THE ORIGINAL MAGAZINE FOR MODEL ENGINEERS

Vol. 225 No. 4641 • 19 June - 2 July 2020

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COVER FEATURE

BOLTON Marine Engine

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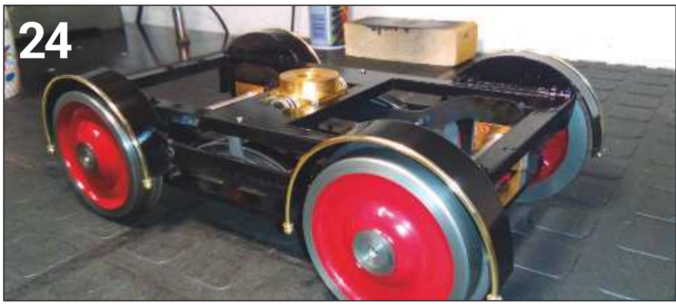

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KEEP CALM AND BUILD SOMETHING

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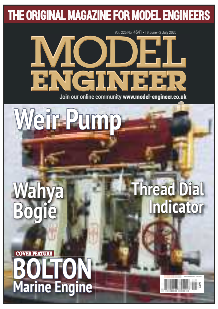

ON THE COVER...

Richard Castle's model of a Bolton marine triple expansion steam engine (photo Richard Castle).

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Covers for the safety valve, inner dome and top feed.

Driver's steam brake valve.

Firehole doors.

How Was It For You?

Lockdown was, no doubt, a great inconvenience to most of us but I think it was also a great opportunity for many of us to explore alternative ways of living our lives. So, what did you do that was different to your usual habits? Perhaps you developed a new interest or found time to rediscover old ones. In my case, the main benefit I experienced was more time to spend in the workshop. This allowed me to re-establish the custom of spending time there regularly (most days) and to resume serious work on a couple of neglected projects. I hope this can continue once lockdown is finally lifted and competing ways of spending time once more become available (meeting friends in the pub, trips to the cinema or theatre, etc.). Lockdown was, perhaps, a good time to establish good habits!

The time gained in lockdown has allowed me to make rapid progress with my 5 inch GWR pannier tank. The list of tasks required to complete the engine now fits onto a single page which, as any builder of engines will understand, puts me well within sight of the end! For your entertainment, here are a couple of pictures to illustrate progress.

Firstly, **photo 1** shows a set of three covers for the safety valve, dome and top feed. The safety valve cover and the dome cover are machined from brass castings. The dome cover, unusually, is almost completely flat bottomed as it has to fit on the top plate, not the boiler itself. There is, though, a small rise in the 'skirt' to fit the slight hump in the top plate which accommodates the top of the boiler. The top feed cover is made from a one-piece laser-cut development of the cover, bent to shape and silver soldered. The 'shoulders' are small pieces of square section brass soldered in and then filed to shape.

Egged on by Doug Hewson, I decided to include a steam brake on my engine and designed and made my own brake valve, which is shown in **photo 2**. **Photograph 3** shows a pair of sliding doors (no conveyor belt though!). I discovered (yes, the hard way) that LBSC got his geometry slightly wrong for these doors, in that they do not open symmetrically. The prototype has the pin on the right-hand door slightly higher than that on the left-hand door. This is necessary to make the geometry work. LBSC, no doubt to simplify the design, puts both pins at the same height. I corrected the geometry and remade my doors and linkages accordingly, which now open perfectly symmetrically.

If you would like to send me a photograph of what you have achieved during lockdown I should be pleased to include it in a special 'lockdown gallery'.

Pembroke

In the early hours of Tuesday 19th May the Pembrokeshire Model Engineers' clubhouse was broken into, some items stolen and the building set ablaze. In the words of Trevor Thomas, the club secretary, it was 'very upsetting to see our hobby going up in smoke, literally. The building inside is totally gutted, nothing has survived, roof gone, generator, strimmers, furniture, trolleys – nothing, it's all ash on the floor. The police have spent all night there as the building is now unsafe. Fire investigators will hopefully attend the site today (there is no doubt it's arson). It would not surprise me if the building has to come down, certainly listening to the senior fire officer early this morning.'

It's difficult to understand why people do this kind of thing but I hope that the club will soon be up and running again.

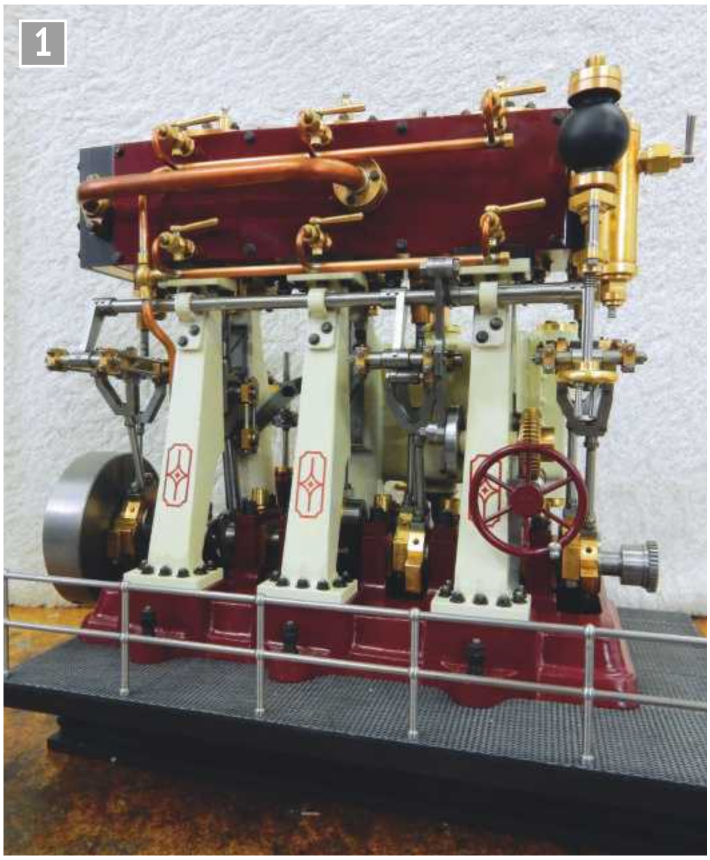
Murdock Engine

It appears that the cross-sectional view, printed in the last issue, of this engine has suffered the same fate as the frames drawing for *Wahya*. My apologies once again. However, I think we have discovered why this happens and will be reprinting the drawing next time.

The Bolton Marine Triple Expansion Steam Engine

PART 1

Richard Castle builds this classic marine engine.



The author's Bolton triple expansion marine engine.

Following many years of model steam locomotive construction, stationary engines, vertical boilers and a horizontal marine boiler for supplying steam to an experimental single rotor Stumpf turbine I was searching for another steam project. A visit to the Midlands Exhibition in 2016 provided the spark. A very neat, compact, triple expansion engine was on display. This looked to be a model of interest that provided at least two years of work at my retired speed and on completion could be demonstrated on either air or steam.

Having established the availability of castings for the model, of which there are approximately 40 in total, together with a comprehensive set of detail drawings, I spent some time in researching the history of the original engine design and its marine use.

Although of a British obsolete design these engines were selected for installation in the USA and Canadian built Liberty ships built throughout WW2. They were seen to be of a basic construction, well suited to the use in cargo ship and troop carriers on convoy duties. In excess of 2700 ships were built with the single triple expansion engine providing 2500 indicated HP at 76 RPM giving the ships a nominal speed of 11 knots, this being adequate for the above duties.

Over 3000 engines were built; a major design advantage was the ability of many engineering shops of the time, in the US, Canada and the UK to manufacture parts, enabling the production output required to keep up with production of the Liberty ships. Two of these wartime ships, the *Jeremiah O`Brien* and the *SS John W. Brown*, are still operating in the US as museum vessels. Closer to home, a very pleasant day can be spent on the various excursions undertaken by the *SS Shieldhall*, originally a cargo vessel built in 1910, now part of the National Historic Fleet out of Southampton.

The *SS Shieldhall* has twin triple expansion engines driving two screws, somewhat smaller but very similar in construction to those installed in the Liberty ships. An output of 800 IHP each provides a service speed of 9 Knots.

Passengers are very welcome in the engine room during the sailings where a heady mix of steam oil and the beat of six piston strokes provide the background music that is required of a good day out!

Following the research much of which can be taken from numerous websites online, the Bolton Marine was definitely my next project. The order was placed for the full set of castings – individual castings can be ordered if required. A spring back set of drawings, which are copies of the *Model Engineer* series *A Marine Triple Expansion Engine* 1985/1986, were already to hand.

The model follows its full-size counterpart very closely and provides a compact construction built from the many individual details, mounted onto a single aluminium base casting. All the machining is within the capacity of a Myford ML7.

Brief specification

The following provides an overview of the size, shape and features of the model.

- Overall size – 10(L) x 7(W) x 9(H) inches
- Total weight - 27½ lb
- 3 Cylinders -
  HP ⅞ inch diameter
  IP 1¼ inches diameter
  LP 1¾ inches diameter

- Crank throw – 1¼ inches
- Valve gear Stephenson link motion, slide valves.
- The model is equipped with an integral condenser for exhaust steam.
- A rocking lever operated air pump is driven from the LP crosshead.
- Twin boiler feed pumps are driven in tandem with the air pump.
- A steam shut off valve is mounted to the HP steam line.
- A displacement lubricator has been added for cylinder lubrication.
- The engine has been mounted onto a chequer plate platform with handrails for a touch of realism and scale.

Cutting the reverser wheel.

The crank pins and webs.

General comments on the build

The 54 page book of A4 size drawings and general instructions were found to be quite comprehensive although I would advise anybody starting this project to spend time in creating an index. The effort spent in finding information from one drawing detail to another when in the middle of a machining operation wasted a great deal of time and was extremely frustrating.

Casting quality was good, the gunmetal machined well and there were good machining allowances resulting in the collection of approximately 22 lb of swarf at the end of the project!

The drawing accuracy was good with only a few errors found during the course of assembly. These were overcome without too much difficulty.

Tooling jigs and fixtures were made as required for use on the lathe or mill. These simplified machining and provided accuracy where multiple details had to be made.

A large number of digital pictures were taken through the build for future reference.

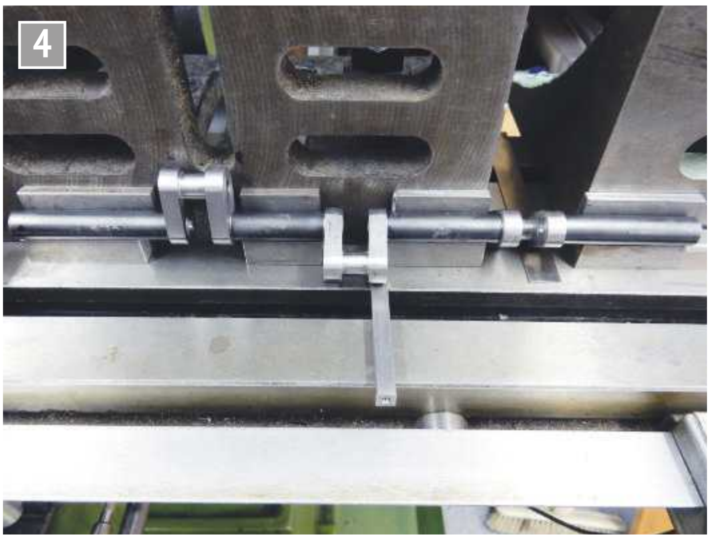
Build sequence

The model design dates back some 35/40 years and materials and machining methods have developed over this time, allowing a number of modifications to be made in the interest of simplifying some aspects of the original design and build.

While waiting for delivery of the castings a start was made on the reverser worm and wheel - these are not fully detailed in the set of drawings although they may be purchased finish machined. Making these gears is a simple screw cutting operation to complete the worm and to make a silver steel hardened hob for cutting the wheel (**photo 2**).

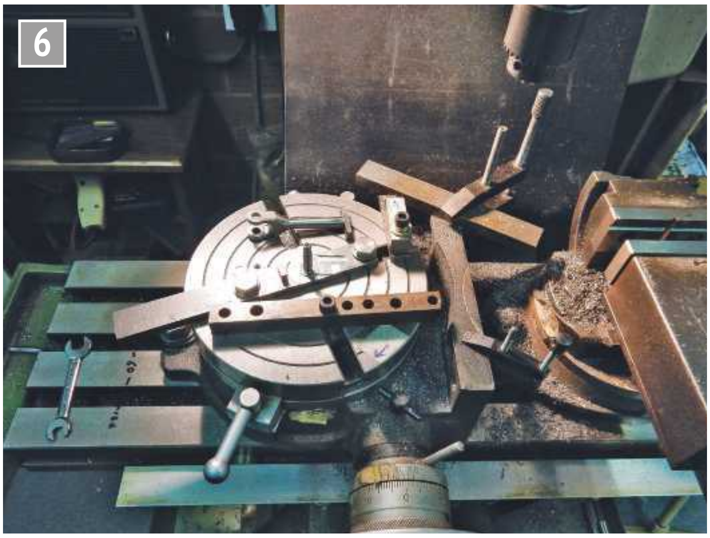
The crankshaft is of a built-up construction with the three crank pins and six webs (**photo 3**) machined and assembled using Loctite to form the locking medium for the three crank throws. For final assembly the mainshafts are set up in an alignment jig on the mill table to provide accurate positioning for final Loctite fixing into each of the webs (**photo 4**). The main shaft bearing diameters were left oversize to allow machining of any minor assembly error. This error was found to be within 0.002 inch for corrective machining (**photo 5**).

To form the full connecting rod section three mild steel sections are prepared and are silver soldered together forming the base, the rod and



Alignment jig for the crankshaft.

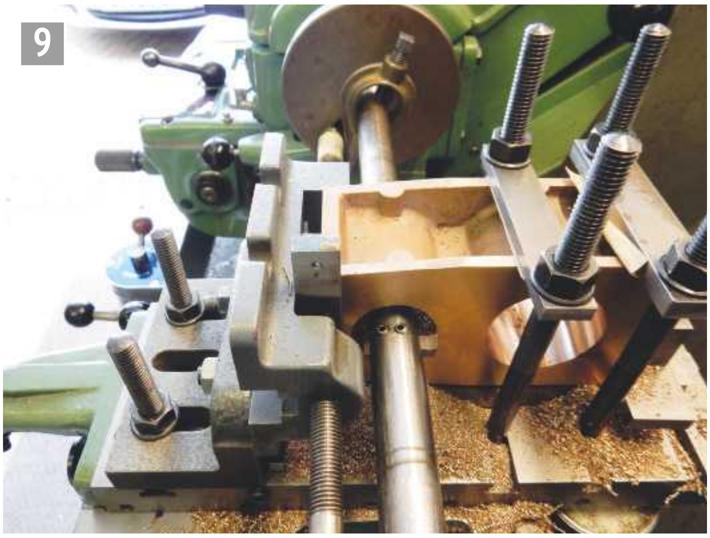
Final machining of the crankshaft.



Milling the ends of the connecting rods.

Bearing brasses fitted to the connecting rod.

Machined base plate with bearings and crankshaft installed.



Boring the HP cylinder.

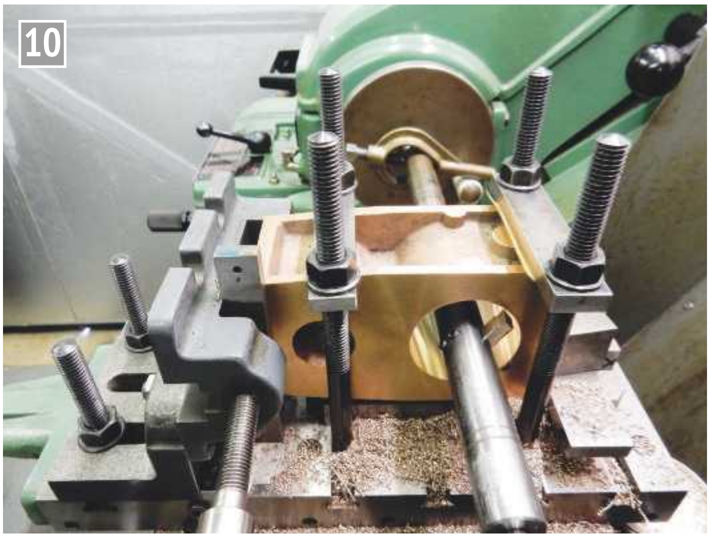
the eye. Finish turning and milling (**photo 6**) together with the fitting of the bearing brasses and strap completes the assembly (**photo 7**).

The ordered castings arrived and were soon checked over and fettled where necessary. The aluminium base casting was machined to provide a flat base surface and the milled slots for the crank bearing brasses (**photo 8**).

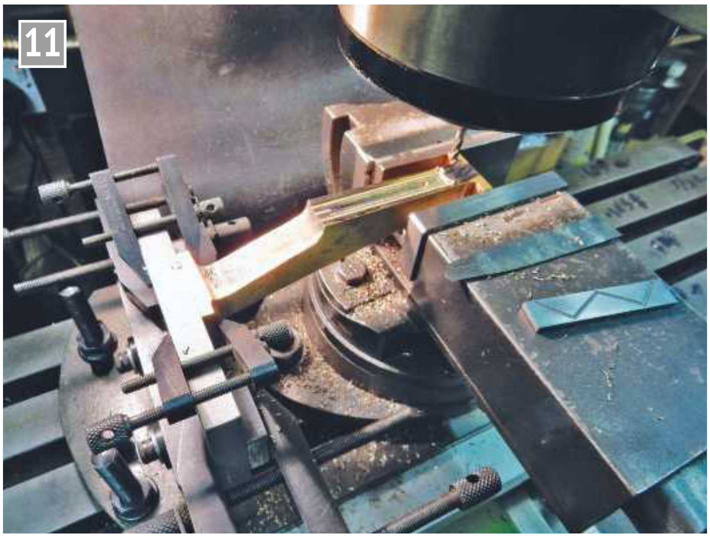
Care was required in the marking out of the cylinder castings. The top, bottom, side and end faces were flycut to size before setting on the lathe for finishing the bores (**photos 9** and **10**). A generous amount of material was found on all faces, the castings being of good quality.

The standard and crosshead bearing plates (**photo 11**) are modified in their design to dispense with the countersunk screws and to bond the plate into a recess in the standard using a two-part epoxy. This procedure simplifies the fixing arrangement and provides an unbroken bearing face for the zig-zag lubrication grooves.

Where the two standards are integral with the condenser frame, flycutting and drilling the standard pads



Boring the IP cylinder.



Machining the standard.

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Flycutting the standards integral with the condenser frame.

Set-up for flycutting the bottom of a standard.

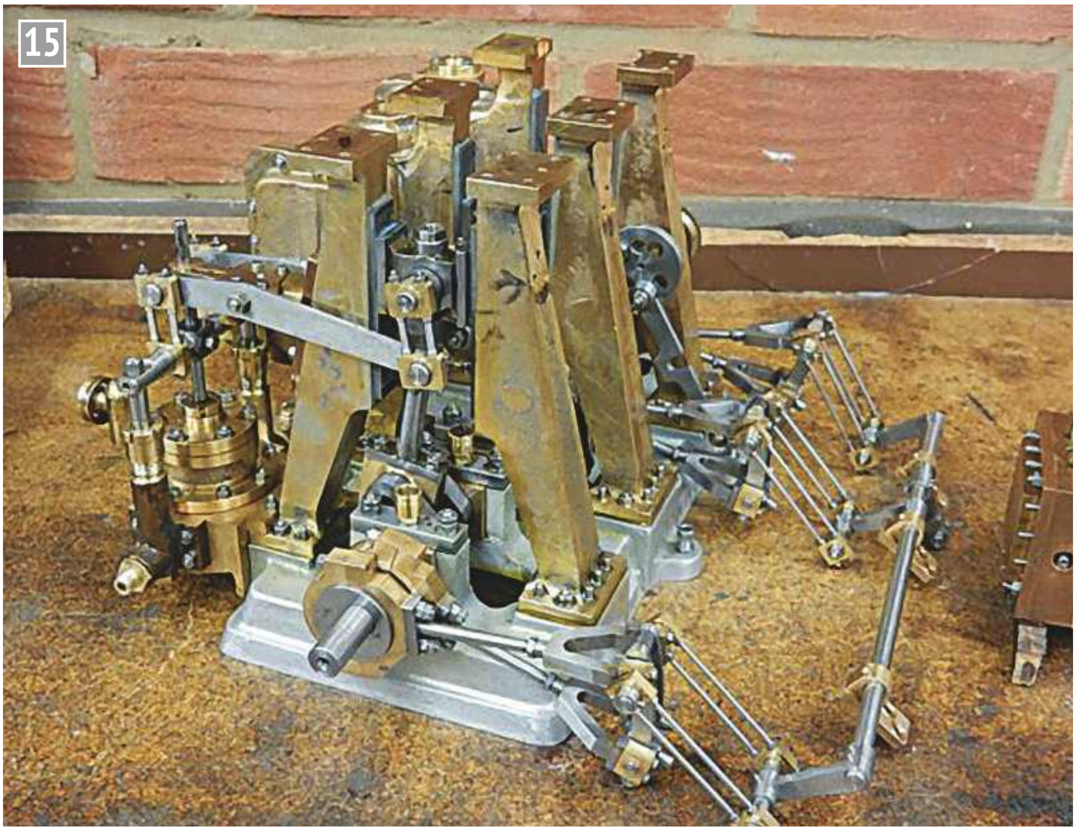
Long spot face cutter for reaching the base of the standard.

was a simple set-up (**photo 12**). The same procedure for each of the single standards needed some imaginative jigging on the mill due to the draft angles on the standard side faces (**photo 13**). The spot facing of many of the flange holes required a small cutter to be made for use on a long extension (**photo 14**).

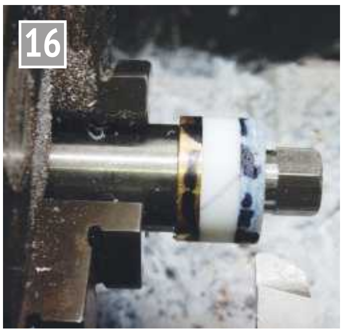
The crosshead design (**photo 15**) is altered to provide a solid detail with the side faces machined to accept a bonded phenolic bearing strip that bears against each of the standard bearing plates. There are many types of bearing materials today that provide good frictional characteristics and are used in the machine tool industry. The material is supplied in strip form for bonding directly to machine slides before finish machining to provide the final accuracy.

The specified piston ring material has been changed to a PTFE (**photo 16**) with a specified maximum working temperature of 250°C. The usual piston ring machining procedure is followed using a turning mandrel with a centre clamp for holding the ring closed to finish the outside diameter. The benefits of this change in material are the ease of finish machining and the low sliding friction in operation.

●To be continued.



Partly assembled engine showing the crossheads.



PTFE piston ring.

Fantastic Materials and Where to Find Them

PART 2: NON-FERROUS METALS

Luker says you don't have to rely on suppliers to find the materials you need.

Continued from p.812
M.E. 4640, 5 June 2020

In the previous article I had a look at ferrous metals. Typically, they are off-the-shelf bar stock items, and relatively cheap. Unfortunately, a large portion of the non-ferrous metals, specifically the copper alloys, are expensive, and I can honestly say I seldom buy bar stock. As a rule, all sections above 20mm are cast for purpose or I use the runners from my castings as machining stock. With this in mind the copper alloy section will deal more with first principle alloying elements. Any good metals sales person will be able to supply the closest equivalent (at a premium!).

