THE ORIGINAL MAGAZINE FOR MODEL ENGINEERS

Vol. 228 No. 4686 • 11 - 24 March 2022

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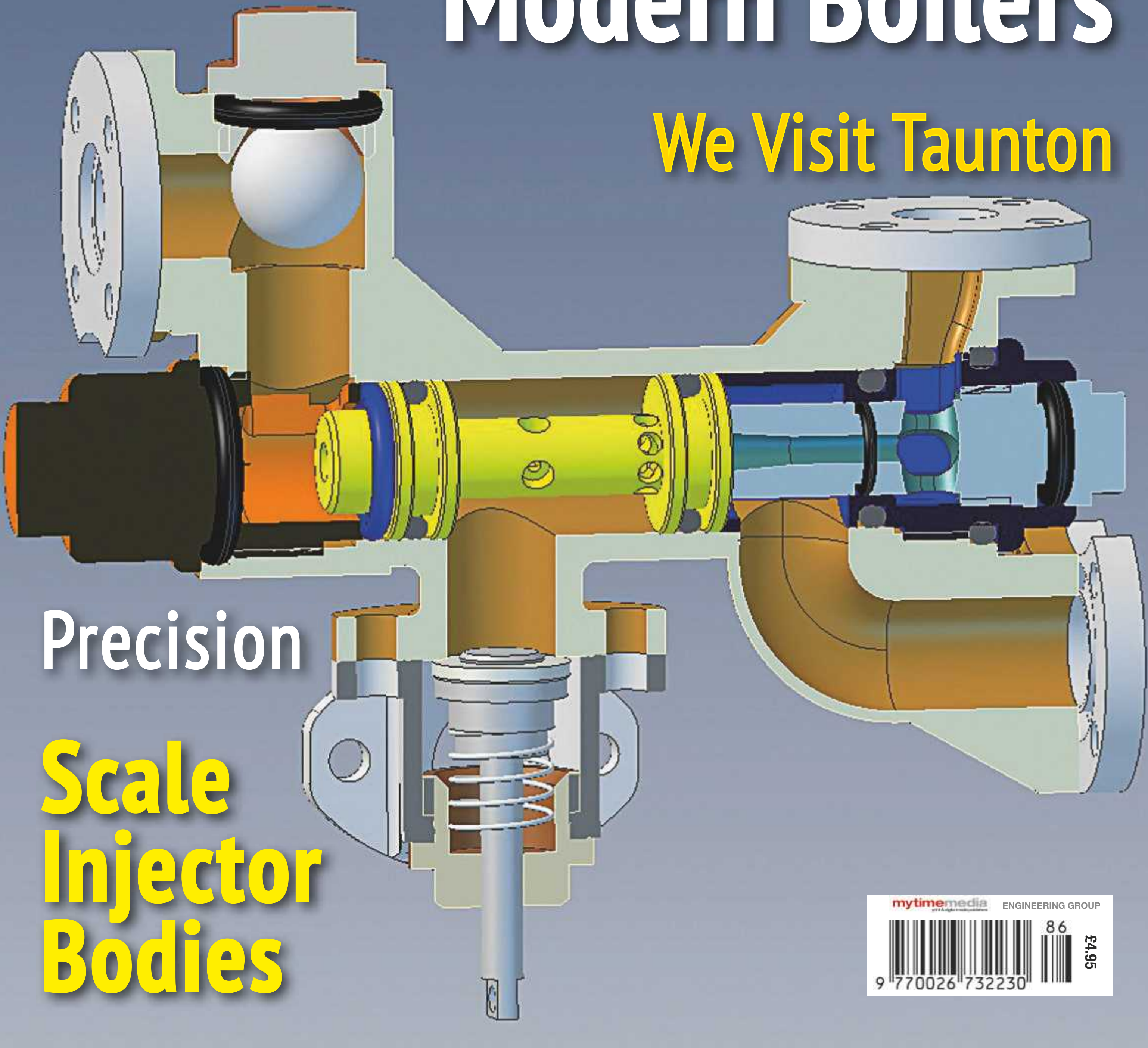
Modern Boilers

We Visit Taunton



Precision

Scale Injector Bodies

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MODEL ENGINEER

Published by **MyTimeMedia Ltd**.
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Model Engineer, ISSN 0026 - 7325 (USPS 24828) is published fortnightly by MyTime Media Ltd, Suite 25S, Eden House, Enterprise Way, Edenbridge, Kent, TN8 6HF, UK. The US annual subscription price is 136USD. Airfreight and mailing in the USA by agent named World Container Inc, 150-15, 183rd Street, Jamaica, NY 11413, USA. Periodicals postage paid at Brooklyn, NY 11256. US Postmaster: Send address changes to Model Engineer, World Container Inc, 150-15, 183rd Street, Jamaica, NY 11413, USA. Subscription records are maintained at DSB.net Ltd, 3 Queensbridge, The Lakes, Northampton, NN4 5DT, UK. Air Business Ltd is acting as our mailing agent.

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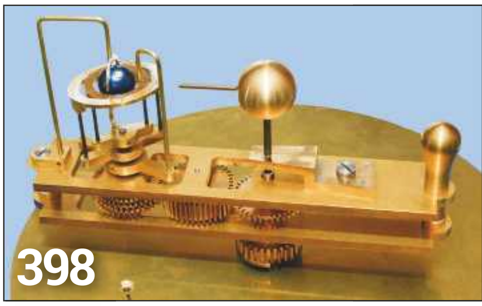
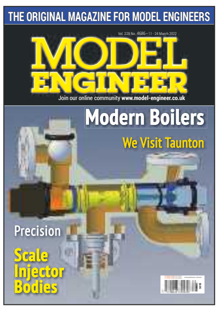


IN THIS ISSUE

Vol. 228 No. 4686 11 - 24 March 2022



ON THE COVER...

3D CAD model of an experimental injector with a scale body by Roger Froud (photo: Roger Froud).

SMOKE RINGS

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IMLEC 2022

Bryan Finch, secretary of the Guildford Model Engineering Society writes:

'The International Model Locomotive Efficiency Competition, IMLEC, is an annual event for 5 and 3½ inch gauge steam locomotives held at model engineering societies up and down the country. It is sponsored by the *Model Engineer* magazine, was first run in 1969 and is open to any locomotive owner to enter. The basic objective is to go as far as possible in about 30 minutes with the maximum load of passengers that the driver chooses to take, whilst using the minimum amount of coal. Efficiency is calculated from the work done measured with a dynamometer vehicle and the amount of coal used. It is a test of both the locomotive and the driver's skill. For practical reasons of available time, the maximum number of entrants is usually around 25. New entrants are always welcome.

'Guildford Model Engineering Society is pleased to announce that the 2022 IMLEC will be held at its site in Stoke Park, Guildford, over the weekend of Friday 22nd to Sunday 24th July. We would like to take the opportunity of inviting applications to take part in the competition and we will also welcome interested folk to come along to watch. We anticipate starting the competition on Friday afternoon if necessary, and we'll have the final run early on Sunday afternoon giving time for those travelling long distances to be homeward bound at a sensible time.

'The competition will be run on the Society's dual gauged 3½/5 inch raised track which comprises some 1405ft of flat-bottomed steel rail. The track has a variation of about 5ft in elevation from the lowest to the highest points and gradients range from 1 in 72 to 1 in 201. Curves are typically 60ft to 70ft in radius with a short length of 50ft radius and the track incorporates anti-tip rails.

'For friends and relatives who might wish to spend a few moments of the weekend away from the competition, Guildford has many tourist attractions – historic buildings, the castle grounds and its gardens, the 'cobbled' High Street (actually, they're setts), a good range of shops, cafes and restaurants, riverside walks, and the 20th Century brick-built cathedral on Stag Hill. The town centre is about 20 minutes' walk away or there are bus stops for both directions just outside the GMES site. There are also ornamental gardens and an open-air Lido at the other end of Stoke Park.

'There are a good number of hotels and guest houses in the Guildford area and it is anticipated that we will be able to offer a limited number of camping spaces on the adjacent Challengers Field for the weekend, on a first come first served basis.

'The closing date for entries is Friday 27th May 2022. Applications can be submitted at any time and will be acknowledged. A place in the competition will be confirmed subject to the receipt of the following documents before the closing date:

* Biographical details of the locomotive being entered – needs to be between 80 and 100 words.
* Current photograph of the locomotive.
* Copy of the loco's boiler certificate that will be valid at the time of the competition.
* Evidence of adequate public liability insurance for the driver valid at the time of the competition.

'Please contact GMES via imlec2022@gmes.org.uk to request further details including the competition rules, track diagram, and an entry form.'

SMEE Meets Eunice

During Storm Eunice a tree belonging to Lambeth Council fell in front of SMEE's base Marshall House, completely blocking steps, damaging railings and hitting the distinctive lamps outside.

Thanks to hard work by members Jaz Loyal, Stephen Bondfield and others the steps were cleared ready for the first of SMEE's training courses on Saturday 19th February. The first of SMEE's classes to run for two years, the start of the three-day Basic Model Engineering training was considered a great success despite problems caused by the storm.

Chairman Alan Wragg comments: 'SMEE is resilient if nothing else, we have survived two World Wars and two pandemics, so a gentle breeze like Eunice won't stop us. We're now looking for members with wood burning stoves to take the wood!'

Adventures with Injectors

Roger Froud studies the theory and practice of making injectors.

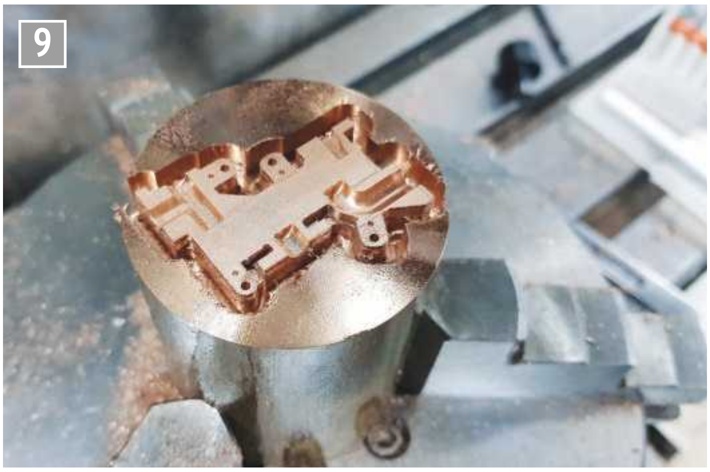
Continued from p.344
M.E. 4685, 25 February 2022

Making the scale body

This is clearly best made as a casting, but I want to make as much of the locomotive as possible myself, rather than rely on others. I have a decent CNC mill, so that's what I decided to use.

As previously mentioned, you can't machine all the internal cavities from the outside, so this means it has to be made from two parts. The 3D model is easily sectioned so that CAM outputs can be created for one half at a time. Since it's actually symmetrical I just mirrored the X coordinates for the other half.

Photograph 9 shows the first step which involves cutting deeply all the way around the shape so it can be parted off in the lathe later to release the part. The area around the back of the overflow flange is particularly tight but it's just possible to get in there with a 1mm cutter. It's easier to do that from this side than when doing the other, so I cleared most of that out here. Some of the internal passageways can be machined from the ends and I've removed some of the material so I can get in there with a clock for an alignment sanity check when I machine those later.



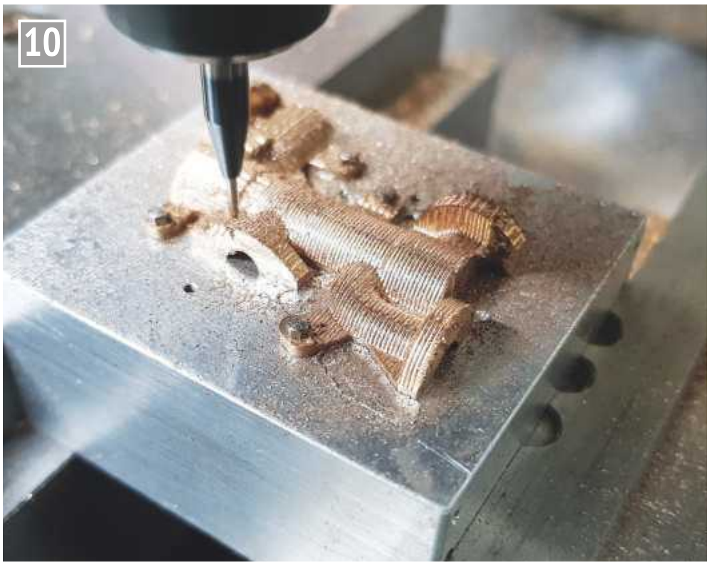
Step one.

You'll notice that I've added four lugs to the outside of the body. Each of those has two holes in them; a 1.4mm one for M1.4 fixture screws and a 0.8mm hole in each for four rivets we'll need later.

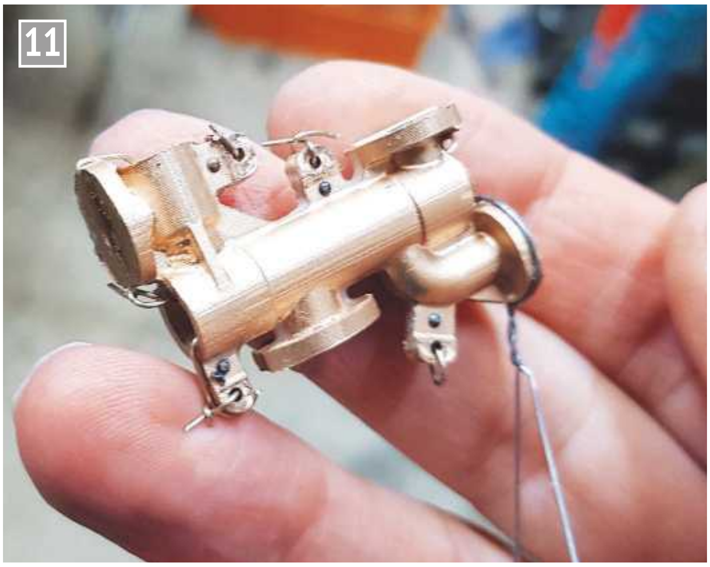
The hole shape was finished with a 1mm ball nosed cutter. Total machining time for this step was around three hours. It could be done a lot quicker but I like to take things gently and be able to leave the machine to get on with it unattended.

The aluminium fixture has M1.4 tapped holes for the lugs for both hands. The bolt positions are spot faced individually while the job is being held by the remaining three. I need to get these low down and out of the way to be able to machine the rest of it.

The bulk of the material was removed with a 2mm conventional cutter in 0.25mm steps so as to leave a fine enough set of steps to be cleaned up with a 1mm ball nosed cutter (**photo 10**). The ball nose operation is actually three steps, each getting finer and leaving less stock until the final pass traces over the profile with 50micron (2 thou) overlap. This side takes about five hours of gentle machining. You could probably do it in less than half that if you really needed to.



Step two.



Step three.

Step four.

Step five.

Completed scale body.

Step 3 is to silver solder the two halves together (**photo 11**). Four steel rivets hold the two halves firmly together and I've also added a wire around the end which wanted to gape open for some reason. The inside channels were painted with Tippex to stop silver solder from running over them.

I'd put some twists of fine silver solder wire through the bolt holes, the intention being that there will be enough of it to wick into the face.

The silver soldered assembly was trimmed and a 3D printed set of clam shells were made to hold it firmly for machining (**photo 12**). I've left the lugs in place in case it's later found to have a leak and needs re-heating and further silver soldering.

The 3D printed fixture is plenty strong enough to hold the part for machining (**photo 13**). This has to be done gently anyway. The fixture shares the same coordinate system as the part and I've arranged the size so that I can use the edge finder on both sides to set the machine to the middle in both axes.

Okay, it's a lot of work to make it this way, but it's very satisfying (**photo 14**).

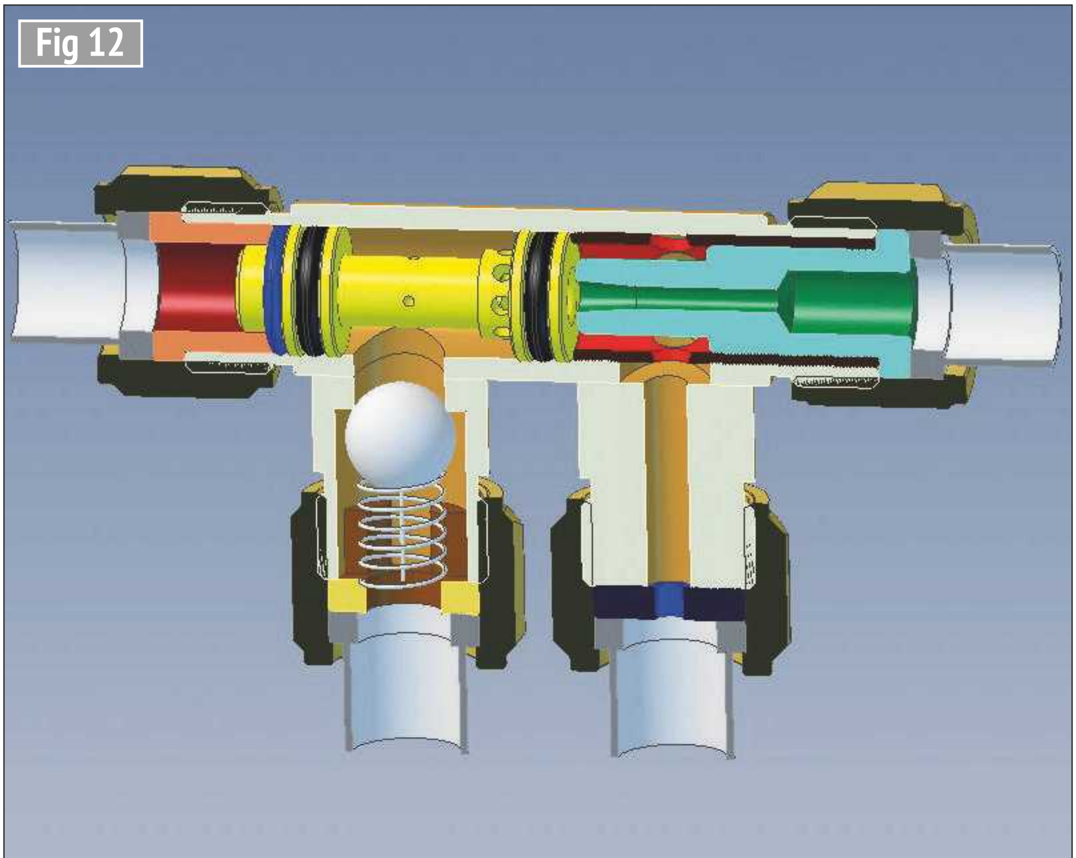


Fig 12

Standard 16 fl oz injector with disc regulation.

Summing up

It's taken months of effort to design and make an electric test boiler, machine the development and prototype injectors as well as the dozens of experiments. However, it's been well worth the effort because I understand injectors much better than I would have otherwise. It's also demonstrated that there are still worthwhile developments to be made, especially in terms of ease of construction and discovering the truth behind that pesky humpback valve which is such a nuisance when designing for scale bodies.

Hopefully this will encourage others to make their own injectors using this type of design. The benefits of the simplified construction aren't

The benefits of the simplified construction aren't limited to scale injectors. This arrangement is equally suited to non-scale bodies.

limited to scale injectors. This arrangement is equally suited to non-scale bodies.

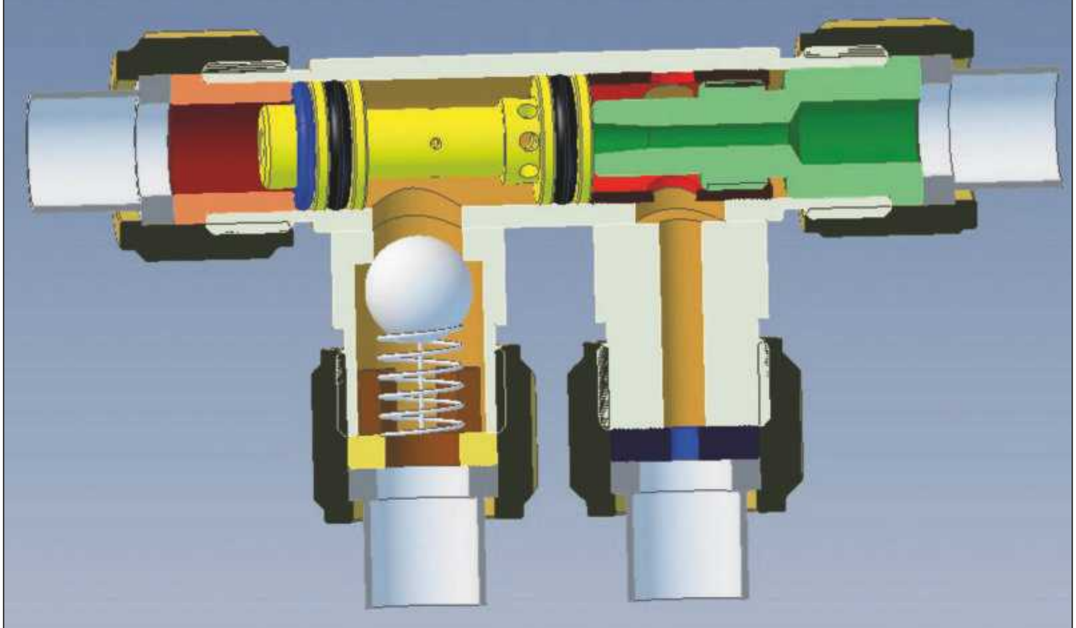
This isn't the first design to use a valve for the delivery overflow; those already exist, albeit by using two separate valves for the two overflows. The purpose of the delivery overflow is to prevent air being sucked into the boiler, something that's very bad news for steel boilers, causing corrosion. However, injecting air is not ideal for any injector from the point of view of efficiency. Air in the flow makes it more elastic and we know that this will cause the injector to stall prematurely in edge cases. Delivery overflow valves are not deemed to be essential for copper boilers and the loss of performance isn't catastrophic, so why go to the extra complexity of a second valve? This completely misses the point that you only need one valve anyway, something that seems to have been overlooked ... until now.

Future development

I'm of the opinion that there are still significant improvements to be made to ease the manufacture of injectors. To that end I've designed a couple of experimental injectors that are drop in replacements for existing non-scale designs.

It was pointed out to me that injectors of this size work perfectly well with the same 9 degree taper angle throughout and my final experiments verified this. In my opinion this is hugely important in helping people to make their own injectors. A 9 degree reamer is more rigid and hence easier to make than ones with a shallower angle. It not only reduced the amount of work but also means you only have to set up one reamer with a collar to a known position.

Fig 13



Standard 16 fl oz injector with adjustable sleeve.

The first of these (**fig 12**) uses a fixed length sleeve to allow the regulation gap to be roughly set to somewhere in the working range. The disc on the water inlet has a regulation hole that can be changed for a fine adjustment. You can, of course, adjust the length of the sleeve if you prefer.

The design shares all the characteristics of the previously described scale injectors. The outlet end sleeve is made over length, such that the O-ring is compressed by about 0.2mm. This keeps it all held together without excessive force.

Here's an alternative arrangement where the sleeve is screwed onto the nose of the steam cone (**fig 13**). This allows the regulation gap to be adjusted. Once the required characteristics have been achieved, the sleeve can be locked in place with a drop of sealant, or a line could be scribed to record the angular position. The gap should be set with the feed water at the highest temperature you need it to work with at the maximum boiler pressure. Higher water temperature will require a larger gap, which will then impact on how quickly the injector will stop feeding as the pressure drops.

I've shown this design with a regulating disc on the input but that can be discarded.

Conclusion

Putting all of these ideas together, the one piece cone, a shared single overflow and a method of adjusting the end regulation, gives the designer much more flexibility as to what body style can be used. The internal valve poses a significant hurdle for making a scale injector of the 8X or 10X type.

The one piece cone is obviously the most difficult part to make, but less so than making three separate ones and fitting them precisely. In my opinion, the level of difficulty is well within the reach of most model engineers.

ME

A 7¼ Inch Gauge Driving Truck PART 2

Tim Coles constructs a driving truck built for two, in true prototypical style.

Continued from p.341
M.E. 4685, 25 February 2022

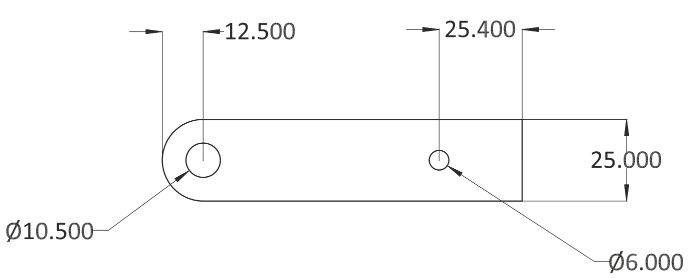
The chassis structure

I originally planned to use steel angle to fabricate the chassis, much like Doug Hewson's design, but Tom Hubble was keen to maintain a prototypical structure and he was able to supply two lengths of beautifully folded ⅛ inch thick mild steel channel for the main longerons. I'm sure 'Little Western' (www.littlewestern.com) would be happy to supply others with this folded steel channel. The scale length for a 50-ton brick wagon would be 53 inches but that would not fit easily into our van and so the finished version is 48 inches over the buffer beams.

I am a big fan of water cutting and so I got the buffer beams and bogie bolsters, along with a number of brake gear components, and the body strapping, from water cutting specialist Sciss Ltd (usual disclaimer) in Staplehurst. I just sent them an AutoCAD dxf file for each component and a few days later a heavy parcel arrived on the doorstep. A quick whizz round with an emery block to take off the very sharp edges,

Fig 4

6-Off Mild Steel 1/4" Thick



Footboard hanger.

A simple jig was used to drill the four 6 mm holes (for M6 bolts) in the ends of the channel longerons. The other end of the 48 inch long channel was resting on the table of the nearby milling machine, and the drilling machine table adjusted to bring the job level.

Drilling the buffer beam for the buffers. Gloves are a necessary precaution for a job like this. Note that the bracket has already been bolted to the beam. In this case the blank bracket was clamped to the beam which had accurately placed water cut holes, and the holes in the bracket were 'spotted through'. After this, the holes in the beam were countersunk for Allen screws, so that the buffer stocks could sit on a flat face.

