

PROPANE BURNERS IN 7¼-INCH GAUGE ● MAKING A MILLING VICE STOP

THE MAGAZINE FOR MODEL ENGINEERS

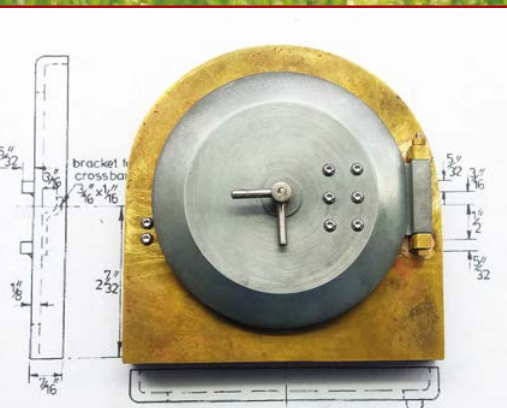
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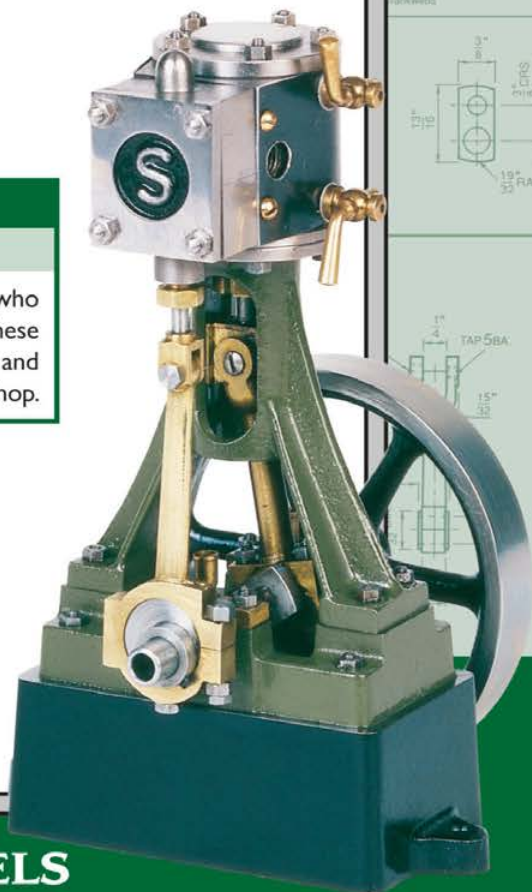
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EDITORIAL

Coming out the other side and seeing the positives

Welcome to the August edition of **EIM** – August eh? Normally at this time of year we would be out running our engines on club tracks or at rallies, and likely keeping away from our workshops because at this time of year they are just a bit too warm.

All change, however, in 2020. Covid-19 has of course cut a swathe through all aspects of normal life, and as I write there are still no club tracks running. However as lockdown restrictions ease and clubs feel increasingly able to have working parties at their tracks (see page 40) there is renewed hope that by the time next month's issue publishes we may well have to resume publishing our diary section – certainly the *Club News* pages this month are more upbeat than for some time.

Meanwhile reading through the most recent editions of the various club newsletters, one aspect of the virus that we predicted way back at the start of all this appears to have been proven. Model engineers have been spending a lot more time in their workshops (your editor included!), and projects have made far more progress than they might normally have done, had we been living through a more normal few months. Some of these projects are scattered through our pages and reading about the variety of builds underway makes you realise just how rich a vocation model engineering is – I almost feel sorry for those who have found nothing better to do during lockdown than complain about the state of daytime TV...

As mentioned in our club pages a very pertinent point was made by City of Oxford SME chairman Denis Mulford, who when the lockdown was first imposed in March feared how long it would last because the social aspect of model engineering was so important a part of his life. You are not wrong Denis, we are sure your sentiment is shared by many others, and glad that it seems some form of normality is now in sight.

We have another varied selection to offer you this month, everything from classic engines to zinc plating to gas-firing in 7¼-inch gauge. To maintain that variety we still need more features, especially on rail and road engines, so if you've completed that project during lockdown, write it up and send it in!

Andrew Charman – Editor

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Editor: Andrew Charman Technical Editor: Harry Billmore

Email: andrew.charman@warnersgroup.co.uk Tel: 01938 810592.

Editorial address: 12 Maes Gwyn, Llanfair Caereinion, Powys, SY21 0BD

Web: www.engineeringinminiature.co.uk

Facebook: www.facebook.com/engineeringinminiature

FOR SUBSCRIPTION QUERIES call 01778 392465 – the editor does not handle subscriptions.

Publisher: Steve Cole
Email: stevec@warnersgroup.co.uk

Design & Production: Andrew Charman
Advertising manager: Bev Machin

Tel: 01778 392055
Email: bevm@warnersgroup.co.uk

Sales executive: Hollie Deboo
Tel: 01778 395078

Email: hollie-deboo@warnersgroup.co.uk

Advertising design: Amie Carter
Email: amiec@warnersgroup.co.uk

Ad production: Allison Mould
Tel: 01778 395002

Email: allison.mould@warnersgroup.co.uk

Marketing manager: Carly Dudge
Tel: 01778 391440

Email: carlyd@warnersgroup.co.uk

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FRONT COVER

The delight of model engineering for all ages beautifully summed up in this summery picture. Jan-Eric Nyström, driving his loco, reveals some of the problems he's had to solve over 20 years of model engineering in this issue.

Photo: Thomas Westerholm

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ENGINEERING in Miniature

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Mike Pavie



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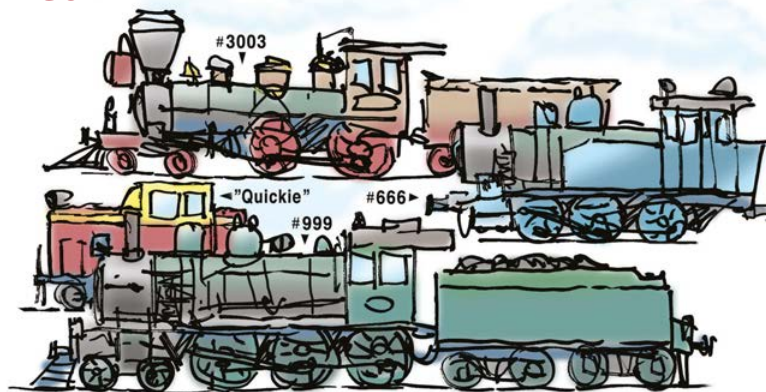
The good, the bad and the ugly....

Jan-Eric looks back on some lessons learnt in his 20 years as a model engineer.

BY JAN-ERIC NYSTRÖM



FIGURE 1



During the past 20 years, much has happened in my hobby, most of it good, but quite a few mishaps, too. This article looks back at some of my experiences, first as a novice builder, when I was prone to errors (measure twice and cut once, you know...), making a number of bad choices, and also some minor 'breakthroughs' thanks to a better understanding of the principles involved, all learned during the construction of four engines, three of them live steamers (as in the drawing), as well as by reading books and many years' worth of hobby magazines – old and new, own and borrowed.

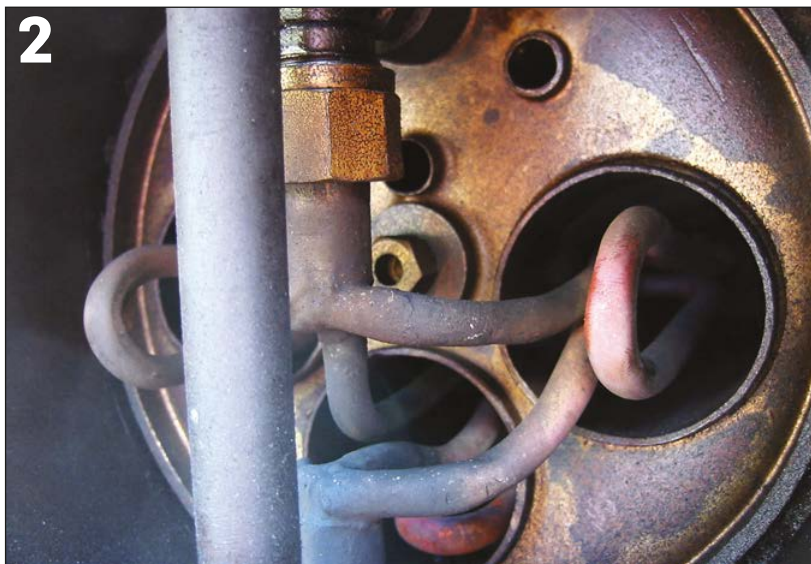
The 'Good'...

With the very first steam generated during the 'maiden run' of the first

loco, a Baldwin 4-4-0, everything seemed rosy (Photo 1). However, it was not long before I noticed that the steam was very wet – this can actually be seen in the photo, taken on a nice, warm and sunny summer afternoon. Usually, such a steam plume is seen only on cold autumn and winter days, so there certainly is something slightly amiss, here.

The solution (Photo 2), was simple – I cut the steam pipe going from the throttle to the cylinders, and inserted three loops of copper tubing into the three fire flues of the boiler. This is usually called a superheater, but in my case it is no more than a steam dryer, since the tubes don't enter very far into the flues. In fact, they can't, since the propane burners are in the way!

As you may remember from the





article series describing the construction of this loco (**EIM** November 2015 to January 2016), it has no firebox; the heat is generated by three propane torches, one in each of the flues. With this simple steam dryer accessory, you can hardly see any steam when 'running light' in fair weather! The water consumption is also significantly lower.

This little addition, which gave the 4-4-0 some necessary pep, definitely belongs in the 'good' category – as does the accumulation of new tools in the workshop, (**Photo 3**), which started out very empty indeed – just the lathe and a drill.

A few years after starting this hobby in the year 2000, most of the necessary tools had been acquired. Many of them are simple, low-cost versions made in Asia, but some smaller British, Austrian and German tools can be found among them.

The 'Bad'...

Cheap tools do have their problems and the little Asian mill/drill seen in the middle of the panorama did cause a lot of trouble – the solution, a complete rebuild of the originally plastic gear transmission (using steel gears purchased from a stockist) was described in **EIM** in August 2017. The mill has worked satisfactorily (but rather more noisily) since that modification was carried out.

On the bench at left in photo 3, you can see the 4-4-0 with its smokebox opened up for service. I had to disassemble it quite a bit more to get to a few problems that developed during the first season.

First, let's have a look at one of the Stephenson links, (**Photo 4**). What a mess! Since the bronze die block slides in the slot in the steel link, it is of course important that everything is well lubricated. I run on two tracks – firstly my own 'portable' track, laid over lawns and gravel walks (this was eventually supported by a foundation of 1ft square concrete paving slabs, see **EIM** September 2017), and the track at our railway museum which is partly laid on sandy soil. These are definitely not ideal, due to the amount of sand and dust which is kicked up. This sticks to all oily parts, forming a nasty,

PHOTO 1: The very first steam – an exhilarating experience! This novice engineer has yet to learn that 'wet' steam, even though it looks nice, is not the most economical...

FIGURE 1: The author's four locomotive projects, all in 7¼-inch gauge, 1.5-inch scale. The hobby began in the year 2000, building the 4-4-0 'American' #3003, then came the little battery-powered 0-4-0 'Quickie', followed by 0-6-0 'Chicken' #666. The latest 4-6-0 Ten-wheeler #999, is currently being described in an article series in **EIM**.

PHOTO 2: Steam dryer made from loops of ¼-inch copper tubing.

PHOTO 3: Panorama of the author's messy workshop, three years after entering the live-steam hobby.

PHOTO 4: Oily Stephenson links collect sand and dust.

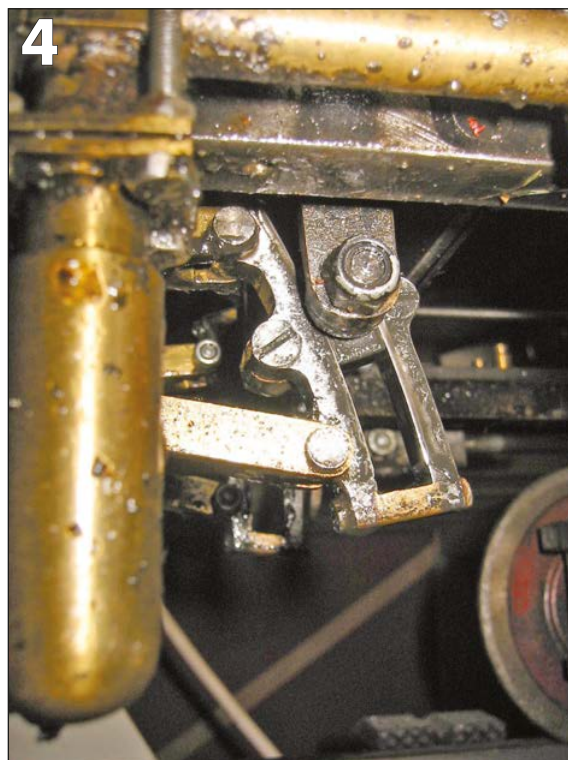
PHOTO 5: Even the saddle below the smokebox is full of sand and grime.

abrasive goo, clearly seen in the photo.

I do clean these parts ever so often, using a rag and oil from a spray can, but some places in the loco can only be cleaned by partly disassembling the engine. In **Photo 5**, I have removed the smokebox to get to the front truck bearing, obviously in dire need of cleaning!

The most serious of the early problems can be glimpsed inside the opened steam chest: the steel port face, fortunately made as a removable insert, is severely corroded. This is due to the water that remains in the steam chest after every run. Another reason is that plain steel is incompatible with brass and bronze in a wet environment – steel is much lower than brass and bronze in the 'electrochemical series', and an electric current is thus generated between the steel and the brass. This causes 'galvanic corrosion' of the steel, but leaves the brass intact.

The close-up of the steel insert in **Photo 6** clearly shows the localised corrosion: deep pitting where the



6


PHOTO 6: Severely corroded steel port face plate, lower, brass replacement, upper.

7


PHOTO 7: New brass port insert after several years of use – no noticeable wear. Lubrication is paramount, of course.

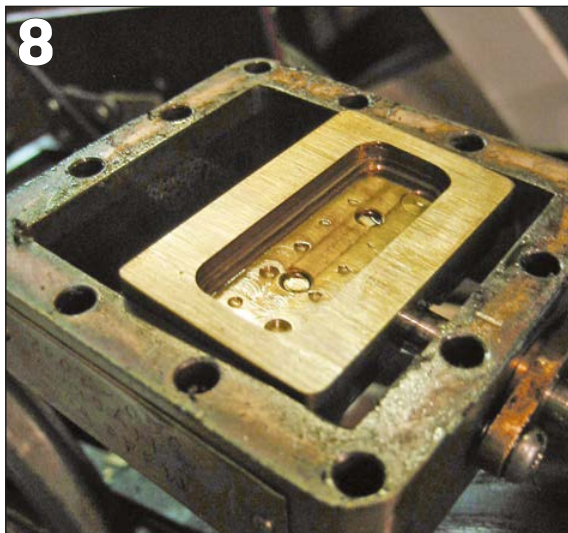
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PHOTO 8: D-valve made from aluminum bronze – a hard-to-machine, but slippery material that stands up well to wear.

PHOTO 9: Stainless steel cannot withstand 1000°C temperature in a propane ‘poker’ burner. The burners had to be re-designed.

PHOTO 10: ‘Glow-cones’ of stainless steel mesh suffer in heat, but easily replaced.

PHOTO 11: Scale formed on check-valve ball, causing malfunction of the water feed.

bronze slide valve has contacted the steel. The solution to the problem is in the top of the photo; a new port face insert made from brass plate – brass is very close to bronze in the series, and much less prone to corrosion than steel. Since the port face is a separate part (although ‘glued’ to the cylinder with silicon gasket paste), it was easy to replace.

Having read J. F. Nelson’s book *So you want to build a Live Steam Locomotive* (published half a century ago in the US), I was a bit apprehensive over using brass as a port face, against the bronze of the D-valve – according to the book, brass sliding on bronze is supposed to be “Bad”... However, my experience proves that it is not that bad, after all!

Photo 7 shows the brass port face, and **Photo 8** the underside of the aluminum bronze slide valve after several years of running. The surfaces of both parts are not severely scratched or galled in any way, just slightly matted, as if polished with emery paper – which they originally were, when first assembled!

It is of course imperative to have good lubrication, so I take care to fill the oil cups on the steam chests whenever it is necessary – in practice, that’s about every hour or so of running. These oil cups are not built to scale (you can see one in **Photo 3**, above the loco’s cylinder). They need to be much larger than prototype to provide enough oil. Thanks to friends running preserved, full-size steam locos, I have a source of real steam oil (called ‘600W’, referring to its viscosity); it’s a thick, dark brown molasses-like substance, quite unlike ordinary motor oil (which often is 10W-50 or thereabouts).

The ‘Ugly’...

The original propane ‘poker’ burners in the flues did not last very long. The burner bodies were made of stainless tubing, with numerous slits for the gas to emerge from. In addition, the burners were enveloped by stainless steel mesh. The original, very fine mesh burned out in just a few weeks, so I replaced it with a heavier mesh which lasted a little longer.

However, I had to re-build the burners themselves after only two seasons. The slotted stainless tubes suffered from severe ‘spalling’ or flaking, since they were operating at a temperature around 1000 °C (1800 °F). **Photo 9** shows the pathetic state of one of the tubes – severely bent in the red heat, the slits filled with flakes of oxide. No wonder the engine felt quite sluggish when the second running season approached its end...

The following winter I constructed new propane burners, of a very standard, basic ‘brazing torch’ type. They blow their flames into ‘glow-cones’ made from stainless netting. The cones do suffer greatly in the heat, too (**Photo 10**). However, they are easy to replace, and must be considered consumables.

The cones last for 50 to 100 hours of running, in other words a whole season, sometimes two. I always have a few spare cones available – the stainless steel mesh isn’t very expensive in these small quantities, it costs about £20 to make a new set of three cones. I can exchange them by simply opening the smokebox front, removing the superheater – sorry, the steam dryer – and pulling out the ‘spent’ cones.

Another problem surfaced in the beginning of the third running season

9


10



– the boiler feed pump simply refused to work. The reason was obvious, once found: the valve balls were encrusted with a light scale, (**Photo 11**)!

These valves are the check valves

All photos and diagrams in this feature by the author

closest to the boiler – the heat causes solids to precipitate from the water, forming the white deposit. It acts almost as a glue, sticking the ball tightly to the valve seat when the

residue dries during winter storage. No wonder the pumps didn't pump! Having learned that lesson, I now open and clean the check valves ever so often... **EIM**

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BENCH TALK

A shoulder to rely on...

John discusses Myford tool setting and secure wheel locations.

BY JOHN BAUER

When I acquired my first lathe almost 50 years ago I inherited the Myford curved tool boat with the cutting tools that matched it. At least I was spared the problem of shimming my larger tools but getting them to centre height was inevitably still time-consuming and frustrating.

I solved my frustrations with the simple device in the picture. It took almost no time to make and was calibrated by the simple expedient of setting a facing tool to cut dead across centre. With a bit of care neither tool tips or lips are at risk.

In the October 2019 issue of **EIM** it is proposed in a box on page 32 that wheel seats should be machined with a groove into the axle to ensure that a wheel with a square axle face will fit snugly. It is more common for the wheel to have a small rounded shoulder and the axle to have a small and smooth radius at the inner corner of the axle face.

It is certainly correct that a sharp corner there will cause a stress concentration that could lead to a fatigue crack starting and progressing. However, a smooth radius there will obviate the problem.

Smoothly does it

Avoiding a rough surface is just as important as avoiding sudden changes in section when designing to prevent

Photo by the author

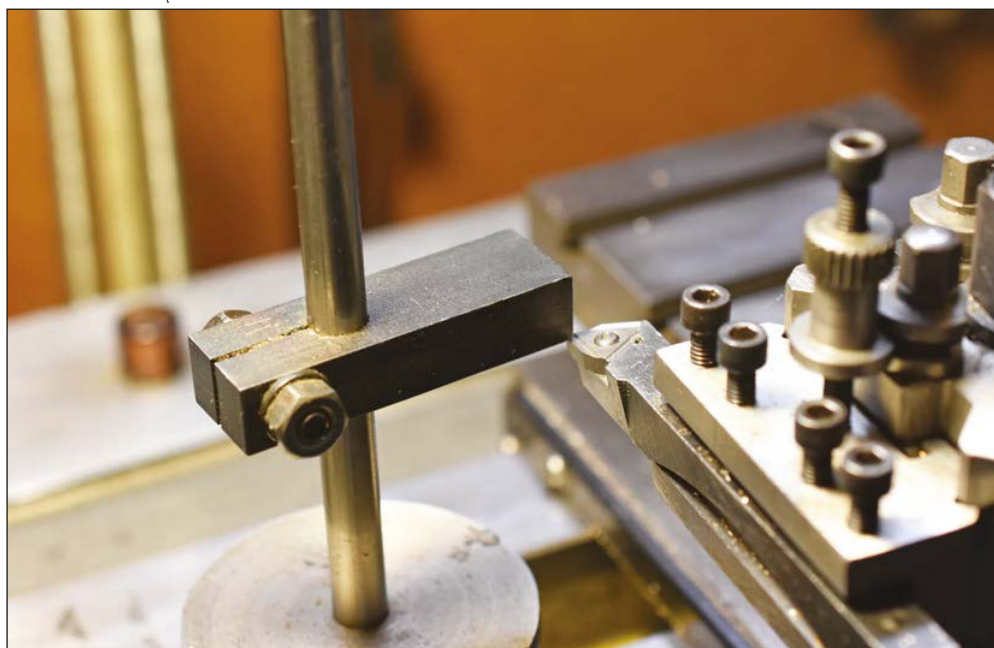
fatigue cracks from being initiated by microcracks inherent in a machined surface (I once had an aircraft T-tail main structural fitting in my hands, an example of which failed and caused the horizontal part of the tail to depart with lethal consequences – it was no great feat to notice the machining marks where the crack would have started.)

It might be noted that keeping the wheel running true is not only a matter of the size of the face of the

axle seat but also of the fit of the wheel on the axle stub and of the force holding the wheel against the seat.

It might also be appropriate to point out that the radius given for the outside edge of a bearing is a minimum value. Any smaller radius at the inner face of a bearing housing will then ensure that the bearing will seat properly. **EIM**

■ Got a workshop tip to offer readers? Send to the address on page 3...



A vice stop for the milling machine

Edward produces a useful tool for multiple production that anyone can easily make.

BY EDWARD J PARROTT

Sooner or later when building a model, you'll want to machine two parts the same, or four, or 10, or if you're as crazy as I am then you'll have chosen to build a Garratt, and who knows how many parts you'll need! I'm just making a set of new connecting rods for my 5-inch gauge 'Lion', and as the same machining operation needs to be repeated on each blank, I use my stop to position the blanks in the vice, and I only have to clock in the first part (Photo 1).

In industry this comes up regularly, and while CNC machining provides the means of doing the actual identical machining, what it doesn't normally do is take care of positioning materials (unless you're really in to mass production and robotic arms). For that it invariably comes down to the operator to position materials into vices or fixtures, just the same as we do at home on our own machines.

Setting the material in the vice is the easy bit, but getting it in just the

"If any reader is new to machining – milling especially – it is a good piece to get stuck in to making in order to find out how things work..."

right place for all the settings from the previous run of the part is what matters. You could locate each part on every setting with an edge finder or a Haimer 3D probe, but every time you do that takes time.

So the quick way is to use a stop, against which the material is pushed up before the vice is clamped. Once you have clocked in the first piece of material, as long as every subsequent piece is pushed up to the stop before it's clamped, then all the datums will remain the same and it is not necessary to clock the part back in.

There are many different designs of vice stop that can be purchased, some of them are very pretty and have a pretty price tag to match too. The question of which to buy comes up regularly on machinist groups on social media, and I always give the same reply – make your own! At the time of writing a quick look on the internet will find a similar free-standing type of stop to the one I am about to describe for around £55, in a very fetching shade of red. Even with the company I work for that would buy around 90 minutes machining time, and I reckon on around spending less than that to manually machine my own from materials in the workshop – I can spend that money on parts for the engines I'm building instead.

