit to assist setting up.

The pendulum has a length which gives a cycle time of two seconds, the count wheel has 15 teeth and the gathering click will rotate the count wheel one tooth every two seconds. There is thus one complete rotation every 30 seconds and the backstop will prevent the count wheel from rotating backwards. Once

per rotation the vane (release pin), which is fixed to the count wheel, will contact the gravity arm catch and move it to the right, thus releasing the gravity arm, which falls. (In my variation this effect of gravity is increased by the push of the pressure lever.)

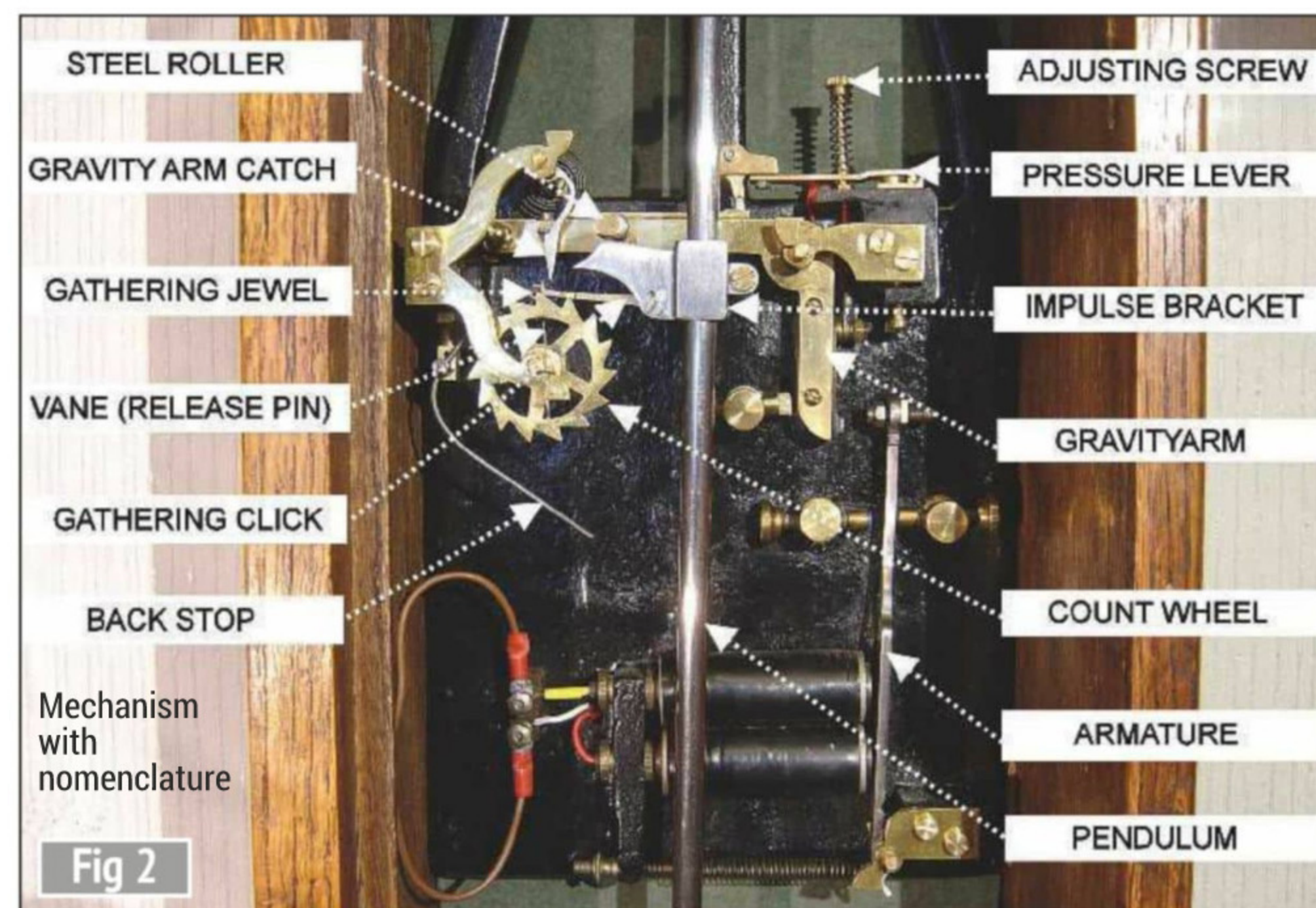
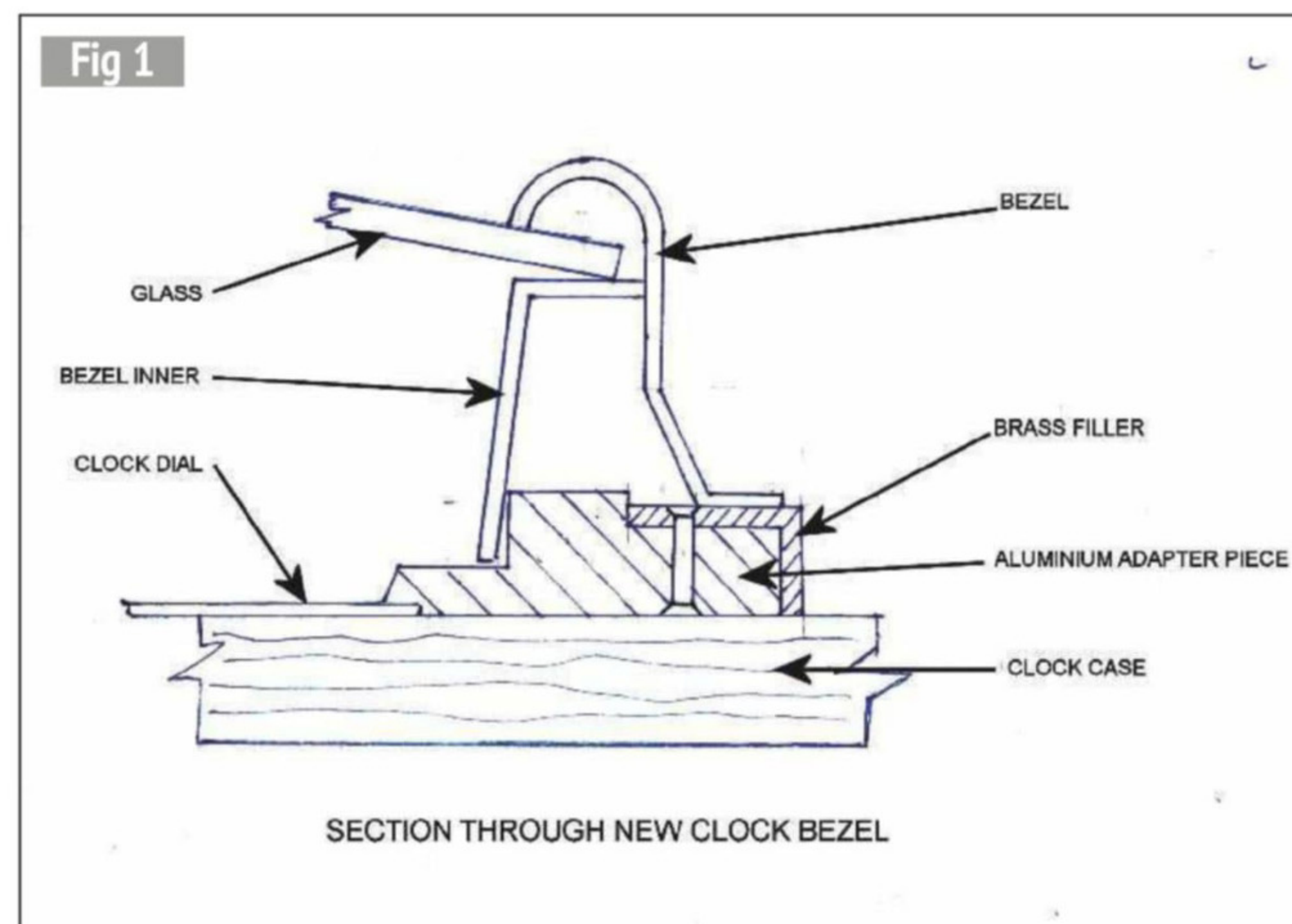
In falling, the steel roller drops against the curved surface of the impulse bracket, giving the pendulum a push to the right. As the

pendulum moves to the right the roller drops further and enables the contact at the lower end of the gravity arm to touch the contact on the armature. When this electrical circuit is completed current flows through the coils and the magnetism attracts the armature, which moves sharply to the left. This throws the gravity arm also to the left and its upper end catches on the spring-loaded gravity arm catch, ready for the next cycle.

In addition, the same current flows through the clock mechanism, which is so designed as to move the second hand forward by a half a minute. When correctly set the clock will function as long as a current is applied.

Unfortunately, in use the clock kept stopping, so I examined various parts to seek a solution starting with the gravity arm, believing that there was not enough weight to give an adequate impulse to the pendulum. In doing so I found an additional difficulty; the arbor had pivots in the form of cones which were seated in the dimpled recesses at the ends of steel grub screws, which acted as bearings. It was extremely difficult to locate the pivot ends as the dimples were so small, so an improved bearing to ease assembly was necessary.