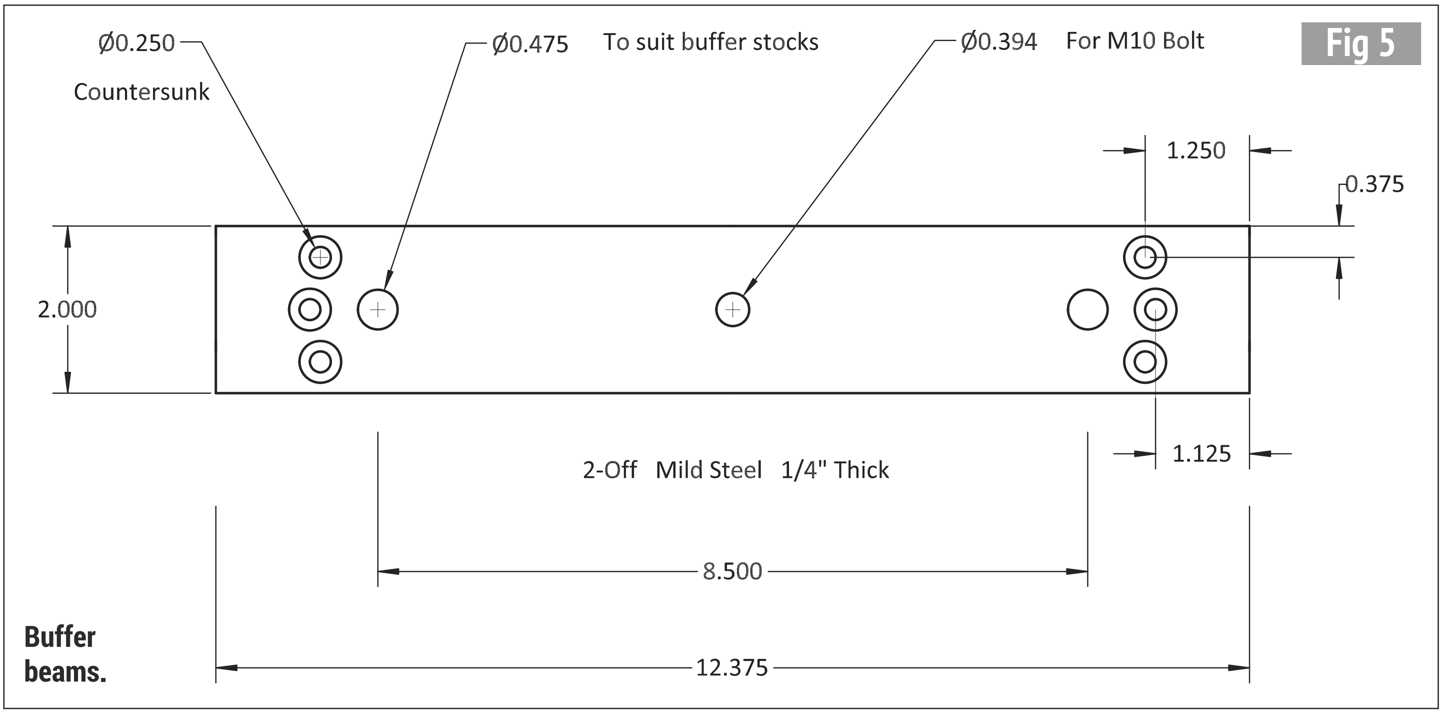


Fig 5

Buffer beams.

Here you can see the buffer beam bolted to the channel longeron with the 40 x 40 x 3 mm angle bracket. The countersunk screws can be seen on the face of the beam, partially covered by the buffer stock. One side of the bracket has a half-moon cut-out to clear the nut on the back of the buffer stock.

Here the chassis has been assembled, complete with the brake gear, showing the very simple all-bolted construction.

run a drill of the appropriate finished size down each water cut hole, and the part is generally ready for fitting. Incidentally, many parts for the two Jinty tanks were water cut, including the expansion links and die blocks. With only a little hand finishing, these components ran together smoothly. I understand Sciss have water cut full size connecting rods, taking some days to profile the huge billet of steel.

Welding is amongst the very many skills I lack completely, so the chassis is simply bolted together with a load of M6 screws and corner brackets cut from 40 x 40 x 3 mm steel angle. Countersunk

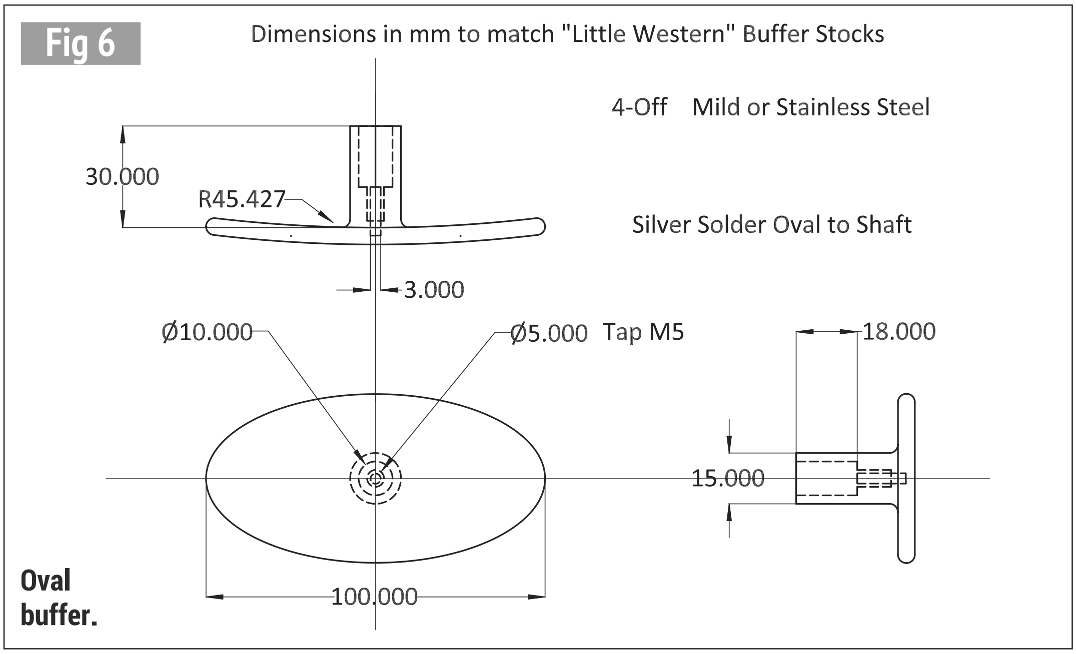


Fig 6

Oval buffer.

An underside view of the chassis during painting. Note the countersunk screws in the bogie stretcher, to provide the bogie rotation ball races with a flat bearing surface. Note also the small chamfer filed in the front bogie stretcher, needed to clear the front brake pull rod.

screws were used in the buffer beam faces to give a flat surface for mounting the buffers. Little Western offer some nice 7¼ inch gauge buffers and so I got a set of these. However, I did swap the original round heads for rather handsome oval versions, water cut in stainless steel.

NEXT TIME
We add the brakes.

●To be continued.

Top view of the complete and painted chassis.

Fig 7 **Main chassis longeron.**

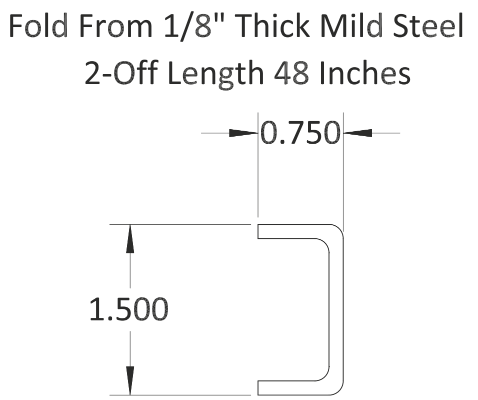
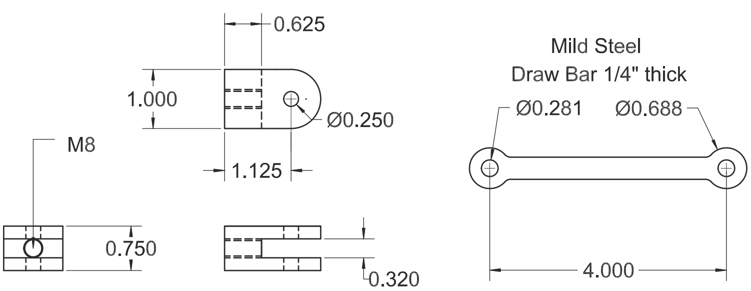


Fig 8 **Coupling back and draw bar.**



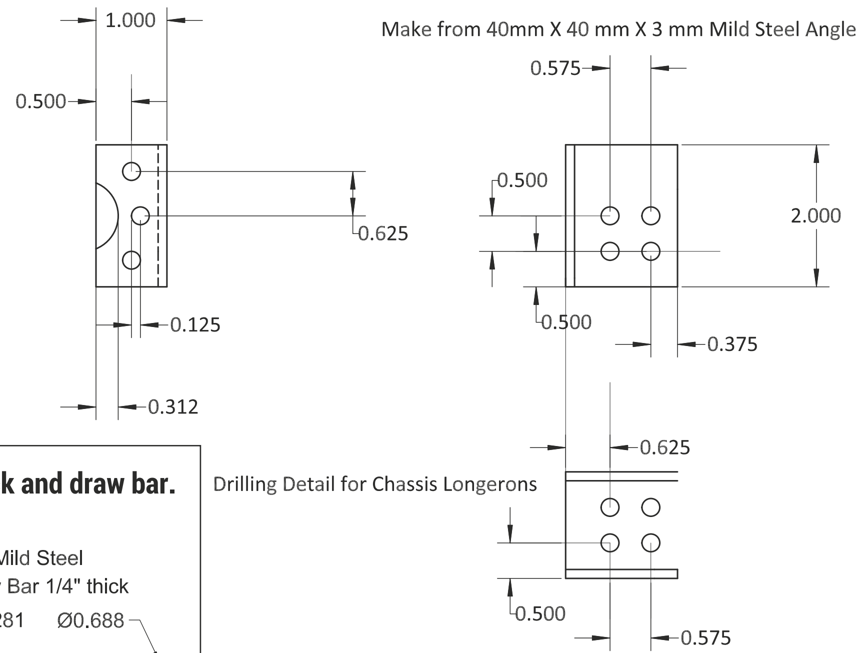
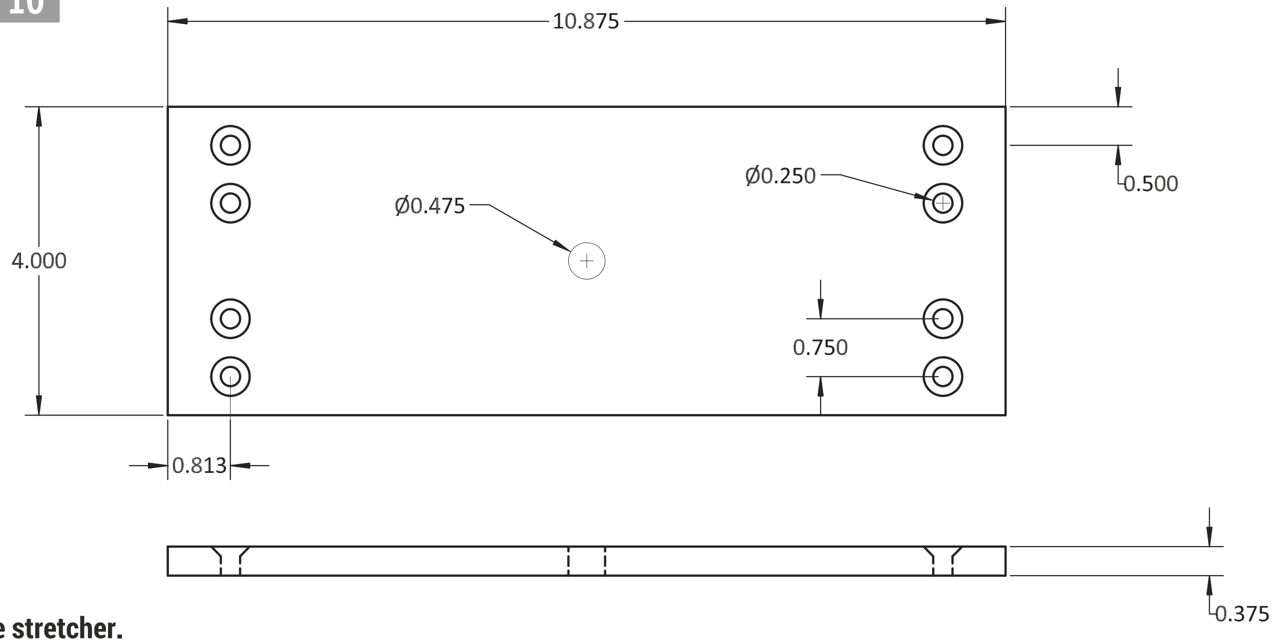


Fig 9 **Chassis corner brackets.**

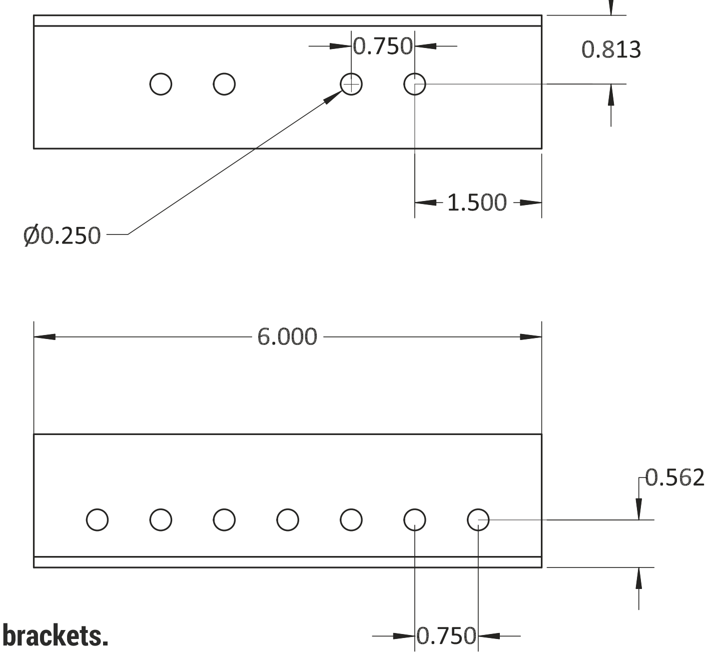
Fig 10



Bogie stretcher.

Fig 11

4-Off Make from 40mm X 40mm X 3 mm Steel Angle



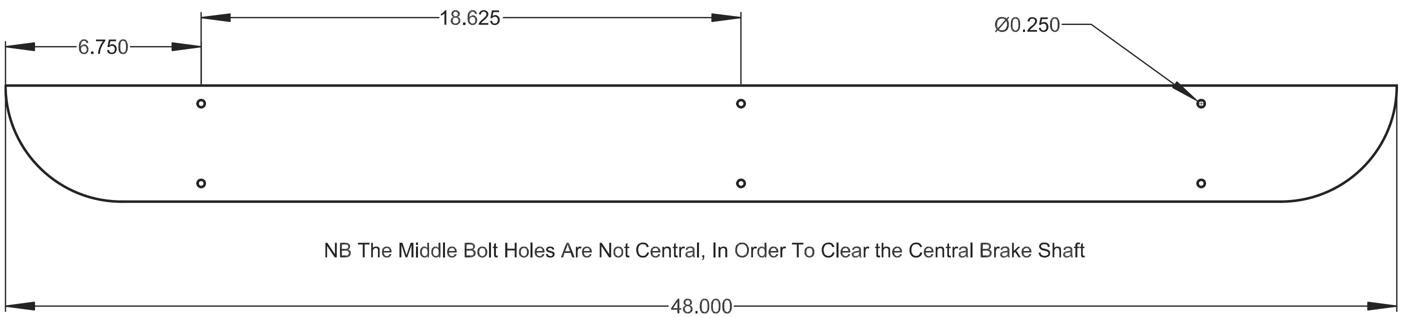
Bogie stretcher brackets.

Many parts for the two Jinty tanks were water cut, including the expansion links and die blocks. With only a little hand finishing, these components ran together smoothly. I understand Sciss have water cut full size connecting rods, taking some days to profile the huge billet of steel.

Fig 12

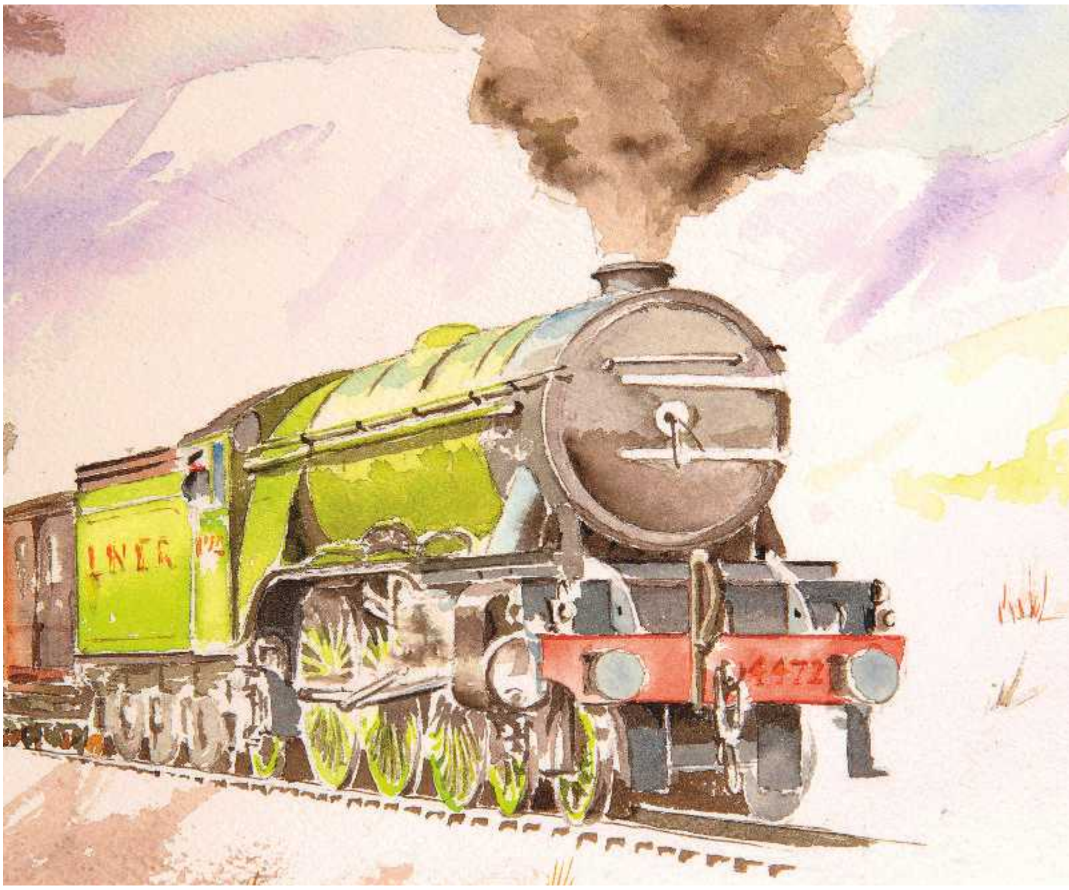
2-0ff Plywood 1/2" Thick

Footboard.



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

Continued from p.349
M.E. 4685, 25 February 2022



Painting by Diane Carney.

PART 30 - CRANKPINS AND COUPLING RODS

Flying Scotsman in 5 Inch Gauge

FAR LEFT: 1. The first picture shows the main crank pins having been machined down to the required size for the spigot - not much of a cut from the stock size. I have done a rough cut here as these will be both pressed and Loctited in place.

LEFT: 2. Next was to reverse the pin in the chuck and turn the various journals. Looking at the profile going left to right we have the spigot held in the chuck, the step, the inner journal and the outer journal (a fraction oversize for polishing). The last small spigot will need to be machined into a square section for holding the return crank.

Crankpins

All of the crankpins have raised steps that sit flush with the wheel boss and each started off as a piece of silver steel at the diameter of the step. The first job was to machine the spigots that fit into the wheels. These are ½ inch deep which gives plenty to hold in the three-jaw chuck for the machining of the pin journals themselves.

I turned the main driver pins first and then dealt with the trailing and leading pins. Although these are different to each other the journals are the same diameter so I did all

3. Here is one of the trailing pins finished, except for a little polishing of the journal. I'll machine up the caps to fit later. Seems that I forgot to blow down the thread for this picture!

4. The leading pins are a little more involved - these have a no. 34 hole drilled right through with recesses either end. The journal is slightly shorter too.

5. Here is a picture to show the various parts together. I won't fix the crankpins permanently (I still need to machine the square for the return crank) until I have machined up the bearings.

6. I decided to drill the centres of the leading coupling rods first. I need to be careful here as the knuckle hole is of two different sizes to allow for the pin.

four of them together. Before I could machine the journals I needed to do the steps first; these are different to the main pins as these have a concave face instead of square.

Drilling the centres

For the coupling and connecting rods I have taken advantage of using laser cut blanks, saves a lot of time although with laser you do have the outer hard surface to deal with. The blanks are cut oversize to allow for this - what I mean is, there is more material to remove than if they had been water cut.

I had thought that I didn't have the correct sized drills but after a good search of all the odds and ends collected over the years managed to find the sizes required.

After setting up the first rod in the machine vice and packing it for support, I zero'd the DRO and drilled the hole for the leading crankpin. Then I moved along the 'X' axis by the specified distances to drill the other holes. The process was repeated for the other three rods.

Machining to thickness

First, I made up a jig for holding the rods for machining. I deliberately went for something heavy and rigid in an attempt to reduce any chance of chatter, in this case a length of 2 x 1½ inch steel. After plotting the centres for both rods I drilled the two furthest out to take bushes and also drilled deeper to tap 10 mm. To secure the rods I'll have bushes of various sizes to fit the jig, both held with 10 mm bolts and buttons. I can also make use of clamps for extra rigidity during machining.

Another advantage of using such a large lump of steel for the jig is that I can easily hold it in the machine vice which is already running true to all axis, which makes setups much easier and quicker. The other thing is it acts like a big heat-sink. I generated little to no heat at all during machining and I could barely feel anything after each pass, the jig remained stone cold at all times. Although I had checked that the steel block was truly square, I decided it was prudent to clean it up a little by facing off each flat, starting with the drilled face of course.

7. So we now have the four rod blanks with their respective centres drilled. These blanks are a lot larger in both thickness and width to the finished size and it's going to take a lot of machining to get to drawing.

8. Here is the holding jig mounted in the machine vice. I drilled and tapped a few holes for holding down clamps - one in the middle on the far side and two others equally spaced between that and the two end 10 mm holes.

>>

9. Picture shows a start being made on reducing the thickness from the left. (Before anyone takes me to task for using the chuck rather than a Clarkson's, I had no option as the new cutters are all plain shank and I had no collet chuck... I had no issues though.)

10. A view showing me working along the length. All I had to do was move the various clamp bolts as I reached them.

Profiling

I machined the edges in stages using three different sized cutters. When it came to the ends I lifted the cutter keeping 'Y' locked and then plunge cut until very close to the buttons. For the leading wheel end I changed the cutter to the relevant size and brought it in until it touched both the length and the other smaller button and again plunge milled. I then cut the last radius along that side which was the one between the knuckle/main driver boss. I then moved onto the next rod length following the same order of doing things although the radius for the lower knuckle/driver boss is different to the top.

For machining the various curved sections I needed the rotary and a mandrel. To save time from making lots of spigots I decided to make the mandrel to fit the largest hole and then machine it down after each size hole was completed. Besides being a good fit to the table the mandrel also has a short taper near the collar to match that on the table to give it as good a location to the table as possible. The tip was turned down and threaded 10 mm to hold the rods tightly - this setup worked for the two larger of the holes.

11. And so the four rods are ready for the profiling of their edges.

For the middle, straight, sections, the rods were placed back on the jig but this time standing upright. With this setup I can thin the centres, machine the flutes, machine the slot in the knuckle and drill and tap the holes for the oil reservoirs. There will still be a lot of hand work to do after all of the machining though - the fish belly will have to be done by hand as will the softening of all of the edges and final polishing.

Fluting

The jig was used again for machining the flutes. I first cut the rears to get a feel for the cutter and to check that I was happy with its profile and position, which needed to be central with the rod. The cutter

12. Here we have the leading rod again in its jig but this time it's joined by the three buttons, ready for profiling. The buttons have been hardened to protect them during the next stages, or should I say protect the job underneath. The buttons are stepped to be a good fit in the 3 bush holes and the two on the knuckle joint have been flat edged to fit.

14. I drilled a $^3/_{16}$ inch hole in the end of the stub to allow for a quick set-up of the rotary table. The hole was deep enough and the $^3/_{16}$ steel rod true enough to allow for a quick and accurate alignment.

13. Here is the first rod with the lengths machined to size as well as all of the concave curves completed. The remaining convex curves will be done on the rotary table and as you can see there's quite a lot of material to remove on one end. I have placed the other leading rod close by to try and give some idea of how much material needed to be removed.

15. Here we see the leading rod knuckle being machined. This was the last operation on the rotary table as it required losing the 10 mm stub and drilling and tapping 2BA, this being a close size to the hole in the knuckle. I left a short spigot on the mandrel to fit the hole remembering to keep it short enough so that the step of the button could fit and allow the button to be tightened up tightly.

itself is a modified ⅝ inch endmill that was ground for me to the proper profile

I then needed to take a look at the fish belly profile for the centres of the rods. It's barely noticeable but for me it has to be there so I made up a metal template for the arc, marked each rod (full size the rods are 5 inches in the centre and 4⅜ inches either end. With the arcs marked I ground each rod slowly on a 1 inch vertical belt sander (a tool that sees a lot of use in my workshop) until I was happy with the profile. I then blended this into each of the end curves. This was all done by hand and it took many hours of filing to remove the marks made by the belt sander. Once happy with the basic shape I then needed to take a look at profiling the flutes to match the fish belly. This took many hours of filing, scraping and polishing and it literally drew blood!

Knuckles

Machining the knuckles required the use of the jig again, in both orientations – horizontal for machining the tongue and vertical for machining the slot.

Once this was done I machined and fitted all of the bronze bushes. With the bushes fitted I then opened them out a little with a reamer to fit the pins (naturally with a heavy press fit the holes closed slightly) and tried the leading rods for the first time. I was very happy to see that the driving and leading wheels turned when coupled with no lock-ups - they are stiff but most of that is due to the fit of the bushes to the pins which is very close and will naturally need some running in.

16. This picture shows the first half of the middle section having been machined to size.

FAR LEFT: 17. Here is the first rear face being cut. Note the packing piece behind the cutter to keep the rod straight.