Novice project

Once upon a time manufacture of a stop like this would have been an apprentice piece, and I suggest that if any reader is new to machining – milling especially – it is a good piece to get stuck in to making in order to find out how things work, and at the end of it you'll have something you'll use again and again and again, all the time satisfied that it's something you made yourself.

Make sure of what materials you've got before we start so that you can drill holes to suit – see what's in your drawers or under the bench. Anything will really do, but to make mine here's what I used;

- 1) 5 inches of $1\frac{1}{4}$ x $\frac{3}{4}$ -inch BMS (Bright Mild Steel) to make the base
- 2) 5 inches of $\frac{1}{2}$ -inch round bar to make the column

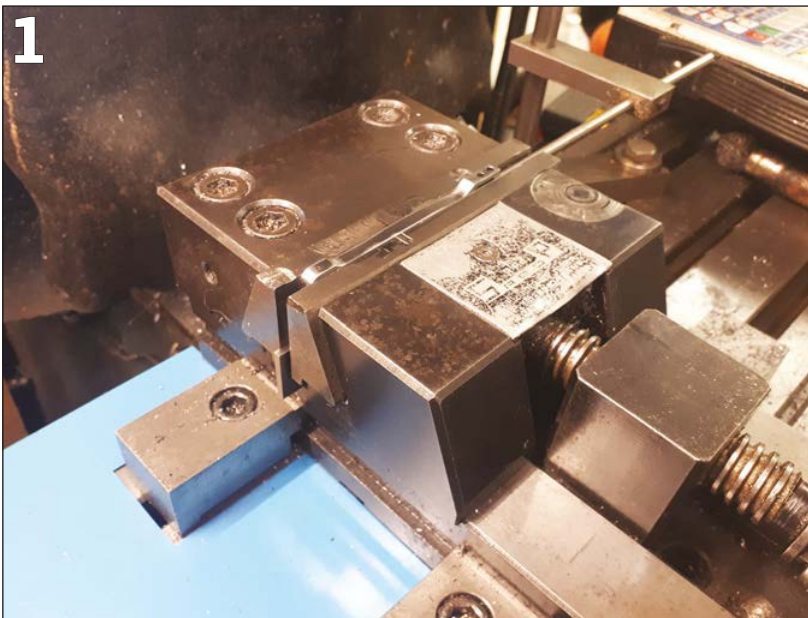


PHOTO 1: Positioning blanks for connecting rods using the vice stop.

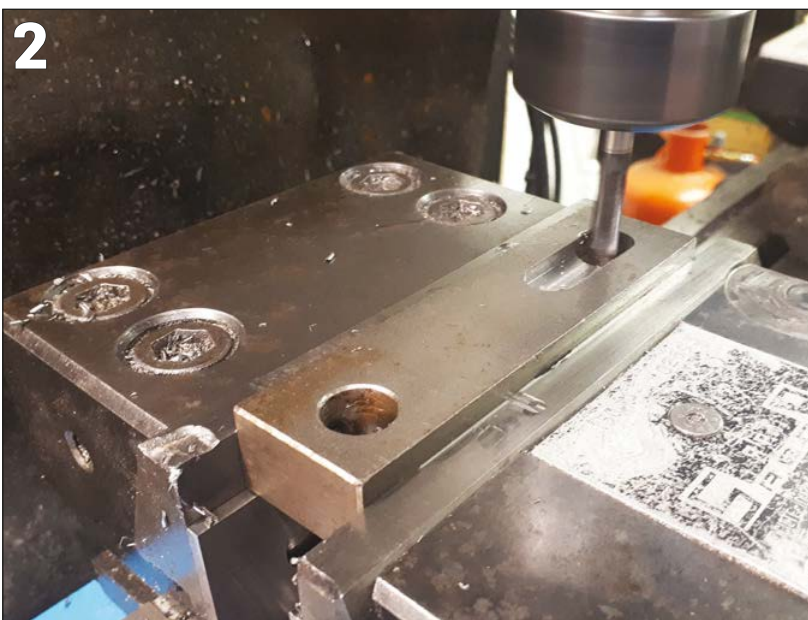


PHOTO 2: Drilling holes in base of stop.

PHOTO 3: Grub screw locks column in place.

PHOTO 4: Chamfering top of column cuts potential for injury.

PHOTO 5: Filed flat provides firm mating surface for grub screw.

PHOTO 6: Tee-nut clamps vice stop to table.



- 3) 3 inches of 1 x $\frac{3}{8}$ -inch BMS to make the arm
- 4) 8 inches of 6mm silver steel to make the stop rod
- 5) 3 x M6 dog point grub screws

To begin with, we'll make the base that supports the stop. This needs to be rigid and sturdy, and for mine I used some $\frac{1}{4}$ x $\frac{3}{4}$ -inch steel flat bar that I had in stock left over from something. Make it from a decent chunk of aluminium if you like but it needs to be rigid – you'll find little aluminium in my workshop, can't stand the stuff!

I've made my base to be five inches long, and I have machined the ends square so that we can clock them in for future operations. We also need to machine a slot into it to allow for the fixing bolt, followed by a hole for the column.

Set the material on parallels in your vice, and drill three holes in it, one for the column (which I recommend reaming) and one for each end of the slot (Photo 2). I have a Bridgeport milling machine (or rather a clone of one) and so I have made my slot to be $\frac{1}{16}$ -inch wide to allow for the M12 clamp bolts I normally use.

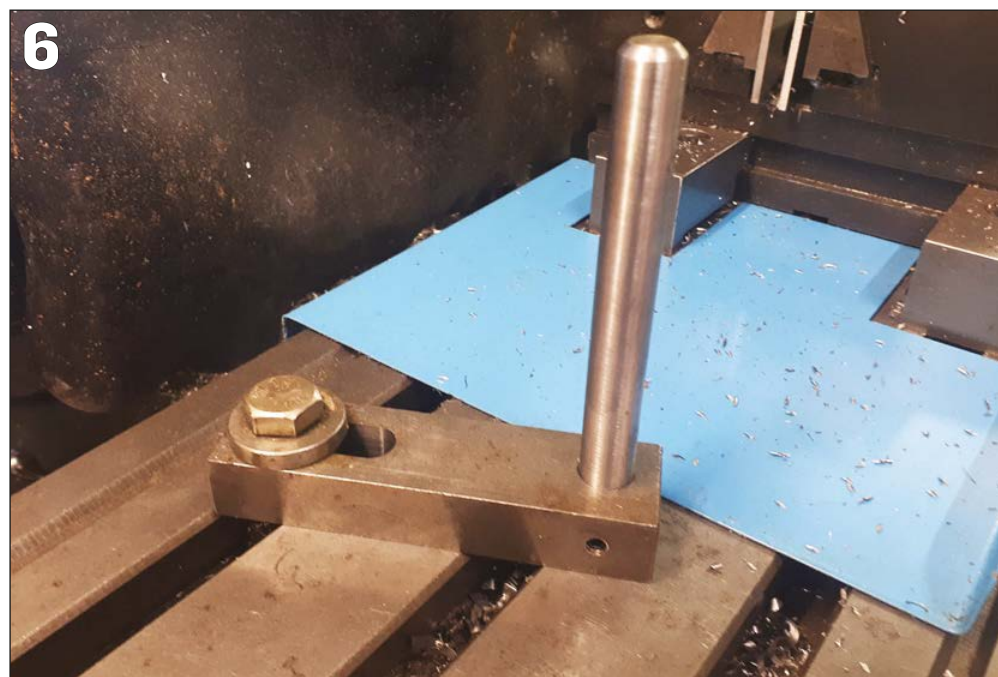
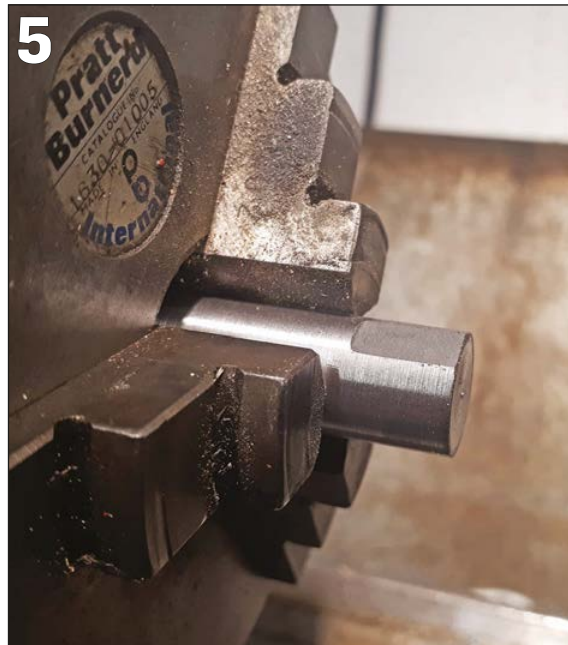
Once you have drilled each end of the slot, then set a smaller milling cutter in the spindle and machine out the slot. I do not recommend using a cutter the same width as the slot you want, use a smaller cutter and step across to make the width. I used an 8mm carbide milling cutter with three flutes for mine.

Once you have completed this stage, we need to just quickly drop in a grub screw to lock the column in place (Photo 3). Set the material on parallels in the vice again, use an edge finder to locate the stock and wind in to the centre of the reamed hole from the end of the stock, then use a centre-

drill and tapping drill, before tapping through to the hole.

I have used an M6 dog-point grub screw for mine, and you'll have noticed from the photo that my column isn't in the middle of the base, done deliberately so that my grub screw didn't stick out the side to catch swarf on. Deburr all the machining, and if you want to chamfer or radius the corners do so now – I'm lazy and didn't bother!

For the next part draw a length of round bar from stock to make the column. I used some $\frac{1}{2}$ -inch bright bar for mine, I think it's just ordinary mild steel again. The top of the column is going to be right in the working zone, so to save yourself from injury I suggest you machine a decent chamfer or radius on the end (Photo 4) so that you don't cut the back of your hand with it. I did mine with a ▶





45-degree chamfer tool in the lathe, and then polished off the edges of the corners with some emery tape.

How long is a...

The length of the column is largely a matter of guesswork. Mine was longer to start with, but experience showed it was unnecessary and so I trimmed it down. It's now $\frac{1}{2}$ -inch higher than the top of my vice and is much less in the way, I recommend you do similar. The bottom needs to be faced off square in the lathe, just break the corner with a chamfer tool, and then a quick polish.

While in the lathe I used a file to create a flat for the grub screw to bear on (Photo 5). If your reamer cuts to a good size, the column should now slip into the base, and can be locked off with the grub screw.

I made a batch of blank Tee nuts some time ago, I drilled and tapped one of these M12 and used an M12 set-screw and large washer to clamp the assembled base and column to the table (Photo 6).

The arm is made from a 3-inch length of $1 \times \frac{3}{8}$ -inch BMS I had kicking around, and to make this part we again set the material in the vice on parallels. Drill and ream one end (Photo 7) the same size as the base to suit the column, remember to leave enough room at the end to fit in a grub screw.

Trial fit the column and make sure it's a nice sliding fit, but it doesn't want to be a tight or a loose fit. Once happy stand the part up on end in the vice and drill and tap to suit your grub screws again (Photo 8). I have a tapping guide for the vertical spindle that I like to use to keep the tap vertical and aligned with the drilled hole, this makes 10BA holes easy.

Repeat the operations for the

other end of the arm, remembering to drill the hole for the stop rod at 90 degrees to the hole for the column. I do a lot of parts from $\frac{1}{4}$ -inch upwards, it's not very often I make anything thinner, so I chose to use a length of 6mm silver steel for my stop rod, which would be good and rigid, and still fit between the vice jaws when clamping $\frac{1}{4}$ -inch material.

I highly recommend using silver steel for its rigidity, for accurate positioning the stop relies on not flexing, but you may wish to use 5mm or 4mm (imperial equivalents available!) depending on the type of work you regularly do. You can now assemble the stop rod and arm to the column (Photo 9) and now you're ready to make those 40 brake hangers, without having to clock in each part! **EIM**



PHOTO 7: Material for arm set in vice on parallels before being drilled and reamed.

PHOTO 8: Once fit of column determined (not too tight, not too loose), arm drilled and tapped to accept grub screw.

PHOTO 9: The finished vice stop, assembled and mounted, and ready to bulk-produce components.

All photos in this feature by the author



Building a Legacy

A year in the life of growing road steam and vintage dealer Legacy Vehicles Ltd.

Twelve months ago Legacy Vehicles was a young company finding its feet in the vintage market place – a year later the company is now one of the largest and most trusted dealers in the road steam and vintage vehicle scene.

Here Tom and Sammy Allen, the husband-and-wife team, who own Legacy Vehicles, give an insight of how they turned their lifelong passion into a career.

Tom Allen: “I was very fortunate to grow up around all types of vintage vehicles including our family’s 1920 Aveling and Porter steam roller. Unlike most children who played football at the weekends mine were spent attending steam rallies or restoring the roller with my family and friends. As we did virtually everything ourselves, including the boiler work, the restoration took almost 20 years!

Before starting Legacy, I began my career as a service engineer for a pump specialist and over the years moved into a sales role eventually becoming sales and marketing manager for a large engineering company.”

Sammy Allen: “Like many steam wives (widows?), my introduction to steam engines and vintage vehicles was through Tom. Over the years we have taken all sorts of exhibits to steam rallies and completed a number of projects and restorations together.

The idea for Legacy Vehicles came about when we were looking for our own miniature traction engine to buy. Even though we were ‘in the know’ it was frustrating trying to find the right engine, often adverts were scattered over different forums or magazines and lacked the information and detail we needed.”

Tom: “Legacy Vehicles was Sammy’s idea as she had the skills to put together the website – the original concept was an *Auto Trader*-style website but for steam and vintage vehicles. Speaking to people we quickly discovered what they really wanted was someone to look after all the advertising and initial enquires when selling a vehicle.

We created our unique advertising service to incorporate online, social media and print-based advertising and to save sellers time by sorting the ‘wheat from the chaff’ of potential buyers.

Online adverts are where most enquiries now come from and our service works particularly well for those who are not so au fait with computers, but are happy to do the viewings and final negotiation with a buyer.

Buyer protection

Another key motivation was to offer the buyers some protection – stories of newcomers to the market buying a ‘lemon’ is sadly a common thing. We made it clear to sellers that any vehicles had to be described honestly and we also produced buyer’s guides and lots of information helping potential buyers to make informed decisions – much



of this is available for free on our website.”

Sammy: “With the advertising service working well some customers asked if we could look after the full sales process for them including the viewings and final deal with the buyer. We introduced our flexible brokering service which has proved very popular, especially as all engines go through our workshop to ensure they are in the best condition for sale. We offer steam and hydraulic testing but unlike other dealers we only use trusted independent boiler inspectors rather than doing it ourselves.

Tom: “We also buy and sell our own stock of miniature steam engines. We pride ourselves on the quality of engines that we sell and often this involves many hours in the workshop bringing them up to our standard.

Before any engine leaves us, stock or brokered, I ask “Would I be happy/confident taking this to a steam rally?” an engine only goes when the answer is “YES!”

ABOVE: Sammy and Tom, the Legacy team.

BELOW AND RIGHT: Before and after a 4-inch Fowler has been in the Legacy workshops.



Our workshop and restoration services are also available to private owners who wish to have works undertaken.

Currently we do not trade in railway locos (unless taken in part exchange). I like to have good knowledge of what I am selling and my railway knowledge is somewhat limited, as much as I do enjoy driving them!”

Sammy: The company has grown at a pace neither of us ever expected, we think our personable and genuine approach to dealing with both buyers and sellers has been the main reason for success. Often people are coming to us through recommendations from other customers which is the greatest compliment we can receive.”

If you are thinking of selling or buying a road steam engine, full size or miniature or any other vintage vehicle please call Legacy Vehicles or check out the firm’s website.

LEGACY VEHICLES LTD

Tel: 01462 506502

Web: www.legacyvehicles.co.uk

Email: info@legacyvehicles.co.uk



Mountaineer – a classic...

Bill traces the history of the model that has become his latest build project.

BY BILL EDMONDSON



LEFT: Full steam ahead for 'Mountaineer' on the Ffestiniog Railway – except that this 2012 shot is a lie! Six years after the loco's withdrawal 'for rebuild' it was displayed at an FR Gala, propelled by another loco behind it and providing the steam effects!

CENTRE LEFT: The loco on show at Blaenau Ffestiniog during the same 2012 event. *Both photos: Michael Chapman*



BELOW: Bob Harris, Don Young and Fred Barnes discuss Fred's model in 1974. *Photo: Russell Burrridge*



Don Young passed away in 1994 having earned a well-deserved place in the model engineering history books as a producer of miniature steam locomotives with many designs to his credit. One such is the subject of this short article.

Don first saw 'Mountaineer' on the Ffestiniog Railway in 1969 whilst on one of his regular holidays in north Wales. He was immediately captivated by the 2-6-2 locomotive.

Mountaineer, works number 57156, was one of a batch of 100 locos built by the Cooke works of the American Locomotive Company (ALCo) in 1916, and sent for service behind the trenches in the First World War, gaining the War Department designation 1265.

After hostilities ceased, the locomotive saw further service in France, firstly on reconstruction work and later along with two sisters on the 600mm Tramway de Pithiviers à Toury, which at the time was some 80km in length. The Tramway closed in 1964, though part of it has since been restored and one of the other ALCo loco, WD no 1240, is preserved on the line.

John Ransom was the first to fall for Mountaineer – he knew it was lying disused in France in 1964 and managed to buy it. In 1965 he brought 1265 to London and in 1967 it was gifted to the Ffestiniog Railway where it resides to this day.

In 1972 Don Young released his design for a 3½-inch gauge version of this 2-6-2 narrow gauge locomotive. To enable Don to produce his design, access to the full-size locomotive was made possible (at that time, there were no ALCo drawings of the design available despite many enquiries in the US). He quickly made friends with the then Ffestiniog general manager Alan Garraway, but also the staff in the line's Boston Lodge workshops; in particular Bob Harris.

Bob was the foreman at Boston Lodge around the time that Don was putting the design for the model together; he became the main contact when Don needed a component part measuring or photographing.

Fine detail

Individuals approach model construction at various levels. Some follow the design as given whilst others get lured into looking closely at

the prototype in order to add some of the fine detail which may have been omitted on the miniature design.

I fall into the latter category and so when I decided to build a model of Mountaineer, as a volunteer on the Ffestiniog Railway, access to the full-size loco is possible. Therefore my attempt to build an example of 1265 should be authentic – I hope.

This aim has, however, turned into the proverbial can of worms! When Mountaineer arrived at the FR in 1967 it was quickly put to work and continued so until early 2006 – it now awaits a full overhaul. Over the years, many significant modifications have been made in an effort to improve the locomotive – some of the more obvious ones include a redesigned cab, a new boiler to a design closely following the Hunslet former Penrhyn locomotives also on the line (with a raised round-top firebox), and conversion from slide valve to outside admission piston-valve motion.

Changes were also made to the rear balanced suspension components in order to free up space in the ashpan, which sits in a congested area of the frames, while there were also many less obvious alterations. Now all of the above serves to confuse anyone attempting a 3½-inch gauge model – the question is, which version of the loco to follow?

Back to Bob Harris. Many years ago he and wife Frances moved to Canada. However they return to the UK every year and spend time catching up with friends and relatives. During these trips he's always to be found socialising with FR volunteers around the railway in Porthmadog.

Visual revelation

It was during one such social evening that the subject of Don Young and his miniature design cropped up. Bob explained how he had helped with enquiries Don would make asking for dimensions or photographs. And – the most interesting news, that he was there when what is thought to be the first example of the design to be completed was brought to North Wales in 1974 to show to Alan Garraway and the FR staff! When Bob then produced photographs of the day, this article celebrating the design began to seem like a good idea.

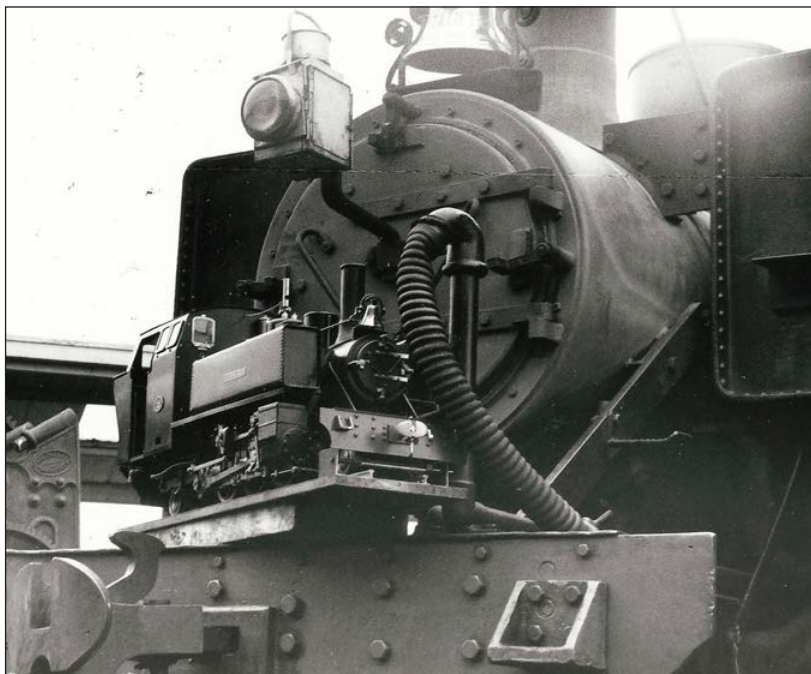
The photographs on these pages of that day speak for themselves, harking back to a period of time when the FR was still pushing ahead to complete the line back to Blaenau Ffestiniog (and building the Deviation with its spiral in order to do it).

This first miniature Mountaineer had been built by Fred Barnes – one time member of the Urmston Model ►

“All of the above serves to confuse anyone attempting a 3½-inch gauge model – the question is, which version of the loco to follow?”

THIS PAGE:

Three views of the 3½-inch gauge model built by Fred Barnes posing with its full-size counterpart in Boston Lodge works yard. Note the difference in cab between these pictures and the 2012 versions on page 14 – the full-size engine has undergone many changes since it arrived on the Welsh line. Photos: Bob Harris



Engineering Society. Enquiries to the Urmston club led to a conversation with Alan Williams who remembered Fred. Described as something of a loner who didn't get much involved in club activities, he had passed away in the 1990s and sadly the whereabouts of his locomotive are unknown – is anyone out there able to help locate this model?

Many miniature locomotive designs have become well known – there's Jack Buckler's 'Sweet Pea', or Martin Evans 'Simplex'. LBSC of course remains the father figure of our hobby – think of his 'Ayesha' – the design being first published in 1922. But Don Young also earned his place in our hobby with his many miniature locomotive designs – Mountaineer proving over time to be very popular.

As for the real thing; there are many devotees who wait patiently to see it returned to working order! **EIM**

■ We hope to carry an update from Bill in a future edition of the magazine as his Mountaineer locomotive build project progresses.

RIGHT: Ian Stewart with his ALCo, pictured running at the weekend Narrow Gauge event held in July 2019 at the Rugby ME track. Photo: Andy Kiddell



ABOVE & BELOW: Over the years the Don Young design for 'Mountaineer' has produced a goodly number of models – two are illustrated here on the Northern Association of Model Engineers stand at the 2009 Midlands Model Engineering Exhibition (above) and an almost complete example (below) at the 2013 version of the Midlands show, displayed on the Erewash Valley ME stand. It's interesting that most modellers seem to choose one period in the full-size loco's life, the models having a similar visual appearance.

Photos: Andrew Charman



■ Michael Chapman is a regular contributor to **EIM**'s sister magazine *Narrow Gauge World*, and when we asked him for the photos of the full-size engine on page 14 he revealed he has his own 3 1/2-inch gauge model of the loco, sitting in a display cabinet at his home (above).

Michael admits that the loco was an opportunistic purchase 15 years ago when he spotted it for sale on the eBay online auction site and it received no bids. "It's Mountaineer as running in the 1970s – there was one season where she ran painted black with green panels but no red lining," he tells **EIM**. "Also she is modelled prior to the fitting of the Fairlie-profile cab in 1984."