The clock kept stopping at the same position of the count wheel; this was probably due to the wheel having been made without the aid of machinery, so I determined to make a new count wheel. While examining the count wheel I discovered that it was only



a push fit on the arbor and was probably rotating out of alignment during operation, so a firmer fixing was necessary, in addition to the improved bearings described above.

The gathering click adjustment was also not to my satisfaction so an improved height adjustment while *in situ* was considered necessary.

The set-up instructions required the clock to be firmly

fixed to the wall, whereas mine was standing loose on carpet and it occurred to me that the pendulum, at 9.5 pounds weight (4.3kg), was moving the case slightly and changing the relationship of the moving parts, so I set up a measuring device to check this. The result was negative but the thought was that every time the clock was touched it may have adopted a different position,

thus affecting the timekeeping. I decided to delay this wall fixing and apply it only as a last measure if required.

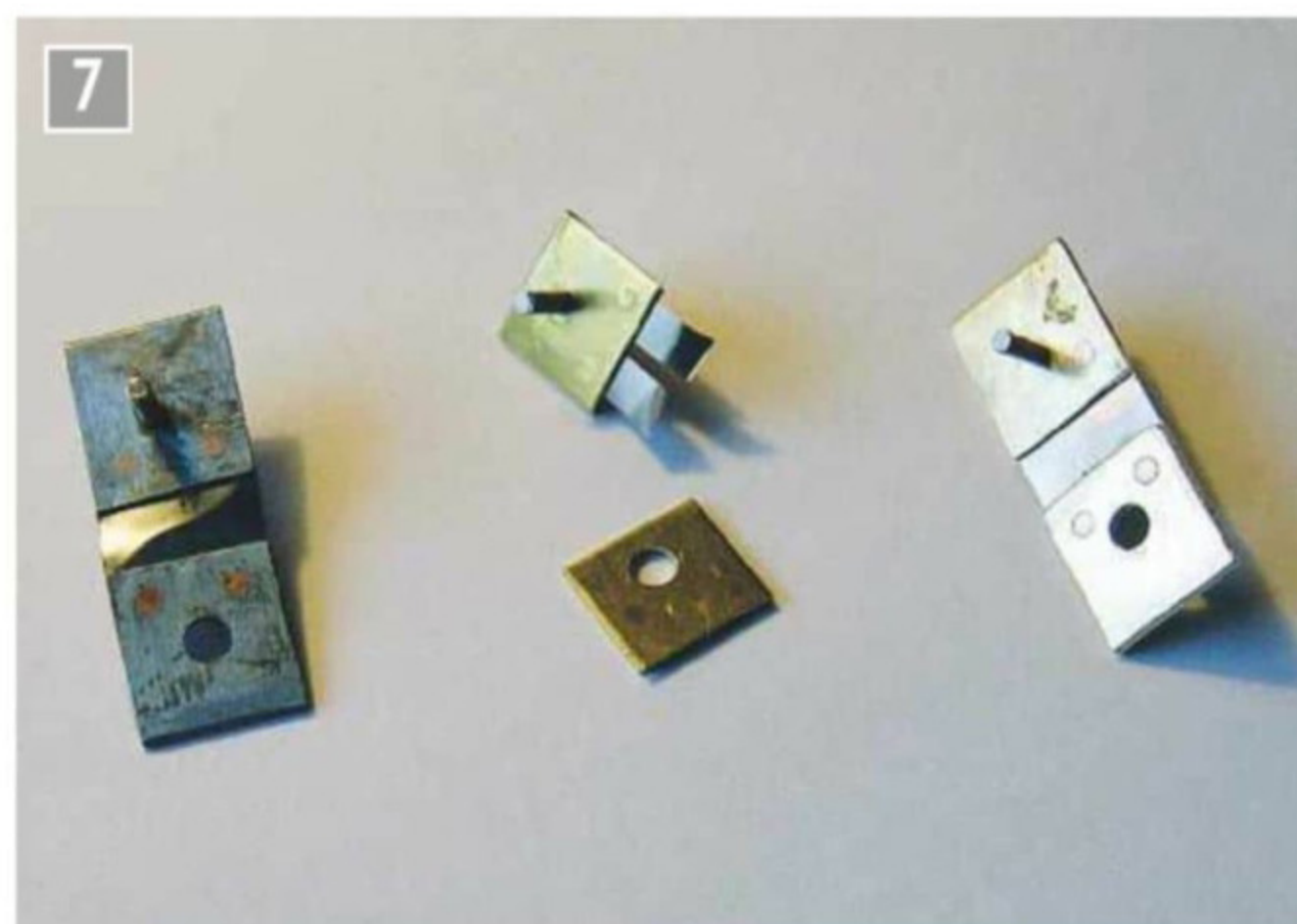
●To be continued.

NEXT TIME

I shall discuss the details of the further improvements I made to the clock.



Trunnion location template.



Foil suspension versions.

3D Printing for Model Engineers

Brian Marchant ventures into the realms of high technology and builds up his 3D printing skills by creating a set of six brake hangers.



I am quite a patient man, but also quite lazy, so when faced with producing six identical brake hangers (**fig 1**) for the tender of my Stirling Single, I wondered how it could be done without spending hours whittling away at a bar of BMS, inevitably resulting in six similar but not identical items. Aha! I thought. What about 3D printing? But that only works with plastic! Not a problem, thought I, the braking system is largely cosmetic and there would not be much stress on the components anyway. But I had two problems: one, I don't have a 3D printer; two, I don't know how to use one. In fact, I hadn't a clue about the whole process.

The first issue seemed unsurmountable. Don't they cost a fortune? But a quick search on Google revealed several in kit form for not much more than £100. One in particular caught my eye, the Geeetech Pro I3. It had great reviews and the price was right, so three days later I took delivery of the acrylic version which seemed more durable than the wooden one, albeit a bit more expensive. I opened the box and was stunned. I have never seen such a detailed and well-documented kit for anything. All the bits packaged and clearly labelled and the quality of the components looked great. A thinking man's Meccano set!

It came with a very detailed component list. I checked and everything was there. I downloaded the Assembly Manual and the User's Manual from the Internet, fetched a

few basic tools and made a start. The blurb said it could be built in five hours. It took me six. Assembly went without a hitch and I soon had a 3D printer in front of me, although it looked more like a model of these crane thingies that you see on the docks for handling containers (**photo 1**).

I switched it on! And all the house lights went out! Why? For some reason, the instructions say to remove the wiring harness from the power switch, which I had done, after photographing it to ensure I put the various wires back in the right place. A bit of checking revealed that in fact I had not put them back correctly. A quick adjustment and all was well. Actually, there is no need to take the harness off; it is perfectly possible to thread the various wires through the corresponding holes with the power switch attached.

I ran through the setting up procedure and all seemed well. But what do I do with it? Now to tackle issue two!

The user's manual is very clear and apparently written by someone whose first language is English! (Makes a change!) I downloaded the operating system, *Repetier*, which came free and worked first time. Now, what could I print? The manual included several links to sources of print files, suffixed .stl. I went to the NASA site and found all sorts of files to print space vehicles, components and maps of the surface of the moon and planets, all free of charge. I selected one of the surface of the moon

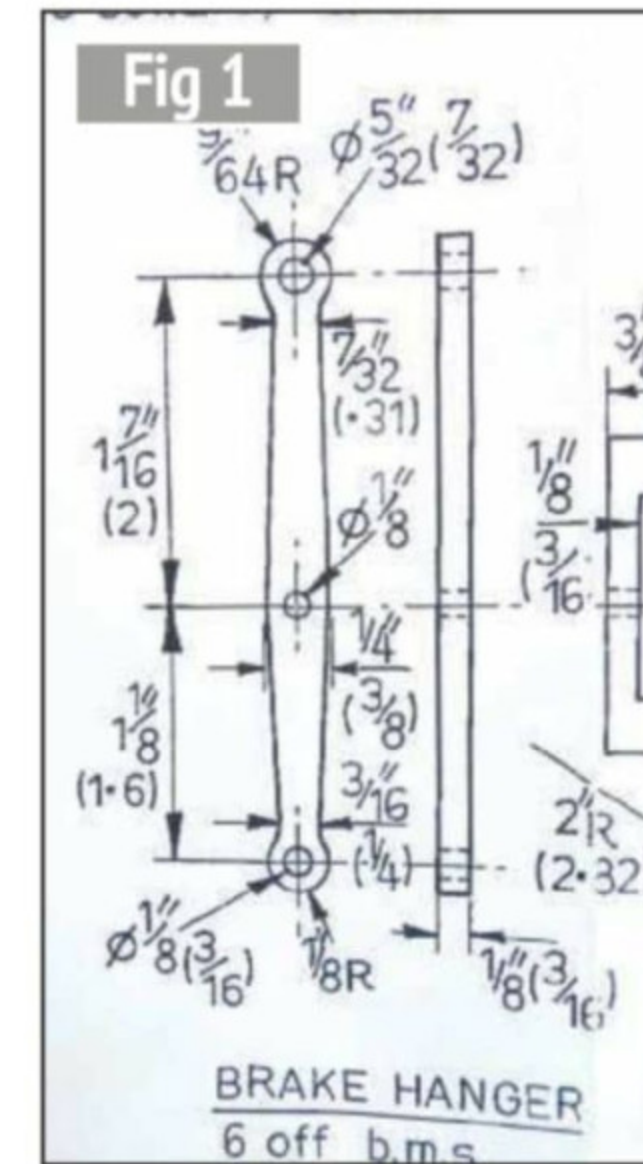
where one of the moon vehicles had landed. It was downloaded into *Repetier*, the button clicked and the machine burst into life. And I soon had a 3x5 inch 3D plaque with the contours of the various craters and seas. Amazing! Well, 'soon' is a bit of an exaggeration! It took seven hours! So what? it was fascinating to watch, as the print head flew back and forward and the map gradually took shape. I eventually got bored and I left it to its own devices and watched the telly while it churned away.