Aluminium

The most well-known and common non-ferrous metal is aluminium and its respective alloys. The weight to strength ratio is superb, they melt easily and machine beautifully. In fact, it is easy to obtain a mirror finish if the cutting tools are sharpened correctly and you can keep the swarf from rubbing on the machined surface. Aluminium is also highly conductive and works well as a heat sink or electrical conductor (**photo 13**) Note that the rake and clearance for the cutting tool is greater than normal mild steel. A quick Google search will bring up helpful sketches.

Copper alloys

The copper alloys are numerous, both in chemistry and application. I'll have to limit this section to the four alloys I commonly use. The cheapest is brass, which I typically mix to 60% copper, 2.5% lead and the remainder zinc. The lead improves the machinability. This is a general rustproof metal for any non-bearing application, typically for ornamental fittings or airtight castings (**photo 14**).

For standard bearings that don't see excessive wear or pounding I make a standard bearing bronze (7% tin, 7% lead, 5% zinc and the remainder copper). These work well for valves and steam chests (**photo 15**).

For high wear bearings that take a pounding you need something a little stronger, especially if you don't want to strip and replace too often. I have had good success with tin bronze (10% tin and the remainder copper). This results in a tough material that shows little wear, both to the shafts and bearings (**photo 16**). A few years ago I bought a drawn section of phosphor bronze for use in a rather rough bearing application. It lasted six months before it had worn to a point that it was causing mechanical issues. I promptly removed the bearings and replaced them with risers from a tin bronze casting I had done and the bearings are still going two years on.

If you're looking for an incredibly tough material that machines like stainless steel and has a tensile strength comparable to steel then you

Small aluminium heat sink.

Brass castings.

Standard bearing bronze valves.

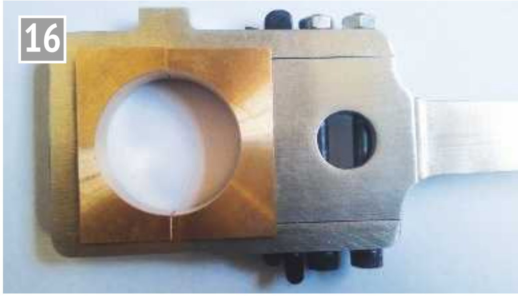
need alumina bronze. This alloy doesn't make good bearings on unhardened shafts - the shafts will tell you why! I have used it for a gauge I made that needed an incredibly thin wall (**photo 17**). I had no issues with machining the casing wall to below 0.5mm thick and it was still rigid. Incidentally, this was also casting material.

Typically, the copper alloys are soldered either with silver solder or tin-lead solder. Brazing should be avoided as the melting points are a little too close for comfort and you might end up melting the lot. These alloys are generally not welded in the home workshop. The welding temperatures are too high and will result in the zinc fuming. This is dangerous and is a one-way ticket to the hospital!

Most of the alloying elements for the copper alloys I obtain from commonly discarded items. I gave up going to scrap yards in South Africa to get materials. In recent times they seem to be hesitant to sell to the public and when they do, they sell at prices akin to buying new materials. Having said that, you'll be surprised by how much material you can collect just by watching what you throw away and stripping the metals out that can be reused. By keeping an eye open and knowing where these metals are commonly used I seldom need to buy alloying elements. Any scrap motors, cable or plumbing pipe are a good source of copper. Brass is a good source of copper and zinc. Tin is the only element I source commercially from a metal supply company, but for smaller amounts, lead free solder can be used at a cost! Lead can be scavenged from batteries or fishing sinkers. I also keep all the non-ferrous chips from the lathe for reuse. This is true recycling!

Stainless steels

The two most common stainless steels, here in South Africa, are SS304L and SS316L. I prefer SS316L. It is slightly easier to machine, and safer in small boiler applications.



Tough bearing bronze.

Alumina bronze casing.

Stainless steel taper spindle.

Tin bronze left, commercial gunmetal right.

Machining stainless steels requires lots of cutting fluid and generally you'd machine at half the cutting speed typically used for mild steel. Stainless steel rubbing on stainless steel should be avoided at all costs; it tends to cold weld. Even stainless nuts and bolts will seize if heated or over tightened. This cold welding occurs when the extremely thin oxide layer, which gives it its corrosion resistance, rubs off, resulting in metal to metal bonding.

Stainless steels can be readily TIG welded, but care needs to be exercised to prevent sensitisation of the welded area. This can result in corrosion or sensitivity to chlorides which would ultimately cause cracking. If the correct filler rod and correct welding amperage (to minimize overheating) is adopted you shouldn't have any issues.

I once found a couple of discarded coffee bodums (the plunger type). The centre shafts made a few steam valve spindles - being of a good quality, free machining stainless steel (**photo 18**) - and the strainers made a nice filter for a tender I was busy with. If you keep an eye open you'll be surprised by how many materials are just thrown away.

Differentiating between materials

Often you come across materials where you're not entirely sure of the grade. I recently machined a piece of mild steel hollow bar that was anything but mild. If you do a search for differentiating steels you will come up with the 'spark' test. Basically, using a bench grinder you can determine the type of material by the characteristics of the sparks. I personally don't use this method too often; my methods are a little more pragmatic.

The first test is the general appearance of the steel. Stainless looks different to the carbon steels and the cast irons. I always have a known marked sample for comparison. A magnet will differentiate between the carbon steels and the austenitic stainless steels (e.g. SS316 and SS304, although SS304 can be slightly magnetic). A simple corrosion test like leaving the steel partially submerged in water for a couple of days will tell you if it's stainless or carbon steel.

To further separate the carbon steels you can heat a test piece and quench it to see if it hardens. Then my final check is how it machines. The free machining steels make small chips that break off; they also don't come off blue at average speeds and feeds. Generally speaking, if you see long curling chips turning blue it's probably a high carbon steel, assuming of course you are not machining at break neck speeds or with blunt tools.

The copper alloys are a little more difficult. With my bearing alloys I start with comparing the colour of the surface. The redder colour typically tells me there is less zinc and lead. The next step would be to see how it machines and the type of chips (**photo 19**). Curly chips that sometimes discolour would indicate the harder bearing alloys, with smaller chips indicating small amounts of zinc or lead and very fine chips that shoot everywhere, the brasses (lots of zinc).

In general, then, if I need a stainless steel I check for corrosion resistance. If I need a tool steel I see if it hardens. Tests fit for application!

This concludes the series on workshop materials. I hope you found it useful and a good starting point when deciding what material to use. The materials discussed were rather limited but I have tried to keep it generic.

ME

An Engineer's Day Out

Milestones at Basingstoke PART 2

Roger Backhouse takes a trip into the past at Basingstoke's living history museum.

Continued from p.802
M.E. 4640,5 June 2020

Please note: Due to COVID-19, all museums are presently closed. If you are planning a visit once public attractions begin to reopen we recommend that, before travelling, you check their websites for information and revised opening times.

Thornycroft opened their Basingstoke factory in 1898 moving operations from Chiswick. They began making steam engines and this steam lorry was owned by Bournemouth Borough Council. The unfortunate driver had to manage without a cab.

First making steam launch engines, Thornycroft moved into other branches of naval engineering. They made over 3000 of these depth charge throwers during the First World War.

Most vehicles shown at the museum were made by Thornycroft. One partner in the firm, which started building boats in Chiswick, was Sir John Isaac Thornycroft, the naval architect. His brother was Sir William Thornycroft, best known for his statue of Boudicca on the Thames Embankment which was cast by the family firm. Unfortunately, space at Chiswick was limited so his brother, Edward Thornycroft, cycled out to assess the country around Salisbury Plain for a new works. Reaching Basingstoke he saw the meadow farmland of West Ham which he chose as the factory site, near the present museum.

The new location was near the London and South Western and Great Western Railways and so benefitted from good transport connections. Thornycrofts built many steam lorries (**photo 19**) and launch engines, developing their own fast boats and building the first racing hydroplane in 1910.

Their output was varied and included depth charge throwers produced in quantity during the First World War (**photo 20**). The firm had given up producing steam transport by 1907.

They tried cars, building over 250 from 1903-1912 (**photo 21**) - with several competing successfully in motor sports - and made motor trucks from at least 1902 (**photo 22**). These were highly successful with several railway companies

Thornycroft tried making cars, eventually building around 250 between 1903 and 1912. They had some success in TT and other motor sport events.

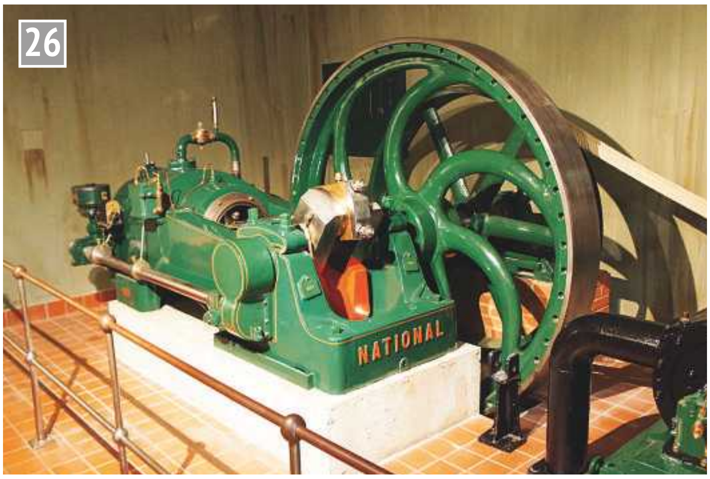
This Thornycroft X Type lorry was sold to a Worcestershire farmer who used it to transport damsons to a local jam factory. It was made around 1918. The museum also has a Type J open top bus from 1913 used in Portsmouth.

>>

Thornycroft gave names to their various models. This was the Sturdy, used as basis for a Middlesex County Council road sweeper, seen in 2018 awaiting restoration.

Besides vehicles, Thornycroft made smaller portable engines like this 'Handy Billy' much used in small boats during the1930s.

1928 portable gas engine made by Listers of Dursley. Such power units were rivals to oil or small steam engines.



The National Gas Engine Co. of Ashton-under-Lyne produced many gas engines, having surface similarities to steam engines of the period. The author's home town of Kington, Herefordshire, had a small gas engine at Crooked Well pumping water for the town.

using them in the 1930s. As was normal at the time, the firm usually sold the chassis and cab so the new owners could then add their own bespoke bodies. Their chassis was a base for many uses including a Middlesex road sweeper from 1949, built on the classic Thornycroft Sturdy chassis, seen awaiting restoration (**photo 23**).

Exports even reached Peru where the Peruvian Corporation (owners of the railways) used several lorries. Some vehicles are being restored and workshop staff did a good job with a former Rugby Co-op delivery lorry from 1936. Thornycrofts continued at Basingstoke until closure in 1969 but as Vosper-Thornycroft the firm still flourishes, building naval boats on the Solent.

Other internal combustion engines feature around the museum. Thornycroft's 'Handy Billy' engine developed in the 1930s was often used in boats and confirms the variety of this firm's products. (**photo 24**). There are gas engines including a Lister portable gas engine plus a stationary gas engine made by the National Gas Engine Company of Ashton under Lyne (**photos 25** and **26**). Gas engines were serious competitors to steam engines. They offered advantages where use was intermittent, there was no need for a boiler and there was less maintenance and inspection required. (Tees Cottage Pumping Station at Darlington has a much larger gas engine.)

This is not a museum of traditional country life; for that Reading's Museum of English Rural Life or Tilford Rural Life Centre are places to visit in the area. There are, however, several horse-drawn vehicles displayed including traditional Romany caravans (**photo 27**). (George Sturt's classic book, *The Wheelwrights Shop* praised traditional Hampshire craftsmanship but his work features in Farnham Museum.) There is a sawmill, once a common feature in Hampshire as parts of this county are heavily wooded.

Shop re-creations include a clockmaker's workshop (**photo 28**), a photographer and camera dealer, a gramophone and record shop, and an ironmonger's, although this one seems understocked compared to the small town shops of my youth. (Traditional hardware/ ironmongers shops are largely disappearing but in nearby Fleet there is a classic, family run shop in W.C. Baker. Worth a visit to see how good a small shop can be.)

One of the most popular displays is the Penny Arcade of historic slot machines. For some reason most of those trying these machines were males enjoying delights such as the 'Laughing Sailor' (**photo**

29), the 'Drunkard's Dream' (**photo 30**) and 'Shake hands with Merlin. He will tell you the strength of your personality'. (The author came out as 'expert on everything'. If only ...!)

Costumed interpretations take place daily and several special events are held during the year. The museum has an active programme for schools. There is a recreated pub named the Haverstock Arms, a traditional sweet shop, a café and shop so visitors are well provided for. Please allow at least three hours for a visit and if you have the stamina, why not go for a full day out?

ME

There are several examples of the coachbuilder's art in Milestones. Romany caravans were always a specialist product. Some were hired out to tourists in the New Forest.

Classic clockmaker's workshop. Many towns had their own makers and repairers, sometimes buying in parts made elsewhere to assemble locally.

The National Collection of Slot Machines (Penny Arcade) is one of the most popular parts of the museum. This Laughing Sailor was made by R & W in London in the early 1950s. The modeller also made the famous Archie Andrews ventriloquist's dummy.

Also from the slot machine collection, The Drunkards' Dream is one of several showing apparitions. Machines still take old pennies.

Getting there

Milestones is to the west of Basingstoke but is not particularly well signposted though it is near the Leisure Centre which has an extensive car park.

There is a shuttle bus to the Leisure Centre from Basingstoke Railway Station - details **www.basingstoke.gov.uk/shuttle**

Open Tuesday to Friday, 10.00 - 16.45
and Saturdays/Sundays, 11.00 - 16.45.
Admission is quite expensive, currently £16.00 adults, £13.00 concessions and £10.50 children but tickets are valid for a repeat visit within a year. There is plenty to see so a return visit is advised to avoid 'gallery fatigue'.

Please note: For this article Milestones was visited in September 2018. ***At the time of writing the museum is presently closed.*** For future visits, please check opening times before you travel.

Address:
Milestones, Leisure Park, Churchill Way West
Basingstoke RG22 6PG
Tel. 01256 639550
W. www.milestonesmuseum.org.uk

Some other places in the area with engineering interest:

Museum of English Rural Life
University of Reading, Redlands Road, Reading, RG1 5EX.
Tel. 0118 378 8660
W. www.merl.reading.ac.uk
(see *Model Engineer* No. 4592, 4 August 2018)

Tilford Rural Life Centre
Farnham, GU10 2DL
Tel. 01252 795571
W. www.rural-life.org.uk

Hollycombe Steam Collection
Iron Hill, Liphook, Hants, GU30 7LP
Tel. 01428 724900
W. www.hollycombe.co.uk
'Britain's largest collection of working steam' with steam powered fairground and narrow gauge railway.

Farnborough Air Sciences Trust
Trenchard House, 85 Farnborough Road,
Farnborough, GU14 6TF
Tel. 01252 375050 manager@airsciences.org.uk
W. www.airsciences.org.uk
(See *Model Engineer* No. 4625, 8 November 2019)

Further away Hampshire has several naval museums and historic ships around Portsmouth and Gosport, all well worth visiting.

Building the Model Engineer Beam Engine

PART 20

David Haythornthwaite writes a series on how he built the *M.E.* Beam Engine. This is an old favourite and construction of this engine to 1½ inch scale was serialised in *Model Engineer* back in 1960. Times, methods and equipment have now moved on and the series describes how to build this magnificent engine in 1 inch scale from available castings.

Continued from p.743
M.E. 4639, 22 May 2020

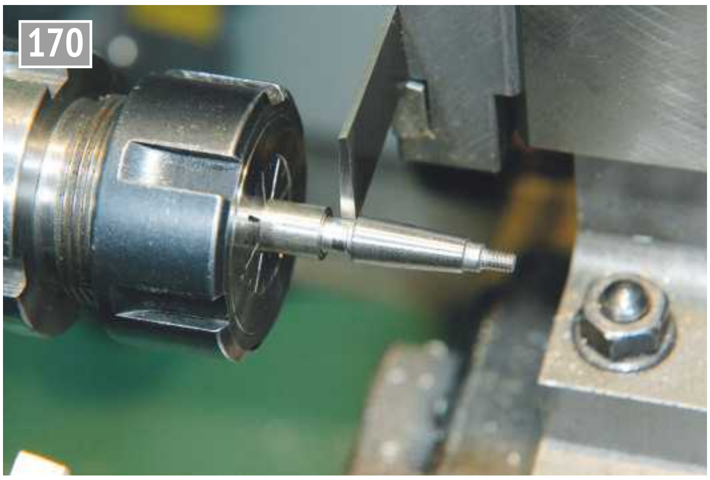
Throttle and steam shut-off valve

The throttle valve, controlled by the governor, is integral with the steam shut-off valve on the drawing. This means that any problem that occurs in machining either valve will affect the whole valve assembly, so my nerves were on full alert with this item. I did consider making a proper globe valve for the steam shut-off valve, but on examining the machining sequence needed to make the two valves in one piece, I quickly reverted to the plug valve shown on the drawing. Some builders may care to buy a commercial miniature globe valve and connect it to the throttle either by a concealed screwed joint or by flanges. There is no restriction in space and I consider that it would greatly simplify the construction.

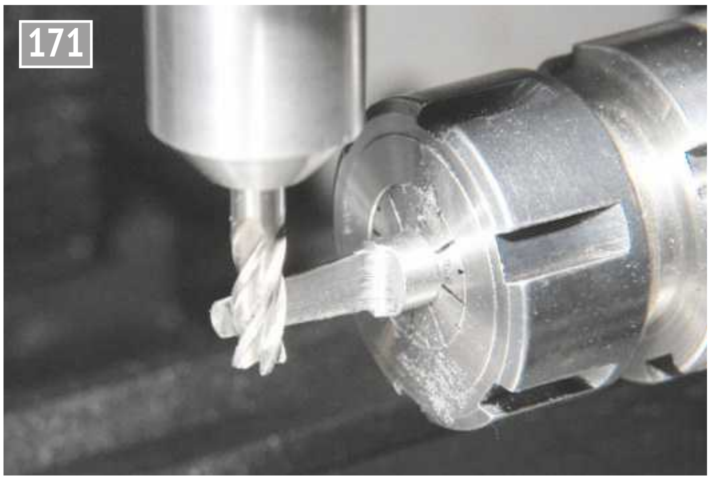
Having worked out a plan of action, I decided that the first thing to make would be the tapered valve plug and a tapered D-bit to make the mating valve socket. I have a taper turning attachment on the Myford but I decided to use the top slide, set over to just under 4 degrees. It is over 50 years since I took trigonometry at school and my 'trig' is now very rusty. I therefore guessed at just under four degrees and, right or wrong, it seemed to work. Starting with the valve plug, this was turned from a piece of 5⁄16 inch (or 8mm) silver steel. The parallel section at the small end was brought to size and then the end was threaded 5BA using a tailstock die holder. Next, the tapered section was turned to 4 degrees using the top-slide (compound slide), making sure that a fine finish was achieved to ensure that the valve would be steam tight. The chucking piece was left on so that it could be used when making the square top for the valve handle. A short section at the large end was turned to 0.187 inch diameter where the ⅛ inch square handle fitting would be formed. This is illustrated in **photo 170.** Now it is necessary to make a tapered D-bit while the top slide remains undisturbed at the same 4 degree setting. A short length of 10mm silver steel rod was turned to exactly the same taper and then, whilst still in the chuck (collet holder), the whole assembly was transferred to the milling machine as shown in **photo 171.** Making sure that the item was exactly in line with the X axis, the tapered part was reduced to a couple of thou over half diameter as shown in the photo.

The D-bit was brought to cherry red (780 degrees in my kiln) and then quenched in cold water, whilst stirring vigorously. I was not sure whether to temper the bit or not but decided to temper to dark straw. I managed to overdo this (by accident) to deep blue, but the D-bit still cut the tapered hole in the valve without a problem. The D-bit was lightly stoned on the edges, prior to use, to ensure that it was sharp, being very careful to maintain the correct angles on the cutting edges.

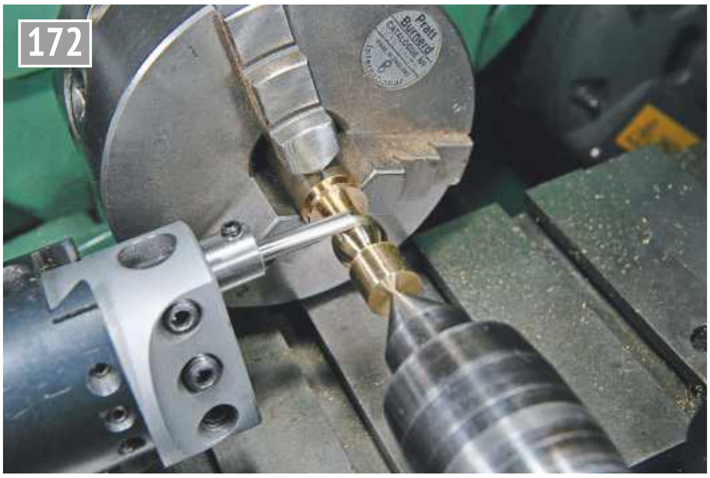
I was now set up to start making the valve body proper. In order to facilitate fitting the butterfly valve into the throttle, it is advisable to make the assembly in two parts



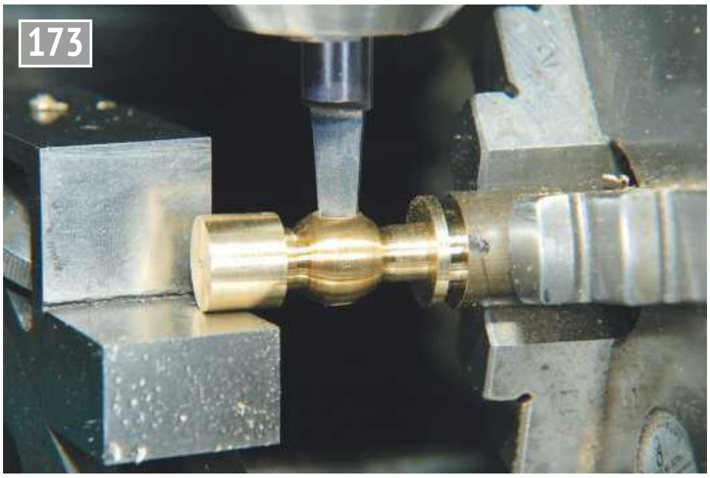
Machining the shut-off plug.



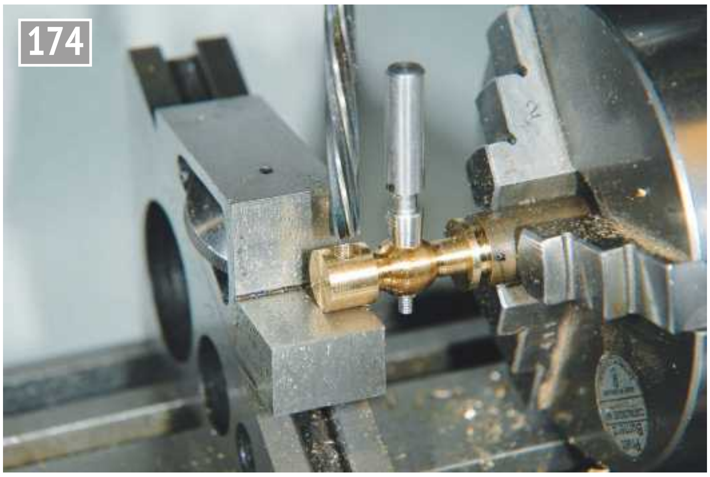
Creating the valve D-bit.