Michael would not describe himself as a model engineer and says a Ffestiniog Railway driver who has looked the loco over has advised him not to steam it as "the pipe work needs 'work'". But everyone who visits him is drawn to the model in its display case.

"It's been on display at the Ffestiniog Railway's Porthmadog Harbour Station and on the Welsh Highland Heritage Railway at Gelert's Farm, Porthmadog," Michael says, adding that transport is challenging in his small three-door Volkswagen hatchback. "It means moving the front seats in the car forward, laying the back seat flat and taking the parcel shelf out, and the loco's chimney off."

"With the loco on board the car handles completely differently and if I go round a corner too quickly Mountaineer rings her bell."

"The last time she went to Wales she had to stay in the boot for two days until a mate was free to help get her out – it takes two people..."

On the straight and narrow

David finds a variety of applications for an innocuous-looking pair of metal bars...

BY DAVID CONEY

When undertaking any sheet metal work I have found that one of my most useful tools in the workshop are a pair of what I call 'Parallel Bars'.

These bars consist of two strips of steel measuring approximately 15 inches x 1-inch x 1/4-inch, with a 1/4-inch diameter hole at one end, and a number of 1/4-inch holes at the other end, with 1/4-inch screws and wingnuts in same, as in **Photo 1**.

I do not claim to have invented this accessory as I bought it in one of my model engineering club's jumble sales, with no description attached giving any clue what it was. I merely want to illustrate how such a simple item can help with sheet metal work, in my case the construction of the cab for a 3 1/2-inch gauge Rob Roy steam loco.

Host of uses

The bars are very useful for work holding, especially for those of us who only have a small vice to hand (I have a larger vice but this is mounted in my 'garage' workshop, not in my main model engineering workshop).

Photo 2 shows the bars being used as a guide for cutting a thin strip of sheet metal. And **Photo 3**

shows the bars holding an almost completed cab in the vice in order to carry out some clean-up filing work.

The bars could also be used for the folding of sheet metal and no doubt my fellow model engineers will find other uses for such a simple piece of equipment. **EIM**

PHOTO 1: Mystery purchase at a club jumble sale hid its variety of uses.

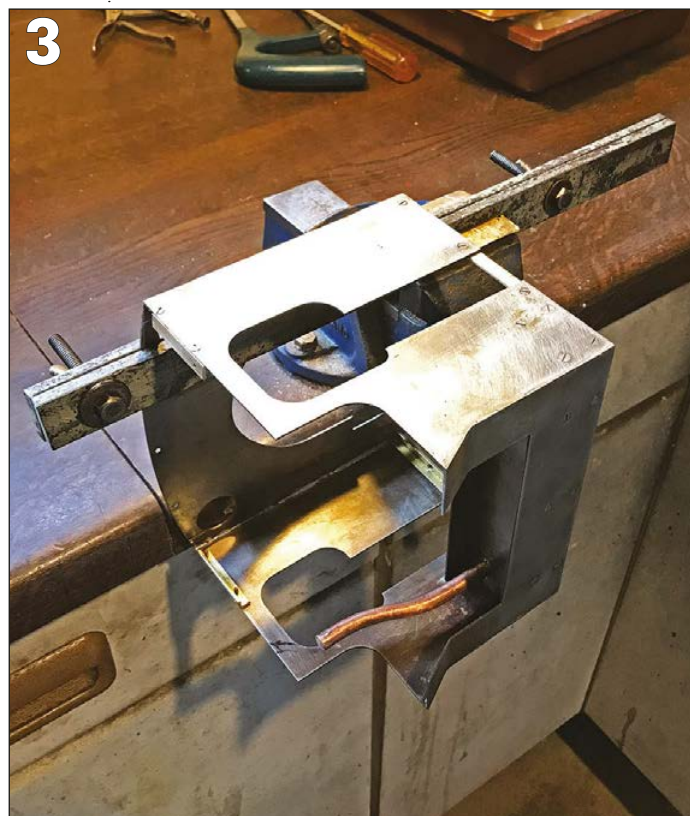
PHOTO 2: Bars provide both firm grip and straight edge to follow when cutting thin sheet metal.

PHOTO 3: Firm holding when working on an awkward shape such as a locomotive cab is just one more use the bars can be put to.

All photos by the author



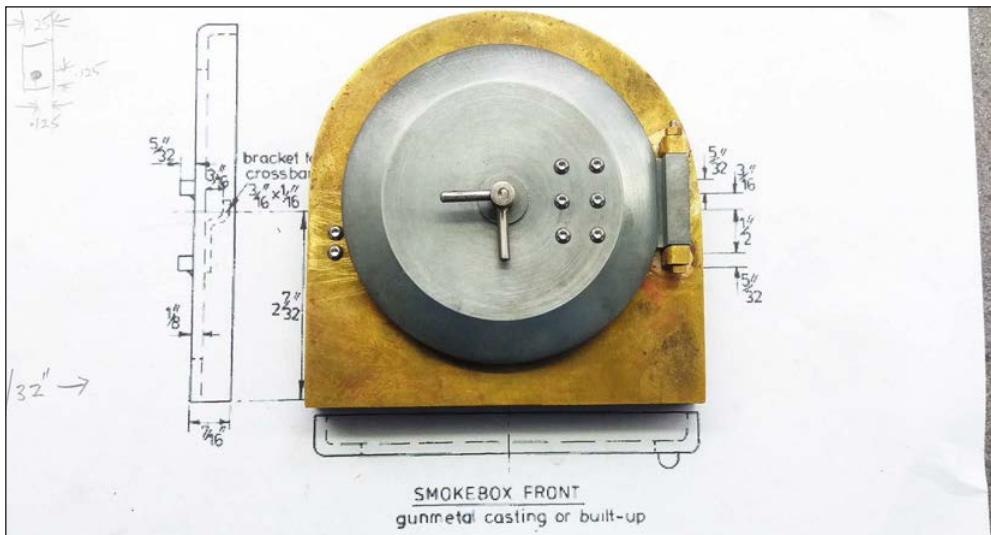
Workshop and technical tips from experienced model engineers provide vital help to **EIM** readers, especially newcomers to the workshop. If you have a tip to pass on, send it to andrew.charman@warnersgroup.co.uk. We pay for all tips used in the magazine.



Electrical plating for model engineers

Beginning a short series, Rich focuses on various methods of protective coating.

BY RICH WIGHTMAN Part one of four



During the course of my current locomotive build, 'Conway' an 0-4-0 3½-inch gauge tank engine, I came up against the age-old problem of rust. Nicely machined and shiny steel parts didn't stay that way for very long, an unwelcome brown colour covering the surface of each. A quick rub over with wire wool and a dowsing in oil sort of cured the problem but handling oily parts when you are trying to build a loco isn't ideal – some means of rust prevention would be handy.

After some research I came across the process of plating electrically. Some more research led me into the dark art of electrolysis and plating. Zinc plating seemed to be the way to go for steel parts as a protection against rust. That led me onto nickel plating which in turn led me onto copper plating and finally etching brass name plates.

I must add here that I take no credit for these methods, these are just the ones I used and the ones I would like to share.

First of all a bit of necessary health and safety. Even though we are going to be using quite safe chemicals and in small quantities care must be taken. Always wear protective clothing, gloves, eye protection and such and read the safety labels on each product.

Disposal of chemicals must also be considered. In the small quantities we shall be using it's not a major problem but worth taking into consideration. I found a section on chemical waste disposal on my local council website so check out the information on your local authority's website as it may differ to mine.

Above all common sense is the order of the day.

So as not to confuse the processes I will split this series into four separate articles, starting this month with zinc plating, then nickel plating, copper plating and finally etching.

Zinc plating

Rust, the enemy of model engineers, is not an easy thing to control. It's been in my workshop since day one and regularly sneaks out to attack the



ABOVE: The steel smokebox door after it was zinc plated.

PHOTOS 1-8:

Ingredients for zinc plating – left to right, top to bottom they are a container for plating (note the marking up to avoid cross-contamination), sugar, Epsom salts, white distilled vinegar, pieces of zinc, electrical leads with crocodile clips, a power source and finally, a pair of rubber gloves to protect one's hands.



latest bit of steel that I have just machined. It was while building my Conway 0-4-0 that I decided to look into what I could do to stop the creeping brown mence. Quite by chance while searching the interweb I came across zinc plating so decided to investigate further.

Zinc plating has been around for many years of course, it's nothing new. It is used on nuts and bolts, ironmongery and corrugated steel roofing sheets to name just a few applications. The good thing about zinc plating is the fact that it will go straight onto steel with no other process required. So I wondered if it could be done in the home workshop.

Back on the interweb I spent a week or so researching the possibility. There are many methods, some involving chemicals I have never heard of and not really the sort of thing I wanted to get involved with. The method I eventually settled upon is the one I shall describe here as I know it works.

Okay, here's what's needed (I have no connection to any of the brands described here).

1) A plastic container, about 2½ litres in capacity, with a lid that seals. There are plenty of options down at the local hardware store, tall, long, narrow and such like. Get a container that suits the size of parts you intend to plate. I initially started with a smaller container shown in some of the photos but later changed to this larger one which is approximately 12 x 12 x 4 inches (Photo 1). I wanted to do the coupling and connecting rods to name just a couple of parts of my loco, and these are around eight inches long.

2) Sugar (Photo 2)

3) Epsom salts (Photo 3)

4) White distilled vinegar (Photo 4)

5) Zinc (Photo 5)

6) Electrical leads with crocodile clips (Photo 6)

7) A power source (Photo 7)

8) Rubber/nitrile gloves (Photo 8).



Items one to four are readily available at most supermarkets so should not present a problem. Item five, zinc is easily obtainable from a certain well-known internet auction site. Search for zinc plating anode and you will find plenty there costing from a few pounds upwards. Some fishing weights are zinc and so are some wheel-balancing weights. It's also available at ship's chandlers but whatever source you choose its pure zinc you need.

Be careful not to end up buying lead. Usually zinc has a sharp edge and is much harder than lead, while zinc is also usually die cast. Anything other than pure zinc will contaminate the electrolyte and may render it useless.

Coloured electrical leads with crocodile clips are available on auction sites for less than £3.00 for a pack of 10. They make connecting the various pieces very easy.

The electrical supply – I would recommend you get an adjustable regulator like the one shown in photo 7 and a power supply. The power supply could be from a laptop, battery charger or such like. The regulators are readily available for as little as £2.00 or so, including the postage! It is possible to use 1.5-volt AA batteries but because there isn't

the option to control the voltage the finish that will be obtained is a bit hit and miss.

Electrolyte Preparation

Don't forget your gloves, eye protection and such, then weigh out the sugar and Epsom salts (Photo 9).

Mix up your solution in the following quantities;

- 1 litre of white distilled vinegar
- 100 grams of Epsom salts
- 120 grams of sugar
- 10 square inches of zinc.

Vinegar is a mild acid and will slowly dissolve the zinc metal into solution. Epsom salt is magnesium sulphate and is the electrolyte of the plating solution. Sugar is used as a brightener. It causes many smaller crystals to form on the surface instead of fewer larger crystals.

Note that because I used a larger container I doubled all the quantities.

Pour the vinegar into the container, then add the sugar and Epsom salts at room temperature and mix in until it is fully dissolved (Photo 10).

Add the zinc pieces. I suspended mine from copper wire stripped from some household cable (Photo 11).

Nothing will happen for a couple of hours or so but by the end of the next day you should be able to see

PHOTO 9:

Weigh the sugar and Epsom salts.

PHOTO 10:

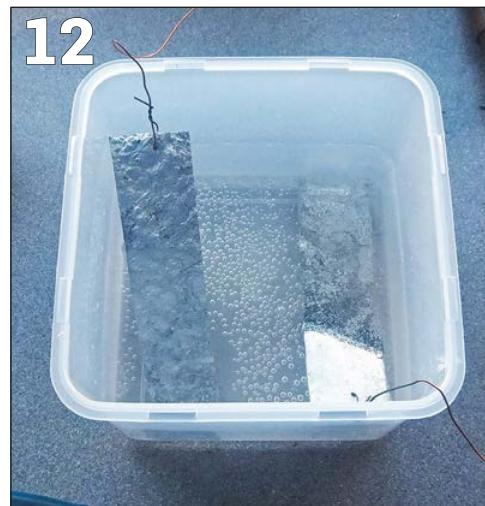
Mix the sugar and the Epsom salts into the vinegar.

PHOTO 11:

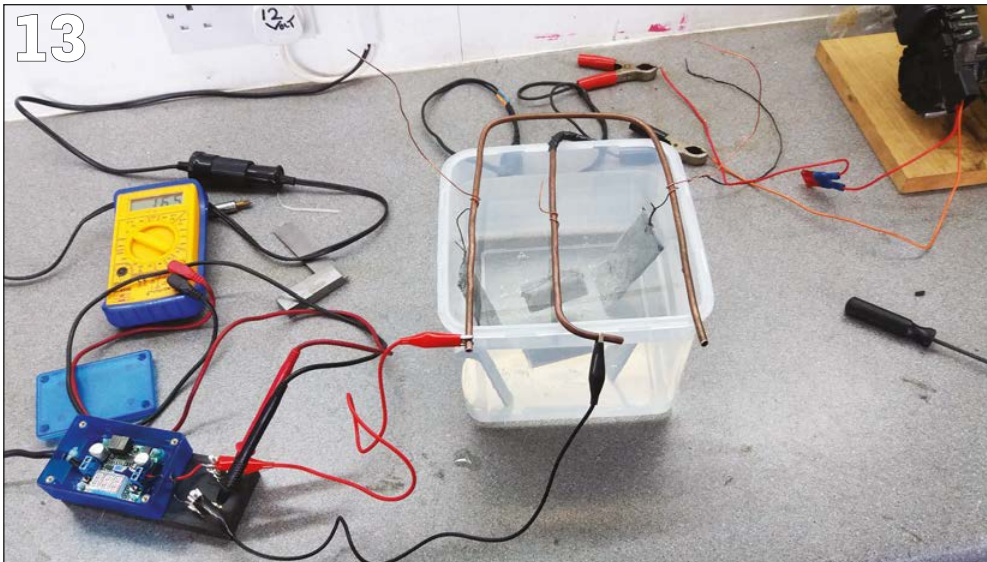
Add the zinc pieces to the mixed solution.

PHOTO 12:

Zinc pieces bubbling as the process gets to work.



13



14



PHOTO 13:
Suspend the zinc and the part in solution

PHOTO 14:
Test piece as it came out of the solution

15



PHOTO 15:
Test piece and clamp after brushing up.

PHOTO 16:
The connecting rods after they were zinc plated.

All photos in this feature by the author

tiny bubbles coming off the zinc pieces (**Photo 12**). This is the zinc being converted to soluble zinc acetate but it does give off a little hydrogen gas so don't tightly seal the lid in case pressure builds up in the container. When we start zinc plating the zinc anode will dissolve at the same rate that zinc is being deposited onto the cathode so the zinc solution should remain stable and not weaken.

Plating a part

Okay, onto actually plating something. I cannot emphasise enough that cleanliness is the key to a successful finish (don't ask me how I know), so firstly any scratches or dents should be removed. The plating is not a filler so any blemishes on the part will show through. Wear rubber gloves and clean the part thoroughly. The plating will not take to finger prints, oil, dirt or such. Scrub the part under clean water.

I used some lengths of copper brake pipe across the container and

used copper wire to suspend the zinc and parts. In this trial I have zinc to each side and the part in the middle. Make sure of course that the + and - connections don't touch each other. Strips of wood can also be used (**Photo 13**).

Make an **anode** (+ terminal) of zinc metal and attach the **cathode** (- terminal) to the part to be plated. Connect to the power supply, and start at about 3 volts.

If the solution contains a sufficient amount of dissolved zinc you should see the part being plated start to turn zinc-coloured almost immediately.

Aim to adjust the voltage so that a small amount of bubbling can be seen. If the voltage is too high you might get a slightly burned and rough look around the edges. If the voltage is too low the plating will take longer and might have a frosted look. Some experimentation on a few scrap pieces first will be beneficial.

After 10 to 15 minutes turn the power off and lift the part out, remember to use the rubber gloves. Give it a rinse in clean water and a light rub with a cleaning pad. If the plating looks a little thin in places stick it back in for another 10 minutes or so. It's better to do several short runs than one long one.

The plating will have a greyish look to it. A lot of the parts I did for my loco I left like this as they would eventually be painted.

The test piece in **Photo 14** is as it came out of the plating solution.

Adding shine

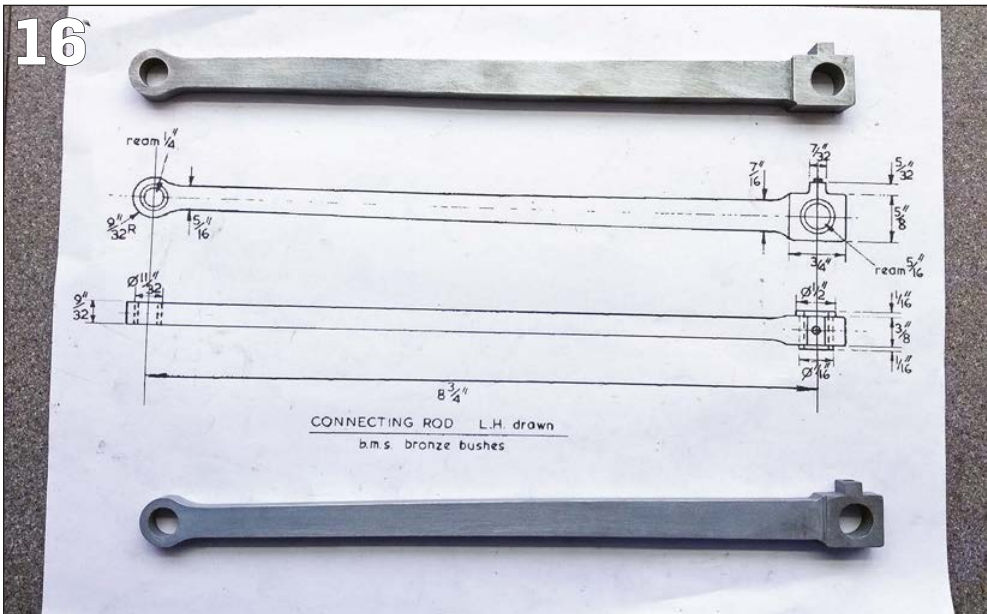
If you want a shinier finish give the part a rub with a brass wire brush. Be careful to make sure that the brush is indeed brass. Some are described as brassed which are in fact brass plated steel - these are too rough and will scratch the plating.

The two items in **Photo 15** are the steel tube test piece and a replacement blade clamp that I made for a woodworking plane. Both have had the brass wire brush treatment.

Photo 16 is the zinc plated connecting rods and the heading photo to this article shows the steel smokebox door zinc plated. I have used the process many times in the workshop on homemade tooling. All of the parts I have plated have remained rust free, some of them for several years.

That's about it for the zinc plating, reasonably successful and reasonably safe to carry out in the home workshop and not overly expensive. The success prompted me to look into something a bit shinier, nickel plating, which is the subject of part 2 of this series next month. **EIM**

16



Building a Ten-Wheeler

No coal in Jan-Eric's 7¼-inch gauge locomotive – this month he explains the attractions and challenges of gas firing with propane, and makes the burners.

BY JAN-ERIC NYSTRÖM Part Seven of a series



Live steam 'purists' may scorn at the use of propane as a fuel source for my 7¼-inch gauge ten-wheeler, but it is a fact that it is an eminently suitable fuel for passenger-hauling engines, provided that certain precautions are adhered to.

Propane, also called LPG (liquified petroleum gas) is a hydrocarbon, in other words it consists only of atoms of hydrogen and carbon – the chemical formula is C₃H₈. Since it is odorless, a small amount of odorant is added to provide a warning of leaks.

Complete combustion leaves only carbon dioxide and water vapour. Incomplete combustion may generate poisonous carbon-monoxide gas, so proper ventilation should be taken care of if the boiler is fired in a confined area – this of course applies to any fuel!

Soot but no ash

Propane leaves no ash, but may form soot on firebox and firetube surfaces if there is insufficient air for complete combustion. Since propane is heavier than air, good ventilation is necessary, both when doing experiments in the workshop, as well as when running a train. The wagon used for transporting the gas container should have an open bottom, in order to avoid a build-up of gas-air mix, which is explosive in certain concentrations.

A propane tank will get colder as gas is drawn from it. With very small tanks, this may pose a problem. A tepid water bath for the tank can be used, but in no circumstances should the tank be heated to higher temperatures. I have experienced no problems with freezing in 1.5-inch

scale, where my tanks are of 5-kilo/10-litre capacity.

As you have read in the previous articles, my 4-6-0 has a 'proper' firebox boiler, contrary to my first two locos, which use two- or three-flue boiler designs with burners inside the flues – thus these two engines can only be fired with propane.

With a 'standard', firebox-type boiler, you can use any of several fuels; coal, wood, oil or propane are all suitable, with only small modifications to the firebox components required. In fact, I designed the ten-wheeler's boiler so that it can accept either a standard grate for solid fuel, or a set of propane burners. Since most of my running involves carrying passengers, and using propane is the most effortless type of firing, I decided to build the gas burners first, and leave the grate, and possible coal firing for later.

In this article I'll relate my experiences designing a burner system for a 'deep' firebox, with an inside height of some 200mm, the grate area measuring 210 by 120mm.

A gas flame has a certain 'burning speed', and if that is exceeded, the flame will separate from the burner, and may go out entirely. An experiment I made with a simple gas jet demonstrates this.

First, I cracked the valve on the propane tank only slightly, and ignited the gas. Opening the valve slightly more, the flame lifted off the burner (Photo 1). I could get it to separate by more than 20 centimetres. More than that, and it became very unstable, and eventually went out.

Note that here, the top of the flame is luminous, just like a candle



PHOTO 73:

A flame that has 'lifted off'.

All photos and drawings by the author.

■ Parts 1 to 6 of this series appeared in the February to July 2020 issues of **EIM**. To download digital back issues or order printed versions go to www.world-of-railways.co.uk/engineering-in-miniature/store/back-issues/ or call 01778 392484.

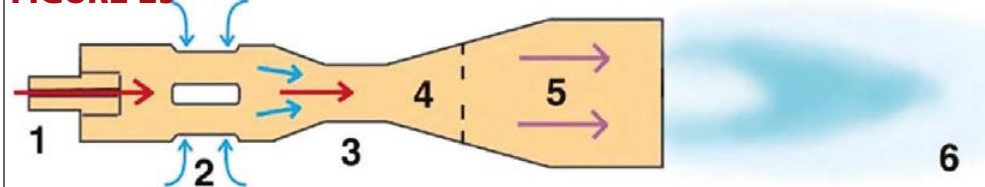
flame. This is something that must be avoided in a boiler firebox – if such a yellow flame touches cool metal (well, cooler than the flame), soot will be deposited, and we want none of that!

In order to get a clean-burning flame, devoid of any soot, it is necessary to ensure a proper gas-air mix. The luminous flame is lacking in oxygen, so the gas decomposes and generates carbon particles – soot – which can burn only by using additional air.

In the experiment, air is surrounding the flame, but in a confined firebox, all necessary air should be mixed with the gas before it burns. For this reason we need to construct a burner that will provide enough air for total combustion. This is usually done by utilizing a very small nozzle for the gas, adding air openings just in front of it, and possibly a 'venturi' constriction a little bit further on.

Figure 1 shows the principle. At ►

FIGURE 29



point 1, the gas exits the small bore of the nozzle, and due to the high speed of this gas jet, air is drawn in through the openings at 2 (this is the well-known 'ejector' principle.)

A venturi at 3, and a perforated baffle at 4 (these two are not always present) ensure proper mixing of air and gas as it exits the burner at 5. The familiar blue flame, 6, can extend to half a metre or more, depending on the burner size and the gas pressure. In typical workshop burners, the pressure is around 1 or 2 bars (one bar

is 100 kPa, or 14.5 psi.)

In another type of burner, as found in barbecue grills and cooking stoves, the pressure is much lower, often no more than 30 millibars. These burners do have a jet nozzle and a venturi, but disperse the air-gas mixture to a burner head with multiple, small holes. This type is not efficient enough to power a large-scale live-steam loco.