Great! It works! But how do I get a profile of the brake hangers into the machine?

The Geeetech website suggested several suitable CAD programmes. The ones I tried seemed very crude and their documentation was also poor so the project went on the back burner for a week or two. Then I went to the Doncaster Model Engineering Exhibition, more interested in buying some supplies than in 3D printing. By chance I came across a very nice and patient man who was printing out propeller components with a machine very like mine. He told me he used Autodesk Fusion, which is a fully professional programme but which can be used free of charge by hobbyists. He gave me a quick demonstration and in 10 minutes he had produced something very similar to my brake hangers.

I rushed home and soon found the Autodesk site. I downloaded it without any problems, although it was not too obvious how to get it free of charge. Thanks to the help I had in Doncaster and to the various tutorials on the Autodesk website, I eventually created a brake hanger on screen (**fig 2**), copied it over into *Repetier* and set it off. Very soon I had a beautiful bird's nest of tangled plastic filament on the heated table! Not good. And how to resolve?

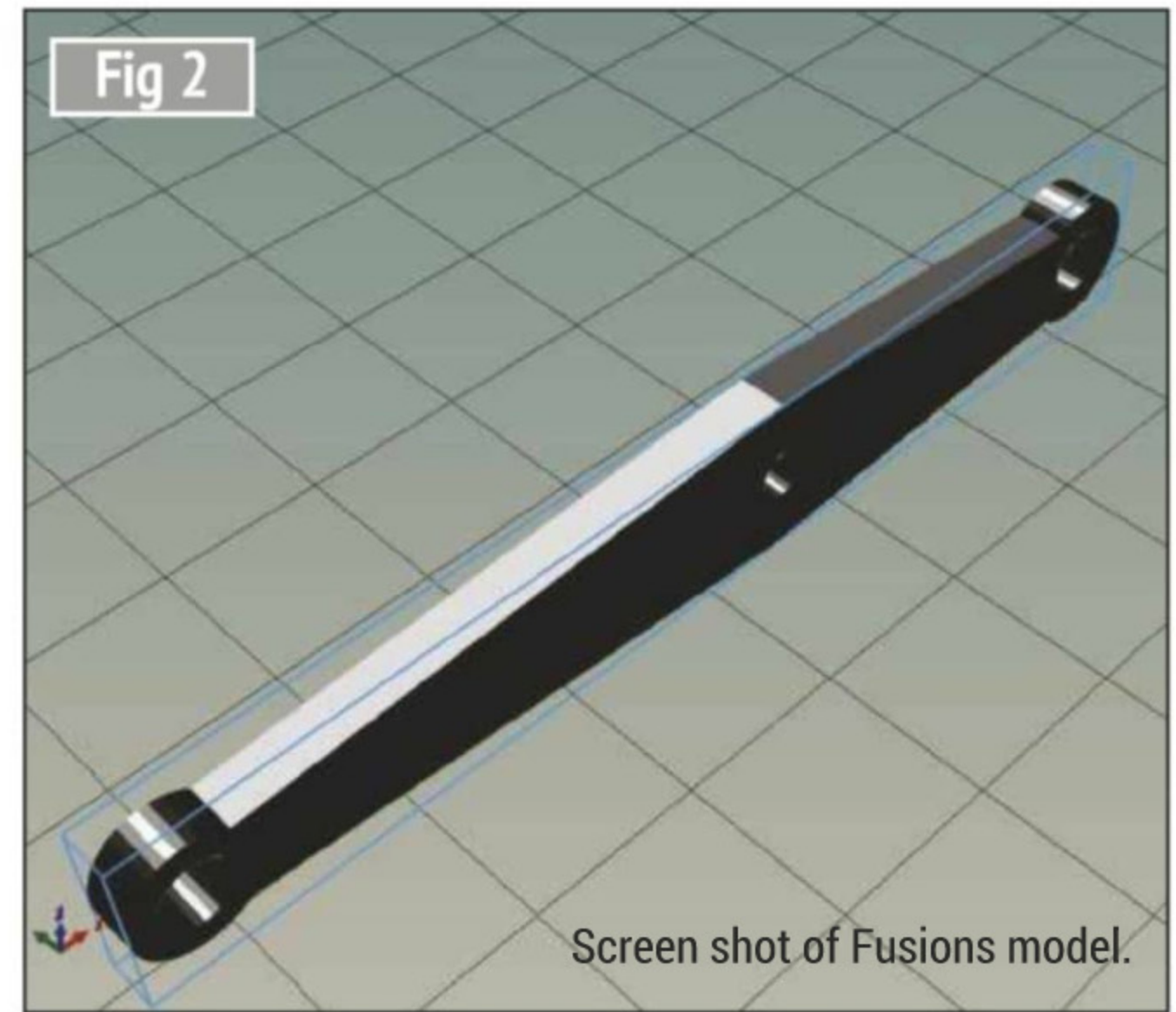
I guessed that the temperatures of the extruder and the hot bed are critical, so set about trying various



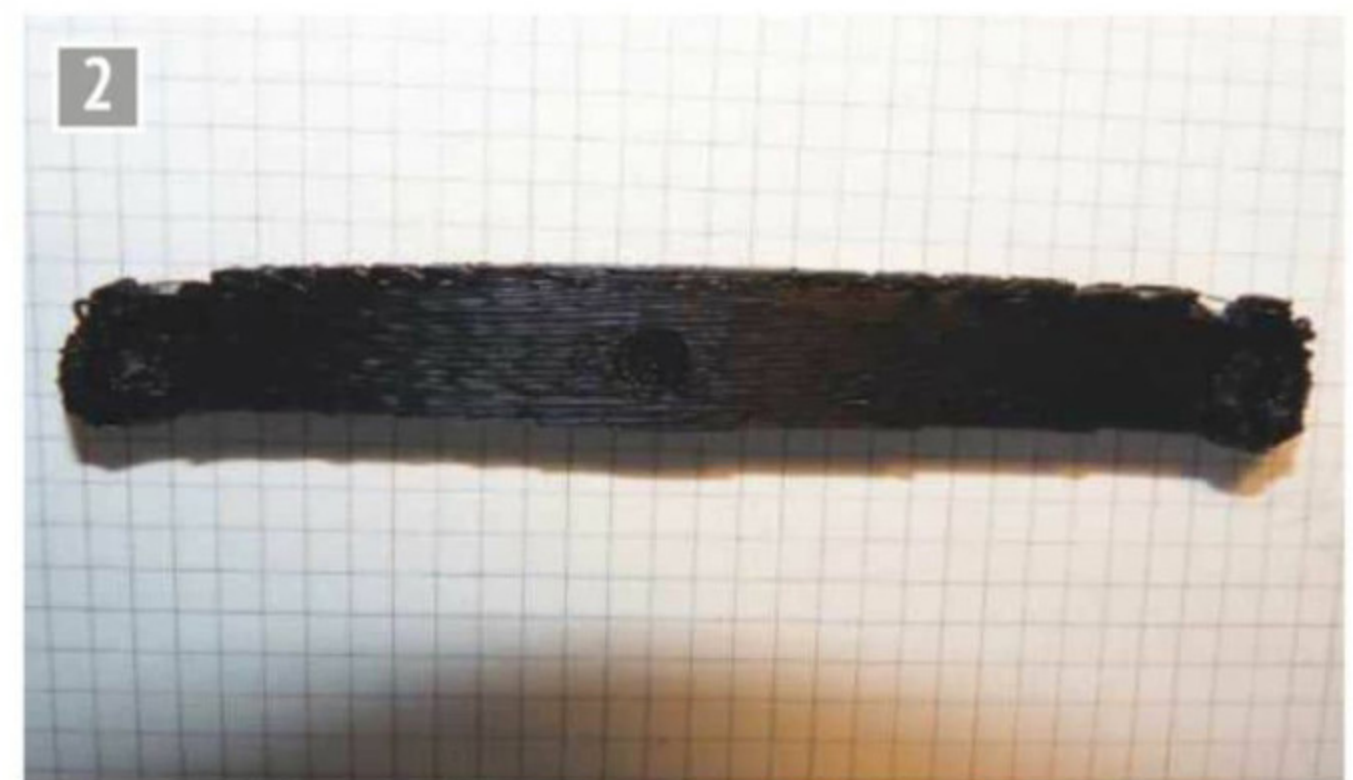
Brake hanger drawing.

combinations, working mainly on the theory that the two heated components had to be hot enough to allow the extruded filament to stick together, but not so hot that the component sagged and collapsed. Fortunately, *Repetier* gives full control over all the parameters of temperature, feed rate, number and depth of slices etc. Yes, slices! (No, it doesn't double as a bread making machine.) Before your eyes it produces a diagram of all the slices that the printer will put together on the model. You can watch it build up on the screen layer (sorry, slice) by layer.