Creating the valve body.



Reaming the tapered hole.



Reaming the throttle shaft hole.

Tapping the throttle joint.

so that, during construction, the butterfly is accessible through the end of the valve. The throttle valve is split from the flanged end by a concealed (not very concealed in my case) screwed joint, so that during manufacture, the throttle shaft is near to the open end of the item. This makes it possible to assemble the valve. The butterfly has to be inserted into the bottom of the shaft, *in situ,* and then fixed in place by a 12BA grub screw whilst the valve is in the 45 degree position. This is best done by a well trained, very strong spider, but in the absence of one of those, you will be pleased that you have made the valve in two pieces to improve access.

Ensure that you leave chucking pieces on both parts until the last moment, otherwise you will find that you have nothing to get hold of near the end of the machining. I also ensured that I centre punched the chucking pieces at vice jaw No. 1 so that I could remove the piece from the chuck and return it with a reasonable chance of concentricity.

In **photo 172** it can be seen that the flange has been turned on the chuck end and the globe of the shut-off valve is being created using a boring head mounted in a spindle on the cross slide, to act as a ball turner. The larger parallel section is the throttle valve body. Whilst still in the chuck, the item was transferred to the dividing head on the milling machine table as shown in **photo 173**. Using an adjustable parallel to support the throttle end, the centre of the spherical section was found and a hole drilled right through the ball at a size to match the smallest diameter of the tapered D-bit. At the same setting, the D-bit was then used to open up the hole until the plug would fit into the hole, extending underneath by the correct amount. I raised the drill and tried the plug several times to check the size (as my 'putting-on' tool has been lost!). I had previously tested the D-bit on a scrap piece of brass bar to ensure that it cut okay.

ONE WORD OF WARNING here: the drawing shows that the diameter of the parallel section between the flange and the globe of the shut-off valve should be $\frac{13}{32}$ inch (0.406 inch). In **photo 173**, this has been turned to the size on the plan. If you follow the plan and make the holes in the flange on $\frac{7}{16}$ inch PCD (0.437 inch) then you will find it impossible to get the nuts onto the 10BA flange bolts. Of course I discovered this shortly *after* parting off from the chucking piece and I had to make a mandrel in order to turn that section down to 0.280 inch. Words like 'bother' 'dash' and 'blow' or similar were uttered at the time! The same goes for the parallel section adjacent to the other flange, which is shown as $\frac{5}{16}$ inch diameter on the drawing.

While the valve assembly was set up in the milling machine for drilling the tapered hole, the throttle section was cross drilled and reamed ¼ inch as shown in **photo 174** so that a short length of ¼ inch brass bar may be silver soldered into place later for the valve shaft. The throttle extension was turned in the lathe, creating the flange, narrow parallel section (see previous warning) and a flange to match the throttle body. I had the taps and dies for $\frac{5}{16}$ inch x 32 M.E. so I used this thread size (**photo 175**) to connect the two parts together. The extension was drilled $\frac{13}{64}$ inch through as far as the chucking piece – as illustrated in **photo 176** and the end threaded using a die in the tailstock holder. Because of the flange, it was necessary

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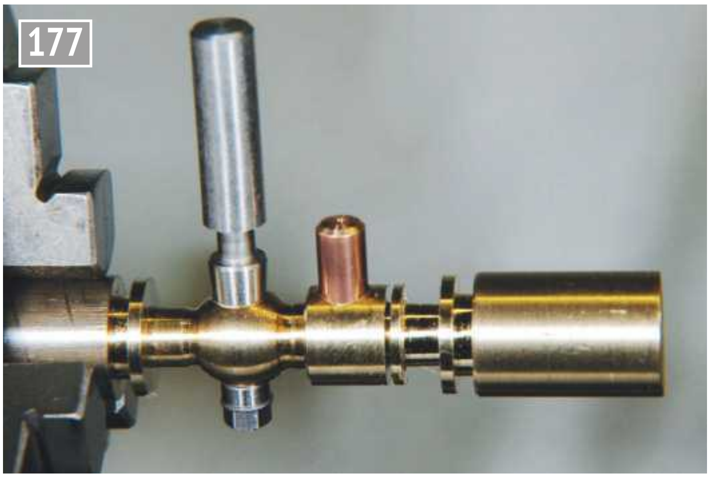
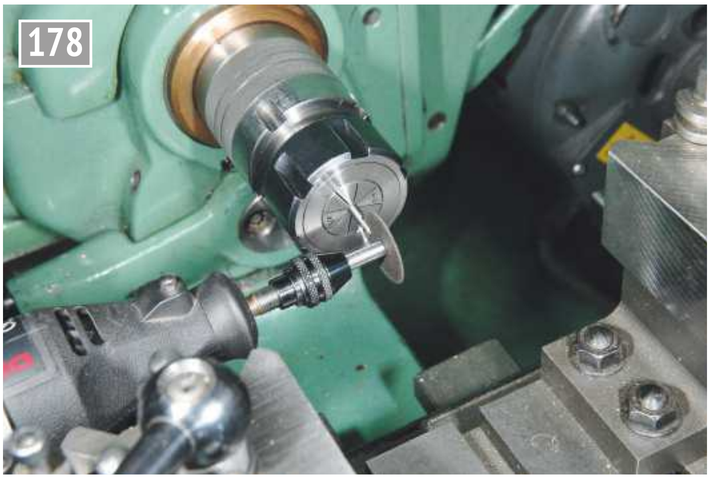
Drilling the throttle extension.



Shut-off valve and throttle assembly.



Splitting the throttle shaft.

Cutting the butterfly disc.

to relieve the thread adjacent to the flange. The two parts were screwed together loosely (left loose in order to show the joint in the photograph) and **photo 177** shows the assembly held in the lathe chuck. The next process was to silver solder a short piece of ¼ inch brass rod into the assembly to create the throttle spindle shaft. It is just placed loosely in the photograph. The cross shaft was then reamed and then threaded $\frac{3}{16}$ inch x 40 TPI for the gland nut.

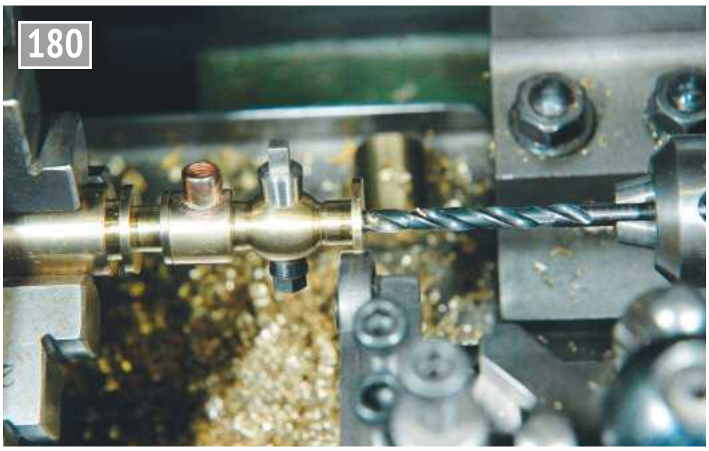
I studied the drawing for some time as it is not clear what shape the throttle shaft should be. I decided that the top part of the shaft should be $\frac{1}{16}$ inch diameter, as shown on the drawing, and the bottom part of the shaft should be $\frac{1}{8}$ inch diameter, split to hold the butterfly disc. Thus the gland nut should be reamed $\frac{1}{16}$ inch so that the gland nut holds the shaft in place. **Photograph 178** shows the end of the valve shaft being split using a Dremel cut off disc to hold the butterfly disc.

While I had the Dremel set up in the lathe, I decided to cut the butterfly throttle disc. This is not round, but is elliptical as the throttle closes with the disc at 45 degrees to the steam passage. I therefore turned a length of silver steel to $\frac{13}{64}$ inch diameter and then cut off a disk at 45 degrees to create the elliptical disc by cutting a slice with two diagonal cuts (**photo 179**). This was then fastened into the slot in the valve stem using a 12BA set screw, with the valve stem *in situ*. Be careful not to break the set screw whilst tightening it as they are very fragile. Do not ask me how I know!

At this stage I parted the chucking piece from the shut off valve and then, having tightened the valve stem dead tight in the valve body, I drilled through at $\frac{5}{32}$ inch diameter as shown in **photo 180**.

The hole should go right through the valve plug and you will see from **photo 180** that I actually used a home made roller steady to ensure that the drilled end was running true. I find that a roller steady is a great aid when trueing up long items in the lathe. Once this was drilled, I parted the assembly from the other chucking piece. The finished valves are shown in **photo 181**.

The stop cock handle should be made with a wood outer over a steel core but I didn't have the correct wood handy so I made it out of brass and steel. I may re-visit this to be more authentic in the future. The square hole was carefully filed with a miniature square file. Fitting the nuts and bolts through the flanges was a nightmare, best done with that carefully trained spider, and



Drilling through the shut-off valve.

The finished valve assembly.

The valve support.

if I were to make this again I would make the distance between the rear flange and the valve body longer to aid assembly. The bottom bolts fouled the copper pipe during assembly and they were impossible to push through the flange from the 'camera' side. You will see that I fitted an air pipe connector to the nearest flange and the whole assembly was, to my mind, very insecure, being only supported from the steam chest bolts.

It is not shown on the drawing, but I decided to make a support for the 'steam' inlet to ensure that the copper pipe into the steam chest was not strained by rough handling. The item shown in **photo 182** was made from steel. It consists of a ⅝ inch diameter decorative flange at the bottom, supporting a $\frac{5}{16}$ inch column, the top half of which is tapered down to ¼ inch diameter with a small collar at the top of $\frac{5}{16}$ inch diameter. On the top is a fabrication to hold the steam pipe (or air pipe) and the bottom is bolted to the baseboard by a 5BA bolt.

The end result was a valve assembly which was very rigid and would stand the rigours of constant turning of the stop cock and disconnection of the air line.

●To be continued.

NEXT TIME
We'll complete the engine by adding the water pump.

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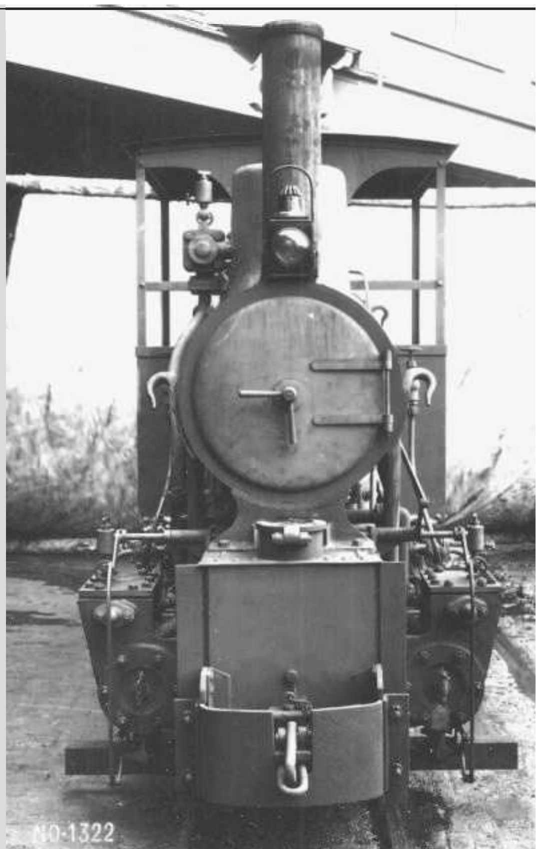
- **Baldwin**
  Mark Smithers presents the Baldwin 10-12-D class 4-6-0 tank as a suitable engine to model.
- **Murdock Engine**
  Geoff Spedding machines the cylinder for his Murdock engine from the Myers Engine Works.
- **Barclay Well Tanks**
  Terence Holland takes a break from bending metal to look at the part the Barclay well tanks played during the First World War.
- **Lubricator**
  Nick Feast makes a displacement lubricator for *Charlie*, his 3½ inch gauge Southern Q1.
- **Cardiff MES**
  John Arrowsmith visits the Cardiff club at Heath Park and takes a look at the rebuilt tramway and rerouted ground level track.
- **GWR Pannier Tank**
  Doug Hewson discusses the dome cover and the blast nozzle for his 5 inch gauge pannier tank.

Content may be subject to change.



ON SALE 3 JULY 2020

POSTBAG

Write to us

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Enterprise Way, Edenbridge,
Kent, TN8 6HF
F. 01689 869 874
E. mrevans@cantab.net

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Responses to published letters are forwarded as appropriate.

Don Ashton

Dear Martin,

I was sad to read of the death of Don Ashton. He was a gentle giant in the field of valve gear geometry! I was having trouble with the valve gear on a published design of 7¼ inch gauge BR Standard Class 5 and asked the then editor of *Model Engineer* if he could put me in touch with Don. Later that day I had an email from Don asking how he could be of assistance. I explained that the build was a commercial project and therefore I expected to pay for his time and expertise. This offer was firmly rebuffed on the grounds that as he continued to learn and enjoyed challenging problems he certainly didn't wish to be paid! He even declined the offer of a bottle of something alcoholic because, he said, 'I am teetotal'! There then ensued an exchange of emails and much useful guidance on the use of the Wallace valve gear simulator. I have all his books on valve gear and I shall miss the occasional correspondence. I knew he was not in the best of health but his parting is a great loss to the full-size locomotive engineering fraternity as well as the model engineering brotherhood.

Regards,
Andrew Binning

Dear Martin,

The letter in the latest *Model Engineer* from Dave Owen (Postbag, M.E. 4639, 22^{nd} May) prompted me to write a note or two to you about the great Don Ashton. I emailed him initially to ask if he could have a look over the valve gear I had designed for my 2-6-4 BR tank engine which I described in *Engineering in Miniature*. His reply came back saying that I had got my union link 15 thou too long! Anyway, we struck up a good conversation and had been friends ever since. I was speaking to Dave Owen one day whilst leaning on the frames of 4709 in Llangollen shed. It was one of my must-do visits on holiday there and who should also be there but Pete Thomas of Polly and the great man himself, Don Ashton, so we were able to have a really good natter.

When I began the redesign of the GWR pannier tank I emailed him again to ask what he thought of the *Pansy* valve gear. This time his three-word reply came back saying 'Not a lot!' I just laughed out loud when I read that but I then asked him if he would like to elaborate a little. This time his reply came back as a six-page report on what was wrong with it. What he said was that it was 45% out in forward gear and 40% out in reverse. However, what he also said was that with the valve gear being upside down there was no point in trying to make it accurate as it just would not work. What he did say was that with two small alterations to the valve gear it could be made as near perfect as possible. I used Don's details in my new design and, as it happened, we had one in build in our society at the time. The builder altered his *Pansy* according to these alterations and, unbelievably, you could notch the engine up to within half a notch of mid gear in both forward and reverse and it would still run beautifully.

I then asked him if he had any details of the LNER B1 valve gear so he just sent me all the full-size details - can't be better than that.

Regards, Doug Hewson

Firearms

Dear Martin,

Recent editorial comments about firearms and the 'perils' of replicas reminds me that I have in my loft a few wartime copies of *Model Engineer* where all dimensions necessary to manufacture a Mk.III STEN Gun. The only dimensions missing are of the cartridge, which any competent model engineer would have no problem in obtaining. The article also included instructions for 'back converting' the Mk.III to the more sophisticated Mk.I.

I just wonder how many model engineering members of the Home Guard used these instructions 'with malice aforethought' to enhance their capabilities.

Best regards, Chris Davison

Metal Fatigue

Dear Martin,

First, thank you to Mike Tilby for his very interesting series of articles on turbines. For some years I've thought that I would like to make a model turbine and I may now make some effort to make a start.

My main reason for writing, though, was to comment on the article about metal fatigue in M.E. 4636 (10^{th} April). I read the article with some interest as I spent the first six years of my career as an aeronautical engineer doing fatigue research at the Royal Aircraft Establishment Farnborough.

My work between 1962 and 1968 was to study fatigue initiation and crack growth in copper based aluminium alloys for use in the structure of *Concorde*. Control tests were done on specimens subjected to constant amplitude fluctuating stresses. The range of specimens covered amplitudes from very low levels (i.e. lives up to 10 million cycles) up to yield stress. Other tests were done with a spectrum of stress amplitudes applied to each specimen.

In some tests high stress amplitude cycles were applied before low ones, in other tests low amplitude cycles were applied first and in yet others the stress amplitudes were applied in random order. It was found that the order in which the stress fluctuations were applied had a significant effect on the lives of the specimens, suggesting that the damage done by a particular amplitude of stress excursion depends on the preceding load history. It is believed that this was because high stress fluctuations applied before low ones can reduce the damage done by the low ones and conversely low stress fluctuations applied first can increase the damage done by the high ones. For this reason, critical components were tested by applying a spectrum of loads in random order which represented the expected service loading as closely as possible. Miner's cumulative damage rule was never regarded with any confidence by structural engineers or stress analysts and as far as I know still isn't.

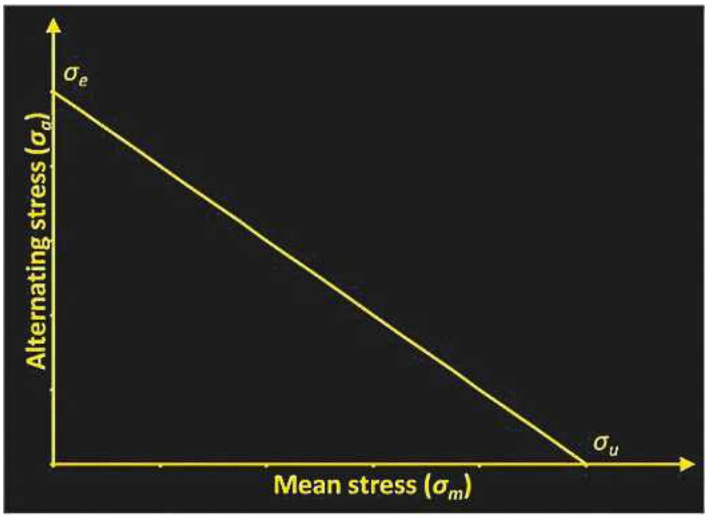
I would also add that we have had fatigue failures in guards truck axles at my club. They were typical in that they occurred at changes of section where the shoulder had been cut with a pointed tool, i.e. they had no discernible radius at the shoulder. Good design to avoid high stress concentrating features is essential. The radius on the corner of the bore of ball and roller bearings is there to accommodate a radius on the axle.

Regards,
Trevor Carter (Ross on Wye)

Dear Martin,
I found Robert Walker's article on metal fatigue in M.E. 4636 (10th April) to be of great interest. I can think of few applications in model engineering where metal fatigue is likely to be a design criterion - gas turbines perhaps - but an understanding of the subject is important for professional mechanical and structural engineers involved in the design of components subject to repetitive transient loading. I hope the following observations on Mr Walker's article will be of interest.

Regarding the final sentence, it is certainly true that it is important to know the stresses expected in service at all locations in the component or structure being designed. In my experience (which is confined to design in low alloy and stainless steels and therefore somewhat narrower than Mr Walker's) stresses due to service loading, including stress concentrations (where the relevant feature can be modelled), are relatively easy to determine, especially given the power of Finite Element (FE) techniques now widely available to the professional engineer. Having said that I would concede that service loading can be difficult to quantify and may be outside the control of the designer – but that is the reason for the adoption of margins of safety appropriate to the degree of uncertainty. It is worth pointing out that fatigue design is usually based on the principal tensile stress, which is a combination of co-existent axial stress (as Mr Walker's examples), plus bending and shear stresses where present.

The main point I would like to make is that the maximum stress at any given point is the algebraic sum of the principal stress due to service load and the residual stress. The latter may be much the larger component. Typical causes of residual stress in low alloy steel components and structures are cold bending and welding, both of which cause local yielding of the metal, say 450MPa stress, in both tension and compression – although it is the tensile stress that is important for design in respect of fatigue. It follows that even if the calculated stress range about a mean of zero is small, say +/- 50MPa, the actual stress at that location will cycle between 350 and 450MPa. The calculated fatigue life will accordingly be much reduced compared with that calculated for the service load range of -50 to +50MPa. Mr Walker refers to annealing '... to remove residual stresses ...' and I believe this technique is commonly used for welded fabrications, e.g. for new frame stretchers, drag boxes, etc. for restored steam locomotives. However, I note that BS7608:2014 'Guide to the fatigue design and assessment of steel products' states at clause 16.3.6 *'If the applied stress range is fully tensile, stress relief has no significant effect on fatigue strength (for welded details).'* I assume, therefore, that the main purpose of such treatment is to minimise distortion during subsequent machining operations.



I confess to not understanding the Goodman diagram in figure 3. It would, I think benefit from annotation of the horizontal and vertical axes and explanation of how the stress cycling between 48 and 496MPa is read on the diagram, i.e. how is it used? I am aware that the Goodman diagram has been around for a long time and in its simplest form is represented as in the figure above. This diagram indicates that for a given number of cycles, n, the allowable stress range reduces linearly from that calculated by the basic S-n curve for $S_{average}$ = 0 to zero for $s_{average}$ = yield stress. I am aware its reliability, in this simple form at least, has been called into question. Mr Walker's diagram is clearly different but, as noted above, not clear.

The Goodman diagram does not appear in any of the British Standards with which I am familiar, including BS7608 mentioned above, my experience being that the correction for mean, or more importantly maximum tensile stress due to service loading is already incorporated in the S-n diagrams. As, incidentally, are residual stresses due to welding but not those due to cold bending.

Jeremy Buck

Robert Walker replies:

Thank you, Mr Buck, for taking the time and interest in my article to write such detailed and useful additions. The points about the stresses generated during bending are a very important consideration in model engineering.

I am not familiar with the welding standard you quote and the fact that annealing is not recommended seems to conflict with normal engineering practice. I must assume that in the light of experience welded structures are safe without annealing, I assume because there is a high safety factor or perhaps it adversely affects the material structure around the weld.

With regards to the Goodman diagram, I am sorry that the explanation was not clear enough. The method I tried to describe is a more reliable method compared with simple Goodman diagram in Mr Buck's email. The key point of using the Goodman diagram is to enable test data where the stress cycles about zero, which is the most common, to be used more widely. In practice, it is seldom the case that the stress cycles about zero as there almost always a static load, if only the weight of the part, hence the need for the Goodman diagram.

Old girl all dressed up posing for the camera.

PART 2 - ENGINE BOGIE

WAHYA A 5 Inch American Type Locomotive

Luker builds an American 4-4-0.

Continued from p.756
M.E. 4639, 22 May 2020

Fig 1, which reproduced so badly last time, is printed again with this instalment. I hope it will be clearer this time. The General Arrangement, which should have been included this time, will appear next time – *Ed*.

The bogie frames

Of all the assemblies I've made for this little locomotive, I had the most fun with the engine bogie (or engine truck as they called it). It has the compensated spring arrangement with cast pedestals like the original bogies. The centre plate holding the bogie to the main frame (and the lateral spring arrangement) has been simplified for more rugged model engineering use and because it's not really visible I doubt Professor Meticulous will kick up a fuss.

The bogie top and bottom frame are laser cut items like the main frames with the holes drilled in afterwards, either using the laser engraved crosses as a reference for the centre pop or the good old fashioned blue marker and scribing method. Not to put too fine a point on scribing, pardon the pun, I never passed straight line drawing with a ruler at school. To get around this lack of basic education, I generally scribe a line by using a suitable piece of plate, in this case 2.5mm thick, on a flat surface and scribe the lines along this plate. No measuring, no fuss, and they're always straight.