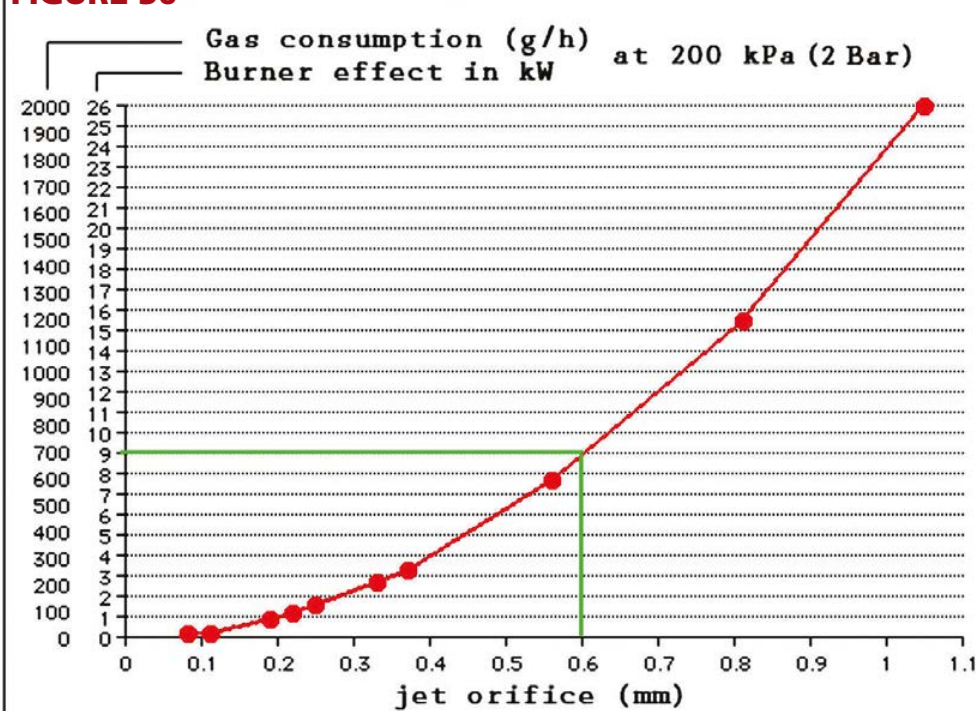
The gas jet draws enough air into the burner to ensure complete combustion. Note, however, that it is

the exit of the combustion gases that usually causes problems in a loco – if the exit is constricted, as in a boiler with firetubes and a narrow smokestack, the flame may 'blow back' through the firehole door or the bottom of the firebox. This must be prevented by inducing a draft into the system – just as necessary as when firing with coal.

Contrary to coal firing, this draft must be present all the time – so, a fan is necessary for raising steam, as is the judicious use of the blower while the loco is standing. The exhaust steam will take care of the draft while running, but it may be a good idea to keep the blower on all the time, to prevent blowback in case of a sudden or unexpected stop.

The risk of blowback is the major drawback of propane firing. Automatic systems have been built, which regulate the blower and the propane gas pressure, all depending on the position of the throttle and the steam pressure in the boiler. This is, however, outside the scope of this article.

FIGURE 30



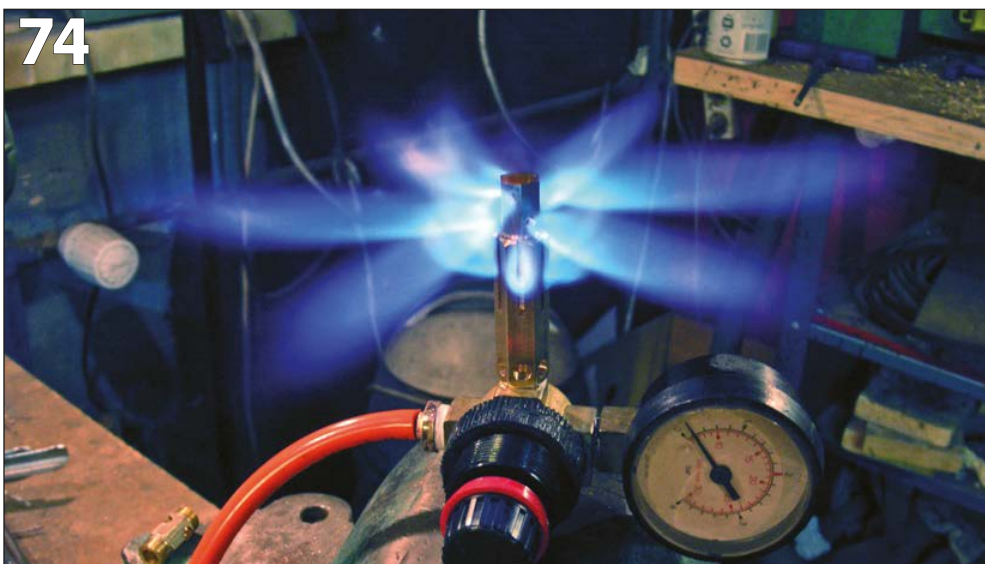
Building burners

Having read quite a few articles about propane firing and burner designs, I decided to try something a bit different, as is my wont... Instead of the common 'barber pole' or 'Marty'-type burners, which have a rather small flame necessitating a dozen or more burners in a large firebox, in mine I wanted just a few, but more effective ones.

The maximum heat input needed for a largish 1.5-inch scale loco must be in the 30 to 50 kilowatt range. This sounds incredible, but we must remember that the total efficiency of a model steam loco is seldom more than 2 per cent – even the best full-size steam locos had only about 12 to 15 per cent efficiency! So, 2 per cent of 50 kilowatts is one single kilowatt – converted to another measure that's only 1.3 horsepower!

In addition to being limited by the boiler's steaming capacity, the actual drawbar pull is dependent on cylinder size, as well as the adhesive weight of the engine. The documentation that came with my Sievert brazing burner included a handy table describing different gas nozzles, and from that information I prepared Figure 2, showing the gas consumption for different nozzle sizes at 2 bars.

Noting that a jet orifice of 0.6mm would provide enough gas to generate a maximum of 9 kilowatts, I decided to build a system consisting of six such burners, a total of 54 kilowatts at full blast. This should be enough for any conceivable circumstance – as a comparison, my 0-6-0 has only half this effect in its burners, and that



engine has performed quite well during our public run days.

After making some experiments, I settled on a burner design consisting of two pieces, the gas orifice and air intake in a 'base' piece, and the actual burner 'head' as a separate piece, which would be attached to the base with a threaded fitting.

My first trials used a burner head with six holes, alternately staggered on the sides of a hex piece of brass. The flame produced by this design was nicely symmetrical (Photo 2), but of a shape more suitable for use in a wide firebox boiler, or, as a single burner, in a small, round, vertical boiler.

The flame kept its shape regardless of the gas pressure – I could vary it up to the full 2 bars that my regulator provided. Also, the flame contained no yellow at all – a proof of complete combustion. This gave me confidence to continue with this design principle.

Making Swiss cheese

As can be seen in Photo 2, small flames are exiting through the air intake slits in the burner body – so maybe I should design a head with still more holes? Making quite a few more experimental burner heads, I finally settled on the design shown in Figure 3: the burner head has 21 holes, plus 12 more in the body. This should pretty well explain why I call them 'Swiss Cheese' burners...

The six base units can be seen in Photo 3. In addition to the six air intake holes drilled close to the gas jet end, my experiments revealed the necessity for additional air intakes, here made in the form of long, narrow slots milled in each side of the hexagonal burner body.

Note that there is a piece of fine stainless steel mesh inserted into the bottom of each burner body, seen in Photo 4. This mesh will prevent any particles inadvertently introduced into the gas line reaching, lodging in, and

FIGURE 29: Principle of typical propane burner.

FIGURE 30: Gas consumption and maximum burner effect related to jet orifice size. Green lines indicate chosen dimension.

PHOTO 74: First test shows nice, but too wide flame.

PHOTO 75: Six burner bodies made from hexagonal brass bar.

FIGURE 31: Construction drawing of the 'Swiss Cheese' burners. Experiments by author suggest measurements not very critical.

PHOTO 76: Stainless steel mesh protects jet orifices from dirt particles.

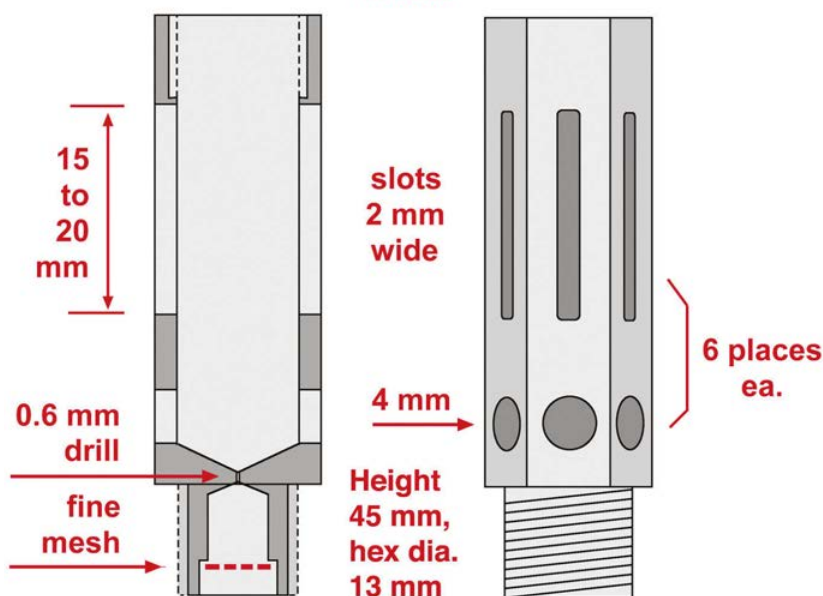
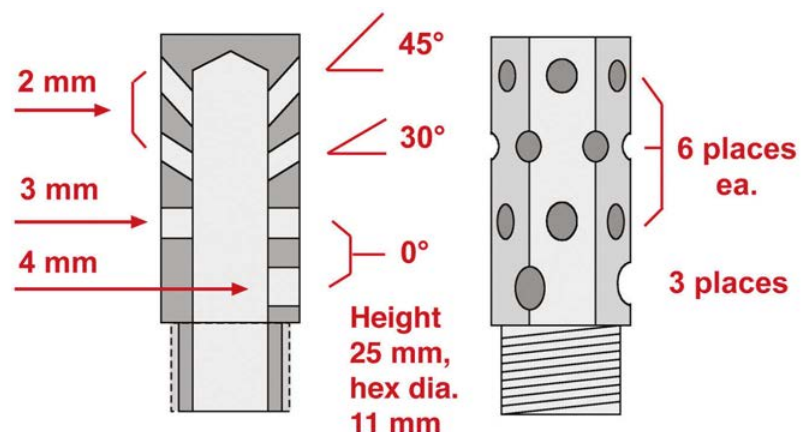


FIGURE 31 Approx twice full-size

blocking the tiny 0.6 mm jet orifice.

In order to achieve a more vertically oriented flame than in the first experimental burner, the two top rows of holes in the burner head are inclined, at 30 and 45 degrees respectively. This will force the flames upwards.

Photo 5 shows how these holes were drilled – or milled, actually. Screwing a burner head firmly into its base, I could clamp the assembly in my mill vice at the desired angle.

Carefully applying 2mm and 3mm end mills cut the required holes into the oblique surface – this would be impossible to do with ordinary drills, which would slip on the surface, and possibly break.

With a burner head made in this way, the flame had an entirely different appearance. Photo 6A shows the flame 'idling' at a low gas pressure setting, lower, in fact, than the gauge could register – I estimate the pressure being less than 0.1 bar. Photo 6B



77



shows the flame at a much higher pressure, 0.7 bar. An even higher gas pressure didn't change the flame shape much. Again, note the lack of yellow in the flame – a good sign.

Manifold of burners

Now, with the six burners built, I needed a 'manifold' for them, in other words a system of piping that would provide gas to each of them. Since the manifold will be kept cool both by the inrushing gas and air and by being placed at the bottom of the firebox, I could use flattened copper pipe and silver solder for the assembly (any assembly that is going to be red-hot, such as a radiant superheater inside the firebox, needs to be constructed from welded, stainless steel. Copper will quickly deteriorate in such use – the oxide flakes off, and clean copper is revealed and attacked.

Photo 7 shows the six burners attached to the manifold, at full blast, with a gas pressure of around 1.5 bars. Since the orifices for the 'major' flames point at 45 degrees upwards,

PHOTO 77:

Milling the angled holes.

PHOTO 78:

Flame shape changes little as gas pressure increased.

PHOTO 79:

Six burners at full blast. Flames do not overlap, though they fill space to large extent.

PHOTO 80:

Hydro test at 17 bars, almost 2.5 times working pressure.

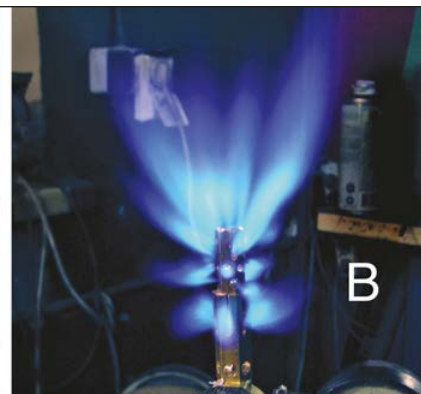
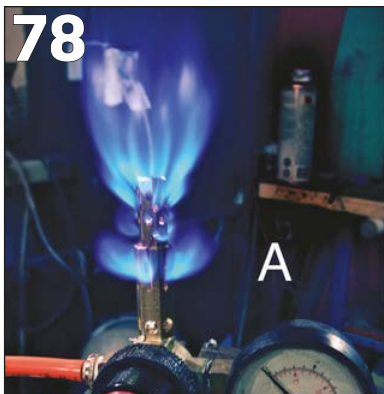
PHOTO 81:

The six burners in action inside the firebox.

80



78



79



the flames do not overlap. Here, the 'minor' flames bend slightly upwards, not because of the direction of the holes they emerge from, but because of the updraft generated by the entire burner system.

Note that the flames emitted from the long slits are much stronger than in the previous examples run at lower pressures. There is still some free space in the slits, which should give a good margin for tolerances in machining, as well as any other factors that may be affecting the flames and their stability.

A hydro test

Before trying to fire up the boiler, I of course had to perform a hydrostatic test to ensure that the boiler would stand the intended steam pressure of 7 bars (100psi). I had built a small hand pump incorporating a 35-bar pressure gauge, and coupled it to one of the boiler's threaded bushings using a hydraulic hose capable of 100 bars pressure. Filling the boiler to the brim with cold water, just a few strokes of

81



the pump quickly caused the pressure to rise.

I decided to test the boiler to almost 2.5 times working pressure, so I pumped up the pressure to 17 bars (240 psi), see the inset in **Photo 8** (the Cu-Ni tube material was actually certified for a much higher pressure).

The pump was placed in an old photo developing tray, which had been dormant after I switched to digital photography almost 20 years ago. Inserting the burner assembly into the firebox of the now tested boiler, I could ascertain that this burner design also worked in the confined space.

Photo 9 shows the flames as seen through the firehole opening – even here, there is no yellow in the flames, so the combustion does not generate any soot.

In actual track use, the six burners are usually fired at a gas pressure of 0.25 bars, sufficient for pulling a train of several carriages with passengers. At this setting, the burners consume a little under 2 kilograms of propane per hour, so one tank suffices for almost three hours of running. During a longer stay at the station, I can drop the pressure to idling at even less than 0.1 bar, only what is needed to keep the flames alight.

Using propane, I have never yet had to brush the firetubes or flues in this locomotive – a testament to the clean burning of this very practical and easy-to-use fuel! **EIM**

■ Next time, moulding and casting processes for the wheels.

Where there's a wheel...

There's more to locomotive wheels than the obvious, as our series for beginners reveals.

BY ANDREW CHARMAN

The wheels are of course the essential items the locomotive sits on and you might think there's a not a lot to learn about them, but they are actually a lot more than just circular lumps of steel.

Firstly size – locomotive **driving wheels** (those joined to each other by the coupling rods and providing the propulsion) can be very large items indeed, but their size gives a clue to the loco's intended purpose.

In standard-gauge practice at least, a loco designed around large coupled driving wheels fewer in number, will be expected to cover long distances at high speed. However if a loco will be expected to need a lot of grunt to haul heavy freight trains at a slower speed, then it will be designed with more wheels of a smaller diameter, providing a bigger footprint and therefore more grip onto the rail.

So for example the British Railways standard class 7 4-6-2 Pacific express locos had six driving wheels each of 6ft 2in (1880mm) diameter, whereas the last standard class built, the 9F 2-10-0s intended for freight use, carried 10 driving wheels each of 5ft (1524mm) diameter. And of course the first express passenger locos of the late 19th century had just two driving wheels of more than eight feet in diameter, earning such names as the 'Stirling Single.'

Tyre change

Locomotive wheels were initially made from cast iron, but these were fairly quickly superseded by cast steel wheels. And while a model engineer building a loco will usually machine up a single casting, all full-size loco wheels are fitted with tyres – cast steel rings of around two inches (50mm) in thickness, that fit around the wheel circumference. The tyre adds extra strength and when worn it can simply be replaced without needing to scrap the entire wheel.

Tyres are fitted by heating – their inner rim is sized fractionally smaller than the wheels they are designed for, and then heated up so that they expand allowing the wheel to be placed between them. As the tyre cools it shrinks and grips the wheel.

For tyres on smaller leading or trailing wheels such grip is enough to retain them in place, but driving wheels are subjected to a whole range of forces, not least from the motion rods transferring the propulsive force

from the cylinders. Therefore the tyres have to be more firmly secured to prevent them slipping on the wheel.

The initial method of doing this was via studs or rivets, but later locomotives used a Gibson Ring – a large circler fitting in a groove mounted on the inner surface of the tyre. A development of this was a double-lipped ring – this fits within the tyre and is then completely surrounded by it during the heating process when fitting the wheel.

To emphasise again, new model engineers should not be too concerned about this as such measures are rarely necessary on locos built in the traditional model engineering scales, up to 7¼-inch gauge.

Of many spokes

Driving wheels are traditionally of a spoked design with up to 20 or more spokes radiating from the wheel centre. However some smaller and narrow gauge locomotives use cast plate wheels and the smaller wheels in the leading or trailing trucks are commonly of this disc format.

The centre hub of the driving wheel, through which the axle passes, is typically pear shaped, on an inside-frame loco (the wheels on the outside of the frame) forming the crank at the end of which a pin is inserted – the connecting and coupling rods are hung on these pins. On outside-frame locos (wheels between the frames) the crank is a component in its own right, attached directly to the axle which extends out from the wheels through the frames.

To compensate for this significant weight running off-centre, the wheels have balance weights cast into the



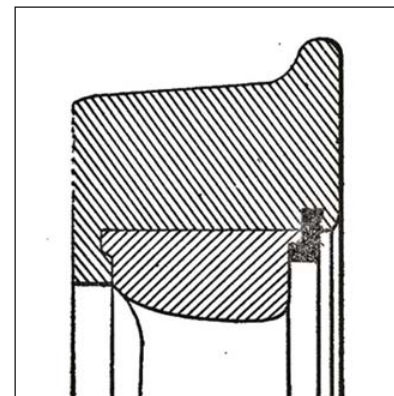
ABOVE: Cast wheel for Jan-Eric Nyström's ten-wheeler. Note the pear-shaped centre for motion pins and balance weight on rim.

inner surface of the rim. The main driving wheel, which has the end of the connecting rod on its crank pin as well as the coupling rod, carries a significantly larger balance weight than the other coupled wheels. **EIM**

■ Next time: The frames, forming the base of the locomotive.

RIGHT: One method of attaching tyres, steel retaining ring in a groove.

BELOW: Disc wheels for narrow-gauge loco. Note polished tyres mounted around cast rims. Photo: Andrew Charman



Starting with a Square Peg

EIM's resident 3D printing researchers, the Kenington family, find yet another workshop issue with small laser-cut parts that can benefit from their new technology...

BY PETER & MATTHEW KENINGTON

As children, we are all taught that it is not possible to fit a square peg into a round hole. A little later on, we all realise that it is perfectly possible to do so provided you use a big-enough hammer.

In this article, we start with the equivalent of a square peg; in our case this is a laser-cut connecting rod forming a part of the brake-adjustment mechanism on the GWR tender we are constructing at present (or, to be more accurate, four of them comprising two different lengths – **Photo 1**).

We decided to experiment with laser-cutting for as many of the chassis parts for the tender as we could and see if we could turn them into what was needed, from whatever starting point laser-cutting gave us. We calculated that the cost of these parts is tiny (pennies) and so if our ideas didn't work out, then we hadn't wasted much money (or too much time), whereas if it was successful, then we would have saved a good deal of time and effort.

Clearly, in the case of frames, this is straightforward, as laser-cutting has been used for many years. When it comes to at least some of the connecting rods however, this is a little more tricky (since they need to be at least partially round) and we describe one solution to this problem here.

As for the round hole, a three-jaw, self-centering lathe chuck is primarily intended to hold round objects (or hexagonal, triangular and such) and a collet chuck is definitely only designed for holding round objects. Our laser cut, rectangular cross-section parts were not compatible with either of these options.

But surely we could have used a four-jaw chuck, with independent jaws? The simple answer to this is, of course, that we could have done so, however there were a couple of issues we faced. The first is that our four-jaw chuck is huge – this is very handy in most circumstances, but not when trying to hold small objects which are too narrow for the jaws to clamp. We would have to have made and then added spacers, which would have been a nuisance.

The second is that accurately adjusting the four jaws, so that you end up with a round bar, from a

PHOTO 1:

Laser-cut connecting rod blanks with rectangular cross-section 5mm x 4mm. Required holes located with centre-punch, prior to photo being taken.

FIGURE 1:

CAD drawing (in DXF-format) of connecting rod outline, as supplied to laser-cutting company. Both cut in 5mm thick mild steel with holes 'spotted' (with cross – see Photo 1).

FIGURE 2:

CAD drawing of required finished parts (including threaded sleeve). Finished rod diameter should be 4mm, with M4 thread for adjuster (left-hand thread on one rod, right-hand thread on other).

All photos and diagrams in this feature by the authors



rectangular starting point and with essentially no leeway in the dimensions (we wanted to create a 4mm diameter rod from a 4 x 5mm cross-section bar), would have been beyond the patience of a certain 14-year old (and many somewhat

older machinists...). We therefore sought a simpler solution.

Our starting point was the two DXF drawings shown in **Figure 1**. These show the exact paths the laser-cutter followed in the 5mm thick steel plate from which the parts were

FIGURE 1

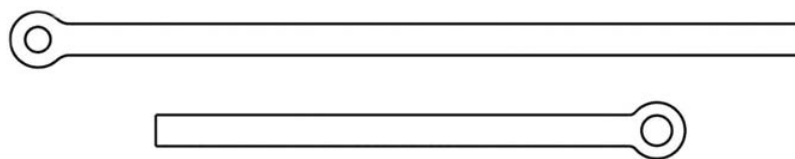
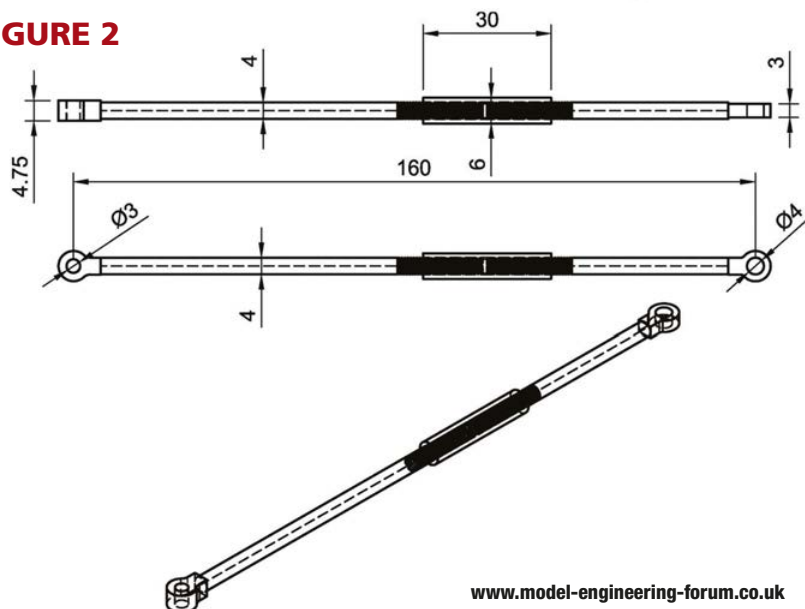


FIGURE 2



made. The aim was to produce an assembly of the form shown in **Figure 2**, with only the threaded collar joining the two rods starting out life as a round piece of metal.