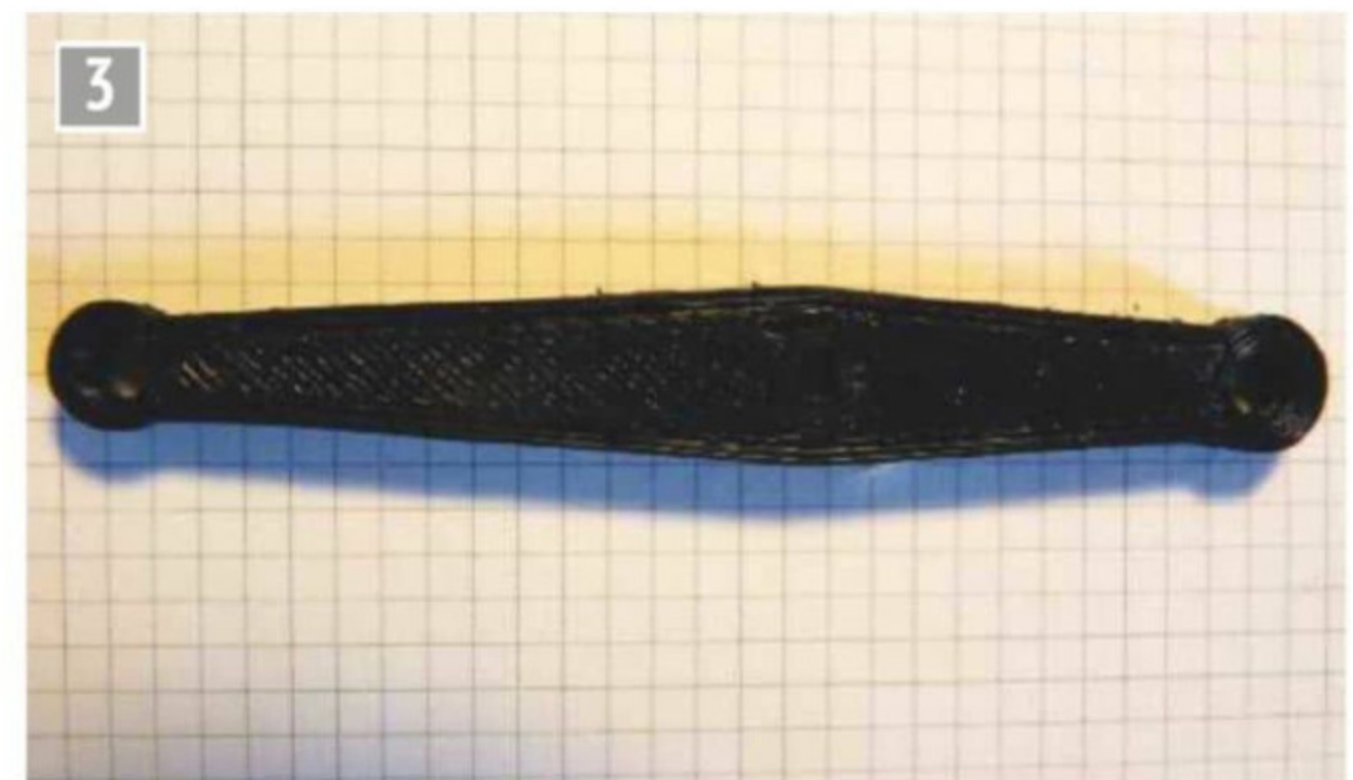
I eventually managed to get something which looked like the thing I wanted but distorted and liable to separate (**photo 2**). The problem seemed to be that the model was on its edge on the hot bed, so the printer was trying to print a curved edge on a flat surface. This involved much iteration of little squares stacked on top of each other on the hotbed but, without any real support, the curve sagged and became flat! What I needed was to be able to turn the hanger through 90 degrees so that its flat surface was against the hot bed. Eventually, under a sub-menu on the *Repetier*



Screen shot of Fusions model.



First attempt at printing the brake hanger.



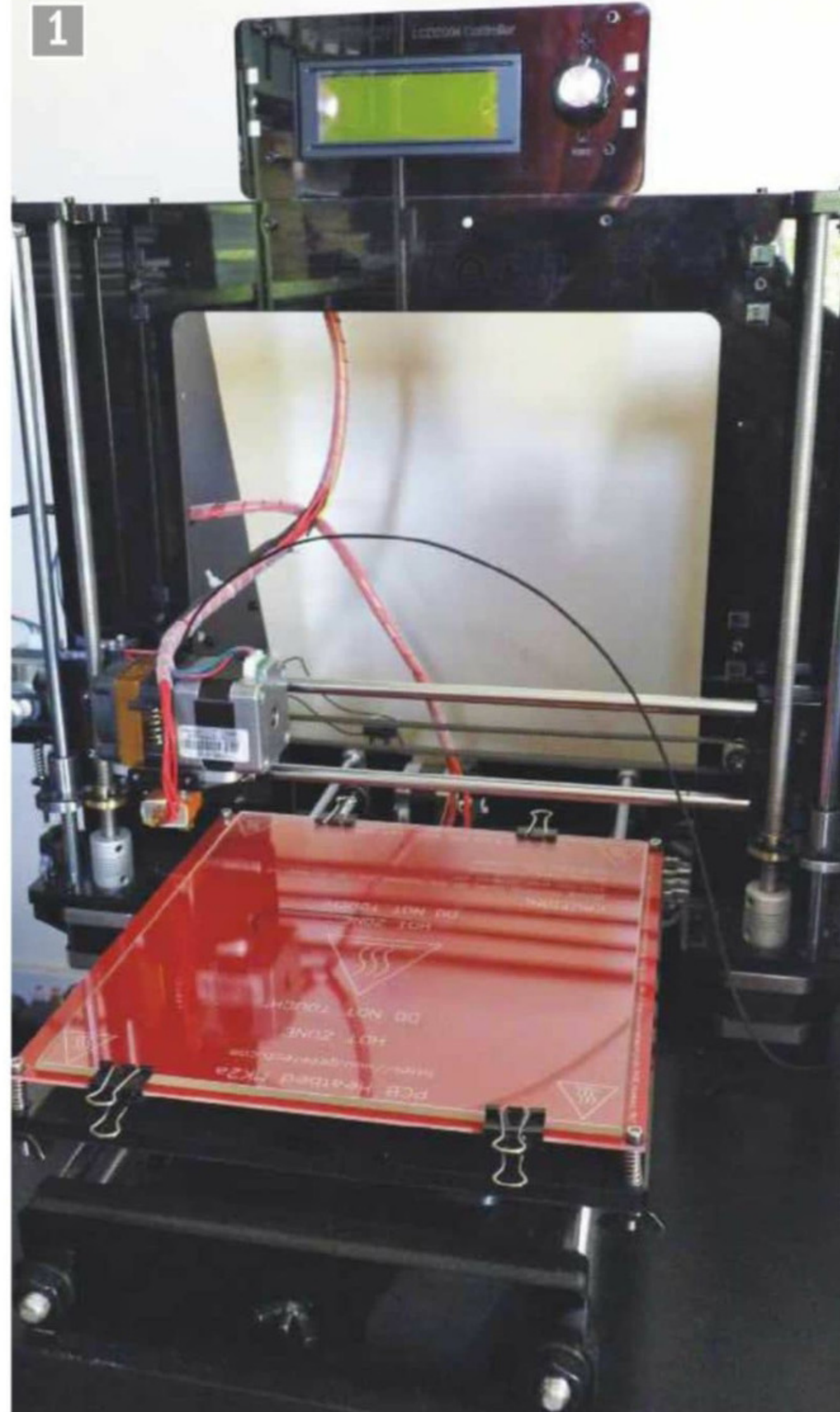
Final version of hanger.

screen, I came across an option to lay the object flat. Problem solved (**photo 3**).

I now have six perfect, identical hangers and can go on to assemble the brake system and move a bit closer to the day when I have a completed locomotive. Yes, the whole exercise took about three weeks from start to completion, by which time I

could have carved 50 hangers from solid steel! But I wouldn't have the new tool and the knowledge how to use it. It's a great way to get to grips with CAD.

Anyone out there want a brake hanger or 50?



Completed printer.

SHOWCASE

7¼ inch Gauge GWR King Class Locomotive



I wondered if the photograph above, taken by Keith Whithey, would be of any interest. The picture, sent with his permission, shows my seven and a quarter inch gauge GWR 'King' Class engine saddled up to run on the Wythall Miniature Railway, which is operated by the Elmdon Model Engineering Society.

At 85 years of age this was a day of delight for me as the engine had not run for four years. My workshop too, had been silent for a very long time as my priority had been 24 hour care for my wife who suffered with Alzheimer's and other distressing complications.