The pedestals

The original pedestals for this era of American type locomotives were generally cast iron and in two pieces. With the scaled down tolerances of models this is impractical and the smallest amount of movement in the clamping screws will lock the axle boxes. To solve this all the pedestals were cast as one piece but the other dimensions are scaled close to drawing. I also standardised the pedestals for the engine bogie and tender bogies; this will save a little time on the machine setup. All in all, you need 12 pedestals.

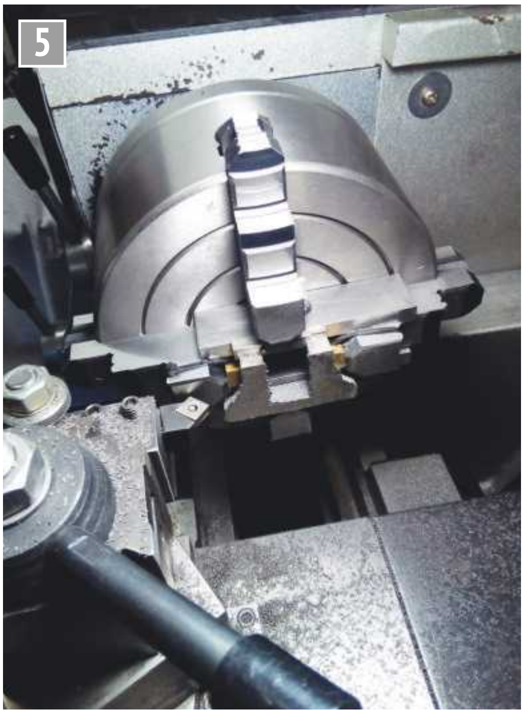
The first facing operation takes a little time to set up but once you get the hang of it you'll have faced the back of all 12 pedestals in no time (**photo 5**). My castings only required a light skim but I wanted the front and back on size and flat to avoid any issues with the equalizer beams.

A jig is needed to clamp the pedestals for facing the front and, if the backing face of the jig is faced on the lathe and kept in place, the back and front faces of the pedestals will be true and parallel (**photo 6**). If you lock the cross slide you'll also have each pedestal thickness identical, provided you can skim all of the faces in one cut. I would still check each one to make sure nothing has moved as this is an intermittent cut.

At this point you can glue (two part epoxy works well) the pedestals together in pairs back-to-back with two of those sets together to make groups of four (**photo 7**). All other machining operations will be done on these batches to make sure each set of pedestals for a bogie matches nicely. The top and bottom can then be skimmed on the lathe using a four-jaw chuck, and the slots for the axle boxes opened out using a stout endmill in the milling machine.

With the machining operations for the sets done they can be match marked by engraving and separated with a little heat applied gently until they release. I generally cast a few spare components (especially when casting cast iron using green sand because you do get the odd draw or short fill) and nothing is more annoying than lighting up the furnace for a few odd components you need to redo after all its friends have been nicely machined. The downside is that after each locomotive I tend to have a few orphaned castings left over.

With the frames done and the pedestals accurately machined the pedestals can be fitted and match drilled to the frames. I used M2.5 screws and these matched the scaled drawing quite nicely, with the large scale using machined bolts.



Facing the backs of the bogie pedestals.

Bogie pedestals clamping jig.

Completed bogie pedestals.

Wheel covers.

Bogie springing

The equaliser beams are laser cut from 2.5mm plate and, when writing this piece and getting the drawings ready, I realized I hadn't even bothered dimensioning them. The two plates only required the holes for the hanger pins to be drilled. The springs are made in the same way as the main frame springs, with the spring saddle fashioned by folding 1mm plate and brazing that to a suitable piece of threaded square bar. An M3 countersunk screw with a 10.1 mm spacer will clamp the spring assembly including the equaliser beams, hangers and springs. This will be slipped over the pedestals and the axle boxes will rest on the rounds of the equaliser beams giving you a fully compensated front bogie.

I went a step further with my locomotive and added wheel covers (yep, that's what they called them - very original!) but these were not added to all of the locomotives and can be left out without offending the original builders. I never drew these up, because they were fitted on the job, but they were made from 0.5 mm brass plate, 2 mm brazing rod and 5 mm machined brass balls to finish off the ends nicely (**photo 8**). The whole job was soft soldered together and was bolted to the bogie frame using the screws holding the pedestals in place. The whole assembly can be painted and the end trimming polished for a little bling.

Centre plate

The centre plate which holds the bogie to the main frame is a four-jaw machining job and can be made from either brass or cast iron. I must be very honest - I really dislike making springs! It's a schlep and most of the springs I use come from items that have been discarded; the springs for the centre plate are no different. The stiffness depends on the amount of curvature and condition of the track the locomotive will spend its time on.

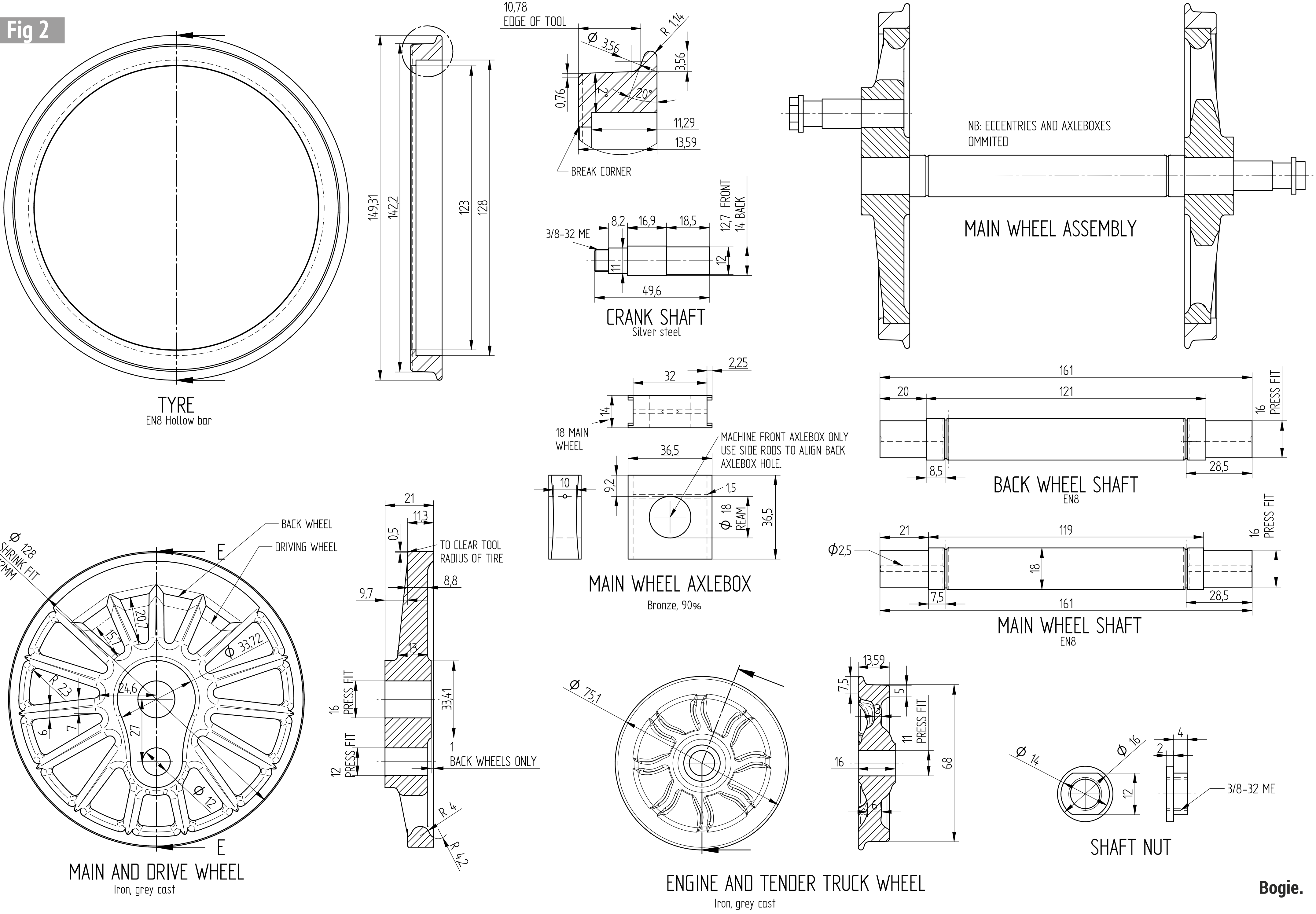
In my case I went a little stiffer (0.8 mm spring wire diameter) to avoid unnecessary clashes between the wheels and the cylinders. The springs just need to be identical with the tabs in the main frame locating them in place. The centre catch plate is them screwed to the bottom of the bearing and should allow for easy movement of the bearing in the frame slot.

Bogie axle boxes

We have a ground level track at our club which tends to be a little harder wearing on the bearings and links. I've found that the alloys with zinc and lead tend to wear rather quickly and for the last two

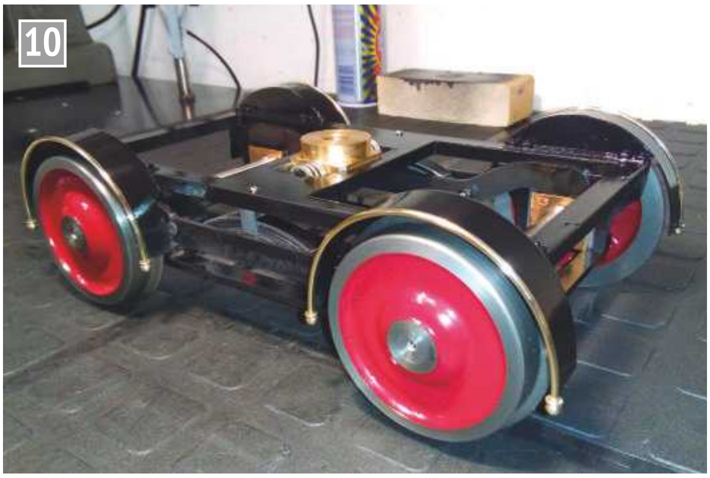
»

Fig 2


TYRE
EN8 Hollow bar
BREAK CORNER
EDGE OF TOOL
CRANK SHAFT
Silver steel
3/8-32 ME
12,7 FRONT
14 BACK
MAIN WHEEL ASSEMBLY
NB: ECCENTRICS AND AXLEBOXES
OMMITED
18 MAIN
WHEEL
MACHINE FRONT AXLEBOX ONLY
USE SIDE RODS TO ALIGN BACK
AXLEBOX HOLE.
REAM
MAIN WHEEL AXLEBOX
Bronze, 90%
BACK WHEEL SHAFT
EN8
MAIN WHEEL SHAFT
EN8
PRESS FIT
BACK WHEEL
DRIVING WHEEL
SHRINK FIT
0.12MM
TO CLEAR TOOL
RADIUS OF TIRE
BACK WHEELS ONLY
MAIN AND DRIVE WHEEL
Iron, grey cast
ENGINE AND TENDER TRUCK WHEEL
Iron, grey cast
SHAFT NUT

Bogie.

Bogie wheels.



Assembled bogie.

locomotives I've built all the bearing material has either been phosphor bronze or a 10% tin bronze and generally they are all cast.

For the axle boxes I cast rectangular bars to the size I'm looking for with the slots for the frames or pedestals machined on the milling machine along the entire length. The outside can be skimmed on the milling machine or in the four-jaw chuck. With the slots and outer dimensions on size the band saw cuts the individual axle boxes with a little extra material for final machining in the four-jaw chuck or milling machine. Each box is tried in the pedestals and the best fitting ones are left in place and the odd bugger that refuses to sit is filed to size. The bogie axle boxes for both the engine and tender have the same outside dimensions with only the hole size for the wheel shaft different, so they can all be fitted at the same time.

The centre hole for the engine bogie is machined in the four-jaw chuck with the opposing axle boxes glued together (aligning the pedestal bearing surface) either using a reamer or a boring bar. You'll need some brass square bar between the chuck and slot to make sure you don't damage the lip of the axle box. The inner lips of the axle boxes need to be rounded to allow vertical movement of the wheels without locking the shaft but I leave this till last. I first make sure the shaft rotates freely with the springs in place before finishing off this radius. Incidentally, this radius is a filing operation done by eye, using a file with the bottom teeth removed using a fine flapper disk and grinder. No need to damage a perfectly good machined surface with a file!

Wheel shaft

The wheel shaft is a classic example of centre turning. I must admit I do cheat a little and rough machine all my shafts using a three-jaw chuck for the ends, and three-jaw chuck and dead centre for the shaft thinning in the centre. I then do a proper job of finishing to size the shaft using the normal dog clamp and dead centre method.

The bearing surfaces are cleaned up using fine (600 grit) sandpaper on the lathe, making sure you keep fingers and knuckles away from the turning chuck. You will need to use a little cooling fluid to keep the shaft cool and under NO CIRCUMSTANCES should you use gloves anywhere near a lathe.

The oil groove is for ease of oiling when starting the day's run. There's nothing more annoying than moving the locomotive forward and backwards trying to get oil holes to align. The hole at the top of the axle box will allow the oil to overflow and, with the equaliser beams hugging the pedestals, will direct the oil nicely to the sides of the axle boxes.

Bogie wheels

One thing that can be said about this era of locomotive design in the US is they were not scared; in fact, some would say they were a bunch of cowboys! Sorry, that was a little corny, but when researching the different wheel designs I found patents for wheels made from pressed paper, plate designs and a few more interesting ideas, all of which were used and worked. By far the most common were the full cast bogie wheels with the part of the wheel contacting the rails cast chilled. I couldn't resist doing the cast option, and I had full drawings that I could scale down. The design of the ribs at the back of the wheel shows the level of understanding of casting in those days, being very favourable for shrinkage and final stresses.

The wheel profile is not to scale and all my locomotives are designed using the SMEE standard (this is how our points and track gauges were built here in South Africa). There are a few ways of machining the wheel profile and a number of fine articles have been scribed on the subject. Generally, I machine all the bores, with a boring bar or reamer, using the inner rim (as cast surface) as a reference for truing the casting on the lathe. All the subsequent facing and turning will then be done on a mandrel with a securing bolt.

The outer profile is rough cut to within 0.2-0.5 mm and I generally don't bother with the 2° taper at this point. I have a tip tool which I brazed to a square piece of mild steel and ground to the included angle of the flange and profile with the correct corner radius. Each wheel can be tightened on the mandrel and the tool can be plunged cutting the 20° and using the taper slide the rest of the profile is cut at 2°. If you zero the gauges on the cross slide and taper slide when the first wheel is cut correctly, all the remaining wheels can be cut to the exact same size; twelve of them!

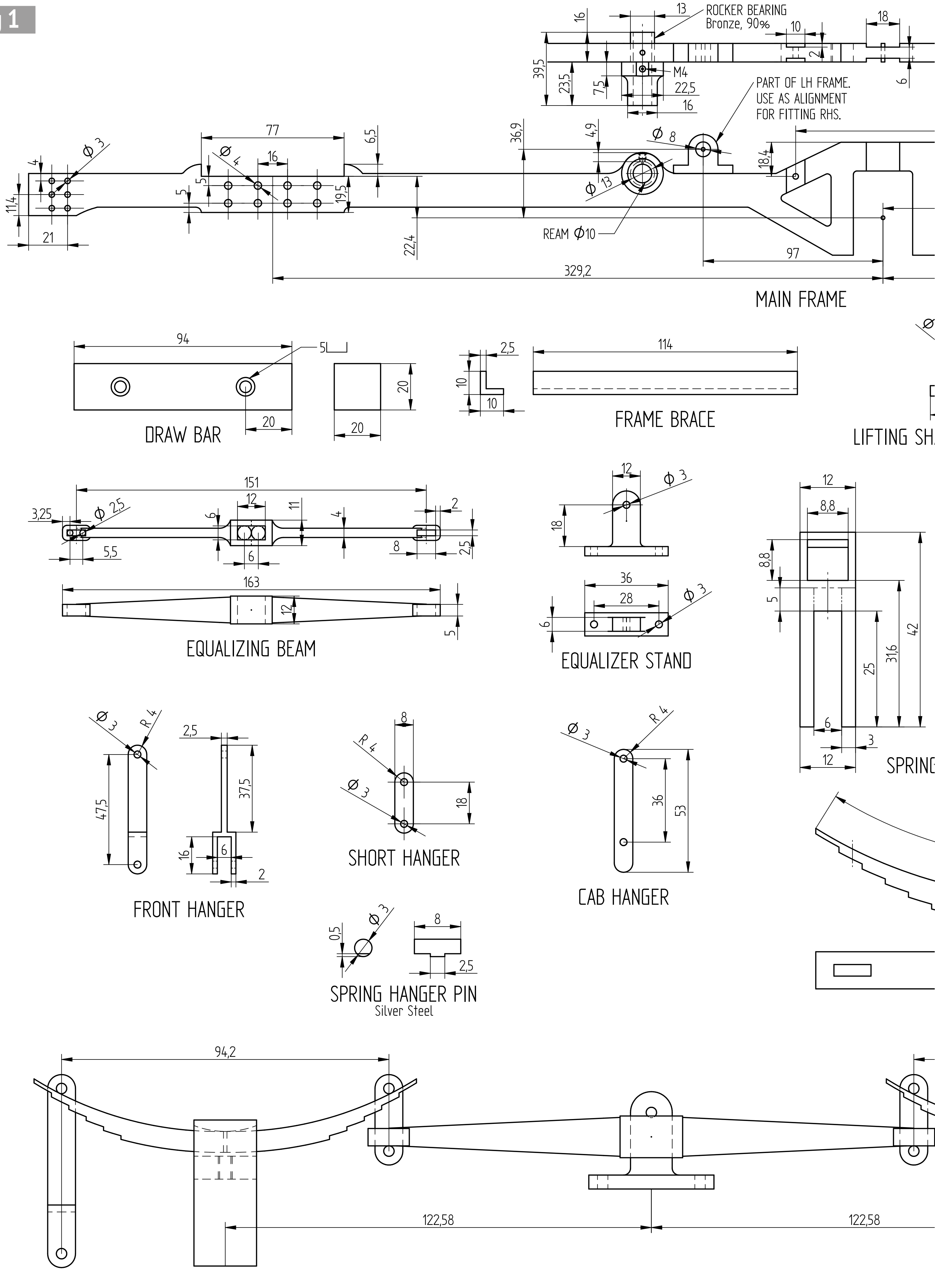
A tip on painting; if you paint the wheels after they have been cleaned prior to machining you will end up with perfect breaks between the machined and painted surface (**photo 9**). This eliminated the need for a steady hand when painting the wheels. I only received a blue star in painting at the end of preschool so every trick in the book helps.

Assembled Bogie

Finally, the bogie is assembled to the frame with a simple pin and an M8 nut and washer to make sure it doesn't drop out when lifting the locomotive (**photo 10**). The front of the original bogies had chains and shackles to the main frame and this detail can be added with very little effort by slotting a screw and soldering a ring to the end. I used a chain from a deodorant can that looked pretty good in terms of scale, but useless strength wise.

●To be continued.

Fig 1


ROCKER BEARING
Bronze, 90%
M4
PART OF LH FRAME.
USE AS ALIGNMENT
FOR FITTING RHS.
REAM Ø10
MAIN FRAME
DRAW BAR
FRAME BRACE
LIFTING SH
EQUALIZING BEAM
EQUALIZER STAND
SPRING
FRONT HANGER
SHORT HANGER
CAB HANGER
SPRING HANGER PIN
Silver Steel

MODEL ENGINEER

Incorporating Mechanics, English Mechanics and Ships & Ship Models

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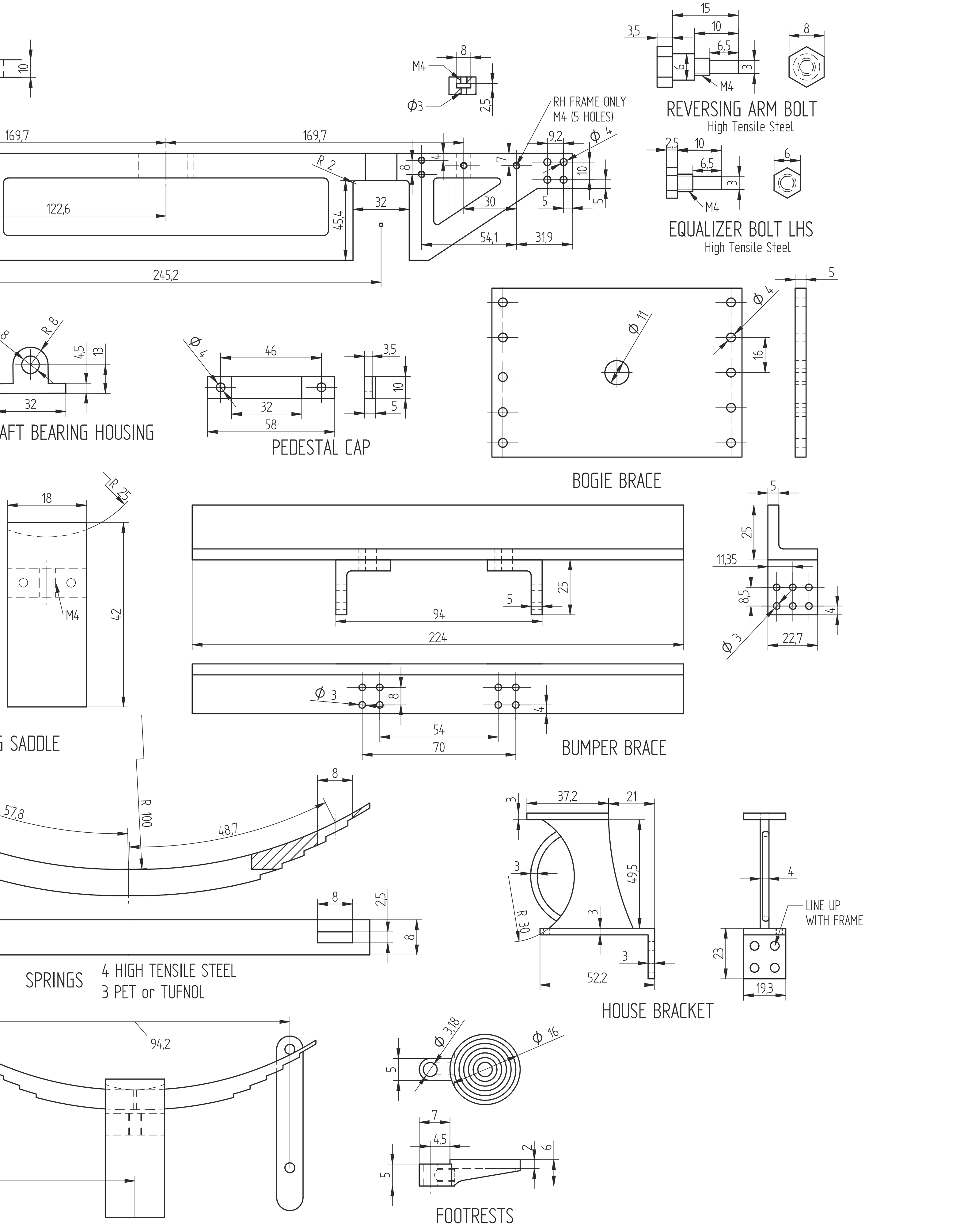

RH FRAME ONLY
M4 (5 HOLES)
REVERSING ARM BOLT
High Tensile Steel
EQUALIZER BOLT LHS
High Tensile Steel
AFT BEARING HOUSING
PEDESTAL CAP
BOGIE BRACE
G SADDLE
BUMPER BRACE
SPRINGS
4 HIGH TENSILE STEEL
3 PET or TUFNOL
HOUSE BRACKET
LINE UP
WITH FRAME
FOOTRESTS

In Praise of the TDI

Jacques Maurel explains the merits of the thread dial indicator and shows how you can make your own.