The bosses at one end of each rod are designed (required) to be flat, hence these need no further work, other than a little cleaning up with a file and some emery paper and a hole drilling through. The laser-cutting process could have bored the holes, of course, but forming holes which are small relative to the thickness of the metal is tricky for a laser – they don't tend to come out particularly round – and hence it is usually better to have them 'spotted' and then to drill them manually.

Borrowing 'with pride'

Some years ago, I did some work for the Highways Agency and had to make a series of presentations at a succession of 'roadshow' events around the country. One of my fellow presenters was a former senior police officer and he had plagiarised some material from an outside source, for use in his presentation. He was completely up-front about this, referring to his plagiarism as 'borrowing with pride' – a phrase which has stuck with me down the years and one which is quite apt here.

As with many things in 3D design, someone has generally done it (or something similar) before and is willing to share it (for free) online. This applies to ER collets of every size – my lathe collet chuck is ER40 and there are relatively few designs available for that size (although one is sufficient!). If you have an ER32 collet chuck then you are spoilt for choice.

The design I used was downloaded from GrabCAD (www.grabcad.com). Membership of this site is free and there are a huge number of mostly professionally-oriented CAD designs available on the website – it is always worth checking this site before embarking upon a lengthy CAD design, only to discover you have re-invented a 'circular transportation facilitation device' or similar.

The file to download is: 'ER40 Collet.STEP' – this was added by Roger Morton on 21st January 2020 and is the one I used (although there are others, by other designers, which may work just as well). STEP files are more versatile than igs files, although this format is also available if your package works better with these files.

Once you have saved the file to a suitable directory, you will need to load it into your CAD package. I use Fusion 360, although I expect that the process is similar with other packages. Even if you are new to Fusion, the steps described below are hopefully

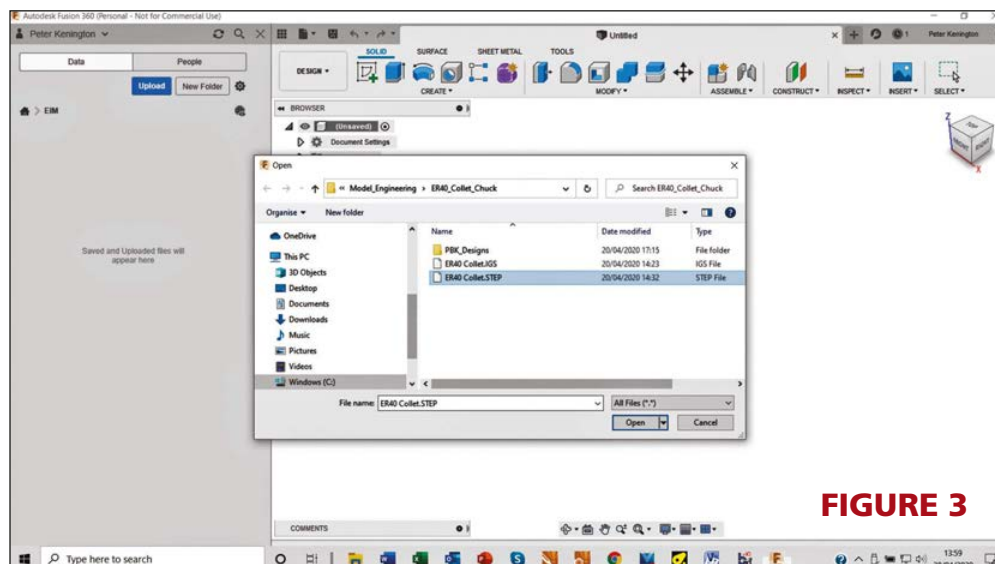


FIGURE 3

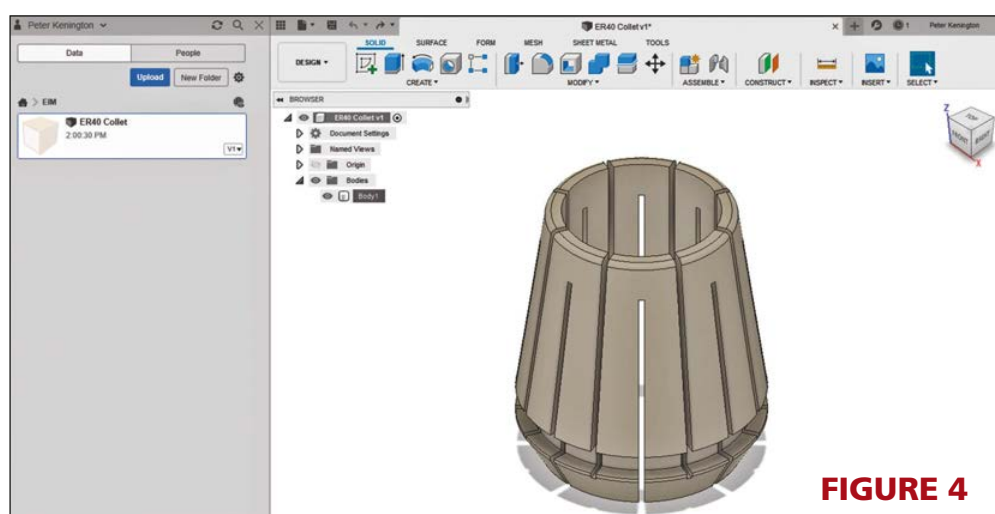


FIGURE 4

simple enough that you can plough straight in, without going up too steep a learning curve.

Once Fusion is open, select the directory where you want to store the design (I created a new directory called 'EIM' for this illustration), using the panel on the left-hand side of the screen and use the 'upload' button to upload the STEP file (**Figure 3**).

Once the file has loaded, you can open it (again, from the panel on the left) and will see a fully-fledged ER40

collet on your screen (**Figure 4**). You can then close the left-hand panel to create a little more space on the screen.

We now need to reveal the features of the part, so that we can change them to suit what we need for this project. Clicking on the arrowhead adjacent to the 'Bodies' label will reveal 'Body1' and right-clicking on 'Body1' will expand a sub-menu from which you need to select 'Find Features'. This is a handy capability which reveals all of the operations

FIGURE 3: Uploading the STEP file for ER40 collet.

FIGURE 4: STEP file for collet loaded and opened in Fusion.

FIGURE 5: Construction steps of collet revealed (on left-hand side) using 'find features' step of program.

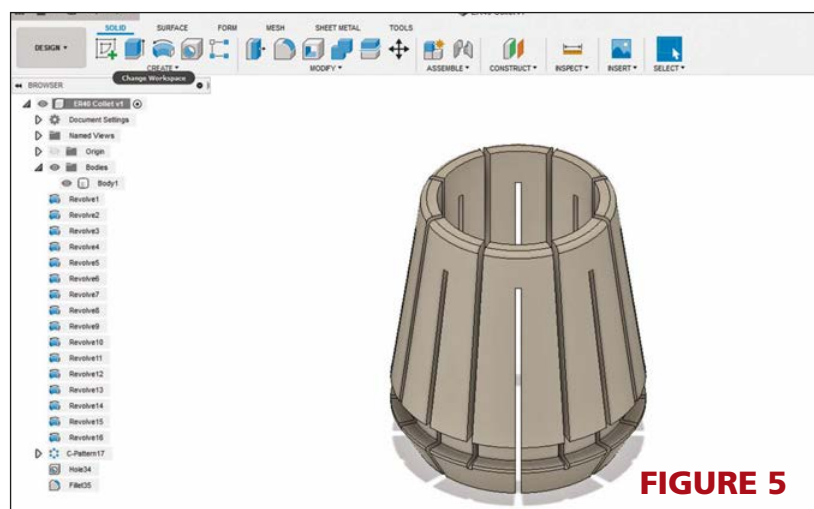


FIGURE 5

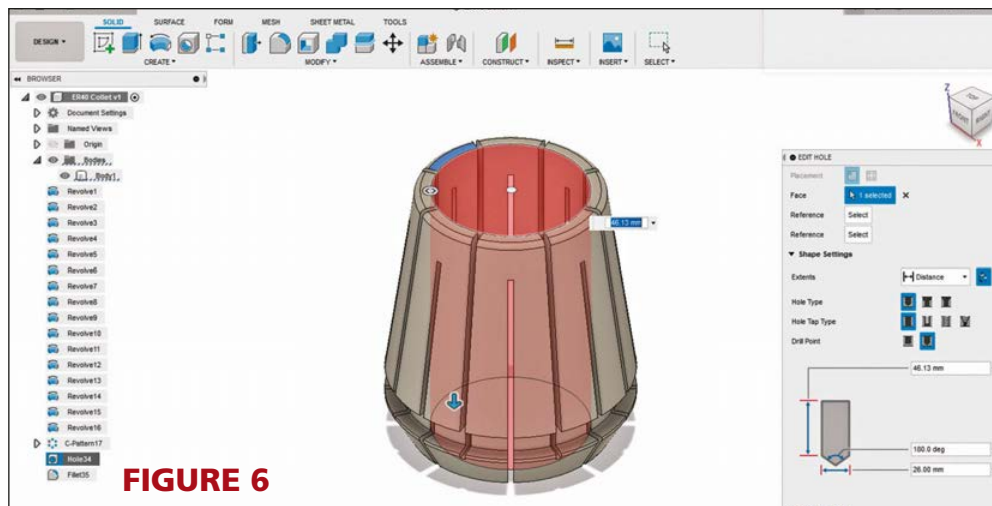


FIGURE 6

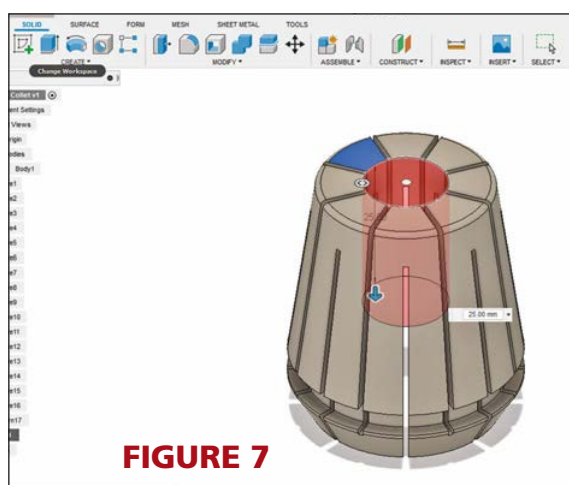


FIGURE 7

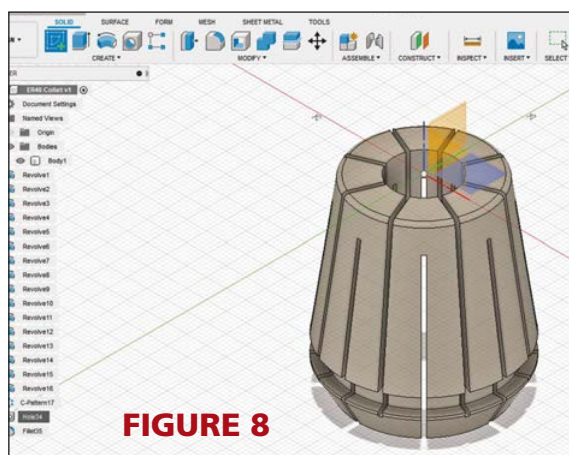


FIGURE 8

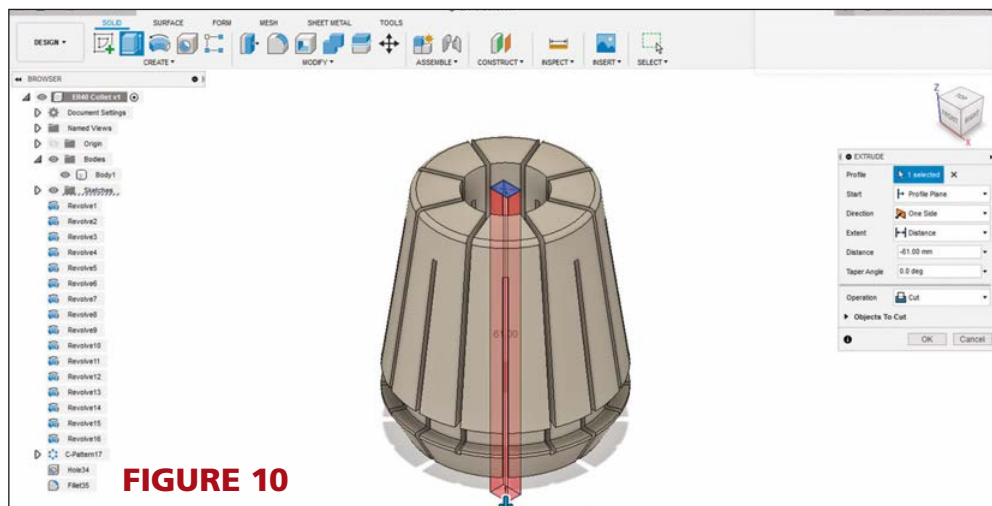


FIGURE 10

which were used to construct the body (collet, in this case) in the first place and, pertinently, allows these features to be edited to suit our requirements.

Once you have clicked on 'Find Features' and 'OK' on the subsequent dialogue box (leaving all features ticked, which is the default), you will need to wait a few seconds (depending upon the grunt available from your PC) for the operation to complete. You will then see a display similar to **Figure 5**, with all of the steps revealed (I guess that the clue is in the file type: STEP!).

We now need to do two things:

- 1) Restrict the circular opening to a narrower one, on the rear of the collet (mimicking the one that most commercial collets have and which we will use to accommodate the 'boss' on our part)
- 2) Insert a rectangular opening, to suit our part.

To do the former, find 'Hole34' in

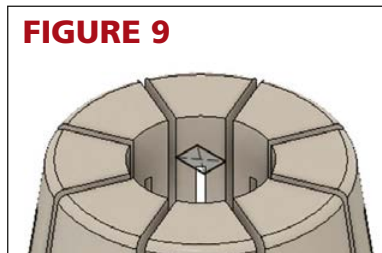


FIGURE 9

the list of steps on the left-hand side, right-click this and select 'edit hole'. You will then see a display like that shown in **Figure 6**. Using the dialogue box, reduce the hole diameter to say 15mm and the hole depth to say 25mm (the precise figures will depend, to an extent, on the length of the part you wish to make and the diameter of its boss, if any) – see **Figure 7**.

Now, to insert a suitable rectangular opening in the business-end of the collet, we need to quickly sketch our rectangle and then extrude it to 'cut' a rectangular hole in the body. So, to begin, select the <create sketch> icon (right): and then the bottom plane (highlighted in blue in **Figure 8**) – this is the plane on which we want to draw our rectangle.

To draw the rectangle, which corresponds to the cross-section of the part we wish to hold, use: <Create>, <Rectangle>, <Centre Rectangle>, click on the centre of the part (which should also be (0, 0) on the displayed grid) and then expand the rectangle to approximately the desired size.

You will note that one of the edge dimensions is highlighted. Type in the exact dimension required (such as 5 for 5mm), then press the <TAB> key on your keyboard and enter the second dimension (say 4 for 4mm), followed by <Enter> and finally, click on 'Finish Sketch' (either version of the button will do). The rear of the resulting part should now look like **Figure 9**.

Finally this rectangle needs to be extruded to 'cut' a rectangular hole through the collet (if only cutting small rectangular holes was so easy in real-life...). Select the 'Extrude' icon (right) and then select (click on) the rectangle you have just created. Pull the blue arrow down until it is clearly visible through the bottom of the collet (**Figure 10**), check that 'Operation' in the dialog box is set to 'Cut' (as shown – change it, if not) and click 'OK'.

The part is now complete and can be converted into an STL file for 3D printing. Right-click on 'Body1' and then select 'convert to STL', then 'OK' on the resulting dialogue box. Select somewhere to save your file and you're ready to begin the process of 3D printing it. Don't forget to save your design before exiting Fusion.

3D Printing

We printed both PLA and PETG versions of the collet – there is some discussion of the relative merits of the

PLA vs PETG

PLA is a more brittle material than PETG, unless it is annealed (we've not tried this). Both materials have very similar densities, although PETG is generally much more durable and flexible – PLA is quite brittle. It is this durability and flexibility which makes it ideal for the collet application we are interested in here.

PETG will need a heated print bed when printing, whereas PLA can be printed cold (although we typically use a heated bed for this also). Layer adhesion with PETG is extremely good, resulting in very strong and durable prints.

PLA begins to lose strength around 50 deg C whereas PETG can generally cope with around 75 deg C (and much more for some variants). Note that, in both cases, this is far below their printing temperatures and needs to be borne in mind when machining – hot components being held by such materials can cause the material to deform, with a consequent loss of strength, and great care needs to be taken. This is discussed further in the main text.

Hopefully this discussion shows that PETG is much the better material for use in 3D printed collets.

Quality		
Layer Height	0.2	mm
Initial Layer Height	0.15	mm
Line Width	0.4	mm
Wall Line Width	0.4	mm
Outer Wall Line Width	0.4	mm
Inner Wall(s) Line Width	0.4	mm
Top/Bottom Line Width	0.4	mm
Infill Line Width	0.4	mm
Shell		
Wall Thickness	2	mm
Wall Line Count	5	
Outer Wall Wipe Distance	0.2	mm
Top/Bottom Thickness	0.8	mm
Top Thickness	0.8	mm
Top Layers	3	
Bottom Thickness	0.8	mm
Bottom Layers	2	
Top/Bottom Pattern	Lines	
Bottom Pattern Initial Layer	Lines	
Top/Bottom Line Directions	[]	
Outer Wall Inset	0	mm
Outer Before Inner Walls	☐	
Alternate Extra Wall	☐	
Compensate Wall Overlaps	☒	
Compensate Outer Wall Overlaps	☒	
Compensate Inner Wall Overlaps	☒	
Fill Gaps Between Walls	Everywhere	
Horizontal Expansion	0	mm
Initial Layer Horizontal Expansion	0	mm
Z Seam Alignment	Shortest	

Infill		
Infill Density	100	%
Infill Line Distance	0.4	mm
Infill Pattern	Lines	
Infill Line Directions	[]	
Gradual Infill Steps	0	
Material		
Printing Temperature	210	°C
Build Plate Temperature	50	°C
Diameter	1.75	mm
Flow	100	%
Enable Retraction	☒	
Speed		
Print Speed	40	mm/s
Infill Speed	40	mm/s
Wall Speed	20.0	mm/s
Outer Wall Speed	20.0	mm/s
Inner Wall Speed	40.0	mm/s
Top/Bottom Speed	20.0	mm/s
Travel Speed	150	mm/s
Initial Layer Speed	20.0	mm/s
Cooling		
Enable Print Cooling	☒	
Support		
Generate Support	☐	
Build Plate Adhesion		
Build Plate Adhesion Type	Raft	
Raft Air Gap	0.3	mm
Initial Layer Z Overlap	0.15	mm
Raft Top Layers	2	

TABLE 1: shown in two parts

two materials in the box above, which hopefully makes it clear that PETG is definitely the one to choose in this case. A PLA collet is probably okay for one-off usage but, in our experience, is simply too brittle to be able to be re-used reliably.

The PLA version of the collet was printed directly onto a glass build-plate, using the parameters shown in Table 1. For PETG, the printing parameters were the same as shown in Table 1, except:

- Extrusion temperature should be set to 240 deg C
- No raft is required for build-plate adhesion (blue 3M '3434' painter's masking tape is used instead, on the build plate).

In both cases, the print orientation should be front-down (basically, as shown in the Fusion diagrams, e.g. Figure 10). With this orientation, it is not necessary to use support material in either case, which saves the hassle of removing it afterwards.

The resulting collet should look like **Photo 2**, with the internal structure being shown in **Photo 3** – it should be reasonably 'springy' with all of the vanes able to move both apart and together. Gently check this with a fingernail – if any of the vanes are stuck together (we experienced this problem), they can be persuaded to part with careful and gentle use of a small flat-bladed screwdriver.

Photo 4 shows the completed collet with one of the parts inserted. ►

FIGURE 6/7: Hole editing process and modified hole.

FIGURE 8: Creating sketch and selecting sketch plane (blue highlight).

FIGURE 9: Rear of collet shows sketched rectangle.

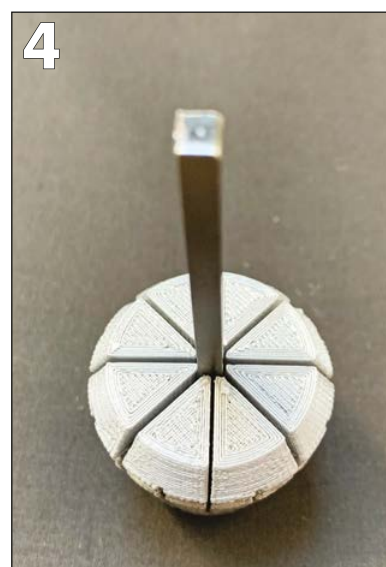
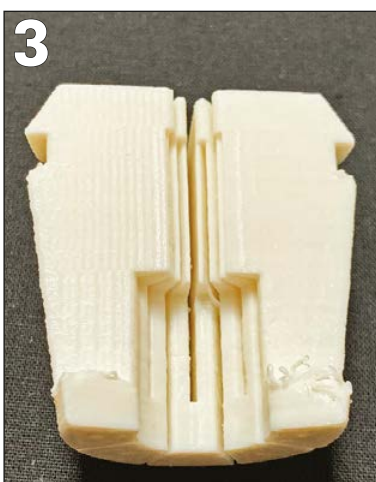
FIGURE 10: 'Drilling' a rectangular hole.

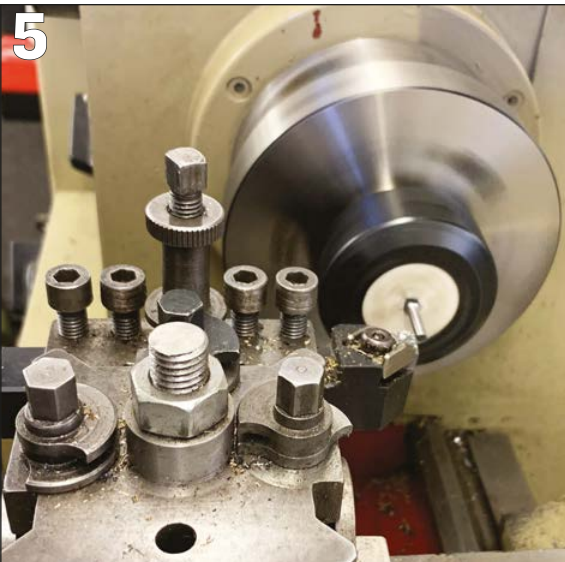
TABLE 1: 3D print parameters for part in PLA.

PHOTO 2: 3D printed collet. Top view (a) shows 'stringy' parts in recess due to lack of support material (see text). Rear view (b) shows large recessed centre-hole for boss on rod end.

PHOTO 3: View of internal structure of collet in PETG

PHOTO 4: 3D printed collet with part inserted (from rear) – rounded boss end sits in recessed hole visible in Photo 2b.





Great care is needed when machining the part (**Photo 5**) – a small stick-out is recommended and light cuts should be taken.

Once the initial machining has been completed, the parts will look like those shown in **Photo 6**. There are then two options for machining the remainder of the shaft:

1) Continue to use the printed collet and stick the part out another short distance to allow a further section to be machined. Continue this process until as much of the shaft as possible has been turned, then continue as described in the next point.