I would like to sincerely thank my society colleagues; the help and camaraderie of these likeminded folk has indeed recently given me nothing short of a lifeline.

I was 70 years of age when the castings and drawings for the engine came my

way and the engine took seven years to build, with a further year of modification to make it run successfully. Some may ask - why the engine is numbered 6011? I spent 46 years as a footplateman and did in later years drive the royal train with her Majesty on board. In my younger days I was a fireman on the Paddington - Wolverhampton service and worked on many of the 'Kings'. Strangely, some engines were always a good performer. Unlike the forerunner of the class, having the bell on the front, 6011 always responded well for me.

During the extended time that caring restricted my time from the home, to keep myself focused I published my reminiscences of 70 years as a model engineer on Amazon Kindle. Any royalties were donated to Alzheimer's Research U.K. directly, therefore did not enter my private account.

Whilst I did appreciate at the time that such a publication would have a very limited readership, I was naïve to the fact that all my effort would become a grain of sand on a beach when published on line. Also, ways of promoting the book on the Kindle web-site are certainly not for the 85 year old brain.

I have been a long-term reader of *Model Engineer* and used to buy it fortnightly on Thursdays when it was nine pence. It would therefore bring me great pleasure if you could bring some attention to my book, 'The Mettle for Metal'. I would indeed be more than grateful, as would Alzheimer's Research U.K.

Dennis Herbert

National Model Engineering Exhibition 2019

Competitions and Trophies Part 2

John Arrowsmith reports on the competition results at recent Doncaster exhibition.



Class C2: Marine Models – Kit Built

There were two entries in this class but only one was presented for competition. This was a model of the USS BARB Gato Class Submarine built by Christopher Behan. A sleek model well constructed and finished, it gained a Bronze Medal (photo 16).

Continued from p.16
M.E. 4615, 21 June 2019



Long sleek and menacing, this Gato class submarine built by Christopher Behan was awarded a Bronze Medal in Class C9.



The 1/8th scale Conestoga Wagon built by John Castle won a Silver Medal in Class G1.

Class G1: Model Horse Drawn Vehicles

With a class of six entries this was a good competitive section which resulted in three Silver Medals and three Very Highly Commended certificates being awarded. A Silver Medal and the Guild of Model Wheelwrights Trophy for best model went to John Castle for his 1/8th scale Conestoga Wagon. These wagons were used extensively in the USA and Canada in the late 18th and 19th centuries and could carry up to 6 tons in load

(photo 17). The second Silver Medal of the section was won by Mike Casey for his 2¼ inch scale model of a Merryweather Gem fire engine (photo 18). John Castle was again successful in gaining the third Silver Medal for his 1/8th scale model of a Northumberland long cart (photo 19). Two of the three VHC certificates went to prolific builder Brian Young for his examples of a horse drawn sling cart (photo 20) and a Beach's jam wagon (photo 21). John Castle was also successful again with his



A delightful Merryweather fire engine built by Mike Casey was awarded a Silver Medal in Class G1.



John Castle's Silver Medal winning example of a Northumberland long cart.



A horse drawn sling cart built by Brian Young received a VHC certificate.



Brian Young's Beaches jam wagon received a VHC certificate in Class G1.



John Castle also received a VHC certificate for his Northants. water cart.



This scratch built futuristic car was built by Richard Foster and was awarded a VHC certificate.



This unusual model of a Russian ICBM built by David Gore received a VHC certificate.

1/8th scale model of a Northants. water cart (photo 22).

Class K1: Model Vehicles – Non Working Cars and Small Commercials

There was just the one entry in this class with the scratch built Futuristic Flying Car by Richard Foster (photo 23). This was an interesting exhibit with a lot of detail and it gained

a Very Highly Commended certificate. If this is an example of future transport vehicles I wonder what the environmentalists would say about the exhaust!

Class K2: Model Vehicles – Non Working Trucks

Another unusual and interesting exhibit in this class gained a Very Highly



The Delorian car built by Richard Foster was awarded a Silver Medal in Class K6.



The Gold Medal winner in Class K7 was the Allis Chambers M8 high speed tractor built by Christopher Behan.v

Commended certificate for David Gore. His Russian ICBM missile transporter and rocket was a very well made model of a large prototype which created a lot of interest (photo 24).

Class K6: Model Vehicles – Any Available Body Shell

A single model by Richard Foster gained a Silver Medal in this class for a model of a DeLorean car. Full of detail and with a good finish it created a lot of interest (photo 25).

Class K7: Model Vehicles – Functional Vehicles

A well supported class here with seven very good entries taking the awards. Ten models had been entered but only seven actually competed. The Gold Medal was awarded to Christopher Behan for his example of an Allis Chambers M8 high speed tractor (photo 26). Obviously adapted for American Army use, the model was full of detail and finished in the prototype manner. A Silver Medal was awarded to David Plant for his model of a Liebherr 634 track digger machine. Presented on a suitable low loader, the model exhibited all the detail of the original (photo 27). David Plant was also awarded a Bronze Medal for his fuel proof Diesel bowser which was another finely executed model (photo 28). Not content with two medals in this class, David also gained three VHC certificates and an HC certificate for his

other entries. The model of a Fendt 930 tractor coupled to a Krampe tipper trailer made a fine combination and was awarded a VHC certificate (photo 29). The Kane low loader carrying the Liebherr digger also gained a VHC. His Class Xerion 5000 tractor gained an HC certificate.

Stand prizes

There were two other notable presentations and that was to the mainstay of the exhibition the Club Stand awards. The winner of the N.A.M.E. Shield for the Best Club Stand went to the Grimsby & Cleethorpes Model Engineering Society. The stand covered just about every model engineering discipline you can imagine and was laid out in a very visitor friendly way with access to



David Plant's Silver Medal winning Liebherr Lr 634 excavator.



A fuel proof Diesel bowser built by David Plant gained a Bronze Medal in Class K7.

all the exhibits. The winning club for the Ship Model Trophy was the Kirklees Model Boat club. This large colourful display covered many different aspects of marine modelling and provided lots of interest for visitors.

I hope that I have covered all the competition entries so that readers can see what a high quality exhibition this was along with all its other features which I will cover in my final report next time.

●To be continued.



A VHC certificate was awarded to this Fendt 930 tractor built by David Plant.

Hello everyone, for this issue only I am standing in for Geoff who is on a well-earned holiday. I hope he and his wife enjoy themselves and no doubt he will have a few anecdotes to amuse us with when he returns. As 2019 passes by there are lots of activities within the model engineering world despite all the doom and gloom associated with the current political scene but model engineering seems to be holding its own with a number of clubs either embarking on quite large track extensions or having completed them etc. I have noted five in this page alone and those are the ones I know about - there may be more.

I hope all those of you who visited the exhibition at Doncaster enjoyed themselves and came away suitably impressed with the presentations. It was good to see the introduction of the SMEE and My Time Media competition trophies again at the Doncaster Exhibition. It has been some time since these were competed for and hopefully this will now be a permanent feature of the Doncaster show (photo 1).

About one third of the membership at the **Bournemouth & District SME** enjoyed the Cream Tea Special at Haskins Garden Centre recently and as it was so successful another one is being planned for September. They are planning to host a visit to their Littledown track by the Malden Society on the 27th July which is followed on the 28th by the Littledown Centre's Family Day, so it sounds like the members are in for a busy weekend. Progress continues on the extension to the 16mm narrow gauge railway with a turntable and additional sidings being completed. It is now possible to follow three different routes around the circuit and there is more space for locomotives and rolling stock. One member involved in the 'Ellie' project has found



For those of you who suffer from unwanted guests at your site, perhaps this rocket launcher on show at Doncaster might deter them.

a good source of thin tin plate by using evaporated milk tins which have no corrugations in them - a good tip there for anyone wanting a source of this material. With the cost of postage being increased the club have been able to cope with this by increasing the number of members who have

their newsletter delivered by email in PDF files. No doubt many clubs are looking at this if they haven't already. The newly formed Stationary and I/C Group within the club is progressing well so if you have interests in this area you would be most welcome to join.

W. littledownrailway.co.uk



Part of the impressive and immaculate track site in Cutteslow Park, home of the City of Oxford SME.

Many readers will know about the problems members at the **Bristol SMEE** have been experiencing over the last 12 months or so. Well, I am pleased to report that the eviction notice has been rescinded and a new five-year lease agreed with Bristol City Council. The terms are not the same as what they had previously but at least they can operate again for public running. The last four running days have been quite successful, even with the increase in fares they have had to make, and they have had no complaints about that. Model engineer visitors are not allowed to park on their site but have to pay to park in the adjacent public parking area. The relationship with the council is better now than for some time, so they are hopeful that the five-year lease will lead onto a much better future. Perhaps the council have realised that the club is an asset to Ashton Park after all!