LEFT: 18. Here is one of the rods back on the jig ready for me to begin the arduous task of hand shaping the flute. If you look closely at this roughed out stage you'll be able to see that the flute is still parallel which is how Flying Scotsman *is today.*

19. First job for the buckle is to counter bore the leading rod to create the tongue.

20. The next thing is the slot and the first job is to cross drill the trailing rod.

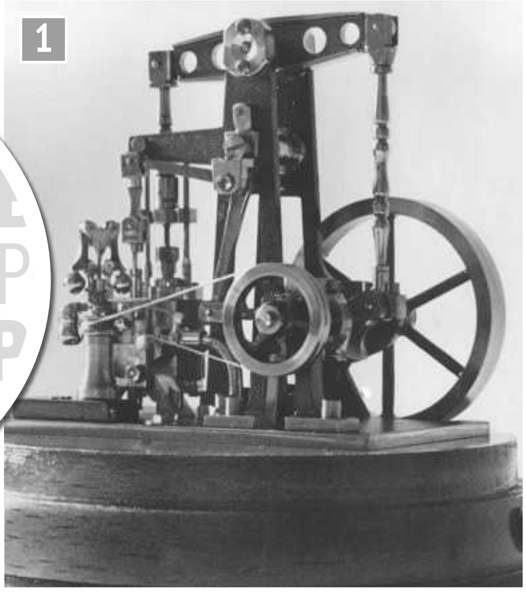
21. I then cut out the middle by hand with a hacksaw and milled the opening to size. This is a little larger than the tongue which is to allow a little sideways movement when subjected to an uneven track.

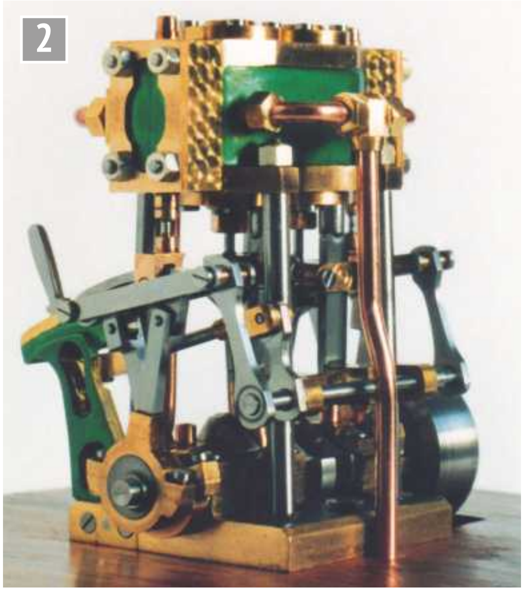
I then made the two knuckle pins from ¼ inch ground silver steel and assembled the rods to check that the joint has no play and all seemed good so far.

●To be continued.

21. Here are the rods in place, looking the part...

POSTBAG





Teeny-Tiny Engines

Dear Martin,
The article in M.E.4683 (28th January) entitled 'Teeny-Tiny Engines' by Gerald Martyn caught my eye. My cousin Dudley was not allowed to join up during WWII as his services were required in connection with precision instruments, such as miniature gyroscopes and watches associated with the war effort. The following appeared in a local newspaper dated January 3, 1976.

'Three years ago, Mr Dudley Rouse took on a challenge to prove that the watchmakers art is both a fine and skilled one. "Many people have a low regard of watchmaker's but I set out to prove them wrong" said Mr Rouse. He proved them wrong by making a perfect one-and-a-half inch high replica of a Cornish beam engine, using only simple watchmaker's tools (**photo 1**).

'Mr Rouse, a retired watchmaker, used only a lathe and files and with these he fashioned every part of the engine, right down to the smallest screw. The engine runs off compressed air supplied by an old tyre inner tube. The governor took a whole year to build and is the most complicated part of the engine. The ball bearings (i.e. the governor balls) which determine the speed of the engine are only 32nds of an inch in diameter and had to be softened, drilled and polished before they were ready.'

That engine was quite an achievement. But even more so was a twin cylinder steam engine (**photo 2**) also made by Dudley when he was about 88. It is fully contained within a 1¼ × 1¼ × 1⅝ inch volume except for the base. Note the inclusion of the reversing gear with tiny quadrants. He told me that the threading taps were made from watch screws then hardened.

So as Gerald's excellent efforts are called Teeny-Tiny engines I think those of Dudley might be called Teeny-Weeny-Tiny engines! I am very tempted to try my hand at something small although my smallest lathe is a Myford super 7 and I am 87 years young. How about somebody trying to put even a simple engine within a sewing thimble?

Regards, Roger Castle-Smith (Milton Keynes)

Straw Elevator

Dear Martin,
I would like to pick you up on a little mistake that I noticed in a recent *Model Engineer* (issue 4684, 11th February). At the bottom of page 243 you have referred to a 'Straw Bale Elevator'. If that is a bale elevator, where does one feed the bales into it? We always used to use an elevator whilst we were threshing corn in the 1940s and 50s but I have to say that it is not a bale elevator. It is a loose straw elevator and we always used to have one in front of our threshing drum and we used to load the straw on to five trailers which we had standing by to bed the cattle down for the following week whilst the cattle were in our yards for overwintering. At that time, we had in excess of 200 head of cattle.

Anyway, I am enjoying reading Ian Couchman's article and can't help but think he must have had some pain on to make all those intricate and interesting little castings. I have to say that our elevator wasn't the same as his but we did see plenty of elevators that were of the same configuration on neighbouring farms, with what I used to call 'upside down tines' on them. When we were not filling trailers we sometimes used a 'straw batter' in front of the drum which tied the straw into bundles (called 'batts') so that they could be built into a 'straw stack' as opposed to a corn stack, which is where the corn, with straw, was fed into the drum for threshing. I often used to feed the drum once I was old enough. There's a piece of history for you. Anyway, very interesting!

Regards, Doug Hewson (North Lincs.)

You're quite right, Doug – I set out to write 'Straw Elevator' but the word 'bale' sneaked in while I wasn't looking! – Ed.

Write to us

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Modern Boiler Construction Methods for the Model Engineer

PART 1

Luker argues the case for considering the adoption of TIG welded stainless steel boilers.

Introduction

Model engineering boilers have been a topic of hot debate from as far back as the legendary 'battle of the boilers' between Greenly and LBSC. I can see no end to the ongoing saga, and rightly so. As ideas, regulations and manufacturing techniques change so should the methods of design and construction. I fiercely contest any draconian regulation, nor will I be bold enough to insist on specific boiler manufacturing techniques being imposed on fellow model engineers (I have far too much admiration and respect for anyone capable of making a live steam 'anything'). The following is simply a little write-up on my methods of boiler construction, with reference where applicable, to the model engineering codes I currently have at my disposal. Having said that, some regulation is necessary if only to give the paper pushers, armchair engineers and bureaurats (*sic*) something to do.

If a builder is to use their boiler in a public space they need to be aware of the rules and regulations specific to that region. The local club boiler inspector is the proverbial gate keeper and more often than not they are a wealth of information and advice. All of the model engineering boiler codes require builders to submit the boiler plans and test samples etc. before construction begins to the duly authorised club boiler inspector. I personally have a very good relationship with our boiler inspector. As all of my designs are new, I go through my calculations and manufacturing methods with him. I am always upfront with issues I have encountered during design and construction and I value his input and advice. His advice is highly regarded amongst other model engineers as well, most likely due to the fact that he is a degree'd engineer, and has personally constructed numerous boilers, both copper and welded steel.

The older designs, for the smaller gauges, used copper and silver soldering techniques with each new boiler just implementing known plate size and stay ratios based on past experience. To take one of the older copper designs and simply swap out the materials or methods of construction without doing the necessary calculations is foolish, and any good club boiler inspector will stop that before construction. A brilliant boiler inspector will help you with the calculations and point you in the right direction without insisting you do it **their** way.

Due to financial constraints, and with no intention to bankrupt myself with a hobby, most of my designs use TIG welding techniques instead of silver solder; this will be the predominant focus of the series. The methods described are specific to the size of boiler I typically use for my builds (below 60 bar-litre). All methods are geared to decrease the cost of manufacture and, where possible, time (a highly valued commodity). Completely new boiler designs can be complex depending on the materials and methods of construction with most of the examples used in this series specific to my boiler designs and builds. This, simply, is because they have been designed, made, tested and are working models, making the write-up more than an academic exercise.

Hopefully the series will show any model engineer hesitant to tackle TIG for boiler construction that it is a process relatively easy to master with a little practice and a basic understanding of the underlying principles (**photo 1**). I also hope the series will give both the builder and boiler inspectors some comfort in modern manufacturing techniques, and their application, by highlighting typical welding flaws and pitfalls by means of examples. I hope the published weld pictures can show the flaws in enough detail.

Boiler design for different materials and construction

It would be unreasonable to expect any boiler inspector to accept any design changes to an existing proven boiler design without accompanying practical tests or calculations. For example, the recent (brilliant, I might add) article on flangeless boiler plates (by Joseph-Jean Pâques, issue 4651, 6th November 2020) should serve as a proof of concept with some simple shear calculations of the joint, specific to the actual boiler,

1

Pressure testing my first stainless boiler.

enough to convince the boiler inspector the design is safe.

TIG welded copper boilers or a combination of TIG and silver soldered boilers is a simple method of decreasing the overall cost of a copper boiler by sparing the very costly silver solder. Standard welding calculations will help convince the boiler inspector the design strength has not been compromised, although if they have any experience with welding I doubt even that would be necessary. You would need to submit welded samples and hopefully with this write-up and the simple bend test described later you'll get the go-ahead.

Changing the material of construction to a stainless steel boiler is a little trickier. Stainless steel is not covered by the UK **Boiler Test Code 2018** (**ref 1**) due to, and I quote, *'specific requirements and difficulties'* but this does not mean it is not allowed. The code does give allowance for commercial boiler certification. This will inevitably require a full design write-up as well as all the regulatory requirements for pressure vessel welding design and fabrication, which is what we do for our boilers anyway. Unfortunately, there is very little in the way of design specific advice for the smaller boilers with even the Australian **Boiler Code** (**ref 2**) more suited to the larger boilers (150mm barrel and larger) with a duplex stainless steel (Ferritic austenitic type UNS S31803 SANDVIK SAF2205) specified (**photo 2**). For my designs I've had to make extensive use of Finite Element Analysis (FEA) and other thermal stress and surface potential calculations specific to the problems associated with stainless to design a safe working boiler.

Nobody would argue with the fact that the boiler should be viewed as a component in a larger system including auxiliaries like the safety valves and blower. I have personally found through the thermal simulations and track testing of my stainless steel boilers that the design of the safety valves and blower is different from that of copper. For my last two boiler designs I seem to have got the ratios reasonably close to optimal with no subsequent changes to the blower, safety valve or blast nozzle necessary. Counter intuitively, the safety valve is slightly larger and the blower jet designed for less draft when compared to an equivalent copper boiler design. All of my stainless boiler designs have a working pressure of 90 psi with a limit pressure of 100 psi. The blower nozzle and safety valves need to be adjusted during the initial steam tests if the limit pressure is exceeded with a good fire and the blower on full (**photo 3**).

Using dissimilar construction materials with a rigid joining process like TIG welding is inviting failure; the FEA says so! Nobody can deny that the overall differential thermal expansion varies in a boiler, inducing stresses and strains. This is marginal when compared to the massive localised thermal stresses induced by different coefficients of thermal expansion at a rigid connection. If one of the materials is ductile it will just yield but in the case of stainless it's more likely to crack.

TIG welding in general

The TIG welding process is described *ad infinitum* on the internet, and I have no intention of regurgitating the first few Google hits. I will however highlight some pertinent points.

Firstly, TIG is a clean welding process, with the quality of the weld preparation one of the most important factors for a successful weld. There can't be any grease, oxides or any other contamination in or around the weld area. If I had a Rand for every time I saw porosity in a weld due to the welder not removing the mill scale I'd be rich (only here though, looking at the exchange rate). Often stainless is left on the bench ready for the next weld run only for the weld to be contaminated by grinding a piece of carbon steel on the same bench. On the topic of contamination; the correct filler rod is critical for a good weld and that also should be clean and not covered in workshop grime and grease.

The TIG rod and cup sizes can be found on the web but there is considerable variation and differences in what is recommended. To make life a little easier I've tabulated my set-up for easy reference (**table 1**). The grinding of the electrode is important with the point ground such that the grinding marks are in line with the rod; this will ensure a stable arc. The Argon gas used in welding is a rental cylinder in my neck of the woods, and is inexpensive (much cheaper than the cheapest cell phone contract locally). This most likely differs from region to region; with a little planning and forethought the cylinder can be leased and used only when needed if the cost is exorbitant.

For both copper and stainless a direct current electrode negative (DCEN) configuration is used. This is the most common configuration and an entry level induction TIG welder with high frequency start can be bought for a very reasonable price (probably less than a good brazing torch). An AC/DC high frequency pulse welder is beneficial when welding stainless because it decreases the heat input into the parent material and limits distortion but it is very possible to get away without this luxury. I was

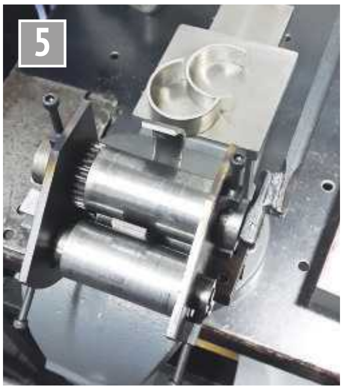
Inside a larger boiler designed to the Australian code.

Checking blower and safety valve for limit pressure during first steaming.

Table 1. TIG welding setup

Electrode Diameter (mm)	Gas Cup ID (mm)	DCEN Current Range (Amp)	Notes
1	8 (no. 5)	15-80	Tubes
1.6	9.5 (no. 6)	70-150	All seams and tack welding
Red band tungsten electrode (AWS-EWTh-2) with a sharp point (no point shortening).			

Inner boiler welded assembly.



Heavy-duty home-made ring roller.

Outer boiler assembly tacked.

fortunate; my very fancy pulse welder was a thank-you gift for welding training I gave.

One common mistake when TIG welding is getting the tungsten rod stuck in the weld. There is always the temptation to just weld over the infraction hiding the mistake but this is a crack waiting to happen, especially with stainless. It only takes a few minutes to pencil-grind that small area and re-weld. Incidentally, as a general rule, back grinding and repairs are only allowed once in any given area on boilers.

As welding processes go TIG welding is not very forgiving. This is actually a good thing because a bad looking weld is a bad weld, making visual inspection much easier. My personal view is that it can be mastered with a little patience and a lot of practice, and welding faults can be picked up very easily, making it perfect for the model engineer (amateur) boiler maker.

Weld preparations negating the need to back purge.

General notes on boiler fabrication and assembly using stainless TIG welding

The construction of a fabricated boiler follows a similar sequence to any silver soldered boiler constructed. The firebox wrapper used in all of my boilers is a single sheet to eliminate any unnecessary welding seams. I have found a 3mm wrapper to be suitable for the boilers I have designed and it can be formed over the tube and back plates with a little brute strength, G-clamps and levers, tacking as you go. I always leave some trimming allowance past the foundation to help with the end welds and for a small amount of deviation when forming (**photo 4**).

The barrel will typically be rolled using industrial rollers but any steam dome or firebox hole will need to be made in the home workshop. This can either be formed over suitably sized bar stock or rolled using a home-made ring roller with adequate design strength to roll the relatively stiff stainless plate (**photo 5**). If a roller is made the feeding rollers need to be linked, typically by gears. With proper placement of the three rollers a perfect ring can be rolled without the normal flat at the end.

With the inner assembly welded, the outer shell can be tacked (**photo 6**). Each joint should be designed to overlap a thicker backing plate with the weld size designed for the thinner plate. This is done to improve the heat dissipation, decreasing distortion and also to eliminate the need to back purge (**photo 7**). If full penetration butt welds are used on any seams the boiler needs to be back purged or welded with a backing plate to prevent sensitization of the welds on the inside of the boiler shell.

The tubes are by far the trickiest part of the whole assembly. A 1mm tungsten rod is needed to focus the weld pool without collapsing the tubes. I typically extend the tubes 2-3mm past the tubeplate and use a fusion welding process which gives better control than trying to fillet weld the tubes (**photo 8**). It is possible to expand copper tubes into a stainless boiler but this is not recommended if a crown or girder stay is used simply because this will result in higher forces on the side stays and foundation.

For the welds requiring a V-prep like the firedoor hole and foundation the depth of the prep should not exceed the thickness of the thinner plate to prevent excessive heat build-up (or over penetration) in the thinner section (**photo 9**).

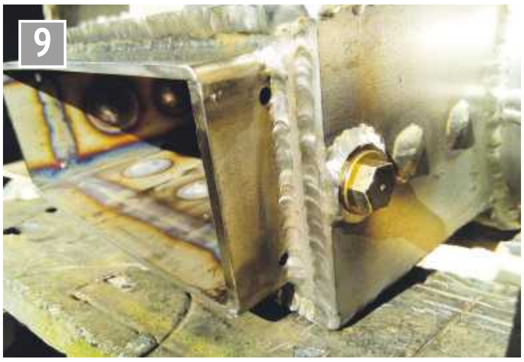
That covers the basics; identifying and knowing how to rectify welding defects is the tricky part, which I'll tackle next time.

●To be continued.

REFERENCES

1. The Boiler Test Code, 2018, Volume 1 - Boilers 3 bar litres to 1100 bar litres
2. AMBSC Code Part 4 - Duplex steel boilers

Welding the tubes to the smokebox tubeplate.



Foundation ring welding.

We Visit the Taunton Model Engineers Society

John Arrowsmith continues his tour of the West to witness progress at the Taunton Society's new site.

My next visit was to the new home of the Taunton Model Engineers Society at West Buckland. The club has had a difficult time over the last two or three years with uncertainty about relocating to a new home. Having been given a very short notice to leave their previous site at Creech St Mary, after 14 years' occupancy, they struggled to find a piece of land on which to build a new track.

The club was formed in 1946 by a group of 20 local model engineers and since then has grown into a well established organisation in the Taunton area. In 1995 they became a Company Limited by Guarantee with a further development in 2018 when they obtained charitable status and this is the situation they enjoy today. They have an older track located in Vivary Park where they operate very popular public running days but, unfortunately, the club's relationship with the local authority was not of the best so finding a new site became very much a priority.

The south-east end of the new building showing some ground water pipework and yet more track panels.

Their new site at West Buckland will be 'something else' when it is finished. The club has managed to purchase just over four acres of land which is being turned into a wonderful facility. A great deal of planning has gone into what they want to achieve and how they are going about it. Having secured the site the first thing they have done is to purchase and erect a new 60 x 30 feet steel framed agricultural building (**photo 1**). This building will be their headquarters and be fully fitted out with everything a forward-looking model engineering club will need including a club room for members. The rough green field site has been surveyed and an impressive track plan has been drawn up (**photo 2**). Before any track laying could be done, however, the track base had to be excavated and they have made remarkable progress in quite a short time (**photos 3** and **4**). All the track base sides have been lined with concrete gravel and soil boards, each length having a couple of built-in drain holes

The site track plan laid out for all to see.

View showing the superb ground works for the new track, neatly battened embankments and edging boards.

Some trackwork towards the main station and road crossing.

Gordon Roberts using the bending machine for the rail.

Members busy constructing track panels.

Track panels ready for laying.

Part of the sleeper drilling operation.

to allow ground water to reach the land drains fitted alongside the track. The task of making all these gravel boards has been another slick operation with horizontal moulding tables laid out to make 30 at a time. When all this is added to the track base, they will have a very smart and efficient system for keeping the ballast and soil where it should be. It will also assist with the inevitable grass cutting and keep everything neat and tidy.

Within the new building they have set up what can only be described as a track making production line; benches at convenient lengths, heights and widths enable 30 foot track panels to be made up in next to no time (**photos 5** and **6**). This is proved by the sheer number of these panels now awaiting laying (**photo 7**). The club decided to buy all the track they needed before they started production and the 25mm deep flat bottom rail was bought direct from a steel mill in Switzerland because a) it was available when they wanted it and b) - and more importantly - it was cheaper than the equivalent in the UK. That tells you something about UK industry! Another bench has »

Rail end drilling jig.

The fly press in operation bending the rail clips.

Close up of the rail clip bending jig.

Rail clips before and after bending.

Work on the carriage shed continues.

six drilling machines available to process all the recycled plastic sleepers which need to be made (**photo 8**) and drill the rail ends for the fishplates (**photo 9**). A suitable fly press (**photos 10, 11** and **12**) has been set up to bend the track clips which have all been laser cut to suit the track, ensuring that, again, there is always a supply available for the track gangs.

Thought has been given to the unloading facilities they will need and to this end they have prepared a strip of land, alongside the new building, which is accessible from the entrance. This will enable large, heavy locomotives to be unloaded straight onto the track system itself. For lighter locomotives there will be a hydraulic platform installed to assist.

Whilst on the subject of future work, the ground works and excavations have already taken place for their new carriage shed which will be situated adjacent to the main building, having direct track access to enable maintenance and repair. The access tracks have already been built into the floor slab of the building.

The earthworks for the carriage shed are another major undertaking but, again, there has been some creative thinking; in order to save time laying suitable footings, they dug the trenches for the building and then utilised BR concrete sleepers to provide the base for the main building work. This has two advantages in that i) the sleepers are reinforced, and ii) the club doesn't have to mix and pour quantities of concrete into the trenches, thereby saving time and work by having no shuttering to make. The sleepers are positioned into the trench, fixed with a concrete mix, levelled in and left to set. When everything is complete the base slab can be laid and the building erected straight onto the sleepers. My photos show the operation of positioning and laying the

Concrete sleepers being unloaded for the footings.

Chairman, David Hartland grabs the next sleeper for the footings.

The road crossing in place but awaiting the finishing touches and gates.

A selection of young trees await planting around the site.

sleepers so as avoid most of the heavy lifting involved - at some relief, no doubt, to ageing backs (**photos 13, 14** and **15**)!

In amongst all this endeavour to get the ground level track built, a raised track is also being planned in the middle of the site and within the ground level track. The route will follow closely the line of the ground level track and will have its own station and steaming bays. Access will be via suitable road crossing into the middle of the site (**photo 16**).

All this work has been carried out by about 30 of the 100 strong membership and they are to be congratulated on what they have achieved in a relatively short time. The quality of the work they have done in building the track, point work and ground works, along with all the necessary utilities that will be needed to operate a large model engineering club and miniature railway, is superb. There is still a great deal to be done before they can open but the plan is to get the first ground level circuit completed before the end of 2021. With the energetic chairman, David Hartland leading the way I am sure this goal will be achieved.

I would like to thank David and John Pickering for their time and information during my visit as well as all the other members I met on the day. Gentlemen, you are building a first class facility here and I am sure at the pace you are working it will not be long before the West Buckland area of Taunton will be resounding to the sounds of steam locomotives hard at work on your new track and all the members enjoying their new surroundings.

ME

A sign of things to come, the running-in board for Southpointe Halt is already in position.

LNER B1 Locomotive

PART 3 - TENDER FRAME PLATES

Doug Hewson presents an authentic 5 inch gauge version of Thompson's most successful locomotive.

Continued from p.151
M.E. 4682, 14 January 2022

I think the next stage should be the tender frame plates with their variations. The drawings are reproduced here but take note of the engine number that you are intending to build as the tender frames changed with the locomotives from 61350 onwards. (Also note that the drawings reproduced here are not intended as working drawings and that if you are going to build a B1 you will need to obtain a set from Geoff Stait at G & S Supplies.)

The frames are cut from $\frac{3}{32}$ inch plate and, overall, they are $3\frac{11}{16}$ inches wide. At the top of the plate is a piece of $\frac{1}{4}$ x $\frac{3}{8}$ inch angle which on the outside can be the full length less $1\frac{1}{16}$ inches to miss the connecting angles at each end. The plate on the inside it should be $19\frac{19}{32}$ inches long to miss the front and rear drag boxes. Along this angle are the 'spring helpers' which are there to catch the axle box should a leaf spring break. You will just need to fettle the castings a little to make sure that there is no flash inside where they fit over the angle.

At $2\frac{1}{16}$ inches from the front axle box there are three No. 45 holes for $\frac{5}{64}$ inch (or 2mm) rivets for the brake hanger brackets and therefore it follows that there will be two more of these groups of holes at $2\frac{1}{16}$ inches beyond each axle. Towards the front of the tender is the steam brake cylinder stretcher and that fits between the double plates. Whether you want to make the steam brake work is up to you, I don't really think there is any need for it as I will be describing the steam brakes for the engine later on in the series. It will be just another pipe to couple up before you get on with steaming your engine. It does need to be there, however, as the engine will not be complete without it so I would put it in just to complete the tender detail.

13

Darlington built B1 tender (February 1955).

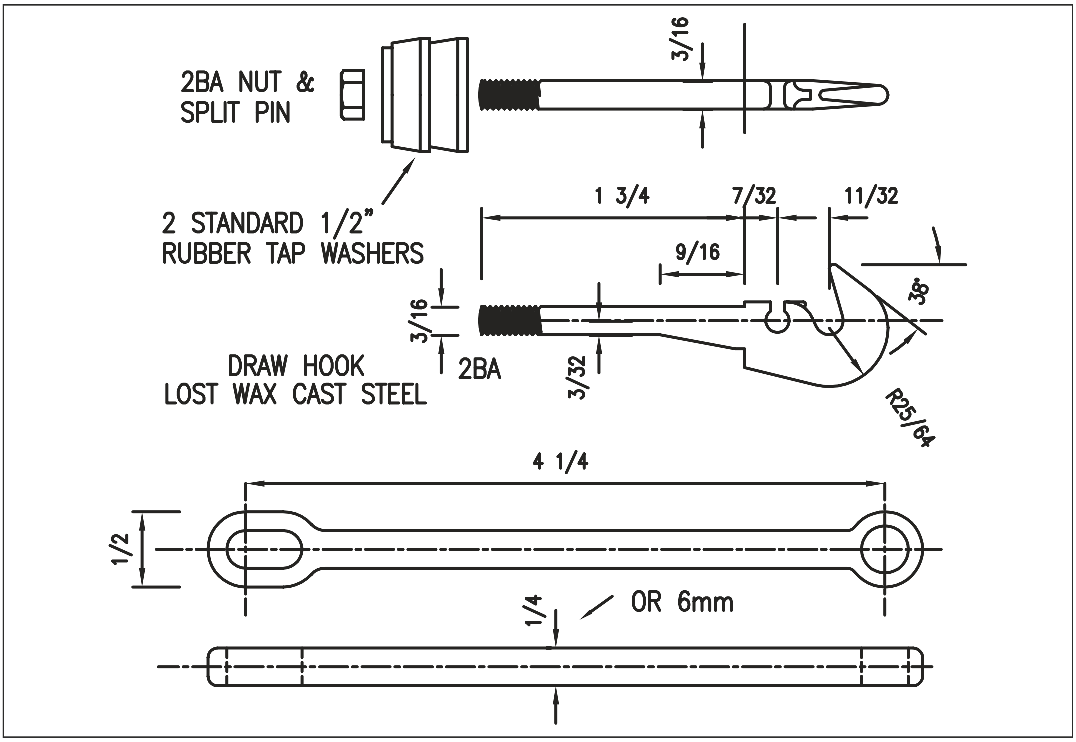
Photograph 13 is of an LNER B1 tender taken in February 1955 and it shows a tender for one of the engines between the numbers 61041 and 61349 and it is a Darlington built tender as can be seen by the inclined water valves. It also has the one-piece tender side plates and it looks very much like it is freshly painted, straight out of the box!