2) Exchange the printed collet for a conventional metal one (with a round hole) and grip the previously-turned end of the part in this and then turn a further (or the final) section – see **Photo 7**. This approach has the disadvantage of resulting in a large stick-out from a relatively thin part,

PHOTO 5:

Turning end of shaft using the PETG collet to hold it. Note use of modest stick-out (~25mm) to minimise lateral forces on what is a plastic collet.

PHOTO 6: Step 1 complete – turned shaft ends from setup in Photo 5.



meaning that bending is likely and the tool may 'catch' (as discussed below).

We tried both approaches and would recommend the first, although it is worth noting that a collet chuck is impressively good at holding a small workpiece with only a very small amount actually being gripped by the collet.

We were nervous that it would be the grip of the collet which caused the cut to fail whereas all of our problems were with 'grabbing'. Note that I wouldn't expect the same to be true of the printed collet and would be very nervous about clamping only a small length of material in such a collet.

We did consider using a live centre in conjunction with the arrangement shown in Photo 7, however we didn't want the necessary 'pip' in the end of the boss to detract from its appearance (I'm not aware of such things featuring on the equivalent part on a full-size tender!). It would, of course, be possible to use this approach with the printed collet, as the part would be the other way around and the 'pip' would be on the end of the shaft ultimately contained within the collar (and hence not visible) although I'm not sure how much axial force could be exerted by the live centre before the part was simply pushed back into the chuck. Maybe we'll try this next time, as it would certainly help, if successful.

Rogues gallery

If you've got this far, then you are clearly intrigued by the concept of a plastic collet chuck. I can almost feel the scepticism, however, and I fully understand it. The idea of turning metal, particularly steel with the hard crust typically associated with laser-cut parts, whilst only being held in a plastic chuck sounds positively dangerous. Like anything in machining, it can be dangerous, if you don't take precautions (or are positively silly in your approach). Some tips for safe operation follow:

1) Use a small stick-out. The precise length to be used will depend upon the accuracy of your print and hence the accuracy of the lateral (X-axis) motion of the part when clamped – in other words does the end wobble when the part is rotated by the chuck – and also on the thickness of the material and its propensity for bending (more on this below). For the parts discussed above, we used a 25mm stick-out and this seemed to work well.

2) Don't take aggressive cuts. Initial cuts (whilst the part is still entirely rectangular in cross-section) will need to be very light – in the region of 0.1 – 0.25mm. Once the corners have been rounded a little, a 0.25mm cut

seems to work well. Likewise, a slow and gentle feed-rate is advisable (say 1mm/sec). We used a rotation speed of 800 rpm to ensure that the load on the collet was not too intermittent and this seemed to work well.

3) Don't let the part get (too) hot. If you take the cuts advised above, then you are very unlikely to encounter a heat problem during a single pass, however it is worth checking the temperature of the part periodically (say after each pass) and letting it cool, as required. Plastic will lose strength well below its nominal melting point (as discussed earlier in regard to both PLA and PETG) and, whilst it's extremely unlikely that the part will fly out of the chuck, it will certainly be ruined if the collet deforms. As a rule of thumb, if the part is too hot to keep your fingers on, then it needs to cool! We had no problems with the PETG collet melting, despite reaching temperatures at which the 'finger test' was painful.

4) Check and tighten the chuck regularly, particularly the first time a new 3D-printed collet is used. The printing process is not perfect (at least on our printer) and small artefacts and surface roughness on the internal faces of the vanes will wear/break off during initial use. This means that the initial tightness of the collet will reduce as the vibration of the cuts generates this 'wear'.

Once this roughness had been removed (we found that this happened whilst completing one part), then the collet remained tight (with subsequent parts), but it does no harm to check. There is no need to tighten the chuck with every ounce of your strength (this may crush it, if you are strong!) – just a good 'nip' is fine.

Don't forget that the rectangular shape of the part and the matching hole in the collet mean that the 'grip' on the part is intrinsically very good in terms of its ability to resist rotational slippage and all you are really doing in tightening the chuck is preventing the part from being drawn out of, or forced into, the collet with the friction of the axial movement of the cutting tool when moving the compound-slide.

Potential issues

So, what can go wrong? Well, there are a few possibilities and it is worth exploring them in order to convince you of the inherent safety of the process – even if it does 'go wrong', the setup remains intrinsically safe.

Exhibit 'A' in this discussion is a PLA-printed collet after a single use (**Photo 8**). It can be seen that an entire segment has detached (upon removal of the collet), thereby rendering it as a 'single-use' plastic (although,

fortunately, it is biodegradable).

It should be emphasised that at all times the part was held firmly in the chuck and there was no danger of this failure leading to the part coming out. The basic clamping mechanism of an ER collet ensures this – it can be thought of a little like the use of the soft jaws we described in a previous **EIM** article: if the chuck was not tightened (at all), then it is conceivable that these could come loose and ‘fly off’, however there is no application in which they would be used with an open chuck (their whole purpose being to clamp a part).

Likewise, in this case, the only way a part could ‘fly out’ is if the chuck is not tightened and this remains true whether the collet has fractured, as shown in Photo 8, or not (and the same would also be true of a metal collet).

Indeed, the fact that the part has a boss on one end and that it is this end which sits within the rear-body of the chuck (meaning that the boss end would have to pass through the narrow rectangular opening in the front of the collet in order to eject from the chuck) further ensures the safety of this process.

The reason for the fracture in the PLA collet is down to the brittleness and lack of flexibility in the material itself – its layer adhesion is not especially good and so a force which puts a layer in tension (or shear) can easily cause a fracture – the twisting force when tightening the collet nut (which inevitably slightly grips the end of the collet) is often sufficient to do this with PLA. This is similar to wood, which when supported parallel to the grain, is unable to support a heavy weight, whereas when supported perpendicular to the grain, is much stronger – or concrete, which without reinforcement, is notoriously poor in tension.

Not so heavy

The other option to consider is what happens in the event of an accidental gross load being placed on the part (such as inadvertently taking way too heavy a cut, which is easily done as we shall see). Matthew conducted this particular experiment, without intending to, and undertook a catastrophic destructive test on a PETG-printed collet – the result is quite spectacular as can be seen from the collection of bits shown in Photo 9.

The mistake he made is an easy one and worth pointing out. He was using the PETG collet, with a relatively large stick-out, to machine a section of the part, ending at the required distance from the boss (which needs to retain its rectangular cross-section). He was therefore making a succession

PHOTO 7:

Turning rest of shaft, using conventional (metal) ER40 collet to hold (now round) section turned with 3D-printed collet. Use of a neutral turning tool allows us to get closer to the chuck, thereby maximising the amount of the turned section which can be clamped in the (metal) collet.

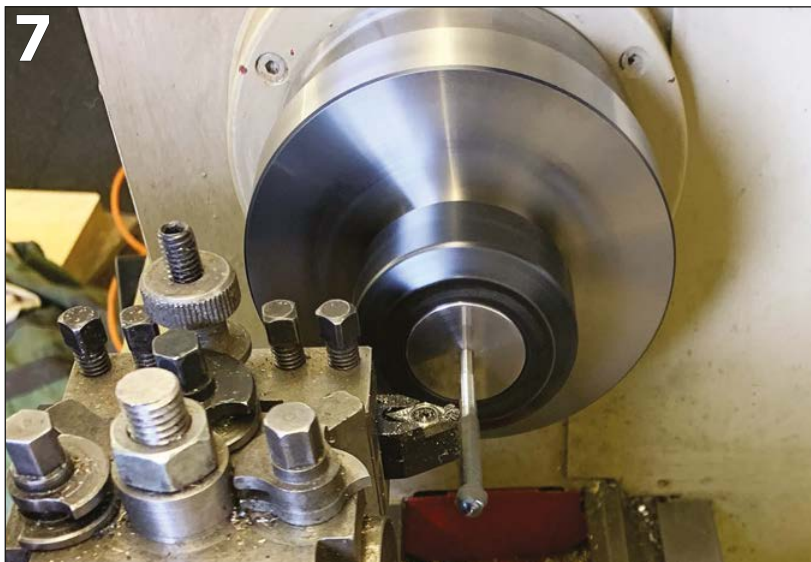


PHOTO 8:

PLA-printed collet after single insertion, tightening (on part) and release/removal after. Collet was heard to ‘crack’ as it was tightened, but still held the part firmly.

PHOTO 9:

PETG collet tested to destruction.

PHOTO 10:

Completed brake adjuster, after initial cleaning up.

of light cuts and stopping at what was becoming an increasingly abrupt circular-to-rectangular transition (for example a shoulder).

On what should have been almost the last cut, he went a little too far and clipped the (rectangular) shoulder – this put an enormous load on the part and it ‘kicked’ and bent to an angle somewhere around 70 degrees! (I’ll remind you of the large stick-out here). Despite this, the part was still firmly held in the PETG collet, although (as can be seen from Photo 9) the collet itself was largely destroyed and came out of the chuck in bits.

The reason it still worked as a collet, despite the devastation, is down to the design of ER collet chucks – essentially the individual parts had nowhere to go; they remained clamped together and since the rectangular hole in the collet survived the experience, it was still able to

provide a firm clamp to the workpiece.

We managed to straighten the part and finish machining it successfully, as can be seen in Photo 10.

As a construction method, laser-cut parts, plus custom-designed 3D-printed collets to hold them, seems to be a good way of making a ‘square-peg fit a round hole’ (without the liberal application of a large ‘Manchester screwdriver’). You do, of course, need a collet chuck in the first place, however these are not too expensive, if you go for a Chinese version. The two we have, one on a Harrison M300 (D1-4 Camlock) and another on a Boxford CNC lathe (D1-3 Camlock), both have an acceptably low level of run-out.

So, you can now return to childhood and re-visit the problem of how to fit a square peg into a round hole with a little more confidence and no need for warm milk or rusks. **EIM**



The Amazing H₂O

Jan-Eric takes a close-up look at the element vital to most of our engines – water...

BY JAN-ERIC NYSTRÖM

Life on earth, as we know it, would be impossible were it not for the amazing properties of that most common liquid on our planet, water. Live-steam enthusiasts would also be without their hobby, if water did not behave in the way it does. I hope you'll excuse me for the following somewhat theoretical foray into the properties of water, which I find very fascinating indeed!

Most substances expand when they are heated, and respectively contract when cooled, and, if liquid, when solidifying. Water, however, is at its most dense (most contracted) while still liquid at 4 degrees C, or 39.2 degrees F. If that were not so, in other words if ice were heavier than water, most of our seas and lakes would be frozen solid!

Now, as soon as the surface water temperature drops below 4 deg C, that water will no longer sink; any further cooling will affect the top layer only – that's why deep lakes only have a cover of ice in the winter, instead of being frozen all the way down to the bottom. This enables fish and other water organisms to stay alive over the winter, under the ice.

Sea water behaves in the same way, but due to the amount of dissolved salts, the freezing temperature is a few degrees lower than the 0 deg C/ 32 deg F freezing point for pure water.

In the Arctic regions, the ice is thicker, and around the poles, there is a constant, year-round layer of ice. Note, however, that the North Pole (which, unlike Antarctica, doesn't have a land continent under it) can be navigated by submarines under the ice – a feat first performed by the US nuclear submarine 'Nautilus' in 1958.

Much of the water in the ocean deeps is at 4 deg C, except in the vicinity of underwater hot-spots; such as the 'black smokers', hot-water fountains called 'hydrothermal vents' on the sea floor. They can be incredibly hot, up to 400 deg C/750 deg F, but the enormous pressure in the depth of the oceans prevents the forming of any steam rising to the surface. Even underwater lava flows just sizzle in the deep...

Changing states

The three states of water, ice, water and steam – those are all familiar to us. It is interesting to study the change from one to another, and, as live steamers, we can better understand why our engines work if we take a closer look at the amount of heat needed to go from ice to steam.

Figure 1 shows what happens when we heat a chunk of ice with a constant inflow of energy; first, the temperature of the ice rises from its original, starting value up to 0 deg C/ 32 deg F. But then, something strange happens – even though we heat the ice at the same rate as before, the temperature will not rise (between point 1 and 2 in the diagram). Instead, the ice melts to water. Not until the entire amount of ice has melted does the temperature start to rise again.

Also note that the temperature rises more slowly than before melting, it takes about twice the time to increase by one degree. The water thus 'stores' heat energy more efficiently than the ice.

We continue heating, and assuming that our water is in a normal environment, such as in a beaker, pan or skillet, nothing appears to happen

For descriptions of diagrams in this feature see text.

*All diagrams by the author.
Image sources:
A Text-Book on Steam and Steam-Engines, London 1891
De stora Uppfinningarna, Stockholm, Sweden 1883
Herder's Konversations-Lexikon, Germany, 1906*

for a long time (from point 2 to 3), until the water starts to boil at 100 deg C/212 deg F. At first, the boiling is seen on the heated bottom of the container only, but soon the entire liquid is vigorously roiling.

Note, in the diagram, the long time that has passed, in other words the large amount of heat that has been introduced into the water. Not until all the water has boiled away (at 4), can the temperature rise above the boiling point – but at that point, we don't have any water left!

The fact that water under normal atmospheric pressure can get no hotter than 100 deg C enables you to perform a little trick that appears amazing the first time you see it: fill a paper cup (of the 'pleated' water-cooler type, having no protruding flange on the bottom) half-full with water, and hold it over a candle flame – the water in the cup will soon boil, but the cup will be undamaged, except for a little soot on the bottom. But beware, as soon as the water has boiled away, the cup will catch fire!

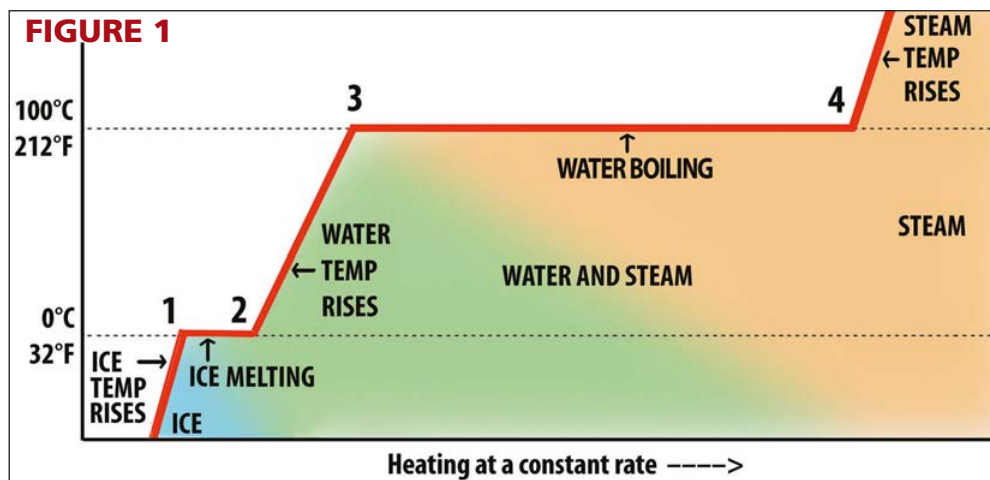
Heating water in a confined space, such as in a pressure cooker or locomotive boiler, enables us to raise the temperature to more than 100 deg C. At first, the water boils at that temperature, but as steam is being generated, the pressure in the container rises.

Figure 2 shows the different states of water at different temperatures – an interesting study of a very complicated set of factors, indeed! The blue, horizontal line in the diagram represents normal atmospheric pressure, and the state of our water can be seen to change at the points where it cuts the black curve – going from left to right, from ice to water to steam.

The latter happens at point B in the diagram – the vertical red line indicates the 'normal' boiling temperature of water at atmospheric pressure (at lower pressures, water boils at a lower temperature – for instance in Denver, Colorado, water boils at 94 deg C/202 deg F, due to the altitude of 1610 metres/5280 ft.)

Triple point

A curious thing happens when the pressure drops significantly (to a 'partial vacuum') – the red point at A is water's 'triple point'; the only combination of temperature and pressure where water can exist



simultaneously in all three states. This is very close to 0 deg C, but at a pressure of only $\frac{1}{166}$ th of normal atmospheric pressure.

At the very high pressure and temperature of 218 bars and 374 deg C (3,200 psi and 705 deg F), the liquid and gaseous phase of water become indistinguishable. This is called the 'critical point', marked with a **C** in the diagram. This extreme state is only found in some industrial processes, and underwater in volcanic areas.

However, if you increase that already enormous pressure even further, by a thousand times or so, eventually this hot gas/liquid will become solid ice again! Who could imagine ice hotter than molten lead? (On the other hand, those pressures are hard to imagine, too...)

Notice that I've coloured the blue part of the diagram in different shades – they represent the 15 or so different crystal structures of ice. Some of them have strange qualities, but we won't delve into that – we're steam people, remember! But note that the black, almost vertical line from point A, separating ice and water, leans slightly to the left – this represents the melting point of ice under different pressures, and explains why ice skates slide so well over the ice; due to the high localised pressure of the skate blade on the ice, the ice melts, and the resulting water works as an excellent lubricant between steel and steel!

In this diagram, the large, white point is of special interest to us live steamers: it is the boiling point of water at a pressure of 7 bars / 100 psi, the most usual pressure in our miniature boilers. This point represents a temperature of 164 deg C / 328 deg F.

Supposing we keep our boiler at that temperature and pressure, we have an equilibrium where no further boiling takes place. But now, as we open the throttle of our engine, the pressure will immediately drop as some of the steam escapes from the boiler into the cylinder. However, at this now lower pressure, the water in the boiler is suddenly in an 'overheated' state, and immediately starts to boil violently.

For this reason, it is important to open the throttle gradually, so as not to experience 'priming', which is the carrying of large amounts of water into the cylinders, together with the inrushing steam – I guess that we have all experienced a spray of hot water from the chimney, sometimes...

Propelling a loco

The boiler has taken a while to reach the working pressure, and all the energy (heat) that was put into it during that time is now stored in the

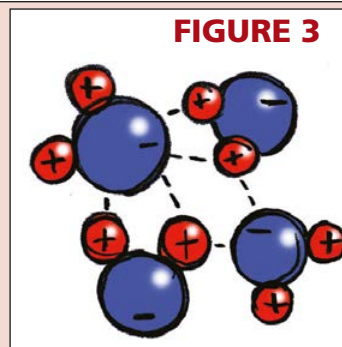
"Increase that already enormous pressure by a thousand times or so, eventually this hot gas/liquid will become solid ice again! Who could imagine ice hotter than molten lead?"

Mickey Mouse water?

The amazing properties of water can partially be explained by its molecular structure – the two hydrogen or 'H' atoms of the H₂O are not attached to the oxygen atom 'O' in a straight line, but instead, there is an angle of a little over 90 degrees between them, as seen in **Figure 3** (right).

This makes the water molecules 'polar'; they have a negative electrical charge at the oxygen end, and, respectively, a positive charge at the hydrogen end.

As we know, opposites attract, and 'hydrogen bonds' form between the water molecules, marked with dashes in the sketch above. These bonds increase the boiling point of water (without these bonds, water would be a gas at normal temperatures), and they also affect the crystal structure of ice – this is why ice is lighter than water, and as a result the Earth's oceans are not frozen solid, but full of life instead.



water. That explains why we can get some work done with it, propelling the locomotive.

As the pressure drops further, still more of the water is boiled away, generating more steam, albeit at a lower temperature. This steam, when it reaches the cylinder, has a pressure high enough to move the piston, and via the rods, turn the wheels.

We can even cut off the entry of the steam in mid-stroke, and the steam will still expand and do work, while its temperature drops further. This is called 'expansive running', and saves a lot of fuel. It works best when the engine is running at a high speed, and the cylinders are hot.

Of course, to keep our engine rolling for extended periods, we must heat the water in the boiler continuously, in order to replace the energy that has been carried away by the steam. Maintaining the balance is

tricky; we don't want the safety valves to blow, since that wastes both fuel and water, nor do we want the pressure to drop significantly when the engine is running.

A coal-fired loco, if properly built, is somewhat self-regulating in this respect. The exhaust steam blown through the nozzle in the smokebox generates a draught that makes the coals in the firebox glow hotter. Oil- and propane-fired engines need more attention by the driver to keep the boiler pressure constant.

A blower in the smokebox helps with keeping up the draught when the engine is not running. My personal experience with my ten-wheeler is that the blower needs to be open all the time – if I need to close the throttle for any reason, the flame would otherwise come out through the fire-door!

When we start a loco from cold, the cylinder walls are not yet hot, and ►

FIGURE 2

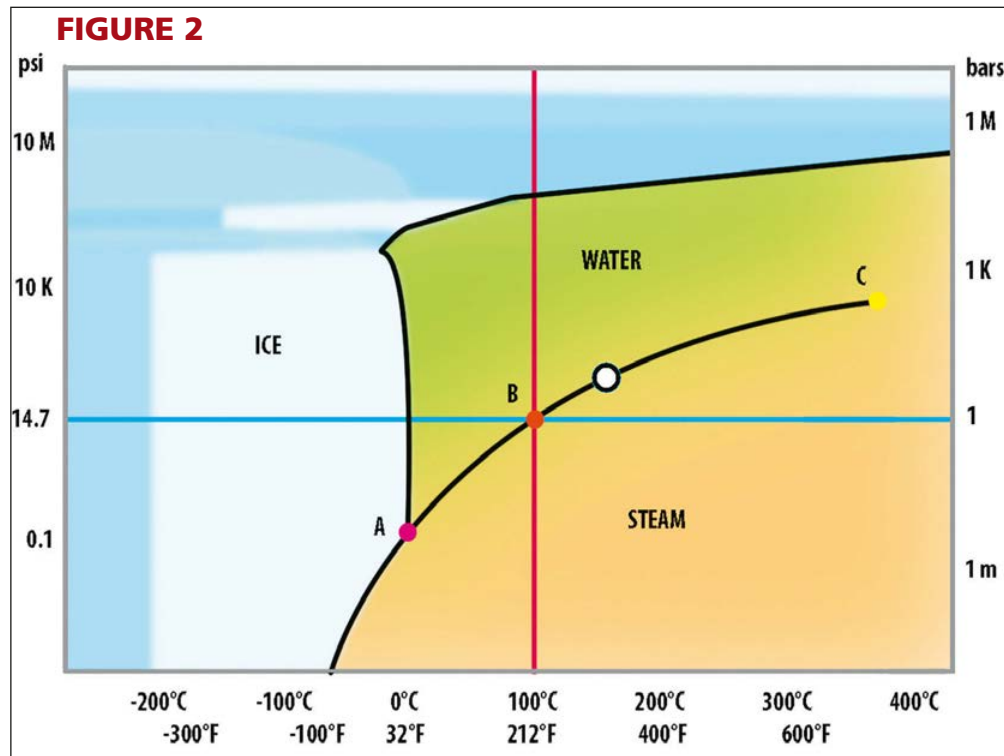


FIGURE 4 PROPERTIES OF SATURATED STEAM.

Absolute Pressures.	Boiling Point of Water and Temperature of Steam.	Total Heat from Water at 32° or Sensible and Latent Heat.	Latent Heat.	Volume of 1 lb.	Weight of 1 Cubic Foot.	Relative Volume or Cubic Feet of Steam from 1 Cubic Foot of Water.
Lbs. per sq. inch.	Fah.	Units of heat per lb.	Units of heat per lb.	Cubic feet.	Lbs.	Cubic feet.
1	102.1	1112.5	1042.9	330.36	.0030	20600
2	126.3	1119.7	1025.8	172.08	.0058	10730
5	162.3	1130.9	1000.3	72.66	.0138	4530
10	193.3	1140.3	978.4	37.84	.0264	2360
Atmos. pres. 14.700	212.0	1146.1	965.2	26.36	.0380	1642
20	228.0	1150.9	952.8	19.72	.0507	1229
25	240.1	1154.6	945.3	15.99	.0625	996
30	250.4	1157.8	937.9	13.46	.0743	838
35	259.3	1160.5	931.6	11.65	.0858	726
40	267.3	1162.9	926.0	10.27	.0974	640
45	274.4	1165.1	920.9	9.18	.1089	572
50	281.0	1167.1	916.3	8.31	.1202	518
60	292.7	1170.7	908.0	7.01	.1425	437
70	302.9	1173.8	900.8	6.07	.1648	378
80	312.0	1176.5	894.3	5.35	.1869	333
90	320.2	1179.1	888.5	4.79	.2089	298
100	327.9	1181.4	883.1	4.33	.2307	270
110	334.6	1183.5	878.3	3.97	.2521	247
120	341.1	1185.4	873.7	3.65	.2738	227
130	347.2	1187.3	869.4	3.38	.2955	211
140	352.9	1189.0	865.4	3.16	.3162	197

thus cool the steam immediately, causing huge amounts of water to be condensed in the cylinders. This water must be expelled through the drain cocks. In full size, forgetting to open the cocks while starting a loco could

cause the cylinders, or their covers, to burst. In our small live-steam sizes, the risk for that is minimal.