Why?

Why do you need one of these? Because with it you can clutch the 'half nuts' when the nut groove is just in front of the lead screw crest, thus avoiding the 'false starts' when the half nuts are not fully engaged on the lead screw that certainly will spoil the machined thread. So, it's worth using it even if the machined pitch is a sub-multiple of the lead screw pitch. In this case it's said that you can clutch 'anywhere', this being of course false as it will be impossible to clutch if the lead screw crests are in front of the half nut crests. In reality, 'anywhere' means here any part of the lead screw where clutching is possible.

It's also possible to thread from left to right starting against a shoulder as described in my video (search for 'screw cutting from a shoulder' on YouTube) - see also **ref 1**. This method is very convenient but you must use a left-hand tool for machining a right-hand thread. A right-hand tool can be used for an external thread if the height of the shoulder is not too great but it's necessary for an internal threading tool to use a left-hand one.

If the lathe is not new, it's worth stripping down and cleaning the half nut system, that's very often filled with swarf.

TDI engaged with lead screw.

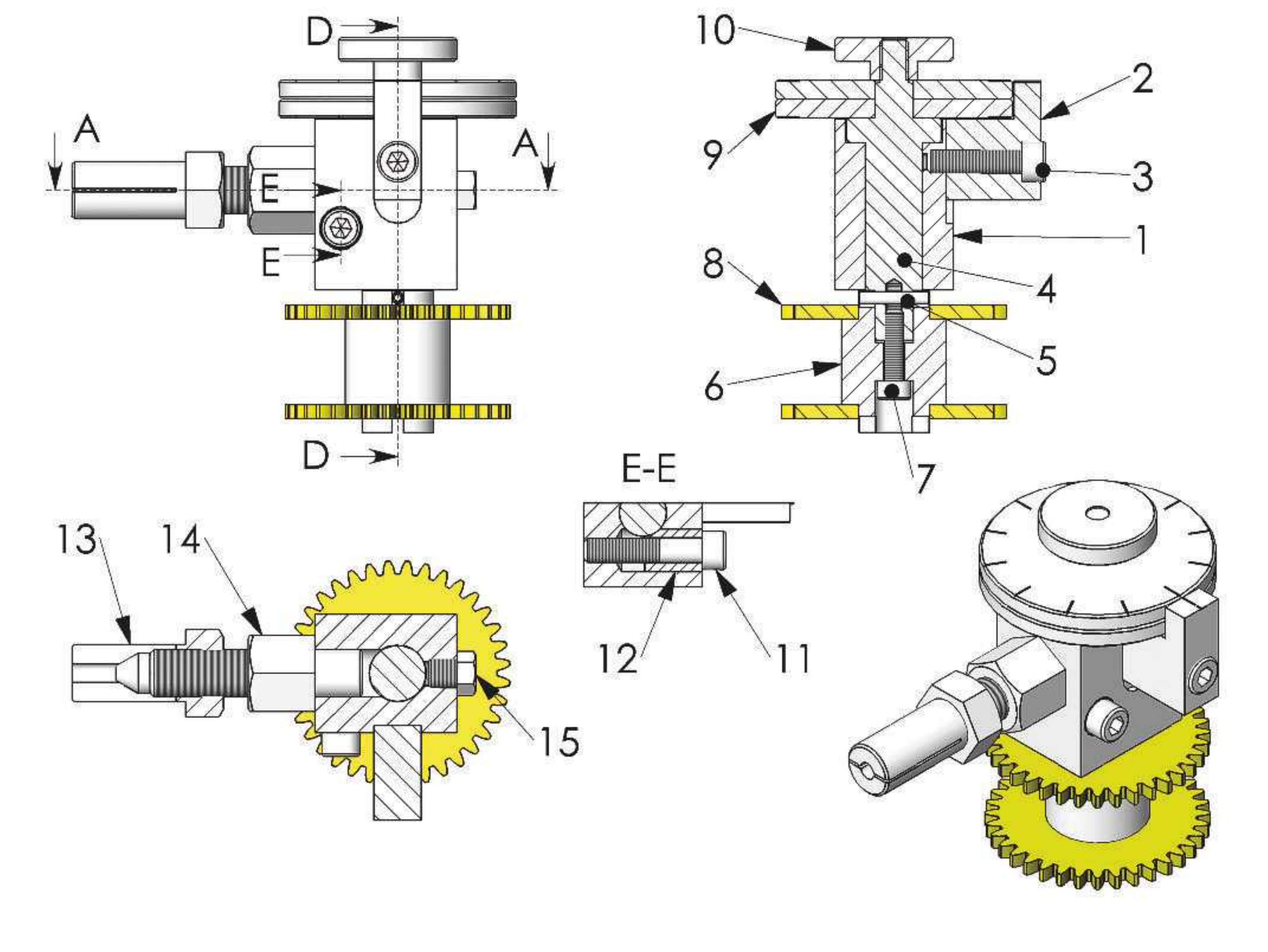
How it works

See **photo 1** and **fig 1**.

You can clutch the lead screw 'anywhere' if the machined pitch is a sub-multiple of the lead screw pitch. For example, for my lead screw (4mm pitch) the common sub-multiples are 2, 1 and 0.5mm. This is not possible if the pitch is not a sub-multiple of the lead screw pitch. (Note that the 'machined pitch' here is the figure after taking account of the change gear/gearbox setup – *Ed.*) For example, if I want to machine a 1.5mm pitch (this is very frequent as this is the fine ISO pitch for the diameters above 10mm) the nearest multiple of this pitch and of the lead screw pitch is 12mm (3x4mm) so you must re-clutch after every 3 (lead screw) pitches counted from the un-clutching situation. This is done with help from the TDI: a 36 tooth gear (Z=36) is meshed with the lead screw and on the gear axle is set a graduated dial on which 12 graduations are stamped. Clutch the lead screw (lathe at rest), free the disc, align one of the graduations with the fixed index and lock the disc on its axle by tightening the knurled nut. When the machine is running (carriage movement, lead screw turning) you can be sure that any of the graduations is situated at 3 pitches (that is, 12mm) from the previous one. You can now open and close the half nuts at the right point for all the sub-multiples of 12mm - 6, 4, 3, 2, 1.5, 1, 0.75, 0.5mm.

Why use a 36 tooth gear (a 24 one could do the job)? Because it's also a multiple of 9 so it's possible to machine 9 and 4.5mm pitches with

Fig 1

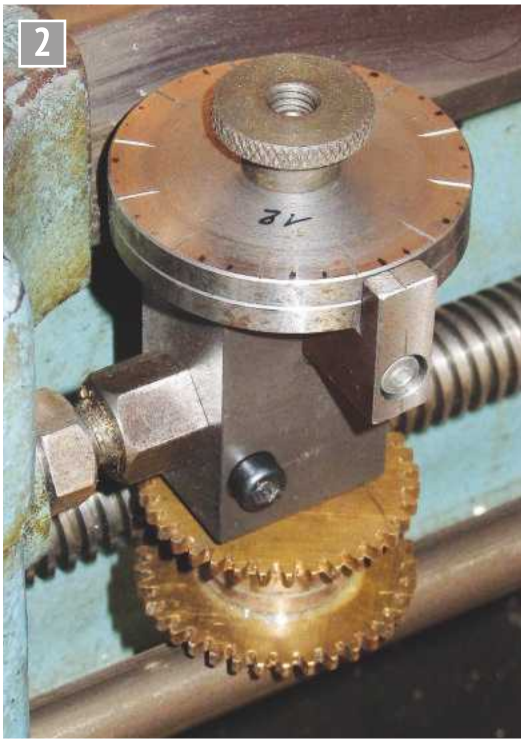


a four graduation dial (so 9 lead screw pitches = 36mm between each pair of graduations). Of course, the smaller the number of graduations on the dial, the longer the time you'll have to wait before clutching.
Using a 35 tooth gear, it's possible to machine the sub-multiples of 20mm with a 7 graduation disc (10, 5, 4 , 2.5, 2, 1.25, 1, 0.5mm) and the sub-multiples of 28 with a 5 graduation disc (14, 7, 4, 3.5, 2, 1.75, 1, 0.5mm).

A 33 tooth gear would be necessary for the sub-multiples of 11 (5.5mm) and a 26 tooth gear for the sub-multiples of 13 (6.5mm).

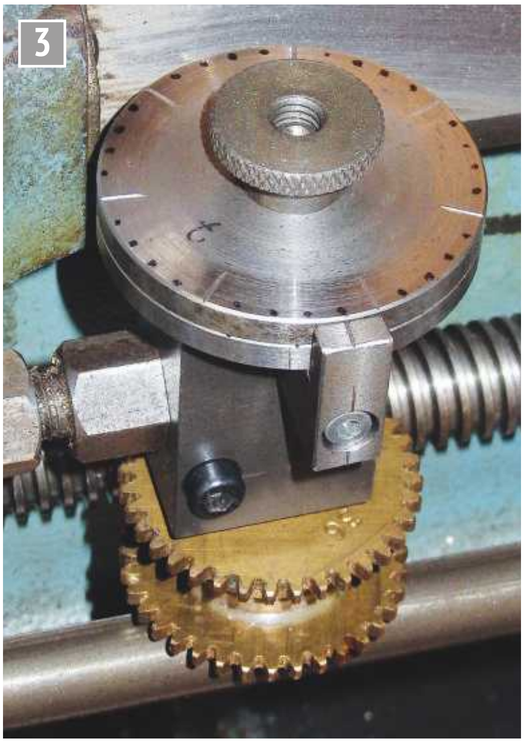
Using the TDI with sub-multiple pitches

The problem when using the supplied discs is that



2

12 division disc marked for Z=36.



3

7 division disc marked for Z=35.

>>

If the lathe is not new, it's worth stripping down and cleaning the half nut system, that's very often filled with swarf.

you have to wait for the graduation to arrive before clutching, whereas for the sub-multiple pitches you could clutch at certain points between graduations!

So, it's worth marking the intermediate positions with a felt pen to remind yourself. This is very easy as you have just to move the carriage by the appropriate number of lead screw pitches, clutch and mark a point with a felt pen on the disc at the fixed index (see **photo 2** for 36 teeth and **photo 3** for 35 teeth). There is no need for any dividing attachment.

Making your own TDI

Of course it's not possible to give a universal design but fig 1 should provide a useful guide.

Gear design

The gears meshing with the leadscrew (**8**) are not standard (module = pitch/3.14, pressure angle 15° for a standard ISO metric trapezoidal thread). For my lathe the module should be m = 4/3.14 = 1.273mm. I used the nearest standard m = 1.25mm module with a 20° pressure angle. These gears worked perfectly well. I used 3mm thick brass plate as they are rubbing on the lead screw. The small thickness is necessary as the gear should really be of the helical type to fit the lead screw. Don't forget to punch the number of teeth on each gear.

These gears are stuck on the gear holder (**6**) with epoxy glue, a 36 tooth gear on one side and a 35 tooth one on the other side.

I think that this will work for other leadscrew pitches: m = 1mm for 3mm pitch, m= 1.5mm for 5mm pitch, m= 2mm for 6mm pitch.
Another gear holder should be necessary to carry two other gears having 33 and 26 teeth but I've not yet made this.

Graduated dials

As already explained, you can graduate the dials (**9**) directly on the lathe without any dividing attachment and then engrave the lines with a cold chisel or a punch.

Two dials are required: one with 12 and 4 graduations (to use with the 36 tooth gear) and one with 5 and 7 graduations (to use with the 35 tooth gear), as explained earlier.

Note: I use 50mm diameter for these dials; my first prototype was with smaller ones but the greater the diameter the better for accurate clutching.

Spindle

The large collar on the spindle (**4**) is to get a good 'friction hold' for the dials so machine a slight recess on the collar face so that contact with the dials is made only near its outside diameter. Don't forget to apply some grease before fitting with the body.

Table 1. Parts List

No.	No. Off	Name	Material
1	1	Body	FCMS
2	1	Index	FCMS
3	1	Screw CHc M5-20	8-8
4	1	Spindle	FCMS
5	1	Elastic pin diam 2.5mm, length 15 mm	
6	1	Gear holder	FCMS
7	1	Screw CHc M4-15	8-8
8	2	Gear (see text)	Brass
9	2	Graduated dial (see text)	FCMS
10	1	Knurled nut	FCMS
11	1	Screw CHc M5-25	8-8
12	1	Cotter	FCMS
13	1	Collet nut	FCMS
14	1	Spigot screw	FCMS
15	1	Oiler	

Collet nut and spigot screw

I needed a spigot (**14**) to set the body on and as there was only a plain hole in the carriage casting, I made a collet nut (**13**) that will expand and lock in the carriage hole when the spigot screw is tightened due to the conical contact (60° angle - easy to make with a centre drill).

Cotter

Drill first the cotter hole and its tapped end in the body, turn a cotter (**12**) that will fill the cotter hole and lock in place with the screw (**11**). Now drill the spigot hole in the body. Take out the cotter and saw it, then trim the cut by filing before replacing.

Setting on the lathe

The gear must fit the lead screw with no play, so turn the body around the spigot for no play and lock the cotter. One day I experienced clutching problems - this was because of meshing play, the carriage having been run too far on the right side of the lead screw and the thread end having slightly pushed the gear out of mesh. **ME**

REFERENCE

1. *Workshop Practice Series No.3 Screwcutting in the Lathe*, Martin Cleeve, p. 80 (special application of the leadscrew indicator) of my 2003 reprint, the description being for threading inside a blind bore from the bottom.

The Stationary Steam Engine

PART 9 - WATT'S YEARS OF STRUGGLE

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

Continued from p.751
M.E. 4639, 22 May 2020

Almost ten years separated Watt's momentous insight as he walked over Glasgow Green in the spring of 1765 from the first commercial engines to make use of the separate condenser. For Watt these were years of great personal adversity and a continuing struggle to translate the concept into a viable piece of engineering. His trade in scientific instruments continued but did not prove capable of supporting an independent career in scientific study and he was periodically compelled to work as an engineer and surveyor, work which extended to the design and construction of several conventional Newcomen engines.

If these diversions from the task of developing his steam were irksome they did prove to be a formative experience in the organisational side of business and provided many contacts which were to prove invaluable subsequently. Of these, John Roebuck was to prove the most significant.

Roebuck had been educated in chemistry and medicine at Edinburgh and Leyden Universities. After qualifying as M.D. at Leyden in 1743, he had settled as a doctor and chemist in Birmingham where he joined the group of industrialists and natural philosophers, the brightest intellectual gathering in Britain outside Glasgow and Edinburgh. Roebuck was to make his first fortune from sulphuric acid production, replacing glass retorts by lead chambers, greatly increasing production.

His affinity with the intellectual life of Edinburgh proved more compelling than that of Birmingham and in 1749, with another of the Birmingham circle, Samuel Garbett, he moved to Scotland to launch the Prestonpans sulphuric acid works. Less interested in the pedestrian business of running an industrial enterprise than he was in the stimulation of starting new ones, Prestonpans was left to become steadily profitable under a manager whilst Roebuck turned his attention to the potentially vast prospects that producing iron with coal fuel promised.

By substituting coke for coal half a century earlier, Abraham Darby I had broken through the technological barrier posed by the sulphur in the coal contaminating the iron. For various reasons coke smelting was slow to gain acceptance but Roebuck could see the prospects.

Together with Garbett and the Scot, William Cadell, the partners in 1760, established the Carron Ironworks, Scotland's first coke smelting ironworks. Technical success in the smelting process was achieved after initial difficulties, mainly arising from the dissolute workforce. The product that remains the company icon (**ref 68**), the cannon, was amongst its earliest castings along with vast numbers of cannon balls but the intention also was to challenge Coalbrookdale in the market for Newcomen engine cylinders and a boring mill was the first major machine to be installed at the ironworks, in 1761.

Again, once the company was operating, Roebuck became increasing disengaged from the day-to-day management leaving the administrative burden to Cadell and his son. As the Cadells gradually instilled industrial discipline and improved production methods, output rose but this led to a further major problem, the shortage of coal suitable for the coke making. To meet this situation Roebuck contracted with the Duke of Hamilton to work his extensive coal reserves at Bo'ness but rapidly encountered pumping problems which the existing Newcomen engines were unable to resolve.

With the Bo'ness coal rights Roebuck had acquired extensive salt pans and it was salt that appears to have provided Watt's first contact with Roebuck. Watt's father was a Greenock ship's chandler and merchant. James Watt's residence in Glasgow allowed him to act as agent for his father's business and at least as early as August 1765, Watt was recommending Roebuck's salt to his father.

At about the same time he became more closely associated with Roebuck and Black in a venture that attempted to produce alkali from salt. Watt's expertise as a chemist was sufficiently esteemed by both of the partners to persuade them to entrust the conduct of the experiments to Watt. At first the venture was energetically pursued but the trials became »

CLARIFICATION

It appears some clarification may be required for a couple of the illustrations in part 8 (M.E. 4639, 22nd May).

Photo 27 is a diagram of Watt's first model of the separate condenser arrangement, not his experimental apparatus, as claimed in the text. Photos 29 and 30 show the second version of the separate condenser, not the first, as implied in the text. The captions in all cases are correct.

more desultory as they proved less promising and Roebuck increasingly shifted his attention to the possibility that Watt's work on the steam engine might salvage his disastrous involvement with coal mining.

From at least as early as mid-1765 Watt had taken Roebuck into his confidence concerning his steam engine work and in August he wrote to tell him of the early success of the inverted cylinder model. Thereafter Roebuck was to be drawn more closely into the experiments, supplying iron work and giving Watt the facility to use one of the Newcomen engines at his pits for experimental purposes.

He also seems to have been the sounding board for the experiments which led to the formulation of the perceptive but flawed 'Watt's Law' which, whilst recognising the importance of summing the latent and sensible heats (total heat) and correctly identifying an inverse relationship, mistakenly assumed that they would equate to a constant. This matter was not to be fully elucidated until fifty years later when Victor Regnault undertook his monumental programme of systematic investigation.

As part of the Bo'ness agreement Roebuck had recently taken over premises at Kinneal and towards the end of 1765 plans were made to erect the first large-scale Watt engine in the grounds of Kinneal house (**photo 31**). Carron was to provide cast-iron cylinders bored on their boring mill (**ref 69**). This promised to solve the problem which Watt had encountered in making satisfactory cylinders but in the event the cylinder fell far short of expectations, both as a casting and in the boring. The cylinder was rejected by Watt and the first Kinneal engine was abandoned.

Whilst these developments were taking place Watt's financial situation was deteriorating. His partner in the Glasgow business, John Craig, had died leaving Watt with debts owing to Craig's brother. Roebuck agreed to assume these and other of Watt's debts and, for a share in the outcome of his steam engine experiments, he agreed to finance the continuation of Watt's work.

Hitherto Watt had carried out his experiments in the basement near to his shop in Glasgow's Trongate but the agreement included the provision of premises at Kinneal and a stone workshop building was erected for Watt's use which still survives today.

In spite of Roebuck's assistance, Watt had still to divert his attention away from the steam engine and towards his civil engineering and surveying career in order to maintain himself and his family. This was not wholly a distraction from steam engines as the work included designing and building a number of Newcomen engines, one at Kennet for the Lord of that name and one for the Carron ironworks.

In connection with the parliamentary application for a Forth Clyde canal, which he had surveyed and planned with his then partner Mackell, Watt journeyed to London in March 1767 and on the return passed through Birmingham where he first met Dr. William Small. Until his death in 1777, Small was to become one of Watt's closest friends and confidants. A fellow Scot, he had trained in medicine and natural philosophy and for a period had held a Chair in natural philosophy and mathematics at Williamsburg College in Virginia. The climate there threatened his health and he returned to Birmingham in 1765 where he established an outstanding reputation as a physician.

In the same year his patient, Matthew Boulton, manufacturer of Birmingham smallwares (metallic buttons, buckles and toys), had opened his revolutionary Soho Works which concentrated all of the trades involved under one roof. Although Boulton was absent at the time of Watt's visit,

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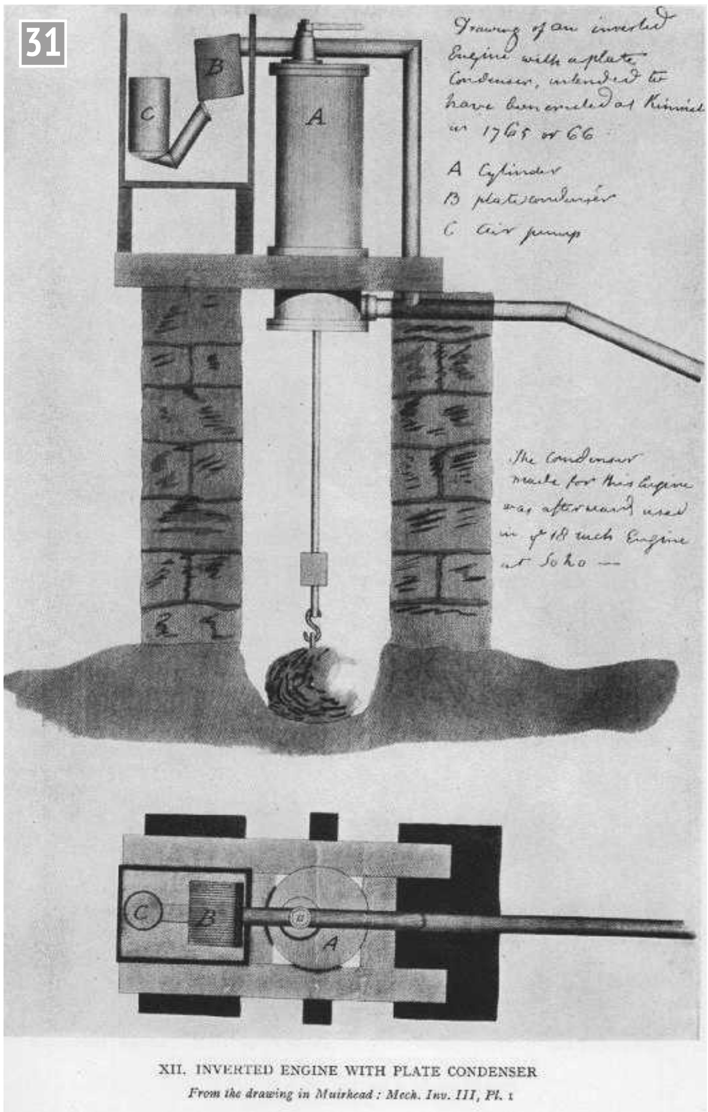


The proposed first engine at Kinneal House (J. P. Muirhead, The Origins and Mechanical Progress of the Inventions of James Watt*, 1854).*

Small and Boulton's partner Fothergill showed him around the works. As it did with all visitors, the organisation and high quality of the tools used made a profound impression on Watt.

Work on the model or models resumed in early 1768. The work at Kinneal seems to have been left largely in abeyance and Watt now based his experiments in an old cellar in King Street and at the Delftfield pottery where he was engaged as a manager and of which he was to become part-owner thereafter.