W. bristolmodelengineers.co.uk

The spring edition of the **COSME Link**, the club magazine from the **City of Oxford SME**, contains lots of interesting details about the recently opened new track extension (photo 2). Members have made a really splendid job of building it, and I will be describing it in more detail in a future issue of *Model Engineer*, but it is a tremendous new asset for the club. Their AGM in March was notable for a number of reasons; firstly, because a vote had to be used to elect committee members for the first time in years, which was encouraging for the club, knowing that more members were willing to get involved than there were places on the committee. The other notable issue was that Sue Mulford stepped down as treasurer after 22 years of service. The meeting decided that Sue should become an Honorary Life Member of the club and duly awarded her the Savile Bradbury Award for services to the club. Congratulations are in order for a tremendous



The new public toilet facilities at the Hereford SME.

commitment to the club. Laurence Fouweather was elected to the post of treasurer. Members enjoyed a visit to a company who specialise in bell hanging. Whites of Appleton have been hanging bells since 1824 and the visit highlighted the detail machining and suspension processes needed to achieve a suitable result. All the members who went totally enjoyed a completely different aspect of engineering.

W. cosme.org.uk

The **Hereford SME** had a busy opening period at their Broomy Hill track with quite large crowds attending their open days in April. During the winter period a new public toilet block was installed which has greatly enhanced the site facilities (photo 3). The new club locomotive, a Romulus 0-6-0, is progressing well with the chassis almost complete so hopefully with the boiler already available it should not be too long before it is added to the operating rota. Much of the underground airline which is used to operate the signals and points on the ground level track has been replaced during the winter months as the old material had become a favourite food of certain furry species. It is hoped the new material will not be such an attractive meal. Their Young Engineer section is still working very well with plenty of enthusiasm and projects to keep them busy. Last year of course Daniel Bell

won the Southern Federation and Polly trophy for his efforts at the club. The club's annual Open Weekend and Boating Regatta is to be held over the weekend of the 7-8th July. Camping and caravans can be accommodated on site but if you are interested do contact the club direct to book in. The club are also saddened by the passing of longstanding member Stan Compton at the age of 94. Stan was a prolific top-quality model engineer, having built around 10 locomotives and a number of clocks. He was also a mainstay during the building of the Broomy Hill track site. He will be sadly missed by his family and all his fellow members at Hereford.

W. hsme.co.uk

The **Leyland SME** located in Worden Park Leyland will be hosting this year's IMLEC efficiency competition over the weekend of the 12th-14th

July but readers must contact the club direct for more details if they want to attend or take part. Members here enjoy a good social and meetings programme throughout the year with a range of interesting talks and events. For example, on the 25th July they have a talk entitled 'Get a Grip Night' or how to hold things tight! This is followed on the 8th August by 'What a Grate Night' - from firebars to rosebuds - and so on throughout the year. Members here are very fortunate to have such an active social side to their model engineering activities. To improve their ground level track a tree cutting service was employed to remove the difficulties they were experiencing with roots etc. The ground level track can now be re-laid in the area affected. The annual 3½ inch gauge rally will be held at the club on Saturday 7th September and, again, if you would like to attend do contact the club direct. On a sad note the club lost one of its stalwart members recently when Sam Bates passed away - no doubt he will be sadly missed by all at Worden Park.

W. leylandsme.wixsite.com/website-1

One club who have built a new track extension is the **Nottingham SME**. The Parkgate Extension Project is well on its way to being completed with the road crossing being finished in mid-January (photos 4 and 5). Hopefully, the club will officially open this new



Working hard on the new extension at Nottingham.

Guest
Club
News
editor



John Arrowsmith
reports on the latest
news from the clubs.



The base for the major road crossing at Ruddington is levelled out.

extension in August. The photographs show just a very small part of the major task undertaken by members. The club have recently launched a new site to help promote and inform both members and the public about activities at Ruddington. There is a good account in *Kingpin*, the spring edition of their club magazine, about the procedure for setting up a new website. As the author says it sounds easy but in reality it has taken about 100 hours of work to ensure everything works as it should. **W. nsme.org.uk**

The **Romney Marsh MES** have had a busy year so far with their winter meetings program being very well attended. The talk by John Wimble, who showed a film about the progress of the club over the last 50 years, attracted around 50 to see and hear what had happened. The club of course celebrated their 50th anniversary in May so congratulations are in order on achieving this milestone in their history. A 56-page book is being published to coincide with this anniversary. The 2½, 3½ and 5 inch gauge tracks are 700ft long so can provide a good test for any locomotive and the garden railway has six tracks which can cater for Gauge 1 standard gauge and 'G' scale along with 'O' gauge, especially narrow gauge, so there is plenty to get involved with here. **W. rmmes.co.uk**

Another club who have made a great deal of progress with their track extensions is the **Rugby MES**. The ground level track has all but been completed giving them a length now of around one mile (photo 6). Work is now in hand to extend the elevated track and when completed it will be around 750 metres long which has virtually doubled the old track length. When all this work has been completed they will enjoy one of the longest miniature railway tracks in the Midlands area. Along with all this track work a new roadway has been constructed to a new parking area as well as the installation of two 40ft shipping containers to provide secure storage for the club. They will also be celebrating their 70th anniversary over the weekend of the 20th/22nd July which will include the grand opening of their new station. **W. rugbymes.co.uk**

At the **Taunton Model Engineers** they are looking forward to developing their new site at West Buckland. It has been quite a drawn-out saga since they were asked to leave their Creech St Mary site. Planning permission has now been granted subject to a few conditions which the club say are not too onerous so they are hoping that development of the site can now get underway. If all goes to plan construction work will start on the GWR (Great Westbuckland Railway) as soon as practical with the

principal aim being to build a ground level railway with all the usual facilities. *Model Engineer* looks forward to hearing about the progress of this new project and we hope it all goes to plan. **W. tauntonme.org.uk**

It was announced in April that the **Scottish Model Engineering Trust** and the **Perth Model Railway club** have merged which provides a unique opportunity in Scotland for prospective members to enjoy a very wide range of activities to suit any interest in model railways. There is the comprehensive ground level track with 7¼ and 5 inch gauge tracks, providing about 1.5km of rail to drive on. This is combined with an area for miniature road vehicles to operate towards Duds End Station, crossing the new railway in two places. In the new clubroom located at Wester Pickston the Perth MRG have re-located their layout and are keen to recruit new members to work with them. This provides members with a complete range of railway gauges from N gauge to 7¼ inch gauge. Looking on their web page it all looks very interesting and inviting. **W. smet.org.uk**

The **York City and District SME** had a very successful Easter period with large crowds visiting their site. A young engineers day proved very popular with many different activities to inspire young people such as a shunting game, rocket building and launching, Lego building, as well as drawing

and colouring areas. Traction engine rides were being given along with the ground level track rides and all together it was a very busy period. The catering department had to send out for more supplies at one time and the donation boxes were full. While all this was going on the club were also attending the York Model Railway show with their attractive new display stand, which was a focal point for visitors. They had many enquiries about membership and hopefully this will have a positive outcome for the club. The new stand was part of the display at the Doncaster Exhibition. In his notes in the May newsletter the chairman Dave Wood says the site has never looked so good as it does now due to the efforts of the Wednesday gang led by Cliff Hudson. A new traction engine track has almost been completed which will provide a useful ½km of operating space. There is to be a members' running day on Saturday 6th July combined with an exhibition of best work. The club lost one of their long serving members when Jack Dee passed away in March. Jack was a committee member for a number of years and is described as a gentleman of the world. He will be sadly missed by his family and fellow club members. **W. yorkmodelengineers.co.uk**

Contact:
geofftheasby@gmail.com



The new station at the Rugby SME under construction.

DIARY

JULY

3 Bradford MES.

Steerage trophy competition, 7:30-10pm, Saltire Methodist Church. Contact: Russ Coppin, 07815 048999.

3 Brandon DSME.

Meeting at The Ram Hotel, Brandon, 7.45pm. Contact Mick Wickens: 01842 813707.

3 Bristol SMEE.

Talk: 'Injectors' – D. A. G. Brown. Contact Dave Gray: 01275 857746.

4 South Lakeland MES.

Meeting in the pavilion, 7.30pm. Contact Adrian Dixon: 01229 869915.

5 North London SME.

BBQ at Colney Heath. Contact Ian Johnston: 0208 4490693.

5 Portsmouth MES.

Club night – 'Eats in the Park', BBQ evening, 6.30pm. Contact Roger Doyle: doyle.roger@sky.com

5 Rochdale SMEE.

Annual model running night, at Springfield Park, 7.30pm. Contact Rod Hartley: 07801 705193.

6 Tiverton & District MES.

Running day at Rackenford track. Contact Chris Catley: 01884 798370.

6/7 Guildford MES.

Stoke Park Railway Gala Weekend 10am-5pm. Contact Mike Sleigh: pr@gmes.org.uk

6/7 North Wiltshire MES.

Charity weekend, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker: 07710 515507.

6/7 West Huntspill MES.

Silver Crest Models Rally, 10am-6pm. Contact Roger Flower: 07957 533235.

7 Bedford MES.

Public running, from 10.30am at Summerfields Miniature Railways. Contact Brian Walton: 07498 869902.

7 Bradford MES.

Rae gala day, 2-4.30pm, Northcliff track. Contact: Russ Coppin, 07815 048999.