The brake hanger brackets are a nice little detail I thought but they will need to be fabricated. They are detailed on the front elevation of the drawing (top left). You will need six pieces of 16swg plate 1 inch wide and $1\frac{3}{8}$ inches high as a basis and then cut the corners at the top just so that they clear the angles at either side. Now, bend a piece of $\frac{1}{4}$ inch x 16swg strip around the edge and silver solder it on. On the back of this plate are the two actual brake hanger brackets and they are just two pieces of triangular plate silver soldered on. I would clamp them together with an old toolmaker's clamp so that they are $\frac{3}{8}$ inch apart and then you can position them properly for silver soldering. I keep several old clamps especially for jobs such as this but, it goes without saying, the screws need to be kept well oiled! Along the bottom of the frame plates are holes for the steps and the lower frame stretchers and at each end of course are the holes for the front and rear drag beams.

Photograph 14 shows a very similar tender to those of the B1s. It is a V2 tender, the only difference being that the V2 tender was vacuum braked and the B1 had steam brakes on the tender. Quite clearly, it is a Darlington built one with the inclined water valves and the

14

Darlington built V2 tender (photo by Alistair Bootland).



V2 tender water valve (photo by Alistair Bootland).

The first locomotive with the squared off tender frames (photo by the TT).

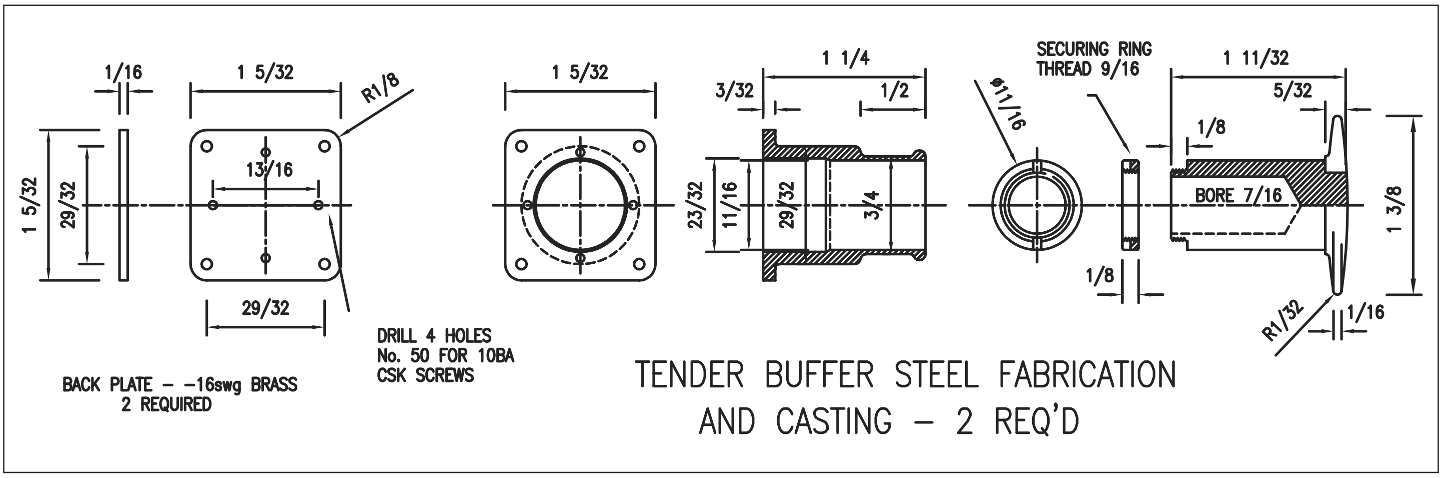
photograph gives some good detail of the coal doors and cupboards. It is looking a bit moth eaten but I understand this is now in Sheffield which has given the lads a good step up on building the new Gresley B17. Just wants a good lick of paint around it! **Photograph 15** is a bit better view on the water valve.

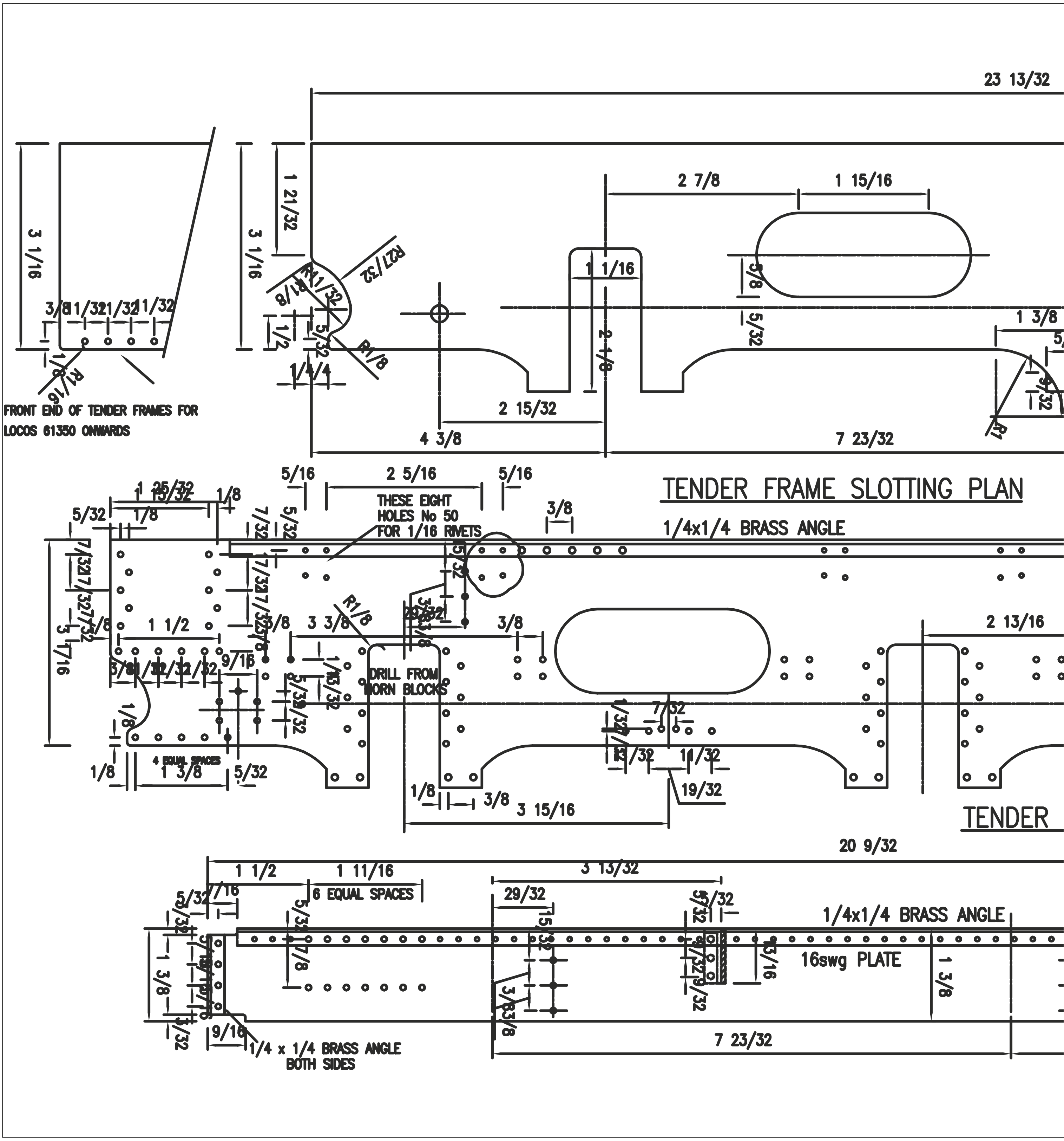
Photograph 16 is the first locomotive (61351) to be built with the new frame plates which were squared off at the front and rear. The doubler plates are 20 9/32 inches long x 1 3/8 inches wide with notches cut out of both underside and top side, with the underside one being 9/16 inch long and the one topside 7/16 inch long. Both are 3/32 inch thick. From one notch to the other is a piece of 1/4 inch brass angle on the outside of the double plate. There are two more stays to make, and this one is a small stay which goes in front of the water scoop to prevent stones from getting up the spout. Essentially it is just a piece of 16swg plate stiffened up with a piece of angle around three sides with a flap on one side of it. That can be a piece of 20swg plate.

The other lower stay is a much wider one and can be fabricated from another piece of 16swg plate which has a flange plate across the end of it and it also has a stiffener down the centre of it which is fabricated from 5/32 inch x 16swg plate for the stalk of the Tee and a piece of 3/8 inch x 16swg plate for the table. Just make sure that you round off the stalk of the Tee before you silver solder the whole lot together. Also, do not forget to fit the little tab which holds the end of the return spring for that brake rigging. All of this should come with the laser cut kit.

The one thing that you can do now is to bolt the horn blocks on. They should be bolted using 'fitted bolts', i.e. ones that are tight in the holes which have to be hammered in but if you can't do that, I am sure that you would be forgiven if you use ordinary 8BA bolts!

The other thing which you can do is to make the buffer shanks and the best way to do this is the way I learned from LBSC in my very early days of model engineering and that is to take a piece of steel 1 3/8 inches diameter and about



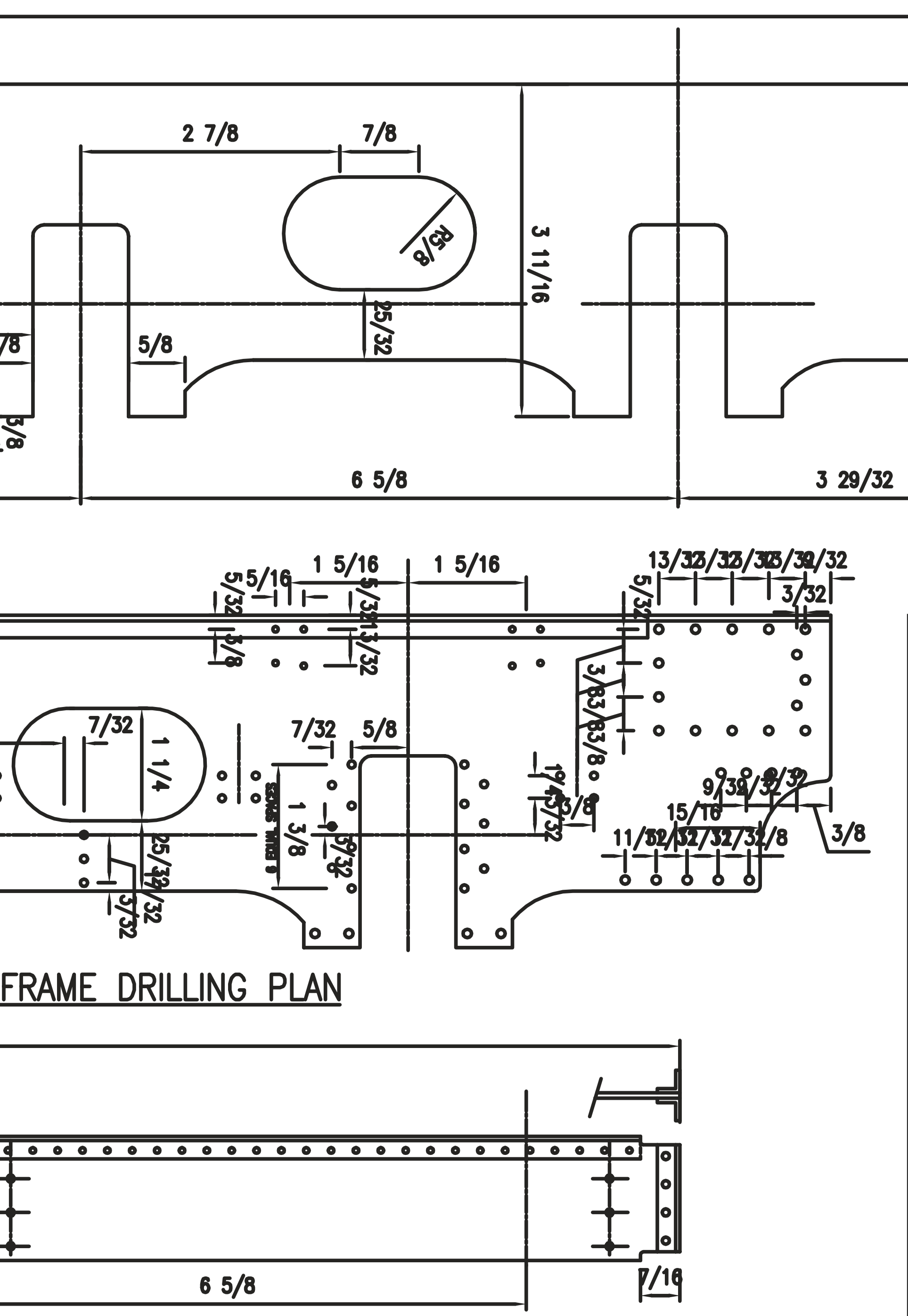


2⅞ inches long and turn both ends down so that they are a very close fit in the housing - we don't want to see any droopy buffers! All the work can be done on both ends before you part them off in the middle. You can then turn them all to the correct profile on their faces.

I have a profiling tool which is made from a piece of ⅜ inch tool steel especially for turning buffers. It is a quarter elliptical shape and I can turn buffers in one cut if I take it steady. All you do is to use the part of the ellipse which suits your buffer. I appreciate that the buffer shown in **photo 17** is a wagon buffer but you get the idea.

The full-size buffer on the B1 tender is shown in **photo 18**; just make sure yours are comparable with the full-size ones. Any thicker than that and you will lose marks for that if you enter it in any competition. Another thing which you will always lose marks for is fitting the buffers with set screws. It is one of the things I always look closely at and hate it when I see it. They are fixed on with bolts and should have 1½ threads showing and then it will be top marks for you.

The buffer housings are lost wax castings and should be



Machining a buffer head with Doug's special tool.

Full-size B1 buffer head.

available from G & S Supplies but inevitably they might just need a skim out with a ¾ inch reamer. At the back of the buffer is a second 18swg plate which is to retain the spring which is fitted with 10BA countersunk screws for the rear. Now, one thing I always check on is how the springs compress and if you can press them in by more than ⅛ inch then they will be of no use whatsoever. For the springs you need them to be ⅜ inch diameter made from 18swg wire and certainly no less.

There are two more very small items that you might as well fit and that is the tender draw bar and the draw hook. You will have to do a little bit of machining to make the draw bar and the draw hook can be bought off the shelf from G & S Supplies, all being well. We have them made in lost wax cast stainless steel as I understand that it pours better than mild steel. You can also buy the shackles for the screw coupling from them too. They are also in stainless steel. All you need do to the draw hook is to extend it with a length of 3⁄16 inch round bar.

●To be continued.

Accuracy and Precision with Some History

John Bauer argues that we must be precise about the terms we use to describe the measurement process.

Accuracy and precision are different concepts. The two terms are confused in common usage, not to mention that precision has a dual formal meaning, one dealing with measurement and the other used in mathematics to describe the number of significant digits in a number. For the purposes of this article we will leave mathematical precision to the applied mathematicians who ensure that complicated calculations, as in modern navigation systems, do not go off the rails.

Formerly and formally, accuracy dealt with agreement with a predefined standard while precision deals with repeatability of a measurement. In 1994 accuracy was redefined by ISO 5725-1. For the moment we will stick to the older definition because it is more easily visualised and does not detract from the discussion.

To give an example, a 'precision' lathe need not be accurate. It only needs to cut to the same point with the same settings to within an acceptable range. Similarly, a precision measurement instrument gives consistent results. An 'accurate' lathe translates the numbers on the dials to acceptable agreement with predefined standards of measurement, again to within predefined or known limits, the tolerances. Again, similarly, an accurate measuring instrument gives you a result related to a standard value. To put it in terms of the artillery, precision is how closely grouped the projectiles are when they land and accuracy has to do with how close the centre of the salvo is to the target.

A reasonable question is when did accuracy and precision begin to matter in the making of machinery. (I have purposely avoided the use of the word 'production' because of its modern connotations in manufacturing.) I would opine that in a basic way precision would begin to matter in the making of multiple spindle spinning machinery and of weapons. When one looks at the history of the making of reasonably complicated metallic objects and the history of machine tools, one reaches the conclusion that requirements for precision far outweighed requirements for accuracy until the beginning of the 20th century. One reason is that it took until then to achieve widespread agreement on standards of measurement and the other reason is that most manufacturing of any specific article was confined to a particular factory and thus locally made jigs, fixtures and measuring devices, not to mention skilled fitting, could ensure successful assembly and operation. The relatively slow speeds of most machinery also supported this situation.

The necessity of standardisation of weights and measures has been recognised for thousands of years and has a long and colourful history, including the sizes of the appendages of rulers. However, it is reasonable to skip the travails of medieval merchants and renaissance sailors and point out that the locality of mechanical design and construction did not even require nationally accepted standards until the 19th century.

The initial recognition of the need for international standards of physical measurement came not from engineering but from the physical sciences. Comparison of experimental results would otherwise be undermined more and more as the precision of measurement at different universities in different countries increased. It was not until 1889 that the first standards of mass and length were distributed internationally from Paris after a series of conferences on weights and measures. It is interesting to find that as early as 1870 James Clerk Maxwell of electromagnetic theory fame prophetically stated that basing standards on, for instance, the rotation

and size of the earth were far from enough as these values could and would change over time (**ref 1**). At a meeting of the British Association for the Advancement of Science he stated:

'If, then, we wish to obtain standards of length, time and mass which shall be absolutely permanent, we must seek them not in the dimensions, or motion, or the mass of our planet, but in the wavelength, the period of vibration, and the absolute mass of these imperishable and unalterable and perfectly similar molecules.'

His prediction needed quantum physics to be fulfilled and was not complete until 149 years later when the replication of mass by inherent physical processes had been accomplished and had been accepted internationally.

It should not be surprising to students of history that demands for high standards of precision, or to put it another way, high standards of replication, came initially in the area of armaments. The repair of musket locks had to be undertaken individually because the gunsmith had to make replacement parts to fit a particular lock. As one result England had 200,000 muskets needing repair toward the end of the Napoleonic wars (**ref 2**). The effort to produce interchangeable parts began in France with LeBlanc in the 1780s before the French revolution (ref 2). These efforts did not bear fruit because Leblanc, and others, did not use limit gauges as the Americans did in the next century.

After Whitney's first attempts to produce weapons with interchangeable parts finally succeeded after substantial cooperation with US government armories the US government demanded that all the parts of weapons made under a contract be interchangeable 'but also with weapons of the same design made at the national armouries' (ref 2). This was achieved not with dimensioned drawings but by issuing master examples of the weapons to be made.

Mass production was now using jigs, fixtures and gauges and remained dependent on them until the end of the 19th century. This was forced on the manufacturers at first by a lack of stable and agreed measurement references. Two Wikipedia entries (**refs 3** and **4**) give an indication of the state of measurements during this century. Micrometers, inherently precise devices, became generally available in the second half of the 19th century, Brown & Sharpe starting to provide micrometers for general sale in 1867 (**ref 5**). However, the author suspects that they were used as local standards and were not necessarily traceable to national, certainly not international, standards as we understand traceability and standards today.

Toward the end of the century in Sweden, at the Carl Gustafs Stads (rifle) Factory in Ekilstuna, Sweden, an armourer inspector had reached the conclusion that the proliferation of custom gauges for each product was highly unsatisfactory. The inspector was C.E. Johansson and he had come to this conclusion on the basis of work practices in his factory and on the further basis of an inspection visit to the Mauser arms factory in Germany in 1894. Within two years he had thought out the concept of gauge blocks as reproducible standards and produced the first set for his employer. It took time for the idea to gain general traction and the resulting measurement revolution was not greeted with trumpets but with gradual and satisfied acceptance (**ref 6**). As part of his work Johansson made his inch gauge block 25.4 mm and that decision, followed by other makers, erased the 7th place difference between the American and British inches of the time. Standards bodies had no recourse except to follow (**ref 7**) after the relationship had been in use for decades as the standard inch.

Svenska Kullagerfabriken (SKF) was founded in 1907 based on the invention of a self-aligning double-row ball bearing that could deal with power shafting misalignments. Previous designs failed regularly because of unavoidable misalignment; causes included the settling of factory foundations. From there SKF went on to become a first-class supplier of ball bearings for all purposes and achieved high standards of accuracy based on Johanssen's gauge blocks, also known as Joblocks.

In the early 1920s the concepts precision and accuracy collided at the Ford Motor Company (ref 1). Henry Ford had achieved mass production on a huge scale with the Model 'T' figuratively flowing out of his plant. He had achieved this by developing tooling of adequate precision to ensure that parts were interchangeable and thus could be assembled with random choices from the parts bins. This involved not only innumerable jigs and fixtures, but gauges specific to each measurement required. It has been stated that Ford at first refused to replace the Model T because of his huge investment in specialized tooling (ref 2). It is also reasonable to infer that the plant had adequate control of accuracy for bought-in parts like screws, studs, bolts and the like if they did not make them themselves.

In the early 1920s Ford wanted better wheel bearings and looked to SKF as the supplier. When the specified bearings arrived on the assembly line there was trouble; too often the bearings would not fit and the line had to be stopped (ref 1). The initial reaction was to blame SKF but SKF, using gauge blocks, demonstrated that their bearings were not at fault. Ford realised that Ford car components were precise in terms of the other components of the car but not accurate with respect to the SKF bearings in the case of the axle assemblies. The implications of precision and accuracy for dispersed manufacturing of components for complicated and highly stressed machinery had struck home with a vengeance.

Accuracy had come to the forefront. To the need for interchangeability had been added the need for immediate fit which, in a sense, trumped the demands of precision. If articles from separate manufacturers have to fit each other, then they have to be designed and built to common standards of measurement. Thereafter precision is achieved by keeping the articles within tolerances specified by the designers. It is, of course, necessary that the tolerances be defined such that the articles fit regardless of where in its tolerance range any particular dimension sits.

Precision is of prime importance in machine tools, whether basic lathes or CNC machines. If a lathe tool cannot be returned to its original position after a cut then the additional cut put on after a measurement is

uncertain. In a drill press or milling machine with worn bearings lack of adequate repeatability would condemn the machine to overhaul or the scrap pile. The same would apply to more complicated machine tools. On the other hand, constant offsets can be allowed for.

From a casual scan of the Internet it appears that, at least in North America, the formal meaning of precision for CNC machines is expressed as repeatability, and accuracy is referred to as precision. This brings us back to the inevitable statement in advertisements that a tool is a precision item. This is where the wise buyer reverts to *caveat emptor* and asks what is actually meant by 'precision' in the particular case and is also careful in interpreting the specifications. Sometimes the answer might be that the hand wheels are marked in 0.001 inch increments and one is not the wiser. In another case it might mean that the machine is accurate and precise to the numbers stated in the specification sheet but if numbers are not provided one might not even wish to consider the item. A personal inspection of non-brand name items is certainly indicated. The needed precision and accuracy of the machine are, of course, driven by the application of the machine, which may range from woodworking, to engine-building, to making components of optical systems.

If one's machines and measurement devices are not adequately repeatable, i.e. precise enough, one might not be in position to do useful work at all unless one had an infernal amount of skill. I have used the word 'adequately' to point out that one does not always have to be equipped to work to small fractions of a thou. Steam locomotives were built with 1/128 inch rules and the last metrologist of the Kingston, Ontario, locomotive works told the author that when diesels started to be produced it was a struggle to get the machinists to replace their rules with micrometers. On the other hand, buying cheap measurement tackle of unknown provenance is something that can and will lead to rueful reflection. Lastly, it is wise to remember that the machinists of 50 and more years ago were able to do excellent work without the aid of silicon life forms clinging to their micrometers, calipers, and height gauges and that quality instruments that have been cared for have an indefinite life.

ISO 5725-1 redefines accuracy and precision (**ref 8**). Accuracy is defined to be a combination of trueness and bias where trueness refers to the average of a series of measurements and bias refers to any constant offset. Precision is defined as the closeness of agreement between independent test results obtained under stipulated conditions. However, the intent of this document is to guide the evaluation of measurement methods, not to guide specific day-to-day measurements. For this reason, other than the redefinition of accuracy and precision, it is more in the realm of scientific metrology than industrial metrology. The redefinitions do not impact day-to-day measurement with calibrated instruments in any practical way.

How might all this affect the model engineer? At the closer end of the scale is the model engineer with only hand tools who manages to build a single cylinder steam engine on the kitchen table. At the far end of the scale is the model engineer aiming at the Duke of Edinburgh trophy. Most of us are somewhere in between. In a simple way, if we just want a running locomotive for the club track, accuracy only matters as far as the track gauge and the wheel tread form are concerned and precision is only necessary to ensure that all the coupled wheels and some allied components are alike. Everything else is limited by practicality, although the boiler inspector will want to know the size of the boiler components.

Leaving the free-lance Rowland Emmett stage one next comes to working from formal drawings. In this case the desire for accuracy is driven by the wish for ease of assembly and correct functioning but not by any outside pressure except the occasional appearance of a noxious 'inspector meticulous'. Lastly comes the true scale model, where the size of every part of the model should be a stated fraction (the scale) of the size of the original part. When the model is built from drawings the need for accuracy is obvious; if built from actual measurements of the original then the measuring instruments only have to be precise in the sense of giving repeatable results. As model engineers, as we work mostly from drawings, accuracy usually dominates our thinking.

Finally, in common usage the use of the words 'accuracy' and 'precision' has deviated from the formal meanings for a long time, if not forever. We are just as likely to say that a length is precisely such-and-such as to say that it is exactly so-and-so. The only way around this is to specify what we mean when we have to use the words with their rigorous meanings with respect to measurement.