By this time, he was working with an engine which had a 9 inch diameter cylinder and a conventional beam arrangement, although various other cylinder sizes are mentioned in his correspondence and it is clear that he was also still using an inverted cylinder arrangement. With the latter he had raised a weight of 42 lb by April 1768. Progressively, the piston was made relatively steam tight but the condenser proved difficult to make airtight. Various types of air pump were tried but Watt had brought down difficulties onto his own head by mistakenly assuming that the pump had to work stroke-on-stroke with the engine cylinder. This continued to be a bugbear until he realised that once established, the vacuum would maintain itself at a constant level irrespective of the exhaust pulsations.

Watt's engine was now promising to become a viable working proposition and although he was hesitant

Roebuck began to urge that a patent should be applied for. Matthew Boulton had seen the potential and intended to erect a machine on Watt's principles but was prepared to desist until Watt's rights were protected. Spurred by the possibility that rivals were making threatening moves, Watt journeyed to London in August 1768 to make the patent office oath, the first part of the patent ritual. It was on his return journey to Scotland that he met Boulton personally for the first time.

It would take six months for the patent to pass through all its stages until it was sealed on the 5th January 1769 and enrolled on the 29th April following. Whilst this was taking place Watt erected another Newcomen engine, for John Colville at Torreyburn, but when Roebuck tried to persuade him to build one on his own principles at Bo'ness Watt prevaricated. Roebuck even had to urge him onwards with the patent proceedings. By this time Matthew Boulton was expressing an interest in becoming financially involved, an approach that Roebuck at first was inclined to welcome. Small and Boulton were consulted and together altered Watt's draft of the specification. As it finally appeared their influence is evident.

Specification

FIRST, that vessel in which the powers of steam are to be employed to work the engine, which is called the cylinder in common fire engines and which I call the steam vessel, must during the whole time the engine is at work, be kept as hot as the steam that enters it; first by inclosing it in a case of wood, or other materials that transmit heat slowly; secondly by surrounding it with steam or other heated bodies; and, thirdly by suffering neither water nor any other substance colder than the steam to enter or touch it during that time.

SECONDLY, in engines that are worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from the steam vessels or cylinders whilst the engines are working, these condensers ought to be kept as cold as the air in the neighbourhood of the engines, by application of water or other cold bodies.

THIRDLY, whatever air or other elastic vapour, is not condensed by the cold of the condenser may impede the working of the engine, is to be drawn out of the steam vessels or condensers by means of pumps wrought by the engines themselves or otherwise.

FOURTHLY, I intend in many cases to employ the expansive force of steam to press on the pistons, or whatever may be used instead of them in the same manner as the pressure of the atmosphere is now employed in common fire engines: in cases where cold water cannot be had in plenty, the engines may be wrought by this force of steam only by discharging the steam into the open air after it has done its office.

FIFTHLY, where motions round an axis are required, I make the steam vessels in the form of hollow rings …with inlets and outlets for the steam….like the wheels of a water mill…within them are placed a number of valves that suffer weights so fitted to them as entirely to fill up a part…of their channels… When the steam is admitted … between these valves…it acts equally on both so as to raise the weights on one side …to give a circular motion …it is supplied with steam from a boiler… and may either be discharged into a condenser or into the open air…

SIXTHLY, I intend in some cases to apply a degree of cold not capable of reducing the steam to water but of contracting it considerably so that the engine shall be worked by the alternate expansion and contraction of the steam.

So perceptive was the advice of Small and Boulton that the patent covered the key developments in steam engine technology for the next fifty years. The first three clauses protected the separate condenser and its evacuation by an air pump but the fourth clause also covered expansive operation without a condenser whilst the sixth could be construed to cover either double-acting operation or compounding. The fifth clause related to an entirely different type of steam engine that operated on a rotary principle without the intervention of any other mechanism.

●To be continued.

NEXT TIME

We look at further details of Watt's condensing engine.

REFERENCES

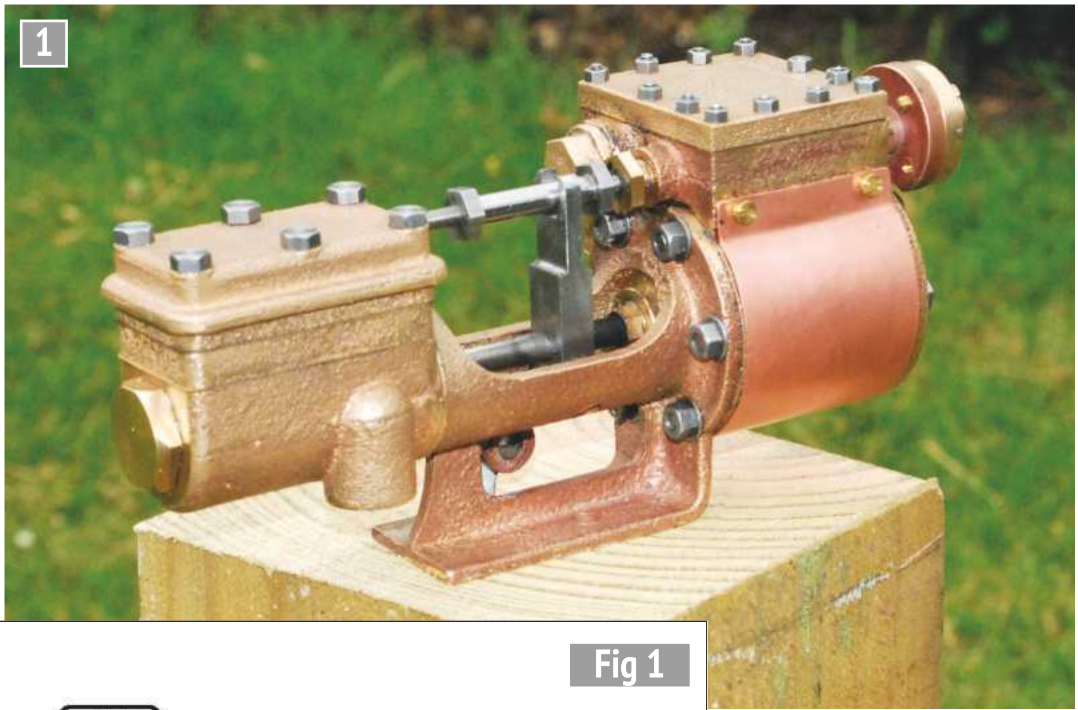
68. Crossed cannon balls still form the Carron Company crest and the Carronade, a short-barrelled cannon, was one of the main pieces of naval armament for the next hundred years. *The Carron Company*, R. H. Campbell, Pub. Oliver and Boyd Ltd. 1961.

69. Smeaton's famous boring mill was not installed until 1770 and was never used for Watt's cylinders.

The Weir Pump

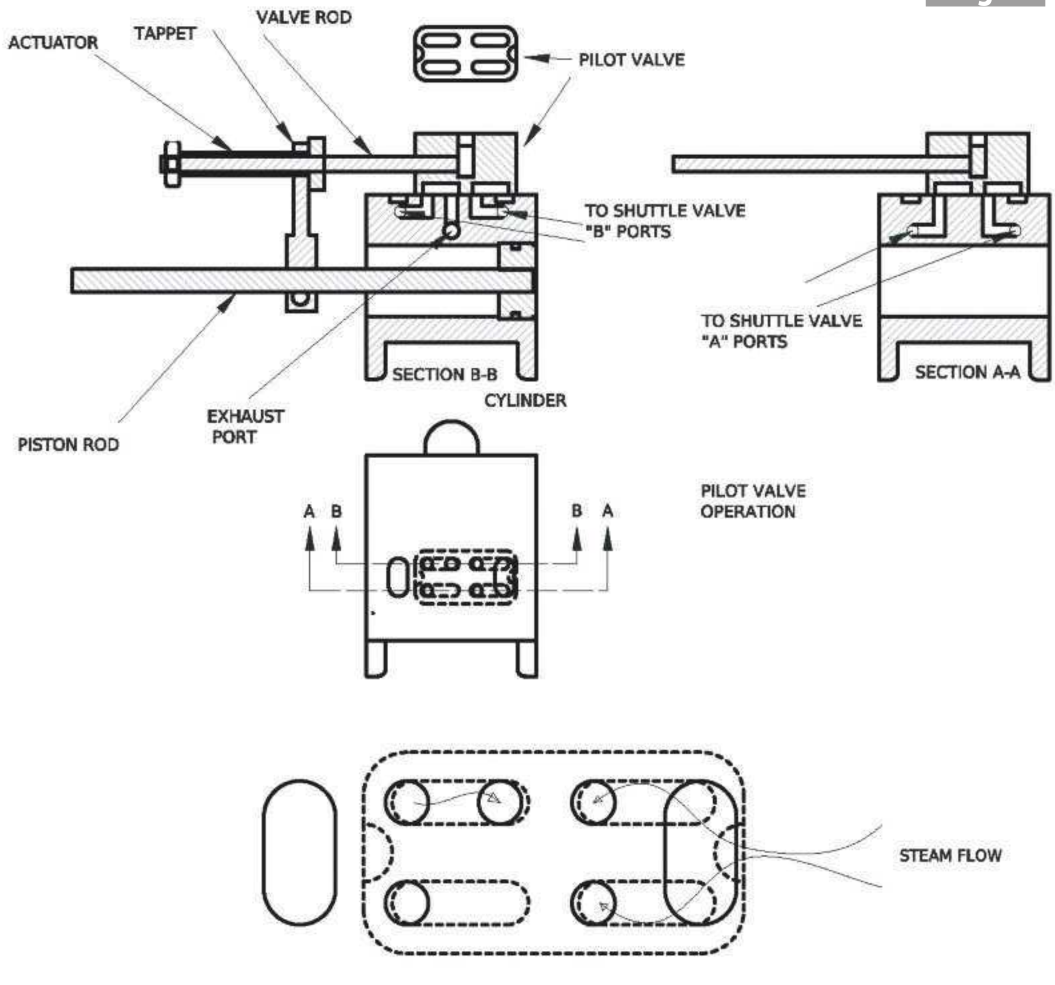
Ian Couchman follows up on the description of his 4 inch Ruston water pump with an explanation of how a Weir pump works.

1



My feed pump.

Fig 1



After many requests (well, one anyway) I'm going to try to explain the operation of my pump (**photo 1**) in more detail, so here goes...

The problem with a single cylinder, reciprocating engine like this is to get a positive changeover of the control system at each end of the stroke. In this case, this is achieved by the use of a shuttle, switched from one end to the other at each end of the stroke. We need two valves, one to control the shuttle and the other, controlled by the shuttle, to control the steam flow to and from the cylinder. I've included the exploded view in **photo 2** to hopefully make things a bit clearer.

Let's start with the pilot valve (**fig 1**). This is moved by the valve rod, which in turn is operated by a tappet on the piston rod. In fig 1, the piston rod is on the left, so with the pilot valve in the position shown, the piston has moved to the right, to the end of its

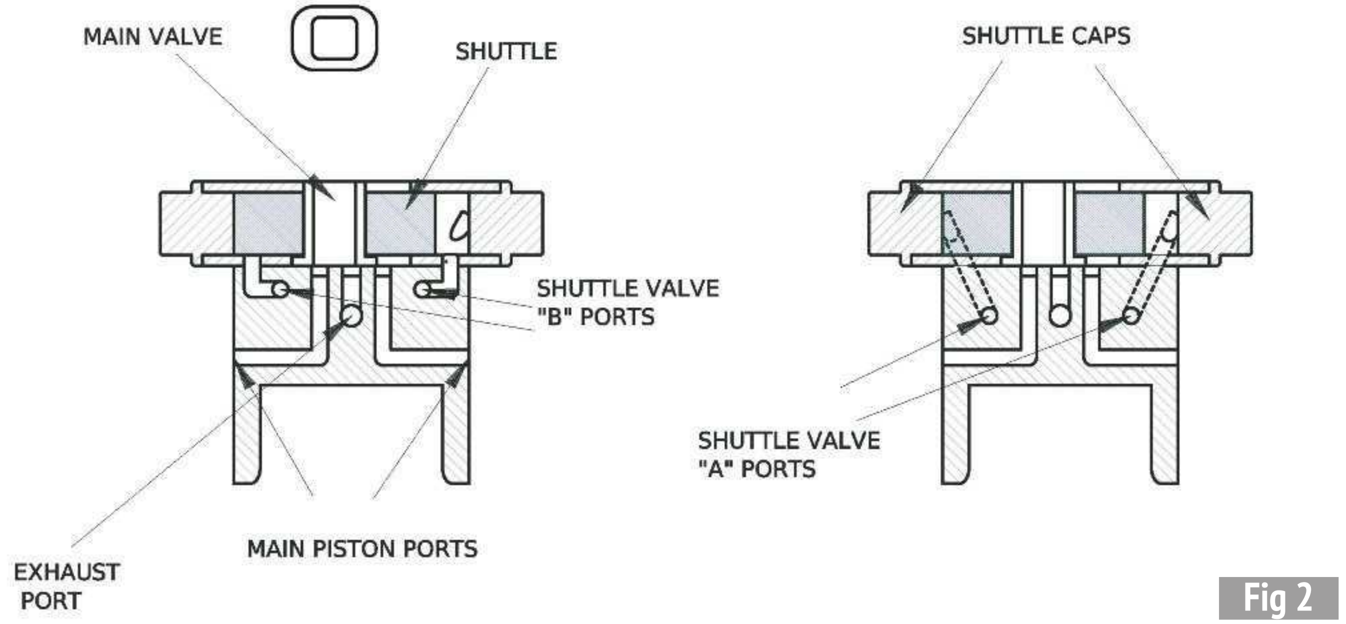
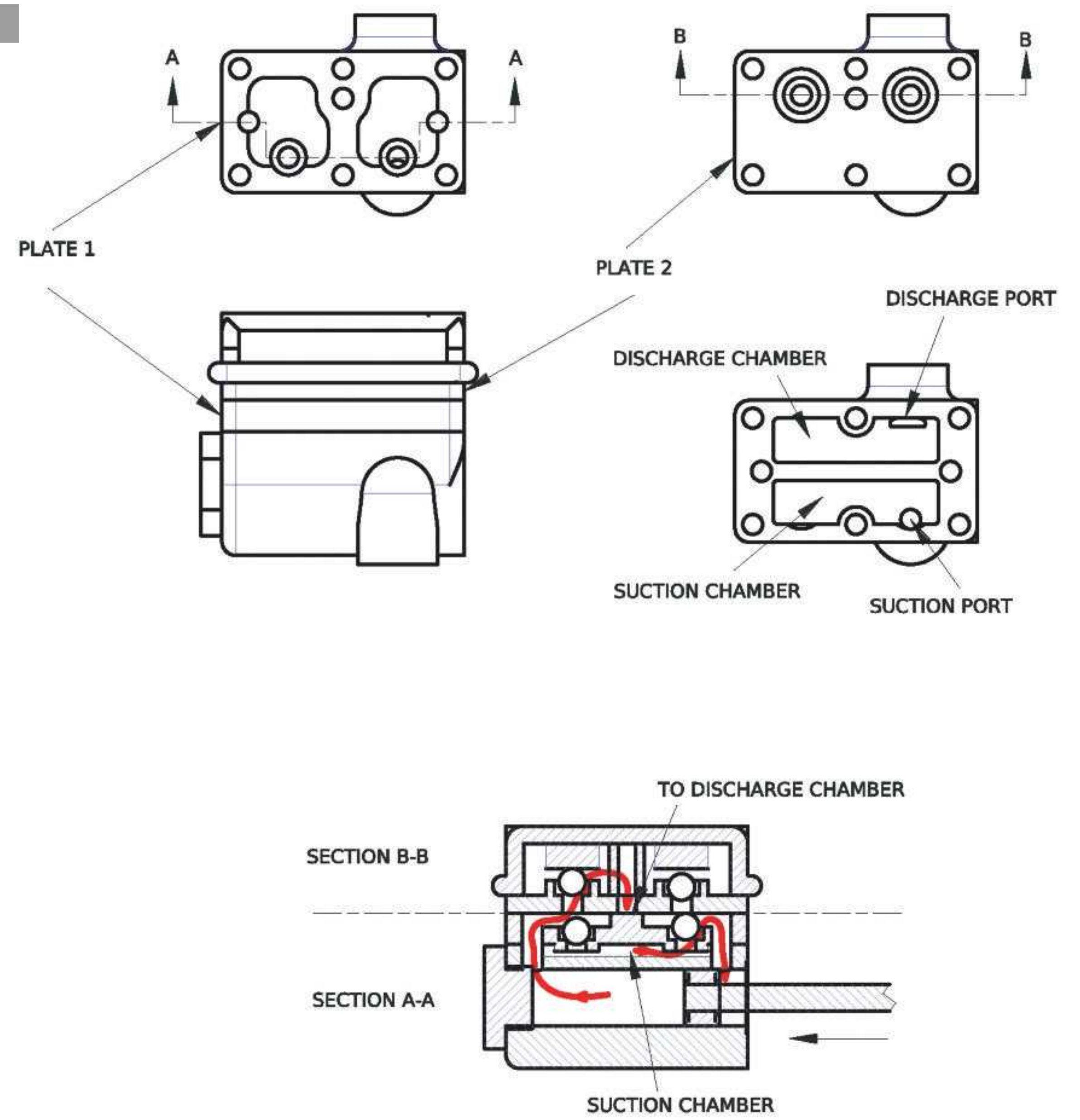
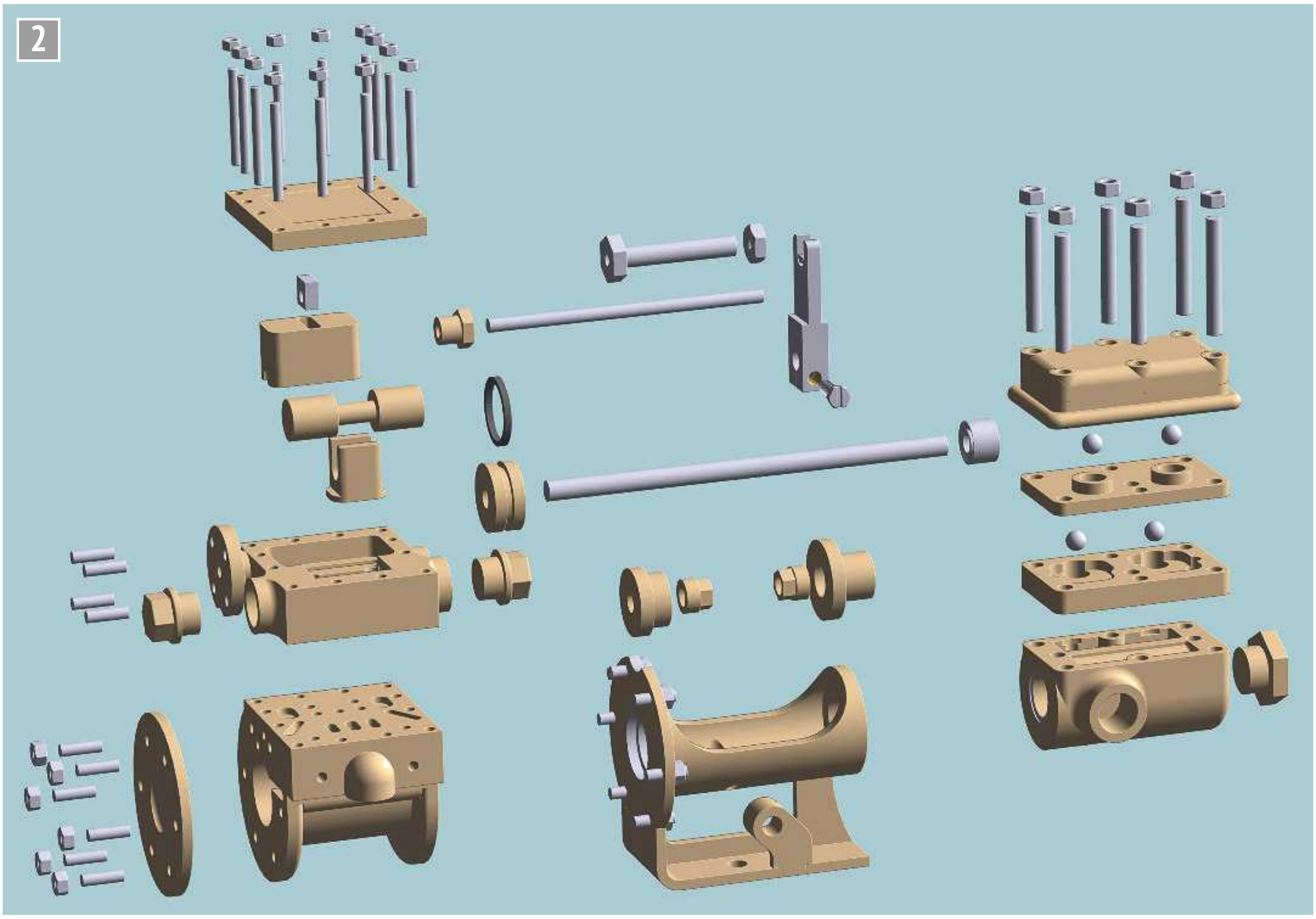

MAIN VALVE
SHUTTLE
SHUTTLE CAPS
SHUTTLE VALVE
"B" PORTS
SHUTTLE VALVE
"A" PORTS
EXHAUST
PORT
MAIN PISTON PORTS

Fig 2

Fig 3


A
A
B
B
PLATE 1
PLATE 2
DISCHARGE PORT
DISCHARGE CHAMBER
SUCTION CHAMBER
SUCTION PORT
TO DISCHARGE CHAMBER
SECTION B-B
SECTION A-A
SUCTION CHAMBER



An 'exploded' Weir pump.

travel. Steam can now flow from the pressurised valve chest - via the cut-out on the end of the valve, the slot in the cylinder valve face and the two slots in the valve - to both 'A' and 'B' ports at the right hand end of the shuttle. At the same time, the left-hand end of the shuttle can exhaust via the slot in the valve, BUT only via the 'A' port. More on this later.

So now let's look at what's happening to the shuttle. We have seen that the right hand 'A' and 'B' ports are now pressurised and the left hand 'B' port is open to exhaust, while the left hand 'A' port is closed. The shuttle is pushed to the left, getting faster as the right-hand end of the shuttle clears the right hand 'B' port, allowing more steam in. As the left-hand end of the shuttle covers the left hand 'B' port, there's no longer anywhere for the remaining steam at the end of the shuttle to go. As a result, this steam is compressed, acting as a buffer for the shuttle, avoiding too hard an impact on the cap. Since the main valve is connected to the shuttle, steam will now be admitted to the right-hand end of the piston. This is the position we see in **fig 2**.

When the shuttle has changed over, the piston will start to move to the left. There will be no movement of the valve rod until the tappet reaches the left-hand end of the actuator, at which point the reverse of the action described will occur. It will be apparent from this that the distance between the ends of the actuator (less the width of the tappet) will determine the piston travel. It will also be seen that pressure will be continue to be applied to the right-hand end of the shuttle until the piston reaches the other end of its travel. This is what gives the positive change-over we need.

In operation, as steam is turned on, the first steam in, hitting the cold pump, instantly condenses. As the ports are designed for steam, everything goes much slower when the system is full of water. In fact, the pump will work perfectly, albeit slowly, on pressurised water. As everything heats up, the steam stops condensing and the pump speeds up to normal running speed.

Now let's have a brief look at the water end. It's not the easiest thing to visualise but let's have a go...