7 Newton Abbot & District MES.

Running day at Lindridge Hill. Contact Ted Head: 07941 504498.

7 Oxford (City of) SME.

Running Day, 1.30-5pm. Contact: secretary@cosme.org.uk

7 Portsmouth MES.

Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

7 Plymouth Miniature Steam.

Public running, Goodwin Park (PL6 6RE), 2 – 4pm. Contact Rob Hitchcock: 01822 852479.

9 Romney Marsh MES.

Track meeting, 11am onwards.

Contact Adrian Parker: 01303 894187.

12 Tiverton & District MES.

Club meeting at Old Heathcoat Community Centre, Tiverton, 7.30pm. Contact Chris Catley: 01884 798370.

13 Cardiff MES.

Steam Up & Family Day. Contact Rob Matthews: 02920 255000.

13 North Wiltshire MES.

AME Owners' Day, Coate Water Country Park, Swindon. Contact Ken Parker: 07710 515507.

13/14 Rugby MES.

Narrow Gauge event from 10am – overnight camping available. More info. at rugbymes.co.uk.

14 Newton Abbot & District MES.

Running day at Lindridge Hill. Contact Ted Head: 07941 504498.

14 North Wiltshire MES.

Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker: 07710 515507.

14 Portsmouth MES.

Public running, 2-5pm, Bransbury Park. Contact Roger Doyle: doyle.roger@sky.com

14 Welling DMES.

Public running at Falconwood 2-5pm. Contact Martin Thompson: 01689 851413.

16 Romney Marsh MES.

Track meeting, 11am onwards.

Contact Adrian Parker: 01303 894187.

19-21 Brandon DSME.

Weeting rally. See www.weetingrally.co.uk

20 Romney Marsh MES.

Track meeting, 11am onwards. Contact Adrian Parker: 01303 894187.

20/21 Rugby MES.

Public running 2-5pm – visiting locos welcome with boiler certificate. More info. at rugbymes.co.uk.

20 Westland & Yeovil DMES.

Track running day 11am – 4.30pm. Contact Bob Perkins: 07984 931993.

21 Bedford MES.

Public running, from 10.30am at Summerfields Miniature Railways. Contact Brian Walton: 07498 869902.

21 Cardiff MES.

Open day. Contact Rob Matthews: 02920 255000.

21 North Wiltshire MES.

Public running, Coate Water Country Park, Swindon, 11am-5pm. Contact Ken Parker: 07710 515507.

21 Oxford (City of) SME.

Running Day, 1.30-5pm. Contact: secretary@cosme.org.uk

21 Plymouth Miniature Steam.

Public running, Goodwin Park (PL6 6RE), 2 – 4pm. Contact Rob Hitchcock: 01822 852479.



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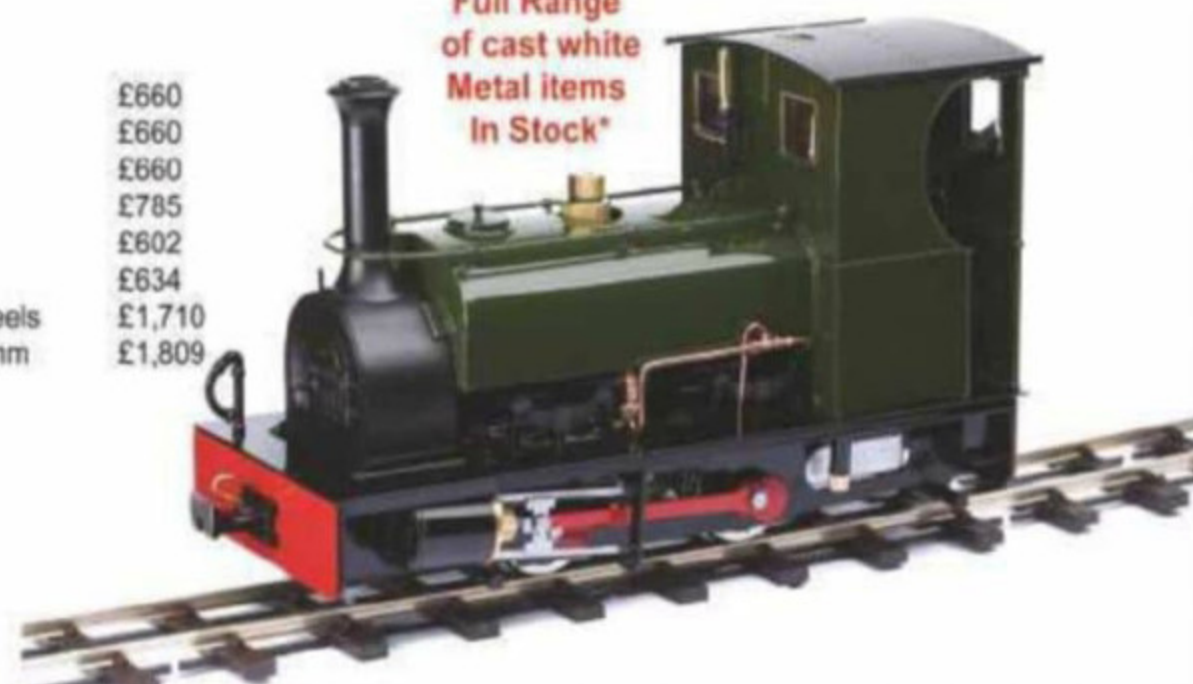
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LMS Duchess Class

Designed by Sir William A. Stanier the first locomotives out of Crewe works were originally built as streamliners. Later some were built without streamlining.

All of the streamliners were finally re-built in un-streamlined form, and all eventually featured double chimneys. The model offered here is representative of the class as re-built. The locomotives were produced in a variety of liveries in BR days including maroon, blue and lined green.

"It was a pleasure to contribute to the design of this fine 4 cylinder model. The LMS Duchess uniquely combines ease of handling and pulling power. When not at work on the track it is an ideal size for showcase display. This is the first Silver Crest model for 3.5" gauge and, as an award winning professional model maker, I highly commend it"

Mike Pavie



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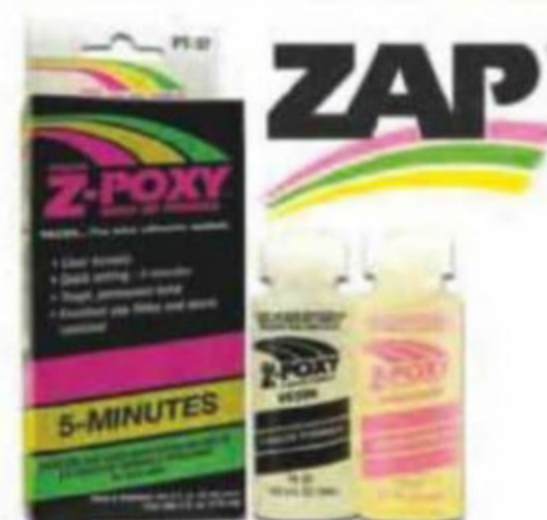
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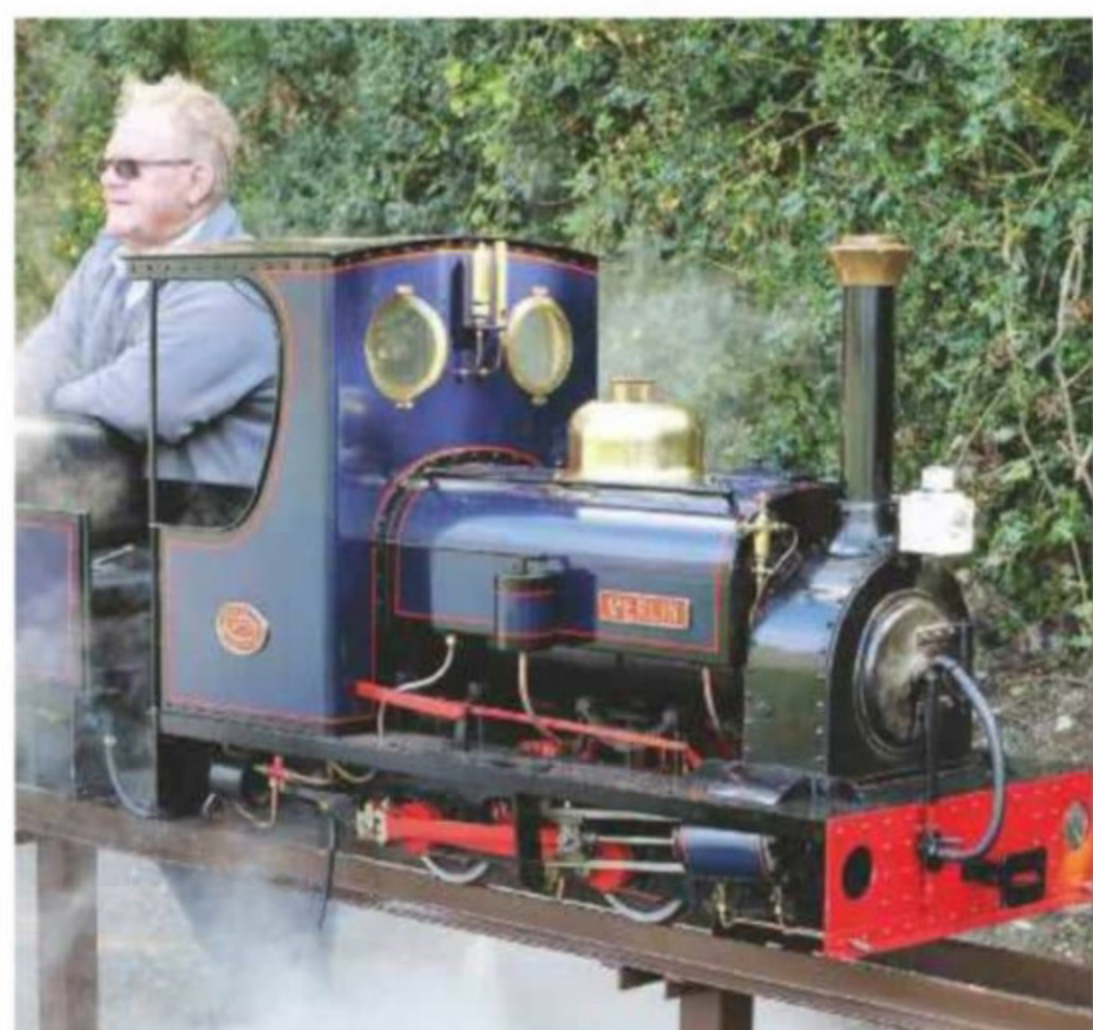