Some builders do add relief valves to their cylinders, just as in full size. They open as soon as the pressure in the cylinder rises above the valve's setting, usually slightly higher than the boiler pressure.

'Saturated steam' is steam at a temperature and pressure exactly on the black curve in Figure 2, but if we

"The white stuff we see coming from the chimney is actually already condensed water, emerging as mist and droplets..."

heat the steam to a higher temperature without increasing its pressure, we get 'superheated steam'. This will not condense as easily, and so superheaters have been used in most modern steam locomotives. The superheated steam also contains more stored energy, providing additional power to the engine.

Strong superheating can cause lubrication problems due to the high temperatures, and special cylinder oils have to be used. In our model sizes, the usefulness versus complications of superheating is still an ongoing debate. I do have superheaters in my ten-wheeler, but in practical use they work only as steam dryers; no superheated steam reaches the cylinders. They do reduce the risk of priming, though!

Figure 4 shows some properties of saturated steam. A number often quoted is seen in the last column; the fact that a cubic foot of water will expand to more than 1,600 cubic feet of steam at atmospheric pressure. That is theoretically true, but inaccurate in a practical sense.

Suppose we have a boiler filled with one cubic foot of water – we can get 1,600 cubic feet of steam from it, provided that the steam expands without condensing to atmospheric pressure. In running a locomotive, though, this doesn't happen in the cylinders; the exhaust steam is still at a somewhat higher than atmospheric pressure, and much of this steam is invariably condensed.

Non-condensed steam is in fact invisible, being a true gas – the white stuff we see coming from the chimney is actually already condensed water, emerging as mist and droplets. There is a formula with which you can calculate the theoretical power of a steam engine (using imperial units only):

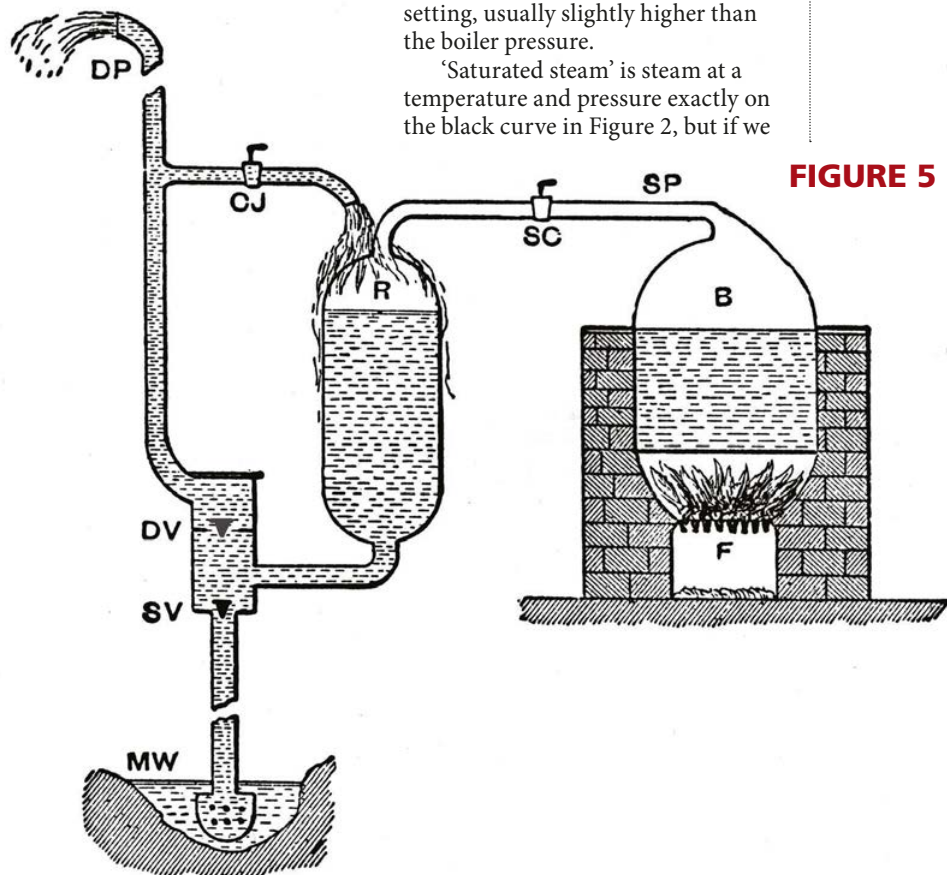
P L A N / 33,000

P is the mean effective pressure in the cylinders during running (usually taken as half the boiler pressure), **L** is the piston stroke in feet, **A** its area in square inches, and **N** is the engine's speed in strokes per minute, counting strokes on both sides of the piston. Multiply all these, and divide by 33,000, and you get the nominal horsepower of the engine.

For my 1:8th scale, 7¼-inch gauge ten-wheeler, the formula gives me about ½ hp per cylinder, thus 1 hp total, when running at speed – a figure entirely believable, considering the fact that I can easily pull a dozen or so passengers up the four per cent grade at our railway museum.

Early steam engines

When the very first industrial use of steam began, the inventors knew very little about the properties of steam.

**FIGURE 5**

SAVERY'S ENGINE, 1698.

One of the first practical uses was Savery's steam pump from 1698, schematically depicted in **Figure 5**. It worked by letting the steam generated in the boiler **B** push the water in the receiver cylinder **R** through the delivery valve **DV** into the delivery pipe **DP**. The maximum height of this pipe was determined by the boiler pressure, which wasn't very high in those days.

As soon as the receiver was emptied of water, the steam cock **SC** was closed, and cooling water was poured on the receiver via the cock at **CJ**. This caused the steam in the receiver to condense, and the vacuum generated sucked up water (usually from a coal mine, **MW**) through the suction valve **SV**. The theoretical maximum height of the suction tube was only 11 metres/34 feet, if a complete vacuum could be generated in the receiver. In practice, it was very much less.

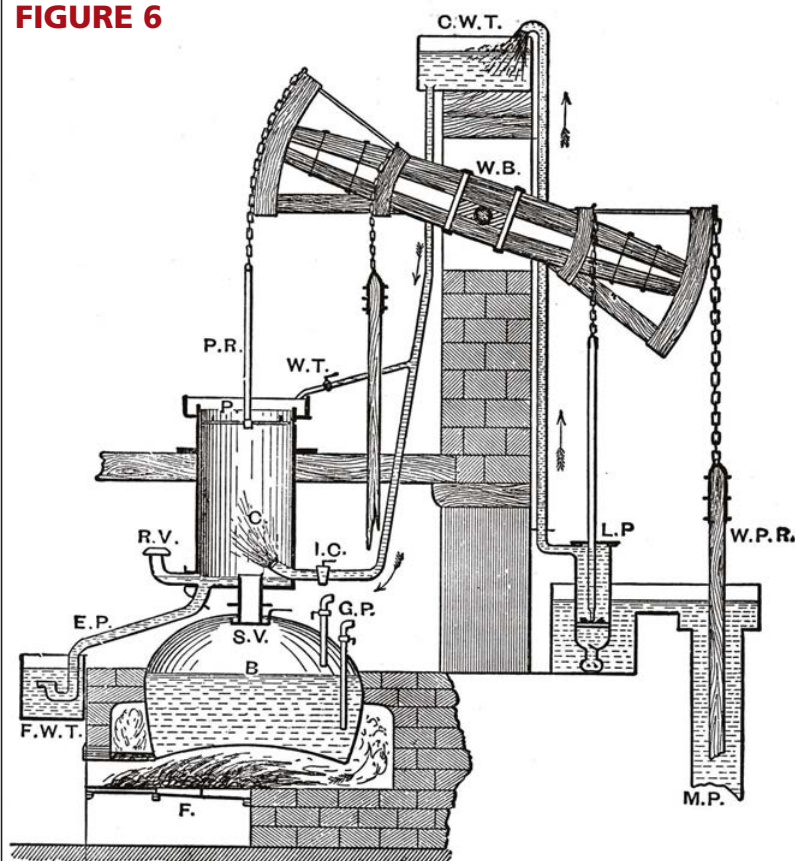
Newcomen's pump engine, from 1712, was about four times as effective, thanks to a proper 'lifting' mechanical pump, seen on the right in **Figure 6**. This engine condensed the steam with a spray of water directly into the steam cylinder.

Both these designs suffered from several flaws, the main one was the necessity to alternately heat and cool the cylinder, and also the fact that these engines were 'atmospheric'; the working pressure was always less than 1 bar/14 psi, generated by outside air pressure against the partial vacuum formed in the cylinder.

James Watt designed the first engines that can be called 'modern'.

"Both designs suffered from several flaws, the main one a need to alternately heat and cool the cylinder..."

FIGURE 6



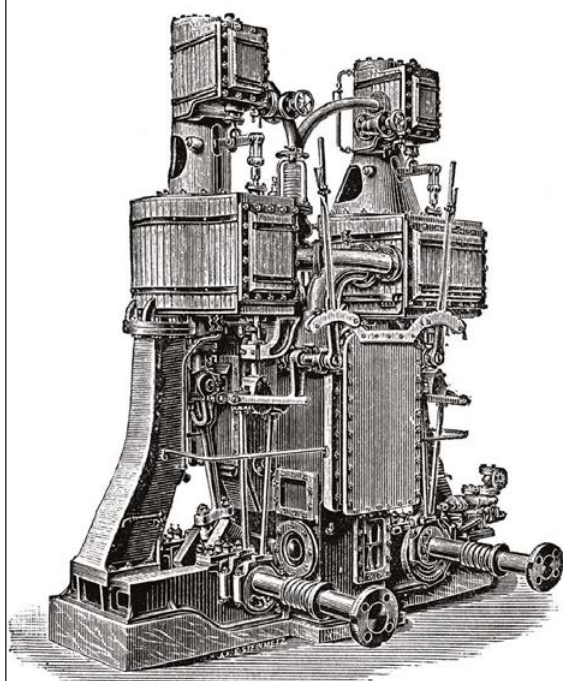
NEWCOMEN'S ENGINE, 1712.

He realised the advantage of using high-pressure steam, as well as letting it act on both sides of the piston. Furthermore, the steam was condensed outside the cylinder, which could thus be kept hot all the time, preventing thermal losses.

One of Watt's engines, built in the

1780s, is depicted in **Figure 7**. It is so similar to the engines we live steamers build and use, that its function can be easily deduced from the engraving. The fact that it also produced a rotary motion, as opposed to the back-and-forth movements of previous engines, enabled it to be used for many other

FIGURE 8



TRIPLE-EXPANSION TWIN-SCREW ENGINES.
By Messrs. RANKIN & BLACKMORE.

FIGURE 7

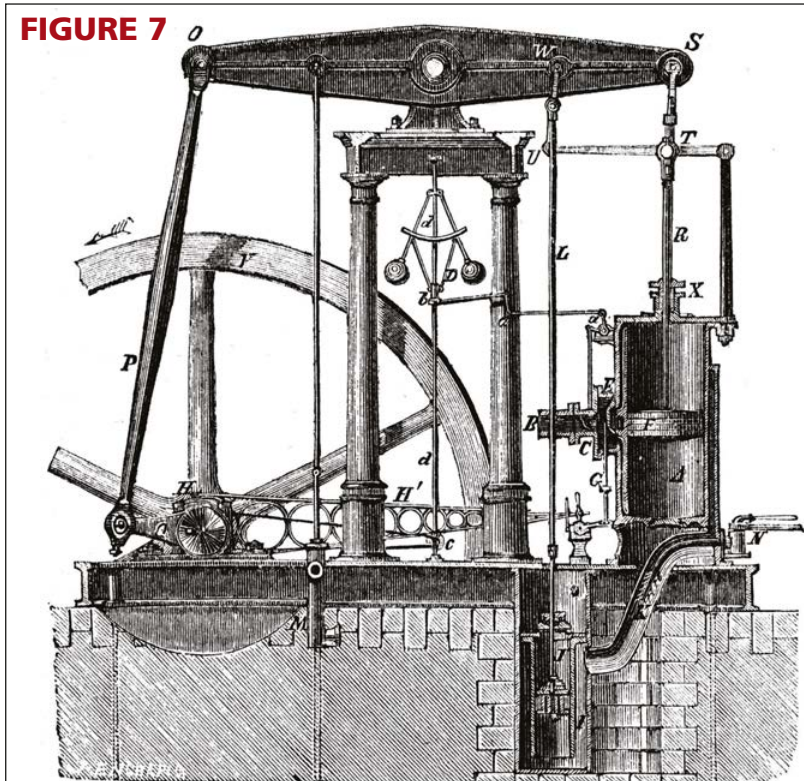
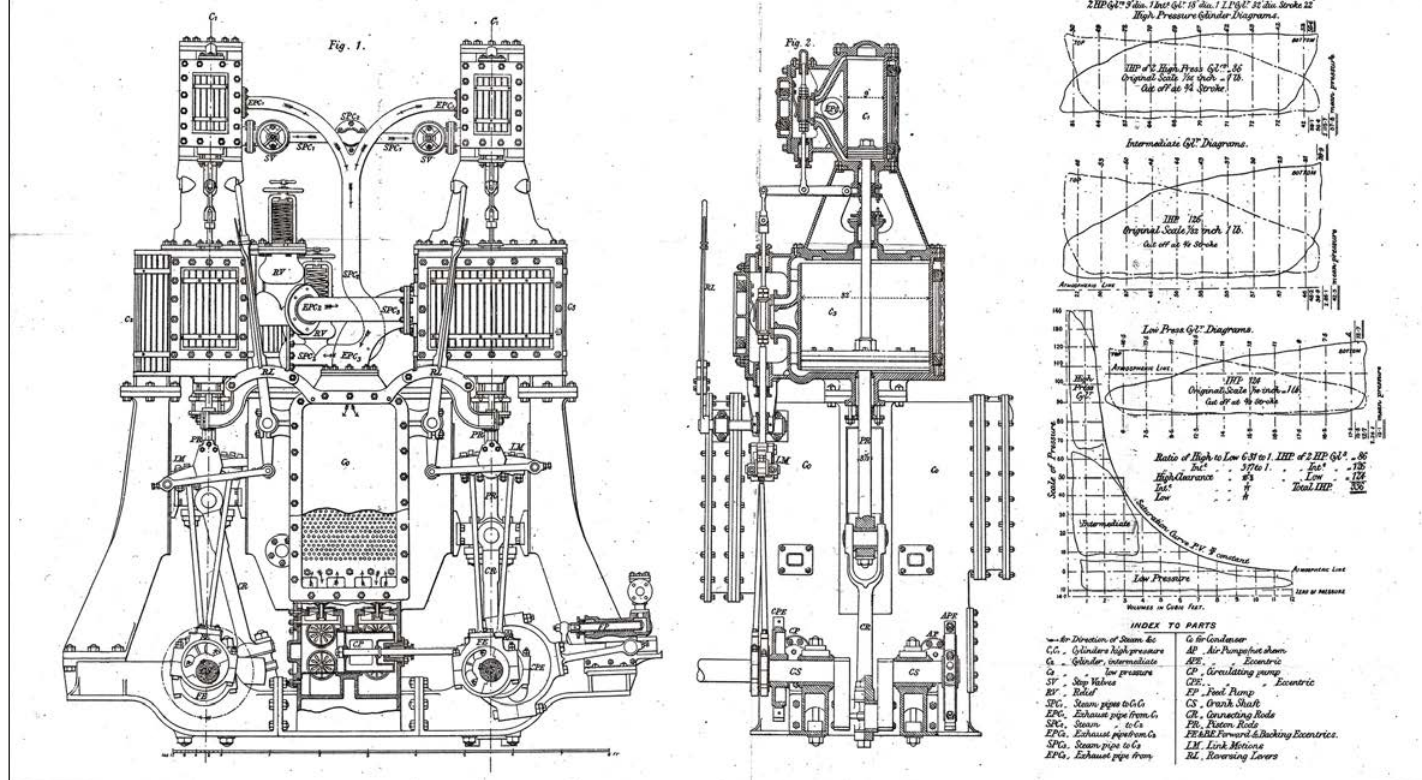


FIGURE 9

TWIN-SCREW TRIPLE-EXPANSION ENGINES OF THE S.S. "ARABIAN"

CONSTRUCTED BY MESS^{RS}. RANKIN AND BLACKMORE, ENGINEERS, GREENOCK.



purposes besides pumping. The industrial revolution had begun!

Back then, the measure of the power of a steam engine was often expressed in how many tons of water the engine could lift one foot while burning 100 lbs of coal. Savery's primitive pump managed only 900 tons, Newcomen's 3,200 tons, while Watt's best engines pumped a whopping 14,000 tons. Later, as

technology improved, the steam engines of the late 1800s managed even better, being rated at 40,000 foot-tons per 100 lbs of coal.

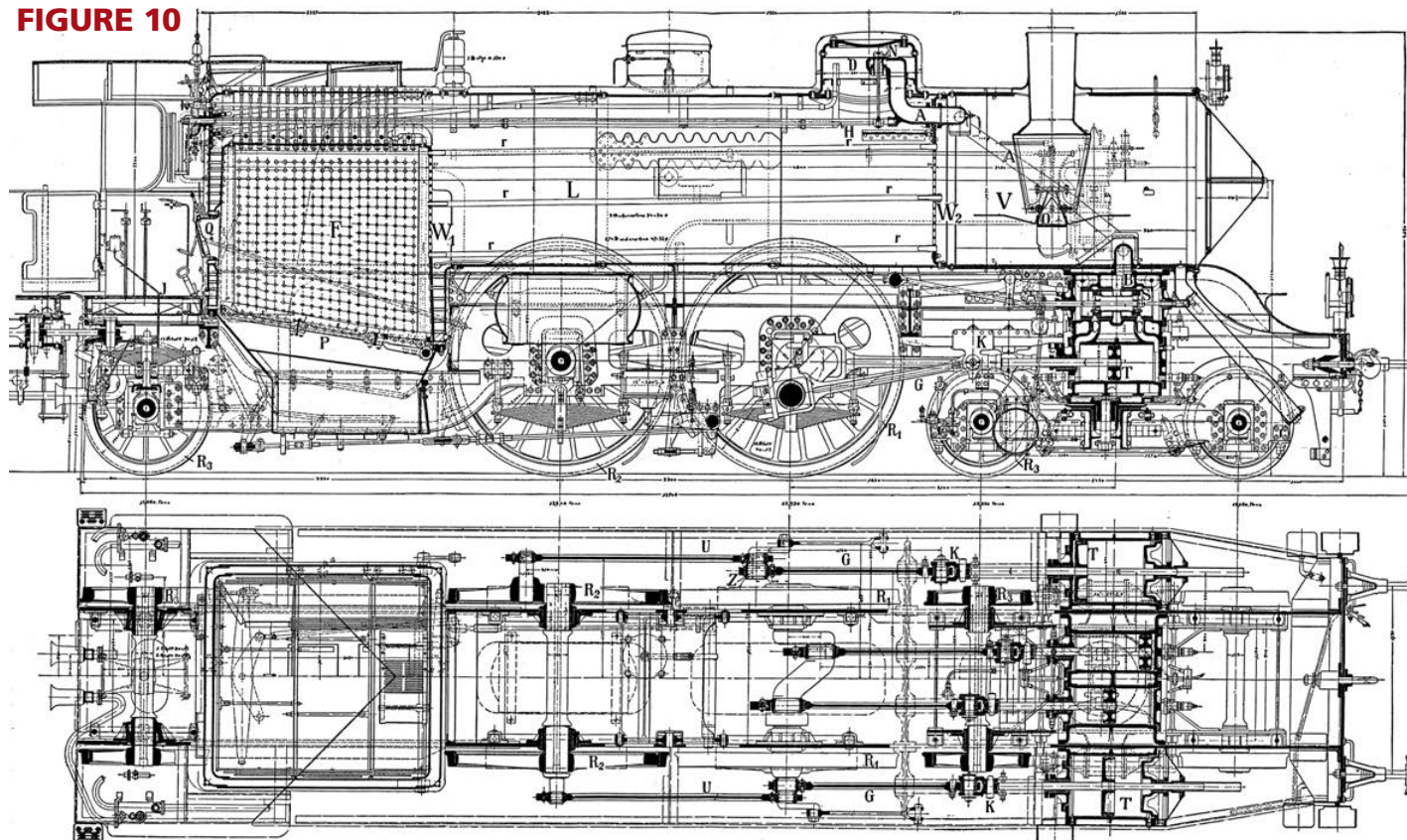
Multiple expansion

Even after the steam has done its work in a cylinder, it still contains a lot of unused energy. This can be used in a second or third, even a fourth cylinder, by building a 'compound'

engine, letting the steam exhausted from a small, high-pressure cylinder work in a larger one, at a lower pressure. This technique was first employed on a Cornish beam engine in 1804, and was further developed, especially in marine engines, where efficient use of fuel and low water consumption was crucial.

Figure 8 shows such a marine engine, of the triple-expansion type.

FIGURE 10



The drawings in **Figure 9** show all the parts of this engine, including the large condenser in the centre. This condenser produced a partial vacuum for the exhaust steam, further improving the performance of the engine. The diagrams at right are created with an 'indicator', showing cylinder pressure vs. piston stroke. From the diagrams, the true power of the engine, logically named 'indicated power', can be calculated.

Many locomotives used the double-expansion principle, for

instance the German Maffei 4-4-2 engine built in Bavaria the early 1900s, seen in **Figure 10**.

I find these old drawings interesting and rewarding to study, and to compare with what we see in smaller scales in this magazine and in live-steam books – the principles are always the same, but the practical arrangements do vary. Our small engines have to be simplified a bit, but their function is easy to understand when you know the amazing properties of H_2O ! **EIM**



ABOVE: "Already condensed water, emerging as mist and droplets..."

Photo: Andrew Charman

LETTERS

Listen to the voice in your ear...

I read the box-out 'Safety First', which formed part of Jan-Eric Nystrom's feature on building the boiler for his ten-wheeler in the June issue, with approval, having been too close to trouble on past occasions. However, there is an additional piece of malpractice that I now deplore particularly, namely not clamping objects for drilling.

I got away with it, barely sometimes, in my youth and then 'got religion', so to say. But a couple of years ago I had to put a hole in a long narrow bar of steel and temptation came back.

After all, there should be little or no risk of the drill jamming because the bar is adequately thick, the drill has a split point, and its length provides adequate leverage to hold on to it.

Just as I was lowering the drill, however the small advisory gremlin who resides on my shoulder hissed in my ear, "At least put on some gloves!" I have long learned that not listening to him can cause pain and regret.

I put on the leather gloves, started the drill, and was rewarded by a painful rap on my hand. As the gloves had largely protected my hand I did not have to go to the emergency (casualty) department and explain my stupidity.

John Bauer

The Editor replies: A salutary lesson John – one mantra that all model engineers should always follow, at all times, is that safety precautions can never be put aside, no matter how experienced one feels one is...

Keep it simple

With reference to new model engineer Russell Snowdon's letter in the July issue, enquiring as to what sort of engine he should build as a first project, my advice would be simple and very similar to that offered by our editor – build something simple!

Talk to long-experienced model engineers and you will find that many of them have unfinished projects rusting away in a dark corner of their workshop, started many years ago in a flash of enthusiasm, but then abandoned after running into difficulties or being side-tracked onto something else.

A common factor with these projects is that they are usually not the most simple of builds, and once that enthusiasm is dented their fate is sealed. In the same issue our editor admits to still having the bits to a Minnie traction engine which he started building in evening classes at the age of 15 – and without being rude Mr Editor, judging by the picture on page 3 that was not very recently! (*The cheek of it! But, yes, he's right, it was more than 40 years ago... Ed*).