I need to thank Doug Angle, a fellow member of the Frontenac Society of Model Engineers, for saving me from the worst of my original misconceptions.

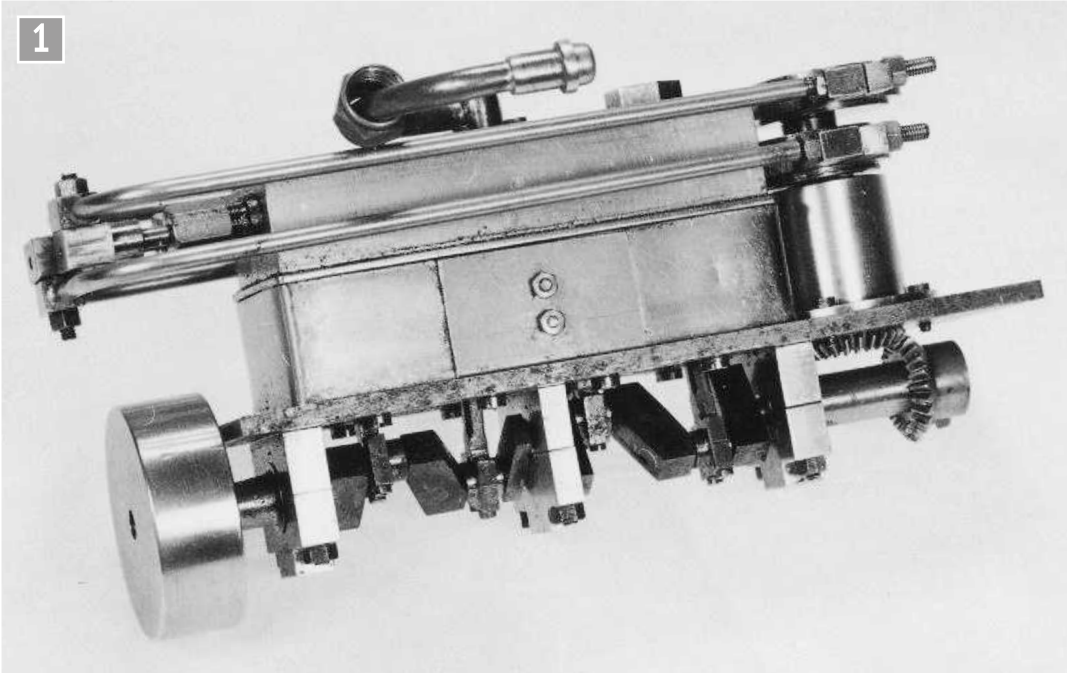
ME

REFERENCES

1. Winchester, Simon, *The Perfectionists - How Precision Engineers Created the Modern World,* Harper Collins, 2018
2. Rolt, L.T.C., *Tools for the Job: A History of Machine Tools to 1950*, London, HMSO, 1986
3. Wikipedia, *Inch*, **https://en.wikipedia.org/wiki/Inch**
4. Wikipedia, *Mendenhall Order*, **https://en.wikipedia.org/wiki/Mendenhall_Order**
5. Wikipedia, *Micrometer*, **https://en.wikipedia.org/wiki/Micrometer** (Section: History of the device and its name)
6. Althin, Torsten K.W., *CE Johansson 1864-1943 The Master of Measurement*, Stockholm MCMXLVIII
7. Busch, Ted, *Fundamentals of Dimensional Metrology*, Wilkie Brothers Foundation, 1964
8. ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results - Part 1: General Principles and Definitions*, First Edition 1994-12-15

Hotspur constructs a three-cylinder reversible oscillating engine.

Continued from p.329
M.E. 4685, 11 February 2022

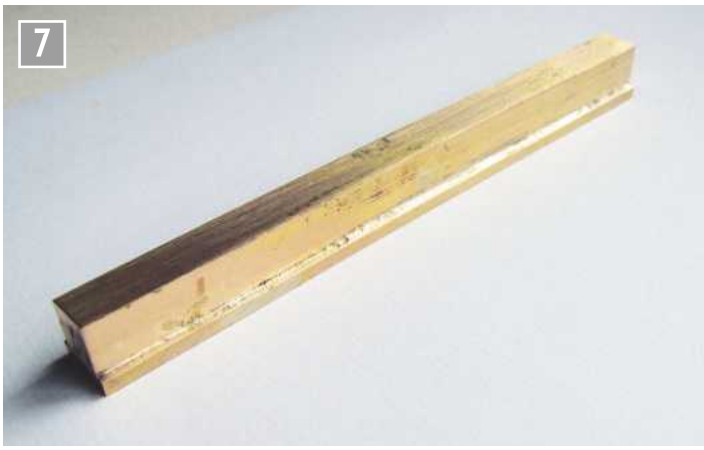


The writer's first experimental engine was a single acting four-cylinder unit with a common steam chest housing the two slide valves but there were no extra facilities and no reversing mechanism.

A Miniature Oscillating Steam Engine PART 2

Making a start

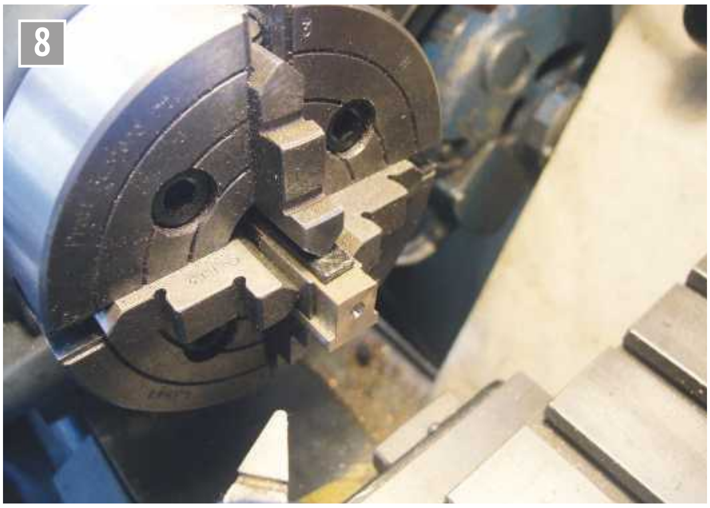
For the cylinders, the first task was to silver solder a length of ⅜ inch square brass bar to a length of ⅛ by ½ inch brass flat to create the section for the cylinder blocks. For the three-cylinder version, I used lengths of 4 inches for both as this gave sufficient to allow for the cutting into three pieces for the blocks to be machined. Part of fig 2 shows the details. The mating surfaces should be cleaned with fine sandpaper with the square section chamfered slightly on the intended joint face then held together with one or two old toolmakers clamps for fluxing and silver soldering. It is not imperative for the overhang of the strip to be equal each side but it looks better if it is. **Photograph 7** shows the fabricated bar ready to be cut into three sections a full 1¼ inches long for each cylinder. It is absolutely essential that each port face on each cylinder block is perfectly flat and this can be done on a surface plate by rubbing the contact face on some very fine emery paper.



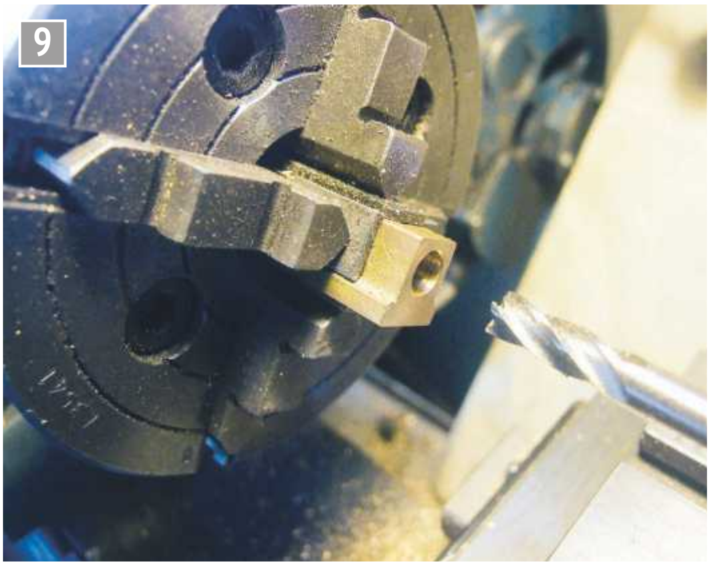
The two sections of stock brass silver soldered together to form the section for the cylinders.

To machine these small blocks I used my smallest four-jaw chuck with four pieces of suitable packing to protect the clamped faces. The need is to centre the blocks so that the ⅜ inch material has the cylinder bore on its centreline. I do not mark out the centre; I just use a lathe tool to touch each side of the bar and get the material in the centre by ensuring the reading on the cross-slide dial is the same when the chuck is turned through a rotation of 180 degrees. If the actual reading is noted then the top face of the block needs to be set at the same reading and the task is done. **Photograph 8** shows the first block set up with a centre drilled in the outer face ready for the next operations.

The cylinder bore is not drilled right through as might be expected but machined to a depth of $1\frac{3}{16}$ inches (maximum) by using a series

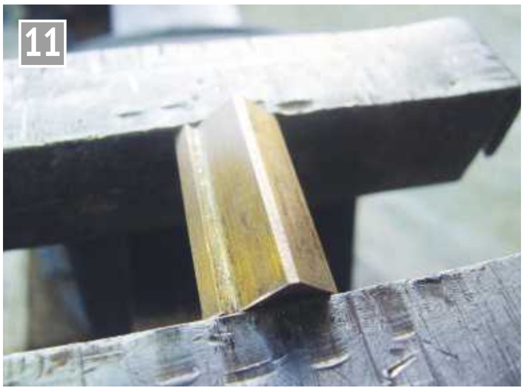


Here a short section of the cylinder block material is held in a small four-jaw chuck to centralise the bore by using a lathe tool touching the three sides and equalising the cross-slide readings.



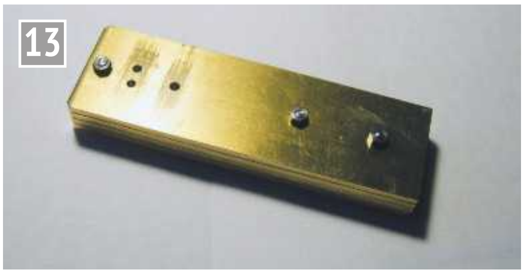
Using drills and a reamer plus an end mill to finish the cylinder bores.

Marking out and drilling the hole for the pivot pin and the steam port.



Putting a chamfer of the outer corners of the cylinder blocks for appearance's sake.

The cylinder assemblies ready for the next stage in the build.

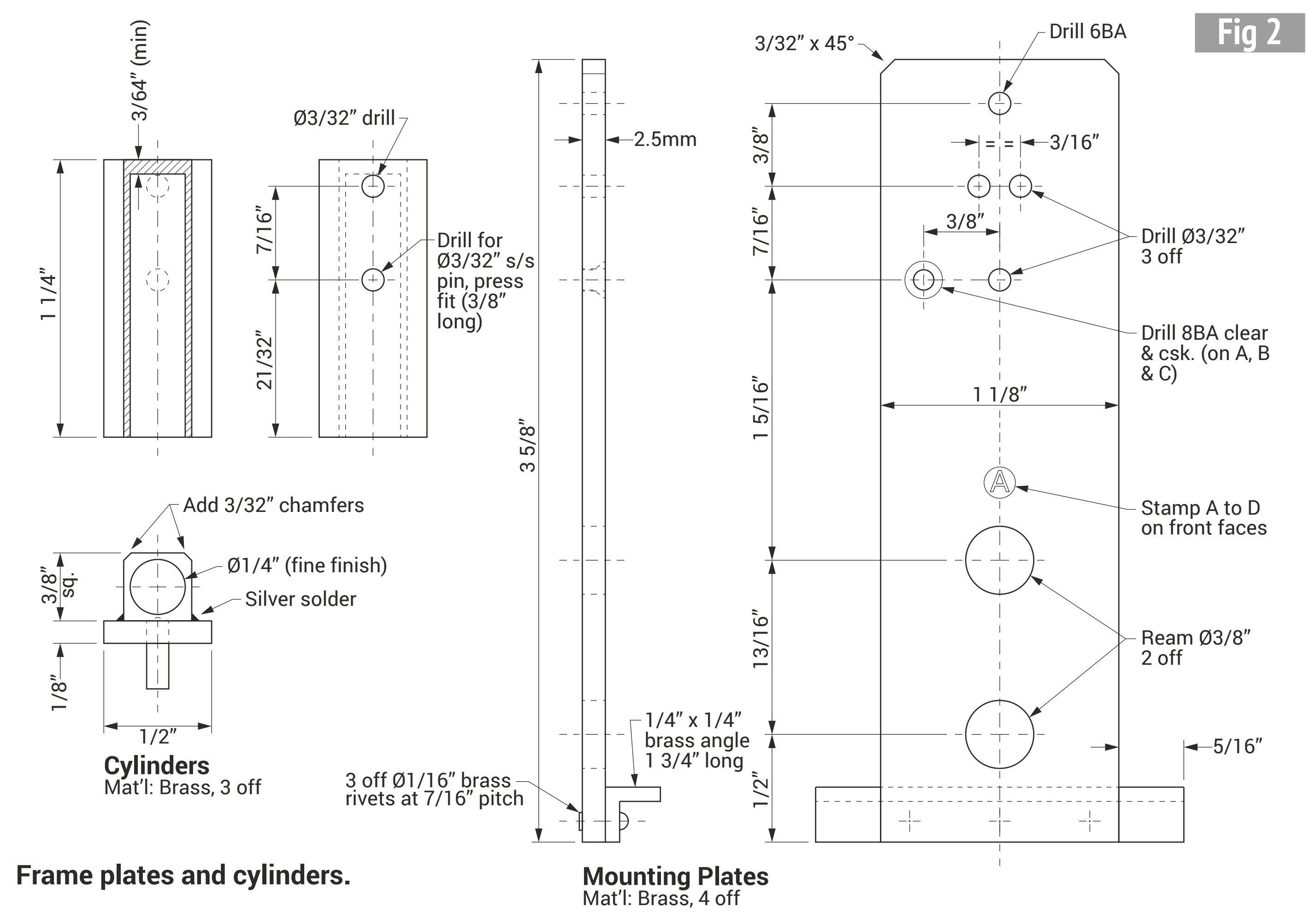


This view shows the four plates bolted together for the marking out and drilling of the steam ports and the cylinder pivots. Toolmaker's clamps were used to hold the pack for the drilling and reaming of the 5/16 inch holes afterwards.

of drills up to the reaming size for ¼ inch. The lathe tailstock graduations were used to judge the depth of the drilling and the outer end was given a small countersink before a ¼ inch reamer was used. Then, a 6mm slot drill was passed down the bore to finalise the depth and give it a flat inner end. To complete the sequence, a selected ¼ inch diameter end mill was used to ensure the bore was parallel all the way in. This series of tools was actually tried out on a scrap piece of brass bar beforehand to make sure they would give the right finish and fit for the stainless steel rod for the pistons. **Photograph 9** shows the final machining operation.

Next, the block was de-burred and reversed in the chuck to machine it to length then marked out to drill the two holes in the valve face. The first drilling into the bore was made with a number 43 drill and the pivot hole which is only 4mm deep was initially made with a number 41 drill. **Photograph 10** shows the valve face drillings completed and smoothed flat afterwards as the drillings cause the brass to lift around the edges of the holes. Later, a small countersink can be used on the pivot hole in the plate to ensure the valve faces have full contact. As a final embellishment the two outer corners of the cylinder blocks were filed to add a 45 degree chamfer that can be between 1/16 and ⅛ inch wide, but builders may prefer to radius the corners instead. **Photograph 11** shows the task in progress.

To complete these parts, the cylinder block pivot pins have to be added by pressing in a ⅜ inch length of 3/32 inch stainless steel and for this the holes already drill had to be opened up to give a suitable fit. I used a number 39 drill but this size needs to be checked against the size of the rod being used and the steel should have a small lead in taper to make the assembly easy. At the same time the three pistons can be cut from the stainless rod and made 1½ inches long and have three fine groves cut into them say ⅛ inch apart near the top end to assist the fluid sealing properties. Then, with all the burrs carefully removed, the 3/32 inch cross-holes for the crankpins can be added 5/32 inch up from the bottom end. I made my crankpin holes by holding the material in a small machine vice which has a 'V'- slot to hold the material horizontally and used a small square file to make a shallow mark horizontally on the diameter. This was then given a centre mark for the pin hole and it was drilled and reamed 3/32 inch diameter. If this diameter seems too tight for the crankpin then the next larger number drill size should



Frame plates and cylinders.

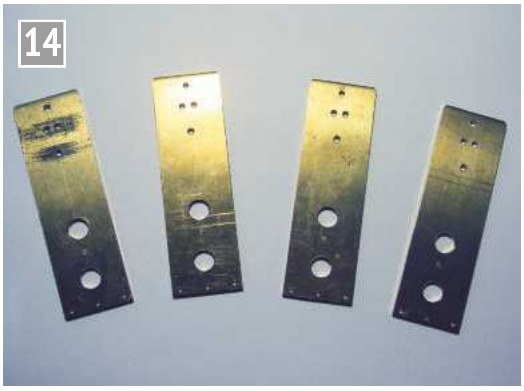
be used. Finally, **photo 12** shows the assemblies ready for the next stage.

Building the engine frames

The details for the four frame plates are given in fig 2 for the three-cylinder engine. Mark out the 2½mm thick material and cut them into rectangles then select one of the plates to have a centre line and be the one on which to mark out all six hole centres. You may consider using just pilot holes for the various positions on the first plate and then clamping them all together for filing or machining the outside faces. My plates were all cut and finished to size so they could be accurately clamped together to drill the holes at one setting. **Photograph 13** shows the plates held together with three 6BA bolts. The holes are, from the top downwards: the top spacing stud hole, the two steam ports, the cylinder pivot hole and the clamping hole for the 8BA screw for the leaf spring (only needed on plates A to C), the main crankshaft bearing hole and the driven shaft bearing hole at the bottom. My drawing also shows that the full pattern of holes applies to only three of the four plates and these are identified A to D from the front end. Note that the 5/16 inch diameter holes for the lower driven shaft can be the same for all four plates and used for checking the alignment when they are mounted on the side angles but, later, only the two end holes will have bushes added for the driven shaft. I have also added the three 1/16 inch diameter rivet holes at the base to attach the plates to brass angle cross members.

Dismantle to do the de-burring and make sure that all the plates are marked, A-D, and that the face sides are used for the assembly of the cylinders on B, C and D; see **photo 14**.

Plate A has a spring to ensure the first cylinder mounted on plate B will be in contact with its mating face but it also has two 3/32 inch brass rivets added to seal the two redundant ports and a short length of a plain shouldered 7BA bolt can be used to provide the centre location for the spring on its rear face. **Photograph 15** shows the finished plate A and a spring added onto plate B.



Here the four plates have been finished except for the 8BA holes and identified A-D on their faces sides.

The left-hand plate has been given the centre pivot bolt that locates the spring and the 8BA screw and nut securing the spring is shown countersunk into the plate beside it. The right-hand view shows a typical plate B or C.

●To be continued.

An Astronomical Bracket Clock PART 24

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

Continued from p.321
M.E. 4685, 25 February 2022

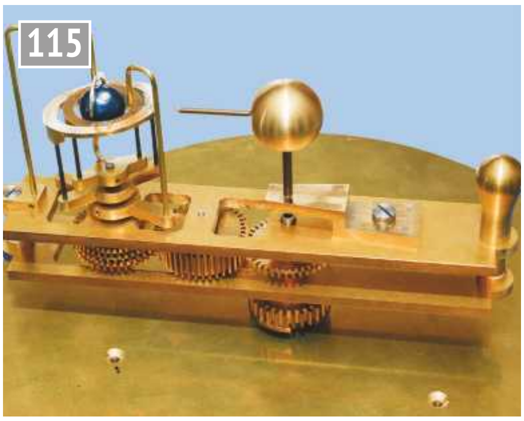
Tellurian

With the case complete we can return to the metal workshop and make the tellurian.

A tellurian is a special form of orrery depicting aspects of the earth, moon and sun. The design chosen was invented by James Ferguson (1710 – 1776) and provides both astronomical and engineering interest. The former includes the effect of the tilt of the earth's axis in changing the length of the day and the related seasons, the rotation of the plane of the path of the moon which is a determinant of eclipses of the sun by the moon and the variation of the apparent size of the moon from perigee to apogee. The engineering interest, the so-called 'Ferguson's Paradox', is an optical illusion in which one of the three gears, all driven by the same gear, appears to rotate backwards, another stationary and a third to rotate forwards. This is not apparent in the slow motion of the clock's drive and so the design allows it to be driven by hand to demonstrate this effect as well as for resetting.

Those wishing to add this feature should read the excellent articles published in *H.J.* (**ref 17**) describing both the Ferguson tellurian and the construction of two versions. Those who have CNC equipment may also wish to read the articles in the *Digital Machinist* (**ref 18**).

Construction of the tellurian is similar to the clock so I will therefore restrict my comments to specific issues. The accompanying photograph shows the tellurian as machined (**photo 115**).



115

The complete tellurian.

116

The tellurian frames.

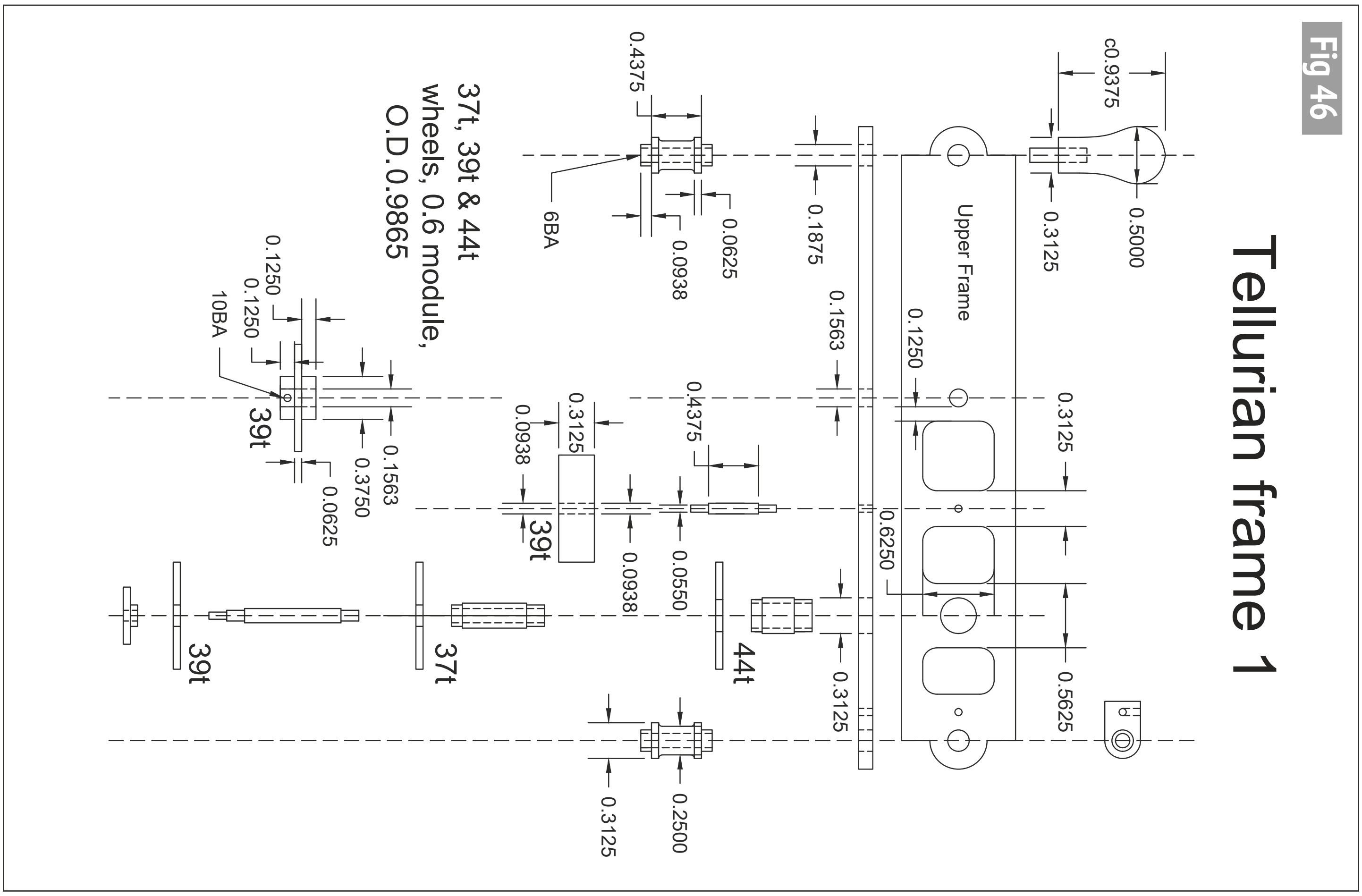


Fig 46 Tellurian frame 1

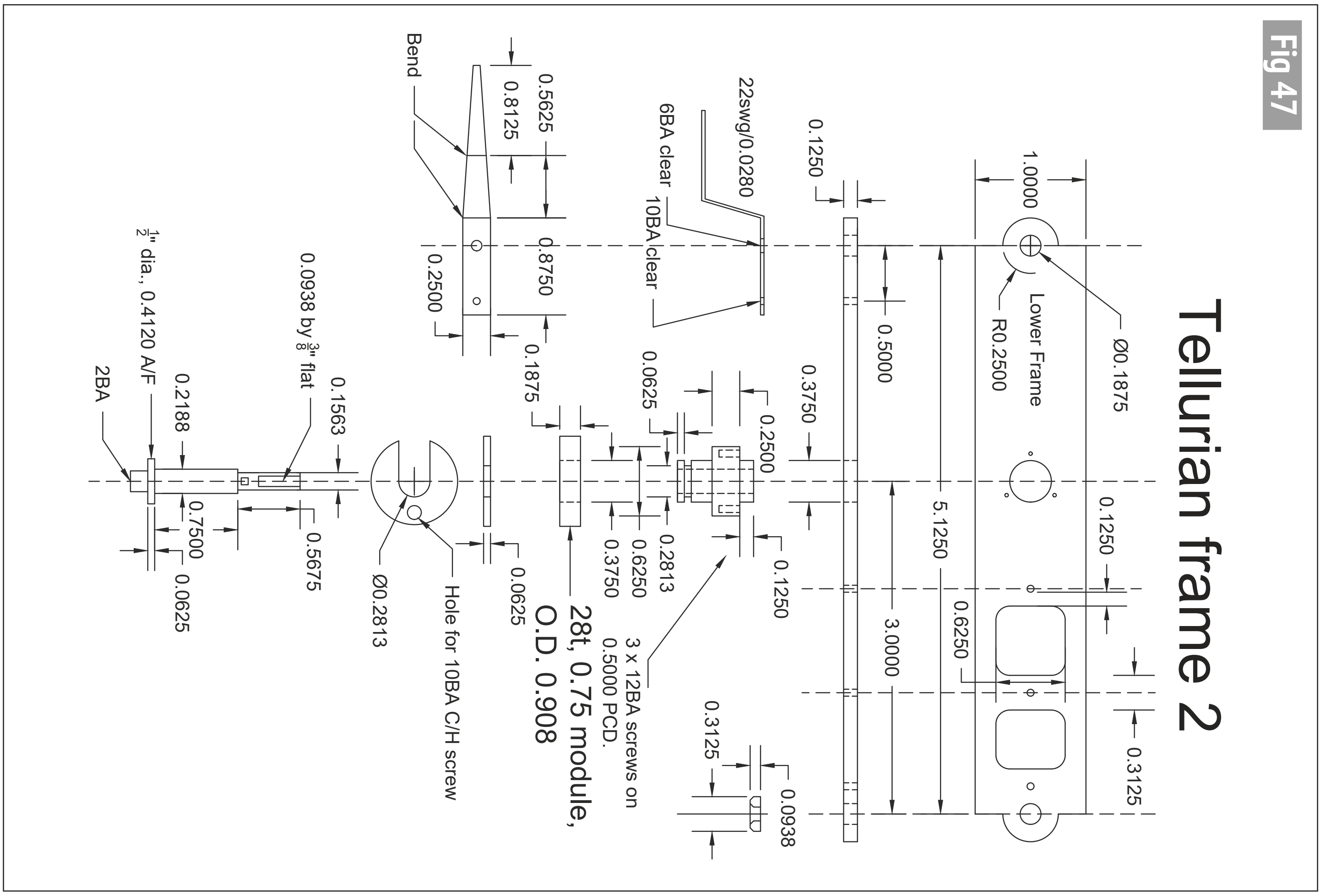


Fig 47 Tellurian frame 2

Frames

The two ⅛ inch thick frames should be treated as clock plates and registered together with taper pins at two diagonally opposite corners. This will ensure that the pillar and pivot holes are aligned and it also allows the edges of the frames to be easily milled parallel and to the same width (**photo 116**).