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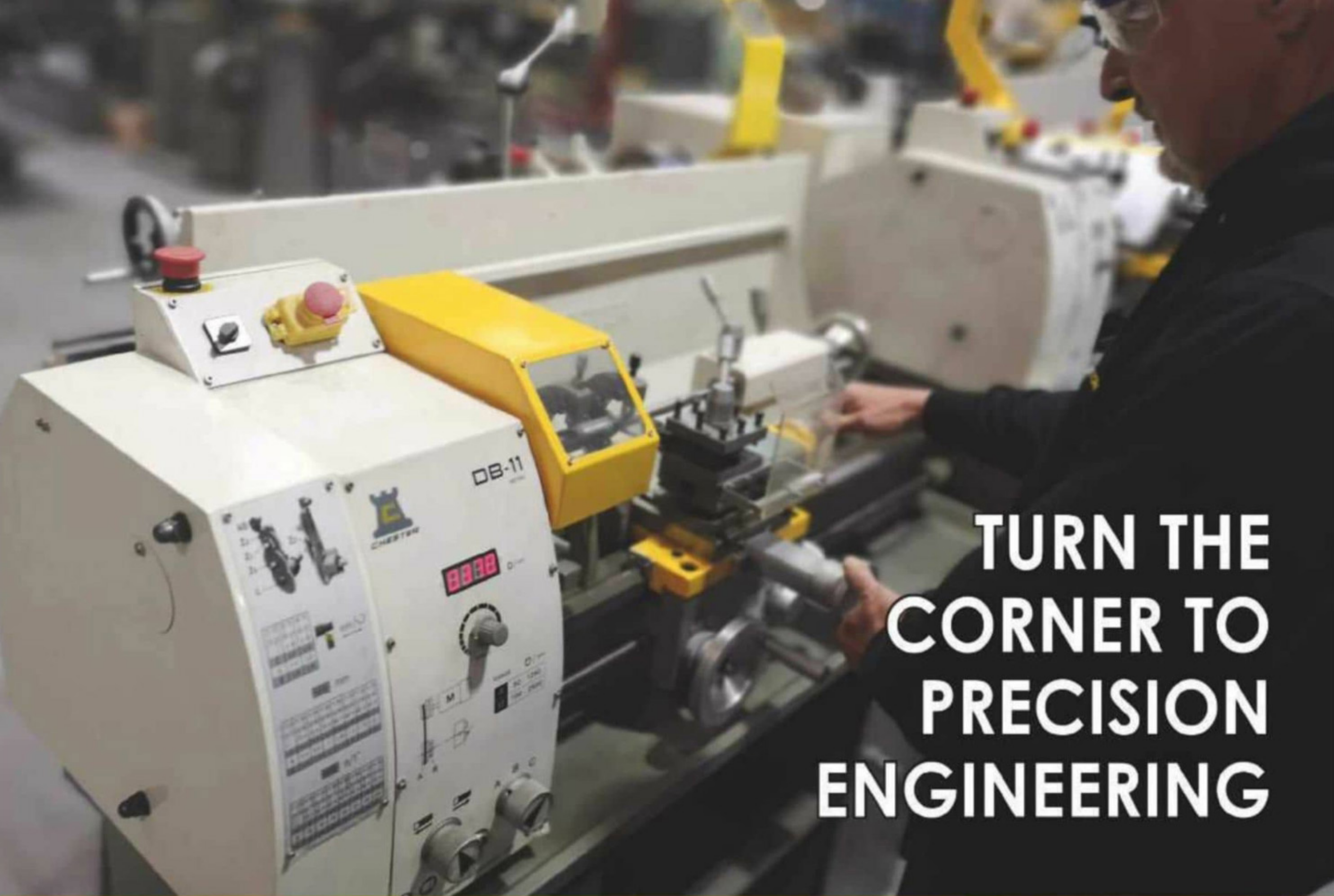
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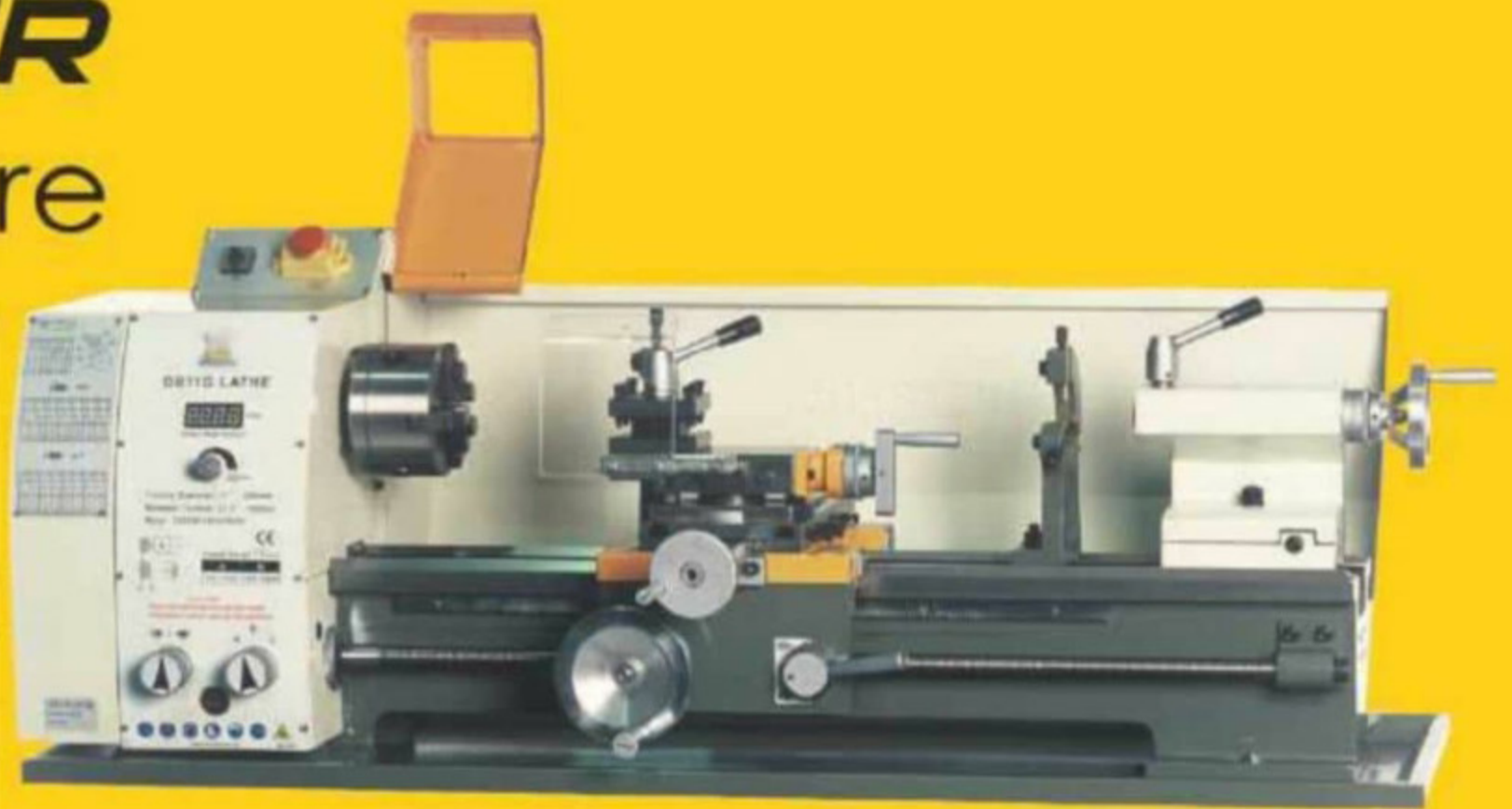


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