Looking at the sectional drawing at the bottom of **fig 3**, the piston is moving to the left, creating a vacuum behind it. This draws water into the cylinder from the suction connection at the bottom of the pump, via the suction chamber and the right-hand ball valve in plate 1, while keeping the ball valve above it in plate 2 closed. At the same time, water is forced out of the left-hand end of the cylinder via the left-hand ball valve in plate 2, keeping the ball below in plate 1 closed. The water then travels from the cavity in the top cover, via the hole through both plates, into the discharge chamber and then out through the discharge connection. At the end of the stroke, the operation is reversed, so that the pump pumps on both strokes.

There. That was simple, wasn't it?!

A couple of refinements I made to the installation on my 4 inch Ruston are a heat exchanger, recovering some heat from the pump's exhaust, and an expansion chamber to damp down some of the shock from the pump strokes. While these do work, whether they are worth the extra work, I'm not sure.

Happy Pumping!

ME

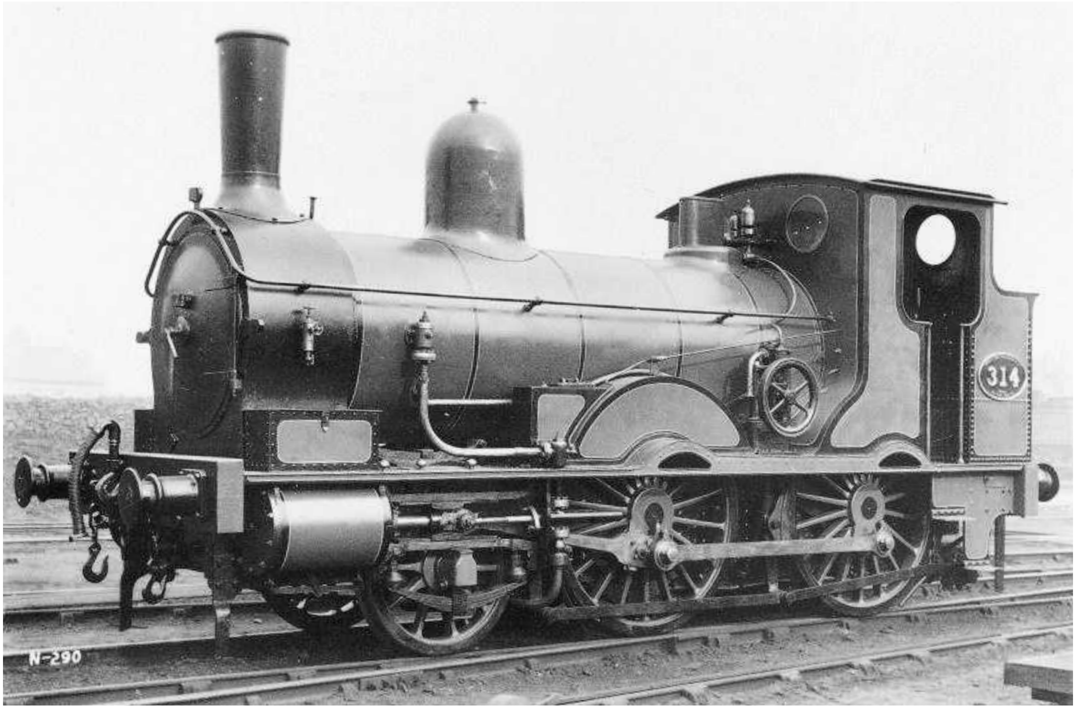
Wenford

PART 8

A 7¼ Inch Gauge 2-4-0 Beattie Well Tank

Hotspur catches up on the description of his Beattie well tank.

Continued from p.773
M.E. 4639, 22 May 2020



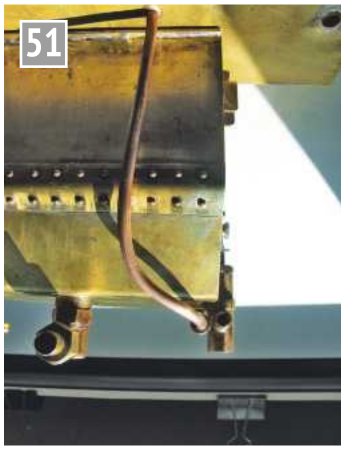
Tank and pipework installations

It is now time to begin to put the three water tanks into the chassis and make up the various pipework connections. There will be very nominal drawings provided for these operations and there will be photographs to show what is required.

Last time I showed the rear well tank assembled with its fittings and placed in the chassis but there was one more action to take. A tapped hole is needed in the bottom of the well tank to be marked out with a scriber from underneath, through the hole in the mounting bracket which is fixed behind the rear axle suspension spring casing, and the tank can then be removed for it to be drilled and tapped 4BA for a stainless steel screw or a stud fitted if preferred. A stud is preferable as this fixing will be used later to secure the bracket for the whistle. After this task the tank can be thoroughly washed out with warm water to ensure no remaining flux or loose metal particles are left inside. Placing a pipe nut over all the external threads also protects them from damage during handling and it will be found that adding just the nut and not the pipe nipple will fulfil this purpose and leave clearance for installation. Next, the bunker tank can be cleaned and fitted with the two O-rings for the connecting joint down to the well tank and lightly lubricated with a little petroleum jelly to ease any assembly stiffness. Now the

50

51



These are underside views of the two water control valve pipes that run up into the bunker tank. The left one can be permanently attached to the valve but the right hand one is bent and fitted into place, then undone at the valve outlet, to allow the well tank to be fitted down into the chassis.

CORRECTION

I am sorry to have to report an error in fig 4 of this series (p.385, *M.E.* 4633, 28 February). The dimension for the height of the well tank is given as 4⅞ inches whereas it should be 4⅜ inches. I believe the fix for this error is reasonably straightforward, basically involving sawing off the excess height and reattaching the top plate. I regret any inconvenience caused. *Ed.*

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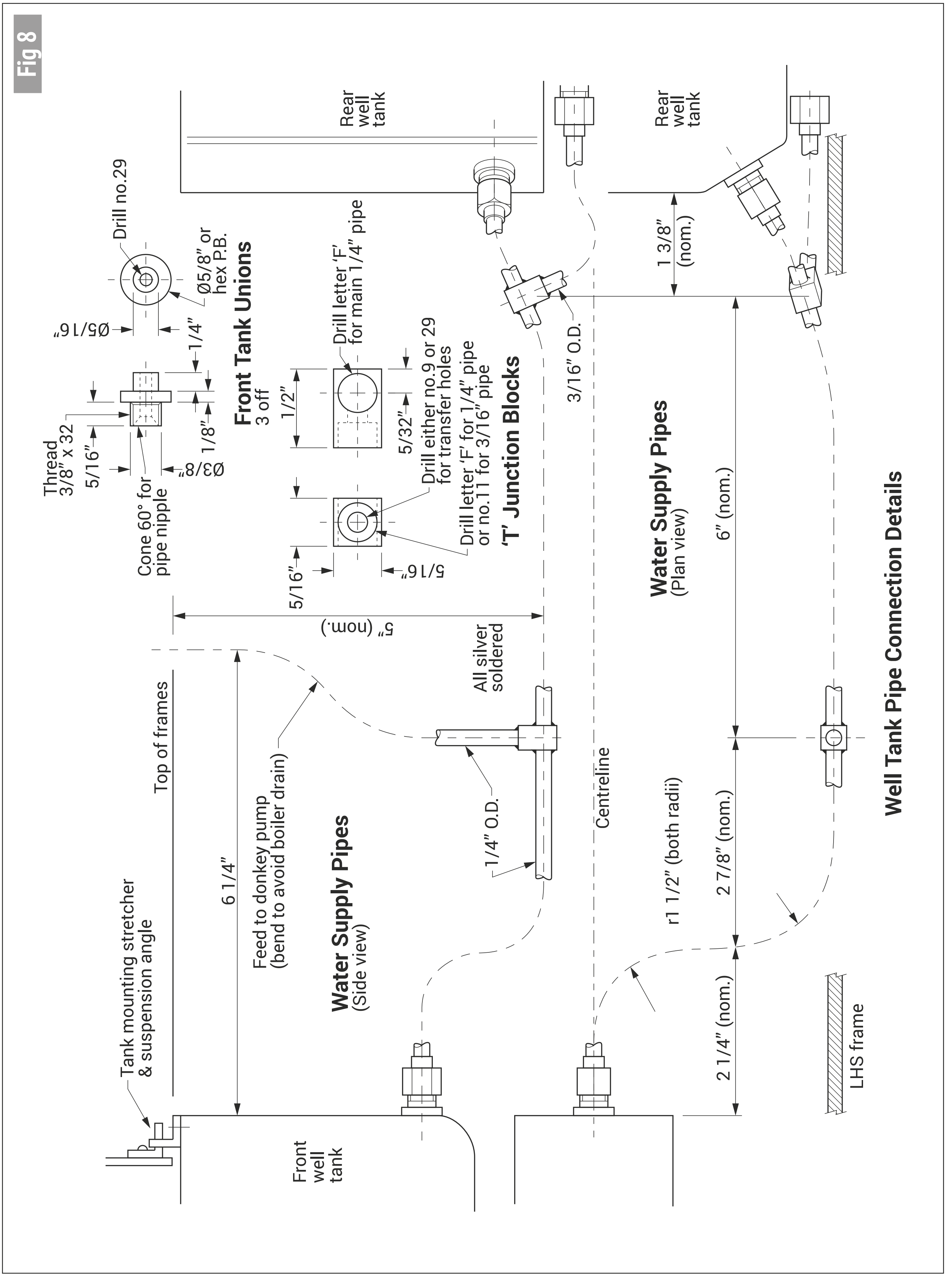


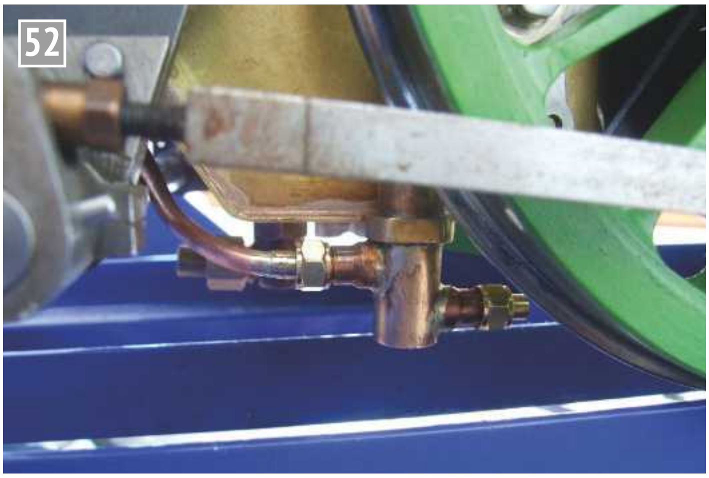
Fig 8
Rear well tank
Rear well tank
Drill no.29
Ø5/8" or hex P.B.
Front Tank Unions
3 off
Ø5/16"
1/4"
Thread 3/8" x 32
5/16"
1/8"
Ø3/8"
Cone 60° for pipe nipple
Drill letter 'F' for main 1/4" pipe
1/2"
5/32"
Drill either no.9 or 29 for transfer holes
Drill letter 'F' for 1/4" pipe or no.11 for 3/16" pipe
'T' Junction Blocks
5/16"
5/16"
3/16" O.D.
1 3/8" (nom.)
Water Supply Pipes
(Plan view)
6" (nom.)
5" (nom.)
All silver soldered
Top of frames
6 1/4"
Feed to donkey pump (bend to avoid boiler drain)
Water Supply Pipes
(Side view)
1/4" O.D.
Centreline
r1 1/2" (both radii)
2 7/8" (nom.)
2 1/4" (nom.)
Tank mounting stretcher & suspension angle
Front well tank
LHS frame
Well Tank Pipe Connection Details

two tanks have been brought together, the two crosshead pump water return pipes can be formed around the rear face of the well tank. The pipework was heated to soften the material, then formed and shortened where necessary and the pipe fittings added to connect with the control valves. I found that each pipe had to be shortened by just over 1 inch. **Photographs 50** and **51** show upside-down views of the assembled pipes. The left hand pipe was easy to route around underneath to its valve but, for assembly purposes, the right hand pipe was fitted then disconnected and moved to the left to be under the tank while the assembly was re-fitted to the chassis. This was to ensure the pipe did not foul the right hand chassis frame support pillar for the tank and it was then quite accessible, afterwards, to connect the fitting to the valve body from the outside of the tank underneath. **Photograph 52** shows a close-up view from the right side of the locomotive with the cab steps removed for access.

The next length of pipe to be added will be the main ¼ inch diameter water feed pipe that runs along the left side of the chassis to the front well tank; making a single length that is also easy to install is not tidy but can be done. For those making and installing the steam donkey pump it may just be possible to see from the picture of my prototype that there is a vertical water feed pipe into the pump base. This upright pipe is the same diameter as the main supply and my drawing (**fig 8**) shows the outline of the system with some stage positions dimensioned together with details of the fittings. The distance between the tanks is around 12½ inches and I have shown the individual lengths as nominal dimensions. For those that may not be familiar with the front tank, I am including **photo 53.** This view shows the rear end of it. The novel construction follows the shape of the prototype. Brass strip was used for the tank shape to represent the way the water volume was maximised and it is joined on the front and rear faces. Under the brass angle there is also a thicker piece of brass to take the tapped holes for the bracket. A large hole at the bottom requires the union for the standard ⅜ inch x 32 pipe fitting for the ¼ inch diameter pipe. Also seen in this view are two other holes; the one at the bottom towards the front is the hole for the water feed to the right hand crosshead pump and this is duplicated on the left side. Two more identical unions are needed for these side connections to the crosshead pumps. A further small hole towards the very front of the tank and near the top corner is the connection point for the vent pipe. This pipe allows the air to escape and water to gravity feed into the front tank, but it is quite a small diameter. It can usually be seen on early pictures of the prototype and it comes out around the boiler, behind the smokebox, and ends up near the chimney base but without any retaining clips, so it is a bit vulnerable to being damaged. Out of sight at the front of the tank is another bracket with a tapped hole for a securing bolt that comes up through the stretcher plate under the cylinders.

Removing the boiler from the chassis is quite simple as taking off the usual clamp plates alongside the firebox and the securing screws in the smokebox ring allows it to be moved back sufficiently to lift it out, but be careful, it's very heavy. Then the front well tank can be fitted into place from underneath (providing the front brake pivot rod has been taken out) and the angle bracket seen on the rear end has slots that fit over the supporting tabs on a small stretcher just ahead of the driving axle. Turn up a shouldered phosphor bronze pipe union connection with the ⅜ inch by 32 pipe thread size, as shown on my drawing, and soft solder it into the hole at the back of the tank. **Photograph 54** shows the rear union soldered to the tank. At the same, time turn up the other two and fit them for the pump feeds.

My model sits on a stout scissor frame and, for convenience, I can raise it up to over waist height which makes access quite easy. The front tank is another close fit between the sets of valve gear and manoeuvring it up from underneath means rotating the driving axle so the eccentric bosses are as far to the rear as possible to give clearance for the suspension bracket. **Photograph 55** shows a view from above. Now the connecting water pipe can be formed and fitted back to the rear well tank. At this point I realised that the filter adaptor for the rear well tank has to be added from underneath as it protrudes too far to allow the tank to be fitted with it *in situ*. The smokebox was removed and the lift lowered sufficiently for the chassis to be gently rolled off onto the conservatory floor, to be pivoted on its front guard irons and lifted to stand upright on its front buffers. This gave wonderful access for the pipe fitting task, so the water outlet connection was then fitted, with a smear of petroleum jelly around the O-ring and the six


52

Here the right hand pipe is fitted to the valve again once the tank is down in position.


53

This is the rear view of the forward well tank showing the holes for the ¼ inch pipe connections and the vent hole towards the front at the top. The bracket at the rear engages with the tabs on the light stretcher over the driving axle.


54

The first of the three identical ¼ inch pipe unions soft soldered to the rear of the front well tank. The other two are similarly fitted each side for the outlet feeds to the crosshead pumps.

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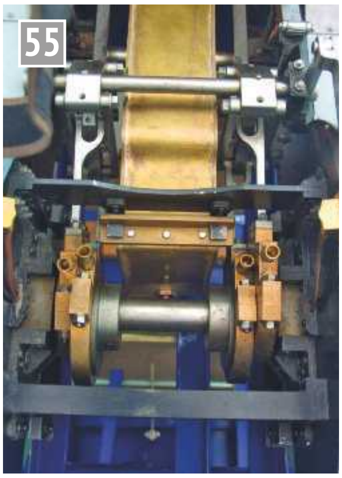


For those unfamiliar with the build of the model, this is the view from above the front well tank showing the way the suspension bracket engages with the tabs on the cross-stretcher but with minimal clearance between the valve gear. The water connection on the rear of the tank can just be seen.

off ¾ inch long 6BA stainless bolts could be added with a tube spanner.

Starting at the rear of the front tank, the pipe has a double bend to bring it across and down under the left hand chassis frame. To create the radius for the double bend I turned a groove in a scrap of round aluminium bar (**photo 56**). The tool was just under ¼ inch wide with a full radius and the cut was made to allow the tube to fit just under the outside diameter. The material had to be turned slowly with the lowest back gear on the lathe and with plenty of neat cutting oil. The inside diameter of my groove is 2¾ inches which gave the required pipe bend radius.

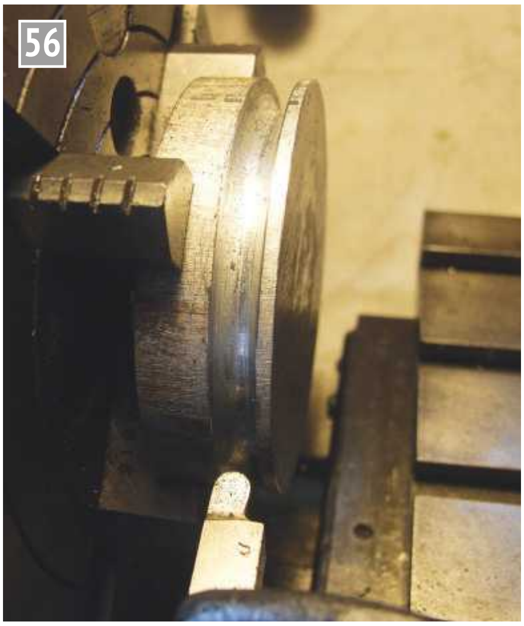
A length of pipe was cut off the coil at 25 inches long and the pipe straightened as far as possible, gently in the vice. Then a pipe nipple was silver soldered to the pipe and the material annealed for the first bend to be carried out. It was actually found necessary to form the bends at less than right angles as this gave some longitudinal movement when making the end connections. The pipe, as fitted to the tank, needs to pass under the spring and rear hanger for the driving axle and this allowed the position for the upright connection to be marked out. The two Tee-junction blocks were made from bronze bar a full 5/16 inch square and the holes for the larger pipe were drilled slightly over size to allow for some pipe distortion and adequate solder penetration. These blocks are shown on the main pipe in **photo 57**. The drill sizes for the inter-connecting holes in the junction blocks are the same as the bore sizes of the pipes to be supplied and these drills were used to drill into the pipe where marked. Fully clean off any burrs and It is then easy to locate a junction block over the hole and place the short, loose pipe section into it for the soldering operation. This main intersection was then carefully held to file away the corners and make the union respectable. The result is shown in **photo 58**.

For the connection to the rear tank the end section was annealed and the alignment achieved by bending the main pipe both upwards and then in towards the angled face for the screwed union already on the filter assembly. A short length of 3/16 inch pipe was then cut and added to the second pipe junction to be formed down and back, to suit the union with the injector water valve. To illustrate this, **photo 59** shows the arrangement of the two tanks and the new interconnecting pipes along the chassis where the alignment can be appreciated. The two rear connections were finalised first and tightened, then the pipe could be carefully ‘sprung’ into place to attach the front connection. It was decided that no additional pipe support brackets were necessary and it will be seen that the main pipe is almost under the left hand frame.

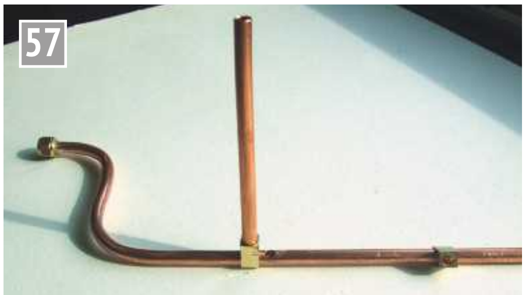
●To be continued.

NEXT TIME

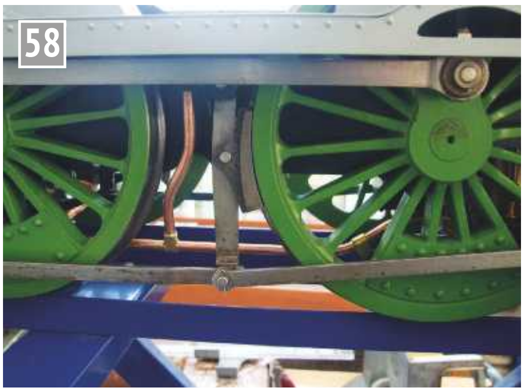
I will look at the pipe connections to and from the crosshead pumps.



Turning the pipe forming diameter on a scrap of aluminium bar with a radiused form tool. The tool was slightly less wide than the final pipe width to allow it to cut on each side of the groove in turn.



Preparing the main pipe run with the two junction blocks in place. The pipe for the feed up to the donkey pump is ready for soldering but the second one, for the feed to the injector water valve, will not be positioned until the upward bend at the rear has been made.



This view is taken from outside the chassis to show the fettled union block for the vertical feed to the donkey pump. The corners have been filed off the block to give the appearance of the more usual pipe junction.

This view from underneath the chassis shows the routing of the pipework described. It is important that the main pipe sits underneath the chassis frame so it does not hamper the fitting of the boiler as the ash pan is alongside the main pipe.

The Middleton Double Sided Beam Engine PART 10

Rodney Oldfield constructs another of Bob Middleton's stationary engines.

Continued from p.805
M.E. 4640, 5 June 2020

Engine frame crossheads

Get four pieces of ¼ inch thick x 6 inches long x 2½ inches wide bright drawn mild steel plate, face off one end square with the sides and, using this as a datum, mark out as accurately as possible the outline and the nine hole centres. Drill all the holes ⅛ inch on the plates and, using this as a jig, clamp onto another plate with mole grips, making sure that the base and sides line up, then drill through (**photo 71**). Do this to all four plates. Next drill out the two ⅜ inch holes.

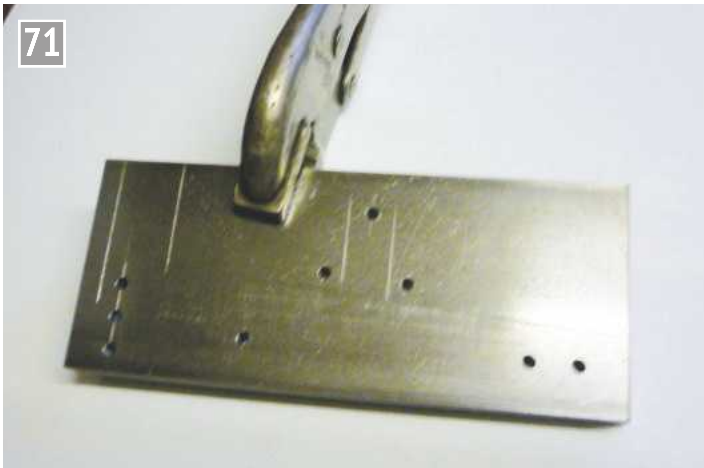
I used 11/32 inch for the slot holes (to leave myself some wriggle room for milling out the slot – **photo 72**) Next tap down flat in the miller and mill the slot out using a 5/16 inch milling cutter making sure the edge is 5/16 inch in from the outside edge of the plate and exactly ⅜ inch wide. Do this to all four plates.