Getting started with a simple project is definitely the way to go and something like a Stuart engine, as also suggested, is a very good idea. Once it is completed it will be there in the metal, sitting permanently on view as something you have built, and you'll really want to press on with something more complicated, while also having that little bit more experience to not abandon your new hobby when you hit the first fork in the road..

Stewart James



A simple stationary engine – an excellent start point for the novice.

Model engineering tip to pass on or point to make? Send your letter to the editor at andrew.charman@warnersgroup.co.uk

Coming next
month in...

THE MAGAZINE FOR MODEL ENGINEERS
**ENGINEERING
in Miniature**

New stationary engine
construction project –
and it's tiny!

Jan-Eric casts wheels
for his ten-wheeler

Nickel-plating to
protect brass

Arbor support for the
milling machine

Latest from the clubs
as they reopen

And much more!

September issue
on sale 13th August

Contents correct at time of going
to press but subject to change



Back on the road...

Lockdown-induced lack of access to his club track did not stop Walter steaming his loco.

BY WALTER RINALDI-BUTCHER

Ever since I bought my Simplex, many years ago, I intended to have a rolling road made for test purposes.

The present Covid-19 restrictions meant that there was no chance to run at my club, the Ryedale Society of Model Engineers track at Gilling East. Thus the opportunity to construct a rolling road and run the Simplex was unstoppable.

First I decided on a simple three-part road rather than one long piece, as I could use a three-part road could be used for testing other six and four-coupled locomotives.

Next the materials were bought. These comprised;

- 1) 12 6 x 17 x 6mm ball-bearings
- 2) 4ft of $\frac{3}{16}$ x 1-inch BMS flat
- 3) 4ft of 25mm x 3mm BMS angle
- 4) M6 socket countersunk screws, 20mm length
- 5) M6 Nyloc nuts
- 6) M5 socket countersunk screws, 14mm length
- 7) M5 Nyloc Nuts.

Construction

First the angle was cut into 6-inch lengths and the bearings bolted on with the 6mm screws, sized at the correct distance to suit the wheels of my Simplex loco.

The flat BMS was cut into 8-inch



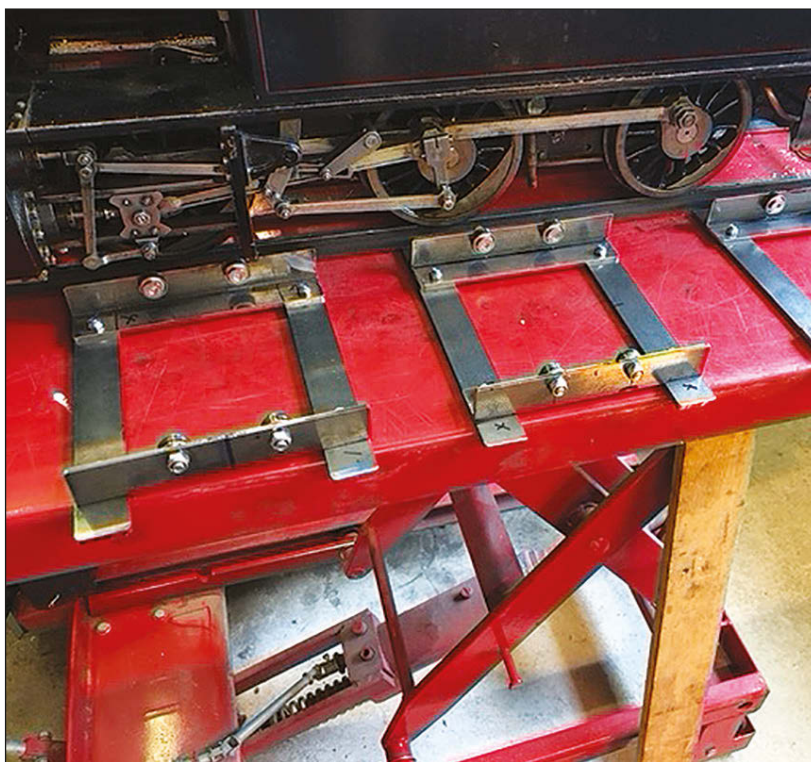
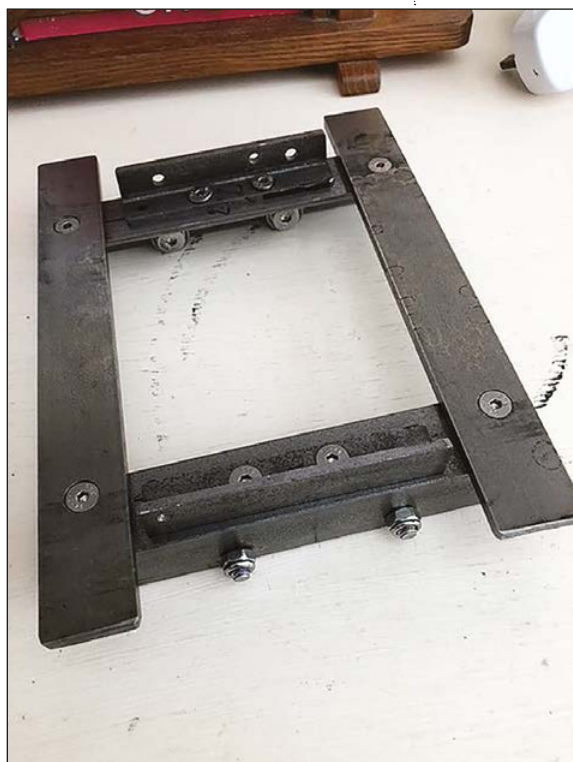
All photos in this article by the author.

lengths and the angle bolted on with the 5mm screws, measured to produce 5-inch gauge.

When I tried the rolling road with the loco on air, however, a problem arose. There was a tendency for both the loco and the rolling road to move sideways. This was solved with some lengths of $\frac{1}{2}$ -inch angle boded on to the two end units, to sit under the rolling road and on the outside of the track.

With this modification carried out the rolling road has proven to be most successful and great fun to use while I cannot run on the proper track at Gilling! **EIM**

Completed your own long put-off project during lockdown? Show it off to fellow readers by sending details and photos in to the editor at andrew.charman@warnersgroup.co.uk



Recreating a Colossus of a loco...

Traditionally a new model steam locomotive build starts with the frames – once they are made the engine is said to ‘exist’, and that is certainly the route being taken by the team behind a 15-inch gauge new-build project.

The original ‘Colossus’, built in 1913, was an iconic example of miniature locomotive construction. The 4-6-2 Pacific was commissioned from the renowned manufacturer Bassett-Lowke, by Captain J E P Howey, who would later become rather better known as the driving force behind the creation of the 15-inch gauge Romney, Hythe & Dymchurch Railway in Kent.

Howey wanted a powerful locomotive for his private railway around his home at Staughton Manor near Northampton, and Bassett-Lowke came up with effectively an enlarged version of its Class 30 4-4-2 Atlantic loco, extending the boiler and the frames to accommodate an extra pair of driving wheels. The Class 30 had been designed by Henry Greenly, another icon of the miniature railway world.

The new engine was more than 19 feet in length and weighed in excess of two tonnes. Bassett-Lowke designated it Class 60 or Gigantic – the loco was the first and only Pacific that the firm would build.

It was also in fact only the second 4-6-2 of any size to be built in the UK, the first being the Great Western Railway’s ‘Great Bear’ – “The number of Pacifics has doubled overnight” *The Railway Magazine* boldly stated. Gresley’s A classes and Bullied’s Southern locos would follow where the GWR and Bassett-Lowke led...

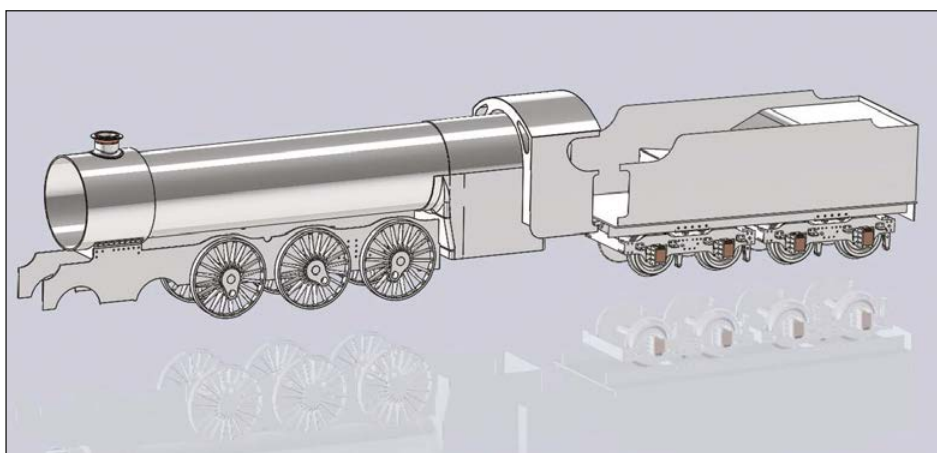
Sent to the Lakes

Howey named the new engine ‘John Anthony’ after his son, but its time at Staughton Manor was to be brief due to the First World War. When the war broke out the loco was on trial at the Eaton Hall Railway and was placed in store there, before two years later being among the stock that was sold to the then fledgling Ravenglass and Eskdale Railway.

Despite its scale appearance not really being suited to the rigours of the Cumbrian line, the loco was heavily used until 1927, when it was withdrawn. Even then the chassis saw further employment as part of the first ‘River Mite’, an attempt to create an articulated loco and which lasted to 1937. Then the chassis was sold to dealer Harry Barlow of Southport Miniature Railway and then to a private buyer in Staffordshire. Does anyone know what became of it?

Four years ago a small group started to acquire drawings and information regarding Colossus with a view to recreating the loco as a new-build project. Design work and smaller component manufacture has since been started, and now the project is planning its first major components, the main frames.

To achieve this 60 supporters are being sought to donate £60 each, either as a single



amount or in six instalments of £10. Each person that signs up will have their names permanently stamped on the frames of the new Colossus and receive a certificate along with a print of the loco by renowned rail artist Jonathan Clay (right).

Supporters will also receive a regular newsletter on progress, and an invitation to the first running days of the new engine.

Anyone interested in joining the new-build project can call 07773 185342 or e-mail colossuslocomotive@outlook.com for further information. And watch for a forthcoming feature in these pages including ways in which **EIM** readers can get more

directly involved, doing what you do best – making things...



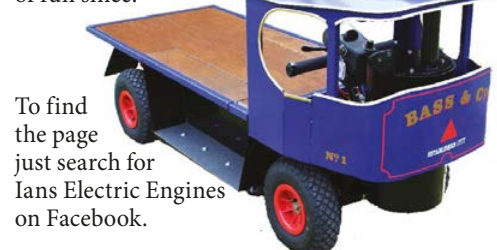
Electrifying social media...

Ian’s Electric Engines Ltd, which has carved itself a solid place in the market by offering body kits for Sentinel steam waggons and period AEC Matador lorries that fit over the proven running gear of a mobility scooter, has set up a Facebook page.

Running alongside the firm’s website at www.ianselectricengines.co.uk, the new page will feature photos and videos of the firm’s products and interaction with customers.

The 3-inch scale body kits have proven very popular – they come part-assembled with laser-cut, welded and powder-coated steel parts, and include sound generators,

wooden decks and various accessories. One customer on the Facebook page said that it took him around six hours to bolt his kit together and it has given him and his grandchildren a great deal of fun since.



To find the page just search for Ians Electric Engines on Facebook.

Awakening from short slumbers...

More positive outlook ahead as the clubs start to get back to work.

COMPILED BY ANDREW CHARMAN

Compiling these pages over the past couple of months has been a slightly strained process, as we dealt with the almost complete cessation of club activity brought on by the Covid-19 pandemic and subsequent lockdown. Therefore it is particularly pleasing to be able this month to present pages with a far more positive note, as the restrictions are eased and the clubs start to come back to life.

Having said that, there is no getting away from how serious the effects of coronavirus have been and are continuing to be, and we hope readers are continuing to stay safe as much as they can.

The best news this month is the resolution of a problem that was afflicting **Rugeley Powerstation SME** long before the virus arrived. The pictures on this page, by club member John Dutton, date to September 2017 when the club held what it thought would be the last running days on its raised track in the grounds of the Staffordshire power station, due to impending redevelopment of the site.

The club has been without a home for three years and members forced to run as guests at other club tracks, but now Rugeley club secretary Albert Haywood has been in touch to say that the club can return to its old site.

"Having now completed negotiations with Engie/Rugeley Power we now have a lease on our old site," Albert told us, adding that the club's well-known raised track of some 2000 feet in length is still in situ and is generally in good order.

"As we are still under the regulations of Covid-19 we hope in the very near future to return to the site and bring it back to life," Albert said.

Members only - for now

Due to the ongoing demolition of the power station, which is expected to take a further two years, only club members will be able to be on site for now, but the club hopes to be able to welcome back visitors before too long. "Our website and Facebook page will be updated from time to time as we are able to give more information about our progress," Albert added.

So an excellent way in which to start this month's round-up. Meanwhile we've been perusing the usual selection of newsletters and journals that have arrived at **EIM** Towers (the quality of which, by the way, has not been adversely affected



"Restrictions are eased and the clubs start to come back to life.."



THIS PAGE:

When taken in September 2017 these photos were supposed to show the final running day at the Rugeley Powerstation ME track, but following a reprieve the club will be back! Note in the picture at right John Ward and his lightweight 'Sweet Pea', featured in the June issue of **EIM**. Photos: John Dutton





by the pandemic-enforced inactivity – if anything it's gone up) and there is a rapidly growing theme of clubs getting back to work on essential maintenance as lockdown restrictions are eased.

Regular readers of this column will know that there is always a great deal of activity at the **Rugby ME's** extensive track site, and not being able to attend it must have been very frustrating for members. July began with only a few very local members dropping in to keep vegetation in check, and one member making use of the clubhouse tables in the laudable task of cutting out essential 'scrubs' for front-line NHS workers.

By the end of the month with the easing of restrictions the club was able to hold its first working parties – these were described by secretary Howard Brewer as "tentative", members observing proper social distancing even during the essential tea breaks.

Despite this much has already been achieved – a long length of track has been reballasted, point motors serviced, as well as digging out a large hole for a connecting bridge to the extension of the club's raised track, and breaking up the concrete of the lift table at the start of a project to replace it.

Members have been busy at home too, projects varying from building a 7¼-inch gauge steamer and scratchbuilt diesel to overhauling a 5-inch gauge Liverpool & Manchester 'Lion', fitting scale injectors to a New York Central 'Mikado' and maintaining radio-control model boats and even gliders. There's never a quiet time at the Rugby club...

Social club

Also able to resume working parties at their track site have been the members of the **City of Oxford SME**. Writing in

"This was something that has been in my life for 32 years, going over there at least once if not twice or more a week to meet up with fellow members..."



the club's summer newsletter chairman Denis Mulford commented that when shortly after lockdown was imposed in March he had been to the club to carry out some essential duties, such as the switching off of fridges and checking all was safely locked up, he drove away wondering when he would see it all again. "This was

something that has been in my life for 32 years, going over there at least once if not twice or more a week to meet up with fellow members and talk about all the usual things that model engineers talk about when we get together," Dennis said, highlighting just how important a social facility our clubs are.

ABOVE AND ABOVE RIGHT:

Rugby ME members have been delighted to get back to hole digging and ballasting at their track site, but there has always been time to take a socially distanced tea break...

RIGHT: Two fine diesels pose on the new track at the City of Oxford SME. Photo: Josh Allen





Thankfully, by July he was able to see it all again, the club making good use of its resumed working sessions. One project completed is a new siding and headshunt to the rear of the workshop. Seen on page 41 with two of the club diesels posing on the new rails, the facility both allows access to the workshop from both ends and provides hard-standing for essential deliveries of ballast. Unsurprisingly it has quickly become known as the 'ballast siding'.

The lockdown brought a cessation of much winter activity at the

Stockholes Farm Miniature Railway, the popular 7¼-inch gauge line near Doncaster, but work has now been able to restart and particularly impressive is the newly completed Tunnel West Portal – the picture above shows the first steam locomotive exiting from it on 14th June.

In the latest edition of the Stockholes newsletter the line's Ivan Smith no doubt reflects the thoughts of many readers when he states, "a real bonus is that I have done more model engineering in this last three months than I have been able to do for years."



ABOVE LEFT: Impressive new tunnel portal at Stockholes Farm. Photo: Ivan Smith

ABOVE: Steve Whittaker got one last run.

BELOW: Big 25 class loco build in South Africa. Photo: Lucas Stein

His current projects include resurrecting a Garratt loco that has lain untouched for some time.

Stationary steam

Another theme that emerges from the newsletters is the determination of club members to steam their locos, even if they were not allowed to go to their local track. The latest edition of the **High Wycombe ME's Criterion** newsletter includes pictures of members Martin Page and Peter Goddard steaming their locos, Martin's 'Polly' on a newly-built rolling road attached to the top of a Workmate, and Peter's newly built 'Butch' also strapped down and stationary. "A few wrinkles to sort out but should run like a Rolex any day now," Peter reports...

Enclosed with the latest High Wycombe newsletter was a copy of the special publication celebrating the club's first 100 years, and which should have resulted in a year of celebration at the track. With an earlier decision to make the booklet only available online reversed, members have been sent copies and your editor considers himself lucky to have got hold of one, much of interest in its 56 pages particularly the pictures. As we said before, we hope the club will feel able to have a proper celebration knees-up once life is back to some form of normality.

Returning to lockdown steaming



efforts, **Ryedale SME** member Walter Rinaldi-Butcher even resurrected a long put-off project to build a rolling road, described in full on page 38.

Last opportunity

Fellow Ryedale member Steve Whittaker went a stage further by laying some portable track in the driveway of his home, so that he could steam his loco 'Waterbuck' on 7th May to celebrate the NHS and the following day to mark the 75th anniversary of VE Day. And he had good reason – at midnight on the 8th, as the loco cooled in the garage, its boiler ticket expired...

Of course coping with the virus has, unusually, been something connecting model engineers the world over, and the latest *Maritzburg Matters* newsletter from the **Pietermaritzburg ME** in South Africa shows that club members have been coping just like their compatriots around the globe, by getting on and building things.

Particularly impressive among the projects illustrated is the South African Railways 25 class being built by member Lucas Stein. Over recent weeks Lucas has battled with the application of many lengths of boiler cladding, complete with essential detail, and as newsletter editor Martin Hampton comments, "this is turning out to be a magnificent engine..."

Making significant progress in recent months has been *The Flying Bedstead*, the project of **Nottingham SME** member Roy Hollingworth, and originally combining a basic loco chassis with an experimental hybrid petrol/electric drive system.

Roy admits that progress on his project had previously been slow, the loco often put on the 'back-burner' but the lockdown has served to accelerate matters. "This model is entirely to my own design and I am not the kind of person who can sit down and design the whole thing on paper before I start to build it," Roy says, adding: "I need to be able to see the various components and how they will fit together before I know if it's going to work, so I tend to produce 'mock-ups' so I can tweak the design as I go along."

The extra time available saw the design for the laser-cut bogies completed in mid April, and the parts arrived just in time to be pictured in the latest edition of the club newsletter *Kingpin*. Roy is hopeful of the project being ready for a second test run "by the time Boris Johnson says we can all come out to play again." We hope to have more on this project, which will eventually be styled to look like a class 43 Inter-City 125 loco, in a future edition of **EIM**.

A salutary reminder that not all problems are Covid-19 related features



in the last edition of *Whistlestop*, the magazine of the **Hereford SME**. 'The Great Flood of February 2020' shows how severely the club was affected when the adjacent river Wye burst its banks. Club members are no strangers to flooding at the site and have learnt to move stock above anticipated high-water levels when trouble was expected, "but on this occasion the flood was of such unprecedented magnitude that a considerable amount of stock was 'drowned'."

For most clubs an incident such as this would put a poor slant on an entire year but we wouldn't be surprised if in this particular year the flood already seems a long time ago to members of the Hereford club...

A welcome newcomer to the newsletters received at **EIM Towers** is that of the **Chingford & District ME**, another club that appears impressively to keep in touch with its members on a weekly basis. The newsletter appears to be a new project too, the 21st June edition issue number 12.

Disney time

Notable among the contents of the latest Chingford newsletter is a report looking back to 12th July 1952 when the club entertained a very special visitor – Walt Disney no less! Apparently he had been made aware of the club by a report in a US publication and according to reports from members at the time he clearly knew his stuff. "There is no doubt that he is a real model engineer as could be seen by the keen interest he took in the motion and construction of locomotives and passenger trolleys. When offered a drive around the

ABOVE:

Nottingham member Barry Glover is the guinea-pig trying out the loco being built by Roy Hollingworth, who took the photo:

BELOW:

"I told you daddy, that is not the right drill for that tap..." Photo: Edward Parrott

track, which he accepted, he took the trains round the circuit in an expert manner which proved he was no novice in the handling of small locomotives..." Not surprisingly, the club hierarchy took an immediate decision to make Walt Disney an honorary member...

And finally, a picture of possibly the youngest member of the Rugby club, Erica Parrott, daughter to regular **EIM** contributor Edward. Erica is not yet two years old but as the picture shows she has clearly been apprenticed to daddy during lockdown – Edward appears to have an interesting concept of what constitutes home schooling! **EIM**



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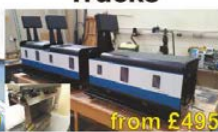
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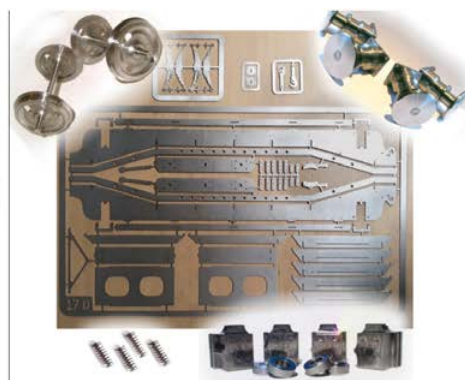
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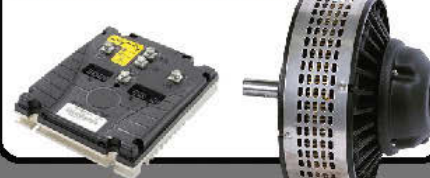
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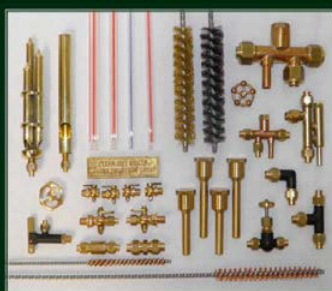
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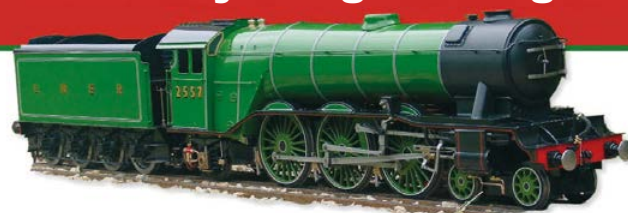
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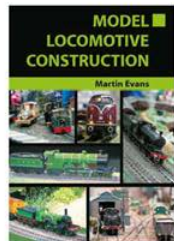
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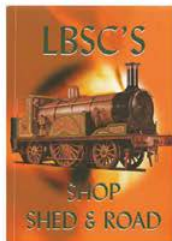
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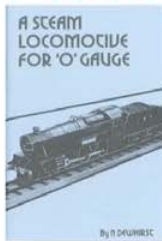
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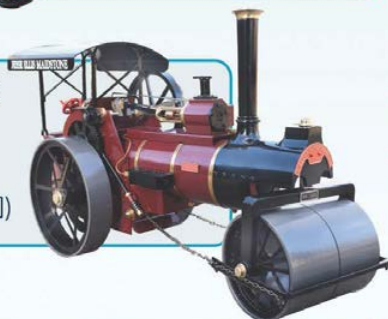


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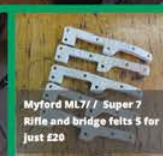
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