Note that the cut-outs in the frames to help balance their weight are not the same on both frames. I drilled all four corners of each and cut out the middle with a piercing saw and then filed to final shape. I thought the corners looked better left round but they could be filed square if preferred.

Wheels

From an engineering viewpoint Ferguson's design is appalling as it involves cutting 37t, 39t and 44t wheels from blanks of the same diameter, all of which need to engage with the same 39t wheel within the rotating arm. It is not theoretically possible to vary the number of teeth without changing either the diametric pitch or the blank diameter. Luckily epicycloid gearing is surprisingly forgiving when the rates of rotation are low and hardly any power is transferred.

Cut the teeth for these wheels in the usual way with a 0.6 module wheel cutter but do use a black marker pen on the edge of the blank so that you can judge when the cutter is at the needed depth (the black witness line just vanishing). Using a Thornton cutter this will theoretically require the depth on the 39t wheel to be 0.0795 inch. On the 44t wheel I found I only needed to feed in 0.0760 inch whilst on the 37t wheel I needed to feed in 0.0815 inch.

All the other wheels can be cut in the usual way, just as those for the clock.

Concentric wheel support tubes and arbor

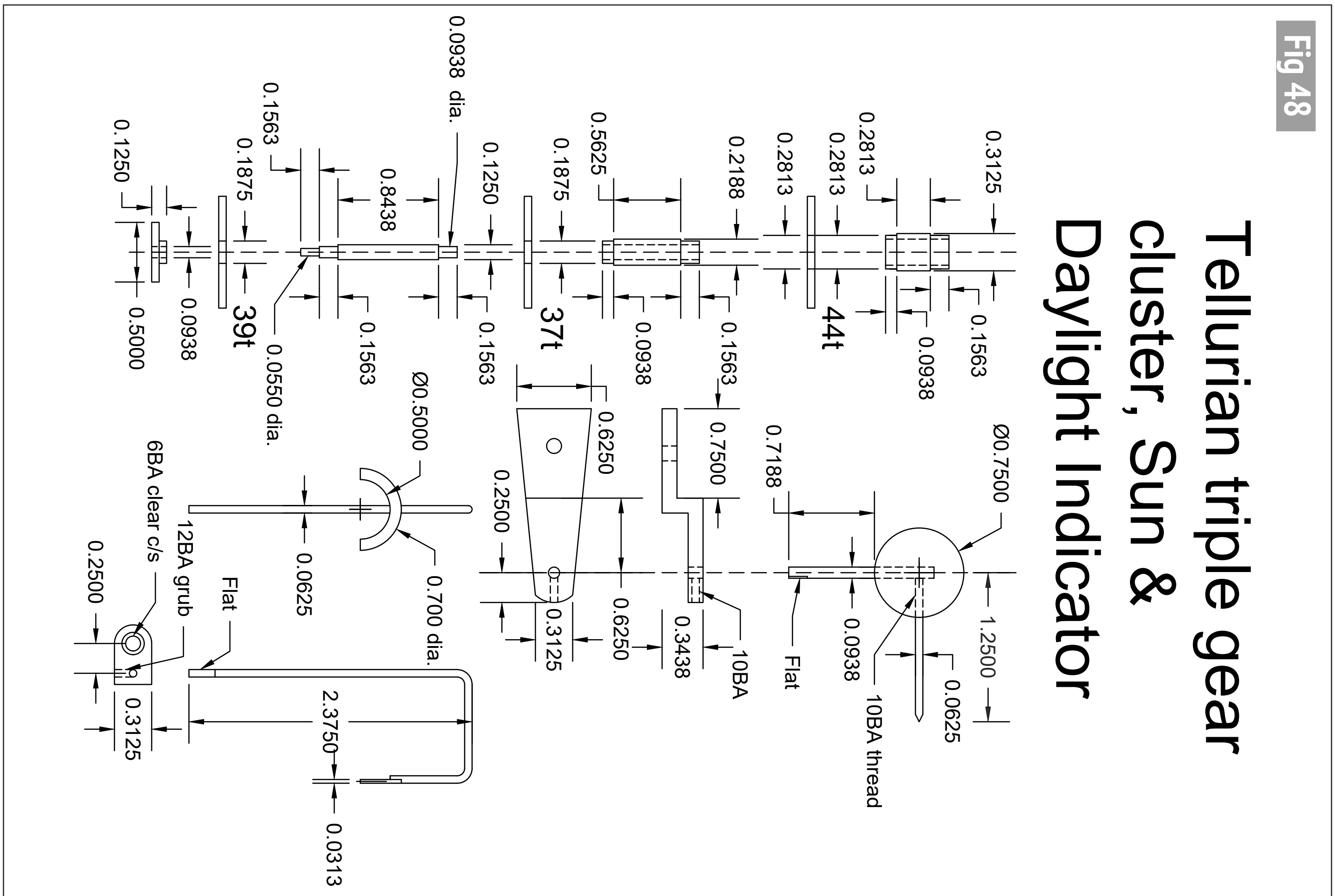
These were all turned from silver steel and not hardened. The tellurian turns very slowly and hardly any power is involved so wear will be minimal. After one hundred years the tellurian may have only turned a few hundred times even including for demonstrations! The arbors could have been turned from mild steel but silver steel has the advantage of being straight and the outside ground to a known diameter. The tubes were drilled, bored and reamed to the correct bore. A short polishing session on the outside of the silver steel and an equally short lapping session with a dowel gave a close and easily running fit to the three concentric parts. Do wash the parts after polishing and lapping to stop further abrasion.

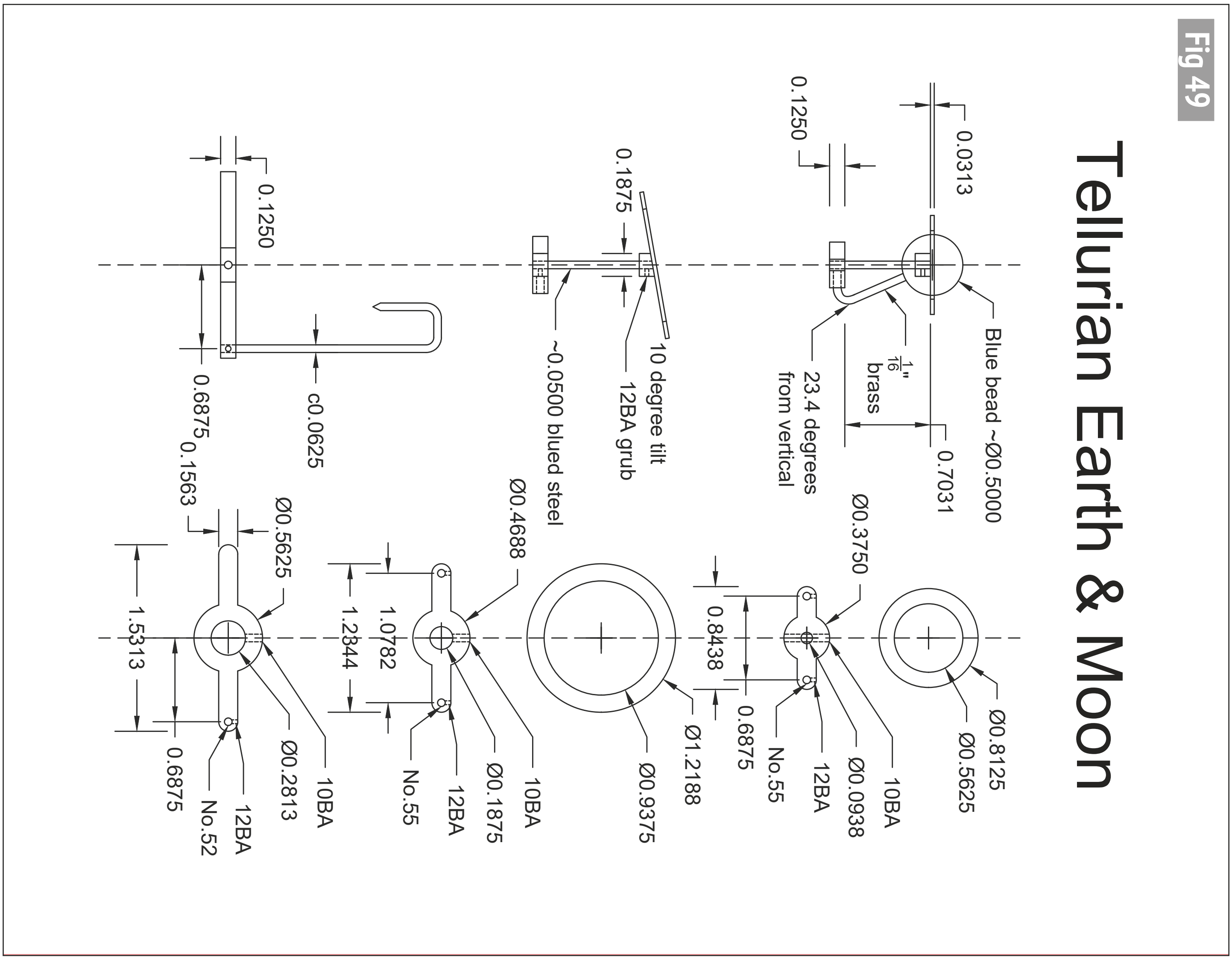
The 44t and 37t wheels were Loctited to their respective tubes. The 39t wheel was not fixed to its arbor until after the wheels were depthed (**photo 117**).

117

The main wheels for the tellurian.

Fig 48





Wheel depthing

The only comment is that when depthing the wide 39t wheel with the 37t, 39t and 44t wheels do check that all three mesh. Do not assume that if one does then the others will also depth correctly. I mounted all three wheels on my wheel depthing tool at the same time to check depthing with the wide 39t wheel. It will be found that the wheels need to be a little further apart than normal.

Slip washer to allow the tellurian to be adjusted.

The drive under the frames

The 28t wheel drive wheel is held in place on the collet by a slip washer which allows the tellurian to be driven by the clock or rotated by hand for setting or demonstrating the mechanism. The bush on which the wheel is mounted is secured to the lower plate by three 12BA screws (**photo 118**).

The cross beams supporting the earth, moon ring and apogee pointer

The three brass cross beams which fit on to the concentric tubes were filed to shape after drilling and reaming the central hole as well as the outer holes. Mild steel filing buttons are, in my view, essential for this type of work but in this case they are small. Once filed, the 10BA cross hole can be drilled and tapped for the 10BA brass grub screw. Similarly drill and tap the 12BA holes for the grub screws that secure the blued support rods.

●To be continued.

REFERENCES

17. *James Ferguson's Mechanical Paradox Orrery* by Ian Coote and James Donnelly, *Horological Journal*, September 2009, pp396-0399, October 2009, pp444-447 and November 2009,488-491.

18. *Ferguson's Mechanical Paradox Orrery Table* by James Donnelly, *Digital Machinist,* Vol.4, No.3, pp6-12, Vol.4, No.4, pp14-18 & Vol.5, No.1, 14-19.

A Geared Transmission for Westbury's Road Roller PART 2

Ted Hansen replaces Westbury's original with a more prototypical gearbox.

Continued from p.315
M.E. 4685, 25 February 2022

The case

My original transmission used a welded steel case but a later case made of silver soldered brass sheet proved much easier to construct (see **figs 3** and **4**).

In brass, the sides should be a minimum of 3/32 inch thick to allow threading screws directly into them. Clamp the sheets for the two sides together, mark out the profile and the locations for the three transmission shafts plus the hole for the idler shaft. Drill the holes for the transmission shafts to ¼ inch diameter only and cut the outside profile to shape. Only the right-hand plate needs the hole for the idler shaft. Separate the two sides, then drill this hole 5/32 inch (tapping size for a #10-32 screw) through the plate.

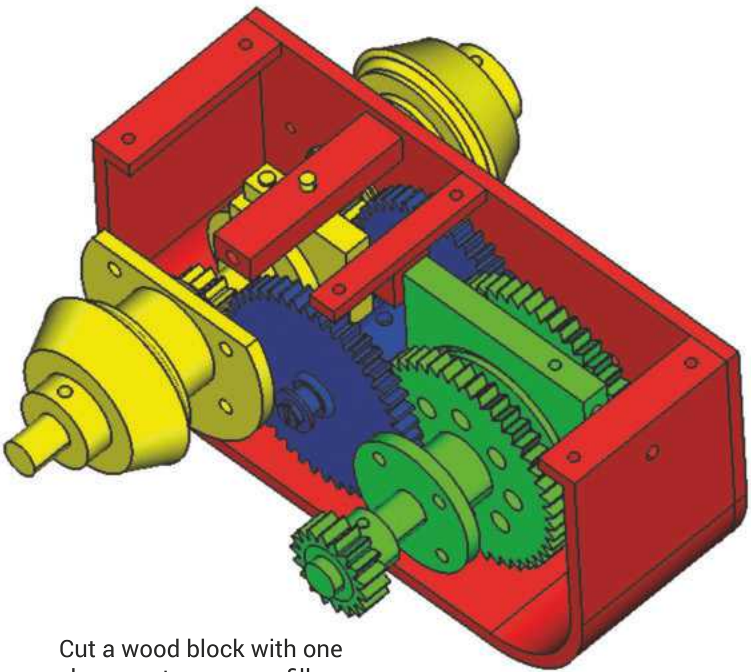
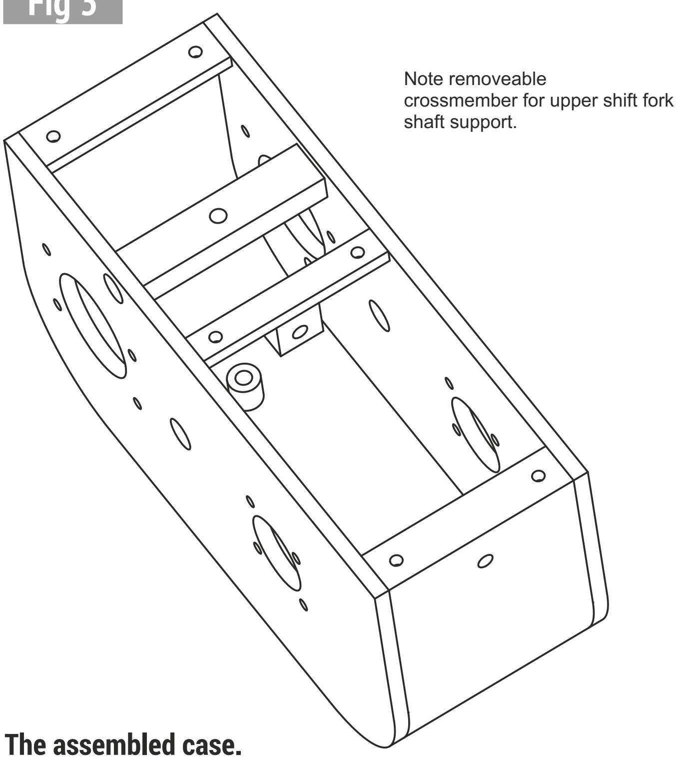


Fig 3



The assembled case.

Cut a wood block with one end square to use as a filler for assembling the pieces. The thickness of the block should be 1⅞ inches minus twice the thickness of the side plates (i.e. 1⅝ inches for ⅛ inch thick side plates). Clamp a side plate to the block to locate the holes for the input and output shafts. Drill ¼ inch through the block at these locations, making sure the holes are perpendicular to the block surface. Shape the outside of the block to match the shape of the side pieces with a small allowance for the thickness of the bottom and end material. To prevent burning the wood former when brazing, trim the block back from the edges in places where the initial spot welds will be applied (**photo 3**).

3

The pieces for forming the case in brass. Note the cutaway parts of the wood former where the initial spot brazing will be applied.

The bottom and ends start from a piece of brass 1⅞ inches wide by approximately 10 inches long. It can be of thinner material than the sides. Use the wood block as a form to bend the material to shape.

Clamp the side pieces together over the wood former using ¼ inch bolts through the sides to maintain alignment (**photo 4**). Spot braze in several places then remove the wood block and finish the brazing in short sections to minimize distortion (**photo 5**). Add the small cross pieces at the top and braze them in place then finish the top

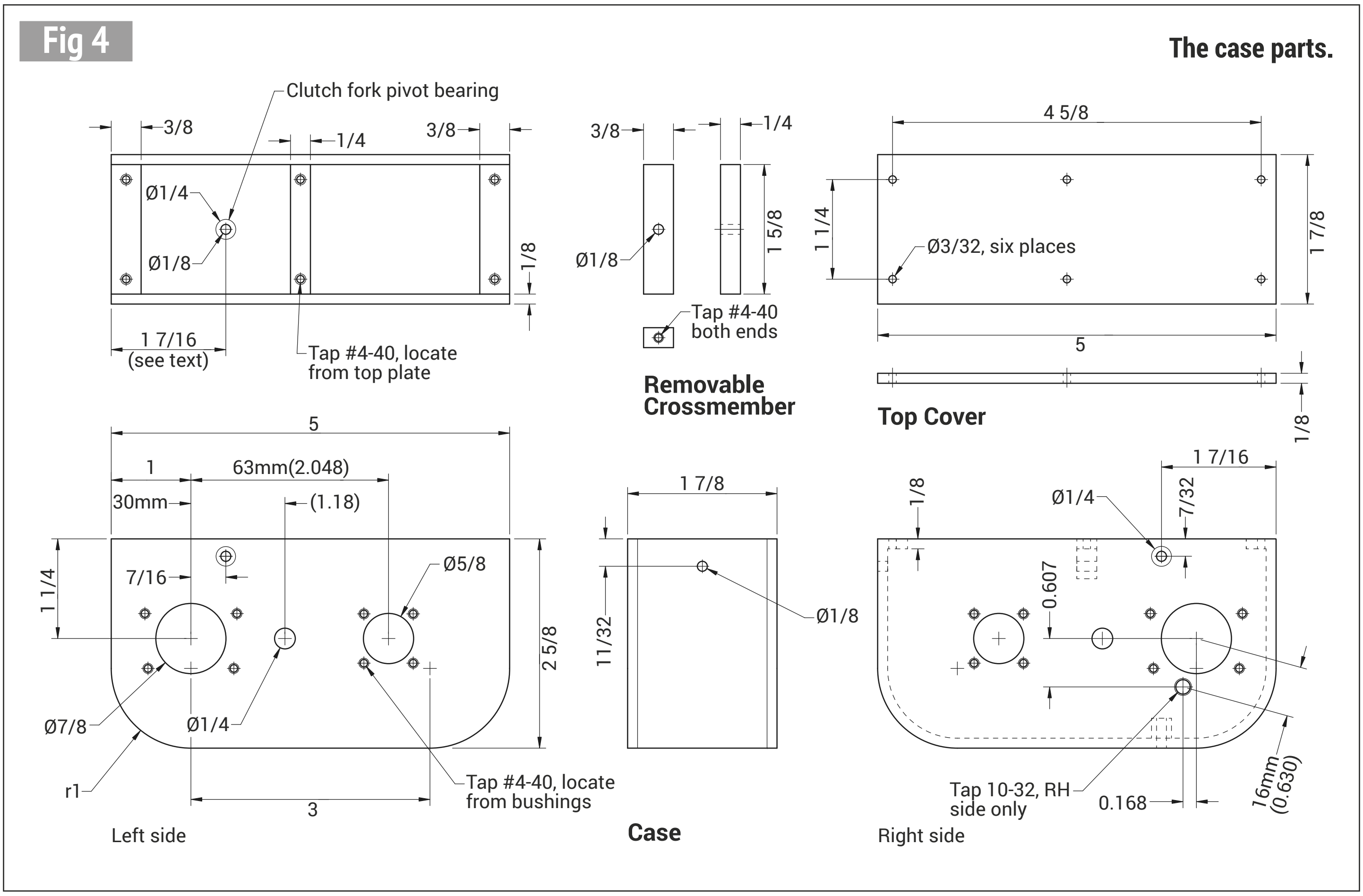


Fig 4 The case parts.

surface. It should be flat but does not have to be accurately located so this can be done with a file or a belt sander.

After the case is complete, open out the holes for the shaft bushings to the finished size. Try to locate the holes at the proper centre distance for the gears but, if necessary, the hole in the case for the bushings can be made a bit oversize to allow some room for alignment to get the gears to rotate smoothly.

Make up the small boss for the bottom bearing of the clutch shifter fork and braze it to the inside of the case bottom. Locate, drill and ream the holes for the shifter fork rod. It should be centred in the case and 7⁄16 inch to the rear of the input shaft centre line.

For a steel case (**photo 6**) the bottom and the ends are separate pieces because steel thick enough to weld easily would be difficult to bend. As with the brass version, the side material should be at least 3⁄32 inch thick. The end and bottom material can be thinner, although it must thick enough so that burning through while welding will not be a problem. Since steel is a more difficult material to shape than thin brass, a simple chamfer may be preferable to a curved corner at the bottom edge.

Cut the side pieces to shape as outlined above for the brass version and similarly make the wood former.

Clamp the sides to the wood former and clamp the end and bottom pieces to it, then spot weld in place. Check that the sides are still in line and complete the welds.

Weld the two small top end cross pieces and the central cross member in place, then machine the top surface flat to fit the top cover.

Instead of brazing a boss to the bottom of the case as


Clamped together and ready for brazing.


Brazing completed and pickled. Note how the ends are much thinner material than the sides.


Variations: two slightly different welded steel cases.

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above, drill and tap a #10-32 threaded hole in the proper location, then fit a threaded brass bushing into it.

For both versions, cut the top cover to size, clamp it in place and drill the holes for the fastening screws through both it and the case at the same time.

Cutting the Gears:
All the gears are bronze (or brass) and are 20 degrees metric Module 1 pitch. My set was cut on one of the popular 7 inch mini-lathes using shop made tool bits in a flycutter, a vertical slide and the Modular Dividing Head described in *Model Engineer's Workshop* magazine, January to April, 2020 (**photo 7**). (It is not a coincidence that the change gears on the mini lathe are also 20 degrees Module 1.)

There are 11 gears in total, 3 of 14 teeth, 2 of 18 teeth, 2 of 46 teeth and one each of 20, 42, 52 and 96 teeth (see **table 1**). Four standard gear cutters are normally specified to cover this range of gears - a number 1 cutter (56 to 134 teeth), a number 2 (35 to 54 teeth), a number 6 (17 to 29 teeth) and a number 7 (14 to 16 teeth).

Table 1. List of gears.

Quantity	Teeth	Outside Diameter (in/mm)	Purpose	Notes
2	14	0.625/15.9	Input shaft	See drawing: 3/16 inch wide gear 0.005 under ideal diameter with 7/16 dia x 11/16 long flange attached & are press fitted into the clutch inner
1	14	0.630/16.0	Counter shaft	plain gear ¼ inch wide
1	20	0.866/22.0	Counter shaft	plain gear ¼ inch wide
1	46	1.890/48.0	Counter shaft	plain gear 3/16 inch wide
1	52	2.126/54.0	Counter shaft	plain gear 3/16 inch wide
1	18	0.787/20.0	Idler	plain gear ¼ inch wide
1	52	2.126/54.0	Output shaft	3/16 wide with 19/32 dia x 5/16 long flange attached
1	46	1.890/48.0	Output shaft	3/16 wide with 19/32 dia x 5/16 long flange attached
1	18	0.787/20.0	Final drive	3/16 wide with 19/32 dia x 5/16 long flange attached and tapped for set screw
1	96	3.858/98.0	Final drive	3/16 wide and fitted to differential carrier

Commercial cutters are expensive and I prefer to do as much 'home shop' as I can. I was able to cut all the gears with only three shop made cutters carefully sized to cover the 14 to 20 tooth range with a single cutter (**table 2**, **figs 5** and **6**).

All gears except the 96 tooth final drive gear and the idler are made with a 5/16 center hole.