Next, leaving the side and base square (this is to make it easier and more accurate when you are drilling the three holding down bolts onto the cylinder), cut and file out the profile (**photo 73**).

Using this profile place some ⅛ inch diameter bar through at least three holes to line up the frames and scribe a deep line around the cut-out shape. Then cut out the other three engine frame shapes. I used my trusty hack saw but use whatever means you find easiest and best.

Top cross brace

Machine this out of ½ inch diameter bar and waist it in to give it a bit of flair and shape. Machine the length to the exact width of the cylinder, then drill and tap both ends



Start by drilling the ⅛ inch holes.

Add the slot holes.

Machine the slot then cut the frame sides to shape.

Matching the frames up to the cylinder.

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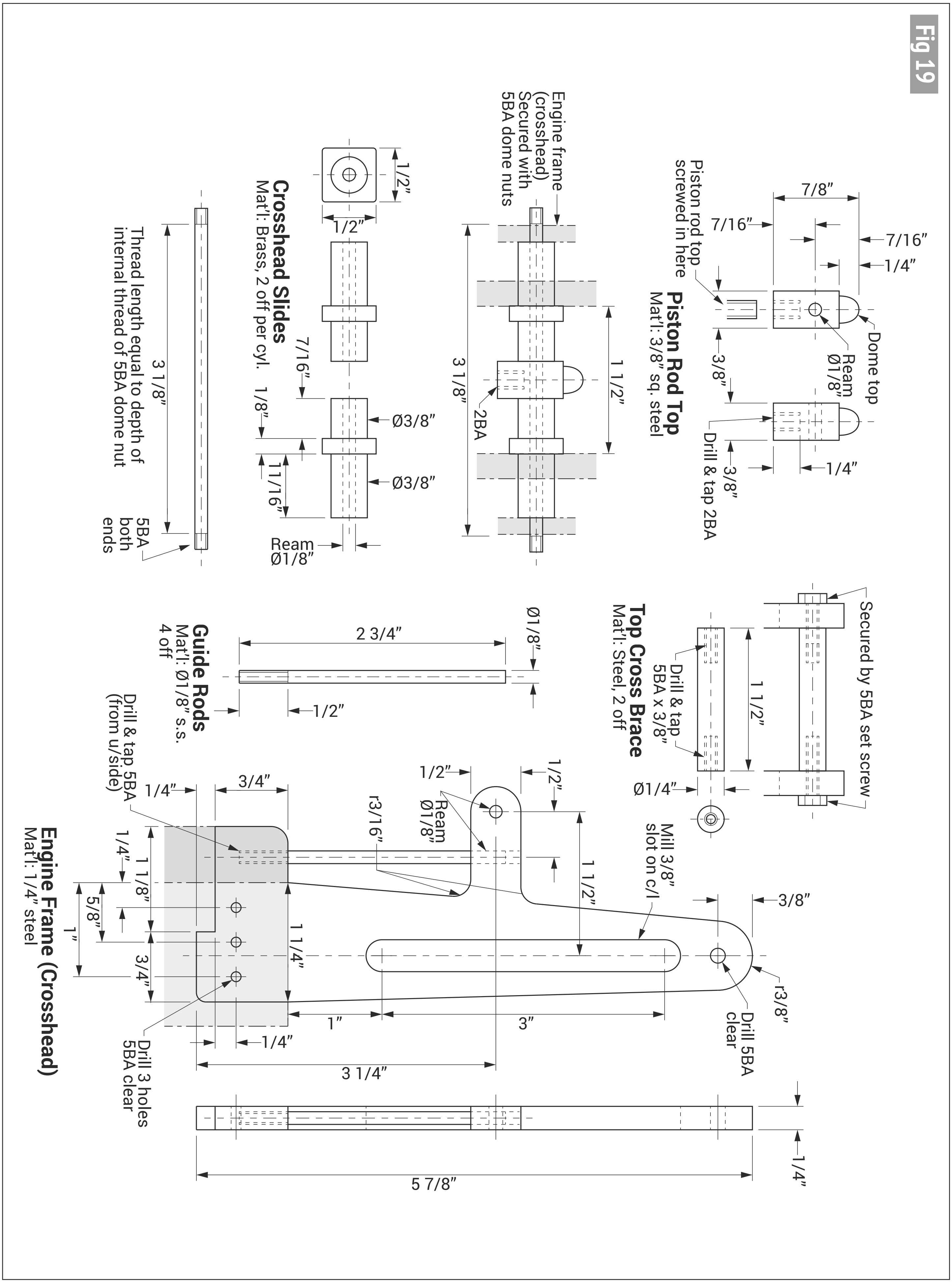
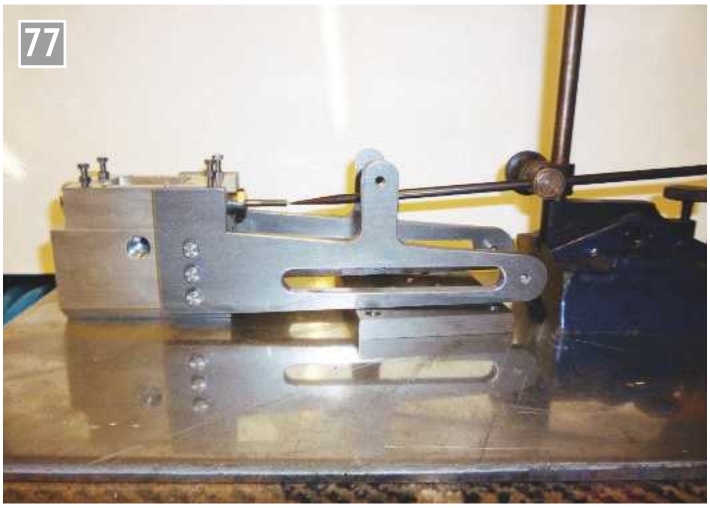

Piston Rod Top
Mat'l: 3/8" sq. steel
Piston rod top screwed in here
Dome top
Ream Ø1/8"
Drill & tap 2BA
7/8"
7/16"
7/16"
1/4"
3/8"
3/8"
1/4"
Engine frame (crosshead) Secured with 5BA dome nuts
2BA
3 1/8"
1 1/2"
Crosshead Slides
Mat'l: Brass, 2 off per cyl.
1/2"
1/2"
7/16"
1/8"
11/16"
Ø3/8"
Ø3/8"
Ream Ø1/8"
3 1/8"
Thread length equal to depth of internal thread of 5BA dome nut
5BA both ends
Top Cross Brace
Mat'l: Steel, 2 off
Secured by 5BA set screw
Drill & tap 5BA x 3/8"
1 1/2"
Ø1/4"
Guide Rods
Mat'l: Ø1/8" s.s.
4 off
2 3/4"
Ø1/8"
1/2"
Engine Frame (Crosshead)
Mat'l: 1/4" steel
Drill & tap 5BA (from u/side)
1/4"
3/4"
1/2"
1/2"
Ream Ø1/8"
r3/16"
1 1/2"
Mill 3/8" slot on c/l
3/8"
1 1/8"
1/4"
5/8"
1"
3/4"
1 1/4"
r3/8"
Drill 5BA clear
1"
3"
1/4"
3 1/4"
Drill 3 holes 5BA clear
5 7/8"
1/4"
Fig 19


Spotting through the fixing holes.


Milling all the frames to the same profile.


Transferring the valve rod height onto the frame top legs.

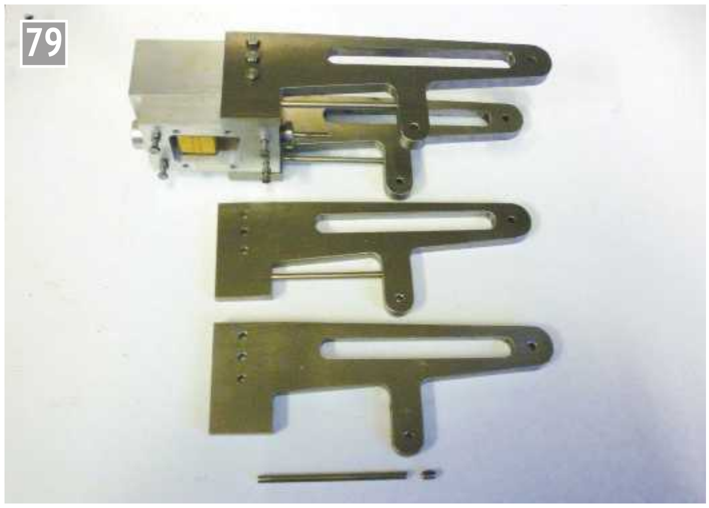

Drilling for the valve guide rods.

5BA. Screw the two frames together. Next, mark a line 1 inch down from the top of the cylinder. Place the cylinder down on a flat base plate, with some ¼ inch thick cut offs from the frame placed under the frame and down to the 1 inch scribed on the cylinder (**photo 74**). Clamp together, spot through, drill and tap though the three holes 5BA (**photo 75**). Split the plates and mark 'right' and 'left' on the bottom inside.

Next, with the original marked frame, machine or saw the angle side and round off the top. With all the plates located together with the pins, clamp into the milling vice and mill the other three frame angles and round off the tops (**photo 76**).

Fasten the two frame sides onto the cylinder and line them up with the ⅛ inch diameter bar. Assemble the cylinder and steam chest and lay the entire assembly on a flat base plate with the valve rod sticking out. Make sure the frames are level by packing them. With a scribing block find the centre of the steam chest slide valve rod end and scribe a line on the frame's top legs (**photo 77**) and in the middle of the ¼ inch frames. You will have spent so much time and effort on the frames – so take care with the lining and drilling of the ⅛ inch holes!

Next, nip the four frames square up in the miller, lining up using the ⅛ inch diameter holes (**photo 78**). Drill the ⅛ inch hole through the top for the guide rods. Now, insert some silver steel with a point turned on the end through the top hole and lightly tap down onto the bottom (this will give the long reach drill something to line up on). Using a ⅛ inch long series drill, drill into the bottom ¼ inch deep. Next, tap the top hole to the depth of the grub screw you are using (I used 6mm). This is not what the drawing shows but it worked for me and I think it is easier and neater – do your own thing (**photo 79**)


A complete set of frame crossheads.

NEXT TIME
We make the valve operating arms.

●To be continued.

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

Wellington trams, at the eponymous museum (photo courtesy of Russell Jenkins).

April 23rd, St George's Day, still no sight of land. We are running short of food, our last was obtained by Robin the cabin boy. One of our number wanted Starbucks but we decided to stick to cannibalism... The crew enjoyed Roger the other cabin boy, after which Cap'n Ahab shared his home-made *Pequod* wine and released the Great Wail, which he does every day at about this time. He's getting on a bit...

In this issue, scrounged materials, twist drills, blank pages, a still life, buffing buffers, 3D for the NHS, a tidy workshop and a cool Toyota Yaris.

Steam Whistle, April, from **Sheffield & District Society of Model Engineers**, has been the first, there will be others, I'm sure, to cease publication and the club track closed until we are allowed out of our sheds. Consequently, any club or member of such, bearing tidings of great import, can send them to me and they will appear here some weeks later. SW mentions Murray Wilson's resignation as Events Organiser after 15 years in post. He has found speakers on a great number of subjects to enrich members' life experiences. Thank you, Murray. Len Hicks wrote (In 1986) about his locomotive *Iris*, which began life on board *HMS Cowdrey,* beached off Algiers in 1942 after a heavy bombing attack. Immobile for three months under heavy repair, the skeleton crew found ways to occupy their time. Not one for embroidery or carpentry, Len took to metalwork from scrounged materials. The frames were cut from pipe, slit and beaten flat. Hornblocks were made from shell cases, driving wheels from non-identical castings, and eighth Whitworth screws from welding rods. Oh, and the springs were spares from Oerlikon AA guns. By the time he got back to the UK the assembled rolling chassis was running on air.

W. www.sheffieldmodel engineers.com

Blast Pipe, April, from **Hutt Valley & Maidstone Model Engineering Societies**, says that both clubs have also cancelled meetings and closed the club track. Editor Stephen Sandford will try to keep the newsletter going. Prompt payment of subscriptions will help the finances. Gavin McC is writing a club history and Bruce Edney showed his 'Potty' engine at the Open Weekend. A recent talk on the Wellington tram museum produced this picture (**photo 1**).

W. www.hvmes.com

Mike Collins, editor of **St Albans & District Model Engineering Society** *Newsletter*, April, meets the lockdown in a different way. A brief newsletter will be produced every fortnight to keep members up to date. To keep us going, the current newsletter is a biggie! Mike says that his request for more items from members has met with a great response, so keep up the good work. His comment is accompanied by a drawing of a journalist wearing a green eyeshade. Very few actually admit to having one, for some reason. I have, as I thought it was essential, otherwise how would I be recognised? A helpful suggestion referred to drilling hard steel with a tiny bit. (Don't buy a pack of 60 over 't internet! I did and some blunted while drilling their first hole and one cold-twisted by 180 degrees in use! The odd one survived to be used again – Geoff.) Michael Wood reviews his new bandsaw. Roy Verdon has some ideas for dealing with the coronavirus, not all of which would I wish to inflict on my wife, although secretly changing around the jigsaw box lids amused me. (I found out afterwards that Debs had swapped over several boxes of screws. Hmmm!) Rob Briancourt built a Harbour Pilot boat, whilst Mike Grossmith made a Gauge 1 LMS 'Jubilee' from a kit. The major snag concerned rivets. They are embossed into the plates in the kit but each one must be properly formed, by

an expensive little machine, which was out of stock. Fortunately, Model Engineers Laser did a little kit, which was entirely satisfactory. An item from *Road & Track*, 1968, reviewed the horse as one would a motor vehicle, which is rather good. I was amused that the April Fool spoof got me initially - well done to the anonymous author. The mystery object was obvious to me, being a tool of great utility in my previous occupation. Finally, I recommend a poem by Joe Seth, called 'Entrapment', the gist of which (Cont'd over).
W. www.stalbansmes.com

On Track, April, from **Richmond Hill Live Steamers**, has developed a virtual track visit for those missing their fix of steam and railways. Coincidentally, air freshener company, Glade, have produced a steam and coal smoke aroma to further help us enjoy, vicariously, our enforced incarceration. A restored 'Rotary OY' snowplough was fired up on the Cumbres & Toltec Railway, see YouTube, 'Rotary OY', also these... 'Chama Steam V', and www.youtube.com/watch?v=Moh2l7udjio&feature=youtu.be for some really hazardous silent film clips.
W. www.richmond-hill-live-steamers.tripod.com

The Journal, April, from **The Society of Model & Experimental Engineers**, opens with a fine photo of *HMS Caroline*, a light cruiser built in 1914, now a floating museum in Belfast. Editor Alan Wragg intends to keep the *Journal* going but says there may be a lack of up to date photographs. John Clarke has made a model of the *Seven Stones* lightship siren and writes up his discoveries in preparing it. Unfortunately, he was unable to reproduce the reed mechanism creating the sound and reverted to electronic methods. Neil Read separated a milling chuck from the amorous embrace of its spindle with tapered wedges when the approved drawbar method was not possible. An interesting item concerning proposed new regulations for the use of motor vehicles provides fool* for thought.
W. www.sm-ee.co.uk

Ryedale Society of Model Engineers' March *Newsletter* reveals new vistas as some trees have been trimmed and the never-ending tasks of track being replaced, repaired or fettled. Editor Bill Putman was told that a newspaper in Oz is including blank pages for the convenience of readers. He says that if it is blank sheets you need he can supply any number in the newsletter! Speaking of er, (ahem) Bill printed a picture of a wheelbarrow of ordure, to illustrate his spare time activities, i.e. not at Gilling. No flies on him, (yet).
W. www.rsme.org.uk

The Prospectus, March, from **Reading Society of Model Engineers**, opens with a 'Still Life' from David Scott. A beautifully made locomotive chimney, with a sprig of mint(?) in it. Chairman, John Billard says that the club will continue to publish *The Prospectus* and looks to the membership to supply copy. Subscriptions are placed in abeyance and will be charged *pro rata* when the future becomes clearer. David and Lily Scott tell the humorously expressed tale of how the subject of the opening picture came to pass. Analytics investigates photographs taken by the

Make your own historic poster.

editor, John Billard, in another hat. In this case, a Park Royal DMU in 1963 and a Derby four car DMU at North Harrow, and the history of each type is detailed. Peter Jennings tells us how to produce clean and tidy buffers – it's not very high tech, just steel wool, white spirit, scouring pads and elbow grease! Finally, to 'quarter' them, using emery paper to produce a four-quadrant effect. (Yes, I know it's a tautology, but I couldn't think of a better term – Geoff.)
W. www.prospecrpark railway.co.uk

The Link, April, from **Ottawa Valley Live Steamers & Model Engineers**, relates Michael Ross's attempt at making metric gears for an Imperial lathe and secretary David Hayman updates us on the progress of his 7¼ inch gauge 0-6-0 switcher.
W. www.ovlsme.x10host.com

Linda Nicholls sends *Tyneside SMEE News,* spring, from **Tyneside Society of Model & Experimental Engineers** and says, in essence, 'think positive' and to carry on with our projects. 'Keep Calm and Build Something'. I therefore built this, from the *Keep-Calm-O-Matic*, www.keepcalms.com (**photo 2**). Essential NHS staff number several in the membership, including a radiologist, a paramedic and a pharmacist, plus others in less obvious roles. Junior Engineer Sam Yeeles has taken up photographing railways, see his Flickr site **sam yeeles photography**. He's also posted some videos on Youtube – look for **Sam6200 5** - several other websites

Berkshire' 2-8-4 locomotives at Riverside Live Steamers (photo courtesy of Jim Nolan).

More 'Berkshires' at Riverside (photo courtesy of Jim Nolan).

are recommended, including 'Cab Rides' on YouTube, plus www.gadgetbuilder.com.
Jim Nolan likes 'Berkshire' locomotives and is modelling a Nickel Plate Road example. He visited America and saw these models at Riverside Live Steamers Club (Los Angeles) (**photos 3** and **4**). He says US models are usually not fully documented and built mostly to ⅛ scale.
W. www.tsmee.co.uk

Norwich & District Society of Model Engineers, sends their *e-Bulletin* for February-April, in which Bob Webber describes the creation of his 'Romulus'. Something different is a LMS poster of a Sheffield steelworks by Norman Atkinson, RA, who also invented the 'dazzle' paint scheme for WWI shipping as a defence against submarine attack. Spotted on YouTube was this documentary on swordmaking www.youtube.com/watch?v=fCPN1Oslyw0. The pen is said to be mightier than the sword (and easier to write with – Geoff). Pete King writes on his locomotive *St Ella* - his first attempt at model engineering, using an elderly Myford, some hand tools and a basic bench drill. After taking part in IMLEC 2005, and many years' public running, she was retired. Ten years on, Pete has restored her and she is ready for a new career as *Teal*. Another graphic artist created Mr. Therm, for the Gas Light & Coke Company in 1931, who remained in use until the advent of North Sea Gas in the 1970s. He is not dead but sleepeth and moonlighting as a central heating company in Scunthorpe.
W. www.mrtherm.co.uk

Centurion Smokebox, April, from **Centurion Society of Model Engineers**, contains a fine example of what happens when a budding model engineer (Johan Maritz) is let loose for the first time with a laser cutter. (A Humvee !)
W. www.centuriontrains.com

Richard Lunn, editor of *The Bristol Model Engineer,* published by **Bristol Society of Model and Experimental Engineers,** has produced a 'Lockdown Special', digital copies only, compiled mainly from postings to a WhatsApp online group set up for members to keep in contact for the duration. An online 'on the table' event showed us Andy Bowdidge's 3D printed steam locomotive pan head. Although a photograph appears, I am no wiser and Mr. Google was no help. What is a 'pan head'? Bernard North made a press tool, which took him all day to make and 10 minutes to use; Bob Lilley showed his bogies for new locomotive, *Brunel*; David Ward's 4F has served him faithfully for 20 years and he is now building a smaller, lighter *Maisie;* Donald Harrison is building a 'Poppin' flame gulper engine and completely failed to drill an 8mm hole in a component. Thought to be brass, it was unmachineable. John Beddis, besides restoring motorcycles, also makes r/c aircraft. His latest is a *Curare*, a classic aerobatic machine, with 10cc engine, retractable undercart and an endurance of 15 minutes. There were other models equally good, except that Neil Dare's workshop was thought to be 'too tidy'. He made an electric blower for firing up steam locomotives, using the fan from a Toyota Yaris, but claims that his wife has reported the failure of her car heater... Several members are making PPE equipment for the NHS, using their 3D printers. Michael Goom is running four such printers for 16 hours per day, whilst Roger Davis made face shields for his daughter's surgery and found there is now a nationwide shortage of 250 micron acrylic sheet. Rob Spear made this authentic 1:12 scale lean-to from a baked bean can. Good innit (**photo 5**)? Rob also says that Sainsbury's compact sweet corn tins are just right for making the oil drums found in most workshops.
W. www.bristolmodelengineers.co.uk

The Whistle, April/May/June from **British Columbia Society of Model Engineers,** is another that intends to produce a monthly e-mail digital copy yclept *The Milepost,* for members delectation and delight. Chuck Laws has provided a picture of a locomotive which he can't identify, supposedly a Fowler 0-6-0, and currently in the Vancouver area. To me it looks like a GWR design but it is lettered LMS. Chuck also produced an item on lubricant terminology, which I found most interesting - in fact I have copied it and placed it in my workshop.
W. www.bcsme.org

*Yes, Fool!

And finally, how many sound engineers does it take to change a light bulb? 1, 2, 3... 1, 2, 3...

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Rob Speare's lean-to shed at Bristol (photo courtesy of Rob Speare).

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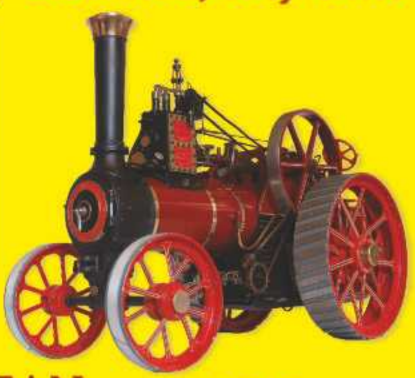

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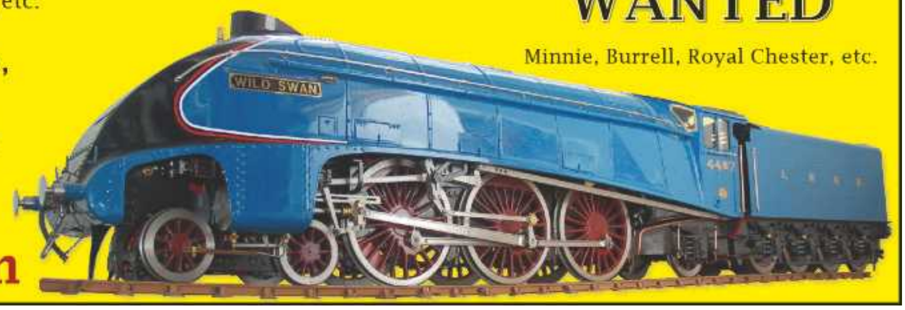


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