The cutters are made from hardenable steel approximately ¼ inch thick. My source material was an old file with the teeth ground

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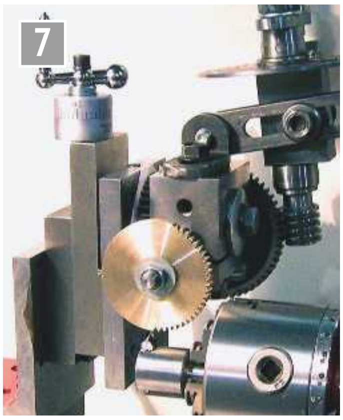
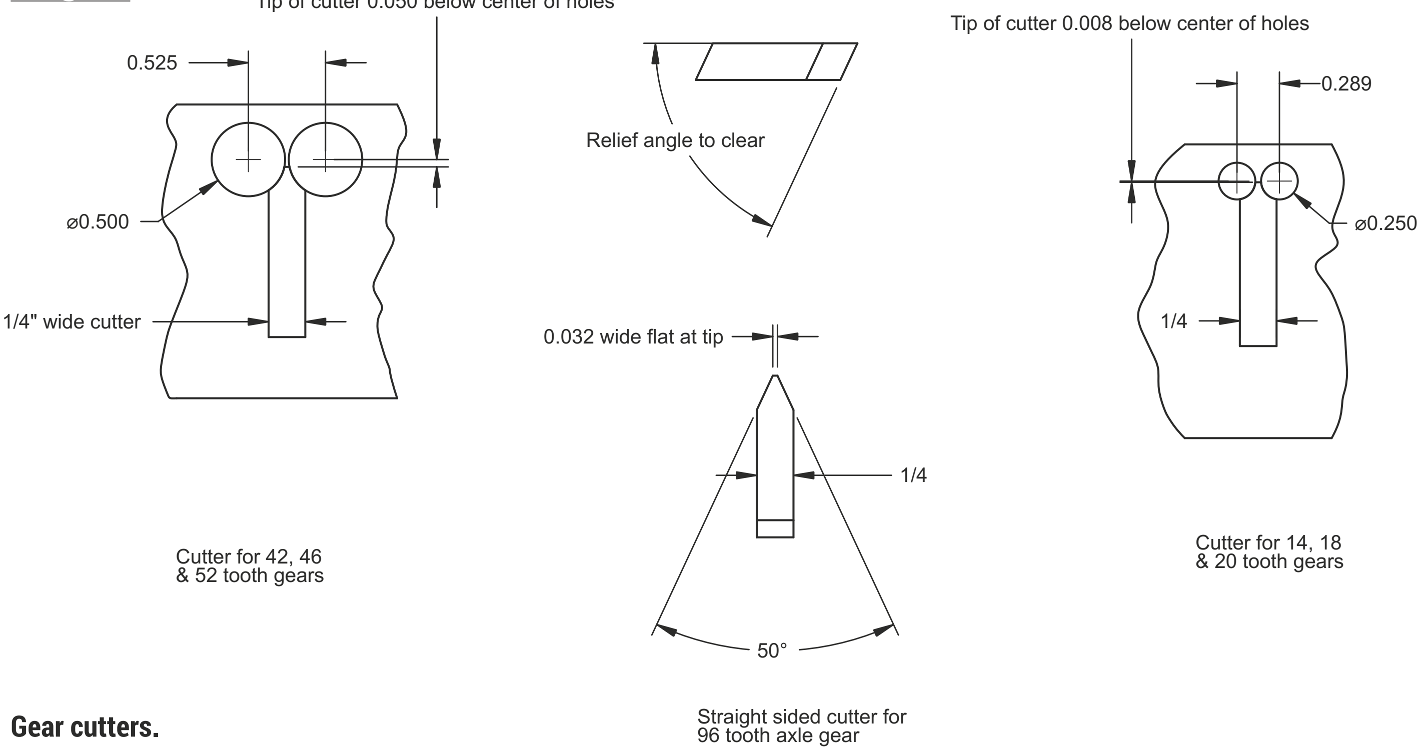


Flycutting one of the transmission gears using a shop made indexing head and a vertical slide in the lathe.

8

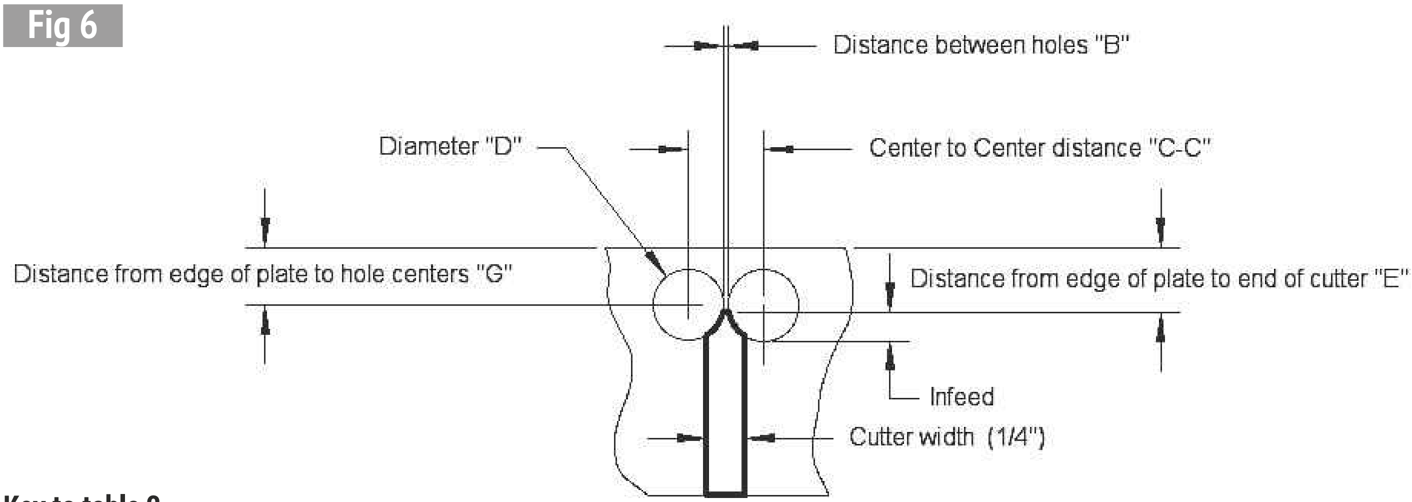
A cutter marked out on a piece of hardenable steel.

Fig 5



Gear cutters.

Fig 6



Key to table 2.

off smooth. Anneal the file by heating it to a dull red heat then leaving it to cool slowly. It helps to first coat it with soap (normal washroom bar soap) which will prevent scale forming on the hot metal.

Table 2. Gear tooth cutter dimensions

Teeth	Drill size 'D'	Hole centres 'C-C'	Infeed	Layout data		
				Edge to hole centres 'G'	Edge to end of cutter 'E'	Space between holes 'B'
42,46,52	½ inch	0.525	0.447	0.375	0.425	0.025
14,18,20	¼ inch	0.289	0.117	0.250	0.258	0.035
96	Use straight sided cutter, 50 degrees included angle, 0.035 inch wide at the tip					

Instead of making hardened disks to shape the cutter as in the 'normal' method of forming gear cutters (**ref 3**), holes are drilled in the annealed source material (**photo 8**). These holes create the radial sides on the tip of the cutter and must be sized and located as accurately as you can. Be especially careful to get the distance from the center of the holes to the tip of the cutter as accurate as possible. Drill the holes first, then cut the rest of the cutter to shape.

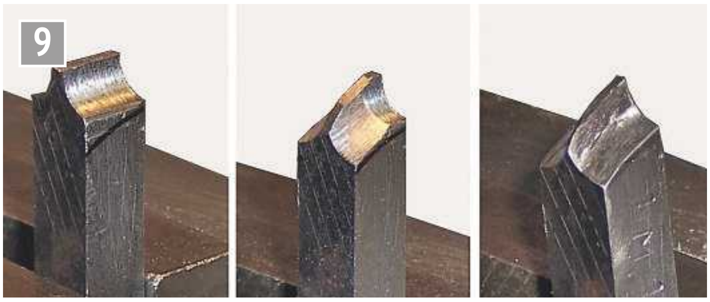
Once the basic shape of the cutter is completed, coat the sides at the tip with marking blue and grind the tip and side relief by hand using a 'Dremel' type grinder (**photo 9**). Take the angle up as close to the top edge of the cutter as you can, leaving only a very small land untouched to make sure the shape of the cutting edge is not changed. Because this is a relatively small diameter flycutter, the relief angle must be quite extreme.

The surface of the back relief must not contact the workpiece. If it does, it may shift the gear blank slightly on the indexing device with each revolution, resulting in an inaccurate gear. I once created a 96 tooth gear which ended up with only 84 teeth because of the cumulative effect of this small shifting!

Check that the back relief is adequate by coating the sides of the cutter with marking blue and making a test cut in scrap material. Grind down any spots where the ink has been rubbed off.

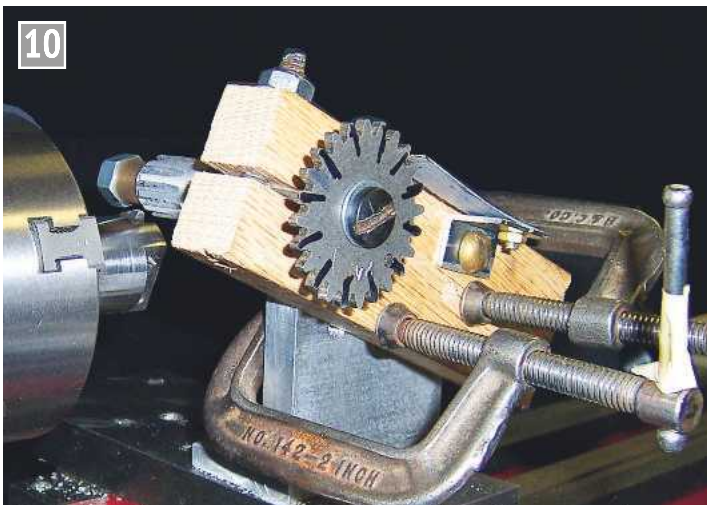
Re-harden the cutter by heating to red hot ('colour of cooked carrots' red) and plunging into water or oil. Again, coat first with soap to prevent scaling. It will now be very hard but also very brittle. Anneal by placing in the domestic oven at about 350 degrees F (180 degrees C) for half an hour or so and the cutter is ready for use.

9



Grinding the back relief on a cutter.

10



An improvised indexing device with a hardwood block clamped to an angle plate on the lathe cross slide.

Cutting the gears

Cutting the gears will vary depending on your equipment but the basic procedure will be the same.

First, form the gear blank with a 5⁄16 inch centre hole and the outside diameter specified in table 1.

Set up your dividing equipment to give the required number of divisions. It is possible to make gears using a rotary table with a dial calibrated in degrees but it is much easier with an indexing plate. It is also possible to make gears using an improvised indexing system – provided you have a gear with the proper number of teeth to use as an indexer (**photo 10**).

The actual cutting of the gear teeth is a simple, repetitive operation. Position

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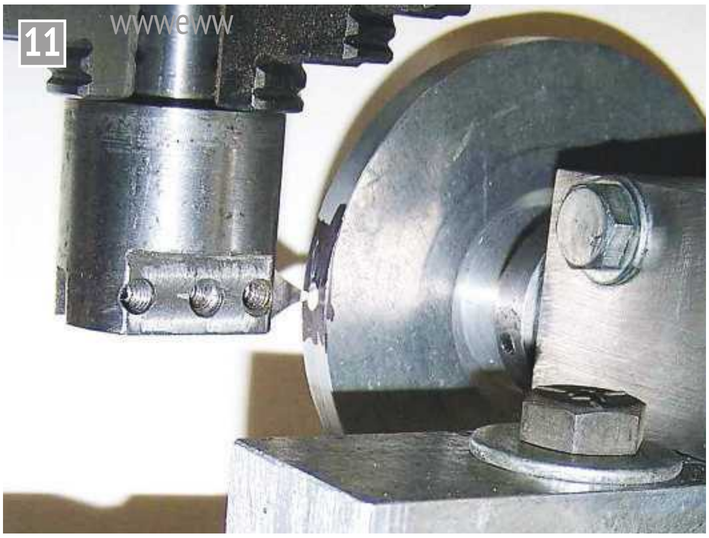


Finding the centre of a gear blank.

Gears and the flycutter bits used to make them.

the flycutter on the centre of the gear blank by marking the side of the blank with layout ink, then advancing the cutter until it just touches the blank. Raise and lower the cutter so that it makes a small mark on the side of the blank (**photo 11**). This mark will be at centre height and can be made small enough so that the cutter can be positioned by eye. Advance the cutter the required amount of infeed (0.091 inch (2.314mm) for Module 1 gears) and cut each tooth in turn. In brass or aluminum, each tooth can usually be cut in one pass. Steel gears may require two or more passes, especially with a shop made carbon steel cutter.

Photograph 12 shows the flycutter and some of the gears cut using it, although these are for the differential, not the transmission.

●To be continued.

REFERENCES

3. Law, Ivan, *Gears and Gear Cutting*, Special Interest Model Books Ltd 2014

NEXT TIME

We deal with the internals of the transmission.

NEXT ISSUE

Little Demon

Mick Knights builds Steve Huck's Little Demon supercharged V8 internal combustion engine.

Brushless DC Motors

Brian Gawthorpe shares the results of his experiments with driving brushless DC motors.

Accuracy and Precision

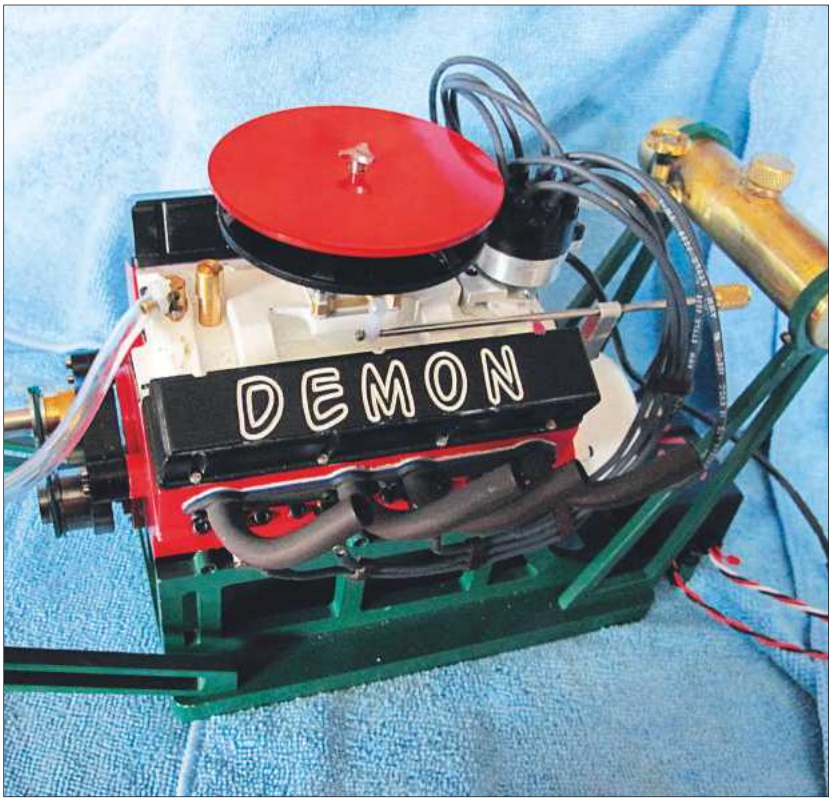
Rhys Owen continues the discussion of accuracy and precision by looking at how various measuring instruments achieve these two things.

Astronomical Clock

Adrian Garner creates the sun and earth and adds them to the tellurian of his astronomical bracket clock.

Steam Engine

Ron Fitzgerald continues his tour of Boulton and Watt's Soho Foundry with a look at the first cylinder boring machine installed there.



Content may be subject to change.

ON SALE 25 MARCH 2022

Puma A Four Cylinder, Twin Camshaft, 30cc I/C Engine PART 6

Pete Targett builds his own version of Malcolm Stride's twin cam internal combustion engine.

Continued from p.313
M.E. 4685, 25 February 2022

Setting up the timing

I followed Malcolm's instructions to set up the *Bobcat* and it just did not work for me. It started with the method of setting the cams on the camshaft, which I have already covered. So, let us assume you have an accurately positioned set of cams. If you haven't then you will find out here.

There are two parts to this job; the valve timing and ignition timing. The valve timing is done first but before that, a few little gadgets need to be produced to assist you

Malcolm provided a disc with the various timing positions. I struggled with getting it to stay in position while the engine is turned over to the various angles for the set-up. As I was using a flywheel, that gave me a better surface to work from and I resorted to two marked up strips, one for cylinders 1 and 4 TDC and the other for 2 and 3 TDC. Of course the layout of these strips is dependent upon the diameter of your flywheel - if you have one. The offset from TDC is calculated as π x diameter x offset/360.

You will notice that the exhaust open and close positions for each cylinder pair are on the strip for the opposite cylinder pair (**table 7**, **fig 11** and **photo 39**).

The key to an accurate set-up is determining TDC and poking something down the spark plug hole isn't that accurate! Fix a short length of stiff wire to the top of the crankcase that extends over the periphery of the flywheel. Make a simple ¼ inch x 32 plug that can be screwed into the spark plug hole and is long enough to touch the top of the piston (**photo 40**). With the plug in place, in cylinder 1, carefully turn the flywheel until the piston touches the plug and mark the flywheel where the pointer is located. Rotate the flywheel in the opposite direction until the piston touches the plug again. Mark the flywheel. The midpoint between the two marks is TDC for cylinders 1 and 4. Repeat with the plug inserted in cylinder 2 and determine TDC for cylinders 2 and 3. With suitable tape fix the timing strips to the flywheel with the TDC at the marks on the flywheel. Do not forget to remove the plug.

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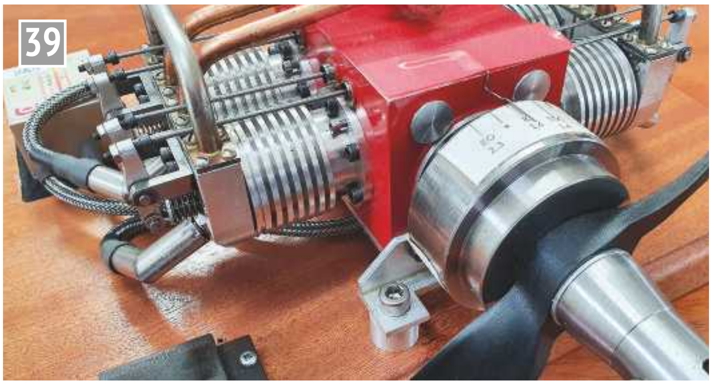
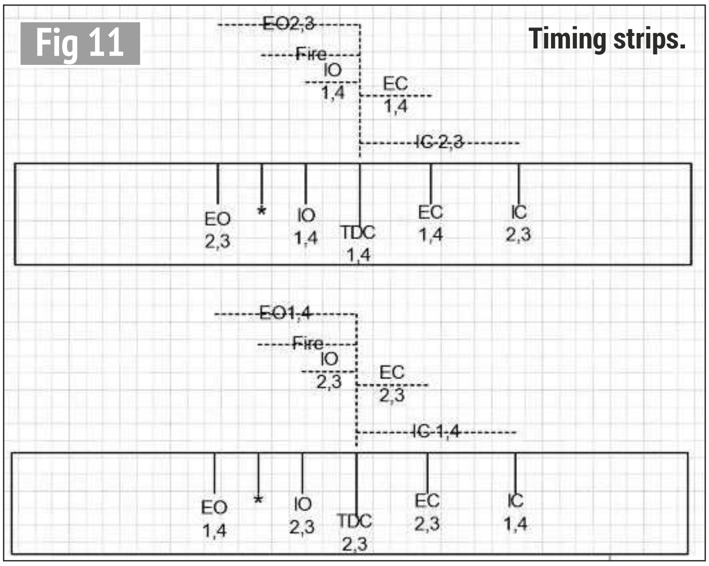


Timing strip in on flywheel.

Table 7. Data for timing strips.
(** Note for RCXel units not the Mini Mag units)

Cylinders	Action	Angle	Example for 60mm dia flywheel
2,3	EO	-40	-20.9mm
1,4	Fire	-28 **	-14.7mm
1,4	IO	-15	-7.9mm
1,4	TDC	0	0.0
1,4	EC	20	10.5mm
2,3	IC	45	23.6mm
1,4	EO	-40	-20.9m
2,3	Fire	-28 **	-14.7mm
2,3	IO	-15	-7.9mm
2,3	TDC	0	0.0mm
2,3	EC	20	10.5mm
1,4	IC	45	23.6mm

Fig 11



Timing strips.

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Valve timing

The next job is setting up the two camshafts. With the timing pulleys, timing discs, belt and tensioner installed - but without the camshaft timing pulleys attached to the shaft - use the magnets mount disc to turn the camshafts. Check and set the tappet clearances for all eight valves to 0.01mm.

Rotate the flywheel in the normal direction of rotation (anticlockwise viewed from the front) and lock at the 1,4 EO mark. Now rotate the left-hand camshaft clockwise from the rear, using the magnet mount disc until the No. 1 exhaust valve just begins to open. You cannot do this by eye; use a DTI on the top of the No. 1 valve adjustment screw. Lock down the timing pulley for the camshaft using just one grub screw for now. Not too tight, it is more than likely you are going to make adjustments. Now unlock the crankshaft and rotate the crankshaft anticlockwise from the front a half turn only to align the 2,3 cylinders EO mark and lock the camshaft. Now with the magnet mount disc turn the right-hand camshaft clockwise from the rear, set the exhaust valve opening point for the No. 2 cylinder, again using a DTI and, when done, lock off the timing pulley with one grub screw.

Now rotate the crankshaft (anticlockwise from the front) and check that both valves start to open at the point the appropriate EO mark comes up to the pointer. Again, use the DTI to check the start of the lift of each exhaust valve and confirm it aligns with the appropriate mark on your timing strip. Do not be concerned if the valve you expect to lift does not start to lift the first time the mark comes by - that will be because that mark is also for the other cylinder.

If that check passes I would suggest that you now check the EO and IO lift points, that all the valves are where they should be as indicated by

Plug for determining TDC and other gadgets.

the timing strip. It pays to be methodical here and be aware of the designed firing order for the engine: 1, 3, 4, 2. Believe me it is easy to get confused by this and have to start the checks again.

Checking the accuracy of the valve lift points was where I realise that Malcolm's original Vee-notch jig for assembling the camshafts was just not accurate enough. If you do find you have an error, however, it isn't that major. Gently heating the camshaft releases the Loctite and once everything is cleaned up the camshaft can be re-assembled. Of course, this also applies if you have managed to incorrectly set the cams on the shaft in the first place. Do not be too quick to pull your camshaft apart, however. Do the valve lift check again and make doubly sure.

If one valve lift does seem to be slightly out it is possible to average out the error across all the valves on that camshaft by a tweak on the position of the timing pulley.

If you are happy that all is well, tighten down the second grub screw on both timing pulleys. Do not use the D-bit to make the detents on the camshaft just yet. You may well still find yourself with a strip down and need to do the camshaft set-up again.

Ignition timing

As I have said before, I have used two RCXel twin ignition units. These are wasted spark units (both plugs fire simultaneously). Malcolm used a twin coil unit from Mini Magneto; the same unit can be used for the *Puma*. You will need two. As either of these units can be destroyed if fired without plugs fitted always fit two plugs before you power up and once you have powered up treat the plug ends as live.

As I have used an RCXel unit, the firing point is 28 degrees before TDC. The reason for this is these units auto advance the firing point depending on the speed of the engine. The hall sensor triggers the unit at 28 degrees before TDC and then delays the spark appropriately. The micro controller in the unit can then control the amount of advance of the ignition unit depending on engine speed. It does this by calculating the firing point by having accurately timed the period since the previous trigger pulse. I am not sure at what angle the firing point is for the Mini Mag units. No doubt that information comes with the units.

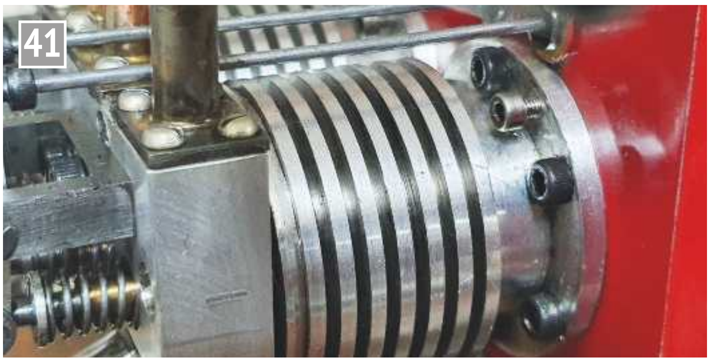
With the ignition units connected up and spark plugs in the plug holders but not the cylinders, power up the unit and set the crankshaft to the engine firing point for the 1, 4 cylinders. Release the grub screw holding the magnets mount disc on the left-hand camshaft and rotate it slowly clockwise unit the spark plug fires. The spark occurs at the point the magnet has passed the hall sensor, not the point it arrives. This can be a cause of confusion if you use another means of determine the firing point. It is not the point of the first changes of state of the hall sensor but the point that it reverts to the original level.

Once the firing point has been set, lock the disc in position and repeat for the cylinder 2, 3 firing point on the second ignition unit.

Useful gadgets

Photograph 40 also includes a number of useful gadgets:-

- Plug for setting TDC
- Spark plug spanner made from an old 10mm socket
- Spark plug blanking plug for the valve lapping jug
- Cam alignment jig for the camshaft assembly
- D-bit for detents in camshaft for timing pulleys
- Puller for timing discs and timing pulleys (if the grub screws have been tightened too much, they can raise a burr and make the discs and timing pulley hard to remove).



Cylinder jacking screws.

In addition, if gasket sealant has been used on the installation of the cylinders or the timing base/bearing holder and they need to be removed it is useful to include a pair of jacking screws (**photos 41** and **42**).

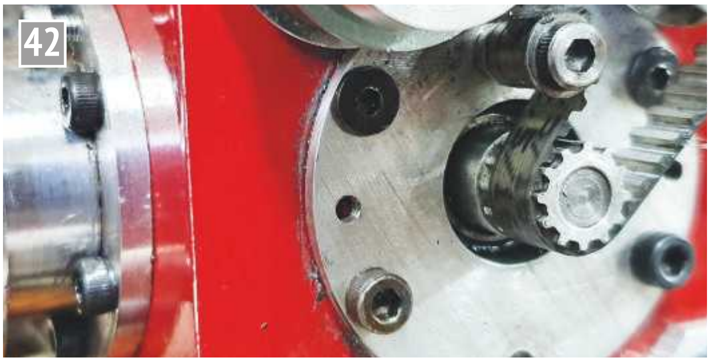
Running

The *Puma* should now be ready to run. As I do not know which carburettor you will be using, attempting to describe setting it up would be impossible so I'll assume you have some instructions that came with it.

With my *Bobcat* and *Lynx*, I had a devil of a job trying to get them to start. This was due to a number of factors, not least of which was my having no experience of model I/C engines. One problem I had was being able to turn over the engine with enough speed and, once the engine started, releasing the starter before it stalled the engine. I resorted to a starter unit for I/C engine helicopters. This has a 'sprag' clutch one way bearing. I modified the unit to provide a simple starter dog (**photos 43** and **44**). That said, this engine has been the easiest to start of the three engines, partially due to the O-rings in place of piston rings, taking time to lap the valves in and the fact that the engine has four cylinders. If one cylinder is playing up the other three will drag it along.

That finalises the series. I hope you have as much fun in making this engine as I did. By way of encouragement I include some photos of the completed engine (**photos 45** and **46**) and reference a video of the running engine on YouTube (www.youtube.com/watch?v=b-MQ1PyI5T4). Note the use of radio control for the throttle. I find it is far easier to maintain a throttle setting this way.

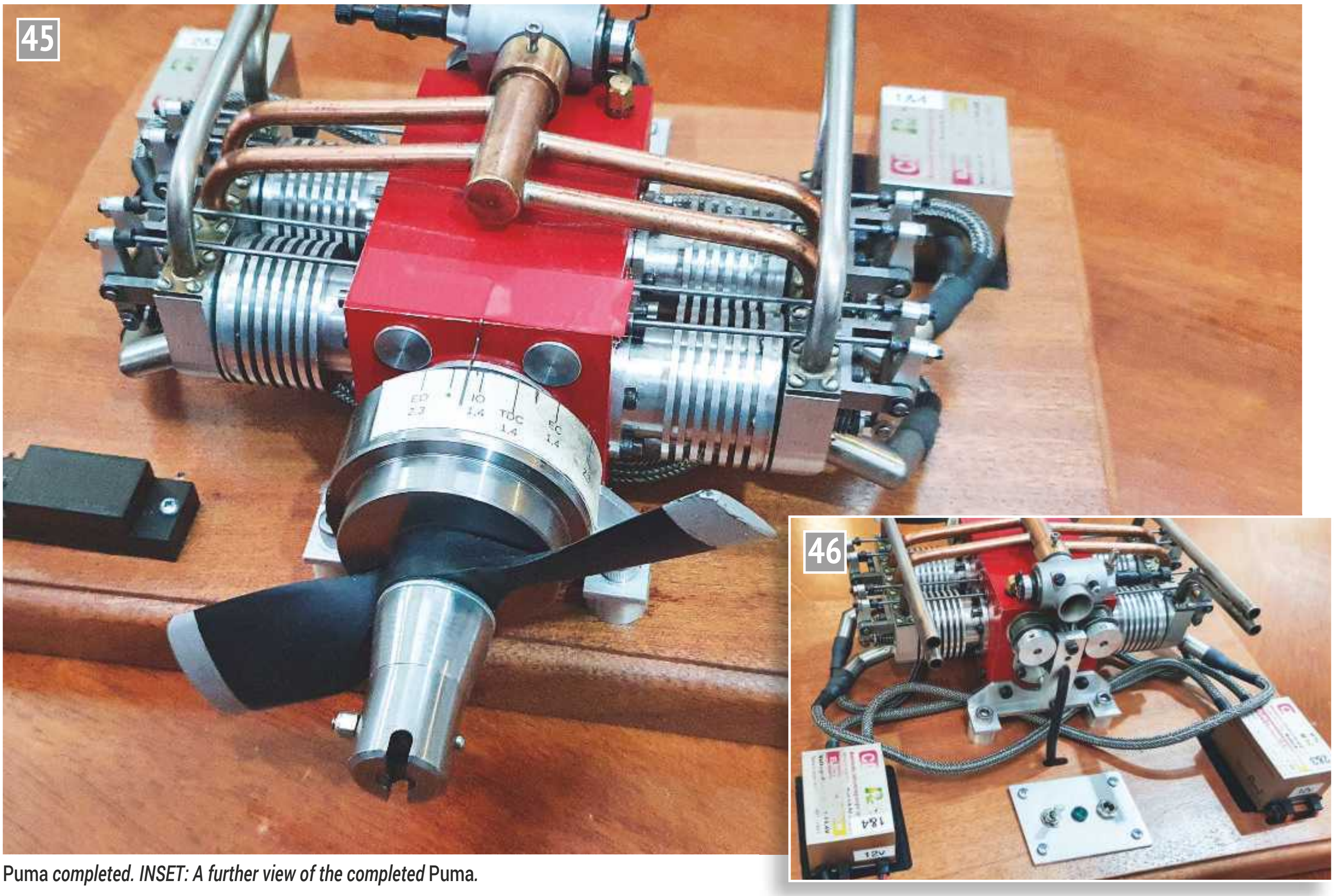
ME



Holes for jacking timing base/rear bearing holder.

Helicopter starter as purchased.

Modified helicopter starter.



Puma *completed. INSET: A further view of the completed* Puma.

CLUB NEWS

Geoff Theasby reports on the latest news from the Clubs.

P2 Wolf of Badenoch *at IMLEC, Maidstone (photo courtesy of David Scott).*

Guten tag, eisen arbeiterren, in a packed issue today… (continued on page 42)

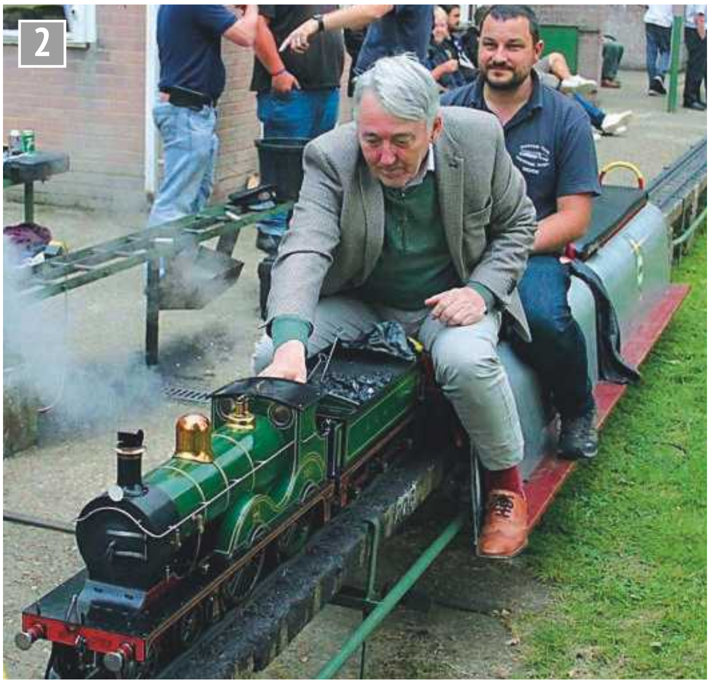
Here are the answers to last week's questions: 1) under a gooseberry bush, 2) down the Swannee, 3) up the creek, 4) over the rainbow and 5) in an old radio bought off eBay. Well, I found one there, but I couldn't get it to resonate.

One of my fellow Northern Heights Amateur Radio Society members, G3UI, now deceased, once said, "Whatever it is you want to do, there's always something else you have to do first". And so it was that I was preparing to reinstall the filter in my KW 202 receiver when I was distracted by the plume of grey smoke pouring out of it. Certain words found their way, unbidden, to my lips, i.e. 'it's not supposed to do that'. A blob of solder had shorted the 12 volt line. When the visibility improved, I found a burnt and cracked 47kohm anode load in the audio section, an easy job to sort out. "How are you getting on?" asked Debs, "I'll tell you when the smoke clears…."

In this issue, cordless drills, a BRM, an electric boiler, Guy Fawkes, a tunnel, Mates (not Richard Branson's), the SMEE courses, SOS - 'Save our sheds!' and a shell mill.

Welling & District Model Engineering Society *Magazine* for December/January reports on progress on the track. Concern was expressed that building from both ends to the middle might have led to alignment errors, much as depicted in a cartoon I once saw, whereby the US railroad tracks met at Promontory Point but each was building track with the 'other' rail to its right, resulting in one common rail and the two 'other' rails not meeting… In this case there was no need to worry. The vast new clubhouse has been erected and clad, being now weather tight and secure. Andy Houston muses on the usefulness of the cordless drill, invented in 1961 by a Mr Decker, of Black & Decker. Editor Tony Riley writes an interesting piece on 'locomotive examination in the blackout'. Normally conducted under floodlights, the buildings were modified so that no light showed, denying enemy bombers the opportunity to confirm their whereabouts.
W. www.wdmes.co.uk

The Prospectus, December, from **Reading Society of Model Engineers** entertains and instructs. On page 6 is a fine picture of an Engineers Brew, oh, and the 'Claud' boiler that John Billard is constructing. Also, a good pic of P2 *Wolf of Badenoch* with a load of work to do (**photo 1**). Concluding, *Model Engineer* editor Martin R. Evans driving an SECR 4-4-0 (**photo 2**) and David Scott with his cordless drill-powered engine.
W. www.rsme.org



Martin Evans out on his own!

The **Stamford Model Engineering Society** *Newsletter* has editor Joe Dobson mentioning a book he had been advised to read, containing a picture which I identified (correctly) as a BRM. This beast had a small engine of 1500cc, supercharged, under the regulations in force at the time, and V16 configuration.

Norwich & District Society of Model Engineers' *e-bulletin* for winter reports that the Society had been invited to exhibit at the city's Science Week. This was taken up with alacrity, although model engineering was more likely. In keeping with the interests of most model engineers, a visit to Bressingham Steam Museum revealed two Stanley Steamers, built in 1910 and 1921.

W. www.ndmes.org

From the **Rand Society of Model Engineers** Tienie Jonker relates how he built an electric boiler (with an immersion heater) as a practical answer to a 'proper' boiler. Intended for the testing of injectors, it was quick and easy to build. Keith Appleton restored a *Chub*, which is very similar to 'LBSC's *Tich*. Editor *Luker* has introduced 'Nostalgia Corner', reprinting old photographs of very young members 'Then and Now'.

Stockholes Farm Miniature Railway's December *Newssheet* says that in view of the current political unrest they decided to celebrate Guy Fawkes night… (his relatives still live at Farnley hall, Otley). The mobile fishpond was on the move again. Its third reincarnation is where it can be seen from the house. (Wouldn't do to let it become stagnant… - Geoff)

Inside Motion, December, from **Teeside Small Gauge Railway,** has Michael Mee investigating eCoal. His main concern is that it comes as briquettes much too large for our locomotives and breaking down the five kg lumps into small enough pieces is tiring and difficult. Trying it in both a rebuilt SR West Country and in a *Speedy*, Michael reports that it is a superb fuel (apart from the exhaust smell), both locomotives steaming well, and continuously. (Perhaps there will be an outburst of interest in working model rock crushers… Geoff) Jim Nolan visited Canada on his way to the model engineers' train meet in October. He called in on Ernie Beskowiney, a friend often met at the Train Mountain meets. Ernie is building his own 7½ inch gauge railway, starting in 2015 and doing everything himself, digging out and surveying. The line is 9000 feet long, and about half again in sidings and loops. It incorporates a 200 foot tunnel lined with timber from a redundant trestle bridge. He built up his own track, made on his own jigs, and including 60 (sixty) sets of points. Ian Spencer built a 5 inch gauge Gresley V2 (*Green Arrow*) fitted with his own design of valve gear.

W. www.tsmee.co.uk

In the absence of any other picture, here is a Curnon steam flow meter at Bolton Steam Museum for your delight or puzzlement (**photo 3**).

The Bristol Model Engineer, from **Bristol Society of Model and Experimental Engineers,** contains 'A radical cure for temperamental injectors', i.e. bin them and fit an electric pump. The story tells how the author did it for his 7¼ inch gauge *Feldbahn*. David Gray suggests that 'X' rings may work better than the normal 'O' rings in cylinders. (No, neither had I - Geoff) The Hallowe'en steam-up included a locomotive driven by a skeleton, with even the engine itself wearing a white sheet as a howling banshee.

W. www.bristolmodel engineers.co.uk

CoSME Link (another 40 pages!) winter edition, from **City of Oxford Society of Model Engineers,** reports that Tim Trotman has departed this green and pleasant land for the 'Land of Song', i.e. George Borrow's *Wild Wales*. (An interesting book - Mr B is very prejudiced against the Welsh, regarding them as little more than savages.) The raised track carriages are being repainted in the style of Pullman coaches, the one named *Carol Ann* being the first. A meeting on 4th January was to be about alternative hobbies, from collecting stamps to archery, Morris dancing (and accumulating defunct radio equipment?)

W. www.cosme.org.uk

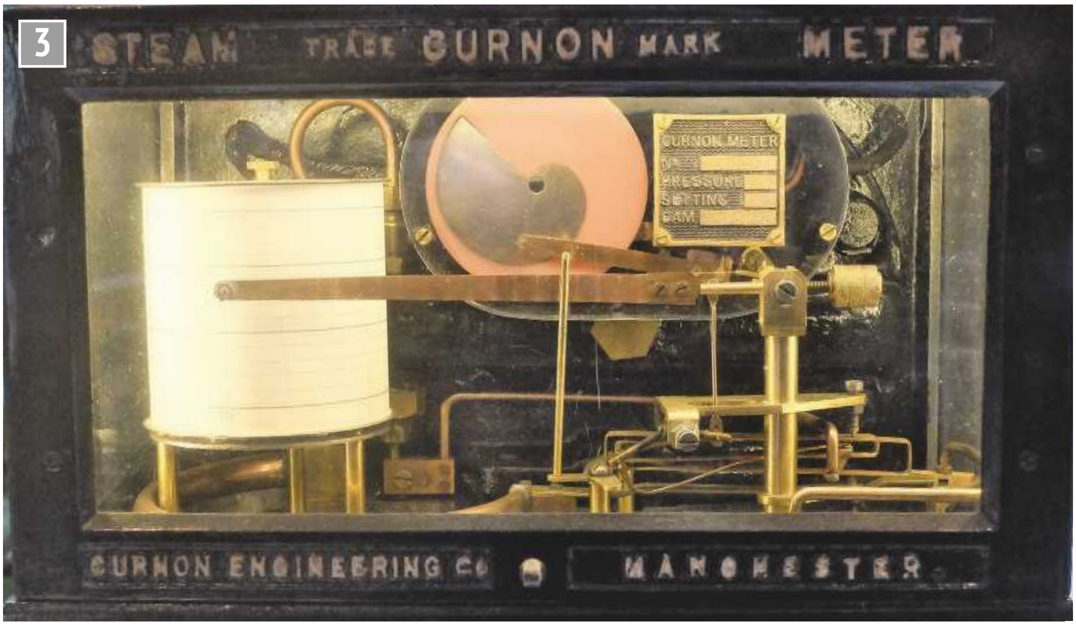
GMES News, November, from **Guildford Model Engineering Society,** reports that they received a Gold Award from Guildford in Bloom - thanks to Matt Butler for all his efforts. GMLEC was held in September at the club track, on IMLEC principles, and the *News* reports on the event. As it was held in the brief period allowed in 2021, due to Covid, and a fun event (although the competitors took it seriously), everyone was declared a winner just for turning up.

W. www.gmes.org.uk

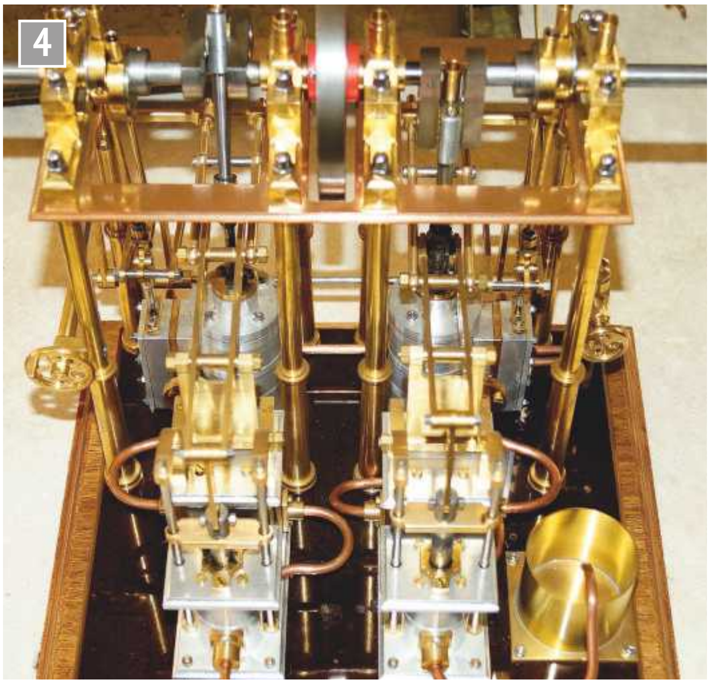
Pickering Experimental Engineering & Model Society sends *PEEM Newsletter* for December. The Society visited Scarborough Mates, a Men in Sheds type of group. They have a model railway area, kiln and wood turning workshop and are located in the old Londesborough Road station just outside the main railway station. Built half a mile from the main station to alleviate the pressure of visitors in holiday periods, it was capable of accommodating 14 carriages at the through platform. John Heeley has built a Stumpf turbine, finding in the process that it would not run with 'any' viscous fluid in the bearings - WD40 is the only lubrication it will tolerate. A members' survey was run in the autumn and the remarks and suggestions discussed at the AGM and afterwards.

The Link, May-December, from **Ottawa Valley Live Steamers and Model Engineers** contains a 'rant' by editor Graham Copley about anti-vaxxers, whose demands for freedom conflict with the needs of the rest of us to stay well. He mentions a picture in the local paper

3



Steam flow meter.



HMS Gorgon engine (photo courtesy of Murray Lane).

dealing with anniversaries showing policemen in 1897 physically 'encouraging' people to get smallpox vaccinations. The newsletter issues have been combined since there has been little to add to the proceedings on Zoom, held regularly over the months. Pictures of the track relaying and general site work show what a lovely sylvan setting the club occupies.

W. www.ovlsme.com

December's *MEEA Newsletter,* from **Model & Experimental Engineers, Auckland** contains Hugh Martin's latest, a clamping stand for a rather sophisticated Stanley laser level, whilst Graeme Quayle's HMS *Gorgon* engine model is now finished and presentable (he says) and he took it to the meeting (**photo 4**).

The **Society of Model & Experimental Engineers** asks me to publicise their model engineering courses in 2022, which have been inactive all year, for obvious reasons. The text below explains all.

'Following a year of restrictions, the Society of Model and Experimental Engineers (SMEE) plans to run its popular training courses for newcomers to model engineering in 2022, starting in February. Part 1 is a three-day course running on Saturdays, February to April, designed to introduce newcomers to the hobby, and to help with decisions on the setting up of a workshop, and the purchase of machines and tools as well as introducing their use. The course also deals with silver brazing, tool sharpening, measurement and marking out. Part 2 is the 'Polly' course which covers the building of a simple model boiler and engine. This is spread over six, monthly, Saturdays. In each session we demonstrate making a different part of the project which students complete in their home workshops between sessions, ending up with a working steam model. The project involves sheet metal work, soft soldering, silver brazing, turning, milling and painting, and will equip students with all they need to undertake further engineering projects and develop their skills. Although aimed at model engineering, previous students have also been involved in restoration of classic cars and motorcycles. The Society also runs one day courses in milling and in tool grinding.'

SMEE is based in Lambeth, South London. Access is easy via Thameslink trains calling at Loughborough Junction station from where the building is just a few minutes' walk.

Full details of the courses are available on the SMEE website at www.sm-ee.co.uk

Shoulder to Shoulder, from the **Mens Shed Association,** plagiarises a certain verse: 'Twas the night before Christmas when all through the shed...' I'm sure you get the gist. It continues, 'No shed was harmed in the plagiarising of this poem'.

W. www.menssheds.org.uk

St Albans & District Model Engineering Society *Newsletter,* December, arrives, in which chairman Mike Collins announces that they have won the Best Newsletter award from Northern Association of Model Engineers. Refurbishment of the lake in Verulamium Park is proposed but this does not meet with club approval; negotiations are ongoing. 'Metal Mangler' offers guidance on unsticking your balls, including a picture of a very battered clack valve, the owner of which has claimed anonymity. Guy Kean reviews a Chinese shell mill, bought as a 'punt' for £31. He considered using a fly cutter, but finds them not too good on steel unless carbide cutters are used, having established this from experience. Added to which, the time involved in making a holder, buying the tips etc, would not be cost-effective. Another difficulty raised its head when he found that he could not fit it into his mill due to lack of headroom and a tight taper on the existing tool as fitted. His cure was to make a double wedge tool often used to remove drill chucks which have become too cosy with their matching taper. This worked well, and led to a book recommendation *The Rusty Nut Bible*, available from the usual suspects. The Mystery Object is I believe a Fire Service 'monitor', a water jet on a frame which can be attached to a convenient object and operated remotely or unattended.

W. www.stalbansmes.com

To conclude, here are the fine pictures of Chloe and Tracy's 'Vardo', or living wagon, and its prime mover, as mentioned in *Model Engineer* issue 4684 (**photos 5** and **6**).

And finally, I was printing this out for proofreading, when I was called for my evening meal. I can't wait to see what I have written.

CONTACT

geofftheasby@gmail.com

Traction engine and Vardo 'combination' (photo courtesy of Chloé and Tracy).

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Model	Tytan 750 Universal Lathe
Condition	New
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Swing over cross slide	150mm
Centre width	750mm
Bed width	135mm
Spindle bore	26mm
Spindle tip	MT4
Spindle speed (smooth adjustment)	50–2250 rpm
Metric thread	(18) 0.2–3.5 mm/rev
Inch thread	(21) 8–56 threads/inch
Longitudinal feed	0.07 -0.4mm/rev
Tool holder	4-Way
Tool holder Dimensions	12 x 12mm
Maximum cross support travel	70 mm
Maximum transverse support travel	110 mm
Maximum longitudinal support travel	650 mm
Tailstock Quill Diameter	30 mm
Tailstock spindle travel	60 mm
Tailstock quill taper	MT2
Motor power	1.1kW / 230V
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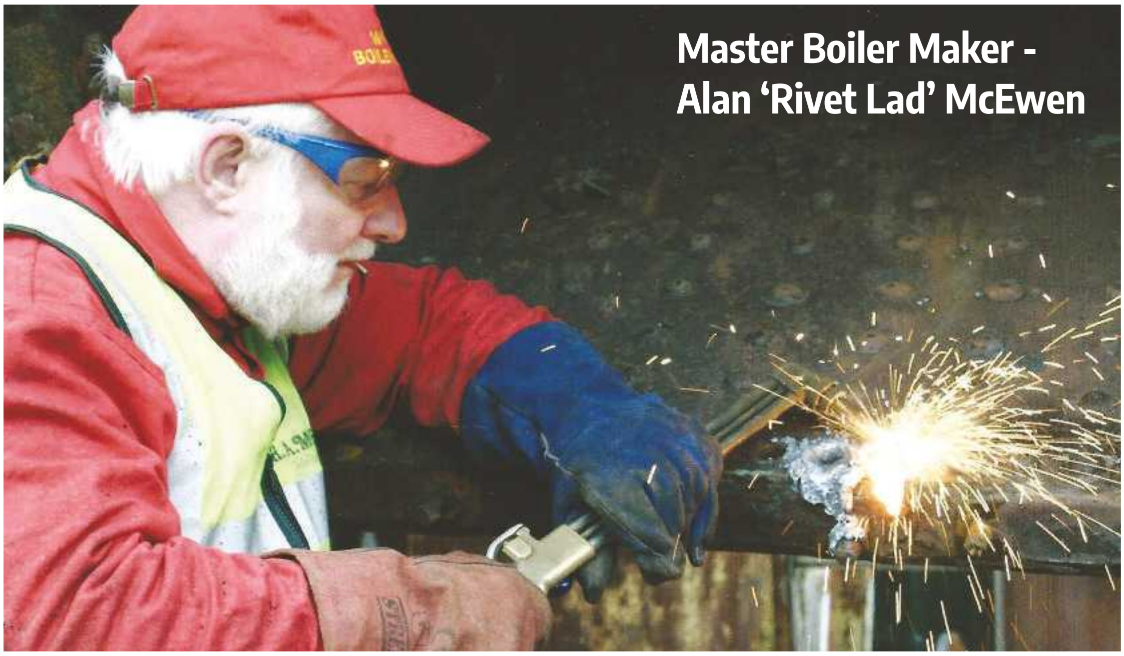
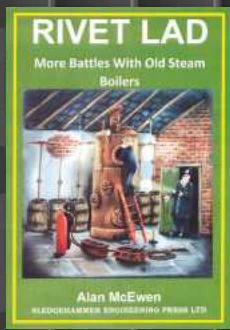
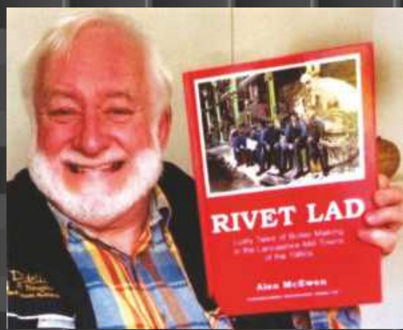


Master Boiler Maker -
Alan 'Rivet Lad' McEwen

When Master Boiler Maker and author, Alan McEwen was a young sprog, he loved banging and hammering on rusty old boilers; now that he is an old hog, he just prefers others to bang and hammer!





Alan McEwen's Boiler Making adventures and also 'potted histories' of several Lancashire and Yorkshire Boiler Making firms, can be read in **RIVET LAD** - *Lusty Tales of Boiler Making in the Lancashire Mill Towns of the 1960s.* The book is crammed with 'hands on' technical information of how Lancashire, Locomotive, Economic, and Cochran Vertical boilers were repaired over 50 years ago. The book's larger-than-life characters, the hard as nails, ale-supping, chain-smoking Boiler Makers: Carrot Crampthorn, Reuben 'Iron Man' Ramsbottom, Teddy Tulip, genial Irishman Paddy O'Boyle, and not least Alan himself, are, to a man, throw-backs to times gone by when British industry was the envy of the world.

Alan McEwen's first RIVET LAD book: *RIVET LAD – Lusty Tales of Boiler Making in the Lancashire Mill Towns of the Sixties* published September 2017 is now priced at £25 plus £3.00 postage and packing to UK addresses.

Alan's second RIVET LAD book: *RIVET LAD – More Battles With Old Steam Boilers* was published in September 2018. **Now priced** at £25 including postage and packing to UK addresses.

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